DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR

PROFESSIONAL PAPER 58

THE GUADALUPIAN FAUNA

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WASHINGTON
GOVERNMENT PRINTING OFFICE
1908

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THE GUADALUPIAN FAUNA.

By George H. Girty.

INTRODUCTION.

The first descriptions of the Guadalupian fauna were published nearly fifty years ago. This early account of Shumard's was meager enough, but gave promise of a facies interesting and novel among the known Carboniferous faunas of North America. The following pages add largely to our knowledge of Guadalupian life, and I believe more than make good any promise contained in the previous account. Nevertheless, even the collections of the Guadalupian fauna here described fail to do justice to its richness and diversity, and the present report is completed with the hope of returning to the subject after another visit to the Guadalupe Mountains.

Although a description of this range and the adjacent region can be found elsewhere, a repetition of the more important facts will conduce to a better understanding of the geologic relations of the fauna described herein and will serve to illustrate the references to localities and horizons necessarily involved in the paleontologic discussion.

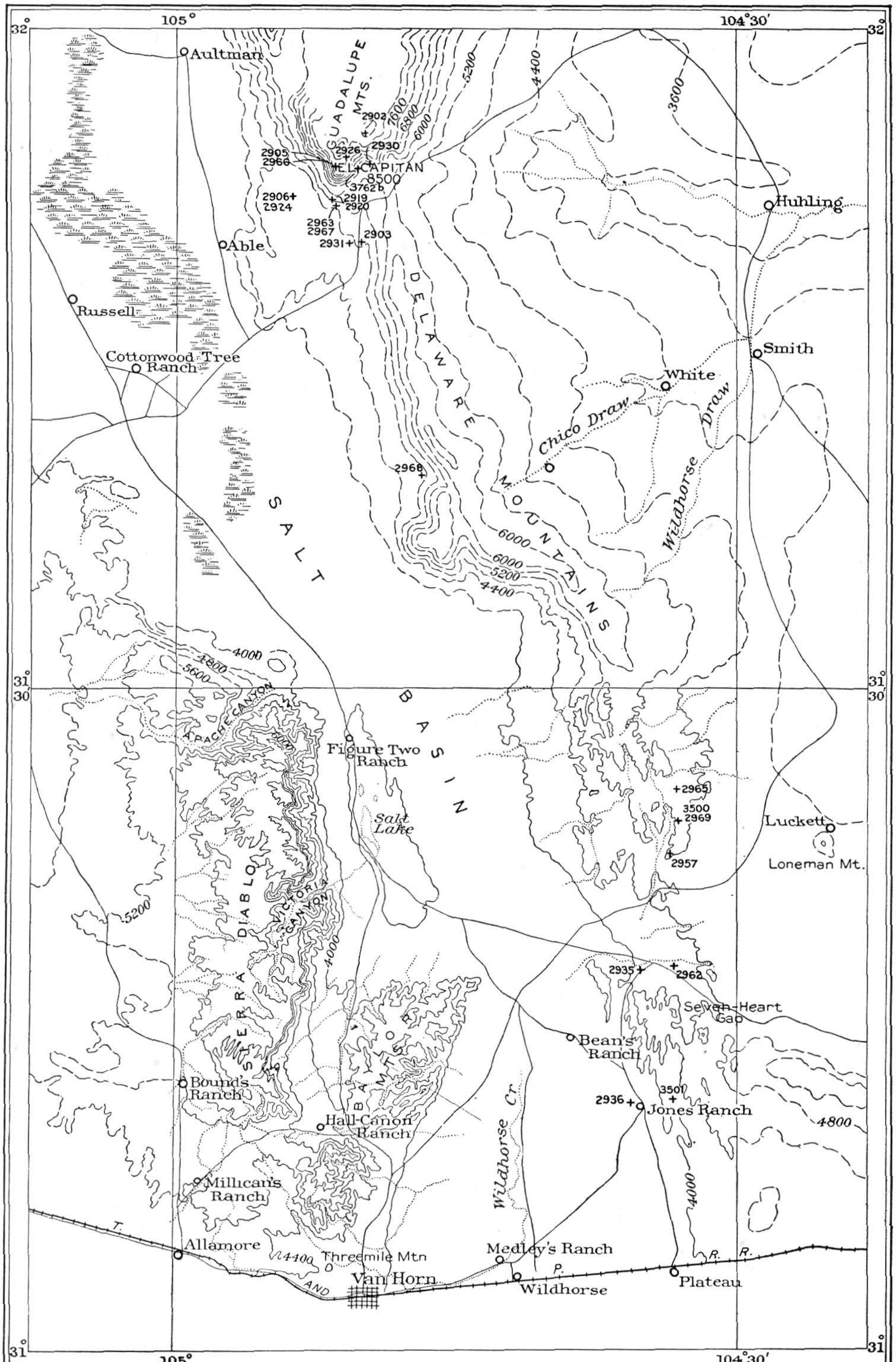
The Guadalupe Mountains are situated chiefly in southeastern New Mexico, but extend across the border for a short distance into the trans-Pecos region of Texas. Save only for this southern extreme both their geology and their topography are practically unknown, and it should be understood that anything hereafter said of them relates only to that portion.

These mountains form a north-south range of considerable height, which rises abruptly from an arid and treeless plain, stretching westward to more mountainous elevations, the Cornudas Mountains and the Sierra Tinaja Pinta. This plain is locally known as Crow Flats and forms a part of the Salt Basin (Pl. I). It is now used as cattle ranges, water being raised by windmills. The only permanent surface water consists of salt lakes—broad, shallow pools incrusted with saline deposits, which in the early days were extensively sought for domestic use. This water is of course unfit for consumption, but cattle seem as a rule not to mind the less highly impregnated waters brought up by the pumps. These vary considerably in the amount and character of their saline contents, but even the best is unsatisfactory for human use.

On the east side, from the foot of the mountains the land slopes gradually eastward and merges with the plains of Texas. There are springs of sweet water and perennial streams on this side of the range, such streams being in this region, as a rule, associated only with the highest mountains. Usually the canyons and sandy channels serve merely to carry off the occasional torrential rains, and this is the case for the most part even with the perennial streams, which almost immediately on striking into the plain are drunk up by the soil. Beyond their débouchure from the mountains their course is merely a dry sandy channel. There are, however, flowing streams east of the Guadalupes, one such being Delaware River. In seasons of rain this watercourse is formed by the confluence of numerous small tributaries—some leading back into the mountains—which pour their sudden waters through channels usually dry; but the source of the perennial stream seems to be a very definite point situated some distance east of the Guadalupes and generally referred to as the "headwaters of the Delaware." This expression would naturally be taken to have a more general significance, but Shumard uses it, I believe, in this local sense, and as it is often difficult to fix references to local geography it seems desirable to make the present record of the fact. At this point, which is also known as Huhling's ranch, three springs, one of them strongly charged with sulphur, break out close together in the bed of the Delaware, which below this point is a permanent watercourse.

The Guadalupe Mountains are formed by uplifted strata, consisting of a thick limestone series above and a thick sandstone series below. The abrupt termination of the limestone in an almost sheer precipice of practically its entire thickness not far south of the New Mexico border marks the termination of the formation and of the Guadalupe Mountains proper. The sandstone, however, continues southward, forming a westward-facing escarpment, which with the adjacent foothills and outliers is known as the Delaware Mountains.

The southern branch of the old Santa Fe trail passed up Delaware River and close around the base of Guadalupe Point, as the abrupt, precipitous termination of the range is commonly designated. The ruined walls of a blockhouse situated near the mouth of Pine Spring Canyon bear witness to the days when a stage route passed this way. Now, however, the trail has been long unused, and heavy washouts have rendered it in places impassable, so that a traveler approaching from the west would be compelled to make a considerable detour to the south if, as in our own case, he was necessarily hampered by wagons. After again coming nearly abreast of Guadalupe Point the road passes up Guadalupe Canyon (Pl. II), which penetrates the mountains in a direction nearly north and south and contains toward its head a little spring called Guadalupe Spring. Before reaching the spring, however, the trail turns to the east and, rising to the level of the plateau by a short though steep ascent, extends northward past the ruined caravansary which stands at the mouth of Pine Spring Canyon. This canyon is situated almost on the flank of El Capitan, the spur which bounds it on the south forming the most satisfactory if not the only avenue of



MAP OF SALT BASIN AND PARTS OF THE BOUNDING RANGES.

ascent to that peak. Near this spring was the site once, probably in the old staging days, of an encampment of regulars, evidences of whose occupancy are not rare—a brass button or an empty cartridge being the least frequently found. Nearly every adjacent peak is surmounted by a cairn, probably raised by their hands, while on an eminence near by, from which a sweeping view can be had across the eastward plain, a number of small tumuli, containing, it is said, only ashes, appear to mark the stands of outposts or sentries. A hint of the occasion for the presence of troops at this point is furnished by a stone erected beside the road in Guadalupe Canyon, which bears a date somewhere in the early sixties, I believe, and above two crossed arrows an inscription commemorating the death of a Mexican guide at the hands of Indians.

The party to which I belonged camped at Pine Spring, and during the eleven days of our stay were made the different trips that furnished the collections on which the present report is principally based. The other collections from the Guadalupe Mountains included in this report are comparatively unimportant, but, on the other hand, I am entirely indebted to my colleagues for valuable collections from other areas.

In view of the highly fossiliferous character of some of the strata, our collections, though considerable, are less extensive than would be expected if the fruits of eleven days' work in some other fields were used as a standard. Owing to the height and steepness of the mountains themselves and the broken character of the country at their base, it is in many places no easy matter to reach points comparatively near by, and it will probably be necessary for those who purpose to visit the Guadalupe Mountains with the intention of collecting fossils to calculate on expending more than the usual time and labor.

The lowest beds in the Guadalupe section are limestones, very black in color and formed in rather thin and even beds. These are exposed in some dry canyons south of Guadalupe Point to a thickness of perhaps 200 feet, the base not being seen. These limestones are succeeded by a heavy series of variable beds, chiefly of sandstone. There are also strata of calcareous sandstone, of dark shale, and of dark- and light-colored limestone. The conditions of deposition appear to have been fluctuating, not only vertically but laterally, prominent beds of sandstone seen in cliff sections dying out and appearing with rather remarkable abruptness. Including the black limestone, this portion of the section was found by Richardson to attain a thickness of about 2,225 feet, and he gave it the name Delaware Mountain formation. A bed of dark limestone above the sandstones and below the white limestone deserves especial mention because of references in the literature to it and because of the distinctive fauna which it contains. The succeeding formation, called by Richardson the Capitan limestone, consists of massive limestone measuring about 1,800 feet in thickness. The color of these beds is in general white, but they are in places tinged with red and yellow. Much of the rock is a pure limestone, but at least one considerable stratum is dolomitic, having the structure of pisolite; and other beds, especially in the lower part, have a sandy texture, which may be due to the same cause.

The Guadalupe Mountains are a structural range with a precipitous western escarpment which has been ascribed to faulting, but which at its southern extremity, as Richardson has shown, can be explained as an unsymmetrical broken fold. At all events, in the main range the beds dip to the east at a rather high angle, their abrupt termination on the west forming the mountain's side in that direction. It must not be thought, however, that the Guadalupe Mountains are, like the Delawares, really a plateau with a gradual descent toward the Pecos from a level near the top of the Capitan limestone. On the contrary, the eastern slopes are difficult and rugged. Erosion in this direction has cut away the Capitan and part of the Delaware Mountain formation, and the present surface of the plateau at Guadalupe Pass is formed, locally at least, by a bed of limestone, such as has already been mentioned, occurring about two-thirds of the way up in the Delaware Mountain formation.

In its eastern spread the Capitan limestone has been limited by erosion, and probably owing to the same cause its southern extension abruptly terminates in a bare and lofty crag. Mounted as it is upon the entire thickness of the Delaware Mountain formation, this bold headland has an appearance singularly monumental. It is known pretty generally as Guadalupe Point or Guadalupe Peak. Although the most imposing, this is not the highest point of the range, for just beyond it to the north rises another which overlooks it. This peak has been called El Capitan, and I have, when called on to refer to it, retained this name, which is further perpetuated in the Capitan limestone (Pls. II, III).

Owing to the conditions of structure and erosion above described, the general level on the west side of the fold and fault, where the streams show several hundred feet of the basal black limestone, is lower than on the east, where erosion has cut down only part way through the overlying sandstones. While the Capitan limestone terminates precipitously at Guadalupe Point, these sandstones continue in a long southward extension, their westward-facing escarpment being known as the Delaware Mountains, from which circumstance they have received the name of the Delaware Mountain formation. West of the Delawares and some distance south of Guadalupe Point rise the Diablo Mountains, formed by an elevated block of the Hueco formation, to which reference will be made later.

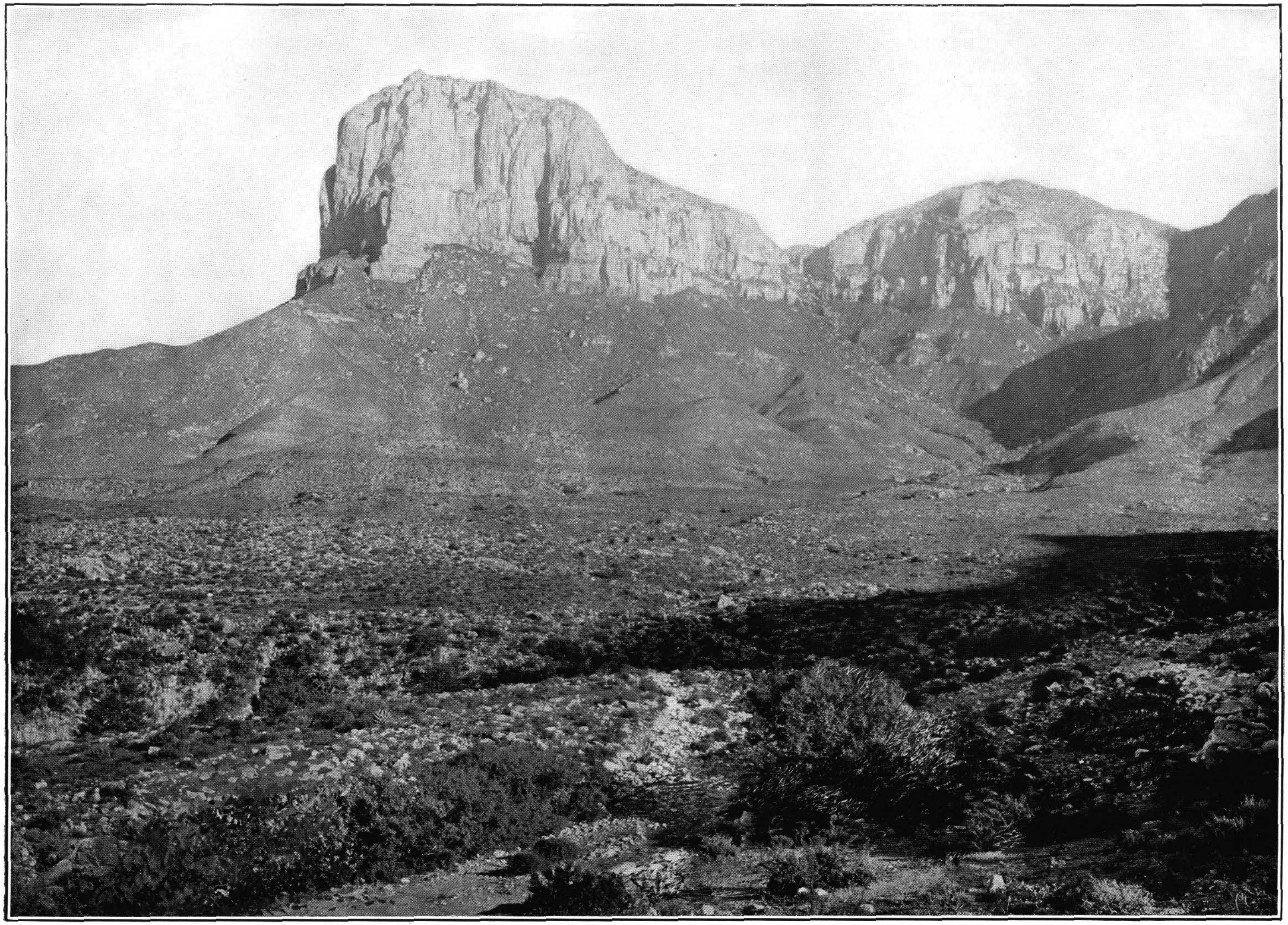
The first accounts of the geology and paleontology of the Guadalupe Mountains were published by the two Shumards in 1859 and 1860.[a] As geologist of the expedition under Captain Pope, dispatched to discover artesian waters in the arid lands of the Southwest, George G. Shumard obtained some collections of fossils from the south end of the Guadalupes, which were subsequently described by his brother. Shumard does not give a clear account of the structure of the Guadalupe Mountains, but his section is as follows:[b]

Section of Guadalupe Mountains (Shumard).

	Feet.
1. Upper or white limestone	1,000
2. Dark-colored, thinly laminated, and foliated limestone	50– 100
3. Yellow quartzose sandstone	1,200–1,500
4. Black, thin-bedded limestone	500

[a] Trans. St. Louis Acad. Sci., vol. 1, 1856-1860, pp. 273-297, 387-403.

[b] Idem, p. 280.



GUADALUPE POINT, EAST SIDE, VIEW NORTH UP GUADALUPE CANYON.

The massive crag exposes 1,200 feet of the Capitan formation; the softer beds below are the Delaware Mountain formation. (From a photograph by R. T. Hill.)

The sequence of the formations in this region is obvious and in the more recent accounts remains practically as described by Shumard, although more accurate measurements have since been made, the upper limestone and the sandstone proving to be even thicker than indicated by him, while no subsequent observer has reported so much of the basal black limestone. Fossils were obtained from the three upper members of Shumard's section, those from the two limestones being later described by B. F. Shumard and proving to have each a rather distinct facies. The two formations were distinguished in the paleontologic account as the "dark limestone" (bed 2) and the "white limestone" (bed 1). Apparently the "white limestone," the "dark limestone," and the sandstone were regarded by Shumard as belonging in the Permian.

For many years after Pope's expedition this immediate region does not figure in geologic literature, although one of the main routes of travel, the Santa Fe trail, passed around Guadalupe Point.

The next observer on record is R. S. Tarr, who in 1892 published a paper in which he describes the geology of the southern part of the Guadalupes.[a] This author gives the following section as measured at the point of the mountains (Guadalupe Point):[b]

Section at Guadalupe Point (Tarr).

	Feet.
1. Upper or white limestone	1,200-1,500
2. Dark-colored limestone	50
3. Yellow clayey sandstone, with numerous bands of black and white limestone	1,200
4. Black limestone, shale, and slate	200

A detailed section partly through the white limestone at McKitterick Canyon is also given by Tarr. He clearly states the monoclinal structure of the range and describes its precipitous western scarp as probably due to faulting. His tentative conclusions regarding the correlation of the Guadalupian section with that of central Texas is supported by too little and opposed by too much evidence to warrant adoption. He found that there was nothing in the Guadalupian section to correspond lithologically with the Permian ("Red Beds") of Texas, and concluded that the Guadalupian section lay below the Permian and was probably of the age of the "Upper Coal Measures" of Texas and the Mississippi Valley. In view of the completely different fauna of the Guadalupian, this question must still be regarded as unsettled.

Some time later R. T. Hill visited this region, but he has not yet published an account of his observations. The year following (1901) B. F. Hill and I made a trip as nearly as possible over Shumard's old route, but from the west eastward, and therefore in an opposite direction. The present work is a final report of that trip, being an amplification of the short paper which I wrote at that time on the geology and paleontology of the Guadalupes.[c] Meanwhile G. B. Richardson has made a general reconnaissance of the Guadalupe Mountains and adjacent regions, and to his

[a] Bull Geol. Survey Texas No. 3, 1892, pp. 9-39.
[b] Idem, p. 29.
[c] Am. Jour. Sci., 4th ser., vol. 14, 1902, pp. 363-368.

account [a] the reader should refer for more authoritative information regarding points here only lightly touched.

In my brochure of 1902 the thickness of the upper limestone, including Shumard's "dark limestone," was given at 1,700 to 1,800 feet, that of the underlying sandstone as 2,000 to 2,500 feet, and that of the basal black limestone as 500 feet exposed. The chief point made was in relation to the faunas, which were shown to be very different from anything known elsewhere in America. On this account "Guadalupian" was introduced as a regional term, provisionally to include the entire rock series exposed near Guadalupe Point, but more specifically centering about the upper portion, the white and the dark limestones. Note was also made of the resemblance of the Guadalupian fauna to certain faunas of Asia and Europe.

Although Richardson made only a reconnaissance, his report on the region under consideration is the most accurate and complete which we yet have, for the formations were described and mapped over an extensive area. The highest member of the series he named the Capitan limestone and the underlying beds the Delaware Mountain formation. The latter name includes both Shumard's "dark limestone," the great sandstone series, and the basal black limestone. Richardson states that in view of the small extent of the black limestone in the area mapped (it is exposed only in the immediate vicinity of Guadalupe Point), it was thought best for the time being to regard it as a member of the Delaware Mountain formation rather than as a distinct formation. The fauna of this bed, however, at present appears to have a rather distinctive facies and is kept separate in this report. With somewhat less reason the upper limestone of the Delaware Mountain formation (Shumard's "dark limestone") has been distinguished from the main body of the formation, which in the vicinity of Guadalupe Point consists chiefly of sandstone. The fauna of this upper limestone appears to have a rather well-marked facies, while lithologically in this immediate region the limestone is distinguishable both from the sandstone below and from the Capitan limestone above. Furthermore, for the purpose of correlating my horizons with Shumard's, it is desirable to recognize this zone; and it is as yet a little uncertain whether the fauna is more closely related to that of the Capitan or that of the Delaware Mountain sandstone. Accordingly, in the Guadalupian section I distinguish the basal black limestone, the Delaware Mountain formation, the "dark limestone," and the Capitan limestone, all but the last being comprised in the original Delaware Mountain formation. The basal black limestone, however, is not known to occur elsewhere than in the vicinity of Guadalupe Point, while in the southern Delawares the "dark limestone" can not be recognized as a separate member. In this connection I may recall that Richardson's observations indicate that, whereas in the vicinity of Guadalupe Point the sandstones greatly predominate in the Delaware Mountain formation, these rocks become largely replaced by gray limestones to the south.

In point of thickness Richardson found that only 200 feet of the basal black limestone are exposed. At its greatest exposure the Delaware Mountain formation ranged to about 2,300 feet, but its base was there concealed by the Salt Basin deposits. At Guadalupe Point he measured 2,025 feet exclusive of the basal black lime-

[a] Bull. Univ. Texas Min. Survey No. 9, November, 1904, 119 pp., 11 pls.

stone. The Capitan limestone he gives at 1,700+ feet at the scarp of Guadalupe Point; our own measurement was 1,800 feet to the top of the still higher peak, El Capitan (Pl. III).

As to structure, Richardson's conclusions seem to be that the uplift was a fold in the southern part of the field visited by him, passing into a fault in the northern part, the zone of transition apparently occurring in the vicinity of Guadalupe Point.

Since the scheme of mapping employed by the Survey demands that the Guadalupian series be called categorically either "Permian" or "Pennsylvanian," it seemed best to refer it to the Permian, because of the very different and at the same time younger facies of the faunas, even that of the basal black limestone, as compared with the Pennsylvanian of the Mississippi Valley region, and because the underlying Hueco formation has a fauna more nearly comparable to that of the Russian Gschelstufe, which underlies the Russian Artinsk and Permian.

Neither Richardson nor any other observer has determined what immediately precedes or immediately follows the Guadalupian series, and this remains one of the important problems awaiting investigation in this region. It is true, Tarr says that above the massive limestone is another series of limestones and sandstones which are found only on the highest points in Texas, but which farther to the north, in New Mexico, are well developed and form the bulk of the mountains. He made no section of these beds, but states that they can not be less than 1,000 feet in thickness,[a] and again: "The total section exposed in the Guadalupes, approximately stated, can not be less than 4,000 feet, including the New Mexico series, which exist above the white limestone."[a] I do not know what rocks are intended by this indefinite statement. The Capitan limestone is not known in Texas, so far as I am aware, save in the Guadalupe Mountains and the foothills adjacent, where no overlying series is exposed. It must of necessity extend northward into New Mexico, unless faulted out, but all our faunas from New Mexico, so far as I have examined them, show an altogether different facies, one more suggestive of the beds which there is every reason to believe really lie below the Guadalupian.

The formation underlying the Guadalupian is the Hueco. The typical exposures of this formation are in the Hueco Mountains and the higher beds are uplifted to the east in the Cornudas Mountains and the Sierra Tinaja Pinta. Still farther east the Hueco beds are concealed by the Salt Basin deposits, and in the Guadalupe Mountains we have an altogether different series, even the basal member of the Guadalupian having a fauna widely different from that in any zone of the Hueconian. The structure in the vicinity of the Guadalupe Mountains, the stratigraphic relations of the Hueco beds with underlying formations, and the biological character and relations of the Guadalupian fauna all point to the position of the Guadalupian series as overlying the Hueco formation. By how large an interval the highest known exposures of the Hueco are separated from the lowest known exposures of the Guadalupian can not be told, but at present it is not supposed to be great.

We owe our first account of the Guadalupian fauna to B. F. Shumard, one or two of the bryozoan forms having, however, been turned over for description to Prout.

[a] Bull. Geol. Survey Texas No. 3, 1892, p. 31.

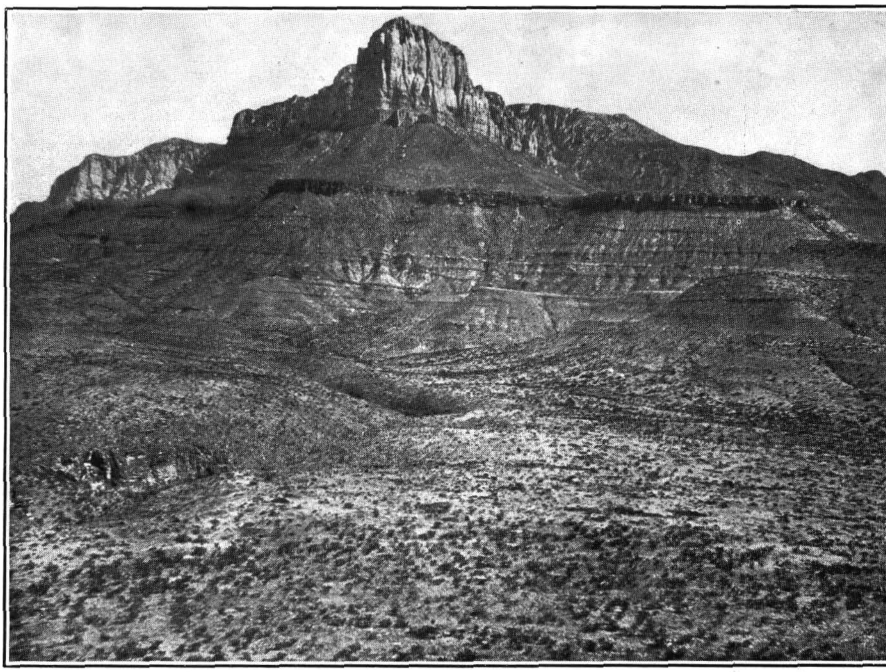
The following table shows the species cited by Shumard and the names under which they appear in the present report:

Fossils from Guadalupe Mountains described by B. F. Shumard.

Shumard's list.[a]	Equivalents in the present report.
Chaetetes mackrothii Geinitz	Undetermined, possibly Leioclema shumardi.
Chaetetes sp. ?	Undetermined, possibly Fistulipora grandis var. americana.
Campophyllum ? texanum n. sp	Campophyllum texanum?
Polycoelia ?	Lindstrœmia permiana.
Phillipsia perannulata Shumard	Anisopyge perannulata.
Bairdia sp. ?	Not recognized.
Fenestella popeana Prout	Not recognized; see Fenestella popeana.
Acanthocladia americana Swallow	Probably Acanthocladia guadalupensis.
Fusulina elongata Shumard	Fusulina elongata.
Productus calhounianus Swallow	Undetermined; possibly Productus semireticulatus var. capitanensis.
Productus mexicanus Shumard	Not recognized.
Productus pileolus Shumard	Productus ? pileolus.
Productus semireticulatus var. antiquatus Martin	Probably Productus semireticulatus var. capitanensis.
Productus popei Shumard	Productus popei.
Productus norwoodi Swallow	Not recognized.
Productus leplayi ? Verneuil	Possibly Productus semireticulatus var. capitanensis.
Strophalosia (Aulosteges) guadalupensis Shumard	Aulosteges guadalupensis.
Chonetes permiana n. sp	Chonetes permianus.
Chonetes flemingi ? Norwood and Pratten	Probably Chonetes hillanus.
Spirifer mexicanus Shumard	Spirifer mexicanus.
Spirifer guadalupensis n. sp	Squamularia guadalupensis.
Spirifer sulciferus Shumard	Not recognized; see Spirifer sulcifer.
Spirifer cameratus Morton	Spirifer sp. b.
Spiriferina billingsi Shumard	Spiriferina billingsi.
Terebratula elongata Schlotheim	Possibly Dielasma spatulatum.
Terebratula perinflata n. sp	Not recognized; see Dielasmina perinflata.
Rhynchonella guadalupae Shumard	Not recognized; see Rhynchonella guadalupæ.
Rhynchonella indentata n. sp	Rhynchonella indentata.
Rhynchonella texana n. sp	Not recognized; see Rhynchonella texana.
Rhynchonella sp. ?	Not recognized.
Camerophoria bisulcata Shumard	Pugnax bisulcata.
Camerophoria swalloviana n. sp	Pugnax swallowiana.
Camerophoria schlotheimi? Buch	Not recognized.
Retzia papillata Shumard	Hustedia papillata.
Retzia meekiana Shumard	Hustedia meekana.
Streptorhynchus (Orthisina) shumardianus Swallow	Not recognized.
Orthisina sp. ?	Probably Orthotetes guadalupensis.
Crania permiana n. sp	Richthofenia permiana.
Myalina squamosa Sow	Probably Myalina squamosa?
Myalina recta Shumard	Not recognized.
Pleurophorus occidentalis Meek and Hayden	Not recognized.
Monotis speluncaria Schlotheim	Not recognized.
Monotis sp. ?	Not recognized.
Axinus securus n. sp	Schizodus securus.
Edmondia semiorbiculata Swallow	Not recognized.
Cardiomorpha sp. ?	Not recognized.
Turbo guadalupensis n. sp	Not recognized; see Turbo guadalupensis.
Turbo helicinus ? Schlotheim	Not recognized.
Straparollus sp. ?	Not recognized.
Bellerophon sp. ?	Not recognized.
Pleurotomaria halliana n. sp	Not recognized; see Euconospira halliana.
Chemnitzia swalloviana n. sp	Zygopleura swallowiana.
Nautilus sp. ?	Not recognized.
Orthoceras sp. ?	Not recognized.

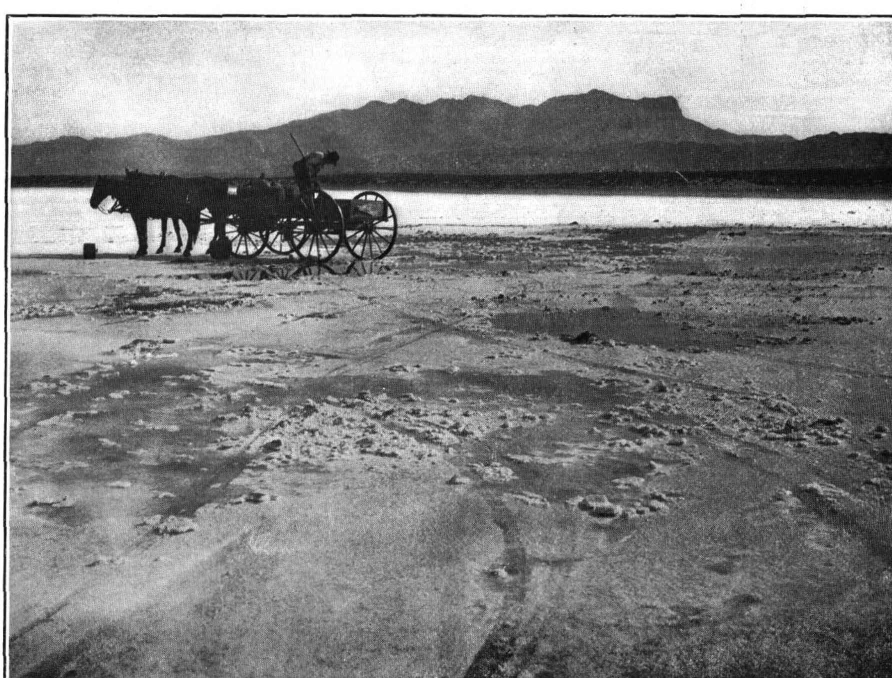
[a] Trans. Acad. Sci. St. Louis, vol. 1, 1859, p. 387.

Shumard recognized 54 species among the fossils collected at that time, 26 of which were described as new. As based on recent collections made in the Guadalupe Mountains and adjacent regions the Guadalupian fauna now known contains 326 forms, and the resources of the fauna at present appear to be almost inexhaustible. Collections which did justice to its richness and importance would greatly enhance the number distinguished in this report. The 326 forms at present constituting the Guadalupian fauna belong to the different zoological groups in the following quotas.



A. GUADALUPE POINT FROM A GREATER DISTANCE AND MORE DIRECTLY FROM THE SOUTH.

The Delaware Mountain formation is well shown underlying the massive Capitan limestone. (From a photograph by G. B. Richardson.)



B. GUADALUPE MOUNTAINS FROM THE WEST.

In the foreground are the salt deposits of the Salt Basin, from which rises the bold profile of the range. At the right is the precipitous front of Guadalupe Point, and back of it the loftier summit of El Capitan. (From a photograph by G. B. Richardson.)

Zoological groups represented in the Guadalupian fauna.

	Species.		Species.
Protozoa	9	Pelecypods	45
Sponges	24	Scaphopods	1
Cœlenterates	10	Amphineura	1
Echinoderms	7	Gasteropods	42
Vermes	1	Cephalopods	9
Bryozoa	44	Crustacea	5
Brachiopods	128		
			326

As shown by this list the Guadalupian fauna manifests an unusually symmetrical development, for while it is true that the brachiopods predominate, the other groups also are represented in a proportion which is seldom equaled. It is also an extremely rich fauna, for it should be borne in mind that our collections are not exceedingly extensive. In few other regions would an equal amount of material have furnished so great a variety of species, a fact due in part no doubt to the unusual thickness of the Guadalupian section.

The Guadalupian species are mostly small as compared with those of other regions and with the average in the groups to which they belong. An exception, striking because of its isolation and degree, is found in *Fusulina elongata*, one of the most abundant and characteristic Guadalupian species and probably the largest *Fusulina* that science has yet brought to notice. Aside from this, the Foraminifera are rather poorly represented in comparison with some late Paleozoic faunas, though they are probably less completely studied than any of the other groups.

The sponges, if certain peculiar forms be allowed to remain under that designation, are, on the other hand, unusually abundant and varied, developing some novel and characteristic types of structure.

Cœlenterates are more rare, small, and poorly differentiated. The absence of forms like *Lonsdaleia, Michelinia,* and the stromatoporoids, such as are found in some of the Asiatic faunas, is worthy of note, as is also the presence of *Cladopora,* which is a rather characteristic fossil of some of the lower beds. On the whole, however, the cœlenterate fauna is rather meager and colorless.

Echinoderms are rare, the most noticeable being a new genus of cystidians. The presence of crinoid stems, however, shows that the true crinoids, such as occur in some of the related faunas, are present, though none of the heads have been found.

Except for one or two types the Bryozoa are rather scanty, and contain little that is striking or highly novel. The series of forms which I have assembled under *Domopora* is so important an exception to this statement, however, as almost to contradict it. These forms, which find their closest allies apparently in the Mesozoic, rather than in the Paleozoic, occur nowhere, so far as I have been able to discover, except in the trans-Pecos region. They form one of the most abundant and one of the most characteristic features of the Guadalupian bryozoan fauna. *Acanthocladia guadalupensis* is equally abundant but less peculiar.

Among the Brachiopoda, which demand a somewhat more detailed consideration than the other groups, the strophomenoids show an unusual generic differentiation, in which the presence of the rare genus *Geyerella* and of several species of *Streptorhynchus* is noteworthy. *Orthotetes guadalupensis,* a characteristic species of the

Capitan, is likewise a unique type. The presence of *Richthofenia* and *Leptodus* also forms a novel and important feature of the Guadalupian fauna.

The Productidæ, while fairly numerous, are not so highly differentiated as in many other faunas. We note the comparative absence of large species of the *semireticulatus* group, and the entire absence of the *fimbriati*, a group which includes such common forms as *Productus punctatus*, *P. humboldti*, or our own *P. nebraskensis*. No forms related to *P. horridus* of the European Permian have been brought to light, while the *Marginifera* group also appears to be wanting. There are a few singular types, such as *P. limbatus*, *P. pileolus*, etc., while the development in the "dark limestone" of a group of small, strongly arched shells with deep sinus, of the general type of *P. semireticulatus*, though with more or less faint ribs and wrinkles, may be mentioned; but as a rule the *Chonetes* and *Producti* do not stand out in strong relief. *Aulosteges*, however, is rather remarkably differentiated, though I have not found it in any abundance.

The *Orthis* group is rarely encountered. No other type is yet known than *Enteletes*, and with one exception the species all belong to the ventrisinuate group. The *dorsisinuati*, which develop such peculiar species in the faunas of India and the Carnic Alps, are represented by only one imperfect specimen. In the upper beds of the Guadalupian (Capitan formation) this group appears to be absent.

Compared with some faunas the Pentameridæ are poorly represented. To some extent this is true of the Rhynchonellidæ also, since they present less variety, both in species and genera, than, for example, the Salt Range faunas. In the group of *Pugnax bisulcata*, however, the Guadalupian possesses a feature which is both characteristic and abundant. The absence of *Uncinulus*, *Terebratuloidea*, *Rhynchopora*, etc., may here be noted.

The Terebratulidæ are highly differentiated and present at least one new generic type.

The Spiriferidæ are represented by a number of genera, but show less variety in their specific representation. In the genus *Spirifer* especially we miss group after group which is found in faunas more or less related, the representation being restricted practically to *Spirifer mexicanus* and its allies. The Spiriferinas, on the contrary, show a high differentiation. Many of the species belong to the group of *S. billingsi*, which is rather characteristic of the Guadalupian. *S. welleri* is also a marked species.

The Athyridæ and the Retziidæ call for little comment. Like *Ambocœlia*, *Composita* is rather an American genus, though not exclusively so, and it is also rather abundant in the Guadalupian fauna, where it is represented by a novel and interesting type. The absence of *Cleiothyridina* is perhaps deserving of mention.

The remaining groups may be passed over with less comment, for while not meanly developed they show few peculiarities of note. Among the pelecypods a unique Guadalupian type is the group of species referred to the genus *Camptonectes*, which seems to have an analogue nowhere else in the Carboniferous, so far as I have discovered. The remainder of the Guadalupian pelecypods, while new in their specific characters, are more like the generality of Carboniferous faunas. The Pterias seem to be unusually differentiated, and we notice the absence or rarity of certain types common in many other Carboniferous faunas, such as the large Myalinas, the Edmondias, and the genus *Pseudomonotis*. Shumard, it is true, cites

Monotis speluncaria in this fauna, but it is uncertain what form he actually had in hand, and in this, as in other instances, my comparisons are made exclusively with the collections which I have been able to study.

The gasteropods show few points of note. The development of the Pleurotomarias is perhaps a little extraordinary, as is the slight representation of the Bellerophons, which include, however, what is probably a representative of the Indian genus *Warthia.*

The Cephalopoda are evidently of the late Paleozoic type, but show less differentiation than might have been expected. Indications are not lacking, however, that at favored localities, which I was personally not fortunate enough to discover, the group is very plentiful, and that subsequent collections will show the Guadalupian Cephalopoda to have been highly differentiated.

The Crustacea are, with the exception of the trilobites, poorly represented. Decapods, which Gemmellaro found in some abundance in his Sicilian faunas, are unknown, and Ostracoda, which are apparently rather common in the Permian of Europe, are rare. The trilobites, not the least interesting section of this group, are however, fairly abundant, and show a construction which apparently is typical of a new genus.

The highest horizon at which Guadalupian fossils were obtained is the top of El Capitan, which by our barometric measurements is 1,800 feet above the base of the Capitan limestone. Here, from the summit and just below, I collected the following species (station 2905):

Fusulina elongata.
Fusulinella sp. a.
Endothyra sp. a?
Spirillina aff. S. plana.
Virgula rigida?
Guadalupia cylindrica.
Guadalupia cylindrica var. robusta.
Guadalupia? sp.
Cystothalamia nodulifera?
Fenestella capitanensis.

This fauna, it will be observed, consists almost exclusively of Protozoa and sponges. A considerable thickness of white limestone carrying the large *Fusulina elongata* so thickly packed and so uniformly laid down in one direction as almost to appear as if arranged by hand, is an interesting feature of this locality. At what appears to be the same point Richardson obtained the following (station 2966):

Fusulina elongata.
Guadalupia cylindrica.
Cystothalamia nodulifera.
Amblysiphonella guadalupensis.
Sollasia? sp.
Domopora? ocellata?
Fistulipora grandis var. guadalupensis.
Fistulipora guadalupæ.
Stenopora polyspinosa var. richardsoni.
Leioclema shumardi?
Fenestella spinulosa?
Acanthocladia guadalupensis?
Derbya sp. b.
Composita emarginata.
Rhynchonella guadalupæ?
Dielasma spatulatum?
Notothyris schuchertensis var. ovata.
Heterelasma shumardianum.
Pteria guadalupensis.
Patella capitanensis.

This fauna is more varied than that which I obtained, and has, consequently, more of the typical Capitan facies, but my own efforts at collecting were limited by stress of time to picking up a few specimens on the way down.

By far the best point which we found for collecting in the Capitan formation was halfway up Capitan Peak (station 2926), midway in the formation which bears its name. Here the fauna is extensive and varied, as shown by the following list of species collected by B. F. Hill and myself:

Anthracosycon ficus var. capitanense.
Virgula neptunia.
Virgula rigida.
Virgula rigida var. constricta.
Pseudovirgula tenuis.
Guadalupia zitteliana.
Guadalupia zitteliana var.
Guadalupia cylindrica.
Guadalupia cylindrica var. concreta.
Guadalupia favosa.
Cystothalamia? sp.
Steinmannia americana.
Sollasia? sp.
Lindstrœmia permiana.
Campophyllum texanum?
Domopora? terminalis.
Fistulipora grandis var. guadalupensis.
Leioclema shumardi?
Fenestella capitanensis.
Acanthocladia guadalupensis.
Acanthocladia sp.
Goniocladia americana.
Crania sp.
Streptorhynchus gregarium.
Derbya sp. a.
Orthotetes guadalupensis.
Orthotetes declivis.
Orthotetes distortus.
Orthotetes distortus var. campanulatus.
Geyerella americana.
Orthothetina sp.
Chonetes hillanus.
Productus waagenianus.
Productus semireticulatus var. capitanensis.
Productus occidentalis.
Productus latidorsatus.
Productus? pileolus.
Productus pinniformis.
Aulosteges medlicottianus var. americanus.
Richthofenia permiana.
Spirifer mexicanus.
Spirifer mexicanus var. compactus.
Martinia rhomboidalis.
Martinia shumardiana.
Squamularia guadalupensis.
Squamularia guadalupensis var. subquadrata.
Squamularia guadalupensis var. ovalis.
Ambocœlia planiconvexa var. guadalupensis.
Spiriferina billingsi.
Spiriferina billingsi var. retusa.
Spiriferina evax.
Spiriferina sulcata.
Spiriferina pyramidalis.
Spiriferina welleri.
Composita emarginata.
Composita emarginata var. affinis.
Hustedia meekana.
Hustedia meekana var. trigonalis.
Pugnax? bisulcata var. seminuloides.
Pugnax swallowiana.
Pugnax elegans.
Pugnax shumardiana.
Rhynchonella indentata.
Rhynchonella longæva.
Camarophoria venusta.
Dielasma spatulatum.
Dielasma cordatum.
Dielasma sulcatum.
Dielasma? scutulatum.
Dielasmina guadalupensis.
Notothyris schuchertensis.
Notothyris schuchertensis var. ovata.
Heterelasma shumardianum.
Heterelasma venustulum.
Leptodus guadalupensis.
Oldhamina? sp.
Edmondia? bellula.
Parallelodon multistriatus?
Parallelodon politus.
Pteria guadalupensis.
Myalina squamosa?
Schizodus securus?
Camptonectes? papillatus.
Camptonectes? sculptilis.
Camptonectes? asperatus.
Aviculipecten infelix.
Aviculipecten laqueatus.
Aviculipecten sublaqueatus?
Euchondria? sp.
Pernipecten obliquus.
Plagiostoma deltoideum.
Limatulina striaticostata.
Myoconcha costulata.
Cypricardinia? contracta.
Pleurotomaria mica.
Pleurotomaria putilla.
Pleurotomaria discoidea.
Pleurotomaria neglecta.
Euconispira obsoleta.
Trochus? sp.
Zygopleura swallowiana.
Foordoceras shumardianum.
Anisopyge perannulata.

This may be regarded as the typical Capitan fauna, and the fact that in so short a time and in relatively so small an amount of material we were able to obtain over a hundred species attests the richness and variety of life during the Capitan epoch.

About the same horizon, or one a little higher, was visited on the peak above Pine Spring, on the north side of Pine Spring Canyon, but this locality (station 2902) did not prove fruitful. I obtained only the following species:

Virgula neptunia?
Virgula rigida?
Guadalupia cylindrica.
Guadalupia digitata.
Guadalupia sp.
Ambocœlia planiconvexa var. guadalupensis.

The facies of this fauna recalls that obtained at the top of El Capitan (station 2905).

The lower beds of the Capitan furnished fossils from two widely separated stations. One of these is the hill southwest of Guadalupe Point (station 2906), where a detached block of the Capitan limestone is faulted to a much lower level than that on the crest of the range. At this locality fossils are plentiful, but their preservation is poor, as the rock appears to be more or less altered and many of the specimens are crushed or distorted. The fauna obtained here, which comes from immediately above the "dark limestone," has almost identically the facies of the middle portion. In the brief time at my disposal I obtained the species named below:

Amplexus sp.?
Cladopora spinulata.
Domopora terminalis.
Domopora ocellata.
Leioclema shumardi.
Acanthocladia guadalupensis.
Derbya sp. a.
Orthotetes guadalupensis.
Orthotetes declivis.
Chonetes subliratus.
Productus semireticulatus var. capitanensis.
Strophalosia cornelliana.
Spirifer mexicanus.
Martinia rhomboidalis.
Martinia shumardiana?
Squamularia guadalupensis.
Squamularia guadalupensis var. ovalis.
Spiriferina evax.
Spiriferina welleri.
Composita emarginata.
Hustedia meekana.
Hustedia meekana var. trigonalis.
Hustedia papillata?
Pugnax elegans.
Rhynchonella longæva?
Leptodus americanus.
Aviculipecten sublaqueatus.
Pleurotomaria? sp. c.
Anisopyge perannulata.

The other point at which fossils were obtained from the lower Capitan was in McKitterick Canyon (station 2932). The rock, a dense white limestone, lies conveniently at stream level, and the horizon appears to be in the lower part of the formation. Fossils proved scarce, and almost no time could be given to the search for them, so that I obtained only two species—*Spiriferina sulcata?* and *Dielasma prolongatum*.

The character and status of Shumard's "dark limestone" are somewhat uncertain to me. The cliff at Guadalupe Point contains at its base an undetermined thickness[a] of dark limestone, which was presumably the bed referred to by him, but the precipice was too abrupt to scale and no fossils were obtained. Again, on the hill southwest of Guadalupe Point, beneath a whitish limestone (station 2906) having the lithology of the Capitan and a fauna closely related to that collected from the middle

[a] Fifty feet, according to Richardson.

of the formation (station 2926) occurs a not very thick series of dark limestones (station 2924), which are also supposed to represent the "dark limestone" of Shumard. I obtained here the following forms:

Fusulina elongata.
Cladopora spinulata.
Domopora? terminalis.
Fistulipora grandis var. guadalupensis.
Fenestella sp. c. var.
Acanthocladia guadalupensis.
Productus popei?
Spirifer mexicanus var.
Hustedia meekana.

On both occasions when we ascended Capitan Peak, as nearly as possible the same route being selected, the contact between the Capitan and Delaware Mountain formations was concealed by talus. My notes contain no reference to the rocks of this horizon in the vicinity of Pine Spring, but from loose blocks on the north side of the canyon (station 2930) I collected a considerable amount of material which probably belongs to the "dark limestone." The following list represents the fauna obtained from this source:

Fusulina elongata.
Endothyra sp. a.
Endothyra sp. b.
Spirillina aff. S. plana.
Polysiphon mirabilis.
Steinmannia americana.
Lindstrœmia permiana.
Lindstrœmia permiana var.
Lindstrœmia cylindrica.
Lindstrœmia sp.
Cladopora spinulata.
Archæocidaris sp. c.
Archæocidaris sp. d.
Domopora? terminalis.
Domopora? ocellata.
Domopora? constricta.
Domopora? vittata.
Fistulipora grandis var. guadalupensis.
Stenopora granulosa.
Stenopora sp.
Leioclema shumardi.
Fenestella guadalupensis.
Fenestella guadalupensis var.
Fenestella spinulosa?
Polypora mexicana?
Polypora sp. c?
Acanthocladia guadalupensis.
Acanthocladia sp.
Crania sp.
Derbya sp. a.
Chonetes permianus.
Chonetes hillanus.
Chonetes subliratus.
Productus semireticulatus var. capitanensis.
Productus popei.
Productus popei var. opimus.
Productus indentatus.
Productus occidentalis.
Productus? pileolus?
Productus limbatus.
Productus sp. d.
Aulosteges guadalupensis.
Richthofenia permiana.
Spirifer mexicanus.
Spirifer mexicanus var.
Spirifer sp. a.
Spiriferina billingsi.
Spiriferina laxa.
Spiriferina hilli var. polypleurus.
Spiriferina welleri?
Composita emarginata?
Hustedia meekana.
Hustedia meekana var. trigonalis.
Hustedia papillata.
Hustedia bipartita?
Pugnax bisulcata.
Pugnax bisulcata var. seminuloides.
Pugnax bisulcata var. gratiosa.
Pugnax swallowiana?
Pugnax osagensis?
Pugnax bidentata.
Pugnax pinguis.
Pugnax sp. a.
Rhynchonella? indentata.
Dielasma spatulatum.
Dielasmina guadalupensis.
Notothyris schuchertensis var. ovata?
Myalina squamosa?
Aviculipecten guadalupensis.
Aviculipecten sp. a.
Euomphalus sulcifer.
Euomphalus sulcifer var. angulatus.
Anisopyge perannulata.
Cythere? sp.

The position of this loose material was such that little if any could have come from high in the Capitan, and little if any from below the top of the Delaware Mountain formation. The rock is a limestone partly dark colored and partly a light brown. The fauna shows rather marked differences from that obtained midway in the Capitan formation, species occurring in one which are not found in the other, or being abundant in one and rare in the other. On the other hand, there is a considerable community of forms. Some of the more distinguishing characteristics of this "dark limestone" fauna are the abundance of *Fusulina elongata,* which, though occurring in the greatest profusion at the top of the Capitan (station 2905), seemed to be absent from the point where our typical Capitan fauna was obtained (station 2926), the greater abundance of cup corals, the presence of *Cladopora spinulata,* the greater abundance of the Domoporas and other Bryozoa, the presence of *Chonetes permianus* and *C. subliratus,* the abundance of small *Producti* of the *semireticulatus* group, such as *P. popei, P. indentatus,* etc., the presence of *Aulosteges guadalupensis* and *Spiriferina laxa,* the abundance of the group of *Pugnax bisulcata,*[a] the presence of *Aviculipecten guadalupensis,* and of *Euomphalus sulcifer* and its variety *angulatus,* and the abundance of *Anisopyge perannulata.* An equal number of distinctive forms might be named on the part of the Capitan fauna. The faunas of stations 2926 and 2930 are marked by about the same differences which originally distinguished Shumard's "dark limestone" from his "white limestone," but our more extensive collections show more differences than his rather meager ones. I believe, therefore, that our collection 2930 is Shumard's "dark limestone" fauna, and that it is represented stratigraphically by a not very thick series of dark-colored limestones occurring at the junction of the Delaware Mountain formation with the Capitan. The Capitan fauna, as exemplified by the collections obtained in its middle portion at station 2926, and the fauna of the "dark limestone" show well-marked differences, and suggest the question whether the latter should be grouped as a lower division of the Capitan, as a distinct member, or as a portion of the Delaware Mountain formation.

For purposes of stratigraphy it would perhaps be more convenient to divide the two series in the vicinity of Guadalupe Point at the top of the sandstones, but lithologically the "dark limestone" shows greater resemblance to the dark-colored calcareous members of the Delaware Mountain formation in which Richardson has included it, than to the white limestone of the typical Capitan.

Faunally, if we consider only the collections made in the sandstones of the Delaware Mountain, the "dark limestone" is quite different from that division and would probably have to be regarded as a distinct series, or, better, as a subdivision of the Capitan. Evidence will appear in its turn, however, which indicates that the "dark limestone" is really a part of the Delaware Mountain formation.

Before turning to the discussion of the typical Delaware Mountain fauna it will be desirable to comment on some collections from the upper series made by R. T. Hill. They were obtained at the south end of the Guadalupe Mountains, at a horizon described merely as the "upper limestone." They may, consequently, have

[a] Only a single specimen of this species is contained in our collection from station 2926, and the lithology suggests that it may really have come from the "dark limestone."

come from either the "dark limestone" or the Capitan. The species identified are as follows:

Station 3762.

Fusulina elongata.	Productus semireticulatus var. capitanensis.
Endothyra sp. a.	

Station 3762a.

Fusulina elongata.	Spiriferina welleri var. a.
Fistulipora grandis var. guadalupensis.	Hustedia meekana.
Acanthocladia guadalupensis.	

Station 3762b.

Lindstrœmia permiana?	Domopora? ocellata.
Lindstrœmia sp.	Fistulipora grandis var. guadalupensis.
Zaphrentis? sp.	Acanthocladia guadalupensis.
Amplexus sp.	Chonetes permianus.
Cladopora spinulata.	Richthofenia permiana.
Archæocidaris cratis?	Hustedia meekana.
Domopora? terminalis.	

Station 3762c.

Archæocidaris sp. a.	Acanthocladia guadalupensis.

Station 3762d.

Lindstrœmia permiana var.	Leioclema shumardi?
Domopora? terminalis.	Acanthocladia guadalupensis.
Domopora? ocellata?	Hustedia meekana.
Fistulipora grandis var. guadalupensis.	Dielasma spatulatum?

Station 3762e.

Lindstrœmia permiana var.?	Polypora mexicana?
Cladopora spinulata.	Acanthocladia guadalupensis.
Domopora? terminalis.	Acanthocladia sp.
Domopora? ocellata.	Richthofenia permiana.
Fistulipora grandis var. guadalupensis.	Spiriferina laxa?
Leioclema shumardi.	Hustedia bipartita?
Fenestella hilli.	

In no instance do these lists indicate the fauna obtained from the middle portion of the Capitan limestone, and several appear to present the fauna of the "dark limestone." Lots 3762b, 3762d, and 3762e are the most clearly indicative of the "dark limestone" and 3762 and 3762c the most ambiguous. From the manner in which the Fusulinas are preserved in lot 3762, I am disposed to believe that it came from the highest beds of the Capitan. It has been provisionally assigned to this horizon in the records published here, and the other collections have been placed in the "dark limestone."

From the sandstones of the Delaware Mountain formation I obtained material at only three points, and since fossils are not so abundant or so well preserved in these sandstones as at other horizons my collections are a little meager. From about 250 feet above the base of the formation (station 2919) the following forms have been identified:

Fusulina elongata.
Fistulipora grandis var. guadalupensis.
Enteletes sp. d.
Chonetes subliratus.
Productus waagenianus var.
Productus texanus?
Productus sp. a.
Productus guadalupensis.
Spirifer sp. b.
Martinia rhomboidalis.
Squamularia guadalupensis.
Composita emarginata?
Hustedia papillata.

The two other collections were obtained at about the same level, approximately 700 feet up in the formation. One of these (station 2903) furnished the following species:

Fusulina elongata.
Fusulinella sp. a.
Chonetes sp.
Productus waagenianus var.
Productus texanus.
Productus sp. a.
Productus latidorsatus.
Productus walcottianus.

At the other (station 2931) I obtained the forms named in the following list:

Fusulina elongata.
Chonetes sp.
Productus guadalupensis.
Productus meekanus.
Productus signatus.
Productus signatus var.
Productus sp. e.
Productus subhorridus var. rugatulus?
Productus walcottianus.
Richthofenia permiana.
Spiriferina billingsi?
Pugnax osagensis?
Leptodus americanus.
Edmondia? bellula?
Edmondia sp.
Nucula sp. b.
Parallelodon multistriatus.
Parallelodon politus.
Bakewellia? sp.
Pteria richardsoni?
Pteria sp.
Myalina permiana?
Camptonectes? papillatus.
Aviculipecten delawarensis.
Acanthopecten aff. A. carboniferus.
Pernipecten obliquus.
Myoconcha costulata var. delawarensis.
Astartella nasuta.
Pleurophorus delawarensis.
Cleidophorus pallasi var. delawarensis.
Plagioglypta canna?
Pleurotomaria multilineata.
Pleurotomaria sp. d.
Pleurotomaria euglyphea.
Pleurotomaria strigillata?
Pleurotomaria arenaria.
Pleurotomaria? planulata.
Pleurotomaria? delawarensis.
Pleurotomaria? carinifera.
Bucanopsis sp.
Warthia americana.
Naticopsis sp.
Pseudomelania sp. a.
Bulimorpha chrysalis var. delawarensis.
Macrocheilina? sp. a.
Orthoceras guadalupense.
Gastrioceras serratum.
Anisopyge perannulata.

To these may be added a collection made by Mr. Elder from one of the limestone members in the Delaware Mountain formation not far above the last two. Here (station 2963) he obtained five species, as follows:

Fusulina elongata.
Stromatidium typicale?
Cladopora spinulata.
Fistulipora grandis var. guadalupensis.
Stenopora polyspinosa var. richardsoni?

In the same region, but from a somewhat higher horizon (station 2968), Mr. Richardson collected the following species:

Lindstrœmia permiana var.
Paraceltites elegans.
Gastrioceras sp.

As disclosed by these collections, the fauna of the Delaware Mountain formation presents many differences from either that of the "dark limestone" or that of the Capitan formation. The chief positive difference consists in the development of a relatively extensive suite of Pelecypoda and Gasteropoda, in the main very unlike those which succeeded them. Negatively, the Brachiopoda are less abundant and well differentiated. Consequently many of the forms characteristic of the series next above are wanting. The brachiopods which are present are in part the same, but the *Productus* fauna of this division seems to be distinct from that of either the "dark limestone" or the Capitan.

The black limestone at the base of the Guadalupe section is not as a rule highly fossiliferous, but would surely furnish an interesting and extensive series of forms if carefully collected. I had time to essay the black limestone at only one point. It was not found to be fossiliferous there except near the top (station 2920), where I obtained the following species:

Anthracosycon ficus.
Anthracosycon? sp.
Enteletes sp. c.
Orthotetes? sp. a.
Chonetes sp.
Productus latidorsatus var.
Richthofenia permiana.
Composita mexicana var. guadalupensis.
Hustedia meekana.
Pugnax nitida.
Pugnax osagensis.
Pugnax bidentata.
Rhynchonella longæva?
Leda sp.
Plagiostoma deltoideum?
Pleurotomaria strigillata.
Pleurotomaria arenaria var. monilifera.
Euomphalus sulcifer.
Foordoceras shumardianum var. præcursor.
Peritrochia erebus.
Bairdia aff. B. plebeia.

A collection from about the same locality and horizon (station 2967) brought in by Mr. Elder presents to a considerable extent a different facies, as follows:

Stenopora granulosa?
Enteletes sp. c.
Meekella attenuata.
Meekella multilirata.
Aulosteges sp. a.
Aulosteges sp. b.
Richthofenia permiana.
Spirifer sp. b.
Composita mexicana var. guadalupensis.
Hustedia meekana.
Hustedia papillata?
Pugnax? pusilla.
Solenomya? sp.
Clinopistha? cf. C. radiata var. lævis.
Nucula sp. a.
Nucula sp. b?
Yoldia sp.
Aviculipecten sp. a?
Pleurotomaria strigillata.
Naticopsis sp.
Loxonema? inconspicuum.
Macrocheilina? modesta.
Foordoceras shumardianum var. præcursor.
Agathoceras texanum.
Paraceltites elegans.
Anisopyge perannulata.
Anisopyge? antiqua.

This fauna is unusually well balanced, containing Brachiopoda, Pelecypoda, Gasteropoda, and Cephalopoda in nearly equal proportions, besides a corresponding share of other groups. At this horizon, in fact, the ammonoids appear from our collections to be more abundant than at any other in the typical Guadalupian section. It is interesting to note that they have a Permian aspect, an indication which is corroborated by the presence of *Richthofenia* and *Aulosteges*. While unmistakably related to the overlying faunas, that of the basal black limestone has an individual facies. It is widely different from any of the known faunas of the Hueco formation, and without doubt is to be regarded as a member of the Guadalupian series. It may be remarked that neither as a lithologic nor as a faunal unit is this limestone known to occur except in the immediate region of Guadalupe Point.

In the section exposed at the south end of the Guadalupe Mountains there are, according to our collections, four rather well-marked faunas, which occur in the basal black limestone, the Delaware Mountain formation, the "dark limestone," and the Capitan formation.

As already remarked, in the Delaware Mountain formation, which even in the vicinity of Guadalupe Peak is more or less interspersed with dark limestone, the calcareous component appears to become more and more important as the strata are followed southward into the southern Delawares, where almost the whole of the section is composed of limestone beds. This area was not visited by me, but collections were made by Mr. Richardson and Mr. Elder from a number of different localities and horizons. From a point 7 miles north of Marley's ranch (station 2935) Mr. Richardson obtained the following collection:

Martinia rhomboidalis.
Pernipecten obliquus.
Pleurotomaria putilla?
Euconospira sp.
Bellerophon crassus.

From the low hills west of Marley's (station 2936) the two following species were collected: *Chonetes permianus* and *Ambocœlia planiconvexa* var. *guadalupensis*.

A collection made 1½ miles east of Marley's ranch (station 3501) contains four forms, as follows:

Enteletes sp. d.
Derbya sp. a.
Meekella skenoides.
Spirifer sp. b.

At another point, about 15 miles north of Marley's (station 3500), the following species were collected:

Fusulina elongata.
Lindstrœmia permiana.
Archæocidaris sp. d.
Domopora? terminalis.
Domopora? ocellata.
Fistulipora grandis var. guadalupensis.
Stenopora polyspinosa var. richardsoni?
Acanthocladia guadalupensis.
Derbya? crenulata.
Composita emarginata var. affinis?
Hustedia meekana.
Pugnax bisulcata var. seminuloides.
Gastrioceras serratum?

At about the same locality as the foregoing was obtained the largest of all the faunas collected in the southern Delawares (station 2969). The following species have been identified:

Fusulina elongata.
Fusulinella sp. b.
Fusulinella sp. c.
Stromatidium typicale.
Lindstrœmia permiana?
Lindstrœmia permiana var.
Cladopora spinulata.
Cladopora tubulata.
Aulopora sp.
Cœnocystis richardsoni.
Archæocidaris sp. b.
Archæocidaris sp. b var.
Archæocidaris sp. d.
Spirorbis texanus.
Domopora? terminalis.
Domopora? ocellata.
Domopora? vittata.
Domopora? incrustans.
Fistulipora grandis var. guadalupensis.
Stenopora polyspinosa var. richardsoni.
Leioclema shumardi?
?Fenestella spinulosa?
Fenestella texana.
Fenestella sp. a.
Fenestella sp. b.
Fenestella sp. c.
Fenestella sp. e.
Fenestella sp. f.
Fenestella sp. f?
Polypora sp. a.
Polypora sp. b.
Polypora sp. c.
Polypora sp. d.
Acanthocladia guadalupensis.
Rhombopora? sp.
Goniocladia americana.
Derbya? crenulata.
Derbya sp. b.
Orthotetes guadalupensis?
Chonetes permianus.
Productus walcottianus?
Productus? pileolus.
Productus sp. d.
Strophalosia sp.
Spirifer mexicanus var.
Spiriferina billingsi?
Spiriferina sulcata?
Spiriferina laxa.
Spiriferina pyramidalis?
Spiriferina hilli var. polypleurus.
Spiriferina welleri?
Spiriferina welleri var. b.
Composita emarginata var. affinis?
Hustedia meekana.
Hustedia bipartita.
Pugnax bisulcata var. seminuloides.
Dielasma prolongatum.
Notothyris schuchertensis var. ovata.
Heterelasma shumardianum.
Heterelasma venustulum.
Leptodus americanus.
Nucula sp. c.
Parallelodon politus?
Pteria richardsoni.
Myalina squamosa?
Protrete texana.
Cymatochiton? texanus.
Pleurotomaria texana.
Pleurotomaria cf. P. planulata.
Pleurotomaria elderi.
Murchisonia? sp. a.
Murchisonia? sp. b.
Warthia americana?
Turbo? sp.
Pseudomelania? sp. b.
Anisopyge perannulata.
Argillœcia sp.

At station 2957, which is situated 45 miles south of El Capitan, the following species were collected:

Fusulina elongata.
Fusulinella sp. a.
Zaphrentis? sp.?
Domopora? ocellata.
Fistulipora grandis var. guadalupensis.
Acanthocladia guadalupensis.
Rhombopora? sp.
Productus popei.
Strophalosia sp.

About 20 miles north of the railroad station called Plateau (station 2962) Mr. Elliott collected the following:

Cladopora spinulata.
Domopora? ocellata.
Fistulipora grandis var. guadalupensis.
Acanthocladia guadalupensis.
Actinotrypa? sera.
Streptorhynchus pygmæum?
Streptorhynchus perattenuatum.
Derbya sp. a.
Orthotetes guadalupensis?
Martinia rhomboidalis.
Squamularia guadalupensis.
Dielasma spatulatum?

In a collection made 10 miles northwest of Kent (station 2964) the following species were identified:

Fusulina elongata.
Endothyra sp. c.
Lingulina? sp.
Guadalupia? sp. var.
Cystothalamia nodulifera.
Lindstrœmia permiana?
Richthofenia permiana.
Pugnax osagensis.
Pleurophorus sp.
Pleurotomaria richardsoni?
Pleurotomaria? carinifera var.
Bellerophon crassus.
Macrocheilina? sp. b.

Finally, a small collection made 35 miles northeast of Van Horn (station 2965) furnished *Pugnax? bisulcata* var. *seminuloides* and *Waagenoceras cumminsi* var. *guadalupense*.

These collections from the limestones of the southern Delawares have a fauna which is somewhat ambiguous. In the main it seems to be that of the "dark limestone" of the Guadalupe Mountains. This is suggested by the Bryozoa and corals and by the abundance of *Pugnax bisulcata* var. *seminuloides*, *Chonetes permianus*, etc. In no instance is there a recurrence of the characteristic fauna found near the middle of the Capitan formation, yet in a good many of these collections Capitan species have been identified which in the Guadalupe section have not been found in the "dark limestone." I refer to *Goniocladia americana*, *Productus? pileolus*, *Heterelasma shumardianum*, *H. venustulum*, and a few others. The sandstones of Guadalupe section have to a considerable extent different species. Nevertheless, in view of the facts that we still know the Guadalupian faunas very incompletely, that lithologically these limestones of the southern Delawares resemble those of the typical Delaware Mountain sections, that from observations in the field they appear to replace and represent the sandstones of that formation, that the conditions of limestone deposition on the one hand and of sandstone deposition on the other would probably influence the character of the faunas, and that our collections from the sandstones of the Delaware Mountain were made chiefly in the lower half of the formation, while in the southern Delawares they were probably made in the upper portion—in view of these facts I am ready to believe that these southern faunas do not represent any horizon of the typical Guadalupe section above the "dark limestone." It is unfortunate that we know so little of the forms which occur in the limestones of the Delaware Mountain formation in the Guadalupe sections. I neglected them entirely, and the two collections brought in by Richardson's party are too meager to be of much service. The faunas from the southern Delawares seem to show that at least some of the Capitan species range lower than is indicated by our data from Guadalupe Point. These faunas are so closely allied to that of the "dark limestone" as to suggest that the latter belongs with them rather than with the Capitan formation. This may not mean the elimination of the "dark limestone" as a distinguishable faunal facies, for it may characterize the upper portion of the Delaware Mountain formation while the lower portion also has a facies of its own.

Although the Guadalupian series is supposed not to occur in the Diablo Mountains, this memoir involves a small suite of fossils which are reported to have come from that range. They were found among the collections of the National Museum, having been received from E. T. Dumble in 1892. On internal evidence I have divided this material into two parts. One of these appears to consist of collections made by Von Streeruwitz and mentioned in his report,[a] although the different lots are now intermingled so that nothing can be exactly located. This fauna is that of the Hueco formation, which Richardson found to be the dominating if not the only Carboniferous formation in the Diablo Mountains.

The remaining portion of the material differs lithologically from the other. In the main the fauna also is widely different, not only from that of the other assemblage of forms, but from anything since obtained in the Diablo Mountains, or from the Hueco fauna as a whole. It contains some striking types, such as *Leptodus*, which are supposed to be characteristic of the Guadalupian, and yet it is not identical with any of the known Guadalupian faunas. While of too interesting a nature to be omitted from the present report, a twofold uncertainty, therefore, surrounds this material, since a question may be raised not only as to whether it belongs to the Guadalupian fauna, but as to whether it was obtained from the Diablo Mountains. As some of the striking forms were not mentioned by Walcott, who I believe determined the fossils for Von Streeruwitz's report, it is possible to suppose that the collection was not made in the Diablo Mountains, but was sent in at the same time, possibly from the same general region, and thrown in with the Diablo forms. As to the other point, the Guadalupian fauna seems to be so extensive, and as yet so imperfectly known, that it is, theoretically at least, quite possible for local collections from a distinct area to present an individual facies and yet to belong to the same period.

The following species are present in the fauna determined in this way (station 3764), and it will be seen that the facies is considerably different from any of the faunas of the Guadalupe section or of the southern Delawares:

Lindstrœmia permiana.
Cladopora tubulata.
Thamniscus digitatus.
Acanthocladia guadalupensis.
Enteletes dumblei.
Enteletes angulatus.
Enteletes sp. c.
Derbya nasuta.
Derbya? crenulata.
Meekella attenuata.
Leptodus americanus.

Two more collections are included in this report which show considerable individuality of facies and yet without much doubt belong to the Guadalupian series. They were made by R. T. Hill in the vicinity of Marathon, Tex., nearly 150 miles southeast of the Guadalupes. One of them was obtained in the Glass Mountains,

[a] Ann. Rept. Geol. Survey Texas for 1892, 1893, p. 170.

17 miles northwest of Marathon (station 3763). From this point I have identified the following species:

Fusulina elongata.
Guadalupia zitteliana.
Cystothalamia nodulifera.
Lindstrœmia permiana.
Zaphrentis? sp.
Amplexus sp.
Cladopora spinulata.
Domopora? ocellata.
Domopora? hillana.
Fistulipora grandis var. guadalupensis.
Fistulipora sp.
Meekopora sp.
Acanthocladia guadalupensis.
Enteletes globulosus.
Enteletes sp. a.
Enteletes sp. b.
Enteletes sp. d?.
Streptorhynchus pygmæum.
Streptorhynchus? sp. a.
Orthotetes guadalupensis?
Orthotetes distortus.
Orthotetes? sp. a.
Meekella skenoides.
Meekella difficilis.
Productus sp. c.
Productus guadalupensis var. comancheanus.
Productus meekanus.
Productus subhorridus var. rugatulus.
Strophalosia hystricula.
Richthofenia permiana.
Spirifer sp. b.
Squamularia guadalupensis.
Spiriferina billingsi?
Spiriferina hilli.
Composita emarginata var. affinis?
Composita mexicana.
Hustedia meekana.
Hustedia papillata.
Hustedia bipartita.
Camarophoria venusta.
Notothyris sp.
Leptodus americanus.
Parallelodon multistriatus.
Parallelodon? sp.
Pteria squamifera.
Aviculipecten sp. b.
Aviculipecten sp. b var.
Aviculipecten sp. c.
Aviculipecten sublaqueatus.
Astartella nasuta.
Pleurotomaria richardsoni?

The other locality (station 3840), which is described merely as the "mountains northwest of Marathon," has furnished the following species:

Fusilina elongata.
Platycrinus? sp.
Phyllopora? sp.
Thamniscus sp.
Septopora aff. S. robusta.
Rhombopora aff. R. lepidodendroides.
Rhombopora? sp.
Acanthocladia guadalupensis.
Fistulipora grandis var. guadalupensis.
Meekella difficilis.
Productus subhorridus var. rugatulus.
Aulosteges magnicostatus.
Spiriferina welleri?

These two faunas are evidently related to one another and in a general way to those of the Guadalupe and Delaware mountains. Their resemblance to any of the facies manifested in those areas is far from being so close that they may be called identical, but is greater to the fauna of the Delaware Mountain sandstone than to that of the Capitan limestone, or even to that of the "dark limestone." Accordingly, I have provisionally registered these forms as from the Delaware Mountain formation.

Thus different degrees of uncertainty are involved in the faunal relation of these collections to the Guadalupe section, and in some cases in their geographic position as well, and it seems best to refer to this matter here and to omit for the most part from the account of range and distribution that follows each species the marks of query really needed to express the modified certainty with which some of the assignments are made. As a rule where an interrogation point is used it refers to the identification of the species.

In view of the different localities and different horizons represented by the subject-matter of this report the determination of the best method of arranging the illustrations of species has been a matter of some concern. Since the ultimate purpose here, as in my other work, is faunal, the use of a zoological arrangement which would obscure the original assemblages of formational or regional groups of species seemed objectionable. On the other hand, when trying to compare several species, or to consult the illustrations of only one, I have found it highly annoying to be compelled to refer to several plates. Still, the grouping to the eye of forms associated in nature seems to me too important to be lightly dispensed with, and the loss of this instructive arrangement the greater of the two evils. An attempt to ameliorate the trouble occasioned by having kindred forms distributed on several plates has been made in connection with the arrangement of the figures on the plates themselves, so that they have rather rigidly been placed in serial order. This militates against a balanced appearance of the plate, which is very agreeable; but in some works, a class of which those of Gemmellaro may be cited as instances, the illustrations are so artistically distributed that it is almost impossible to find them. After losing much time over Gemmellaro's plates and others like them, it has seemed to me that this is a matter in which utility outweighs beauty as a desideratum. Consequently the plates in this report will be found arranged according to the stratigraphic and geographic groups in which the different collections have been considered above. Although this method does not misrepresent the natural grouping, it fails to represent it completely, because I have not sought to figure the common or recurrent forms in each set of plates.

Although in one particular the present report adds considerable to the available knowledge of the Guadalupian fauna, in another its contribution is small, for geographically the fauna is restricted, so far as known, to the general region where it was first discovered. It is quite unlike the faunas of eastern North America and almost equally unlike most of those of the West which I have seen. Of the latter a very few suggest the Guadalupian in some degree, but for one reason or another, because our material is very scanty or the resemblance remote, it has seemed best to reserve these instances for future discussion. This limited distribution of the Guadalupian need not indicate an extremely local development of a fauna contemporaneous, perhaps, with others of a different facies which we already know, but it may be due to several causes—to our incomplete knowledge, especially of western faunas; to the fact that the Guadalupian beds may be represented elsewhere by strata which do not contain invertebrate fossils, such as red beds; or to the removal by erosion of a part of the Guadalupian deposits, which were formerly more extensive. Probably all three causes contribute to limiting the present knowledge of the Guadalupian territorially.

The difference manifested by the faunas of the Guadalupe Mountains from those of the rest of North America, though not necessarily, at least in fact involves a resemblance to certain Asiatic and European faunas. Rather careful comparisons have been made with these alien faunas, but although evidently related to some of them the Guadalupian seems, as indicated farther on, to maintain a highly individual facies.

Aside from the species which Shumard had described, most of the Guadalupian forms appeared to be new. So different are the Guadalupian and Pennsylvanian faunas that in most cases the species of the one have no related species in the other, but the Pennsylvanian literature has been searched with care for kindred forms, and where found the usual comparisons have been instituted. It has been found necessary, however, to import few names of Pennsylvanian species into the Guadalupian fauna. Still fewer have been introduced from foreign literature, though I have been careful to note instances where it seemed that a relationship existed. But in the latter case particularly, even when the relationship seemed rather close, the Guadalupian form has generally been given a new name, because the data were not at hand by which I could reach a conclusion as to their identity or distinction.

It is reasonably safe to depend on descriptions and figures for an identification of species where the geographic separation is not wide and where the faunal association is essentially the same, but, otherwise, characteristic specimens are necessary for a satisfactory comparison. In the present case all these conditions were conspicuously absent. The most nearly related foreign faunas were separated by a terrestrial quadrant. They prove to have in the main a very different facies, to be related in one species and different in twenty, and I was practically without foreign material with which to make comparisons when comparisons were most desirable.

It has been said not less truly than often that it is easier to combine two species that have been injudiciously discriminated than to disengage two species that have been injudiciously combined, and it is also true that loose discriminations and loose identifications lead to loose correlations. I have felt under obligation to other workers in this field to leave a species whose relationship I was unable to determine as unentangled as possible, and to establish the nomenclature on a reasonably independent and permanent basis. Consequently, in doubtful cases I have leaned consciously to the side of species making, nor would I feel deeply concerned should it prove on just evidence not now accessible to me that some of my names are synonyms.

It has been my intention to go over the literature with some thoroughness in comparing the Guadalupian with other faunas, but so wide is the field and so rich the accumulation of literature that it was evidently necessary to contract and eliminate in order ever to bring such an attempt to completion and to make the result at all commensurate with the cost in time and labor. My object being to obtain the broad and general facts as to faunal and specific relationship, it seemed safe to refer, so far as possible, to monographic works, omitting the smaller contributions of which they were the culmination, even though such omission might entail some loss in minutiæ. The literature of Asia, Africa, etc., by reason of its still limited quantity was not unmanageable, and that of North America I had already pretty well in hand; but the works on European Carboniferous shells, even though my survey was restricted to the more important, were so numerous as to be impracticable for my purpose. The obvious faunal relations and the geologic position of the Guadalupian beds, however, are such that only a part of these reports were significant in this connection, and these were found to be a much more manageable quota. Even after selection of this sort the labor of comparing the Guadalupian fauna was not trivial, some of the incidental difficulties aside from those of a quantitative nature being the various languages in which these investigations were couched, with some of which I am unacquainted, and the lack of uniformity in classification and nomenclature.

In order to avoid the repeated citation of the same authorities hereafter, it has seemed best to give in brief résumé the most important works used in making comparisons of the Guadalupian fauna. Were other important works within my knowledge I would of course have had reference to them, and it is probable that some which would have furnished valuable data have been overlooked. In commencing this literary survey I may begin with the admirable work of Waagen on the fauna of the Productus limestone of the Salt Range of India,[a] since this fauna is geographically about as near as any which is related to the Guadalupian, and since Waagen's monograph, both in magnitude and thoroughness, is second to none with which I have had to deal. The earlier and partial accounts by Davidson, De Koninck, and others being passed over, this work is the only authority which I have employed as representing the Carboniferous fauna of the Salt Range.

The faunas of the Himalaya are much less completely known than those of the Salt Range, and for them I have had recourse chiefly to Diener's reports, not neglecting, however, brief accounts by Davidson and Salter. The latter in 1865[b] issued a pamphlet in connection with Blanford, in which a limited fauna is described from Niti, in the northern part of the Himalayas. In the same work a few forms are cited from Spiti Pass, a locality which yielded Diener also some material. Davidson published in 1866 two short papers, appearing consecutively in the Quarterly Journal, one dealing with some Brachiopoda from Tibet and the other with representatives of the same group from Kashmir.[c]

Faunas from Kashmir and Spiti (see above) were in 1899[d] made the subject of a memoir by Diener, who discussed the Spiti fauna again in 1903.[e] Another memoir by the same author treats of the "Permo-Carboniferous" fauna of Chitichun No. 1,[e] and to this fauna also he had occasion to return in 1903.[f] A third memoir by Diener, published in 1897, deals with the Permian fossils of the Productus shales of Kumaon and Gurhwal;[g] and, lastly, that put out in 1903 contains, in addition to a discussion of the Spiti and Chitichun faunas, accounts of some Permian fossils from the neighborhood of Malla Sangcha, from the Productus shales of the Lissar Valley (Johár), and from the Permian Productus shales of Byans.[h] The same author has given us an account of a geologic expedition in the central Himalaya,[i] accompanied by lists of fossils; but this work did not seem especially to concern the present investigation.

[a] Waagen, W., Salt Range fossils: Mem. Geol. Survey India, Pal. Indica, ser. 13, vol. 1, 1887.
[b] Salter, J. W., and Blanford, H. F., Palæontology of Niti, in the northern Himalaya, etc., Calcutta, March, 1865.
[c] Davidson, T., Jour. Geol. Soc. London, vol. 22, 1866, pp. 35 et seq.
[d] Diener, C., Himalayan fossils: Mem. Geol. Survey India, Pal. Indica, ser. 15, vol. 1, pt. 2, 1899.
[e] Idem, vol. 1, pt. 5, 1903, p. 133.
[f] Idem, vol. 1, pt. 5, 1903, p. 3.
[g] Idem, vol. 1, pt. 4, 1897.
[h] Idem, vol. 1, pt. 5, 1903, pp. 62, 100, 114, respectively.
[i] Denkschr. math.-naturwiss. Klasse, K. Akad. Wiss., Wien, vol. 62, reprint, 1895.

The explorations of Krafft[a] and of Obrutschew[b] in Bokhara have furnished information of slight moment so far as the present investigation is concerned. Their reports contain lists of a few Carboniferous species in no way indicating any special relationship to the Guadalupian fauna.

Carboniferous faunas occur also in Turkestan, but the only literature which relates to them is a report by Romanowsky published in 1880.[c] Romanowsky seems to have had a number of rather meager faunas, representing possibly several geologic periods. None of them shows much relationship with the Guadalupian, but I have included them pretty consistently in my comparisons.

Suess and Frech[d] give a few rather restricted lists of Carboniferous species occurring in central Asia and Pamir, but although a few forms are figured there is little available for comparisons with the present fauna, and nothing to indicate that a comparison would prove very profitable.

Our knowledge of the Chinese Carboniferous is regrettably scanty. First in time and first probably in celebrity are the accounts by Kayser and Schwager in the paleontological volume of Richthofen's China.[e] The only Carboniferous fauna, to use the term strictly, which is here described, however, is that from Lo Ping. Fliegel somewhat revised the Lo Ping fauna in 1901,[f] in connection with another work, to be mentioned later. Of equal importance are the accounts by Loczy, Lörenthey, and Frech on the Carboniferous faunas collected during the journey of Count Béla Széchenyi in eastern Asia.[g] These faunas also are for the most part rather meager, and like that from Lo Ping the most extensive one has recently been reviewed by Fliegel.[h] Another expedition into eastern Asia—that made by Fütterer and Holderer—appears to have obtained collections of Carboniferous material. I infer that a report on this material is in preparation, or has been completed, but I have been unable to obtain a copy of it, if it has appeared in print. The only account that has come to hand consists in a small brochure by Schellwien, entitled "The Trias, Permian, and Carboniferous in China."[i] It contains very little which is concerned in the present investigation. The recent Carnegie expedition into China obtained a small amount of Carboniferous material, a brief report on which is now in process of publication. These faunas, however, are so fragmentary and so unlike those of the Guadalupe Mountains that it did not seem necessary to include them in the comparisons which I have undertaken. Douvillé on two occasions[j] has given short lists of Carboniferous fossils from China, but in neither case does the fauna appear to be closely related to that of the Guadalupe Mountains. The only other information regarding the Carboniferous faunas of China which I have come

[a] Krafft, A. von, Denkschr. math.-naturhist. Klasse, K. Akad. Wiss., Wien, vol. 70, 1901, pp. 49 et seq.

[b] Obrutschew, V., Materialien zur Geologie von Russland: K. min. Gesell., vol. 13, 1889, pp. 167 et seq. In Russian; no faunal lists.

[c] Romanowsky, G., Materialien zur Geologie von Turkestan, pt. 1, St. Petersburg, 1880.

[d] Suess, E., and Frech, F., Denkschr. K. Akad. Wiss., Wien, vol. 61, 1894, pp. 431 et seq.

[e] Kayser, E., and Schwager, C., in Richthofen, F. von, China, vol. 4, Berlin, 1883.

[f] Fliegel, G., Palæontographica, vol. 48, 1901, p. 125.

[g] Loczy, L., Lörenthey, E., and Frech, F., Wissenschaftliche Ergebnisse der Reise des Grafen Béla Széchenyi in Ost-asien, Wien, vol. 3, 1899.

[h] Fliegel, G., Palæontographica, vol. 48, 1901, p. 134.

[i] Schellwien, E., Sonderabdruck aus den Schriften der Phys. ökon. Gesell. zu Königsberg i. Pr., 1902.

[j] Douvillé, H., in Jourdy, E., Bull. Soc. géol. France, 1886, p. 448; and (independently) Comptes-rendus Acad. sci., Paris, vol. 130, 1900, p. 592.

upon consists of some notes and lists by Frech[a] based on material collected by Richthofen but not included in Kayser's report. As the species are neither described nor figured, it did not seem practicable to compare the Guadalupian fauna with those which they constitute. Our knowledge of the Carboniferous faunas of China as conveyed in these reports appears to be highly fragmentary and scattered, much more so than that of the Himalayan faunas, which in turn is much less complete than that of the faunas of the Salt Range.

Regarding the Carboniferous faunas of the northern part of eastern Asia, the literature contains almost nothing. The only data which I have been able to discover are in a short notice by Tschernyschew[b] of a small collection from the vicinity of Vladivostok.

Carboniferous rocks occur in Korea, but little is known of their faunas. Yabe[c] has recently identified species of *Fusulina, Stacheia, Bigenerina,* and *Lagena* from the vicinity of Phyongyang. Gottsche, Credner, and Fliegel are also said to have reported the occurrence of Carboniferous fossils in this state (fide Yabe).

Carboniferous rocks appear to have but a limited distribution in Japan, and their faunas are largely restricted to the Foraminifera. Schwager's account of this group in Richthofen's China has already been referred to, and Yabe[d] also has devoted especial attention to them. The other groups of fossils are not well represented in these beds and have apparently not been carefully studied. Gottsche lists a few species from Akasaki, and similar brief lists are to be found in two works by Harada.[e] Aside from the Foraminifera too little is known of the Japanese Carboniferous fauna to warrant a comparison with the Guadalupian. A noteworthy entry in the Japanese lists is the genus *Leptodus* (*Lyttonia*), which is a striking member of the Guadalupian as well. The Foraminifera of the two faunas, however, appear to present very different facies.

The Carboniferous is known to occur in French Indo-China, with *Lonsdaleia* and *Schwagerina;* and from Tenasserim, in Burma, Noetling[f] has cited a list of eleven species combining a relationship to the Carboniferous faunas of India on the one hand and of Sumatra on the other, but none at all, or one only, showing even a remote kinship to that of the Guadalupe Mountains.

Rather more complete than anything which we have about eastern Asia is our knowledge concerning the Carboniferous of the Indian Archipelago. The earliest account was that written by Beyrich, published in 1865,[g] on a rather extensive suite of fossils from Timor. A few additions were made to this fauna by Martin in 1881,[h] and in 1892 it underwent revision by Rothpletz[i] from new collections, the species in many cases being redescribed and refigured. In 1880 Roemer[j] described a Kohlenkalk fauna from the west coast of Sumatra, which was revised by Fliegel in

[a] Frech, F., Neues Jahrbuch, 1895, vol. 2, pp. 47 et seq.

[b] Tschernyschew, Th., Bull. Com. géol., St. Petersburg, vol. 7, No. 22, 1889, p. 353.

[c] Yabe, Y., Jour. Coll. Sci., Imp. Univ. Tokyo, vol. 21, art. 5, 1906, pp. 28 et seq.

[d] Idem, pp. 10 et seq., and other works in Japanese.

[e] Harada, T., Die japanischen Inseln, Berlin, K. jap. géol. Reichsanstalt, 1890, pp. 63 et seq.; Outlines of the geology of Japan, Imp. Geol. Survey Japan, Tokyo, 1902, pp. 34 et seq. Several works in Japanese also probably refer to the Carboniferous faunas.

[f] Noetling, F., Records Geol. Survey India, vol. 26, 1893.

[g] Beyrich, E., Abhandl. K. Akad. Wiss. Berlin, 1864, vol. 1, 1865, pp. 61 et seq.

[h] Martin, K., Sammlungen Geol. Reichs-Museums in Leiden, ser. 1, vol. 1, 1881, pp. 1 et seq.

[i] Rothpletz, A., Palæontographica, vol. 39, 1892, pp. 57 et seq.

[j] Roemer, F., Palæontographica, vol. 27, 1880, pp. 4 et seq.

1901.[a] In making comparisons of the Sumatran fauna, Fliegel also revised those of Lo Ping and Tengtjancsing, as mentioned above. In 1904 W. Volz[b] published a rather extensive account of the geology of Sumatra, with lists of species and descriptions of a few Foraminifera and corals. Both groups present a non-Guadalupian facies.

The Carboniferous faunas of the Australian region have been the subject of several important memoirs and a number of shorter papers. Among the latter may be mentioned a report by Etheridge, senior,[c] on some Queensland fossils, one by Etheridge, junior,[d] on some fossils from the Bowen River coal field, and one by Frech[e] on marine Dyassic Brachiopoda. There is also of course Dana's classic account of some Carboniferous faunas from New South Wales obtained by the Wilkes exploring expedition,[f] but for data relating to these faunas I have relied chiefly on two summary works. One of these is De Koninck's memoir, entitled "Recherches sur les fossiles paléozoïques de la Nouvelle-Galles du Sud," conveniently translated into English and republished by the Geological Survey of New South Wales.[g] The other is the account of the geology and paleontology of Queensland and New Guinea by Jack and Etheridge.[h] Although other reports on the same faunas have appeared from the pens of Sowerby, Lonsdale, McCoy, Morris, D'Orbigny, and others, I have felt that they could justly be superseded by the two monographs mentioned, especially since the Australian faunas appear in no essential way related to those of the Guadalupe Mountains.

From Persia Möller[i] cites some small suites of Carboniferous fossils, chiefly Foraminifera, with such brachiopods of *Productus semireticulatus* and *Orthotetes crenistria*. So far as one can tell from the very inadequate data, this region contains no fauna comparable to the Guadalupian. Schellwien also has published an account of some Carboniferous fossils from the Egypt-Arabian desert.[j] The fauna is very limited and manifests scant relationship to the Guadalupian.

A very interesting memoir appeared in 1878 from the pen of Abich,[k] consisting of a description of a late Carboniferous fauna from Djoulfa, in Armenia, which was again discussed and revised in 1900 by Arthaber and Frech.[l] The same year Enderle described a Carboniferous fauna from Balia Maaden, in Asia Minor.[m]

The Carboniferous is known to occur on the island of Chios, but only a few species have been cited by Stache[n] and Teller.[o]

[a] Fliegel, G., Palæontographica, vol. 48, 1901, pp. 91 et seq.

[b] Volz, W., Zur Geologie von Sumatra: Geol. und pal. Abhandl. Jena, 1904, pp. 1-112.

[c] Etheridge, R., sr., Quart. Jour. Geol. Soc. London, vol. 28, 1872, pp. 317 et seq.

[d] Etheridge, R., jr., Proc. Royal Phys. Soc. Edinburgh 1878-80, 1880, p. 263.

[e] Frech, F., Zeitschr. Deutsch. geol. Gesell., vol. 50, pp. 176 et seq.

[f] Dana, J. D., Geology: U. S. Expl. Exped. 1838-1842, under command Charles Wilkes, U. S. N., vol. 10, Philadelphia, 1849, pp. 681-730.

[g] De Koninck, L. J., Mem. Geol. Survey New South Wales, Paleontology, No. 6, 1898.

[h] Jack, R. L., and Etheridge, R., Geology and palæontology of Queensland and New Guinea, Brisbane and London, 1892.

[i] Möller, V., Jahrb. K.-k. geol. Reichsanstalt, vol. 30, 1880, p. 573.

[j] Schellwien, E., Zeitschr. Deutsch. geol. Gesell., vol. 46, 1894, pp. 68 et seq.

[k] Abich, H., Geologische Forschungen in den Kaukasischen Ländner, pts. 1 and 3 (pls. 1-5), Wien, 1878. Part 3, which was not accessible to me till 1907, contains, of matter germane to this report, only the five plates without any descriptions whatever.

[l] Arthaber, G., and Frech, F., Ueber das Paläozoicum in Hocharmenien und Persien: Beiträge zur Pal. und Geol. Österreich-Ungarns, etc., Wien und Leipzig, 1900, vol. 12, heft 3, pp. 209 et seq.

[m] Enderle, J., Ueber eine anthracolithische Fauna von Balia Maaden in Kleinasien: Beiträge zur Pal. und Geol. Österreich-Ungarns, etc., vol. 13, heft 2, pp. 49 et seq.

[n] Stache, G., Verhandl. K.-k. geol. Reichsanstalt, Wien, 1876, p. 371.

[o] Teller, F., Denkschr. math.-naturhist. Klasse K. Akad. Wiss., Wien, vol. 40, p. 344.

The Russian section is of especial interest to the description and correlation of the Guadalupian fauna, because it contains the typical Permian. I did not, however, feel at liberty to neglect entirely the lower portion of the section, though paying especial attention to its upper members. The *Productus giganteus* zone, however, was regarded as being practically beyond my purview.

An extensive literature has grown up about the Russian geologic and faunal sequence, only part of which I could hope to include with profit in the comparisons undertaken here. Some papers were intentionally passed over in favor of others of a more comprehensive scope, my object, as elsewhere, being to make a general survey rather than an exhaustive one, but some works which would have served my purpose well have doubtless been unintentionally omitted. The papers which I have consulted on this subject group themselves in three categories—(1) those which describe the rocks and faunas of a single geographic or political province; (2) monographs of certain faunas or parts of faunas, and (3) monographs of certain groups of fossils. As belonging to the latter category I have used of course Möller's monograph on the Russian Foraminifera,[a] Stuckenberg's account of the corals and Bryozoa of the Carboniferous limestone of upper middle Russia,[b] Tschernyschew's memoir on the Gschelian Brachiopoda of the Urals and Timan,[c] Amalizky's account of the Anthracosias of the Perm-formation of Russia,[d] Karpinsky's monograph on the Ammonites of the Artinskstufe,[e] Jakowlew's account of the Cephalopoda and Gasteropoda of several upper Paleozoic terranes of Russia[f] and Tzwetaev's discussions of the cephalopods of the Russian Carboniferous limestone.[g]

In the way of monographs of certain stratigraphic zones use was made especially of Trautschold's monograph of the Moskovian,[h] also in the Gschelian of Tschernyschew's brachiopod monograph and in the Artinsk of Karpinsky's Ammonite monograph, reference to both of which has already been made. There is also Krotow's geologic and paleontologic monograph of the sandstone of the Artinsk,[i] a work chiefly in Russian, with but few of the numerous species figured, or discussed or described in German. The Permian fauna was viewed chiefly through the pages of Tschernyschew,[j] Netschajew,[k] and Golowkinsky,[l] including of course Amalizky's discussion of the Permian Anthracosias.

Amalizky has also given an account in Russian of the Permian of the Volga and Oka basins,[m] but the species are merely listed and the work, for my purpose, has been of little service.

The general discussions which were actually employed might have been largely increased in number without probably increasing the available data in anything

[a] Möller, V., Mém. Acad. imp. sci., St. Petersburg, 7th ser., vol. 25, No. 9, 1878; vol. 27, No. 5, 1879.
[b] Stuckenberg, A., Mém. Com. géol., St. Petersburg, vol. 5, No. 4, 1888.
[c] Tschernyschew, Th., Mém. Com. géol., St. Petersburg, vol. 16, No. 2, 1902.
[d] Amalizky, W., Palæontographica, vol. 39, 1892, pp. 125 et seq.; also printed in Russian the same year.
[e] Karpinsky, A., Mém. Acad. imp. sci., St. Petersburg, 7th ser., vol. 37, No. 2, 1889.
[f] Jakowlew, N., Mem. Com. géol., St. Petersburg, vol. 15, No. 3, 1899.
[g] Tzwetaev, M., Mém. Com. géol., St. Petersburg, vol. 5, No. 3, 1888.
[h] Trautschold, H., Die Kalkbrüche von Mjatschkowa, Moscow, 1874-1879.
[i] Krotow, P. I., Kazan Obshchestvo Estestvo-Ispytatelei, Trudy, vol. 13, 1885.
[j] Tschernyschew, Th., Verhandl. Russ. k. mineral. Gesell. St. Petersburg, 2d ser., vol. 20, No. 9, 1885, p. 265.
[k] Netschajew, A., Kazan, Obshchestvo Estestvo-Ispytatelei, Trudy, vol. 27, 1894.
[l] Golowkinsky, N. A., Verhandl. Russ. k. mineral. Gesell. St. Petersburg, vol. 1, 1869, p. 273.
[m] Amalizky, W., Deposits of the Permian system in the basin of the Volga and Oka, St. Petersburg, 1887.

like a corresponding degree. Foremost among the works used should probably be mentioned Murchison, De Verneuil, and Keyserling's account of the geology of Russia and the Ural Mountains,[a] which is now valuable chiefly, at least in the matter of Paleozoic paleontology, for its excellent figures. Keyserling's "Reise in das Petschora-Land"[b] must not be overlooked, though I recurred to it but seldom. Stuckenberg's partially illustrated account of the Gschelian and Artinskian faunas (of sheet 127 of the Russian Survey)[c] added valuable data to those which I was able to gather in relation to these faunas from other sources. Krotow gives a brief illustrated account of the Carboniferous faunas of the western slopes of the Urals.[d] Tschernyschew lists some other Carboniferous faunas and summarizes the Artinskian brachiopods in connection with his geologic report on sheet 139 (western slope of the central Urals).[e] The same author gives extensive lists of the Gschelian fauna in connection with his brachiopod monograph. Lists are also given by Nikitin in his paper "Artesian wells in the vicinity of Moscow,"[f] as well as a description of a rather small fauna of Gschelian age. Sibirzew has likewise given rather extensive lists of Moskovian, Gschelian, Artinskian, and Permian faunas,[g] to which I have had occasional recourse, but as a rule it has not seemed practicable to use bare faunal lists, since, aside from such question as might legitimately surround identifications without the vouching afforded by descriptions and figures, rises the task, discouraging enough for one not too familiar with the literature and synonymy of Russian species, of pursuing the identified species to their sources.

So distantly related to the Guadalupian are most of the Carboniferous faunas of continental Europe and the British Isles, and so extensive is the literature which relates to them, that I have not felt called on to convoke most of it to my comparisons. An exception has been made, for reasons previously stated, in the case of the Russian section. Faunas very important to the present investigation have been described, however, from the province of Palermo, in Sicily, from the Carnic Alps, and from the Permian of Germany and England. I have also undertaken to include in my comparisons some of the scantily known Arctic faunas.

Gemmellaro has described in parts an extensive and interesting fauna from Palermo, but the several numbers of his work are to be had with difficulty, if my experience is a criterion. Many bibliographic references to them appear to be misleading, indicating that they were private publications. Some parts may have appeared independently, but such as I have been able to obtain have been published either by the Palermo Scientific Society or the Royal Academy of Sciences of Naples. Whether he obtained and described the lower invertebrate classes I have been unable to discover; all the parts seen by me relate to the Brachiopoda, the Mollusca, and the Crustacea.

The brachiopods, so far as the volumes which I have seen are concerned, are not completely described. In 1897[h] he gave an account of two genera (*Scacchi-*

[a] Murchison, R. I., De Verneuil, E., and Keyserling, A. von, Paléontologie, London and Paris, vol. 2, pt. 3, 1845.
[b] Keyserling, A. von, Wissenschaftliche Beobachtungen auf einer Reise in das Petschora-Land, St. Petersburg, 1846.
[c] Stuckenberg, A., Mém. Com. géol., St. Petersburg, vol. 16, No. 1, 1898, pp. 193 et seq.
[d] Krotow, P. I., Mém. Com. géol., St. Petersburg, vol. 6, 1888, pp. 468 et seq.
[e] Tschernyschew, Th., Mém. Com. géol., St. Petersburg, vol. 3, No. 2, 1886, pp. 338, et seq.
[f] Nikitin, S., Mém. Com. géol., St. Petersburg, vol. 5, No. 5, 1890.
[g] Sibirzew, N., Mém. Com. géol, St. Petersburg, vol. 15, No. 2, 1896, pp. 233 et seq.
[h] Gemmellaro, G. G., Giorn. Soc. sci. nat. ed econ. di Palermo, vol. 21, 1897, pp. 113 et seq.

nella and *Megarhynchus*) from the Fusulina limestone of Palermo, besides mentioning a number of other associated generic types. In 1899[a] he described a large number of species found in the Sicilian fauna, but evidently only a part of the brachiopod representation. *Streptorhynchus, Derbya, Strophalosia, Aulosteges, Marginella, Richthofenia,* and *Lyttonia,* mentioned in the preliminary notice, are omitted, and if he has elsewhere published descriptions of the species belonging to these genera I have been unable to find them. The pelecypods were described in 1897[b] in the same volume which contained the preliminary notice of the Brachiopoda. Part but not perhaps all of the Gasteropoda were described in 1890, the same volume containing also the description of the nautiloid division of the Cephalopoda and a considerable appendix to the Ammonoidea.[c] The main portion of the Ammonoidea was described in 1888.[d] The descriptions of the Crustacea were published in another series in 1890.[e] In addition to being incomplete, Gemmellaro's description of the Sicilian fauna is annoyingly faulty in another particular. Most, or probably all, of the copies lack plates referred to in the text. Several instances of this sort occur, and too frequently the citations of figures on the plates have to be corrected.

Somewhat similarly incomplete have been the data which I have been able to gather relating to the fauna of the Carnic Alps. The earlier Carboniferous faunas of the region are out of relation with the Guadalupian, and consequently I have neglected De Koninck's monograph on Carboniferous fossils from Bleiberg, in Carinthia.[f] The Brachiopoda of the younger faunas were described by Schellwien first in 1892, in a paper entitled "The fauna of the Carnic Fusulina limestone,"[g] and later, in 1900, in an article upon the fauna of the Trogkofelschichten.[h] He described the Foraminifera in 1897,[i] and apparently projected a discussion of the other groups, but I have been unable to find any evidence that he carried the purpose into execution. Several invertebrate faunas from the Carnic Alps not closely related to the Guadalupian have recently been described by Gortani,[j] and he cites other works on the same subject by himself, Angelis d'Ossat, and others. For some reason many of these citations appear to be incorrect. As an instance, for a work by himself in which *Fusulina alpina* var. *communis* is cited with synonymy, Gortani refers[k] to "I, Paleontogr. Italica, X, 1904." My copy of that work contains no paper by Gortani and no paper dealing with the Carboniferous of the Carnic Alps. The same is true of the volumes for the four or five years adjacent. I have, however, found a work by Angelis d'Ossat on the corals and Bryozoa of the Carnic Alps,[l] but the species, though described, are not figured.

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[a] Gemmellaro, G. G., Giorn. Soc. sci. nat. ed econ. di Palermo, vol. 22, 1899, pp. 95 et seq.

[b] Idem, vol. 21, 1897, pp. 9 et seq.

[c] Idem, vol. 20, 1890, pp. 53 et seq., pp. 37 et seq., and pp. 9 et seq., respectively.

[d] Idem, vol. 19, 1888, pp. 1 et seq.

[e] Gemmellaro, G. G., Reale accad: sci. fisiche e mathematiche, Napoli (reprint?), 1890.

[f] De Koninck, L. J., Recherches sur les animaux fossils, pt. 2, Brussels, 1873.

[g] Schellwien, E., Palæontographica, vol. 39, 1892, pp. 1 et seq.

[h] Abhandl. K.-k. geol. Reichsanstalt, vol. 16, heft 1, 1900.

[i] Palæontographica, vol. 44, 1897, pp. 237 et seq.

[j] Regny, P. Vinassa de, and Gortani, M., Fossili Carboniferi del M. Pizzul e del Piano di Lanza nelle Alpi Carniche, Rome, 1905; Rivista italiana di paleontologia, anno ix, fasc 1, 2, Bologna, 1903 (?); Atti Reale accad. Lincei, ser. 5, vol. 11, 1902, p. 316.

[k] Fossili Carboniferi del M. Pizzul e del Piano di Lanza nelle Alpi Carniche, 1905, p. 529.

[l] Angelis d'Ossat, G. de, Classe sci. fisiche, mathematiche e naturali, Atti Reale accad. Lincei, Mem., ser. 5, vol. 2, 1898, pp. 242 et seq.

I must not fail in this connection to speak of the fauna of the Bellerophon limestone. This interesting fauna from southeastern Tyrol, which has been described by Mojsissovics, Stache, and Gümbel,[a] shows almost no resemblance to the Guadalupian. Its facies is in fact so unusual for the Carboniferous that Gümbel held its geologic age to be lower Trias, while Stache was led to believe that it was upper Permian. The stratigraphic occurrence seems to indicate a horizon close to the top of the Paleozoic, if not even beyond the division plane which separates that terrane from the Mesozoic. Very recently Schellwien and Kossmat[b] have reported a fauna from the Bellerophon limestone which establishes its age as Paleozoic, and by indicating a correlation with the Salt Range Carboniferous fauna of India tends to prove that the latter is Permian throughout, instead of largely Artinskian, as claimed by Tschernyschew. In the preliminary statement of Schellwien and Kossmat only a few, the most significant types, are mentioned, such as *Richthofenia* aff. *lawrenciana*, *Productus indicus*, *P. abichi*, *Marginifera ovalis*, and *Lonsdaleia indica*, and they suggest a somewhat closer resemblance to the Guadalupian than would have been inferred from the earlier known fauna.

For the Permian faunas of Germany and England I have contented myself with consulting the well-known works of Geinitz[c] and King.[d]

The first account of the Carboniferous faunas of Spitzbergen appears to have been given by De Koninck in 1850,[e] but he had only a few species. In 1874 Toula published an account of some Carboniferous fossils from the south point of Spitzbergen,[f] followed in 1875 by another on some Kohlenkalk and Zechstein fossils from the Hornsund,[g] on the western coast of Spitzbergen, and by a description of Permo-Carboniferous fossils from the western coast of Spitzbergen (Axel Island) and the cape between the two arms of North Fjord.[h] More recently (1887) Lundgren[i] published an account of some Permian fossils from Spitzbergen, and Göes[j] describes a species of *Fusulina* from the same island. Of the Carboniferous of Nova Zembla Toula's work dealing with a Carboniferous limestone fauna from the Barents Islands[k] is the only one which I have found. Andersson[l] has listed some Carboniferous species from Bären Island, which is not the same as the foregoing in spite of the similarity of name and location.

Other works on Arctic faunas have been considered to some extent, as, for instance, one by Haughton,[m] another by Etheridge,[n] a third by Salter,[o] etc., but as a

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[a] Frech states (Lethæa Geognostica, p. 551) that the nautiloids were described by Mojsissovics, the Ostracoda and Foraminifera by Gümbel, the ammonoids by Diener, and the Mollusca by Stache. I have been unable to locate the papers by Gümbel and Mojsissovics, but Stache describes the nautiloids and gasteropods in the Jahrb. K.-k. geol. Reichsanstalt, vol. 27, 1877, pp. 271–318, and the pelecypods and brachiopods in the same series, vol. 28, 1878, pp. 93–168. Diener's account of the ammonoids appears in the Sitzungsber. math.-naturhist. Classe, K. Akad. Wiss., Wien, vol. 106, pt. 1, pp. 61–76.

[b] Schellwien, E., and Kossmat, F., Zeitschr. Deutsch. geol. Gesell., vol. 57, heft 4, 1905, pp. 357–359.

[c] Geinitz, H. B., Animalischen Ueberreste der Dyas, Leipzig, 1860.

[d] King, W., Monograph of the Permian fossils of England, Palæontographical Society, 1850.

[e] De Koninck, L. J., Bull. Acad. roy. sci. Belgique, vol. 16, pt. 2, 1850, p. 632

[f] Toula, F., Sitzungsber. math.-naturwiss. Klasse, K. Akad. Wiss., Wien, vol. 68, 1874, pp. 267 et seq.

[g] Idem, vol. 70, pt. 1, 1875, pp. 133 et seq.

[h] Neues Jahrbuch, 1875, pp. 225 et seq.

[i] Lundgren, B., Bihangtill Kongl. svensk. Vet.-Akad. Handl., vol. 13, afd. 4, No. 1, 1887, pp. 1 et seq.

[j] Göes, A. T. von, Oefvers. Vet. Akad., Förhandl. for 1883, No. 8, 1884, pp. 29 et seq.

[k] Toula, F., Sitzungsber. math.-naturwiss. Klasse, K. Akad. Wiss., Wien, vol. 71, pt. 1, 1875, pp. 527 et seq.

[l] Andersson, J. G., Bull. Geol. Inst. Upsala, vol. 4, pt. 2, No. 8, 1900, p. 243.

[m] Haughton, S., Jour. Royal Dublin Soc., 1857, pp. 183, 239–250.

[n] Etheridge, R., Quart. Jour. Geol. Soc. London, vol. 34, 1878, pp. 568 et seq.

[o] Salter, J. W., in Belcher, E., Last of the Arctic voyages, vol. 2, 1855, pp. 377 et seq.

rule the known faunas are too poor and fragmentary to yield anything of interest in connection with the Guadalupian, besides being, so far as can be determined, only remotely related.

Stache[a] recorded several Carboniferous faunas in the West Sahara, to which, though they show no close relationship with the Guadalupian, I have assigned a place in my comparisons.

Relatively little is known of the Carboniferous of South and Central America. The earliest and perhaps on the whole the most widely known account is that by D'Orbigny,[b] in which he described several Carboniferous faunal occurrences, chiefly in Bolivia. Salter[c] a score of years later listed and partially figured a small suite of fossils from Lake Titicaca, in Bolivia, and Toula[d] not long thereafter described a small Carboniferous fauna from the vicinity of Cochabamba, in the same country. The only record of the occurrence of Carboniferous in Peru which I have come upon was made by Gabb,[e] and includes only four or five species. On the Brazilian Carboniferous faunas[f] we have primarily Derby's admirable memoir[f] in which, however, only the Brachiopoda are discussed. A recent publication by Katzer[g] gives a résumé of the Brazilian faunas as a whole. They appear to bear a remarkably close relation to those of the typical Pennsylvanian and consequently are widely different from the Guadalupian. Although there are a few types which are unknown in the Pennsylvanian, such as some of the species described by Derby, a large number appear to be the same in both faunas. Katzer's figures are in part copies from Derby, in part copies from Meek, Geinitz, and others, and in part original drawings from Brazilian specimens. Of the latter some appear to be new species, figured but not described.

Carboniferous strata occur also in Guatemala, where they were reported by Sapper.[h] This author lists a small number of species from each of four provinces, but the faunas appear not to be closely related to those of the Guadalupe Mountains. With this my South American citations come to a close.

To canvass the extensive literature dealing with the Carboniferous of North America would be impracticable at this place, nor is it called for. My comparisons, in truth, have been made less specific in the case of the North American faunas than in some others, partly because the faunas are so extensive and the literature so scattered that to do otherwise would be a serious task, partly because, being fairly familiar with the literature and the faunas, I could select what seemed most appropriate; and partly because the Guadalupian fauna differs so widely from either the Pennsylvanian or the "Permian" of the eastern section that no more than general comparisons seem to be for the most part necessary. Such comparisons as I have made, however, have been with the faunas of the Mississippi and Ohio valleys, the Appalachian region, and central Texas. The faunas of the West are for the most

[a] Stache, G., Denkschr. math.-naturwiss. Klasse, K. Akad. Wiss., Wien, vol. 46, 1883, pp. 369 et seq.

[b] D'Orbigny, A., Voyage dans l'Amérique méridionale, vol. 3, pt. 4, 1842.

[c] Salter, J. W., Quart. Jour. Geol. Soc. London, vol. 17, 1861, p. 64.

[d] Toula, F., Sitzungsber. math.-naturwiss. Klasse, K. Akad. Wiss., Wien, vol. 59, pt. 1, 1869, pp. 433 et seq.

[e] Gabb, W. M., Jour. Acad. Nat. Sci. Philadelphia, 2d ser., vol. 8, 1874-1881, p. 302.

[f] Derby, O. A., Bull. Cornell Univ., Science, vol. 1, No. 2, 1874.

[g] Katzer, F., Grundzüge der Geologie des unteren Amazonas Gebietes, 1903.

[h] Sapper, C., Petermann's Mittheilungen, Ergänzungshefte, No. 113, 1894.

part so imperfectly known and correlated and so different from the Guadalupian that I have systematically left them out of consideration.

In general comparisons of the Guadalupian with the upper Carboniferous faunas of central and eastern North America I have referred back to Weller's useful bibliography.[a] Such additions as have been made since that work appeared do not materially alter the combined data of previous publications. In describing the Guadalupian species, however, I have intended to keep in view all the more recent literature.

The works cited in the foregoing résumé are of course only a part of those actually consulted in the course of my study of the Guadalupian fauna, but they are the ones which were used most frequently and which seemed most important to consider in connection with it.

In all these faunas there is none, I regret to say, with which the Guadalupian can really be considered closely allied. The nearest are probably those of the Salt Range and Himalaya, in India, and of the Fusulina limestone of Palermo, in Sicily; but in this judgment, in the case of the Indian faunas especially, I may have been too strongly influenced by the occurrence of those two singular brachiopod types *Richthofenia* and *Leptodus*. The fact is perhaps without especial significance, but it may be noted that the occurrences of this faunal facies, or at least the occurrences of these genera, in the three instances mentioned, occupy closely corresponding positions with regard to the earth's equator, and may indicate a zonal development in the late Carboniferous.

The resemblances shown by the Guadalupian fauna to even the most similar of those brought into comparison are sporadic and almost immediately offset by differences as great. In number and importance the differences outweigh the resemblances. My comparisons accordingly indicate that the Guadalupian has a very individual facies among known fanuas, though it is probably related to several of them. Such differences would perhaps be expected from their widely separated geographic positions and doubtless from the greater freedom of migration as well as the greater susceptibility to environmental conditions possessed by some types. It is somewhat surprising, however, to find the Guadalupian fauna so completely different from anything known in the Mississippi Valley, whose geographic position is relatively so close. The differences are so great and so pervading that I shall not attempt to name them in detail, for they must be patent to the most superficial investigation. The position maintained in 1905[b] seems fully justified—that if the Guadalupian fauna is Permian then the Kansas "Permian" is not, for they differ too greatly for both to belong in the same epoch, or, if it should prove they were in part contemporaneous, for the same name to be applied to them. At present I believe that the Guadalupian, defined below by its oldest known fauna, is younger than the Kansas "Permian" and that it belongs to a different epoch.

Its correlation with the Russian section is, unfortunately, ambiguous. In spots it resembles the Gschelian, the Artinskian, and the Permian. As I pointed out in the paper just cited, the resemblances between the underlying Hueco forma-

[a] Weller, S., Bibliographic index of North American Carboniferous invertebrates: Bull. U. S. Geol. Survey No. 153, 1898.
[b] Proc. Washington Acad. Sci., vol. 22, 1906, pp. 29-25.

tion and the Gschelian are so much more important and complete as to exclude from the probabilities a correlation of any part of the Guadalupian with any part of the Gschelian. The abundance and character of the ammonoid development in the lower and middle portions of the Guadalupian contain some suggestion of the Artinsk fauna, and the abundance and character of *Streptorhynchus*, *Strophalosia*, or *Aulosteges* in the middle and upper Guadalupian suggest the Permian of Russia and Germany, so that probably the best correlation is that of the Guadalupian on one hand with the Artinsk and Permian on the other; but, intrinsically, the Russian and American faunas appear to me to have but little in common.

At this point I may well mention a recent paper by Prof. Charles Schuchert[a] dealing with the same general topics. It came into my hands after the present work had been completed and transmitted for publication, and on this account it is not perhaps receiving such ample consideration as it deserves. I have not been compelled, however, to alter my views on account of this addition to the literature, because I find them in close accord with those expressed by Schuchert, whose paper to a certain extent anticipates the enunciation of the opinions here set forth.

I would gladly evade, if I could do so, a discussion at this time of the relationship of the Guadalupian with other faunas, both at home and abroad, for such a discussion must necessarily involve the question of the so-called Permian of Kansas, and it seems to me that one can venture to express few positive opinions on this subject. The short paper published in 1905[b] gave my views with a freedom which I may sometime regret, and it would possibly be well to let matters rest without recurring to them here, but my studies of the past year have added a few considerations which I believe to be new, and a recent paper by Mr. Prosser,[c] which, among other things, comments on the aforesaid opinions, places matters in a light in which I do not wish them to remain. Mr. Prosser has the appearance of refuting the opinions and at the same time convicting me of the use of very bad reasoning or no reasoning at all. His line of argument, as I make out, is this: The Guadalupian is upper Permian; the underlying Hueco formation is equivalent to the Pennsylvanian below the Kansas "Permian" and does not include the latter; consequently my statement that "if the Capitan fauna is Permian, certainly that of Kansas is not," does not follow at all. Mr. Prosser is right. It does not follow at all. But this is Mr. Prosser's argument, not mine, and to construct it he has taken first a preliminary correlation which I made four years ago and to which I no longer adhere, then a correlation of his own which he will find it difficult to maintain, and as a conclusion half of a sentence from my recent paper which has in the context a somewhat more qualified meaning than that which is obvious in its fragmentary and isolated condition.

I used the term "upper Permian" in the title to a preliminary paper which appeared four years ago,[d] and to this Mr. Prosser refers in the first of his premises. Indeed, as was clearly intimated at that time, the expression "upper Permian" was used because, on the supposition that the Kansas "Permian" was properly so called, the Guadalupian fauna (chiefly characterized by station 2926, in the middle portion

[a] Am. Jour. Sci., 4th ser., vol. 22, 1906, pp. 29-46, 143-158.
[b] Proc. Washington Acad. Sci., vol. 7, 1905, pp. 1-25.
[c] Prosser, C. S., Notes on the Permian formations of Kansas: Am. Geologist, vol. 36, September, 1905, pp. 142 et seq.
[d] Am. Jour. Sci., 4th ser., vol. 14, 1902, p. 363.

of the Capitan formation) is so widely different from it; because the Guadalupian is so similar in certain striking particulars to Indian faunas which competent authorities regarded as of Permian age, and because it was stratigraphically so high in the Carboniferous, situated as it is at the top of the extensive trans-Pecos section. Subsequent studies have led me to believe that it was ill advised to call the Guadalupian fauna upper Permian even in the title of a preliminary paper, and that it would be unwise at present to correlate the Guadalupian series with any definite stage of the Russian section. The qualification of my earlier inference was rather clearly indicated in my 1905 paper,[a] where I called attention to a resemblance between the Guadalupian fauna and that of the Fusulina limestone of Sicily, which Tschernyschew correlates with the Artinsk. The Artinsk, I need hardly recall, underlies the typical Russian Permian and is by some Russian authors included under the same designation, but by others is distinguished under a separate name as Permo-Carboniferous. In the same connection, regarding the Guadalupian I said: "Several circumstances leave me still of the opinion that this bed may be Permian." It seems to me that to anyone reading the paragraph in which these passages occur it must be apparent that I no longer hold to the assignment of the Guadalupian to the upper Permian. I would infer that Mr. Prosser read this paragraph, from the fact that he honors me by quoting from it, so that if for purposes of argument he calls the Guadalupian upper Permian, it is on his own responsibility, and he is liable to be called on to support the opinion, in which it is hoped the present work will be of some assistance.

In the second of Mr. Prosser's premises he says that my lists of the Hueco fauna indicate that it is not related to any of the Kansas formations above the top of the Chase stage. From this he appears to infer that the Kansas "Permian" is younger than the Hueco formation, but in this case it is Mr. Prosser's inference that does not follow, for the Hueco fauna in some of its zones is so different from anything known in the Mississippi Valley that he would find it no easy task to show that the Kansas "Permian" is not represented there under a different faunal aspect. Besides, he seems to have overlooked the fact, at least once appearing in print,[b] that a gap, of undetermined though probably no very great extent, occurs between the highest known beds of the Hueco formation and the base of the Guadalupian. But supposing it to have been shown that the horizon of the Kansas "Permian" is in the upper part of the Hueco formation,[c] on its own merits one would be compelled to class the "Permian" with the Hueco fauna, rather than with the Guadalupian, for I doubt very much whether Mr. Prosser would venture, on the strength of the faunal evidence now available, to trace much relationship between either the lowest fauna of the Guadalupian (that of the basal black limestone) or the overlying Delaware Mountain sandstones and the Kansas "Permian." The third possibility, that of recognizing a Permian fauna of the Kansas type as an independent division, does not appeal to me at present with favor, but I shall refer to this point later.

[a] Proc. Washington Acad. Sci., vol. 7, 1905, p. 22.

[b] Bull. Univ. Texas Min. Survey, No. 9, 1904, pp. 35, 40.

[c] The hypothesis in this case places its correlate above the highest known fauna of the Hueco, but presumably in what should be regarded as part of the same formation. Of course now and at all times the hypothesis is held in reserve that the two sections may have been more or less contemporaneous, though with very different faunas. Under those circumstances, however, it is in my judgment almost futile even to discuss their relationship on the strength of any evidence now in hand.

In regard to the third stage of the argument, the passage which Mr. Prosser quotes from me as if it were a deduction from the two premises just passed in review really has no connection with his line of reasoning, and embodies a different meaning in the connection in which I wrote it from what is apparent in the connection in which he places it. The remaining half of the sentence quoted by Mr. Prosser, together with the context, is as follows: "If the Capitan fauna is 'Permian,' then certainly that of Kansas is not, for two Carboniferous faunas could scarcely have less in common. While it is possible that the so-called Kansas 'Permian' is a provincial phase of the Guadalupian, this is yet to be demonstrated, and it is questionable whether for two faunas so essentially unlike, even if proved to have been contemporaneous, the same name could with propriety be used." For my own part, I do not see how any other meaning can be drawn from these two sentences save that while I am not certain that the Kansas "Permian" may not have been contemporaneous with the Capitan, the two faunas are so different that the same name should not be applied to both. What I wished to state was that, the question whether Capitan *time* was contemporaneous with the time of deposition of the Kansas "Permian" being waived, the Capitan *fauna* is so different from the fauna of the Kansas "Permian" that the same *name* should not be applied to both. My discussion, in other words, had especially to do with terminology, while Mr. Prosser unfortunately makes it appear that I assert that if Capitan *time* was contemporaneous with the Permian epoch, then that of the Kansas beds was not, the faunas being so unlike. In point of fact I am ready to admit that two marine faunas may have a very different facies and still be contemporaneous. But at present I believe that the Capitan and the Kansas "Permian" were not contemporaneous, and that any two marine faunas differing as widely as the Guadalupian and the Kansas "Permian" should be distinguished by regional names.

Such investigations as I have made regarding the subject have left me positive on but few points. Two of these, however, have just been mentioned—that the Guadalupian fauna is entirely different from the Pennsylvanian and from the "Permian" of the Mississippi Valley, and that whether they are contemporaneous or not it would be a blunder to employ for both the same designation, either Permian or Guadalupian. Few will, I think, differ with me on these points. For the most part, however, I find myself seeing grave objections to the views maintained by others without being able to offer anything positive in the way of substitute, and entertaining a number of alternative hypotheses with no more than an opinion, more or less temporary, as to which the facts are likely to substantiate.

The two main points of Mr. Prosser's holding carry for me some serious difficulties, though while I can not yet accept them I do not wish to be understood as too positively maintaining opposite views. He finds the Kansas "Permian" fauna much more distinct from the underlying Pennsylvanian than appears to me warranted, and he correlates it too confidently with the Russian Permian. On neither point does it seem to me that very satisfactory evidence has been adduced. It is true that on the question of the Permian age of the Kansas beds he has canvassed professional opinion pretty extensively, and that at present the ayes seem to have it; but the ballot system, while not without value, has certain obvious shortcomings as a means of settling scientific questions.

I have never been able to see marked faunal changes in passing from the Pennsylvanian to the "Permian" of the Kansas section, and the lists which I prepared for Adams's bulletin on the Kansas formations[a] do not indicate any important differences between the two. It is true that the lists are preliminary, and that their imperfections, failure on my own part to discriminate between related forms, and possible incorrect assignment by Mr. Adams of collections to one formation or another, would tend to obscure faunal changes which really exist; but on the whole I doubt if they seriously misrepresent the range of species or the facies of successive faunas. To me the Kansas faunal succession appears to be a gradually progressive one, modified of course by the passage of time and toward the end by the development of conditions which first banished or destroyed most of the brachiopod life and finally extinguished invertebrate life altogether. It is doubtful, if the question of the representation of the Permian in this country had never come up, whether the upper beds of the Kansas section would ever, on their merits, have been separated from the subjacent ones. The difference between the "Permian" and Pennsylvanian faunas of Kansas is to me by no means comparable to the difference between the Mississippian and Pennsylvanian faunas, but rather to the difference between some of the subdivisions of the Mississippian. Consequently, if the Kansas "Permian" really is Permian, then, so far as the facts are at present known and so far as this section is concerned, it appears to me doubtful whether more than two subdivisions are justified—the Mississippian and the Pennsylvanian—the "Permian" being no more than one of several members of the Pennsylvanian.

Regarding the correlation of the Kansas "Permian" with the Russian Permian I have not seen any very explicit or satisfactory statement of evidence. The question, it appears to me, should be considered both in the relation of the Kansas fauna and the Permian fauna as individual and detached entities; in the relation of the entire faunal sequence of Kansas to the sequence of the Russian faunas; and, finally, in the relation of the collateral evidence which the faunas of other sections bring to the discussion.

The chief arguments which Mr. Prosser has advanced for the correlation seem to be these: The great development of *Fusulina* in the Russian section just below the Permian, paralleled by the development of the same group precedent to the "Permian" of the Kansas section; the development of *Bakewellia* in the Kansas "Permian" and the typical Permian of Russia; and the development in the same beds of the *Pseudomonotis* group of shells. As to *Pseudomonotis*, the genus was introduced in the Kansas section considerably before the "Permian." The abundance in which it occurs at about the horizon of the Kansas "Permian" appears to me a subordinate matter. Again, after critically examining the best specimens of *Bakewellia* which could be obtained I have been brought to entertain serious doubts as to their generic identity with the Bakewellias of the English Permian as represented in King's monograph. The dentition appears to be different and they seem to lack the characteristic series of external ligamentary pits.

It might also be pointed out that just below the Artinsk a zone in the Russian section is characterized by a profusion of *Schwagerina* occurring in association with Fusulinas. Now *Schwagerina* has never been reported from the Mississippi Valley,

[a] Adams, G. I., Bull. U. S. Geol. Survey No. 211, 1903, pp. 77 et seq.

while I have recently[a] offered reason for believing that the Fusulinas of the Kansas section, if they do not belong to a different genus, at least show important differences from the typical Fusulinas. These facts seem to destroy Mr. Prosser's argument so far as this item of evidence is concerned. At the same time these very forms furnish more stable evidence looking somewhat in the same direction.

In a paper just received Mr. Yabe expresses the opinion that the generic term *Triticites*, which I introduced for the type of *Fusulina* found in the Mississippi Valley, is a synonym not of *Fusulina* but of *Schwagerina*. It should be remarked at this point that Mr. Yabe regards *Fusulina* sensu stricto, *Schwagerina*, *Doliolina*, and *Neoschwagerina* as subgenera of *Fusulina* in the broad sense. With Mr. Yabe's opinion regarding the relationship between *Schwagerina* and *Triticites* I am disposed in the main to agree. When studying the Kansas Fusulinas I did not fail to consider the genus *Schwagerina*, but unfortunately employed Schwager's work on the Chinese Foraminifera as my authority relating to the genus which bears his name. Not having had the opportunity to examine the Asiatic species at first hand, nor having been led by my studies to more than a casual acquaintance with the literature of these difficult forms, I was unaware that Schwager had included two distinct types under *Schwagerina*, for one of which Schellwien had in 1897 introduced the name *Möllerina*, which he subsequently (in 1902) changed to *Doliolina*. I saw that *Triticites* differed widely from the *Doliolina* structure, which has its inception in the basal skeleton of the Chinese Schwagerinas, and concluded that the two were distinct. Nor did I fail to note that *Triticites* did not differ greatly from our western Schwagerinas (e. g., *Schwagerina robusta* of California), but the inference from this naturally was (still using Schwager's *Schwagerina* as a point of departure), not that *Triticites* was a *Schwagerina*, but that the western *Schwagerina* was not a true representative of the genus, but more probably related to *Triticites*. With the misleading *Doliolina craticulifera* removed, *Triticites* becomes very closely similar to *Schwagerina*.

As the case now stands, therefore, with the Kansas form cited under *Schwagerina* there appears to be some authority for correlating the upper part of the Kansas section with the *Schwagerina* zone of Russia. On this basis, however, the beds above would correlate not with the Permian but with the Artinsk, and the propriety might legitimately be impugned of separating on internal evidence the beds overlying the abundant occurrence of *Schwagerina* in the Kansas section and of correlating them with the Artinsk rather than assigning to the Artinsk some of the nonfossiliferous beds still higher in occurrence, since the rather thin series above the *Schwagerina* horizons (for the genus ranges practically throughout the Kansas section) neither shows any great difference from the fauna below nor any marked affinity with the fauna of the Artinsk or Permian, while the higher nonfossiliferous horizons at least have the virtue of potentiality in the way of convincing evidence. After all, the evidence created by the transfer of the Kansas Fusulinas to *Schwagerina* is not very strong, and Mr. Prosser's argument is retroactive, since if the beds below the Russian Permian are so characterized by the abundance of *Fusulina* the total absence of this genus (now *Schwagerina*) in the Kansas section may not

[a] Am. Jour. Sci., 4th ser., vol. 17, 1904, pp. 234-240.

be without its significance, while the Kansas Schwagerinas certainly belong to a distinct group from the typical ones, whose zone is below the Artinsk, the Kansas forms being distinguished by their fusiform instead of globular shape, their thickened instead of slender septa, and the absence of any trace of a basal skeleton.

Anyone acquainted with the Carboniferous faunas of Kansas who examines Geinitz's work on the Dyas must be struck by the resemblance between the American and the German faunas It is this resemblance probably which led Geinitz to correlate the two, but the Dyas is not the Russian Permian, though doubtless closely allied to it, and the American fauna which it especially resembles is not Mr Prosser's Permian, but an antecedent one Of course, a fortiori, if the underlying beds are Dyas the Kansas "Permian" is Permian if the Dyas is Permian, but at the same time the resemblance indicates what has already been stated as my opinion—that no marked break divides the Kansas "Permian" from the Pennsylvanian, and that if the former is to be correlated with the Russian Permian there is no reason why an indefinite thickness of the underlying measures should not be considered Permian also, and no reason why the "Permian" in Kansas should be distinguished as a separate system or epoch ranking with the Mississippian.

The relationship between the Dyas and the Kansas faunas lies chiefly in the pelecypods, the Bryozoa and the Gasteropoda showing somewhat less important resemblances The latter group especially is apt to furnish rather unsatisfactory correlative evidence, since generic characters of the first importance are not preserved in the Paleozoic at all and the minor generic characters are frequently destroyed or concealed Comparisons, therefore, have often to be made with uncertainty as to whether forms do or do not belong to the same genus, and depend not infrequently on rather superficial or subordinate characters

Even among the pelecypods, however, one can not but observe some noteworthy differences, such as the presence in the German fauna of *Liebea hausmanni, Plagiostoma permiana*, and several species of *Bakewellia* doubtfully congeneric with *Bakewellia parva* of the Kansas "Permian." Other points might also be noted, such as the abundance of *Chiton* in the Dyas, but in the main the resemblance is certainly striking. It is important to observe, however, that the resemblance is not restricted to the higher faunas of the Kansas section, but continues to exist when the earlier Pennsylvanian horizons of the Mississippi and Ohio valleys are held in view

The most marked differences, however, are to be found among the Brachiopoda, a group which is of special importance because of their general abundance and good preservation, the precision with which genera can be determined, and often the relatively brief range of specific and generic types [a] The Brachiopoda of the Kansas "Permian" are survivals of those of a previous horizon, and they are very different from the brachiopods of the Dyas. There is nothing in the entire Kansas section to compare with the Dyas species of *Streptorhynchus*, *Productus* (*P horridus, P. latirostratus, P. geinitzianus, P. hemisphærium*, and *P. robertianus*), *Strophalosia, Spirifer* (*S. curvirostris* and *S schrenki*) and *Camarophoria*. Some of the types mentioned

[a] This is, I am aware, contrary to what has often been maintained, but it seems to me that in the Carboniferous at least genera and species of brachiopods are distinguished on more valid and better established data, and they have a briefer range, than other groups

appear to be abundant in and characteristic of the Dyas, so that the Brachiopoda of the two faunas appear to contain wide and important differences. The types which are held in common date from an earlier stage in both areas and have an almost world-wide distribution.

In Tschernyschew's account of a Permian fauna from Kostroma there are few striking differences when compared with the Kansas "Permian," and most of these occur among the brachiopods, such as *Camarophoria*, *Strophalosia*, and *Aulosteges*, genera not known in the Kansas section. The resemblances, however, are not especially with the Kansas "Permian," but rather the reverse, and consist of types which range well down in the Pennsylvanian section. Much the same is true of the Permian fauna described by Golowkinsky. The greatest differences here are shown among the Brachiopoda (*Strophalosia horrescens*, *Productus cancrini*, *P. hemisphærium*, and *Spirifer rugulatus*); but the resemblances are by no means with the Kansas "Permian" as distinct from the Pennsylvanian. Also, in the extensive Permian fauna described by Netschajew, aside from the Brachiopoda, which are for the most part very unlike any phase of the Kansas faunas, there are few marked differences which can be pointed out. One important exception, however, consists of the Permian Anthracosias (*Palæomutela*, *Oligodon*, *Naiadites*, and *Anthracosia*), of which Netschajew cites 40 species. Amalitzky distinguishes 60 species of this group, which is, so far as known, entirely absent from the Kansas series. In this case also the resemblances do not point to a relationship between the Russian Permian and that of Kansas as distinguished from the Kansas Pennsylvanian, but appear to be equally great with the latter. I would not, however, interpret this to indicate that the Kansas "Permian" is younger than the Russian Permian. The Kansas "Permian" appears to me to represent the last stage of a fauna which was being somewhat modified, indeed gradually annihilated, by conditions which were adverse to it. The meager representation of the final stages naturally affords a less satisfactory basis for comparison with the highly differentiated Russian Permian (Netschajew cites 249 species of invertebrates), presenting fewer points of resemblance and more points of negative difference.

I have, however, considered only the features in which the Russian Permian fauna differs from the Kansas "Permian," and even in this rapid and very general survey have neglected a number of instances which are worthy of notice. A more critical and detailed comparison of the two faunas would, I venture to say, still more increase the sum of difference. Nor have I considered elements in the Kansas "Permian" which are absent from the Russian Permian. On the intrinsic characters of the two faunas it seems to me that no more than a very provisional correlation is justified.

The paleobotanical evidence which has recently been brought forward [a] to identify as Permian part of the Kansas section is not unimportant, but if I may do so without appearing to try to prove that the Kansas beds are not Permian, rather than merely to examine critically the evidence for believing that they are, I would point out several considerations in relation to this line of evidence. In the first place, here and elsewhere in speaking of the Kansas "Permian" I refer to the

[a] Kansas Univ. Quart., vol. 9, 1900, pp. 63, 64, 180-189; vol. 10, 1901, pp. 1-12; Trans. Kansas Acad. Sci., vol. 17, 1901, pp. 208, 209.

Chase and Marion formations, but not to any of the higher beds, as I believe that the only practical method of correlating terranes so widely separated as those of Kansas and Russia is by paleontologic evidence; and since the evidence of invertebrate paleontology only is that which I am in a position to understand and weigh, it is natural that any statement of mine must apply to that portion of the Kansas section where invertebrate fossils are found, and can not consistently apply to formations overlying the Marion, where invertebrate evidence appears to be absent. Furthermore, unless otherwise indicated, in speaking of the Permian I refer primarily to the Russian Permian exclusive of the underlying Artinsk or "Permo-Carboniferous."

Now, regarding the plant evidence, it appears that the horizon from which it was obtained is not as yet definitely fixed, but is regarded as being at the top of the Marion or the base of the Wellington, or, in other words, in the highest strata of the Kansas "Permian" if not above that series. On the other hand, the correlation by paleobotany is not with the Russian Permian but with the German, and not with the Zechstein, whose fauna seems most to resemble the typical Permian, but with the Rothliegende, which underlies it and may belong to a different epoch.

It is instructive to compare the entire series of Russian faunas with that found in Kansas in its bearing on the age of the Kansas "Permian." Whoever examines Trautschold's monograph on the Moskovian, the lowest terrane of the Russian Carboniferous above the Mountain limestone, must be struck by its resemblance to the ordinary Kansas fauna. The resemblance is to the Pennsylvanian of Kansas, however, rather than to the "Permian," but, as I see it, the Kansas "Permian" differs from the lower beds more by elimination than by any positive qualities. The Gschelian, the next succeeding fauna of the Russian section, shows considerable that is different from the Moskovian, and it varies widely from the Kansas faunas as a whole or from the fauna of any particular bed in the section. If 50 Gschelian species were found in the Mississippi Valley, probably 49 of them would be recognized as new and the whole as constituting a fauna having a facies widely different not only from anything in Kansas but also from anything in eastern North America, so far as known. In my judgment the difference between the Gschelian fauna and any of the Kansas faunas is far greater than that between the Kansas "Permian" and the underlying Pennsylvanian. A thoughtful inspection of Tschernyschew's monograph on the Gschelian Brachiopoda will, I am convinced, bear out this statement. The Artinskian fauna, most interesting on account of its ammonoids, but otherwise rather closely allied to the Gschelian so far as I could make out from the literature, is also unrepresented in Kansas. Above the Artinsk is the Russian Permian, which we are told is equivalent to the "Permian" of Kansas.

No one would seriously hypothetize a gap between the Pennsylvanian and "Permian" of Kansas during which the Gschelian and Artinskian beds were being put down. The alternative hypothesis is that, while comparable at first, the Russian faunas went through very different metamorphoses, the American faunas remaining more nearly uniform, and both concluding in a similar vein. This hypothesis would also account for the important differences which seem to me to exist between the Russian Permian and that of Kansas, but if the differences are admitted the particular difficulty making need for the hypothesis is eliminated.

It is necessary finally to consider the evidence which a few other faunas contribute to this question. That which Beede obtained from the red beds of Oklahoma [a] is too scanty to prove more than that Carboniferous faunas extended considerably higher into the red beds than is shown by the Kansas section. The beds at Whitehorse Springs are, I believe, supposed to be several hundred feet above the top of the Marion. Their limited fauna is related to that of the Kansas "Permian," but shows at the same time some differences suggestive of a different and younger facies. The differences from the Kansas "Permian," however, are not resemblances to the Russian Permian, the close relationship to which of either fauna seems to me rather questionable.

The ammonoid fauna of Texas appears to be related not to the Russian Permian, to which period American writers have usually assigned it, but to the Artinsk. This fauna does not occur in the Kansas section. The position there of the Wichita is not definitely known. I have imagined it to be no older than the Kansas "Permian," and possibly younger.[b] This would make the "Permian" of the Kansas section, if not older than the Artinsk, older than the Russian Permian. Tschernyschew correlates part but not all of Prosser's "Permian" with the Artinsk. Prosser's extension of the term "Permian" to cover the Marion, if this correlation is correct, is quite justified by the precedent of some of the Russian geologists, who include the Artinsk in the Permian, as previously noted. This does not, in my view, constitute the best usage, for, as I understand the matter, the Permian as originally defined did not include the Artinsk, and there is no peremptory faunal evidence demanding a departure from the original meaning. On the basis of this doubtful correlation it would appear that even the Marion is older than the typical Permian.

The faunas of the trans-Pecos section also bear on the present question, for in some of them I believe there can be traced a distinct relationship with some of those of the Russian section, while it is possible if not to determine at least to approximate the stratigraphic relationship which they bear to the Kansas section. As stated in my recent paper,[c] the fauna of the Hueco formation which underlies the Guadalupian, appears to me closely related to the Russian Gschelian, while a different fauna which lies below the Hueconian may tentatively be correlated with the Moskovian stage. The ammonoids of the lower Guadalupian are very suggestive of the Artinsk, but aside from this I must confess that there appear but broken analogies between the Guadalupian and the Artinskian or the Permian. Faunally the Guadalupian is quite unlike any of the faunas of eastern North America. The Hueco fauna, though still considerably different, shows decidedly greater resemblance to the Kansas faunas, while the faunas beneath the Hueco are perhaps least different of all. To trace the trans-Pecos section into the Mississippi Valley by the south is at present impossible. In passing northward it appears that the Hueco beds, typically consisting of dark limestones, change their color and lithology, and are represented by red beds interspersed with limestones. In the Grand Canyon section they appear as the Aubrey sandstone and limestone, while in Utah the Weber

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[a] Beede, J. W., Am. Geologist, vol. 28, 1901, pp. 46–47; Adv. Bull. First Bien. Rept. Okla. Geol. Survey, 1902, 9 pp.

[b] Cummins states (Trans. Texas Acad. Sci., vol. 2, 1897, p. 98) that the upper portion of the Wichita division of Texas in which White's ammonoid fauna was found is the same as the Fort Riley horizon of Kansas, whose position is in the middle of the Chase group.

[c] Proc. Washington Acad. Sci., vol. 7, 1905, p. 20.

quartzite seems to be equivalent to them. These correlations are at present provisional. With still greater reserve are the red-beds faunas of Wyoming correlated with the Weber on the one hand and the upper part of the Kansas section on the other. Their relationship with the eastern fauna is far stronger than with the western. At present I see no evidence of their being younger than the Weber, but they may be older. Conservatively they may be placed in the same epoch. If we accept this correlation of the Hueco formation with the Gschelian on the one hand and the Kansas Carboniferous on the other, the Guadalupian would consequently correspond to the Artinsk or to the Artinsk and the Permian. This would agree with the correlations of some European writers, for the Guadalupian fauna is more nearly related to that of the Fusulina limestone of Palermo than to any other European fauna, and the Sicilian beds are correlated with the Artinsk by some writers or with the Permian by others. Or, if, as Prosser claims, we assume that the upper part of the Kansas section is younger than the Hueco formation, or the known fossiliferous portion of it, it would follow, if the Kansas "Permian" is Artinsk, as Tschernyschew believes,[a] that the Guadalupian is presumably Permian; but in this case the difference between the faunas of the Kansas "Permian" and any part of the Guadalupian is so great that in North America at least the Guadalupian as Permian must be sharply distinguished from the Kansas "Permian" as Artinsk, and the course adopted by some geologists of uniting both divisions under the Permian would not answer for the North American series. The relationship between the fauna of the Kansas "Permian" and those of the underlying beds is so close that the Kansas "Permian" as Artinsk would have to be regarded as forming a part of the Pennsylvanian.

Or, if we still assign the Kansas "Permian" to a position above the known faunas of the Hueco formation though presumably below the Guadalupian, but suppose it now to be equivalent not to the Artinsk but to the Permian of the Russian section, then it must follow that, if not strictly all, at any rate most of the Guadalupian series is a new group younger than the Permian. This does not seem at first sight at all probable, and yet on deeper consideration it is not entirely impossible.

It does not seem to me necessary to regard the Russian Permian as the last chapter in the Paleozoic history. Apparent gradation is a dangerous criterion in determining whether sedimentation was continuous, since an encroaching sea reworking the detritus of much older deposits could and apparently sometimes does form to the eye continuous series of sediments. Faunally the Permian does not seem to me to be at all strongly suggestive of the Mesozoic, but to be distinctly Paleozoic in its facies. The cœlenterates, the echinoderms, the bryozoans, the brachiopods, the pelecypods, and, less strikingly, the gasteropods and cephalopods (including those of the Artinsk) are in my view distinctly Paleozoic, with but slight inclination to the Mesozoic facies. The decline of the brachiopods in the Permian has sometimes been cited as foreshadowing the advent of the Mesozoic, but brachiopods are abundant in the lower Mesozoic of Europe, and the groups which are being extinguished in the Permian are the wrong ones for this deduction. The types especially differentiated in the Mesozoic are the Rhynchonellas, the Spiriferinas, the Terebratulas, and the Thecidiidæ. These four groups are rather notable in the Permian by the poverty

[a] Mém. Com. géol., St. Petersburg, vol. 16, No. 2, 1902, pp. 395, 706.

of their development, the most abundant forms being apparently the distinctly Paleozoic strophomenoids and productoids. In the faunas of Palermo and of the Guadalupe Mountains the strophomenoids and productoids are also well developed, but the Rhynchonellas, the Spiriferinas, and the Terebratulas are differentiated to a high degree and thus contain an intimation of the Mesozoic. Other similar features could be noted wherein these faunas more than the Permian appear to be anticipatory of the subsequent epoch. Finally, the important differences in facies which are shown by the faunas of Palermo and the Guadalupe Mountains when compared with the Permian may indicate differences in age almost as much as differences in environment. In closing this argument, however, I may say that I have elaborated it not so much because I believe that the relations are so, as because I believe that they may be so, from which perhaps it will be gathered that the measure of my credence is rather large.

Thus far I have considered the relations which would exist if the Kansas section were equivalent to the Hueco formation. That it overlies the Hueco formation seems at present, from data in hand, too little likely to engage discussion. Less improbable is it that the Kansas beds underlie the Hueco. In the light of the present insufficiency of facts or supposed facts this hypothesis is not without substantiatory evidence. We have the facies of the Hueconian fauna different from but related to that of the Kansas beds, a relationship which lends itself to the interpretation of being due to succession in time as well as to a contemporaneous but different environment. There is evidence for believing that the Hueconian is a red-beds fauna, in spite of the different lithology of the typical section. A series of beds below those carrying the typical Hueco fauna have an assemblage of forms much more like the Pennsylvanian than the Hueco fauna itself—that is, it has fewer non-Pennsylvanian types. Thus we have in each area a group of rocks with like faunas followed by a series of red beds of Carboniferous age. The red beds of the Kansas section are unfossiliferous, save for the fauna from Oklahoma, which Beede described and which is not very distinctive. The Hueco fauna consists largely of brachiopods and gasteropods, and so is out of touch with that from Oklahoma. Perhaps the most noticeable feature of the latter is the *Dielasma*, distinct from the Pennsylvanian Dielasmas and rather suggestive of the western types. This hypothesis also makes the Mississippi Valley faunal sequence analogous to that of Russia. The Kansas beds and pre-Hueconian beds would correspond to the Moskovian in faunal aspect, the Kansas red beds and the Hueco formation to the Gschelian, and the Guadalupian to the Artinsk and Permian. Of course in this case the Kansas "Permian" could be no younger than the Gschelian.

While this hypothesis should not be overlooked, it seems to me more probable that the upper Carboniferous of the Mississippi Valley represents not the pre-Hueconian alone of the trans-Pecos and New Mexico section, but the pre-Guadalupian as a whole, the eastern faunas having remained almost uniform throughout, but the western faunas having in the latter half of the period represented taken on a new facies. Whether the enrichment of the fauna during this epoch was by differentiation or by immigration I do not see any way of determining, nor, in the latter event, whether the migration was from America to Asia, from Asia to America, or to both from a third region.

It remains to express the heavy obligations under which I stand to various friends and colleagues in the preparation of this report. As the work, owing to frequent and prolonged interruptions, has extended through several years, some acts of kindness and of aid have probably been overlooked. I have frequently advised with Mr. Charles Schuchert and Mr. R. S. Bassler on scientific points and with Mr. T. W. Stanton, Mr. David White, and Mr. G. B. Richardson on more general matters. I have also on several occasions consulted Mr. E. O. Ulrich. Dr. J. H. Britts, of Clinton, Mo., kindly loaned me some specimens collected and identified by the Shumards. To all these gentlemen my sincerest thanks are extended. To the United States National Museum I am, as always, indebted for facilities and for the use of specimens, partly as the subject-matter of this paper and partly for purposes of comparison. Nor am I forgetful of those whose efforts contributed to build up the collections which form the basis of the investigations here reported—Mr. R. T. Hill, Mr. G. B. Richardson, Mr. B. F. Hill, and Mr. E. H. Elder.

Range and distribution of the Guadalupian species.

	Guadalupe Mountains.				Southern Delaware Mountains.	Diablo Mountains (?).	Glass Mountains.
	1.	2.	3.	4.	5.	6.	7.
Fusulina elongata	×	×	×		×		×
Fusulinella sp. a	×		×		×		
Fusulinella sp. b					×		
Fusulinella sp. c					×		
Endothyra sp. a	×	×					
Endothyra sp. b		×					
Endothyra sp. c					×		
Spirillina aff. S. plana	×	×					
Lingulina? sp					×		
Anthracosycon ficus				×			
Anthracosycon ficus var. capitanense	×						
Anthracosycon? sp				×			
Virgula neptunia	×						
Virgula rigida	×						
Virgula rigida var. constricta	×						
Pseudovirgula tenuis	×						
Stromatidium typicale			(?)		×		
Guadalupia zitteliana	×						×
Guadalupia zitteliana var	×						
Guadalupia cylindrica	×						
Guadalupia cylindrica var. concreta	×						
Guadalupia cylindrica var. robusta	×						
Guadalupia favosa	×						
Guadalupia digitata	×						
Guadalupia sp	×						
Guadalupia? sp	×						
Guadalupia? sp. var					×		
Polysiphon mirabilis		×					
Cystothalamia nodulifera	×				×		×
Cystothalamia? sp	×						
Amblysiphonella guadalupensis	×						
Steinmannia americana	×	×					
Sollasia? sp	×						
Lindstrœmia permiana	×	×			×	×	×
Lindstrœmia permiana var		×	×		×		
Lindstrœmia cylindrica		×					
Lindstrœmia sp		×					
Zaphrentis? sp		×			(?)		×
Amplexus sp	(?)	×					×
Campophyllum texanum?	×						
Cladopora spinulata	×	×	×		×		×
Cladopora? tubulata					×	×	

Range and distribution of the Guadalupian species—Continued.

	Guadalupe Mountains.				Southern Delaware Mountains.	Diablo Mountains (?).	Glass Mountains.
	1.	2.	3.	4.	5.	6.	7.
Aulopora sp					×		
Cœnocystis richardsoni					×		
Archæocidaris cratis?		×					
Archæocidaris sp. a		×					
Archæocidaris sp. b					×		
Archæocidaris sp. b. var					×		
Archæocidaris sp. c		×					
Archæocidaris sp. d		×			×		
Spirorbis texanus					×		
Domopora? terminalis	×	×			×		
Domopora? ocellata	×	×			×		×
Domopora? constricta		×					
Domopora? vittata		×			×		
Domopora? hillana							×
Domopora? incrustans					×		
Fistulipora grandis var. guadalupensis	×	×	×		×		×
Fistulipora guadalupæ	×						
Fistulipora sp							×
Meekopora sp							×
Stenopora granulosa		×					
Stenopora granulosa?				×			
Stenopora polyspinosa var. richardsoni	×		(?)		×		
Stenopora sp		×					
Leioclema shumardi	×	×			(?)		
Fenestella popeana							
Fenestella hilli		×					
Fenestella capitanensis	×						
Fenestella guadalupensis		×					
Fenestella guadalupensis var		×					
Fenestella spinulosa?	×	×			(?)		
Fenestella texana					×		
Fenestella sp. a					×		
Fenestella sp. b					×		
Fenestella sp. c					×		
Fenestella sp. c var		×					
Fenestella sp. e					×		
Fenestella sp. f					×		
Fenestella sp. f?					×		
Polypora mexicana?		×					
Polypora sp. a					×		
Polypora sp. b					×		
Polypora sp. c		(?)			×		
Polypora sp. d					×		
Phyllopora? sp							×
Thamniscus digitatus						×	
Thamniscus sp							×
Acanthocladia guadalupensis	×	×			×	×	×
Acanthocladia sp	×	×					
Septopora aff. S. robusta							×
Rhombopora aff. R. lepidodendroides							×
Rhombopora? sp					×		×
Goniocladia americana	×				×		
Actinotrypa? sera					×		
Crania sp	×	×					
Streptorhynchus gregarium	×						
Streptorhynchus pygmæum					(?)		×
Streptorhynchus perattenuatum					×		
Streptorhynchus? sp. a							×
Derbya nasuta						×	
Derbya? crenulata					×	×	
Derbya sp. a	×	×			×		
Derbya sp. b	×				×		
Orthotetes guadalupensis	×				(?)		(?)
Orthotetes declivis	×						
Orthotetes distortus	×						×
Orthotetes distortus var. campanulatus	×						
Orthotetes? sp. a				×			×
Geyerella americana	×						
Meekella attenuata				×		×	
Meekella skenoides					×		×
Meekella difficilis							×
Meekella multilirata				×			
Orthothetina sp	×						

Range and distribution of the Guadalupian species—Continued.

	Guadalupe Mountains.				Southern Delaware Mountains.	Diablo Mountains (?).	Glass Mountains.
	1.	2.	3.	4.	5.	6.	7.
Leptodus americanus	×		×		×	×	×
Leptodus guadalupensis	×						
Oldhamina? sp	×						
Chonetes permianus		×			×		
Chonetes hillanus	×	×					
Chonetes subliratus	×	×	×				
Chonetes sp			×	×			
Productus waagenianus	×						
Productus waagenianus var			×				
Productus semireticulatus var. capitanensis	×	×					
Productus mexicanus							
Productus sp. c							×
Productus popei		×			×		
Productus popei var. opimus		×					
Productus indentatus		×					
Productus texanus			×				
Productus sp. a			×				
Productus guadalupensis			×				
Productus guadalupensis var. comancheanus							×
Productus occidentalis	×	×					
Productus meekanus			×				×
Productus signatus			×				
Productus signatus var			×				
Productus latidorsatus	×		×				
Productus latidorsatus var				×			
Productus sp. e			×				
Productus subhorridus var. rugatulus			(?)				×
Productus walcottianus			×		(?)		
Productus? pileolus	×	(?)			×		
Productus pinniformis	×						
Productus limbatus		×					
Productus sp. d		×			×		
Strophalosia hystricula							×
Strophalosia cornelliana	×						
Strophalosia sp					×		
Aulosteges guadalupensis		×					
Aulosteges medlicottianus var. americanus	×						
Aulosteges magnicostatus							×
Aulosteges sp. a				×			
Aulosteges sp. b				×			
Richthofenia permiana	×	×	×	×	×		×
Enteletes globosus							×
Enteletes dumblei						×	
Enteletes angulatus						×	
Enteletes sp. a							×
Enteletes sp. b							×
Enteletes sp. c				×		×	
Enteletes sp. d			×		×		(?)
Camarophoria venusta	×						×
Pugnax? bisulcata		×					
Pugnax? bisulcata var. gratiosa		×					
Pugnax? bisulcata var. seminuloides	×	×			×		
Pugnax nitida				×			
Pugnax swallowiana	×	(?)					
Pugnax elegans	×						
Pugnax shumardiana	×						
Pugnax osagensis		(?)	(?)	×	×		
Pugnax bidentata		×		×			
Pugnax pinguis		×					
Pugnax? pusilla				×			
Pugnax sp. a		×					
Rhynchonella? indentata	×	×					
Rhynchonella? longæva	×			(?)			
Rhynchonella? guadalupæ	×						
Rhynchonella? texana							
Dielasma spatulatum	×	×			(?)		
Dielasma prolongatum	×				×		
Dielasma cordatum	×						
Dielasma sulcatum	×						
Dielasma? scutulatum	×						
Dielasmina guadalupensis	×	×					
Dielasmina? perinflata							
Notothyris schuchertensis	×						

Range and distribution of the Guadalupian species—Continued.

	Guadalupe Mountains.				Southern Delaware Mountains.	Diablo Mountains (?).	Glass Mountains.
	1.	2.	3.	4.	5.	6.	7.
Notothyris schuchertensis var. ovata	×	(?)			×		
Notothyris sp							×
Heterelasma shumardianum	×				×		
Heterelasma venustulum	×				×		
Spirifer mexicanus	×	×					
Spirifer mexicanus var. compactus	×						
Spirifer mexicanus var		×			×		
Spirifer sp. a		×					
Spirifer sulcifer							
Spirifer sp. b			×	×	×		×
Martinia rhomboidalis	×		×		×		
Martinia shumardiana	×						
Squamularia guadalupensis	×		×		×		×
Squamularia guadalupensis var. subquadrata	×						
Squamularia guadalupensis var. ovalis	×						
Ambocoelia planiconvexa var. guadalupensis	×				×		
Spiriferina billingsi	×	×	(?)		(?)		(?)
Spiriferina billingsi var. retusa	×						
Spiriferina evax	×						
Spiriferina sulcata	×				(?)		
Spiriferina laxa		×			×		
Spiriferina pyramidalis	×				(?)		
Spiriferina hilli							×
Spiriferina hilli var. polypleurus		×			×		
Spiriferina welleri	×	(?)			(?)		(?)
Spiriferina welleri var. a		×					
Spiriferina welleri var. b					×		
Composita emarginata	×	(?)	(?)				
Composita emarginata var. affinis	×				(?)		(?)
Composita mexicana							×
Composita mexicana var. guadalupensis				×			
Hustedia meekana	×	×		×	×		×
Hustedia meekana var. trigonalis	×	×					
Hustedia papillata	(?)	×	×	(?)			×
Hustedia bipartita		(?)			×		×
Solenomya? sp				×			
Clinopistha? cf. C. radiata var. lævis				×			
Edmondia? bellula	×		(?)				
Edmondia sp			×				
Nucula sp. a				×			
Nucula sp. b			×	(?)			
Nucula sp. c					×		
Leda sp.				×			
Yoldia sp.				×			
Parallelodon multistriatus	(?)		×				×
Parallelodon politus	×		×		(?)		
Parallelodon? sp							×
Bakewellia? sp			×				
Pteria guadalupensis	×						
Pteria squamifera							×
Pteria richardsoni			(?)		×		
Pteria sp			×				
Myalina squamosa?	×	×			×		
Myalina permiana?			×				
Schizodus securus?	×						
Camptonectes? papillatus	×		×				
Camptonectes? sculptilis	×						
Camptonectes? asperatus	×						
Aviculipecten guadalupensis		×					
Aviculipecten sp. a		×		(?)			
Aviculipecten delawarensis			×				
Aviculipecten sp. b							×
Aviculipecten sp. b var							×
Aviculipecten sp. c							×
Aviculipecten infelix	×						
Aviculipecten laqueatus	×						
Aviculipecten sublaqueatus	×						×
Acanthopecten aff. A. carboniferus			×				
Euchondria? sp.	×						
Pernipecten? obliquus	×		×		×		
Plagiostoma deltoideum	×			(?)			
Limatulina striaticostata	×						
Myoconcha costulata	×						
Myoconcha costulata var. delawarensis			×				

Range and distribution of the Guadalupian species—Continued.

	Guadalupe Mountains.				Southern Delaware Mountains.	Diablo Mountains (?).	Glass Mountains.
	1.	2.	3.	4.	5.	6.	7.
Astartella nasuta			×				×
Cypricardinia? contracta	×						
Pleurophorus delawarensis			×				
Pleurophorus sp					×		
Cleidophorus pallasi var. delawarensis			×				
Protrete texana					×		
Plagioglypta canna?			×				
Cymatochiton? texanus					×		
Patella capitanensis	×						
Pleurotomaria richardsoni	×				(?)		(?)
Pleurotomaria mica	×						
Pleurotomaria multilineata			×				
Pleurotomaria putilla	×				(?)		
Pleurotomaria euglyphea			×				
Pleurotomaria ? sp. c	×						
Pleurotomaria discoidea	×						
Pleurotomaria strigillata			(?)	×			
Pleurotomaria texana					×		
Pleurotomaria neglecta	×						
Pleurotomaria sp. d			×				
Pleurotomaria arenaria			×				
Pleurotomaria arenaria var. monilifera				×			
Pleurotomaria? planulata			×				
Pleurotomaria cf. P.? planulata					×		
Pleurotomaria? delawarensis			×				
Pleurotomaria? carinifera			×				
Pleurotomaria? carinifera var					×		
Pleurotomaria? elderi					×		
Euconospira obsoleta	×						
Euconospira halliana							
Euconospira sp					×		
Murchisonia? sp. a					×		
Murchisonia? sp. b					×		
Bellerophon crassus					×		
Bucanopsis sp			×				
Warthia americana			×		(?)		
Euomphalus sulcifer		×		×			
Euomphalus sulcifer var. angulatus		×					
Turbo guadalupensis							
Turbo? sp					×		
Trochus? sp	×						
Naticopsis sp			×	×			
Zygopleura swallowiana	×						
Loxonema? inconspicuum				×			
Pseudomelania sp. a			×				
Pseudomelania? sp. b					×		
Bulimorpha chrysalis var. delawarensis			×				
Macrocheilina? modesta				×			
Macrocheilina? sp. a			×				
Macrocheilina? sp. b					×		
Orthoceras guadalupense			×				
Foordoceras shumardianum	×						
Foordoceras shumardianum var. præcursor				×			
Peritrochia erebus				×			
Paraceltites elegans			×	×			
Gastrioceras? serratum			×		(?)		
Gastrioceras sp			×				
Agathoceras texanum				×			
Waagenoceras cumminsi var. guadalupense					×		
Anisopyge perannulata	×	×	×	×	×		
Anisopyge? antiqua				×			
Cythere? sp		×					
Bairdia aff. B. plebeia				×			
Argillœcia sp					×		

1. Species from stations 2905, 2966, 2926, 2902, 2906, 2932, 3762, representing the Capitan formation.
2. Species from stations 2924, 2930, 3762a, 3762b, 3762c, 3762d, 3762e, representing the "dark limestone."
3. Species from stations 2919, 2903, 2931, 2963, 2968, representing the Delaware Mountain formation.
4. Species from stations 2920, 2967, representing the basal black limestone.
5. Species from stations 2935, 2936, 3501, 3500, 2969, 2957, 2962, 2964, 2965, supposed to represent the Delaware Mountain formation.
6. Species from station 3764, supposed to represent the Delaware Mountain formation.
7. Species from stations 3763, 3840, supposed to represent the Delaware Mountain formation.

DESCRIPTIONS OF SPECIES.

PROTOZOA.

FORAMINIFERA.

The known foraminiferal representation of the Guadalupian is meager compared with that of some regions to which reference will be made. It comprises only nine species, distributed as follows:

	Species.
Fusulina	1
Fusulinella	3
Endothyra	3
Spirillina	1
Lingulina?	1

Fusulina elongata is large and abundant, while the other types are much smaller and much more rare, so much so in fact that except a couple of silicified examples of *Fusulinella* none have been seen macroscopically. They occur, where noted, here and there in thin sections. In this condition, owing to the small number of observations, the fortuitous orientation in which they appear, the generally altered or obscured microscopic structure, and, I may add, my own too slight familiarity with the group, I have been able to determine their generic relations only somewhat unsatisfactorily, and have identified them specifically not at all. Persistent effort in sectioning would probably bring to light many other forms and lead to a more exact determination of them, but I am fain to believe that Foraminifera, aside from *Fusulina*, are considerably less abundant in the Guadalupian than in some other Carboniferous faunas.

For the Foraminifera, somewhat at variance with the scheme adopted for other groups, I have not introduced any family headings, as I find that the authorities who have been consulted disagree very widely in their family groupings and I am myself unable to determine the matter on its merits.

In the Salt Range of India Schwager found four species of *Fusulina*, one of *Fusulinella*, one of *Lingulina*, one of *Involutina*, and one of *Margaritina*. Among the Fusulinas there is nothing to compare with *F. elongata* of the Guadalupian, and it will thus be seen that the two faunas show very little relation to one another in this particular at least.

From China and Japan (in Richthofen's China) Schwager cites a still more extensive and varied fauna, consisting of 15 species, representing 8 genera, as follows:

	Species.		Species.
Fusulina	4	Tetraxis	1
Schwagerina	4	Endothyra	1
Fusulinella	1	Valvulina	1
Lingulina	1	Climacammina	2

Here again there is nothing to compare with *Fusulina elongata,* and the whole fauna has a different complexion from the Guadalupian, though, as I have before remarked, a more perfect knowledge of the Guadalupian Foraminifera is likely to increase its generic resemblances, at least, to the other more abundant faunas. Lörenthey also records an extensive protozoan fauna from China. He obtained the following types:

	Species.		Species.
Fusulina	4	Lingulina	2
Schwagerina	2	Valvulina	1
Fusulinella	2	Tetraxis	2
Archæodiscus	1	Climacammina	4
Spirillina	5	Endothyra	4
Nodosaria	1	Bradyina	1
Nodosinella	1	Cribrospira	1

This fauna, which comprises 14 genera and 31 species, is of course much more extensive than the Guadalupian. Most of the Guadalupian genera, however, are found among those cited by Lörenthey. Among the non-Guadalupian genera especial importance attaches to *Schwagerina.*

The Indian Archipelago has furnished but a small record, one or two species of *Fusulina, Moellerina,* and *Schwagerina* being all that I have encountered.

In Möller's monograph on the Russian Foraminifera no fewer than 43 species are discriminated, representing the following genera:

	Species.		Species.
Nummulina	1	Spirillina	4
Fusulina	6	Cribrostomum	8
Schwagerina	1	Tetraxis	2
Hemifusulina	1	Nodosinella	3
Bradyina	2	Archæodiscus	1
Cribrospira	1	Fusulinella	6
Endothyra	5	Stacheia	2

Already in the Moskovian this group was fairly abundant. Trautschold cites the following:

	Species.		Species.
Nummulina	1	Endothyra	1
Fusulina	1	Fusulinella	2
Bradyina	1	Bigenerina	1

Möller also names the following genera from the "Lower Carboniferous," which I take to be a corresponding horizon:

	Species.		Species.
Bradyina	1	Tetraxis	2
Cribrospira	1	Nodosinella	3
Endothyra	5	Archæodiscus	1
Spirillina	4	Fusulinella	1
Cribrostomum	6	Stacheia	2(?)

They are, perhaps, especially abundant in the Gschelian, where one genus is regarded as a diagnostic fossil, the Schwagerina zone being named after it. It is of importance to note that *Schwagerina* is not known in the Guadalupian series. Where it does occur in western North America, its horizon is, so far as can be determined, lower and its associated fauna different. If it occurs in the trans-Pecos section, as is very likely, its position is in the Hueco, below the Guadalupian.

To return to the Russian section, the number of species in the Artinskian is still considerable. Möller cited only *Fusulina verneuili* and *Schwagerina princeps*, but Stuckenberg records *Fusulina verneuili*, *F.* cf. *longissima*, together with two undetermined species of the same genus, as well as *Cribrostomum gracile* and *C.* cf. *commune*. Krotow is authority for the occurrence at this horizon of *Cribrostomum gracile*, *Cribrostomum* sp., *Fusulina verneuili*, *Fusulina* 3 sp., and *Schwagerina princeps*.

In the Russian Permian the class is still present in force, for although other authors give but scanty mention, Netschajew records four species of *Nodosaria*, one species of *Endothyra?*, one species of *Cribrostomum?*, and two species of *Spirillina*.

Enderle cites from Balia Maaden, in Asia Minor (as identified by Schellwien):

	Species.
Moellerina	2
Schagwerina	1
Fusulina	2
Miliola	1

I do not know whether Gemmellaro described any Foraminifera from the Fusulina limestone of Palermo, but this name indicates that the genus Fusulina, at least, was abundant. Schellwien described a very considerable foraminiferal fauna from the Carnic Alps, of which the following is a summary:

	Species.		Species.
Fusulina	9	Ammodiscus	2
Schwagerina	2	Textularia	2
Fusulinella	2	Bigenerina	3
Endothyra	2	Tetraxis	2
Stacheia	1		

Gortani also found forms belonging to this group in the Carnic Alps, to wit:

	Species.
Nodosinella	1
Fusulina	3
Schwagerina	1

The German Dyas is not without this class of organisms, Geinitz citing them under the following genera:

	Species.
Nodosaria	6
Dentalina	2
Textularia	4

In the Permian of England, King cites three species of *Dentalina*, two of *Textularia*, and one of *Spirillina*. Brady[a] quotes four species of *Trochammina*, one species of *Nodosinella*, one species of *Nodosaria*, two species of *Dentalina*, and two species of *Textularia* from this horizon. He also cites distribution for other areas, his entire work involving 62 species and 20 genera; but as he excludes the Fusulinas, and as the Permian horizon is that which chiefly interests this discussion, it does not seem necessary to consider his other data.

[a] Brady, H. B., Carboniferous and Permian Foraminifera: Mon. Pal. Soc., London, 1876, pp. 1-166, pls. 1-12.

I have not found recorded any representatives of this class from the Arctic region, from New South Wales, or from South America.

The survey of the foraminiferal development of the upper horizons of the Carboniferous, thus hastily made, seems to bring out several facts of at least seeming significance. The different types aside from *Fusulina* can not positively be said to be less well represented, rather than less well known, in the Guadalupian, but I believe that they really are less well represented than in certain favored areas in other parts of the world. *Fusulina elongata*, the characteristic Guadalupian foraminifer, is unique the world over for its robust growth and elongate shape. The conditions which proved so salubrious for *Fusulina* may have been adverse to the development of other types, so that they are, as already noted, somewhat scarce. In the typical Russian Permian, the Dyas of Germany, and the Permian of England, while other foraminiferal types persist the genus *Fusulina* is made notable by its absence. It is represented in the Artinsk by two species; *F. verneuili* and *F. longissima*. These two Russian species, together with several from India, where *F. longissima* is also found, are especially similar to *F. elongata* by reason of their long slender shape, a configuration which seems to be rather significant of late Carboniferous horizons, of a faunal province, or of both.

If references in literature furnished an accurate index of the distribution of fossils, one would be justified in inferring that except for the fusulinoids Foraminifera were much less numerous and well differentiated in the Carboniferous of North America than in other parts of the world, since there have been obtained in England, in continental Europe, in India, and in China a large number of genera, such as *Fusulinella, Stacheia, Psammophis, Hemidiscus, Archæodiscus, Spirillina, Nodosinella, Lingulina, Climacammina, Bradyina, Cribrospira, Cribrostomum, Moellerina,* and others, which are as yet unknown in the two American continents.

Compared with this list our own representation is meager indeed, including little besides the fusulinoids. *Endothyra* is plentiful at certain localities in the typical Mississippian, and a species has also been cited from probably the same general horizon in the Rocky Mountains. Bagg, furthermore, has given a list of genera not, for the most part, recorded elsewhere, observed in a Mississippian limestone of Colorado.[a] A species of *Nodosinella* has been also described from the Carboniferous limestone of Windsor, Nova Scotia, but these occurrences are also, so far as known, in the lower Carboniferous.

In the upper Carboniferous we have five species of *Valvulina* from the Mississippi Valley, which have never been rediscovered since their first description, and the following list, which Spandel[b] has recently described from the Pennsylvanian of Kansas: *Ammodiscus* cf. *filum, Ammodiscus concavus, Bigenerina* cf. *eximia, Monogenerina atava, Monogenerina nodosariiformis, Textularia gibbosa, Tetraxis conica* var. *lata, Nodosaria postcarbonica, Geinitzina postcarbonica, Dentalina bradyi, Fusulina* cf. *regularis*,[c] and *Fusulina* sp. There are, in addition, the Fusulinas,

[a] Mon. U. S. Geol. Survey, vol. 31, 1898, p. 29.

[b] Spandel, E., Festschr. Natur-hist. Gesell. Nürnberg, 1901, p. 174.

[c] Schellwien also cites this species from the Pennsylvanian of the Mississippi Valley region (Palæontographica, vol. 44, 1897, p. 251). He notes (p. 280) that though *Fusulina cylindrica* is cited with the greatest frequency from this region, the identifications are, in many cases at least, incorrect.

which are so abundant that they occur almost everywhere. In this general reference are also included fossils of the genus *Schwagerina* which are found only in the far western areas of this continent, so that the foraminiferal representation of the typical Pennsylvanian with these few exceptions is restricted, one might almost say, to the genus *Fusulina* itself. But the Fusulinas of the Mississippi Valley for the most part belong to a single type, for which I recently introduced the name *Triticites*. *Triticites* ranges well westward, but the typical Fusulinas with fluted walls appear to be rare in the Pennsylvanian and so-called Permian of the Mississippi Valley.[a]

If one compares the foraminiferal fauna of the Guadalupian with that of the Pennsylvanian the greatest difference is apparent. Not only does the Guadalupian contain a larger and more varied representation, but where there is common ground the differences are really remarkable. *Fusulina elongata* both belongs to a different and more complex group of the fusulinoids than *Triticites secalicus*, and is even unique among the Fusulinas themselves.

When fossils strike the eye they are collected, and when collected they are described; but they escape observation not only by reason of rarity but by smallness of size as well, and the Fusulinas owe their frequent citation to excellence in both particulars, since, though smaller than most fossils, they are readily visible as individuals, and in many places they occur in incalculable profusion. The other types are, for the most part, of less robust proportions, and while they might thus more readily escape observation and owing to difficulty be neglected in research, it is pretty safe to conclude that they are really far less plentiful than the Fusulinas. Therefore it is probable that a well-directed and persistent search would show that the Pennsylvanian foraminiferal fauna was fully as diversified as the Guadalupian, and that the Guadalupian itself was much more varied and extensive than we now know it.

Thus while it is likely that the Foraminifera of the Guadalupian are really no more varied than those of the Pennsylvanian, I can not but lay stress on the great difference manifested by the single type which they possess in common, and express the expectation that, in view of this difference and that of the associated fauna, the remaining Guadalupian and Pennsylvanian Foraminifera, when they shall have become better known, will prove to be almost equally distinct.

Although the true Fusulinas, of which *F. elongata* is a representative, occur in western North America, they are quite distinct from the latter specifically and are, so far as known, associated with very different faunas. The only exception which need be made to this statement is a large elongate species occurring in the highest Paleozoic rocks of California, which, though I have not examined it microscopically, by its shape and size is very suggestive of *F. elongata*. The associated fauna, however, contains little that recalls the Guadalupian.

Schwagerina, at least the large rotund type, appears to be restricted to the western portion of the continent, its horizon in California being below the elongate *Fusulina* just mentioned. This genus is not known in the Guadalupian fauna, its position in the trans-Pecos section—if it really occurs there, which I can not positively assert—being in the Hueco formation, which lies below the Guadalupian beds.

[a] That they do occur there, however, appears to be shown by the citation by Spandel and Schellwien of *Fusulina regularis*, as above noted.

Genus FUSULINA Fischer de Waldheim.

This genus is represented in the Guadalupian fauna, so far as known, by but one species, that described by Shumard nearly fifty years ago as *Fusulina elongata;* but while apparently possessing the structural characters of typical *Fusulina*, *F. elongata* is unique among known members of the genus in the relatively gigantic proportions which it attains. It is found in the profusion in which shells of this class are wont to occur, whole strata being practically composed of it.

It has this abundance in the highest known horizon of the Capitan limestone, where, with the exception of sponges, it dominates the faunal representation to the exclusion of other types.[a] It is absent in the middle portion of the Capitan, however, where the most prolific molluscan fauna was found. In the "dark limestone" and in other portions of the Delaware Mountain formation it is also abundant, associated with trilobites, mollusks, etc. It is not known in the black limestone at the base of the Guadalupe section, however, but has been obtained from the southern Delawares and probably from the Glass Mountains.

Although, as before remarked, but one species has at present been discriminated in all this wide range and distribution, it is possible that local conditions of preservation may have operated to conceal the presence of related forms, although unrelated species, unless very rare, probably do not occur. In the Guadalupe Mountains these fossils are not found free and with the detailed characters brought out by weathering. On the contrary, at some horizons, before they were covered over and solidified into the hard Capitan limestone, each organism became the center of a thick dolomitic envelope, which effectually conceals everything except general proportions. Thus, for the most part, instead of using macroscopic characters for the index of specific discrimination, this has to be reached much more laboriously by thin sections of individuals selected more or less at random. While, as already stated, similar species may from these causes have been passed over, obviously distinct ones, such as have a notable difference of proportion, must be absent or rare.

F. elongata possesses the structures of typical *Fusulina*, but differs importantly from the Pennsylvanian forms, which commonly pass as representatives of this genus. This fact led me to introduce the term *Triticites*[b] for the Pennsylvanian type. While in *Fusulina* the radial walls are so fluted as to form with one another a division of each longitudinal chamber into a great number of little chamberlets, in *Triticites* the radial walls are straight, except in the terminal regions, and the chambers practically continuous from end to end. All the structural features which I noted in *Triticites* had already been described by Schellwien for *Fusulina*,[c] and the main differential character lies in the plication of the radial walls. Although Doctor Schellwien writes me that, as I had already surmised, an intergradation is found between these two types, and expresses the opinion that *Triticites* on this account is not a valid term, I venture to hold to the belief, having due regard to his extensive knowledge of this group, that where the extremes are as widely divergent as in the present case they should not be placed in a single genus. A distinguishing name will do good service in recording differences, both in dispersion and geologic range.

[a] At least where I collected it, at station 2905.
[b] Am. Jour. Sci., 4th ser., vol. 17, 1904, p. 234.
[c] Palæontographica, vol. 44, 1897, p. 238.

FUSULINA ELONGATA Shumard.

Pl. V, figs. 1 to 5; Pl XVII, figs. 1 to 8; Pl. XXII, figs. 7 to 9; Pl XXVII, figs 1, 2.

1858. *Fusulina elongata.* Shumard, Trans Acad. Sci. St. Louis, vol 1, p 297 (date of volume, 1860). White [Permian] limestone, dark limestone, and sandstone: Guadalupe Mountains, New Mexico and Texas

1859. *Fusulina elongata.* Shumard, idem, p. 388.
White [Permian] limestone and underlying sandstone: Texas and New Mexico

Shell nearly cylindrical, very slender and much elongated, pointed at the extremities, which are slightly curved; chambers very numerous, aperture very narrow, linear, extending the entire length. Surface covered with fine, somewhat flexuous striæ.

Dimensions.—Length, from 1 to 2 inches, width, from 1 to 2 lines. This species is at once distinguished from *F cylindrica* by its remarkable length.

Occurs in the white limestone, dark limestone, and sandstone of the Guadalupe Mountains of New Mexico and Texas.

Shumard's rather brief characterization of this species, which is quoted above in full, leaves considerable to be added in the way of detail and somewhat in the way of correction. Probably the most remarkable feature of *F. elongata* is its length and slender proportions. Shumard gives the length as from 1 to 2 inches (25 to 50 mm.), and the width as 1 to 2 lines. About 5 mm. is the maximum diameter observed by me, and the average is perhaps 3 to 3½ mm., while many examples are still smaller. I also, in a brief preliminary announcement of this fauna, said that *Fusulina elongata* probably attained a length of 2 inches. This is perhaps an overestimate, as no specimens have come to hand exhibiting these dimensions. These fossils show an unexpected tendency to break up into short sections, and also to exfoliate spirally. This is especially true of examples from the Delaware Mountain formation and from the "dark limestone," where probably the largest individuals occur. It is rare to find specimens complete, even in the matrix, at these lower horizons, and I have never seen one of the larger specimens complete. Fragments measuring 30 mm. are rare. One is, moreover, liable to be misled in estimating the original length from fragments, for, instead of tapering gradually to a point, many examples, especially large ones, terminate rather abruptly with bluntly rounded ends. It seems to me not improbable, however, that some large examples did reach nearly to the dimensions indicated—50 mm.

The shape is usually more or less contorted, sometimes once curved, less often in several directions. The sutures are as a rule flexuous, and sometimes their course is very irregular. They are also occasionally confluent, in which case of course the chambers do not extend the entire length of the shell. The sutures are somewhat depressed and are closely disposed. They number 36 to 39 in a large volution, as indicated by the partitions seen in transverse sections. In addition to the longitudinal markings produced by the sutures there are also to be clearly seen in some specimens transverse rings, which are close together and are undoubtedly to be associated with the division of the chambers into chamberlets. The number of volutions in this species is uncertain, and of course varies in proportion to size. It is difficult if not impossible to count those in the extreme center. Certainly ten or eleven turns are completed in some instances.

Although several authors, more recently Schellwien in particular, have described the structural features of *Fusulina* with much care, some observations on the structure of *F. elongata* seem in this connection deserving of record. The initial cell is well shown in a number of the sections studied and is of unusually large size. What may be regarded as the mature condition seems to have existed during the formation of most of the shell. Growth was effected by the addition of chambers extending usually from end to end of the axis. The back and floor of each chamber are formed by earlier portions of the test, the top and front by a new mural growth which at first has a spiral direction and later by a sudden bend becomes radial. Thus what superficially in cross sections has the appearance of a continuous revolving wall, and has sometimes been represented as such, is in reality made up of many discrete sections, each of which is directly connected with a radial partition. Neither the spiral nor the radial walls which constitute the two structural elements are simple or continuous as a whole. They are mutually continuous, but are discriminated by a change in structure accompanying a change in direction. Almost always it is possible to make out, and in most cases to do so clearly, an outer layer, which is thin and opaque, and an inner portion, quite distinct from the crystalline calcite that usually fills the chambers, which is translucent and relatively much thicker. That the dark line which bounds the outer half of each chamber does not simply mark a plane against which organic material was deposited from two directions is shown by the fact that it defines the outline of the final volutions. It is true, however, that on the inner volutions secondary deposits of testaceous material are sometimes made. This layer forms a plane of dehiscence along which the volutions separate, but it remains with the older volution of which it formed the external surface.

There is also a structure which has caused the shell in this genus to be described as perforate. In brief, the wall seems to be intersected by innumerable tubular pores, or if solid by rods, whose direction is normal to the two surfaces. As these have the same appearance in sections perpendicular to the axis as in those parallel to it, they can safely be said to be cylindrical, though, as they can often be distinctly seen to contract toward the outer side of the wall, their real shape is rather that of an elongated cone. They are dark when seen in section, like the outer superficial layer with which they appear to connect. This circumstance, together with the fact that they are evidently not continuous with or of the same substance as the crystalline calcite with which the chamberlets are filled, leads me to doubt that they were ever hollow tubes. This structure seems to be limited to the revolving wall, the radial wall being solid and homogeneous.

Just after the wall is flexed from a spiral to a radial direction it becomes regularly and strongly fluted transversely to its length. Each of the partitions is so arranged with regard to those adjacent that the concave folds of the one are opposite and adnate to the convex folds of the other, so that each long longitudinal chamber is in this way cut up into many chamberlets. It is the absence of this structure in *Triticites* which distinguishes that genus from *Fusulina*. Practically no intimation of this structure is retained upon the exterior, where a straight, linear, longitudinal furrow marks the suture between each two chamberlets; but if the outer wall is removed the anastomosing partition walls are seen forming a regular network whose openings have a quincuncial arrangement and extend in spiral lines. Almost equally marked evidence of the same structure can often be seen at the aperture in the columnlike fluting of the partition wall. Indications less striking appear in sections in the loops and lines which the partitions make when cut in different directions.

Probably no single chamber is completely inclosed by its partition wall, which many sections, both in *Triticites* and *Fusulina* itself, show to be incomplete—that is, it is seen not to extend quite to the revolving wall beneath. In a transverse section the partitions appear to be sometimes complete and sometimes incomplete, and as it often happens that for a whole volution or two they are the one, and then for an equal distance the other, it seems rather probable that little openings are left at the base of the partition wall, and that these are somewhat regular in their distribution, appearing more or less consecutively in a linear way in concentric lines. It was through these openings, and not probably through the pores, that the protoplasm issued to feed and to secrete new chambers.

Shumard cites the range of this species as being extended from the yellow sandstone through the "dark limestone" and into the "white limestone" above. This statement is corroborated by later observations, and I have not been able to discriminate specifically between the lowest and the highest occurrences of this form. While maintaining about the same proportions throughout this range it is possible that a discrimination can be effected on certain microscopic differences. For example, in cross section the specimen from the Delaware Mountain formation represented by fig. 8 of Pl. XXII shows the shell to be more loosely coiled; or, in other terms, the quotient of revolution to be different from that found in figures of specimens from the "dark limestone" and from the top of the Capitan formation. My studies have not yet progressed sufficiently for me to state whether this difference is constant between forms occurring at the two horizons, or whether it can possibly come within the limits of specific variation.

Fusulina elongata is frequently found in extreme abundance. Calcareous bands are produced in the sandstone by its occurrence, and thick strata in the limestones are composed almost entirely of it. It is especially abundant in the very highest strata seen in the Capitan formation,[a] where the fauna seems to consist almost wholly of these Fusulinas and of calcareous sponges. At this horizon, where considerable beds are almost entirely made up of these organisms they show a marked tendency to assume uniform orientation, as if arranged by current action, so that when the rock is broken in one way only transverse sections are exposed, and in another only longitudinal.

Near the base of the Capitan, in what is probably Shumard's "dark limestone," they are again very abundant, but are here associated with a considerable brachiopod fauna. The main Guadalupian fauna described in these pages, which was obtained about midway between these two horizons, is not associated with *Fusulina*. In the Delaware Mountain sandstone these fossils occur at several horizons in great abundance, but they have not yet been found in the basal black limestone.

In addition to localities in the immediate vicinity of Capitan Peak we have *Fusulina elongata* from points many miles to the south, where it occurs in limestones supposed to represent the Delaware Mountain sandstone of the typical Guadalupian section, as well as from the same horizon (provisionally) far to the southeast, near

[a] Station 2905. The statement is not true of the collection made by Mr. Richardson at presumably the same locality and horizon (station 2966).

Marathon. A large, much elongated, and slender species, probably identical with this, is found in great profusion in California, on McCloud River, in the upper beds of the Carboniferous section above the McCloud limestone, which carries *Omphalotrochus* and *Schwagerina*—i. e., in the Nosoni formation, or, as it was formerly called, the McCloud shales—and also in other areas.

Horizon and locality.—Top of Capitan formation, Capitan Peak (stations 2905, 2966, 3762); "dark limestone," station 3762a, Pine Spring (station 2930), and hill southwest of Guadalupe Point (station 2924); Delaware Mountain formation, Guadalupe Point (stations 2903, 2919, 2931, and 2963), Guadalupe Mountains, Texas. Delaware Mountain formation, southern Delaware Mountains, Texas (stations 3500, 2969, 2957, and 2964). Delaware Mountain formation, Comanche Canyon, Glass Mountains (station 3763) and mountains northwest of Marathon (station 3840), Texas.

Genus FUSULINELLA Möller.

FUSULINELLA sp. *a*.

Pl. V, fig. 6.

Although much less abundant than the Fusulinas, the Foraminifera belonging to other genera hardly form a negligible quantity in the Guadalupian fauna. For the sake of completeness I have felt constrained to give them a cursory treatment, although with much diffidence. On the one hand, I have not had previous occasion to give these forms much attention, and consequently approach the subject with but little experience; and, on the other, the study of the Guadalupian Foraminifera is beset with something more than the ordinary difficulties. Though the Fusulinas occur in great profusion, I have been unable to find the other forms in the gross, owing to their small size and much less abundance, and it is necessary both to discover and to study them by aid of thin sections. This means, of course that no examination can be made of their external characters and that the orientation of the sections is entirely a matter of chance. Furthermore, in most cases the original substance of these organisms has been so altered that the detail of their structure has been impaired if not altogether obscured.

Although, as I have said, they are very much less numerous than the prevailing *Fusulina elongata*, as also very much smaller, a number of organisms of foraminiferal nature are shown in the sections which I have had made; but for the most part the few cells are arranged in so irregular a manner that the sections evidently depart widely from the critical orientations in respect to which the structure of the organism can be intelligently studied. I regard it as possible, therefore, that the sections examined really represent a more varied foraminiferal development than I have been able to discriminate; and, on the other hand, that some of the forms discriminated may really be one and the same.

In the highest horizon of the Guadalupe Mountains, associated with *Fusulina elongata*, though much less abundant, is a form which I think should be referred to *Fusulinella*. One section especially shows a regularity of arrangement indicating that it is oriented in accordance with one of the axes. It is represented by fig. 6 of Pl. V. It seems to be directed at right angles to the axis of revolution and to be situated rather near one of the ends. Other sections which can probably be referred to the same species appear to have cut the shell more at random. The general shape of the organism, so far as can be ascertained from my very imperfect data, was spheroidal, much flattened through the axis. There are about 24 chambers in the final volution, as near as can be counted. The walls appear to be double and imperforate, but the minute structure of many of these forms has been obscured or even perverted by preservation. These characters seem to warrant the provisional assignment of this shell to *Fusulinella*, but my material is too imperfect to justify me in describing it as new or attempting to identify it with species known.

Horizon and locality.—Top of Capitan formation, Capitan Peak (station 2905); Delaware Mountain formation, Guadalupe Point (station 2903), Guadalupe Mountains, Texas. Delaware Mountain formation, southern Delaware Mountains, Texas (station 2957).

FUSULINELLA sp. *b*.

Pl. XXVII, figs. 5 and 5a.

This species is represented by a single silicified specimen from the southern Delawares. Only the exterior is accordingly known. The shape is compressed spherical, the axial diameter being about half that in the plane of revolution. The latter measures about $1\frac{3}{4}$ mm. There are, as well as can be counted, 26 chambers in the last volution. The partitions are simple and straight. Either the sutures are very deep or, more probably, what is presented for study is not the shell itself but a silicified mold of the interior, and what appear to be the sutures are really the cavities left by the walls.

There are no American species with which to compare this form save *Fusulinella* sp. *a* of the Capitan, and as the present form is known only macroscopically and *Fusulinella* sp. *a* only in thin sections, which are, moreover, for the most part oriented at random and have the structures but poorly shown, the conditions are not at hand for a very satisfactory comparison. The present form appears to demand recognition as a distinct species because it is much larger and has, for the size, less numerous chambers.

It hardly seems profitable to compare with foreign species the form under discussion, because the conditions under which it is studied would prevent a satisfactory conclusion in any event.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

FUSULINELLA sp. *c*.

This species, like the foregoing, is represented by a single specimen and, though found in association with it, appears to belong to a distinct species, or at all events a distinct variety. The number of chambers and other characters are about the same in both, the only obvious difference being that of proportion, the present form having about twice the axial diameter of the other, resulting in a nearly spherical, instead of a flattened, shape. Owing to their size and shape it seemed probable that this and the preceding form were Fusulinellas rather than Schwagerinas, it being impossible to resort to thin sections for the determination of this point.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

Genus ENDOTHYRA Phillips.

ENDOTHYRA sp. *a*.

Pl. XVII, fig. 11.

One of my slides shows a shell referred with some doubt to the genus *Endothyra*. The section does not pass through the test with a critical orientation, but somewhat obliquely. For a short distance it nearly coincides with the plane of one of the partitions, probably the outer partition, and partially shows an interesting feature, namely, that this wall was pierced by relatively large round pores. How many of these there were and whether they had any definite arrangement are at present unanswerable questions. They appear to have been few.

The obliquity of the section which enables this character to be seen distorts the remaining parts so that the facts that would be shown in a section normal to the center of the axis can not be definitely ascertained. There must have been from 15 to 20 chambers in the last volution, and the partitions can be inferred to be strongly convex. As so often occurs in the Guadalupian rocks, the original composition of the shell seems to have been altered and the present appearance can not be entirely trusted. There is a thin dark-colored outer layer and a thicker, less dense inner one which shows very indistinct traces of having been perforate.

The appearance of this section is shown by my figure. The general character seems to agree best with *Endothyra*. The number of chambers is perhaps a little high for that genus, and much too high for *Bradyina* or *Cribrospira*. The important feature presented by the perforated outer partition is, to be sure, rare in *Endothyra*. Möller has found it in a few species, where it seems to occur chiefly in the final chambers when they assume a rectilinear instead of the usual spiral direction. It is much more common in *Bradyina* and *Cribrospira*, but so far as can be inferred the pores are larger and less numerous in the form under consideration than is characteristic of those genera.

Horizon and locality.—Top of Capitan formation, Capitan Peak (stations 2905?, 3762); "dark limestone," Pine Spring (station 2930), Guadalupe Mountains, Texas.

ENDOTHYRA sp. *b*.

Pl. XVII, fig. 10.

My figure shows the appearance of the form on which the present division is based. I judge that the section is not quite perpendicular to the axis and that it lies a little to one side of the center. Some of the partitions are incomplete and some appear to be complete. The line of growth in the final volution of the shell seems about to be changing from a spiral to a rectilinear direction, a feature sometimes found in *Endothyra* but rare in other genera. The final volution appears to have consisted of about 18 chambers.

The microscopic structure is obscure, but appears in the main to be like that of the foregoing species, with a thin dark outer and a thick light inner layer, but in places the walls seem to be divided by a line of nearly transparent material, so that they have the semblance of being double, as was described by Möller for *Fusulinella* and as is seen in the figured specimen of *Fusulinella* sp. *a*. To this fact but little weight can attach, as owing to alteration a similar appearance can occasionally be noted in *Fusulina elongata*, and as Schellwien regards this apparent structure to be adventitious even in typical *Fusulinella*. Indeed, the discrimination between *Fusulinella* sp. *a* and these two species of *Endothyra* rests on uncertain evidence. The figured specimens of the Endothyras have of course peculiar characters, which are not to be found in the other sections referred to the same species. These differ from *Fusulinella* sp. *a* in being larger and having, for their size, fewer chambers. But if the figured section of *Fusulinella* sp. *a* were supposed to be taken near an extremity of the axis, a section through its center would give at the same time a larger size and no greater number of chambers. Such a section would present no marked differences, so far as I can see, from most of those referred to *Endothyra* sp. *a* and *Endothyra* sp. *b* without, however, necessarily possessing the peculiar features of what may be called the typical specimens of either. But unless situated at the very extremity of the axis, and unless very nicely oriented to it, the figured section of *Fusulinella* sp. *a* could hardly fail to cut some of the earlier volutions and consequently to present a different appearance from what is really the case. It seems probable, therefore, that the forms placed with *Fusulinella* sp. *a* are different even from the nontypical shells referred to *Endothyra*, being neither peculiarly located sections nor small and immature specimens. As the number of chambers per volution increases with size, in the latter event the number in mature shells of the *Fusulinella* would be greater than in the corresponding size of the *Endothyra*.

If really congeneric with the types, the other specimens referred to *Endothyra* sp. *a* and *Endothyra* sp. *b* can hardly be Fusulinellas, even if they prove not to belong properly to *Endothyra;* while if not congeneric they may be Fusulinellas, but they are as distinct from *Fusulinella* sp. *b* as from *Fusulinella* sp. *a*, being much smaller and for the same size more highly chambered.

Horizon and locality.—"Dark limestone," Pine Spring, Guadalupe Mountains, Texas (station 2930).

ENDOTHYRA sp. *c*.

Pl. XXVII, fig. 4.

Unlike the two other types which I have referred to this genus, that under consideration is represented by a section which is nearly parallel with, instead of nearly perpendicular to, the axis. I have not thought it to be the same species as they, however, because it is much smaller and composed of a larger number of cells than they would have had at the same size. The general character of this form is shown by my figure, to which I am unprepared to give any additional data.

The other species were referred to *Endothyra* with some doubt, but the appearance of the present section is more characteristic and the generic reference is made with greater confidence.

While the four different types of coiled shells which I have discriminated as *Fusulinella* sp., *Endothyra* sp. *a*, *Endothyra* sp. *b*, and *Endothyra* sp. *c* are quite distinct in the oriented sections on which they are based and in some others, the many views fortuitously cutting these organisms present, naturally, very varied appearances, and many of them I find it impossible to refer with any confidence to to one type or the other. Of such assistance as might be afforded by the minute structure of the test I have been deprived, as the structure has in most cases been lost through alteration.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (station 2964).

Genus SPIRILLINA Ehrenberg.

SPIRILLINA aff. S. PLANA Möller.

Pl. XVII, fig. 9.

This species is based essentially on the little specimen a section through which is shown by fig. 9 of Pl. XVII. It appears to be related to *S. plana* Möller, but to be probably a distinct species. The rate of expansion is considerably less than in Möller's species, the walls relatively thinner, and the number of volutions greater. The walls do not show the closely perforate structure represented in Möller's figure, appearing in fact to be nearly structureless, but this is probably the effect of alteration. I am not certain that my specimens do not belong to the group for which Schellwien recently introduced the name *Hemidiscus*.

Because my material is so limited and its characters so imperfectly known I have, as in other cases, refrained from proposing a specific term for this form.

Horizon and locality.—Top of Capitan formation, Capitan Peak (station 2905); "dark limestone," Pine Spring (station 2930), Guadalupe Mountains, Texas.

Genus LINGULINA D'Orbigny.

LINGULINA? sp.

Pl. XXVII, fig. 3.

The figure on Pl. XXVII shows all that is known of this form, which occurs, however, in several slides from this station. It appears to consist of a rectilinear series of flattened, subspherical, more or less embracing chambers, which gradually increase in size from one end to the other. The microscopic structure has been entirely obscured, and the section does not show whether the chambers were connected by large oral apertures. The general appearance is rather suggestive of *Lingulina széchenyii* Lörenthey,[a] but the generic and the specific relations are at present a matter of uncertainty.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (station 2964).

[a] Wissenschaftliche Ergebnisse der Reise des Grafen Béla Széchenyi in Ostasien, Wien, 1899, vol. 3, p. 280.

SPONGIÆ.

The sponges of the Guadalupian form a remarkable feature of the fauna, both in abundance, variety, and peculiar development. This group is apt to be neglected, in the field as well as in the laboratory, and in the present case no special effort was made when collecting to obtain material. In fact, attention was particularly centered on the brachiopods and mollusks; yet the sponges have proved not the least novel and varied element of the fauna.

The preservation of my specimens leaves in many cases much to be desired, and often it has been impossible to refer them even to the genus with certainty. The two types of Silicispongiæ and Calcispongiæ have been recognized, not because of any difference in their present mineral composition, but by reason of apparent structural affinities. In the white limestone of the Guadalupe Mountains, where sponges are especially abundant, both types lack the original siliceous composition which one of them is supposed to have possessed. It is chiefly at this horizon alone that the Calcispongiæ, so far as known, are found. In the lower beds of the Guadalupe section and at some of the outlying localities the Silicispongiæ still retain their siliceous nature, though probably not the original siliceous material or form.

Owing to the aberrant character of some of the organisms here referred to the sponges, their determination as belonging to the Lithistida of the Silicispongiæ or to the Calcispongiæ is still debatable. *Steinmannia*, *Amblysiphonella*, etc., which seem by common consent to be grouped with the calcareous sponges, have completely lost the spicular structure of their walls, and the types from the Capitan in which this has happened, especially those that manifested an appreciable analogy in their organization to the genera named, have been placed with the same group, as indicating apparently the best disposition which it is at present possible to make of them.

Owing partly no doubt to their real scarcity, but in some degree probably to their unattractive character and the little promise of return which they hold out, sponges have been described in but few of the works with which it seemed desirable to compare the Guadalupian fauna. One of the exceptions is, of course, Waagen's monograph on the faunas of the Salt Range of India. In this work species belonging to the genera *Amblysiphonella* and *Steinmannia* are described, showing an agreement, so far as they go, with the Guadalupian fauna, which possesses, however, a much greater abundance and variety of these organisms. In his paper on the Chitichun fauna No. 1 Diener cites a species of *Amblysiphonella* and a *problematicum* which may prove to be one of the Calcispongiæ, though of a genus different from any of the Guadalupian types and probably new.

Among the scattered references in which sponges of this period are treated, perhaps the most noteworthy, aside from that of Waagen, are several which deal with the European Permian. In the Russian Carboniferous series these organisms would appear to be very rare. Netschajew, however, in his account of the Permian faunas of eastern Russia figures two specimens[a] representing a type which is rather suggestive of some of the Guadalupian genera (*Guadalupia cylindrica*). Whether this resemblance is entirely superficial or has some real basis in structure can not be told.

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[a] Netschajew, A., Kazan Obshchestvo Estestvo-Ispytatelei, Trudy, vol. 27, 1894, Pl. I, figs. 27, 36.

In his monograph on the Dyas, Geinitz cites a number of sponges, most of them, it is true, quoted from King. The two German species which he figures are too imperfectly known for me to ascertain their relationship to the Guadalupian forms.

King's monograph, already referred to, contains the citation of five species of sponges, which he distributes among the genera *Tragos*, *Scyphia*, and *Mammillopora*. The form figured as *Scyphia tuberculata* is very suggestive of that which in the Guadalupian has been named *Cystothalamia nodulifera*, but here again the means are not at hand for determining whether the resemblance is accidental or intrinsic. The four other species do not recall anything in the Guadalupian fauna, although the form referred to *Mammillopora mammillaris* may be related in point of structure, though less so in growth, to *Virgula neptunia*.

Hind's catalogue of sponges in the British Museum shows a rather limited list of species, and one which manifests very little resemblance to the Guadalupian. Among the monactinellids he cites one species of *Reniera?* and one of *Haphisteon;* among the tetractinellids one species of *Geodia* and one of *Pachasterella;* among the lithistids one species of *Doryderma;* and among the hexactinellids two of *Hyalostelia* and four of *Holasterella*. *Mortiera vertebralis*, a type of unknown affinities, is also recorded. We note here the large development of hexactinellids and the absence of calcareous sponges, almost the reverse of what is found in the Guadalupian.

I should not neglect to mention in this connection the fauna collected by Barois from Sebargas, Spain, in which Steinmann described the genera *Sebargasia*, *Amblysiphonella*, and *Sollasia*. I do not know what the associated fossils were, nor the age they indicate, but in the abundance of sponges, and to a certain extent in the character of those present, though probably but one of the genera found in Spain is represented in the Guadalupian, a certain affinity is shown with the fauna of the Guadalupe Mountains.

Lastly, in North America we have five genera of sponges in the Pennsylvanian, only one of which—*Amblysiphonella*—is common to the Guadalupian.

Lacking in conclusiveness as these comparisons probably are, they certainly show to some degree the unusually prominent place these organisms take in the Guadalupian fauna, and the unique structural types by which that fauna is distinguished.

SILICISPONGIÆ.

Order LITHISTIDA.

Suborder TETRACLADINA.

In the Guadalupian fauna three generic types are referable to the lithistid sponges (*Anthracosycon*, *Virgula*, and *Pseudovirgula*), and according to the best of my present knowledge they have been placed with the Tetracladina. The intimate spicular character and construction of these sponges has not been determined with ease or certainty, for the spicules are small and so completely consolidated that it is practically impossible to tell where one begins and the other ends.

While these genera have been placed with some confidence among the Lithistida, and less confidently among the Tetracladina, I have avoided entering on the subject of assembling them into families, not only because of uncertainty or incompleteness of information, as above recorded, but also from a doubt as to what should constitute a family among these forms. It appears, at all events, that *Anthracosycon* should be referred to a different family from *Virgula* and *Pseudovirgula*, and possibly these two genera also should be placed in different families, a decision depending on the presence of certain characters which are as yet doubtful.

Genus ANTHRACOSYCON n. gen.

Shape turbinate or pyriform, attached by the smaller end, without a peduncle or with but a small, ill-defined one. Cloaca represented by a slight depression on the upper surface, from which descend several (three or four) tubular openings through the axial region of the sponge. Ostia small and numerous. The spicular structure consists of minute, regular tetraxons, more or less digitate toward the extremities of the arms (?), where they unite with one another to form a rigid skeleton. Loose monaxial spicules associated with typical specimens may belong to the same genus.

Not having found any Carboniferous genus to which this sponge could consistently be referred, I have erected a new one for it. Its systematic position seems to be clearly with the Lithistida, and I would be disposed to place it among the Tetracladina.

Type.—Anthracosycon ficus.

ANTHRACOSYCON FICUS n. sp.

Pl. XXIV, figs. 1, 1a, and 2.

Shape turbinate or ficiform, more or less oblique, attached at the small end. Peduncle small or absent. Cloacal depression slight. Ostia small, averaging about one-half millimeter across, circular, closely arranged at distances from one another of about their own diameter. They tend to be connected, especially in the upper portion, by channels whose general direction is radial from the cloaca.

The spicules are very small, apparently regular tetraxons, more or less branching at their ends, by which they are cemented to form a rigid skeleton. With these sponges are associated numerous loose monaxial spicules, which, if they belong to the same organism, probably had a dermal position.

The type specimen of this species, which was obtained in the black limestone south of El Capitan, is of medium size, having an axial length of 18 mm. and a greatest diameter of 24 mm. It is strongly oblique and much flattened above, with a scarcely perceptible cloacal depression. There are slight constrictions of growth parallel to the upper surface.

Horizon and locality.—Basal black limestone, Guadalupe Point, Texas (station 2920).

ANTHRACOSYCON FICUS var. CAPITANENSE n. var.

Pl. VII, fig. 10.

When I first described the species *Anthracosycon ficus*, with the typical specimen, which was obtained from the black limestone at the base of the section, was placed one from the white limestone of the Capitan. The two are very similar in external form—much more nearly identical than would be expected from their wide separation in geologic horizon, the chief difference being that the typical specimen is strongly oblique and that from the Capitan more nearly erect. Another difference consists in the fact that the Capitan example, which is considerably smaller, has distinctly larger ostia, while more careful comparisons seem to show that the spicular structure is also coarser. Some latitude must be allowed to the last statement, for it is just possible, though I do not believe it to be the case, that in the typical *A. ficus* we have not the original spicular structure of the sponge, but a fibrous, siliceous mass retaining only the general arrangement.

On account of these differences of structure, for that manifested in the inclination of the axis is probably only an individual character, it seemed necessary to separate the Capitan specimen from those obtained at a lower horizon. Another specimen from the Capitan subsequently came to hand, much smaller than the first, which on being broken lengthwise shows a group of several relatively large tubes occupying the axial portion and apparently representing several cloacæ debouching in the depression which occupies the upper end of the sponge.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926).

ANTHRACOSYCON? sp.

Associated with portions of a sponge which have been referred to *Anthracosycon ficus* was found a little group of consolidated spicules, distinguished from them by having a distinctly coarser mesh. On more careful examination the component spicules appear to be of the four-rayed type and to have the arms, or at all events three of them, considerably branched. It did not, therefore, seem appropriate to place this form with *Anthracosycon ficus* because of the larger sized and more conspicuously branched spicules, and even the assignment to the same genus is attended with much uncertainty, since the construction of the sponge body as a whole is yet unknown. More exact knowledge as to the character of the spicular elements, as well as of the general structure, will be needed before the affinities of this form can be determined.

Horizon and locality.—Basal black limestone, Guadalupe Mountains, Texas (station 2920).

Genus VIRGULA n. gen.

Sponges belonging to this genus are rather abundant in the Guadalupian and can be differentiated into several species. The spicular mesh is rigidly consolidated, and it is very difficult to determine with certainty the character of the typical individual spicules, since there is no definition between them. It is inferred to be a regular tetraxon, with the arms but little divided, if at all. From the distinct outline in rock sections of certain of these sponges a dermal layer of some sort may be inferred, but its character can not be determined from the material in hand.

The general shape in which these organisms grow is subramose, sometimes in relatively slender stalks with few branches, and at others irregularly and frequently branching. There is in some specimens a tubular cloaca extending part way through the center of the sponge, but this has not been demonstrated as a permanent feature. Ostia appear to be absent.

Type.—*Virgula neptunia.*

VIRGULA NEPTUNIA n. sp.

Pl. VII, figs. 11 and 12.

While this species is fairly abundant in the Capitan limestone, it so happens that in the most perfect specimens, those which best show the shape, the structure is obscured, while the specimens in which the spicular architecture is especially well preserved are fragments. The general shape seems to be more or less irregularly cylindrical, rather frequently bifurcating or putting out short branches. It seems very probable that in the upper ends of the branches there was a tubelike cloaca of greater or less depth, but this can not be affirmed positively. The branches sometimes attain a diameter of 10 mm. and rarely exceed it to any extent. Usually these bodies are seen on the broken surface of the dense limestone, nearly circular when the section is transverse, more or less elongate when otherwise directed, and irregular when near the branching point. When the preservation is good the outline is fairly distinct and entire, indicating, it would appear, that there was a thin dermal layer, the spicular structure of which, however, has not been made out.

Where well preserved the skeleton is seen to consist of a rigid complex of cemented spicules, which are of rather large size. This complex is not easily analyzed into its constituents elements. So seldom do four rays diverge from a point, and so often three, that it seems highly probable that the spicular unit was a tetraxon. Absolute regularity is not maintained in this respect, however, and one or two specimens, which appear to be for the most part composed of tetraxons, show part of the structure as if made up of continuous parallel rays with cross arms at right angles to them, a type of structure which is most naturally associated with the Hexactinellida. Nevertheless, I am fairly satisfied that this sponge belongs with the Lithistida.

These fossils are liable to be poorly preserved, and instead of appearing composed of distinct spicules the structure is sometimes represented merely by a fine mottling of opaque and semitransparent whitish dots, or the structure may be lost altogether, the definition of the sponge as a whole, nevertheless, remaining fairly distinct. When poorly preserved, it is of course difficult to distinguish this form from even such types as *Guadalupia cylindrica* and *Cystothalamia nodulifera*, which, though widely different in structure, have a similar growth, and it is possible that some of the obscure specimens placed under this name may be of a bryozoan nature; in their present condition it is impossible to be sure.

Horizon and locality.—Middle of Capitan formation, Capitan Peak (station 2926), and peak north of Pine Spring (station 2902?), Guadalupe Mountains, Texas.

VIRGULA RIGIDA n. sp.

Pl. VII, fig. 13.

I am a little uncertain as to the proper position of the specimen on which this subdivision is chiefly based. As will be seen from the figure, it consists of two straight cylindrical branches connected at their bases and marked by irregularities due to growth. The spicular network is largely obliterated, but seems to be the same as in *V. neptunia*. There is no cloaca. The external surface is seen to be reticulated more finely than a spicular framework like that of typical *V. neptunia* would produce. It may be the dermal layer. In a general way one notices that the dominating system of lines in this superficial network is longitudinal.

A number of other specimens have been assigned to this species, but the reference is more or less uncertain in proportion to their very imperfect preservation. They consist, so far as known, of simple cylindrical stems without bifurcations. Typical specimens of *V. neptunia* are short, often tapering, with a tendency to send out imperfect branches. On account chiefly of these differences in the mode of growth it seemed best to keep the present forms distinct from *V. neptunia.*

Horizon and locality.—Top of Capitan formation, Capitan Peak (station 2905?); middle of Capitan formation, Capitan Peak (station 2926), and peak north of Pine Spring (station 2902?), Guadalupe Mountains, Texas.

Virgula rigida var. constricta n. var.

Pl. VII, figs. 14 and 15.

This variety is based on some slender specimens which have a diameter of 7 mm. or less and are distinguished by somewhat contorted growth and by more or less pronounced constrictions, which are neither parallel to one another nor equal distances apart. These constrictions are purely external and are independent of structures within. They do not mark internal partitions, the spicular skeleton being uninterrupted by them.

The spicular structure is similar to that of *V. neptunia.* A deep tubelike cloaca seems to be a constant feature.

This form is distinguished from *V. rigida* by its smaller size and more pronounced constrictions.

Fig. 15 of Pl. VII represents a specimen which has been referred here with some doubt. Weathering has caused it to show clearly the reticulate surface, due most probably to spicular framework. In this particular it has a different appearance from the typical examples, which have been broken from unweathered rock. Aside from this and one or two trivial differences, the only other point of disagreement is the complete absence of a cloaca, a structure which is present in the typical examples.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926).

Genus PSEUDOVIRGULA n. gen.

This term is introduced for a species which I originally placed with the genus *Virgula,* but which on reconsideration it seems desirable to refer to a distinct group. The general appearance, as cylindrical stemlike growths, is similar, and the character and arrangement of the spicules also resemble those of *Virgula.* On the other hand, *Pseudovirgula tenuis* is provided with large ostia, structures which have not been observed in the other group. Inside the dermal layer, between it and the consolidated spicular median portion, is an empty or hollow zone, which if a real character (this being very doubtful) would constitute an important distinction between the form in question and those subsumed under the title *Virgula.* Again, *Pseudovirgula tenuis* is somewhat obscurely divided off into structural segments. The presence of large ostia is the only difference subsisting between *Pseudovirgula* and *Virgula* which can perhaps be called real and constant, but in view of the indications of the additional differences mentioned it hardly seems a sound course to place both types in the same genus.

Type.—*Pseudovirgula tenuis.*

PSEUDOVIRGULA TENUIS n. sp.

Pl. VII, figs. 16, 16a, and 17.

This species forms small, more or less irregular, cylindrical branches, which probably sometimes divide. The branches seem to vary in diameter from 2 to 4 mm. The spicular skeleton is as in *Virgula neptunia*, but considerably finer. The spicules are arranged so that in tangential section one axis tends to form, with others similarly arranged, continuous, longitudinal lines. In cross section no particular arrangement is noticeable. Individual spicules can not be distinguished, so complete is the cementation of the framework, but as frequently three axes diverge from a point the typical spicular element is interpreted as being a tetraxon, though it is possibly a hexact. In the typical example the spicular structure does not continue quite to the sharply defined perimeter of the sponge body, but leaves a somewhat irregular zone, which would appear to have been hollow; I suspect, however, that the spicular framework actually did connect with the dermal layer and that its peripheral portions have been obliterated. In the typical specimen the outer surface is furnished with a number of relatively large, somewhat tubularly projecting mouths, or ostia, and in another specimen these structures are seen to penetrate the spicular network as wall-less tubes. In one example in which a longitudinal section is seen, the sponge body appears to be obscurely divided off as if by several cessations and renewals of growth. Some specimens have the spicular mesh finer than in others.

In its general mode of growth and spicular structure this form resembles *V. neptunia*, so that one would at first be disposed to refer them to the same genus, but the presence of large ostia is a character not known in any species of *Virgula*. It is certainly not present in the form described as *V. rigida*, and could hardly fail of preservation if it had been present.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926).

Order HEXACTINELLIDA.

Suborder DICTYONINA.

The hexactinellid sponges are represented in the Guadalupian fauna by a single species of so unusual a character that it clearly belongs to a new genus and probably to a new family. I have not, however, introduced a family designation for this form, awaiting more complete and exact data as to the proper character of its organization before essaying to fix its relations and affinities with others of the Hexactinellida.

Genus STROMATIDIUM n. gen.

This name is introduced for a new genus of siliceous sponges whose general shape and construction are as yet unknown, but whose spicular structure has been definitely ascertained. It is mainly made up of layers of spicular reticulations, separated and held together by pillarlike rays. The spicular elements are believed to belong to the hexactinellid system, one ray being aborted, one constituting the pillar ray, and the four others forming the mural layers. These mural rays apparently branch, probably several times, all of the elements lying in the same plane and inosculating with one another and with adjacent spicules so completely that the constituent arms can no longer be differentiated. The more or less regular mesh which results appears to be quite continuous and homogeneous. Associated with fragments having the foregoing structure are great numbers of loose spicules, which may belong to the same sponge, fulfilling the function of flesh or dermal spicules. A few of these are hexacts but most are monacts, some short, curved, and tapering to blunt points, others much longer and very slender, sometimes nearly if not quite straight.

While it will appear from what has been said that these sponge fragments probably belong to the Hexactinellida, the difficulty of discriminating individual spicules in the mural layers is such that the individual elements may possibly have been normal tetracts and the systematic position really with the Lithistida. If a hexactinellid, this is clearly an aberrant form, and while it probably belongs to the Dictyonina, is of doubtful family position.

Type.—Stromatidium typicale.

STROMATIDIUM TYPICALE n. sp.

Pl. XXVII, figs. 7, 8, 8a, 9, 10, and 10a.

The size and general shape of the entire sponge in this species are unknown, the parts which are preserved permitting only an adumbration of these characters. The nature and arrangement of the spicules, on which the species is accordingly based, are, however, well shown by the typical specimens. The spicular skeleton consists of more or less regular, superimposed layers, which are connected by pillars having a radial direction. These slender connecting pillars are evidently single rays of spicules, whose other rays lie in a plane normal to them and inosculate with one another to form the superimposed reticulated layers. The reticulation of the latter is so complete that it is impossible, in the specimens examined, to discriminate individual spicules. Spicular centers are often indicated by broken ends of the pillar rays, the initial number of mural rays proceeding from which is usually four, meeting rather regularly at angles of 90°; but these rays appear to branch and to inosculate with one another and with those of adjacent spicules to form a more or or less regular mesh, the apertures of which are approximately circular, but of variable sizes. The pillar rays are apt to be rather far apart, so that if some of them have not been destroyed without leaving any very perceptible traces, the mural rays may branch several times before meeting those of adjacent spicules.

I regard this structure as being made up of hexacts, the sixth ray in each case being aborted (for the pillars do not seem to be continuous from layer to layer) and four of the five other rays branching and inosculating to form the mural reticulations. This belief finds additional support in the discovery of loose normal hexactinellid spicules associated with this sponge, and of one of them in fact apparently forming an integral part of the skeleton. In this connection mention must be made of loose spicules, mostly monacts, which occur in really great numbers, associated with fragments of this sponge. Many of these are small, slender, slightly curved, and tapering to a point at both ends. Others are nearly or quite straight, very much longer, though equally slender, and either gently tapering or truncated, in the latter case probably being merely broken segments of long acicular forms. The spicules usually show clearly the fine central canal, a structure, the retention of which, taken in connection with the present siliceous composition of the spicules, suggests that the original material was also siliceous.

Considerable intervals, to speak relatively, are left among the sparse pillar rays and the spicular layers which they connect. This space may have been occupied by the loose spicules of which mention has already been made. One large hexact does in fact occupy some such position, as already noted, though its location in the sponge at all may be accidental.

Owing to the arrangement above described, the anastomosing mural rays form a much more firm and solid structure than their union with one another by means of the pillar rays, so that it is common to find thin scalelike fragments of the mural reticulation which retain but little evidence of the pillar rays that originally united them. These fragments are usually more or less strongly curved, indicating that aside from irregularities in the layers themselves the shape was probably more spherical than planate. Doubtless a canal system, of which no trace is found in the small pieces thus far examined, was originally present, but its character is unknown.

Another feature of this sponge which must not be overlooked consists in the development of numerous small spines or papillæ upon the mural rays. These occur in varying degrees of eminence and are usually more striking on one side than on the other. In one example, one side of which is apparently smooth, the other side, as a result, it would seem, of an unusual development of these apophyses, is covered by a complete entanglement of fine branching structures like an adherent layer of delicate inosculating spicules. This is interpreted as being part of the same sponge to which the other fragments belong, representing perhaps some specialized portion of the anatomy. In a corresponding manner the pillar rays also, though to a limited extent, bear spinelike developments.

Horizon and locality.—Delaware Mountain formation, Guadalupe Point, Guadalupe Mountains, Texas (station 2963?). Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

CALCISPONGIÆ.

Order SYCONES.

The sponges of the Guadalupian fauna comprise some very remarkable types referable to the Calcispongiæ. First in interest among these is the genus *Guadalupia,* which embraces forms so peculiar that it has seemed necessary to regard them as representing not only a genus but a family which is new. Scarcely less remarkable is the genus *Polysiphon* for which also the establishment of a new family seemed to be demanded. Standing less aloof from types previously described is *Cystothalamia,* a group which though more obviously related to existing genera I have nevertheless felt compelled to regard also as a new genus and family. To the previously described genus *Amblysiphonella,* representing the Sphærosiphoniidæ, the Guadalupian furnishes one new species. The Sphærocœliidæ also are represented in the Guadalupian by species in one instance belonging to the genus *Steinmannia* and in another referred, with much hesitation, to *Sollasia.* These five families, with their six genera, I am at present placing in the order Sycones.

Family GUADALUPIIDÆ n. fam.

Although several species have been discriminated as belonging to the genus *Guadalupia,* I find much difficulty in framing a description of this new family, because since only one genus is known it is impossible to separate family characters from those which are solely generic. The distinctive features suggested by the species of *Guadalupia* are the growth, usually in lamellar expansions, and the construction of the walls, which are composed of tubes having a direction normal to the two surfaces, the superficial layers being reticulated and apparently formed of large, mutually consolidated spicules. A cloaca, strictly so called, seems to be absent, though possibly the whole organism may be analyzed into a colony of cylindrical individuals having some of the characters of the Sphærosiphoniidæ. In this case the cavities of the tubes would be cloacæ. The surfaces, while porous, probably have nothing corresponding to ostia.

Genus GUADALUPIA n. gen.

This generic name is introduced for a structural type which is fairly common in the white limestone of the Guadalupe Mountains, but while a number of specimens have been obtained they are so liable to be fragmentary and to have the more minute structure obscured that their study has been pursued under some difficulty and attended with incomplete success. These organisms are believed to belong to the class of Spongiæ, but they are sufficiently obscure and aberrant to make their exact zoological position a matter of some doubt. They assume a variety of shapes—massive, cylindrical, frondlike—the walls being of considerable thickness and of unusual construction. The most striking feature, and one which is most largely developed, occupying the greater portion of the mural body, consists of a series of cylindrical tubes parallel to one another and perpendicular to the two walls which they connect. These tubes are rather closely arranged, usually almost in contact. Their walls are substantial, yet at the same time a considerable caliber is left within. They contract somewhat at either end, and are gently curved. They are also intercepted at very variable intervals by straight, flat diaphragms, which may be close together or, on the other hand, almost absent, though the continuity of the tube is generally more or less interrupted close to the point where it terminates. The structure of the surfaces in which the mural tubes terminate has not been ascertained in its details. It consists of a rather open but moderately fine mesh, which is probably composed of large spicules, the exact shape of which it has not been possible to make out. It is not certain that both walls had the same structure, though such is not improbably the case.

Various shapes are assumed by the organisms, which possess, in the main, this sort of structure, but it is probable that they may have had initial stages very much alike. Such a condition appears to be presented by the young specimen figured on Pl. VI, which is attached below by a thickened and rather dense basal portion. Its growth has begun to form an explanate shape, the tubes being perpendicular to the plane of expansion. The upper wall is thin and has a reticulate structure. This specimen is provisionally referred to *G. zitteliana*, which in its mature stages is a branching frond, and it is evident that the mode of growth in which this young example started to develop would have to be changed in order to produce the configuration of the mature sponge. Similar modifications of growth must be supposed if the mature shape is that of *G. cylindrica*.

The spicular structure of these organisms has been to a considerable extent obscured. The dermal layer, as already remarked, seems in many cases quite clearly to be the result of large consolidated spicules, while the mural tubes frequently appear to be entirely structureless. It seems probable, however, that they also are made up of interlocking spicules of large size, for in some thin sections their walls are seen to be marked with rather regularly distributed dots, which probably represent sections through the arms of spicules. At the same time, these darkened spots in the walls of the mural tubes have, so far as observed, always a circular shape, while it would be expected that in some cases at least the direction of the section would coincide with the longer axis of the spicular rays.

In some respects the structure of this sponge suggests the geologically much older genus *Receptaculites*, and one might be tempted to interpret the mural tubes as the axes of large spicules, but the analogy soon ends, as there is nothing to correspond to the other rays of such spicules, while the occurrence of transverse partitions dividing the tubes entirely negatives the interpretation of them as spicules.

Type.—Guadalupia zitteliana.

GUADALUPIA ZITTELIANA n. sp.

Pl. VI, figs. 1 to 1d, and 2 to 2b.

This species occurs in the form of broad, gently convex fronds, which, as in the typical specimen, are sometimes branching. One of the largest fragments referred to this species is about 45 mm. square. The thickness seldom equals 10 mm. and averages perhaps but 6 or 7 mm. It diminishes somewhat toward the margins of the frond, which are rounded. The fronds are marked with transverse irregularities and wrinkles, which presumably represent stages of growth. The mural tubes average 1 mm. in diameter, or perhaps a little less, and the partitions by which they are crossed vary much in frequency in different cases. The dermal mesh is much finer than the tubes, but at the same time is rather coarse and made up of large spicular elements.

A small specimen which appears to belong with this species has a small peduncular attachment, the main portion of the organism being explanate, with a flattened upper surface, to which the mural tubes are perpendicularly directed. While the growth in this specimen is approximately symmetrical, it is to be supposed that one side would have expanded at the expense of the other, to produce the frondlike shape which distinguishes mature forms like the type specimen.

It is a little surprising that this species has a convex instead of a flat shape, since the first inference is that it is represented by fragments of what was originally a cone or a cylinder, but the structure is so finished at the margins as to furnish evidence that this was not the case.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926). Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763).

GUADALUPIA ZITTELIANA var.

In this form, which is known only from limited and imperfect material, the mode of growth is in flat lamellar expansions having a thickness of 4 mm. or a little more. The mural tubes come about eight or nine in a distance of 5 mm. They are, therefore, considerably smaller than in typical *G. zitteliana*, and this constitutes at present the chief reason for distinguishing the two forms. It is possible that this is the same species as *G. zitteliana*, by reason of being not younger or undeveloped portions of a frond, but merely a more delicate variety connected by intermediate stages not yet discovered. On the other hand, it is possible that with the small proportions are associated other differences which in my imperfect material it is impossible to make out.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926).

GUADALUPIA CYLINDRICA n. sp.

Pl. VI, figs. 3 to 3c.

The type specimen of this species has a somewhat cylindrical shape, tapering gradually at one end, and with the cross section approximately circular. The largest diameter is about 13 mm. and the length is estimated at 40 mm. The outer surface is obscured, but other specimens referred to the same species are marked by gentle swellings and constrictions, due to irregularities of growth.

Guadalupia cylindrica not only has a cylindrical form, but is hollow, the internal cavity not improbably corresponding to the cloaca of other sponges. In the typical example the thickness of the walls is about 3 mm. The mural tubes have essentially the same size as in *G. zitteliana*, about five or six occurring in a linear distance of 5 mm., and their direction is of course normal to the two surfaces which they connect. They are intercepted by tabular partitions, as in *G. zitteliana*, and, as in that species, the dermal layer is composed of large spicules whose character has not yet been determined. The walls of the mural tubes sometimes show dark spots, which appear to represent sections through spicular rays, and from this it may perhaps be inferred that the tubes also were composed of consolidated spicules, as in the dermal layer, though in most sections the tube walls appear to be structureless, even when the spicular mesh is obvious in the latter.

It is only in a sense that this species can be said to be hollow. In the type specimen the mural tubes terminate some distance before reaching the axis, their ends forming a rather irregular inner boundary whose ragged outline contrasts with the regular exterior one, but what would otherwise be a hollow cavity is partially filled by cysts. (See figs. 3 and 3a of Pl. VI.) Whether these form part of the real sponge body, or their presence is adventitious, I have been unable to determine, but they have in a general way some of the structural features of the sponge with which they are associated. Some of the specimens referred here appear to be without the central cavity, but as it was probably confined to the upper portion of the organism it is not necessary to suppose that they were entirely without it.

All the specimens at present referred to this species are single stalks, which have not divided to form branches; but one individual shows on its upper margin what seems to be the inception of a small bud, although it is possible that it is the commencement of a new and alien individual.

Nine or ten specimens have been referred to this species, and they show considerable diversity in appearance, but this is due in part to the alteration which has to a greater or less degree affected all the Guadalupian sponges and made it extremely difficult to identify many of them even generically.

Horizon and locality.—Top of Capitan formation, Capitan Peak (stations 2905 and 2966); middle of Capitan formation, Capitan Peak (station 2926) and peak north of Pine Spring (station 2902), Guadalupe Mountains, Texas.

GUADALUPIA CYLINDRICA var. CONCRETA n. var.

Pl. VI, figs. 4 to 4b.

The specimen which has been separated under this title appears to have arisen not so much by gemmation as from a natural lateral expansion, or possibly from the amalgamation of two or three separate individuals which have independent but contiguous points of origin, and since they developed in contact became organically confluent. On the upper portion, at all events, there are separate "cloacæ" and the mural tubes are directed in a measure toward independent centers. This is only to a certain extent true of the specimen, for though at one end there appears to be a circular "cloaca" of about the size and character of that in *Guadalupia cylindrica*, followed laterally by two other similar but much smaller ones, for the rest the growth seems to have assumed a bifoliate arrangement, without any central opening at all.

If this colony originated by gemmation from a single original individual the budding or fission took place at a very early stage.

In other respects this form is closely allied to the type specimen of *G. cylindrica*, having an external spicular layer and mural tubes of about the same diameter. It is possible that it may have arisen from a typical example of *G. cylindrica* by some unusual process of increase.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926).

GUADALUPIA CYLINDRICA var. ROBUSTA n. var.

Pl. V, fig. 12.

Several specimens are subsumed under this title. Their preservation is very unsatisfactory, but they seem to have the essential structures of *Guadalupia cylindrica*. At the same time the epidermal spicular layer, though presumably present, has not been observed. The size is considerably greater. The specimen figured is branched, but the internal structures have been obscured, so that intrinsically one can not determine whether it actually belongs to *Guadalupia* or not. Another example shows the characteristic mural tubes, but the central cavity seems to be lined with a relatively thick, dense layer which the mural tubes do not penetrate. In another part the same specimen appears to be filled up centrally by this secretion, a "cloaca" being absent. A third example has a diameter of 33 mm. and remarkably large mural tubes. The "cloaca" appears to be open, and I am not prepared to affirm definitely the presence or absence of an inner layer. The specimen is referred here with doubt.

Horizon and locality.—Top of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2905).

GUADALUPIA FAVOSA n. sp.

Pl. VII, fig. 9.

This species is based on a small, apparently massive, somewhat irregularly shaped specimen, whose greatest diameter is about 24 mm. The mural tubes have a small diameter, and while approximately circular are in close contact. About six or seven occur in a linear distance of 5 mm. I am not sure that the dermal layer has been observed, but what appears to be this portion is full of small openings, more or less uniform in size and regular in distribution, which may be circumscribed by the arms of large-sized spicules. This layer is rather thin and the pores are small, being about one-fourth the diameter of the tubes.

In this specimen the walls of the tubes show a singular structure not noted elsewhere. They are now represented by dolomite (?), but this material has the appearance of being very finely porous, resembling in appearance the shells of some punctate brachiopods. This structure is probably rather secondary than organic.

The irregular massive growth and the small size of the mural tubes distinguish this form from the others here described.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926).

GUADALUPIA DIGITATA n. sp.

Pl. V, fig. 13.

This name is proposed for a specimen which is rather regularly cylindrical in the lower part, where it has a diameter of about 11 mm., gradually expands above, and is terminated by an umbel of rather stout, equal branches. Four of these are developed on the side of the specimen which is exposed to view, and if symmetrical there must have been about eight in all. The lower part of the body is solid, while the branches have cylindrical "cloacæ."

The structure in this specimen is largely obscured, but the branches show not only the "cloacæ" but traces of mural tubes. The main part of the stem, moreover, is covered with regular little elevations or monticules, which may have had the same origin. These are considerably smaller than the mural tubes in other species of the genus, and also smaller than the mural tubes in the branches of the same specimen. They might be thought to represent the inner diameters of the tubes, but are too closely arranged to be so interpreted.

There might at first seem to be some question as to whether the digitate end were not really the basal end, and the branches really roots. The fact, however, that the branches are clearly hollow—i. e., occupied by "cloacæ," while the opposite end is solid, seems adverse to such a view, while other members of the genus are known to attach themselves merely by cementation, without developing rootlike processes.

Horizon and locality.—Middle of Capitan formation, peak north of Pine Spring, Guadalupe Mountains, Texas (station 2902).

GUADALUPIA sp.

Pl. VI, fig. 5.

Fig. 5 of Pl. VI represents a specimen, probably belonging to the genus *Guadalupia*, whose specific position at least is uncertain. It appears to have been an elongate, generally cylindrical body composed of tubes having an approximately radial direction. In cross section the tubes, instead of being circular, are crescentic or shield shaped. They taper in size toward the center, where they appear to be rather small, and are gently curved either upward or downward, it is impossible to tell which. None of the finer structures are preserved.

I am disposed to believe that this may be the same species as *G. cylindrica* var. *robusta*, differences in preservation causing these forms to present considerable difference in appearance. It is true that the typical example of *G. cylindrica* is hollow; yet, as other examples apparently representing the same species are solid, this difference probably would not hold. The mural tubes in *G. cylindrica* are normally, perhaps always, circular in cross section, yet the rhombic shape of those of the present example may be distorted by compression or by mutual crowding. This specimen is considerably larger than the type of *G. cylindrica*, but not so large as an example provisionally referred to the variety *robusta*, and it is not conceived that this difference would have much weight if an agreement were found to exist in other particulars.

A second specimen referred to this species is much smaller and with finer tubes.
Horizon and locality.—Middle of Capitan formation, peak north of Pine Spring, Guadalupe Mountains, Texas (station 2902).

GUADALUPIA ? sp.

Pl. V, figs. 7 to 11.

In the highest fossiliferous horizon of the Capitan limestone occurs a form whose zoological affinities are obscure. Several sections are represented by figs. 7 to 10 of Pl. V. The original shape seems to have been short-cylindrical, open at one end and closed by a rounded wall at the other. It is true that most of the sections are nearly circular, from which a spherical shape would be inferred, but some are elliptical and several are elliptical with one end open. If the latter are not broken or misshapen my interpretation as to the real configuration would appear to be demanded.

These bodies are of appreciable size, with a diameter of 1½ mm. or less. The walls are rather thick and pierced by large circular pores extending through to the inside. Somewhat depends, however, on the interpretation of the sections. Some of these appear as hollow rings and some as disks having a rather coarsely reticulate structure, the "pores" being round. Intermediate conditions are found, showing clearly that the reticulate sections merely represent more tangential views through the same organism. Nearly always there is an outer envelope of dark-colored material to be distinguished alike from the surrounding rock and the included transparent calcite, which represents, as I suppose, the original test. At this horizon the large Fusulinas, and doubtless the smaller organisms, are completely covered by a coating, more or less thick, composed probably of dolomite deposited about them before they were buried by the calcareous sediments. In sections which show a reticulate structure the filling of the openings is of the same dark (dolomitic) material of which the outer coating is composed. Where the section shows an annular structure there is usually an inner as well as an outer coating of dolomite. If these sections were exactly perpendicular to the axis they would doubtless show alternating radial bands of light and dark, representing walls and pores, respectively, but this has rarely been observed. Almost always, owing to obliquity of sections, the pores are represented merely by regular scallops, sometimes on one but usually on both sides of the ring-shaped section, which very seldom pierce quite through the transparent testaceous or probably pseudotestaceous material.

Just what place in the animal kingdom these bodies occupy is a matter of doubt. That they are not foraminiferal is clear. I doubt that they are radiolarian, not only because of their supposed shape but because of their large size. It is possible that they may prove to be something in the nature of calcareous algæ, but the most probable hypothesis seems to be that they are calcareous sponges related to *Guadalupia* or possibly belonging to that genus. Their very small size is unfavorable to such a hypothesis, as is also the absence, so far as known, of any spicular structure or of a spicular outer layer, as in *Guadalupia*.

The form and structure of these small bodies somewhat recalls Schwager's genus *Margaritina*. Several important differences are, however, at once noted, since the Guadalupian form is smaller, is not inflated, and appears to have one end rounded and closed, with the other open. Even were the resemblance still closer it would not resolve the doubts in which its zoological relations are involved, since the position of *Margaritina* is not known with certainty.

Fig. 11 of Pl. V represents a similar though much more delicately constructed organism, which appears to have had a conical shape. Whether this should be regarded as belonging to the same or a different type can not be told. The small size and correspondingly diminutive construction of this body render the probability much greater than in the other case that it may be a radiolarian.

Horizon and locality.—Top of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2905).

GUADALUPIA? sp. var.

Pl. XXVII, figs. 11 and 12.

The form which I have referred to merely as *Guadalupia?* sp. occurs near the top of the Capitan limestone, where it is associated with abundant *Fusulina elongata* and with sponges. At another somewhat distant locality, belonging probably to a different horizon, and in a different faunal association, since *Fusulina elongata* does not occur there, is found a form which much resembles *Guadalupia?* sp. The fossils from the latter station (2964), while in very close agreement with the others, show certain intrinsic differences, of a minor character, it is true, but such as for the present indispose me to refer both without reserve to the same species. While individual specimens can be selected in which these differences are not found, yet as a rule the forms under consideration differ in having the walls thicker and the length greater. No section, for example, like that shown by fig. 11 of Pl. XXVII, was obtained from the Guadalupe Mountains, where, in fact, most of the sections were nearly circular. This circumstance is possibly to be accounted for through drifting of the specimens by current or wave action, as a result of which the Fusulinas, as already mentioned, occur with their axes more or less parallel.

This form, by reason of its thicker walls and more pronounced cylindrical shape, resembles *Margaritina* still less than the foregoing species.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (station 2964).

Family POLYSIPHONIDÆ n. fam.

While it is difficult in the case of the only species which is known of this genus and family to distinguish the specific characters from the generic, it is still more difficult to give a family diagnosis which may be expected to stand, and to discriminate the family characters from those which are generic and specific. Probably all types which could be referred to this family would have a conical or cylindrical shape, a thin outer wall, porous possibly but without ostia, and an internal structure consisting of tubular canals, some of which run lengthwise and some in a radial direction.

Genus POLYSIPHON n. gen.

The characters of the singular form on which this genus and family are based are so unique that it is difficult, in the case of the single species known, to distinguish the generic characters from those which are more purely specific. Nevertheless, I would briefly note here some of the structural features which would presumably be present with some modification in all species of the genus.

The shape and general appearance of this form remind one of a zaphrentoid coral, as the shape is conical, with a depression in the upper or larger end semblable to a calice. Internally the structures consist of tubular canals, one of which occupies a central position, the others being arranged regularly about it. In the typical species the peripheral tubes are five in number. These bifurcate and by this means connect with one another, and they also connect with the axial tube by radially directed tubular ducts, which are developed at the same level. The outer wall and those of the tubes are thin; the tubes and intervening spaces are hollow.

At first I was disposed to regard this as a singularly preserved coral, but it would indeed be a peculiar preservation which would metamorphose the typical structure of a zaphrentoid coral into that of the organism above described. We can probably eliminate the corals entirely from the list of possibilities.

There is another group which I must mention in this connection, though its relationship at first seems so remote that I almost hesitate to introduce it—the Echinodermata. Pentameral symmetry is rather persistently maintained by this class of organisms, and in a silicified fragment which I think must be regarded as the proximal end of an echinoid spine somewhat similar structures are shown. Aside from structure, however, the size and shape of the specimens which form the subject of the present description are such that it seems to me rather unlikely that they belonged to a crinoid or an echinoid, although it can not be said that such an origin is impossible.

On the whole, the calcareous sponges of the order Sycones can best be made to receive this form, whose position would probably lie in the vicinity of *Cystothalamia* and *Guadalupia*, but scarcely in the same family. A new family must be provided, which may be called the Polysiphonidæ.

It is hardly necessary to give in detail the family characters which distinguish this singular type. The family Polysiphonidæ is quite distinct from the other families of the Sycones, the nearest being doubtless the Cystothalamiidæ. From this the Polysiphonidæ differ in having a solid instead of a perforated outer wall, in being without ostia, and in having a definite and peculiar arrangement of the internal tubular structures, the tubes in *Cystothalamia* being more numerous, imperfect, chiefly radial in direction, and without and definite order of arrangement.

Type.—Polysiphon mirabilis.

POLYSIPHON MIRABILIS n. sp.

Pl. XVI, figs. 11 to 11b.

This species is based on two specimens, which may originally have belonged to the same individual. In general they look much like a zaphrentoid coral, and I temporarily placed them with the *rugosæ*, attributing to some peculiarity of preservation the internal structures, which are quite unlike those of the cœlenterates. From the outside, however, they show differences from the corals, because the exterior is smooth, without annular growth lines, and more especially without the fine longitudinal ribs which are connected with the development of the septa. On the interior the structure is still more unlike that of the corals, but it is also so different from the normal sponge structure that my reference to the sponges is not made without misgivings. There is a thin conical bounding wall, and in the larger specimen a depression in the upper end corresponding to the calice. Within, however, instead of plates we find tubes. There is an axial tube, which is closed at the top and makes an elevation or boss in the center of what presumably should be considered the cloaca. Around this there are in the present specimen five other tubes, which are in part free and in part adnate to the outer wall. Toward the top these tubes bifurcate, and thus connect with one another. They also connect with the axial tube by large radial ducts, developed at the same level just below the point of bifurcation. In the present specimen these tubes, except the central one, are open around the edge of the cloaca, but it is impossible to tell whether this is the original condition or whether the rim of the cloaca has been broken off and with it the upper or terminating portion of the tubes. The walls are thin, without at present any perceptible traces of spicules. The tubes themselves and the intertubular spaces are empty.

These structures have been described as if they were perfectly regular, and they are in fact remarkably so, but slight deviations from the ideal scheme above described do occur, and they are represented in my figures.

Horizon and locality.—"Dark limestone," Pine Spring, Guadalupe Mountains, Texas (station 2930).

Family CYSTOTHALAMIIDÆ n. fam.

The difficulties which were met with in the case of the Polysiphonidæ in defining the family characters when only one species is known occur again with the Cystothalamiidæ. Genera so related to *Cystothalamia* as to be referable to the same family would probably have a cylindrical or conical form, the upper end depressed into a more or less profound cloaca, which does not, however, persist to the bottom. The external wall is thin and perforated by pores of two sizes and by ostia. The internal cavity is occupied by cysts, which have a more or less irregular arrangement, and in especial are not grouped into separate rings, as in the Sphærosiphoniidæ and the Sphærocœliidæ. It is the absence of this character, as well as the presence of others, which distinguishes the three families of Guadalupian Sycones here discriminated and named from those mentioned above. They are so distinct from one another and from such other zoological families as I have found distinguished among the Sycones that it has hardly seemed necessary to indicate specifically the characters on account of which they are believed to demand separate recognition.

Genus CYSTOTHALAMIA n. gen.

This genus grows as rather slender, cylindrical, branching stems. It is probable, but not certain, that a more or less profound cloaca was present in the upper end. The internal structure consists of vesicles, which toward the periphery assume to a greater or less degree regularity of size and shape, while toward the interior they are more irregular, but they do not form regular superimposed chambers or tiers of chambers, as in the Cœlosiphoniidæ. Being built up by aggregations of vesicles, the exterior usually, perhaps normally, has a mammillate surface. The vesicles communicate with one another by means of circular openings and to some extent by tubelike canals. With the surrounding medium, they communicate by means of numerous small, regularly arranged openings in the outer walls and also probably by a series of larger and less numerous pores, or ostia, which sometimes project as little tubes.

The walls are thin and, at present, apparently structureless, but doubtless originally consisted of an entanglement of spicules.

I have felt compelled to propose a new family name for this genus, because among the imperfectly known Paleozoic Calcispongiæ I have been unable to find one described in which it could appropriately be located. It can not be placed in the Sphærosiphoniidæ or the Sphærocœliidæ, because it is not made up of a series of rings or segments, nor, in spite of a certain analogy, can it be placed with the Gualupiidæ, because it is not composed of discrete, separate-walled tubes and because it lacks (?) an outer spicular or fibrous layer. The most significant features of the Cystothalamiidæ at present appear to be the absence of a persistant tubular axis, the continuous nonsegmented augmentation, and the camerate structure, consisting of apparently hollow cystiform chambers.

Type.—*Cystothalamia nodulifera.*

Cystothalamia nodulifera n. sp.

Pl. VII, figs. 1 to 3; Pl. XXXI, figs. 20 to 20b.

This species grows in irregularly cylindrical, more or less contorted forms, having a diameter of 7 to 10 mm. or more. That these stemlike bodies are sometimes forked is indicated by several specimens. In a silicified example there is a central tube extending part way down the organism, which would seem to be a cloaca, although I am not sure that this is a constant feature. Many specimens do not show this structure, which, however, would be confined to the terminal portion of branches. Externally, the surface is covered with small rounded elevations or monticules, and in one specimen by spoutlike tubular projections. In this case the stem is large and probably old, and it lacks, over this part of the surface, the little monticules which smaller branches show. This appearance may be accounted for by supposing it to belong to old age, the branches having been thickened so as to obliterate the monticules and to prolong into short tubelike projections the ostia soon to be described.

The surface is covered with numerous small circular openings, rather regular in size and distribution, separated by intervals about two, but sometimes one or three times their own diameter. There are also other openings, which, as seen in a silicified specimen, may possibly be holes broken through the wall, but are, I judge, really ostia and proper features of the sponge. In old portions they appear to be extended into tubes, as above described.

The internal structure consists of cysts, more or less equal in size, regularly arranged around the periphery. They manifest no tendency to an arrangement in circular series, and wherever regularity is shown the series are more diagonal than transverse. In cross sections, so far as observed, there is no uniformity in their size, shape, or arrangement. In tangential sections, however, they tend to be rather regular in these particulars, having somewhat of a rhombic or, more exactly, a shield-shaped outline, especially near the surface. From this, however, they pass locally and probably regularly toward the middle into cavities of larger size and irregular shape. The walls in section are frequently incomplete, showing that the chambers communicate freely, and in the silicified specimen above referred to the chambers are seen to open into one another by rounded pores, while here and there a few tubes, whose direction is approximately axial, though more or less slanting, probably served as an additional means of circulation. It is the outer walls of these cysts which produce the mammillate surface of the sponge already noted.

While it may be supposed that this organism was composed of spicules, absolutely no trace of such structures remain so far as my observations go.

A first examination of this sponge conveys the impression that it is very widely different from the genus *Guadalupia*, while an axial view of the tangential section might mislead a casual observer into confusing them. The two sponges may, however, be really somewhat more nearly related than at first appears, while they are far from belonging to the same genus. The outer surface of *Cystothalamia*, with its monticules and little pores, as seen in the silicified specimen, certainly does not resemble the reticulate spiculous surface of *Guadalupia*. Specimens from the Capitan formation referred here show, in fact, no superficial structure at all, neither the spicules of one form nor the pores of the other. The internal structure also at first seems to possess as little resemblance, but if one considers the cysts as modified in shape so as to form tubes, or the tubes, in view of their being separated by diaphragms, as composed of several cysts arranged in linear series, a structure not far removed from *Guadalupia* would be produced. Of course there still remain some perhaps fundamental differences, such as the intercommunication between the chambers of *Cystothalamia* and the fact that the tubes in *Guadalupia* have complete and separate walls, while in *Cystothalamia* the chambers have only partial walls, the upper surface of one partition answering for the lower part of the next, or, at least, such appearing to be the case.

In spite of this very doubtful analogy between them, I am not including *Cystothalamia* and *Guadalupia* in the same family—that of the Guadalupiidæ—although it may be that such a course should be followed. While related to *Amblysiphonella*, *Sollasia*, etc., *Cystothalamia* differs from the Sphærosiphoniidæ in not being made up of regular superposed chambers or systematic annular groups of chambers.

Horizon and locality.—Top of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (stations 2905? and 2966). Delaware Mountain formation, southern Delaware Mountains, Texas (station 2964). Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763).

Cystothalamia? sp.

Pl. VII, fig. 5.

This species is represented by the single specimen illustrated on Pl. VII. It consists of a complex or more or less spherical bodies arranged about an axis so that they form an approximately straight stem. Their outward portions are regularly curved, but toward the axis they are deformed by mutual contact. The minute structure of this organism is no longer preserved. Portions of the surface seem to be covered with small rounded elevations or tubercles, which may be taken for ostia. Through the nongranular calcite which composes the bulk of the organism small opaque spots, probably of dolomite, are distributed, but it can not be told whether these are inorganic grains or represent fine tubular or porous structure. Similar appearances have been noted where it was difficult to tell whether the substance was of organic or inorganic nature.

In a preliminary account of the Guadalupian fauna I referred this organism to *Mammillopora,* or at least to the type which King includes under that name in his account of the Permian fossils of England. That it is not congeneric with *M. mammillaris,* however, I am now fairly assured, for it consists of an aggregate of several discrete spherical bodies, while *Mammillopora* appears to be a single homogeneous organism, growing, however, in a more or less mammillate shape. Moreover, *Mammillopora* consists of a solid spicular network, while the form under consideration was, I suspect, made up of hollow shells, the present fossil, which is solid, being a filling up of these chambers, and its apparent structure not really organic. It is only on the latter supposition that this form can be even provisionally placed with *Cystothalamia.* Should the interpretation adopted be correct, however, there might well be some doubt as to the propriety of placing this sponge in that genus. Its proper position may be in the Sphærocœliidæ, somewhere near *Sollasia.* In fact, it might with equal propriety be placed with that genus, but it is doubtful if it really belongs to either.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926).

Family SPHÆROSIPHONIIDÆ Steinmann.

Genus AMBLYSIPHONELLA Steinmann.

Amblysiphonella guadalupensis n. sp.

Pl. VII, figs. 7 to 8a.

This species grows in the usual cylindrical shapes, reaching a diameter of about 16 mm., and so far as known it occurs in single stalks and not in colonies. The cloaca has a diameter of 4 mm. The exterior is more or less marked by constrictions, but the superposed rings of which the organism is constructed do not, as such, show clearly upon the exterior, which appears to be irregular or verrucose. The interior of the structural rings is divided into simple cysts, which are large and not very numerous. The walls are thick, and at present appear dense and structureless, the outer and inner walls being perhaps a little heavier than those of the cysts.

But two specimens have come to hand, both of which are represented in my figures. That furnishing a natural longitudinal section may be taken as the type, as it best shows the structures characterizing the genus. The other specimen affords a better idea of the configuration, though possibly misleading in appearing to be verrucose on the exterior. From this example was cut the thin transverse section which is illustrated by my figure. It can not be determined that this specimen belongs to the same species as the type, but this is believed to be the case.

The only American species of *Amblysiphonella* known at this time is *A. prosseri* Clarke, from the Pennsylvanian of the Mississippi Valley. From this species *A. guadalupensis* is clearly distinct, by reason of its greater diameter, less strongly annulated shape, lower chambers, and thicker walls.

A. guadalupensis is a smaller form than any of the four species described by Waagen from the Salt Range, but it most nearly resembles that to which he gave the name *A. multilamellosa*. The much less numerous and much thicker walled cysts of the American form distinguish it. It differs from the other Indian species not only in smaller size, but in relatively smaller cloaca, more massive walls, and more equal vesicle and tube walls. In some respects it more closely resembles the typical species *A. barroisi*,[a] differing, however, in having a relatively smaller cloaca, thicker walls, less strongly annulated exterior, and more copious vesicles(?).

Horizon and locality.—Top of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2966).

Family SPHÆROCŒLIIDÆ Steinmann.

Genus STEINMANNIA Waagen and Wentzel.

STEINMANNIA AMERICANA n. sp.

Pl. VII, figs. 4 and 4a.

Of this interesting form there has come to hand only one specimen. It has a subcylindrical shape, somewhat regularly interrupted by gentle constrictions, and is slightly curved. It is incomplete at both ends, the present length being 23 mm. The diameter of the larger end is 9 mm. and that of the smaller 7 mm. The constrictions correspond in a general way to internal partitions, which are about 3 mm. apart. There is no central cloaca, and the presence of a small osculum in the center of each partition has not been ascertained. The flattened segments made by the gently curved partitions are apparently not entirely hollow, but the definition of the thick walls and of whatever internal structures are present is not very distinct. There is certainly a much less extensive development of vesicular tissue than in the Indian specimens belonging to this genus.

The surface is perforated by small, round openings, while the structure of the test as a whole appears to be finely porous. Ostia are apparently absent. The larger pores, and probably the smaller ones also, appear to be a structural feature of the partitions as well as of the outer wall.

[a] Neues Jahrbüch, 1882, vol. 2, p. 169, pl. 16, figs. 1-1d.

I have been in some uncertainty whether to place this species with Waagen's genus *Steinmannia* or with Steinmann's *Sollasia;* but the data at hand seem distinctly to favor a reference to the former. The structures in my specimen are not very clear, the test and the infilling whitish matrix being of about the same color and without any sharp boundaries between them. Such partitions as may be said to divide the otherwise hollow chambers have an appearance less of vesicles, as presented by my specimen, than of divisions more or less parallel to and near the upper or lower wall. Because of the probable presence of internal walls, although they are few, and the absence of ostia, it seemed best to place the Guadalupian species with *Steinmannia.* It is, however, strongly distinguished from the Salt Range species by the flattened or discoidal instead of spherical shape of the segments. The larger pores are of greater size in the American form, though it is really a smaller species and they are relatively much larger than the smaller pores.

From the exterior this form might be mistaken for a weathered example of *Guadalupia cylindrica,* but the tangential section shows the structure to be very different.

Horizon and locality.—Middle of Capitan formation, Capitan Peak (station 2926); "dark limestone," Pine Spring (station 2930?), Guadalupe Mountains, Texas.

Genus SOLLASIA Steinmann.

SOLLASIA? sp.

Pl. VII, fig. 6.

This division includes three small spongoid bodies, one from station 2926 and two from station 2966, both in the white limestone of the Capitan. They have a linear, somewhat moniliform shape, but the swellings in the specimen shown by fig. 6 of Pl. VII are unusually elongate. In the other specimens the nodes are more nearly spherical. In both cases what seems to be the filling of an original, rather thin-walled capsule is structureless, and the walls themselves are represented by fibrous or granular dolomite. No spicular structure can be now made out, and the obscure structures which at present replace the original walls I prefer to regard as inorganic.

These small bodies in their general nodular or moniliform shape strongly suggest Steinmann's genus *Sollasia,* but they do not show any evidence of being provided with ostia, nor, furthermore, of being divided at the constrictions by partitions, thus failing to conform in one essential particular to the Sphærocœliidæ. They probably belong to the Calcispongiæ, but, as I have already indicated, are very doubtful representatives of Steinmann's genus.

Horizon and locality.—Top of Capitan formation (station 2966), middle of Capitan formation (station 2926), Capitan Peak, Guadalupe Mountains, Texas.

CŒLENTERATA.

The Guadalupian corals are inferior in interest to the other groups. The genera recognized are *Lindstrœmia, Zaphrentis, Amplexus, Campophyllum, Cladopora,* and *Aulopora.* Most of these types range upward from much earlier horizons, and in the case of *Cladopora* this is, I believe, the first recorded occurrence at so late a period. Nevertheless, the Guadalupian Cladoporas, in one instance at least, afford no adequate ground in my opinion for separating them from the earlier types.

Certain genera which Waagen and Wentzel included with the cœlenterates but which I would place with the Bryozoa being omitted, the corals of the Salt Range fauna include *Aræopora, Pachypora, Michelinia, Lonsdaleia, Amplexus, Carterina, Disjectopora, Irregulatopora*, and *Circopora*, comprising in all 19 species. The corals would therefore seem to be not only far better represented in the Salt Range fauna, but to have largely a different character. The genus *Amplexus* is all that our lists show the faunas to have in common, although it is possible that the forms which Waagen and Wentzel have referred to *Pachypora* and those which I have placed with *Cladopora* may be congeneric. An interesting feature of the Salt Range fauna consists in the development of certain stromatoporoid corals belonging to four new genera. All these types are quite foreign to the cœlenterate representation found in the Guadalupian, though some of Waagen's and Wentzel's figures are certainly strongly suggestive of the sponges rather than of the cœlenterates. It is singular that these authors should have selected the specific name *placenta* for one of their species of *Michelinia*, as the name was preoccupied by an American species, although now the latter is placed with the genus *Leptopora*.

In his first paper on the Chitichun fauna No. 1 Diener cites a species of *Amplexus* and one of *Lonsdaleia*, and in his later paper on the same fauna a species of *Amplexus*, one of *Zaphrentis*, one of *Clisiophyllum*, one of *Dibunophyllum*, and one of *Plerophyllum*. It is evident that the cœlenterates of the Salt Range and of the Himalaya are not closely allied to those of the Guadalupian.

Kayser cites only two varieties of *Lophophyllum* and a species of *Michelinia* from the Carboniferous fauna of Lo Ping. From the neighborhood of Kantschoufu Loczy mentions an undetermined species of *Hallia*, from the neighborhood of Batang an undetermined species of *Lonsdaleia*, from Talischau in the province of Yünnan a species of *Favosites* and one of *Hallia?*, and from Youngtschangfu a species of *Zaphrentis*. The Carboniferous faunas of China also, so far as known, would appear from this to show no very close relationship with the Guadalupian.

Beyrich's corals from Timor afford more analogies with the Guadalupian than almost any other fauna. Among the forms distinguished by him there belong to this group certainly three species—*Zaphrentis?* sp., *Cyathophyllum?* sp., and *Clisiophyllum australe*. The latter species particularly recalls the forms which I have placed with *Lindstrœmia*. A fourth form, which Beyrich calls *Calamopora* sp., appears to have too large cells for a bryozoan and strongly suggests the Guadalupian species which I have cited under *Cladopora*. Martin cites from Timor a number of species of corals belonging perhaps to several faunas. These comprise a new species of *Lophophyllum*, three varieties of *Lithostrotion*, a species of *Favosites*, and one of *Amplexus*, a cœlenterate group certainly not closely allied to that from the Guadalupe Mountains. Rothpletz, in describing the faunas of Timor and Rotti, distinguishes a considerable list of species, including the genera *Pachypora* (2 species, one of which will perhaps prove to be a bryozoan), *Polycœlia* (1 species), *Zaphrentis* (1 species), *Amplexus* (2 species), *Dibunophyllum* (1 species), and *Clisiophyllum* (4 species). A certain resemblance to the Guadalupian fauna is shown, which may be increased by the possibility that the forms which I have placed with *Lindstrœmia* and those referred by Rothpletz to *Clisiophyllum* are in some cases congeneric; but at all events the resemblance is not close.

Roemer cites a species of *Clisiophyllum* and one of *Lithostrotion* from Sumatra and Fliegel a species of *Clisiophyllum* and one of *Lonsdaleia* from Padang.

In the Russian section corals appear more or less abundantly in every division, and persist into the Permian, where Netschajew cites *Petraia* (1 species), *Zaphrentis* (2 species), *Polycœlia* (1 species), and an undetermined form. Probably this representation could be much augmented by collating different lists, and really large numbers of species names could be gathered from other horizons in the same manner. Among works in which fossils of this group are described and figured, that by Trautschold on the fauna of Mjatschkowa contains representation of a good many species. Stuckenberg's monograph on the corals and Bryozoa of the Russian Kohlenkalk treats of still more. Netschajew's work on the Permian contains a few others, as already noted, and so does the monograph by Murchison, De Verneuil, and Keyserling; but in no case is any special resemblance to the corals of the Guadalupian manifested, so that to consider the matter in detail would be unprofitable as well as laborious. Some comment on the genus *Chætetes*, however, will not be out of place, for it is a form readily determinable and in many places abundant. Stuckenberg records three species in the upper Kohlenkalk of middle Russia, Trautschold two species in the Moskovian, and Stuckenberg one in the Gschelian. In his monograph on the Gschelian Brachiopoda, Tschernyschew also cites *Chætetes* at that horizon. The absence of this genus from the Guadalupian seems to establish a difference between it and the lower formations of the Russian section and an agreement with the Artinskian and Permian, where it appears to be absent.

Abich recognizes 5 species of *Amplexus*, 2 of *Clisiophyllum*, 2 of *Zaphrentis*, 1 of *Lophophyllum*, and 1 of *Michelinia* in his fauna from Djoulfa, in Armenia, an assemblage which certainly possesses little in common with that of the Guadalupe Mountains. Arthaber, who subsequently worked over much the same fauna, discriminated *Amplexus* (1 species), *Zaphrentis* (1 species), *Favosites* (1 species), and *Michelinia* (1 species).

In the fauna from Balia Maaden, in Asia Minor, Enderle found only 2 species of *Lonsdaleia* and 1 of *Amplexus*.

I do not know whether Gemmellaro published an account of the corals belonging to the fauna from Palermo, but if so I have been unable to examine a copy of his work; nor have I been able to find whether Schellwien has described this group as it appears in the fauna of the Trogkofelschichten.

Gortani has noted a few corals from the Carnic Alps which he refers to the genera *Zaphrentis* (1 species), *Cyathophyllum* (1 species), *Monilipora* (1 species), and *Syringopora* (1 species). We apparently shall not find here any close analogy with the Guadalupian cœlenterates.

The Dyas of Germany would appear to contain merely *Calophyllum* (or *Polycœlia*) *profundum* and a doubtful *Dingeria depressa*.

The corals of the Permian of England seem to be equally scanty. King cites *Calophyllum donatianum* and *Petraia profunda*.

In the Spitzbergen fauna likewise the corals play a subordinate part, but Toula cites two species of *Clisiophyllum* from the cape between the two arms of North Fjord. Among the Nova Zembla fossils this author cites 1 species of *Campophyllum*, 1 of *Zaphrentis*, 3 of *Lithostrotion*, 1 of *Michelinia*, 1 of *Chætetes*, and 1 of *Clisiophyllum*.

Stache cites a number of species from localities in the West Sahara, but they are of different genera from the Guadalupian types (*Favosites*, *Cyathophyllum*, *Hadrophyllum?*, *Amplexus?*, and *Duncania?*), and for the most part probably belong to an older fauna.

The "Permo-Carboniferous" beds of Queensland and New Guinea contain, according to Etheridge, only a few corals—*Zaphrentis* (1 species), *Cyathophyllum* (2 species), and *Cladochonus* (1 species)—a rather meager and characterless list, but one which, as far as it goes, is quite different from the Guadalupian.

De Koninck's account of the Carboniferous fossils of New South Wales contains descriptions of an extensive suite of corals, viz, *Axophyllum?* (1 species), *Lithostrotion* (2 species), *Cyathophyllum* (1 species), *Lophophyllum* (2 species), *Amplexus* (1 species), *Zaphrentis* (4 species), *Cyathaxonia* (1 species), *Cladochonus* (1 species), *Syringopora* (2 species), and *Favosites* (1 species). This list seems to indicate a more primitive facies than the Guadalupian, and certainly a very different one. From the associated data I judge that all were obtained from the lower beds of the Australian section, and it would accordingly not be to the purpose to consider them further here. *Syringopora reticulata* appears to be cited from the upper as well as the lower beds and to form an exception to the first part of the preceding remark but not to the last.

The only coral which I have found noted from the Carboniferous of South America is from Bolivia. D'Orbigny cites *Turbinolia striata*, a zaphrentoid species which will have to be redescribed before one can tell much about it.

The Guadalupian corals, so far as they are known, contribute but little toward endowing the fauna with an individual or novel character, and yet they do not manifest any marked affinities with the other faunas with which comparisons have been made.

The coral fauna of the Pennsylvanian is much less extensive than that of the Mississippian. According to Weller's bibliography, the western forms, as usual, being rejected, the Pennsylvanian comprises only the following species:

	Species.		Species.
Axophyllum	2	Michelinia	2
Campophyllum	2	Millepora	1
Chætetes	1	Syringopora	1
Cyathaxonia	1	Trachypora	1
Lophophyllum	1	Zaphrentis	1

Of these, *Campophyllum*, *Lophophyllum*, and *Chætetes* are perhaps the most abundant and characteristic. If the list of Guadalupian species be compared with this it will appear that the generic representation of the corals is very different in the two faunas, that they have in fact only two genera in common—*Campophyllum* and *Zaphrentis*—while the Guadalupian forms doubtfully placed with *Campophyllum* are very different from the common Pennsylvanian *Campophyllum torquium*. I am satisfied that *Lindstrœmia permiana* is not congeneric with the characteristic Pennsylvanian species *Lophophyllum profundum*, nor does it belong to *Axophyllum*, which includes another Pennsylvanian species. Thus it would seem that in its corals, not less than in the other groups, is the Guadalupian fauna different from the Pennsylvanian.

TETRACORALLA.

Family ZAPHRENTIDÆ Milne-Edwards and Haime.

Genus LINDSTRŒMIA Nicholson.

LINDSTRŒMIA PERMIANA n. sp.

Pl. XVII, figs. 13 and 14.

?1859. *Polycœlia(?)*. Shumard, Trans. Acad. Sci. St. Louis, vol. 1, p. 388 (date of volume, 1860).
Dark [Permian] limestone: Guadalupe Mountains.

Corallum of medium size, conical, gently curved, varying somewhat in the rapidity of its expansion, which is seldom either unusually rapid or unusually gradual. The exterior is sometimes marked by constrictions due to unequal growth and by numerous rather regular longitudinal ribs or ridges, the distinctness of which varies in different specimens. They are usually rather faint. These are grouped in such a way that the periphery is divided into three unequal parts. One longitudinal line of division, formed by the convergence of the ribs, is situated on the concave side of the corallum and the two others are about 90° of arc from it.

In estimated length the largest specimens probably do not exceed 40 mm., while the greatest diameter is about 18 mm.

The calice is very deep; the septa are numerous and closely arranged and number from 48 to 56, of which half are primary and half secondary. This relation, however, is seldom apparent except in the calice, where sometimes the septa are regularly alternating, and in special instances in the lower part of the epitheca. The septa for the most part extend to the center and unite in a pseudocolumella. The pseudocolumella is large when compared with that of *Lophophyllum*, but it is small when compared with the corresponding structure in *Axophyllum*. It appears not to be solid like that of *Lophophyllum*, but to consist of the interlocked ends of some of the septa. It often has the aspect of being solid, however, because the interstices are filled with a stereoplasmic deposit. I am uncertain about the existence of a fossette. In some specimens such a structure appears to be present (by the atrophy of one or two of the septa) and in others not; at all events it is not conspicuous. If it does exist it seems to bear no relation to the curvature of the corallum. Dissepimental tissue is present in moderate abundance, but tabulæ are absent. In longitudinal sections the dissepiments are seen to ascend steeply to the pseudocolumella.

Considerable variation is shown by coralla referred to this species. In some specimens the longitudinal striæ are much less distinct than in others, and, correspondingly, the annular striæ and constrictions are much more pronounced in some. The difference in expansion has also been a subject of comment, and this exercises an influence on the internal as well as the external appearance, for since the number of septa remains fairly constant their arrangement in the narrow forms is more crowded than in the spreading forms. A difference in silicified specimens in the extension toward the center of septa in the calice can in some cases be definitely ascribed to the fact that their inner extremities were not silicified. The length of the secondary septa also varies, as well as their arrangement, since they are occasionally situated to one side of the interseptal spaces or are bent over to unite with the principal septa.

In the calice, which is floored by dissepimental tissue, even the primary septa do not extend to the pseudocolumella, but at lower levels, as shown by sections, they extend to and unite with it.

In young specimens referred to this species the number of septa is proportionally less, according to their size, and the secondary septa proportionally smaller.

This species appears to be represented at several different horizons and at a number of localities. While the sum total of specimens is considerable, not many have been obtained at any one station. Therefore in considering the material as a whole, the danger that it may not all belong to the same species is somewhat increased. Many of the specimens are fragmentary and the preservation is unsatisfactory. In but few instances do these fossils retain their original calcareous composition. In most cases they are silicified, but sometimes, as in the "dark limestone," the silicification, while sufficient to render sectioning laborious and unsatisfactory, is not complete enough to give a faithful replacement of the original body, while sometimes, as in the Glass Mountains, the matrix also is highly siliceous, so that etching does not serve to free the corallum. Thus all the characters described can not be made out on any one specimen, and the danger resulting from a confusion of more than a single species becomes more grave. However, this circumstance has been kept in view and care taken to avoid error as far as possible.

Of the generic position of this form I am somewhat in doubt. It can hardly be referred to *Axophyllum* and appears in fact much more nearly allied to *Lophophyllum*. The fact that the columella is composite, not simple and solid, and that it is connected with many of the septa, perhaps sometimes with all of them, seems to debar that genus also. The presence of dissepiments is likewise a distinguishing character of some value, though I have found that *Lophophyllum* possesses these structures, contrary to many descriptions of the genus. The development in *Lophophyllum*, however, is always scanty.

The paper in which the name *Lindstrœmia* was first proposed was published as an abstract, and I have not come upon a subsequent characterization of the genus, though Nicholson discusses it at some length in his manual of paleontology. The original abstract, however, contains a rather full generic diagnosis, which can be supplemented by the remarks contained in the manual. With the first description the Guadalupian form agrees in most particulars. The chief points of divergence seem to be that the diagnosis calls for a small coral, while this species, though small in comparison with many Devonian and even some Carboniferous species, is near the average of Carboniferous forms. Neither can it be said of the pseudocolumella, though it is relatively larger than that of *Lophophyllum*, that it occupies a large portion of the visceral chamber. These differences can, it is true, hardly be regarded as generic, but it is possible that in structures not described in detail by Nicholson, especially that of the columella, differential characters would be found. Furthermore, the type species of *Lindstrœmia* (*L. columnaris*) is a Devonian fossil and the genus is reported by Nicholson as being especially abundant in the Ordovician and Silurian rocks, though he notes finding it in the Carboniferous also. In the manual of paleontology above referred to Nicholson gives some additional characters which have a bearing on the generic reference of the present species. He remarks that the septa are pinnate in their arrangement and that the symmetry is bilateral, though a fossula seems not to be present. It has already been said that a certain trimeral arrangement of the external ridges has been observed in the Guadalupian form, though I doubt if all the specimens show even this, and no such arrangement is apparent in the interior, where a general radial symmetry prevails. As already stated, there is some uncertainty about the possession of a fossula by the Guadalupian form, and I believe that a structure of this nature is not a constant feature. In this character it is apparently in agreement with *Lindstrœmia*. While the maximum development of the genus, as recorded by Nicholson, is much earlier than the present occurrence, the fact that Waagen has found corals such as *Michelinia*, and stromatoporoids, in the "Permo-Carboniferous" of India, affords some sort of a precedent for extending the range of *Lindstrœmia* to the Guadalupian beds of Texas and New Mexico.

Horizon and locality.—Middle of Capitan formation, Capitan Peak (station 2926); "dark limestone," Pine Spring (station 2930), and Guadalupe Point (station 3762b?); Delaware Mountain formation, Guadalupe Point (station 2919?), Guadalupe Mountains, Texas. Delaware Mountain formation, southern Delaware Mountains, Texas (stations 2964?, 2969?, 3500). Delaware Mountain formation, Diablo Mountains, Texas, as reported (station 3764). Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763).

LINDSTRŒMIA PERMIANA var.

Pl. XVII, fig. 15.

Associated with the typical *Lindstrœmia permiana* is a form resembling it in a general way but possessing this obvious difference, that it is smaller and has somewhat fewer septa. The difference in size seems to me not such but that coralla belonging to *L. permiana* would have had more numerous septa when of similar dimensions. The number of primary septa in this form is 19 or 20, the total number of septa in a corallum being, therefore, 38 or 40. It hardly seemed justifiable to place these fossils immediately with *L. permiana*, and at the same time the difference does not at present seem sufficiently important to warrant proposing a new name for them.

Horizon and locality.—"Dark limestone," Pine Spring (station 2930) and Guadalupe Point (stations 3762e?, 3762d), Guadalupe Mountains, Texas. Delaware Mountain formation, southern Delaware Mountains, Texas (stations 2968 and 2969).

LINDSTRŒMIA CYLINDRICA n. sp.

Pl. XVII, figs. 16 and 16a.

Corallum rather small, subcylindrical, strongly curved. The entire length is 23 mm., the diameter at the aperture 8 mm. When the typical specimen had reached a length of 11 mm. it had nearly attained its full diameter and was a straight cone. The remaining growth was in shape cylindrical and in a different direction from the original one. The external surface is marked by distinct longitudinal ribs and by rather prominent transverse bands, due to irregular and interrupted growth. The calice is rather deep, but not so deep as often seen in *Lindstrœmia permiana*. It contains 16 septa, all of which are primary. No secondary septa appear. In the calice the septa do not extend to the center, the unoccupied space between their inner ends being floored by dissepimental tissue, from the midst of which the rather small, low pseudocolumella projects. A similar appearance has been observed in *L. permiana* also, but it is probably misleading as to the real structure beneath, and is doubtless calicinal in character, later growth adding to and altering the structures before the soft parts were withdrawn and partitioned off. In part, too, this appearance is due to silicification, the septa in partially etched specimens being sometimes much shorter where free than where embedded in the portions of limestone remaining in the bottom of the calice. Thus the septa in the calice may have extended in reality nearly if not quite to the pseudocolumella, just as they do below, showing one of the distinctive structural characters of the genus.

The somewhat unusual conformation of the only specimen yet found belonging to this species is probably of little value in determining its specific relations, and may be entirely an individual character. The fact that no secondary septa are shown in the calice and that the primary septa number but 16, instead of 24 to 28, as in *L. permiana*, distinguish this species from the one last mentioned.

Horizon and locality.—"Dark limestone," Pine Spring, Guadalupe Mountains, Texas (station 2930).

LINDSTRŒMIA sp.

Under this title are included two specimens, each from a different locality, which should not, I feel, be referred to either of the species recognized in this fauna. They are rather small and of a cylindrical shape. Their diameter is 4 mm. and their length 8 mm. The septa number 29 or 30. In one specimen the septa are distinctly separable into primary and secondary, the primary septa extending to the center and uniting with a large axis. In the other specimen the primary and secondary septa can scarcely be distinguished by difference in length.

In its shape this species resembles *Lindstrœmia cylindrica*, but the number and arrangement of the septa are different, while not only in its smaller size and shape but also in the number of septa does it differ from *L. permiana*. It is true that young specimens of *L. permiana* have fewer septa than the large ones, but as a rule fewer also than the form under consideration. Besides, judged by its shape the latter has apparently reached its final or mature condition, while the small corals referred to *L. permiana* have a different shape and one which from its nature admits of or almost necessitates augmentation in the number of septa, etc., in process of enlargement.

Horizon and locality.—"Dark limestone," Pine Spring (station 2930), and Guadalupe Point (station 3762b), Guadalupe Mountains, Texas.

Genus ZAPHRENTIS Rafinesque.

ZAPHRENTIS? sp.

After removing the coralla referred to *Lindstrœmia* and *Amplexus*, a residual group, somewhat varied, yet having a certain amount of unity, remains. These fossils closely resemble *L. permiana*, but appear to be without the pseudocolumella of that group. The septa are numerous. In an example having a diameter of but 6 mm. 35 were counted. The primary and secondary septa are not readily distinguished and the plates are distorted. They are connected by moderately abundant dissepimental tissue. In a larger example, having a diameter of 10 mm., there appear to be 40 septa, primary and secondary, but they are not very distinct, and I believe that some were overlooked, their irregular growth aiding in making a precise count very difficult. In some of the specimens assigned to this group a pseudocolumella seems to be absent, in others the evidence on this point is lacking, and of no example probably can it be said that the corallum was certainly without a pseudocolumella.

Horizon and locality.—"Dark limestone," Guadalupe Point, Guadalupe Mountains, Texas (station 3762b). Delaware Mountain formation, southern Delaware Mountains, Texas (station 2957?). Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763).

Genus **AMPLEXUS** Sowerby.

AMPLEXUS sp.

The specimens which clearly possess the structure of the group for which the name *Lindstrœmia* is here used being withdrawn, there remains in our collection a heterogeneous assemblage, consisting of examples which appear more or less clearly to have a different structure and of those whose structure is imperfectly shown. From these coralla has been subtracted a group distinguished by being rather small, slender, and cylindrical and by having, so far as could be observed, the kind of structure characterizing the genus *Amplexus*. It seems necessary to distinguish two subordinate divisions, one of them represented by specimens from the Glass Mountains and the other by specimens from the Guadalupes. In the former the diameter is 7 to 10 mm. and the subcylindrical corallum is marked by numerous fine longitudinal ridges, likewise by transverse constrictions. There are about 26 primary and the same number of secondary septa. None of the septa reach to the center, and the large axial space thus left was probably crossed by tabulæ. No columella was present. More or less sparse dissepimental tissue occurs around the outer margin. Enough divergence can be noted in the length and character of the septa to indicate the possibility of two species among the fossils of this division, but as my material is scanty, silicified, and difficult to study it did not seem warranted to subject it to the final analysis.

The specimen especially representing the second division has a diameter of 4.5 mm. The growth is irregular, the exterior is marked by a number of angular transverse ridges, but the longitudinal ribs are obscure. There are 15, possibly 16, rather long primary septa. The secondary septa are mere ridges between the primary ones, and dissepimental tissue seems to be absent. This specimen has the appearance of being young or pathologic.

Horizon and locality.—Base of Capitan formation, hill southwest of Guadalupe Point (station 2906?); "dark limestone," Guadalupe Point (station 3762b), Guadalupe Mountains, Texas. Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763).

Family CYATHOPHYLLIDÆ Milne-Edwards and Haime.

Genus CAMPOPHYLLUM Milne-Edwards and Haime.

CAMPOPHYLLUM TEXANUM Shumard?

Pl. VII, fig. 18.

1859. *Campophyllum* (?) *Texanum.* Shumard, Trans. Acad. Sci. St. Louis, vol. 1, p. 388 (date of volume, 1860).
White [Permian] limestone: Guadalupe Mountains.

Shumard gives the foregoing name to a form from the white limestone, his description of which is so inadequate that the name itself is practically invalid. He says of this form:

> This is a long, subcylindrical, flexuous species, having a diameter above of about one-third of an inch. It is covered with a thin epithelium. The interior structure is unknown. I place it provisionally in the above genus until I can have an opportunity of examining better specimens.
> *Locality.*—White limestone, Guadalupe Mountains.

In our collection there is only one specimen from the same horizon as *Campophyllum texanum* which can with any probability belong to it, and it is represented by fig. 18 of Pl. VII. It agrees with the original description in all of the characters designated except that the diameter is nearly twice as great, and yet I doubt whether it really represents Shumard's species. It is, however, so far as I can make out—for it is imperfect and somewhat crushed—a true *Campophyllum.* There are about 50 septa, which did not reach to the center. There is a marginal region intersected by dissepiments, while the central or axial cavity is partitioned by rather distant tabulæ.

As, however, the interior of the real *Campophyllum texanum* was not known to Shumard, the latter may have belonged to quite another genus and have been a form like *Lindstrœmia cylindrica,* which, though from a slightly different horizon, had the same diameter and other characteristics much like *C. texanum.* It may even have been one of the sponges which are not uncommon in the Capitan formation, such as *Guadalupia cylindrica, Virgula rigida,* etc.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926).

HEXACORALLA.

Family FAVOSITIDÆ Milne-Edwards and Haime.

Genus CLADOPORA Hall.

CLADOPORA SPINULATA n. sp.

Pl. XVII, figs. 17 and 17a.

This species forms cylindrical, simple, or branching coralla, the diameters of which vary from 4 to 8 mm. The proportion of large and small corrallites varies widely in different coralla. The larger apertures have a nearly uniform diameter of 0.75 mm. The corallum is covered with projecting, spinelike processes, usually lost in weathered specimens, which seem as a rule to originate from the angle where three corrallites come into contact. The mural pores are large, though rather scarce. Septa are represented by internal spinules which appear to be arranged in longitudinal rows. I have not been able to ascertain by observation the exact number of these rows, but estimate that there were nine or ten.

This species and the one following recall especially two middle Paleozoic genera, *Cladopora* and *Striatopora*, the latter rather because of the forms which have from time to time been referred to it than from the character and appearance of the genotype. The type species of *Cladopora* and *Striatopora* do in fact differ strongly in general aspect, and the Guadalupian species resemble *Cladopora seriata* rather than *Striatopora flexuosa*. According to Rominger, however, the two genera are really very similar, and certainly the groups of species at present included under these generic titles have much in common. One of the important structural characters indicated in Hall's original description of *Cladopora* is the absence of diaphragms. Rominger reports having observed these structures, though usually they are absent. According to the definitions of the author last mentioned, the distinctive characters of the two genera as compared with one another are the thickened and striated apertures in *Striatopora* and the abundant development of mural pores. In *Cladopora* the apertures are not thickened, tabulæ are absent or rare, and pseudosepta rudimentary or absent.

In *Cladopora spinulata* the apertures of the cells are not thickened and striated, and therefore the general appearance is more that of *Cladopora* than of *Striatopora*. Diaphragms seem to be absent as a rule from both of the genera mentioned, and none have been observed in *C. spinulata*. The comparative rarity of mural pores is likewise a point in common with *Cladopora*, whereas the rows of spines constituting what may be called pseudosepta tend to ally it rather with *Striatopora*. It is not stated in Rominger's description of *Striatopora* that these structures extend from the aperture where they are most obvious into the interior of the tube, but it is presumed that this is the case. In *Cladopora spinulata* they can be seen only below the aperture. This species, therefore, is not entirely in agreement with either of Hall's genera and the recurrence of this type in the Permian is rather suggestive that its characters will be found too far modified for admission into either of the earlier groups. This seems to a certain extent to be the fact in the matter of the septal development of *Cladopora spinulata* and more especially in the case of *Cladopora tubulata*. Both from the scantiness and from the silicified condition of my material I am unable to pursue the study of either species so far that an accurate generic diagnosis would be possible, and it seems safer to refer them to *Cladopora*, to which they are clearly allied and where they may really by rights belong.

I have referred to this species some specimens from station 2963 which are differently preserved and show somewhat different characters from the others. The others, in brief, are silicified while these, though fragmentary, are calcareous. They are composite coralla, in general respects like the silicified examples. The rather thick walls are pierced by occasional mural pores. Tabulæ appear to be absent, but a striking feature consists of what resemble long septa, which though often much thicker near the walls are very variable in size, in length, and in arrangement. Some of the longer ones extend to the center or beyond, while the others are much shorter. They are not only unequal distances apart, but sometimes as much as half the circumference of a corallite will be unprovided with them. Indeed, in some specimens none at all appear to be present. Owing to the small size of the corallites and the imperfect or partial development of the septalike structures it is difficult to give an exact number for those present. Eight or nine can be counted in several instances and in others there may be four or five fragmentary ones in addition.

So far as I have been able to discover, these septa are not plates but spines, and they are best developed in the interior parts of the corallum and least developed in the peripheral parts. It is of course the latter which are seen in silicified specimens, where septal spines can sometimes be detected, though they do not form a striking feature, and thus I believe it highly probable that these calcareous examples, which at first look very different because of their apparently well-developed septa, are really the same species as the silicified ones.

Horizon and locality.—Base of Capitan formation, hill southwest of Guadalupe Point (station 2906); "dark limestone," Pine Spring (station 2930), near Guadalupe Point (stations 3762b and 3762e), and hill southwest of Guadalupe Point (station 2924); Delaware Mountain formation, Guadalupe Point (station 2963), Guadalupe Mountains, Texas. Delaware Mountain formation, southern Delaware Mountains, Texas (stations 2962 and 2969). Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763).

CLADOPORA? TUBULATA n. sp.

Pl. XXV, figs. 5 and 5a.

In this species the corallites form small, more or less branching coralla, which seem to broaden out at the base or on occasion and become somewhat incrusting. The corallites are nearly of equal size and have a diameter of about three-fourths of a millimeter. They are not very thickly clustered and their apertures are sometimes separated by considerable intervals. They are strongly inclined to the axis, so that the aperture is semicircular or crescentiform, with a projecting lower lip, yet individual corallites contrive to elevate themselves above the general surface as short, separate tubular cells. The walls are thick, and I have ascertained that in a few instances they are pierced by mural pores, but these structures seem to be only occasional. No septa or tabulæ have been observed.

The general resemblance of this fossil to *Cladopora spinulata*, which occurs at nearly if not quite the same horizon, seems to warrant a reference of both to the same genus, but while the latter appears to have nearly all the characters of a true *Cladopora*, the present species must certainly be regarded as a peculiar and aberrant form.

Horizon and locality.—Delaware Mountain formation, Diablo Mountains, Texas, as reported (station 3764). Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

Family AULOPORIDÆ Nicholson.

Genus AULOPORA Goldfuss.

AULOPORA sp.

Growing upon an indeterminable species of *Fenestella* there was found at station 2969 an *Aulopora* which presents no appreciable differences from much older types of the genus. Portions of three corallites in a linear series are present, and the whole has a length of only 6½ mm., so that the species is a very small one. The length of each corrallite was probably about 2½ to 3 mm. and the greatest diameter 1 mm. or a little less. Each corallite appears to have been a regularly enlarging cone slightly curved, if at all, developing a single offshoot by gemmation when it had attained two-thirds or three-fourths the full size.

These data, however, can not be made exact, owing to imperfections in the material.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

ECHINODERMATA.

Echinoderms are usually rare at the later horizons of the Paleozoic, and in the Guadalupian fauna they form but an insignificant factor. Crinoids are represented only by fragments of stems, which occur in many of the collections, though never in abundance. Of the cystoids our material has furnished a single form of considerable interest, representing both a genus and a species which are new. Echinoids occurring as dissociated plates and fragments of radioles are rare and of small size. Six varieties apparently can be discriminated, but the material is so imperfect that nothing has been described as new in this group.

Although the echinoderm remains of the Guadalupian are so scanty, it will be of interest to see how this class is represented in other faunas and wherever possible to make comparisons. The true crinoids, of which our collections furnish only stem fragments, are rather unusually well represented in the Salt Range fauna, where Waagen described 4 species of *Cyathocrinus*, 1 of *Hydriocrinus*, 2 of *Poteriocrinus*, and 1 of *Philocrinus*. No cystoids were found and only one species of echinoid, occurring as loose spines and plates. This was placed by Waagen in the genus *Eocidaris* and is not closely related to the corresponding Guadalupian types. The crinoid stems which Diener cites from Malla Sangcha and from Chitichun No. 1 may well be omitted from consideration, and the fact be pointed out—so far as it has significance when based on such imperfect data—that the Guadalupian fauna differs widely from those of the Salt Range and Himalaya with respect to this class of organisms.

In China remains of the Echinodermata are rare, the only record I have found being by Loczy, who notes fragments of stems and an occasional plate belonging to the Crinoidea.

Almost the same may be said of the Carboniferous of the Indian Archipelago. Roemer cites some crinoid stems from Sumatra and Martin does the same for Timor. From Timor, Beyrich not only obtained the usual crinoid stems, but described a new genus and species of cystoid (*Hypocrinus*) of considerable interest in this connection, since it appears to be related to the Guadalupian *Cœnocystis*. In his treatment of the faunas of Timor and Rotti Rothpletz discusses at some length the fragments of crinoid stems, which his collection seems to have contained in considerable abundance. He likewise obtained a fragment of a radiole of an echinoid and an additional species of *Hypocrinus*.

In the Russian section the Moskovian contains a rather abundant echinoderm fauna. We have first, according to Trautschold, the echinoids *Archæocidaris rossica*, represented by a variety of parts, and *Lepidesthes lævis;* among the starfish, so rarely found in the Paleozoic, *Palæaster montanus*, *Calliaster mirus*, and *Stenaster confluens*. The crinoids are cited as *Poteriocrinus originarius*, *P. multiplex*, *P. bijugus*, *Hydriocrinus pusillus*, *Cromyocrinus simplex*, *C. geminatus*, *C. ornatus*, *Phialocrinus patens*, *P. urna*, *Stemmatocrinus cernuus*, *Forbesiocrinus incurvus*, and *Platycrinus* sp. This unusually extensive and varied fauna is entirely dissimilar to the much more meager representation of the Guadalupian.

Much less common appears to be the occurrence of this group at higher horizons. From the Gschelian Sibirzew lists radioles and plates of *Archæocidaris* (like *A. rossica* Von Buch) and fragments of *Poteriocrinus* and *Cyathocrinus*. Stuckenberg notes about the same assemblage, *Cyathocrinus* sp., *Poteriocrinus* sp., *Archæocidaris* sp., and *Palæechinus paradoxus*.

From the Artinskian Stuckenberg cites *Palæechinus* sp., *Archæocidaris* sp., and *Cyathocrinus* sp. The two echinoids resemble *Archæocidaris cratis* and *Archæocidaris* sp. *a* of the present report. The Kungurstufe furnished this author only *Cyathocrinus* sp. Sibirzew lists from the Artinsk *Archæocidaris* and *Cyathocrinus*.

From the Russian Permian Tschernyschew cites *Cyathocrinus ramosus*, Sibirzew the same, Netschajew *Cyathocrinus* cf. *ramosus* and *Poteriocrinus quenstedti*, and Golowkinsky *Poteriocrinus quenstedti*. In some of these, at all events, though not in the last, the identification is based on fragments of stems.

So far as comparisons can be made on this scanty evidence, the Guadalupian echinoderms do not resemble the Russian species to any extent. The absence from the fauna of determinable crinoids is worthy of some notice, though where there are stems there must of course have been cups. The presence of the cystid is also noteworthy.

In the fauna from Djoulfa Abich cites only *Poteriocrinus*, represented by stem fragments, and Arthaber recognized *Cyathocrinus* cf. *ramosus*, *Cyathocrinus* cf. *virgalensis*, and *Poteriocrinus?* sp. in reviewing Abich's fauna, the identifications in every case being based on stems alone. Only stems were found by Enderle also among his fossils from Balia Maaden.

Of data bearing on the representation of these types in the interesting fauna from Palermo, described by Gemmellaro, and in the related one from the Carnic Alps which Gortani and Schellwien have partially described I have found no trace; but in the German Dyas the echinoderms are again noted. Geinitz cites *Eocidaris keyserlingi*, *Asterias bituminosa*, and *Cyathocrinus ramosus*. To the two latter the

Guadalupian fauna presents nothing comparable. *Archæocidaris cratis* and *Archæocidaris* sp. *a* resemble the radioles of Geinitz's *Eocidaris keyserlingi*, but apparently the two species belong to different genera.

From the English Permian, King cites *Cyathocrinus ramosus* and *Archæocidaris verneuiliana* (*Palæechinus* in the description of plates). The echinoid is of the same general type as *Archæocidaris cratis* and *Archæocidaris* sp. *a*, but we have as yet nothing which can be compared with the crinoid.

Toula's papers on the Carboniferous faunas of Spitzbergen contain references to crinoid stems alone, while from Nova Zembla he noted only an indeterminable species of *Archæocidaris* and *Cyathocrinus* sp., together with stem fragments. From two areas in the West Sahara, Stache obtained abundant crinoid stems, which he studied in great detail. Only fragmentary remains of the same group are recorded from South America. Gabb notes them from Peru, and Salter and Toula from Bolivia.

In De Koninck's account of the Carboniferous fossils of New South Wales a number of echinoderm species were noted belonging to the genera *Synbathocrinus*, *Poteriocrinus*, *Actinocrinus*, *Platycrinus*, *Tribrachyocrinus*, *Cyathocrinus*, and *Palæaster*. All appear to have come from the lower beds except the *Tribrachyocrinus*, the *Cyathocrinus*, and the *Palæaster*. Nothing at all resembling these species is known from the Guadalupian.

In the "Permo-Carboniferous" of Queensland and New Guinea echinoderms are unusually abundant—much better represented, at all events, than in the Guadalupian. Etheridge cites *Actinocrinus* (1 species), *Platycrinus* (1 species), *Poteriocrinus* (2 species), besides fragments of other forms; also, among the blastoids, *Mesoblastus?* (1 species), *Granatocrinus?* (1 species), and *Tricœlocrinus?* (1 species), while the echinoids are represented only by a single plate of *Archæocidaris*. There seems to be here scarcely any common ground with the Guadalupian.

Relating to the present discussion, I find listed in Weller's bibliography of North American Carboniferous invertebrates, species representing the crinoids and echinoids alone, the cystoids, blastoids, and asteroids being at present unknown. All species of lower Carboniferous (Mississippian) age have of course been eliminated from this list, and all such as have a purely western distribution.

Crinoids, while as a rule rare in the Pennsylvanian, in the aggregate constitute an extensive fauna, comprising 14 genera and 47 species, as follows:

	Species.		Species.
Acrocrinus	1	Graphiocrinus	1
Agassizocrinus	1	Hydreionocrinus	8
Ceriocrinus	6	Lecythiocrinus	2
Cromyocrinus	1	Phialocrinus	6
Cyathocrinus	2	Poteriocrinus	3
Erisocrinus	2	Rhodocrinus	1
Eupachycrinus	9	Zeacrinus	4

The echinoids, while more plentiful, are much less varied. The only genera known are *Archæocidaris* and *Eocidaris*, the former with seven and the latter with one species. Since the publication of Weller's bulletin, from which the foregoing data were derived, a few additional species of echinoids and crinoids have been described, but they do not modify to any extent the previously known fauna.

One might easily be led too far in comparing the Guadalupian and Pennsylvanian faunas in point of their echinoderm representation, but so far as known the Guadalupian is without determinable crinoids, while cystoids, which, of a single type, are fairly abundant at one station in the Guadalupian, are unknown in the Pennsylvanian. As for the echinoids, a group which is represented in both faunas, it seems to be true that those of the Guadalupian are rarer and of smaller size than the Pennsylvanian representatives.

CYSTOIDEA.

Family CRYPTOCRINIDÆ Zittel.

Genus CŒNOCYSTIS n. gen.

The generic description of *Cœnocystis* is included in the description of the specific characters of *Cœnocystis richardsoni*, which is taken as the genotype.

CŒNOCYSTIS RICHARDSONI n. sp.

Pl. XXVII, figs. 19 to 22.

The lower half of the cup in this interesting species is composed of a calyx-like group of consolidated plates, representing apparently two serial rows. What may be regarded as the basal plates consists of an elongated cone, which is nearly solid or only partly calibrated, apparently formed by the consolidation of several plates whose line of juncture is now entirely lost. This conical basal portion is followed by a hemispherical expansion formed by five pentagonal primary plates of equal size. They are firmly joined with one another laterally, though the suture is distinctly marked by a depressed line. With the basal portion, however, they are so closely ankylosed that they appear for the most part to be continuous. Although there seems to be an obscure basal outline to this second series of plates, I suspect that this is rather a phenomenon than a reality. The contiguous upper angles of two adjacent plates of this series are deeply excavated for the relatively large anal pore. Similar pores appear to be symmetrically developed on the four remaining lines of suture, but these are much smaller. They have not been observed on the outside, but regularly appear as channels transversely cutting the thick basal cup. (See fig. 20 of Pl. XXVII.)

There may be some question whether the solid basal portion of this structure consists of two series of plates, according to the above interpretation, or of but one, the lower portions being more completely merged with one another than the upper; but the explanation here adopted appears to be the more natural one.

The five pentagonal plates here regarded as representing the second series are arranged with one side downward and two at the top. They are succeeded by another row of large, apparently loose plates, which probably have two short sides meeting at an obtuse angle below, and two long sides meeting at an acute angle above. They are so arranged that the point of the basal outline fits into the reentrant angle at which two plates of the preceding series meet, and vice versa. The upper portion of the few specimens which have come to hand is obscured, so that I can not tell whether there is an additional series of small oral plates, or whether the series last described continues to the oral aperture.

One or two additional points are necessary to complete the description of this form. One feature of it is the very small size which even the largest of our specimens presents. Another has to do with the upper or roofing portion, whose plate structure is not completely known. This roofing disk is marked by five regular diverging angulations, following the lines of juncture of the upper series of plates. These lines are continuous with very obtuse dihedral angles which are formed longitudinally along the center of the series of pentagonal plates just below. These angular lines, thus almost continuous from top to bottom, are obscure in one specimen, but rather strong in another which is probably immature. The latter possesses the additional character of having a deep dimplelike depression about midway along each of these angles, situated apparently at the apex of each of the pentagonal plates regarded as forming the second series.

One specimen, somewhat differently preserved from the others, shows a feature in them obscured. In this example the outer and inner surfaces alone appear to have been silicified, so that when the specimen was freed by etching, a thin outer and inner shell was left to represent the original thick plates. The outer shell in this case has been broken away and the inner one shows five elliptical elevations radiating from the mouth, apparently corresponding to depressions on the interior.

The only genus with which I can think to compare this curious cystoid is *Hypocrinus* Beyrich; but it is evidently so distinct from that type that it scarcely seems necessary to point out the differences in detail. If we suppose that there are no little plates around the mouth, and accept the interpretation here adopted as to the basal cup, the cystid is composed of three rings of plates, but the basal ring, instead of consisting of three distinguishable plates, is formed of an uncertain number of completely ankylosed ones, to which, in turn, those of the second series are ankylosed.

I have referred this form to the cystoids instead of the blastoids, because of the absence of large, regular, ambulacral areas and the presence of a large eccentric anal pore. At the same time a certain affinity with the blastoids is shown in the small number of plates, together with their very regular size and arrangement, while the five structures of undetermined function which radiate from the mouth on the inside of the test superficially suggest the ambulacral areas of *Pentremites*, etc.

While certain features of this species remain unascertained, it is so clearly a new genus, and withal so interesting, that I feel justified in introducing a new generic name. At present I include *Cœnocystis*, with *Hypocrinus*, among the Cryptocrinidæ.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

ECHINOIDEA.

Family ARCHÆOCIDARIDÆ McCoy.

Genus ARCHÆOCIDARIS McCoy.

ARCHÆOCIDARIS CRATIS White?

The Guadalupian specimens referred to this species are fragmentary, representing the median portion of three radioles parallel and almost in contact. They are cylindrical, the largest example having a diameter of about 2 mm., without any perceptible taper. The length of the fragments is only about 11 mm. The spinules are rather small and very scattering, the general appearance suggesting a species closely allied to *Archæocidaris cratis*.

Horizon and locality.—"Dark limestone," east of Guadalupe Point, Guadalupe Mountains, Texas (station 3762b).

ARCHÆOCIDARIS sp. *a*.

This very minute form is represented by a single radiole, which has a cylindrical shape, with a diameter of scarcely more than half a millimeter and a length of 5½ mm. It is incomplete at the upper end. There are a few large spinules at relatively long intervals, and the general character is very much as in *Archæocidaris cratis*, although the size is greatly inferior.

Owing to its minute dimensions and rather imperfectly silicified condition it is impossible to determine definitely the character and distribution of the spinules.

Horizon and locality.—"Dark limestone," Guadalupe Mountains, Texas (station 3762c).

ARCHÆOCIDARIS sp. *b*.

Pl. XXVII, figs. 18 and 18a.

This form, which is very imperfectly known, is based on two specimens. One of these shows the distal end of the radiole, which is seen to expand rather abruptly from a very slender shaft having a diameter of about three-fourths mm. into a subspherical end which has a diameter of 2 mm. The terminal portion and the shaft adjacent appear to be armed with short spinules.

Associated with the foregoing is the proximal portion of a radiole, showing a long, slender, smooth, cylindrical shaft, which has a diameter of about three-fourths mm., with the usual subterminal collar near the lower end. It is very probable that this and the foregoing fragments belong to the same species, one which is characterized by its small size, long, slender, smooth shaft, and terminal spinose knob.

The Pennsylvanian species which most resembles this is *Archæocidaris spiniclavata*, which is still very different.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

ARCHÆOCIDARIS sp. *b* var.

Associated with the foregoing is the distal portion of a radiole of a very similar type. The terminal knob in this case is relatively larger and somewhat differently shaped. The end is in some degree pointed, and has midway a subangular zone above which it is covered with little spines, but below which it is smooth, like the shaft connected with it.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

ARCHÆOCIDARIS sp. *c*.

The material on which this division is based consists of fragments of radioles, some of them representing distal ends and some proximal, but nothing to show the length or character of the shaft between. The proximal ends have the usual configuration, with a subterminal milled collar. The distal end consists of a nearly spherical enlargement covered with little elevations or nodes. Of the two specimens representing this portion the larger has a diameter of 5 mm. One can not, of course, be sure that these fragments belong to the same species, but it seems not unlikely.

This form resembles that which I have designated *Archæocidaris* sp. *b*, but is very much larger. In view of this fact, especially since it was found at a different locality and since it is impossible to determine whether it is similar in other respects, such as the arrangement of spinules, etc., it seemed advisable to discriminate them provisionally as distinct species.

Horizon and locality.—"Dark limestone," Pine Spring, Guadalupe Mountains, Texas (station 2930).

ARCHÆOCIDARIS sp. *d*.

It seems best to group under this title a number of plates, some of which are associated with the radioles above described and probably belong to the same species; but the preservation of my material is too unsatisfactory to determine with any strong degree of probability, by studying the tubercles and the bases of the radioles, which radioles and plates belong together.

At station 2969, where *Archæocidaris* sp. *b* and *Archæocidaris* sp. *b* var. were found, five of these plates were obtained, each of them presenting more or less marked differences in size and configuration, so that unless some evidence were available to indicate that such was the case, I would hardly feel justified in referring any two to the same species. A single fragmentary plate from station 3500 agrees fairly well with one of those from station 2969. Five plates collected at station 2930 represent two somewhat distinct types, neither of which has the same characters as the others mentioned.

Consequently, if I were to divide these specimens on intrinsic characters, I would have to recognize seven species of *Archæocidaris*, based on the configuration of plates; this would demand more space and consideration for my scanty and fragmentary material than it at all merits.

Thus, *Archæocidaris* sp. *d* probably comprises more than a single species, possibly as many as seven, some of which, however, it seems very likely belong with the spines that have been entered above under separate titles.

Horizon and locality.—"Dark limestone," Pine Spring, Guadalupe Mountains, Texas (station 2930). Delaware Mountain formation, southern Delaware Mountains, Texas (stations 2969 and 3500).

VERMES.

Genus SPIRORBIS Daudin.

SPIRORBIS TEXANUS n. sp.

Pl. XXVII, fig. 6.

The specimen which forms the subject of this description is somewhat incomplete, but, on the other hand, is very well preserved, so that all the essential characters are readily ascertained. The shell is small, and irregularly and very loosely coiled. It is marked by numerous strongly projecting lamellose collars, which are rather regularly and closely arranged. They are not perpendicular to the surface, but project forward somewhat strongly. There are also very delicate longitudinal liræ, which are not entirely regular and not continuous between the different stages of growth marked by the annular lamellæ.

This species resembles *Spirorbis imbricatus* Ulrich. It is much smaller and more delicately constructed. The annulations are relatively a little more crowded, while the interspaces instead of being marked by concentric liræ show delicate radiating ones.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

MOLLUSCOIDEA.

BRYOZOA.

The Guadalupian Bryozoa, so far as known, comprise 14 genera and 44 species, as indicated in the following list:

	Species.		Species.
Domopora?	6	Phyllopora?	1
Fistulipora	3	Thamniscus	2
Meekopora	1	Acanthocladia	2
Stenopora	4	Septopora	1
Leioclema	1	Rhombobora	2
Fenestella	14	Goniocladia	1
Polypora	5	Actinotrypa	1

For the most part this group has proved rather surprisingly scanty, and my meager material would hardly have yielded so respectable an array of forms without the skillful manipulation of my friend Mr. Bassler, who made the sections which I studied and gave valuable aid in their investigation. The most abundant type is probably *Acanthocladia guadalupensis*, with the interesting group which I have placed under *Domopora* very nearly as plentiful. The greatest variety of species is found among the Fenestellas and Polyporas, which are more rare in the Guadalupe section itself than in the southern Delawares. Most of the types discriminated, however, are based on mere fragments. All the other forms, except possibly *Fistulipora grandis* var. *guadalupensis*, are rare.

In addition to being fragmentary, the Guadalupian Bryozoa proved unsatisfactory for study in another particular. A good deal of the material is silicified and thus unfitted for sectioning, while the structure was often found more or less obscured where siliceous replacement had not taken place.

In some cases the study of thin sections is less essential to the determination of species. Among the Domoporas I have discriminated species on external characters, and etched specimens, unless too coarsely silicified, were very favorable to this treatment. The Fenestellas, on the other hand, mostly proved to be too coarsely or too imperfectly replaced by silica to yield satisfactory results.

The Guadalupian Bryozoa differ considerably from those of the Salt Range. Many of the Indian forms which I should be disposed to place with the Bryozoa and compare with the present fauna Waagen and Wentzel have assigned to the cœlenterates. Such are the following:

	Species.		Species.
Monotrypa	1	Hexagonella	3
Orbipora	1	Dybowskiella	2
Geinitzella	2	Fistulipora	1
Stenopora	4		

Among the Bryozoa cited are the genera named below:

	Species.		Species.
Rhombopora	2	Synocladia	1
Fenestella	3	Goniocladia	1
Polypora	8	Thamniscus	2
Phyllopora	3	Acanthocladia	1

This list must be further modified by replacing *Geinitzella* by *Batostomella*, of which Waagen's genus is probably a synonym, and enlarging *Fistulipora* so as to include and eliminate *Dybowskiella*.

The two faunas have in common the genera *Fistulipora*, *Stenopora*, *Fenestella*, *Polypora*, *Phyllopora?*, *Acanthocladia*, *Thamniscus*, *Rhombopora*, and *Goniocladia;* while the Guadalupian contains species of *Domopora*, *Meekopora*, *Leioclema*, and *Actinotrypa* not found in the Salt Range, and the latter fauna contains *Monotrypa*, *Orbipora*, *Batostomella*, *Hexagonella*, and *Synocladia* not found in the Guadalupian. There are thus a considerable number of generic types which are peculiar to each. Of these, foremost in importance on the part of the Guadalupian are without doubt the Domoporas, which form so abundant and striking a feature of that fauna. There appears to be no single genus which plays the same rôle in the Salt Range fauna, but *Batostomella* (*Geinitzella*) and *Synocladia* are somewhat important, and *Hexagonella* is sufficiently abundant and striking to deserve special mention, while *Phyllopora* and *Thamniscus* are rare in the Guadalupian and more or less unsatisfactorily identified.

Among the points of resemblance represented by the possession of types in common *Goniocladia* is perhaps the most noteworthy, for that genus, first described from Scotland, was for a long time known elsewhere only in India. Later it was obtained in the Guadalupe Mountains, and about the same time specimens were brought back from Alaska. *Acanthocladia* is to a less degree important, but aside from these the bryozoan genera which are common to the two faunas are such as have a wide dispersion and a long range and might be contained in almost any two faunas of late Carboniferous age.

Some of the species are also related, but the types are not so peculiar or the affinity so intimate as to be especially noteworthy. Perhaps the most important instance of specific relationship is to be found in *Fistulipora grandis* var. *guadalupensis,* which represents the type of fistuliporoid for which Waagen and Wentzel introduced the generic term *Dybowskiella,* and is closely allied to *Dybowskiella* or *Fistulipora grandis.* One may remark, on the other hand, in this connection the large development of *Polypora* in comparison with *Fenestella,* rather the reverse of what is indicated in the American fauna.

On the whole, therefore, the bryozoan faunas of the Salt Range and Guadalupian do not seem to me to indicate any marked relationship.

But scanty mention of Bryozoa has been found in literature dealing with the Himalayan region. Diener records a species of *Fenestella* in his first paper on Chitichun No. 1, and in that on anthracolithic fossils from Kashmir and Spiti two species of *Fenestella,* one of *Protoretipora,* and one of *Acanthocladia.* In a subsequent paper on the Spiti fauna he cites one species of *Fenestella* and one of *Protoretipora* from the lower horizon and no Bryozoa from the upper.

The record from China is equally meager. Kayser identified *Synocladia* sp., *Polypora* sp., *Rhombopora lepidodendroides,* and *Fistulipora tuberosa* from Lo Ping. From Kantschoufu Loczy notes *Rhabdomeson* cf. *rhombiferum;* from the Lantsankiang Valley *Polypora fastuosa, Polypora* sp., *Septopora biserialis, Acanthocladia* cf. *anceps,* and *Callopora* or *Fistulipora* sp.; and from Pupjao, in the province of Yünnan, *Polypora koninckiana, Polypora* cf. *gigantea,* and *Fenestella* or *Polypora* sp. These Chinese faunas certainly resemble the Guadalupian, in a general way, but are not sufficiently extensive to form a satisfactory index of relationship.

If we may assign *Calamopora* sp. to the corals, the only Bryozoa cited by Beyrich from Timor seem to be those which he identifies as *Alveolites mackloti* and *Heliolites mülleri.* The latter is presumably a *Fistulipora,* possibly of the type on which *Dybowskiella* was founded, and which is represented by *F. grandis* var. *guadalupensis* in our fauna. The *Alveolites* probably belong to the same genus, the vesicular tissue between the cells not being visible. It may even belong to the same species, or at least to a closely related one. In the apparent absence of vesicular interspaces this form somewhat suggests those which I have placed with *Domopora,* but the cells are not circular, and prominent star-shaped maculæ appear to be absent. Rothpletz, in his paper on the faunas of Timor and Rotti, cites several Bryozoa, namely, *Fistulipora mülleri, Fistulipora? mackloti, Fenestella virgosa,* and *Polypora* sp. The two former are the species which have already been mentioned in connection with Beyrich's report. Somewhat in contrast to Beyrich's figure, Rothpletz represents

F. mülleri as having circular zoœcia. If he is exact in this particular the species certainly does not belong to the group of *Dybowskiella*, as I had supposed. On the other hand, as Rothpletz's figures represent the zoœcia not only as circular, but without a lunarium and with interrupted walls, there is some legitimate doubt as to whether the form is a *Fistulipora* at all. It rather suggests the Guadalupian form which I have referred to *Actinotrypa*. Rothpletz's *Polypora* has unusually coarse fenestration, and the branches instead of being persistent are represented as anastomosing. These characters suggest to me that the generic relations are really rather with *Goniocladia* or perhaps with *Phyllopora*.

The "Permo-Carboniferous" of Queensland and New Guinea contains rather numerous representatives of the Bryozoa. Etheridge distinguishes 1 species of *Monticulipora*, 4 species of *Stenopora*, 4 species of *Fenestella*, 1 species of *Phyllopora*, 3 species of *Protoretipora*, 1 species of *Glauconome*, 1 species of *Rhombopora*, and 1 species of *Myriolithes*. Aside from a few types of wide distribution and long range this fauna and that of the Guadalupe Mountains have very little resemblance, though it is difficult to tell much about the Australian fossils, owing to their poor condition and unsatisfactory illustration.

The Australian Bryozoa described from New South Wales by De Koninck comprise 1 species of *Penniretipora*, 1 species of *Dendricopora*, 6 species of *Fenestella*, 1 species of *Protoretipora*, 1 species of *Retipora?*, and 1 species of *Polypora*. All these seem to have come from the lower beds except a couple of Fenestellas and *Protoretipora ampla*, a fauna too meager to denote much relationship with the Guadalupian, even if it existed. I have not referred any form to *Protoretipora*, but it is to be noted that De Koninck regards *Polypora mexicana*, which I have provisionally identified in the "dark limestone," as belonging to that genus.

Owing to the fact that most of the older writers and some of the more recent ones have failed to study their bryozoan faunas by means of thin sections, and that even among authors of the present day there is considerable variation of usage in the employment of generic terms, it is less possible with the bryozoans than with almost any other group to trust to mere lists unaccompanied by descriptions and especially by figures. On this account a good deal of the data contained in the Russian reports which I have consulted is rather unsatisfactory for the present purpose.

Stuckenberg's paper on the corals and Bryozoa of the upper mid-Russian Kohlenkalk is a notable exception, but in this case I find it almost impossible to distinguish the horizon of the different forms. This author cites only one species of *Fistulipora*, apparently of the general type of *F. grandis* var. *guadalupensis*. *Fenestella* is represented by 6 species, *Polypora* by 4, *Carinella* by 1, *Penniretipora* by 1, *Coscinium* by 1, *Rhabdomeson* by 1, *Ascopora* by 1, *Orbipora* by 2, and *Archæopora* by 1—20 in all. The generic representation is almost entirely different from the Guadalupian and need not be discussed. Aside from *Fistulipora* the only genera possessed in common are *Fenestella* and *Polypora*.

The position of many of these species seems to be in the Moskovian. Trautschold cites from this horizon *Fenestella veneris*, *Polypora martis*, *P. irregularis*, *P. dendroides*, *Ascopora rhombifera*, *Ceriopora inæquabilis*, *Coscinium selliforme*, and *C. michelinia*.

In his monograph on Gschelian Brachiopoda, Tschernyschew lists the following Bryozoa among the associated fauna: *Dybowskiella, Geinitzella, Stenopora, Fenestella, Archimedes, Polypora, Coscinium, Thamniscus, Synocladia, Phyllopora, Archimedipora,* and *Penniretipora.* The commonest to occur and the best represented in species appear to be *Fenestella, Polypora,* and *Archimedes.* The last genus, as I hardly need to mention, is found in eastern North America only in the Mississippian. In the western portion of the continent the horizon seems to be, in the few instances in which it has been found at all, in the upper Carboniferous, making this region in this particular, as in some others, comparable to the Russian section. This singular genus is of course not known in the Guadalupian nor in the underlying Hueco formation. In Utah, where I have found it in the upper Carboniferous, its associated fauna is such as to indicate a correlation with the Hueconian much more than with the Guadalupian series.

A good many genera are common to the Gschelian, as illustrated by Tschernyschew's list, and the Guadalupian, but they are such as are world-wide in distribution and very long in range, and do not necessarily indicate for the two faunas any very close relationship. Stuckenberg lists from this zone 15 species of *Fenestella,* 1 of *Ptilopora,* 12 of *Polypora,* 1 of *Goniocladia,* 2 of *Penniretipora,* 1 of *Thamniscus,* 1 of *Synocladia,* 1 of *Ramipora,* 2 of *Dybowskiella,* and 2 of *Geinitzella.* This list, as well as that of Tschernyschew, shows a considerable percentage of common genera. Perhaps the most significant of the genera which occur in both faunas is *Goniocladia.*

Passing over less copious notices of Gschelian Bryozoa, I find that Stuckenberg cites a somewhat less extensive list of the same group from the Artinsk, namely:

	Species.		Species.
Fenestella	5	Penniretipora	2
Polypora	6	Dybowskiella	1
Synocladia	1	Geinitzella	1
Goniocladia	1	Rhombopora	2
Ptilopora	1		

In the Kungurstufe the number is still less, consisting of only 3 species of *Fenestella,* 2 of *Polypora,* and 2 of *Geinitzella.* These lists indicate about the same community of generic types with the Guadalupian as those of Gschelian forms. The absence of *Domopora* from the Artinsk and of *Geinitzella* and *Synocladia* from the Guadalupian are deserving of remark, though there are a number of less important Guadalupian genera not found in the Russian beds.

Krotow's monograph on the fossils of the Artinskian sandstone contains reference to a number of bryozoan species, but unfortunately none of them is figured. He cites 6 species of *Fenestella,* 11 of *Polypora,* 2 of *Phyllopora,* 2 of *Ptilopora,* 2 of *Penniretipora,* 1 of *Coscinium,* 1 of *Monticulipora,* 1 of *Stenopora,* 1 of *Rhombopora,* and 5 of *Vincularia.* This list discloses a bryozoan fauna which is of a considerably different complexion from the Guadalupian.

From the Permian of Kostroma, Tschernyschew cites only *Synocladia virgulacea, Fenestella retiformis, Stenoporă columnaris,* and *Fistulipora lahuseni.* The Permian Bryozoa cited by Netschajew consists of *Fistulipora permiana* (poorly figured but possibly not a *Fistulipora* at all), *Geinitzella columnaris*, and *G. crassa* together with 5 species of *Fenestella*, 9 species of *Polypora*, and 3 of *Phyllopora*. Golowkinsky cites *Stenopora columnaris*, *Phyllopora* sp., and *Fenestella* sp. In proportion as the bryozoan fauna of the Russian Permian has become reduced to a relatively few generic types of universal distribution it has lost character altogether. It lacks a number of genera, some of which are rather important in the Guadalupian, besides containing some which are non-Guadalupian, such as *Batostomella* and *Synocladia*. On the whole it can not be said that the faunas of the Permian of Russia and the Guadalupian show any marked relationship in point of the Bryozoa which they contain.

The only bryozoan cited by Abich from Djoulfa, in Armenia, is *Polypora fastuosa*, and by Enderle from Balia Maaden a species of *Phyllopora* and one of *Fenestella*.

I do not know whether Gemmellaro described the Bryozoa of the Sicilian fauna from Palermo, but if so, I have been unable to consult the work. Likewise, Schellwien's account of the Bryozoa of the Carnic Alps, if he prepared one, has escaped me. Angelis d'Ossat has published a report upon the corals and Bryozoa of the Carnic Alps, but the species while discussed are not figured. The following are recorded among the Bryozoa, constituting a fauna which has very little in common with the Guadalupian:

	Species.		Species.
Monticulipora	2	Penniretipora	1
Fenestella	2	Geinitzella	1
Polypora	2	Archæopora?	1

Gortani, who also fails to figure his forms, cites from this region a fauna closely related to that of Angelis d'Ossat:

	Species.		Species.
Monticulipora	1	Fenestella	2
Geinitzella	1	Polypora	1
Rhabdomeson	1	Penniretipora	1

From the Dyas of Germany Geinitz cites the following:

	Species.		Species.
Stenopora columnaris	1	Synocladia	1
Fenestella	3	Acanthocladia	2
Polypora	1	Hippothoa	1
Phyllopora	1		

While most of these genera occur in the Guadalupian also, it is doubtful whether this fact should be regarded as very significant. The absence from the latter fauna of *Synocladia* and *Batostomella* (*Stenopora columnaris*), and the presence of *Domopora* are deserving of notice.

The Bryozoa of the English Permian are cited by King under the following titles:

Calamopora mackrothi.	Synocladia virgulacea.
Stenopora columnaris.	Phyllopora ehrenbergi.
Alveolites buchianus.	Thamniscus dubius.
Fenestella retiformis.	Acanthocladia anceps.

This list, almost the counterpart of that of the Dyas, shows a moderately close relationship with the Guadalupian, but here again the absence from the latter of *Synocladia*, which seems to be something of a feature of the European Permian, is worthy of note.

From the south point of Spitzbergen, Toula cites *Stenopora* sp.; from Axel Island, *Fenestella* (1 species), *Polypora* (3 species), *Ramipora* (1 species), and *Phyllopora* (1 species); and from the cape between the arms of North Fjord, *Stenopora ramosa*, *Stenopora tubulosa*, *Fenestella* sp., and *Polypora* sp. Lundgren records only *Stenopora columnaris*. In these faunas from Spitzbergen I recognize no special affinity with the Guadalupian.

A rather extensive series of bryozoan forms is recorded by Toula from Nova Zembla, but this also seems but remotely related to the Guadalupian.

	Species.		Species.
Glauconome	1	Stenopora columnaris var. ramosa	1
Polypora	8	Rhombopora bigemmis	1
Archimedes	1	Millepora oculata	1
Fenestella	7	Callopora arctica	1

The occurrence of *Archimedes* in this Arctic fauna at an upper Carboniferous horizon is of considerable interest, connecting it with the occurrences in Russia and Utah.

From the West Sahara (Igidi) Stache cites only 2 species of *Fenestella*, 1 of *Ascopora*, and 1 of *Stenopora?*, and the associated fauna is probably much older than the Guadalupian.

Gabb cites *Retipora* from Peru and D'Orbigny *Ceriopora ramosa* and *Retipora flexuosa* from Bolivia.

After withdrawing species of western distribution, the Bryozoa of the typical American Pennsylvanian, according to Nickles and Bassler's catalogue, comprise 14 genera and 49 species, as follows:

	Species.		Species.
Acanthocladia	1	Polypora	7
Chainodictyon	2	Prismopora	3
Cystodictya	1	Rhombopora	4
Diploporaria	1	Septopora	6
Fenestella	11	Stenopora	5
Fistulipora	2	Streblotrypa	1
Pinnatipora	3	Thamniscus	2

Other species have since been added, but these do not materially affect the matter in hand. I may note, however, that *Meekopora* is now known in the Pennsylvanian as well as in the Mississippian.

Comparing this list with that of the Guadalupian we find that the two faunas have in common *Fistulipora*, *Meekopora*, *Stenopora*, *Fenestella*, *Polypora*, *Acanthocladia*, *Thamniscus*, *Septopora*, and *Rhombopora*, while the Guadalupian has *Domopora*, *Leioclema*, *Goniocladia*, *Phyllopora?*, and *Actinotrypa?*, not found in the Pennsylvanian, and the Pennsylvanian has *Chainodictyon*, *Cystodictya*, *Diploporaria*, *Pinnatopora*, *Prismopora*, and *Streblotrypa*, not found in the Guadalupian. As to the genera which are present in both faunas, it is to be noted that in almost every instance the species representing them are different in each. Seldom, however, are the types so well marked and peculiar that the two faunas do not contain species more or less closely allied. In regard to the genera not held in common by the Guadalupian and Pennsylvanian faunas, the most significant on the part of the former are unquestionably *Domopora?* and *Goniocladia*, which lend the fauna a decidedly non-Pennsylvanian aspect. *Actinotrypa* and *Leioclema*, as is well known, are represented in the typical Mississippian, and the extension of their range into the Pennsylvanian may possibly be looked for, and would certainly be less of a novelty than the appearance of *Domopora* or *Goniocladia*.

Over half the Pennsylvanian genera have not been found in the Guadalupian, but in view of the still very partial knowledge which we possess of the latter fauna this number stands to be considerably diminished.

On the whole, I regard the bryozoan faunas of the Guadalupian and Pennsylvanian as rather closely related, probably more closely than the Bryozoa of the Guadalupian and any foreign fauna with which comparison has been made. They are, however, rendered very distinct both by the presence throughout of different species, though often of the same genus, and the presence in the Guadalupian of some novel and peculiar types, such as *Domopora?* and *Goniocladia*. I have found nothing comparable to the former genus in any of the Paleozoic faunas which have been consulted.

Family CERIOPORIDÆ Busk?

Genus DOMOPORA D'Orbigny?

In the Guadalupian series, especially in the lower beds of the Capitan formation, occurs an interesting and beautiful bryozoan type, which I have placed provisionally with D'Orbigny's genus *Domopora*. Although the position of the Carboniferous forms will probably prove to be in the taxonomic neighborhood of *Domopora*, it is not certain that they will find place directly with that genus. Nevertheless, I am not at present prepared to demonstrate their distinctness and to establish them as a new genus, for although the material examined is fairly plentiful, little of it is in a condition suitable for the study of zoarial structure. The majority of the specimens are silicified, and while it is thus possible by means of acid to obtain them free from inclosing rock, the processes of replacement have usually been such as to obscure or alter the details of structure in some degree. In specimens which have not been replaced by silica, moreover, the original test seems to be represented by dolomite, which has equally obscured the structure. Nevertheless, a certain amount of knowledge has been obtained of the microscopic structure of these forms from such examples, and occasionally from calcareous ones.

The zoœcia consist of cylindrical cells of nearly uniform size, which here and there at the surface tend to become confluent or to be connected by short grooves, especially in lines radiating from the maculæ. The zoœcia are interrupted by occasional tabulæ, though these structures are usually rare. They have no peristome nor any lunarium. Large maculæ having usually more or less of a stellate shape are a striking feature. At the surface the zoœcia are separated merely by the thickened walls, without either acanthopores or mesopores. In thin sections, so far as can be judged from our material, the thickened walls are not moniliform, as in *Stenopora,* but appear to be structureless or else with but small, dense granules, which may possibly represent obsolete acanthopores.

In some respects the form thus characterized may be compared to *Batostomella,* to *Stenopora,* and to *Fistulipora,* or, perhaps better, to *Cyclotrypa.* If in the latter genus the interspaces, instead of being occupied by mesopores, were filled with solid deposit, the structure would be like the forms under consideration. Similarly, that group of *Stenopora* which has thickened but not moniliform walls and few tabulæ, with sometimes very small if numerous acanthopores, seems but a step removed structurally from the group under discussion. Likewise, in *Batostomella,* if the transmutation of the mesopores into solid tissue were carried still farther, and followed by the gradual loss of acanthopores which replace them, one might imagine the present type to be related to *Batostomella* or even descended from it. A more complete knowledge of the minute structure of these Guadalupian forms, however, is necessary to such questions, as well as the discovery and investigation of intermediate types.

Although it is at present impossible to reach a satisfactory conclusion as to the relation of the present forms with D'Orbigny's genus, certain differences may yet be pointed out. Among the more obvious, the comparison being based on D'Orbigny's description and figures,[a] are the absence of series of large cells, often emerging along elevated rays (the present forms showing cells of but a single size), and the fact that colonies seem not to be formed by superimposed layers, though sometimes a few interruptions can be seen. Furthermore, in typical *Domopora* there appear to be no maculæ, at least of the type which is such a striking feature in the forms under consideration; but it is possible that *Domopora* should be reviewed on the basis of characteristic material from European beds.

Domopora? shows a rather extensive specific development in the Guadalupian, as well as an abundance of individuals. The characters used for discrimination are less those of mensuration of parts than those of structure. In fact there often appears to be no more variation in the size of the zoœcia and their distance from one another in different species than in different individuals of the same species. The mode of growth, both of the zoarium as a whole and of its individual zoœcia, especially in relation to the macular areas, seems to form a practical and satisfactory method of discriminating species in this group.

This type of bryozoan, which appears to be rather Mesozoic than Paleozoic in its character, is not known in the Carboniferous except in this one area, faunas in other regions which are supposed to represent about the same horizon being, so far as known, without representatives of it. It therefore forms an individual feature of the Guadalupian fauna, and one which contributes considerable to its neo-Paleozoic facies.

DOMOPORA? TERMINALIS n. sp.

Pl. VII, figs. 19 to 21a; Pl. XVIII, figs. 1 to 6a.

The zoaria belonging to this species usually come in small subspherical masses, rounded above, somewhat prolonged and contracted below into a short, stout stalk.

[a] Animaux invert., Terrain Crétacé: Pal. française, vol. 5, Bryozoaires, 1850-1852, p. 986.

The upper portion of the zoarium is poriferous; the lateral portions are closed. Such forms, however, though in our collection by far the most numerous, are perhaps only a partially mature condition, for some colonies have been found, with but little question developed from the type just referred to, which have an elongate or subcylindrical shape, produced by a considerably more extensive prolongation of the stalk. The small bulbous colonies are usually symmetrical, but they are sometimes rendered irregular by the character of the object to which they were affixed. Occasionally one side is developed more extensively than the others, as if the projections thus produced were the beginning of a bifurcation, but no really branched examples have been noted. The imperforate condition of the lateral areas is without much question a modification of a porous condition, the zoœcia having been closed over and apparently having received an additional testaceous coating. The lateral pores are less completely closed in the long cylindrical colonies than in the short spherical ones.

The terminal portion of the growing end in each zoarium is occupied by a macula, that is, an area upon which no cells are developed. The apertures extend in more or less regular rows from the borders of the macula, which projects rays of noncelliferous surface among them. The apertures are small, circular, separated by intervals of about their own diameter, and they come about eight in a space of 2 mm. in a radial direction. They vary somewhat in size in the same specimen and also in different specimens.

To a certain and somewhat limited extent the macula is a variant with the age of the colony, at least the large zoaria possess it in a high degree of development, while one or two specimens in which the feature is fairly obsolete are rather small. If it does vary appreciably with the age of the colony it at least is usually a recognizable feature in very young zoaria. In different specimens the maculæ also present certain variations in shape and in their relation to the rows of pores with which they interdigitate. This structure seems to be formed, in some cases at least, by an overarching platform, which conceals but does not entirely close the pores below; for in some examples it is possible from the side to look under this covering and see the cells, which are concealed when viewed from above. In one example from which the end has been broken, as would be expected, an earlier macula is exposed, apparently similar and subjacent to that which was doubtless terminal in the perfect condition.

The cells, as has been remarked, are circular in section without, so far as can be seen, any mesopores. By a thickening of the walls they are often separated at the surface at considerable intervals by a dense undifferentiated deposit. Underneath this outer flooring they are sometimes seen as tubes, which are not in contact; nor are the intervening intervals occupied in any manner except here and there by a small tube, which is probably a young cell. This may be the original condition, but of this I entertain some doubts, as the appearance might easily be due to the incomplete replacement to which these objects have been subjected. The interzoœcial spaces may have been solid below, as well as at the periphery, and all but the superficial silicified portions may have been removed by etching. The zoaria appear not to have been interrupted by tabulæ. They are nearly straight, with but a slight outward curvature, and slope strongly outward from an axial line.

As might be inferred, these colonies originate in an explanate zoarium having its external surface covered with an epitheca and cemented to some external object. When the object of attachment is large and regular a symmetrical colony usually results; where it is small and irregular an unsymmetrical colony; but irregularities also often occur from apparently intrinsic causes, such as the incipient branching, or what appears to be such, mentioned above. The basal portion is as a rule more or less expanded where attached, narrowing above and finally expanding to form the subspherical bulb bearing the zoœcia.

In point of size few colonies reach a diameter of 5 mm.

Horizon and locality.—Middle of Capitan formation, Capitan Peak (station 2926); base of Capitan formation, hill southwest of Guadalupe Point (station 2906); "dark limestone," Pine Spring (station 2930), hill southwest of Guadalupe Point (station 2924), Guadalupe Point (stations 3762b, 3762d, 3762e), Guadalupe Mountains, Texas. Delaware Mountain formation, southern Delaware Mountains, Texas (stations 3500 and 2969).

DOMOPORA? OCELLATA n. sp.

Pl. VIII, figs. 7 and 7a; Pl. XVIII, figs. 7 to 10; Pl. XXVII, figs. 13 to 14a.

This species occurs in the form of elongate cylindrical stems, which occasionally seem to manifest a disposition to bifurcate, though no branching specimens have yet been found. The largest stems have a diameter of about 5 mm., and they occur as small as 3 mm. or less. This form, unlike *Domopora? terminalis*, does not have the lateral zoœcia closed, nor does it develop a single terminal macula. Instead, the entire surface, except possibly the point of attachment, has open zoœcia, among which, especially on the sides, are distributed large well-marked maculæ. The latter have a stellate shape and are characterized by the entire absence of zoœcia. They are arranged about 3½ mm. apart from center to center.

The zoœcia are similar to those of *Domopora? terminalis*. They vary somewhat in size in the same colony, those nearest the maculæ being proportionately larger than the more distant ones. They are separated, as a rule, by intervals about equal to their own diameter, sometimes more and sometimes less. The interzoœcial integument appears to be solid, no traces of mesopores having been noted.

The internal structure, so far as it can be made out, without thin sections, from silicified specimens, is similar to that of *D.? terminalis*. The zoœcia bend outward, however, much more strongly, and a cross section of a branch shows two more or less distinct zones, an inner one, in which the tubes are transected more or less crosswise, and an outer one, where the course of the section is more or less longitudinal.

Well-preserved and characteristic specimens of this species are readily distinguished from *Domopora? terminalis*, but unfortunately many specimens are neither one nor the other. No especial profit would accrue from considering the obscurities which unquestionably arise from preservation, but it is sometimes not possible to discriminate with certainty between intrinsic and extrinsic characters. Our material seems to show that in the older portions of large colonies the zoœcia tend to close up through the thickening of the walls, thus solidifying the same and obscuring not only the arrangement of the zoœcia and maculæ, but their presence as well. In connection with the more terminal portion such occurrences would occasion little difficulty, but as all the large colonies are more or less fragmentary it is usually impossible to dispose of such examples satisfactorily.

Another difficulty arises from the opposite source. Very young colonies before they have become elongated stems, have very much the appearance of colonies of *Domopora? terminalis* of similar size. The lower portion is often similarly covered with a dense investment, and the length is scarcely sufficient to afford room for the lateral maculæ. The absence or presence of a terminal macula might serve as a practical criterion, but I am not sure that this is invariably present in an appreciable degree in *D.? terminalis*, and of course where only imperfectly developed it would so much the more easily be effaced by imperfect preservation.

One or two specimens represent another type which has been placed here with some hesitation. They are in the shape of irregular hemispherical masses having but a small diameter. They possess no distinct stalk or annular nonporiferous area, and the zoœcia are interspersed with large stellate maculæ, as in *Domopora? ocellata*. I have regarded these as representing a young stage of a rather large cylindrical colony. They might, however, be considered as belonging to an incrusting species.

Horizon and locality.—Top of Capitan formation, Capitan Peak (station 2966?); base of Capitan formation, hill southwest of Guadalupe Point (station 2906); "dark limestone," Pine Spring (station 2930), Guadalupe Point (stations 3762b, 3762d?, and 3762e), Guadalupe Mountains, Texas. Delaware Mountain formation, southern Delaware Mountains, Texas (stations 2957, 2962, 2969, and 3500). Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763).

DOMOPORA? CONSTRICTA n. sp.

Pl. XVIII, fig. 11.

This form, which is represented by several specimens, is related to *Domopora? ocellata*, but is distinguished chiefly by having the zoarium crossed by constrictions, which are located with reference to the maculæ, passing across their centers. In the type specimen the constrictions seem not to surround the cylindrical colony, but to be confined to the general region of macular development. Maculæ on the other side, not on the same circumferential line, seem not to be accompanied by constrictions. Aside from the feature just mentioned, there is little to distinguish this form from *D.? ocellata*, and I doubt whether it can be properly considered more than a variety of the other.

Horizon and locality.—"Dark limestone," Pine Spring, Guadalupe Mountains, Texas (station 2930).

DOMOPORA? VITTATA n. sp.

Pl. XVIII, figs. 12 and 12a; Pl. XXVII, figs. 15 and 15a.

Associated with *Domopora? ocellata*, and apparently derived from it, occurs a form which very much resembles *D.? hillana*. It attains this appearance by reason of the maculæ, which occur rather regularly alternating in two rows, taking on a lunate or fillet-shaped instead of a stellate configuration. The maculæ are usually elevated, as in *D.? ocellata,* but sometimes depressed. To make the resemblance to *D.? hillana* even greater the branches are sometimes more or less flattened or compressed. A difference which seems to me quite fundamental, however, is found in the method of cell construction. In *D.? hillana* the zoœcia spring from a median plate, while in the form under consideration they are directed radially. In addition to the structural difference the somewhat more compressed branches and slightly larger zoœcia of *D.? hillana* should serve as an additional means of distinguishing the two forms.

Horizon and locality.—"Dark limestone," Pine Spring, Guadalupe Mountains, Texas (station 2930). Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

DOMOPORA? HILLANA n. sp.

Pl. XXXI, fig. 19.

This handsome species is distinguished from its associates in the same genus by its growth more than by structural characters, the size of the cells, etc., being, so far as one can tell without thin sections, essentially as in *Domopora? ocellata. Domopora? hillana,* however, is a bifoliate form, which grows in rather slender, frequently bifurcating, flattened branches. So far as examined these seldom have a width of more than 2.5 mm., while the thickness is about 1.5 mm. This dimension diminishes toward the top of the branches. The zoœcia originate from a median plate, which is distinctly seen forming the long diameter of the branches, and extend somewhat obliquely forward. Large maculæ are developed along the edges of the fronds, extending onto both faces. Instead of being circular, they are fillet-shaped, the central and broader portion being situated on the edge of the frond and more proximal than the ends which point backward. The maculæ also as a rule form a depressed or constricted area, so that, quite additionally to branching, the edges of the frond present a notched or dentate outline.

This is a very pretty and strongly characteristic species. With good specimens it ought not to be possible to confuse it with any of the species yet discovered in the Guadalupian fauna.

Horizon and locality.—Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763).

DOMOPORA? INCRUSTANS n. sp.

Pl. XXVII, figs. 16 to 16b.

The type and only specimen of this species formed a small elliptical expansion bent along its longest diameter around some object which has now disappeared and to which it was attached, so that at present it possesses an annular shape. Its inner and lateral surfaces are covered by an epitheca, and its outer surface is poriferous. The zoarium is about $1\frac{1}{2}$ mm. thick in the thickest portion.

The size of the apertures in general appearance is similar to that seen in *Domopora? ocellata,* but there are no stellate maculæ. This feature is represented by nonporiferous rays diverging from certain points on the margin of the zoarium, as if from maculæ whose centers lay without the present complete limits of the zoarium.

The relations of this form are doubtful. It is possibly but a very aberrant initial colony of *D.? ocellata*, but it differs so much from such mature or even youthful colonies as are known to me (or of *D.? terminalis* as well) that it did not seem justifiable, without further evidence, to refer both to one species.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

Family FISTULIPORIDÆ Ulrich.

Genus FISTULIPORA McCoy.

FISTULIPORA GRANDIS var. GUADALUPENSIS n. var.

Pl. XVII, fig. 18; Pl. XXV, fig. 7; Pl. XXVII, fig. 17.

This form usually occurs as cylindrical masses of various dimensions, which sometimes attain a diameter of 20 mm. but are often smaller. The longest fragment yet noted is about 50 mm. in length. It is evident that these vertically elongated masses must have arisen from an initial flat expansion, and in fact specimens having this shape are also found possessing apparently all the characters of the cylindrical examples. Some of these explanate specimens have a greater diameter than any of those which are cylindrical, and it seems not unlikely that the latter may have been attached by expanded bases, or that the shape may have varied from cylindrical elevations to rather thick flat expansions having nodular areas rising above the main mass. Cylindrical specimens frequently have the lateral surface more or less completely covered with an exterior investment resembling an epitheca. In places this is sufficiently heavy to completely mask the cells beneath. In places also the cells are partially visible, while elsewhere they appear to have been open and functional.

In transverse sections the zoarium is seen to consist of the usual autopores and mesopores, in the arrangement of which there is the greatest latitude. The zoœcia vary somewhat in size, but usually are about two-fifths of a millimeter in diameter. They are characterized by a very strongly marked lunarium, which surrounds about half of the zoœcial tube, or a little more. The zoœcia usually run about four to four and a half in a distance of 2 mm., but may occur in as great number as five and a half. In macular areas, however, they are of course farther apart, and in these regions spaces of 2 mm. can sometimes be measured in which none at all are found. The mesopores vary greatly in size. Occasionally they reach as large dimensions as the zoœcia, but usually they are about half that size. They occur as a rule in one or two rows between the zoœcia, but, as already remarked, in maculæ they are much more abundant. Usually the zoœcia are situated from one-half to a full diameter apart, but sometimes they are almost in contact.

In longitudinal section corresponding variations are shown. The mesopores exhibit a wide range, not only in the number which intervene between adjacent zoœcia, but also in the size and frequency of tabulation. From 10 to 24 tabulæ occur in 2 mm., and the structures may make segments which are twice as wide as long; or, on the other hand, twice as long as wide. The zoœcia are rather sparsely and irregularly tabulate. In places, especially near the surface, they are often uninterrupted for as much as 2 mm. or more, but below, three or four tabulæ may occur at distances of one-fourth of a millimeter apart or less.

This species is readily distinguishable from the two known species of the American Pennsylvanian. From *F. carbonaria* it differs in its mode of growth, in its more abundant mesopores, and in its larger and more highly developed lunarium. From *F. nodulifera* it differs in its mode of growth, its larger cells, and its more extended lunarium.

Several species have been described from India which are also related to this. The growth is similar to *F. grandis.* Minor differences connected with the size of the zoarium, of the individual cells, of the abundance of maculæ, etc., might be pointed out, but the most striking distinction is to be found in the much larger and more embracing size of the lunarium in the American form. About the same difference exists between the latter and *F. expansa,* and there is the additional one of mode of growth, *F. expansa,* as the name suggests, forming flattened expansions. *F. parasitica* Waagen and Wentzel forms incrusting lamellæ similar to the American *F. nodulifera* and has the lunarium less well developed.

Waagen and Wentzel included the first two species in their genus *Dybowskiella.* When that name was first introduced the genus *Fistulipora* was imperfectly understood, and *Dybowskiella* would seem to have been well established; but at present the weightiest authorities seem to regard *Dybowskiella* a synonym of McCoy's genus, a conclusion which my own judgment entirely sanctions.

F. grandis var. *guadalupensis* is, with possibly one exception, the commonest bryozoan of the Guadalupian fauna, having been recognized at a large number of localities representing the horizons of the Delaware Mountain sandstone and the Capitan limestone, both Shumard's "dark limestone" and his white. A good many of these identifications, however, have been made on silicified material, which is not only refractory in making sections but has also been more or less altered in appearance in the processes of replacement. Where the silicification is good the lunarium projects as a strongly elevated spine, which on examination is seen to have a crescentic shape. Sometimes the cells appear to be more or less completely closed over in a sort of pustular elevation. This last may in fact truthfully represent the original calcareous condition, but there are various other aspects which are more clearly accidental to fossilization.

Horizon and locality.—Top of Capitan formation (stations 2966 and 3762a) and middle of Capitan formation (station 2926), Capitan Peak; "dark limestone," Pine Spring (station 2930), hill southwest of Guadalupe Point (station 2924), Guadalupe Point (stations 3762b, 3762e, 3762d); Delaware Mountain formation, Guadalupe Point (stations 2919 and 2963), Guadalupe Mountains, Texas. Delaware Mountain formation, southern Delaware Mountains, Texas (stations 2957, 2962, 2969, and 3500). Delaware Mountain formation, Comanche Canyon, Glass Mountains (station 3763), and mountains northwest of Marathon (station 3840), Texas.

FISTULIPORA GUADALUPÆ n. sp.

Pl. VIII, figs. 5 and 5a.

This species grows in thin incrusting expansions of undetermined extent but very small height. In the specimen studied the latter dimension is less than 2 mm.

The zoœcia are very various in size, the average among the smaller ones being only about 0.1 mm., while they range up to 0.2 mm.[a] They are also variously disposed, being sometimes 0.1 mm. or less apart and at others probably as much as 0.3 mm. There seems to be a certain compensation in these arrangements, the larger cells being close together and the small ones far apart. The cross section of the zoœcia is nearly circular. A lunarium is fairly well developed, but does not materially indent the outline. It embraces less than half of the zoœcium. The spaces between the zoœcia are occupied by two or more series of rather small vesicular mesopores. Tabulæ seem to be wanting in this form as seen in longitudinal sections. The external surface is strongly undulating, by reason of numerous closely set, rather strong monticules.

This species is distinguished by its incrusting lamellar habit of growth, very small zoœcia, and prominent, closely arranged monticules, characters which, so far as known, are not found combined in any other American species.

Horizon and locality.—Top of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2966).

Fistulipora sp.

This form is represented by a small silicified specimen which permits the determination of only a few of its distinctive characters. The growth is in highly contorted laminæ a little over 2 mm. in thickness.

This species is at once distinguished from *F. grandis* var. *guadalupensis* by the small size of its zoœcia, which are separated by distances equal to one or two zoœcial diameters. About six occur in a distances of 2 mm., but the conditions are such that an accurate count is difficult. So far as can be made out the lunarium also, which is so strongly developed in the other species, is here inconspicuous. Further particulars are not furnished by the material in hand.

Horizon and locality.—Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763).

Genus MEEKOPORA Ulrich.

Meekopora sp.

Pl. XXXI, figs. 18 to 18b.

This species is represented by a single specimen, which is fragmentary and silicified. Thin sections have not been made, and some of the characters have not been determined.

Owing to the fragmentary condition of the specimen the shape and general nature of the frond can not be described. It appears to have been at least stoutly constructed, as the specimen has a diameter of a little over 4 mm.

The zoœcia are distributed rather evenly on the surface and quite up to the edges. Maculæ are small and not very conspicuous. The zoœcia vary considerably in size and shape, and while in a general way their distribution is regular they also vary in the distance which separates them. Four apertures and three interspaces, or sometimes four apertures and four interspaces, occur in 2 mm. in nonmacular areas.

[a] The figure is drawn from a portion of the section where the zoœcia are of the smaller size and nearly uniform.

They usually stand about their own diameter apart, but may be confluent or separated by one and one-half times their own diameter. They average about 0.3 to 0.4 mm. in diameter, as well as can be determined. In the present specimen the apertures possess no peristome, and it is doubtful whether there was an appreciable lunarium, though this is by no means certain. The number of mesopores is likewise uncertain, but there appear to have been three or four rows between the zoœcia. The zoœcial tubes slope gently but distinctly in both a distal and a lateral direction. They appear to have had a few tabulæ situated more toward the base of the tubes than near their mouths. Probably not more than one or two were developed in each zoœcium.

This is clearly distinct from *Meekopora prosseri*, the only "Coal Measures" species as yet described from American rocks. It is also with but little question distinct from the lower Carboniferous species of the genus, though the differences, which are quite obvious on comparison, need not be recited here. The Guadalupian form therefore appears, as might have been expected, to be an undescribed species, but it has not seemed desirable to distinguish it as yet by a new name, because its characters are hardly known with sufficient fullness and certainty to discriminate it from more closely related forms whose discovery is probable.

Horizon and locality.— Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763).

Family BATOSTOMELLIDÆ Ulrich.

Genus STENOPORA Lonsdale.

STENOPORA GRANULOSA n. sp.

Pl. XIX, figs. 1 to 1c.

This species grows in thin lamellar expansions consisting of one or two layers of zoœcia, each of which has a thickness of about 0.5 mm. or less. The zoœcia rise with strong obliquity to the lower surface, and have occasional or moderately frequent mesopores. As a rule they are separated by rather thick walls, which have on an average a diameter of one-third to one-fourth that of the zoœcia themselves. The outline of the latter in transverse section is usually curvilinear, the thickness of the walls taking up most of the difference between the regularly curved and the polygonal figure. Acanthopores are fairly numerous, and all are of the granular type, none of the normal concentrically banded kind having been observed. Usually they are scattered and situated in the triangular thickening of the wall where three cells corner, or side by side where a thick wall separates two adjacent zoœcia, but occasionally they form relatively broad continuous bands through the center of the thick walls, the individual acanthopores being indistinguishable. Tabulæ seem to be completely wanting. The zoœcia are not readily followed in straight lines, but seven, or sometimes eight, come within a linear distance of 2 mm.

This species is especially characterized by its delicate lamellar growth, by the absence of diaphragms, and by the peculiar structure of the walls. It belongs to a section of the genus, well developed in Pennsylvanian time, of which *Stenopora? signata* is a representative form. It is of course very distinct from *S.? signata*, having a different mode of growth, more numerous mesopores, no acanthopores of the normal type, and differently arranged ones of the granular type, since those of *S.? signata* are more regularly distributed, are usually more numerous, and seem never to lose their identity in forming continuous granular bands, even when most closely arranged.

In its mode of growth as well as other characters this seems to be distinct from any of the species recognized in the Salt Range of India. It is true, however, that Waagen and Wentzel do not give very complete descriptions of these species, not mentioning, for example, whether the acanthopores are granular or concentric, etc.

Horizon and locality.—"Dark limestone," Pine Spring, Guadalupe Mountains, Texas (station 2930).

STENOPORA GRANULOSA n. sp. ?

Pl. XXIV, figs. 3 to 3c.

The form for which this identification is employed is known from very scanty material. In its mode of growth and structure it comes in many respects close to *Stenopora granulosa*. Some differences of moment can be pointed out, but as it is not clear that they may not be due to different stages of growth it seems best not to introduce for it a new name, on the one hand, or to confuse it with typical *S. granulosa*, on the other.

The mode of growth is essentially the same as the species with which it is provisionally identified, but the cells are somewhat smaller, nine, or even ten, occurring in 2 mm. in a not entirely straight line. The cell walls are considerably thicker averaging about one-half of a zoœcial diameter, or even more. Mesopores seem to be entirely lacking. A few acanthopores of the concentrically constructed type are scattered here and there. A few granular acanthopores seem to be equally disseminated, while the median portion of the thick walls is rather profusely granular.

The somewhat finer construction of this form may possibly indicate a specific distinction, but the thick walls and consequently smaller zoœcia, the absence of mesopores, and the presence of concentric acanthopores, with a slightly different construction of the walls themselves, are differences very marked in the two specimens studied, though they may be the result of difference in maturity. This form is still more like *Stenopora? signata* than is typical *S. granulosa*, but differs in the mode of growth, smaller zoœcia, thicker walls, less numerous and smaller normal acanthopores, and the more generally granular condition of the walls as distinguished from the individual granular acanthopores of the Pennsylvanian species.

Horizon and locality.—Basal black limestone, Guadalupe Point, Guadalupe Mountains, Texas (station 2967).

STENOPORA POLYSPINOSA var. RICHARDSONI n. var.

Pl. VIII, figs. 6 to 6b.

This species forms cylindrical branching (?) zoaria, that of the type specimen having a diameter of 3 mm. The maximum diameter noticed is 5 mm. The macroscopic characters are unknown. The zoœcia are subangularly polygonal in outline, and separated by walls from one-fourth to one-half their own diameter. Six zoœcia occur in a linear distance of 2 mm. Mesopores are very rare. Acanthopores are numerous, small, and apparently of but a single size, though a certain amount of variation is shown in this particular. Some doubtful instances, however, of acanthopores two or three times as large as the usual size have been noted. The distribution of the acanthopores is irregular. In many specimens they are about their own diameter apart and occur in single rows, but in others their distance is somewhat less or greater, sometimes much greater, while occasionally a considerable space is left without any at all. Again, where the wall is especially thick, they are fairly numerous, but so irregularly disposed that no expression can be formulated as to how many rows they constitute.

In longitudinal section the walls are seen to be somewhat thickened in the mature region, but the characteristic nodose structure is wanting. Small points of greater density, whose arrangement is more or less regular, are a striking feature of the mature region, a character which has been noted also in *Stenopora signata.* Tabulæ are very scantly developed, practically absent.

This species is related to *Stenopora signata,* but is clearly distinct, having considerably larger zoœcia and smaller and more numerous acanthopores, which if not altogether of one size are yet very nearly so, the large ones being extremely rare. It is also related to *Stenopora spissa,* a significant and well-marked difference being found, however, in the thicker walls and larger acanthopores of Rogers's species. Much more closely related, however, is *Stenopora polyspinosa,* described by Condra, and I am uncertain how far the differences shown by the Guadalupian species, which is known from very scanty material, would be increased or diminished by more complete information regarding it, and by actual comparison of specimens. In view of the widely different fauna with which it is associated I feel disposed to give due weight to such as have been noted. It appears to have had less numerous, somewhat more widely separated and irregularly distributed acanthopores, of which there are fewer of the large size, and perhaps also fewer mesopores, which Condra describes as being one-fourth as numerous as the zoœcia. At present these differences are real enough, though not very great in degree; otherwise the two species, so far as known, possess almost identical characters.

A strongly developed specimen from station 2969 has the walls in the mature region considerably thickened so that they average one-third to one-half the diameter of the zoœcia, which have quite lost their polygonal outline. The other characters are the same.

A silicified specimen from station 3500 has been placed here with doubt. In the main it possesses the characters outlined above, differing only in having tabulæ which if not numerous are relatively so.

Horizon and locality.—Top of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2966). Delaware Mountain formation, southern Delaware Mountains, Texas (stations 2963 ?, 2969, 3500 ?).

STENOPORA sp.

This form was found as an incrustation upon a small cylindrical or spinelike object, and apparently formed a zoarium by means of thin superimposed layers.

The typical specimen, however, consists of only one such layer having a maximum thickness of not over 1 mm. The macroscopic characters are unknown. In tangential section the zoœcia are seen to be small and circular, with thick walls. There are usually about ten zoœcia in the space of 2 mm., and the interval between two adjacent ones is usually about one-half a zoœcial diameter, though sometimes considerably less. Mesopores are practically absent. Large acanthopores are situated in the angles between three zoœcia. Usually along the mesial line of the walls connecting the acanthopores is a row of granules, which may represent small acanthopores, though they are of small size, irregular, and indistinct.

In sections passing longitudinally through the zoœcia these are seen to be short, having the walls highly thickened but not moniliform from the point where they bend into an upright position. Tabulæ appear to be practically absent.

So small a fragment was obtained of this species that it is feared it does not show the mature and characteristic condition of the colony. It appears, however, to be an undescribed form, and is distinguished by its mode of growth, very small zoœcia, thick walls, absence of mesopores, etc.

Horizon and locality.—"Dark limestone," Pine Spring, Guadalupe Mountains, Texas (station 2930).

Genus LEIOCLEMA Ulrich.

Leioclema shumardi n. sp.

Pl. XIX, figs. 2 to 2d.

This species grows in cylindrical, sometimes bifurcating branches, which seldom exceed 3.5 mm. in diameter, and are often smaller.

The apertures show no serial arrangement in any direction, but appear in general to be rather regularly distributed. Nevertheless, when examined critically they are seen to vary in their relations to one another. Usually the distance from one zoœcium to those which are nearest is from one and one-half to two zoœcial diameters, but it is not difficult to find linear intervals which are as much as three or four times the ordinary. These interspaces are occupied by mesopores, of which there are usually three or four rows between adjacent zoœcia, and by acanthopores. The mesopores vary much in size, some being as large as the zoœcia, but as a rule they have only one-half or three-fourths the diameter of the latter. The average diameter of the zoœcia is from 0.15 to 0.20 mm. About five zoœcia and five interspaces occur within a distance of 2 mm.

The zoœcia are rather closely tabulate, though the tabulæ are usually separated by intervals greater than a zoœcial diameter. The mesopores are also abundantly and irregularly tabulate, the distance between these structures being sometimes greater and sometimes less than the diameter of the mesopore.

This form is well distinguished from the several Mississippian species of the genus, no species of Pennsylvanian age having thus far been described from American rocks. The most closely related species is unquestionably *L. punctatum* of the Keokuk, a comparison with which shows that in *L. shumardi* the zoœcia, while of about the same size, are in the mature region placed at wider intervals—that is, there are more rows of mesopores between them. The acanthopores are at the same time less numerous and of distinctly larger size. The tabulation of the zoœcia is also more abundant.

Leioclema shumardi is perhaps more nearly related to the species from India and Europe which Waagen and Wentzel figure as *Geinitzella columnaris*, especially that form which they designate as var. *ramosa multigemmata*. From this, however, the Guadalupian species is distinguished by the large size and great development of the mesopores and by the wide spaces which separate the zoœcia. The authors mentioned above give no direct measurements of the species in question, but from their figures and the magnification which they are said to show there are many more zoœcia in a given distance, in fact well-nigh twice as many.

These authors place in the synonymy of *Geinitzella columnaris* Schlotheim. Geinitz's species *Stenopora mackrothi*, which under the name of *Chætetes mackrothi* Shumard cites from the "dark limestone" of the Guadalupe Mountains. It seems probable that the form thus referred to by Shumard is the one under present consideration.

The typical specimens of this species were obtained in the "dark limestone." From the white limestone of the Capitan formation a few examples of *Leioclema* have come to hand which present in the main the same characters as *L. shumardi* and yet show certain differences of apparently minor importance. For the present, therefore, these later representatives are placed in the same species with those which they succeed. When both are better known their relations can be better determined.

Horizon and locality.—Top of Capitan formation, Capitan Peak (station 2966?); middle of Capitan formation, Capitan Peak, (station 2926?); base of Capitan formation, hill southwest of Guadalupe Point (station 2906); "dark limestone," Pine Spring (station 2930), and Guadalupe Point (stations 3762d?, 3762e), Guadalupe Mountains, Texas. Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969?).

Family FENESTELLIDÆ King.

Genus FENESTELLA Lonsdale.

In our collections the genus *Fenestella* forms but an insignificant factor in the Guadalupian fauna, although when the material was gathered this class of fossils was by no means neglected. It is true that thirteen types have been discriminated, indicating that the genus was present in variety if not in abundance, and it is even possible that at favorable localities and horizons abundant material also could be obtained.

Most of the specimens at present known from this horizon are in a silicified condition and were obtained by etching. They are mostly small fragments, and in general not well preserved. Under ordinary circumstances it would have been permissible to pass over with some general mention a part of the fauna in such condition, but so much adventitious interest attaches to even this small and imperfect element, by reason of the novel character of the whole, that it appeared to me desirable to afford it more careful attention. On the other hand, the data obtainable in many of the forms was too incomplete to permit satisfactory treatment from a specific standpoint. Thus, while it has been possible to identify only one of these varieties with species which have already been described, I have felt justified in describing only two or three as new, an unfortunately large number being merely described, so far as description was possible, in an anonymous manner.

It might be inferred from the very individual character of the associated fauna that the Guadalupian Fenestellas would present altogether novel types when compared with those found with Pennsylvanian faunas of the Mississippi Valley. This has not proved to be the case. While it may be said with some confidence that nearly if not quite all the Guadalupian species are different, they present no especially striking developments nor, so far as I have been able to ascertain, any marked individuality considered as a whole. The only significant fact which my study of these forms seems to develop is that, like the rest of the fauna, they are different from Pennsylvanian forms of the interior region, though much more analogous than is the case with the brachiopods. As a rule the Guadalupian species are rather fine regular forms, often delicate but sometimes more solid.

The exploration of Shumard in this general region brought to light, as is well known, a small number of forms which were described by Prout nearly fifty years ago. Only one of these was obtained at the locality and from the horizon at which my collections were made, and it is unfortunately not included with them, Prout's description being neither very complete nor accompanied by figures. As will be expected, most of the species described by him from this region, since they were collected at much lower horizons than the Guadalupian, prove to be distinct from anything in this report. As a rule they are larger and more robust types, and will doubtless be found in the Hueconian fauna (to which horizon they belong), which I hope later to describe.

Waagen discriminated only two species of *Fenestella* in the Salt Range, from which it would appear that the genus is even less well represented than in the American fauna. Neither of Waagen's two species appears to be identical with those from the Guadalupe Mountains, which really find closer analogies in the Pennsylvanian rocks of the Mississippi Valley, a circumstance not altogether surprising in view of the much greater number and variety of species found there. It may be mentioned that one of the two species discriminated by Waagen is identified by him as *F. elegans*, which Meek described from Nebraska. The identification appears to be very close.

FENESTELLA POPEANA Prout.

1858. *Fenestella Popeana.* Prout, Trans. Acad. Sci. St. Louis, vol. 1, p. 229 (date of volume, 1860).
White Permian limestone: Guadalupe Mountains, New Mexico.

1859. *Fenestella Popeana.* Shumard, Trans. Acad. Sci. St. Louis, vol. 1, p. 388 (date of volume, 1860).
White and dark [Permian] limestone: Guadalupe Mountains.

Corallum most probably campanulate, rapidly curving outward from frequent bifurcation. Longitudinal rays or interstices subangular, striated as seen by the impression on the cortical envelope of the reverse; keel obsolete; bifurcations frequent, mostly about one line apart, large near the base, nearly as wide as the fenestrules. Dissepiments moderately large, round, expanded at junction with interstices. Fenestrules ovate or quadrangular, rounded at the angles, five in the space of two lines longitudinally, about five transversely. Cells large, ovate, directed upward and outward to the axis of interstices, alternate on the two sides of the longitudinal ray, three to each fenestrule, rarely four, caused by a supernumerary placed at the angle of bifurcation.

This beautiful species is dedicated to Capt. John Pope, whose indefatigable labors in the service of his country and whose zeal and devotion to the interests of science deserve the compliment. It was collected, with other specimens, from the Guadalupe Mountain, by Dr. George G. Shumard, and is classed by our worthy president, Dr. B. F. Shumard, as a Permian species. The description is drawn from a fragment of one side of the expansion; but its form, we think, can be inferred as campanulate. Only a small portion of the poriferous side is preserved, the fracture being mostly down to the cortical portion of the reverse; sufficient, however, can be made out to identify it as a new species.

Comparisons.—It resembles very nearly *F. patula* (McCoy), but the latter has larger interstices, with a strongly marked keel. It is only half as large as the *F. Popeana;* and, besides, the latter has fenestrules nearly double as wide as the interstices, being at the same time strongly corticated, at least on the reverse.

It resembles the *F. antiqua* (Gold. sp. McCoy), but differs by the thickness of its interstices, as well as by the greater length and fewer number of fenestrules in a given space.

Locality.—Permian white limestone, Guadalupe Mountain, New Mexico.

The foregoing is Prout's original description of this form, which seems to be distinct from the single species in our collection from the same locality and horizon and has not been recognized among the fragments thus far obtained from other localities and horizons in the Guadalupian.

Fenestella hilli n. sp.

Pl. XIX, figs. 3 and 3a.

This species consists of a fine regular mesh composed of straight branches and stout dissepiments, which are not depressed below the nonporiferous surface. The fenestrules are about twice as long as wide, and vary in shape from subelliptical to subquadrate. There are about four rows (and five branches) and longitudinally four fenestrules (and three dissepiments) in a distance of 3 mm.

On the nonporiferous side the branches seem to be smooth. On the obverse they are traversed mesially by a high carina, with an expanded top, along whose center is a row of small perforations, apparently about three opposite each fenestrule. The zoœcial apertures are not well shown, but they appear to be arranged one opposite each dissepiment, with two intermediate. A variation from this arrangement places three of them opposite each fenestrule, without any opposite the dissepiments.

Of species found in the Mississippi Valley this form is perhaps most closely similar to *Fenestella wortheni,* from which it may be distinguished by its more robust proportions. *F. hexagonalis* also is related, but clearly distinct. Under the name of *F. corticata* Prout has described a form somewhat similar to that under discussion, but having more zoœcial apertures to the fenestrule, and apparently a row of nodes down the back of each branch.

Horizon and locality.—"Dark limestone," Guadalupe Mountains, Texas (station 3762e).

Fenestella capitanensis n. sp.

Pl. VIII, figs. 4 and 4a.

This species includes a single specimen from the white limestone (Capitan), of which the nonporiferous face is exposed to view.

The zoarium had a shape more or less approximating to that of a portion of an inverted cone. The length of the frond as represented by the specimen is 17 mm. and the width about the same.

Branches and dissepiments, while the latter are distinctly smaller, are nearly of one size. The dissepiments expand at their junction with the branches, giving the fenestrules a rounded outline, which rarely becomes noticeably quadrate. The width of the dissepiments, while sometimes nearly equal to the length, is as a rule distinctly less. There are five rows (and six branches) in the space of 3 mm., and longitudinally four fenestrules (and five dissepiments) in the same distance.

The surface of the branches is smooth on the nonporiferous side, except that a distinct tubercle seems to have been developed where the dissepiments and branches intersect. The poriferous side, as already remarked, is not well shown. The arrangement of the zoœcia appears to vary considerably. Sometimes they are placed one opposite each dissepiment, with another intermediate, and sometimes there are as many as three intermediate ones, with all gradations between.

A common arrangement is for three apertures to open against a fenestrule without any opposite the dissepiments. As already intimated, the characters of the celluliferous face are largely obscured. A carina, if present, was probably low. At the same time there is evidence of a row of distant spines dividing the two series of pores. These statements, however, are tentative, needing future confirmation.

This species is very near the proportions of the form designated *Fenestella* sp. *a*, but is somewhat more massive in its construction, with more rounded fenestrules, and with the nonporiferous face tuberculate instead of smooth. What additional differences would appear if both forms were completely known can not be conjectured.

While comparable in some respects to several forms found in the Pennsylvanian of the Mississippi Valley, this species is distinguished from most of those which it resembles in other respects by its solid, compact structure, resulting from the relatively thick dissepiments, and by the presence of nodes on the reverse face. Its nearest allies seem to be *F. conradi* and the variety *compactilis*. It is a little more robust than *F. conradi*, with somewhat thinner dissepiments and with more elongate fenestrules, which have more numerous apertures opposite them. The reverse face of *F. conradi* is also smooth.

It is evidently distinct from *F. popeana*, as represented in Prout's description, a species which apparently was found at about the same locality and horizon. The sculpture is very different and the proportions somewhat so.

Horizon and locality.—Top of Capitan formation, Capitan Peak (station 2905), and middle of Capitan formation, Capitan Peak (station 2926), Guadalupe Mountains, Texas.

FENESTELLA GUADALUPENSIS n. sp.

Pl. XIX, fig. 5.

This form consists of a rather coarse, somewhat irregular network. The branches are straight, slender, round, and separated by nearly equal intervals of two to three times the width of their own diameter. The dissepiments are slender, round, and distinctly smaller than the branches, but approximately equal to them. They are depressed and irregularly disposed, both as to distance and direction. The fenestrules consequently are of different sizes and shapes, occasionally wider than long, usually longer than wide, but always distinctly quadrangular in outline. There are three rows of fenestrules and four branches in a distance of 3 mm., and two or three fenestrules (and four dissepiments) or less in the same distance longitudinally.

The nonporiferous side is smooth. On the poriferous side the branches had a median angulation, which may have been a distinct through certainly not a high keel. The apertures are small and give rise to a wavy outline on the margins of the branches. There is usually one aperture opposite each dissepiment, and intervening between these from two to four, depending somewhat on the length of the fenestrule.

Of species found in the Mississippi Valley this form is clearly most nearly related to *Fenestella delicatula*. The description of that species would indicate that the two forms were similarly constructed, but that from the Guadalupe Mountains when compared with a somewhat fragmentary example from Seville, Ill., proves to be more rubust in its growth, the dissepiments especially being relatively stronger. The surface of *F. delicatula*, furthermore, is ornamented by fine granulose liræ, no trace of which is found upon the form under discussion.

Three species from the same general region, though from a lower horizon, demand comparison. I refer to *F. albuquerqueana*, *F. intermedia*, and *F. variabilis*, the first-named species, recently described by Bendrat, being probably a synonym for the older one founded by Prout (*F. variabilis*). These two, with their striated surface and prominent carina, are safely distinct from the present species. While I have little doubt that the latter is distinct from *F. intermedia* also, it is not easy, without specimens of that species, to point out differences which should distinguish them. It would appear, however, that there were fewer fenestrules to a given distance longitudinally in Prout's species.

It might be expected that this form would be the same as *F. popeana*, described from essentially the same locality and horizon, but while showing characters in common it is unlikely that the two species will prove to be the same. That described by Prout would appear to be more regular, with fewer fenestrules (longitudinally) in a given distance and fewer zoœcial apertures to a fenestrule.

Horizon and locality.—"Dark limestone," Pine Spring, Guadalupe Mountains, Texas (station 2930).

FENESTELLA GUADALUPENSIS var.

This species is represented by a single specimen in a thin section. Three rows and three branches occur in a distance of 3 mm. transversely, and two and one-half fenestrules and two dissepiments in the same distance longitudinally. The branches are about twice as wide as the dissepiments and about two-thirds as wide as the fenestrules. The latter are subquadrate and about twice as wide as long. Apparently three cells lie opposite each fenestrule. In addition to the usual finely porous character of the test the noncelluliferous side of the present species was pierced by rather large-sized pores, in a general way so distributed that one is opposite to a dissepiment and one intermediate.

In its measurements this form is in close agreement with *Fenestella guadalupensis*. The chief differences recognized consist in the relatively narrow branches, while the large-sized pores, if, as seems not unlikely, they are the result of nodes or spines upon the exterior, clearly discriminate the present form. If the pores are due to nodes or spines, this form recalls *F. capitanensis* and *Fenestella* sp. *f* in this particular more than any other Guadalupian species, but the proportions are very different.

Horizon and locality.—"Dark limestone," Pine Spring, Guadalupe Mountains, Texas (station 2930).

FENESTELLA SPINULOSA Condra?

Pl. XIX, figs. 4 and 4a.

1902. *Fenestella spinulosa.* Condra, Am. Geologist, vol. 30, p. 343, pl. 21, figs. 4, 5. "Coal Measures:" Roca and Dawson, Nebr.

1903. *Fenestella spinulosa.* Condra, Nebraska Geol. Survey, vol. 2, pt. 1, p. 55, pl. 10, figs. 1–5. "Coal Measures:" Roca and Dawson, Nebr.

This species consists of a regular, fine network of straight branches and dissepiments. There are five rows of fenestrules (and six branches) and longitudinally five fenestrules (and six dissepiments) in the space of 3 mm., or possibly a little less in both cases.

The dissepiments are considerably slenderer than the branches and somewhat depressed below the level preserved by their upper surfaces. The fenestrules are usually a little longer than wide, their outline as a rule being more or less distinctly quadrate.

The outer surface of the branches appears to be smooth. The inner surface is raised into a rather thin, high, median carina, which seems to develop a row of median nodes disposed in much the same manner as the zoœcial apertures. The latter are usually so arranged that one occurs opposite each dissepiment, and one halfway between; but occasionally an aperture occurs on either side of the dissepiment without an intermediate one.

Such characters are retained by the small but rather well-preserved fragment. Another small example has been referred to the same species, though it departs in certain details from that on which the description depends. The proportions are almost the same, but the construction is distinctly heavier; the branches and dissepiments are thicker, and the fenestrules are less quadrate. The poriferous side of this example is imperfect. It appears to have had two zoœcial openings opposite each fenestrule, but the arrangement may prove to be as in the first specimen.

Here has also been referred a specimen from the Capitan formation (station 2966), which is embedded in limestone and shows only the obverse face. It is somewhat exfoliated and obscured. The dimensions are essentially the same as those of the specimen from which the first description was drawn. The dissepiments appear to be a little larger, but this may easily be due to their difference in preservation. The apertures are as a rule so arranged that two of them are opposite each fenestrule. Occasionally there is also one opposite a dissepiment, but such cases are single, none having been observed where they regularly occur two opposite each fenestrule and one opposite each dissepiment.

In some of its characters this species can be compared with a number of Pennsylvanian forms from the Mississippi Valley, but it appears most to resemble *Fenestella parvipora, F. perelegans,* and *F. spinulosa.* The first-mentioned species hardly demands careful comparison, and the second, which is imperfectly known, is said to have the carina nearly obsolete. With *F. spinulosa,* however, as described and figured by Condra, the agreement is very close. Perhaps the only difference at present available is that the Guadalupian form seems to lack the faint striæ which *F. spinulosa* is described as possessing. So different, however, are the faunal associations of the former that it seems little likely to prove identical with Condra's species could well-preserved examples of both be brought into comparison. *Fenestella shumardi,* a species described from the same general region as the one under consideration, but from a different horizon, shows many points of similarity, but it can safely be concluded that this is not the species which Prout was describing.

Horizon and locality.—Top of Capitan formation, Capitan Peak (station 2966); "dark limestone,"Pine Spring (station 2930), Guadalupe Mountains, Texas. Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969?).

FENESTELLA TEXANA n. sp.

Pl. XXVIII, figs. 9 and 9a.

A rather small fragment is all that remains of this species; it shows the following characters:

The growth is fairly even and regular. About three and one-half rows of fenestrules (including four branches) occur in a distance of 3 mm., and about the same number in the same distance in a longitudinal direction, including also four dissepiments. The branches and dissepiments are slender, and more nearly of the same size than is usual, the branches being naturally somewhat larger. The fenestrules are slightly longer than wide, being angular on the nonporiferous side and more rounded on the other side. The dissepiments are slightly depressed.

The outer surface of the branches is marked by fine, obscure, interrupted striæ. On the poriferous side they are traversed by a high carina, not very greatly expanded at the top, which is wavy and nodose. Along the center of each is a row of little spinules, which are often arranged so that one is opposite each dissepiment and two are intermediate. Opposite each dissepiment is an aperture, while two others are intermediate along the sides of the fenestrules.

F. texana has a fine regular mesh, like several of the other forms described, but is distinguished at once by the slenderness and nearly equal size of the dissepiments and branches and the nearly square shape of the fenestrules. Other differences also appear in individual cases.

This species is probably new, but I have hesitated, because of the small amount of my material and the imperfect information regarding some of its details, to give it a new name. It is related to *Fenestella binodata, F. corticata, F. delicatula, F. modesta,* and *F. subretiformis,* but is more or less strongly distinct from any of them. It is perhaps especially close to *F. modesta,* but differs in its more regular growth, in having a more elevated carina, and possibly in other characters.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

Fenestella sp. *a*.

Pl. XXVIII, fig. 6.

A small specimen, about 5 mm. square, is all that our collection contains of this species. It is silicified and at present free from adhering rock, but some of the most important characters have been lost. So far as may be judged from material in hand the zoarium was a large, flat, regular frond.

The growth is very uniform. Five rows of fenestrules and their inclosing branches (or a little less) occur in 3 mm. transversely, and four fenestrules with their inclosing dissepiments occur longitudinally in the same distance. The fenestrules are nearly twice as wide as long. They are elliptical in outline on the poriferous face and somewhat quadrate on the opposite one. The dissepiments are one-half the width of the branches, or in some cases less, and usually lie even with their surface on the nonporiferous side, but are depressed on the poriferous side. The back of the frond appears to be entirely smooth, but delicate sculpture may have been lost in the process of silicification. This process has apparently obscured the zoœcial structures, whose number and character can not now be determined. There appears to have been a carina, but details as to its height, etc., can not be ascertained.

This form resembles several found in the Pennsylvanian strata of the Mississippi Valley, but it is doubtful if it prove to be the same specifically, even if all its characters were known, for those which have been determined do not entirely agree with any of them. It is as near *Fenestella remota* as any, but that species is striated on the reverse side. *F. parvipora* is another related species.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

Fenestella sp. *b*.

Pl. XXVIII, fig. 10.

This species is similar to that discriminated as *Fenestella* sp. *a*, but has a distinctly coarser mesh.

What may be taken as the typical example shows four fenestrules transversely and three longitudinally in a space of 3 mm., with the inclusive branches and dissepiments. The fenestrules are about twice as long as wide, and the branches about twice the diameter of the dissepiments. On the nonporiferous side the dissepiments are on the same plane as the branches, but they are depressed on the poriferous side. The fenestrules are strongly quadrate on the nonporiferous side, but more elliptical on the other.

The nonporiferous side appears to be without ornamentation of nodes or striæ. The character of the poriferous side has been obscured during silicification, so that even the number of apertures can not be made out.

This form resembles in a general way several species found in the Pennsylvanian of the Mississippi Valley, especially *F. binodata* and *F. subrudis;* but the final comparisons for determination of the actual degree of difference and resemblance can not be made. It may be no more than a coarse variety of that discriminated as *Fenestella* sp. *a*.

In addition to the fragment on which the foregoing description is chiefly based, several others having essentially the same character have been placed in this species.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

FENESTELLA sp. *c*.

Pl. XXVIII, fig. 7.

This form in many respects resembles the foregoing (*Fenestella* sp. *b*), but differs in several points. While constructed on about the same scale and with about four rows of fenestrules in 3 mm., the fenestrules themselves are a little more elongate, there being only from two and one-half to three in a space of 3 mm. The growth is considerably less regular. The dissepiments are often depressed on the nonporiferous side. The fenestrules are oval. This side of the frond (the nonporiferous) appears to be ornamented with fine longitudinal striæ not shown in my figure, but this may be due to imperfect silicification of the fibrous skeleton.

The poriferous side is not satisfactorily preserved, being more or less eroded, but the apertures seem to have numbered about three to a fenestrule.

This species is related to several from the "Coal Measures" of the Mississippi Valley, especially to *F. binodata*, *F. kansasensis*, *F. modesta*, *F. ovatipora*, and *F. subrudis*, but especially resembles *F. modesta*. The preservation is, however, scarcely competent to a careful determination of its specific relations.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

FENESTELLA sp. *c*. var.

This form is represented by a single specimen whose characters bring it close to *Fenestella* sp. *c*., but as it was obtained from a different locality and presents some differences of importance it did not seem advisable to refer it to the same species without further evidence of intergradation.

The poriferous side of this specimen is uppermost, the opposite side being embedded in rock. Exfoliation has removed all superficial characters of the exposed portion. The branches are straight and about equal distances apart. The dissepiments, however, stand at varying intervals from one another, so that the fenestrules range in length from two and one-half to one and one-half times their own width. They are subquadrate in shape. The dissepiments are slender and depressed, in width about half that of the branches, which are in turn about half as wide as the fenestrules. Five rows and six branches come in 3 mm. transversely and two and one-half fenestrules in 3 mm. longitudinally. Four cells, or in some cases three, occur opposite each fenestrule.

The chief differences manifested between this form and typical *Fenestella* sp. *c* are the subquadrate shape of the fenestrules (which may be due to their being viewed chiefly on the opposite side), their slightly narrower width, so that more rows occur in a given distance, and the larger number of cells which lie opposite each fenestrule. It appears to be closely allied to *Fenestella* sp. *b* also, perhaps more nearly than to the present form.

Horizon and locality.—"Dark limestone," hill southwest of Guadalupe Point, Guadalupe Mountains, Texas (station 2924).

FENESTELLA sp. *e*.

Pl. XXVIII, figs. 5 and 5a.

Like the foregoing, this is a small species and discriminated on very fragmentary material. The branches are straight and extremely heavy. The dissepiments, on the other hand, are as a rule short and thin. The fenestrules are elongate elliptical. Sometimes the dissepiments are much thicker at the expense of the fenestrules which they separate, but in any event, being sunk beneath the level of the thick, strong branches, they play in appearance a subordinate part in the construction of the zoarium. There are about three rows of fenestrules and four branches, or a little over, in a distance of 3 mm. Longitudinally, there are three fenestrules (and four dissepiments), or a little less, in the same distance.

The nonporiferous side is without much doubt artificially varicose from heavy silicification, the original ornamentation, if such there was, being concealed. On the obverse side the apertures are arranged about as in *Fenestella hilli*, namely one opposite each dissepiment and two intermediate. There is in addition a high carina, much expanded at its top, upon which are set, in regular arrangement, a number of large nodes or spinules. These occur about six to a fenestrule, arranged alternately, three on each side of the broad summit of the carina, to which their enlarged bases, practically in contact, lend a sinuous outline. It may be that these structures also have been exaggerated by heavy silicification, but whether this is so, or to what degree, it is impossible to say. I think, however, that the real appearance may have been appreciably altered by exaggeration in this manner.

This species also is probably new, but for the reasons mentioned in the foregoing case a distinctive name has not been applied to it.

It is related to several forms which have been described from the "Coal Measures" of the Mississippi Valley and in the proportional measurements to *Fenestella dentata* and *F. kansasensis;* but from these it differs considerably in other details. In the structure of the carina a parallel form is found in *F. binodata,* but there are minor differences in the carina itself besides those of proportion, which forbid joining the Guadalupian form with that species. In the Guadalupian itself we have *F. popeana,* which shows much the same dimensions, but possesses an obsolete carina instead of a highly developed one. *Fenestella subretiformis* described from the Organ Mountains is related in a somewhat similar manner, and besides possessing important structural differences is believed to hold a much lower horizon than the form under consideration.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

FENESTELLA sp. *f*.

Pl. XXVIII, fig. 8.

This species resembles the foregoing in having the branches relatively massive for the dissepiments, but is somewhat more delicate in construction. There were probably four rows of fenestrules and five branches in 3 mm. and about five fenestrules and five dissepiments longitudinally. The fenestrules are elliptical and from one and a half to two times as long as they are wide. The dissepiments are somewhat depressed on both sides of the frond and the fenestrules elliptically elongated. I am not sure whether the nonporiferous side was ornamented or not, but the branches appear to have been somewhat nodose at their junction with the dissepiments, and there are strong indications of other nodes of smaller size. On the poriferous side there was probably a high carina, whose character can not be made out in detail. The zoœcial apertures are so arranged that one of them is placed opposite each dissepiment and one in an intermediate position.

The disparity between the branches and the dissepiments is less marked in this species than in the foregoing, and the proportions, as well as the arrangement of the zoœcia, are also different.

Of this form too little is known to determine its relationship to existing species, but it appears to be as yet undescribed. It shows some resemblance to *Fenestella shumardi* and *F. spinulosa*, but is clearly distinct from them. One of its most peculiar features is the large number of fenestrules relative to the number of rows in a given distance. This relation is not very well shown by the specimen, however, and the statement made above may represent an extreme case.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

FENESTELLA sp. *f*?

The specimen referred to by this title very closely follows the characters of the typical variety save in one important particular. There are four rows and four branches in 3 mm. transversely and four fenestrules and five dissepiments in the same disance longitudinally, these particulars being thus very similar to but not identical with those of the type. The dissepiments are much depressed on the nonporiferous side and very thin—one-third to one-fourth the diameter of the branches. The latter are not as strong as in the type, but are as wide or slightly narrower than the fenestrules. The latter average one and one-half times as wide as long and have a more or less quadrate shape.

The cells are so arranged that one is opposite each dissepiment and one opposite the center of each fenestrule. They are separated by a high carina, expanded at its top.

The nonporiferous side is marked by fine, linear, longitudinal striæ and possibly by nodes, though the presence of the latter is not a positive character.

The most marked difference which seems to separate this form from *Fenestella* sp. *f* is the striated surface and the much less numerous and less obviously developed nodes. There are perhaps very faint traces of striæ in the latter form which may have been obscured by coarse silicification, and the fact that it probably represents an older portion of the zoarium may account for the more strongly developed nodes.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

Genus POLYPORA McCoy.

This genus, somewhat in contrast to *Fenestella*, is better represented, in both species and individuals, in the Salt Range than in the Guadalupian fauna. Waagen and Pichl recognize eight species, some of them fine, robust types and represented, it would appear, by large, well-preserved fronds. My material shows representatives of what may be four species; but these occur for the most part as small fragments, often silicified or otherwise poorly preserved. Where it seemed to be demanded, comparison has been made with Pennsylvanian forms from the "Coal Measures" of the Mississippi Valley; but the character of my fossils seems scarcely to warrant careful comparisons with Salt Range species, as such comparisons could hardly be anything but unprofitable.

Polypora mexicana Prout?

Pl. XIX, figs. 6 to 6b.

1858. *Polypora Mexicana*. Prout, Trans. Acad. Sci. St. Louis, vol. 1, p. 270 (date of volume, 1860). Permian: Jornada del Muerto, New Mexico.
1859. *Polypora Mexicana*. Prout, idem, p. 451, pl. 16, figs. 2–2b.

Of this species but three specimens have come to hand, two of them mere fragments. While it has been possible to free them from the inclosing matrix so that both surfaces are presented to view, the silicification which rendered this practicable is not so perfect but that some of the more delicate details have been obscured or misrepresented.

The zoarium in this specimen is rather large and heavily constructed, and shows irregularity in many details. Instead of being planate or infundibuliform, it is strongly undulated or contorted. The branches are of nearly equal size, except at points of bifurcation; but bifurcation seems not to occur at regular or rhythmic intervals. The dissepiments, on the other hand, when viewed on the poriferous face, vary in size from equality with the branches to a width one-half or one-third as great. The fenestrules, while as a rule of rather constant width, vary much in length, and range in shape from subcircular to elongate. The zoœcial apertures are rather evenly distributed, but are not conspicuously arranged in rows, either vertical or oblique, but of the two a vertical arrangement is more obvious. In some cases the dissepiments are celluliferous and in others not. The branches which are rather thick through, are slightly narrower on the nonporiferous than on the poriferous face; but this is far more marked in the case of the dissepiments, which appear much thinner and are depressed below the level formed by the back of the branches.

Measured on the poriferous face there are from two to two and one-half fenestrules (and three dissepiments) in a space of 5 mm.; measured transversely there are from two fenestrules and three branches to four fenestrules and four branches in the same distance.

The zoœcial apertures are small and separated by intervals more or less nearly equal to their own diameter. The number lying opposite a fenestrule naturally varies considerably with the size of the fenestrule, but it seems to range from three or four to six, without counting those immediately opposite the dissepiments. They come in four to six or seven longitudinal rows, but, as before remarked, this arrangement is not very conspicuous. Both faces of the zoarium appear to be without ornamentation, except that the lower portion of the rim of many of the apertures seems to project as a little lip or spine; but this may be merely an effect of preservation. The nonporiferous side appears to be quite smooth.

A large number of species have been considered in the effort to identify this form, but none of them possesses more lines of approximation than *Polypora mexicana* Prout, which, moreover, was described from the same general region, though from a horizon which at present appears to be somewhat lower. The points of resemblance are sufficient to have encouraged me to make the identification; the points of difference have caused me to feel some doubt of it.

The chief differences are as follows: The zoarium in the typical specimen is regular in its curvature and structure, while the form under consideration is contorted, its fenestrules are of unequal size, and its structure in general is somewhat more irregular than that represented in Prout's figures and description. While radial measurements in the two specimens give the same result, the present example seems to be a little more expanded in a transverse direction. The size of the zoœcial apertures and their number in a given interval appears to be about the same; but in the type the apertures are said to be regularly distributed in oblique rows, an arrangement not often very obvious in my form. Prout, furthermore, represents the apertures as emerging from little elevations, the bases of which are well nigh in contact, the actual apertures, on the other hand, being farther apart than in my specimen. It is doubtful if the details of this face were sufficiently preserved in the original example to bear out Prout's figures, especially as he does not describe this appearance in the text. Several important features are left unknown in Prout's description, especially those of the nonporiferous face; and it is quite possible that the differences already noted are indices of still greater ones that would appear were the full details of both forms available for comparison.

Prout cites this species from the Permian and gives as a locality the Jornada del Muerto. It is very doubtful if the Guadalupian occurs in that region, the real horizon of *P. mexicana* being, therefore, the Hueco formation. This constitutes an additional reason for doubting the identity of the present form with Prout's species.

Several American species resemble *Polypora mexicana* more or less closely, but besides showing differences of character they are from distant areas and from different faunal associations. One of these is *P. burlingtonensis*, a species in fact closely similar in a general way but more regular in structure and less sturdy in growth. *P. simulatrix* also shows some resemblances, but is not sufficiently close to make comparisons necessary. Of much nearer relation, however, is the imperfectly known *P. crassa*, which differs at least in this particular, that the fenestrules are regularly more elongate. Of the species from our western States, aside from that with which the specimen under consideration has been identified, none possesses characters sufficiently close to admit confusion. The same is true of most of the Indian species described by Waagen and Pichl, many of which are characterized by very robust growth. One of the most similar is doubtless *P. sykesi* De Koninck, which is readily distinguished, however, by its large size, more regular growth, less elongate fenestrules, and heavier dissepiments. The same differences distinguish *P. ornata*, which, moreover, possesses a system of ornamentation unknown in the American species.

De Koninck[a] has placed *P. mexicana* in the genus *Protoretipora*, I know not on what evidence, but he is clearly mistaken if the present identification is anywhere near correct.

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[a] Mem. Geol. Survey New South Wales, Pal., No. 6, 1898, p. 137.

Horizon and locality.—"Dark limestone," Pine Spring (station 2930) and Guadalupe Point (station 3762e), Guadalupe Mountains, Texas.

POLYPORA sp. *a*.

Pl. XXVIII, figs. 1 and 1a.

Of this form our collection contains a fragment, which is well preserved on neither side. It is a moderately robust form, of fairly regular growth. The branches are straight and strong, highly rounded on the reverse side. They expand considerably at their junction with the dissepiments, which are narrow in the middle and also considerably expanded. The dissepiments are much depressed.

The fenestrules are elliptical in outline, about twice as long as wide, and with a width slightly greater than that of the branches. There are four rows (and five branches) in a space of 5 mm., and three to three and one-half fenestrules (and four dissepiments) longitudinally in the same distance. The surface of the reverse is rendered rough by the nodular silicification, but there appear to be traces of an originally striated sculpture. The present nodular surface is probably not an original character.

The surface of the obverse base is eroded, so that the cell walls are exposed. Consequently its superficies can not be determined. The cells in this preservation are rhomboidal and regularly arranged. At present the diagonal instead of the longitudinal rows, of which there are usually four, are most noticeable. There are about four opposite each fenestrule. Sometimes one stands opposite a dissepiment, with three intermediate.

This species is of finer and more regular growth than the form referred to, *Polypora mexicana?*, a specimen of which is found at the same locality, and it probably has a striated instead of a smooth reverse side. The latter character, if it prove a real feature instead of an appearance due to silicification, would aid in discriminating this form from several Mississippi Valley species which it resembles. In this category may be mentioned *P. bassleri*, *P. cestriensis*, *P. distincta*, *P. stragula*, and *P. ulrichi*. These are all more or less closely related, but even if the sculpture of the reverse of the form under consideration is found to be illusory it hardly agrees exactly with any one of them, and is likely to prove a new species.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

POLYPORA sp. *b*.

Pl. XXVIII, fig. 2.

A number of fragments belonging to this species have come to hand, but they are all small and poorly preserved. They show an irregular and coarsely reticulate form, the branches of which are moderately stout, flexuous, and frequently bifurcating. When, at unequal intervals, the branches come close to one another, they are connected by short but moderately strong dissepiments. Often the resulting network looks as if through their irregularities the branches have actually become connate without any connecting dissepiments.

The branches are strongly rounded on both sides, so that a cross section is in a general way circular. The superficial character of both surfaces has been altered by imperfect silicification. The reverse is irregular and nodose, due, I feel no doubt, to chalcedonic replacement, and a similar feature may be noted in some cases on the obverse. The latter surface is thickly covered with apertures, which have no well-defined interspaces and are disposed in five rows, sometimes a greater number. Their linear arrangement is not striking, and that in an oblique direction is possibly more noticeable than in a longitudinal. They appear to open obliquely and to have an elliptical outline, the interspaces, which seem to represent the thickened zoœcial walls, being about the width of their shortest diameter. The general appearance of these zoœcia resembles irregular growths of *Acanthocladia guadalupensis*, whose branches are connected by dissepiments.

Owing to the large size of the mesh and the small size of the fragments it is impossible to give measurements in the ordinary way. Large branches have a diameter of about 1 mm. or a little over, but there have been referred here fragments, supposed to be terminal in position, which are considerably more slender. A long fenestrule is about 3 mm. in length, the width, which is usually about that of the intervening branches, being about one-third. In shape the fenestrules often taper almost to a point at one or both ends.

This species appears to be nearest related to *P. crassa*, of the "Coal Measures" forms of the Mississippi Valley, but both species are too imperfectly preserved to render possible a determination of their relationship. It is unlikely that they are specifically the same.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

Polypora sp. *c*.

Pl. XXVIII, fig. 3.

This species is represented by a very small fragment, whose characters ally it in some degree to *Polypora* sp. *a*. It is, however, a considerably coarser form. There are about three rows and three branches in 5 mm. and about two fenestrules and one dissepiment in the same distance. The branches are about 0.75 mm. in width, straight, somewhat expanding at their juncture with the dissepiments, slightly narrower than the fenestrules. They are flattened and apparently striated on the reverse and rounded on the obverse. The dissepiments are slender (about one-third the branches), somewhat depressed, expanding. The fenestrules are subelliptical to subquadrate, about twice as long as wide.

The apertures lie in about seven rows, the arrangement being more noticeably diagonal than longitudinal. They are about their own diameter apart. Five are opposite a fenestrule, with sometimes an additional one opposite a dissepiment.

In addition to the small silicified fragment on which the foregoing characterization is based, there has been provisionally referred here an equally fragmentary example from station 2930, embedded in limestone, with the poriferous face exposed. The network is of about the same degree of coarseness as the fragment whose characters have just been set down, but the celluliferous face, which probably comes from one of the early or initial portions of the frond, has been so thickened with testaceous deposit as to present characters probably quite different from those which really belong to the species. It is possible that these two specimens have been incorrectly grouped together.

This form answers very well to Prout's description of *P. mexicana*. It differs, however, from the form here provisionally identified as that species in its more regular growth, thinner dissepiments, and somewhat coarser reticulation. It may prove to be the same, but this is rather unlikely.

It would appear to be not unlike *P. remota*, though showing marked differences in some respects, such as the much closer arrangement of pores on the obverse and the striated sculpture on the reverse. It must be conceded, however, that in both these particulars the imperfect preservation of the Guadalupian species may have led to misinterpretation of the real characters. Another similar species is *P. submarginata*, but it likewise shows distinct differences in certain points, such as the central row of nodes on the reverse.

Horizon and locality.—"Dark limestone," Pine Spring, Guadalupe Mountains, Texas (station 2930?). Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

POLYPORA sp. *d.*

Pl. XXVIII, fig. 4.

Two small and poorly preserved fragments are all that represent this species, of which it is impossible to give a description at this time. In most of its characters it rather closely resembles the form here provisionally placed under *Polypora mexicana*, but the reticulation is distinctly coarser and the fenestrules of very unequal sizes. In the proportions of its reticulation and in some particulars it resembles the form designated as *Polypora* sp. *c*, but besides being somewhat more heavily constructed, a difference which under the circumstances would not necessarily be very important, it is much more irregular in the size and shape of its fenestrules, which are also, as it were in compensation for the heavier branches, somewhat smaller. It may be that the species *c* and *d* will prove to be the same, since the fragments of both forms at present known are so small as to hardly justify an unqualified inference that they are representative of the entire zoarium.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

Genus PHYLLOPORA King.

PHYLLOPORA? sp.

Our collections contain but one fragmentary specimen of this form, regarding whose generic position I am in some doubt whether it belongs to *Phyllopora* or to *Polypora*. The branches, which seem to be fairly straight, have a width of 1 mm. or a little less, and this is slightly greater than the width of the fenestrules. The latter are two to three times as long as wide, elliptical, narrowing strongly at either end. What would necessarily be regarded as dissepiments if the form is a *Polypora* are well nigh as broad as the branches, sometimes depressed, sometimes celliferous. The zoœcia appear to occur in four to six rows. The nonporiferous side is without ornamentation.

From the small silicified fragment which we have of this species it is impossible to place it satisfactorily. The branches are almost too distinct from their connections for *Phyllopora*, while the dissepiments are almost too broad and indistinct as such to make this a typical *Polypora*.

Horizon and locality.—Delaware Mountain formation, mountains northwest of Marathon, Tex. (station 3840).

Genus THAMNISCUS King.

THAMNISCUS DIGITATUS n. sp.

Pl. XXV, figs. 6 and 6a.

This species forms small, branched, more or less palmate colonies, which are attached by a short peduncle. Several branches spring from the peduncle, and these themselves divide, especially a short median main branch, which gives off a few secondary branches pinnately, the whole growth being in a general way irregular yet not especially unsymmetrical. The branches are about 2 mm. in diameter, stout, short, and dactyloid. All bend upward, forming a shallow cup-shaped colony about 13 mm. long and 11 mm. wide. Along the center of the upper side of each branch extends a band of small zoœcial openings which appear to be in about six longitudinal rows and to have more or less of an oblique arrangement also. As well as can be counted seven occur in a distance of 3 mm., longitudinally. In mature or old colonies the zoœcial band is strongly elevated and narrower than the branch, occupying only part of its upper surface. Toward their bases the branches are still more expanded, spreading out on each side into a sheet, which becomes confluent with similar expansions of adjoining branches. The back of the frond appears to be smooth.

Several specimens of this species have come to hand among the silicified material from the Diablo Mountains. Although I originally supposed that they might be old specimens or basal portions of colonies of *Acanthocladia guadalupensis*, this now hardly seems to me a tenable hypothesis, and I have decided to introduce a new name for them, referring them to the different but kindred genus *Thamniscus*.

This form seems to be closely related to *Thamniscus palmatus* of Condra. A number of differences can be named between my typical specimen and Condra's description and figures, but the other Guadalupian specimens fail to show some of the characters of the type, which is probably an old colony. It differs from *T. palmatus* somewhat in its manner of developing the zoœcium, but principally in having much thicker branches and with expanded and confluent basal portions.

Horizon and locality.—Delaware Mountain formation, Diablo Mountains, Texas, as reported (station 3764).

THAMNISCUS sp.

Pl. XXXI, fig. 16.

Of this species our collection has furnished but a single example, which is distinguished by its delicate construction. The branches have a diameter of only 0.5 mm., and they divide at intervals of about 3 mm. The nonporiferous side appears to have been smooth and the zoœcia on the poriferous side seem to have been arranged in four to six longitudinal series, but the silicification which these specimens have undergone has more or less obscured the character of both surfaces.

This is without much doubt a species new to the American Carboniferous at least, but it seems that its characters should be determined on better and more extensive material before it is described under a new name.

Horizon and locality.—Delaware Mountain formation, mountains northwest of Marathon, Tex. (station 3840).

Family ACANTHOCLADIIDÆ Zittel.

Genus ACANTHOCLADIA King.

ACANTHOCLADIA GUADALUPENSIS n. sp.

Pl. VIII, fig. 1; Pl. XVIII, figs. 13, 13a, 14, 14a, 16 to 16b; Pl. XXII, figs. 10 and 10a.

?1859. *Acanthocladia Americana.* Shumard (non Swallow), Trans. Acad. Sci. St. Louis, vol. 1, p. 388 (date of volume, 1860).
Gray [Permian] limestone: Guadalupe Mountains, Texas and New Mexico.

This is one of the most abundant Bryozoa of the entire Guadalupian fauna, and numerous examples have been examined. The following description is derived from the typical specimen, which was obtained at the horizon of Shumard's "dark limestone." Much of the material is less complete and less perfectly preserved than the typical specimen, and shows certain departures from it to which reference will later be made, but which do not enter into the specific diagnosis.

Zoarium robust, consisting of three somewhat sinuous branches lying in the same plane. The two lateral branches are nearly opposite and directed at an angle of about 60° or less to the median one, which is persistent. The branchlets make, with the branches, a nearly flat frond, but stand at various angles to them. Usually the angle is slightly less than 90°, and it varies to about 60°. The branchlets also present considerable variety in length, the longer ones being themselves branched. They are a good deal smaller in diameter than the branches; otherwise the forked branchlets might themselves be considered branches. The branchlets attain an extreme length of 5 mm., but usually are shorter. The shortest, which have without much doubt been broken, are just prominent enough to be recognized. Probably 3½ or 4 mm. would cover the length of the majority of perfect ones. The average width of these is from 0.75 to 1 mm. The thickness of the branches ranges from 1½ to 2 mm.

On the poriferous face of the zoarium, especially on the branches, the apertures are grouped along a central zone, which is usually much elevated. The expansion of the branches below the celluliferous portion seems to be a rather striking character in all the specimens seen. On the branchlets this does not occur or is much less obvious. On this portion of the frond the apertures extend far down on the sides. They are small, only one-sixth to one-eighth of a millimeter across, and open somewhat obliquely lengthwise of the axis, so that their shape is rather elongated. The distal margin projects upward into a spiniform lip, which in well-preserved specimens like the type is a striking feature. The spines cover the poriferous surface, which they ornament in a beautiful manner. Those on the sides appear to be longer than the rest and tend to form a lateral row of especial prominence. The apertures are separated from one another by rather thick walls, their average distance apart being about the same as their average diameter. On the poriferous face I have been able to detect no auxiliary pores, no raised or depressed lines, pustules, or ornamentation other than the spines, which abundantly cover the surface. The apertures are not obviously arranged in rows, but appear for the most part rather promiscuously crowded together. The eye follows them along diagonal rather than longitudinal lines, of which, loosely considered, there may be four or five, with a slightly narrower band on the branchlets.

On the reverse side the branches are well rounded. The branchlets, also fairly round, are much depressed. The nonporiferous surface of the typical specimen is obscured by the coarse plates of chalcedonic silicification, but another example, so closely associated with the typical one that I am not sure that they did not belong to the same zoœcium, shows the reverse side to be covered by very delicate, moderately strong, somewhat flexuous and inosculating longitudinal liræ, which gives this surface an exceedingly handsome appearance. These markings are too fine to be represented in my figures.

I have identified this species at a number of localities, and referred to it most of the material belonging to the genus which has come into my hands. In most cases the fossil is silicified, and by etching is obtained in a free condition. While this is in some ways an advantage, the silicification is often rather coarse or chalcedonic and the specimens are fragmentary. Considerable variation is shown. A rather constant character is the presence of a broad elevation along the median portion of the main branches, to which the zoœcial apertures are restricted. While the distance between the pinnules and their general arrangement remain fairly constant, considerable difference in size and some in appearance is produced by age. As the zoarium grew older it increased in size, not only in a lengthening of the branches (the pinnules apparently remaining more nearly constant) but also in a thickening of them, chiefly over the back. Layer after layer was added to the nonporiferous side, making a thick, strong basal plate, and at the same time producing a gibbous arching of the surface which elevates it far above the plane of the pinnules. In specimens which are not silicified these plates of shell peel off in concentric exfoliation. Thickened specimens sometimes reach a diameter much greater than that of the types and indicate that these colonies attained a considerable size. Another effect apparently produced by thickening was to straighten the branches, which near their terminations are slender and have a zigzag course in relation to the development of the pinnules. Whether it also caused the pinnules to appear less distinctly alternating than is perhaps the rule, I am in doubt. Several examples occur, however, in which these branchlets originate nearly opposite each other. To the same cause may perhaps be attributed the absence in some specimens of the fine striation which was seen on the back of one of the types. Other specimens from the same station fail to show this sculpture, and it is conceivable that it is not developed on later testaceous deposits. A character which occasionally appears in thickened examples consists of a few irregularly distributed nodes along the median line of the back of some of the pinnules. (See fig. 16a, Pl. XVIII.)

The poriferous face also appears to have received testaceous deposits, though to a less extent than the other. The tendency in this case appears to be the closing of the zoœcial openings and the obscuring or burying of the spines which project from them. While as a rule the branches and branchlets lie in nearly the same plane, in some examples the pinnules bend backward so that the nonporiferous faces make an angle of less than 180°. Under such circumstances the pinnules do not of course appear depressed on the reverse side.

The little spines, which are a striking feature of the poriferous surface of the type specimen, have been observed only here and there, and the fine liræ seen on a specimen accompanying the type in no other instance. Much of the material seems to have been more or less worn, the pinnules occasionally reduced to short stumps cut obliquely across. This usage would of course tend to destroy primarily the little spines on the front and also the striæ on the back of the zoœcium. Silicification has also done its part in affecting the appearance of these organisms. Usually it is of a chalcedonic nature and tends to give them a wrinkled or warty look and to obscure all structures. Any delicate sculpture on the back would almost certainly be obliterated. On the front it operates to close the zoœcial openings and generally to obscure them, perhaps sometimes to replace them by small spinelike projections, though I think that the spines on the typical specimen are not due to this cause. It is possible, however, that the very delicate striation noticed on the auxiliary specimen, but in no other instance, may have resulted from this process. While as a rule more or less obscured, some silicified specimens were almost certainly smooth on the nonporiferous side.

Thin sections, where the preservation is good, show that the test is very finely tubular. The tubules are generally normal to the outer surface, but their direction from the zoœcial apertures is radial.

I am not altogether satisfied that all the specimens identified with *Acanthocladia guadalupensis* which show the variation mentioned above belong to the same species as the type. Could I be sure that the differences noted are not due to imperfect preservation and to unequal age a separation into several species would seem to be demanded, though under present conditions impossible to be satisfactorily carried out. On the other hand, the factors tending to produce such apparent differences are certainly operating, and it has seemed to me more appropriate to refer all to one species.

Acanthocladia guadalupensis is so unlike *A. americana*, *A. fruticosa*, *A. pinnata*, *A. anceps*, or any of the species known to me that a detailed comparison is unnecessary. I may recall, however, that Shumard suggested the name *americana* for a form from Kansas, and that a year later he identified the same species in the Guadalupe Mountains. It seems altogether likely that the Guadalupian form which he refers to *A. americana* is that described here. There is little likelihood of *A. guadalupensis* occurring in the Mississippi Valley, and little also of its being the same as *A. americana*, which though imperfectly described is nearly related to *A. anceps* Schlotheim.

Horizon and locality.—Top of Capitan formation, Capitan Peak (stations 2966? and 3762a); middle of Capitan formation, Capitan Peak (station 2926): base of Capitan formation, hill southwest of Guadalupe Point (station 2906); "dark limestone," Pine Spring (station 2930), hill southwest of Guadalupe Point (station 2924), Guadalupe Point (stations 3762b, 3762c, 3762d, and 3762e); Delaware Mountain formation, Guadalupe Point (station 2903), Guadalupe Mountains, Texas. Delaware Mountain formation, southern Delaware Mountains, Texas (stations 2957, 2962, 2969, and 3500). Delaware Mountain formation, Diablo Mountains, Texas, as reported (station 3764). Delaware Mountain formation, Comanche Canyon, Glass Mountains (station 3763), and mountains northwest of Marathon (station 3840), Texas.

Acanthocladia sp.

Pl. VIII, figs. 2 and 2a; Pl. XVIII, figs. 15 to 15b.

I have been unable to refer to *Acanthocladia guadalupensis* several fragments found in the Capitan formation and the "dark limestone." The size and mode of growth of this form are not well known, but apparently do not differ materially from those of the common species. The cells do not, however, open from a central raised zone. In fact, the poriferous surface is rather markedly flattened, and the apertures distributed all over the obverse side of the branches and branchlets. The intervals between them, furthermore, are wider than in the common type, and the arrangement into rows, especially diagonally, is a little more obvious. The general appearance is not unlike that of *Acanthocladia anceps* Schlotheim. It is possible, however, that both these peculiarities—the absence of a raised zone and the wider spacing of the apertures—may be the result of a deep exfoliation of the poriferous face. I hardly think, however, that this has occurred. The nonporiferous side, in the single instance where it has been possible to observe it, is quite smooth; but, as in the case of other silicified specimens, possible ornamentation of some sort has been lost, either by erosion or during the process of silicification.

Horizon and locality.—Capitan formation, Capitan Peak (station 2926); "dark limestone," Guadalupe Point (station 3762e), Guadalupe Mountains, Texas.

Genus SEPTOPORA Prout.

Septopora aff. S. robusta Ulrich.

Of this species but two specimens have come to hand and the fragments are so small and the silicification so imperfect that the proposal of a new name hardly seems justified.

The form under consideration is characterized by the slender branches, which have about the same diameter as the dissepiments, and by the quadrate proportions of the fenestrules. Two branches and one fenestrule seem to come in 2 mm. in a transverse direction. The branches have a diameter of half a millimeter and the dissepiments are as a rule equal to them. The fenestrules vary from somewhat longer than wide to somewhat wider than long, and the shape is quadrate.

It is difficult to give data regarding the zoœcia from my material. They seem to occur in two rows, with a slight carina between, but sometimes there are three, especially near the junction with the dissepiments. Three or possibly four zoœcia occur opposite each fenestrule, with two opposite each dissepiment.

The nonporiferous side seems to be without ornamentation, but is pierced by rather large, somewhat widely spaced auxiliary pores, more or less irregularly ranged in three alternating series.

This form appears to be quite closely allied to *Septopora robusta* of the Pennsylvanian, but my material is too imperfect to permit a comparison in all points.

Horizon and locality.—Delaware Mountain formation, mountains northwest of Marathon, Texas (station 3840).

Family RHABDOMESIDÆ Vine.

Genus RHOMBOPORA Meek.

RHOMBOPORA aff. R. LEPIDODENDROIDES Meek.

Pl. XXXI, fig. 17.

To determine satisfactorily just what are the characters and affinities of *Rhombopora lepidodendroides* Meek would be a very difficult matter, seeing that the typical specimens can not be definitely fixed upon and the ramifications of the subject are extensive and intricate; but it can at least be said that the form under consideration is extremely similar to Meek's figures in his report on the paleontology of eastern Nebraska.

The fragmentary example which alone represents this species, having a length of 5 mm., is but $1\frac{1}{2}$ mm. in diameter. The cylinder thus defined is crossed externally by two sets of strongly oblique ridges going in opposite directions, marked with nodes where they meet and with granules on the intervening portions. The rhombic depressions which they form, constituting the vestibular portion of the zoœcial tubes, narrow down in such a way that the apertures of the zoœcia are elliptical, very narrow, about two or three times as long as wide. About three rhombs or a little less occur longitudinally in 1 mm.

It has been impossible to study this form by means of thin sections, since only a single specimen has been found, and that is silicified. In view of the fact that neither form can be said to be satisfactorily known, I feel indisposed to place the Guadalupian one unreservedly with *Rhombopora lepidodendroides*, especially since the associated faunas are so unlike, and since certain differences appear to exist between the Guadalupian specimen and Meek's figure, such as the greater obliquity of the rows of cells and the more elongate shape of the zoœcial apertures.

Horizon and locality.—Delaware Mountain formation, mountains northwest of Marathon, Texas (station 3840).

RHOMBOPORA? sp.

Under this title are included three specimens from two localities, which appear to belong to the genus *Rhombopora*. They are small fragments and are silicified. The range of diameter of the branches is from 2 to 3 mm. The smallest specimen has the cells obviously arranged in diagonal rows, in which they are about their own diameter apart. Longitudinally they are a little more than their own diameter apart, and about four cells and four intervals occur in a distance of 2 mm. The zoœcia are circular, and the vestibule appears to have essentially the same shape; at least it is not conspicuously rhombic or elliptical, nor does the outer surface appear to have been studded with tubercles. If Rhomboporas, therefore, these hardly belong to the *lepidodendroides* group. In the larger specimens the spiral arrangement of the zoœcia is much less rigid and extensive, which, taken with some slight deviation in their size, suggests that the larger examples belong possibly to another species, or even to another genus.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (stations 2957 and 2969).

Family CYSTODICTYONIDÆ Ulrich.

Genus GONIOCLADIA Etheridge.

GONIOCLADIA AMERICANA n. sp.

Pl. VIII, figs. 3 to 3c.

Waagen and Pichl relate that they had but a single specimen with which to carry on their studies of *Goniocladia indica*, and a supply of material equally limited circumscribes my observations on the American form. While I have little doubt that the latter is distinct from the Indian species, as well as from *G. cellulifera*, the only other member of the genus known to me, it is with some hesitation that I have described it as new, because of the rather imperfect knowledge which it has been possible to obtain of it.

Goniocladia americana consists of a more or less flat expansion formed by interlocking branches, producing a more or less regular network. In the single specimen known it is impossible to trace the constituent arms into continuous branches. Still less is it possible to distinguish any arrangement of branches and dissepiments. The thickness of the branches is as a rule considerably greater than their width from side to side. The nonporiferous face is sharply angulated, the surfaces which slope away from the central line being more or less flattened. Aside from this angulation, the nonporiferous side seems to be without ornamentation. The poriferous side is not shown by the specimen, but appears to be strongly rounded without any distinct carination. There seems to be a median plate from which the cells diverge. It is quite distinct along the nonporiferous side of the frond, but has not been seen on the poriferous half of the structure. Near their point of origin the cell walls are rather thin, but they rapidly become thicker with advancing length, so that their apertures on the poriferous side are separated from one another by intervals considerably greater than their own diameter. The width of the branches is frequently 2 mm. and sometimes 2½ mm.; it is sometimes also less than 2 mm. The fenestrules vary so greatly in size and shape that it is difficult to make a statement in regard to them which will be at once specific and true. They seldom have a length of 6 mm. and are frequently smaller. The width of the fenestrules is still more variable than their length, though they are seldom as long as wide, and sometimes are very narrow.

The characters which seem satisfactorily to distinguish the American form from that described from India are these: Our species is distinctly more robust, with heavier branches and larger fenestrules. The outlines of the fenestrules are not so strikingly serrated as shown by Waagen and Pichl's figures, though possibly no great difference exists in this particular. The poriferous side of the American form appears not to be carinated, though possibly on this point also but little stress should be laid, as my observations are imperfect and unsatisfactory. *G. americana* also apparently lacks the striated surface ornamentation of the Indian form. Waagen and Pichl do not describe the great thickening of the cell walls as they approach the poriferous surface, a character which is well marked in the specimen from the Guadalupe Mountains. As their figures show the apertures of the cells to be separated by considerable intervals, it may be inferred that in *G. indica* also the walls become heavier near the celluliferous surface. Furthermore, Waagen states that a lamella can usually be seen on the poriferous side of the zoarium in *G. indica,* which is quite in keeping with the carinated condition of this surface. In *G. americana,* on the other hand, the plate is seen only near the nonporiferous side.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926). Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

Family ACTINOTRYPIDÆ Ulrich.

Genus ACTINOTRYPA Ulrich.

ACTINOTRYPA? SERA n. sp.

Pl. XXVIII, figs. 11 to 11b.

This interesting form is known from material so fragmentary that only a small tangential section has been obtained. From this the following description is taken.

The zoarium consists of zoœcia and mesopores. The former are circular and come about four in a linear distance of 2 mm. They stand at intervals from one another varying from one-half to the same as their own diameter, or sometimes even more. The mesopores are very irregular in size and shape. They range in diameter from one-fourth to one-half that of the zoœcia. Apparently they are of a more or less cystose nature, being sometimes angular and sometimes rounded, not infrequently partly one and partly the other. The walls of the zoœcia possess a singular and characteristic structure, seeming to be rather regularly interrupted, or, better, to be subject to more or less regularly distributed areas of densification. These spots in thin section are of about the same intensity of shade as the walls of the mesopores, while the intervening spaces are much lighter, though as a rule they can be distinguished from the calcitic filling of the zoarium and can be traced in their complete circumference. These spots are densifications and not thickenings. They do not form, so far as observed, denticles projecting into the zoœcial interior, though more or less doubtful traces of such structure have been observed in one or two instances. They are of varying length, are not often conspicuously circular, and occur at varying intervals apart.

In almost the majority of cases the mesopore walls when directed so as to intersect that of a zoœcium do not impinge upon a densified segment of the wall but upon one of the translucent segments, and occasionally appear to fall short of contact. This form at first strongly suggests the genus *Actinotrypa,* and in fact the differences noted may possibly be due to difference in the maturity of the specimens where the section was taken.

Actinotrypa? sera should be readily distinguished from *A. peculiaris.* One well-marked difference is the continuous, dense, denticulate zoœcial wall of the latter species and the interrupted nondenticulate wall of the former. If it is a real difference (and the denticulate condition begins at an early stage in *A. peculiaris*) it is such as possibly to demand even a generic separation, but if, as suggested above, this difference is merely a matter of maturity there are still others by which they can be discriminated. The zoœcia in *A.? sera* are considerably larger and not quite so many occur in a given distance. The mesopores appear to be actually smaller, and relatively the mesopores and interzoœcial distances are distinctly smaller.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (station 2962).

BRACHIOPODA.

Family CRANIIDÆ King.

Genus CRANIA Retzius.

CRANIA sp.

Under this title are subsumed two very imperfect specimens, one from the white limestone of the Capitan, the other from Shumard's "dark limestone." The former is the better preserved, though smaller. It is nearly circular in outline, with a diameter of about 5 mm. or a trifle less. The shape is depressed-conical and the apex is situated about one-third the diameter from the posterior margin. The thick shell is deeply exfoliated, but retains suggestions of rather strong sublamellose concentric markings.

The specimen from the "dark limestone" is somewhat larger, having a diameter of 8 mm. and a height of about 2 mm. The apex appears to be subcentral, but the marginal outline is very indefinite. The surface has been much exfoliated, but was probably marked by faint concentric lines.

Provisionally it seems necessary to refer both specimens to the same species. Their generic position is a little uncertain, but probably lies with *Crania*. The shell seems to lack the phosphatic constitution which would indicate that it was a discinoid, such as *Lingulidiscina;* nor do I believe that it is a patelloid gasteropod.

This species is clearly distinct from Shumard's *Crania permiana,* which is without much doubt a *Richthofenia,* though it is not without resemblance to *Crania modesta* White and St. John.

Horizon and locality.—Middle of Capitan formation, Capitan Peak (station 2926); "dark limestone," Pine Spring (station 2930), Guadalupe Mountains, Texas.

Family STROPHOMENIDÆ King.

During the Carboniferous epoch one branch of the Strophomenidæ, the Orthotetinæ,[a] underwent numerous and interesting developments of structure and con-

[a] I have changed the form of this name to agree with the corrected spelling of the generic term from which it is derived. I am in doubt about the propriety of retaining this subfamily name. It can hardly be employed so as to have as its central idea the group of species to which the name *Orthotetes* no longer applies, and I am uncertain how far precedent will warrant shifting the central conception to another group. However, since Orthotetinæ will connote the same genera with either *Orthotetes* (in its revised sense) or *Schuchertella* as the central idea, and since there is some doubt as to whether this case has any established precedent, I have consulted my own preferences and retained the familiar term.

figuration. The structural peculiarities chiefly relate to the ventral valve. The structures of the dorsal valve, either because they did not undergo corresponding modifications or are less easy of observation, are less distinctive for classification. The ventral valve shows variation in the degree of development of the septum and dental lamellæ, and in their relation to one another. In one type both septum and dental plates are wanting; in another the septum is well developed, but the dental plates are more or less obsolete; in a third both dental plates and septum appear, but the dental plates converge and unite with one another and with the septum in a Y-shaped structure, the dental plates and pseudodeltidium forming a pyramidal chamber on the back of the shell; in a fourth a septum is absent and the dental plates are extended in a discrete condition to the convex shell wall. With these variations in ventral structure are sometimes associated others in the dorsal valve relating to the cardinal process and the development of socket plates. The variation in configuration consists largely in the development in certain groups of species of more or less strong radial plications. There is an almost complete parallelism between structure and configuration, most of the structural types including plicated and unplicated species, the unplicated forms appearing earlier in point of time. Waagen has remarked this circumstance, and commented on it at some length. He says:[a]

A fact that has already occurred three times to our observation, and which can not be passed in silence, is that in several groups of the forms more or less nearly related to *Streptorhynchus* the geologically younger species attain more or less distinctly radially plicated valves. This peculiarity we had occasion to observe in the genus *Streptorhynchus* itself, where the form occurring with or above *Strept. pelargonatus*, viz, *Strept. pectiniformis* and *distortus*, are strongly radially plicated. Quite the same occurs in the genus *Meekella*, the Mountain limestone species, *M. oliveriana*, Vern., being smooth, while the species from the Coal Measures and the Upper Carboniferous limestone, *M. striatocostata*, Cox, and *M. eximia*, Eichw., have a strong radial plication. Another instance is the section of the "*Camerati*," within the genus *Derbyia*, where the geologically oldest species, *Derb. correna*, Derb., is not plicated; while the Permian forms, *Derb. eusarkos*, Abich, and *Derb. peregrina*, Ab., are more or less distinctly radially plicated. Lastly, in the section "*Septati*" of the genus *Derbyia* a similar peculiarity prevails, though in a much less degree. The geologically older species like *Derb. senilis*, Phill., *Derb. grandis*, W., and *Derb. regularis*, W., are smooth, without a trace of a radial plication; *Derb. plicatella*, on the contrary, which occurs in the Cephalopoda bed of Jabi, has tolerably strong traces of such a plication. It is now in many instances very highly probable that the plicated forms are the descendants of the smooth ones, but if this be the case it is at the same time very improbable that a character which occurs in absolutely the same manner over the whole world should have been caused by external influences, as climate, food, etc.; there must have existed within these organisms an innate law according to which they were forced to assume with the progress of time, sometimes sooner, sometimes later, a radially plicated shape under most widely different external circumstances.

Many of the types have received names, some of them generic, some subgeneric; and it seems to me that each structural type can appropriately be esteemed of generic rank with the plicated varieties distinguished as subgenera.

Among strophomenids in which the ventral valve has neither dental plates nor septum two divisions have been recognized. For one of these King proposed the name *Streptorhynchus*, the other was first discriminated and characterized by Waagen, who revived for it the name *Orthothetes* (properly *Orthotetes*) Fischer de Waldheim; but I find that Fischer de Waldheim's description of *Orthotetes* and the type species with which the name must be associated have the characters of that

[a] Waagen, W., Salt Range fossils: Mem. Geol. Survey India, Pal. Indica, ser. 13, vol. 1, 1887, p. 594.

group for which Waagen simultaneously proposed the name *Derbya*. The term *Orthotetes*, therefore, passes to the group (or part of it) at present called *Derbya*, leaving anonymous that now passing under the name of *Orthothetes*. For this group the name *Schuchertella*[a] has been proposed, and *Streptorhynchus lens* White designated as the type species. Schellwien[b] employs the term *Orthothetes* to designate a group of Devonian and early Carboniferous species having two short, strongly diverging dental plates in the ventral valve. The shells which Waagen called *Orthothetes*, and for which the name *Schuchertella* has been substituted, Schellwien refers to *Streptorhynchus*. I hold to the groups used by Waagen in this instance, though not to his nomenclature, for the term *Orthotetes* can not be retained, either in the sense in which Waagen or that in which Schellwien employed it.

In *Schuchertella* growth is usually regular and symmetrical, the width at the hinge line being equal to or greater than that in front. The two valves meet along a plane which is as a rule nearly perpendicular to the cardinal area. There is no median septum in the ventral valve, and dental plates are also absent, though the edges of the delthyrium may be more or less thickened. The dorsal valve has for the family a rather high area. The cardinal process is bilobed, and in some species of large size. It expands at its base into two winglike supports, which are short and not prolonged so as to surround the muscle scars. This genus begins in the Silurian, but seems to attain its greatest development rather late in Devonian and early in Mississippian time, being more or less completely replaced later on by *Derbya* and *Orthotetes*. No North American species of *Schuchertella* are known in the upper Carboniferous, though one South American form (*Streptorhynchus tapajotense*) is found at that horizon, and it may be that some of the upper Carboniferous forms referred to *Streptorhynchus crenestria* really belong here. Waagen describes one species (*Orthothetes semiplanus*) from the Permian of India. This species Schellwien now places in *Streptorhynchus*. The Mississippian forms of *Schuchertella* do not possess dental plates, and the genus can not contain the shells having this structure, for which Schellwien uses the name *Orthothetes*.

I am not entirely sure that the group of shells with which Waagen and also Hall and Clarke associate the name *Orthothetes* is distinct from *Streptorhynchus*. Schellwien, as already noted, throws them together. The differences recognized by Waagen reside chiefly in the dorsal valve. He describes *Streptorhynchus* as having a large septum supported by two crural plates which partly surround the muscular impressions. In "*Orthothetes*" he records that the cardinal process is small and not supported by crural plates. He also mentions a low median dorsal septum as usually present.[c] The dorsal septum is very rare in the forms seen by me. The cardinal process, though often fairly constant in specimens of the same species, yet varies so much, both in size and shape, in different species as to indicate that the value which has been assigned to this structure in discriminating *Schuchertella* (*Orthothetes*) and *Streptorhynchus* has been overrated. The figures given by Hall and Clarke of the cardinal process of *Streptorhynchus hallianum* show much variability in that structure, both as to size and conformation. I am convinced, however, that more than a

[a] Proc. U. S. Nat. Mus., vol. 27, 1904, p. 734.

[b] Neues Jahrbuch, Jahrg. 1900, vol. 1, 1900, pp. 6 et seq.

[c] Waagen, W., Salt Range fossils: Mem. Geol. Survey India, Pal. Indica, ser. 13, vol. 1, 1887, p. 576.

single species is represented by these figures. It seems probable that, like other areas of muscular attachment, the cardinal process is subjected in old age to excessive shell secretion, not only increasing its size, but by strengthening its muscular features also modifying its shape, so that the process varies much in both particulars, owing to difference in age. My own observations lead me to doubt if any constant difference exists in this structure available for discriminating *Schuchertella* from *Streptorhynchus*. The absence of crural plates in *Schuchertella* seems to be a constant feature, but I doubt if their presence is so in *Streptorhynchus*. In *Streptorhynchus pelargonatus*, the type of the genus, as represented by Davidson's figures or as observed by myself in specimens, the structure of the hinge plate does not differ from that of *Schuchertella*. The dorsal area of *Schuchertella* seems to be as a rule higher than in *Streptorhynchus*, though I doubt if this is constantly the case, or is true in more than a comparatively slight degree. The configuration of the genotype, *Streptorhynchus pelargonatus*, is peculiar. Its strongly elevated and somewhat twisted ventral valve, narrow hinge line, and curved area of valve junction all distinguish it from the common type of *Schuchertella*, but these peculiarities of configuration are by no means persistent throughout the forms referred to *Streptorhynchus*. Among species known to me *Streptorhynchus hallianum* and *Schuchertella tapajotensis* do not differ materially in configuration nor in the matter of dorsal area, in both of which they are more like *Schuchertella* than *Streptorhynchus pelargonatus;* yet *Streptorhynchus hallianum* has the crural plates characteristic of *Streptorhynchus*, while these are absent from *Schuchertella tapajotensis*.

There is another character which I do not recall having seen mentioned in that connection, but which may, if not always an aid in discriminating the two genera, at least serve to show that they are really distinct. Two of the three species of *Streptorhynchus* noted in this report were attached not by a pedicle issuing from between the two valves, but by cementation of the apex of the ventral valve. The third Guadalupian species was probably attached in the same manner, and some at least of the foreign species, though I have not been able to examine them to ascertain this fact. There is no reason to believe, however, that any species of *Schuchertella* departed from the normal peduncular attachment. One can not but believe that atrophy of the pedicle accompanied attachment by cementation, entailing with it muscular and other organic modifications, such as must demand a discrimination of *Streptorhynchus* from *Schuchertella* on the soft parts, even if the test sometimes fails to show variations to correspond. On the other hand, some of the Derbyas almost certainly practiced cementation, yet they appear to manifest no modifications of structure resulting from it, nor would I advocate separating them on this account from the normal type.

I do not know, therefore, of any characters which can always be relied on to discriminate these two genera, though possibly those already mentioned will be found to serve in a majority of cases. However, the great expansion of the *Schuchertella* group in the upper Devonian and lower Mississippian, and its practical extinction thereafter, taken with the development of *Streptorhynchus* in the late Carboniferous and Permian, show to some extent that the stock is not the same, even if the distinctive characters can not yet clearly be designated. In suggesting the term *Schuchertella* for the species left without a name by the diversion of *Orthotetes* to the camerate Derbyas, I have not altered the existing group, but only made some necessary changes in the nomenclature.

Streptorhynchus as at present defined includes both plicated and unplicated shells, though the type species is of the latter sort. I think that a valid subgenus might be established for the plicated shells, which Waagen is satisfied with calling the *plicati*, to distinguish them from the typical series, which he terms the *simplices*. The fact that the *Schuchertella* group of forms does not develop a plicated series of species might also be taken as indicating a difference in the origin of the two genera. But two North American species of *Streptorhynchus* have been described up to the present—*Streptorhynchus ulrichi* Hall and Clarke and *Streptorhynchus williamsi* Weller,[a] both of them from the lower Carboniferous rocks of the Mississippi Valley, though Waagen[b] believed the genus to be confined to the Permian. The Guadalupian fauna contains three species which seem to belong to this genus, but so far all the American forms are of the unplicated type. Waagen,[c] however, mentioned having seen specimens from Nebraska in the Royal Paleontological Museum in Munich, in which these septa seem to be absent. I suspect that if really from America, the specimens were Meekellas, which by some accident failed to show their proper structure.

For strophomenids with a median septum in the ventral valve Waagen has proposed the name *Derbya*. Two variations of this type are found. In one the dental plates appear merely as columnar thickenings terminating below in the hinge teeth, with which they are continuous. They never are extended into distinct places, and since they have about the same degree of development as the corresponding structures in *Streptorhynchus*, it might with equal truth be said that here also dental septa are absent. These projections vary in degree from being practically absent to appearing as moderately high ridges, and their direction is vertical to the area, or often somewhat diverging. At the apex of the shell the septum connects with the areal wall, but may or may not do so below. The septum and dental ridges come into union only at the apex, where, however, there is sometimes a solid deposit of shelly matter uniting the internal structures with the inclosing walls. To this division Waagen gave the name *septati*.[d] In the other, which he calls the *camerati*, the cardinal teeth are supported by short dental plates, which converge and unite with the septum, forming a small, prismatic chamber in front of the pseudodeltidium. In this group the septum extends no farther than its junction with the dental plates, and only touches the areal wall at the apex. The differences of structure of the *camerati* and *septati* is both striking and sustained among the later developed types, but in the Mississippian epoch these septiferous shells show much variability in structural development, some examples of the same series appearing to belong to the *camerati* and others to the *septati*. In these forms the dental lamellæ do not unite with the septum for their whole length, and though converging do not completely inclose a chamber where they are free. The duration of their union varies greatly in different individuals. Often, too, the apex of the shell is filled to varying

[a] I am not satisfied that these species are not survivors of the group *Schuchertella*, rather than harbingers of *Streptorhynchus*.
[b] Waagen, W., Salt Range fossils: Mem. Geol. Survey India, Pal. Indica, ser. 13, vol. 1, 1887, p. 576.
[c] Idem, p. 578.
[d] Idem, p. 591.

lengths with a solid shelly deposit. In some forms the chamber is rather long, and either open or filled with calcareous matter. In others it is so small and closed with shell that the specimen might without much violence be placed with the *septati*. The plates in this case of course converge, whereas I have never observed them to have this direction in the real septate group. It may be that the direction of these dental ridges will prove of some importance. The genus *Derbya* Waagen, as originally defined, includes both the septate and camerate types of structure, though the genotype, *D. regularis*, is one of the *septati*. The genus *Orthotetes* Fischer de Waldheim, though misconceived by Waagen to connote the group of shells for which the name *Schuchertella* is here substituted, really seems to be exactly coextensive with *Derbya*, though the genotype, *O. radiatus*, belongs to the *camerati*. The camerate and septate types of structure, where well differentiated, present differences so striking that I at one time contemplated proposing a new name for the camerate division, not being at that time aware of the true significance of *Orthotetes*. This idea was later abandoned because of the ambiguous Mississippian forms referred to, but I shall be glad to avail myself of a name already in the literature. By restricting *Derbya* and *Orthotetes* to the phase of structure exemplified by the typical species of each, the name *Derbya*, which conveys a compliment so well deserved, can be retained as well as *Orthotetes*, which has a long priority; and since the true Derbyas are much more numerous than the *camerati*, comparatively few changes in nomenclature will be entailed.

Among both the *camerati* and the *septati* Waagen points out species, some of which have a smooth and others a radially plicated surface. Of the plicated Derbyas Waagen mentions only *D. plicatella*, from the "Cephalopoda bed" of Jabi, and no other species having this character has come to my knowledge. The plications in this species, however, are so faint and irregular as to be far from striking. As instances of plicated shells of the camerate group (*Orthotetes*) Waagen mentions *Streptorhynchus crenistria* var. *eusarkon* Abich and *S. peregrinum* Abich. After examining specimens of these species, however, Schellwien states that instead of having a single median septum they have two nearly parallel dental plates. He refers them, therefore, to his genus *Orthothetina*, but if they have a plicated surface, as represented by Abich, they would probably be more correctly placed with *Meekella*. Shells having radially plicated exterior joined with the internal structure characterizing the genus *Orthotetes* do occur, however, and Schellwien has recently proposed for them the generic name *Geyerella*[a] (type *Geyerella gemmellaroi* Schell.). The admission of this name with the rank of genus makes an inconsistent and irregular classification if the groups of *Streptorhynchus* called *plicati* and *simplices* are borne in mind.

The fact that *Derbya* does not develop a group of species having well-marked radial plications may be considered as having some bearing in estimating the propriety of distinguishing the *septati* and the *camerati* as two separate genera.

The genus *Derbya* is well represented in the Mississippian and Pennsylvanian rocks of North America, but no species of *Orthotetes* have been recognized with the exception of the ambiguous Mississippian species referred to above. In fact, shells

[a] Neues Jahrbuch, Jahrg. 1900, vol. 1, 1900, pp. 4, 12.

having the distinctive characters of *Orthotetes* well developed appear not to have come in until after the genus *Derbya* had been long established. In the fauna described here several species of *Derbya* are found, but in the Capitan formation *Orthotetes* occurs in abundance, with the characteristic structure strikingly developed and with a rather peculiar configuration and sculpture. All the American species of *Derbya* are of the unplicated type. The plicated division of *Orthotetes* for which Schellwien has recently proposed the name *Geyerella*, though previously unknown in the western hemisphere, is represented by a species from the Capitan formation for which the name *Geyerella americana* will hereinafter be proposed.

Both the plicated and unplicated kinds of surface are found among shells having two strong dental plates uniting the anterior and posterior walls. For one of these (the plicated type) the well-known term *Meekella* has been used, and for the other Schellwien has introduced the name *Orthothetina*.[a] There appear to be two groups of unplicated forms having this biseptate structure, one of them, found in the European Devonian, in which the septa are short and diverging, the other widely distributed in the upper Carboniferous and Permian, in which the septa are long and more nearly parallel. It is apparently for the latter group only that the term *Orthothetina* is employed by Schellwien, and for the septate Devonian forms he uses the name *Orthothetes*. Species having the structure of *Orthothetina* are at present not known from North America, though I have an undescribed form from the Permian (?) of Kansas, and a species with converging, closely proximate septa is described below from the Guadalupe Mountains. Nor is the type to which Schellwien misapplies the term *Orthothetes* known here. The group of species which abounded in this region at the corresponding geologic epochs is characterized by having the dental plates virtually absent (*Schuchertella*). Schellwien subsequently seems to have concluded that the more recent septiferous shells should not be separated from the early ones, and accordingly he employs the term "*Orthothetes*" for the whole, abandoning *Orthothetina*. But Fischer de Waldheim's name clearly can not be used for shells having extended dental plates but no septum, and accordingly *Orthothetina* should be recognized. I am, however, by no means content that the early Carboniferous biseptate shells should be referred to the same genus as the late ones, and at the same time it is inappropriate to place them with *Schuchertella*. Perhaps a new name should be introduced to cover them.

The genus *Meekella* is abundant in the upper Carboniferous of the Mississippi Valley, no Mississippian forms being known. Several new species occur in the Guadalupian. Waagen did not find in the Salt Range shells which possessed the structure of *Meekella*, and having remarked a specimen from Nebraska in which the dental plates were apparently absent and which at the same time possessed the exterior of *Meekella striaticostata*, he expressed himself as doubtful whether that genus ought not for the most part to be merged in *Streptorhynchus*. I have not myself observed, nor seen noted by others, any specimen like that mentioned by Waagen, and the occurrence of this type in the Mississippi Valley must be rare. Most American identifications of *Meekella striaticostata* with little doubt are at least congeneric with that species. The plicated shells without dental lamellæ in

[a] Neues Jahrbuch, Jahrg. 1900, vol. 1, 1900, p. 8. This is the earliest use of this term to which I have found reference, but it is not defined in a formal manner, neither is it accompanied by any indication that this is the first time that it has been employed, nor is any citation of original place of description appended.

the ventral valve, if such really occur here, can not of course be referred to *Meekella striaticostata* or to the genus *Meekella* at all.

The Orthotetinæ in their later development show numerous lines of modification. One of the first changes is the loss of an area in the dorsal valve. This structure is well marked in *Schuchertella*, but seems to be missing in the other Carboniferous divisions, if one may trust the current generic diagnoses. It does occur sporadically in several genera, as I have observed it in *Derbya cymbula* and *Streptorhynchus hallianum.* It is probable that this structure is relatively broader in *Schuchertella*, but that it is never entirely absent.

A very striking character occurring in nearly all the later groups is the development of radial plications. The extension of the ventral valve into exaggerated, high, and distorted shapes is still another feature. Some forms are also cemented to other bodies by the apex during part of their life. This has been observed in *Streptorhynchus* and in the young of *Derbya*. Accompanying these other developments is often a shortening of the hinge line, which appears to be a rather constant character in some groups. Perhaps a line of retrograde development is found in *Streptorhynchus*, in which the absence of dental plates is accounted for by Schellwien as being an atavistic trait.

In his interesting and suggestive paper on the Strophomenidæ [a] this author repeatedly states that the median septum is a development of the dental plates. To my mind these are entirely independent structures, though all converge and unite at the apex of the ventral valves, where they often merge in a solid shelly mass. I have not seen evidence that the septum was developed from the dental lamellæ any more than the dental lamellæ were developed from the septum. Both structures act with almost entire independence. Hall and Clarke have recently described a species of *Derbya* in which this is especially marked. *Derbya cymbula* has as a character a distinct groove down the center of the high pseudodeltidium. This groove is caused by the attachment of the septum to the pseudodeltidium, which continues for a considerable distance, probably 10 mm. or more in some cases. On either side of the septum, yet independently, the rather high dental ridges project. Only at the apex have they any connection. The structures of *Geyerella*, however, where the long converging dental plates and the septum form a triradiate figure, lends some color to Schellwien's hypothesis, and may indicate that the septum in all types of structure is not formed in the same way. Still, even here the septum may simply unite with the dental plates, instead of being formed from them. Another fact which also might be invoked to support Schellwien's claim is that nowhere (except perhaps in *Geyerella* and *Orthotetes*) are the dental lamellæ and septa simultaneously developed in strength. Both structures may be absent, as in *Schuchertella* and *Streptorhynchus*, but in other forms either the septum is well developed and distinct dental lamellæ are absent, or the dental ridges are extended into plates and the septum is absent, unless, as above remarked, they unite to form a three-rayed figure. Yet somewhat differently viewed, these facts might better be construed as evidence that the septum and dental plates were supplementary but independent. If the septum in *Geyerella* is the result of the welded dental plates, and if, on the other hand, the septum in

[a] Beiträge zur Systematik der Strophomeniden des oberen Palæozoicum: Neues Jahrbuch, Jahrg. 1900, vol. 1, 1900, pp. 1-15.

Derbya, as I am inclined to believe, is an independent structure, the course adopted here of distinguishing as independent genera the two original divisions of *Derbya* is justified, for the structure of *Orthotetes* is so like that of *Geyerella* as to leave little doubt that it arose in the same way, and consequently the septum in the two groups, *Derbya* and *Orthotetes*, would have had a very different origin. Another circumstance possibly favoring the same discrimination is that *Derbya* does not devolve into plicated forms, while *Orthotetes* does so (*Geyerella*).

The following table shows the structural modifications of the Carboniferous Orthotetinæ and the nomenclature employed:

Classification of Carboniferous Orthotetinæ.

Shells having neither septa nor dental lamellæ in the ventral valve.

1. Ventral valve mostly high, distorted, sometimes, possibly generally, attached by cementation. Dorsal valve with large cardinal process and well-developed socket plates. Area obsolete in the dorsal valve. (Schellwien makes no distinction between this group and 2.)
   a. Unplicated forms.................Typical *Streptorhynchus;* Waagen's group of *simplices*.
   b. Plicated forms....No distinct generic name; Waagen's group of *plicati* under *Streptorhynchus*.
2. Ventral valve low, regular. Attachment peduncular. Dorsal area narrow but distinct. Cardinal process usually small. Socket plates absent. No plicated species known. Waagen erroneously uses for this group the name *Orthothetes*. Schellwien assembles these with 1a, and uses the name *Streptorhynchus*.............................*Schuchertella*.

Shells having a well-developed median septum in the ventral valve, with the dental lamellæ more or less completely atrophied, and discrete from the septum except at the apex. This group formed the division of *Derbya* which Waagen designated as the *septati*. It is also the group to which *Derbya regularis* Waagen, the type of the genus, belongs. *Derbya* as originally defined included also another division, called the *camerati*, to which the genotype of *Orthotetes* belongs. If the term *Derbya* can be retained at all, it will only be by separating the camerate and septate divisions as two distinct genera or subgenera and restricting *Orthotetes* to one and *Derbya* to the other. This course is here adopted.

3. a. Shells unplicated..Typical *Derbya*.
   b. Shells plicated. Only one species known. It has obscure and irregular plications. Not discriminated by a distinctive name from 3a.

Shells having moderately developed dental plates in the ventral valve, which converge and unite, inclosing with the pseudodeltidium a triangular pyramidal chamber. At their union with one another the dental lamellæ unite also with the median septum, with which they form a triradiate figure. These shells, together with 3, constitute *Derbya* Waagen, of which the present group forms the section called *camerati*.

4. a. Shells unplicated..*Orthotetes*.
   This is the typical section to which the genotype *Orthotetes radiatus* belongs, and to which the name *Orthotetes* may be restricted.
   b. Shells plicated..*Geyerella*.

Shells in which the ventral valve is provided with two more or less long parallel dental plates without a median septum. The plates are prolonged to meet the anterior or convex wall of the shell.

5. Dental plates long and parallel. Dorsal area absent (?). Species mostly Permian and "Permo-Carboniferous."
   a. Shells unplicated..*Orthothetina*.
   Proposed by Schellwien as a subordinate group under *Orthothetes* (not *Orthotetes* Fischer de Waldheim, nor *Orthothetes* Waagen and later abandoned.
   b. Shells plicated..*Meekella*.
6. Dental plates short and diverging. Dorsal area present (?). Species mostly Devonian and early Carboniferous. Supposed by Schellwien to be the same as *Orthothetes* Waagen (=*Schuchertella*). Probably distinct from *Orthothetina*, which Schellwien proposed as a subdivision ....No distinctive name.

Of these divisions 1a (*Streptorhynchus*), 3a (*Derbya*), 4a (*Orthotetes*), 4b (*Geyerella*), 5a (*Orthothetina*), and 5b (*Meekella*) have been found either in the typical Guadalupian or in beds in adjacent areas supposed to be equivalent. 1b, 2, 3b, and 6 are the only divisions unrepresented in the fauna.

It may well be questioned whether the different groups in the foregoing table which are based on structure are of equal value. Probably they are not so, but the differences seem to be of insufficient importance to have been recorded in the nomenclature. Schellwien apparently recognizes no distinction between groups 1 and 2. Practically all authors place 3 and 4 under the same generic term, but Waagen, at least, recognizes them as subordinate groups. I at one time proposed in manuscript a distinctive name for the camerate division, intending to recognize it as a genus, but subsequently suppressed the name. Some doubt still remains as to the advisability of recognizing the *camerati* and the *septati* as independent genera, and I would not venture to carry out this purpose by proposing a new name, though I avail myself of the existence of two appropriate ones already in the literature to tentatively establish this classification. It is true that as originally proposed *Orthotetes* and *Derbya* included both shells having a camerate and those having a septate structure; but the type species of *Orthotetes* belongs to one and that of *Derbya* to the other division, and it is proposed to restrict each name to the division to which its type species belongs. This course has the additional advantage that it will conserve the terminology as largely as possible in its present form, since the name *Derbya* has received wide acceptance, and since, comparatively few species of *Orthotetes* being known, it will continue in use mainly for the group for which it is now in vogue.

While there is room for doubt as to the equality of the different divisions of strophomenids here recognized, there can be little question, I think, as to the irregularity of existing nomenclature for them. For example, *Geyerella* is distinguished from *Orthotetes* and *Meekella* from *Orthothetina* merely by having a plicated surface; but the plicated group of *Streptorhynchus* which has the same relation to the *simplices* is not distinguished as even a subgenus. It is apparent that with a few exceptions each of the structural types recognized above contained species which have simple and those which have plicated shells. A notable exception to this rule is the group *Schuchertella*, which so far as known is without plicated species. Another instance is the group of Devonian and early Carboniferous shells for which Schellwien erroneously employs the name *Orthothetes*. As a similar case, may possibly be instanced the genus *Derbya* in its restricted sense. Only one plicated species of this group is known up to the present, and in it the character is so indistinct and irregular that the question might be raised whether it should be really considered a plicated form. In the case of *Geyerella*, however, the kindred group *Orthotetes* has a well-marked plicated division. This difference may be used as an argument justifying the recognition of *Derbya* as distinct from *Orthotetes*.

I am much in doubt as to what taxonomic importance should attach to the plicated shell in this family, but convenience and logic demand that a similar importance should be given to it in each case. From the facts as known it certainly seems lacking in both to retain *Meekella* and *Geyerella* as genera and leave the plicated *Streptorhynchus* as a group of less value than a subgenus. There would probably be few who would advocate giving the plicated groups full generic rank. On the other hand, not many would consent to the reduction of *Meekella*, for example, to the same rank as the *plicati* of *Streptorhynchus*. An intermediate course, which would perhaps more accurately express the relationship of these shells, would be to recognize the plicated groups of species as subgeneric to the simple ones. The genera which would, in my view, be appropriate for recognition are *Streptorhynchus*, *Schuchertella*, *Derbya*, *Orthotetes*, and *Orthothetina*. Possibly an additional group of equal rank should be made of the shells which Schellwien calls *Orthothetes* in distinction from *Orthothetina*.

The Carboniferous Orthotetinæ are widely distributed over the earth, and in many places occur in very great abundance. They present variations in certain particulars, such as fineness of liration and height and inclination of the area, to rather wide limits, while maintaining otherwise a rigid adherence to a general type of expression. Here and there a striking and apparently well-marked variety occurs, of which *Orthotetes guadalupensis* of the present work is an example, but as a rule the different varieties melt into one another so completely that it is extremely difficult to distinguish them, so much so that some of our best known authors have in despair referred all the unplicated types to a single species. This was for the most part before an investigation of internal structures had made much progress, and serves to point another circumstance—that different groups now recognized as genera by reason of structural differences are essentially alike in external expression. In fact, practically the only well-marked external difference which these shells develop consists in whether the surface is simple or plicated, a feature which has been used more for generic than for specific definition. As a result, in comparing the Guadalupian strophomenids with those of other faunas it has been found more practicable to do so rather on the basis of their generic than on that of their specific differentiation, so little individuality being as a rule manifested by the smaller groups.

Considerable variation is shown in the distribution of these higher groups, which can be brought out to better advantage if the comparisons are made in one place; and they can be more briefly and conveniently made in that way than if distributed under the different generic headings. Accordingly, I shall proceed to discuss this matter at the present point.

Strophomenids are represented by numerous structural and specific types in the Salt Range of India. Of *Streptorhynchus* Waagen recognizes no less than seven species, four of which have unplicated shells and belong to the division which he has called *simplices*, and three belong to the *plicati*, a group which is entirely without representation in the Guadalupian fauna. Probably all the Guadalupian species would belong to what Waagen calls the group of *Streptorhynchus pelargonatus* among the *simplices*. The rather striking group of *S. capuloides* has no representatives in the American fauna. The form here described as *Orthotetes guadalupensis* is strikingly similar in external appearance but entirely unlike in internal structure.

The type of structure which characterizes Waagen's group of the *camerati* under his genus *Derbya* is not known in the Productus limestone fauna, but has several fine and characteristic representatives in the Guadalupian. They are here distinguished under the name of *Orthotetes*. Plicated shells having the camerate structure, for which I have adopted from Schellwien the distinctive term *Geyerella*, though represented by a characteristic species in the Guadalupian, are not found in the fauna of the Productus limestone. Of the septate division of *Derbya*, here called *Derbya* sensu stricto, Waagen recognizes six species. While extremely variable in a few characters, the Derbyas seldom deviate far from a primal typical expression, and as a result the Guadalupian species are in a general way very similar to those of the Productus limestone. In the Capitan formation, however, this group is to a considerable extent replaced by *Orthotetes*, the most characteristic Derbyas being from lower horizons. They appear to be less numerous, less varied, and less robust than the Indian species. All the American forms are unplicated. Waagen describes one plicated *Derbya*, but from his figure the plications are so obscure and irregular as to leave one in doubt whether the form really deserves to be so designated.

Under the name of *Orthothetes subplanus* Waagen describes a species which Schellwien later assigned to *Streptorhynchus*. As a mere matter of synonymy this form should go to my genus *Schuchertella*, if it has the characteristics which Waagen ascribes to it, and not to *Streptorhynchus*. In the Guadalupian I have found no species which it seemed to me could properly be placed in *Schuchertella*.

Of strophomenoids with two long dental plates, for which the term *Meekella* has been employed in the case of plicated shells, and *Orthothetina* in that of unplicated shells, no species are known from the fauna of the Productus limestone. Several well-characterized species of *Meekella* have been obtained from the Guadalupian, and one doubtfully belonging to *Orthothetina*. The latter was found in the Capitan formation, but the horizon of the Meekellas is in the Delaware Mountain sandstone.

Another strophomenoid type, very different from the foregoing, which Waagen recognizes in the Productus limestone fauna and doubtfully identifies with *Leptæna*, is unknown in the Guadalupian.

From this brief survey it appears that the strophomenoids of the Guadalupian on the whole possess but little in common with those of the Salt Range.

In the case of the Himalayan faunas also the resemblance is, so far as known, very slight. In neither of Diener's papers dealing with the "Permo-Carboniferous" fauna of Chitichun No. 1 are any strophomenoids cited, nor in that which describes the Permian fauna of Kumaon and Gurhwal, nor again in the one dealing with the fauna of the Productus shales of the Lissar Valley and of Byans. From Malla Sangcha he has described a species under the title of *Orthothetes krafti*,[a] which by a synonymic change should perhaps be written *Orthothetina krafti*, but the figures show a species so remarkably orthoid in expression as to create a feeling that they really represent a *Schizophoria* or an *Orthotichia*, although they do not show the median ventral septum of the latter genus. Nothing similar to this form is known among the Guadalupian strophomenoids. In his paper on anthracolithic fossils of Kashmir and Spiti Diener records *Strophomena analoga* and *Derbya* cf. *senilis*. The former, instead of the characteristic lower Carboniferous species here associated with an upper Carboniferous fauna, I have suggested to be the dorsal valve of a *Productus* of the *P. aagardi* group. The other shell is of doubtful generic position.

[a] The generic name being here employed as Schellwien proposed.

Writing subsequently on the fauna of the anthracolithic beds of Spiti, Diener figures from the lower beds a shell which also has no analogous species in the American fauna. He identifies it as "*Derbyia* cf. *senilis*," but it seems to be quite different from the species cited under that title in the previous paper. Not long ago Professor Schuchert called my attention to this form, which, he wrote, looked to him like an *Atrypa*, a resemblance that to me also is singularly close. The form in question occurs in beds which contain a spiriferoid of the genus *Syringothyris* (described as *Spirifer curzoni*), a fact which would indicate an early fauna of the Carboniferous, and although *Atrypa* is not, I believe, definitely known from Carboniferous strata, it is possible that still earlier faunas occur at the locality. Diener mentions other shells belonging to "*Derbyia*," some of which he thinks resemble *D. crassa* of our American Pennsylvanian. From the upper horizon he obtained one of the plicated species of *Streptorhynchus*, cited as *Streptorhynchus* cf. *pectiniformis*, a type which is notable by its absence from the Guadalupian. It is perhaps this same species which as a small plicated and striated dorsal valve Davidson figures from Kashmir under the title *Streptorhynchus?* sp. An unplicated shell is figured as *Streptorhynchus crenistria*.

From Turkestan Romanowsky figures one of the ordinary Orthotetinæ which might belong to one of several genera, so far as can be determined from the text and figures. It is identified as *Streptorhynchus crenistria*.

From China, in the Lo Ping fauna, Kayser cites only *Streptorhynchus crenistria* var. *senile* Phillips and *Meekella striaticostata* Cox?. It is a rather singular form, or group of forms, which is figured as *Streptorhynchus crenistria* var. *senile*, and a reexamination of Kayser's material by Schellwien and by Fliegel has resulted in subdividing it into several genera and species. Fliegel recognizes no less than five, viz, *Streptorhynchus kayseri*, *S. subpelargonatum*, *Orthothetes* [*Orthothetina*] *circularis*, *Orthothetes* [*Orthothetina*] *kayseri*, and *Derbya* sp. *Streptorhynchus kayseri*, from its large size and configuration, is rather distinct from the Guadalupian representatives of the genus. The species *S. subpelargonatum*, which is not figured, would perhaps have more in common with them. The single specimen of *Orthothetina* from the Guadalupian is too imperfectly known to stand for much in the way of comparison, but so far as one can tell it does not differ widely from *O. circularis* and *O. kayseri*, which are closely related to one another. The undetermined species of *Derbya* found in the Lo Ping fauna does not form a practicable basis for comparison with congeneric types in the Guadalupian. Kayser's *Meekella striaticostata* is almost certainly not our common Pennsylvanian species, and it may be doubted whether it is a *Meekella* at all, instead of one of the other types having a similarly plicated exterior but different internal structure. Indeed, Fliegel states that the plication in this specimen is by no means as distinct as represented in Kayser's figure and that it may well be a representative of his species *Orthothetina kayseri*.

In the various imperfectly known faunas described by Loczy from the Carboniferous of China, strophomenoids are cited in but two instances, and in each case they are identified as *Orthothetes crenistria*. One of the localities furnishing this species was Tengtjantsching and the other Youngtschangfu. Loczy appears to have followed the classification introduced by Waagen, and if so his shell would probably be a *Schuchertella*, a group which I have not found represented in the Guadalupian fauna.

From the Carboniferous of Padang but two strophomenoid species are at present known, one of which Roemer cited as *Streptorhynchus crenistria* var. *senile*. This has later been determined by Fliegel to be a new species, and has been called by him *Orthothetes* [*Orthothetina*] *politus*. The other is briefly characterized under the title *Orthothetes* [*Orthothetina*] sp. The Guadalupian representative of this group is too poor to permit a comparison.

From the so-called Permian of Timor and Rotti, in the Indian Archipelago, Rothpletz cites two strophomenoids which he calls *Streptorhynchus* cf. *crenistria* Phillips and *Streptorhynchus beyrichi* n. sp. I am unable to determine whether the generic name *Streptorhynchus* is here used in the general or the restricted sense. The fragmentary specimen of *Streptorhynchus beyrichi*, which alone is figured, is of the ordinary type.

Beyrich had previously identified and figured these species as *Streptorhynchus crenistria?* and *Streptorhynchus radialis*. Externally they belong to the usual unplicated type, and there is no clue as to their internal structures.

Martin cites from Timor as *Streptorhynchus* cf. *pectiniformis* Davidson a small, rather strongly plicated species, presumably a *Meekella*, but possibly a true *Streptorhynchus*. In the former case it appears to be of the usual type and is related to several Guadalupian species. If a *Streptorhynchus*, the Guadalupian contains nothing like it.

The Strophomenidæ of New South Wales as described by De Koninck comprise only two species—*Strophomena analoga* and *Orthotetes crenistria*. The horizon of both species seems to be in the lower part of the Carboniferous section, which is probably much older than the Guadalupian.

The Strophomenidæ of the "Permo-Carboniferous" of Queensland and New Guinea comprise, according to Etheridge, but two species—*Strophomena rhomboidalis* var. *analoga* and *Derbya senilis*. In several other instances where *Leptæna rhomboidalis* was cited from some of the higher beds of the Carboniferous, I have thought there was some reason to believe that the identification was based on the dorsal valve of some productoid, such as *Productus aagardi*, or *P. waagenianus* of the present memoir. Some at least of Etheridge's figures seem to represent real Leptænas, and I can not avoid the suspicion, since that genus is restricted in its upward range in the United States, and in Europe so far as I am aware, to the lower portion of the Mississippian or sub-Carboniferous, that these Australian formations (the Star and the Gympie, but not the Bowen River) are not "Permo-Carboniferous," but much older. The suspicion is based not on this one species alone, but on the generality of them.

If we may depend on the figures, which are freely given, *Derbya senilis* is not a *Derbya*, but a *Streptorhynchus*. It is represented as without a septum or dental plates and with two well-developed socket plates. It is, however, evidently not closely related to any of the Guadalupian species of *Streptorhynchus*.

Etheridge, senior, described *Streptorhynchus davidsoni* from Queensland, and also cited from a different locality *Strophomena rhomboidalis* var. *analoga*. The

Streptorhynchus is certainly not one of the common strophomenoids if reliance may be placed on the figures, and its generic relations appear to be doubtful.

As to the range of this group in the Russian section, I can not hope to have gained complete data, yet from the works which have come under my observation probably the most important facts can be gathered. From these the Carboniferous strophomenoids seem to have reached their maximum development in the "Upper Carboniferous" or the Gschelian. From the *Productus giganteus* zone I have seen cited only *Streptorhynchus radialis* and *S. crenistria*, the term *Streptorhynchus* here probably being used in its comprehensive sense, so that one might expect almost any of the common types of *Schuchertella*, *Derbya*, *Orthotetes*, etc.

From the *Spirifer mosquensis* zone I have found cited *Orthotetes crenistria*, *Derbya grandis*, *Derbya* sp., *Meekella eximia*, and *Meekella* sp. It is this fauna for the most part which is treated by Trautschold in his work on the fauna of Mjatschkowa. In this work Trautschold discusses *Orthis crenistria*, *Orthis senilis*, and *Orthis eximia*, which belong to the Strophomenidæ, besides some true representatives of the Orthidæ. The figure of *O. crenistria* given by Trautschold clearly belongs to Waagen's genus *Derbya*, but whether it shows the septate structure (*Derbya* sensu stricto) or the camerate (*Orthotetes*) can not be determined with absolute certainty. It appears to belong to the *camerati*, however, and may be a representative of Fischer de Waldheim's species *Orthotetes radiatus*, the genotype of *Orthotetes*. If so, it is not like the Guadalupian representatives of *Orthotetes*, which, with the exception of the doubtful form from the base of the section, are distinguished by having tall, conical ventral valves. Much more similar in this respect is the apparently smooth form which Trautschold figures as *Orthis senilis*. It is impossible to tell in what division to place this shell. *Orthis* [*Meekella*] *eximia* is one of the ordinary types of *Meekella*, and does not depart so widely from the American Pennsylvanian or Guadalupian species.

From the Gschelian I have found listed a large number of strophomenoids, to wit: *Orthotetes crenistria*, *Derbya senilis*, *Meekella eximia*, *Meekella striaticostata*, and *Meekella* cf. *eximiiformis*. Tschernyschew in his monograph on the Brachiopoda of this fauna distinguishes a much greater variety. In the genus *Streptorhynchus* he identifies *S. pelargonatum*, *S. hallianum*, and *S.* aff. *tapajotense*. *S. hallianum* is one of the plicated group of *Streptorhynchus*, a type not yet known from the Guadalupian while *S. pelargonatum* and *S. tapajotense*, although I believe them to be distinct specifically from the Guadalupian species, are yet more nearly of the same general character. Of *Derbya* this author identifies two of Waagen's Indian species, *D. regularis* and *D. grandis*, together with *D. crassa*, our common American Pennsylvanian form. I notice that he includes *Orthis crenistria* Trautschold, to which I have referred above, in the synonymy of *D. regularis*. These species are of the same general type as the Guadalupian ones, and, in fact, more or less similar species are found at different horizons the world over. Of *Meekella* Tschernyschew distinguishes no less than seven species; but I am not sure that he does not include among them some which would more properly be placed with *Orthothetina*. *Meekella ufensis*, *M. baschkirica*, and *M. uncitoides* have shells so slightly folded that one can in the figures detect it with difficulty, if at all. If we except these from *Meekella*, no very marked differences can be pointed out between the Gschelian and the Guadalupian representatives of the genus. Perhaps the Guadalupian species *M. difficilis,* with its angular plications and almost obsolete liration, might be cited as an exception to this statement, which is, however, further borne out by *M. attenuata,* in which the plications are inclined to be faint, and by *Orthothetina* sp., which has a smooth shell, but with the internal structures of *Meekella.* Tschernyschew also describes a species of *Orthothetes* (*O. simensis*) from these beds, the generic term being employed in the sense used by Waagen. *O. simensis* is represented as possessing faint radial plications near the margin, a feature not before noticed in this group, so far as I am aware. I find myself a little disposed to follow Schellwien in referring the Permian shells which have this structure to *Streptorhynchus.*

From this or possibly lower horizons De Verneuil has described and figured strophomenoid shells, which he calls *Orthis arachnoidea, O. eximia,* and *O. olivieriana.* The first mentioned may possibly be a *Schuchertella;* the second is *Meekella eximia* of Tschernyschew's and other reports; and the last-named species one would not hesitate to call, from De Verneuil's figures, a characteristic representative of *Orthothetina.*

In view of Tschernyschew's extensive memoir on the brachiopods of this fauna, the other references to Gschelian strophomenoids can well be passed over, especially as they are for the most part citations in lists, without descriptions or illustrations. From the Artinsk Stuckenberg cites *Streptorhynchus crenistria* and from the closely related Kungurstufe *Streptorhynchus crenistria* and *Meekella eximia.* Krotow also records only *Streptorhynchus crenistria* from the Artinsk. Tschernyschew is authority for the citation of *Streptorhynchus pelargonatum,* and he has figured specimens from this horizon. We thus have the genera *Streptorhynchus* and *Meekella* in the Artinsk, and probably *Derbya* or *Orthotetes,* though it is impossible to tell what is intended by the name *Streptorhynchus crenistria.*

From the Permian Netschajew has figured a small, imperfectly preserved shell, which he calls *Streptorhynchus* cf. *pelargonatum.* One can tell little about this form from the poor figures, and the text is in Russian.

The sudden suppression of the strophomenoids, along with most of the other brachiopodous groups, before the commencement of the Artinsk, leaves the greatest show of resemblance between the Gschelian faunas of the Russian section and the Guadalupian. This resemblance is in some respects rather close. In both is found a considerable differentiation of the genus *Meekella.* In both the type of *Orthothetina* is probably represented, in the Guadalupian by an undetermined species, in the Russian beds by *O. olivieriana,* and perhaps by some of Tschernyschew's species of *Meekella.* *Derbya,* in the sense that that term is here employed, is present in both faunas and of the same general type. *Orthotetes* is represented in the Russian section by at least one species, *O. radiatus.* In the Guadalupian fauna camerate shells are also developed, the nearest allies to the Russian form being in the lower part of the section. The Russian faunas certainly contain, so far as known, nothing analogous to the conical, highly characterized Guadalupian species, especially to *Orthotetes guadalupensis* and its allies, nor do they contain any plicated examples of this type (*Geyerella*), a representative of which is known in the Capitan fauna. On the other hand, the Russian faunas contain both plicated and unplicated types of *Streptorhynchus*, while in the Guadalupian only the plicated type is known, though it occurs at widely different horizons. Lastly, Tschernyschew describes one species of "*Orthothetes*," a type which, if the same as *Schuchertella*, as Waagen appeared to think, has no Guadalupian representatives. On closer inspection of these data it appears, in a general way, that the resemblances are strongest between the Delaware Mountain fauna and the Gschelian stage and the differences strongest between the Capitan fauna and the Gschelian, though this may not be uniformly the case. In this connection one may recall that *Orthotetes*, of the *guadalupensis* group, and *Geyerella* are found only in the Capitan division, not in the Delaware Mountain fauna nor in the Gschelian, while the Meekellas are in the Guadalupian section confined to the Delaware Mountains, nor do they extend above the Gschelian in Russia. On the other hand, we have in the Guadalupian section *Streptorhynchus* of the same general type in both the Delaware Mountain and Capitan formations, and, likewise, in Russia *Streptorhynchus* occurs in the Artinskian and Permian, as well as in the Gschelian.

Enderle found only two types representing this group in the Carboniferous fauna of Balia Maaden, in Asia Minor. One of these he cites, without figures, as *Orthothetes* sp., comparing it with *O. subplanus* of the Salt Range of India; the other he calls *Streptorhynchus* cf. *pelargonatum*. The shell which he figures under this name is distinct from any of the corresponding species in the Guadalupian.

In the Armenian fauna described by Abich from the vicinity of Djoulfa, members of this group seem to occur in considerable abundance, and Abich recognizes no less than twelve types, which he describes as varieties of *Streptorhynchus crenistria* or of *Streptorhynchus peregrinum*, a new species. *Streptorhynchus* is here employed in a general sense, and some of these types are now known to belong to other genera. Waagen refers three of them (*Streptorhynchus crenistria* var. *eusarkon*, *Streptorhynchus crenistria* var. *incurvum*, and *Streptorhynchus peregrinum*) to his genus *Derbya*, supposing them to be representatives of the camerate division thereof,[a] but Schellwien has shown that in *Streptorhynchus crenistria* var. *eusarkon* the two dental plates do not unite with the median septum, but remain parallel and distinct, as in *Meekella*. He refers this species, therefore, to his genus *Orthothetina*, although Abich represents it as having a plicated shell. Arthaber later redescribed this Armenian fauna, recognizing in his work three species of *Orthothetes* (*Orthothetina*), *O. armeniacus* n. sp., *O. eusarkos* Abich, and *O. peregrinus* Abich, in the synonymy of which most of Abich's names appear. *Orthothetina* seems to have reached a special degree of development in this Armenian fauna, for elsewhere it is as a rule rather rare. The single Guadalupian specimen which can be referred to this genus unfortunately does not permit comparisons with the Armenian forms. While rich in Orthothetinas, the Armenian fauna contrasts with the Guadalupian in lacking, so far as known, the more varied strophomenoid differentiation. In association with Arthaber, Frech studied the lower faunas of the Paleozoic section, among which he cites *Orthothetes crenistria* and *O. crenistria* var. *kellii* from the earlier Carboniferous deposits at Arpatschai, but this fauna does not concern us.

I am unfortunate in being unable to consult that portion of Gemmellaro's work in which he treats of the strophomenoids of the Fusulina limestone of Palermo, for

[a] Waagen, W., Salt Range fossils: Mem. Geol. Survey India, Pal. Indica, ser. 13, vol. 1, 1887, p. 592.

one might expect from the resemblance shown by other groups that comparisons of this one would prove of considerable interest.

Schellwien recognizes three species of strophomenoids in his paper on the fauna of the Carnic Fusulina limestone. They are identified as *Orthothetes semiplanus*, *Derbya waageni*, and *Derbya expansa*. To the first the Guadalupian appears to contain no analogous species, but the two Derbyas resemble the Guadalupian representatives of the genus. Gortani cites from the same region *Orthothetes crenistria*, *O. crenistria* var. *senilis*, *Orthothetes expansus?*, *Streptorhynchus semiplanus*, *Derbya grandis*, *Derbya altistriata*, and *Meekella vinassai*. His figures of the last-named species, which indicate that the original specimens were poor, do not represent the surface as plicated, and consequently the species would appear to belong to *Orthothetina*, rather than *Meekella*. The Derbyas appear to be of the ordinary type and not materially different from the Guadalupian Derbyas. I judge that *Streptorhynchus semiplanus*, which Schellwien first described as an *Orthothetes* (in Waagen's sense), is really not a *Streptorhynchus*, strictly speaking; but a *Schuchertella* and consequently a member of a group not found in the Guadalupian. Non-Guadalupian also are probably the species of *Orthothetes*, for I believe Gortani is using this term as Schellwien interprets it, for species having two short diverging dental plates but no septum.

In his paper on the fauna of the Trogkofelschichten Schellwien finds strophomenoid species belonging to the genera *Streptorhynchus*, *Meekella*, and *Geyerella*. It is surprising to note the absence of both groups of Waagen's genus *Derbya* in this fauna, for these shells are usually abundant. Schellwien cites but two species of *Streptorhynchus*—*S. pelargonatum* and *S.* cf. *operculatum*. Both belong to the unplicated type of the genus, and are not very unlike the Guadalupian forms, though I have not recognized among the latter representatives of the group of *S. capuloides*, to which *S. operculatum* belongs. Of the genus *Meekella* the Trogkofelschichten contain five species, agreeing in this respect with the Delaware Mountain formation of the Guadalupian, but contrasting with the Indian Salt Range fauna and the Guadalupian Capitan. The Meekellas are said to constitute an important element in the fauna of the Trogkofelschichten, and they form a rather well-marked group, to which those of the Guadalupian are not closely allied. Schellwien's species in general are distinguished by being large, with numerous small and more or less indistinct plications. Strongly in contrast to them is such a shell as *Meekella difficilis* of the present work. Of *Geyerella* Schellwien cites but a single species. He had already described a species from Sicily, which stands as the type of the genus, and I infer that there are others from the same area. Thus the Guadalupian fauna shares with that of Palermo, of Trogkofel, and of Auernig the only known representation of the genus. On the whole, though showing some notable points of difference, especially in the matter of *Derbya* and *Orthotetes*, the American fauna appears in its strophomenoid representation rather closely allied with the Alpine one. In the Upper Carboniferous of the same area Schellwien describes two new species of *Derbya*, of the depressed-convex, regular type, and identifies *Orthothetes subplanus*, a species which he subsequently assigned to the genus *Streptorhynchus*. The absence of such groups as *Orthotetes* sensu stricto, *Meekella*, *Geyerella*, *Orthothetina*, etc., is noteworthy.

The fauna described by De Koninck from Bleiberg, in the Carinthian Alps, little concerns the present discussion, as it is a different and older fauna.

Geinitz, in his monograph on the Dyas, recognizes only one species belonging to the Strophomenidæ, the well-known *Streptorhynchus pelargonatum*. While some of the Guadalupian types of *Streptorhynchus* probably belong to the same group with *S. pelargonatum*, none can rightly be placed in the same species. Of course the American fauna has a much more varied strophomenoid representation than that of the Dyas.

The Carboniferous faunas of Spitzbergen and Nova Zembla concern us little. The latter contains but two forms demanding attention. *Strophomena depressa* may be supposed to be the same as *Leptæna rhomboidalis*, but it looks like a *Productus*. *Orthis eximiiformis*, cited also from the Russian section, is probably a *Meekella*. It is founded on a fragmentary dorsal valve.

Toula cites from the south point of Spitzbergen a shell which his figures show to be without much doubt a *Derbya* of the common type. This form is identified as *Streptorhynchus crenistria*. As *S. crenistria* var. *macrocardinalis* he describes a species from the cape between the two arms of North Fjord which is probably of a different genus, as it apparently has no septum, and seems to be without Guadalupian allies. Lundgren cites *Streptorhynchus pelargonatus* from the Permian of Spitzbergen. Altogether the Spitzbergen faunas are rather indifferent in their relationship to the Guadalupian.

The Permian of England, like that of Germany, seems to contain but a single representative of this group, and it is the same species, *Streptorhynchus pelargonatum*, so that no additional comments are necessary.

The fauna which Stache describes from the West Sahara appears to be much older than the Guadalupian, and so far as known contains but two species of the Strophomenidæ, identified as *Streptorhynchus crenistria* and *S. pusillus*. "*Streptorhynchus*" seems here to be employed in the general rather than the restricted sense. If, as seems probable, the African forms belong to *Schuchertella*, there is nothing in the Guadalupian which can be compared with them.

In the Brazilian fauna, which Derby describes with such ability, he recognizes in all three strophomenoid species, which he calls *Streptorhynchus correanum*, *Streptorhynchus hallianum*, and *Streptorhynchus tapajotense*. Waagen has already discussed these species, calling attention to the fact that the first possesses the structure of his camerate group of Derbyas, the second belongs to the plicated group of *Streptorhynchus*, sensu stricto, while the third is one of the septate Derbyas. In this fauna we note that *Meekella*, *Geyerella*, *Orthothetina*, and the group of *Streptorhynchus* called *simplices* are wanting. These are found in the Guadalupian, which lacks, on the other hand, the plicated *Streptorhynchus*. Both faunas possess similar types of *Derbya* and *Orthotetes*, but the striking group of *O. guadalupensis* is peculiar to the North American.

The upper Carboniferous strophomenoids of the Mississippi Valley and Appalachian region, so far as known, appear to be divided between the genera *Meekella* and *Derbya*. Many of these shells were originally described as belonging to *Streptorhynchus*, but that genus is apparently not known in this fauna. Waagen, it is true, mentions having seen in Munich a specimen from Nebraska identified as *Meekella* *striaticostata*, in which the characteristic dental plates were not developed. But I can not help thinking either that there was a mistake in the locality, or that the dental plates had somehow been destroyed. Otherwise the shell noted by Waagen would be one of the plicated group of *Streptorhynchus*, a type otherwise unknown from North America. I should remark, however, that from California I have seen a plicated shell which seemed to belong to *Streptorhynchus*. It is an internal mold, somewhat weathered, and the impression of the plates may have been lost. Mention may also be made of an undescribed species of *Orthothetina* from the upper Carboniferous of the Mississippi Valley and Wyoming. Of *Derbya* perhaps eight species in all are known from the upper Carboniferous of central and eastern United States, all of which belong to the septate division, or to *Derbya* proper. Some of them, as well as the single species of *Meekella*, at present recognized from this area, have Guadalupian representatives more or less closely related. *Orthotetes*, *Geyerella*, and *Streptorhynchus*, however, are found in the Guadalupian, but not in faunas with typical Pennsylvanian facies. This statement may, however, be only partially true of *Streptorhynchus*, and is made with the qualification rendered necessary by Waagen's observation noted above.

Genus STREPTORHYNCHUS King.

Schellwien employs the term *Orthothetes* for a group of shells for which Waagen did not provide—those having two strong dental plates without a median septum—while the group for which Waagen used *Orthothetes* he unites with the genus under discussion. Both Waagen and Schellwien are in error in their employment of the term *Orthothetes*, as I have elsewhere attempted to show; but it is surprising that these two authors, using the same species as a type, should have arrived at two different sorts of structure for the genus. Waagen's conception of *Streptorhynchus crenistria* was undoubtedly influenced by if not derived from Davidson, who probably knew what the characters of the species really were; but Schellwien also invokes Davidson as representing *Streptorhynchus crenistria* with two dental plates, just as Waagen implies that he represents it without any. I must confess that Davidson's fig. 5., Pl. XXVI, which represents the interior of a ventral valve, appears to me to be without the strong dental plates claimed by Schellwien. As for the small dental or rostral plates which Davidson, as Schellwien points out, certainly does describe as strengthening the hinge teeth, these are as likely to be ridges, like those of *Streptorhynchus*, as plates such as Schellwien represents in his figures. Indeed, Davidson uses almost the same words, "dental ridge or plate,"[a] in describing the interior of *Streptorhynchus* as based on *S. pelargonatus* that he does in the case of *Schuchertella* (*Streptorhynchus*) *crenistria*.

As elsewhere set forth, I have found it necessary to divert the name *Orthotetes* from the group for which Waagen used it, and to substitute the new term *Schuchertella* for it, naming for the type of *Schuchertella* the well-known *Streptorhynchus lens* from the Kinderhook of Missouri. This species is characteristic of a certain group of species found in abundance in our American lower Mississippian rocks. The dental plates in these shells are represented only by a thickening, sometimes very slight, of the edges of the delthyrium, and the dorsal valve contains no socket plates

[a] Mon. Permian Brachiopoda, 1858–1863, p. 30.

except very short, stout, curved ridges. If *Streptorhynchus crenistria* shows these characters, as Davidson's figures and description indicate, it belongs to *Schuchertella*. If it shows those represented by Schellwien's figures it does not, but can probably be referred to *Orthothetina*, which I would provisionally extend to include these forms. *Schuchertella* is exactly equivalent to the *Orthothetes* of Waagen and of Hall and Clarke, and includes shells which Schellwien merges with *Streptorhynchus*. With the procedure of Schellwien I can not agree. *Schuchertella* was developed chiefly in early Carboniferous time; *Streptorhynchus* near the end of it. In *Schuchertella* the ventral valve is mostly low, regular, and unattached; in *Streptorhynchus* it is mostly high, distorted, and probably attached. In *Schuchertella* the hinge line is usually long; in *Streptorhynchus* it is usually short.[a] In *Schuchertella* the dorsal valve has a distinct area but no socket plates; in *Streptorhynchus* the dorsal valve has no area,[b] rather strong socket plates, and a more deeply grooved and a somewhat differently shaped cardinal process. While it is doubtless true, as Schellwien claims, that considerable variation is manifested in these particulars, I think that the differences will be found numerous enough and constant enough to demand the recognition of both groups.

Waagen recognizes two divisions of this genus in the Salt Range, one of which he calls the "*simplices*" and the other the "*plicati*." The former, as the name indicates, embraces species having a smooth and the latter those having a plicated shell. In the Salt Range, according to this author, the *simplices* are restricted to the lower and middle divisions of the Productus limestone, while the *plicati* occur chiefly in the upper division. In North America only two species of *Streptorhynchus* are known—*S. ulrichi* and *S. williamsi*. To these may be added *S. hallianum* from Brazil, and three species, to be described later, from the Guadalupe Mountains. All of these species belong to Waagen's division of the *simplices*, the *plicati* not being known in either of the Americas, so far as I am aware. Waagen,[c] however, states that he has seen a specimen, apparently from Nebraska, in the Royal Paleontological Museum of Munich, which has the exterior of *Meekella striaticostata*, but which appears to lack in the ventral valve the septa characteristic of *Meekella*. If this occurrence is authentic, the plicated group would appear to be represented in the "Coal Measures" of the Mississippi Valley. This one would hardly expect from its occurrence at the top of the Salt Range section associated with very different genera and species. Furthermore, so many specimens of *Meekella striaticostata* from the Mississippi Valley have been observed by other paleontologists, and I have myself seen so many, that while possible, it seems not altogether probable that this representative of what must be a very rare type should find its way into a foreign collection, none being known in this country. Therefore Waagen's suspicion that the genus *Meekella* ought to be in large part merged with *Streptorhynchus* is unfounded so far as the citations in American literature and the occurrence in American formations are concerned. The range of this genus in the Carboniferous of North America is somewhat peculiar. *S. williamsi* and *S. ulrichi* are both from the Mississippian series of the Mississippi Valley, and no representatives of the genus are known from the Pennsylvanian or so-called

[a] That is, shorter than the width in front.

[b] According to Hall and Clarke, who describe it as linear. Davidson (Mon. Permian Brachiopoda, 1858–1863, p. 30) says that there is a small, narrow rudimentary area. It is probably not absent, but as a rule narrower than in *Schuchertella*.

[c] Waagen, W., Salt Range fossils: Mem. Geol. Survey India, Pal. Indica, ser. 13, vol. 1, 1887, p. 578.

Permian beds of the same area. Its reappearance in the Guadalupian fauna is therefore of some interest.

Still further novelty would be added to the range of the genus if the plicated type supposed to be a later development of the simple one, were really, as Waagen claims, found in the "Coal Measures." The peculiarities of range in American rocks which might be taken as evidence against referring *S. gregarium* to *Streptorhynchus* are equally or even more cogent against assigning it to *Schuchertella*.

This genus is sparingly represented in the Guadalupian fauna. Waagen found seven species in India and Schellwien two in the Carnic Alps. The fineness of the radiating liræ of the Guadalupian species (except *S. pygmæum*), a character which it shares with representatives of related genera associated with it, invites remark. In this particular, though not in form, comparison can be made with Waagen's *Streptorhynchus operculatus*.

If one were asked to divide the Guadalupian species of *Streptorhynchus* into subordinate groups he would probably at once place *S. gregarium* and *S. perattenuatum* in one subdivision, since they have lofty ventral valves and fine sculpture, and into another *S. pygmæum*, which has a low ventral valve and relatively coarse liration. With *S. pygmæum* appears to go the imperfectly known species *Streptorhynchus* sp. *a*. Such at the present time appears to be the natural grouping of these species.

STREPTORHYNCHUS GREGARIUM n. sp.

Pl. XI, figs. 3 to 7.

This form is fairly abundant in the Guadalupe Mountains, and can not be passed over unnoticed, though I have not been fortunate in obtaining complete specimens on which to base descriptions and figures. Much of my material came from a single fragment of limestone, of rather small size, in which the different specimens were crowded together, and their mutual attitude in some cases suggests that they may have been attached one to another. The matrix, in this case a gray, compact limestone, adheres closely to the fossils, and is, moreover, both hard to the tool and difficult to distinguish from the shell substance. The following description is drawn up from a number of specimens, no one of which shows all of the characters.

Shell small. Ventral valve high, conical. Growth usually extremely irregular and contorted. Area flat transversely, more or less concave longitudinally, and inclined backward at an angle of 135° or less to the plane of the edge; more or less poorly defined from the convex portion of the shell. Pseudodeltidium broad and divided into three parts, the central of which is strongly convex and elevated. The lateral portions, which are more nearly on a plane with the rest of the area, represent the internal ridges supporting the hinge teeth. These do not run out into septiform plates, and in one specimen appear to be tubular.

The dorsal valve is moderately or decidedly convex. The shape is subcircular, but varies greatly to correspond with the irregular form of the ventral. The hinge line is almost always shorter than the shell below. The beak is small, but the umbo is sometimes tumid. There is frequently a slight fold in this valve corresponding to a faint sinus in the other, chiefly noticeable on the anterior margin, where they produce a distinct sinuosity.

The surface is marked by very fine radiating liræ, which are thin and sharp, though but little elevated, and rather distant. They come about 18 or 19 in the space of 5 mm.

Internally the ventral valve is without septiform plates of any sort, though the hinge teeth are supported by strong ridges. The interior of the dorsal valve is imperfectly known to me. There is a distinct median septum, but socket plates have not been observed. The generic position of this form, therefore, is not conclusively ascertained, but the possibilities are reduced among known genera to *Streptorhynchus* and *Schuchertella*. To a certain extent in the presence of a dorsal septum, but much more in the absence of socket plates, if they are indeed absent, the affinities appear to be with *Schuchertella*, but the general expression is so much more that of *Streptorhynchus* that it has been assigned to the latter genus.

There is scarcely a feature in which this species does not show considerable variation, and I have been forced to assign to it wider specific limits than might be wished. I feel that more perfect material might permit me to make assurance of the presence or absence of characters where now I am in doubt. In general appearance this form much resembles that which I have described as "*Orthotetes distorta*," but the presence in the latter of dental plates and the extravagant median septum remove the two forms not only into different species but into different groups.

Associated with the form whose more important characters have just been enumerated is another, represented by a single incomplete ventral valve, which should probably be distinguished as a distinct variety. It differs from the other specimens chiefly in being depressed and more rapidly expanding. The growth is irregular and asymmetrical. The width, which was probably greatest at or near the hinge line, must have approached 20 mm; the height probably did not exceed 5 mm. The surface ornamentation consists of regular, sharp, low, radiating striæ, about 22 in 5 mm.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926).

STREPTORHYNCHUS PYGMÆUM n. sp.

Pl. XXX, figs. 3 to 6b.

This species is fairly abundant at station 3763, but while a considerable number of dorsal valves have been found only three ventrals have yet come to hand. The size is very small, a large dorsal valve having a width of about 7 mm. and a length of 6 mm. The ventral valve is high, erect, and subconical. The aperture contracts posteriorly, is as a rule slightly wider than long, and, owing to a tendency in the lateral outlines to make straight lines near the hinge, is somewhat imperfectly polygonal. The area is high and flat and makes an angle of about 90° with the aperture. Its width is slightly less than that of the shell in front, and it is defined by an angle from the curved antero-lateral wall. The large and strongly elevated pseudodeltidium occupies about one-third of the entire area. Two of the three ventral valves are attached by cementation over a considerable part of the antero-lateral surface and the remaining individual shows a large scar of attachment over this area. This seems to demonstrate a persistent habit, which probably accounts for the relatively large number of free dorsal valves which have been found. For the same reason the surface characters are obscured over most of the ornamented area, and are best studied in the accompanying valve. On the interior the progression of the hinge teeth is marked by two prominent ridges, which are not, however, prolonged as plates, while anything in the nature of a median septum is quite absent.

The dorsal valve is very small and subcircular in outline, the growth more or less irregular and asymmetrical, the convexity moderate to great. The hinge line is shorter than the width below. The surface is marked by comparatively strong, thin, high, more or less irregular, alternating, spaced liræ, crossed by strong but irregular crenulations. Lamellar varices of growth seem to be a common feature of the external surface. The hinge plate and cardinal process are large and massive, projecting from the shell at nearly right angles to the plane of its edges. A low median septum is usually more or less plainly developed. The high convexity of this shell and its relatively massive thickness would indicate that these are mature and not ungrown specimens, an inference which is supported by the general uniformity in size of the specimens collected. With the thickness of the shell appears to be connected the more obvious development of the septum, since it seems to be one of the results of calcareous deposition produced by old age.

I have been in some uncertainty whether to place this form with *Streptorhynchus* or with *Schuchertella*, which is very similar in general structure. *Schuchertella* in this continent is practically confined to the earliest beds of the Carboniferous, types with a well-developed median septum soon succeeding it. *Streptorhynchus*, on the other hand, seems to be mostly a late Carboniferous development, and in its distribution to have been confined largely to European and Asiatic waters. Nevertheless, certain forms, presumably congeneric with *Schuchertella*, have, under the name of "*Orthothetes*," been cited from late Carboniferous strata of India, etc., while in the United States the only accepted species of *Streptorhynchus* are found in Mississippian horizons.

Aside from stratigraphic and geographic occurrence, the main differences between the two genera seem to be (1) that of configuration, the ventral valve of *Streptorhynchus* being high, contorted, and contracted at the hinge, instead of low, regular, and with quadrate cardinal angles; and (2) that of structure, the cardinal process of *Streptorhynchus* being perhaps somewhat differently shaped and the socket plates, according to Waagen, prolonged so as partly to surround the muscular area of the dorsal valve. Different species, however, appear to have varied essentially in the structure of the cardinal process, while figures of interiors of *Streptorhynchus* seldom show much difference from *Schuchertella* in the prolongation of the socket plates. In the case of the present species I can distinguish no difference in the structure of the hinge plate from that found in typical examples of *Schuchertella*, while the configuration of the shell is distinctly in better agreement with that of *Streptorhynchus*, but a more essential difference seems to subsist in the fact that *Schuchertella*, like *Derbya* and *Orthotetes*, was attached by a pedicle issuing from beneath the lower edge of the pseudodeltidium, while the present species was almost certainly attached by cementation upon the other side of the valve. Whether this very marked difference from *Schuchertella* is one of agreement with *Streptorhynchus*

I am uncertain, but have some reason to believe that it is. In such case this character indicates a most important difference in structure and habit from *Schuchertella*, whether it can be detected in every specimen or not, since such cementation, as above described, can only coexist with atrophy of the pedicle. At least such an inference seems at present to be unavoidable.

Horizon and locality.—Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763). Delaware Mountain formation, southern Delaware Mountains, Texas (station 2962?).

Streptorhynchus perattenuatum n. sp.

Pl. XXIX, figs. 3 to 3c.

Shell very small. The shape of the ventral valve is subelliptical, contracting at the hinge line, and having the longitudinal dimension greater than the transverse. The convexity is rather low and the beak small and depressed. The ventral valve is very high and conical. The aperture is subelliptical and the hinge line shorter than the width in front. The area is rather sharply defined from the sides. The pseudodeltidium is broad, not much elevated, and it occupies fully one-half the width of the area, which is strongly inclined backward. This valve is attached not by a pedicle issuing from between the two valves, but by cementation of the apex of the ventral shell. The growth is irregular. The surface seems to be obscured on the ventral valve, which is nearly smooth. The dorsal valve, however, shows strongly defined liræ, which are somewhat thick and rounded and separated by deep striæ of about the same width as themselves. The liræ are rather fine, coming about five or six in the space of 1 mm. Crenulations are obscure or absent.

This description is based on the typical specimen, and enough material has not been examined to gage the extreme of variation from it. The few additional specimens which have thus far come to hand, however, do not show any notable departures.

I am not sure that this species is more than a much-dwarfed variety of *Streptorhynchus gregarium*. It comes from a different area, and besides being much smaller has a somewhat different surface ornamentation. The liration is a little finer and the liræ themselves thickened at the expense of the intervening striæ, so that instead of being thin and separated by relatively wide interspaces the liræ and striæ are about equal. Such an appearance, however, is sometimes due to crowding, especially in old shells, and to a certain extent may be produced by silicification.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (station 2962).

Streptorhynchus? sp. *a*.

Pl. XXX, fig. 7.

This type is represented by but a single specimen, and as it is a dorsal valve its generic position is of course considerably a matter of doubt.

In size it is small, having a length of only about 5 mm. The shape ascribed to it must depend somewhat on the restoration made, as a guide to which either varices of growth or concentric striæ are almost entirely lacking. The right-hand side, as seen in the figure, appears to be nearly the natural outline, and restored thus the shape would be strongly contracted at the hinge and the width somewhat less than the length. The growth is irregular. The sculpture consists of slender elevated liræ, which are irregular and more or less alternating. Crenulating concentric liræ are faint or absent. The cardinal process is small and the socket plates not prolonged.

The outline, contracting at the hinge, and the internal characters are suggestive of *Streptorhynchus* and of the species recognized in this report *Streptorhynchus?* sp. *a* most closely resembles *S. pygmæum*, with which it is associated. It does not seem advisable to place it with that species, however, because of several differences. The liræ, while similar in a general way, are thinner and higher, and crenulations and varices of growth appear to be absent. The cardinal process is smaller. The test instead of being massive and mature is thin and possibly immature.

The liration is suggestive of *Orthotetes?* sp. *a*, to which an associated specimen has been referred, but the liræ are more irregular and the shape is different. The shape, the sculpture, and the internal structure combined are not found in any other Guadalupian species. Among the specimens from station 2969 identified as *Derbya crenulata* some approach closely to the form in hand. Most of these have a more or less similar outline, and one has the crenulations very faint or absent, so that it has a pretty close resemblance to the present specimen. Perhaps the example from station 2969 should be withdrawn from *Derbya crenulata* and placed here, but it does not seem justifiable to assign the present specimen to *D. crenulata* on its proper characters.

Horizon and locality.—Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763).

Genus **DERBYA** Waagen (emend.).

Waagen proposed the term *Derbya* in 1884, distinguishing two sections which possess in extreme cases rather striking differences of structure. These are the *septati*, to which the genotype *D. regularis* Waagen belongs, and the *camerati*. Though Waagen uses the term *Orthotetes* for quite a different group, I find that it was originally employed by Fischer de Waldheim for the same shells for which Waagen proposed *Derbya*. Fischer even included both types of structure in *Orthotetes*, though the type species, *O. radiatus*, belongs to the camerate division. I had been in some doubt as to the advisability of including these two types of structure under a single generic term, and finding two names already in the nomenclature have availed myself of this fact to retain both, the name in each case being restricted to the division to which its genotype belongs. Should a different conclusion be adopted, *Orthotetes* must clearly supersede *Derbya*. For this reason *Derbya* is here used in a restricted sense, as applying only to the septate division of the original generic content, while *Orthotetes* is employed for the *camerati* alone. I am, however, in some doubt as to the wisdom of separating the *septati* and the *camerati* under distinctive names, and have some misgivings lest I may have ventured too far in trusting to the accuracy of Fischer de Waldheim's rather explicit description of the structure of *Orthotetes radiatus*. The boldest course would perhaps have been the most prudent one, to have eliminated the term *Derbya* entirely by placing it as a direct synonym of *Orthotetes*. The course adopted aims to conserve the present terminology as far as possible with adherence to fact.

To *Derbya* belong the following species described in this report: *D. nasuta*, *Derbya* sp. *a*, and *Derbya* sp. *b*. The position of *D. ? crenulata* is doubtful. Several of these types have characters which render them rather striking. *D. nasuta* is remarkable for the height of the septum and the great size of the cardinal process, and *D.? crenulata* is conspicuous among the forms treated here for the coarseness of its surface ornamentation. A natural grouping of these species is not obvious. No one would think of putting *D.? crenulata* and *D. nasuta* into the same group, but *Derbya* sp. *a* and *Derbya* sp. *b* are not so easily to be disposed of. In fact, *Derbya* sp. *a* is itself probably too composite to be at present handled satisfactorily.

The representation of this genus, especially in its most distinguished types, is chiefly outside of the Guadalupe Mountains, in beds supposed to be equivalent to the Delaware Mountain formation. A few examples have been found in the Capitan formation, but there its representation is distinctly subordinate. *Orthotetes*, which is not known at the lower horizon, is much more abundant.

The Orthotetes of the Guadalupian fauna are in a general way distinguished from the Derbyas by the character and fineness of the liration. Many of the Derbyas do not differ materially in these respects from the common Mississippian and Pennsylvanian species of the Mississippi Valley. Some, however, have fine liræ, and no contrast with the Orthotetes can be drawn which is persistent and absolute.

Derbya nasuta n. sp.

Pl. XXVI, figs. 6 to 6c.

I have taken for the type of this species a rather imperfect specimen showing portions of both valves in conjunction, together with some interesting structural features. From this the following description can be framed:

Shell large. Ventral valve semiconical, inclined backward so that the cardinal area makes a rather strongly obtuse angle with the plane of the edge. Area high, flat transversely, with a strong concave curvature longitudinally; width, 50 mm., height, 25 mm. Width of the delthyrium at its base 11 mm. The pseudodeltidium is divided into three distinct portions, the median of which is strongly convex, the lateral portions concave and slightly depressed below the rest of the area. Its lower portion is crossed by imbricating transverse lamellæ. The lateral portions of the area are again subdivided by two diagonal lines situated somewhat nearer the outer edges of the area than the edges of the delthyrium.

The dorsal valve is rather strongly convex and the umbo considerably inflated. The width at the hinge line is 50 mm., but the outline expands rapidly below, and the greatest diameter could not have been much less than 90 mm., while the length must have been not far from 75 mm. Both valves show many irregularities and distortions, due to unequal growth.

The interior of the ventral valve is provided with a long, high median septum, which apparently is not in contact with the pseudodeltidium, except possibly near the apex. The hinge plate and cardinal process of the dorsal valve are extraordinarily large and massive. Their general character is shown in the accompanying illustration (Pl. XXVI, fig. 6c). The most marked peculiarity consists in the strongly diverging and much produced apophyses, which receive between them the septum of the ventral shell. Their general direction is nearly parallel to the plane of the shell edge.

The surface is crossed by moderately thin and high radiating liræ, increased by implantation and having a more or less irregularly alternating arrangement, because of the imperfectly developed intermediate liræ. The spaces between them are about equal to the liræ themselves. The liræ number 8 to 11, usually 10 or 11, in 5 mm., according to the number of young and intermediate ones present.

Horizon and locality.—Delaware Mountain formation, Diablo Mountains, Texas, as reported (station 3764).

Derbya? crenulata n. sp.

Pl. XXVI, figs. 5 to 5d.

Shell of medium size, subsemicircular. Ventral valve rather low. Growth regular. Surface from apex to front and sides nearly plane. Area directed at about right angles to the plane of the edge. Pseudodeltidium rather strongly convex, narrow, not well defined. Width of area, 30 mm.; height, 5 mm. Width of pseudodeltidium at its base, 2.5 mm. Length of valve from apex to anterior margin, 19.5 mm.

Dorsal valve moderately convex. Beak small, strongly incurved. Umbo rather inflated. Length from beak to front, 18.5 mm.

Surface marked by rather coarse, thin, strongly elevated liræ separated by rather narrow, deep grooves. The liræ come about six or seven in the space of 5 mm., and are crossed by strong crenulations. New liræ are introduced by intercalation, and until they attain full size are somewhat alternating. At intervals also certain of the liræ will sometimes be larger and more prominent, with three to five apparently full-grown but smaller ones between them.

This, the typical specimen, shows strong old-age characters in the superimposed marginal lamellæ. In its youthful stages the hinge extremities were not projecting; at maturity they were very materially prolonged at one side, while the senile stages returned to a form having a quadrate cardinal margin. The interior of the shell is unknown, so that it is impossible to assign it to either the septate or camerate groups, or even with certainty to the genus *Derbya*. It differs from the common *D. crassa* of the Mississippi Valley upper Carboniferous in showing a tendency to extension of the cardinal extremities, in having a coarser and stronger liræ and crenulations, and in possessing a somewhat higher area and proportionately narrow pseudodeltidium.

In addition to the type we have specimens apparently belonging to this species from two other localities. Aside from the fact that they are very much smaller, it seems rather probable that they belong to *Derbya crenulata*. The liration is about the same, though the individual liræ are perhaps a little thinner, and crenulations are very strong. These are all dorsal valves, and do not, therefore, furnish any collateral evidence as to whether *Derbya crenulata* has a septate or camerate structure.

Horizon and locality.—Delaware Mountain formation, Diablo Mountains, Texas, as reported (station 3764). Delaware Mountain formation, southern Delaware Mountains, Texas (stations 2969 and 3500).

DERBYA sp. *a*.

Pl. XI, fig. 1; Pl. X, fig. 11, 11a.

Under this heading is included an assemblage of forms which with complete material might be found to represent more than a single species, but which at present it did not seem advisable to subdivide. In size these specimens present various degrees, from the large dorsal valve, represented on Pl. XI, fig. 1, to diminutive examples having a width of only 6 or 7 mm. The latter are of course presumed to be but immature representatives, whose adult growth would have brought them to the dimensions found in the others.

Generally speaking, the dorsal valves have a low convexity, with the hinge line equal to the width below. Ventral valves have a similar outline. The area is not as a rule very high. While in some specimens it is about perpendicular to the margin of the valve, in others it is inclined backward, and in still others forward. Growth appears to have been more or less irregular, though some specimens are symmetrical. The pseudodeltidium is broad and not strongly elevated.

The surface ornamentation consists of rather fine liræ, of which about 18 to 20 occur in a space of 10 mm. The liræ are naturally thin and separated by relatively wide striæ, but by exfoliation they are liable to appear rounded and somewhat obscure. Crenulating concentric liræ are faint, if present.

On the inside the ventral valve has a strong median septum, which appears to be normally distinct from the dental plates and which in no specimen has been observed to be connected with them so as to form a well-defined chamber. In the dorsal valve the cardinal process is relatively small and the socket plates somewhat stout and prolonged.

The representation of this species is scattering, and in no instance have a ventral and a dorsal valve been found in conjunction.

The large dorsal represented by my figure has a length probably exceeding 57 mm., while the greatest width must have been 80 mm. or more. The shape is transverse, subelliptical, the width at the hinge being as great as at any point below. Convexity is only moderate.

The surface ornamentation is largely obscured by exfoliation, but the liræ appear to be fine and not very distinct. A small area in a better state of preservation shows them to be moderately thin and high, with interspaces of about the same width. There are about 17 to 19 in a space of 10 mm.

The cardinal process is bilobed, moderately extended, and directed somewhat downward when the shell is viewed from the convex side.

The size of this specimen and the surface ornamentation are suggestive of the form here described as *Derbya nasuta*, but it is of more regular growth, shorter at the hinge line, and with a much shorter and smaller cardinal process. It also recalls *Derbya robusta* Hall, but it is larger, less strongly convex, and wider at the hinge.

Associated with this was found another smaller fragmentary dorsal valve, and a small ventral valve which is represented by figs. 11 and 11a of Pl. X. Here the size is rather small and the growth unequal and unsymmetrical. The area is generally flat, moderately high, and backward inclined. Its width is about 12 mm., considerably less than that of the shell in front, and the height is 4.5 mm. The pseudodeltidium is elevated, somewhat flattened, 2 mm. wide at its base. The length of the shell from apex to anterior margin is 19 mm., from cardinal line to anterior margin slightly less. Width 21 mm. The septum has a length of only 8 mm.

The surface is marked by more or less angular and spaced, rather strongly elevated radiating liræ, of which 11 or 12 occupy the space of 5 mm. The liration, though perhaps imperceptibly finer, gives the exterior of the shell an appearance so exactly like that of the large dorsal valve with which it was found associated that it seems not wise to separate them, yet the contraction of the outline at the hinge causes me to doubt the propriety of placing it with the other. This shell differs from *Orthotetes guadalupensis* and its allies in the coarser liration and also its lower area, broader pseudodeltidium, etc. Other ventral valves placed here have relatively wider hinge lines and in some cases more regular growth.

Horizon and locality.—Middle of Capitan formation, Capitan Peak (station 2926); base of Capitan formation, hill southwest of Guadalupe Point (station 2906; "dark limestone," Pine Spring (station 2930), Guadalupe Mountains, Texas. Delaware Mountain formation, southern Delaware Mountains, Texas (stations 2962 and 3501).

DERBYA sp. *b*.

Pl. X, fig. 12.

This species is primarily represented by a single ventral valve from the Capitan limestone. The shape is elevated, conical. The area is sharply defined from the anterolateral curvature and generally nearly flat. Its width is 16 mm. and its height about 12 mm. The pseudodeltidium is wide (about 4.5 mm. at its base) and moderately convex.

Because the anterior part of the shell is imperfect the shape of the aperture can not be definitely determined, but it appears to be semicircular and strongly transverse. Restored as nearly as possible, the plane of the aperture is perpendicular to that of the area, and its length is about 10 mm., its width being of course the same as the width of the area, or 16 mm. The growth is irregular.

The surface is marked by varices of growth and by rather coarse concentric striæ. The liræ are distinct and sharp, but low, the intervening striæ being shallow, rounded, and traversed by the concentric striæ. There are about 9 liræ in 3 mm.

The internal structure of this shell indicates that it should be considered one of the septate Derbyas. The septum is high and independent of the low dental lamellæ. It has some appearance of being composed of two plates, which are in contact and cemented one to the other for most of the way, but separate a little near the anterior wall. One might possibly be justified in regarding this shell as an abnormal *Orthothetina*, though that view is not adopted here.

This form recalls *Orthotetes guadalupensis*, but the liræ are too angular and the pseudodeltidium too wide. In the latter respect it resembles *Orthotetes distortus*, but the liræ are much too coarse. Indeed, it does not seem to possess the camerate structure which is found in this group of forms. It seems to be clearly distinct from *Derbya* sp. *a* and from *Derbya crenulata*, nor do I feel that it could safely be united with *Derbya nasuta*.

I have also referred to this species a small silicified shell from station 2969. It is fragmentary, but in every particular, so far as its characters are shown, it agrees with the original specimen from the Capitan limestone. Perhaps one difference may be found in the fact that the well-developed septum consists of a single homogeneous plate. This shell possesses the feature—rare for a *Derbya*—of showing a large and unmistakable scar left by apical cementation. As the apex of the original specimen is broken, however, this may be a character of identity rather than a character of difference between them.

This specimen is associated at station 2969 with certain small shells of somewhat similar dimensions, which have been placed with *Derbya crenulata*. The circumstance that they occur associated is suggestive that they may represent the same species, but the ventral valve here under consideration has finer, rather obscure, and apparently uncrenulated liræ, from which I am led to infer that it is not conspecific. If it does belong with the dorsals, the latter can not be referred to *Derbya crenulata*, where I have placed them, nor probably to the present species.

Horizon and locality.—Top of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2966). Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

Genus ORTHOTETES Fischer de Waldheim.

It seems almost certain, after careful examination into the history of the names, that Fischer de Waldheim's term *Orthotetes*, which Waagen employs with quite a different force, was originally applied to shells having the characters that distinguish Waagen's genus *Derbya*. The history of this genus, so far as it is known to me, is as follows:

The term *Orthotetes* was first introduced in the year 1829.[a] The following is a complete reproduction of the original description of this genus:

TRAVAUX.

Le directeur a disserté sur quelques fossiles du gouvernement de Moscou.

?Gryphæa biceps. an Inocérame Brongn.?

Strigocephali spec.

Strophomenæ spec.

Il a rendu surtout attentif sur une coquille bivalve que Mr. Évans a trouvée à Pakhrino et qu'il croit d'un genre nouveau, qu'il a nommé: *Orthotetes*, du grêc ορϑωτης; droiture, parce que la charnière présente une impression transversale, droite et linéaire. On n'en connait malheureusement qu'une valve.

Voici les caractères génériques qu'il lui assigne:

Coquille libre, subrégulière, plate, subéquivalve, subéquilatérale. Charnière droite et transversale. La valve operculaire, offre une impression articulaire droite interrompue au milieu par un enfoncement

[a] Bull. Soc. imp. des naturalistes de Moscou, vol. 1, 1829, p. 375.

profond, qui est couvert par un prolongement de la charnière comme par un toît qui avance même au delà du plan de la valve et parait s'adapter à la valve supérieure.

Cette apophyse on [ou] ce prolongement avance en dedans de la coquille en une arête droite et canaliculée.

L'enfoncement pour l'attache du muscle est très grand, circulaire et rayonné. Le dos de la charnière et [est] applati, lisse et comme scié et poli.

Cette coquille offre quelque ressemblance avec les genres Placuna, Pedum, etc. Il y a même un canal creusé, dans le dos de la charnière, ce qui peut montret [montrer] quelque analogie avec la dernière. Elle est au reste presque aussi mince qu'une Anomie, mais très regulièrement aplatie et rayonnée.

This description was unaccompanied by figures, and no species were cited under the genus thus newly established.

The year following, Fischer de Waldheim published another reference to the genus[a] in the form of three figures, which are reproduced in Pl. IV (figs. 1, 1a), of the present work. The only text relating to these figures which can be connected with the publication of the previous year is the following, the description of Pl. 20, fig. 4:

4. *Orthotetes*, nouveau genre de coquilles bivalves. v. Bulletin de la Soc. imp. des naturalistes de Moscou, 1829, p. 375.

The next reference to the genus was in a later edition of the work last cited, published in 1837.[b]

I have seen it claimed in a book catalogue that the current statement that there are two editions of this work is erroneous, and that it appeared in parts or fascicles from time to time. The actual truth, as is so often the case, probably occupies halfway ground. Two copies of this work are found in the library of the United States Geological Survey. One bears as the date of imprint the year 1830. It contains an advertisement by Fischer de Waldheim dated March 23, 1830, plates to the number of 66 (maps and cuts, Pls. A–G; fossils, Pls. 1–44; natural history, Pls. 1–15), and brief explanations relating to them, but no text. The imprint of the other volume is dated thus: "1830=1837." It contains a similar advertisement, somewhat changed, but over the same date, a table of contents (pp. xi–xvii), descriptive text (pp. 1–189), explanations of plates (pp. 191–195), an index (pp. 196–202), 7 maps and cuts (Pls. A–G), and 51 plates of fossils (Pls. 1–51), those on natural history having been omitted, presumably to make the contents properly fit the title. There have been not only additions, however, but changes. The advertisement has been set up afresh; the typography is different, the pagination is different, and the matter, while repeated word for word for the most part, has at least one important textual change. The description of the plates has also been changed, being now arranged on the page in two columns instead of one, and some of the matter itself has been altered. Two of the plates even have been changed, by the insertion of additional figures, one instance of this being important to the subject in hand. The conclusions which I draw from these facts is that the bulk of the plates, with explanations but without text, were published in 1830; that additional plates and parts or all of the text were issued during the succeeding seven years; and that in 1837 was published a final revised edition of the whole.

[a] Oryctographie du gouvernement de Moscou, 1830, pl. 20, figs. 4a and 4b.

[b] Oryctographie du gouvernement de Moscou, 1830–1837, pl. 20, figs. 4a, 4b, and 4c.

In this volume figs. 4a and 4b are reproduced from the edition of 1830, and an additional figure (4c) is inserted, which appears as fig. 1b of Pl. IV in the present work. The explanation of the plate reads:

PL. XX.

1. 2. 3. Inoceramus concentricus, BRONGN., p. 177.
4. Orthotetes, n. g., p. 133. valve inférieure de l'intérieur.
(a) charnière applatie vue en dessus,
(b) canal dorsal de la même valve,
(c) valve supérieure.
5. 6. Strophomena Pecten, p. 145.
Orthis Pecten, DALMANN.
7. 8. Strigocephalus Defrancii, p. 145.
Sphæra corrugata, Sow., Pl. IV, p. 335.

The complete text relating to this genus, which, it may be remarked, Fischer de Waldheim includes along with *Chonetes* among the pelecypods, is as follows:

ORTHOTETES.

Pl. XX, f. 4, a, b, c.

Coquille bivalve libre, subéquivalve, inéquilatérale; charnière droite, transverse, lisse.

La valve operculaire présente une impression droite, qui est interrompue par un avancement de la charnière, en forme de tablette carrée, creuse intérieurement, prolongé intérieurement par une apophyse médiane et droite.

Deux impressions musculaires presque circulaires à côté de l'apophyse médiane.

Orthotetes, FISCHER. Bulletin de la Soc., 1829, tome I, p. 375.

Le nom est déduit du grec, ορθοτής, *droiture*, faisant allusion à la forme droite de la charnière.

Je ne connais rien de semblable à cette forme de la charnière, difficile à rendre claire par la description. On peut dire que la forme totale peut rappeler celle d'un peigne sans ailes, qu'elle est rayonnée comme une *Strophomène*, qu'elle a une impression dorsale sur la valve operculaire comme *Pedum*, et qu'elle est presqu'aussi mince comme une *Anomie*.

La forme de la charnière avec ses apophyses intérieures paraît rapprocher cette coquille des *Brachiopodes*.

Cette coquille se distingue de toutes les autres bivalves, par la charnière droite, mince et édentée dont le sillon en dessous reçoit le bord mince de la valve opposée. Le prolongement carré du milieu dépasse de beaucoup la charnière et cohère dans l'intérieur de la coquille avec une longue apophyse droite, qui partage le creux musculaire. La valve opposée ou dorsale n'a qu'un endroit bombé près de la charnière, elle est au reste plate dans tout son pourtour. M. EVANS a trouvé cette coquille le premier dans le calcaire de *Kalouga;* je l'ai retrouvé dans celui de *Podolsk*.

The fourth important publication relating to the genus appeared in 1850.[a] This is quoted in full as follows, and the accompanying figures are reproduced in Pl. IV.

ORTHOTETES.

Genre de la Famille des Brachiopodes restitué par G. Fischer de Waldheim, avec Pl. X.

Lorsque j'ai produit le genre Orthotètes en 1829 (Bulletin de la Soc., I, p. 375), mes connaissances n'étaient pas assez claires pour en fonder les caractères génériques. J'ai reproduit ce genre dans l'oryctographie de Moscou, accompagné d'une figure (1837, 133, Pl. XX, f. 4), mais j'avoue franchement que je n'y ai rien ajouté à la vraie connaissance du genre.

Maintenant, grâce aux recherches géologiques de M. Vosinsky qui a trouvé dans le district de Serpoukhof de notre gouvernement une seconde espèce, je suis à même de compléter les caractères de ce genre.

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[a] Bull. Soc. imp. des naturalistes Moscou, vol. 23, pt. 1, 1850, pp. 491-494.

M. d'Orbigny dans le second volume de l'ouvrage sur la Russie de Murchison a placé cette coquille sous le genre Orthis. Il faut convenir que les deux genres présentent une grande affinité. Mais l'Orthotètes se distingue déjà extérieurement de l'Orthis, par la grandeur, par la compression totale de ses valves, et par la forme arrondie depuis la charnière jusqu'au bord opposé, par les stries élevées rayonnantes et surtout ensuite par sa charnière.

Caractères génériques du genre Orthotètes.

Testa bivalvis, subæquivalvis, plana valde compressa cardine dentato, dentibus binis latis acuminatis, f. 1.

Area recta, lævis, plus minusve lata, deltidio oblongo, apice obtuso, f. 2.

Valve dorsalis intus appendicibus donata.

La forme large et déprimée de la charnière la distingue au premier coup d'œil de l'Orthis. L'une des espèces ne montre qu'une petite élévation ou bosse sous la charnière, qui dépend d'une espèce de charpente intérieure et quadrangulaire. Cette petite caisse est collée à la valve, ainsi que l'appendice longitudinale médiane. Cette appendice est accompagnée de deux autres obliques, qui forment avec la médiane une espèce de croix. Dans l'autre espèce l'appendice médiane est simple, sans les branches latérales.

Voici la description de ces deux espèces.

I. *Orthotetes radiata.*

Pl. X, f. 3.

Testa plana striata, striis elevatis radiatis.

C'est cette espèce qui montre à l'intérieur ces appendices dont il est question plus haut. Elle est très comprimée et ne montre que sous la charnière une petite bosse qui couvre cette charpente carrée intérieure. Deux sillons circulaires se trouvent près du bord et le suivent dans son contour.

Orthis arachnoidea, d'Orbigny-Murchison. Géologie de la Russie, II, p. 196–197. Pl. 10, f. 18, a, b. Pl. II, f. 1, a, b.

La description en est faite de main de maitre et il faut la comparer. C'est la même coquille. Mais l'Orthis ou Strophomena Pecten de l'Oryctographie (Pl. XX, f. 5, 6) en est différente; elle s'en distingue par sa charnière dilatée et par son épaisseur. Elle se trouve dans les couches supérieures d'un calcaire ferrugineux de Dorogomiloff près de Moscou.

L'orthotètes rayonné existe isolement dans les couches inférieures du calcaire carbonifère de Podolsk du Gouvernement de Moscou et près de Médine du Gouv. de Kalouga.

2. *Orthotetes socialis.*

Pl. X, f. 4.

Testa plana valde compressa, tenuis fere papyracea, striata: striis tenuissimis radiatis.

Cette coquille est plus petite que la première. La hauteur depuis la charnière jusqu'au bord est d'un pouce six linges; la largeur de l'*Area* comprend un pouce quatre lignes.

M. Vosinsky, membre de notre Société, connu par ses recherches géologiques, a trouvé cette espèce dans les couches infèrieures du calcaire carbonifére dans le district de Serpoukhoff, à Lisenki, propriété de M. le Prince Wiazemsky (Gouvernement de Moscou). Elle est répandue dans un calcaire schisteux qui s'étend à plusieurs verstes et s'y trouve l'une couchée contre l'autre, ou souvent l'une couvrant l'autre. Elle est tellement mince que les deux valves ne dépassent pas l'épaisseur d'une ligne.

Les stries sont extrêmement fines et rayonnées. On y observe quelquefois deux sillons parallèles au bord.

These four publications of Fischer de Waldheim include, so far as I am aware, all the authentic data relating to the genus *Orthotetes*. Lacking the typical specimens, we must try to decide from these four works what the characters of the genus really are, and to this consideration I now proceed. The other publications relating to this genus, which will be briefly considered later, are important chiefly for historical reasons. It is possible that one of these (Trautschold) actually dealt with the same species which Fischer de Waldheim investigated, but the others offer discussions of *Orthotetes* apparently based upon species belonging to other genera.

The opinion seems to have been common (Waagen and Trautschold) that Évans was the real author of this genus, and that Fischer de Waldheim acted only as an agent in adopting or introducing the name. The point is not a material one, as in any event there could hardly be any questions as to the technical authorship. It seems to me, however, entirely unnecessary so to interpret the statement in the publication of 1829. I understand that nothing more than the finding of the specimens was ascribed to Évans, and that "croit" and "nommé" do not refer back to "Mr. Évans," but to the subject of the whole sentence, "le directeur," Fischer de Waldheim.

It is evident also, from the derivation cited by Fischer de Waldheim, which should be written ὀρθότης, that the only correct orthography of this name is "*Orthotetes*," and not, as usually seen, "*Orthothetes*."

It is also evident that Fischer de Waldheim did not at first give an adequate description of the genus according to present ideas; that not only was his description inadequate, but that he did not name a type or cite any species from which a type could be selected; and that he even misconceived the structures which his fossils showed. What these characters really were appears with progressive clearness in subsequent publications by the same author, and it is to the consideration of this point that I shall now proceed.

One can safely say that in Fischer's own mind many of the characters of the genus were not clear, and that from this circumstance, from his misconceptions and false analogies, and from the lack of a definite terminology, many of his statements convey either an untrue meaning or no meaning at all. At the same time I feel satisfied that from the first description this genus was founded on a ventral instead of a dorsal valve, as has usually been declared, and that it contained a septum which probably connected with the dental plates to form the typical structure of Waagen's camerate division of "*Derbya*."

One must bear in mind that in these earlier publications Fischer de Waldheim thought this to be a pelecypod genus. Had he known both valves it is less probable that he would have entertained this idea, and in fact he states in the first description that only one valve is known. His comparison of either valve with *Anomia* and *Placuna*, at least as these genera are now understood, shows what a very imperfect and fantastic conception the author must have had, both of *Orthotetes* and of those types as well. The key to the whole matter seems to me to rest in his comparison with *Pedum*, a pectinoid genus having a large cardinal area with an elongate median pit for the ligament. There can be no question which valve of a strophomenoid brachiopod presents the closest similarity to this structure. It is true that in "*Derbya*" and its allies the cardinal structures of the dorsal valve are analogous to those of the ventral. The dorsal area, however, is always extremely narrow. It has no proper delthyrium[a] and chilidium. By the reduction of the area the delthyrium is reduced in size, and it is closed by the development of a large cardinal process, at the base of which, on its outer side, the chilidium occurs as two little ridges more or less connected into a continuous transverse band. The presence of a septum in the dorsal valve is, according to my observation, very rare, and it is usu-

[a] I can not find that this structure in the dorsal valve has ever received a separate name, and have been forced to employ a term which seems to pertain to the ventral.

ally obscure. It seems to me that these structures in the dorsal valve are so inconspicuous as to have escaped any but a closer scrutiny than it is probable Fischer de Waldheim ever gave to his specimens, while in the ventral valve they could hardly be overlooked.

See how his description answers to this interpretation. The shell is described as "flat," an expression much more appropriate for the ventral than for the dorsal valve. At the same time his remarks here seem to apply to the genus as he supposed it to be in its entirety, both valves combined, for he immediately proceeds to discuss the "lower" valve. So I understand his expression "operculaire" (operculated, or provided with a cover), and in fact he subsequently figures his specimen as a "lower" valve. This, he says, has a straight cardinal area "impression articulaire") interrupted in the middle by a delthyrium ("enfoncement profond") covered by a prolongation of the hinge "comme par un toît," which must be a pseudodeltidium. The area again seems to be referred to in the words "dos de la charnière," and "arête droite" is evidently a median septum whose relation to the pseudodeltidium is misconceived and not clearly described. The distinction is perhaps made between the cardinal line ("charnière"), described as "linéaire," and the area, for which the expression "impression articulaire" is used. Had this been a dorsal valve such a description could hardly have been given. The adjective "linéaire" is not applied, as I interpret it to the cardinal area, nor, I believe, can the term "apophyse" be taken to mean a cardinal process (which would immediately settle the status of the valve under discussion), since it projects inward and connects with the septum.

These interpretations are fully borne out by the illustration published in the Oryctographie the year following. Here we are clearly shown from the view of the interior that the shell had a strong median septum, and from the elevation above that it had a high area and pseudodeltidium entirely incompatible with the identification of this as a dorsal valve. The figure leaves much to be desired in representing the relation of the septum to the area and pseudodeltidium, but this ambiguity is quite in harmony with that of the language employed the year previous in describing the same structures. Certain features are clearly out of drawing in the illustration 4a, and the other cut (4b) is almost unintelligible, though it may represent the area, septum, and flabelliform muscular scar. In the edition of 1837, however, this is described as being the "dorsal canal," whatever that may signify. These figures at least make it clear that Fischer de Waldheim had in hand a ventral and not a dorsal valve, and that it belonged to the group for which Waagen proposed the name "*Derbya*," having within a single strong median plate or septum. Here again it will be noted that the figured specimen is not identified specifically, so that the genus is still without a quotable type.

The same is true of the publication of 1837, in which the genus is defined in about the same words as seven years previously. It would, indeed, appear, as Fischer de Waldheim remarks, that the structures of the hinge are "difficile à rendre claire par la description," but in his words "impression droite" I recognize the cardinal area interrupted by "une avancement de la charnière" (pseudodeltidium covering the delthyrium). This ("en forme de tablette carrée, creuse intérieurement"), "prolonged within by a straight median apophysis" (which is a median septum), describes, if I am not much mistaken, the structure of Waagen's camerate group of *Derbya*. It will be remarked that his comparisons to the pelecypod genera *Pedum*, *Placuna*, and *Anomia* are less insisted upon. *Placuna* is omitted altogether. The resemblance to *Pedum* would seem to rest on its dorsal muscular impression and to *Anomia* on its delicate shell. Resemblance to the structures of brachiopods is noted. The figures, two of which were reproduced from the first edition, yield less additional knowledge than the text, where some changes were in fact made. The third figure is a cut of what is called the "upper valve," which is described as being flat except for an inflated region near the hinge. This might be said either of the dorsal valve or of a not quite regularly developed ventral, but the figure looks like the latter. As at this time Fischer de Waldheim regarded the genus as belonging to the Pelecypoda, and therefore being nearly equivalve, it would not be unnatural for him to assume two somewhat differently shaped ventral valves to be one the upper and the other the lower shell of his supposititious genus, especially since one was known only from the outside and the other from the inside.

In Fischer de Waldheim's final discussion of the genus it will be observed that at last two species are described and definitely referred to *Orthotetes*. The usual procedure would be to use for a type that called *Orthotetes radiatus*, no type being named and that species standing first under the description. Of the four figures accompanying this publication only two are cited in connection with any specific name, the two others being mentioned in connection with the generic description. Thus fig. 3 represents *Orthotetes radiatus* and fig. 4 *O. socialis*, while fig. 1 is supposed to show the hinge teeth and fig. 2 the cardinal area. Anyone comparing the figure of *O. radiatus* (fig. 3) with the original figures of the Oryctographie, for which an opportunity is here presented, must become convinced that it is merely a more faithful representation of the same specimen, while fig. 2 is evidently but an improvement of another of the original figures, that showing the cardinal area of the same specimen. It beyond question accompanies fig. 3 in belonging to *Orthotetes radiatus*. It seems to me clear, therefore, that *O. radiatus*, which would naturally be used for the genotype of *Orthotetes*, is based on the same specimens which furnished the original description and figures of the genus before any species belonging to it had been given names. That *O. radiatus* is really the species originally used by Fischer de Waldheim in describing *Orthotetes* is shown by the remark that by means of a second species, found in the district of Serpoukhoff, he was able to supplement the characters of the genus. The second species thus referred to is *O. socialis*, found by M. Vosinsky in the "Lower Carboniferous" limestone of the district of Serpoukhoff, while *O. radiatus* is the original species, as the figures indicate.

For the species which must be taken as the type of *Orthotetes* Fischer de Waldheim uses the name *O. radiatus*, but it is somewhat doubtful whether this name can be so applied. In the first edition of the Oryctographie, on the same plate as the *Orthotetes* figures, this author represents a shell from Dorogomilov, near Moscow, under the name *Strophomena radiata*. In the 1837 edition these figures are reproduced, but because he believed his shell to be the same as Dalmann's *Orthis pecten* he drops his own name, *Strophomena radiata*, and cites the species as *Strophomena* *pecten*, but later he says, as quoted above, that *Strophomena pecten* from Dorogomilov is distinct from the type of *Orthotetes*, and that it occurs in higher beds. It is evident, therefore, that this form from the Russian "Coal Measures" is generically distinct from the Ordovician species *Orthis pecten* Dalmann, and that for its specific name we must fall back on *radiata*, used for it in the first edition of the Oryctographie. Unfortunately, as it has already been seen, Fischer de Waldheim revives this specific name for the type species of *Orthotetes*, which he says is distinct from *Strophomena? radiata*. The appearance of his figures is exactly that of an *Orthotetes* or a *Derbya*, but might be equally well an *Orthothetina* or a *Schuchertella*, etc. Of course if *Strophomena radiata* Fischer de Waldheim 1830 is found to belong in the same genus as *Orthotetes radiatus* Fischer de Waldheim 1850, another name will have to be proposed for the type of *Orthotetes*, unless an available one can be found in the synonymy. As to this I am not sufficiently familiar with the synonymy of Russian forms to reach a conclusion, and doubtless recurrence would have to be made to original specimens, which for me is of course impossible. I therefore use the name *O. radiatus* for the type species of *Orthotetes*, conditionally on the contingencies above defined.

In the publication under consideration (that of 1850) figs. 2 and 3 belong to *Orthotetes radiatus*; fig. 4 is definitely ascribed to *Orthotetes socialis*, with which fig. 1 also should probably be associated, a point to which I shall recur. On the other hand, while the twin figures which appear in the Oryctographie merely as fig. 4a are represented in the later publication as figs. 2 and 3, fig. 4c, which purports to represent the "upper valve," has been suppressed (possibly because it is really a ventral), which is also the fate of 4b, described as the "dorsal canal" of the "lower valve," unless it appears as fig. 1, which I have otherwise disposed of as belonging to *O. socialis*.

Let us now consider what are the characters of *Orthotetes* as based on the latest and most intelligent authentic account of the genus. Two types of structure are here discriminated by Fischer de Waldheim. One species is described as having the median septum ("appendice longitudinale mediane") connected with two other plates oblique to it, forming a sort of internal quadrangular chamber ("caisse").[a] In the other species the median septum is simple, without lateral branches. This language, while not technical, is quite plain and clearly describes in the first instance the type of structure on which Waagen based the camerate division of his genus *Derbya*, while the other describes his *septati*. Since under *O. radiatus*, described immediately thereafter, Fischer de Waldheim says "It is this species which shows on the inside the lamellæ ['ces appendices,' by which term are designated both the septum and dental lamellæ in the remarks quoted] referred to above," it seems clear that it is *O. radiatus* which possesses the internal chamber, a structure which is imperfectly represented also by his figures of that species, while *O. socialis* has the structure of the *septati*. It is clear that the interior of the latter species was known to Fischer de Waldheim, because one of his first remarks is that it permits him to

[a] It is this structure, here for the first time described and figured in a fairly intelligible manner, which is referred to as an "apophyse" or "prolongement" of the pseudodeltidium (toît, *vide* context), prolonged within as a median septum (arête droite et canaliculée), and which is somewhat correspondingly represented in the 1830 edition of the Oryctographie. The camera combined with the pseudodeltidium is evidently meant by the words of the 1839 edition, "un avancement de la charnière, en forme de tablette carrée," and in the work under consideration is first mentioned as "une petite élévation ou bosse" beneath the hinge, being described more fully immediately thereafter.

complete his generic diagnosis, and because he proceeds to give characters belonging to the internal structure. It would be natural, therefore, that he should illustrate the interior of *O. socialis*, as well as the exterior, which is shown in fig. 4, and it seems highly probable that fig. 1, which is not ascribed to either of the species, and which appears to represent a shell belonging to the *septati*, really serves this purpose, and goes with fig. 4 as illustrating *O. socialis*.

To consider now the work of certain other authors as it bears on the history or the proper understanding of this genus, the remarks of De Verneuil in the "Geology of Russia" (1845) first call for comment. This author places *Orthotetes* among the Brachiopoda, so that when this step was taken by Fischer de Waldheim five years later he was merely accepting the views of the distinguished Frenchman, but De Verneuil confuses the group with *Orthis*, of which genus he makes *Orthotetes* a synonym. Indeed, he places both *Orthotetes* Fischer de Waldheim and *Strophomena pecten* in the synonymy of *Orthis arachnoidea* Phillips. His description of the interior seems to be based on Fischer's figures as much as on actual specimens, and apparently applies to the "septate" type of structure. To his description, however, much weight can not be attached so far as it stands against Fischer de Waldheim's, unless it is shown to have been derived from more authentic or more accurately identified material than would appear to be the case. Fischer, as we have seen, while acknowledging the correctness of De Verneuil's description as a whole, yet maintained the independence from *Orthis* of his genus *Orthotetes*, as was quite justified, and described as new the two species *Orthotetes radiatus* and *O. socialis*.

We find in 1873[a] De Koninck accepting *Orthotetes* as a valid genus distinct from *Orthis*, but his knowledge of the great diversity of forms which he assigns to it under a single specific designation seems to be restricted to the external configuration, not having extended to the structure of the dental and septal plates. He therefore uses *Orthotetes* to replace *Streptorhynchus* and overlooks all the internal differences which have since been used for generic discrimination among the unplicated Orthotetinæ. In recognizing *Orthotetes* as distinct from *Orthis*, De Koninck makes no advance, however, since Fischer maintained the same distinction in his work last quoted, while English paleontologists had for many years separated the shells under the name of *Streptorhynchus*, which, as we have just seen, De Koninck regards as the same as *Orthotetes*.

In 1876, or three years after De Koninck's description, Trautschold,[b] in describing the Carboniferous fauna of Mjatschkowa, had occasion to discuss some of the species on which Fischer de Waldheim worked. He places *Orthotetes radiatus* in the synonymy of *Orthis crenistria* and represents that species by a figure which one would say clearly showed the structure of the camerate group of "*Derbya*." Schellwien[c] refigures Trautschold's specimen as *Derbya* sp. The somewhat better figure given by Schellwein is not altogether unambiguous, but I have little doubt that it represents one of the *septati*. Mjatschkowa is the locality from which this specimen was obtained. *Orthotetes radiatus* was first cited from Pakhrino, a small hamlet

[a] Monographie des fossils Carbonifères de Bleiberg, en Carinthie: Recherches sur les animaux fossiles, pt. 2, 1873, p. 42.

[b] Die Kalkbrüche von Mjatschkowa, Moscow, 1876, p. 63.

[c] Neues Jahrbuch, Jahrg. 1900, vol. 1, 1900, pl. 1, fig. 9.

south of Moscow. In the publication of 1850 Fischer de Waldheim mentions as the locality Podolsk, a larger town near Pakhrino and somewhat west of it. Pakhrino is situated about midway between Podolsk and Mjatschkowa. It is not improbable therefore that Trautschold's specimens actually belong to *Orthotetes radiatus*.

A great step in advance was marked by Waagen's monograph on the Salt Range fossils,[a] in which he employs septal structures for the classification of this group of shells. As we have seen, even after the later description of *Orthotetes*, which, indeed, if not quite adequate was sufficient to distinguish it from *Orthis*, Fischer de Waldheim's genus did not find general acceptance and apparently was for the most part quite overlooked or where recognized was confused with *Orthis*, as by De Verneuil and Trautschold, or made to include most of the Orthotetinæ, as by De Koninck.

Waagen's remarks on this genus are as follows:

Genus: *Orthothetes*, Fischer v. Waldheim.

Though this name has been quoted as applied by Evans to certain forms already in the year 1829, yet the genus can not be considered as fairly established before the year 1830, when in the first edition of the "Oryctographie" the interior of a dorsal valve was distinctly figured and the genus definitely transferred to the Brachiopoda by Fischer v. Waldheim. In the edition of 1830 only the interior of the dorsal valve was figured, whilst in the edition of 1837 an external view of a ventral valve is added.

In both cases there can not remain the slightest doubt that the name was applied to a shell very nearly related to *Streptorhynchus crenistria*, Phill., and which chiefly in the internal characters of the dorsal valve is generically identical with Phillips's species. The name must thus be restricted to those forms and the genus may be characterized in the following manner:

The external shape of the shells belonging to this genus is in no way characteristic and it is only by the internal characters that the genus can be recognized.

In the dorsal valve a cardinal process of moderate dimensions exists, which is generally bifid and comparatively broad. Laterally it is joined to the walls of the dental sockets. These latter are not very large and not supported by shelly lamellæ, so that the diverging septa which are characteristic of the preceding genera are absent in the present one. Instead of these, however, there seems to be not rarely a median dorsal septum developed which is immediately joined to and takes its origin at the cardinal process. This median dorsal septum appears on Fischer v. Waldheim's original figure as well as on Pl. XXVII, fig. 6, of Davidson's Carboniferous monograph.

In the ventral valve as far as my experience goes every kind of septum is absent.

The muscular impressions of both valves have been excellently described by Mr. Davidson, but they are in their general arrangement very similar to the muscular impressions of other genera.

There can be no doubt that *Strept. crenistria*, Phill., belongs to this genus even if it should be proved that Fischer v. Waldheim's original specimen did not belong to the same species. Also the species or varieties *St. radialis*, Phill., and *St. arachnoidea*, Phill., perhaps, too, the typical *St. cylindrica*, McCoy, will have to be connected to it. Otherwise not much is known of species of the genus.

There can be no question that the spelling of the name "*Orthothetes*," which appears to have originated with Waagen is without authority or argument. The implication that the name was first employed by Evans also seems to me unwarranted. It is, furthermore, quite clear that the genus was not recognized by Fischer as belonging to the Brachiopoda in 1830 nor in 1837, but much later, in 1850, after it had been so determined by De Verneuil. Waagen also commits an error which seems to have begun with De Koninck, in saying that Fischer's original figures represent a dorsal valve. A careful comparison of Fischer's texts and figures, as I have

[a] Mem. Geol. Survey India, Pal. Indica, ser. 13, vol. 1, 1887, pp. 575 et seq.

attempted to show, must convince an impartial student that the shell was a ventral valve. This misapprehension on the part of Waagen is so fundamental that for once this excellent paleontologist has been led quite astray and his diagnosis based on *Streptorhynchus crenistria* and its allies is erroneous.

Hall and Clarke, the latest contributors to the history of the genus, unfortunately follow Waagen, without having referred to the original sources. Indeed, these publications are so rare that but few opportunities for making the necessary comparisons exist in this country. These authors give an excellent discussion of the group of forms to which Waagen misapplies the name *Orthotetes* and under *Derbya* an equally adequate discussion of the group to which it more properly belongs, but naturally add nothing to the present subject. They do indeed call attention to the fact that in his 1850 publication Fischer de Waldheim figures a species of *Orthotetes* which shows the structures of "*Derbya*," but they fail to note that this is the typical species of *Orthotetes* and that the figures are drawn from the same specimens from which the original description of the genus was derived.

It seems to me that the evidence submitted shows almost beyond dispute that the shell first described by Fischer de Waldheim was a ventral valve; that the same specimen was used later to illustrate his improved diagnosis of *Orthotetes* and to found his species *O. radiatus*; that he was consistent in describing a second species of *Orthotetes* possessing essentially the same structures; that though he took cognizance chiefly of structures calculated to distinguish *Orthotetes* from the Orthidæ, and failed to lay stress on such as would distinguish it from other groups of the Strophomenidæ, these distinctive characters are more or less clearly described in his text and represented by his figures from first to last; and that while Waagen proposed the name *Derbya* for the structural type to which *Orthotetes* really applies, he employs the name *Orthotetes* for a group having the structures neither as described by Fischer de Waldheim, nor as shown by the type species *O. radiatus*. Thus *Derbya* of Waagen becomes, strictly speaking, a synonym of *Orthothetes* and the group which Waagen discriminated under the name *Orthothetes* becomes anonymous. For this group I proposed the name *Schuchertella*, in honor of my one time colleague, taking for the type of the genus the Kinderhook species *Orthotetes lens* White. As I shall elsewhere (p. 198) have occasion to remark, there seems to be some doubt as to the structure of *Orthotetes? crenistria*, the species commonly employed as the genotype of *Orthotetes*, so that Phillips's species could not safely be selected for this office. On the other hand, the interior of *Schuchertella lens* is accurately known from specimens undeniably belonging to that species. The characters of the group for which the name *Schuchertella* was proposed have been described not only by Waagen, but more recently by Hall and Clarke,[a] who also illustrate the type species *S. lens*.

It would appear that as *O. radiatus* seems to represent the *camerati* and *O. socialis* the *septati*, the genus *Orthotetes* in its original content is precisely equivalent to *Derbya*. But the typical species of *Derbya* is one of the *septati*[b] while the

[a] Nat. Hist. New York, Pal., vol. 8, pt. 1, 1892, p. 253.

[b] While Waagen had Derby and his Brazilian species especially in mind, in naming the genus *Derbya*, the only Indian shells which he discovered belonged to the septate division; and shells of this type were for a long time the only ones which were well known. Waagen did not designate a type species for *Derbya*, and probably the first one described under that genus, *Derbya regularis*, should be used. This species has been employed in this sense by Hall and Clarke, and as it belongs to the septate division the name *Derbya* may safely be confined to this type of structure.

typical species of *Orthotetes* is one of the *camerati*. Since the difference between the camerate and septate structures when characteristically developed is somewhat striking, I avail myself of this circumstance, by restricting each name to the division which its typical species represents, at the same time to give independent existence to these two groups of shells and to retain both of the current names. The term *Orthotetes,* therefore, is here employed only for the camerate division of the original genus *Derbya,* while *Derbya* is restricted to its typical division, the *septati*.

While I think there can be but little question that the shells from which the first description of the genus *Orthotetes* were drawn belong to the group for which Waagen's term *Derbya* is now in use, there might possibly be a difference of opinion as to the date which should be given for the establishment of the genus. Fischer de Waldheim's first description is not very clear, but it certainly implies structures the possession of which warrants the discrimination of *Orthotetes* from the other strophomenids. On the other hand, no figures accompany it, nor any list of species, one of which might be taken as a type. Figures were given in the Oryctographie (edition of 1830), but only such as represent the interior. No specific name was connected with the figures, in which are no intrinsic means for specific identification. The later edition, in 1837, contained a figure of the exterior of a dorsal valve, but again without a specific name or adequate means of identification with a known species. It was apparently these figures which were identified by De Verneuil (not D'Orbigny, as stated by Fischer, nor Bronn, as stated by Dall) with *Orthotetes arachnoides,* which Davidson regards as merely a variety of *Streptorhynchus crenistria* Phillips. This opinion has received general acceptance, and in this way the type species of *Orthotetes* is sometimes cited as *Orthis crenistria,* e. g., Hall and Clarke. Waagen's interpretation of *Orthotetes* was also determined by this species, and by the figures of the interior of *Streptorhynchus crenistria* which Davidson has furnished. He remarks: "There can be no doubt that *Strept. crenistria,* Phill., belongs to this genus, even if it should be proved that Fischer v. Waldheim's original specimen did not belong to the same species." [a] *Streptorhynchus crenistria* may have had no septum in the ventral valve, as it is described by Waagen and Davidson, or it may have had two septa (dental plates), as Schellwien represents it; but apparently it did not have a single median septum on any count. Thus it can not belong to the same species, nor, according to present ideas, to the same genus, as *Orthotetes radiatus*.

With the publication of 1850 we first have a thoroughly intelligible description of *Orthotetes* associated with the description of a species which might be taken for a genotype. Some might take the ground that the genus was adequately founded only at this time, the generic name being bound up with *O. radiatus* as its type. Were this all, I would even yet incline to recur to the earlier description of 1829, though a type was not associated with it until later, because that description does, after all, indicate the essential points, and clearly is in agreement with the 1850 description. The probability, amounting almost to certainty, however, that the specimens figured in 1830 were the same as those on which *O. radiatus* was based in 1850, and on which the generic description of that date depends, seems to strengthen the argument for going back to the earlier date.

[a] Waagen, W., Mem. Geol. Survey India, Pal. Indica, ser. 13, vol. 1, 1887, p. 607.

Some argument, too, might be made in favor of retaining Waagen's name *Orthothetes*, even if *Orthotetes* does replace *Derbya*, on the ground that the two words are not the same, letter for letter; but they are near enough to occasion much confusion, in view of the close biological relationship of the two genera and the association of the names in taxonomy. I am also disposed to attach importance to the common-sense argument that Waagen was not proposing a new genus in using *Orthothetes*, but was clearly redefining a group to which he believed Fischer de Waldheim had half a century earlier applied the name *Orthotetes*.

Reference has already been made to the uncertainty about the internal structures of *Streptorhynchus crenistria*. The interiors figured by Davidson can probably be taken as belonging to Phillips's species. If so, they can certainly be placed in the genus *Schuchertella*. Schellwien, however, figures specimens identified as *Orthothetes crenistria*, which have two long septiform dental plates. It is evident that these shells do not belong to the same species, and probably not to the same genus, as those figured by Davidson and embraced in Waagen's definition of "*Orthothetes*." Apparently Schellwien held the same view, for he excludes from this group of biseptate shells, for which he employs the name "*Orthothetes*," a species which Waagen ascertained to be without ventral plates, and so to belong to "*Orthothetes*" as understood by him. This form, *O. subplanus*, Schellwien places in *Streptorhynchus*, apparently disregarding the difference in other respects which distinguish *Streptorhynchus* from Waagen's "*Orthothetes*," unless, indeed, he ascertained characters which showed Waagen's reference to have been an error. For the later representatives of this biseptate group, which differ from the earlier ones in having the dental plates parallel or converging, instead of very strongly diverging, Schellwien suggests the term *Orthothetina*. It is clear to me that these biseptate shells can not be placed in any of the subdivisions previously recognized; and I also doubt the advisability of distinguishing the earlier from the later types, unless other characters can be assigned than difference in the direction of the dental plates. Though it seems probable that these differences exist and will yet be ascertained, it is deemed best for the present to extend the term *Orthothetina* so as to embrace both forms.

The genus *Orthotetes*, its known representation the world over being considered, is much rarer than *Derbya*. Waagen found it to be lacking in the faunas of the Salt Range, while, strangely enough, Schellwien observed neither genus in the Alpine Permian fauna. The forms described by Abich from Armenia, which Waagen conceived to belong to *Orthotetes*, Schellwien has stated to be representatives of *Orthothetina*. The South American species *Orthotetes correanus* is a classical example of this group, and it is almost certain that the genotype, *O. radiatus* of Russia, was one of the camerates. Under the title of *Orthis crenistria* Trautschold has figured a Russian species which appears to have the camerate structure. A better illustration of the same specimen by Schellwien, however, makes it very doubtful whether it is not one of the *septati*. The interpretation of the figure depends largely on the inclination at which the view is supposed to be taken. If the view is foreshortened the structure may well be the septate type. But the outline of the specimen as a whole indicates that there is no foreshortening, and if the view is perpendicularly downward the structure would appear to be of the camerate type. In that case it may belong to *Orthotetes radiatus*, the type of *Orthotetes*. Schellwien's remark, however, that this specimen "zeigte die Merkmale von *Derbyia* in vortrefflicher Weise und dürfte mit den hier in Text abgebildeten Exemplaren von der Indiga specifisch übereinstimmen,"[a] seems to settle the matter, for the text figure referred to clearly represents one of the *septati*.

In North America species possessing the camerate type of structure have not as yet been noted. Such as occur are probably rare, or possess the characteristic septal arrangement in an inconspicuous degree. The latter is true of *Orthotetes keokuk*, which seems to belong to this group. No post-Mississippian representatives of *Orthotetes*, however, are known to me, with the exception of the Guadalupian species described hereafter. Of these the forms discriminated are five in number—*O. guadalupensis*, *O. declivis*, *O. distortus*, *O. distortus* var. *campanulatus*, and *Orthotetes* sp. *a*. The four species named first are all found in the Capitan limestone, and show the characteristic camerate structure in a high degree of development, so that, with the exception of *Orthotetes* sp. *a*, whose generic affinities are doubtful and whose horizon is the basal black limestone, the development of this genus appears to have taken place in the higher measures of the Guadalupian section.

The Guadalupian representatives of *Orthotetes*, and also of *Derbya*, are distinguished from the Pennsylvanian species, and I suspect from many of those of foreign areas as well, by their extremely fine liration. One species (*O. guadalupensis*) is peculiar in having the liræ smooth, flattened, and crowded, instead of sharp, crenulated, and spaced, a type of surface which probably belongs also to *O. declivis* and differs from anything I have before seen in these shells. All things considered, this type constitutes a rather individual feature of the American fauna.

O. guadalupensis and *O. declivis* may be taken to represent one group which is distinguished from another, composed of *O. distortus* and *O. distortus* var. *campanulatus*, by having broad, rounded liræ, instead of thin, sharp ones, though the distinction is not easily enforced, because exfoliation is apt considerably to obscure this feature. These two groups are distinguished from *Orthotetes* sp. *a*, by having a much more elevated ventral valve.

ORTHOTETES GUADALUPENSIS n. sp.

Pl. X, figs. 1 to 5.

1859. *Orthisina*, sp. (?). Shumard, Trans. Acad. Sci. St. Louis, vol. 1, p. 395 (date of volume, 1860). White [Permian] limestone: Guadalupe Mountains.

Shell small, planoconvex, subpyramidal. Dorsal valve transverse, subcircular, or subelliptical. Hinge line straight, much narrower than the width below. Anterior margin straightened; lateral margins strongly and evenly rounded, merging into the anterior, but joining the cardinal margin with a faint angulation. Convexity moderate. Umbo rather prominent. Beak small, not projecting beyond the hinge line. Cardinal area apparently linear. Dental lamellæ long and not strongly diverging, making an angle of less than 90° between them.

Ventral valve high-conical. Area high, well defined, flat, divided by the delthyrium into two equal portions, each of which is again divided by a diagonal line running from the apex to the cardinal margin and situated somewhat farther from

[a] Neues Jahrbuch, Jahrg. 1900, vol. 1, 1900, p. 10.

the outer edge of the area than from the edge of the delthyrium. The inner portion of each side of the delthyrium is somewhat raised and indistinctly striated longitudinally. The outer portion on either side bears conspicuous transverse striæ. The delthyrium is narrow and covered by a rather strongly convex pseudodeltidium, which extends almost to the cardinal line and is distinctly, though finely, cross striated. Longitudinally the area is sometimes flat, but more often somewhat concave. Occasionally the curvature is considerable, and sometimes the apex is more or less bent to one side or the other. The area usually seems to make a slightly obtuse angle with the plane on which the edges of the two valves unite. The expansion of the shell was, as a rule, symmetrical and regular, but rugosities now and then occur. Usually the line from apex to edge of the shell is nearly straight, occasionally somewhat concave, and when the apex is distinctly bowed is somewhat convex. This valve often has a faint sinus and the other an indistinct fold; but this feature is hardly to be perceived, except on the joined edges of the two valves, where it produces a faint sinuosity.

Surface marked by fine, regular, equal, radiating liræ, of which 16 or 17 are found in the space of 5 mm. Toward the hinge line they are somewhat curved. Increase is by implantation; and where some of the liræ are small and young the number given above is considerably increased. The liræ are depressed, rounded, not separated by relatively large intervals; neither are they alternating nor crenulate, as in so many strophomenoids, but rather resemble those of *Orthis*. This character, together with their fineness, makes this shell noticeable among the related forms in our collection.

Up to the present this shell is practically unknown save at the El Capitan locality (station 2926), where, however, it is abundant. A single specimen from station 2906, southwest of Guadalupe Peak, agrees closely with dorsal valves from the typical locality, and though in size it somewhat exceeds the types, a large ventral valve from the same station indicates about equal dimensions.

Horizon and locality.—Middle of Capitan formation, Capitan Peak (station 2926); base of Capitan formation, hill southwest of Guadalupe Point (station 2906); Delaware Mountain formation, Guadalupe Point (station 2963?), Guadalupe Mountains, Texas. Delaware Mountain formation, southern Delaware Mountains, Texas (stations 2962? and 2969?).

ORTHOTETES DECLIVIS n. sp.

Pl. X, figs. 6 to 8a.

The following description is taken from the type specimens—a ventral and a dorsal valve found in the Capitan formation of the Guadalupe section. Variations shown by other specimens will be described thereafter.

Ventral valve high, conical. Area flat, moderately high, probably strongly inclined backward. Width of area at least 30 mm.; height 13 mm. Pseudodeltidium about 5½ mm. wide at base, rather convex, marked by fine transverse lines. Other characters as in *Orthotetes guadalupensis*. Shape probably transversely semicircular, more or less strongly contracting at the hinge. A line drawn on the surface from the apex to any point in the periphery would be nearly rectilinear, very slightly convex. Surface as in *O. guadalupensis*, with very fine flattened liræ separated by narrow grooves.

Three dorsal valves associated with the ventral described above have been referred to the same species. None of them is sufficiently perfect to show the shape, which is probably nearly semicircular, contracted at the hinge. The convexity is considerable; the beak small, depressed, and projecting but little beyond the cardinal line. Surface as in *O. guadalupensis*. The cardinal process is long and bilobed, and its direction is nearly at right angles with the plane of the shell edge. The dental lamellæ are long and mutually directed at an angle of about 60°.

In the foothills southwest of Guadalupe Peak, where the Capitan limestone is faulted down to a much lower level, a form occurs in considerable abundance, though imperfectly preserved, which seems to be conspecific with the types. The ventral valve in some specimens is proportionately a little narrower and higher; in others a little broader and lower. The type specimen is peculiarly regular and symmetrical; these others are more or less distorted and uneven. It is impossible to ascertain the real shape of these specimens, because the anterior portion is in every case broken away, but the dorsal valves appear to have normal proportions. The dorsal valves with which these ventrals are associated agree with those from the main range, except that the dental plates are less lengthy than in the somewhat extreme example figured. A dorsal from this locality, of the usual type, is represented in Pl. X, fig. 8. The type ventral valve does not show the character of the septum and dental plates, but others demonstrate the presence of a large chamber.

The most nearly related species is evidently *Orthotetes guadalupensis*, which occurs in the same beds. From this form *O. declivis* is distinguished in several ways. It is a much larger shell, and the ventral valve has a lower and broader area. The shape does not contract as rapidly near the area as in the smaller form. The dorsal valve closely resembles that of *O. guadalupensis*, but is larger and has proportionately longer dental lamellæ.

Horizon and locality.—Middle of Capitan formation, Capitan Peak (station 2926); base of Capitan formation, hill southwest of Guadalupe Point (station 2906), Guadalupe Mountains, Texas.

Orthotetes distortus n. sp.

Pl. X, figs. 9 to 9c.

Of this species but a single specimen has been obtained, and it presents differences from *Orthotetes guadalupensis*, with which it is associated, so marked that they can hardly be referred to the same specific group. *O. distortus* is a small shell, much inferior in size to *O. guadalupensis*. The maximum width is only 11 mm. Both valves are highly unsymmetrical and distorted. The hinge line is narrower than the shell in front. The dorsal valve is moderately convex; the ventral is relatively high, measuring about 6 mm. The area, about 6 mm. in width, is flat, and the pseudodeltidium convex, but broad, low, and not well defined. In this regard it is in marked contrast to *O. guadalupensis*. It also bears a longitudinal callosity that is narrow and almost linear. The surface is marked by extremely fine subequal liræ, of which 35 or more occur in the space of 5 mm. The liration is thus seen to be much finer than in *O. guadalupensis*, and is, in fact, but little more than just visible to the naked eye.

In my preliminary list I referred this shell to *Derbya bennetti?*. The general aspect is rather similar to that species, but the Guadalupian form is much smaller and more finely striated, besides possessing the structural peculiarities of the camerate group.

To this species has provisionally been assigned a small, fragmentary, silicified example from the Glass Mountains. It is distinguished primarily by its extremely fine liration, in which it agrees with *O. distortus*, itself unique among Guadalupian strophomenoids in this particular. The liræ, however, are a little thinner, with relatively wider striæ between. The hinge plate is large, with a tendency to extend downward into the valve as if when fully grown it might have surrounded a muscular area. The fragment has a length of scarcely 5 mm., but this appears to be nearly the original dimensions.

It is of course highly uncertain whether this specimen belongs with the Capitan species. No other identification, however, appears equally promising.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926). Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763).

Orthotetes distortus var. campanulatus n. var.

Pl. X, figs. 10 to 10c.

Of this form a single specimen has been obtained—a ventral valve. It resembles *Orthotetes distortus* in a general way, and yet presents some marked differences, and being uncertain whether it would with propriety be thrown with that species, on the one hand, or made the type of a new one on the other, I have chosen what may be considered as a middle course and distinguished it from *O. distortus* merely as a variety. Only the ventral valve of this species is known, and from it the following description has been drawn up:

Shell rather small, high, conical, campanulate. Growth irregular and asymmetrical. Area narrow, high, nearly flat, but twisted and slightly concave. It is poorly defined from the convex walls of the shell. Its general direction to the plane of the shell edge is nearly vertical or slightly inclined forward. Hinge line 7 mm., much shorter than the width in front, which is 16 mm. Length of aperture 17 mm. Nearly all of the area (about 5 mm.) is occupied by the pseudodeltidium, which is convex, and by the greatly thickened edges of the dental plates. The latter are rather long, uniting with the septum, which extends well nigh to the edge of the shell. The liræ are very fine, equal, regular, subangular, and depressed, separated by intervals about equal to their own thickness.

In its irregular growth and rapid expansion near the aperture this shell develops several distinct plications, which might possibly warrant the assignment of it to the genus *Geyerella*. It appears, however, that this is but an accidental feature. The larger size, greater relative height, and narrower area should distinguish this form from *O. distortus*.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926).

ORTHOTETES? sp. *a*.

This division is introduced for a type occurring in the black limestone which forms the basal member of the Guadalupian series. Only a single ventral valve has been found, and on it the following description has been based:

The area is low, flat, and either at right angles to the plane of the edge or slightly inclined forward. Width about 12 mm., height about 3 mm. The pseudodeltidium is moderately convex, about 3 mm. wide at the base. The shape of the shell is depressed, subconical. The growth is symmetrical, but somewhat irregular. The maximum width is about 18 mm., the length uncertain. The liræ number about 20 in a space of 5 mm., the measurement of necessity being taken not far from the apex. They are slender, moderately high, and separated by intervals greater than themselves. Fine concentric liræ of considerable strength can also be noted, and at present are confined to the flat interliral spaces. The septum is long and thin, and probably unites with the dental lamellæ. It is seen to be continuous with the plate on one side, but that on the other side appears to be missing.

As it is not clear to which of the two great groups of *Orthotetes* (*Orthotetes* sensu stricto or *Derbya*) this form belongs, it seems hopeless to attempt to fix its specific position. Its most noticeable features are its low altitude, small size, and fine, sharp liræ. The latter feature at once distinguishes it from the group of *Orthotetes guadalupensis*. It is in fact more similar in superficial appearance, and possibly in internal structure, to *Derbya* sp. *a*, but appears to differ in having more regular growth and a relatively lower and more upright cardinal area, and besides being much smaller, it has finer liræ and occurs at a lower geologic horizon.

To this same group I have provisionally assigned an imperfect dorsal valve from the Glass Mountains, which is distinguished by having very fine, slender, somewhat spaced, and occasionally alternating liræ, long, straight socket plates, and a long cardinal process directed nearly at right angles to the plane of the edge. The size attained was upward of 20 mm. in transverse diameter. The sculpture in this specimen is largely obscured, but appears to be very similar to the ventral valve from the black limestone, though possibly somewhat finer. The prolonged and strongly elevated socket plates are suggestive of the form described as *Orthotetes declivis*. The chief positive difference resides in the liræ, which are broadly rounded in *declivis*, though they appear more angular when exfoliated, their usual condition. As the Glass Mountain specimen is silicified, however, this explanation can not be invoked in order to unite them. Except for this circumstance I would have tentatively placed this shell with *O. declivis*.

Horizon and locality.—Basal black limestone, Guadalupe Point, Guadalupe Mountains, Texas (station 2920). Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763).

Genus GEYERELLA Schellwien.

Geyerella is another name introduced by Schellwien, and is valid for the group to which it was applied, though hardly, it appears to me, in a full generic sense. The shells which it includes are especially distinguished by their plicated surface and by the internal structures of the ventral valve, where the long dental plates converge and unite with the median septum. This is precisely the internal structure of the camerate group of *Derbya*, a fact to which Schellwien does not, in my view, give sufficient weight—indeed, I do not know that he calls attention to it at all. *Geyerella* then stands in the same relation to *Orthotetes* that *Meekella* does to *Orthothetina*, and that the plicated group of *Streptorhynchus* does to the simple one. I can not accord these plicated shells full generic rank, nor am I willing to reduce them to mere divisions. In any event, it appears to me that all should be treated alike.

The only American representative of this genus at present known to me is the species described below. It apparently does not possess any marked traits by which it is strongly distinguished from the European species.

GEYERELLA AMERICANA n. sp.[a]

Pl. XI, figs. 2 to 2b.

This species is represented in our collections by a number of specimens, all of which, unfortunately, are extremely fragmentary. The most complete example is represented by the figures, and even that is better for showing generic characters than specific. It consists of part of the ventral valve of a large shell, the dorsal valve of which is missing. The height when complete must have been about 40 mm.; the length from the anterior margin to the center of the area is also about 40 mm. The shape is thus seen to be rather elongate conical. The area makes nearly a right angle, possibly a somewhat acute angle, with the opening of the shell. The delthyrium is rather broad, and the convex pseudodeltidium is probably somewhat depressed below the surface of the area.

The surface is marked by about 26 strong but irregular plications, which become obsolete on both sides near the area. A few of the plications bifurcate. The superficial liræ with which the surface is covered are almost obliterated by exfoliation; but they appear to be fine and equal, and manifest a tendency to curve upward from the sides of the plication onto their crests, just as in the genus *Meekella*.

Geyerella americana finds its closest ally in *G. gemmellaroi;* but as Schellwien figures that species[b] without, so far as I have been able to discover, describing it, and especially as I have not been able to examine any specimens belonging to it, I find it impossible to make a close comparison. The present species shows more strongly marked plications than *G. distorta* or *G.? eusarkos*.

Shumard cites from Guadalupe Peak a form which he calls *Streptorhynchus* (*Orthisina*) *shumardianum*, a name now generally regarded as a synonym of *Meekella striaticostata*. It is possible that the form mentioned may have been a representative of this species, or it may have been a true *Meekella*, though not probably one conspecific with Cox's species.

This type of structure and surface combined is entirely unknown in the faunas of the Mississippi Valley, and this first citation of *Geyerella* from either of the Americas is attended with some interest.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926).

[a] In the preliminary notice of this species I referred to it as *Meekella* n. sp.
[b] Neues Jahrbuch, Jahrg. 1900, vol. 1, Separat-Abdruck, 1899, pl. 1, figs. 7a, 7b.

Genus MEEKELLA White and St. John.

This genus is distinguished from *Orthothetina* very much as *Geyerella* is distinguished from *Orthotetes,* and both groups can hardly be allowed full generic rank. The distinguishing features of *Meekella* are its plicated surface and its long, nearly parallel dental plates. A remarkably well-preserved example in the Guadalupian fauna possesses structures compelling a doubt, however, as to whether these septa are really dental plates. They do not meet the area along the margins of the delthyrium, but considerably to the sides, while from the delthyrial margins, where the dental plates should originate, a pair of small platelike structures arise, bend outward, and unite with the two septa. (See fig. 10, Pl. XXX.) Indications of a similar structure have been noted in *Meekella striaticostata.* What interpretation should be placed on these observations is doubtful, but they may mean that the two septal plates correspond to the single septum of *Derbya* and *Orthotetes,* and that the real dental plates join but are not continuous with them.

It is perhaps rather striking that this genus has been found only in the lowest beds of the Guadalupe section. It is true, however, that Shumard cites *Streptorhynchus shumardianum* Swallow (= *Meekella striaticostata* Cox) from the sandstones near the base of the Guadalupe Mountains. Whether this was a *Geyerella* or a *Meekella* will probably never be known. From the black limestone at the base of the section we have *M. attenuata* and *M. multilirata.*

The three other species distinguished in this paper were obtained in other areas, but probably from the horizon of the Delaware Mountain sandstone, and it may be one of them that Shumard found in the Guadalupe Mountains. These four species of *Meekella* are rather closely related to one another, and do not lend themselves readily to separation into different groups. Perhaps the best subordinate classification would assemble *Meekella attenuata, M. skenoides,* and *M. multilirata* in one group, and leave *M. difficilis* by itself to represent another.

MEEKELLA ATTENUATA n. sp.

Pl. XXIV, figs. 7 to 9a; Pl. XXV, figs. 4 to 4d.

Shell small. Ventral valve high, subconical, inclined backward, so that the area makes an angle of not far from 135° with the plane of the shell opening. Area well defined, generally plane, but more or less contorted; width about 7 mm., height about 6½ mm. Pseudodeltidium apparently rather broad, nearly flat, and not well defined. The growth of this valve is marked by constrictions and contortions.

Dorsal valve subcircular, outline regularly rounded, with somewhat straightened and converging sides. Width of hinge 7 mm.; width below 10 mm.; length 10 mm. Convexity moderate. Growth rather unequal and irregular.

Surface marked by nine or ten plications, which are low and not very distinct, reaching but a short distance back from the anterior margin and not extending to the sides. The liræ, which furnish the only ornamentation over much of the shell, are, for its size, comparatively coarse. They are more or less alternating, but tend to become finer over the plicated portion of the valves.

This species is distinguished from either *Meekella skenoides* or *M. difficilis* by the coarseness of its liræ and the faintness of its plications. The separation recorded here is that which seems to be demanded by the material studied, but this is scanty and in some instances incomplete. The relationship to one another of these three species is more or less close, and owing to the well-known variability of shells belonging to *Meekella* it is possible that some of the differences, though now rather striking, will be bridged over by intermediate forms.

In the basal black limestone of the Guadalupe section (station 2967) occurs in abundance, though in a poor state of preservation, a species of *Meekella* which with our present knowledge it seems unavoidable to refer to *M. attenuata*, although necessitating some minor change in the limitation of the species. This change is connected with the configuration, in regard to which Meekellas are never very constant. The specimens from the black limestone attain a size considerably greater than the specimen described, and exhibit variations, both in the elevation of the ventral valve and the angle at which the area extends to the plane defined by the margin of the shell. On the other hand, the black-limestone specimens agree in having the liration equally coarse, in having the earlier stages unplicated, and in having the plications, when they do appear, relatively faint and fine. It is unfortunate that the specimen from the Diablo Mountains, from which the description is taken, is not accompanied by enough material to show the range in size and other characters which this species manifests.

Comparisons of the typical specimen with the common *M. striaticostata* of the Mississippi Valley are scarcely necessary, but the larger, more mature examples from the black limestone present a much closer resemblance. The two species should be readily discriminated by their sculpture, for the liræ in *M. attenuata* are rounded, crowded, and coarser than in *M. striaticostata*, in which they are thin and separated by relatively wide striæ. *M. pyramidalis* Newberry and *M. occidentalis* Newberry are too imperfectly known to make comparisons of much value. They are much larger species than those described here, and probably from a different geologic horizon. It is interesting to note that Waagen describes no species belonging to this genus from India, nor does Abich figure any from Armenia. In the Carnic Alps, however, Schellwien found a number of forms, some of them of large size. None of these seems specifically identical with those described here, nor have I the material at hand for adequate comparison, except in the case of *M. irregularis*, which seems to be distinct.

Horizon and locality.—Delaware Mountain formation, Diablo Mountains, Texas, as reported (station 3764). Basal black limestone, Guadalupe Point, Guadalupe Mountains, Texas (station 2967).

MEEKELLA SKENOIDES n. sp.

Pl. XXX, figs. 8 to 9.

Shell small. Ventral valve high, symmetrical, subconical, leaning backward, so that the area makes an obtuse angle with the plane of junction of the valves. Area well defined, high, flat transversely, slightly concave longitudinally; width 8 mm., height 9 mm. Delthyrium of medium size, about 2 mm. in width at its base. A line following the shell from apex to anterior margin would be gently convex; to the lateral margins it would be slightly concave.

Dorsal valve transverse, subcircular. Outline regularly rounded below, contracting at the hinge line to 8 mm.; width below, 13 mm.; length 11 mm. Convexity moderate, with umbo rather gibbous.

Surface marked by 11 or 12 plications, which are high and thin over most of the shell, but die out as the cardinal area is approached. The superficial liræ are fine, subequal, and persistent over the whole surface. They appear to be more or less interrupted or nodose, but this may result, in part at least, from the coarse silicification which the shell substance has undergone.

The foregoing description is based on the type specimen alone, which can readily be distinguished from the type of *Meekella difficilis* by reason of its smaller size and more lofty ventral valve, making a proportionately narrower and higher area, and by the persistence of the striation over the whole surface. To the same species, however, I have referred certain other shells, for the most part more or less fragmentary, which if actually conspecific, as they appear to be, introduce certain modifications of the characters above set down. These are chiefly dorsals, and indicate a width of 20 mm., or even greater in one instance. All, however, are conspicuously lirated, the liræ toward the front curving upward from the bottom of the sulci. One small ventral valve has a lower and broader area, with the apex bent to one side.

Horizon and locality.—Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763). Delaware Mountain formation, southern Delaware Mountains, Texas (station 3501).

MEEKELLA DIFFICILIS n. sp.

Pl. XXX, figs. 10 to 10g.

Shell of medium size. Ventral valve subconical; height about 13 mm., width 24 mm. Area well defined; flat in a transverse direction; slightly concave longitudinally. Pseudodeltidium narrow, slightly convex, poorly defined. An indistinct line dividing the lateral portions of the area about midway indicates the attachment of the dental lamellæ. These structures converge toward the shell wall, which they join in nearly parallel lines, somewhat diverging anteriorly and reaching a little less than halfway from the apex to the front edge. Two other shelly plates, originating one on each margin of the delthyrium, bend strongly to the sides, so that they are nearly parallel to the plane of the area, and become adnate with the two septa just before they join the latter. It seems as if we should call these the true dental plates and the others independent structures. If the large septa are really the dental plates and these small laminæ merely auxiliary, the relation of the latter to the pseudodeltidium and of the pseudodeltidium to the whole area is hard to account for. Surface from beak to front somewhat convex; from apex to sides slightly concave. Cardinal process long and four pronged.

Dorsal valve moderately convex; shape transverse, broadly rounded, somewhat contracted toward the hinge line, which is a little narrower than the shell below.

Surface marked by 11 or 12 strong angular folds, which become less and less distinct laterally. Toward the apex also the plications subside and resolve into moderately coarse subequal liræ. An intermediate stage exists in which the bottoms of the sulci are occupied by liræ considerably smaller than the incipient ridges. Over most of the shell, except at the sides, where the plications are obsolete, the liræ appear to be completely absent, though they may be somewhat obscured by the coarse silicification which the specimen has undergone.

The development of the dental plates in this species, to which reference has already been made, is peculiar. As in most strophemenoids, the area is intersected on each side by an oblique line, extending from the apex to the hinge, which divides more or less equally the triangular surface defined by the edge of the area, the hinge line, and the delthyrium. The two areas on each side of the delthyrium are symmetrical and marked by hatchings extending in one case longitudinally and in the other transversely. In the present species the two plates are directed, not toward the margin of the delthyrium, from which at the hinge line the cardinal teeth presumably project, but to the oblique intersecting line. From the edge of the delthyrium, however, two other plates originate, one on each side, which diverge strongly from one another at an acute angle with the area wall, and become consolidated with the septa not far from where they meet the latter. The interpretation of this singular construction is not entirely obvious, but it may indicate that, to speak strictly, the septa are not dental plates but independent structures.

Horizon and locality.—Delaware Mountain formation, Comanche Canyon, Glass Mountains (station 3763), and mountains northwest of Marathon (station 3840), Texas.

MEEKELLA MULTILIRATA n. sp.

Pl. XXIV, figs. 6 to 6b.

Shell rather small. Length from back to front 21 mm., width 25 mm. Height of ventral valve 12 mm.

The shape of the ventral valve is subcircular at the aperture, much contracted at the hinge line, which has a width of but 14 mm. The area, which is not very sharply defined, is slightly concave longitudinally and strongly inclined backward. The delthyrium occupies about one-third of its width, being 5 mm. wide at its base and 13 mm. high.

The surface is marked by 10 or 11 moderately strong, simple, rounded plications and by very fine, rounded, radiating liræ. The latter have been largely exfoliated, but where preserved come about 6 in the space of 1 mm. They run up from the bottom of the sulci on the sides of the plications in the manner often found in and to a considerable extent distinctive of this genus.

This species is based on the ventral valve represented by my figures, the dorsal valve being unknown. In discriminating this species reliance has been placed not so much on the configuration as on the very fine liration. It occurs associated with shells identified as *Meekella attenuata*, and resembles them in shape rather closely, but is somewhat larger, and above all is much more finely striated. In a general way this shell resembles *M. difficilis;* it differs, however, not only in the finer features of its surface but in having the plication and sulci lower and much less angular. It is more nearly related to *M. striaticostata* than the associated shells referred to

M. attenuata, and I am not satisfied that it will not prove to be identical with our well-known Pennsylvanian species. At present it seems to be distinguished by its less well-defined area, wider pseudodeltidium, and less strongly plicated surface—characters all liable to modification by exfoliation, to which the Guadalupian specimen has been subjected—and to some extent by the sculpture, though this also has been largely lost by exfoliation. The liræ are possibly no finer than in characteristic *M. striaticostata,* but they appear to be low, rounded, and closely arranged. In the Pennsylvanian species they tend to be thin, spaced, and more or less alternating.

Horizon and locality.—Basal black limestone, Guadalupe Point, Guadalupe Mountains, Texas (station 2967).

Genus ORTHOTHETINA Schellwien.

Schellwien's interpretation of the genus *Orthotetes* so far differs from Waagen's, and indeed from that of the original author, that he employs the name for shells having two elongated dental plates like septa in the ventral valve. Waagen, equally wide of the author's real meaning, uses it for shells without any partitions whatsoever. Both—erroneously, it may be said—employ for the type species *Streptorhynchus crenistria* Phillips; but Schellwien's material was specifically—I can not but think generically—distinct from Phillips's species, while Davidson's specimens, from whose illustrations Waagen's conception of the structure of *S. crenistria* was doubtless in part derived, are more probably correctly identified. Schellwien found that in the upper Carboniferous and Permian forms which have this structure the dental plates are parallel and close together, while in the Devonian and early Carboniferous forms they are strongly diverging. For the former Schellwien suggested the term *Orthothetina.*[a] The manner in which this name was put forward was apparently merely a suggestion, the first use being found on pages 8 and 13 of Beiträge zur Systematik der Strophomeniden des oberen Palaeozoicum,[b] and later he appears to have abandoned it altogether.[c]

I have attempted to show on page 198 that *Streptorhynchus crenistria* can not be employed as the type of *Orthotetes,* and that the name itself can not be applied either to the group for which Waagen or to that for which Schellwien used it. For *Orthothetes* Waagen (*non* Fischer de Waldheim) I have proposed the name *Schuchertella.* For *Orthothetes* Schellwien (*non* Fischer de Waldheim) Schellwien's name *Orthothetina,* though by him applied only to a portion, may be used. If it should prove, on further investigation, that the late Carboniferous species must be separated from the Devonian and early Carboniferous ones, it is to the former that the name *Orthothetina* will attach. No American representatives of *Orthothetina* are known, though I have one or two undescribed forms in addition to the one whose description is given below without a name. This seems to be a veritable *Orthothetina,* but it is so imperfectly preserved that but little can be said as to its specific relationship.

[a] The form in which the author wrote this name was *Orthothetina,* but as the name is evidently derived from *Orthothetes* it seems that it should be changed to *Orthotetina,* in accordance with the corrected spelling of that name. If written *Orthothetina,* however, it is less liable to be confused with Waagen's subfamily term Orthotetinæ.

[b] Neues Jahrbuch, Jahrg. 1900, vol. 1, Separat-Abdruck, 1899.

[c] Abhandl. K.-k. geol. Reichsanstalt, vol. 16, heft 1, 1900, p. 16.

The internal structures of this group are precisely those of *Meekella*, so far as known, the only ascertained difference being that it has a smooth shell instead of a plicated one. This difference is hardly generic in degree, but the two names can probably be retained, one as a subgenus of the other. It might be thought that *Meekella* was a later development of *Orthothetina*, but the occurrence of the two genera in America appears to refute this supposition, and to indicate that they originated independently, or that *Orthothetina* was a retrograded form of *Meekella*, for the latter genus appears early in our upper Carboniferous series, while the Orthothetinas, so far as known, came in somewhat later, though while *Meekella* still survived.

ORTHOTHETINA sp.

The shell on which this type is based is a ventral valve found, along with *Orthotetes guadalupensis*, on the east side of El Capitan (station 2926), in the Guadalupe Mountains. It is a type less small and delicate in construction than its associates. Unfortunately, its condition is now too imperfect to permit a full description and a discussion of its specific affinities. It appears to have been semicircular in shape, probably somewhat transverse, with the hinge line nearly as wide as the shell below. The area appears to have been high, generally flat, though considerably warped, and rather strongly inclined backward. Its width was probably about 40 mm. and its height not much less than 25 mm. The maximum width of the pseudodeltidium appears to have been about 10 mm., a good portion of which, however, was occupied by greatly thickened dental lamellæ. These structures are long and converging, and they join the vaulted anterior wall just before the point of their union with one another. There is thus no septum in this valve. The surface ornamentation has been largely lost through exfoliation, but appears to consist of slender, spaced, radiating liræ.

This genus has not previously been recognized in America, and it is to be regretted that the present example is too imperfect for illustration.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926).

Family THECIDEIDÆ Gray.

Subfamily LYTTONIINÆ Waagen.

When Waagen described the subfamily Lyttoniinæ but two generic groups were known to belong to it—*Leptodus* (*Lyttonia*) and *Oldhamina*. Tschernyschew has recently introduced a new generic name (*Keyserlingina*) for a smaller and simpler type, which nevertheless without much doubt belongs to the same subfamily. For many years the Lyttoniinæ were, so far as known, restricted in their distribution to eastern Asia, *Leptodus* being found in India, at Timor in the Indian Archipelago, and in China, and *Oldhamina* only in India. *Keyserlingina* has at present been recognized in the Carnic Alps and in Russia. It is of some interest, therefore, to note the occurrence of this peculiar brachiopod type in the United States, and it should be remarked that the forms which occur here distinctly resemble the Asiatic rather than the European group of species, and lend a decidedly Asiatic or non-Pennsylvanian aspect to the Guadalupian fauna.

Although for a long time *Leptodus* appeared to be restricted in distribution to southeastern Asia, the occurrence in the Guadalupe Mountains is not the first instance that is known of its appearance far from the region of its discovery, for I learn from Diener that Gemmellaro has determined the genus in his fauna from Palermo. Unfortunately, I have been unable to obtain a copy of Gemmellaro's paper, and consequently can do no more than note the fact, of which there are many of a similar sort, that the Sicilian and the Guadalupian faunas possess this singular type in common.

I have cited both *Oldhamina* and *Leptodus* from the Guadalupian, and while the presence here of the former type is a matter of some doubt so far as my material is concerned, it can be said with assurance regarding the latter that the two species which have been recognized are congeneric with Waagen's Lyttonias. Specifically there can be no question that both are distinguished by important differences from the two Indian species. It seems probable that they are more closely related to the Chinese form *L. richthofeni,* but the latter is so imperfectly known that it is impossible to determine how close the relationship really is.

So far as the Lyttoniinæ are concerned, therefore, the Guadalupian fauna may be said to be related to those of the Salt Range, of the Himalaya,[a] of China, and of Palermo, rather than to those of the Carnic Alps and of Russia; and if, as Professor Schuchert has suggested to me, the relative complexity of the septal ridges may be used as some sort of an index of chronologic sequence, the Guadalupian fauna, so far as this type is concerned, may be younger than the Gschelian stage of the Russian fauna.

Tentatively, in view of the their specific characters, the Guadalupian forms are possibly more closely related to the Lo Ping occurrence than to the species of the Salt Range and the Himalaya, the Sicilian type being for the time left out of account.

Genus LEPTODUS Kayser.

The generic name which should be employed for these shells is a matter of some uncertainty. Kayser in 1882, thinking that the fossil was a fish tooth, named it *Leptodus.* This name Waagen rejected, on the ground that it is inappropriate, and in 1887 he proposed instead the term *Lyttonia,* which has found general acceptance.

About the inappropriateness of the term *Leptodus* and the incorrectness of Kayser's conception in regard to it there can be little doubt. Yet this is not generally regarded as a valid argument for substituting a new name for one already proposed. On the other hand, though the name *Leptodus* in its literal form has not been preoccupied, we have *Leptodes* Dej. 1833, *Leptodes* Swains. 1839, *Leptodon* Raf. 1820, *Leptodon* Sund. 1835, and *Leptodon* Gaudry 1860. The first of the names mentioned was applied to a beetle, the second to a fish, the third to a mollusk, the fourth to a bird, and the last to a mammal.

[a] In the Himalaya *Leptodus* has been cited by Diener from Kashmir, from "Chitichun No. 1," and from Malla Sangcha the species being, so far as can be told, similar to those of the Salt Range.

As to its derivation, *Leptodon* has the same source as *Leptodus*. *Leptodes* Dej. is differently derived, while the derivation of *Leptodes* Swains. is not known to me. *Leptodus* and *Leptodes* are certainly different words, and in one case at least, as has just been seen, have different derivations. As they were proposed for very different groups of organisms there is little or no danger of confusion, and it seems that Kayser's name can safely be retained so far as *Leptodes* is concerned. *Leptodon*, though having the same origin as *Leptodus*, is still more different from the latter than is *Leptodes*, and like *Leptodes*, except in the case of *Leptodon* Rafinesque, applies to very different zoological groups. It seems to me, therefore, that none of the circumstances related can be considered as interfering with the validity of *Leptodus* Kayser, which is here adopted.

LEPTODUS AMERICANUS n. sp.

Pl. IV, figs. 8 to 8b; Pl. XXV, figs. 1 to 3a.

Shells belonging to *Leptodus* have been found in the Guadalupe, Glass, Diablo, and southern Delaware mountains. Those from the Diablo Mountains are silicified, and it has been possible to ascertain their characters with much greater completeness than in other collections, where the preservation is for the most part imperfect.

These specimens show a rather small species, more the size of *L. tenuis* Waagen than *L. nobilis* Waagen. Its greatest length can hardly have been greater than 50 mm. The largest fragments in our collection are only about half that. But little can be said in regard to the shape, which was probably narrow, truncated at the posterior end and expanded in front. As a rule ventral valves appear to have been more or less flat longitudinally and curved transversely, having what may be called an irregular scoop-shaped configuration. They were attached for a varying but small portion of their extent at the posterior end. The outer surface is marked by obscure transverse folds and by finer striæ. These do not conform altogether to the direction of the septa on the inner side, and if the anterior outline followed their direction it must have been broadly and gently curved.

On the inside there is a low, narrow median septum, with lateral septa. The latter are extremely variable, depending considerably on the distortion of the shell. They may be either nearly straight or strongly curved, the convex side directed toward the hinge; they may be either normal to the median septum or strongly inclined to it; they may be high or low, and are variously shaped. Usually they are thin and high at the inner end, becoming low and flattened at the outer, where they are crowned by a double row of pustules. In other specimens, or even other parts of the same specimen, they have a very different character, consisting of double ridges uniting into a loop at the inner end. This is perhaps the primitive form, later shell deposits elevating and unifying the constituent ridges except at the outer ends. Sometimes the median septum also is double. The shell was probably normally extended beyond the septate portion into broad lateral expansions more or less upturned. The entire inner surface is covered with papillæ, but these are more abundant and noticeable on the lateral expansions. They occur in double rows on the crests of the septa, as previously remarked.

The dorsal valve is small and pinnate in shape. Apparently the lateral branches do not unite into a solid rim. On one side (the inner) there is a median elevated ridge or septum, which is made double by a groove down the center. Farther forward the groove develops into a fissure, so that the valve becomes bilobate. The lateral branches are concave, with an elevated rim which follows the sinuous margin The other (outer) side of the dorsal valve is distinguished principally by its strongly pustulose surface. It has a slight mesial groove and the different branches are convex. Waagen states that it is the outer side of the dorsal valve which is pustulose, and I have oriented my specimens accordingly. I would have thought, but for this, that the pustulose side was the inner one, since the inner surface of the other valve has this character. I have not observed the dorsal valve in place, however, and of the two small imperfect dorsals which have been observed, though both are nearly flat, one is more or less concave and the other slightly convex.

No specimen has come to hand from the "dark limestone" and only a single fragment from the sandstones of the Delaware Mountain formation. This fragment, preserved as an internal mold of the ventral valve, shows what would be a smooth central band, along the middle of which ran a median septum and at the sides of which began the lateral septa. These were simple, thin, and high, and the general appearance must have been that of the Diablo rather than that of the Guadalupe specimens. I have accordingly identified this form provisionally with *L. americanus*.

Horizon and locality.—Base of Capitan formation, hill southwest of Guadalupe Point (station 2906); Delaware Mountain formation, Guadalupe Point (station 2931), Guadalupe Mountains, Texas. Delaware Mountain formation, Diablo Mountains, Texas (station 3764). Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969). Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763).

LEPTODUS GUADALUPENSIS n. sp.

Pl. IV, figs. 6 to 7.

In the white limestone of the Guadalupe Mountains *Leptodus* is fairly abundant, though few specimens are well preserved. The ventral valve usually presents itself as an internal mold, more or less of the shelly substance adhering to it. The dorsal valve is mostly very fragmentary. Unlike the form from the Diablo Mountains, specimens in this region as a rule occur singly, and apparently seldom grew in groups cemented to one another. The largest fragment observed measures 40 mm. and when entire probably reached 50 mm. or more. The width is much less, the shape being elongate, gently tapering toward the posterior end. Longitudinally the shell was nearly flat; transversely it was gently convex at the bottom, with the sides upturned and irregularly folded inward.

On the interior a median septum was present, at least in some examples. Seen in the reverse, as partial molds, the lateral septa present the following appearance: There is a series of rather slender raised ridges arranged pinnately to the median line, connected by curved continuations at alternate ends, so that the whole makes a more or less connected series of closely arranged sigmoid curves. The inner curves occur at short and regular distances from the mesial line, the outer near edge of the shell, where the upturned margin begins. These elevated ridges are studded with a single row of pustules, which are probably not altogether due to weathering, though they may have been exaggerated by it. Partly surrounding each of the lobes thus formed is a depressed line or channel. These pairs of pinnate channels are united at the outer but not at the inner end and thus make narrow U-shaped figures. The channels evidently correspond to the septa of the silicified specimen (of *L. americanus*), the elevated loops being the depressions by which they are separated. We have here, however, a distinct elevation in the center.

An example showing these characters is represented by fig. 6, Pl. IV, while fig. 6a is an artificial impression representing the real configuration of the interior of the same shell, except for the accidents of preservation. Here we see an elevated central band bearing a low median ridge or septum. Extending pinnately from the central area are loop-shaped grooves, the bottoms of which are conspicuously marked by rather large pits. The centers of the loops are gently elevated, and they are separated by high, rather thin, ridges, which are connected at their outer ends by less prominent curved continuations. Toward the front the structure at first appears to be very different, but a careful comparison shows that in fact it is constructed on the same plan, though with some modification. The diverse appearance seems to be due to an increased prominence of the area inclosed by the loop-shaped groove, so that it equals or dominates the ridges dividing the grooves from one another, which more posteriorly stood relatively higher.

This specimen has the sides much extended beyond the septate portion, rolled up, and irregularly arched over. It seems to me probable that this was the normal condition in this species. The slight protection to the animal parts afforded by the semiobsolete dorsal valve would apparently need to be augmented by these expansions of the ventral shell. Their apparent absence in many cases would be amply explained by the breakage due to their thinness and lack of support.

The specimen and impression on which the foregoing description is based are from the Capitan limestone at station 2926. Other specimens from the same station are more imperfect and less well preserved. The central idea of the lateral septa seems to be a loop-shaped ridge bounded within by a groove having the inclosed band gently elevated.

Several examples, somewhat differently preserved, have been obtained from the same horizon at station 2906. Two of these retain the shell, but are more or less exfoliated, so that their assignment to *Leptodus* is not confined to the evidence of the outside. They have a broadly triangular shape, flattened over the back, but turned up at the sides. Here again the lateral lobes of the septa consist of a loop-shaped ridge followed within by a groove surrounding a gently elevated central band. At this locality was found a specimen which with little doubt represents a very young example of the same species. It is a small, triangular, scoop-shaped shell, having a length of 6 mm. It is cemented at its posterior end to a branched bryozoan. The outside is somewhat irregular, but generally smooth. The inside is partially covered by the dorsal valve, which in this instance is four-lobed or four-rayed, being divided into two main branches, each of which again subdivides. The four branches fit into four depressions in the ventral valve, the remainder of which is unprotected. This specimen shows the character of the articulating structure. The dorsal valve terminates in two lateral projections, which are surrounded by an inflection of the shell of the ventral valve, thus effecting a crude sort of hinge, one very different from the normal brachiopod structure.

It should be noted that the exterior of this valve is not papillose, but, on the other hand, the specimen is so immature that the exposed portions of the inner surface of the ventral valve are very slightly papillose, if at all.

From the Glass Mountains only two fragments have been examined. One of these shows a longitudinal median ridge, having indications of a faint septum. The lateral septa terminate at this with a strong backward bend, and their outer ends are connected by curved prolongations. Intermediate between two of these prominent ridges is another fainter one, which is nearer the proximal than the distal of the two septa between which it lies. The grooves separating the ridges seem to be marked by comparatively large pits.

I originally united all the occurrences of *Leptodus* into a single species, but became far from satisfied with the course. Apparently two groups can be distinguished—one represented by specimens from the Capitan formation of the Guadalupe Mountains and from the Glass Mountains, the other comprising specimens from the Delaware Mountain formation and from the Diablo Mountains. The septal lobes in the former appear to be less distinctly formed, to be somewhat more closely arranged, to lack pustulous ornamentation on the crests of the ridges, and to contain pits at the bottom of the grooves not found in the other. These characters are all connected with the septal ridges, but there are also other differences in the configuration and mode of growth found at least in the typical specimens. These forms manifest such variation in the character of the septa, however, not only in specimens from the same locality, but in the same individual, that I feel some doubt about trusting to the differences which appear to exist without more extended observations than my present material permits.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926).

Genus OLDHAMINA Waagen.

OLDHAMINA? sp.

Two fragmentary specimens from the Capitan formation of the Guadalupian are distinguished from *Leptodus guadalupensis* and *Leptodus americanus*, which are fairly constant in being nearly flat longitudinally, by having a strong curvature in that direction. Otherwise the characters appear to be essentially the same.

The inrolled shape, together with the massive hinge plate, discriminates *Oldhamina* from *Leptodus*. The hinge in my specimens has not been made out, but because they possess the marked longitudinal convexity they have been provisionally referred to *Oldhamina*.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926).

Family PRODUCTIDÆ Gray.

In most faunas of Carboniferous age the Productidæ are represented principally, often to the exclusion of all other types, by the great genera *Chonetes* and *Productus*. This is much the case in the Guadalupian fauna, though we have in addition to the genera mentioned two others, *Strophalosia* and *Aulosteges*. The group of shells separated by Waagen under the title "*Marginifera*," which usually occurs more or less abundantly in the later faunas of the Carboniferous, appears to be absent from the one under consideration. Several Guadalupian types have much the external appearance of the Marginiferas, but so far as known lack the characterizing internal structures, while one species which shows some suggestion of the characteristic submarginal ridges is more or less aberrant in point of other internal characters and of configuration. It has therefore seemed inadvisable to refer any Guadalupian species to *Marginifera*.

I have discussed the *Chonetes* and *Producti* under special captions, and propose here to pass in review the remaining Guadalupian Productidæ, as well as those which were found in other faunas but are lacking in the Guadalupe Mountains.

In the Salt Range fauna Waagen recognizes, in addition to *Chonetes* and *Productus*, the genera *Strophalosia*, *Chonetella*, *Aulosteges*, and *Marginifera*. Of *Strophalosia* he distinguishes eight species, as against two in the Guadalupian. While in a general way the Strophalosias of the two faunas are similar to one another, it would appear that they are much less numerous as well as less differentiated in the Guadalupian. No forms corresponding to the group of *S. leplayi* Geinitz, represented by *S. costata*, are known in the American fauna.

Aulosteges occurs in the Productus limestone in two distinct types, each represented by a single species, and a rather marked correspondence can be noted between them and the Guadalupian representatives of the genus. Shumard's species *Aulosteges guadalupensis* corresponds to the Indian *A. dalhousii*, while the Indian *medlicottianus* appears to be represented in Texas by *A. medlicottianus* var. *americanus* and *Aulosteges* sp. The latter two, though to all appearances closely related to one another, occur at widely different horizons in the Guadalupe Mountains. Two other Guadalupian types, represented by *A. magnicostatus* and *Aulosteges* sp. *b*, seem not to occur in the Salt Range.

The genus *Chonetella*, which is represented in the Salt Range by abundant individuals though by only a single species, is not found in the Guadalupe Mountains. *Marginifera* also probably does not occur there, while Waagen found six species in the Productus limestone fauna. It is true that some Guadalupian species of *Productus* externally resemble certain of Waagen's Marginiferas, but so far as it has been possible to determine they do not belong to the same genus. Thus the Indian shells assigned to the group of *Marginifera splendens* may be compared with *Productus popei*, *P. indentatus*, and *P. texanus*; *Marginifera transversa*, representing the group of *M. helica*, with *Productus latidorsatus*; and *Marginifera ovalis*, of the group of *M. spinosicostata*, with *Productus subhorridus* var. *rugatulus*.

In his paper on fossils from Kashmir and Spiti, in the Himalaya, Diener described *Marginifera* and *Strophalosia*, in addition to *Chonetes* and *Productus*. *Marginifera himalayensis* n. sp., the only representative of the genus, has no cognate form in the Guadalupian fauna, though superficially it is of the general expression of certain of the *Producti*—the smaller ones of the *semireticulatus* type. Of the two Strophalosias one, *Strophalosia* aff. *S. costata*, has no corresponding form in my fauna, but *Strophalosia* cf. *? tenuispina* Waagen is more nearly of the same general type. In his later paper on the Spiti fauna, in which he discriminates between an upper and a lower horizon, this author cites *M. himalayensis*, above referred to, and *Aulosteges gigas* from the upper division. The latter appears to resemble *A. guadalupensis* Shumard.

The Chitichun fauna as represented in Diener's earlier paper, aside from *Productus* and *Chonetes*, contains the genera *Marginifera* and *Aulosteges*. *Marginifera* is represented by the Salt Range form *M. typica*, and is, so far as known at present, absent from the Guadalupian. *Aulosteges tibeticus*, the single species of *Aulosteges* cited, is closely related to *A. magnicostatus* of the Guadalupian. The later paper on Chitichun contains no additional species.

The fauna from Malla Sangcha contains of this group, aside from *Productus* and *Chonetes*, only two species of *Marginifera*—*M. typica* and *M. helica*. If these have any corresponding forms in the Guadalupian it must be among species which I have felt constrained to refer to the genus *Productus*. The same applies to *M. himalayensis*, cited from the Productus shales of the Lissar Valley, the only species aside from *Chonetes* and *Productus* belonging to the Productidæ known from this locality. *Marginifera typica* has the same relation in the fauna from Byans.

On the whole it can not be said that the Guadalupian fauna, either in its *Producti* and *Chonetes*, which have been considered elsewhere, or in the other Productidæ, is very closely related to those of the Salt Range and the Himalaya, though both the resemblances and the differences are interesting. Too much stress should not be laid on the apparent absence of *Marginifera* from the Guadalupian fauna, for the shells which might be supposed to represent this genus are not always preserved so as to show the distinctive characters. If what appears proves actually to be the case, however, the absence of *Marginifera*, as of *Chonetella*, will be among the most important differences, and the most striking resemblance will be found in the genus *Aulosteges*, which is, however, much better developed in the American fauna.

Kayser distinguishes two species in the Lo Ping fauna, which he refers to *Strophalosia*, although it is possible that they really belong to *Aulosteges*. His figures, in fact, may include three species, none of which is closely related to those of the Guadalupian fauna, so far as the latter are known. One of Kayser's species of *Productus* can probably be placed with *Marginifera*, namely, *Productus nystianus* var. *lopingensis*.

In the fauna from Kantschoufu Loczy cites a little productoid as *Productus* (*Marginifera*) *longispinus* Sowerby, which is probably a small *Productus* of the *semireticulatus* group, not very unlike some of the Guadalupian species, though apparently belonging to an older fauna. The forms cited as *Chonetes* or *Daviesiella* sp. nov. and *Chonetella dubia* n. sp. have no related forms in the Guadalupian. The form from the "Permo-Carboniferous" of Batang which Loczy compares with *M. ovalis* Waagen suggests some of the Guadalupian *Producti*, e. g., *Productus latidorsatus*. The form from the Lantsankiang Valley, described as *Marginifera desgodinsi*, in which the submarginal band is very pronounced, has no Guadalupian representative. The "Permo-Carboniferous" fauna from Tschungtjen, in the province of Yünnan, contains a species which appears to be closely related to *Aulosteges medlicottianus* var. *americanus*. Loczy cites it as *Aulosteges* aff. *medlicottianus*.

Compared with that of the Productus limestone of the Salt Range, the other Asiatic faunas, even those of the Himalaya, are known in a relatively scanty and imperfect manner. In so far as they involve the minor genera of the Productidæ they show no marked affinity with the Guadalupian fauna; indeed, rather the reverse.

Etheridge senior recorded two species of *Strophalosia* from Queensland (one of them as a *Productus*), and Etheridge junior also recognized two from the Bowen River coal field of the same province. The latter are *Strophalosia gerardi* King and *S. clarkei*, one of those which the senior Etheridge had described as a *Productus*, as above noted. The other form mentioned by the latter is cited merely as "*Productus*" or "*Strophalosia*." It appears to be of the general type of *Aulosteges guadalupensis*, though not closely related to it. The imperfectly known *S. clarkei* is apparently related to *A. medlicottianus* var. *americanus*, while the shell referred to *S. gerardi* seems to have no corresponding form in the Guadalupian, unless perhaps *Aulosteges* sp. *b* proves to resemble it.

In the earlier faunas of the Russian section the Productidæ are represented by the genera *Productus* and *Chonetes* (and *Daviesiella*), with an occasional occurrence of *Marginifera*. In the Gschelian, among the less prominent members of the family Tschernyschew recognizes one species of *Aulosteges*—*A. dalhousii*, which is closely related to *A. guadalupensis* Shumard. *Proboscidella* claims three species. This group appears to be absent from the Guadalupian fauna, though some of the Guadalupian *Producti* of the *semireticulatus* group are like immature stages of the Gschelian species. Eight species are assigned to *Marginifera*. This group also seems to be missing from the Guadalupian fauna, and although some of the Guadalupian *Producti* resemble the Russian Marginiferas (chiefly small members of the *semireticulati*, like *Productus popei*, *P. indentatus*, and *P. texanus*), they are without the characteristic submarginal ridges, so far as known. *Marginifera juresanensis* looks something like *Productus latidorsatus*, but here again the Guadalupian species seems to be a true member of *Productus*. The Guadalupian productoid which seems most likely to prove a *Marginifera* (*Productus? pileolus*) is unlike the Gschelian Marginiferas, of which the nearest is unquestionably *M. juresanensis*.

From the Artinsk Sibirzew cites *Strophalosia* sp. and Tschernyschew *Marginifera typica* and *Marginifera? spitzbergiana*. Krotow found a greater variety in the Artinsk than the other authors consulted, identifying *Strophalosia horrescens?*, *S. morrisiana?*, and three species of *Chonetella*. The latter name was subsequently changed to *Chonetina*, Waagen having published the same name in the same year. It is perhaps not safe to express an opinion without having had access to specimens, but the generic diagnosis of *Chonetella* Krotow and the figures of the species leave one very doubtful of the validity of the name even as a subgenus. *Strophalosia horrescens?* is probably related to *S. guadalupensis*, but *S. morrisiana?*

is presumably without a Guadalupian representative. In the Permian *Strophalosia* [*Aulosteges?*] *horrescens* and *Aulosteges wangenheimi* seem to be most often present among the minor productoid genera, and Netschajew describes also *Strophalosia fragilis* and *Aulosteges gigas*. *Aulosteges gigas* and *Strophalosia* [*Aulosteges?*] *horrescens* may be compared with *Aulosteges guadalupensis*, and *Strophalosia fragilis* with *S. cornelliana* and *S. hystricula*. The types represented by the Guadalupian forms *Aulosteges medlicottianus* var. *americanus*, *Aulosteges magnicostatus*, and *Aulosteges* sp. *b* seem not to occur in the Russian Permian. The Russian *A. wangenheimi* seems to be usually in poor condition, and I am in doubt as to what its specific characters really are.

In the case of these minor genera the Guadalupian fauna appears to be related to the later faunas of the Russian section—perhaps more to the Russian Permian than to earlier horizons. I do not know whether especial importance should be attached to the dying out of the Marginiferas above the Gschelian stage, in which respect a Guadalupian peculiarity is suggested, or whether this should be regarded merely as a phase in the general decline of the brachiopod representation.

From Balia Maaden, in Asia Minor, Enderle cites a form under the title "*Strophalosia?* aff. *horrescens*," which he is uncertain whether to call a "*Productus*" or a "*Strophalosia*." If it is not a *Productus* it may be compared with *Aulosteges guadalupensis*.

Among the Armenian forms which Abich refers to *Productus* are a number that Waagen and later authors have recognized as belonging to *Marginifera*. These in many cases closely resemble Guadalupian types which I have referred to *Productus* (*P. latidorsatus*, *P. subhorridus* var. *rugatulus*, and *P. walcottianus*). It can not be stated definitely that these Guadalupian species are without the submarginal ridges of Waagen's genus, but I have seen no evidence for believing that they possess them. In the Armenian species these ridges are extremely well developed.

The fauna of the Carnic Fusulina limestone seems to contain, according to Schellwien, only *Marginifera pusilla* to represent the minor Productidæ. This form is not closely similar to any Guadalupian species, even if some of them should prove to be Marginiferas. In the Trogkofelschichten he distinguishes *Marginifera longispina*, *M. longispina* var. *lobata*, *M. pusilla*, and *M. carniolicus*. The figures of *Marginifera longispina* and the variety naturally resemble certain of the Guadalupian *Producti*. So also do part of the figures of *M. pusilla*, the others being different and more like the original figures of the species. In *M. carniolicus* can be traced a rather distant resemblance to *Productus? pileolus*, the Guadalupian shell, which at present seems to show most liability of being a *Marginifera*. Schellwien also figures as *?Aulosteges tibeticus* Diener, a specimen which is closely related to *Aulosteges magnicostatus*.

In the Dyas the remarkable diminution in *Productus* forms is in a measure compensated by the great development of cognate genera. Geinitz recognizes eight species of *Strophalosia*, most of which may prove to belong in *Aulosteges*. In addition, the figures of *Productus latirostratus* are certainly suggestive of *Aulosteges*. It is probable that several of the Dyas species are of the same general type as *A.*

guadalupensis. Some of Geinitz's figures of *Strophalosia morrisiana* seem to warrant a comparison with *Aulosteges medlicottianus* var. *americanus* and *Aulosteges* sp. *a*, although others are very different. Indeed, the appearance of these forms is as various as their manner of preservation. *Strophalosia lamellosa* seems to belong to the same type as my *Aulosteges* sp. *b*, but *Productus latirostratus*, if, as I suspect, it is an *Aulosteges*, appears to have no corresponding Guadalupian form.

The Permian fauna of England, closely related to the Dyas of central Europe, is likewise distinguished for its abundance of Strophalosias. King discriminates four species and figures many specimens. The prevailing forms seem to be of the same general type as *Aulosteges guadalupensis*, but *Strophalosia morrisiana* may be compared in certain particulars with *Aulosteges medlicottianus* var. *americanus*.

In the Arctic faunas of Spitzbergen, Nova Zembla, etc., the Productidæ are in the main restricted to the two genera *Productus* and *Chonetes*. It is true that some of these forms may prove to belong to the subsequently established group of *Marginifera*, but in this case, as in others, the fact can hardly be determined from the evidence at hand. In several instances, however, Toula has cited species of *Strophalosia* among these forms. One of these is an undetermined species from the south point of Spitzbergen, which is more similar to *Aulosteges guadalupensis* than to any other Guadalupian type, but at best is only in a general way like it. From the Hornsund he cites *Productus* (*Strophalosia*) *cancrini* and *Strophalosia leplayi*. The latter, if not a *Productus*, is probably closely allied to *Aulosteges magnicostatus*. The other shell seems to be a true *Strophalosia*, having, however, a sculpture much resembling *Productus cancrini*, which I take to be a *Productus* as originally described. *Strophalosia cancrini* of Toula therefore would seem to be related to *S. morrisiana* of the Dyas and to be somewhat similar to *Aulosteges medlicottianus* var. *americanus* of the Guadalupian.

In the South American faunas the only genus besides *Chonetes* and *Productus* (unless among the latter there prove to be representatives of *Marginifera*), the citation of which appears in the volumes consulted, is *Strophalosia*, and the only recorded species *Strophalosia cornelliana*, a form which has two cognate species in the Guadalupian. *S. cornelliana* was described by Derby from Brazil and he is also the author of several species of *Productus* which may prove to belong to the subsequently defined genus *Marginifera*. *P. rhomianus* is the one most likely to be transferred.

In North America the minor genera of the Productidæ appear only in *Aulacorhynchus*, *Strophalosia*, and *Marginifera*. The rare genus *Aulacorhynchus* is, so far as known, confined to the Pennsylvanian of the Mississippi Valley and Appalachian region. The only Pennsylvanian species of *Strophalosia*, *S. spondyliformis*, is related in a general way to the Guadalupian Strophalosias, but the four Guadalupian species of *Aulosteges* find no types at all corresponding to them in the Pennsylvanian. *Marginifera* constitutes an element of greater persistence than variety in the Pennsylvanian faunas, and the representatives of the genus resemble some of the Guadalupian species of *Productus* in which the characteristic internal features of *Marginifera* appear to be lacking. The only Guadalupian species which at present seems likely to prove a *Marginifera* is very unlike any Pennsylvanian member of the genus.

Except for the genus *Marginifera*, which is scantily developed, if at all, in the Guadalupian but well developed elsewhere, the Guadalupian fauna in its minor productoid genera more closely resembles that of the Salt Range and of the higher Paleozoic terranes of Russia and central Europe than any fauna of the Mississippi Valley.

Genus CHONETES Fischer de Waldheim.

Waagen justly directs attention to the differentiation shown by this genus in the Productus limestone fauna, in which he recognizes as many as 14 species, the development being in some respects no less singular than it is varied. Some estimation of this really remarkable differentiation may be reached by recalling that in the Guadalupian fauna but 4 species have so far been distinguished.

Waagen divided the Salt Range species into three groups, which he distinguishes as the *læves*, the *striati*, and the *grandicostati*. Of these the group of *grandicostati*, represented by six species, is practically confined to the Himalayan region. The Guadalupian species seem about equally divided between the *striati* and the *læves*, for I would place *Chonetes subliratus* and *Chonetes* sp. in the former group, while *Chonetes permianus* and *C. hillanus* probably belong to the latter. In certain conditions of preservation or over certain portions of the surface there is an ambiguity about these forms which renders them difficult to place, for owing probably to the development of rows of radiating punctæ, they sometimes appear to be obscurely lirated. Thus, while *C. permianus* usually appears entirely devoid of radiating ornamentation, marginal portions of some specimens show obscure liræ. In this case the appearance may be due to weathering. In *C. hillanus*, also, obscure liration is developed by exfoliation and sometimes seems to be present toward the margin where unexfoliated. In the latter case the radiating lines may be due not so much to unevenness in the outer surface as to internal structures, such as rows of spinules or of punctæ.

As already remarked, the singular group of the *grandicostati* is not represented in the Guadalupian and the *striati* are represented by but two species. The only determinable Guadalupian species of the latter group, *C. subliratus*, has no counterpart in the Productus limestone fauna. A closer correspondence, however, is shown by the *læves*, *C. ambiensis* being represented in the Guadalupian by *C. permianus* and *C. trapezoidalis* by *C. hillanus*, although the latter is more like our common *C. geinitzianus* than any of the Salt Range species. The singular *C. bipartitus* has no analogous form in the Guadalupian.

In the Permian fauna from Kumaon and Gurhwal Diener distinguished but two species, both of the striate group. The *læves* of the Guadalupian are, therefore, so far as known, not represented there, while *C. subliratus*, of the *striati*, finds no analogue among Himalayan shells, which are more nearly like *Chonetes* sp. In the Himalayan region, further, the genus seems to be unrepresented at Chitichun and at Malla Sangcha.

From the Productus shales of the Lissar Valley Diener identifies *Chonetes* cf. *uralica* Möller, one of the *striati* related to *Chonetes* sp. of the present work. Again from the Productus shales of Byans he identifies *C. lissarensis* and *C. transitionis* Krotow, both of which, if they have any representatives in the Guadalupian, find them among shells referred to *Chonetes subliratus* and *Chonetes* sp. Diener describes the surface of *C. transitionis* as consisting of very numerous radiating lines crossed by more distant concentric striæ, remarking, further on, that this combination of radiating and concentric sculpture is so peculiar that a new group name—*striati-concentrici*—must be introduced. Most of the American species which I have supposed should be placed with the *striati* possess what appears to be this same type of sculpture, though as a rule the crenulating concentric liræ are considerably finer than the radiating ones. This feature is frequently omitted in descriptions, but I had supposed it to be present in all well-preserved representatives of this group.

From the upper Anthracolithic beds at Spiti only *C. lissarensis* is cited in Diener's second paper dealing with this fauna, but in that on fossils from Kashmir and Spiti he distinguishes four species of *Chonetes*. Two of these—*Chonetes* cf. *lissarensis* and *C. austenianus*—are referred by him to the *striati*, and the two others—*C. grandicostatus* and *C. barusiensis*—to the *grandicostati*. Waagen considered *C. austenianus* also a representative of the *grandicostati*, a group which, as already remarked, appears to be unrepresented in the Guadalupian fauna. In any event, the only Guadalupian species which are related to them are those here designated *Chonetes subliratus* and *Chonetes* sp.

This Kashmir fauna had been partially described by Davidson as early as 1866. He found some of the species afterwards cited by Diener, as well as certain others. The species of *Chonetes* recognized by Davidson are, among the *læves*, *Chonetes lævis* itself, most nearly related to *C. permianus* Shumard; among the *striati*, *C. hardrensis* var. *thibetensis*, similar in a general way to *C. subliratus*, and, among the *grandicostati*, *C. austenianus* and *C. barusiensis*. The latter was described as a *Spirifer*. *C. austenianus*, as above noted, is placed by Diener among the *striati*, but it is doubtful if either of these imperfectly known forms has a cognate species in the Guadalupian.

From Niti Pass, in the northern Himalaya, Salter describes only one species of *Chonetes*—*C. vishnu*, a coarsely ribbed type with a deep sinus, to which the most closely related Guadalupian forms are *C. subliratus* and *Chonetes* sp., though the relationship is rather remote.

In the Carboniferous of Turkestan Romanowsky distinguishes four species of *Chonetes*—*C. hemisphericus* Sem., *C. variolatus* D'Orb., *C. kutorganus* Sem., and *C. glaber* Geinitz. The three first-mentioned belong to the *striati*, and find analogous species in the Guadalupian in *C. subliratus* and *Chonetes* sp., though in fact many of the *striati*, even though from different horizons and different faunas, are in a general way very similar to one another. *C. glaber* finds a nearly related form in *C. permianus*. The shell from Turkestan, it may be remarked in passing, is probably distinct from *C. glaber* = *C. geinitzianus*, of the Pennsylvanian of America.

Richthofen mentions no species of *Chonetes* in the Lo Ping fauna of China. In the fauna from the vicinity of Kantschoufu Loczy identifies a number of *Chonetes* forms, besides a species which he refers to *Chonetella* and one which he thinks may belong to *Daviesiella*. The two latter have no analogous Guadalupian species, but the *Chonetes* representation is more similar. Among the *striati* he recognizes *C. pseudovariolatus* Nikitin, *C. uralicus* var. *pygmæus* Loczy, *C. flemingi* var. *gobicus*, and *Chonetes* cf. *buchianus*. These are related to *C. subliratus* and *Chonetes* sp. of the Guadalupian, *C. subliratus* being especially comparable to *C. uralicus* var. *pygmæus*. The remaining species cited by Loczy, *Chonetes* cf. *politus* McCoy, is one of the *læves* and resembles *C. permianus*.

The other Chinese faunas described by Loczy are less completely known, and in only one is the genus *Chonetes* represented—that from Youngtschangfu—in which he cites *C. papilionaceus*. No species comparable to this very finely lirate form is known from the Guadalupian.

In the upper Carboniferous fauna of Padang, described by Fliegel, the genus *Chonetes* fails of representation, as also in that from the west coast of Sumatra, described by Roemer. In the Permian of Timor and Rotti, in the Indian Archipelago, Rothpletz cites *Chonetella nasuta*, a type unknown in the Guadalupian, but no representative of *Chonetes*. The genus fails to occur also in the small collection from Vladivostok described by Tschernyschew.

From Queensland and New Guinea Etheridge cites five species of *Chonetes*, only one of which is identified. All are of the striated type, which is imperfectly represented in the Guadalupian by *Chonetes subliratus* and possibly by *Chonetes* sp.

Among the Carboniferous faunas of New South Wales described by De Koninck but two species of *Chonetes* are recognized, both of which appear to occur in the lower beds of the Carboniferous section.

From the younger Carboniferous faunas of Armenia, which Abich and later Arthaber discussed, no representatives of *Chonetes* are known, although Frech cites *C. hardrensis* from a younger fauna, which, however, has little interest to our present comparisons. Also in the fauna of Balia Maaden, described by Enderle, this genus appears to be without representation.

In the Russian Carboniferous section *Chonetes* shows a fairly large and varied representation. From the *Productus giganteus* zone I have found three species cited, but this fauna does not especially concern us. From the *Spirifer mosquensis* zone Trautschold cites only *Chonetes variolatus* of the *striati*. *C. pseudovariolatus* (possibly the same species) has also been cited from this horizon. The *Chonetes* manifest their greatest differentiation, however, in the Gschelian and Artinsk, while in the Permian, like so many of the Brachiopoda, none have yet been found. In the Gschelian Tschernyschew recognizes no less than 12 species. Five of these would probably be assigned to the division *læves*—*C. alatus*, *C. morahensis*, *C. trapezoidalis*, *Chonetes* cf. *geinitzianus*, and *C. mesolobus*. Of these the second and third were originally described from India and the last two from North America. The identification of *C. geinitzianus*, of which Tschernyschew himself was in doubt, is almost certainly in error. The shape is unlike that of our American species, and in the figures the surface appears to have delicate radiating striæ. Furthermore, unless Tschernyschew's figure is poor, one can hardly accept the original of the other species as belonging to *C. mesolobus*. Instead of having a median fold in the ventral valve, bounded on each side by deep furrows, Tschernyschew's figure seems to show only a broad ill-defined sinus. It is true that in some American specimens the lobation is less distinct than in others, although in typical examples it is of course very strong.

Of the læves identified by Tschernyschew, that referred to *C. trapezoidalis*, more than the other species, seems to have a related form in the Guadalupian, *C. hillanus* var. *inflatus* being very similar to it. The remaining seven species, with one exception, belong to the *striati*, a group, accordingly, which is better represented in the Russian fauna than in the American. Two of the names cited by Tschernyschew—*C. granulifer* and *C. flemingi*—are well-known Pennsylvanian species, and the Russian figures, so far as can be told, indicate a much more nearly exact identity than in the case of the two types belonging to the *læves* just mentioned. In the Guadalupian this group of the *striati* is represented only by *Chonetes subliratus* and *Chonetes* sp. *C. uralicus* is, perhaps, nearest to *C. subliratus*, while the remaining Gschelian species are more similar to the imperfectly known *Chonetes* sp. The last of Tschernyschew's *Chonetes*—*C. timanicus*—has a surface, so far as I am aware, unique in the genus, and represents a distinct division coordinate with the *striati*, the *læves*, etc. Nothing like it is known from the Guadalupian.

In the Artinsk this genus appears to have flourished and to have been extensively differentiated. Stuckenberg cites *C. variolaris*, *C. variolatus*, *C. uralica*, *C. productoides*, *C. alatus*, *C. solidus*, *C. transitionis*, *Chonetes* cf. *capitolinus*, *C. sinuatus*, and *C. artiensis*. Of these ten species only two are figured, and only two or three are cited from the preceding Gschelian. In the succeeding Kungurstufe only *C. variolaris* was identified by Stuckenberg. *C. alatus* appears to be one of the *læves*, and its peculiar shape renders it almost unique in the genus. No Guadalupian species can be compared with it. *C. productoides*, however, is one of the normal *striati*, like *C. variolaris*, *C. variolata*, *C. uralicus*, and others. Krotow also cites a number of Artinskian *Chonetes*, viz, *C. variolaris*, *C. variolatus*, *C. uralicus*, *Chonetes* sp., *C. solidus*, *C. capitolinus*, *Chonetes* sp. nov., and *C. transitionis*, as well as *Chonetella minima*, *Chonetella artiensis*, and *Chonetella sinuata*. *Chonetes uralicus*, *C. solidus*, and *C. transitionis*, which are the only ones figured, are modifications of the common striate division. To this group probably belong also the three species of *Chonetella* (a name preoccupied by *Chonetella* Waagen and later changed to *Chonetina*), for I am of the opinion that Krotow's genus is not valid on the characters mentioned by its author. Tschernyschew cites from the Artinsk only *Chonetes variolaris* and *C. transitionis*, the latter remarkable for its very fine liration. On the whole, the Guadalupian *Chonetes* are comparable to the development of the genus in the Russian section, especially to that of the Gschelian stage. On account of the large representation of the *grandicostati* in the Salt Range fauna, the resemblance of the latter to the Guadalupian, in point of this genus, is somewhat inferior to that of the Gschelian, where this group is absent and the other singular type represented by *C. timanicus* is very rare.

I regret that of the fauna of the Fusulina limestone of Palermo, which in the main seems to be so closely related to the Guadalupian, that portion represented by the genera *Chonetes*, *Productus*, etc., as described by Gemmellaro, has proved inaccessible to me.

Schellwien found but two species of *Chonetes* in the fauna of the Trogkofelschichten, one of which he identified as *C. strophomenoides* and the other as *C. sinuosus*. *C. strophomenoides*, as one of the *striati*, is more closely similar to *Chonetes* sp. than to any other Guadalupian form, while *C. sinuosus* is far removed from any known species of that fauna. Indeed, Schellwien includes it in the group of *Chonetes mesolobus*, a fact of some surprise, since in the Pennsylvanian the range of this type is in the lower part of the Pennsylvanian section. On more careful consideration of *C. sinuosus*, however, it appears that it is marked with fine radiating ribs, while *C. mesolobus* is smooth. Thus, though alike in configuration, one species belongs to the *striati* and the other to the *læves*.

In his paper on the fauna of the Carnic Fusulina limestone, besides the species discussed in the foregoing remarks (*Chonetes sinuosus*, there described under the name *Chonetes lobatus*), Schellwien recognizes also *C. papilionaceus* var. *rarispina*, *C. granulifer* (probably distinct from the American species), *C. latisinuatus*, and *C. obtusus*. With the exception of the last, all these species belong to the *striati*, and, so far as they have Guadalupian representatives, are related to *Chonetes* sp. and to *C. subliratus*. *C. obtusus* seems to be one of the *læves*, and is of the general type of *C. permianus*.

Gortani, in the fauna which he recently described from the Carnic Alps, identifies *Chonetes variolatus*, *C. mölleri* var. *carnicus*, and *C. strophomenoides*. All belong to the *striati*, a group which has perhaps no typical representatives in the Guadalupian fauna. *C. mölleri* var. *carnicus* appears to be related to the species from the Trogkofelschichten which Schellwien describes as *C. sinuosus*.

The older Carboniferous fauna described by De Koninck from this same general region contains a representation of this genus, but in general it is too unlike the Guadalupian, and of clearly too different a geologic age, to make further comparisons profitable.

In the Dyas of central Europe, as well as in the closely related Permian of England, the genus *Chonetes* seems not to occur, a peculiarity which these faunas share with the Permian of Russia.

In his papers on the Carboniferous of Spitzbergen Toula cites a number of species of *Chonetes*, such as *C. verneuilianus* var. *spitzbergianus*, *C. granulifer*, *C. hardrensis*, and *C. papilionaceus*. These all belong to the *striati* and are more or less related to the Guadalupian species of that group, though it is probable in this case, as in others, that the Guadalupian species *C. subliratus* would be found to differ from those which have a similar configuration, in the imperfect and faint development of the liræ. Toula also described from Spitzbergen *Chonetes capitolinus*, one of the *læves*, a fine large species with slightly developed fold and sinus. *C. permianus* seems to be the most closely related Guadalupian form. From Nova Zembla also this author cites two Carboniferous species of *Chonetes*—*C. variolatus* and *C. rotundatus*. The former is one of the *striati*, and is perhaps related to *Chonetes* sp. of this report. The other belongs to the *læves*, and is of the general type of *C. permianus*.

Stache, in describing several imperfectly known faunas from the West Sahara, representing apparently a number of different periods in the Carboniferous, cites *Chonetes* aff. *tuberculatus* McCoy from one of them. This species, though it is one of the *striati*, has no very close Guadalupian allies, and it probably belongs in an older fauna.

Salter did not identify this genus from Bolivia, but Toula obtained three species, which he identified as *C. tuberculatus* McCoy, *C. mucronatus* Meek and Hayden, and *C. glaber* Geinitz (= *C. geinitzianus*). *C. tuberculatus* and *C. mucronatus*, the latter generally regarded as a synonym of *C. granulifer* Owen, belong to the *striati*, while *C. geinitzianus* is one of the *læves*. The related species in the Guadalupian fauna have already been indicated. D'Orbigny also, in his material from Bolivia, described a species belonging to this genus—the much-cited *C. variolatus*. It is one of the *striati*, and if it has a related form in the Guadalupian fauna it is *Chonetes* sp.

In his work on the Brazilian faunas Derby distinguishes two species of *Chonetes*, both belonging to the *læves*. One he calls *C. amazonicus* and the other *C. glaber*. It is doubtful if the shell identified as *C. glaber* (= *C. geinitzianus*) is really the same as the North American species; it appears to be closely related to *C. amazonicus*. These forms seem to be in a measure intermediate between *C. permianus* and *C. hillanus*.

The only other South American country from which the Carboniferous is known, so far as I am aware, is Peru, and in this imperfectly known fauna Gabb recognized no species belonging to the present genus.

It is uncertain how many species of *Chonetes* should be recognized in the upper Carboniferous of North America. In his valuable bibliography Weller lists nine, although other names have been introduced which he relegates to synonymy. Most of these species are modifications of the striate type, which is much less well developed in the Guadalupian. While the *striati* were persistent from the Devonian until the genus ceased to exist, the *læves* I have come to regard as a subsequent development and as conditionally indicating rather late Carboniferous time. At least such seems to be the case in the American sequence, so far as known. Perhaps an exception should be noted in the case of *C. mesolobus*, which I think we must regard as a member of this group, but the configuration of this species is so peculiar as to render it almost sui generis, the foreign identifications being, so far as I have surveyed them, very questionable. Some of these striate *Chonetes* of the Pennsylvanian naturally resemble the Guadalupian forms, just as similar types can be picked out in very many faunas. The *læves* comprise among the Pennsylvanian *Chonetes*, aside from *Chonetes mesolobus*, only *C. geinitzianus*, whose most closely related Guadalupian species is *C. hillanus*. The western form described by White as *C. platynotus* is also probably one of the *læves*, although it shows traces of radiating lines. In configuration and surface it is distinct from either *C. geinitzianus* or *C. mesolobus* and more nearly allied to the Guadalupian group, especially to *C. permianus*.

Chonetes permianus Shumard.

Pl. XX, figs. 1 to 3a; Pl. XXIX, figs. 1 and 2.

1859. *Chonetes Permiana*. Shumard, Trans. Acad. Sci. St. Louis, vol. 1, p. 390 (date of volume, 1860). [Permian]: Conglomerate at mouth of Delaware Creek, Texas.

Shell small, subsemicircular, widest at the cardinal border, width one-third greater than the length, front and sides rounded. Ventral (receiving) valve moderately convex, without mesial sinus; cardinal margin sloping gently from beak to extremities and marked with five or six spines; ears mucronate, gently convex, and separated from the vault by a gentle depression. Ventral valve and area unknown. Surface marked with extremely fine concentric striæ of growth.

I have several specimens of this species before me, none of which exhibit any traces of longitudinal striæ.

Found in the conglomerate at the mouth of Delaware Creek, Texas.

The foregoing description, which is taken complete from Shumard, conveys an adequate idea of the characters of this shell, and I am able to add little to it and to change but little. It seems nearly certain, however, that Shumard inadvertently used "ventral" for "dorsal" in the sentence "Ventral valve and area unknown." His statement that the ears are mucronate is difficult to understand, if my fossils rightly belong to his species, for the cardinal angle in them seems to be regularly a right angle, seldom extended, and never produced into mucronate points. The largest specimen in my collection measures 14 mm. across, several measure 11 mm., while the average is somewhat smaller. I find that in some examples the width is a little more than one and one-third times the length. The other characters mentioned agree so closely with my specimens, which differ from the other *Chonetes* found at the same general horizon in just those particulars—i. e., the subcircular shape, absence of sinus, and absence of radiating liræ,[a] together with the presence of faint concentric ones—that the identification certainly appears to be correct.

Shumard's specimens came from pebbles in the conglomerate at the mouth of Delaware Creek, the source of which probably was the limestones of the Guadalupian. In my collections from the Guadalupian section this form occurs only in Shumard's "dark limestone." It has been subsequently found by Mr. Richardson at several points considerably south of the south end of the Guadalupe Mountains, a fact which probably has some significance with reference to correlation. *C. permianus* is evidently related to *C. ambiensis* Waagen, though probably not identical with it. At all events Shumard's name long antedates that used for the India species.

Chonetes permianus is very suggestive of a species which was later described by White as *C. platynotus*. That form, however, shows a slight sinus and possesses radial markings that are either very faint liræ or the effect produced by the linear arrangement of the interliral pores.

Another American species which is related to this is *C. geinitzianus* Waagen.[b] A manuscript footnote in Meek's copy of Geinitz's "Carbon formation und Dyas in Nebraska" suggests a comparison of that species with *C. permianus*. The resemblance is certainly marked, but does not extend to specific identity, for the Nebraska shell is more transverse and more mucronate; there is always a well-marked sinus, and the cardinal spines are more numerous, since Meek mentions 8 or 10 to 12 or 14, while Shumard records but 5 or 6 in *C. permianus*, apparently for the whole area, an observation which is in accord with my own specimens. These seem to indicate also that the concentric growth lines are more apparent in *C. permianus*, in which they are pronounced and strongly lamellose near the margins, with the small punctæ mentioned by Meek as occurring in *C. geinitzianus* either absent or restricted to the anterior portions of the shell; but these characters are so minute as to be greatly affected by preservation, and I am unwilling to maintain this difference without examining more material under different conditions of preservation. However, I feel little doubt that *C. permianus* is distinct from *C. geinitzianus*.

Horizon and locality.—"Dark limestone," Pine Spring (station 2930), and east of Guadalupe Point (station 3762b), Guadalupe Mountains, Texas. Delaware Mountain formation, southern Delaware Mountains, Texas (stations 2936 and 2969).

[a] In some large specimens near the margin, especially on the under layers of the shell, the presence of liræ can be distinctly made out.

[b] It seems clear that this name should be employed for the species described by Geinitz as *C. glaber*, since the latter name is preoccupied by *C. glaber* Hall.

Chonetes hillanus n. sp.

Pl. XI, figs. 8 to 10.

1859. Chonetes Flemingi (?). Shumard (non Norwood and Pratten), Trans. Acad. Sci. St. Louis, vol. 1, p. 390 (date of volume, 1860).
White [Permian] limestone: Guadalupe Mountains.

Shell rather large, very transverse, subtriangular. Ventral valve somewhat strongly convex. Sinus well marked; hinge line much produced, alate. Wing depressed, defined by a broad, obscure sulcus, which is stronger on the inner but indistinct on the outer side. Area rather high. Number of spines not known. In young specimens the convexity is less strong, the shell more transverse, and the sinus less deep.

Dorsal valve known only as an external mold. It is transverse, strongly concave, and in other respects resembles the ventral.

Surface marked by very fine indistinct liræ, which are broad and flat, their tops flush with the general curvature of the shell, defined by fine obscure striæ.

It is probably this species which Shumard cites as *Chonetes flemingi?*, remarking:[a]

> The fossil from the white limestone of the Guadalupe Mountains corresponds pretty well with the figures and description of the above-cited species, though I can see minor points of difference which leave me in doubt as to whether it is really identical.

It seems to me that there can be no doubt as to the distinctness of this shell from *C. flemingi*. It is more transverse and alate, with a stronger fold and sinus. The ventral valve is more convex. The liræ are fainter and appear to lack the tubulose-spinose character of *C. flemingi*.

In my original list of this fauna a certain resemblance between this form and *C. trapezoidalis* Waagen is suggested. The resemblance, however, was more in the shape and general appearance than in detail. A close comparison is hardly necessary, but *C. hillanus* has liræ, though very faint ones, shallow sinus, and no lateral plications.

I take pleasure in naming this species for my friend Mr. B. F. Hill, who aided me in the collection of this fauna.

This species is best represented in the Capitan formation of the Guadalupian (station 2926), where it is fairly abundant. Two specimens possibly belonging to it were found near the base of the series, in Shumard's "dark limestone," associated with *Chonetes subliratus*.

Horizon and locality.—Middle of Capitan formation, Capitan Peak (station 2926); "dark limestone," Pine Spring (station 2930), Guadalupe Mountains, Texas.

Chonetes subliratus n. sp.

Pl. XX, figs. 4 to 7.

Shell of medium size, transverse, alate, tumid. Sinus strong. The shell rises, as it were, into two plications, one on either side of the sinus, falling with a rapid descent to the wings, which are depressed and convex. Number of spines not ascertained.

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[a] Trans. Acad. Sci. St. Louis, vol. 1, 1856-1860, p. 390.

Surface marked by moderately fine ribs, which are depressed and indistinct, crossed by fine, rather strong, somewhat irregular concentric liræ. The sculpture in brief recalls that of *C. ornatus* of the Kinderhook, but it is on a much smaller scale.

As compared with *C. hillanus*, the greater convexity, more subquadrate shape, and stronger sinus make the general appearance of well-characterized specimens very different. The ribs are somewhat more distinct, more numerous, and not so flattened, and the concentric liration is stronger.

In young specimens the sinus is less strong and the convexity more moderate. The chief difference in configuration between them and similar stages of *C. hillanus* is that they are more quadrate and less transverse. In the very young example represented by fig. 7 the sinus is practically absent, yet the convexity is considerable.

The typical examples of this species were obtained from Shumard's "dark limestone" (station 2930), where they are associated with *C. hillanus*. A single specimen from nearly the same horizon was obtained at station 2906, southwest of Guadalupe Peak, and another from the Delaware Mountain formation, at station 2919. The identity of the last two examples is somewhat doubtful. That from station 2906 has the alate, subquadrate, inflated valves and general configuration of the typical examples, but with the sinus faint or reduced to a mere flattening. The terminal spine at the end of the hinge is very long, slightly curved, and directed to the cardinal line at an angle of about 135°. The configuration of the specimen from the Delaware Mountain formation, which is that of the typical examples, though less strongly marked, may be the result of compression. The real affinities of this shell are possibly with *Chonetes* sp.

There seems to be a tendency in these shells toward an evanescence of the sinus and a lowering of the general convexity. Therefore some of them simulate *Chonetes hillanus* in general configuration, but the sculpture should serve to distinguish them if it is not obscured. The Guadalupe specimens are apt to be exfoliated, and I have referred to *C. hillanus* several examples from the "dark limestone" which may really belong here. One of them especially is very similar to the original of fig. 3 on Pl. XX, but is less convex and with a fainter sinus. In *C. hillanus* the ribs are relatively broad and flat, separated by obscure striæ or possibly only by rows of pores. In *C. subliratus* the ribs are also faint, but they are thin, with relatively wide striæ between, and the concentric liræ are stronger than in *C. hillanus*.

Horizon and locality.—Base of Capitan formation, hill southwest of Guadalupe Point (station 2906); "dark limestone," Pine Spring (station 2930); Delaware Mountain formation, Guadalupe Point (station 2919), Guadalupe Mountains, Texas.

CHONETES sp.

In the yellow sandstone of the Guadalupe section at station 2931 were obtained a few specimens of *Chonetes* whose preservation as internal casts makes it impossible to ascertain their relation to other species. Apparently they can not be referred to the other species recognized in this report. The width of one specimen was 18 mm. and the length 11 mm. Of another, more fragmentary example, the width must have been 22 mm. and the length 13 mm. The shape was semicircular, the hinge line as long as or a little longer than the shell in front. The convexity was slight and regular, there being no sinus. The cardinal spines appear to have been rather numerous, probably 6 to 8 on each side. The surface is unknown. The rows of internal spinules may or may not indicate a striated surface. If striated, the liræ were probably rather fine.

A specimen from about the same horizon, from station 2903, has also been referred to this species. It is slightly more convex, but otherwise the configuration is similar, and it is ornamented with distinct though fine ribs. It is possible that another specimen from station 2919 which I have referred to *C. subliratus* may also belong to this species, the greater convexity and different configuration being the result of lateral compression which it has evidently undergone. I have referred here also a fragment from the black limestone at the base of the Guadalupe section. So little is known about either of the forms involved that their specific relationship to one another can not be ascertained.

The low convexity of this shell, comparatively short hinge, and absence of fold and sinus distinguish it from typical *C. hillanus* or *C. subliratus*. For all that is known it might belong to *C. permianus*, but the much greater size is suggestive that if the exterior were preserved other distinctive characters would be found. Though hardly so mucronate, this species is suggestive of young examples of *C. granulifer*, but besides being smaller and lacking cardinal extensions, it has a much larger septum than Owen's species.

Of course if the striated specimen from station 2919 really belongs to this species the presence of ribs would at once distinguish it from *C. permianus* and to a less degree from *C. hillanus* and *C. subliratus*.

Horizon and locality.—Delaware Mountain formation, Guadalupe Point (stations 2903 and 2931); basal black limestone, Guadalupe Point (station 2920), Guadalupe Mountains, Texas.

Genus PRODUCTUS Sowerby.

The faunas of the Carboniferous are characterized by no other type so highly as by the genus *Productus*. These shells are usually present in abundance, and they manifest the greatest diversity of sculpture and configuration. Considered as a whole the group has shown unusual placticity, developing not only widely different types, all referable to the same genus, but also abundant intermediate stages between what one would suppose to be wholly distinct species. In consequence, specific discrimination among the *Producti* has always been a difficult matter, and authors have shown wide differences of opinion as to where the limits of species should be drawn. In spite of a frequent tendency to group really unlike forms under a single specific title because of transitional varieties, a large number of specific types have been recognized and named. In his monograph on the genus *Productus*,[a] De Koninck in 1847 listed 64 species, based to a considerable extent on European types,[b] and he did not cover all the ground. Probably at the present time this number would have to be trebled.

[a] Recherches sur les animaux fossiles, pt. 1, Liége, 1847.

[b] Whether first described from European areas or not, only 5 of the 64 classified species were cited as non-European.

Because of the great number of mutations which the group affords and the uncertainty as to what in most cases should really be included in the limits of a single species, a comparison between the Guadalupian fauna and those of other areas will best be made in terms of more or less distinct groups which have been recognized within the genus.

In the work above referred to De Koninck proposed a classification of the *Producti*, an effort rendered necessary even at that time by the importance of the genus and its copious specific representation, and he was so far successful that his scheme, more or less modified, is still in use. It is perhaps better regarded as a key than as a classification, and appears to possess the imperfections usual to keys if considered as classifications. Species subsequently described from epochs or areas whose faunas were unknown or little known when his monograph was written do not in all cases fall readily into it. Several instances have been met with in the present fauna, as one of which I would regard those strongly ribbed shells which are closely related to the *semireticulati*, but whose posterior portion is more or less completely without concentric wrinkles.[a] Another comprises shells which have a posterior portion crossed by strong concentric wrinkles, but are without ribs.[b]

Another defect in De Koninck's classification, though this is less demonstrable and more a matter of personal opinion, is that it is in some respects at least artificial, assembling unrelated forms and separating related ones. Thus our western species *Productus multistriatus* and the Russian form *P. mammatus*, which resembles it, fall into De Koninck's division *striati*, but to me they certainly do not appear to be related to *P. cora*. On the other hand, *Productus pertenuis* and certain other species which really do seem to be related to *P. cora* would have to be assigned to the *spinosi*.

Finally, the divisions appear to be of very unequal importance. The *caperati* and *horridi* are distinguished merely by the presence or absence of a sinus, a feature which often varies greatly between individuals belonging to the same species. My point is made if the relation between these two groups is compared with that, say, between the *semireticulati* and the *striati*.

It is far from my thought to invent a new classification for the *Producti*, but were I to do so I would endeavor to establish it on certain family, or perhaps I should say gentile, differences, which are sometimes well marked in this group. In some instances these relations have been observed in De Koninck's classification and make the permanent part of it. Possibly they form the basal idea of a whole, an idea which has been obscured by a too brief characterization of some of the groups, and if one adhered more to the spirit and less to the letter of the matter the faults which I have mentioned, with the exception of that of incompleteness, would be remedied. Thus the *caperati* of De Koninck chiefly comprise Devonian and early Carboniferous shells for which Hall established the genus *Productella*, and they are quite distinct from the Permian *Productus horridus*, which probably

[a] These would, I suppose, go with *Productus cora* and *P. giganteus* among the *striati*, but the association would hardly be a natural one.

[b] De Koninck himself puts a species of this type (*P. sublævis*) with the *semireticulati*, but this is not in conformity with the wording of his classification.

gave name and conception to the *horridi*, but De Koninck's fundamentum divisionis, or his statement of it, is such that some of the Productellas, and some of the Marginiferas, too, would be grouped with *P. horridus*.

Nevertheless, a classification of some sort is a great convenience, and De Koninck's, in spite of what seem to me imperfections, is the best available, so I have employed it here, with certain modifications introduced by Waagen, following in a few cases, however, what I take to be the leading of the natural relations rather than the literal description of his divisions.

In the Guadalupian fauna 25 varieties of *Productus* have been recognized, which may be distributed somewhat as follows:

LINEATI.

Group of *Productus neffedievi*.

Productus waagenianus.
Productus waagenianus var.

SEMIRETICULATI.

Group of *Productus semireticulatus*.

Productus semireticulatus var. capitanensis.
Productus mexicanus.
Productus sp. c.

Group of *Productus popei*.

Productus popei.
Productus popei var. opimus.
Productus indentatus.
Productus texanus.
Productus sp. a.

Group of *Productus guadalupensis*.

Productus guadalupensis.
Productus guadalupensis var. comancheanus.

Group of *Productus occidentalis*.

Productus occidentalis.

SPINOSI.

Group of *Productus cancrini*.

Productus meekanus.
Productus signatus.
Productus signatus var.

HORRIDI.

Group of *Productus latidorsatus*.

Productus latidorsatus.
Productus latidorsatus var.
Productus sp. e.

Group of *Productus walcotticnus*.

Productus subhorridus var. rugatulus.
Productus walcottianus.

CAPERATI.

Group of *Productus? pileolus*.

Productus? pileolus.

IRREGULARES.

Group of *Productus striatus*.

Productus pinniformis.

PRODUCTI OF UNDETERMINED POSITION.

Productus limbatus.
Productus sp. d.

The largest number of species belong to the *semireticulati*, but I have referred to that division types in which the wrinkling of the posterior portion is so indistinct that I suspect De Koninck would have placed them with the *striati*. Their relationship with *P. semireticulatus* certainly appears much more close and essential than with *P. cora* or *P. waagenianus*. To the group of *P. semireticulatus* itself but three species have been referred, so that even with the somewhat broad limits with which that group is here interpreted the development of the typical *semireticulati* is rather slight compared with that in other faunas. *Productus semireticulatus* var. *capitanensis* is a typical example of this group, to which the imperfectly known *Productus* sp. *c* also probably belongs, as well as *Productus mexicanus* Shumard, although the exact form which Shumard had in hand is still a matter of doubt. *Productus semireticulatus* var. *capitanensis* is the only large *Productus* known to me from the Guadalupian, the representatives of the genus in this fauna being rather small and somewhat restricted in differentiation.

P. popei stands as the representative of another division of the *semireticulati* to which I have referred the largest number of species. In these shells the ribs are for the most part well defined, except over the posterior portion. The concentric wrinkles are obscure, so that the visceral area is but faintly marked by any sort of sculpture. These species are, furthermore, distinguished by their small size, high convexity, and generally deep sinus.

P. guadalupensis represents another type believed to be of the *semireticulati*, though the evanescence of the concentric wrinkles over the visceral region might be regarded as debarring it. This species resembles the group of *P. popei*, but is much larger.

A fourth type of the *semireticulati* is represented by *P. occidentalis*, distinguished by a general evanescence of the characteristic features. Over the anterior portion especially the ribs become large and obscure.

To the *horridi* have been referred in all five Guadalupian species, which may be divided into two groups, one typified by *P. latidorsatus* and the other by *P. walcottianus*. To the former group belong *P. latidorsatus*, *P. latidorsatus* var., and possibly the imperfectly known *Productus* sp. *e*, while to the latter may be referred *Productus subhorridus* var. *rugatulus*, and *Productus walcottianus* itself. As these forms possess a sinus, more or less distinct, they could not by definition be placed with the *caperati*, and indeed the impropriety of assigning them to a group corresponding especially to Hall's *Productella* is rather obvious. But they certainly are not closely related to *P. horridus* even in the most favorable instance (*P. latidorsatus*), while the least favorable (*P. walcottianus*) is very different indeed. They are not typical representatives of the *horridi*, because of the tendency of the spine bases to pass into continuous ribs and the presence of more or less distinct concentric wrinkles over the posterior portion. It might perhaps be urged that these five species do not make a homogeneous assemblage, and this appears true if only the extremes are regarded, but the intermediate forms are so linked one with another as to require careful discrimination. This row of forms seems in fact to occupy intermediate ground between the *semireticulati* and the *horridi*, one extreme, *P. walcottianus*, being related to the former and the other, *P. latidorsatus*, related to the latter.

One species has been referred to the *caperati*, but in this instance also the reference is doubtful. *Productus pileolus* could be placed in the genus *Marginifera* with greater propriety than any Guadalupian species known, but it has not seemed to me that the facts warranted doing so. On the other hand, though it must needs be referred to either the *caperati* or the *horridi*, from the latter it is debarred by its obvious lack of a sinus, while I feel very doubtful about placing it in a group made up for the most part of Productellas.

Belonging to the *spinosi* and apparently closely related to *Productus cancrini*, the Guadalupian fauna furnishes *P. meekanus*, *P. signatus*, and *P. signatus* var. Here again the assignment of these species is attended with difficulty. For my own part I imagine them to be a development of the *cora* group, but to place them with the *lineati* is, under the definition, quite impossible. *P. meekanus* especially, and *P. signatus*, which is closely related to it, are more or less completely covered with concentric wrinkles. This would seem to warrant referring them to the *undati*, but the *undati* are not supposed to be covered with spines, which are a feature in the present forms still more marked than the wrinkles. It is this character, together with their resemblance to certain of the recognized *spinosi*, such as *P. cancrini*, that has led me to place these species in that division, although the *spinosi* are not characteristically wrinkled to any great extent.

Representing the *striati* we have in the Guadalupian *P. waagenianus* and *P. waagenianus* var., and belonging to Waagen's group of the *irregulares* only *P. pinniformis*.

The disposition of two species affords more than the usual difficulty. One of these is *Productus* sp. *d*, which but for the reflexed margin might belong to the group of *P. popei*, among the *semireticulati*, and the other is the singular and imperfectly known *Productus limbatus*, whose relations are possibly with the same group.

Though the genus *Productus* is represented in the Guadalupian fauna by a considerable number of species, its development is conspicuously inferior to that of the Carboniferous fauna of the Salt Range of India, where it is so abundant, so large, and so diverse as to have given name to the whole Productus limestone. Though smaller and less varied, the Guadalupian *Producti* are of interest no less for what is present than for the types which are lacking.

Of the *lineati* Waagen represents two groups among the Salt Range species, one the group of *Productus neffedievi* (represented by *P. lineatus*) and the other the group of *P. corrugatus* (represented by *P. cora*). In the Guadalupian *P. cora* has no near representative. *P. waagenianus* may be the Guadalupian representative of *P. lineatus*, but its small size and the very distinct character of the dorsal valve which seems to belong to it renders the relationship a remote one. It is possible that *P. guadalupensis* should be placed with the *lineati*, in which case it would probably belong in the group of *P. neffedievi*, along with *P. lineatus*.

Waagen recognizes seven Salt Range species among the *semireticulati*, mostly allied to *Productus semireticulatus* and *P. costatus*. This group of large shells is represented in the Guadalupian by only two species (*P. semireticulatus* var. *capitanensis* and *Productus* sp. *c*), while the other groups of the *semireticulati*, that of *P. guadalupensis*, of *P. occidentalis*, and of *P. popei*, find no closely related forms in the Salt

Range fauna. This is perhaps less true, however, of the group of *P. occidentalis* than of that of *P. popei*, since some of the forms included by Waagen under *P. gratiosus* are very suggestive of some of those included in the group of *P. popei*, though they have a considerably more distinctly reticulated visceral area. They may prove to be closely allied to the imperfectly known *P. mexicanus* of Shumard.

The *spinosi* are represented in the Guadalupian by three species related to *P. cancrini*, and in the Salt Range by only *P. asperulus*. In neither case are the forms found in one related to those found in the other fauna.

Of the *fimbriati* Waagen recognizes six species, and perhaps no greater difference between the *Producti* of the two faunas can be pointed out than in this instance, for this group, so far as known, is not represented in the Guadalupian at all.

Waagen distinguishes two groups among the Salt Range representatives of the *horridi*. *P. opuntia*, of the group of *P. geinitzianus*, finds its Guadalupian representative in *P. subhorridus* var. *latidorsatus*. Neither the Guadalupian group of *P. walcottianus* nor the Indian one of *P. kiangsiensis* is quite characteristic of the *horridi*, and they are also rather unlike one another.

Among the *irregulares* the Guadalupian and Salt Range faunas have related species in *P. pinniformis* on the one hand and *P. compressus* and *P. mytiloides* on the other.

The two Guadalupian types whose affinities have not been satisfactorily settled, *P. limbatus* and *Productus* sp. *e*, seem to have no allies in the Salt Range.

On the whole, therefore, while the two faunas have some rather striking points of resemblance in the *Productus* representation, the points of difference are more numerous and more important.

The faunas of the Himalaya seem in a general way to be related to those of the Salt Range, but certain features brought out in Diener's papers may be given comment. These will chiefly have to do with types not found by Waagen.

In the paper on the Permian fossils from Kumaon and Gurhwal Diener finds five species of *Productus*, three belonging to the *fimbriati*, a group which, as already pointed out, though well represented in the Salt Range, is absent from the Guadalupian faunas, and two species belonging to the *spinosi*. The latter represent the group of *Productus cancrini*, a type which has Guadalupian representatives also and which is absent in the Salt Range, although the section of the *spinosi* occurs there.

In his first paper on the Carboniferous fossils from Kashmir and Spiti Diener distinguishes no less than 11 species of *Productus*, which he distributes among eight divisions of the genus—the *lineati*, the *undati*, the *semireticulati*, the *spinosi*, the *fimbriati*, the *caperati*, and the *irregulares*. The form which he refers to *P. cora*, among the *lineati*, is suggestive of that which I have described as *P. waagenianus*, and probably is wrongly identified with *P. cora*. In this connection attention may be called to a shell which he figures as *Strophomena analoga*. This type, of which *Leptæna rhomboidalis* is the most familiar representative, does not, so far as I am aware, range above the lower portion of the Carboniferous; yet the shell from Kashmir was found associated with *Productus abichi*, *Marginifera himalayensis*, and *Chonetes grandicostatus*, representing a fauna which Diener is inclined to call Permian. This shell so much resembles the dorsal valve of *P. waagenianus* that it seems permissible to suggest that it may represent this portion of the form referred by Diener to *P. cora,* the dorsal valve of which was not thought to occur in Diener's collection.

The division of the *undati* seems to be absent from the Guadalupian fauna, and the form referred by Diener to *P. undatus* has no Guadalupian representative. As belonging to the *semireticulati* Diener cites only *P. semireticulatus* and *Productus* cf. *longispinus.* The former has a representative in the fauna under discussion in *P. semireticulatus* var. *capitanensis,* and *Productus* sp. *c,* and the shell referred to *Productus* cf. *longispinus* seems to be related to *P. texanus* and possibly *P. mexicanus.* The other groups of the *semireticulati* found in the Guadalupian are apparently absent from Diener's fauna.

Two species are placed by Diener among the *spinosi. Productus* cf. *scabriculus* seems to have no representative in the Guadalupian fauna, while *Productus* cf. *spinulosus* may be represented, somewhat remotely, it is true, by *P. latidorsatus,* though I have placed the latter species among the *horridi.* The American shells belonging to the group of *P. cancrini,* among the *spinosi,* seem to be unrepresented in the fauna described by Diener.

The *fimbriati,* of which Diener cites three species, are, as already remarked, absent in the Guadalupe Mountains.

I have found only one Guadalupian species which seemed referable to the *caperati,* to which Diener refers the shell identified as *Productus aculeatus.* These two forms do not appear to be related to one another to any very marked extent, but perhaps the Guadalupian shells which I have called *P. walcottianus* and *P. subhorridus* var. *rugatulus* are really more closely allied than would appear from their having been placed in another division.

Lastly, among the *irregulares* the species described by Diener as *Productus mongolicus* is clearly allied to *P. pinniformis.* In fact, the *irregulares* are as a rule much more nearly related to one another than are the members of the other groups. The *horridi,* to which I have referred certain Guadalupian species, have not been recognized in this fauna, but in some cases they probably find related forms in species which Diener has placed in other divisions.

These fossils seem to have been derived more from Kashmir than from Spiti. Davidson had long before described a suite of fossils from Kashmir in which he recognized nine species of *Productus,* viz, *Productus semireticulatus, P. cora, P. scabriculus, P. humboldti, P. longispinus?, P. striatus?, P. spinulosus?, P. lævis* n. sp., and *Productus* sp. Davidson allowed greater latitude to specific limits than is in my estimation justified, and as some of his identifications are not illustrated it is impracticable to compare such instances with the fauna of the Guadalupe Mountains. It is safe to say, however, that *P. scabriculus, P. humboldti,* and probably *P. spinulosus* have no analogues in the Guadalupian, though some of the forms which I have placed with the *horridi* are perhaps distantly related. The little shell which Davidson describes as *P. lævis* seems to resemble *P. latidorsatus.*

In a later paper Diener discusses the fauna of Spiti, dividing it into two stratigraphic sections. The lower fauna contains *P. lineatus* (perhaps represented in the Guadalupian by *P. waagenianus,* possibly even by *P. guadalupensis*), *Productus* sp.

indet., of the group of *semireticulatus* (also represented in the Guadalupian), *Productus undatus* (seemingly without any related form in my fauna), *P. scabriculus* (also without a Guadalupian representative), and *P. nystianus* var. *lopingensis*. The latter species resembles the form from the Delaware Mountain formation which I have called *Productus* sp. *e*, but the Guadalupian form is too imperfectly known to admit of a safe comparison. To some extent *Productus subhorridus* var. *rugatulus* is a related form, and to a considerably less extent *P. latidorsatus*. From the upper fauna at Spiti Diener cites only one species of *Productus*—*P. gangeticus*, a type as yet unknown in the Guadalupian fauna.

Diener twice treats of the Carboniferous faunas of Chitichun. In the first paper are listed nine species of *Productus*, which he assigns to the *lineati*, *semireticulati*, *spinosi*, *fimbriati*, and *irregulares*. The types which he refers to *P. lineatus* and to *P. cora* appear from his figures to be the same species, which I can not but believe to be distinct from *P. cora*, at least the form which in North America it is customary to identify with that species, though truly it is not altogether safe to trust figures in such comparisons.

The *semireticulati* of the Chitichun fauna, like those of the Salt Range, show in the main the same large species related to *P. semireticulatus* and *P. costatus*, of which *P. semireticulatus* var. *capitanensis* and *Productus* sp. *c* are the only Guadalupian representatives. In a series of specimens referred to *P. gratiosus*, however, a species which is represented in the Salt Range by a number of mutations, we have some forms closely related to *P. popei* and its allies. The Indian forms for the most part are larger, with less distinct sinus, and by reason of stronger corrugations over the visceral region more clearly deserve to be assigned to the *semireticulati*. They are perhaps closely allied to the imperfectly known *P. mexicanus*, but one of the specimens figured by Diener, which is small, highly arched, and with a deep sinus, might almost have been drawn from a specimen of *P. popei*. As in the Guadalupe Mountains, so at Chitichun, the *spinosi* are represented only by species of the group of *P. cancrini*. In the Salt Range, it will be remembered, the group of *P. cancrini* is not found, and the *spinosi* are represented by a quite different type.

The *fimbriati*, which are not known in the Guadalupian fauna, are represented at Chitichun only by the Salt Range species *P. abichi*.

The *Productus* faunas of the Guadalupe Mountains and Chitichun show a community in the representation of their *Producti irregulares* in the related species *P. pinniformis* on the one hand and *P. mongolicus* on the other. With this terminates my comparison of the Guadalupian with the Chitichun *Producti*, for only the same species appeared among the material on which Diener's second paper was based, and he does not describe them again.

The same author distinguishes six species in the Permian fauna of Malla Sangcha. *Productus abichi* of course has no Guadalupian equivalent, and, on the other hand, many Guadalupian types seem to be unrepresented in the Himalayan fauna. The large coarsely ribbed shells belonging to the *semireticulati* which form so noticeable a feature of the Productus limestone fauna, and are represented in the Guadalupe Mountains by *P. semireticulatus* var. *capitanensis* and *Productus* sp. *c*, seem to be missing in the collections from Malla Sangcha, their place being taken by *P. chiti-*

chunensis, a species which has no very close relative in the Guadalupian. Of the latter fauna the group of *P. popei*, also belonging to the *semireticulati*, seems to be represented by *P. gratiosus*, a Salt Range species which Diener says is the commonest in his collection and shows great variability. Some of the forms appear to be very similar in configuration to the American ones, but I have not been able to ascertain whether they have the strong corrugations over the visceral region, the absence of which seems to be a peculiarity of our group of shells. Shumard's *P. mexicanus* is also more or less closely allied to *P. gratiosus*. The remaining species cited from this fauna are *P. mongolicus*, one of the *cora* group, *P. undatus*, without Guadalupian representatives, and *P. planohemispherium*, a small, somewhat nondescript species without, so far as known, any corresponding form in the Guadalupian, unless possibly it be *P. waagenianus*, which is more or less similar, though I doubt if Netschajew's species belongs to the *lineati*.

From the Lissar Valley Diener cites only two species of *Productus*, both belonging to the *fimbriati*, a group not found in the Guadalupian fauna. One of these again is cited from the Productus shales of Byans, the only other *Productus* obtained being *P. cancriniformis*, whose Guadalupian representatives are *P. meekanus* and *P. signatus*.

In describing the fauna from Niti Pass Salter distinguished but two species of *Productus*—*P. purdoni*, one of the *fimbriati*, and a little shell which he calls *P. flemingi* Sowerby?. The figure is not very good, but appears to represent one of the *spinosi*, of the *cancrini* group, similar to *P. meekanus*.

The faunas of the Salt Range and of the Himalaya, being considered together, in view of their representation of the genus *Productus* show many points of resemblance and some of marked difference when compared with the Guadalupian. The most striking differences seem to be the great abundance and variety in the Indian faunas of large shells related to *P. semireticulatus* and *P. costatus*, which are represented in a much inferior manner in the Guadalupian, and the presence of numerous species belonging to the *fimbriati*, a group, so far as known, which is lacking in the Guadalupian fauna altogether.

Romanowsky distinguished 11 species of *Productus* in his material from Turkestan, some of them of rather unusual type. *Productus striatus* has an analogous species in the Guadalupian in *P. pinniformis*. It is somewhat doubtful if the shell identified as *P. cora* really belongs with that species, and the most closely related form in the Guadalupian is *P. waagenianus*. The specimen which Romanowsky figures under the title of *P. giganteus* does not appear to me really to be Martin's species. If it is, its horizon must needs be considerably older than the Guadalupian and older than that of some of the other species of the same report. There is no corresponding form in the American fauna. Of the *semireticulati* he discriminates four species—*P. semireticulatus*, *P. deruptus* Rom., *P. boliviensis*, and probably *P. reticulatus* Rom. It should be remarked that the latter name had been long preoccupied by Gabb for a shell from Peru. These *semireticulati*, especially the first three, find analogous species in the Guadalupian in *P. semireticulatus* var. *capitanensis* and *Productus* sp. *c*, but the other Guadalupian members of the *semireticulati* seem to be unrepresented in Romanowsky's fauna. He identifies two of the *fimbriati* (*P. punctatus* and *P. fimbriatus*), however, a group which, as already pointed out, appears to have no representatives in the Guadalupe Mountains. Romanowsky figures a species which he identifies as *P. spinulosus* and which accordingly should be one of the *spinosi*, but as it is represented without ribs, though with concentric wrinkles and spines, it is also probably one of the *fimbriati* and without any closely related Guadalupian form. The last species, described as *P. vlangalii*, with its heavy radiating costæ and spines, presents a singular appearance, but can probably be placed in the *spinosi*. This species also has no analogous form in the Guadalupian, and as the latter contains types not found in Romanowsky's collection, e. g., the group of *P. cancrini*, it seems to be only distantly related to the faunas of Turkestan, much less nearly than to those of the Salt Range and of the Himalaya.

Thirteen species of *Productus* were distinguished by Kayser in the Lo Ping collections. The *semireticulati* are represented by a variety of forms, some of which appear to be closely related to those of the Guadalupe Mountains. To this group belong the species cited as *P. semireticulatus*, *P. sinuatus?*, *P. costatus*, *P. mexicanus*, *P. plicatilis*, and *P. longispina;* but Kayser's figures show that he included under some of these titles what I would regard as several species. Some of the larger forms, like *P. semireticulatus* and *P. costatus*, are more or less closely related to *P. semireticulatus* var. *capitanensis* and *Productus* sp. *c*, while the group of *P. popei* resembles in the Chinese fauna *P. mexicanus* and *P. longispina.* I do not know if *P. plicatilis* is correctly identified, but the type called by that name does not occur in the American fauna. The dorsal valve of *P. waagenianus* somewhat suggests the Chinese shell.

The form which Kayser calls *P. cora* is clearly not the common Pennsylvanian shell which we are accustomed, and rightly I believe, to refer to D'Orbigny's species. It will subsequently appear that the Chinese shell is really of a different type, without any corresponding Guadalupian form.

Under the name of *P. aculeatus* Martin, Kayser figures what I would regard as several species, exhibiting characters that might warrant assigning some of them to the *caperati*, where De Koninck places *P. aculeatus*. These forms are comparable to the Guadalupian species which I have described as *P. subhorridus* var. *rugatulus* and *P. walcottianus*, perhaps even to *P. latidorsatus*, but not to the single Guadalupian representative of the *caperati*, *P. pileolus*. The American species, it will be remembered, I have placed with the *horridi*, doubtfully in the case of *P. walcottianus*, but the distinction between the *caperati* and the *horridi* is an artificial one. Another Chinese species which should perhaps be placed close to *P. aculeatus* is that described as *P. kiangsiensis*, but as Kayser's figures show a distinct or even rather high area it seems possible that this form may be a *Strophalosia*.

The shell described as *P. pustulosus* var. *palliatus* seems to be one of the *fimbriati*, a group whose absence from the Guadalupian has already been noted. *P. nystianus* var. *lopingensis* may possibly also belong to this group, though the figure suggests that the species may really be a *Marginifera*. The typical *P. nystianus* is one of the *Proboscidei*. Kayser also figures a form which he identifies as *P. undatus*, a type thus far unknown in the Guadalupian. The same is true of the form called *P. carringtonensis?*.

The Lo Ping fauna has been revised by Fliegel and others, with numerous changes in the nomenclature and the specific divisions, but these affect the foregoing comparisons in but one instance. The form which, under the name of *Productus* cf. *cora*, Kayser figures so that it somewhat resembles *P. pinniformis* of the present work, is, according to Fliegel, the same as that which Kayser called *P. undatus*, for which Diener has proposed the name *P. mongolicus*. So interpreted it is of course very different from *P. pinniformis*, and indeed from any Guadalupian species yet found. On the whole, while there is a broad resemblance between the *Productus* fauna of the Guadalupe Mountains and that of Lo Ping in some particulars, the differences are perhaps still more marked.

As might be expected, this genus plays an important part in several of the faunas which Loczy described from different points in China. Nine species are cited from the vicinity of Kantschoufu, only one of which probably, the ubiquitous *P. semireticulatus*, has a closely allied form in the Guadalupian. In fact, it is probable that the Chinese fauna represents an older stage in the Carboniferous. Some of the species cited by Loczy belong to groups which are apparently absent from the Guadalupian, e. g., the *undati* and the *fimbriati*. A distinctly greater agreement, at least in the absence of forms alien to the Guadalupian, is shown by the Permian fauna from the vicinity of Batang. Three small species of the *semireticulatus* type were found there, one said to be allied to *P. gratiosus*, another to *P. semireticulatus*, and the third unidentified. These appear to be more or less like *P. popei* and its allies, or like *P. mexicanus*, while the only remaining form, which is cited as *Productus* cf. *ovalis* Waagen, somewhat recalls *Productus* sp. *e*.

No very close relationship is shown by the five species from the valley of the Lantsankiang. A figure of a fragmentary example cited as *Productus* aff. *pustulosus* is suggestive of *P. signatus*, though the latter is certainly not very closely related to Phillips's species. Another shell compared with *P. scabriculus* belongs to a type not found in the Guadalupian, but Loczy suggests that his specimen may really be an *Aulosteges*. The *Productus semireticulatus* is more or less like its Guadalupian congeners (perhaps *Productus* sp. *c* especially), but a little shell referred to *P. tumidus* appears not to be represented by any form in the American fauna. An entirely unidentified specimen,[a] however, is rather suggestive of *P. walcottianus*, although a more complete knowledge might lessen the resemblance.

Only two species are cited from the "Permo-Carboniferous" of Tschungtjen, in the province of Yünnan. One of these, referred to *P. semireticulatus*, a small, finely ribbed variety, is a little like *P. semireticulatus* var. *capitanensis* of the Guadalupe Mountains. The other is identified as *P. aculeatus*, and recalls two widely different types of the Guadalupian, *P. mexicanus* and *P. subhorridus* var. *rugatulus*. The lack of exact data in the description and figures of the Chinese form prevents a decision as to which group it represents, without reference to the original specimen.

But two species were distinguished from Talischau. The small finely ribbed *Productus* of the *semireticulatus* type similar to the foregoing is only in a general way like *P. semireticulatus* var. *capitanensis* or *Productus* sp. *c*. A little shell cited merely as *Productus* sp. is apparently related to *P. latidorsatus* and *Productus* sp. *e*.

[a] Wissenschaftliche Ergebnisse der Reise des Grafen Béla Széchenyi in Ostasien, Wien, 1899, pl. 4, fig. 7.

The fauna obtained near Youngtschangfu appears to show little resemblance to the Guadalupian, in which there is nothing at all closely related to the three species of *Productus* cited from that locality.

In the Carboniferous fauna which Roemer described from Sumatra he discriminates five species of *Productus*—*P. sumatrensis*, *P. pustulosus*, *P. cora*, *P. longispinus*, and *P. keyserlingianus*. But one of these species is accompanied by figures, and so far as one may judge without this accessory they do not constitute a *Productus* fauna very similar to that of the Guadalupian. The same conclusion must be reached from a consideration of the representation of the genus in practically the same fauna as revised by Fliegel. This author cites *P. lineatus* (*P. cora* of Roemer), *P. sumatrensis*, *P. semireticulatus*, *P. longispinus*, *P. ovalis* (*P. keyserlingianus* of Roemer), and *P. punctatus* (*P. pustulosus* of Roemer).

Beyrich cited two species of *Productus* from the Carboniferous of Timor—*P. semireticulatus* and *P. punctatus?* There really appear to be three species represented by Beyrich's figures, none of which can properly be referred to either *P. semireticulatus* or *P. punctatus*, if the latter are reasonably restricted. One of the shells figured as *P. semireticulatus* appears to be rather closely related to *P. texanus* of this work, but the others are without Guadalupian representatives.

Martin seems not to have found the genus in the collections from Timor studied by him, but Rothpletz cites six species in his work on the Permian fauna of Timor and Rotti. Two of these, *P. abichi* and *P. waageni*, belong to the *fimbriati*, a group which, as I have several times had occasion to remark, is not found in the Guadalupian. The same is true of *P. asperulus*, which has no very close ally in that fauna. The *semireticulati* include the three remaining species of *Productus* recognized by Rothpletz—*P. semireticulatus*, *P. gratiosus*, and *Productus* n. sp. The resemblance of *P. gratiosus* to the group of *P. popei* and to *P. mexicanus* has already been commented on in connection with faunas from India, and the type here receiving that identification (*P. gratiosus*) is without doubt the same as that identified by Beyrich as *P. semireticulatus*, whose similarity to *P. texanus* has also already been remarked.

De Koninck recognized 12 species of *Productus* in his discussion of the Carboniferous faunas of New South Wales. None shows many analogies with the Guadalupian *Producti*, and indeed most of them occur in the lower series of the Carboniferous, and may well be regarded as beyond the bounds of the present discussion. A few species occur in both divisions, as, for instance, *P. clarkei*, which is cited both from Burragood, one of the lower horizons, and from Branxton, which, as it is not recorded in the list of localities where the lower series occurs, may be regarded as belonging to the upper.

Of the *Producti* which were obtained from the upper horizons *P. clarkei*, *P. brachythærus*, and *P. undatus* are perhaps the most important. *P. clarkei* was originally described as a *Strophalosia*, and has been considered elsewhere. De Koninck, according to his own account, saw no specimens of this species, and his assignment of it to *Productus* can not, therefore, be regarded as trustworthy. I repeat that I see but the most elementary resemblance between the *Producti* described by De Koninck and those of the Guadalupian fauna.

The genus *Productus* is represented in the "Permo-Carboniferous" of Queensland and New Guinea by something like 12 species, as discriminated by Etheridge, but a large number of these are not identified, and many are not figured in his report. *Productus cora* is not found in the Guadalupian, and in fact Etheridge's figures from Australia do not seem to me to belong to that species. The one most nearly resembling *P. cora* is a dorsal valve from the Mount Britton gold field. *Productus brachythærus*, *P. subquadratus*, and *P. undatus* are non-Guadalupian, though the figure of the latter, said to be a ventral valve, suggests the dorsal valve of *P. waagenianus*. *P. semireticulatus* is not figured, but presumably resembles *P. semireticulatus* var. *capitanensis* and *Productus* sp. *c*. *P. longispinus?* is more or less semblable to the Guadalupian species of the group of *P. popei*. The remaining *Producti* are unidentified, and with one or two exceptions appear to belong to non-Guadalupian types. *Productus* sp. *d* and *Productus* sp. *f*, however, are probably related to the Guadalupian shells of the group of *Productus popei*, the former more to *P. popei* itself and the latter to *P. texanus*.

In the Russian section the genus *Productus* shows a remarkable differentiation, reaching its acme in the Gschelian, where Tschernyschew recognizes the extraordinary number of 43 species. In the Artinskian the number is much less, while in the Permian I have found recorded but five. It would protract this discussion needlessly to compare the Guadalupian *Producti* with those of the *Productus giganteus* and *Spirifer mosquensis* faunas, but I may remark in passing how much the *Productus* fauna of the Moskovian resembles that of our Mississippi Valley Pennsylvanian.

Tschernyschew divides his 43 species of Gschelian *Producti* into 20 groups, the first of which, the group of *P. boliviensis*, comprises five species of the *semireticulatus* type. This group of forms is represented in the Guadalupian only in a general way. Nearest perhaps are *P. guadalupensis*, which resembles *P. multistriatus* Meek var. of Tschernyschew's report, and *Productus* sp. *c.*, which resembles *P. boliviensis* and *P. gruenewaldti*. As to the identity of the Russian species with our American form, the resemblance is certainly very close, although Meek does not mention or figure the visceral area as being marked by concentric corrugations, the absence of which would preclude the assignment of this form to the *semireticulati*. Rather faint concentric folds are shown in Tschernyschew's figure. It should be noted that *P. multistriatus* is a distinctly western form in the American Carboniferous faunas, no corresponding type, so far as I recall, being found in the Pennsylvanian of the Mississippi Valley. I have been tentatively correlating the horizon of *P. multistriatus* with beds below the Guadalupian.

The next group, that of *P. semireticulatus* itself, has three species. Like the foregoing, this group finds representation in a general way in the Guadalupian fauna, in this case especially by *P. semireticulatus* var. *capitanensis*. One of the members of this group Tschernyschew identifies with our little-known American species *P. inflatus*. Among the most typical *semireticulati* there is so strong a common resemblance and so many intermediate forms that it is difficult to determine and maintain specific limits. I have not seen specimens which could without hesitation be placed with *P. inflatus*, and feel doubtful as to the reference of the Russian specimens.

The third group comprises a single species, *Productus mölleri*, one of the *semireticulati* of the usual type.

All these species are more or less closely related to *Productus semireticulatus* var. *capitanensis*, *Productus* sp. *c*, and *P. guadalupensis*.

The fourth group is represented by *P. lobatus* and *P. mexicanus* White (Shumard?). These two forms are small species of the *semireticulatus* group, a type which is well represented in the Guadalupian. The Guadalupian forms, however, all have a deep sinus, while the Russian species are represented without this feature. *P. mexicanus* was described from the "white limestone" of the Guadalupe Mountains, and unfortunately I have been unable to identify it among my material. This is the more to be regretted since Shumard's description was not accompanied by figures. I am doubtful as to the correctness of White's identification. His species is considerably smaller, and its occurrence appears to be at a lower geologic horizon, since I am tentatively assigning it to a position below the Guadalupian. Tschernyschew's Russian specimens certainly resemble White's identification. It will be remembered that this species has also been identified in China. *P. mexicanus* in North America is distinctly western. So far as I can recall, it has no closely allied representatives in the Pennsylvanian faunas of the Mississippi and Ohio valleys. *Productus* sp. *a.* resembles the Russian shell figured as *P. mexicanus* White (Shumard?).

The next group, comprising only *P. tartaricus*, represents the type which has so many Guadalupian representatives, among which *P. popei* and *P. texanus* are conspicuous.

The sixth group, that of *P. stuckenbergi*, contains but *P. stuckenbergi* itself, another small species similar to *P. popei* and *P. texanus*, but having a strongly corrugated visceral area.

With these the division of the *semireticulati* comes to an end, although it apparently is resumed at a later point. In a general way it may be said that the Russian series of forms resembles the Guadalupian rather closely, but shows a greater differentiation of large species closely related to the typical *P. semireticulatus*. The absence of species of the type of *P. occidentalis* from the Russian faunas may also be noted.

The group of *P. spinulosus* (No. 7) comprises seven species. These seem to have Guadalupian representatives in *P. latidorsatus* and *P. subhorridus* var. *rugatulus*. The resemblance in some cases is rather strong, as between *P. subhorridus* var. *rugatulus* and the Russian shell identified as *P. wallacianus*, and between *P. latidorsatus* and *P. tastubensis*, while some of the Russian forms have no very analogous types in the Guadalupian, as, for example, *P. pustulatus* Keyserling.

The next group, that of *P. humboldti*, has two Russian representatives and none at all in the Guadalupian. The same is true of the ninth group, called that of *P. nebraskensis*. One of the two forms is doubtfully referred to our common American species *P. nebraskensis*. The Russian specimen figured seems to be so poor that the identification may well have been held in doubt.

The next group includes representatives of the *striati* to the number of three. The shell figured as *P. cora* certainly seems to be the same form which D'Orbigny described from South America and which is abundant in the Pennsylvanian faunas of the Mississippi Valley. This type, however, does not occur characteristically in the Guadalupian. The little shell identified by Tschernyschew as *P. aagardi* Toula is suggestive of *P. waagenianus*, but the dorsal valve appears to lack the peculiar configuration of the American species.

The eleventh group is composed of three species, two of which appear to be closely related to *Productus cora*. The third is less so, but none has a closely comparable form in the Guadalupian.

The next two groups, each with a single species, represent types more or less closely related to *P. cancrini*, and find representation in the Guadalupian in *P. meekanus* and *P. signatus*.

Productus pseudomedusa, the singular species on which Tschernyschew's fourteenth group is based, has no corresponding form in the Guadalupian fauna.

In *P. artiensis* and *P. mammatus*, which represent the fifteenth group, we again find species related to Guadalupian forms, the former to *P. popei*, the latter more or less to *Productus guadalupensis*, or possibly to *Productus* sp. *d*.

The group of *P. punctatus* (No. 16) comprises two species, neither of which has any related type in the Guadalupian. It is perhaps worthy of note that Tschernyschew's identification of *P. punctatus* is quite unlike the American form commonly referred to this species, which, however, is very similar to *P. fasciatus*, the other member of the group of *P. punctatus* in the Russian work.

The seventeenth and eighteenth groups, the former with one and the latter with two species, have no representatives in the Guadalupian. The corresponding American species occur at horizons which I regard as older than the Guadalupian and associated with a very different fauna. These are western forms, without closely allied representation in the Pennsylvanian of the Mississippi Valley. The shells which Tschernyschew figures under the name of *P. longus* are so different from Meek's figure of that species that the identification must be regarded as at least doubtful.

P. timanicus, which alone constitutes the nineteenth group, finds a representative in the Guadalupian fauna in the related *P. latidorsatus*. The resemblance is not very striking, consisting more in sculpture than in configuration, and mature specimens are rather strongly different.

The twentieth group comprises but two species, *P. anomalus* Keyserling, whose Guadalupian representative is *P. pinniformis*, and *P. ischmensis*, which has no corresponding species in the American fauna..

To take the *Producti* as a whole the Guadalupian fauna, in paradoxical language, may be said to resemble the Gschelian more closely than the Gschelian does the Guadalupian. In other words, while most of the Guadalupian species find Gschelian types more or less closely related, the latter fauna contains much that is unrepresented in the Guadalupian. Some of these forms may be regarded as survivors from earlier faunas, as, for instance, species closely related to *P. punctatus*, *P. cora*, and *P. nebraskensis*. In many cases these non-Guadalupian species have similar or identical American representatives, but as a rule the latter occur in our western areas and in association with faunas markedly different from the Guadalupian, and found, I believe, at distinctly lower horizons.

Tschernyschew's account may fairly be taken as giving a representative exposition of the Gschelian *Productus* fauna, and while other reports in which this fauna has been discussed have come before me, they can well be neglected in the present discussion, whose scope is more general than particular.

In attempting to ascertain the character of the Artinsk fauna so as to compare with it that from the Guadalupe Mountains, instead of a single volume in which the species are all figured, as in Tschernyschew's work on the Gschelian, I have had to consult several in which the fauna was for the most part listed. The largest *Productus* fauna in the Artinsk seems to be that discussed by Stuckenberg, who lists 21 species. In spite of the fact that but four of these are figured, it is possible to point out that a considerable number have allied species in the Guadalupian. Many of these either occur in the Gschelian or are represented there by cognate forms. Seven of the Artinskian species belong to the *semireticulati*. *P. semireticutalus*, *P. boliviensis*, *Productus* cf. *spiralis*, and *P. möelleri* are large types more or less closely related to *P. semireticulatus* var. *capitanensis* and *Productus* sp. *c* in the Guadalupian, while *P. longispinus*, *P. stuckenbergianus*, and *Productus* cf. *artiensis* are small species more or less comparable to *P. texanus* and *P. popei*. *Productus cora* and the related *P. tenuistriatus* are not represented in the Guadalupian by forms closely allied to them. *P. koninckianus* and *P. cancrini* find allied species in *P. meekanus* and *P. signatus*. The following have no related Guadalupian species and in some cases none belonging to the same section: *P. scabriculus*, *P. punctatus*, *P. silvæanus*, *P. fimbriatus*, and *P. granulosus*. *P. aculeatus* may have a somewhat distantly connected form in *P. walcottianus*. *P. tuberculatus* rather suggests *P. latidorsatus*, with which *P. timanicus* may also be in some respects compared. *P. krasnopolskyanus* presents an appearance not unlike *P. subhorridus* var. *rugatulus*.

How closely related are the *Productus* faunas of the Gschelian and the Artinskian appears from the fact that of the 20 species which Stuckenberg cites from the Gschelian 13 run up into the Artinskian, while of the 21 from the Artinskian the same number of course come up through the Gschelian. So far as this report is concerned, therefore, practically the same remarks which were made regarding the Gschelian may be repeated of the Artinskian *Producti* in their relation to those of the Guadalupe Mountains. Most of the Guadalupian species have forms in the Artinskian to which a correspondence can be traced, intimate in some cases but remote in others, while in the Artinskian are a number of types which have allied forms in the Hueco formation and correlated beds but none in the overlying Guadalupian.

Tschernyschew also gives a list of Artinskian Brachiopoda, many of them figured, in which he cites 12 species representing about the same type of fauna as Stuckenberg's list, many of the species being identical.

Krotow also lists a large number of species from the Artinsk sandstone, only a few of them, unfortunately, being figured. The list comprises 23 species, four of them unidentified, and includes eight which Tschernyschew identifies in the Gschelian. Among the types found by Krotow are large species of the *semireticulatus* group, as well as small ones several of which are closely allied to Guadalupian species such as *P. popei*, *P. texanus*, *P. indentatus*, etc. The Russian forms especially in mind are *P. longispinus* and *P. stuckenbergianus*. There are also *P. koninckianus* and *P. cancrini*, which appear to be related to *P. meekanus* and *P. signatus*. On the other hand Krotow cites *P. cora*, together with a number of the *fimbriati*, such as *P. humboldti*, *P. fimbriatus*, *P. punctatus*, a group whose absence from the Guadalupian has already called for comment.

From the Permian Stuckenberg obtained but few invertebrates and no brachiopods, but Netschajew cites four *Producti*—*P. cancrini* Vern., *P. hemisphærium* Kut., *P. hemisphæroidalis* Stuck., and *P. planohemisphærium* Stuck. *P. cancrini* finds related species in the Guadalupian in *P. meekanus* and *P. signatus*, but there are no Guadalupian forms closely resembling the three others. About the same species (*P. cancrini* and *P. hemisphærium*) are recorded from the Permian by Golowkinsky, while from the province of Kostroma Tschernyschew cites only *P. cancrini*, but his figures represent a form which I would think more nearly related to *P. cora*. It appears to lack the regular distribution and elongate bases of the spines, which are a striking character of De Verneuil's figures. Sibirzew cites *P. cancrini* and the related *Productus* aff. *koninckianus* from the lower Permian series and *P. cancrini* from the upper, while in the original work on the Permian De Verneuil describes *P. cancrini* and *P. leplayi*, the latter being one of the *semireticulati*.

From these data it would appear that there is a great difference between the *Producti* of the Russian Permian and of the Artinsk, manifested, however, more in the defection of old types, with a general falling off in the representation, rather than in the introduction of new ones. Exception may perhaps be found in the three species recognized by Netschajew, but while they are poorly figured and apparently rather characterless types, I believe that they are to be considered rather survivors than newly introduced. It is hardly necessary to comment on the Guadalupian *Producti* in this connection. They contain much that the Russian Permian does not, but the dominating types of the greatly diminished *Productus* fauna of the latter are in the main to be found in the Guadalupian.

The fauna described by Enderle from Balia Maaden, in Asia Minor, need not long detain this discussion, though it contains, according to this author, *Producti* to the number of 21. Four of these are placed with the *lineati*—*P. lineatus*, *Productus* cf. *cora*, *Productus* cf. *margaritaceus*, and *P. mysius*. To the two latter especially the Guadalupian fauna contains no corresponding forms, although *Productus* cf. *margaritaceus* seems to me to be referred to the *lineati* with doubtful propriety and to be more probably a poorly characterized type of the *semireticulati*. To the two former, though *P. lineatus* is not figured, the Guadalupian species *P. waagenianus* is somewhat distantly related.

Nine species represent the *semireticulati*, according to this author, over against which there is about an equal number of Guadalupian varieties. In a general way the *semireticulati* of the two faunas present many correspondences. It could hardly be otherwise; but the large types are prevalent in the fauna from Balia Maaden and the small ones in that from the Guadalupe Mountains. The differences are not very marked, the latter fauna, for instance, lacking a corresponding form to *P. semireticulatus* var. *bathykolpus*, and the former being without anything closely related to *P. guadalupensis* and *P. occidentalis*.

To the Proboscidei Enderle refers a shell identified as *P. nystianus* De Kon., though I can not but doubt profoundly either the direct reference to the species or the implied one to the genus *Proboscidella*, provided the figure be correct. The form in question appears in fact to be very similar to that called "*Productus* cf. *margaritaceus*," both types being more probably small examples of the *semireticulatus* section, related, though not necessarily very closely, to *P. texanus* and its allies. "*Productus* aff. *undati*" (unfigured) finds a related form in the Guadalupian, if at all, in *P. meekanus*. *P. punctatus*, representing the *fimbriati*; *P. scabriculus*, representing the *spinosi*; and *Productus* cf. *tumidus*, incorrectly, I believe, referred to the *horridi*, have no related Guadalupian species. The same is true of *P. aculeatus?*, referred to the *caperati* and not figured, unless *Productus pileolus* or *P. subhorridus* var. *rugatulus* prove to resemble it. *P. subhorridus* var. *rugatulus* is also comparable in some ways to the little shell which Enderle identifies as *P. curvirostris*, but *P. pileolus* is far more closely related. The third species referred to the *caperati*, *P. troianus*, is quite unlike any Guadalupian types of *Productus*. This unusual form in fact rather suggests some species of *Aulosteges*. On the whole the *Producti* of the Balià Maaden fauna show no very close relationship with the Guadalupian species.

Much more nearly related in some respects is the fauna from Armenia described by Abich. The most striking feature of the *Producti* of this fauna is the great development of species having a general resemblance to *P. latidorsatus*, *P. subhorridus* var. *rugatulus*, and *P. walcottianus*. Abich cites members of this group under different names, but one would be disposed to refer to it the forms called *P. intermedius*, *P. intermedius* var. *planiconvexus*, *P. intermedius* var. *helicus*, *P. spinosicostatus*, *P. spinosicostatus* var. *cariniferus*, *P. spinosicostatus* var. *expansus*, *P. spinosicostatus* var. *incurvus*, besides *P. martini*, *P. aculeatus*, and *P. spinulosus*. These appear to be related, some of them very closely and others remotely, to the three Guadalupian species mentioned above, but unfortunately it has subsequently been shown that all except *P. intermedius*, *P. intermedius* var. *planiconvexus*, and *P. martini* belong to Waagen's genus *Marginifera*, the structures characterizing which have not been observed in the Guadalupian species and appear in some cases to be absent. If, therefore, we except these forms, in which the resemblance, it would seem, is only apparent the relationship between the Armenian and the American faunas in point of the genus *Productus* is not very close.

Abich regards *P. intermedius* as a member of the *semireticulati* and Arthaber, who subsequently reworked the fauna, takes the same position, even referring to the same species *P. intermedius* var. *planiconvexus* Abich and *P. martini* Abich *non* Sow.; but I can not see any justification for this, for while the visceral area is marked by concentric corrugations, both authors represent the form in question as entirely without ribs. In my view they should be placed with the *horridi* or *caperati*, although these groups are described as typically without concentric corrugations. They appear to resemble, in a general way, the Guadalupian species which I have called "*P. latidorsatus*." With the foregoing exception the great group of the *semireticulati* would appear to be unrepresented in the Armenian fauna, a really surprising circumstance, since these shells are seldom absent where the genus *Productus* occurs at all.

The remaining Armenian species of *Productus* belong to the *lineati* and the *fimbriati*. To the latter, a group, it will be remembered, which does not occur in the Guadalupe Mountains, are referred *P. scabriculus*, to which as identified by Abich

Waagen subsequently gave the name *P. abichi*, and *P. humboldti*, for which, in like manner, the name *P. waageni* was later substituted by Rothpletz. The *lineati* comprise three species which Arthaber refers to *P. hemisphærium* Kut. (*P. hemisphærium* var. *armeniacus* in the description of plates), but which Abich distinguishes as *P. striatus* Fischer, *P. striatus* var. *sphæricus*, and *P. undatus*. Some of Abich's figures, especially that of *P. striatus*, are very suggestive of our *Productus cora*, and one would be inclined to think that Abich may have two species, instead of one. Arthaber places these forms with the *irregulares*, but they seem to belong more properly in the *lineati*. If they have any Guadalupian representative it is *P. waagenianus* or *P. waagenianus* var.

Arthaber recently redescribed Abich's fauna, introducing many changes, some of which have already been noted. He also introduced one new specific name, that of *P. mytiloides*, of which *P. pinniformis* would probably be the Guadalupian representative. On the whole, if the group of shells which Arthaber withdraws to the genus *Marginifera* is eliminated, the Armenian fauna from Djoulfa does not, in its *Producti*, show any marked resemblance to the Guadalupian.

Gemmellaro's report on the *Producti* of the Sicilian fauna from Palermo being, unfortunately, inaccessible, I must next examine those by Schellwien on collections from the Carnic Alps. In his paper on the fauna of the Fusulina limestone this author cites ten species. Three of these belong to the *lineati*—*P. lineatus*, *P. cora*, and *P. cancriniformis*. The first is perhaps rather remotely related to *P. waagenianus*, but it is doubtful if *P. meekanus* should be considered as the representative of *P. cancriniformis*. The *semireticulati*, comprising *P. semireticulatus*, *P. semireticulatus* var. *bathykolpus*, *P. gratiosus* var. *occidentalis*, and *P. longispinus*, have allied forms in the Guadalupian, *P. semireticulatus* var. *bathykolpus* in *P. semireticulatus* var. *capitanensis* and *P. gratiosus* var. *occidentalis*, and *P. longispinus* in *Productus* sp. *c*, *P. popei*, *P. texanus*, and cognate species. *P. punctatus*, however, has no corresponding type in the Guadalupian, but *P. aculeatus* var. may possibly be compared with *P. walcottianus* and *P. subhorridus* var. *rugatulus*. These forms also resemble in a general way *P. curvirostris*, to which, however, a little shell that may possibly belong to the genus *Marginifera* has a still closer superficial resemblance. On the whole Schellwien's fauna seems in its *Productus* content to be rather similar to the Guadalupian, though the latter contains some types which do not occur in the Alpine fauna (e. g., *P. occidentalis* and *P. latidorsatus*).

In the fauna of the Trogkofelschichten the same author cites 14 species, in many cases the same as those of the preceding one. The group of *P. cora* contains only *P. cora* itself, distantly related to the Guadalupian species *P. waagenianus*. The group of *P. cancrini* consists of *P. cancriniformis* and *P. cancriniformis* var. *sinuatus*, the former comparable to *P. meekanus* and *P. signatus*. The group of *P. semireticulatus* comprises *P. semireticulatus*, *P. semireticulatus* var. *bathykolpus*, and *Productus* cf. *spiralis*. They are more or less closely related to *Productus semireticulatus* var. *capitanensis* and *Productus* sp. *c*. The group of *P. griffithianus* is represented by *P. gratiosus*, which save for its strongly wrinkled visceral area is very suggestive of the group of *P. popei*. *P. aculeatus*, representing the group of that name, is related to *P. walcottianus*. *P. spinulosus*, *P. tuberculatus*, and *Productus* sp., belonging to the group of *P. spinulosus*, are similar, though not very closely similar, to *P. latidorsatus*, *P. subhorridus* var. *rugatulus*, and their allies. *P. curvirostris*, somewhat related to the same species, is much more similar to a little shell described by Shumard as *Productus pileolus*, which is possibly to be referred to *Marginifera*. *P. elegans* and *P. incisus* have no Guadalupian species closely allied to them. The Guadalupian *Producti*, however, in their general facies are rather comparable to those of the Trogkofelschichten.

Gortani also described a fauna from the Carnic Alps, but one which I take to be older than that of the Trogkofelschichten. Fifteen species are distinguished by this author. The three varieties of the *cora* group have, so far as known, no immediate relatives in the Guadalupian. One species is referred, somewhat doubtfully, to *P. giganteus*, a type which would hardly be looked for in this faunal association. The figures suggest a cast of the dorsal valve of *Derbya* or some other strophomenoid. The larger *semireticulati* are identified as *P. semireticulatus*, *P. semireticulatus* var. *transversalis*, and *P. semireticulatus* var. *bathykolpus*. These correspond in a general way to *P. semireticulatus* var. *capitanensis*, *Productus* sp. *c*, and *P. guadalupensis* of the Guadalupian. The smaller types, such as *P. gratiosus*, *P. longispina*, and *P. longispinus* var. *lobatus*, though not figured, are probably comparable to *P. popei* and its allies. It is true, however, that Gortani cites *P. longispina* as a *Marginifera*, though Waagen has stated that typical *P. longispina* does not belong to that genus. The remaining species, *P. punctatus*, *Productus* cf. *fasciatus*, *P. elegans*, *P. humboldti*, and *P. abichi*, appear to have no Guadalupian allies, and indeed the whole *Productus* fauna appears to have a different facies.

In the Dyas of Germany Geinitz recognizes five species of *Productus*—*P. cancrini*, represented in the Guadalupian by *P. meekanus* and *P. signatus*; *P. hemisphærium*, perhaps not properly belonging in the fauna and without closely related Guadalupian species; *P. latirostratus*, possibly an *Aulosteges* and without a Guadalupian representative; *P. horridus*, appearing to be represented in the Guadalupian by the not very closely related species *P. latidorsatus*; and *P. geinitzianus*, possibly to be correlated with the form just mentioned, though in some respects comparable also to *P. walcottianus* and to *P. occidentalis*. Perhaps I should also include a shell placed by Geinitz in the genus *Strophalosia* and identified with De Verneuil's species *Productus leplayi*, which I believe is by its author correctly regarded as a *Productus*. By way of illustration Geinitz produces a figure copied from De Koninck but evidently originally derived from De Verneuil's illustration of *Productus leplayi*.

While comparable in some respects the *Producti* of the Dyas fauna are specifically much less varied than those of the Guadalupian. Except for *P. leplayi*, above mentioned, we miss the great group of the *semireticulati*, and especially the small, arched, deeply sinused forms of the Guadalupian fauna. We miss also the *cora* group and the *irregulares* of Waagen. The absence of other types, such as the *fimbriati*, is shared by the Guadalupian fauna.

In the Permian of England, closely related to that of Germany, King recognizes but one species of *Productus* (*P. horridus*), *P. umbonillatus*, as King suggests, being probably an *Aulosteges*.

From Spitzbergen De Koninck cites four species of *Productus*—*P. horridus*, *P. leplayi*, *P. cancrini*, and *P. robertianus*. The first of these, unless an imperfect specimen or figured very badly, is not a characteristic example of the species to which it is referred. It is not very unlike *P. latidorsatus* or even *P. subhorridus* var. *rugatulus*. *P. cancrini* and *P. leplayi* correspond in a general way to the Guadalupian forms *P. meekanus* or *P. signatus*, and *P. semireticulatus* var. *capitanensis* or *Productus* sp. *c*. The little shell called *P. robertianus* is certainly not like any ordinary type of *Productus*. In fact, from the figures one might be excused for mistaking it for a *Spirifer*. I suspect, however, that it will be found to be a *Chonetes*, belonging to the group of the *grandicostati*.

In his paper on fossils from the south point of Spitzbergen Toula cites six species of *Productus*. *P. payeri* and *P. weyprechti* probably, and *P. humboldti* certainly, have, so far as known, no Guadalupian representatives. The shell referred to *P. koninckianus* is somewhat similar to *P. meekanus* and *P. signatus*. The two undetermined species are not figured and can not enter into a comparison.

In describing later a fauna from the Hornsund, on the west coast of Spitzbergen, this author cites seven species of *Productus*, to which should perhaps be added a fragmentary specimen identified as *P. lèplayi* De Vern. and referred to the genus *Strophalosia*. *P. weyprechti*, which in the preceding paper had been figured from an internal mold, is here shown to be one of the *semireticulati*, together with *P. spitzbergianus*, which Toula, I can not but think with little reason, compares with *P. horridus*. *P. weyprechti* seems to be most nearly related to *P. guadalupensis* of our American fauna. Another of the *semireticulati*, *P. wilczeki*, strikingly resembles *P. popei* and its allies, some of which are comparable to the shell that Toula identifies as *P. longispinus*, perhaps also to the unfigured *P. longispinus* var. *acutirostratus*. The form referred to *Productus* cf. *prattenianus* (=*P. cora*) is said to be without spines, and therefore it is perhaps more nearly allied to *P. lineatus*. There is no Guadalupian species very similar to it. The form identified as *P. undatus* is not figured. If it is the same as typical *P. undatus*, no species in the Guadalupian can be compared to it, except, very loosely, *P. meekanus*.

From Axel Island Toula cites three varieties of *P. horridus*, *P. cancrini*, *Productus* cf. *humboldti*, *P. weyprechti*, *Productus* sp., *P. semireticulatus*, *P. aagardi*, and *P. impressus*. Of the modifications of *P. horridus* one[a] has much the configuration of *P. guadalupensis* and is represented as being marked, especially toward the front, by obscure ribs. The other forms appear not to be striated and can be compared, though but partially, with *P. latidorsatus* and *P. subhorridus* var. *rugatulus*. *P. impressus*, *Productus* cf. *humboldti*, and *P. weyprechti* appear to be without Guadalupian representatives. *P. cancrini* (not figured) is perhaps analogous to *P. meekanus* and *P. signatus*, *P. semireticulatus* to *P. semireticulatus* var. *capitanensis* and *Productus* sp. *c*, though not very similar, and *P. aagardi* to *P. waagenianus*.

From the cape between the two arms of the North Fjord Toula cites *P. horridus* var. *spitzbergianus*, *P. cancrini*, *P. humboldti*, *Productus* cf. *scabriculus*, and *P. longispinus* var. *setosus*. *P. horridus* var. *spitzbergianus* seems to be the same species which this author described from the Hornsund as *P. spitzbergianus* and from Axel Island as *P. horridus*. It is possibly related to *P. guadalupensis*. The form referred to *P. cancrini* is perhaps related to *P. meekanus* and *P. signatus*, though Toula's specimen appears to have been in an imperfect state of preservation. Possibly the same cause would account for differences between Toula's figures and those of

[a] Toula, F., Neues Jahrb., 1875, pl. 5, fig. 2.

typical *P. scabriculus*. This form, together with *P. humboldti* and *P. longispinus* var. *setosus*, appears to have no closely related species in the Guadalupian. The last named is possibly the species which De Koninck described from Spitzbergen as *P. robertianus*, and if so my surmise that *P. robertianus* is one of the grandicostate *Chonetes* must be in error. It more nearly resembles *P. popei* and related forms than any other Guadalupian species.

Lundgren cites only *Productus ?* sp. as occurring in his Permian fauna from Spitzbergen, and it may be said in general, though with here and there an exception, that the *Producti* of the Spitzbergen faunas are not very similar to the Guadalupian ones.

This is still more true of the fauna from the Barents-Inseln, Nova Zembla, from which Toula cites *P. cora*, *P. semireticulatus*, *P. costatus*, *P. punctatus*, *P. humboldti*, *P. aculeatus*, and *P. obscurus*. *P. obscurus* and *P. aculeatus* may in a general way correspond to *P. subhorridus* var. *rugatulus* and *P. latidorsatus*, and *P. semireticulatus* and *P. costatus* to *P. semireticulatus* var. *capitanensis* and *Productus* sp. *c*. I can not repress a suspicion that Toula's figure of *Strophomena depressa* represents a dorsal valve of a *Productus* of the *cora* type, rather than a *Leptæna*.

From the Productus limestone of the Wadi-Draa in the West Sahara Stache has brought to notice a remarkable *Productus* fauna, consisting of numerous mutations of what appear from figures to be a single primal form. They all show more or less close relationship to *P. hemisphærium* and *P. margaritaceus*, the great groups of the *semireticulati*, *fimbriati*, etc., being entirely unrepresented. One species, it is true, *P. devestitus*, Stache refers to the group of *P. sublævis*, but it is certainly not a normal representative of the *semireticulati*. In the Guadalupian the only species which may be compared with these is *P. waagenianus*, and the relationship is probably not close. Stache distinguishes 13 species in this series, only two of which need occasion further remark. One of the new names introduced by Stache is *P. semistriatus*, the combination used by Meek for an American shell in 1860. The form called *Productus ? tripartitus*, both from the figures and the structures which it is said to possess, I suspect to belong to another genus—to be, in fact, a dorsal valve of a strophomenoid.

Stache also cites two species of *Productus* (*Productus* aff. *margaritaceus* and *Productus* sp.) from the "Sandsteinschichten der Mittelregion" of the West Sahara and four from Igidi; but as these forms have little to do with the Guadalupian fauna I shall not delay over them, pausing only to comment on numerous mistakes in plate references which occur in this work and cause labor and uncertainty to anyone wishing to consult them. It seems as if examples of all possible errors could be furnished in text, plates, and descriptions of plates, including incorrect citation, duplication, and omission of numbers.

From Bolivia Toula cites only *Productus* cf. *cora* and *P. semireticulatus*. Salter cites only *P. semireticulatus* and *P. longispinus* (*P. capacii* of D'Orbigny), the latter very similar to *P. texanus* of the Guadalupian. In D'Orbigny's volume, however, we find nine species described. One can easily trust too far to D'Orbigny's figures, but it is safe to say that no species of the type of *P. humboldti* are as yet known in the Guadalupian. *P. villiersi* appears to correspond to *P. meekanus*. *P. cora* is without a closely corresponding form. *P. andii* has been shown by De Koninck to be an orthoid (=*Orthis buchii*). *P. capacii* is closely similar to *P. texanus*, and *P. inca*, *P. peruvianus* (fide De Koninck), *P. boliviensis*, and *P. gaudryi* (figured but not described) are large species of the *semireticulatus* type more or less allied to *P. semireticulatus* var. *capitanensis* and *Productus* sp. *c*. Upon the whole the known Peruvian faunas are not very similar to those of the Guadalupian in point of the genus *Productus*, and I am tentatively holding that they represent an earlier epoch.

In his Peruvian material Gabb distinguishes only three species of *Productus*, one a small form neither described nor figured, the two others large species belonging, it would appear, to the *semireticulati*.

The Brazilian fauna which Derby described includes seven species of *Productus*. *P. semireticulatus*, *P. chandlessii*, *P. batesianus*, and *P. rhomianus* (if the latter does not after all belong to the genus *Marginifera*) can all be referred to the *semireticulati*, without, however, being very similar in any instance to the Guadalupian species *P. semireticulatus* var. *capitanensis*. They appear to be nearer to the imperfectly known *Productus* sp. *c*. *P. chandlessii* and *P. batesianus*, however, have cognate species in *P. guadalupensis*, and *P. rhomianus* possibly in *P. texanus* and its allies. *P. cora* has no very close ally in the North American fauna. *P. clarkianus* bears comparison with *P. meekanus*, and *P. wallacianus* to a certain extent with *P. latidorsatus* and *P. subhorridus* var. *rugatulus*. Though I am tentatively regarding the Brazilian fauna as older than the Guadalupian, the *Producti* show considerable resemblance.

In his valuable bibliography Weller recognizes upward of 50 species of *Productus* from the Upper Carboniferous rocks of North America. Fifteen of these are distinctly western forms, the remainder being for the most part restricted to the Mississippi Valley and Appalachian regions. To treat the Pennsylvanian *Producti* as I have attempted to do in the case of foreign faunas would be impossible, since many of them have not been figured; and the need of detailed comparisons is less imperative, since all who are familiar with the Pennsylvanian faunas will at once recognize that they are very unlike those of the Guadalupe Mountains. Suffice it to recall in this connection that the *Producti* of the Pennsylvanian commonly belong to five types which occur again and again, whether collections be made at different localities or different horizons. We have Marginiferas such as *M. wabashensis* and *M. muricata*, and species of *Productus* more or less closely related to *P. semireticulatus* and *P. costatus*, to *P. cora*, to *P. nebraskensis*, and to *P. punctatus*. Of these the greatest variation is shown by the *semireticulati*. None of the Guadalupian species of *Productus* is, so far as I am aware, identical with a Pennsylvanian form.[a] Some of the *semireticulati* have analogous forms in the two faunas, but the *punctatus* and *nebraskensis* types are entirely alien to the Guadalupian, and *P. cora* nearly as much so, being represented only by the distantly connected *P. pinniformis* and *P. waagenianus*.

Species of *Marginifera* more or less completely identical with *M. wabashensis* and *M. muricata* are a rather constant factor in most Pennsylvanian faunas. The genus *Marginifera* is, so far as known, entirely lacking from the Guadalupian.

[a] Shumard cites *P. norwoodi* from the Capitan formation, but I am at a loss to know with what he had to do. If not an *Aulosteges* the form in question would appear to be one of the *fimbriati*, a type which, at least in our collections, seems to be unrepresented in the Guadalupian.

Productus pileolus, the species which seems from its structure most likely to belong to that genus, is of an altogether distinct type from the Pennsylvanian Marginiferas. On the other hand, the forms which superficially most resemble the Pennsylvanian Marginiferas, such as *Productus subhorridus* var. *rugatulus* and certain shells belonging to the group of *Productus popei*, seem to be without the characteristic *Marginifera* structure.

Among the rarer Pennsylvanian *Producti* one at least seems to have a related type in the Guadalupian, *P. pertenuis* being unquestionably related to *P. meekanus*, but it can be stated without qualification that the Guadalupian *Producti* are markedly different from the Pennsylvanian forms. Nor will it be necessary to devote much time to the scattered species which have been described from the West. In no instance, I believe, are they identical with Guadalupian species, and the associated faunas in every case, so far as I am aware, are different and probably older.

In thus hastily surveying the representative of this most characteristic Carboniferous genus in the different faunas of the world it has become apparent that the Guadalupian in this particular is an individual entity. Its affinities with certain faunas are marked, but almost invariably it presents equally marked differences, so that it can not be said to be identical with any of them.

Productus waagenianus n. sp.

Pl. XII, figs. 6 to 7a.

Shell small. Ventral valve much inrolled, gradually spreading transversely. Beak inflated, pointed, strongly incurved, slightly projecting. Ears small, depressed, quadrate, flattened. Sinus absent. Toward the margin the shell develops a few low folds.

Dorsal valve nearly planate, with a narrow geniculated portion around the front and sides. Beak small, indistinct. Ears undefined.

Surface marked by radiating liræ, concentric liræ, concentric wrinkles, and spines. Liræ very fine, about 14 in 5 mm.; low, rounded, separated by intervals as wide or wider than themselves. Concentric liræ rather coarse but indistinct. Wrinkles faint, distant, covering more than half the surface; strong on the ears. Visceral portion with a few rather large nodes, which may have been bases of spines, some of which appear to have been located on the ears, especially near the hinge line.

The foregoing description, so far as it relates to the surface, is based on the ventral valve. The surface of the dorsal valve is marked by concentric wrinkles (and presumably concentric liræ) and radiating liræ. The wrinkles on this valve are very strong, regular, subimbricating, and rather distant, covering the surface as far as the geniculation. The shape and ornamentation are such as to simulate certain varieties of *Leptæna rhomboidalis*. The wrinkles are so much stronger than those of the ventral valve as to suggest that the two shells do not belong together; but the other characters are similar, they are associated in the same beds, and nothing has thus far come to hand which in either case could be taken for the supplementary valve. I have at present little doubt about their relationship. Were it not for the peculiar character of the dorsal valve it might perhaps have been possible to refer this form to the common *P. cora;* but with the present association it is out of the question.

P. waagenianus is related to the Arctic species *P. aagardi* Toula not only in a general way but in the plicated condition of the dorsal valve. It is distinguished, however, by its much finer liration.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926).

Productus waagenianus var.

The typical specimens of *P. waagenianus* were derived from the white limestone of the Guadalupe section. From the sandstones of the Delaware Mountain formation a few ventral valves of a similar type have been obtained, though I doubt if they can properly be referred to the same species. Nevertheless the fossils so far observed are really too poorly preserved to warrant the introduction of a new name. The convexity of these shells is variable, though generally broad and low. The ears are large, flattened, and undefined. The surface is marked by rather strong thin liræ, with rounded intermediate grooves. There appear to be no wrinkles, except faint ones on the ears, and a few small spines can be observed in the same region. The dorsal valve is not known.

The main points of difference from *P. waagenianus* consist in the coarseness of the liræ, in which the Delawarian specimens show some differences among themselves. The finest of them, however, has but eight or nine in the space of 5 mm., a distinctly coarser liration than in *P. waagenianus* proper. This form resembles *P. cora*, but even if the dorsal valve is not constructed as in the typical variety, the absence of large spines over the surface should serve to distinguish them.

Horizon and locality.—Delaware Mountain formation, Guadalupe Point, Guadalupe Mountains, Texas (stations 2903 and 2919).

Productus semireticulatus var. capitanensis n. var.

Pl. XII, figs. 1 to 3b; Pl. XX, figs. 8 and 8a.

1858. *Productus semireticulatus.* Shumard (non Martin), Trans. Acad. Sci. St. Louis, vol. 1, p. 292 (date of volume, 1860).
White [Permian] limestone: Guadalupe Mountains.

1859. *Productus semireticulatus* var. *antiquatus.* Shumard (non Martin), idem, p. 389.
White [Permian] limestone: Guadalupe Mountains.

Shell large. Ventral valve strongly arched. Beak moderately full. Ears probably large and projecting. Sinus profound, angular, and extending nearly to the beak.

Dorsal valve with strongly flattened visceral region; anterior and lateral portions uniting in an abrupt geniculation and at an angle somewhat less than 90°. Sinus faint over the visceral region, stronger below the geniculation. Ears large, defined by a groove, somewhat arched. Both valves exhibit a tendency to develop along the margin into large, loose folds and irregular growths.

The surface is marked by moderately fine ribs and regular concentric wrinkles of about the same size. The wrinkles are restricted to the visceral area, and produce regular nodes where they cross the ribs. Some of the nodes are more prominent than the rest, and formed the bases of small spines. The ribs increase by bifurcation, and those nearest the sinus exhibit a marked tendency to run down from the sides into it. They come about four or five in 5 mm. The distribution of the spines has not been ascertained.

While the dorsal valve, and doubtless the ventral one also, had much-produced ears, it is noticeable that the growth lines and wrinkles contract at the hinge. The sinus is remarkably deep and angular and reliance is placed on this and other peculiarities in the configuration and ornamentation to distinguish this form from the varieties of *P. semireticulatus* found in the Mississippi Valley, and also from the typical English species. This is undoubtedly the variety which Shumard mentioned in his original list of fossils from this locality, referring to it as *Productus semireticulatus*. His remarks are as follows:[a]

> This widely distributed species is contained in Captain Pope's collection from the white limestone of the Guadalupe Mountains. The specimens resemble most the variety *P. antiquatus*, but the sinus of the receiving valve is more profound and narrower than in the example figured by De Koninck, which are generally marked with a broad shallow sinus. One of our fossils exhibits a group of 15 tubes on a smooth space just under the reticulated portion of the sides, arranged as represented in De Koninck's figures of some examples from Vise, Belgium. (Monog. Prod. et Chon., Pl. IX, fig. 1b, c.)

In his later list[b] the form appears as *P. semireticulatus* var. *antiquatus* Martin. The spines which Shumard describes as being numerous just under the reticulated portion have not been observed by me, on account of the imperfect condition of my material.

This variety is found not only in the white limestone, from which Shumard cites it, but also in the dark limestone. The only difference which my material shows between examples found at the two horizons is that the type from the white limestone is a little more finely ribbed than the other.

This form is by no means rare in the Capitan limestone, but all my material is more or less fragmentary. So extreme a range in size is indicated by the specimens that I suspect several varieties could be discriminated did not their imperfect condition render ineffectual an attempt to do so.

Horizon and locality.—Top of Capitan formation, Capitan Peak (station 3762); middle of Capitan formation, Capitan Peak (station 2926); base of Capitan formation, hill southwest of Guadalupe Point (station 2906); "dark limestone," Pine Spring (station 2930), Guadalupe Mountains, Texas.

PRODUCTUS MEXICANUS Shumard.

1858. *Productus Mexicanus.* Shumard, Trans. Acad. Sci. St. Louis, vol. 1, p. 291 (date of volume, 1860).
White [Permian] limestone: Guadalupe Mountains.

1859. *Productus Mexicanus.* Shumard, idem, p. 389.
White [Permian] limestone: Guadalupe Mountains.

?1877. *Productus Mexicanus?* White, U. S. Geog. Survey W. 100th Mer., Rept., vol. 4, p. 120, pl. 8, figs. 6a to 6c.
Carboniferous: Camp Cottonwood, old Mormon road, Lincoln County, Nev.; near Salt Lake, New Mexico.

?1883. *Productus Mexicanus.* Kayser, Richthofen's China, vol. 4, p. 182, pl. 28, figs. 7a–7b.
Upper Carboniferous: Lo Ping, China.

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[a] Trans. Acad. Sci. St. Louis, Vol. 1, 1856–1860, p. 292.
[b] Idem, p. 389.

?1902. *Productus Mexicanus.* Tschernyschew, Mém. Com. géol. St. Petersburg, vol. 16, No. 2, p. 264, pl. 52, fig. 10.

Schwagerina zone: Ural Mountains.

Shell of medium size, subrectangular, width greater than the length; dorsal valve elevated, strongly arched, marked with a broad, very slight mesial depression, which is scarcely developed into a sinus; sides rounded, falling abruptly to the margins, front very gently convex; beak small, pointed, convex, moderately prominent; surface ornamented with from 18 to 24 prominent, rounded, longitudinal ribs, their number somewhat increased by implantation or bifurcation. The ribs are separated from each other by spaces as wide as themselves, and both ribs and spaces are crossed at somewhat irregular intervals by rounded concentric folds, which give to the ribs at the points of crossing a handsome subnodulose character. The concentric folds are not as prominent as the ribs except on the sides, where, in one of the specimens before us, two or three of those nearest the border are developed into strong wrinkles. Ventral valve unknown.

Dimensions.—Length, 0.64; width, 0.70; height, 0.54. These proportions were taken from a young specimen on account of its being more perfect than the others. The collection contains fragments of full-grown shells, which, if perfect, would perhaps measure one-third greater.

White limestone of the Guadalupe Mountains.[a]

The foregoing are Shumard's description and remarks on this species, which, unfortunately, seems to be without representation in our collections. I know of no form having the large ribs and coarse wrinkles called for by Shumard, not to mention the specifications as to size and sinus.

White identifies this species from points in Nevada and New Mexico, and although his form agrees closely with Shumard's description in most respects except size (it being considerably smaller), it is probable that if representative specimens of *P. mexicanus* were at hand the two would not be found to be the same species.

The form most similar to *P. mexicanus* in the present collection is that designated *Productus* sp. *a*, which is from a different horizon. It seems to be closely related to *P. mexicanus* as identified by White, except that the ribs are coarser; but many characters of *Productus* sp. *a* are not well shown by the single imperfect specimen at hand. *P. walcottianus* resembles perhaps still more closely White's identification of Shumard's species. It has, however, stronger wrinkles over the visceral area, with more numerous spines and less regular and continuous ribs.

PRODUCTUS sp. *c*.

This division is made primarily for a single ventral valve from the Glass Mountains (station 3763). The posterior portion is enveloped in chert, so that the characters of this portion can not be made out. It is evidently nearer to *Productus guadalupensis* than to any of the other species recognized in this report, but differs in being somewhat larger, in having slightly coarser and stronger ribs, and in being less arched and inflated in the posterior portion. The ears appear to be large. The distribution and character of the spines has not been ascertained.

It differs from the large form of *P. semireticulatus* var. *capitanensis* in being smaller, and from both large and small forms in having a broader and shallower sinus and less prominent ribs. Its general shape is that of a species recently described by me as *P. semireticulatus* var. *hermosanus.* It is, however, slightly smaller, has a somewhat deeper sinus, and is more strongly arched in an anterior-posterior direction. The ribs are of about the same degree of coarseness, but it can not be told whether the posterior portion is crossed by wrinkles or not.

[a] Trans. Acad. Sci. St. Louis, vol. 1, 1856-1860, p. 291.

I have also provisionally referred here another ventral from the same locality, only the posterior portion of which has been preserved. The size and shape are such as might ally it with the foregoing. The ribs are peculiarly thin and high and separated by broadly rounded grooves wider than the ribs themselves. There are also fine concentric striæ, and concentric wrinkles which make nodes where they cross the ribs, and ridges between them, and are somewhat farther apart than the ribs themselves. The character of the costæ is not exactly that which would be expected to go with the larger specimen, in which the posterior portion is concealed, but not such as to preclude the association altogether.

Horizon and locality.—Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763).

PRODUCTUS POPEI Shumard.

Pl. XX, figs. 9 to 11b.

1858. *Productus Popei.* Shumard, Trans. Acad. Sci. St. Louis, vol. 1, p. 290 (date of volume, 1860) [Permian: New Mexico and Texas.]

1859. *Productus Popei.* Shumard, idem, p. 389, pl. 11, figs. 8a, 8b. White [Permian] limestone: Guadalupe Mountains.

Shell of medium size, subquadrate, wider than long, greatest width at the cardinal border. Dorsal valve (receiving valve) gibbous, very strongly arched, somewhat inrolled, flattened convex near the beak; anterior prolongation of moderate length, forming a gentle curve from the visceral region to the front; sinus commencing near the beak, where it is very shallow, but it soon increases in depth, and becomes very profound on the anterior prolongation, so as to give this portion of the shell a very marked bilobed appearance; surface with from six to ten unequally rounded, coarse ribs on each side of the sinus, their number sometimes increased by division and implantation. These ribs are usually quite prominent and broad on the anterior prolongation, but on the posterior third of the shell they become obsolete, leaving a nearly smooth surface for some distance before the beak; sides falling abruptly to the margins, near which they are usually marked with a series of eight or nine rather strong tubes, which extend from the beak to the front. Besides these, most of the specimens exhibit a few smaller tubes, sometimes scattered promiscuously over the surface, but generally ranging in oblique lines across the dorsum of the shell; beak small, pointed, slightly incurved, and passing a little beyond the cardinal margin. Ventral valve elliptico-subquadrate, gently concave or flattened on the visceral disk, its sides with a row of spines, which, with other surface ornaments, correspond to those of the opposite valve.

We dedicate this, one of the most beautiful species of the American *Productus*, in compliment to Capt. John Pope, of the United States Corps of Topographical Engineers, whose expedition has the honor of having first procured paleontological evidence of the existence of Permian strata in New Mexico and Texas.[a]

The foregoing is Shumard's original description of this species, quoted in full, in which I find it necessary to make few alterations. My specimens appear to have possessed less numerous spines than Shumard mentions, and in especial they lack any well-marked series of these developments on the sides. In fact the spines appear to be scattered, and are for the most part of small size, except the lateral ones. Shumard's statement that there are six to ten ribs on each side of the sinus is not very satisfactory, since the sinus in *Productus* can not be said to have any well-recognized limits. My specimens have about 20 ribs in all, those in the sinus being indistinct.

[a] Trans. Acad. Sci. St. Louis, vol. 1, 1856–1860, p. 290.

The description of the dorsal valve reads very much as if it were framed from observations of a flattened ventral, especially in the presence and arrangement of the spines. The only dorsal in our collection is similar to the ventral shells, but is flatter and with a less elevated and projecting beak. One specimen associated with the others of this species seems to mark a somewhat distinct variety, being narrower and with weaker ribs. It is represented by figs. 11, 11a, and 11b of Pl. XX.

On page 389 of the volume which contains the description quoted above, Shumard again remarks of this species:

> A number of specimens of this species are in the collection, all of them from the white limestone of the Guadalupe Mountains. There are two distinct varieties; one having a remarkably deep sinus with 5 to 7 costæ on caither side, and the other with a less profound sinus and from 8 to 13 costæ. The latter variety I at first regarded as a distinct species, but a more thorough examination of a number of specimens has led to the opinion that it should not be separated from the species above cited.

Shumard's figures are not so good but that a certain doubt remains in my mind that this may not after all be *P. popei*, yet it is nearer than any other species in our collections. His figures show a narrower form, with more sloping sides. As to what the variety referred to in his later note may be, I am uncertain, unless it is the slightly larger but very similar species which I have described as *P. popei* var. *opimus*.

The shells here discriminated as *P. popei* and *P. occidentalis* are very similar to one another. Only minor differences exist, and larger collections may be expected to bridge them over. *P. popei* is smaller, with stronger and somewhat finer ribs. It is more strongly arched longitudinally, the posterior portion being flattened, with the rostral and umbonal areas depressed.

Horizon and locality.—"Dark limestone," Pine Spring (station 2930), and hill southwest of Guadalupe Point (station 2924?), Guadalupe Mountains, Texas. Delaware Mountain formation, southern Delaware Mountains, Texas (station 2957).

Productus popei var. opimus n. var.

Pl. XX, figs. 12 to 14a.

Associated with *Productus popei* in the "dark limestone" is a type that is related so closely to it that I am able to point out few characters save that of size by which they are distinguished; yet as the difference in size is rather marked, with few if any intermediate conditions, I am unwilling to refer them to the same species without some qualification. The following characters have been noted:

The shell is of medium size. Ventral valve transverse, the visceral portion flat, and the curvature strong and abrupt. Ears small, depressed, and probably slightly extended. Sinus rather deep and narrow, but undefined. Ribs moderately strong and coarse; about 21 on the type specimen. Spines few, large, chiefly on the lateral portion of the shell near the ears. In one specimen several occur in a row approximately defining the ears on each side.

Dorsal valve much like the ventral, but lower and with less elevated beak. The figured specimen has more regular and equal ribs than some of the others referred to the same species.

The shape of these shells is that which usually distinguishes dorsal valves of other species, and they might easily be mistaken for dorsals of *P. occidentalis*, which they resemble very closely. The chief difference seems to consist in the slightly greater prominence of the beak and slightly increased fineness of the ribs. The presence of spines on the convex sides of some of these shells, however, is conclusive evidence, in spite of their configuration, that they are ventral valves.

This form is readily distinguishable from *P. occidentalis* by its flattened shape and lower elevation. Some of the associated dorsal valves, however, are with difficulty assigned to one or the other species, the chief difference being that they are much lower than *P. occidentalis*.

Practically the only character which distinguishes this form from *P. popei* is that it is distinctly larger. The configuration is practically the same. The ribs have almost the same prominence and degree of fineness, but as the shell is larger more of them are to be counted around the circumference.

Horizon and locality.—"Dark limestone," Pine Spring, Guadalupe Mountains, Texas (station 2930).

Productus indentatus n. sp.

Pl. XX, figs. 15 to 16b.

Shell small, transverse. Ventral valve rather strongly arched, the visceral and anterior portions being more or less flattened, of equal length, and nearly at right angles to one another. Beak small, pointed, and slightly transgressing the hinge line. Ears large, flattened, projecting. Sinus narrow, shallow over the visceral portion, and deep anteriorly.

Shape of dorsal valve like that of the ventral, save that it is lower, with flatter visceral portion and less prominent beak.

Surface marked by radiating ribs of moderate strength and coarseness, or somewhat less, a few of which bifurcate about halfway forward from the beak. The bases of a few rather small spines occur on the ventral valve.

This form has about the size and something of the expression of the Marginiferas of the Mississippi Valley section; but such evidence as to its internal character as I have been able to gather would indicate that it is not a *Marginifera*. From the common *Marginifera wabashensis* or *longispina* of the Mississippi Valley it differs in having a deeper sinus, coarser and often stronger ribs, and fewer spines. I believe, however, that instead of being a *Marginifera* it is a *Productus* of the tye of *P. popei* et al.

Horizon and locality.—"Dark limestone," Pine Spring, Guadalupe Mountains, Texas (station 2930).

Productus texanus n. sp.

Pl. XXI, figs. 25 to 26b.

Shell rather small. Ventral valve strongly arched longitudinally, subquadrate transversely, with a distinct but not very deep sinus and abruptly descending sides. Cardinal line extended. Ears rather large, convex.

Dorsal valve very transverse, beak apparently small and depressed. Ears large, projecting, defined by grooves, and upturned. Visceral portion flattened and marked by a narrow obscure sinus, which becomes deeper toward the anterior margin.

The surface is covered by strong, fine ribs, about five in 5 mm., which are obscure over the posterior portion. This area is nearly smooth, without either distinct ribs or distinct wrinkles. Toward the front of the ventral valve the ribs tend to become less pronounced and somewhat coarser, owing apparently to the fact that in some cases the older ribs unite or are replaced several by one. The spines are large and few in number, confined chiefly to the sides near the ears.

This shell somewhat recalls *Marginifera wabashensis*, but when compared with that species it proves to be larger, with coarser and stronger ribs. The dorsal valve is more transverse, with flatter visceral portion, larger ears, and deeper sinus. Indeed, the present species probably does not possess the characteristic structures of *Marginifera.*

It also resembles *Productus indentatus*, but is larger, less highly convex, with stronger ribs and shallower sinus. It stands rather close to *Productus* sp. *d*, with which it occurs in association at one locality. Its larger size and stronger, somewhat coarser ribs are its distinguishing characters, but if *Productus* sp. *d* has the reflexed border shown by a specimen supposed to belong to it, *P. texanus* is undoubtedly distinct.

Another closely related species is *P. walcottianus*. Considered on the basis of their type specimens, *P. texanus* is larger, with shallower sinus, larger and much less numerous spines, and nearly smooth instead of wrinkled and spinous visceral area. When only the anterior portion is examined the two species have a strong resemblance, but the posterior portions are sowewhat different. While these differences rather strongly distinguish the typical specimens, it will be impossible to satisfactorily refer imperfect examples and casts.

In *P. capacii* D'Orbigny has described a shell related to the one under consideration. There is a slight difference in shape, the South American species contracting more rapidly above. The ribs appear to be finer and the surface more thickly covered with spines, but the two species are certainly closely related, and a comparison of specimens may prove them to be identical.

Horizon and locality.—Delaware Mountain formation, Guadalupe Point, Guadalupe Mountains, Texas (stations 2903 and 2919).

Productus sp. *a*.

Pl. XXI, figs. 24 to 24c.

This form is represented by a single small ventral valve having a width of about 16 mm. and a length of 13 mm. The sinus is rather strong toward the front, but indistinct on the posterior half of the shell. The ears are small, and ill defined. Beak rather inflated. Visceral area somewhat flattened. This portion of the shell is nearly smooth, though the more marginal areas are marked by coarse prominent ribs, about 13 or 14 in number. A few large spines are found on the sides and the ears.

This shell is about the same size as the Pennsylvanian species *Marginifera wabashensis*, but is easily distinguished by its stronger sinus and much coarser ribs. It more nearly resembles *Productus indentatus* of the present fauna, from which it is distinguished by its shallower sinus and considerably coarser ribs. Its general appearance is that of a diminutive example of *popei*.

Though from a considerably lower horizon, this is nearer to *P. mexicanus* Shumard than any other of the species recognized. It differs from the specimen identified and figured by White as *P. mexicanus* in being less strongly wrinkled on the visceral region and in having coarser ribs. All the characters, however, are not satisfactorily shown by the single example so far found.

Horizon and locality.—Delaware Mountain formation, Guadalupe Point, Guadalupe Mountains, Texas (stations 2903 and 2919).

PRODUCTUS GUADALUPENSIS n. sp.

Pl. XXII, figs. 1 to 3a.

Shell of medium size, inflated, transverse. Ventral valve strongly arcuate longitudinally. Beak small, slightly projecting. Ears depressed, gently convex, extended. Sinus strong, narrow, and undefined. Surface marked by rather fine ribs, about five in the space of 5 mm., which are not very distinct and apparently die out altogether toward the anterior margin. They are indistinct over the posterior portion also, which is not crossed by well-marked concentric wrinkles, although this area has an obscurely nodose appearance. Spines comparatively large, few in number, and scattered over the more marginal portions of the surface. Dorsal valve not known.

This species has the general configuration of *Productus multistriatus* Meek, but it is more highly arched and has coarser ribs. Perhaps even more similar are the two South American species *P. chandlessi* and *P. batesianus*, both described by Derby. *P. guadalupensis* is somewhat smaller than *P. chandlessi*, with a stronger sinus, more projecting ears, and coarser ribs. It is somewhat larger than *P. batesianus*, with more projecting ears and finer ribs.

The typical examples of this species were found in the yellow sandstone of the Delaware Mountain formation at station 2919, and a single somewhat doubtful example was obtained from the same horizon at station 2931.

Horizon and locality.—Delaware Mountain formation, Guadalupe Point, Guadalupe Mountains, Texas (stations 2919 and 2931).

PRODUCTUS GUADALUPENSIS var. COMANCHEANUS n. var.

Pl. XXXI, figs. 5 to 5b.

This form occurs in the Glass Mountains, and it so much resembles that which is found in the sandstones of the Delaware Mountain formation that I originally identified them as the same species. Their configuration is about the same, though the present form is perhaps a little more strongly arched, and it also has distinctly coarser ribs. The variety *comancheanus*, therefore, suggests *Productus multistriatus* much less than the typical one.

With but a single specimen of the present form and rather imperfect material representing the other, it is impossible to tell whether these differences are mere variations or are constant and associated with others. Consequently the present form has been introduced as a variety, and the matter left standing so for decision by fresh and more perfect material.

Horizon and locality.—Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763).

PRODUCTUS OCCIDENTALIS Newberry.

Pl. XII, figs. 4 to 4c.

1858. *Productus costatus*. Marcou (non Sowerby), Geology of North America, p. 46, pl. 5, fig. 5. Carboniferous: Cedar Creek, Mogollon Mountains; tributary of Gila River; sources of the Colorado Chiquito.

1861. *Productus occidentalis*. Newberry, Ives's Colorado Expl. Exped., Rept., p. 122, pl. 2, figs. 9, 10. Upper Carboniferous (cherty limestone): Banks of Cascade River near junction of Great and Little Colorado.

This species is very abundant in the upper portion of the Aubrey, whose typical outcrops are found in northern Arizona, and it presents many variations, to not all of which the original definition of Newberry strictly applies. One of these varieties occurs in the white limestone of the Guadalupe Mountains, though but a single specimen, representing a ventral valve, has so far come to hand. Three rather imperfect specimens from the "dark limestone," which possibly do not belong to exactly the same varietal group, have also been collected. The more perfect example from the white limestone may be described as follows:

Shell of medium size, narrow, highly arched. Ears moderately large, flattened, depressed, more or less extended. Sinus strong, but broad and undefined. Ribs coarse and irregular, separated by rather wide intervals; not very strongly elevated, more or less nodulose and bifurcating. The spines for the most part are small and scattering, but on the sides near the ears a few large ones occur. The specimens from the "dark limestone" have ribs of nearly the same size, but more numerous and more closely arranged.

As previously remarked, this shell can be almost exactly matched by specimens from the Aubrey which I identify with *Productus occidentalis*. Of the different American forms which have been referred to *P. costatus* probably none approaches Sowerby's species more closely than does the one under discussion. Yet if *P. costatus* be restricted to the type with which the name was first associated none of these forms deserves to be referred to it. *P. occidentalis* has not been cited by name in paleontological papers since it was first described by Newberry, but it is probable that the form described and figured by Marcou as *P. costatus* is the same species. Marcou's figures appear to represent a dorsal valve, if one may judge by the apparently flattened posterior portion and absence of spines. He states that he had larger and better specimens, and his description appears to be based on a ventral valve. The resemblance of his figures to dorsal valves of *P. occidentalis* is striking, and the geologic occurrence which he cites is also favorable to their being the same species.

Marcou's figures, however, represent the visceral portion of the valve as marked by concentric wrinkles, which is rarely the case with characteristic *P. occidentalis*.

Horizon and locality.—Middle of Capitan formation, Capitan Peak (station 2926); "dark limestone," Pine Spring (station 2930), Guadalupe Mountains, Texas.

PRODUCTUS MEEKANUS n. sp.

Pl. XXX, figs. 13 and 13a.

Shell small. Ventral valve moderately convex. Beak small, inconspicuous. Ears small, quadrate, undefined. Sinus absent. Surface marked by concentric wrinkles, spines, and liræ. The wrinkles, which are strong on the sides and ears but fainter and somewhat interrupted elsewhere, cover practically all the surface. The spines are rather large, numerous, regularly arranged, and projecting strongly downward and forward, so that their bases have a "tear-drop" shape. The radiating liræ are fine and rather faint, tending to be interrupted by the spines, which form the most obvious feature of the surface ornamentation. Where preserved as internal molds in the yellow sandstone of the Delaware Mountain formation, specimens belonging to this species show little besides the spines, a few wrinkles near the ears, and the impressions of a few internal spinules about the margins.

P. meekanus is probably closely related to *Productus signatus*, but is constructed on a smaller and more delicate pattern. Its nearest representative in the Mississippi Valley is *P. pertenuis* Meek, although there can be no doubt that the two species are not identical. It is as if the spines, which are subordinate to the liræ and wrinkles in *P. pertenuis*, had in *P. meekanus* come to dominate them.

Horizon and locality.—Delaware Mountain formation, Guadalupe Point, Guadalupe Mountains, Texas (station 2931). Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763).

PRODUCTUS SIGNATUS n. sp.

Pl. XXII, figs. 4 to 4b.

Shell of medium size, transverse. Ventral valve moderately arched, rather rapidly expanding. Dorsum broad and flattened, without a median sinus; falling off rapidly at the side. Ears apparently small, depressed, and rounded(?). Dorsal valve not known.

Surface covered with spines mounted on narrow elongate bases, which make up a sort of coarse, irregular, and discontinuous ribbing. There are also moderately fine, somewhat indistinct, transverse wrinkles covering nearly the whole shell. On the internal mold, the preservation in which this fossil occurs, the surface between the spine bases is marked by fine, discontinuous, longitudinal liræ, especially on the anterior parts, and by pits produced by numerous small spinules on the inner surface of the shell. These fine liræ, like the spinules, may be entirely internal structures, but they may also be and more probably are the expression on the inside of fine intermediate liræ, like those on the surface of *Productus meekanus*.

An external mold of a dorsal valve is marked by moderately fine concentric wrinkles, fine, interrupted radiating liræ, and numerous slender spines, a feature not very common for the dorsal valve even when they occur on the opposite one.

This species is allied to *P. opuntia* Waagen, but can be distinguished by the more elongated character of the spine bases, from the middle of which the spines arise.

It is closely related to *P. meekanus*, but the sculpture, while of the same general character, is on a much larger scale.

Horizon and locality.—Delaware Mountain formation, Guadalupe Point, Guadalupe Mountains, Texas (station 2931).

Productus signatus var.

Associated with the form which I have described as *Productus signatus* is another very similar to it, which, while considerably smaller in size, has the surface ornamentation of the same character and on about the same scale. The internal spinules are much more numerous on the anterior and lateral portions of the shell.

The width of the specimen for which this division is made is about 25 mm. and the length from the anterior margin to the point of greatest convexity 22 mm. The size, therefore, is considerably smaller than that of *P. signatus*, and about that of *P. meekanus*, but the surface ornamentation, in the wider spaces at which the spines stand, rather resembles the former species.

Too little is known of these forms to permit a conclusion as to their actual affinities.

Horizon and locality.—Delaware Mountain formation, Guadalupe Point, Guadalupe Mountains, Texas (station 2931).

Productus latidorsatus n. sp.

Pl. XI, figs. 11 to 13b.

Shell rather small, thin, transverse. Ventral valve moderately convex, the anterolateral curvature being stronger than the transverse. Beak small, incurved, not projecting far beyond the hinge line. Ears small, depressed, somewhat arched, probably slightly projecting. Sinus shallow, ill defined.

Dorsal valve moderately convex, with flattened visceral region. Beak inconspicuous. Ears small, depressed, somewhat arched, and slightly projecting.

Surface nearly smooth. Traces of ribs can be seen on most specimens, but they are usually faint. Equally or somewhat more indistinct concentric wrinkles also are found, and rather strong growth lines. Spines are numerous and small over the posterior portion of the shell, rather scarce and larger over the front, lateral portions, and ears. The ribs in many cases, especially where at all well marked, are more or less discontinuous, and originate severally at the bases of the larger spines.

This species is related to *P. wallacianus* Derby, but it is distinguished by having a more or less distinct sinus and much less numerous spines. It is also allied to *P. subhorridus* Meek, but before comparing the Guadalupian form with that species it will be necessary to define the latter a little more closely than Meek has done.

Meek apparently figures two specimens of *P. subhorridus*.[a] One specimen was probably the original of figs. 3 and 3b, and another of fig. 3a. The description of plates seems to indicate that 3 and 3b represent different specimens, but the undoubted original of 3b corresponds exactly to fig. 3, whereas no other specimen in the type lot is at all like it. But the surface of the specimen which undoubtedly stood as the original of 3b is unlike the illustrations of either 3b or 3. It is in fact largely exfoliated, and the spines represented on both figures are not found on the specimen. I have been able to find traces of less than ten on the entire surface, and it is safe to say that they are much less numerous than represented. Furthermore, on parts of the shell, and especially on a small area on the sides where exfoliation appears not to have touched, the surface is marked by very fine, regular, equal, radiating liræ. I can not be sure, without other specimens, of the validity of these observations as applying to the real surface ornamentation, but these differences, taken with the more slender form and deeper sinus, indicate rather strongly that the original of figs. 3 and 3b does not belong to the same species as that of fig. 3a. To the latter it is proposed to restrict the name *P. subhorridus*, because to it belong most of the type lot of specimens, and because the name *subhorridus* and the description clearly apply to this type. Perhaps the only character in Meek's description which is taken from the original of figs. 3 and 3b is the strong sinus which is ascribed to *P. subhorridus*, a character which is far from distinct in shells having the abundantly spinose surface of fig. 3a.

From *P. subhorridus* thus restricted *P. latidorsatus* differs in being shorter and broader, with much fewer spines.

This species is plentiful in the white limestone, though apparently it was not represented in Shumard's collections. No specimens have been found belonging to it in the "dark limestone," but to the same species has been referred, with some doubt, an imperfect specimen from the Delaware Mountain formation. This example is similar to immature stages of *latidorsatus*, but has rounded cardinal angles and appears to be without sinus, ribs, or spines. The preservation, however, is so imperfect that these characters might be largely lost.

Horizon and locality.—Middle of Capitan formation, Capitan Peak (station 2926); Delaware Mountain formation, Guadalupe Point (station 2903), Guadalupe Mountains, Texas.

Productus latidorsatus var.

A few specimens from the black limestone of the Guadalupian section are related to *Productus subhorridus*, *P. subhorridus* var. *rugatulus*, and *P. latidorsatus*, but my material is too insufficient and imperfect to permit me satisfactorily to ascertain in what degree. These examples can not be precisely identified with any one of the three types mentioned. They possess the size and general expression of *P. subhorridus* var. *rugatulus*, but have a fainter sinus or none at all, lack the posterior wrinkles, and have numerous small spines over the lateral and posterior portions, with a few large ones near the ears. So far as can now be told they agree in every essential particular with *P. latidorsatus* except that they are considerably smaller. On this account and because of the wide difference in stratigraphic occurrence I feel

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[a] U. S. Geol. Explor. 40th Par., vol. 4, 1877, p. 75, pl. 7, figs. 3, 3a, and 3b.

indisposed to unite them directly with *P. latidorsatus*, and it is probable that more abundant material will show that they are a distinct species.

In the Aubrey beds of Utah, Arizona, and New Mexico is found a series of closely connected varieties which probably embraces *P. subhorridus* Meek, together with the form figured by Newberry as *P. costatoides* Swallow, and of whose members some more or less closely resemble *P. latidorsatus*, *P. latidorsatus* var., *P. subhorridus* var. *rugatulus*, and *P. walcottianus*. A rather hurried review of this material indicates that its range of variation approaches though it does not include *P. latidorsatus* and *P. walcottianus*. Some types come very close to *P. subhorridus* var. *rugatulus*, but few if any of the Aubrey forms show the wrinkled posterior surface of that species.

While this almost uninterrupted series embraces *P. subhorridus* also, I would be unwilling to subsume the Guadalupian form under Meek's species as strictly identical with his types. The more careful discussion of the Aubrey forms and their relation to the species in hand is reserved for another occasion.

Horizon and locality.—Basal black limestone, Guadalupe Point, Guadalupe Mountains, Texas (station 2920).

Productus sp. *e*.

Pl. XXII, figs. 5 and 5a.

This division is established for a dorsal valve which I am unable to refer to any of the species recognized in this report. It has a subquadrate shape, with the hinge a little longer than the width below. The front and sides are somewhat rectilinear, but unite in a strong curvature. The ears are small, depressed, defined by grooves, slightly upturned. The beak is small, prominent; the sinus moderately strong. The surface is marked by a number of small prominences (seen as such on molds) and small spines (seen as holes). No ribs are visible, and only extremely faint traces of concentric markings.

These notes being based on a mold of the exterior, the characters as described would in reality of course all be reversed.

This specimen was associated with *Productus signatus* and *P. signatus* var., but from its size, surface ornamentation, and sinus it can hardly belong to either of them. It was also associated with specimens some of which have been identified with *P. subhorridus* var. *rugatulus* and *P. walcottianus*. Typical dorsal valves of the former are marked by fine but very distinct wrinkles, and are without spines on the exterior, so that the specimen under consideration can hardly be referred to the same species. The dorsal valve of typical *P. walcottianus* is not known, but it could hardly fail to show faint indications of ribs. Dorsal valves that seem to belong with the ventrals from station 2931 that have been referred to *P. walcottianus* differ from the specimen before me in having numerous concentric wrinkles, together with finer and much more numerous spinules. If they properly belong to *P. walcottianus*, as I somewhat doubt, this certainly does not. It is perhaps nearest to *P. latidorsatus*, but it is not probable that the dorsal valve of that species is provided with spines.

Horizon and locality.—Delaware Mountain formation, Guadalupe Point, Guadalupe Mountains, Texas (station 2931).

PRODUCTUS SUBHORRIDUS var. RUGATULUS n. var.

Pl. XXX, figs. 11 to 12c.

Shell small, transversely subquadrate. Ventral valve moderately convex. Beak rather prominent and projecting. Ears small, depressed, inconspicuous, and undefined; not extended. Sinus usually present, but variable in strength, sometimes well marked.

Dorsal valve shallow, gently concave over the visceral area, more strongly bent toward the margins. Ears small and undefined.

Surface of the ventral valve marked by numerous concentric wrinkles, which are sometimes moderately strong over the visceral region, but are evanescent toward the anterior margin. Numerous strong growth lines are also present, more or less completely graduating into wrinkles. There are no well-defined radiating striæ, but coarse, indistinct ribs originate at the bases of the spines, and maintain themselves some distance. The spines are rather large, long, and scattered. The surface of the dorsal valve is marked by numerous fine wrinkles and by a number of large shallow pits answering to the spines on the surface of the other valve. On the interior of the ventral valve the line along which the ears would be separated from the body of the shell is marked by a crenulated ridge, as in *Marginifera;* but the dorsal valve does not possess the beveled submarginal band characteristic of that genus.

This species has been obtained at several points, but the typical examples were collected in the Glass Mountains (station 3763), where it is especially abundant and perfect. I have referred to it, though with some hesitation, a few specimens from the yellow calcareous sandstones of the Delaware Mountain formation (station 2930), where the fossils occur as molds. The abundant form at this locality appears to belong to *Productus walcottianus*, and I have not been able to satisfy myself, in the imperfect condition of the shells placed with this species, that they are not extreme variations of the other type, whose characters have been obscured and modified by their preservation. They have about the size and configuration of *P. subhorridus* var. *rugatulus*, and the spines and coarse indistinct ribs of that species. There is, however, little or no indication of a sinus or of concentric wrinkles on the posterior portion. The latter feature, as I have suggested in the case of the associated fossils referred to *P. walcottianus*, which also has a wrinkled posterior portion, is doubtless partly obscured by their preservation as molds. It can not be seen on the inner side of typical examples of *P. subhorridus* var. *rugatulus*. It is evident, however, that variations are indicated by the material of which I have not been able to take cognizance on account of poor preservation, and that there will be difficulty in the case of ill-preserved or imperfect specimens in discriminating between *P. walcottianus*, *P. subhorridus* var. *rugatulus*, and possibly *P. latidorsatus*.

This species is similar in many ways to certain of the forms belonging to *Marginifera*, but lacks some of the internal structures characterizing them. A form almost identical is found in a collection from Lake Titicaca, Bolivia. It resembles also *P. latidorsatus*, but can be distinguished by being very much smaller, with sinus slightly more marked, relatively larger and more numerous spines, coarser ribs, and stronger wrinkles. Certain small and narrow varieties of *P. subhorridus*, which runs through numerous variations, resemble this form very closely, but it can usually be distinguished by its more strongly wrinkled posterior surface. From typical *P. subhorridus* it is distinguished by being much smaller, by having the posterior portion crossed by fine wrinkles, and by having much fewer spines.

It would be desirable to compare this form with *P. costatoides* if it were possible to do so. Swallow describes but does not figure his species, so that I am placed at a disadvantage in attempting to compare the two forms. His description indicates a species of the general character of *Marginifera wabashensis*, *M. splendens*, and their allies, and, indeed, his comparisons are with them. In spite of the fact that Swallow remarks that *P. costatoides* has not the flat band of *M. splendens*, I suspect that it belongs to the same group. In many of the *Marginiferæ* this is not a conspicuous character. The rugæ, striæ, spines, and pits described by Swallow are, however, somewhat different from the ordinary type of *M. splendens* and *M. wabashensis*, and if accurately set down indicate a species distinct from them. The form must at the same time be a rare one, as it has never since been recognized, nor do I recall having seen it among the very numerous representatives of that and related groups which have passed under my observation. Newberry identifies and figures *P. costatoides* from the Grand Canyon country, but it is doubtful if his identification should carry weight of absolute authority. The form figured by him is merely one phase of a very variable series whose members are common in the Aubrey of Arizona, Utah, and New Mexico, and of which some aspects will probably include the type which Meek described as *P. subhorridus*.

The variety of the latter species here under discussion resembles these shells very closely, but seems to be distinguished by the fine wrinkles by which the visceral region of both valves is covered. Its affinities with the typical *P. costatoides* can not be definitely determined until specimens of the latter are obtained for comparison. The two forms seem to be closely related, but differences as well as resemblances are indicated by Swallow's description. *P. subhorridus* var. *rugatulus* is apparently a somewhat larger form than *P. costatoides*. The visceral region of the ventral valve is not flattened; the sinus, which Swallow describes as deep and broad, is less well marked; the ears are smaller; and the costæ are fainter. In view of the fact that the western form probably occurs at a higher horizon than *P. costatoides*, which is not even referred to the Permian, but to the upper coal measures, and of the differences just noted, there is a reasonable probability that if it is ever ascertained just what form Swallow had in hand—which can not be satisfactorily told from his description alone—it will be found to be distinct from that here called *P. subhorridus* var. *rugatulus*. At all events, until *P. costatoides* is better known, it seems to me that it will be advantageous to leave it in abeyance, so that the descriptive side of the discussion may be on as stable a footing as possible.

Horizon and locality.—Delaware Mountain formation, Guadalupe Point, Guadalupe Mountains, Texas (station 2931?). Delaware Mountain formation, Comanche Canyon, Glass Mountains (station 3763), and mountains northwest of Marathon (station 3840), Texas.

Productus walcottianus n. sp.

Pl. XXI, figs. 27 to 28b.

Ventral valve small, narrow, high, very convex, the summit of the curvature being about two-thirds the distance back from the anterior margin. Anterior and posterior slopes flattened. Dorsum broad and planate, with a rather strong sinus. The sides descend rapidly. The ears are probably rather small and not much extended. Beak somewhat large and tumid, though passing but little beyond the hinge line. The visceral portion is strongly but irregularly rugose and thickly covered with rather large spine bases, giving it a pustulose appearance. The anterior half of the shell is marked by rather strong and coarse but not very regular ribs. The spines are especially abundant on the visceral and lateral portions of the shell, but are scattered over the entire surface, becoming less and less numerous toward the anterior margin. Dorsal valve unknown.

This species is primarily based on a unique but well-preserved ventral valve found at station 2903, in the Delaware Mountain formation. At station 2931, also in the Delaware Mountain formation, though at a different horizon, occurs, in considerable abundance, a similar form, which I have with some hesitation referred to the same species. Satisfactory comparison of the two is difficult, because in the one case the specimens appear as internal molds, and in the other they retain the shell. Certain departures from the type specimen can be made out. In some instances the outline contracts more rapidly above, instead of having nearly parallel sides. The surface of some of the molds is also nearly smooth, indicating that the ribs were not so strong as in the type. Evidence of the same thing appears on molds of the outside, and numerous small spines are seen to be mounted on the ribs.

Dorsal valves from this station seen as molds show a low elevation and are either almost regularly curved or flattened with a stronger marginal bend. Sinus rather faint. Surface marked by more or less strong concentric wrinkles, with numerous small depressions leading down to the cavities left by spines, which are arranged in concentric rows.

This species has about the size and configuration of *P. subhorridus* var. *rugatulus*, but the ornamentation is different. The concentric wrinkles are coarser and stronger and the spines more numerous. While it is improbable that there will ever be much difficulty in discriminating the two forms when fairly good specimens are in question, I have been troubled to dispose of the fossils from the sandstones of station 2931 in a manner satisfactory to myself. These are mostly internal molds, and besides imperfectly representing the surface characters of the original shell seem to indicate a certain amount of modification in the characters which distinguish the two forms. I have referred to *P. subhorridus* var. *rugatulus*, though with considerable hesitation, a few specimens from this station having a nearly smooth surface, with a few coarse plications.

This species shows many points of resemblance with White's identification of *P. mexicanus* Shumard. It differs in having larger and more numerous spines, discontinuous ribs, and stronger wrinkles over the visceral area. Even therefore if White's identification proves correct, as seems rather doubtful, *P. walcottianus* can hardly be referred to the same species.

Horizon and locality.—Delaware Mountain formation, Guadalupe Point, Guadalupe Mountains, Texas (stations 2903 and 2931). Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969?).

PRODUCTUS? PILEOLUS Shumard.

Pl. XII, figs. 8 to 15a; Pl. XXIX, figs. 5 to 7a.

1858. *Productus pileolus.* Shumard, Trans. Acad. Sci. St. Louis, vol. 1, p. 291 (date of volume, 1860).
White Permian limestone: Guadalupe Mountains.
1859. *Productus pileolus.* Shumard, idem, p. 389.
White [Permian] limestone: Guadalupe Mountains.

Shell small, strongly arched, gibbous, outline approaching to subquadrate, length greater than the width, widest at the cardinal margin. Dorsal valve gibbous, without mesial sinus, sides and front rounded, terminating below in a projecting band or rim, which is rounded and extends to the cardinal edge; umbo prominent, somewhat flattened anterior to the beak, slopes falling rather abruptly to the ears; beak prominent, rounded, strongly incurved, passing beyond the cardinal border; ears triangular, of medium size, incurved at the cardinal edge, convex in the middle and depressed at their junction with the umbones; surface of visceral region marked with several slightly elevated, concentric folds, which are most prominent on the sides and are continued on the ears, where they are directed backward and become obsolete before reaching the cardinal edge; anterior prolongation smooth or marked with very obscure concentric folds.

The collection contains but one specimen of this little species and this is partially deprived of its test.

Dimensions.—Length, 0.36; width, 0.32; height, 0.24.

Occurs in the white Permian limestone of the Guadalupe Mountains.[a]

The foregoing is Shumard's original description of *Productus pileolus.* The shells which on revision I have placed with this species I originally described as new because of certain departures which they show from the characters as defined above. Imprimis, I think that we must conclude that through some oversight Shumard wrote "dorsal" for "ventral" valve in his description, for that the single specimen on which he based the species was really a ventral is pretty clearly shown by its convexity (given in figures as nearly equal to the width), by the prominence of the umbo, and by the fact that the beak is described as passing beyond the hinge line. The determination of this fact is of some importance both in the matter of specific identification and in the interpretation of the structure, which Shumard describes as a projecting band or rim. If his specimen was a ventral valve the nature of this feature is somewhat obscure. It suggests a configuration resembling *Productus limbatus* or *Productus* sp. *d.* In the dorsal valve one would feel warranted in identifying it as the characteristic structure of *Marginifera.*

On the ventral valve of this species, in some cases at least, is found a feature which is rather unusual and of which I do not understand the significance. After flattening out on the ears as in all species of the genus, on reaching a certain stage, which must mark the limit of width of the hinge line, the shell again assumes a downward direction of growth, a change which of course is imperceptible at the front but becomes more and more obvious toward the cardinal line. The specimen represented by fig. 15 has this character well developed and other specimens have more or less distinct traces of it which have not been shown in my figures. It is probably this structure which Shumard refers to in the passage just discussed.

[a] Trans. Acad. Sci., St. Louis, vol. 1, 1856-1860, p. 291.

The fact that my specimens did not altogether agree with Shumard's description has already been remarked. That they nevertheless belong to the same species is rendered probable by the following considerations. They represent a not uncommon species in the Capitan fauna, and it is probable that Shumard's collection would contain one or more specimens. Again, they agree in a great many points with *Productus pileolus*; and, finally, some material probably belonging to the same species which was received subsequent to my original studies bridges over some of the differences at first noticed. My specimens differ considerably in proportion, but as a rule they are distinctly elongate. Shumard described the shape as widest at the hinge, but much of my material from the Capitan limestone appears to contract toward the cardinal line, and this is especially noticeable in dorsal valves. Considerable variation, however, is manifested in this particular, and in the recently obtained fossils from the southern Delawares (station 2969) the width of the hinge is a noticeable feature. Yet I can not consent to separate these later examples from those from the Capitan limestone.

Shumard's description of the projecting band or rim is still difficult for me to comprehend, though some of my specimens show suggestions of a marginal prolongation, which may be what he observed. The concentric folds which Shumard mentions as a feature of this species are prominent on one or two specimens, but as a rule are obscure or absent. The surface otherwise appears to have been smooth, without a sinus, without ribs, and practically without spines, though in several cases the base of a large spine was seen on one side about halfway toward the front.

Productus pileolus is very similar to the shell from the Trogkofelschichten which Schellwien described as *P. curvirostris*, but it differs in configuration as well as in having less numerous spines. In any event the Guadalupian species has long priority of publication. Indeed, it is not certain that the two species belong to the same genus, for Schellwien refers *P. curvirostris* to *Productus*, while the species under consideration contains traces of submarginal ridges, which may make it necessary to refer it to *Marginifera*. In that event it would probably belong in a group the same or related to that which Waagen calls the group of *Marginifera spinosicostata*. It is very different from our Pennsylvanian Marginiferas of the Mississippi Valley.

Shumard's species came from the Capitan limestone of the Guadalupe Mountains, and the specimens which I especially place in the same species came from the same locality and horizon. A single example from Shumard's "dark limestone" has also been placed here. It is not very perfect, but is a narrow form, more highly arched, and with a more prominent beak and umbo than those from the Capitan. If it should prove to be typical of a series of forms at this horizon, I would be disposed to regard it as a distinct variety or even species. This specimen has very nearly the configuration of *P. curvirostris*, but has fewer spines and no traces of ribs.

Some silicified specimens obtained south of the Guadalupe Mountains, at a horizon supposed to be about equivalent to the "dark limestone," are unfortunately mostly dorsal valves, the characters of which are very suggestive of this species. The only difference which I can at present point out is a relatively wider hinge line, the very point in which typical *Productus*? *pileolus* is reported as differing from my specimens. It has not seemed expedient to distinguish these older shells from those from the Capitan formation, though better material may render such a course necessary.

Horizon and locality.—Middle of the Capitan formation, Capitan Peak (station 2926); "dark limestone," Pine Spring (station 2930?), Guadalupe Mountains, Texas. Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

PRODUCTUS PINNIFORMIS n. sp.

Pl. XII, figs. 5 to 5b.

Shell small, spatulate. Sides more or less straight, and diverging at an angle of somewhat less than 90°. Lateral outline merging with the anterior in a broad, full curve. Convexity moderate; greatest near the beak, which is curved downward somewhat abruptly. Length 20 mm.; greatest width 18 or 19 mm.

The entire surface is marked by rather strong but irregular concentric wrinkles and by very fine radiating ribs, of which from 9 to 11 occur in the space of 2 mm. They are wavy, and increase somewhat irregularly by implantation, so that the number to be counted within a given linear distance is not everywhere the same. They are rounded and separated by rounded intervals of about their own thickness. No spines have been observed.

This species is most nearly allied to *P. compressus* Waagen, which it resembles both in configuration and sculpture. It is, however, a much smaller form and considerably less elongate and apparently more finely ribbed. In view of these differences, of the fact that I have no specimens of *P. compressus* to furnish the final evidence, and of the fact that the American fauna contains so few identical species, though many similar to those in the Salt Range, it has seemed best to assign to the Guadalupian form a new name. I have but a single specimen of this species—apparently a ventral valve—and it is, moreover, rather imperfect; but it forms a rather interesting feature of the Guadalupian fauna.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926).

PRODUCTUS LIMBATUS n. sp.

Pl. XX, figs. 17 to 18.

Shell of medium size, transverse, shortest at the hinge line.

Ventral valve of rather low convexity, flattened over the visceral portion, suddenly curved around its margin. Beak low, pointed, not projecting. The ears are depressed, flat, and extended as a sort of band part way down the sides.

Dorsal valve similar to the ventral, but with flatter visceral area and less distinct beak.

Surface nearly smooth. It is marked marginally by faint, moderately fine ribs, which extend to a greater or less distance up onto the visceral area before dying out, but are not found on the ears. Except for faint concentric striæ the posterior portion of the shell in both valves is practically smooth. A few rather small spines spring from the lateral portions of the ventral valve.

Productus limbatus resembles *P. pileolus* Shumard, but as he describes that species as being strongly arched and widest at the hinge line, it seems unlikely that the two forms can be the same, especially as *P. pileolus* is much smaller. The fact that *P. limbatus* contracts strongly at the hinge line renders it almost unique among the species which have come under my observation.

This is a rare form, only two examples having so far been obtained, and it appears to be confined to Shumard's "dark limestone."

Horizon and locality.—"Dark limestone," Pine Spring, Guadalupe Mountains, Texas (station 2930).

Productus sp. *d.*

Pl. XX, figs. 19 to 21a; Pl. XXIX, figs. 4 to 4b.

This is another of the *Producti* having a flattened visceral portion surrounded by an abrupt, strong curvature amounting in some cases almost to geniculation, a type of shell rather distinctive of the Guadalupian fauna; but, unlike many of the species, the present one does not possess a deep, narrow sinus. It appears to be new, but as my material is unsatisfactory no distinctive name is proposed for it. The following description has been drawn up:

Shell rather small, subquadrate, transverse. The ventral valve is not very convex, the visceral portion being somewhat flattened. The front and lateral margins are low, and likewise flattened, the curvature strongest about the edges of the visceral area. The beak is moderately elevated and slightly projecting (?). The ears are small, depressed, and quadrate. A shallow undefined sinus begins toward the front of the visceral area.

The dorsal valve has much the character of the ventral, except that the visceral area is flatter and the beak scarcely at all elevated.

The surface over the visceral region is almost smooth, without either distinct ribs or concentric wrinkles. The front and sides are marked by fine, somewhat faint, ribs, which begin toward the margin of the visceral area. They number about six or eight in 5 mm. The ventral valve for the most part appears to be without spines, though a few of large size are found on the ears near the cardinal line.

The ventral valve of this form is much like the dorsal valve of *Marginifera wabashensis*, and of course considerably different from ventral valves of that species. The dorsal valve is correspondingly different from the dorsal valve of *M. wabashensis*. In addition to the difference in configuration, the ribs as a rule are coarser and stronger and the spines are less numerous. While there is a certain superficial resemblance to Norwood and Pratten's species, I have not been able to find the distinctive submarginal ridges, so that it probably can not be referred to *Marginifera* at all. It may belong to the group of *Productus popei*, and it resembles *P. indentatus*, from which it is distinguished by being larger and more finely ribbed and by having a shallower sinus.

I have also referred to this species an interesting but fragmentary specimen from a locality considerably south of the typical Guadalupian section (station 2969). It is represented by fig. 4 of Pl. XXIX. Although so imperfect, this example is clearly a ventral valve, for the convex side is marked by fine, indistinct ribs, still less obvious on the concave surface, which is, moreover, provided with little spinous projections, such as frequently cover portions of the inside of *Productus* shells. This example possesses the rare feature of having, as represented in the figures, a strongly recurved margin. This rim looks at first like part of another valve closed upon the less fragmentary portion, but not only is it continuous with the latter, but it shows spinules on its convex surface, and in view of the fact that the rest of the specimen is a ventral valve, it could have no other interpretation than that adopted here, unless the rim were supposed to be part of another individual. This, however, is entirely out of the question. If this specimen really belongs to *Productus* sp. *d*, there can be little doubt that the latter is an undescribed form and one which on account of this singular feature can not be assembled in the group of *P. popei.* Slight indications are found in other examples that they also have a reflexed margin.

Horizon and locality.—"Dark limestone," Pine Spring, Guadalupe Mountains, Texas (station 2930). Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

Genus STROPHALOSIA King.

I can not but feel that the genera *Strophalosia* and *Aulosteges* are at present on an unsatisfactory footing, although I have nothing to add to the situation likely to improve it. There seem to be in the Carboniferous faunas two types of shells which have a productoid expression and yet possess a more or less elevated area in both valves. One of these consists for the most part of small forms with low, imperfectly developed area, which are either cemented to some larger organism or marked by a distinct scar of attachment. The other is larger, with a high and well-developed area in many species, and without evidence of attachment. This form is apt to have a long and pointed beak, while the other, by reason of its lower area and its habit of cementation by this part of the shell, is apt to have the posterior extremity rounded or truncated. The internal structures of these forms are often impossible to determine, and where ascertained the different species seem to show great variability. Hall and Clarke appear disposed to regard the habit of attachment peculiar to one group of forms as the most important or at all events the most practical differentiating character, and they use the term *Strophalosia* for the cemented and *Aulosteges* for the uncemented forms. This seems to conform with the common usage in this country, where, with the exception of Shumard's little-known Guadalupian species *Aulosteges guadalupensis*, the type called *Aulosteges* does not occur.

When, however, I consider the typical species with which the names *Aulosteges* and *Strophalosia* must be associated, I confess to feeling some doubt as to whether they are not the same thing and are not, coincidentally, distinct from the shells which we have been accustomed to place with *Strophalosia*. This opinion is almost exclusively formed on the literature, for these types are either entirely lacking to our faunas or rare and imperfect. Figures of *Strophalosia excavata*, the typical species of *Strophalosia*, and of *Aulosteges wangenheimi*, the typical species of *Aulosteges*, certainly show the same general character and expression, one in a measure distinct from the small cemented American shells, which, for the most part of an earlier geologic period, it has been the practice to place under *Strophalosia*. Nor does it seem to me that the structural differences which have thus far been pointed out between the Permian Aulosteges and Strophalosias are sufficiently constant and well marked adequately to distinguish the two genera. It would rather appear to me, therefore, from an imperfect acquaintance with the subject that the small shells commonly assigned to *Strophalosia* may prove a distinct and possibly a new genus, and that typical *Aulosteges* and *Strophalosia* are really the same, *Strophalosia* being the older name. I have not, however, had sufficient confidence in this conclusion to act on it and have continued to follow the authorities in using *Strophalosia* for the small attached forms, although it involves what seems an inconsistency, since necessarily included with them are the apparently different typical Strophalosias of the European Dyas and Permian, which are at least very closely similar to the typical *Aulosteges*.

In the Guadalupian these two groups are fairly distinct in point of configuration, although the determination of internal or structural characters has not been possible. The small attached shells which I have called *Strophalosia hystricula* n. sp. and *S. cornelliana* Derby represent one type and the imperfectly known *Aulosteges guadalupensis* another. *A. medlicottianus* var. *americanus*, *A. magnicostatus*, *Aulosteges* sp. *a*, and *Aulosteges* sp. *b* are different from either of these forms in sculpture and configuration, but because of intrinsic character as well as of relation to foreign species it has seemed best to place them also with *Aulosteges*.

Strophalosia hystricula n. sp.

Pl. XXX, figs. 14 and 14a.

Shell rather small, subcircular. Convexity moderate. Beak rather elevated. Hinge line shorter than the shell below. Ears small, undefined. Area low. Delthyrium narrow. Dorsal valve not known.

Surface covered by large tubular spines, most of which are straight and bent forward so as to be tangent to the surface. A few distributed over the surface, especially on the ears, are erect and sinuous. There are also a few irregular nonpersistent concentric wrinkles.

This species finds its nearest ally probably in *S. cornelliana* Derby, from which it can be distinguished by having a more distinct and elevated beak and larger and ess numerous spines, fewer of which are reclining. It also appears to lack the lamellæ described by Derby.

Strophalosia hystricula likewise resembles the form figured by Hall and Clarke as *Strophalosia spondyliformis* White and St. John. The real *S. spondyliformis* is a tiny shell, and so inadequately described and figured that comparisons can not be undertaken without specimens on which to base further observations. It is by no means certain that Hall and Clarke's identification in the work above cited is correct.

Horizon and locality.—Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763).

Strophalosia cornelliana Derby.

Pl. IV, figs. 4 to 5.

1874. *Strophalosia Cornelliana.* Derby, Bull. Cornell Univ., vol. 1, p. 45, pl. 3, figs. 28, 30, 32, 33, 35–38; pl. 4, fig. 5; pl. 8, fig. 17; pl. 9, figs. 10, 11.
"Coal Measures:" Bomjardin, Brazil.

1892. *Strophalosia Cornelliana.* Hall and Clarke, Nat. Hist. New York, Pal., vol. 8, pt. 1, pl. 15B, figs. 36, 37.
"Coal Measures:" Bomjardin, Brazil.

Only a single imperfect example has so far been obtained, the origin of which was in the white limestone of the Capitan formation southwest of Guadalupe Peak. It has no marked characters, except the surface, which is thickly covered with small spines. Many of these lie flat and are nearly tangential. There are also concentric wrinkles more or less concealed by other superficial markings.

So far as its characters are demonstrated by the specimen before me, this form is so closely related to *S. cornelliana*, a figure of which is introduced for comparison, that it seems necessary to refer it to Derby's species.

Horizon and locality.—Base of Capitan formation, hill southwest of Guadalupe Point, Guadalupe Mountains, Texas (station 2906).

Strophalosia sp.

Under this title I am subsuming two small and somewhat imperfect shells whose generic relations are evidently with *Strophalosia cornelliana.* They appear to be related to it specifically also. One of these specimens is copiously covered with large spines, all of which are erect, instead of being, as in *S. cornelliana,* in part appressed. The surface between the spines is very irregular, marked both by fine, discontinuous, concentric wrinkles and fine discontinuous ribs leading down from the spine bases. The other specimen has similar erect spines, but only a few of them, most of the surface having an uneven warty appearance. This may not be the normal sculpture, however, so provisionally the two forms have been left under the same caption.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (stations 2957 and 2969).

Genus AULOSTEGES Helmersen.

As noted in connection with the genus *Strophalosia,* I am using that term and *Aulosteges* in a different sense from that which, from a necessarily imperfect knowledge, really appears to me proper. It appears to me in fact that typical *Strophalosia* and *Aulosteges* are the same, and that *Strophalosia,* which is the older name, should be employed for the present forms to the exclusion of those which, as species of *Strophalosia,* have been recognized in the Guadalupian fauna. The latter seem to be congeneric with species of much older geologic periods—for example, with some which occur in the Mississippian of the Mississippi Valley; but the present group, here called *Aulosteges* and believed to include the typical Strophalosias of the European Permian, appears to be restricted to the latest faunas of the Paleozoic.

There can be little doubt that Shumard was correct in referring to this genus *Aulosteges guadalupensis.* Four other species contained in our recent collections with scarcely less certainty belong here. These species, five in all, are the only ones at present known from either of the Americans. As the genus is regarded as a typical Permian one, its presence in the Guadalupian fauna is interesting from a stratigraphic point of view, especially since it occurs in the earliest as well as the latest beds of the series; but the material thus far obtained is too scanty and too poorly preserved to add anything in the way of biology or structure.

The five species found in the Guadalupian fauna represent four rather distinctly marked types. To one of these belongs only the form which Shumard described so many years ago, *Aulosteges guadalupensis*. The second comprises *A. medlicottianus* var. *americanus* and *Aulosteges* sp. *a*. The third is represented only by the imperfectly known *Aulosteges* sp. *b*, and the fourth only by *A. magnicostatus*.

AULOSTEGES GUADALUPENSIS Shumard.

Pl. XX, figs. 22 and 22a.

1858. *Aulosteges Guadalupensis*. Shumard, Trans. Acad. Sci. St. Louis, vol. 1, p. 292 (date of volume, 1860).
White [Permian] limestone: Guadalupe Mountains, New Mexico and Texas.
1859. *Strophalosia* (*Aulosteges*) *Guadalupensis*. Shumard, idem, p. 390, pl. 11, figs. 5a, 5b.
White [Permian] limestone: Guadalupe Mountains.
1890. *Strophalosia? Guadalupensis*. Beecher, Am. Jour. Sci., 3d ser., vol. 40, p. 241.

Ventral valve large, outline subelliptical, gibbous, flattened convex at the umbo, enlarging rapidly from beak to front and forming a pretty regular curve in the same direction; greatest width about the middle of the valve; lateral margins rounded, front slightly sinuate; a broad, shallow sinus commences some distance in advance of the beak and continues to the front in one of the specimens, and in the other the sinus is somewhat profound and narrow on the umbonal region and becomes shallow toward the front; beak elongated, flattened, straight or slightly curved upward at the extremity, which is pointed; area triangular, very much elevated; lateral edges sharp and strongly defined. Surface marked with numerous slightly prominent, radiating, interrupted ribs, crossed by obscure, rounded, concentric ridges, which give to the former a subnodulose character; intervals marked with small circular pits, probably the points of attachment for spines. Dorsal valve unknown.

Dimensions.—Length of ventral valve, 1.40; width, 1.48; height, about 0.59.

This shell is very interesting as no species of the genus has heretofore been observed in American strata. In Europe it has not been found below the Permian.

Geologic position and locality.—White limestone of the Guadalupe Mountains, New Mexico and Texas.[a]

There can be little doubt that the fossils in hand belong to Shumard's species, which seems to be fairly common in the Guadalupian fauna, since four examples, none of them, however, very perfect, have come to hand. Shumard's description, together with the figures, will afford an adequate notion of this form and I find it unnecessary to make many additions or changes of moment. The obscure, rounded, concentric ridges, however, mentioned by this author are certainly not obvious on my specimens, the ornamentation of which consists of short, slender elevations like interrupted ribs, which are often more prominent at their anterior end and sometimes carry short (?) spines. The arrangement of the ridges into longitudinal or diagonal rows is not very striking or persistent. The intervals between frequently contain little pits or dimples from which spinules project into the inside of the shell.

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[a] Trans. Acad. Sci. St. Louis, vol. 1, 1856-1860, p. 292.

and these are represented on internal molds as small holes somewhat irregularly distributed. The surface ornamentation is not unlike that ascribed to *Productus norwoodi*, especially in imperfect conditions of preservation, and as Shumard cites that species from the "dark limestone" of the Guadalupian it is possible that the specimens so identified may have really belonged here.

Horizon and locality.—"Dark limestone," Pine Spring, Guadalupe Mountains, Texas (station 2930).

AULOSTEGES MEDLICOTTIANUS var. AMERICANUS n. var.

Pl. XII, figs. 16 to 16b.

Shell small, transverse, semicircular. Hinge line slightly shorter than the width in front. Convexity regular. Area moderately high, Delthyrium apparently very wide. Beak small and undefined. Dorsal valve not known.

Shell substance thick, marked by fine liræ, about eight in 2 mm., which become indistinct on the sides near the hinge line, and by concentric irregularities of growth, which are especially abundant and strong near the margin. The shell substance, even on the area, is pierced by numerous small holes, more or less regularly distributed, from which probably proceeded hollow spines.

This form has so distinct an aspect and is represented by so fair a specimen that after some hesitation I have given a description and figures of it. Yet its affinities are so uncertain that I would on this account have refrained from doing so. The fact that the apex is partially broken away might indicate that this was not an *Aulosteges* but an attached form like *Strophalosia*, but the other characters are less like *Strophalosia* than *Aulosteges*. The uniform size and distribution of the perforations would seem to indicate that they were an original feature, yet no trace of spines has been observed. They may have been produced by some boring animal, a hypothesis for which the surprising thickness of the shell might be pointed to as evidence. In that case the form would probably be a *Streptorhynchus*, as no internal plates are present.

This species possesses certain points of marked similarity with *Aulosteges medlicottianus* Waagen, and yet there are some important differences, since it is smaller, without a sinus, longer at the hinge line, apparently with a wider delthyrium, and without ears.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926).

AULOSTEGES MAGNICOSTATUS n. sp.

Pl. XXXI, figs. 4 to 4b.

The typical specimen is diminutive in size, but from the strong convexity probably represents a mature shell. The length of the ventral valve is 9 mm., the length of the dorsal valve 7 mm., and the width at the hinge line, which exceeds that below, 8 mm.

The ventral valve has an extended instead of an incurved beak, which gives it a shield-shaped outline. The posterior portion consequently is flattened longitudinally, rising gradually toward the front, where, and at the sides, it is strongly deflected. The area in the typical specimen is about 2 mm. in height, flat, and symmetrical. The pseudodeltidium is narrow.

The dorsal valve is transversely semielliptical in shape, flattened over the visceral area, strongly curved at the front and sides. Beak small, inconspicuous.

The surface of the dorsal valve is marked over the visceral area only by fine, somewhat irregular, concentric wrinkles. Toward the front and sides the wrinkles die out and are replaced by relatively coarse radiating costæ, which are faint at first but become strong later.

The ventral valve is more or less broken and the sculpture lost. It probably agreed with the dorsal valve in this particular, as it is known to do over the more peripheral portions, where it is marked by coarse, strong costæ. In the typical specimen both valves, but especially the ventral, seem to terminate in a narrow, concentric, raised band, in whose elevation the costæ lose themselves, so that the band is smooth, except for a very distinct row of coarse spines, one for each costa. There is a row of such spines along the margin of both the dorsal and ventral valve.

The singular feature last mentioned is certainly a character of the specimen under description, but it is as yet doubtful whether it can be regarded as a specific character or only an individual peculiarity.

In its general expression this form resembles certain shells which have more or less of the appearance of *Productus semirecticulatus*, but have been placed by different authors in the genus *Strophalosia*. *Productus leplayi* is one of these, but in this case at least the generic position, I judge, is almost certainly with *Productus*, and it may possibly be the same in the others.

Horizon and locality.—Delaware Mountain formation, mountains northwest of Marathon, Tex. (station 3840).

AULOSTEGES sp. *a*.

This species is based on two specimens whose original position was in the black limestone at the base of the Guadalupe section. They appear to be closely related to *Aulosteges medlicottianus* var. *americanus*, but their widely different stratigraphic position and faunal association are presumptive evidence that they belong to a different species, and, in fact, certain specific differences are indicated, though a satisfactory discrimination is not at present entirely possible, owing to their imperfect condition. They are smaller than the figured specimen of *Aulosteges medlicottianus* var. *guadalupensis*, but their general shape is nearly the same. They have a thick fibrous shell perforated by many small rounded tubes and apparently marked externally by rather fine radiating liræ. It thus appears that they are very similar to the typical specimen from the Capitan limestone, but the perforations or tubes are much smaller and more numerous. Owing to the imperfect condition of these specimens, however, it is possible that they are only morbid examples of *Enteletes* sp. *c*, which is found associated with them.

Horizon and locality.—Basal black limestone, Guadalupe Point, Guadalupe Mountains, Texas (station 2967).

AULOSTEGES sp. *b*.

This form is represented by a single specimen from which the shell has been largely removed. It is a ventral valve. The shape is subcircular. The greatest width is 18 mm. and the length of the aperture 14 mm. The hinge line is a little shorter than the width in front. The area is flat, sharply defined, inclined backward at rather a strong angle, and 6 mm. in height. The pseudodeltidium is narrow (1.5 mm.) and strongly elevated.

The surface is marked by rather faint concentric undulations, which can be seen on the mold of the interior and where the shell is retained at one side near the hinge, by somewhat irregular, fine, lamellose concentric lines. The area is profusely covered with perforations left by the hollow spines. So far as can now be told, these are much more rare on the remainder of the shell.

From the facts at present obtainable, this form is of a somewhat different type from those recognized in this report, but I hardly feel justified in view of the poor condition of my specimen and the imperfect data which it furnishes in giving it a distinctive name.

Horizon and locality.—Basal black limestone, Guadalupe Point, Guadalupe Mountains, Texas (station 2967).

Family RICHTHOFENIIDÆ Waagen.

Genus RICHTHOFENIA Kayser.

The genus *Richthofenia* has been found in only a few limited areas, but these taken together constitute for the genus a wide distribution. We have one species in the Salt Range of India and another at Lo Ping, in China. Gemmellaro's papers are, unfortunately, in part inaccessible to me, but I learn from Schellwien that he has identified *Richthofenia* among the fossils from Palermo in Sicily. Lastly, the appearance of a species belonging to this genus in southwestern United States lends to the Guadalupian fauna a feature of peculiar interest.

While in most essential respects and in many trivial ones *Richthofenia permiana* is in close agreement with the Indian and Chinese species, one or two differences appear to be of considerable moment. In *R. permiana* there is a much less extensive development of the cystose tissue, but this may probably be reckoned a character of specific rather than generic difference. The feature which I had especially in mind in the foregoing comment, however, was the absence of the three structures which Waagen calls septa, extending along the inner surface of the area in the ventral valve. *R. permiana* shows what may be called two dental callosities or ridges, which occupy the position of the two lateral septa of Waagen's shell, but they are by no means of such a character as would warrant calling them septa. This term is much more appropriate to the structures represented in Waagen's figures. The median septum of Waagen's shell, on the other hand, seems to have no corresponding part in the Guadalupian species. There is, it is true, a sort of longitudinal ridge or septum on the opposite or anterior side of the ventral valve, and it is possible that thin sections through the lower portion would show that this ridge was connected with the development of a median septum, as in the Indian species, and that it might also bring to light two corresponding lateral septa possibly embedded in the cystose tissue; but the available material was too scanty and imperfect to warrant consuming it for sections. In natural sections and exposures, however, these three septal structures appear to be entirely absent from *R. permiana.*

The median septum seems to play a much more important part in the structure of the Sicilian species of *Richthofenia*, and still more in *Scacchinella*, which Schellwien regards as a related genus. *Scacchinella* occurs with *Richthofenia* in the Sicilian fauna, and appears to replace it in that of the Carnic Alps, where *Richthofenia*, so far as known, is missing. A species from Malla Sangcha, in the Himalaya, has been referred to *Scacchinella* by Diener, but from his figures and description I can not but feel that the reference is a very doubtful one. The genus *Scacchinella* therefore, so far as at present known, is restricted to the three or possibly two localities above mentioned, while *Richthofenia* forms a rather striking bond between the Guadalupian fauna and those of the Salt Range, of Lo Ping, and of Palermo. Of course there is nothing at all comparable in the Carboniferous faunas of the Mississippi Valley.

Waagen regarded this genus as representing a distinct family, the Richthofeniidæ, and a distinct suborder, the Coralliopsida; but in this I believe he has somewhat overestimated the really remarkable characters of this type. Most subsequent authors, I believe, have failed to recognize Waagen's suborder. Schuchert places the Richthofeniidæ beside the Productidæ, which is in accordance with my own view. Hall and Clarke include *Richthofenia* among the genera incertæ sedis. Schellwien seems in doubt whether the greatest affinities are with the Productidæ or with the Strophomenidæ. In weighing the evidence he omits one factor, which, though present in the American and Indian shells, may be absent from the Sicilian species—the development of tubular spines as a part of the surface structures. This is eminently a feature of the Productidæ, in distinction from the Strophomenidæ. Indeed, speaking now solely of the American species, I seem to see in *Richthofenia permiana* a distinct relationship with *Productus*, through *Strophalosia* and *Aulosteges*. The general character of the sculpture—spiniferous, without ribs, but with strong growth lines—immediately recalls certain *Producti;* the high area and pseudodeltidium are found in *Aulosteges*, while the little ridge which stands opposite to the area on the inside of *Richthofenia* finds, in some cases at least, an apparently analogous structure in *Strophalosia*. (See the figures of *S. cornelliana* on Pl. IV.)

In the Sicilian form, as described by Schellwien, both in its own structure and in its relation to *Scacchinella*, one might be pardoned for believing he found a different generic type, perhaps much more closely allied to the Strophomenidæ. It appears, in the first place, that instead of having two dental callosities, as in the American form, and to some extent as in that from India, the Sicilian type has a single large pyramidal column, the axis of which is a good-sized median septum. This solid column extends along the back of the valve and well down toward the apex, and contains embedded in it a sort of primordial shell, the like of which is entirely unknown as yet in other species. It would appear also, from the fact that they are not mentioned in Schellwien's description, that the surface was not furnished with spinous projections, but I have observed what I regard as the scars of small spines on the surface of species of *Scacchinella* from the Trogkofelschichten. Thus the Sicilian shell departs rather widely not only from the Guadalupian but from the Salt Range species. The latter has a small septum, according to Waagen, the greater development of which in the Sicilian form may have given rise to the modification of the cardinal structures observed in it. It occupies in some respects an intermediate position between the Guadalupian and the Sicilian species, having the septum of one and the spinous surface of the other; but on the whole it seems to me that *Richthofenia permiana* is closer to *R. lawrenciana*, and therefore to typical *Richthofenia* (though *R. sinensis* should really be considered the type species), than is the Sicilian form.

The Richthofeniidæ evidently afford an attractive field for further research in case other species or better preserved material are obtained, especially if the different forms supposed to belong to the group could be collated.

The little specimen represented by figs. 10 and 10a of Pl. XXIV seems to be a young example of this genus and to throw some light on the early stages of development. The growth, instead of being regularly conical, appears to be schematically that of a strongly curved triangular plane bent around so that the two edges meet in a sort of suture, indicated more by deflections of the growth lines and by a notch in the upper margin than by a callosity. Apparently at a very immature stage, it may be almost immediately after cementation, by a luxuriant development of the mantle of the ventral valve, the shell was so deposited that the sides extended backward until they met behind, thus enveloping the posterior portion of the valve of which they form a part, which instead of being without an area, as in *Productus*, was prolonged upward with the lofty area and normal pseudodeltidium of *Aulosteges*. The intervening portion between the area and the enveloping sides was filled in with cystose shelly matter, which in certain conditions of preservation peels off, leaving an area and pseudodeltidium much resembling the productoid genus above mentioned.

It is possible that the little shell which suggested this explanation of the origin of some of the singular features of *Richthofenia* does not really belong to that genus, although I believe that it does; but such a contingency does not necessarily invalidate the explanation itself, which is a little more specific than any I have seen offered elsewhere, though not differing from them in principle.

If the specimen in question does not belong to *Richthofenia* it would probably go with *Tegulifera*, a genus which Schellwien introduced as a member of the Productidæ. *Tegulifera* appears to have been developed by much the same process which I have hypothetized for *Richthofenia*, except that the area remained narrow in *Tegulifera*, which accordingly stands in about the same relation to *Productus* that *Richthofenia* as here interpreted does to *Aulosteges*.

Schellwien places *Tegulifera* in the Productidæ, but apparently does not believe that *Scacchinella* and *Richthofenia* have such relationship. His doubts in regard to these forms from the Trogkofelschichten may be justified, and while I seem to see on the part of my Guadalupian representatives of *Richthofenia* a greater resemblance to the Productidæ than is found in those from the Trogkofelschichten, it seems inadvisable to place *Richthofenia* and *Tegulifera* in the same family.

RICHTHOFENIA PERMIANA Shumard.

Pl. XIV, figs. 27 to 27d; Pl. XX, fig. 23; Pl. XXII, figs. 6 to 6b; Pl. XXIV, figs. 10 and 10a; Pl. XXXI, figs. 1 to 3.

1859. *Crania Permiana.* Shumard, Trans. Acad. Sci. St. Louis, vol. 1, p. 395 (date of volume, 1860). White [Permian] limestone: Guadalupe Mountains.

Shell large, somewhat variable in form, upper or larger valve very much elongated, subconical, expanding most rapidly toward the base; transverse section elliptico-subquadrate; anterior side flattened; sides rounded and in some specimens subangulated posteriorly; posterior side flat or very gently convex, showing, when the exterior crust is exfoliated, a long, narrow pseudodeltidium, marked with distinct arched striæ; apex nearly or quite marginal, obliquely truncated and sometimes excavated in front. Surface marked with concentric lines, crossed by irregular, interrupted longitudinal (not very distinct) rugæ, which are most prominent, and assume a somewhat varicose appearance, near the base. Smaller valve very gently concave, surface markings obliterated. Interior characters unknown.

Dimensions.—Height of larger valve about 1½ inches; width at base, about 1 inch.

Locality.—White limestone, Guadalupe Mountains.

I have very little doubt either that the material before me belongs to the species for which Shumard proposed the name *Crania Permiana,* or that it actually belongs to Kayser's genus *Richthofenia.* Examples belonging to this genus are represented from a number of localities and horizons, and though all have been referred to a single species, since I am uncertain in what characters and within what degrees to fix the limits of specific variation, it will be better to give a brief notice of each occurrence, both as to superficial and as to structural characters.

Shumard describes *R. permiana* from specimens obtained in the white limestone of the Capitan formation, and our fossils from that horizon can therefore be regarded as representing the typical form of the species. The shape is generally conical, but much varied as to detail. The transverse section ranges from circular to oval, and one side or another may be more or less flattened. These specimens are not greatly distorted, but their rate of expansion varies in different individuals, and often in the same individual at different places. Thus often arise transverse ridges, which are very irregular and seldom extend through a complete circumference. Scattered over the surface are here and there perforations which originally extended as hollow stolonous spines. The largest specimen measures 25 mm. in length, and is incomplete at its base. This is the condition of many specimens, and doubtless resulted from their habit of attachment. The broken apex seldom fails to show the characteristic cystose structure. In the Indian species the conical interior is subdivided by a transverse cystose partition. In these American specimens the cysts appear to occupy the apex of the cone. If there was a chamber below them it must have been small.

The opercular upper valve is represented by several examples. It is flat and marked by very delicate concentric striæ. One specimen especially shows its position and character. The ventral valve in this case is elliptical in transverse outline, and distinctly flattened on the cardinal side. The dorsal valve is elliptical and smaller than the external circumference of the ventral, the inner wall of the ventral shell being separated from the outer by the cystose layer. This layer is rather thin along the front, but increases irregularly toward the cardinal line, where the greatest thickness occurs. Here, however, it is cut rather squarely off, to form a broad longitudinal groove, into which fits a quadrate projection from the opercular valve. This projection, which does not expand at the cardinal line, as in the Indian species, reaches almost to the outer wall, or, rather, the inner wall of the ventral valve retreats at this point almost to a union with the outer one.

From the "dark limestone" seven specimens have been obtained. They show excellently the superficial characters, the unequal growth, the concentric striæ, and the tubular spines. Two examples are partly exfoliated toward the apex and exhibit the structure which Shumard with much acumen calls the pseudodeltidium, in specimens similarly preserved. What, considered from the inside, appears as a deep, broad groove, in the exfoliated condition is a corresponding ridge which bears along its center another much narrower but strongly elevated ridge, having the appearance of a pseudodeltidium. No groove corresponding to this was observed in the other specimen described in some detail, but this structure seems to be restricted to the portion of the ventral valve below the opercular valve.

Practically the same features are shown by a specimen from the Delaware Mountain formation—the only one found—which occurs as an internal mold. The posterior or cardinal side is flattened and bears a central broad, flattened ridge, which dies out toward the apex. This ridge in turn has a strongly elevated, narrow central ridge, which disappears also toward the apex, toward which it does not extend as far as that upon which it is borne. It is probable that both would likewise die out before reaching the mouth of the shell if the specimen were complete.

In the black limestone at the base of the Guadalupe section three specimens were obtained, one mature and the others very small, No internal structures are shown, but externally they have all the characters of Shumard's species. The two small examples, one of them especially, show a rather significant feature, namely, a distinct notch on what is probably the posterior side of the upper margin, accompanied by a corresponding deflection of the growth lines. This apparently indicates the union of the lateral portions of the shell which have been prolonged backward so that they meet behind the area, thus enveloping this posterior portion. It has not been possible to make observations on all my specimens in this particular, but this deflection of the growth lines is certainly found in other specimens, though some appear to be without it. That the characteristic internal structures are developed at an early period is shown by some very young specimens in our collections. Cystose tissue seems at this stage to be entirely lacking, but the dental callosities have already appeared. They are small and delicate, however. The occurrence of this significant form at this lowest horizon known in the Guadalupe Mountains is important as indicating the thickness of the Guadalupian series at this point.

A few specimens have also been obtained from the Glass Mountains, and as they are silicified a favorable opportunity is afforded for studying their internal structure. One somewhat imperfect example must have had a length of 50 mm. The chamber of habitation extends almost to the base in these examples, as it appeared to do in those from the Guadalupe Mountains, the cellular tissue being confined to a small amount on the back and sides. The cardinal side is especially thickened in this way. Here, as has been described from other specimens, is excavated a rather deep, broad groove having another narrow groove along its median line. On either side the shell stands out in a ridgelike projection. At a certain point 7 mm. below the top in the large specimen previously mentioned, the cellular tissue abruptly ceases, producing a sort of circumferential shelf or groove, probably the position of the smaller valve. Opposite the cardinal groove a longitudinal thickening of the shell occurs, varying in extent in different specimens but forming in every case an appreciable ridge. The inside of the shell below the opercular valve is uneven, though fairly smooth, the chief feature of mark being the presence of a few small tubes parallel to the wall and partly sunk in it, the upper ends of which are open and directed toward the aperture. These without much doubt are connected with the hollow tubular spines. Above the position of the dorsal valve the interior of the shell is rough, being pustulose and pitted. The pits are the same size as the perforations of the spines, but apparently they do not extend to the outer surface. The general character of the outer surface has already been described. Only this remains to be added, that above the plane of the dorsal valve the perforations caused by the tubular spines appear to cease, only irregular lines and ridges being present. The three vertical septa described by Waagen have not been observed, and it hardly seems that they could have been developed. The pallial impression has apparently not been retained on my specimens, though Waagen noted it in his Indian shells.

From the southern Delawares (station 2969) about ten specimens and fragments have been obtained. They agree in most respects with the material gathered elsewhere. The chief difference is that these shells tend to be a little more slender and to develop a somewhat greater amount of the cystose tissue, which now deeply fills the lower portion and, extending up around the sides in a thicker layer, chokes the cavity into a more contracted chamber. I do not say that this is true in every case, however.

I have found it impracticable to distinguish more than one species in the material examined without assigning considerable importance to characters which seemed either more or less trivial or else very variable. On the other hand, with the characters said to be present in the Asiatic species but apparently lacking in this, and those present in this but apparently lacking in the other, there can be but little doubt that *R. permiana* is distinct from *R. lawrenciana* and *R. sinensis*. In any event, the American form antedates either of the names just mentioned. In fact some of the structural differences which appear to subsist between the American and Asiatic forms have the appearance of being so important as to suggest the consideration whether they really belong to the same genus. The general appearance is so strikingly similar, however, and the type of structure so peculiar in every way, that I would prefer to reserve the consideration of this point until a wider knowledge of the specific and generic variation will afford a juster conception of the importance which must attach to different lines and degrees of variation. There seem in fact to be but scant possibilities for variation in these forms except in rather trivial or else rather essential characters, and it may be that differences of structure such as exist between the Indian, the Alpine, and the American representatives of the group will have to be used for specific rather than generic discrimination, as would perhaps be the case in other types.

Horizon and locality.—Middle of Capitan formation, Capitan Peak (station 2926); "dark limestone," Pine Spring (station 2930) and Guadalupe Point (stations

3762b and 3762e); Delaware Mountain formation, Guadalupe Point (station 2931); basal black limestone, Guadalupe Point (stations 2920 and 2967), Guadalupe Mountains, Texas. Delaware Mountain formation, southern Delaware Mountains, Texas (stations 2964 and 2969). Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763).

Family ORTHIDÆ Woodward.

The Orthidæ are a declining group in the later horizons of the Carboniferous, showing but limited variation along generic lines and represented often scantily in individuals. *Enteletes*, the most characteristic and abundant representative of the family at these horizons, is the only type which has been found in the Guadalupian fauna, though other genera occur in some of the faunas with which comparison has been made. In the Guadalupian, indeed, this genus is restricted, so far as known, to the earlier portion of the series, none of the Orthidæ having thus far been found in the Capitan formation.

Seven species of *Enteletes* are recognized in the present report, all of them, with one exception, probably belonging to the commoner division of the genus, the *ventrisinuati*.

In India, in the Salt Range, Waagen recognizes seven species of *Orthis*, which may now be distributed into the groups of *Rhipidomella*, *Schizophoria*, and *Orthotichia*, none of which, of course, is represented in the Guadalupian fauna so far as known. Of *Enteletes* he finds two species of the *ventrisinuati* and five of the *dorsisinuati*. *E. kayseri* is perhaps comparable to *E. dumblei*, at least in configuration, while *E. lævissimus* may be compared with *Enteletes* sp. *c*. The *dorsisinuati*, on the other hand, contain some singular and striking types, such as *E. pentameroides* and *E. latisinuatus*, but nothing which closely resembles the Guadalupian *E. globosus*.[a] The Indian fauna thus comprises a number of orthoid genera not found in the Guadalupian and a rich diversity of the dorsisinuate type of *Enteletes*, while it contains but two rare species of the *ventrisinuati*, a condition very nearly the reverse in every way of that which, at the time of writing, appears to exist in the Guadalupian fauna.

In the Himalayan region, at Chitichun, Diener found a species of *Enteletes*, one of the *ventrisinuati*, which he described as new, under the title *Enteletes tschernyschewi*. It is of the same general type as *E. dumblei* and *Enteletes* sp. *d* of the Guadalupian. In his second paper on this fauna Diener cites *E. tschernyschewi*, *E. waageni* Gemm., and *E. subæquivalvis* Gemm., *E. waageni* comprising part of the original material of *E. tschernyschewi*. *E. tschernyschewi* and *Enteletes* cf. *elegans* Gemm. are cited from Malla Sangcha. All of these forms appear to be closely allied to the two Guadalupian species mentioned above. Salter also cites *Orthis* sp. from Niti Pass, and Davidson *Orthis* sp. from Tibet.

From the Carboniferous of Turkestan Romanowsky figures a small *Orthis*, probably incorrectly identified as *O. resupinata*, but cites no *Enteletes* and nothing similar to the Guadalupian orthoids.

[a] It may be noted that practically all the types with extreme gibbosity, large plications, and generally extravagant development seem to belong to the dorsisinuates. This group, as before remarked, is almost absent from American faunas, and this, the only known species, is relatively modest and normal in its development of characters.

In the fauna from Lo Ping, in China, we have a species of *Orthis* and one of *Enteletes*, which Kayser identified with *Rhipidomella pecosi* and *Enteletes hemiplicatus*, respectively. The Chinese forms occur associated with *Richthofenia*, *Leptodus*, and a generally different fauna from that of the Pennsylvanian of the Mississippi Valley, where in America these species are most commonly found. *E. hemiplicatus* Kayser, however, is considerably different from the American *E. hemiplicatus*, and Waagen, recognizing this fact, gave to the Chinese species, which he identified also in India, the name *E. kayseri*. The identity with Marcou's species of the form from Lo Ping called by Kayser *Orthis pecosi* had been questioned by both Waagen[a] and Schellwien,[b] and in 1901 Fliegel introduced for it the specific name *subquadrata*. *E. kayseri* is a member of the ventrisinuate group, and the typical form from China more closely resembles *E. hemiplicatus* than does the Indian *E. kayseri* figured by Waagen. Of the Guadalupian species, *E. dumblei* is comparable to the Chinese form in general configuration, though clearly a distinct species. *Enteletes* sp. *c* is probably still more closely similar, though it is doubtful whether when of the same size as Kayser's figures it would have had equally strong plications.

Among the numerous more or less imperfectly known faunas described from China by Loczy, orthoids are for the most part absent. The only instance where the group is represented is in the collection from the vicinity of Kantschoufu, where Loczy cites an unnamed species of *Orthis* which he compares to *O. lyelliana* (*non* De Koninck) of the Moskovian of Russia and to *O. pecosi* of the Pennsylvanian of the United States, and an *Enteletes* which he identifies as *E. lamarcki* of the Russian Moskovian. The latter is more nearly related to a variety of our Pennsylvanian *E. hemiplicatus* than to any species yet known from the Guadalupian.

The report by Schellwien on the paleontological collections obtained by Professor Fütterer in an exploring expedition through Asia has not come to hand, and the only account of these faunas known to me is a short paper by Schellwien, which contains no citations suggestive of the Guadalupian fauna.

In the fauna from Padang, in Sumatra, described by Fliegel, occur two orthoid types, which he describes, one as new, under the title of *Dalmanella frechi*, the other provisionally assigned to *Dalmanella michelini*. The former species, which alone is figured, is probably an *Orthotichia*, an opinion which is supported not only by its configuration but by what is said of its internal structure (reported to possess in both valves a median and two lateral diverging septa), and by the fact that it is stated to be closely related to *Orthis derbyi* Waagen. Nothing similar to these forms, of course, is known in the Guadalupian.

From the Permian beds of Timor and Rotti, in the Indian Archipelago, no orthoids have been cited, so that a comparison with the Guadalupian fauna is impossible in point of this branch of the Brachiopoda, but the absence of such types is a matter of agreement with the fauna of the Capitan formation of the Guadalupian.

Roemer figures a large orthoid from the west coast of Sumatra, which he identifies as *Orthis resupinata*. It would appear to be a *Schizophoria* or an *Orthotichia*, and has no allied Guadalupian form.

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[a] Mem. Geol. Survey India, Pal. Indica, ser. 13, vol. 1, 1887, p. 574.

[b] Paleontographica, vol. 39, p. 35.

Among the Orthidæ of the "Permo-Carboniferous" of Queensland and New Guinea Etheridge records only two species of *Schizophoria*, a type which is unknown in the Guadalupian. It is surprising to find *Enteletes* absent from the Australian faunas.

The Orthidæ discussed in De Koninck's account of the Carboniferous faunas of New South Wales comprise only two species—*O. resupinata* and *O. michelini*. Both species seem to belong to the lower horizon and are not germane to the present consideration.

The so-called Lower Carboniferous of the Russian section, comparison of which with the Guadalupian can be hoped to yield but little profit, being disregarded, the next succeeding formation is the "Middle Carboniferous" or Moskovian. It is in this division that I seem to see especially close faunal relations with the Pennsylvanian of the Mississippi Valley, perhaps more with the lower portion than with the upper. This is the horizon of occurrence of *Enteletes lamarcki*, which appears to be chiefly allied to our own *E. hemiplicatus*. *E. lamarcki* may be described as a ventrisinuate *Enteletes* which has an incipient plication on the fold and sinus, and may thus possibly be regarded as a passage form to the *dorsisinuati*. Shells having this configuration are also accompanied by others which have a similar shape but lack the mesial plication, and are thus true ventrisinuates. The same condition occurs in *E. hemiplicatus*, but there the true ventrisinuate type is dominant, while in Russia that having a mesial plication appears to be most characteristic. No Guadalupian species yet known possesses the latter character, but with the other variety, *E. dumblei*, and, to a less degree, *E. angulatus*, show some general similarity. In addition to *Enteletes*, the Moskovian fauna contains species of *Rhipidomella*, and also of *Schizophoria*.

From the Gschelian stage, which next succeeds, Nikitin cites *Enteletes lamarcki* and another species of *Enteletes* which is not identified. In Tschernyschew's recent work on the "Upper Carboniferous" brachiopods of the Urals and Timan, in which the term "Upper Carboniferous" appears to be used as exactly equivalent to "Gschelian," he cites no species of *Enteletes*, a condition of affairs which is similar to that prevailing in at least the Capitan formation of the Guadalupian; but he recognizes two species of *Rhipidomella*, two of *Schizophoria*, and one of *Orthotichia*, types which are thus far not known in the Guadalupian and may indicate an earlier age for the Russian beds.

The fauna of the Artinsk ("Permo-Carboniferous") and that of the true Permian contain, as is well known, but relatively few brachiopods, and among them no representatives of *Enteletes*. From the Artinsk, however, Tschernyschew figures a species of *Schizophoria*, which he designates as *Orthis* cf. *O. indica*, and Stuckenberg, while recording no representatives of the family from the Artinsk, notes *Schizophoria resupinata* in the accompanying Kungur beds. Krotow also cites *Schizophoria resupinata* from the Artinsk, but from the Russian Permian the family is, so far as I am aware, unrepresented.

From Armenia Abich cites of this group only a small form, which with doubtful propriety he identifies as *Orthis resupinata*. This fauna, therefore, affords nothing which invites comparison with the Guadalupian orthoids. The same is true of *Rhipidomella michelini*, which Frech identifies from the upper "Lower Carboniferous," and *Schizophoria indica*, which Arthaber cites from the "Upper Carboniferous" of the same principality.

The fauna of Balia Maaden, in Asia Minor, contains but one orthoid, according to Enderle, who identifies it as *Orthis* aff. *resupinatæ* Martin. Whether this form is a *Schizophoria*, as indicated by Enderle, or an *Orthotichia*, does not concern us. It is remote from the Guadalupian orthoids at present known.

In his work on the Fusulina limestone of Palermo, Gemmellaro mentions no species of *Schizophoria*, *Orthotichia*, etc., but describes no less than ten of *Enteletes*, all belonging to the ventrisinuate group, except possibly *E. microplocus*, the small size and considerable number of whose plications do not permit it to be assigned definitely. In this particular, accordingly, the Sicilian fauna is comparable to that of the Guadalupe Mountains, and a number of species are analogous.

In the character of its species of *Enteletes*, as well as in its apparent absence of other types of Orthidæ, Gemmellaro's fauna is especially like the Guadalupian.

In the Carnic Alps Schellwien discriminates one species of *Schizophoria* and seven of *Enteletes*,[a] of which four belong to the *ventrisinuati* and three to the *dorsisinuati*. The latter group is much better represented than with us, and contains the striking species *Enteletes suessi*, but nothing very similar to our *E. globosus*. The ventrisinuates do not compare very closely with Guadalupian species of the same group.

The Dyas of Germany and the closely related Permian of England appear to be without representatives of this family, and agree in this particular with the typical Russian Permian. Although the Guadalupian contains but little which positively suggests these faunas, the Capitan formation is in agreement with them in lacking this group of brachiopods.

From the Carboniferous of Spitzbergen nothing is yet known which can be compared with the orthoids of the Guadalupian fauna. It is true that from the south point of Spitzbergen Toula cites *O. keyserlingiana* and from Axel Island *Orthis resupinata*, of which the latter, from his figures, is suggestive rather of a *Spirifer* or an *Athyris*; but these types, so far as known, are not encountered in the Guadalupian. *Orthis eximiiformis*, described from Nova Zembla by the same author, as indicated by the nomenclature which he himself uses, would, in our present classifications, be a *Meekella*; but a restoration of his imperfect specimen somewhat different from that which he adopts might make it an *Enteletes*.

Stache records three small species of *Orthis* from the West Sahara (Igidi), but they resemble nothing in the Guadalupian, and the associated fauna is probably much earlier. De Koninck cites *Schizophoria resupinata* and *Rhipidomella michelini* from New South Wales, but the genus *Enteletes* seems not to occur there.

From Bolivia D'Orbigny described two species of *Enteletes* (*E. andii* and *E. gaudryi*), which from his figures are only in a general way comparable to the ventrisinuate species of the Guadalupian. He also describes *Orthis cora* (probably a *Rhipidomella*) and *Orthis buchii*, neither species having, so far as known, a corresponding one in the Guadalupian. Toula described *Orthis resupinata* var. *latirostrata* from the same country, the correct generic reference probably now being to *Schizophoria*. Salter cites *Orthis resupinata?* and *Orthis andii* also from Bolivia. His figure of the latter species resembles our common Pennsylvanian *Enteletes hemipli-*

[a] As noted below, Schellwien includes *Orthotichia* with his *Enteletes*.

catus and several of the Guadalupian species much more than the original figures of D'Orbigny. Gabb cites *Enteletes andii* from Peru.

Enteletes was not found by Derby in Brazil, but he cites two unplicated orthoids as *O. penniana* and *O. morganiana*, the latter being now the typical species of Hall and Clarke's genus *Orthotihcia*. Neither of these has, so far as known, any related Guadalupian species.

In the typical Pennsylvanian the Orthidæ are represented by three genera, each containing a single species: *Rhipidomella pecosi*, *Schirophoria resupinoides*, and *Enteletes hemiplicatus*. The first two types are, so far as known, unrepresented in the Guadalupian. Between the *Enteletes* of the Guadalupian and Pennsylvanian there are some important if not striking differences. At least one of the Guadalupian species belongs to the dorsisinuate section, which has no Pennsylvanian representatives. Among the ventrisinuates also certain points deserve comment, such as the greater differentiation of the Guadalupian types and the fact that none of them can strictly be identified with the Pennsylvanian *E. hemiplicatus*.

Genus ENTELETES Fischer de Waldheim.

Waagen has made a division of the *Enteletes* into two groups,[a] one of which he calls the *dorsisinuati* and the other the *ventrisinuati*. In one of these groups, as the name indicates, the dorsal valve bears a sinus, and in the other the ventral. To the *ventrisinuati* belongs our common *E. hemiplicatus* Hall. Of the *dorsisinuati* no North American species have up to the present been found. To this statement some exception must be made, in that Waagen[a] refers to the *dorsisinuati* a shell from Nebraska City figured by Geinitz as *Rhynchonella angulata;* but I feel satisfied that the form figured by him is our common *E. hemiplicatus*, and either that some misunderstanding has produced the present confusion, or that Geinitz uses the terms "kleinere Schale" and "grossere Schale" as equivalent to dorsal and ventral, irrespective of the fact that in *Enteletes* the dorsal valve is usually the larger.

Schellwien[b] points out another and more probable instance of a dorsisinuate form in the Mississippi Valley Pennsylvanian faunas in a shell which has several times been figured as *E. hemiplicatus*, but differs from the typical phase of that species in having an incipient plication on the fold and sinus. The fact of the occurrence of this partially developed plication in no wise obscures the real character as such of the fold and sinus, so that from this point of view the form in question would still remain a ventrisinuate type. While, on the one hand, it is possible to conceive of the dorsisinuates and the ventrisinuates as having sprung directly from a common orthoid prototype (*Orthotichia?*), which developed a primary fold in one instance on the dorsal valve and in the other on the ventral, the dorsisinuates may have come indirectly through the ventrisinuates by the development of a median plication on the fold and sinus. This has already been suggested by Waagen.[c] If this inflection of the fold of the ventrisinuate shell were carried to such a point that it equaled in size or exceeded the lateral plications, the real character of fold and sinus would be obscured and the ventrisinuate shell would become dorsisinuate, not to be distinguished from dorsisinuates derived directly from the unplicated shell, if there are any such. Many circumstances tend, however, to confirm the opinion that the

[a] Salt Range fossils: Mem. Geol. Survey India, Pal. Indica, ser. 13, vol. 1, 1887, p. 552.
[b] Abhandl. K.-k. geol. Reichsanstalt, vol. 16, part 1. 1900, p. 7, footnote.
[c] Salt Range fossils: Mem. Geol. Survey India, Pal. Indica, ser. 13, vol. 1, 1887, p. 562.

dorsisinuates are derived from those having a ventral sinus, in the manner above indicated. In the first place, *Schizophoria* and *Orthotichia*, from which *Enteletes* is supposed to have been derived, comprise shells which with the reversal in dimensions of the two valves have, so far as I have been able to ascertain, the sinus and fold, where these structures are appreciable, on the ventral and dorsal valves, respectively. There is no orthoid, so far as I am aware, which by its characters, external and internal, might present claims to be the ancestor of *Enteletes*, that has a dorsal sinus, and might be the stock from which the dorsisinuate group is directly derived. There is likewise the fact of geologic occurrence; the dorsisinuates apparently coming in only in the late Carboniferous or Permian, while the ventrisinuates appeared earlier. Waagen also calls attention to the significant fact that the geologically oldest species of the Salt Range is the one which is most nearly related to the American "Coal Measures" forms.[a]

Furthermore, we have in *E. lamarcki* Fischer de Waldheim and the forms referred to *E. hemiplicatus* Hall, species representing the very transitionary stage between the two groups. Schellwien has already pointed out that the American form with an incipient median plication can not properly be referred to *E. hemiplicatus*. It occurs in association with the true *E. hemiplicatus*, which it so closely resembles in all other characters that I doubt if this new form should be given more than varietal rank.

In regard to the affinities of these shells and their position in the two groups recognized by Waagen, it appears that the latter author refers *E. lamarcki* to the ventrisinuates,[b] while Schellwién refers that species, along with the above-mentioned variety of *E. hemiplicatus*, to the dorsisinuates. Perhaps the logical position would be to refer species to the *dorsisinuati* on the first introduction of the plication on fold and sinus; but because of the obvious close relationship of one having this configuration to *E. hemiplicatus*, a ventrisinuate type, and the imperfect development of the median plication, I am disposed to retain them in the *ventrisinuati*. The fact that there is some divergence of opinion as to the group to which some of the *Enteletes* types belong indicates how closely related are the two branches discriminated by Waagen, although they appear at first so distinct.

Schellwien includes in *Enteletes* shells which by other authors are distinguished as a distinct division, under the name of *Orthotichia*, or in some cases retained as *Orthis* pars. It will be remembered that *Orthotichia* was introduced by Hall and Clarke[c] for the type of orthoid structure characterizing those forms which Waagen[d] had called the group of *Orthis morganiana*. The introduction of a new name for this type was in effect the carrying out of a suggestion made by Waagen, that the three groups or divisions of *Orthis* recognized in his work might be of subgeneric rank. The species after which Waagen named this group or division was by Hall and Clarke taken as the type of their *Orthotichia*. As pointed out by Waagen, and later by Hall and Clarke, this group is intermediate between *Orthis* (*Schizophoria*) and *Enteletes*; and Schellwien[e] has merged it with the latter genus for the reason

[a] Waagen, W., Salt Range fossils: Mem. Geol. Survey India, Pal. Indica, ser. 13, vol. 1, 1887, p. 557.
[b] Idem, p. 562.
[c] Nat. Hist. New York, Pal., vol. 8, pt. 1, 1892, p. 213.
[d] Op. cit., p. 564.
[e] Abhandl. K.-k. geol. Reichsanstalt, vol. 16, part 1, 1900, p. 3.

that if *Orthotichia* be placed with *Orthis* the only difference distinguishing *Orthis* from *Enteletes* is the absence of plications. Schellwien also points out a possible danger in the use of *Orthotichia*, which, as defined by Hall and Clarke, would include both shells that were in the process of evolution from *Schizophoria* to *Enteletes* and also such types of *Enteletes* as have lost their plicated surface and retain only the characters of the transition forms (*Orthotichia* proper), though a distinct intermediate stage (*Enteletes*) exists between them. He also remarks that although Hall and Clarke call *Orthotichia* a transitional development between *Schizophoria* and *Enteletes*, the type species, *Orthis morganiana*, possesses the characters which he regards as distinguishing the relapsed or atavic type of *Enteletes* structure.[a] He suggests that the possession of an inflated dorsal valve and closely arranged septa in the ventral are characteristic of the later forms, the earlier of which he refers to *Orthis*. He prefers, therefore, an unwieldy or somewhat heterogeneous grouping to one which tends to misrepresent facts of phylogeny. This objection seems to me in some regards to be well taken, for I would be far from advocating a reference to the same genus both of types which were developing into and of those developing out of *Enteletes;* and if *Orthotichia*, as based on *O. morganiana*, does, as suggested by Schellwien, stand for the latter stage, I would favor another name for that which is intermediate in development between *Schizophoria* and *Enteletes*.

The objection to the use of *Orthotichia*, which Schellwien advances, seems to be academic, rather than real. According to accepted theory, species which are in process of evolution from *Schizophoria* (or *Orthotichia*) to *Enteletes* would have the posterior portion smooth and the marginal portions plicated. A similar line of reasoning would lead one to expect that in species which are reverting from *Enteletes*, a condition which Schellwien thinks is manifested in *Orthotichia morganiana*, the shell would have to pass through an *Enteletes* stage, so that the posterior or median parts would be plicated and the lateral ones smooth. This condition is certainly not present in *Orthotichia morganiana*, and I do not recall having seen any specimens or figures illustrating this condition. It is conceivable, however, that instead of passing through an *Enteletes* stage the reversional tendency might manifest itself in the gradual loss of the power to fold the mantle at all stages of growth. Thus this argument loses much of its force.

Evidence based on the occurrence of species in geologic time presupposes a knowledge of these data and a correlation of beds so much more complete and accurate than that which we at present possess that I am disposed to accept it with much reserve. It may be more or less true according to our present knowledge, as urged by Schellwien,[b] that the oldest typical *Enteletes* are strongly plicated, while the faintly plicated forms are especially abundant in Permian strata, yet, at the same time, it is reasonable to believe that smooth and faintly plicated forms must have preceded those with sharply folded shells. In regard to the occurrence of faintly plicated types in the younger deposits of the Carboniferous, I do not see that it is possible to tell whether it is a case of persistence of the faintly plicated stock in association with the strongly plicated one (*Enteletes*) to which it gave rise, or a persistence of the strongly plicated type with the reverted shells of faint plication which descended from it. Neither hypothesis is at present susceptible of very

[a] Abhandl. K.-k. geol. Reichsanstalt, vol. 16, part 1, 1905, p. 5.

[b] Idem, p. 4.

strong direct evidence, and as the former is more simple I am prepared to employ it until better reasons are adduced for supposing that any of the shells having the appearance of *Orthotichia* possessed *Entèletes* as an ancestor.

If I understand Schellwien aright, he proposes to place the intermediate species with *Orthis* and to merge with *Enteletes* the relapsed ones, abolishing the name *Orthotichia*, the type of which, he thinks, belongs to the latter group. My position is somewhat that of an agnostic on the question of there being a relapsed group, and I doubt whether *Orthotichia* really belongs to it if there is one, but I will go so far with Schellwien as, while recognizing *Orthotichia*, to place it as a subgenus of *Enteletes* rather than of *Orthis*. This comes in practice very near to following Schellwien in this matter without, however, accepting the opinions on which his course of action is based.

In the present paper seven species of *Enteletes* are distinguished, and they will be referred to as *E. globosus*, *E. dumblei*, *E. angulatus*, *Enteletes* sp. *a*, *Enteletes* sp. *b*, *Enteletes* sp. *c*, and *Enteletes* sp. *d*. Of these, *E. globosus* belongs to the *dorsisinuati*, and as such is of considerable interest, since *Enteletes* has up to the present time been known to be represented in North America only by the *ventrisinuati* type. A minor subdivision of the Guadalupian ventrisinuate species, none of which seem to be identical with our common *E. hemiplicatus*, can be made, although but provisionally, as so much of the material is fragmentary.

E. angulatus represents one group, and with it should perhaps be associated the well-known form of the Mississippi Valley Pennsylvanian, *E. hemiplicatus*. *E. dumblei* would appear to deserve a position in a distinct group by reason of the unusual character of its minute surface sculpture. The little-known types *Enteletes* sp. *a*, *Enteletes* sp. *b*, and *Enteletes* sp. *d* probably belong together, being characterized by having numerous small angular plications. *Enteletes* sp. *c* probably represents a group by itself, and is of interest because it apparently belongs to that type of *Enteletes* which has obsolescent plications and which, appearing in special abundance after the strongly plicated forms had been dominant, represents, as Schellwien thinks, a retrogression of the genus from a plicated to a smooth condition. On the assumption that the Guadalupian specimens are mature, they represent a stage about equal to *Enteletes dieneri* Schellwien and a little less unplicated than *Enteletes derbyi* var. *demissa* Schellwien. However, young specimens of the size of the latter species would have been equally unplicated. If the Guadalupian form really does belong to a retrograde series, its position at the base of the section is surprising, but may be logically connected with the entire absence of the orthoid group in the Capitan formation.

One may not be certain that some, perhaps all, of the shells forming *Enteletes* sp. *c* do not belong to the group of *Orthotichia*, or that, if grown to a larger size, they would not have been distinctly plicated. This uncertainty often arises when the specimens collected are few in number and of small size, and in surveying the literature I have come upon a number of instances in which forms that I was led to suspect might be young *Enteletes* have been placed with *Orthis* or *Orthotichia*. In the present case also the uncertainty as to whether these small shells are young or mature, and, indeed, whether they have as immediate ancestors plicated or unplicated forms, makes it dangerous to speculate on their biologic or stratigraphic significance.

In the Guadalupian section in the immediate vicinity of Guadalupe Peak the orthoid group is surprisingly rare. Fairly abundant in the black limestone at the base of the section, where it is represented by *Enteletes* sp. *c*, but one specimen has come to hand from the Delaware Mountain formation overlying (*Enteletes* sp. *d*), while in the Capitan formation the genus, and indeed the entire family, is not known to occur at all. In areas contiguous, and in association with faunas in some cases doubtfully and in others satisfactorily correlated with the Delaware Mountain formation, the chief collections by which this group is represented in the present report have been obtained.

There are, in almost every group of fossils, a number of poorly characterized—or one may say primitive—species, which if not actually identical the world over can nevertheless scarcely be discriminated in the different provinces in which they occur. Aside from such forms the Guadalupian *Enteletes*, so far as known, are more similar to those of the Permian (?) of Palermo than to other groups of species whose descriptions are known to me.

DORSISINUATI.

ENTELETES GLOBOSUS n. sp.

Pl. XXX, figs. 1 and 1a.

Shell rather small, globose. Ventral valve moderately convex. Dorsal valve very convex. Outline subcircular. Surface of dorsal valve marked by a broad sinus of moderate depth, bounded by large plications, on either side of which are three small plications. The plications on the ventral valve correspond, so that there are a median sinus and four lateral plications on the dorsal valve and a median fold and four lateral plications on the ventral valve. The fold and bounding furrows of the ventral valve, and the sinus and bounding ridges of the dorsal valve are larger and more prominent than the other grooves and ridges. The superficial liræ appear to be rather coarse, equal, and regular; but their character has been obscured by silicification. The liræ appear to be considerably coarser than in *Enteletes hemiplicatus*.

It is only after much hesitation that I have decided to base a new species on a specimen as disfigured as the one described; but it shows many important characters, though some have been obscured. This form, moreover, is one of especial interest, since it belongs to the group of *Enteletes* which Waagen has called the *dorsisinuati*, and is probably the first representative of this group to be noticed from North America. Fortunately the presence of three septal plates close together in one valve distinguish it immediately as the ventral, while the opposite one bears a median sinus corresponding to the somewhat crushed fold of the septate valve.

This species presents a certain superficial resemblance to *Enteletes œhlerti* Gemmellaro,[a] which was first found in Sicily and has subsequently been identified by Schellwien[b] in the Carnic Alps, but it readily develops from a more careful scrutiny that *E. œhlerti* belongs to the *ventrisinuati*, while *E. globosus* is a dorsisinuate.

[a] Giorn. Soc. di sci. nat. ed econ. di Palermo, vol. 22, 1899, p. 139, pl. 29, figs. 11-15.
[b] Abhandl. K.-k. geol. Reichsanstalt, vol. 16, part 1, 1900, p. 11, pl. 1, figs. 11-13.

Among the *dorsisinuati* I have not found any described species with which *E. globosus* would be liable to be confused.

Horizon and locality.—Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763).

VENTRISINUATI.

ENTELETES DUMBLEI n. sp.[a]

Pl. XXVI, figs. 4 to 4b.

Shell large, orbicular. Ventral valve moderately convex, subcircular, somewhat contracting at the hinge line; width 26 mm., length about 22 mm. The area is flat, except at the apex, and well defined, making an angle of about 90° with the plane of the shell margin. It is 16 mm. wide, 4½ mm. high, and transected by a delthyrium which is 4½ mm. wide at its base. The beak is small, pointed, and incurved, and it overhangs the area. This valve bears a median sinus, on either side of which are four subangular plications and a fifth smaller and less distinct. The sinus is larger than the sulci between the lateral plications.

Dorsal valve highly inflated. Shape like that of the ventral valve. Beak comparatively large and overhanging the low area. Surface with a median fold and five lateral plications, the outer of which is small and indistinct.

The surface is marked by fine, radiating liræ, just visible to the naked eye. They are thin and ridgelike, though low and faint, the spaces between them being wider than the liræ themselves. About the same number of liræ would occur in a given distance in this species as in *E. hemiplicatus;* but in the latter they are more distinct, broadly rounded, and with linear interspaces, while in *E. dumblei* they are thin, narrow, and with wide interspaces.

This shell evidently belongs to the *ventrisinuati* group of Waagen, which includes also our common *E. hemiplicatus*, along with a large number of foreign species. *Enteletes dumblei* can be distinguished from *E. hemiplicatus* by its broader and higher cardinal area, more numerous plications, and different surface ornamentation. It is related to several foreign species, but to none more nearly than to *E. elegans* Gemmellaro.[b] Gemmellaro's figures show a strong resemblance in configuration, but whether this similarity is persistent, and whether the Italian species possesses the rather peculiar striation of the American one, can hardly be determined without a comparison of the shells themselves.

Horizon and locality.—Hueco[a] formation, Diablo Mountains, Texas, as reported (station 3764).

ENTELETES ANGULATUS n. sp.

Pl. XXVI, figs. 3 and 3a.

The ventral valve is all that has been obtained of this species. It presents the following characters:

Shell large, transverse, strongly inflated. Width 30 mm., length 25 mm. Beak small, incurved, and overhanging the area. The latter appears to be flat

[a]Information obtained after this paper was in type indicates that this species and the following were obtained not from the Guadalupian but from the upper beds of the underlying Hueco formation.

[b]Giorn. Soc. di sci. nat. ed econ. di Palermo, vol. 22, 1899, p. 141, pl. 29, figs. 6–10.

transversely, slightly concave longitudinally. Its width is 17 mm., its height 6 mm., and the delthyrium is 5 mm. wide at its base. There is a large median sinus with three obvious and one obscure plication on each side. The sinus is somewhat larger than the furrows between the plications, and the sinus, furrows, and plications are strong and angular. The more minute surface ornamentation appears to resemble that of *Enteletes dumblei,* and to consist of narrow, obscure, threadlike liræ separated by comparatively broad interspaces. The convexity of this valve, in view of the fact that it is a ventral, is remarkable. That it is a ventral, however, is clearly shown by the presence of two proximate dental plates and one intermediate septal plate.

This species is especially characterized by its highly arched ventral valve, by the strong, large, angular plications, and also probably by the fine, narrow, and sharp liræ which mark the surface. The character of the liration is not especially noted in many descriptions nor represented in figures, but *Enteletes angulatus* is distinguished from most of the foreign species which, in the literature, have come to my notice, by the configuration of the shell, as above mentioned. It appears to be most closely related to certain forms from Palermo described by Gemmellaro, especially to *E. waageni* var. *umbonatus.*[a] It must remain for an actual comparison of specimens to determine what are the relations between these two species.

Enteletes angulatus should be readily separable from *E. dumblei* by reason of its fewer, stronger, and more angular plications. I regard it as distinct from *E. hemiplicatus,* because the ventral valve is more gibbous, the cardinal area larger, the plications stronger and more angular, and extended farther toward the beak. If the surface ornamentation is of the character which it appears to have, this also should furnish an excellent means of distinguishing the two species.

Horizon and locality.—Hueco formation, Diablo Mountains, Texas, as reported (station 3764).

ENTELETES sp. *a.*

Pl. XXX, figs. 2 and 2a.

This species is represented by a fragment the general character of which is shown by fig. 2 of Pl. XXX. The internal structures of this specimen can not be made out, but the configuration appears to be that of a ventral rather than of a dorsal valve. On this point, however, it is impossible to reach a satisfactory conclusion. The convexity is remarkably slight, if the shell be supposed a dorsal valve. The beak is rather prominent and somewhat incurved. No distinct area can be observed, the curvature being uninterrupted to the point where the shell is terminated by a wide delthyrium. There is a median sinus and on each side of it three distinct plications, with possibly a fourth, which is very faint. The sinus is but little larger than the sulci, and the plications are subangular. The fine superficial liræ are faint, except for rather numerous and equally distributed tubular ones, which are prominent. The others are indistinct, even when viewed with a glass, and are practically invisible without.

If this is a dorsal valve it evidently belongs to the *dorsisinuati,* and *E. globosus* is the only Guadalupian form with which it is necessary to make comparison. From

[a] Giorn. Soc. di sci. nat. ed. econ. di Palermo, vol. 22, 1899, pl. 29, figs. 22, 23.

the latter it appears to differ in having the liræ much finer and more indistinct and the convexity very much less. Of the other species of *Enteletes* here described, in configuration it most nearly resembles *E. dumblei,* but the different character of the liration distinguishes them at once.

Horizon and locality.—Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763).

ENTELETES sp. *b*.

Associated with the foregoing is a fragment of what probably represents a distinct species. The fragment is nearly square and measures 13 mm. in either direction. There is a median plication somewhat larger than the others. Of the latter, three on each side and part of the fourth are preserved, and the incomplete condition and gradual curvature of the fragment indicate that there were additional ones on portions of the shell now missing. The larger (median?) plication is about 6 mm. wide, the others about 4 mm., and their diminution in size within the limits of the shell preserved is very slight. They are well defined, but neither very high nor very angular. The superficial liræ are fine but strong.

The plications and liræ are those of *Enteletes* rather than of *Meekella;* but it is impossible to determine whether the specimen is a dorsal or a ventral valve and consequently whether it belongs to the *dorsisinuati* or the *ventrisinuati.* The size of the fragment is considerable and the complete dimensions must have been rather exceptional. The shell representing *Enteletes* sp. *a* is likewise so slightly convex that a large complete size is indicated; but the liræ in one case are faint and in the other distinct, so that I have felt that they should not for the present be referred to the same species. The silicification of the form under consideration, however, is coarse and may have exaggerated this character.

This species is probably related to *E. microplocus* Gemmellaro,[a] but is certainly distinct from that species by reason of its larger and presumably less numerous plications. The presence of a well-marked mesial plication of larger size than the lateral ones is also a distinguishing feature.

Horizon and locality.—Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763).

ENTELETES sp. *c*.

Pl. XXIV, figs. 4 to 5a; Pl. XXVI, figs. 1 to 2b.

In the black limestone at the base of the Guadalupe section occurs a species of *Enteletes* which deserves mention, both because of the scanty fauna at present known from that horizon and because of its biologic relations. Though the form is not a rare one no perfect examples have been found and for this reason, and since I am not sure but that certain of the peculiarities exhibited are due to immaturity, I have refrained from proposing a new name for what is probably a distinct and undescribed species.

All the specimens seen are small. The largest size indicated, which several examples approach, is 18 mm. in length and probably but little less than 25 mm. in width. The configuration and striation are practically the same as in *E. hemi-*

[a] Giorn. Soc. sci. nat. ed econ. di Palermo, vol. 22, 1899, p. 147, pl. 28, figs. 40, 46.

plicatus. The socket plates are also about as in that species, but there is a low though very distinct median septum in the dorsal valve. The septum and dental lamellæ of the ventral valve do not differ materially from those of the species mentioned. The dorsal valve has a mesial fold and the ventral a corresponding sinus, so that the form can be referred to the ventrisinuate group. A lateral plication on each side (possibly two on the ventral valve) can also be made out, but they are very faint.

The faintness of the plications and the late period in the shell growth at which they appear are the chief features that distinguish this form from *E. hemiplicatus* in which the plications are much more strongly developed in shells of equal size. The different character of the liration, and to a less degree the obsolescent plications, likewise distinguish it from *E. dumblei*.

A number of faintly plicated species of *Enteletes* have been described in the higher Carboniferous terranes of Europe and Asia, in regard to certain of which there may well be some doubt as to whether they are really based on mature specimens. Some of these, like *E. sublævis* Waagen, belong to the *dorsisinuati*, but others admit of more or less satisfactory comparison, so far as general appearance is concerned, with the form under consideration. This is especially true of two species from Sicily described by Gemmellaro (*E. tschernyschewi* and *E. Waageni*), to one or the other of which *Enteletes* sp. *c* may perhaps ultimately be referred as immature or partially developed individuals. This can be ascertained, however, only by comparison of the specimens themselves, to determine both whether the superficial resemblance shown by the figures actually exists, and whether it is borne out by correspondence in the more minute surface sculpture.

A repetition of shells of this size and character in the black limestone would naturally be taken as indicating a mature stage. If so, they might belong either to the group of late Permian species which are supposed to be losing the plicated configuration of *Enteletes* and returning to a condition similar to *Orthotichia*, or, on the other hand, to the other group of similar appearance which is in the course of development from the smooth *Orthotichia* stage to the plicated condition of *Enteletes*. The horizon of occurrence at the base of the Guadalupe section is somewhat surprising on one hypothesis, and the abundance of the strongly plicated *Enteletes hemiplicatus* in the "Coal Measures" of the Mississippi Valley almost equally difficult of explanation on the other.

With the exception of a single specimen of *Enteletes* from the Delaware Mountain formation, this is the only occurrence of any branch of the family known up to the present time in the Guadalupe section, and the complete absence of *Enteletes*, or, in fact, of orthoids of any sort, in the higher beds is noteworthy.

In addition to specimens from the black limestones, on which the foregoing description is based, I have subsumed under this title a dorsal and a ventral valve belonging to the same individual obtained in the Diablo Mountains. These specimens, which have unfortunately been lost since the drawings were made, are figured on Pl. XXVI of the present volume. Save for an indistinct fold and sinus they are entirely without plications, and as they possess the internal structure of *Orthotichia* as well as of *Enteletes*, I originally referred them to the former genus. I do not, however, see that it would be possible to distinguish them from small examples of the present species or some related form of *Enteletes.* Compared specifically with the form under discussion there are few differences by which they may be distinguished. The liration of the shell from the Diablo Mountains is of the same general character, but much fainter than that of well-preserved specimens from the black limestone. This lack of distinctness, however, I suspect to be due in some measure to siliceous replacement. The dorsal valve is perceptibly less convex, but this as a rule must be regarded as a character of inferior importance. Dorsal valves from the black limestone, moreover, show a distinct cardinal area, and though the structure is absent in the delicate silicified specimens from the Diablo Mountains, it may well be supposed to have been broken away. These silicified specimens, which, as above noted, are less tumid than the others, appear to be related to a species described by Waagen as *Orthis derbyi*,[a] and more especially to a variety of this described by Schellwien, with a change of generic designation, as *Enteletes derbyi* var. *demissa*.[b] From the latter it can probably be distinguished by being more nearly equivalve and by the faintness of its striation. No specimens of the European form, however, are available for comparison. The specimens from the Diablo Mountains occur in association with several species of *Enteletes*, but any one of these, at the size which they have reached, would have developed lateral plications, no sign of which appears on the specimens under consideration.

The specimens from the black limestone also present considerable external resemblance to *Orthis derbyi*, but like those from the Diablo Mountains they show within three high, thin, subparallel septa in the ventral valve, different from the low curved ridges surrounding the muscular imprints in the Indian species. Because of these structures the Guadalupian fossils have been placed in a different genus, namely, in *Enteletes*.

Horizon and locality.—Basal black limestone, Guadalupe Point, Guadalupe Mountains, Texas (stations 2920 and 2967). Delaware Mountain formation, Diablo Mountains, Texas, as reported (station 3764).

ENTELETES sp. *d*.

Pl. XXI, fig. 23.

From the yellow sandstones of the Delaware Mountain formation has come to hand a single dorsal(?) valve of *Enteletes* whose preservation is imperfact, so that many characters can not be made out with certainty. It is strongly inflated and has a subcircular shape. The length is 20 mm. and the width, if complete, probably not less than 25 mm. There are certainly seven plications, and possibly one or two more, and a considerable area at the sides is unplicated. The plications are not so large or so sharp as in *E. hemiplicatus*, but the liration appears to be of about the same size and character. It is impossible to tell from the present specimen whether it belongs to the *dorsisinuati* or to the *ventrisinuati*.

This form is undoubtedly distinct from our common *E. hemiplicatus*, and it is also clearly distinct from *E. globosus* and *E. angulatus*. It has less coarse plication than *E. dumblei*, as well as different striation, and probably can be distinguished

[a] Salt Range fossils: Mem. Geol. Survey India, Pal. Indica, ser. 13, vol. 1, p. 565, pl. 56, figs. 2, 5, 6.
[b] Abhandl. K.-k. geol. Reichsanstalt, vol. 16, part 1, p. 8, pl. 1, figs. 4-7.

from any of the three unnamed forms already described in this report. It most closely resembles the form denominated *Enteletes* sp. *b*, but in configuration is not dissimilar to *Enteletes* sp. *a*, differing, however, in having the liræ more distinct and equal, seemingly without the prominent spiniferous ones. Of foreign species, probably *E. elegans* Gemmellaro is most closely allied.

I have also provisionally placed with this species some fragmentary crushed material from station 3501. These specimens, if complete, would probably be of considerable dimensions. Two examples, showing only the apical portion, have a length of 16 mm. The liræ are moderately fine, rounded, and among the ordinary ones portions of the surface show others of greater prominence, which were doubtless the bases of small spines. Plications on these fragments are not very distinct, but small, and apparently rather numerous. On the more mature areas the plications were correspondingly more pronounced. This form appears to belong to the same group as *Enteletes* sp. *a*, *Enteletes* sp. *b*, and *Enteletes* sp. *d*. In the unequal character of its liræ it suggests the type constituting *Enteletes* sp. *a*.

The general character of this form is especially suggestive of the shell from the Delaware Mountain formation on which *Enteletes* sp. *d* is founded, the chief difference being in that the plications in the latter extend farther toward the beak. The shell from station 3501, however, has apparently been considerably worn. In the faint development of plications, at least over the umbonal area, these shells suggest the form from the black limestone here designated *Enteletes* sp. *c*. The plications are somewhat more distinct, and are smaller than I judge they would be in the latter species.

A very young shell from station 3763, the horizon of which is probably equivalent to some portion of the Delaware Mountain formation, has also been placed in this group. This specimen, which is of course entirely without plications, might be either a *Schizophoria*, an *Orthotichia*, or an *Enteletes*, but from the strength of the three septal plates I judge that it belongs to the latter genus. Its specific relations are of course largely speculative.

Horizon and locality.—Delaware Mountain formation, Guadalupe Point, Guadalupe Mountains, Texas (station 2919). Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763?). Delaware Mountain formation, southern Delaware Mountains, Texas (station 3501).

Family PENTAMERIDÆ McCoy.

In the Carboniferous the family of the Pentameridæ is restricted to the single genus *Camarophoria*, and in the Guadalupian the genus is represented by but a single species. *Camarophoria* is much more abundant at a lower horizon (in the Hueconian), and it is more abundant in the Salt Range, from which Waagen recognized no less than five species. The Guadalupian form probably belongs to what Waagen calls the group of *C. crumena*, in which three Salt Range species are included. The group of *C. rhomboidea*, comprising two Salt Range forms, is unknown in the Guadalupian.

Diener recognized three species of *Camarophoria* in the Chitichun fauna No. 1, of which one, identified as *Camarophoria* sp. indet. aff. *C. crumena*, is unlike the

Guadalupian form. The two others, however, belong to the same general type. As an immature stage of *C. crumena,* Diener figures a little shell which, if the same genus, certainly appears to belong to a different species. It is altogether different from the Guadalupian species of *Camarophoria,* and looks as if it might be a *Pugnax* of the general type of *P. utah,* etc. In his second paper on this fauna Diener cites, in addition to *C. purdoni* var. *gigantea,* which is related to the Guadalupian species *C. venusta, Camarophoria* cf. *semiplicata,* possibly the same as the small specimen commented on above, and *C. globulina.* The two latter are of an altogether different type from *C. venusta.*

In his paper describing the Anthracolithic fossils from Kashmir and Spiti this author mentions only *Camarophoria* cf. *purdoni,* related in some degree to the Guadalupian species. His later discussion of this fauna mentions only *Camarophoria* n. sp. from the lower beds, a form not related to *C. venusta,* but makes no record of the genus in the upper beds. Diener cites *C. purdoni* from Malla Sangcha also.

Like the rhynchonelloids, the Pentameridæ appear to be conspicuously rare in the Carboniferous faunas of China and adjacent areas. Kayser records none from the Lo Ping locality, and Loczy cites only *Camarophoria purdoni* from the Lantsankiang Valley, among the different Chinese Carboniferous faunas which he describes. This form is related to *P. venusta. Camarophoria crumena* is cited by Beyrich from Timor, the form illustrated being of the same general shape as *C. venusta.* In his paper on fossils from Timor and Rotti Rothpletz cites *Camarophoria pinguis,* which, to judge from his figures, is somewhat remotely related to the Guadalupian species.

Tschernyschew cites *C. crumena* and *C. margaritovi* from Vladivostok. *C. margaritovi* is described as a new species and is less closely allied to *C. venusta* than is, presumably, *C. crumena,* which is not figured.

In the Russian section *Camarophoria* is represented in the Moskovian stage by two species, which Trautschold identifies as *C. crumena* and *C. plicata. C. crumena,* which alone is figured, does not resemble the Guadalupian form very closely. In the Gschelian this type shows a remarkable differentiation, Tschernyschew recording no less than 15 species. The 5 species included in the group of *C. crumena* show individually rather wide variation. Some of the forms included there appear to be distinctly related to *C. venusta,* others very slightly so. Some of them have much more the configuration of certain of the Guadalupian species of *Pugnax.* The group of *C. applanata,* which consists only of the species of that name, is also related to *C. venusta,* but the group of *C. isorhynchus,* with three species, the group of *C. rhomboidea,* with four, and the group of *C. sella,* with two species, have little to do with the single known Guadalupian form. These groups show wide variations of configuration, some of which are remarkably dissimilar to *C. venusta. C. superstes* is suggestive, in configuration at least, of *Pugnax bisinuata,* and *C. globulina* of *Pugnax bidentata,* but, so far as known, they are essentially different.

Stuckenberg records from the Gschelian *C. plica, C. purdoni, C. sella, C. biplicata,* and *C. triplicata.* Some of these forms, as already remarked, such as *C. plica* and *C. sella,* are only very remotely related to *C. venusta.* In some of the others the relationship is more obvious. Nikitin also records *C. purdoni* from this horizon, and his figures show a form in a general way comparable to the Guadalupian species.

From the Artinsk Tschernyschew cites only *C. plica*, a species belonging to a different group from *C. venusta*. Stuckenberg recognized *C. duplicata* and *C. purdoni* from this horizon, two species which if not very closely allied to *C. venusta* are more so than *C. plica*. One of the same forms (*C. purdoni*) is recorded from the Kungurstufe.

Netschajew found six species of *Camarophoria* among his Permian fossils from eastern Russia. *C. superstes*, *C. waageni*, and *C. globulina* are not closely allied to the Guadalupian *Camarophoria venusta*, but *C. humbletonensis*, *C. purdoni*, and *Camarophoria* cf. *schlotheimi* probably belong to the same group. The species last named is not figured, however, and Netschajew's specimens of the two others were so poor that a trustworthy conclusion is impossible. Tschernyschew found in the Permian of the government of Kostroma only the species *Camarophoria superstes*, a form altogether dissimilar superficially to *C. venusta* and having much the configuration of *Pugnax bisinuata*. De Verneuil in his classic work on the Russian Permian recognized only *C. schlotheimi* and *C. superstes*, two species which are unlike the Guadalupian representatives of the genus. In configuration they suggest, respectively, *Pugnax bisinuata* and *P. swallowiana*, as I have already had occasion to remark, although the fact is apparently without significance save as an instance of parallel development.

In a general way there is more resemblance shown between the Guadalupian representatives of *Camarophoria* and those of the Russian Permian than between the Guadalupian Camarophorias and those of the Russian Gschel fauna. This is perhaps due rather to negative than to positive elements—to the diminished occurrence of the group in the Permian and the presence of fewer forms which are very unlike the single Guadalupian species. The genus is better represented, both in abundance of individuals and differentiation into species, in the upper beds of the Hueco formation, which underlies the Guadalupian.

Camarophoria seems to be absent in the Armenian fauna described by Abich and reviewed by Arthaber, but it appears among the fossils from Balia Maaden, in Asia Minor, which Enderle described. Enderle identified his fossils as *C. globulina*, and his figures do not indicate a close relationship with *C. venusta*.

Gemmellaro distinguished five species among the Silician Camarophorias, all of which belong to different groups from *C. venusta*. Most of them have the superficial aspect of our American *Pugnaces* (*C. affinis* of *Pugnax rockymontana* and some of the others of *P. utah*, *P. swallowiana*, etc.). *C. acuminata*, however, is more like the Guadalupian species referred to *Rhynchonella*.

In the fauna of the Carnic Fusulina limestone Schellwien found three species of *Camarophoria* which he describes as *C. alpina*, *C. sanctispiritus*, and *C. latissima*. There is no question of identity with these species, but the Guadalupian form is of the same general type. This author recognized three species also in the fauna of the Trogkofelschichten. In contrast to those recorded in his earlier report, the three Trogkofel species only remotely resemble the Guadalupian *C. venusta*.

The Dyas of Germany contains a considerable series of forms belonging to this genus all of which are included by Geinitz under the title of *C. schlotheimi*. Most of them are altogether different in general appearance from *C. venusta*, but a few are less remotely related.

The Permian of England furnishes a greater variety and King recognizes three species. By far the most closely allied to *C. venusta* is the English form identified as *C. multiplicata.* The relationship is less distinct in the case of *C. schlotheimi* and remote in the case of *C. globulina.*

Toula cited *C. crumena* (without figures) from the south point of Spitzbergen, and a little later reported the same species from the Hornsund, his figures in the latter case showing a form belonging to a different group from the Guadalupian species.

The only reference to this genus in the several works consulted which deal with the Carboniferous of South America is found in Derby's account of Brazilian fossils. He there mentions fragments of a small species of *Camarophoria* too imperfect for description.

The absence of Camarophorias in the typical Pennsylvanian faunas constitutes one of their marked peculiarities. The genus is somewhat sparingly represented in the Mississippian, but so far as known does not in the eastern region range into the upper beds. In the West we have *Camarophoria thera,* which is different from *C. venusta,* and *Camarophoria bisinuata,* described by Shumard from the present fauna, which has proved to belong to an entirely different group. In the Hueco formation the genus is better represented than in any of the horizons and areas mentioned. In California and Alaska at horizons tentatively correlated with the Russian Gschelstufe, the genus is also found in relative abundance.

Genus CAMAROPHORIA King.

CAMAROPHORIA VENUSTA n. sp.

Pl. XXXI, figs. 6 to 6c.

Shell rather large, subtriangular. Length and breadth nearly equal. Ventral valve shallow. Beak elongate, pointed, slightly incurved, and apparently without deltidial plates. Sinus moderately deep and well defined; distinguishable about halfway back from the front margin. There are five plications in the sinus and about six on either side.

Dorsal valve strongly convex, fold moderately high and well defined, surmounted by six plications, in addition to which there are about six lateral ones on each side.

The plications are rather slender and strongly rounded or subangular. The lateral ones are lower, rounder, and less distinct than those on the fold and sinus.

I have identified this species, the type of which was found in the Glass Mountains, somewhat doubtfully in an imperfect specimen from the white limestone of the Guadalupe Mountains. The chief difference to be seen at present is that the Guadalupe specimen has somewhat coarser and therefore fewer plications. This example shows a fine large spondylium in the dorsal valve. Aside from this the generic position is not well determined and rests chiefly on the general expression and apparent relation to other species belonging to *Camarophoria.* *C. venusta* is evidently the representative of *C. purdoni* and *C. humbletonensis* of the Salt Range fauna. The last-named species, it will be remembered, is found also in the Permian strata of England.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926). Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763).

Family RHYNCHONELLIDÆ Gray.

According to my present knowledge the Rhynchonellidæ of the Guadalupian fauna are represented by some 16 species, which have been assembled under two generic titles. So far as known, however, the two groups differ more in configuration than in structure. In both the ventral valve is provided with a pair of more or less well-developed dental plates, while the dorsal has a low but distinct median septum. As to configuration, however, the shells placed with *Pugnax* have a few large plications which reach only part way to the beak, those on the sides tending to be obsolete. The fold and sinus are well developed and distinctly defined, and occupied by more pronounced plications than the lateral ones. The forms referred to *Rhynchonella?*, on the other hand, have numerous relatively fine plications, which reach quite to the beak and often increase by bifurcation. The fold and sinus are well developed, but by reason of the occurrence of plications on their sides are not always sharply defined.

Even among the shells referred to *Pugnax* two rather distinct groups are found, one represented typically by *P. bisulcata*, with very gibbous growth, subcircular outline, and rounded, almost obsolete plications, the other with triangular or pentagonal outline and ribs sharp and strong, especially on the fold, though not persistent.

Waagen distributed his Salt Range rhynchonelloids among the genera *Terebratuloidea* (4 species), *Uncinulus* (3 species), and *Rhynchonella* (3 species). It would thus appear that the only generic group which is shared by the Guadalupian fauna is *Rhynchonella*, the Salt Range fauna being without *Pugnax* and the Guadalupian without *Terebratuloidea* and *Uncinulus;* nor can it be said that the specific development of *Rhynchonella* in the two faunas shows much parallelism.

In his first paper on the Chitichun fauna No. 1, Diener recognizes only one species of rhynchonelloid, which he identifies as *Uncinulus timorensis*. Nothing yet known in the Guadalupian appears to be related to this. His later paper on this fauna cites *Terebratuloidea* cf. *depressa* and *Uncinulus jabiensis*, neither of which from our present knowledge can be correlated with any Guadalupian species.

Diener did not find any representatives of this family among the collections on which was based his paper describing the Anthracolithic fossils from Kashmir and Spiti, but Davidson described three species from Kashmir under the titles *Rhynchonella pleurodon* var. *davreuxiana*, *R. barusiensis*, and *R. kashmiriensis*. The latter may be compared with the Guadalupian species *Pugnax pinguis* and the form which I have identified as *P. osagensis*, but the two other species do not possess related types in the Guadalupian. In a later paper on the Spiti Anthracolithic fossils Diener cites *Rhynchonella confinensis* and *Rhynchonella* cf. *wynnei* from the lower beds, but no species from the upper. *R. confinensis* more closely resembles some of our Mississippian species of *Camarophoria* than any Guadalupian form, and *Rhynchonella* cf. *wynnei* also seems to be without any closely related Guadalupian species. The same author among his fossils from Malla Sangcha recognized *Uncinulus timorensis*, *U. jabi-*

ensis, and *Rhynchonella* sp. indet. ex aff. *R. hofmanni*, none of which, however, appears to be allied to Guadalupian species.

From Turkestan Romanowsky recognized four rhynchonelloids, which he distinguished as *Rhynchonella daleidensis* Roem., *R. turanica* n. sp., and two species undetermined. One of the latter suggests by its form a *Pugnax* related to *P. swallowiana* and *P. osagensis*, but the three other species appear to be unrelated to anything in the Guadalupian.

A brief consideration of the Carboniferous faunas of the Salt Range and of the Himalaya, and of the probably older (in part, at least) faunas of Turkestan, shows that they have no very close resemblance to the Guadalupian fauna in point of the Rhynchonellidæ.

Kayser found no representatives of the Rhynchonellidæ among his fossils from Lo Ping, but Loczy cites *Uncinulus timorensis* from the Lantsankiang Valley. The general appearance of this form, as presented by his figures, is not unlike some of the forms which I have referred to *Rhynchonella* (such as *R. indentata* and *R. longæva*), but presumably they are not essentially related.

Roemer cites *Rhynchonella* cf. *R. pleurodon* from the west coast of Sumatra, and Beyrich describes *Rhynchonella timorensis* from Timor. The last-named species in its configuration strongly suggests a relationship with the form from the black limestone, which I have described as *Pugnax? nitida*. Subsequent authors, however, have placed Beyrich's species in the genus *Uncinulus*, to which group, even as it was defined by Waagen, the Guadalupian shell probably does not belong. Furthermore, Rothpletz's figures of this species in his paper on the fauna of Timor and Rotti do not so much resemble *P. nitida*. This author cites from Timor and Rotti, in addition to *Uncinulus timorensis*, a species which he describes as *Rhynchonella wichmanni*. It appears to be related to *R. indentata* and *R. longæva*.

The Rhynchonellidæ of this geographical group of faunas also do not show much affinity with the Guadalupian representatives of the family. Rhynchonelloids seem in fact to be rather rare and to be lacking in many of the characteristic Guadalupian types. An American paleontologist would perhaps be especially struck by the absence in these faunas and in those of India of any representatives of the type so characteristic of the Pennsylvanian of North America, which is commonly identified as *Pugnax utah*.

Only two Rhynchonellas are mentioned by De Koninck in his account of the Carboniferous faunas of New South Wales. One of these seems to belong in the earlier horizon and the other has been shown to be a *Dielasma*.

The only rhynchonelloids which are recorded by Etheridge from the "Permo-Carboniferous" of Queensland and New Guinea are *Rhynchonella pleurodon* and *Rhynchonella* sp. indet., the latter not figured.

In comparing the Guadalupian Rhynchonellidæ with those of the Russian section it has seemed best to disregard such references as are unaccompanied with descriptions, and especially with figures. This course was judged advisable, not only because owing to the great variability of these shells very different types have sometimes passed as the same species, but also because there is very little uniformity, even in the generic terminology.

Trautschold in his monograph on the Moskovian fauna recognized only one species of rhynchonelloid, if we may suppose the two forms placed with *Camarophoria* to be really members of the Pentameridæ. The species identified as *Rhynchonella pleurodon* is presumably a *Pugnax,* and, if so, appears to be more nearly allied to *P. shumardiana* than to any other Guadalupian representative of this group.

In the Gschelian fauna Tschernyschew refers his rhynchonelloids to the genera *Rhynchonella* (3 species), *Terebratuloidea* (2 species), *Pugnax* (8 species), *Uncinulus* (1 species), and *Rhynchopora* (3 species). This fauna contains many forms that are not found in the Guadalupian—in the present case representatives of the genera *Terebratuloidea, Uncinulus,* and *Rhynchopora.* Some of Tschernyschew's figures of *Uncinulus wangenheimi* suggest the forms here placed with *Rhynchonella,* but I am unable to refer the Guadalupian shells to *Uncinulus.* The three species which Tschernyschew refers to *Rhynchonella* are not very similar to those which I have placed with that genus, appearing in fact in one case to resemble superficially some of the Guadalupian *Pugnaces. R. granulum* at least suggests *Pugnax? pusilla* of the present work.

A number of Tschernyschew's species of *Pugnax* appear to be related to the Guadalupian forms referred to *P. swallowiana* and *P. osagensis.* Such are *P. osagensis, P. swallowiana, P. kayseri, Pugnax* sp., and *Pugnax* n. sp. *P. connivens* is in part comparable to *P. bidentata,* but it almost appears as if two species were figured under that name. *P. keyserlingi* and *P. granum* have no known representatives in the Guadalupian fauna, while, on the other hand, the group of *P.? bisulcata,* together with *P. nitida* and probably also *P. shumardiana, P. elegans,* and *P. pinguis,* as well as the Guadalupian *Rhynchonellas,* have no corresponding forms in the Russian fauna.

Nikitin cites among the Rhynchonellidæ only *Rhynchopora nikitini* from the Gschelian horizon and Stuckenberg only *Rhynchopora nikitini* and *R. variabilis.*

From the Artinsk Stuckenberg records *Rhynchopora nikitini* and *Rhynchonella* sp. (not figured), and from the Kungurstufe *Rhynchopora variabilis.* Tschernyschew cites from the Artinsk only *Rhynchopora nikitini* and *Rhynchonella hofmanni* (not figured). The only Rhynchonellas cited by Krotow in his paper on the Artinsk fauna are *Rhynchonella pugnus, Rhynchopora pleurodon,* and *Rhynchopora geinitziana.* None of the identifications is figured and it would be hazardous to do more than again recall that two at least of the species belong to a genus which is absent from the Guadalupian fauna.

In the Permian of the Government of Kostroma the only rhynchonelloid found by Tschernyschew is identified as *Rhynchopora geinitziana,* and in the Permian of eastern Russia *Rhynchopora nikitini.* The same species are recorded by Netschajew.

Considered as a whole the Guadalupian rhynchonelloids are not closely related to those of the Russian section, but are nearest to those of the Gschelian zone. In the Russian Permian the only genus representing the Rhynchonellidæ appears to be *Rhynchopora,* a type whose absence from the Guadalupian fauna is rather remarkable. The Guadalupian species called *Pugnax pinguis* suggests *Rhynchopora* in its configuration, but appears to have an impunctate shell. *Rhynchopora* and *Rhynchonella,* one species of which (*Rhynchonella hofmanni*) has no corresponding Guadalupian form, seem to constitute the entire rhynchonelloid development of the Artinsk.

Even in the fauna of the Gschelstufe the resemblance to the Guadalupian consists principally in the presence of certain types of *Pugnax* related to *P. osagensis, P. swallowiana*, etc. At the same time it contains generic groups (*Uncinulus, Terebratuloidea*, and *Rhynchopora*) not found in the Guadalupian, besides types of *Rhynchonella* and *Pugnax* which are not known there. On the other hand, the Rhynchonellas of the Guadalupian are not closely related to the Gschelian representatives of that genus, while several types of *Pugnax* found here, such as *P. bisulcata, P. nitida*, and *P. pinguis*, are not known in the Russian fauna.

Among the fossils from Djoulfa, in Armenia, Abich recognized *Rhynchonella pleurodon*, and figured two somewhat different specimens under that title. One of them suggests the Guadalupian species which I have described as *Pugnax pinguis*. The other also has somewhat the same resemblance. The latter, but not the former, was subsequently included by Arthaber in his work on this fauna, in the species *Uncinulus wichmanni*. Arthaber's figures, however, remind one somewhat of the Guadalupian *Pugnax nitida*. Arthaber also cites *Uncinulus jabiensis*, figuring two specimens which certainly do not appear to be the same species. Superficially the larger of the two specimens so identified somewhat resembles *Pugnax shumardiana* and the smaller *P.? pusilla*.

The only rhynchonelloid from Asia Minor which Enderle recognized in his paper on the fauna of Balia Maaden is cited by him as *Rhynchonella* cf. *triplex* McCoy. In configuration it is suggestive of the *Pugnaces*, and may be compared, in this particular, at least, especially to *P. elegans*.

Gemmellaro referred his rhynchonelloids of the Fusulina limestone of Palermo to the genera *Rhynchonella, Uncinulus*, and *Terebratuloidea*, the former comprising 7, the second 3, and the latter 1 species. Gemmellaro's Rhynchonellas seem to belong to two groups, one of which is certainly very suggestive of the forms which I have placed with *Pugnax*, and the other of those which I also have called *Rhynchonella*. His *Rhynchonella negrii, R. sosiensis*, and *R. adrianensis* appear to be related to the Guadalupian shells cited as *Pugnax swallowiana, P. bidentata*, and *P. osagensis*. *Rhynchonella withei* resembles, though certainly rather remotely, *P. nitida*. *Rhynchonella salinasi*, however, rather suggests *Rhynchonella indentata* of the Guadalupian, but *Rhynchonella carapezzæ* probably has no corresponding form. *Rhynchonella acuminata*, also, has no Guadalupian species at all related, so far as I am aware, nor does the Sicilian fauna contain species which are really close to *P. bisulcata, P. bisulcata* var. *seminuloides*, and *P. nitida*, or possibly also to *P. pinguis* and *P. shumardiana*.

None of the Guadalupian rhynchonelloids can, in my opinion, be properly referred to the genus *Uncinulus*, but some of the Sicilian species of *Uncinulus* show a superficial resemblance to some of the Guadalupian species of *Rhynchonella* and *Pugnax*—e. g., *Uncinulus amor* to *Pugnax? nitida; Uncinulus velifer* and *Uncinulus siculus* to *Rhynchonella indentata, R. longæva*, etc. This is not true of the Sicilian species of *Terebratuloidea*, for there is nothing in the Guadalupian similar to it.

In his paper on the fauna of the Carnic Fusulina limestone Schellwien recognizes two species of rhynchonelloids which he refers to the genus *Rhynchonella* itself. One of these, *R. grandirostris*, has the general expression of the genus *Pugnax* and may be related to the Guadalupian types referred to *P. swallowiana* and *P.*

osagensis. The other species is unlike anything at present known from the Guadalupian beds.

The rhynchonelloids of the Trogkofelschichten are referred by Schellwien to the genera *Uncinulus*, *Rhynchonella*, *Pugnax*, and *Terebratuloidea*. The single representative of *Uncinulus* in this fauna, *U. velifer*, suggests by its configuration the Guadalupian shells referred to *Rhynchonella*. Schellwien's *Rhynchonella confinensis*, as already remarked, has no species in the Guadalupian at all related. The two species representing the group of *Rhynchonella pleurodon*—*R. wynnei* and *Rhynchonella* aff. *sosiensis*—have somewhat the expression of the Guadalupian *Pugnax osagensis* and *P. pinguis*. Only one Trogkofel form has been referred to *Pugnax*. It is related to the Guadalupian species of the type of *P. swallowiana*, but it is especially semblable to *R. shumardiana*. In configuration, at all events, the two Alpine species of *Terebratuloidea* are less unlike the Guadalupian rhynchonelloids than most of the foreign representatives of that genus. They have somewhat the expression of the Guadalupian *Pugnax swallowiana*, *P. osagensis*, etc.

The relationship between Schellwien's fauna and that from the Guadalupe Mountains seems to me rather slight. One can not but be struck by the differentiation in the American fauna of shells of the type of *P. osagensis*, and their relative scarcity in that of the Carnic Alps. The latter has also nothing to compare with *P. bisulcata*, *P. nitida*, etc., and but little apparently to be correlated with the Guadalupian Rhynchonellas. On the other hand, the Guadalupian fauna is without *Terebratuloidea*, *Uncinulus*, etc. The Guadalupian rhynchonelloids appear to me more closely allied to those of Palermo, and yet the correspondence in this group of shells is not particularly striking.

Gortani cites the Pennsylvanian species *Rhynchonella osagensis* from the Carnic Alps. It is not figured, but is presumably related to *Pugnax osagensis* and *P. swallowiana* of the present fauna.

In the German Dyas the only rhynchonelloid recorded by Geinitz is referred to *Rhynchopora geinitziana* Vern. In the reduction of the rhynchonelloid representation practically to this genus the Dyas resembles the typical Russian Permian, while in the English Permian, so far as King's monograph is conclusive, the entire group is wanting. In this respect, as in certain others, the Guadalupian fauna presents a distinct point of difference from either of these Permian facies.

Among the fragmentary faunas described from Spitzbergen the only mention of representatives of this family which I have come upon are *Rhynchonella* cf. *pleurodon* from Axel Island and *Rhynchonella* sp. indet. from the cape between the two arms of North Fjord. These two forms are closely related, perhaps the same species, but it is doubtful if they have any corresponding Guadalupian types. Toula cites the same species, but without figures, from Nova Zembla.

Stache found *Rhynchonella* cf. *trilatera* and *Rhynchonella* aff. *carringtonensis* at two stations in the West Sahara, but the associated faunas are probably older, and the forms themselves, at all events, have little in common with any Guadalupian species.

Salter cites from Bolivia a species of *Rhynchonella* which he compares to *R. pleurodon*. It is probably a *Pugnax*, and at all events has a configuration which much resembles that of *P. shumardiana*, *P. swallowiana*, and *P. osagensis*. Under the title of *Rhynchonella pleurodon* Toula also cites a similar species from Bolivia.

Its relations appear to be with the same group of species, perhaps with *P. shumardiana*.

The only rhynchonelloid found by Derby among his Brazilian species was described as new, under the title *Rhynchonella pipira*. From certain characters set down in his description it seems likely that this form belongs to the group of shells for which Waagen and a number of European authors have employed the term *Uncinulus*. This group appears to be unrepresented in the Guadalupian fauna. In a general way *Rhynchonella pipira* might perhaps be compared to *Pugnax pinguis* of the Guadalupian, and perhaps to other forms, but probably none of them is closely related to it.

If we eliminate certain western species, especially those which have been described from the fauna under consideration, and a few forms from the Mississippi Valley described without figures and consequently pretermitted except in catalogues and bibliographies, the upper Carboniferous or Pennsylvanian rhynchonelloids of North America, so far as known, resolve themselves into four groups representing two generic types. *Rhynchopora illinoisensis* is rather rare, and *Pugnax rockymontana* is also seldom found. The only species which can be looked for at this horizon to appear frequently and in abundance is the form, or group of forms, for which the name *Pugnax utah* Marcou is most often used. A related species is the form which Hall and Clarke have incorrectly identified as *Pugnax swallowiana*. The genus *Rhynchopora* is unknown in the Guadalupian fauna, and *Pugnax rockymontana*, or any form like it, does not occur there. Species related to *P. osagensis* and *P. swallowiana*, however, form nearly the most abundant rhynchonelloid type. On the other hand, the group of *P. osagensis* presents modifications not found in the Pennsylvanian fauna, such as appear in the species *P. bidentata*, *P. shumardiana*, *P. elegans*, *P. pusilla*, and *P. pinguis*, nor is anything at all resembling *P. bisulcata*, *P. bisulcata* var. *seminuloides*, or *Rhynchonella indentata*, *R. longæva*, etc., known from the Pennsylvanian. Except for a few species of very wide dispersion, of the general type of *P. utah* (*P. osagensis*), therefore, the Guadalupian Rhynchonellidæ and those of the Pennsylvanian have nothing in common and a great deal which is peculiar to each.

Genus PUGNAX Hall and Clarke.

In all, 12 Guadalupian species have been referred to this genus, and they comprise two rather distinct types. One of these is exemplified by our common *Pugnax osagensis* (*P. utah* auctorum). It has a few strong angular plications, which as a rule extend only about halfway back from the margin. In the other group the plications are fainter and still more marginal, practically obsolete on the sides and obsolescent on the fold and sinus. In this latter group are included only *Pugnax bisulcata*, *P. bisulcata* var. *seminuloides*, and *P. bisulcata* var. *gratiosa*. The eight remaining species belong to the group of *P. utah*, but even among these some sort of subdivision can be effected. *P. pinguis* and *P. pusilla* are distinguished from the six other species by the more rounded and persistent nature of the ribs, but the form identified as *P. osagensis* is intermediate in some degree and these two groups are not as distinct from one another as is the group of *P. bisulcata* from either of them.

Structurally these groups, so far as I have ascertained, present but slight differences from one another or from the series of species which I have placed with the genus *Rhynchonella* sensu stricto. In all these forms there are present two well-developed dental plates, and in the dorsal valve a low but distinct median septum. The upper Carboniferous *Pugnaces*, like *P. osagensis*, have a better developed dorsal septum than is generally credited to them, so that in this particular, as well as in configuration, no disagreement is evinced with the Pennsylvanian forms. One structural difference seems to exist between the shells of the group of *P. osagensis* and those of *P. bisulcata* and its allies, namely, the less extensively developed and differently shaped hinge plate of the latter; and I am not sure but that this circumstance, taken in connection with the difference in configuration, would have made it warrantable to assign them to different genera.

The shells referred to *Rhynchonella* have, so far as ascertained, similar internal structures to those placed with *Pugnax*. The singular feature observed in one example of *Rhynchonella* of a perforated hinge plate may serve as an index of other differences that will be manifest when the two types are perfectly known. Externally the Guadalupian Rhynchonellas are distinguished by having numerous fine, sometimes bifurcating plications, which extend quite to the beak, instead of a few large incomplete ones. These differences, although of configuration alone, are sufficiently marked to render the relationship of species entirely unambiguous.

The Guadalupian shells referred to *Pugnax* seem to be distinct from many of the different rhynchonelloid genera which have been discriminated in the Carboniferous faunas of Asia and Europe. They are without the punctate shell structure of *Rhynchopora*. They have less persistent plications than *Terebratuloidea*, lack the truncated beak and round foramen of that genus, and possess different internal structures, since they have a median septum and dental plates.

From *Uncinulus* they differ in having much fewer and larger ribs, which are not furrowed along the top. Internally the structure appears to be about the same, save that the *Pugnaces* do not possess the thickened ventral shell near the septum far from the apex of the ventral valve.

Rhynchonella as usually identified comprises shells having a similar internal organization but finer, more numerous, and more persistent plications. There is not entire uniformity among authors in the usage of these terms, however, especially in that of *Rhynchonella*. Gemmellaro, for instance, includes in that genus forms which seem to me to have the general expression of *Pugnax*.

PUGNAX ? BISULCATA Shumard.

Pl. XXI, figs. 11 to 12.

1858. *Camarophoria (?) bisulcata.* Shumard, Trans. Acad. Sci. St. Louis, vol. 1, p. 296 (date of volume, 1860).

Dark Permian limestone: Guadalupe Mountains; conglomerate at the mouth of Delaware Creek.

1859. *Camarophoria bisulcata.* Shumard, idem, p. 394, pl. 11, figs. 2a to 2d.

Dark and white [Permian] limestone: Guadalupe Mountains; conglomerate at the mouth of Delaware Creek.

Shell variable, outline varying from nearly circular to subpentagonal, with angles obtusely rounded, sometimes very gibbous and sometimes moderately so, usually a little transverse, sides always rounded, front sinuate; shell structure fibrous. Ventral or receiving valve very depressed, gently convex, greatest convexity near the beak; cardinal margins forming an obtuse angle; mesial sinus broad at the front, scarcely reaching the middle of the valve, shallow or rather deep, perfectly smooth or bearing from two to five obscure, rounded ribs; tongue of sinus moderately produced, broadly truncate at extremity, and curved upward, sometimes at nearly a right angle with the general surface of the valve; beak imperforate, pointed, incurved nearly in contact with the opposite valve. Dorsal valve strongly rounded in most specimens, much more gibbous than the opposite valve, marked with a broad, shallow depression or false sinus extending from beak to front, which is bounded on either side by a ridge very obscure on the rostral half of the shell, but forming together a broad mesial fold toward the front, which is smooth, or marked with two or more slightly prominent plications; beak rounded, obtuse, extremity usually hidden by the beak of the opposite valve.

Dimensions of an average specimen: Length, 0.58; width, 0.63; height, 0.35.

Resembles *Terebratula superstes* Verneuil, from which it is distinguished by the greater convexity of the dorsal valve and its more flattened ventral valve.

Restricted to the dark limestone of Permian age at the base of the white limestone of the Guadalupe Mountains; found also abundantly in the conglomerate at the mouth of Delaware Creek, New Mexico.[a]

Shumard's description, which is quoted in full above, includes three varieties, two of which I shall describe as new, under the names *Pugnax? bisulcata* var. *seminuloides*, and *P.? bisulcata* var. *gratiosa*. As indicated by our collections, the variety *seminuloides* is by far the more abundant; but because Shumard figured only the plicated form I retain for it the name originally applied to all three. So similar are the three varieties in general appearance, however, that it becomes necessary to modify Shumard's description but little, in spite of the shells which have been withdrawn from it. I propose to restrict *P.? bisulcata* to shells having the fold marked by four or five narrow plications, and to use the varietal names *seminuloides* and *gratiosa* for those in which the fold is unplicated and marked by two or three broad plications, respectively.

The shape of *P.? bisulcata* is usually subcircular, and somewhat transverse. The ventral valve is rather shallow, the dorsal frequently very gibbous. The ventral beak is small and strongly incurved, not erect, as represented in Shumard's figures. The fold is high, but its limits are not sharply defined, and it can be observed only a short distance back from the front. From three to five plications have been noted on the fold, and a corresponding number on the sinus. I scarcely understand Shumard's description of the dorsal valve as having a shallow false sinus. My specimens, which are, unfortunately, somewhat crushed, show no peculiarity of this sort. The sides are apparently smooth, although very rarely a few evanescent ribs occur on either side near the fold.

Shumard remarks on the occurrence: "This species was found very abundantly in the dark limestone beneath the white limestone of the Guadalupe Mountains and very sparingly in the white limestone. It is also quite common in the conglomerate at the mouth of Delaware Creek, Texas."[b] My material is entirely from the "dark limestone," though I have a single specimen of the variety *seminuloides* from the white limestone. I shall discuss the generic position of the species when considering this variety, of which my material is more abundant.

The forms assembled under this title are, by applying the same fundamentum divisionis which is used in other rhynchonelloids, susceptible of division into a number of species or varieties. Some have lateral plications and some none, while a good

[a] Trans. Acad. Sci. St. Louis, vol. 1, 1856-1860, p. 296.

[b] Idem, p. 394.

deal of variation (shown by the illustrations to some extent) is manifested in the number, size, and sharpness of the plications. For the present, however, it seems best, while not ignoring these differences, to make them the basis of varietal names only.

Horizon and locality.—"Dark limestone," Pine Spring, Guadalupe Mountains, Texas (station 2930).

PUGNAX? BISULCATA var. GRATIOSA n. var.

Pl. XXI, figs. 10 to 10c.

This variety is associated with typical *P.? bisulcata*, and resembles it closely in most particulars. The chief difference, as in the variety *seminuloides*, concerns the plications on the fold and sinus. The present variety, as based on the typical specimen, has three obscure, broad plications on the fold; *P.? bisulcata* has four or five narrow ones; and *P.? bisulcata* var. *seminuloides* has none at all.

That Shumard included the present variety in the description of his *Rhynchonella bisulcata* there can be little doubt, but his figures seem intended to depict the variety of which the original of my fig. 12 of Pl. XXI is a representative specimen. I think that the latter may be regarded as the typical variety, and that the name *bisulcata* may be restricted to it. It seems hardly desirable, however, to include the form represented by fig. 10 without any distinction under Shumard's species, and I have accordingly discriminated it as a variety.

Horizon and locality.—"Dark limestone," Pine Spring, Guadalupe Mountains, Texas (station 2930).

PUGNAX? BISULCATA var. SEMINULOIDES n. var.

Pl. XXI, figs. 13 to 16; Pl. XXIX, fig. 9?.

Shumard, as already remarked, includes this form with *Pugnax? bisulcata*. When well-marked examples are kept in view it would seem that surely here must be two distinct species. On the other hand, the plications of *P.? bisulcata* become so faint in some specimens that the probability of complete intergradation must be admitted. Nevertheless, one is seldom at a loss, if a specimen is at all well preserved, in assigning it to one group or the other. On this account, while refraining from giving both forms full specific rank, as I was at first disposed, it seems to me best to distinguish the unplicated one as a distinct variety. So close is the resemblance in general configuration of the variety *seminuloides* to Shumard's species that no separate description is necessary, the discriminating feature being the absence of plication on the fold or, indeed, anywhere on the shell. There seems to be a tendency, likewise, for the fold to be broader, lower, and with less sharply defined limits, though this is not invariably the case. A gentle mesial depression is sometimes present, which has perhaps been described by Shumard as a false sinus in the dorsal valve of this species. I have not observed it in all nor even in a majority of the specimens, and it appears to be very occasional in its occurrence.

The ventral beak in mature examples is small and strongly incurved. In one young specimen, in which the convexity of both valves is slight, and possibly in others, the beak is erect and there is a small area, probably with deltidial plates. A preparation exhibiting the interior, referred to this variety merely because it is more abundant than the nominal form, shows the presence of a long, slender, but low median septum in the dorsal valve and two dental plates in the ventral. The dental plates are thin. Their collocation is so far apart and their direction so divergent that they are at no point far from the apical walls, and in a specimen preserved in any other way might readily escape notice. The hinge plate is small and scarcely deserves the name, consisting of but little more than a thickening of the margin between the two dental sockets. The crura are short and strongly curved. They originate close together and rapidly diverge. At first they are directed nearly parallel to the plane of the valves, but later their curvature brings their direction nearly at right angles to it.

The structure of the area shown by the young specimen previously described is suggestive of *Terebratuloidea*, but the shell in that genus is plicated, the beak erect in mature forms not small and appressed, and the ventral valve is without dental plates. The internal structures are not far from those of *Rhynchonella* but this shell has no false area and has an incurved and appressed ventral beak.

The configuration of this and the related varieties is suggestive of *Pugnax*, and especially of those species which occur in the earliest Carboniferous time, no less in the general absence of plications than in the incurved beak. From the type represented by *Pugnax osagensis* they differ in these same characters. On the inside, however, they have a low septum and in this respect are much more like *P. osagensis* than the early Mississippian forms. The large indented hinge plate of *Pugnax* and *Hypothyris* is lacking. This form is not therefore in complete agreement with any of the three genera with which it appears most closely allied, and probably the institution of a new group would be justified did not the multiplicity of variation in exterior and structure shown by these forms demand a more extended investigation than I am able to undertake.

This variety and the species to which it is related are rather abundant in the "dark limestone," but only one specimen, which represents the variety, has so far come to hand from the Capitan formation. From this fact and from the lithology I am led to entertain some suspicion of the correctness of the locality label.

Horizon and locality.—Middle of Capitan formation, Capitan Peak (station 2926); "dark limestone," Pine Spring (station 2930), Guadalupe Mountains, Texas. Delaware Mountain formation, southern Delaware Mountains, Texas (stations 2965, 2969, 3500).

PUGNAX NITIDA n. sp.

Pl. XXIV, figs. 15 to 15c.

Shell small, transverse, subpentagonal. Ventral valve shallow over the posterior portion, strongly upturned in the anterior, which includes nothing but the sinus. The latter is broad and shallow. Its limits are not well marked over the posterior half. It is, however, defined along the margin by an angulation, the extension in front of which makes up all the anterior half of the shell. Beak small and erect (?).

Dorsal valve very transverse, nearly flat longitudinally, strongly arched transversely. Fold broad and high, not well defined, except along the margin, where there is a sharp upturning of the edge. The fold and sinus contain five or six plications, which are very indistinct at the margins and can not be seen at all farther back. There are no lateral plications, unless the indistinct grooves on the dorsal valve and the ridges on the ventral by which the fold and sinus are defined be considered as such.

The internal structures, so far as ascertained, consist of two dental plates in the ventral valve and a median septum in the dorsal. The generic identification, therefore, is not well established, but is probably limited to *Pugnax* and *Camarotœchia*. The configuration, however, is distinctly that of *Pugnax*.

The general appearance of the species is such as to lead one to imagine it the ancestor of the *Pugnax? bisulcata* group of the "dark limestone," but it is not yet safe to assert that they belong to the same genus. I have not seen in the literature any other species with which it is necessary to compare this one, though some of the figures of *Camarophoria globulina* given by Davidson resemble it.

Horizon and locality.—Basal black limestone, Guadalupe Point, Guadalupe Mountains, Texas (station 2920).

PUGNAX SWALLOWIANA Shumard.

Pl. XV, figs. 8 to 12d; Pl. XXI, figs. 17 to 19 ?.

1859. *Camerophoria Swalloviana*. Shumard, Trans. Acad. Sci. St. Louis, vol. 1, p. 394, pl. 11, figs. 1a to 1c (date of volume, 1860).
White Permian limestone; Guadalupe Mountains, Texas and New Mexico.
1897. *Pugnax swallovana*. Schuchert, Bull. U. S. Geol. Survey No. 87, p. 295.

Shell small, subpentagonal, flattened or quite gibbous, width equal to or greater than the length, widest near the front. Dorsal valve much more elevated than the ventral, but degree of elevation very variable; in some specimens a distinct depression in front of the beak, and sometimes one on either side forming two small lobes; mesial fold rising near the middle of the shell and becoming prominent in front, variable in width and height according to the number of ribs. Surface marked (in the specimen figured) with seven prominent subangular ribs, which commence about the middle of the valve and extend to the front; of these, three are situated on the mesial fold, and two on either side. Ventral valve gently rounded on the umbo, and marked on either side by a depression, which extends from the beak to the middle of the lateral edges; mesial sinus confined to the anterior half of the shell, broad in the middle and becoming narrow at the extremities, ornamented with two or more rounded plications, which are not as prominent as those limiting the sinus; beak elongated, sharply pointed, and slightly curved; shell structure distinctly fibrous.

This species is very variable in its characters. Some examples are extremely gibbous, and others much flattened. The ribs on the sides are quite distinct in some specimens and nearly obsolete in others. This species resembles in many respects *C. globulina* of Phillips, but it may be distinguished easily by its more elongated and sharply pointed beak and the less angular form of its ribs.

Dedicated to Prof. G. C. Swallow, State geologist of Missouri.

Formation and locality.—Permian rocks of the Guadalupe Mountains in Texas and New Mexico. It is one of the most abundant and characteristic species of the upper white limestone.

The foregoing is the original description of this species, which is one of the common forms in the Capitan limestone. Shumard calls attention to many of the variations, and they are quite as numerous as in its congener *P. osagensis*.

The shape varies from subtriangular to pentagonal. There are usually three plications on the fold and two in the sinus, but in rare examples only two are found on the fold and one in the sinus. In a number of specimens the median plication is lower than those on each side of it. Of the lateral plications there are often three on each side, the final one being faint, especially on the dorsal valve, but sometimes only two appear to have been developed. The plications are usually high and angular, but are sometimes lower and rounded, the lateral ones being as a rule weaker than those on the fold and sinus. This tendency is carried so far in one specimen that though plainly marked by teeth on the line of junction the sides are entirely unplicated. Some of the specimens are explanate and have a triangular shape. Others are more contracted, globular, and with an acuminate-ovate form. Between these all gradations occur. As a rule the globular specimens have faint, rounded plications and the explanate high, sharp ones. I do not, however, at present regard these variations as deserving recognition.

The internal structures of this species consist of two short, stout dental plates in the ventral valve and a distinct though low septum in the dorsal. There is no spondylium, and Shumard's reference of the species to *Camarophoria* is evidently a mistake. The external characters are strongly those of our common *Pugnax osagensis,* so much so that there is some doubt of the validity of Shumard's species. I retain *P. swallowiana,* however, because of its different faunal association, its larger size, and its plications, which are for the most part not so deep, while of those on the fold the central one tends to be smaller than the others. Furthermore, the septum is usually stronger. *P. osagensis* also frequently has a septum in the dorsal valve similar to the one in *P. swallowiana,* and this feature is perhaps more common in the genus, especially in Pennsylvanian species, than Hall and Clarke's diagnosis would lead one to infer.

Horizon and locality.—Middle of Capitan formation, Capitan Peak (station 2926); "dark limestone," Pine Spring (station 2930), Guadalupe Mountains, Texas.

PUGNAX ELEGANS n. sp.

Pl. XV, figs. 13 to 14a.

Though originally including this form under Shumard's term *Pugnax swallowiana,* on revising the subject I find it desirable to discriminate it, and a separation of the specimens proves relatively easy. Shumard's figures fortunately leave but little doubt as to the variety to which the term *swallowiana* should attach, although his figures certainly are not very reliable.

The present form has a very spreading triangular shape, with a prominent fold and sinus. The plications in number and arrangement resemble those of *P. swallowiana.* There are three angular ones on the fold and two lateral ones on either side. It frequently happens that the median plication of the fold is distinctly smaller and lower than those adjacent to it. The lateral plications are rounder and fainter than those on the fold and are more distinct on the ventral valve than on the dorsal.

This species is distinguished from *P. swallowiana* by its more spreading, triangular shape, and by the more pronounced tendency of the median plication of the fold and sinus to be aborted.

Horizon and locality.—Middle of Capitan formation, Capitan Peak (station 2926); base of Capitan formation, hill southwest of Guadalupe Point (station 2906), Guadalupe Mountains, Texas.

PUGNAX SHUMARDIANA n. sp.

Pl. XV, figs. 15 to 17c.

Shell large, triangular, gibbous. Ventral valve rather flat though much turned upward toward the front. Sinus, as exhibited by a depression in the shell, broad, shallow, and somewhat well defined. Beak erect, acuminate. Sinus with four plications. There are three distinct lateral plications; the fourth is indicated chiefly by a denticulation at the margin.

Dorsal valve strongly convex. Fold, as an elevation of the surface, not very high, distinct toward the front, but merging into the general convexity about halfway back. It is occupied by five plications. Lateral plications on each side three in number, with often a fourth indistinct one.

None of the plications extends to the beak, a feature rather characteristic of the genus. They are high and angular, those on the sinus being stronger and more persistent than the lateral ones. While the fold and sinus are not prominent as flexures of the shell they are very distinct and strong in the front view.

Internally this shell bears a low median septum and two rather stout, short dental plates.

I can not regard this as the same species with *P. swallowiana*. It is much larger, and has five instead of three plications on the fold.

The above description is based on four somewhat imperfect specimens from the Capitan limestone. A fifth example, probably a young specimen, is represented by figs. 17 to 17c of Pl. XV. It is instructive in many ways. The fold has five plications, the central of which is strongest and most extended. Those on each side are less prominent and the final ones are shortest and faintest of all. Those in the sinus correspond. Although the shell is rather large there are no lateral plications. The fold and sinus are practically undeveloped and to be detected only by a slight deflection of the contact of the valves in front. Both valves are very flat. This example well shows that the distinctive characters, except the plications of the fold and sinus, are of a late development, the convexity, lateral plications, and fold appearing as the shell nears maturity.

To this species I have referred with hesitation another somewhat fragmentary example from the same beds showing departures from the description given above. The plications are finer and more numerous. There are at least five on the fold, with five lateral ones on each side. It is possible that this may belong to a different species.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926).

PUGNAX OSAGENSIS Swallow.

Pl. XXIV, figs. 16 to 16b.

1852. *Terebratula pugnus.* Roemer, Kreid (non Martin). von Texas, p. 89.
Carboniferous: San Saba Valley, Texas.
1858. *Rhynconella (Camarophoria) Osagensis.* Swallow, Trans. Acad. Sci. St. Louis, vol. 1, p. 219 (date of volume, 1860).
Upper "Coal Measures:" Missouri and Kansas.
1859. *Rhynchonella uta.* Meek and Hayden, Proc. Philadelphia Acad. Nat. Sci., p. 27.
Upper "Coal Measures:" Manhattan, Kans.
?1861. *Rhynchonella* sp. Salter, Quart. Jour. Geol. Soc. London, vol. 17, p. 64, pl. 4, fig. 5.
Carboniferous: Isthmus of Copacabana, Lake Titicaca.
1866. *Camarophoria globulina.* Geinitz, Carb. und Dyas in Nebraska, p. 38, pl. 3, fig. 5. (Not *C. globulina* Phillips.)
Upper "Coal Measures:" Bennetts Mill and Nebraska City, Nebr.
1872. *Rhynchonella Osagensis.* Meek, Final Rept. U. S. Geol. Survey Nebraska, p. 179, pl. 1, figs. 9a, 9b; pl. 6, figs. 2a, 2b.
Upper "Coal Measures;" Nebraska City, Nebr.
"Coal Measures:" Iowa, Missouri, Kansas.
Upper, middle, and lower "Coal Measures:" Illinois.
1873. *Rhynchonella osagensis.* Meek and Worthen, Rept. Geol. Survey Illinois, vol. 5, p. 571, pl. 26, fig. 22.
"Coal Measures:" Danville and Fulton County, Ill.
1884. *Rhynchonella uta.* White, Thirteenth Rept. Geol. Survey Indiana, p. 132, pl. 25, fig. 6.
"Coal Measures:" Indiana.
1891. *Rhynchonella uta.* Keyes, Proc. Philadelphia Acad. Nat. Sci., p. 247.
Lower "Coal Measures:" Des Moines, Iowa.
1893. *Pugnax Uta.* Hall and Clarke, Nat. Hist. New York, Pal., vol. 8, pt. 2, p. 204. (Advance distribution in fascicles.)
"Coal Measures:" Manhattan, Kans.
1894. *Pugnax uta.* Hall and Clarke, Int. Study of Brach., pt. 2, pl. 44, figs. 17–19.
"Coal Measures:" Manhattan, Kans.
1895. *Rhynchonella uta.* Keyes, Rept. Missouri Geol. Survey, vol. 5, p. 103, pl. 41, fig. 7. (Date of imprint, 1895.)
Upper "Coal Measures:" Kansas City and Lexington, Mo.
1895. *Pugnax Uta.* Hall and Clarke, Nat. Hist. New York, Pal., vol. 8, pt. 2, p. 204, pl. 60, figs. 39–42.
"Coal Measures:" Manhattan, Kans.
1896. *Rhynchonella uta.* Smith, Stanford Univ. Publ., Cont. Biol. No. 9, p. 30.
Upper "Coal Measures:" Sebastian County, Ark., and Poteau Mountain, Ind. T.
1896. *Rhynchonella uta.* Smith, Proc. Am. Phil. Soc., vol. 35, p. 30.
Upper "Coal Measures:" Sebastian County, Ark., and Poteau Mountain, Ind. T.
1900. *Pugnax Utah.* Beede, Rept. Univ. Geol. Survey Kansas, vol. 6, p. 93, pl. 12, figs. 7–7c.
Upper "Coal Measures:" Bronson, Bourbon County, Kansas City, Iola, Olathe, Lawrence, Lecompton, Topeka, Beaumont, Grand Summit, Kans.
1903. *Pugnax utah.* Girty, Prof. Paper U. S. Geol. Survey No. 16, p. 412, pl. 7, figs. 14–14b.
Maroon formation: Crested Butte district, Colo.

This species occurs in considerable abundance in the black limestone at the base of the Guadalupe section, and appears to be identical with the common *Pugnax osagensis* of the Mississippi Valley Pennsylvanian. The shape is rather constant and is what may be described as triangular, with rounded basal corners. The fold and sinus are moderately strong and the plications are more or less blunted and rounded. There are regularly three on the fold and three on each side, the last lateral plication being rather faint. However, two specimens have been found with two plications on the fold, and one with four, though these are fragmentary and may not have been really conspecific with the others. The dorsal septum is faint and in some cases possibly absent.

I can not refer this species to *P. swallowiana*, from which it is without doubt varietally distinct. It has blunter plications, less variety in shape, and a fainter dorsal septum. In these characters it agrees with *P. osagensis*, though somewhat larger than the average of that species.

I have also referred here a single dorsal valve from the Delaware Mountain formation obtained at station 2931. It is slightly larger and more inflated than specimens from the black limestone. The plications are rounded. There are three on the fold and three on the sides, the final one being very faint. A distinct but probably not very high median septum occurs in this shell.

American paleontologists have for many years regarded Swallow's *Pugnax osagensis* as the same species as Marcou's *Pugnax utah*, and there is probably little doubt that they are closely related forms. Tschernyschew has recently, and I believe rightly, questioned the advisability of this course. If we accept Marcou's description and illustrations at their face value, and if we are prepared to make fine discriminations of species in this group, it must be admitted that the common Pennsylvanian *Pugnax*, to which the specific term *osagensis* was applied, is distinct from Marcou's figures of *P. utah*. Now, I think it highly improbable that Marcou's figures are to be relied on, but in view of the considerable difference of facies shown by the Utah fauna it seems to me inadvisable to continue to combine the two forms without some evidence that they are really the same. Consequently I am following Tschernyschew in reviving Swallow's species.

Horizon and locality.—"Dark limestone," Pine Spring (station 2930?); Delaware Mountain formation, Guadalupe Point (station 2931?); basal black limestone, Guadalupe Point (station 2920); Guadalupe Mountains, Texas. Delaware Mountain formation, southern Delaware Mountains, Texas (station 2964).

PUGNAX BIDENTATA n. sp.

Pl. XXI, figs. 20 to 20c; Pl. XXIV, figs. 17 to 17c.

Shell small. Ventral valve rather strongly bent longitudinally and inflected at the sides. Sinus broad and deep, occupying most of the valve; defined by a rather sharp angulation, which forms, even where undefined, the line along which the shell is inflected. A slight groove lateral to the angulation adds to its prominence and is the only indication of lateral plication. The sinus contains a low median rib not visible except toward the front margin. Beak apparently rather large, high, and erect.

Dorsal valve strongly convex. Fold high, broad, occupying most of the shell; defined at the sides by an angular groove, which is succeeded laterally by a low ridge, making one indistinct lateral plication on each side. The fold bears a rather strong median sulcus, so that its summit is divided into two plications. The plications of both valves are subangular and moderately strong, but disappear a slight distance from the margin.

The typical example of this pretty species was found in the black limestone at the base of the Guadalupian section. Another very similar though somewhat larger example was found in the "dark limestone" at a much higher horizon. It shows some points of difference, as, for example, the presence of more distinct and more numerous lateral plications, but on the whole appears to belong to the same species as the other. There seems to be but little intergradation between *P. bidentata* of the black limestone and *P. osagensis*, with which it is associated; but of the mutation of *P. swallowiana* found in the "dark limestone" *P. bidentata*, occurring with it, might be considered as a mere variety. It would not surprise me, therefore, if further collecting would produce forms which are intermediate between *P. osagensis*, *P. bidentata*, and *P. swallowiana*.

P. bidentata is closely similar to some of the forms figured as *Camarophoria globulina*. While I am by no means sure, I believe that the species under discussion is a *Pugnax*, in which case further comparisons with *Camarophoria globulina* will be unnecessary.

Horizon and locality.—"Dark limestone," Pine Spring (station 2930); basal black limestone, Guadalupe Point (station 2920), Guadalupe Mountains, Texas.

Pugnax pinguis n. sp.

Pl. XXI, figs. 21 to 21c.

This species is proposed for a specimen from Shumard's "dark limestone" which, though similar to other species of the fauna, is yet too unconnected to permit its union with them. The shell is rather large, the length being 13 mm. and the width 14.5 mm. It has a subtriangular shape, with rounded basal angles. The ventral valve is rather shallow; beak small and erect; sinus broad, shallow, and distinctly defined, but not perceptible far back from the anterior margins.

Dorsal valve flattened over the central portions, strongly curved near the margins. Fold low, not distinct, except near the front. Plications rather thin and high, but rounded, dying out about halfway from the margins. There are four on the fold and three in the sinus, with four lateral ones on each side in the dorsal valve and five in the ventral, the final one in each case being faint.

This species is most closely related to *Pugnax osagensis* from station 2920 in the black limestone, but is larger and has more numerous plications.

Horizon and locality.—"Dark limestone," Pine Spring, Guadalupe Mountains, Texas (station 2930).

Pugnax? pusilla n. sp.

Pl. XXIV, figs. 18 to 18b.

The following description is based on the single specimen which our collection contains. The small size of this specimen suggests that it is immature, but this inference is contradicted by its convexity and by the full development of its fold and sinus. The shape is broadly oval, the length somewhat greater than the breadth. The plications are narrow, high, and angular, extending completely to the beaks. There are three on the fold and four on each side. The fold and sinus are fairly well developed, especially in the anterior view.

The strength of the plications and their persistence to the beaks distinguish this form from most of those here referred to *Pugnax*. The nearest in this respect is

P. pinguis, but the plications are much coarser, broader, and rounder in that species. In regard to the character of the plications, *Rhynchonella longæva* is perhaps nearer than any other Guadalupian species, but there are important differences in their number and arrangement.

Horizon and locality.—Basal black limestone, Guadalupe Point, Guadalupe Mountains, Texas (station 2967).

Pugnax sp. *a*.

This species is represented by a single imperfect ventral valve whose characters do not permit it to be referred to any of the species recognized. In size and shape it is similar to *Pugnax swallowiana*, with which it is associated, but the shape is somewhat less triangular and the plications are finer and more numerous. They are rounded and die out before reaching the beak. There are two in the sinus and five on each side. The difference in size and arrangement of the plications does not permit this form to be placed with *P. pinguis*, unless intermediate stages not represented in our collection should prove to exist.

Horizon and locality.—"Dark limestone," Pine Spring, Guadalupe Mountains, Texas (station 2930).

Genus **RHYNCHONELLA** Fischer de Waldheim?

Internally the shells subsumed under this title do not differ materially from those which have been placed with *Pugnax*. They possess a pair of well-developed dental plates and a median dorsal septum, but if we overlook the single somewhat doubtful instance of an obscure cruralium and perforated hinge plate in the dorsal valve of one of the Rhynchonellas there are no practicable discriminating characters within it, so far as known. Externally a well-marked difference of configuration exists, the Rhynchonellas having numerous fine, persistent, somewhat bifurcating ribs, while in *Pugnax* the ribs are few, large, evanescent, and simple.

The Guadalupian Rhynchonellas are distinguished from the Carboniferous shells which foreign authors have assigned to *Uncinulus* chiefly by external characters, for though there are some differences in internal structure (such as the thickened ventral shell in *Uncinulus*, etc.), and perhaps indications of others, the main internal characters (the presence of a median septum in the dorsal valve and of dental plates) remain about the same in both. The plications in both genera are numerous and fine, but in *Uncinulus* they are more or less restricted to the margin and are indented by sulci, a character not known among the Guadalupian Rhynchonellas. The latter differ from *Terebratuloidea* in internal structure as well as configuration, since they have both dorsal septum and dental plates, possess finer and more numerous plications, and are without the round foramen and truncated beak of Waagen's genus. No comparison is necessary with *Rhynchopora*, since the Guadalupian Rhynchonellas possess a fibrous and not a punctate shell. Although there is considerable variance shown by authors in the employment of the generic term *Rhynchonella*, the Guadalupian shells seem to agree in most points with the species so identified.

In all, four Guadalupian species are included in this group, three of them already described by Shumard and the fourth apparently new. Two of the Shumard species have not been recognized in the more recent collections from the Guadalupe Mountains, and the four constituent types are at present so imperfectly known that I shall not attempt to assemble them into subordinate groups.

RHYNCHONELLA? INDENTATA Shumard.

Pl. XV, figs. 20 to 20c.

1859. *Rhynchonella indentata.* Shumard, Trans. Acad. Sci. St. Louis, vol. 1, p. 393 (date of volume, 1860). White [Permian] limestone: Guadalupe Mountains.

Shell variable, subovate, gibbous, length and breadth about equal, sides converging rapidly from the middle of the shell to the beak, and rounded toward the front, which is slightly indented. Dorsal valve strongly arched, much more elevated than the ventral valve; umbo flattened, broadly and rather deeply excavated in front by the tongue of the opposite valve; mesial ridge slightly elevated, and in some specimens scarcely perceptible except at the front; lateral margins very sinuous, being deeply indented at the cardinal margin on either side of the beak by the false area of the opposite valve; beak flattened and closely incurved. Ventral valve convex in the umbo and sides, scarcely gibbous, having a broad shallow sinus, which becomes obsolete on the umbo; false area well developed, distinctly defined, depressed below the plane of the dorsal valve, and marked with fine striæ; beak acute and moderately incurved. Surface marked with fine striæ of growth and from 20 to 25 rounded radiating costæ, which become obsolete on the umbo; costæ in the mesial fold and in the sinus.

Dimensions.—Length, 0.55; width, 0.50; thickness, 0.40.

Locality.—White limestone of the Guadalupe Mountains.

Of this interesting species I have but four specimens. Two of these are from the "white limestone" and two from the "dark limestone." The latter are rather small and fragmentary. One of the other examples is also fragmentary, but the third is, fortunately, very perfect. There can be no doubt that the two examples from the white limestone belong to Shumard's species, and they permit me to add somewhat to his in the main faithful description. The figured specimen has about 25 plications, nine of which are on the fold and the rest lateral. There are five plications on the top of the fold and two on each side of it. Nevertheless this feature can be said to be moderately high, quadrate, and well defined. The surface is crossed at regular intervals by sublamellose concentric lines, of which no mention is made in Shumard's description. The beak is erect and appears to have a rounded foramen, closed below by deltidial plates. The flattening of the umbo of the dorsal valve is a striking character and appears at first to be artificial, but is repeated in all the specimens. The false area of the ventral valve is also important. It is defined by a distinct angular line. The dorsal valve has a somewhat corresponding flattened lateral area, but it is narrower and not distinctly marked off from the rest of the shell.

The internal characters have not been entirely made out. It has been ascertained, however, that the ventral valve possesses two slender, rather short dental plates, and the dorsal a long, slender, but not very high median septum. It is evident that the internal structures of this species prove Shumard's original assignment to *Rhynchonella* to be very nearly correct. Though the structure of the ventral beak suggests *Terebratuloidea,* that genus is without dental plates, and the general expression of the plications, surface ornamentation, false area, and erect beak are rather those of the true Rhynchonellas. Though the type of *Rhynchonella*, according to Hall and Clarke, is without a septum in the dorsal valve, Waagen names this as one of the characters in his definition of that genus, and it is only in the sense that Waagen used the name that this species can be referred to it.

The concentric striation, erect beak, flattened umbo, and false area, taken in connection with the internal structures, give this species marked individuality, and appear not to exist in combination in any of the described genera. It is possible that *R. indentata* is representative of a new group. This, however, will not admit of satisfactory determination until the internal characters are better known.

The smaller specimens from the "dark limestone" have a less distinct false area, and one of them shows but four plications on the top and but one on the sides of the fold. There are about eight lateral plications on either side.

Horizon and locality.—Middle of Capitan formation, Capitan Peak (station 2926); "dark limestone," Pine Spring (station 2930), Guadalupe Mountains, Texas.

RHYNCHONELLA? LONGÆVA n. sp.

Pl. XV, figs. 18 to 18b, 19 to 19c.

My material representing this species is rather fragmentary, though it is without much doubt distinct from anything so far known from the Guadalupe Mountains. The following characters have been ascertained:

The shell is small and subtriangular. The lateral and front margins are nearly straight; the anterolateral angles broadly rounded. The ventral valve is comparatively shallow, turning up strongly in front in a broad, ill-defined sinus. The beak is probably erect and pointed. The dorsal valve is rather gibbous. Fold not well defined, except at the front. Plications 17 to 20 in number, rather angular, high, and reaching to the beaks, increasing by bifurcation. About four plications occur on the top of the fold and one on each of its sides. There are six or seven lateral plications on either side.

In the interior of the ventral valve there are two dental plates not united into a spondylium but discrete, as in *Pugnax*. The general expression, however, is very different from that of *Pugnax*, and the exact position which this form should assume among the Rhynchonellidæ is uncertain.

In general appearance this species is not unlike *Rhynchonella indentata*, though it is conspicuously smaller and lacks the false area and flattened dorsal umbo which are such marked characters of that type. Similarly, it can not be referred to other species which I have placed with *Rhynchonella?* Compared with *Camarophoria venusta* it is much smaller, somewhat differently shaped, and has deeper and stronger plications.

The foregoing description is based on a few imperfect examples from the Capitan limestone obtained on El Capitan Peak. To the same species has been somewhat provisionally referred a single, rather crushed, example from about the same horizon on the foothills southwest of Guadalupe Peak (station 2906). Still more doubtful is the identification of two small specimens from the black limestone at the base of the Guadalupe section. They seem to have somewhat coarser and less numerous plications, and I suspect may be representatives of the genus *Pugnax*, though distinct from any of the species so far discriminated.

Horizon and locality.—Middle of Capitan formation, Capitan Peak (station 2926); base of Capitan formation, hill southwest of Guadalupe Point (station 2906?); basal black limestone, Guadalupe Point (station 2920?), Guadalupe Mountains, Texas.

RHYNCHONELLA? GUADALUPÆ Shumard.

Pl. XVI, figs. 10 to 10b.

1858. *Rhynchonella Guadalupæ.* Shumard, Trans. Acad. Sci. St. Louis, vol. 1, p. 295 (date of volume, 1860). White [Permian] limestone: Guadalupe Mountains.

1859. *Rhynchonella Guadalupæ.* Shumard, idem, p. 392, pl. 11, figs. 6a to 6c. White [Permian] limestone: Guadalupe Mountains.

Shell subtriangular, with the angles rounded, convex, wider than long; lateral margins nearly straight, converging at an angle of about 85°; sides presenting a large, well-defined, elliptical, concave, or flat, smooth area, which is carinated at the commissure of the valves and extends from the beaks nearly to the front; front strongly or slightly sinuate. Ventral (receiving) valve not as prominent as the opposite one; umbonal region flattened convex, having a broad, shallow mesial sinus extending from beak to front, lateral edges gently arcuate; beak flattened convex, rather strongly incurved. Dorsal valve presents a regularly convex and rather gentle curve from beak to front and a low, broad mesial elevation, which is scarcely perceptible except near the front; beak depressed, gently convex and closely incurved. Surface marked with numerous, rather coarse, rounded, radiating striæ, their number increased by bifurcation and insertion. The bifurcations generally take place near the beak. At the border the number of striæ amount to from 30 to 35 on each valve.

Dimensions.—Length, 0.58; width, 0.76; thickness, 0.48.

A handsome species and quite characteristic of the white limestone of the Guadalupe Mountains of New Mexico and Texas.

This form is evidently related to *Rhynchonella? indentata* and *R.? texana*, and, like the latter, does not occur in our collections from the Guadalupe Mountains. Fortunately, Shumard has left a number of figures which ought to supplement his description and aid in the identification of it. The figures are reproduced on Pl. XVI of the present work.

Although no authentic material has come to hand which could be referred to this species, a single specimen from the Glass Mountains has been somewhat hesitatingly placed here. This specimen I have been so unfortunate as to lose, but as it presented some structural features of considerable interest I shall venture to give a brief account of it from memory. The specimen was silicified and represented only the posterior portion of a dorsal valve. Externally the shell was covered with a large number of very fine, flat, radiating ribs. Their general character recalled the sculpture of *Orthotetes guadalupensis* and differed so much from that of either *Rhynchonella? indentata* or *R.? longæva* that I felt unwilling to identify it with them. On the other hand, it was very suggestive of Shumard's figures of *R.? guadalupæ*. On the interior the apical portion was closed by a rather small horizontal hinge plate. From the bottom of the valve rose a thin, moderately high median septum, whose posterior portion subdivided above to form a very small cruralium. This little channel along the upper edge of the septum would naturally be blocked by the hinge plate, through which, however, it was continued by a small circular perforation. This perforation of the hinge plate is a character which has, I believe, seldom been observed in any group of brachiopods and should not, I thought, fail to be noted here, in spite of the imperfect and unfortunate character of my observations.

Horizon and locality.—Top of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2966?).

RHYNCHONELLA? TEXANA Shumard.

1859. *Rhynchonella Texana.* Shumard, Trans. Acad. Sci. St. Louis, vol. 1, p. 393 (date of volume, 1860.) Dark [Permian] limestone: Guadalupe Mountains; conglomerate at the mouth of Delaware Creek, Texas.

Shell small, ovate, moderately gibbous, front rounded or slightly indented; anterolateral margins rounded, converging posteriorly to the beak at an angle of 63°. Dorsal valve as broad as long, convex, more elevated than the ventral valve, smooth on the umbo and having a distinct mesial elevation in front, bearing usually three prominent subangular ribs, on either side of which are two or three less prominent ribs; cardinal edges rather deeply indented by the false area of the opposite valve. Ventral valve gently convex, most prominent about the middle, marked in front with a moderately deep mesial sinus, which becomes obsolete on the umbo and bears two or more subangular ribs; beak prolonged, acute gently; foramen narrow, triangular; false area rather strongly developed, not very distinctly defined.

Dimensions.—Length, 0.35; width, 0.30; thickness, 0.22.

Formation and locality.—From the dark limestone forming the base of the Guadalupe Mountains, and from the conglomerate at the mouth of Delaware Creek.

This description represents a form in some ways so similar to *Pugnax osagensis* that it might be thought the shells from the "dark limestone" which I referred to that species really belong to this. Shumard, however, associates *R. texana* with *R. indentata* in the same genus, and some parts of his description seem to justify this association. It is evident, at least, that *R.? texana* had a false area similar to *R. indentata,* a character which is quite foreign to the group of *Pugnax.* I especially regret that my collections fail to contain this species, since Shumard neglected to figure it, and except for his description it is practically unknown.

Family TEREBRATULIDÆ Gray.

The Guadalupian Terebratulidæ have been assembled into four generic groups. One of these it has seemed necessary to describe as new, under the title *Heterelasma.* Another has been referred with some reservation to *Notothyris,* while the other two have been assigned to *Dielasma* and *Dielasmina.* Among the Dielasmas two groups can be distinguished, one of which is represented by *Dielasma? scutulatum,* the reference of which to *Dielasma,* or even to the Terebratulidæ, is open to more or less question. The other group includes four species, and might itself be subdivided, did such a course seem desirable.

If this representation is compared with that of the Salt Range of India very considerable differences appear. Waagen recognizes *Dielasma, Dielasmina, Hemiptychina,* and *Notothyris, Hemiptychina* being absent from the Guadalupian fauna and *Heterelasma* from that of the Salt Range. Including doubtful species, I have found only seven varieties of *Dielasma* in the Guadalupian, whereas Waagen recognizes ten in the Salt Range fauna. Of these, *D. guttula,* representing the group of *D. sacculus,* and *D. elongatum* and *D. nummulus,* representing the group of *D. gillingense,* seem to be unrepresented in the Guadalupian. The group of *D. ficus*, with three species, is probably represented by *D. spatulatum* and *D. prolongatum*. Waagen's *D. truncatum* seems to be somewhat intermediate between the two Guadalupian species mentioned, while *D. itaitubense* is rather different from either. The group of *D. biplex* with its four species, has somewhat the configuration of the species belonging to *Heterelasma*, but there are no Guadalupian Dielasmas with which it can be compared. On the other hand, *D. sulcatum* and *D. cordatum*, together with the doubtful form *D.? scutulatum*, have no closely related Indian species.

Dielasmina guadalupensis resembles to a considerable extent *D. plicata* of the Salt Range, but the American species is less abundantly plicated, and should probably be considered as racially somewhat immature.

In contrast to the Guadalupian, which contains only three varieties of *Notothyris*, Waagen found no less than eight species in the Salt Range. *Notothyris simplex* and *N. inflata* are most nearly related to the Guadalupian *N. schuchertensis*. The other Salt Range species are more or less widely different, and are perhaps more highly developed representatives of the genus. There is nothing in the Indian fauna which resembles *Notothyris* sp. found in the Glass Mountains.

In his first report on the Chitichun fauna No. 1 Diener recognizes one species of *Dielasma*, three of *Hemiptychina*, and two of *Notothyris*. The *Dielasma* is more or less related to *D. spatulatum*, but the single species of *Notothyris* of which figures are given (*N. triplicata*) differs considerably from the Guadalupian representatives of the genus.

In a subsequent paper on this fauna Diener distinguished one species of *Hemiptychina*, three of *Dielasma*, and four of *Notothyris*. His figure of *Notothyris triplicata*,[a] prepared to show internal structures, clearly represents what I think must be two dental plates, the presence of which would debar this species from *Notothyris* without doubt. The two species *N. mediterranea* and *N. exilis* appear to be closely related to *N. schuchertensis*, but the singular form described as N. *walkeri* is unlike not only the Guadalupian species but also the typical form of the genus. The configuration somewhat suggests *Cryptacanthia*. The three species of *Dielasma* do not seem closely allied to the congeneric Guadalupian forms. They are nearest to *D. spatulatum* and *D. prolongatum*. The form called *Dielasma* sp. indet. aff. *hastæforme* and *D. elongatum* suggest, in configuration at least, the doubtfully placed *D. scutulatum*.

The paper by this author on the Anthracolithic fossils from Kashmir and Spiti contains references to but one species of the Terebratulidæ, which is identified as *Dielasma hastatum*. It is probably somewhat related to *D. cordatum*, but not closely. When treating this fauna subsequently Diener recognized no terebratuloids in the lower fauna and only *Dielasma latouchei* in the upper. The Permian fauna from Kumaon and Gurhwal contains but an undetermined species of *Dielasma*, which somewhat suggests *D. spatulatum*.

From Malla Sangcha, Diener cites one species of *Hemiptychina* and five of *Notothyris*. *N. mediterranea* is the most closely allied to *N. schuchertensis* of these forms, and *N. triplicata* and *N. minuta* the least. There seems to be nothing comparable to *Notothyris* sp.

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[a] Mem. Geol. Survey India, Pal. Indica, ser. 15, vol. 1, pt. 5, 1903, pl. 2, fig. 12.

Dielasma latouchei, the only terebratuloid from the Lissar Valley, is quite unlike any Guadalupian representatives of the genus. The same species is recorded from Byans.

Two species were cited by Davidson from Kashmir as *Terebratula sacculus* Martin and *T. austeniana* n. sp. Neither seems to be comparable to any of the Guadalupian terebratuloids.

Considered as a whole, the terebratuloids of the Salt Range and Himalaya seem to me to show no very close relationship to the Guadalupian ones. The genera represented are in part different, and where the genera are the same many of the species belong to different groups, yet to say that they are not related at all will be going too far.

The only terebratuloid found by Kayser among the Lo Ping collections was referred to *Terebratula hastata.* It seems to have no closely allied Guadalupian form. From Kantschoufu, Loczy cites *Dielasma vesiculare,* represented by a little shell which does not seem closely related to any of the Guadalupian terebratuloids.

Rothpletz cites a species of *Hemiptychina* in his paper on the Permian of Timor and Rotti, calling it *Terebratula himalayensis* var. *sparsiplicati.* His figures show a form having the general appearance of *Notothyris schuchertensis,* but apparently the two species are not generically related.

From this it would appear that the Terebratulidæ are surprisingly scarce among the faunas of eastern Asia, and display no very marked resemblance to their Guadalupian congeners.

The Terebratulidæ of the "Permo-Carboniferous" of Queensland and New Guinea comprise, according to Etheridge, only four species of *Dielasma.* They are of the usual simple type, and though one or two of the Guadalupian Dielasmas resemble them, only a very remote relationship can be inferred from this group of Brachiopoda.

The Carboniferous Terebratulidæ cited from New South Wales by De Koninck comprise only two varieties, to which must be added the form described as *Rhynchonella inversa.* One of these forms was found only in the lower portion of the series; another, *Terebratula hastata,* which resembles in a general way *Dielasma prolongatum,* appears to have been found in both series. The third form, described as a *Rhynchonella,* also belongs to the earlier fauna.

From the Moskovian of Russia Trautschold records only one species, which he identifies as *Terebratula sacculus.* If we assume that it is a *Dielasma,* it has somewhat the specific characters of *D. prolongatum* without being very close either to that species or to *D. spatulatum.*

The terebratuloids of the Gschelian fauna are subdivided by Tschernyschew into the genera *Dielasma, Hemiptychina, Notothyris, Aulacothyris,* and *Waldheimia.* Of these, *Hemiptychina, Aulacothyris,* and *Waldheimia* are not known from the Guadalupian, while *Heterelasma* and *Dielasmina* of the latter appear to be absent from the Russian horizon.

No less than 14 species, according to Tschernyschew, occur among the Gschelian Dielasmas. The group of *D. sacculus,* including *D. supracarbonicum* and *D. mœlleri,* shows distinct relationship to *D. prolongatum.* The group of *D.*

gillingense, to which Tschernyschew refers sever. species, also resembles *D. prolongatum*, though less closely, while some of the Russian forms can be compared to *D. spatulatum*. One species (*D. plicatum*) even resembles *D. sulcatum*. The group of *D. ficus* contains two species. *D. truncatum* shows some resemblance to *D. prolongatum* and *D. itaitubense* to *D. scutulatum*, but in neither case is it very close. Lastly, the group of *D. biplex*, comprising three species, seems to be unrepresented in the Guadalupian. All the Guadalupian species, with the exception of *D. cordatum*, seem to find more or less related forms in the Gschelian, only one group of three species being strictly peculiar to the Russian fauna. Among the species of the group of *D. gillingense* Tschernyschew recognizes the two American types *D. millipunctatum* Hall and *D. bovidens* Martin. I agree with Tschernyschew in discriminating these two species, which are united by most American paleontologists, for Hall's figures certainly show important differences from typical *D. bovidens*, and it is probable that the differences are real ones; but I must confess that, to judge by his figures, the Russian form which Tschernyschew calls *D. bovidens* does not seem to me by any means specifically identical with the Pennsylvanian species.

Tschernyschew recognizes four species of *Hemiptychina* in the Gschelian, only one of which, that identified as *Hemiptychina* aff. *pygmæa*, appears to me to have the expression of veritable *Hemiptychina*. This type seems to be wanting in the Guadalupian, and I need not dwell on the group save to notice how much some of Tschernyschew's figures of *H. orientalis* recall the Guadalupian species *Dielasma sulcatum* in certain respects. *D. sulcatum*, furthermore, can not be certainly assigned to *Dielasma*.

Three species represent the genus *Notothyris* in the Gschelian fauna. *N. nucleolus* especially resembles the Guadalupian *N. schuchertensis*, the two other species less so. Some of the figures of *N. nucleolus*, however, somewhat suggest *Notothyris* sp., which is probably widely different from *N. schuchertensis*.

To *Aulacothyris* Tschernyschew assigns two Gschelian species. This author suggests that *Aulacothyris* Douvillé and *Cryptacanthia* are one and the same. If his references of the Gschelian species to *Aulacothyris* is correct, this opinion is probably well founded, for *A. uralica* in its peculiar configuration is strikingly suggestive of *Cryptacanthia compacta*. It is hard to believe that the resemblance is merely one of parallel development. This type is entirely lacking to the Guadalupian.

The species identified as *Waldheimia pentagonalis* is also quite unlike any known Guadalupian form.

The other papers relating to the Gschelian fauna which I have examined add so little to what Tschernyschew has given in regard to the Terebratulidæ that I shall pass them by and proceed to the consideration of the Artinskian terebratuloids.

Tschernyschew cites from the southern Urals only *Dielasma prolongatum*, a species which the Guadalupian *D. spatulatum* and *D. prolongatum* somewhat resemble. Stuckenberg cites *D. plica*, *D. elongatum*, *D. uralicum*, *D. sacculus*, *D. seminula*, and *Dielasma* sp., all of them, with one exception, unfigured. I will not, therefore, make individual comparisons with Guadalupian species, merely calling attention to the fact that we seem to have here only two genera represented, *Die-*

lasma and *Aulacothyris* (as *Dielasma uralicum*), the latter of which is not found in the Guadalupian, which has, on the other hand, *Heterelasma, Notothyris, Dielasmina,* and certain types of *Dielasma* which do not occur in the Artinskian. From the Kungurstufe Stuckenberg cites only *Dielasma plica* and *D. elongatum.* Krotow records from the Artinsk almost exactly the same series of species as Stuckenberg, viz, *Terebratula plica, T. hastata, T. elongata, T. sacculus, T. vesicularis,* and *T. uralica,* and the same remarks apply to them. Krotow's identifications also are unfigured. Sibirzew mentions as occurring in the Artinsk *D. vesiculare* and *D. elongatum.*

From the Permian of Russia, Tschernyschew records only *Dielasma elongatum* and *D. sacculus,* two species whose nearest allies in the Guadalupian are probably *D. prolongatum* and *D. spatulatum.* Netschajew from this horizon cites *D. elongatum* and *D. angustum,* of which the latter seems to be without any closely related Guadalupian species. Sibirzew mentions *D. elongatum, D. sufflatum,* and *Dielasma* cf. *sacculus* from the lower beds of the Permian and *D. elongatum* from the upper. Golowkinsky cites only *Terebratula elongata.*

To judge by the records which I have seen, the Terebratulidæ of the Russian section are reduced from very numerous species belonging to a number of genera in the Gschelian to a relatively few species, representing but two genera, in the Artinsk, while in the Permian only the genus *Dielasma* remains, represented by two or three simple, poorly characterized types. In the ample differentiation of its terebratuloids the Guadalupian fauna certainly possesses most points of comparison with the Gschelian, though many of the generic and specific types are different. The Permian terebratuloids resemble those of the Guadalupian only in the presence of a few simple forms of *Dielasma,* most of the Guadalupian genera and species being unrepresented in the Russian Permian.

From Djoulfa, in Armenia, Abich cites only *Notothyris djoulfensis,* a species quite distinct from the Guadalupian representative of the genus, though not unrelated to it.

Gemmellaro divides his Sicilian terebratuloids into the genera *Rhætina, Hemiptychina,* and *Rostranteris.* Curiously enough, the almost universally distributed genus *Dielasma* seems to be absent from this fauna. Only a single species is referred by Gemmellaro to *Rhætina,* and though it presents striking analogies in configuration to the Guadalupian species *Heterelasma shumardianum,* I am forced to believe that they possess no intrinsic relationship, since *Heterelasma shumardianum* has the structures of neither valve as defined by Waagen for *Rhætina.*

Five Sicilian species of *Hemiptychina* are discriminated. Unfortunately, this genus is at present unknown in the Guadalupian fauna. *Rostranteris,* which Gemmellaro describes as a new genus, seems now to be generally regarded, by those who are in a position best to know, as a synonym of *Notothyris.* Gemmellaro recognizes ten species. Several resemble *Notothyris schuchertensis* and *N. schuchertensis* var. *ovata,* especially *Rostranteris inflatum,* but many of them belong to distinctly different groups. Two or three (e. g., *Rostranteris ovale*) to a certain extent recall the imperfectly known *Notothyris* sp. of the Guadalupian.

Somewhat in contradiction to what appears to be the case in other groups, the Terebratulidæ of the Guadalupian have but little in common with those of the fauna from Palermo.

In his paper on the fauna of the Carnic Fusulina limestone Schellwien recognizes only two terebratuloids, which he designates as *Dielasma? carinthiacum* and *Dielasma? toulai*. The former is a simple type, somewhat resembling *D. prolongatum*, but the latter appears to be unlike any of the Guadalupian species. The family seems to be much better represented in the Trogkofelschichten, where Schellwien recognizes eight species and four genera. To *Notothyris* he refers two species, both of which more or less resemble *N. schuchertensis*, especially *N. ovalis*. *Dielasma* is represented by only a single unidentified species of the general type of *D. prolongatum*, and in this fauna, as in the closely related Sicilian one, the scarcity of *Dielasma* is a somewhat noteworthy feature. *Hemiptychina* is accorded four species. This genus is not at present known in the Guadalupian, but *H. carniolica* of the Alpine fauna in configuration strongly suggests the form which I have described as *Dielasmina guadalupensis*. The last generic type from the Trogkofel is identified with White and St. John's genus and species *Cryptacanthia compacta*. The identification is queried; but the resemblance, it must be confessed, is close. Nothing of the sort is known in the Guadalupian. In general the Guadalupian Terebratulidæ seem to show no very close resemblance to those of the Trogkofelschichten. Gortani cites from the Carnic Alps only *Notothyris epilis* and *Dielasma elongatum*, both of them unfigured.

In his monograph on the German Dyas, Geinitz cites only *Dielasma elongatum*, the paucity of terebratuloids in this fauna allying it with the typical Permian. In the description of plates, the series of forms included under this general title are subdivided as *D. elongatum*, *D. elongatum* var. *sufflatum*, and *D. elongatum* var. *latum* and *complanatum*. *D. elongatum* itself resembles *D. prolongatum* and *D. spatulatum* of the Guadalupian, but the varieties *latum* and *complanatum* have no closely related species in that fauna, being perhaps nearest to *D. spatulatum*.

King identifies his terebratuloids from the Permian of England as *Epithyris elongata* and *E. sufflata*. Both seem to be simple forms of *Dielasma*, related, but only in a general way, to *D. prolongatum* and *D. spatulatum*.

In the reduction of the terebratuloids to the single genus *Dielasma*, and the restriction of that genus to primitive and slightly differentiated forms, the Permian of England, the Dyas of Germany, and the typical Russian Permian are in agreement with one another, but in sharp contrast to the Guadalupian.

Among his fossils from the south point of Spitzbergen, Toula mentions a species of terebratuloid which he identifies as *Terebratula hastata*. It may be compared especially to *Dielasma prolongatum* among Guadalupian forms, but is probably not closely related. Lundgren also records an unidentified species from Spitzbergen, which he cites merely as *Terebratula?* sp. but does not figure. No other notices of the occurrence of this group in Arctic works have come under my observation.

Under the title *Terebratula* cf. *gillingensis* Stache cites a species from a fauna in the West Sahara which is probably considerably older than, as it is considerably unlike, the Guadalupian. The species as figured is only remotely related to any Guadalupian form.

From Bolivia, Toula cites *Terebratula hochstetteri*, his figures representing a form more or less resembling *Dielasma spatulatum* and *D. prolongatum*. In *Terebratula titicacensis*, which Gabb described from Peru, I do not see a close relationship with any Guadalupian species. The general outline is something like *Dielasma? scutulatum*, but it is doubtful if the two species are related even generically.

Derby records from Brazil two species of terebratuloids which he cites as *Terebratula itaitubensis* and *Waldheimia coutinhoana.* The former has already been recognized as a *Dielasma,* but is not like any of the Guadalupian representatives of the genus. The *Waldheimia* also appears to be non-Guadalupian.

If we disregard a few species which are quite unknown save for the first description, unaccompanied by figures, the terebratuloids of the typical Pennsylvanian consist of only two species of *Dielasma* and one of *Cryptacanthia.* The Pennsylvanian species *D. bovidens* is comparable to *D. spatulatum* of the Guadalupian, though quite distinct specifically. *D. obovatum,* on the other hand, seems to have no allied Guadalupian species. The genus *Cryptacanthia* is likewise, so far as known, alien to the Guadalupian fauna. The Guadalupian terebratuloids contrast with those of the Pennsylvanian not only in the more varied generic differentiation, but also in the greater differentiation of the single genus which they possess in common, and in the occurrence of different species in each.

Genus DIELASMA King.

The generic position of the species referred to this genus has in no instance been completely demonstrated. For the most part the general expression and the presence of dental plates render the reference to *Dielasma* at least a very probable one, but in the case of *Deilasma? scutulatum* the entire uncertainty as to internal structure and the additional doubt as to the punctate character of the shell render this species an extremely problematical member of the group.

Four species are with considerable confidence placed with *Dielasma,* and they might perhaps with advantage be subdivided into as many groups, as they show considerable difference in character.

DIELASMA SPATULATUM n. sp.

Pl. XVI, figs. 3 to 4c.

?1859. *Terebratula elongata*[a] Shumard (non Schlotheim), Trans. Acad. Sci. St. Louis, vol. 1, p. 392 (date of volume, 1860).
[Permian]: Guadalupe Mountains.

Shell rather large and spatulate. Greatest width near the anterior margin. Ventral valve shallow in its transverse curvature, more strongly bent longitudinally. About midway the shell, which has been convex in its posterior region, becomes slightly concave, producing a broad, shallow, undefined sinus, which toward the front occupies most of the width. Beak probably large and projecting.

Dorsal valve nearly flat longitudinally, gently and evenly arched transversely. There is no fold aside from the regular curvature of the shell, a circumstance which, conjoined with the broad sinus of the opposite valve, produces a truncation of the front margin.

On the interior the dorsal valve shows a median septum, with which are probably associated the other plates of *Dielasma.* The ventral valve has two strong dental lamellæ.

[a] A specimen from Shumard's collection identified, probably by him, as *Terebratula elongata* var. *sufflata* is the dorsal valve of *Squamularia guadalupensis.*

This species resembles *D. truncatum* Waagen, but can hardly be the same thing.

Horizon and locality.—Top of Capitan formation, Capitan Peak (station 2966?); Capitan formation, Capitan Peak (station 2926); "dark limestone," Pine Spring (station 2930), Guadalupe Point (station 3762d?), Guadalupe Mountains, Texas. Delaware Mountain formation, southern Delaware Mountains, Texas (station 2962?).

Dielasma prolongatum n. sp.

Pl. XVI, figs. 5 to 5c.

Shell rather large, elongate-ovate. Greatest width about one-third the length back from the front margin. Ventral valve strongly bent longitudinally. Transverse curvature convex over the posterior third, gently concave farther forward. Toward the front the depression deepens and strengthens into a strong but ill-defined sinus. Both valves, but the ventral one especially, have a flattened reflex rim along both sides.

Dorsal valve nearly flat longitudinally, rather strongly convex transversely, with a flattened rim or margin at the side. No fold distinct from the general curvature. Owing to the configuration of the two valves, the front end is somewhat emarginate. The posterior end is long and pointed, with the beak hardly perceptible as a distinct feature.

This form at first seems to be very distinct from *D. spatulatum* by reason of its flattened margins, more elongate shape, and deeper sinus; but the former character rather suggests that the individual may represent a senile condition. The growth lines of the specimen are unfortunately not visible to serve as evidence, but it seems probable that at a somewhat earlier period the specimen might not have differed greatly from *D. spatulatum*. Should this prove to be the case, the present form would probably be no more than a variety of that species. In its present development, however, it appears to be more nearly related to *D. sulcatum*, but should be readily discriminated by reason of its larger size, more regularly ovate shape, and broader and rounder sinus.

Horizon and locality.—Capitan formation, McKitterick Canyon, Guadalupe Mountains, Texas (station 2932). Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

Dielasma cordatum n. sp.

Pl. XVI, figs. 2 to 2c.

The typical specimen of this species has the dorsal valve much depressed or flattened, especially over the anterior half of the shell, so that the space between the two valves is unusually slight. In the ventral valve the sinus, which extends less than half the shell length back from the front margin, is, though not perceptibly deeper than in *D. spatulatum*, much narrower, producing a distinct indentation in the anterior outline. Otherwise, except where the expression is altered by the variations mentioned, it is much like that of *D. spatulatum*. The narrow sinus and the emargination which it produces are very suggestive of *D. prolongatum*, and in a less degree of *D. sulcatum*. These four forms are evidently related, but my collections are not complete enough to indicate how close. I can by no means at present regard any two of these forms as specifically the same.

Dielasma cordatum simulates some varieties of *Composita emarginata* very closely, but of course the resemblance is extremely superficial.

Horizon and locality.—Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926).

DIELASMA SULCATUM n. sp.

Pl. XVI, figs. 1 to 1c.

Shell of medium size, subpentagonal. Ventral valve moderately convex. Beak as usual in the genus. Greatest width about two-fifths the length back from the anterior margin. The sinus can be traced nearly to the beak as a depressed line, but near the front it rapidly expands, becoming deep and subangular.

Dorsal valve moderately convex. There is no distinct fold, but the valve as a whole has the shape of a dihedral angle, the sides of which are more nearly plane toward the front, producing a distinctly peaked shape. Farther back the shell is more arched and the angulation is lost. The ventral sinus is so strong that a well-marked emargination is produced at the front margin.

The interior of the species is not known and its generic position is therefore uncertain. The punctate shell and configuration demonstrate its relation to the terebratuloids and it can probably be placed with *Dielasma*.

Horizon and locality.—Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926).

DIELASMA? SCUTULATUM n. sp.

Pl. XVI, figs. 8 to 9b.

Shell small, elongate. Ventral valve shallow, most strongly convex in the posterior half. Beak small, produced, rather strongly incurved. Shape rhombic, greatest width about midway. Posterior end pointed and tapering; anterior contracted and strongly rounded.

Dorsal valve shallow but more convex than the ventral. The curvature across the shell is less than that lengthwise. The dorsal valve has not an appreciable fold nor the ventral a perceptible sinus, but a flexure of their plane of union at the anterior margin indicates that these features are present if not obvious.

The surface appears to be smooth and the shell substance fibrous, doubtfully punctate.

I hardly know where to place this little shell generically. Only three specimens, one of them somewhat imperfect, have come to hand and it has not been possible to ascertain any of the internal structures. The general expression, and especially the configuration of the ventral valve, strongly suggest a relationship with the terebratuloids. The shell substance, however, is distinctly fibrous, instead of foliaceous, and it is uncertain whether it is punctate or solid. Certain local areas have the appearance of being obscurely punctate, but I am not altogether sure that this appearance is not connected with the prismatic fibrous structure of the shell substance. At one time I doubtfully placed these forms with *Spirigerella,* but the beak in none of the specimens is sufficiently perfect to show plainly whether it is truncated by a large foramen or incurved and pointed The preservation in the Guadalupe Mountains is such as sometimes to obscure the invertebrate shell structure, and it has seemed less liable to be erroneous to place this species with the terebratuloids, though its position is still subject to revision. The general shape of this species is that of a young and elongate specimen of *Martinia rhomboidalis,* but the form of the beak seems to preclude any possibility of its being a *Martinia.*

Horizon and locality.—Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926).

Genus DIELASMINA Waagen.

This genus differs from *Dielasma,* so far as known, only in configuration, for instead of having a well-marked fold and sinus on the dorsal and ventral valves, sometimes modified by the development of a subordinate mesial sulcus and plication, *Dielasmina* possesses a series of nearly equal submarginal plications without any distinct fold or sinus. The shape of the one type is apt to be flattened and of the other globose.

Dielasmina guadalupensis seems to meet these conditions in every respect. While it differs from the genotype, *D. plicata,* in having the plications larger, fewer, and more marginal, it appears to be much more closely allied to *D. plicata* than to the usual type of *Dielasma,* and I have placed it with some confidence in Waagen's genus. The relations of *Dielasmina? perinflata* are much more uncertain, for Shumard's species has never been figured and its general character is imperfectly known.

DIELASMINA GUADALUPENSIS n. sp.

Pl. XVI, figs 6 to 7a; Pl XXI, figs. 22 and 22a

Shell of medium size, inflated, ovate. Ventral valve strongly convex. Beak large, much incurved. In mature specimens there is a well-marked median sulcus, on each side of which is a smaller sulcus separated by a subangular plication, beyond which, on the type specimen, still another low plication is seen. The plications and sulci are practically marginal and can be traced but a short distance back from the edge of the shell.

The dorsal valve is moderately convex. Its plications correspond to those of the ventral valve. It has a strong mesial plication bonded by two subangular sulci, beyond which on each side is a less distinct plication followed by a very indistinct sulcus.

Of this species I have seven specimens—none of them very perfect—two from the Capitan limestone and five from the "dark limestone." In the plications, which constitute the most striking feature of this species, considerable variation is exhibited, depending largely on difference in size. A large ventral valve from the Capitan limestone shows only a shallow median sinus, its two bounding folds, and a shallow depression on either side, while in a smaller individual only the sinus is developed. In this condition it is practically impossible to distinguish specimens from young *Dielasma sulcatum.* In a general way these shells are very suggestive of some of Waagen's figures of *Dielasma biplex* and *Dielasma problematicum;* but, unfortunately for comparison, the ventral valve of my specimens has a median sulcus, instead of a median plication. It is more loosely and less abundantly plicated than the Indian species of *Dielasmina.* I am, however, in some doubt as to whether this may not really be Shumard's *D. perinflata.* It is evident from Shumard's description that his form did not have the plication developed to anywhere near the degree shown in *D. guadalupensis,* but this feature varies considerably in *D. guadalupensis,* so that *D. perinflata* may be based on small or imperfectly developed specimens of my species. It seemed to me more prudent, however, to employ for the present group a distinct name, leaving it to be settled from further collections in what relation it stands to *D. perinflata.*

Horizon and locality.—Capitan formation, Capitan Peak (station 2926); "dark limestone," Pine Spring (station 2930), Guadalupe Mountains, Texas.

DIELASMINA? PERINFLATA Shumard.

1859. *Terebratula perinflata.* Shumard, Trans. Acad. Sci. St. Louis, vol. 1, p. 392 (date of volume, 1860).
White [Permian] limestone: Guadalupe Mountains.

Shell ovate, very gibbous, width and thickness about equal, one-third longer than wide in full-grown specimens; front subtruncate or slightly emarginate; sides rounded anteriorly and converging posteriorly to the beak at an angle of about 55°. Dorsal valve varying from circular-ovate to subcircular, convex, forming usually a regular curve from beak to front; old specimens marked with a slight mesial elevation in front and an obscure fold on either side, which becomes entirely obsolete before reaching the middle of the valve; cardinal edges rather deeply indented by the false area of the ventral valve. Ventral valve strongly convex, more elevated than the opposite valve; front marked with a shallow sinus, which usually becomes obsolete before reaching the middle of the valve; beak extended considerably beyond that of the dorsal valve, acute and strongly incurved; surface marked with fine concentric striæ of growth. Dimensions of a full-grown specimen: Length, 0.67; width, 0.52.

Formation and locality.—White limestone of the Guadalupe Mountains, Texas. It appears to be quite rare, only two specimens having been found.

This description, quoted from Shumard, does not altogether agree with any of the forms recently obtained from the Guadalupe Mountains. The species most nearly in agreement appears to be one which I have described as new, under the title of *Dielasmina guadalupensis.* A difference seems to exist in the plications, of which *D. perinflata* possessed in old specimens a well-marked mesial elevation on the dorsal valve and an obscure fold on either side, while the type specimen of *D. guadalupensis* has one well-marked and one obscure fold on either side of the mesial elevation. Other examples of *D. guadalupensis* lack the obscure plication, but there is in almost every case a plication on each side of the mesial fold which is well marked. Were it certain that no other difference existed, the name *guadalupensis* would not have been proposed, but a description without figures is so imperfect a manner of defining a species that in view of the confusion which a wrong identification in this case might introduce, it seemed unwise to make one which would be at least doubtful.

Genus NOTOTHYRIS Waagen.

This genus, hitherto unknown in North America, is even in the present instance somewhat doubtfully identified. The chief facts which have been ascertained bearing on its generic position (for I have not felt justified in sacrificing much of my very scanty material to this end) are these: The configuration impresses one as terebratuloid. There are a fairly distinct fold and sinus, which are not strongly elevated in themselves and in addition are somewhat masked by bearing a median sulcus and a median rib, respectively. The sinus and fold do not occupy the usual positions, but occur, the former on the dorsal and the latter on the ventral valve, respectively, so that the species must be considered as belonging to the *antiplicatæ*. The plications are few, rounded, and submarginal.

The shell structure is probably punctate, but is composed of minute fibers, which are finely fluted, thus conveying an impression of punctation which may be misleading.

Of the internal structures but little definite is known, for the specimens which show the interior are so imperfect that their specific relations are not quite certain. In the identifiable specimens the ventral valve appears to be without dental plates. and there is little doubt that if present they would show through the exfoliated shell. The dorsal valve also appears to be without septa, but in this case their absence can not be so surely predicated as a probability. A silicified specimen referred to *N. schuchertensis* var. *ovata*, but not determinable with certainty, shows the absence not only of dental and septal plates in the ventral and dorsal valves, respectively, but the absence of a hinge plate in the latter, the short discontinuous (possibly broken) crura springing immediately from the sides of the shell near the hinge. This is rather against a reference to *Notothyris*, but is perhaps to be regarded as an abnormal or accidental feature. Another example, a silicified dorsal valve, specifically belonging to a very different group from the foregoing, has the normal *Notothyris* structure. Septal plates are absent, but there is a well-developed hinge plate pierced at its upper extremity by a rounded foramen.

It is almost certain that the type of structure found in *N. schuchertensis* can not be placed with the rhynchonelloid genus *Terebratuloidea*, which it resembles in some respects, because of the rounded submarginal plications and the presence of the fold and sinus in a reverse relation to the valves. Much more essential is the connection with the terebratuloids, especially with the genera *Notothyris* and *Hemiptychina*. The absence of dental plates, as it appears, distinguishes it from *Dielasmina*, and the absence of septal plates from *Hemiptychina*. Even if differences based on somewhat doubtful septal structures be eliminated, the character of the plications, especially as regards the fold and sinus, distinguish it from both the genera named, while not only this character, but also the internal structure, so far as known, ally it with *Notothyris*.

Two closely related varieties of this type have been recognized in the Capitan limestone of the Guadalupe section. They are allied to but not identical with Asiatic and European representatives of the genus. A third but very different type specifically has been obtained from the southern Delawares.

Notothyris schuchertensis n. sp.

Pl. XV, figs. 25 to 25c.

Shell small, rotund, rather broadly ovate, with a straightened anterior outline. Ventral valve strongly convex, especially in the posterior portion. Beak large and much incurved. The surface is smooth, except toward the margin, where it is gently plicated. There is a low median fold, imperceptible except along the line of junction of the valves, and still further obscured by a faint median sulcus, so that the fold is surmounted by two plications. It is followed on each side by a sulcus, a lateral fold, and another slight sulcus. Both plications and sulci are rather strongly rounded.

Dorsal valve moderately curved. Along its anterior margin are a few plications corresponding to those on the opposite valve. These consist of a broad, low sinus with a central plication determined on each side by a rather high plication.

The internal characters have not been satisfactorily made out, but there are probably no dental plates in the ventral valve and possibly no plates in the dorsal. The shell structure is not foliaceous, as in *Dielasma* and most terebratuloids, but fibrous, yet at the same time appears to be punctate. The fibers seem to be finely wrinkled, conveying the appearance of punctation, even if this structure does not exist. Specimens of *Pugnax swallowiana* from the same horizon have a similar fibrous structure, but the fibers are not fluted or wrinkled. Furthermore, many internal molds from this horizon have a minutely papillose surface, due, it seems probable, to the obliquely fibrous structure of the shell. Many of these specimens are filled by crystalline calcite, and the appearance referred to may also be due to tiny crystals lining the inside. This appearance is very suggestive of a punctate shell structure. I am therefore doubtful whether the species under discussion really possesses this character. The form of the beak and foramen, however, is that of the terebratuloids and unlike that of any other group to which the species might reasonably be referred, except, perhaps, *Terebratuloidea*, and the configuration is against referring it to that genus.

This species and the variety *ovata* are related to *N. simplex* and *N. inflata* of the Salt Range fauna, to *N. exilis* and *N. mediterranea* as identified by Diener in the Himalayan region, to *N. nucleolus* of the Russian Gschelian fauna, and to *N.* [*Rostranteris*] *inflata* of Gemmellaro's Sicilian fauna, but I can not consider them specifically identical.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926).

Notothyris schuchertensis var. ovata n. var.

Pl. XV, figs. 26 to 26c.

This variety differs from the original species in being narrower and having the point of greatest width nearer the center of the shell. The plications are the same as in *Notothyris schuchertensis*. The median plication on the dorsal valve appears to be a little smaller than those lateral to it.

I have referred to this variety an imperfect specimen from the "dark limestone" (station 2930), the anterior portion of which is missing, so that the specific characters can not be satisfactorily determined; at least there is no apparent reason why it should not be placed with this species. Special mention, however, would not need to be given to this example save that it shows internal characters which seem t oa certain extent to corroborate Waagen's more or less tentative diagnosis of the genus. Dental plates are entirely absent in the ventral valve. In the dorsal valve the loop is short and incomplete, but it may be broken. Septal plates seem to be absent in this valve also, and in fact a hinge plate of any sort if not absolutely wanting is rudimentary, the crura being attached directly to the two sides of the shell near the umbo.

Horizon and locality.—Top of Capitan formation, Capitan Peak (station 2966); middle of Capitan formation, Capitan Peak (station 2926); "dark limestone," Pine Spring (station 2930?), Guadalupe Mountains, Texas. Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

NOTOTHYRIS sp.

Pl. XXXI, fig. 7.

This name is introduced for an imperfect specimen which is interesting chiefly for the generic characters which it shows. It is a dorsal valve, and though a fragment it shows a well-marked median sinus. Consequently it belongs to the *antiplicatæ*. On the inside the apical portion is crossed by a well-developed hinge plate, which is not, however, supported by septa. Its posterior portion is perforated by a rounded or elliptical foramen, as described by Waagen. From its front margin project the crura, which are in this case broken off.

It seems fairly certain that this is a representative of Waagen's *Notothyris*, corroborating his description in a number of important particulars. In its specific relations it is very different from the two other Guadalupian types. It also presents wide differences, so far as can be determined, from any of Waagen's Indian species.

Horizon and locality.—Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763).

Genus HETERELASMA n. gen.

This group of shells, which appears to constitute an undescribed genus, is represented in the Guadalupian fauna by two species, of which *Heterelasma shumardianum* is taken as the type. This species has several rather striking peculiarities of configuration, such as the very compressed shape, which leaves only a narrow distance between the two valves, and the small appressed beak of the ventral valve; but as these features are less well marked in the second species, they would best not be included in the generic description. In regard to configuration, it can probably be said with safety, however, that, as in the Dielasmas, a more or less strong sinus was developed on the ventral valve and a corresponding fold on the dorsal, but in the case of *Heterelasma* a reverse plication is subsequently developed, more obvious on the dorsal than on the ventral valve, which produces an emargination of the front margin more or less pronounced, as the case may be.

On the interior the ventral valve bears two rather short dental plates, a feature very common among the Paleozoic terebratuloids, and in addition there appears to have been a low median septum. In the dorsal valve, however, a median septum is rather well developed. It is moderately high, and extends well forward. Septal plates are entirely absent, and even the hinge plate is rudimentary, being reduced to a thickening of the rim of the dorsal valve under the beak, at which the crura originate. The character of the loop is not known.

The shell substance has of course the usual punctate and foliaceous structure.

The configuration, and especially the internal structure, of these shells makes it impossible to refer them to any of the known genera, at least of Paleozoic forms, and in fact I do not know of any to which they are very closely allied.

HETERELASMA SHUMARDIANUM n. sp.

Pl. XV, figs. 21 to 22b; Pl. XXIX, fig. 10?.

Shell rather small,[a] flat, subpentagonal. Ventral valve moderately curved longitudinally, nearly flat transversely. Greatest width about three-fourths the length back from the front margin. Posterior lateral slopes gently curved, meeting at an angle of approximately 90°. Sides gently curved, slightly converging toward the front. Anterior outline strongly emarginate. The beak is small, wide, and incurved; flattened on the foraminal side into hooded expansions. The transverse curvature is slightly concave except near the posterior end. There is the merest suggestion of a mesial fold toward the front.

The shape of the dorsal valve is like that of the ventral, but with a more obtuse posterior angle. The longitudinal outline is nearly straight; the transverse strongly convex. Beak small and prominent. Near the posterior end the transverse curvature is angular and gablelike, but this elevation is truncated below by a mesial sinus of increasing strength, which is deep at the front. A reentrant angle in the anterior outline is thus produced, on either side of which are projections made by the two plications.

On the interior there are two short dental plates in the ventral valve, with a long median thickening, like a low septum. The dorsal valve also has a median septum.

This species evidently resembles *Dielasma problematicum* Waagen, from which, however, it is at once distinguished by the absence of a fold in the ventral valve, as well as by the general configuration. Waagen refers his species to *Dielasma*. Gemmellaro refers to *Hemiptychina* species, which have a close resemblance to this. It is evident that *H. shumardianum*, since it possesses dental plates, can not be a *Hemiptychina*.

Associated with *H. shumardianum* at station 2926 were found a few small scalelike shells having a punctate structure and other characters indicating more or less close specific relationship. I have provisionally included them in the same species, as they have the expression which *H. shumardianum* would probably have presented in its younger stages. The immaturity of these shells is suggested by

[a] A subsequent addition to our collection shows that, in addition to being relatively broad and flat, like the type specimen, this species may be narrower and much thicker.

their slight convexity, as well as by the beak, which seems to be unusually erect for the genus. They have been placed with *H. shumardianum* in preference to *H. venustulum* because of their slight convexity. The fact that the two specimens found are of one size and that no examples intermediate between them and mature *H. shumardianum* have been found brings this procedure into some question.

Horizon and locality.—Top of Capitan formation, Capitan Peak (station 2966); middle of Capitan formation, Capitan Peak (station 2926), Guadalupe Mountains, Texas. Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

Heterelasma venustulum n. sp.

Pl. XV, figs. 23 to 24b.

Shell small, convex, subpentagonal. Greatest width at about the mid-length. Ventral valve gently flexed longitudinally. The posterior portion is rather strongly convex, the anterior half flattened. Beak of medium size, much incurved.

Dorsal valve moderately curved longitudinally, strongly curved transversely. No fold distinct from the subangular shape of the valve as a whole. At the front, and very restricted in its extension, is a well-marked median depression, giving rise to two short, low plications.

The form is related to *H. shumardianum*, and, like it, possesses in the ventral valve, besides the two dental lamellæ, a long median septum, which can be traced almost to the front margin. The dorsal valve has, likewise, a short median septum, but whether it is connected with other plates, as in *Dielasma*, I have not been able to ascertain.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926). Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

Family SPIRIFERIDÆ King.

In scarcely any group of brachiopods is the difference between the Guadalupian fauna and that of the Salt Range more pronounced than in the family of Spiriferidæ. The generic representation is pretty much the same, both faunas possessing members of *Spirifer*, *Spiriferina*, *Martinia*, and *Squamularia;* but the Guadalupian fauna has *Ambocœlia* and the Productus limestone fauna *Martiniopsis*, not found in the other.

The eight species of *Spirifer* known from the Productus limestone are divided by Waagen into five groups. The group of *S. striatus* has no representatives in the Guadalupe Mountains so far as I am aware. Waagen refers to it two species, *S. striatus* and *S. marcoui*, remarking of the latter that it is a characteristic species of the American "Coal Measures." In this he is quite in error, for so far as my experience goes it is entirely absent from the "Coal Measures" of central and eastern United States, where most of our paleontologic work has been done. It is in fact a distinctly western type, which occurs in the Hueco formation below the Guadalupian. The group of *S. tegulatus*, also embracing two species, is present in the Guadalupian in the form or group of forms which I have called *Spirifer* sp. *b*, represented in our collection by but a few fragmentary specimens. The group of *S. duplicicosta*, to which *S. wynnei* of the Productus limestone belongs, is probably represented in my fauna by *S. mexicanus* and its two varieties and by *Spirifer* sp. *a*. There are, however, strong differences in the configuration of *S. mexicanus*, which make its relationship to *S. wynnei* rather remote, while some of the forms which I have placed in the same group with *S. mexicanus* are still less similar. *Spirifer oldhamianus*, *S. alatus*, and *S. niger* of the Indian fauna have, so far as known, no allied types in that of the Guadalupe Mountains, just as *S. sulcifer* of Shumard has none in the Productus limestone. On the whole the Spirifers of the Productus limestone are much more like those of the Hueconian than of the Guadalupian. In this entire section, however, including both its divisions, this genus is rather sparingly developed, in point of differentiation as well as abundance. In both particulars the Alaskan Carboniferous faunas are more fortunate.

Of *Martinia* Waagen distinguishes five species. The groups of *Martinia glabra* and *M. corculum*, each represented by a single species, appear to be absent from the Guadalupian fauna; but the group of *M. warthii*, comprising the three remaining Salt Range species, will perhaps embrace the only two types at present known from the Guadalupe Mountains, though the resemblance between the Guadalupian and the Indian species is not very great, considering how small the limits of variation really are within the group.

As would be expected, the Squamularias of the Guadalupian fauna resemble those of the Salt Range somewhat closely. I have contented myself with recognizing but three varieties in the Guadalupian. Waagen discriminates three species from the Productus limestone, and apparently his *Reticularia lineata* and *R. elegantula* correspond to the Guadalupian *Squamularia guadalupensis* and *R. indica* to *S. guadalupensis* var. *subquadrata* without any Indian equivalent for *S. guadalupensis* var. *ovalis*, but there may be intrinsic differences of sculpture, etc., which contradict the resemblances observable in configuration.

Between the Spiriferinas of the Indian and the American faunas I find it difficult to make a satisfactory comparison. The minute characters of sculpture, not easily described or represented by figures and very apt to be lost or obscured by preservation, have been destroyed in some of my Guadalupian shells and apparently in some of the Indian specimens also. I regard these as of much importance in discriminating and grouping species, and consequently will not venture to make extensive nor indeed more than tentative comparisons. In the Guadalupian fauna *Spiriferina billingsi* and its allies seem to form a rather well-defined group. These may be represented in the Salt Range by Waagen's group of *S. insculpta*, to which *S. ornata* is referred. This species appears to be very closely related to *S. billingsi* itself. *S. evax*, which I have placed in the same group with *S. billingsi*, is suggestive of the Indian shell which Waagen identifies as *S. multiplicata* Sow. Waagen does not place *S. multiplicata* in the same group as *S. ornata*, but with *S. cristata*, and if this disposition of the species is correct *S. multiplicata* and *S. evax* are not so similar as at first appears. In any event the type of *S. billingsi* apparently shows a wider range of variation in the Guadalupian fauna than has been found in India. *S. cristata*, as identified in the Indian fauna, is perhaps represented by the imperfectly known *S. hilli* and the other Guadalupian forms which appear to be allied to it. Perhaps all three species which Waagen assigns to the group of *S. lima*, viz, *S. cristata*, *S. multiplicata*, and *S. nasuta*, have here their only Guadalupian allies. In spite of its strongly lamellose surface, I believe that *S. nasuta* Waagen is not allied to *S. billingsi*, because it has a median plication in the ventral sinus and very coarse punctation. Perhaps its closest Guadalupian type is *S. hilli* and related species. *S. vercheri* of Waagen probably has no allied form in the Guadalupian, for he refers it to the group of *S. transversa* McChes. and *S. transversa* has none. On the other hand, *S. pyramidalis*, *S. laxa*, and *S. welleri* seem to be without representatives in the Salt Range faunas.

In his paper on the Carboniferous faunas of Kashmir and Spiti, Diener distinguishes among the Spiriferidæ the four genera *Spiriferina*, *Spirifer*, *Martiniopsis*, and *Syringothyris*, the latter belonging probably to a different and earlier fauna. *Martiniopsis*, as I have already had occasion to remark, is not found in the Guadalupian, which contains the types *Martinia*, *Squamularia*, and *Ambocœlia*, not recognized by Diener. The only species of *Spiriferina* is one cited as *Spiriferina* cf. *kentuckyensis*, and while the Himalayan form is without much doubt distinct from our Pennsylvanian one, it represents a type which appears to be absent among the numerous species in the Guadalupian fauna. Thus in point of the genus *Spiriferina* the faunas are widely different, so far as known. Only slightly less different are the Spirifers of which Diener cites ten species. The group of *S. fasciger*, comprising three species, is probably represented by the rare and imperfectly known species or group of species which I have cited merely as *Spirifer* sp. *b*. The group of *S. trigonalis*, that of *S. pinguis*, and that of *S. alatus*, each containing one species, and the group of *S. clarkei*, with two, have no related forms in the Guadalupian fauna so far as known. *Spirifer rajah* and *Spirifer* undet. aff. *rajah*, constituting the group of *Spirifer rajah*, show considerable diversity of character. Some of Diener's figures seem to represent a species related to *S. sulcifer* Shumard, while others are in a measure comparable with *S. mexicanus* Shumard, though the resemblance is somewhat distant. With this possible exception the group of *S. mexicanus*, the most abundant and characteristic *Spirifer* of the Guadalupian, does not occur in Diener's faunas, while most of his Spirifers are either absent from the Guadalupian or, in part, doubtfully represented by rare and little known species.

In Diener's second paper on Spiti fossils the Spiriferidæ from the lower beds appear under the titles *Spirifer* cf. *strangwaysi*, *S. curzoni*, *Spirifer* sp. ind. ex aff. *Spirifer curzoni*, *Spirifer* (*Ambocœlia ?*) sp. ind. aff. *fusiformis*, and *Martiniopsis* cf. *subpentagonalis*. None of these species seems to bear much resemblance to any in the Guadalupian, and, in fact, the fauna to which they belong is probably a much older one. *Spirifer curzoni* has proved to be a *Syringothyris*. The species which Diener thinks is probably closely related to *S. curzoni* is almost certainly very different, as it has plications on the fold and is compared to the Devonian form *S. disjunctus* var. *sulcifer*. The *Spirifer* related to *S. fusiformis*, to judge by the configuration shown by his figures, is probably not an *Ambocœlia*. It is somewhat surprising to find the genus *Martiniopsis* associated with a fauna which is probably either very late Devonian or early Carboniferous in age. Although the punctation of the shell might possibly be an appearance due to the bases of old spines, the form in question can hardly be a *Reticularia*, as one might surmise, because it has two dental plates in the ventral valve, while *Reticularia* has in addition a median septum.

The Spiriferidæ of the upper fauna of Spiti, according to Diener, are confined to five species of *Spirifer*, the other genera found in the Guadalupian being, so far as known, absent. The shells referred to *Spirifer distefanii* much resemble in their configuration *Spiriferina evax* of this report, but I have no species of *Spirifer* which is like them. If *S. marcoui*, *S. fasciger*, and *S. nitiensis* have any related species in the Guadalupian, it is in the imperfectly known *Spirifer* sp. *b*. The resemblance between *S. rajah* and *S. sulcifer* Shumard has already been commented upon.

Among the Spiriferidæ obtained in the limestone crag of Chitichun, Diener cites *Spiriferina*, *Spirifer*, *Martinia*, and *Squamularia*, all of them Guadalupian genera, which include, also, *Ambocœlia*. The only *Spiriferina* is identified as *S. cristata* var. *octoplicata* Sow., and it seems to be similar in configuration to *S. billingsi*, described by Shumard, though concentric ornamentation is said to be absent. No further account of the sculpture is given, and as this feature accordingly appears to be unknown it is impossible effectually to compare the Himalayan form with those from the Guadalupe Mountains.

A rather strong and unexpected resemblance between the Spirifers of the two regions appears to exist. *S. musakheylensis*, if represented in the Guadalupian, is represented in the very fragmentary material which I have called *Spirifer* sp. *b*. *Spirifer wynnei*, however, is closely allied to *S. mexicanus*, while *S. tibetanus* is very similar to *S. mexicanus* var. *compactus*, *S. mexicanus* var., and possibly also to *S. sulcifer*.

Diener distinguishes six species of *Martinia* in the Chitichun fauna, several of which are closely related to the two Guadalupian species. *M. elegans* and *M. acutimarginalis* correspond to *M. rhomboidalis* and *M. shumardiana*, respectively; but the less elongate types, such as *M. semiplana* and *M. contracta*, have not been found as yet in the Guadalupian fauna. The last-named species was originally described from the Mississippian of the United States, the genus not being known, in fact, in the Pennsylvanian of the Mississippi Valley and Appalachian region. White's identification of *M. contracta* in the upper Carboniferous of Nevada is based on a species of *Squamularia*. I must call attention in this connection to one of Diener's figures referred to *Martinia elegans*.[a] It has a different shape from the other specimen figured on the same plate, though not so different from the specimen figured on his Pl. IX. It hardly seems likely that Diener has fallen into this error, but the figure, in its configuration, sculpture, and even in its shell punctation, certainly is very suggestive of a large orthoid, such as *Schizophoria* or *Orthotichia*.

It would be expected that the form which Deiner calls *Reticularia lineata* would closely resemble that which in our fauna Shumard described as *Spirifer guadalupensis*, but such is not the case. One of the varieties figured resembles *Squamularia guadalupensis* var. *subquadrata*, but the others have a configuration distinctly different from any of the Guadalupian forms.

In his second paper on the Chitichun fauna Diener recognizes two species of *Spiriferina*—*S. margaritæ* Gemm. and *S. octoplicata* var. *fastigata* Schell. The latter

[a] Mem. Geol. Survey India, Pal. Indica, ser. 15, vol. 1, pt. 3, 1897, pl. 8, fig. 2.

is the form which he had previously called *S. cristata* var. *octoplicata*. In so far as I can judge, this form possesses neither the regular lamellose sculpture of the *billingsi* group nor the small spines which cover the surface of *S. laxa* and its allies. If, therefore, it has a related species in the Guadalupian, it must be in *S. hilli*, though I have provisionally placed that form with the *spinosæ*. *S. margaritæ*, however, seems to be extremely similar, both in configuration and in sculpture, to *S. billingsi*. Certain types related to *S. billingsi*, found in the American fauna, and others, such as *S. laxa*, *S. pyramidalis*, and *S. welleri*, are not known from the Chitichun crag.

Of *Spirifer* Diener cites only one species, *S. tibetanus*, whose resemblance to *S. mexicanus* var. *compactus* has already been referred to. He also distinguishes three species of *Reticularia* (=*Squamularia*), and if I deemed it advisable to apply similar rather trivial distinctions to the Guadalupian shells, possibly several species could be made out among them as well. I am not sure, however, that such small variations may not be warrantably seized upon in this group, for in it the lines of discrimination are very few and restricted.

The Spiriferidæ of the fauna which Diener described from Kumaon and Gurhwal include only the genera *Spirifer* and *Martinia*. In the Guadalupian we find, in addition, *Spiriferina*, *Squamularia*, and *Ambocœlia*. Diener calls attention to the fact that of the six species of *Spirifer*, which he discriminates, the majority belong to the group of *S. fasciger*. In point of fact, none of the Spirifers of this fauna have any Guadalupian representatives, unless it be in *Spirifer* sp. *b*, and they recall much more strongly the Spirifers of the underlying Hueco formation. Conversely, of course, the dominating and characteristics types of *Spirifer* in the Guadalupian do not occur in Diener's fauna. Equally little resemblance is shown in the genus *Martinia*, the single Himalayan species belonging to a different group from the two Guadalupian ones.

In the fauna from Malla Sangcha the Spiriferidæ are represented by the genera *Spiriferina*, *Spirifer*, *Martinia*, and *Squamularia*, about as in the Guadalupian, which has in addition a species of *Ambocœlia*. The only *Spiriferina* is cited as *Spiriferina* cf. *octoplicata* var. *fastigata* Schell., but Diener is in doubt as to its real affinities. The configuration suggests a somewhat aberrant example of *S. billingsi*. Of the Spirifers, *S. wynnei* and *S. tibetanus* closely resemble *S. mexicanus* and *S. mexicanus* var. *compactus*, as has already been pointed out. *S. fasciger* and *Spirifer* sp. ind. ex aff. *Sp. marcoui*, the two other Spirifers noted by Diener, are represented in the Guadalupian by *Spirifer* sp. *b*. The resemblance of *Martinia acutimarginalis* and *M. elegans* to the two Guadalupian species *M. rhomboidalis* and *M. shumardiana* has already been remarked in connection with another fauna. The two other Martinias cited by Diener are not nearly related to the Guadalupian forms. Of the three species of *Squamularia* which have been recognized in the fauna of Malla Sangcha—*Reticularia* cf. *lineata*, *Reticularia* cf. *pulcherrima*, and *Reticularia* (*Squamularia*) cf. *dieneri*—the two former are possibly similar to the Guadalupian representatives of the genus, but we have nothing which closely resembles *S.* cf. *dieneri*.

The Spiriferidæ of the Productus limestone of the Lissar Valley are confined, so far as known, to the genus *Spirifer* alone, of which Diener cites six species. One of these, *Spirifer rajah*, as already mentioned in another connection, appears to be related to Shumard's species *Spirifer sulcifer*. The five remaining types, if they have any related Guadalupian forms, find them in the scantily known species or group of species which it has seemed best to denominate merely *Spirifer* sp. *b*.

From the Productus shales of Byans Diener cites only three species of *Spirifer*. *S. rajah* may be considered as representing *S. sulcifer* and *Spirifer* cf. *ravana*, and *S. fasciger* as provisionally representing *Spirifer* sp. *b*. of the Guadalupian fauna.

Among the fossils described from Tibet by Davidson only the genus *Spirifer* was found as belonging to the Spiriferidæ. One indeterminable form and another which has since proved to be a *Chonetes* of the grandicostate division being omitted, there are four species but slightly related to the Spirifers of the Guadalupian. Davidson's figure of *S. rajah* Salter depicts a form by no means very similar to any of those of the present work, yet Salter's original figure and those of Diener appear to represent one related to *S. sulcifer* and to some extent to *S. mexicanus* var. *compactus*. *Spirifer vihianus*, and probably *S. kashmerianus*, have no related Guadalupian species, so far as known, and S. *musakheylensis* is represented, if at all, by the shells here grouped under the title *Spirifer* sp. *b*.

The Spiriferidæ of the Salt Range and Himalaya, while related to those of the Guadalupian, present many points of difference. On the whole, pending a detailed study of our collection, they are more closely allied to the faunas of the Hueco formation. In the case of Chitichun (No. 1) and the Lissar Valley, however, the resemblance to the Guadalupian Spirifers is rather striking, one point of difference being the much greater differentiation in the latter of the genus *Spiriferina*, another the presence of *Ambocœlia*, which seems to be absent from all these Asiatic faunas.

The fauna from Turkestan described by Romanowsky contains species belonging to *Spirifer*, *Spiriferina*, *Martinia*, and probably *Reticularia* of the Spiriferidæ, but they have scarcely anything in common with those of the Guadalupian, and probably belong to a much older fauna. I will not, consequently, stop to discuss them in detail, but proceed to speak of the more nearly related faunas of eastern Asia.

In the fauna which Kayser described from Lo Ping the Spiriferidæ cut a rather poor figure. The genus *Spirifer* as now restricted is, so far as known, entirely absent, the types which Kayser cites as such being distributable among the genera *Squamularia* and *Martinia*. The large *Squamularia* from Lo Ping which he identifies with *Spirifer lineatus* resembles some of the large shells which I have called *S. guadalupensis* var. *ovalis*, and the smaller ones referred to the same species resemble *S. guadalupensis* var. *subquadrata*. The large species from Tschantien identified as *Spirifer lineatus* also resembles *Squamularia guadalupensis* var. *subquadrata* more than any other form. The form which he cites as *Spirifer lineatus?* is the same to which Loczy subsequently gave the name *Reticularia waageni* (fide Fliegel) and appears to have no Guadalupian representative. I suspect Kayser's *Spirifer ellipticus* to be a *Martina*, and his *Spirifer glabra?* presumably belongs to the same group. If so, the former species appears to be closely related to *Martinia subquadrata* of the Guadalupian, but the latter is probably unrepresented there. The two faunas appear to resemble each other so far as they have common ground for comparison, but the absence from Kayser's fauna of the genera *Spirifer* and *Spiriferina* is noteworthy.

The fossils which Loczy examined from Kantschoufu represent a different and probably considerably older fauna than the Guadalupian, and the Spiriferidæ present among them, such as three species of *Spirifer* and one of *Reticularia* (*Squamularia?*), have little in common with the American forms.

Among the "Permo-Carboniferous" fossils from the Lantsankiang Valley Loczy distinguishes only three species among the Spiriferidæ, designated as *?Spiriferina* sp. indet. aff. *Spirifer* (*Martinia*) *planiconvexus* Shumard, *?Spirifer* sp. indet., and *Reticularia waageni*. The form which Loczy compares with *Ambocœlia planiconvexa* is of uncertain affinities, as is evident from the author's method of citation. The peculiar character would appear to be its configuration, taken in connection with the presence of dental plates and a median septum in the ventral valve. There can be but little doubt that the form is not an *Ambocœlia* nor, I believe, a *Spiriferina*, as Loczy suggests. The configuration is that of a *Reticularia* or *Squamularia*, and the septal arrangement is precisely that which is present in *Reticularia*. It would therefore appear probable that the form in question will prove to belong to that genus. One contradictory fact is that in other areas, so far as I am aware, the genus *Squamularia* is restricted to the earlier faunas of the Carboniferous. Loczy's species can hardly be a *Martiniopsis*, for *Martiniopsis* is without a septum. The second of Loczy's species is too imperfect to form a subject of comparison. He suggests that it may belong to *Spirifer striatus*, a relationship which certainly would not be inferred from his figure. The last form is a *Squamularia* described as a new species under the title *Reticularia waageni* and is not distantly related to *S. guadalupensis* var. *subquadrata* of the American fauna. Fliegel placed *Spirifer lineatus?* Kayser (non Martin) in the synonymy of this species, but the figures seem hardly to admit such a disposition.

From Tschungtjen Loczy cites *Martinia* cf. *M. glabra* Martin, and from Talischau *Spirifer* cf. *alatus* Schlott., *Spirifer* sp. indet., and *Spirifer* sp. indet. None of these forms shows much affinity with those of the Guadalupian, and in general the Spiriferidæ of the Chinese faunas, at least in their imperfectly known condition, are noticeable for their scanty representation and differentiation and are unlike rather than like those of the Guadalupian.

In the Carboniferous fauna described by Beyrich from Timor he distinguishes Spiriferidæ belonging to the genera *Spirifer*, *Squamularia*, and *Spiriferina*. The only species of *Squamularia* is identified as *S. lineata*. In their more elongate shape and stronger and more distantly arranged fimbriate bands, Beyrich's figures appear to represent a different species from *S. guadalupensis* and its allies. The form identified as *Spirifer musakheylensis* is represented in my fauna, if at all, by *Spirifer* sp. *b*. *Spirifer tasmanianus* Morr. var.? appears to have no corresponding form in the American fauna, while *S. kupangensis* is perhaps remotely related to *S. fasciger*. The single species of *Spiriferina* is identified with *S. cristata*. By its configuration it rather suggests *S. hilli* and its allies. Martin also described some fossils from Timor, among which are *Squamularia* (or *Reticularia*) *lineata*, *Martinia glabra*, and *Spirifer timorensis*. The figures of the first two are so poor that an attempt to compare them with the Guadalupian types would be futile. *Spirifer timorensis* belongs to the *cameratus* group, and is represented in the Guadalupian, if at all, by *Spirifer* sp. *b*.

Rothpletz in revising the faunas of Timor and Rotti distinguished three species of *Spirifer*, one of *Martinia*, one of *Squamularia*, and one of *Spiriferina*. His figures of *Spirifer interplicatus*, the same form which Beyrich had called *S. tasmanianus* var., suggest *S. fasciger* and *S. mexicanus* var. *compactus*, etc., a little more than the original ones, but the relationship at most would appear to be remote. Somewhat closer is that of *S. kupangensis*, as already remarked. The third species, cited as *Spirifer musakheylensis* and said to be the same as Martin's *S. timorensis*, appears to be allied to some of the imperfectly known types which I have been forced to group under the title *Spirifer* sp. *b*. *Martinia nucula* is not very closely related to the Guadalupian *M. rhomboidalis*, while *Reticularia lineata* is for the genus considerably different from *Squamularia guadalupensis*. Indeed it would be a pardonable mistake for one examining the figures to take the species for a *Martinia*. *Spiriferina cristata*, representing the genus *Spiriferina*, is not figured, and if it has any representative in the Guadalupian, which seems a little doubtful, some of the shells allied to *S. hilli* furnish this relationship.

In the "Upper Carboniferous" fauna of Padang, which Fliegel has described, only one type of the Spiriferidæ was found. Fliegel cites it as *Reticularia lineata*, but does not figure it or describe it except in a few general terms.

The small fauna which Tschernyschew lists from Vladivostok furnishes three species of *Spirifer*—*S. striatus*, *S. fasciger*, and *S. alatus*. The latter type is not represented in the Guadalupian fauna, and the two former only by the rare and imperfectly known *Spirifer* sp. *b*.

The "Permo-Carboniferous" Spiriferidæ of Queensland and New Guinea are abundant and well differentiated. Etheridge cites representatives of *Spirifer*, *Spiriferina*, *Reticularia*, *Martinia*, and *Martiniopsis*. The Spirifers comprise 16 species. These fossils, originally preserved as molds and more or less distorted, are not very satisfactorily shown in the figures. This is, however, a much better representation than that of the Guadalupian, and it is also very different. Most of the species belong to types which are rare in the Guadalupe Mountains, being represented only by fragments which I have grouped under the caption *Spirifer* sp. *b*. Several forms have no Guadalupian representatives, such as *Spirifer pinguis* (probably), *S. bicarinatus*, and *S. strzeleckii*. On the other hand, the common and characteristic Guadalupian species *Spirifer mexicanus*, not to mention *S. sulcifer*, belong to groups which appear to be absent from the Australian fauna.

Spiriferina duodecimcostata and an undetermined species are the only representatives of *Spiriferina* recorded by Etheridge. The figure of the former species does not suggest a close relationship with any Guadalupian form, but no safe inference can be drawn in the case of this genus. The specimens which Dana identifies as *Spirifer duodecimcostatus* are true Spirifers of a non-Guadalupian type. They seem closely related to *Spirifer darwini*.

Reticularia is represented, according to Jack and Etheridge, by *Reticularia lineata* and *R. urei*. The latter is presumably an *Ambocœlia*, but as neither form is figured comparisons are impossible.

The singular form described as *Martinia? productoides* is quite unlike any known Guadalupian species of *Martinia*.

Martiniopsis receives three species in Etheridge's account, but one of them (*Martiniopsis darwini*) I believe to be not a *Martiniopsis* but a *Spirifer*. This author says that if *Spirifer subradiatus* is correctly placed in *Martiniopsis, Spirifer darwini* will also fall into that genus, as their internal structure is on the same plan. If I understand the matter aright, the chief distinction between *Martiniopsis* and *Spirifer* is to be found in the configuration. The presence of dental plates, which occur in many Spirifers, especially the Carboniferous ones, distinguishes *Martiniopsis* from *Martinia.* I have examined the forms referred by Dana to *Spirifer darwini* and feel no hesitation in placing them with *Spirifer* rather than *Martiniopsis.* They appear to be the same species which Etheridge identified as *Martiniopsis darwini. Spirifer darwini* is of a type unknown in the Guadalupian. The two other forms also have no equivalents in the Guadalupian, as *Martiniopsis* is not known in that fauna.

According to De Koninck, the Spiriferidæ of New South Wales show an extensive variation. Aside from *Spiriferina,* he described 16 species, some of which would now be referred to other though related genera.

Spirifer lineatus and *S. crebristriatus* probably correspond to the Guadalupian *Squamularia.* The horizon of *S. crebristriatus* is the lower beds of the Carboniferous, while *S. lineatus* seems to occur in both the lower and the upper (Muree quarry). The latter station is not mentioned in the list of known Carboniferous (as distinguished from "Permo-Carboniferous," by which term the upper beds are designated) localities, but probably the inference is not justified that all stations not found in the list are "Permo-Carboniferous." In point of fact, many species which occur at the known Carboniferous horizons are cited from the Muree beds also. There is no telling what horizon furnished the figured specimen of *S. lineatus,* but in any event it is a widely different species from *Squamularia guadalupensis.*

Spirifer glaber and *S. darwini,* which appear to have been found in New South Wales only in the "Permo-Carboniferous" (Muree quarry among other localities), have been shown to belong to Waagen's genus *Martiniopsis.* There are no corresponding forms known in the Guadalupian.

Most of the true Spirifers appear to have come from the "Permo-Carboniferous" series. Such are *S. oviformis,* which has sometimes been referred to *Martiniopsis; S. duodecimcostatus,* which has been referred to *Spiriferina; S. strzeleckii, S. clarkei, S. convolutus, S. vespertilio; S. bisulcatus,* which occurs, it would appear, at both horizons; and *S. tasmaniensis.* The "Permo-Carboniferous" Spirifers are throughout distinguished by their robust size, as are most of the brachiopods. They are much more diverse than the Guadalupian representatives of the genus, and for the most part belong to entirely different groups. I can suggest no comparisons that would not seem fanciful. I do not see in these forms any relationship with the Guadalupian Spiriferidæ worth considering.

De Koninck recognized only two species of *Spiriferina* in his account of the Carboniferous faunas of New South Wales, both from the lower beds of the system. He also cites a species of *Cyrtina* from a practically unknown locality and horizon. Nothing like the latter is known in the Guadalupian.

I need not take time to consider the fauna of the *Productus giganteus* zone of the Russian section, and though some additional species are given in lists, will confine my comparison with the Spiriferidæ of the Moskovian fauna to Trautschold's monograph. From this work it would appear that the family is represented at this horizon by the groups *Spirifer, Spiriferina, Martinia,* and *Squamularia?.* In regard to the latter genus I would remark that Trautschold's figures are suggestive rather of a *Cleiothyriidina* than a *Reticularia* or a *Squamularia*. The Spirifers, embracing *S. mosquensis*, *S. trigonalis*, *S. strangwaysi*, and *S. angustivolvatus*, have little in common with the Guadalupian Spirifers, and evidently belong to a much earlier fauna, being, in fact, more appropriately compared with those of what are at present considered the lower beds of the Hueco formation. *Martinia glabra* and *Spiriferina cristata* are imperfectly figured and described, but these two genera doubtless show the same relationship as the Spirifers.

In the Gschelian Tschernyschew recognizes Spiriferidæ belonging to the genera *Spiriferina*, *Spiriferella*, *Spirifer*, *Martiniopsis*, *Martinia*, and *Squamularia*. Eight species are referred to *Spiriferina*. *Spiriferina simensis*, the only representative of the group of that name, is not represented in the Guadalupian fauna, although *S. sulcata* may be compared with it in some respects. At best the relationship is only distant. The group of *S. insculpta*, which includes the two Gschelian species *S. ornata* and *S. holzapfeli*, is represented in the Guadalupian by *S. billingsi*, which is especially comparable to *S. ornata*. Tschernyschew places three species in the group of *S. cristata*. In configuration *S. cristata* and *S. panderi* somewhat suggest *S. laxa* and *S. hilli*, while the Guadalupian fauna contains nothing similar to the third species, *S. expansa*. But the sculpture of *S. laxa* and its allies is such that I am disposed to believe the group of *S. cristata* to be absent from the Guadalupian fauna, unless it is represented by *S. hilli*. The group of *S. laminosa*, comprising *S. laminosa* var. *sterlitamakensis* and *S. pyramidalis*, is represented in the Guadalupian, if at all, by *S. billingsi* and its allies. The Guadalupian species *S. pyramidalis*, while similar in configuration, appears to be entirely different in surface-ornamentation, though this statement is only provisional, the ornamentation of one of the Russian species being unknown. The subgenus *Spiriferella*, comprising four species, is, so far as known, wanting in the Guadalupian fauna, though some of the species superficially suggest the form which I have designated merely as *S. mexicanus* var.

Of *Spirifer* Tschernyschew distinguishes no less than 24 species, most of which are absent or scantily represented in the Guadalupian fauna. He places six species in the group of *S. striatus*, which, so far as they have any corresponding Guadalupian forms, find them in the rare and imperfectly known *Spirifer* sp. *b*. They are nearly allied to Spirifers in the underlying Hueco formation. From Tschernyschew's figures I would doubt whether the form he calls *S. cameratus* was correctly identified. Characteristic *S. cameratus* is more like *S. fasciger* in configuration, and never, so far as I am aware, passes into forms with high flat areas, like that shown by Tschernyschew's fig. 3 of Pl. XI. The groups of *S. clarkei* and *S. alatus*, comprising between them three species, appear to be entirely absent from the Guadalupian fauna. The group of *S. lyra*, which includes three Gschelian species, is more closely related to the forms grouped with *S. mexicanus* than to *S. mexicanus* itself. *S. lyra* and *S. tibetanus* are similar in many ways to *S. mexicanus* var. *compactus*, and *S. interplicatus* var. *baschkirica* to *S. mexicanus* var. To the group of *S. mosquensis* Tschernyschew refers three species which can be compared to *S. mexicanus*. This is particularly true of *S. nikitini*, some figures of which resemble the Guadalupian species very closely. The group of *S. ventricosus* with one species, that of *S. trigonalis* with one, that of *S. melissenis* with one, that of *S. integricosta* with five, and that of *S. triradialis* with one, are probably unrepresented in the Guadalupian fauna.

The genus *Martiniopsis*, which contains six Gschelian species, is not found in the Guadalupian fauna. Two of Tschernyschew's species possess a feature which I believe to be unprecedented in this group, viz, an unusually distinct fold and sinus and well-marked lateral ribs. The figures of *M. aschensis* and *M. baschkirica* are very suggestive of Spirifers of the *lyra* and *mosquensis* groups. The American forms *S. mexicanus* and *S. mexicanus* var. *compactus*, which are supposed to be related to the Gschelian ones, possess large and very distinct dental plates, while the presence of plates in the dorsal valve (a distinguishing feature of *Martiniopsis*) does not seem to have been ascertained by Tschernyschew. Thus, except for the minute sculpture, it would seem to me that these two aberrant types of *Martiniopsis* might possibly be Spirifers of the *lyra* and *mosquensis* groups. The surface characters are lost in the American shells supposed to represent these groups and appear to have been destroyed in some of the Russian shells also, as in several instances they are not mentioned by Tschernyschew.

Fifteen representatives of *Martinia* are included in Tschernyschew's Gschelian fauna. This is a rather remarkable representation, and when I say that it consists for the most part of types which are alien to the Guadalupian fauna, the statement is made relatively to the very slight differences on which alone the distinction of species in this group is for the most part practicable. It may at least be said positively that the plicated forms of *Martinia*, of which Tschernyschew cites three species under the title "Group of *Martinia linguifera*," are not found in the Guadalupian fauna. These well-ribbed species depart so far from the characteristic *Martinia* expression that one can not banish a feeling that they should be referred to some other genus. The group of *M. polymorpha*, which includes but a single Gschelian species, is represented in the Guadalupian also by one species, *M. shumardiana*, which seems to be closely related to the Russian form. The remaining Russian species, however, are in some cases readily distinguishable from either of the Guadalupian types, and in any event are represented in the American fauna only by the form which I have called *M. rhomboidalis*. Unfortunately, the minute superficial characters of the two American species can not be determined.

Like the Martinias, the Squamularias hold very closely to a single type, and the Squamularias of the Gschelstufe appear from Tschernyschew's figures to be closely related to those of the Guadalupian. The form identified as *Reticularia lineata* especially, but also those identified as *Reticularia* sp. cf. *elegantula*, and *Reticularia* sp. aff. *caroli* suggest *Squamularia guadalupensis*. *Reticularia rostrata* probably has no Guadalupian and the two varieties of *Squamularia guadalupensis* no Gschelian representatives. I am assuming that Tschernyschew's forms are without dental plates, like the Guadalupian shells, and that they do not belong strictly to *Reticularia*, where he places them, but probably to *Squamularia*, which Gemmellaro established on quite other characters.

Among the Ambocœlias Tschernyschew distinguishes two species, of which that referred to *A. planiconvexa* is clearly the more closely allied to the Guadalupian species. The two are in fact highly similar, both to one another and to the Pennsylvanian form *A. planiconvexa*. Like the Squamularias and Martinias, the Ambocœlias possess but few and limited lines of differentiation, and while not much stress can be laid on the specific resemblance in these three occurrences, the fact of the generic presence is of some interest, as *Ambocœlia* appears to have a somewhat restricted distribution and to be absent from many faunas where it would be looked for.

In considering the Spiriferidæ of the Gschelian fauna of the Ural and Timan in relation to those of the Guadalupian many differences become apparent. These are due more to types which are found in the Gschelian but not in the Guadalupian than to such as are found in the Guadalupian and not in the Gschelian. Least true is this in the case of the genus Spiriferina, for apparently the spinose types, such as *S. laxa*, *S. pyramidalis*, etc., do not occur in the Gschelian fauna, nor anything comparable to *S. welleri*.. It is especially true of the Spirifers and Martinias. These groups show a differentiation in the Gschelian fauna, with which the Guadalupian can exhibit nothing to compare, while the few Guadalupian species find for the most part what may be considered equivalent types in the Gschelian. The latter fauna, especially in the case of *Spirifer*, contains numerous species which are either entirely lacking in the Guadalupian or represented by forms so rare and imperfectly known that nothing definite can be stated as to their relationship. An exception must be made in the case of the genus *Martiniopsis*, which is unknown in the Guadalupian fauna. The Squamularias and Ambocœlias, however, are closely similar, the Gschelian containing, as usual, some types peculiar to it. In these genera not much stress can be laid on the resemblance in specific characters. The presence of *Ambocœlia* as a genus in the two faunas, however, may not be without significance, for it appears to be more restricted in distribution than *Squamularia*, which is found almost everywhere at these horizons.

I will not pause over Nikitin's and Stuckenberg's papers on the Gschelian Spiriferidæ, for with one or two exceptions all the species which they quote are found in Tschernyschew's work, but will pass on to comparisons with the Artinskian fauna. In his paper on the Artinskian brachiopods of the southern Urals Tschernyschew cites species of *Spirifer*, *Spiriferina*, *Reticularia*, and *Martinia* (?). They seem to be on the whole much the same as those of the Gschelian, though less varied. The Spirifers include *S. fasciger*, *S. wynnei?* and *S. marcoui* (represented in the Guadalupian possibly by *Spirifer* sp. *b*.), *S. alatus* (without any Guadalupian representative), and *S. waageni*. The latter species appears not to be found in the Gschelian, and is related in some respects to *Spirifer sulcifer* and even *S. mexicanus* var. *Spiriferina cristata* is represented by *S. hilli*, etc., if at all. *Spiriferella saranæ* has no corresponding type in the Guadalupian, unless perhaps *Spirifer mexicanus* var. may rather distantly resemble it. *Reticularia lineata* may of course be compared with *Squamularia guadalupensis* and *Martinia? subplana* to a very limited extent with *M. rhomboidalis*.

In his work on the fauna of the Artinsk sandstone Krotow cites nine species of *Spirifer* and seven of *Spiriferina*. Among the Spirifers we may distinguish *Spirifer* sensu stricto, *Squamularia* (*Spirifer lineatus*), *Martinia* (*Spirifer glaber*), and *Ambocœlia* (*Spirifer clannyanus*). Among the Spiriferinas are also included representatives of Tschernyschew's genus *Spiriferella* (*Spiriferina saranæ*). The only species which Krotow figures is *Spiriferina acutirostris* n. sp., which resembles *Spiriferina sulcata* of the present report.

While the genera of Stuckenberg's fauna are practically the same as those which occur in the Guadalupian, it is doubtful if any essential relationship exists between them. He cites from the Artinsk *Spirifer poststriatus*, *S. crassus*, and *Spirifer* sp., probably without representatives in the Guadalupian. So are also *Spiriferella artiensis* and *Spiriferella saranæ*. *Spiriferina subconica*, *S insculpta*, and *S. hoferiana* are not figured. *Reticularia lineata*, *Reticularia* (*Ambocœlia?*) *clannyana*, and *Martinia glabra*, also not figured, correspond in some degree at least to *Squamularia guadalupensis*, *Ambocœlia planiconvexa* var. *guadalupensis*, and *Martinia rhomboidalis*. From the Kungurstufe Stuckenberg cites *Spirifer poststriatus* (possibly related to *Spirifer* sp. *b*), *S. triangularis* (non-Guadalupian, so far as known), *Spiriferella saranæ* (probably non-Guadalupian), *Spiriferina panderi*, *S. insculpta* (whose relation with Guadalupian Spiriferinas is not to be determined), *Reticularia lineata* (comparable to *Squamularia guadalupensis*), and *Ambocœlia planiconvexa* (similar to *A. planiconvexa* var. *guadalupensis*). The Spiriferidæ of the Artinsk, considered in this imperfect way, impress me as rather less closely allied to the Guadalupian species than those of the Gschelian. The Artinsk fauna seems to be much less rich than that of the Gschelian, and it consequently lacks many types of Spiriferidæ which, absent in the Guadalupian also, constitute an element of difference between the Guadalupian and the Gschelian. It lacks, as well, types which are found both in the Guadalupian and in the Gschelian and constitute a bond between them. One interesting feature of the Guadalupian Spiriferidæ is the differentiation of the genus *Spiriferina*, fully equal to that of the Gschelian, whose Spirifers far surpass the Guadalupian representation, and much greater than that of the Artinsk. So far as I may judge, the brachiopods of the Artinsk fauna are a decimated survival of the Gschelian, with some new forms introduced; but my means of gaining a survey of the Artinskian species are so fragmentary and imperfect that in the case of the Spiriferidæ, as in that of some other families, I feel incapable of forming a just conception of their relation to the Guadalupian, especially when such a relation is set off against that of the more extensive and apparently better known Gschelian.

The Permian Spiriferidæ from the government of Kostroma, as determined by Tschernyschew, seem to be reduced to a single species, *Spiriferina cristata*, which may be represented by *S. hilli* and its allies, but may be without a parallel form in the Guadalupian fauna. Relatively much more extensively developed does this group appear in Netschajew's paper on the Permian fauna of eastern Russia. Three species of *Spirifer* cited by this author appear to be without Guadalupian relatives; the fourth, if considered in the light of De Verneuil's good figures instead of Netschajew's poor ones, seems to be closely allied to the form from the "dark limestone" which I have designated *Spirifer mexicanus* var. *Spiriferina cristata* is possibly to be compared with *S. hilli* and the forms related to it, but may not be represented in our fauna at all. The shell figured as *Reticularia clannyana* is probably an *Ambocœlia*, and in configuration much resembles *A. planiconvexa* var. *guadalupensis*. The little shell called *Reticularia nucella* also suggests a species of *Ambocœlia* in its configuration, but the convexity of the dorsal valve is unusually great. If really a *Reticularia* or *Squamularia* its different shape places it beyond comparison with *Squamularia guadalupensis*.

The only species of Spiriferidæ cited in Golowkinsky's paper on the Russian Permian are *Spirifer rugulatus* and *Spiriferina cristata*. The former has no Guadalupian *Spirifer* at all resembling it, and the latter, while possibly related to *Spiriferina hilli*, is considerably different from *S. billingsi* and the dominant group of Guadalupian Spiriferinas.

Among the Permian Spiriferidæ described by De Verneuil *Spirifer blasii*, as before remarked, is suggestive in general expression of the Guadalupian form which I have called *S. mexicanus* var. It also is very like certain round-winged varieties of *S. cameratus* from the Pennsylvanian of the Mississippi and Ohio valleys. The other Spirifers, *S. hystericus?*, *Spirifer* sp., and *S. curvirostris*, are so far as known without Guadalupian representatives.

Of the different types of the Spiriferidæ found in the Russian Permian *Spirifer*, *Spiriferina*, *Ambocœlia*, and possibly *Squamularia* occur in the Guadalupian as well, while the American fauna contains *Martinia* and possibly *Squamularia*, which are absent from the typical Permian. The Spirifers of the Guadalupian compare with those of the Permian of Russia somewhat as with those of the Gschelian and Artinsk, as the Russian fauna possesses a number of types not known in the Guadalupian. The Guadalupian Spiriferinas reverse the matter, showing a greater differentiation than either the Artinsk or Permian, and so far as I can judge containing types which are absent from any of the Russian faunas. In view of the representation of these groups in the Mesozoic, the decline of the Spirifers and the rising differentiation of the Spiriferinas in the Guadalupian would not be without significance. So far as I grasp the facts and estimate from them, the Guadalupian in its Spiriferidæ is only moderately related to either the Gschelian, Artinsk, or Permian fauna of the Russian section, and possibly a little less to the Artinsk than to the Permian and Gschelian.

A remarkable feature of the fauna from Djoulfa, in Armenia, which Abich described, is the complete absence of the Spiriferidæ, a family so widely present in the Carboniferous and often so well differentiated and abundant. The collection studied by Abich was apparently not quite representative in this respect, however, for in a subsequent paper by Arthaber a collection from what appears to be about the same locality and horizon shows the group to be present, at least so far as the genera *Spiriferina*, *Ambocœlia*, and *Reticularia* are concerned. The absence of *Spirifer* still remains an anomaly, a corresponding condition to which is also evidenced in another direction by the absence of *Producti* of the *semireticulatus* group. Of *Spiriferina*, the only species cited by Arthaber is *S. cristata*, which is possibly represented in the Guadalupian by *S. hilli* et al. To *Ambocœlia* is referred a single Armenian species, identified as *A. planiconvexa*, but referred to the genus *Martinia*. Arthaber states that the external surface of his shell has clearly a punctate structure, from which I am led to suspect that his form really is a *Martinia*, and consequently not referable to *Ambocœlia planiconvexa*. He also distinguishes three species of *Reticularia*. That identified as *Reticularia* cf. *pulcherrima* Gemm. is probably absent from the Guadalupian fauna, but *R. waageni* and *R. indica* are very similar to *Squamularia guadalupensis* var. *subquadrata* and *S. guadalupensis* var. *ovalis*, respectively. There seems to be nothing to compare to *S. guadalupensis* itself. The Spiriferidæ of the Armenian fauna, therefore, show but little connection with the Guadalupian.

The fauna from Balia Maaden, in Asia Minor, contains, according to Enderle, Spiriferidæ belonging to the genera *Spiriferina*, *Spirifer*, *Martiniopsis*, *Martinia*, and *Squamularia*. If *Spiriferina? baliensis* really belongs to the genus indicated, it is a remarkable type and comparable only to *S. welleri* of the Guadalupian fauna. It has the general appearance of a *Spirifer* of the *keokuk* group. Only dorsal valves are known. The punctate structure is not mentioned, and on what the reference to *Spiriferina* is really based does not appear. Of *Spirifer* the five species, *S. striatus* var., *Spirifer* cf. *duplicicosta*, *Spirifer* sp., *S. supramosquensis*, and *S. melissensis*, have no very close allies in the Guadalupian, especially the last two. *S. striatus* var. and *Spirifer* cf. *duplicicosta* are perhaps remotely related to the form which I have called *S. mexicanus* var.

Martiniopsis subpentagonalis, representing the genus *Martiniopsis*, has no related type in the Guadalupian. *Martinia nucula* is allied, though not very closely, to *M. rhomboidalis*. The shell referred to *M. planiconvexa* Shumard though not figured may be inferred to be an *Ambocœlia* and related to *A. planiconvexa* var. *guadalupensis*. *Reticularia lineata* and *R. indica*, which are not figured, presumably resemble *Squamularia guadalupensis*, but this is not true of the crushed specimen figured as *Reticularia caroli?*. Though a general resemblance can be traced between the fauna from Balia Maaden and that from the Guadalupe Mountains, it does not appear to me to be at all close.

The Spiriferidæ in the fauna from Palermo described by Gemmellaro comprise the genera *Cyrtina*, *Spiriferina*, *Spirifer*, *Martinia*, *Squamularia*, and *Reticularia*. *Cyrtina josephinæ*, the only representative of *Cyrtina*, has no corresponding species in the Guadalupian. *Spiriferina pyramidalis* resembles it to some extent in configuration, but so far as known belongs to a different genus. In Gemmellaro's fauna there are recorded eight species of *Spiriferina*. On account of their peculiar surface ornamentation, though they are more or less similar in configuration, I judge that *S. papillosa* and *S. elegantissima* have no corresponding forms in the Guadalupian. *S. margaritæ* appears to me unquestionably the representative of *S. billingsi* Shumard, and *S. rupicola*, *S. salamonensis*, and *S. toulai* appear to be modifications of it. A modification similar to the last of these, at least, is as yet unknown in the Guadalupian fauna; but, on the other hand, the Guadalupian contains *S. sulcata*, which is without a parallel among the Italian species. So far as I have ascertained, the spinose group *S. laxa*, *S. pyramidalis*, etc., as well as *S. welleri*, are not represented in the Italian fauna, and probably *S. hilli* et al. are also without a representative. *S. schellwieni* seems to represent a type which does not occur in the Guadalupian, but *S. tornata* can possibly be correlated with *S. evax*.

Gemmellaro distinguishes 14 species of *Spirifer*, most of which appear to be without correspondence in the Guadalupian. *Spirifer battu* can apparently be correlated with *S. sulcifer*, but *S. siculus* (though it may be distantly connected with *S. mexicanus*), *S. trigonalis*, and *S. distefanii* may fairly be said to be non-Guadalupian types. While some of the figures of *S. siculus* remotely resemble *S. mexicanus*, others somewhat suggest *Spirifer* sp. *b*.

In the genus *Martinia* Gemmellaro distinguishes 17 species, discriminated, as it must appear to one who knows only the figures, on rather slight differences. Probably the Guadalupian Martinias would by a smaller scale of differences admit of greater subdivision, but even if desirable so many of my specimens are imperfect or consist of separate valves that I doubt whether it would be practicable. At all events, the Sicilian species appear to have furnished a much greater representation in individuals and also a greater differentiation than the Guadalupian. Some of the Sicilian forms represent types at present unknown in the Guadalupian (e. g., *M. polymorpha*, *M. bisinuata*, etc.), and some are very closely related to the two species which I have recognized. Thus *M. rupicola* and *M. distefanoi* may be compared to *M. rhomboidalis*, and *M. cornelia* and *M. bittneri* to *M. shumardiana*. The remaining forms from Sicily are less similar to the two Guadalupian types.

It is doubtful if there is anything in the Guadalupian to correspond with Gemmellaro's two species of *Squamularia*. It is almost certain that there is not if they are generically distinct from the group that he called *Reticularia*, to which all the Guadalupian species belong and to which, since I believe it to be different from true *Reticularia*, I have extended the generic name "*Squamularia*." Gemmellaro recognizes six species of *Reticularia*, distinguished by differences as slight as some of those between his Martinias seem to be. The majority of the Guadalupian Reticularias, all of which I have identified as *Squamularia guadalupensis*, resemble Gemmellaro's figures of *Reticularia lineata*, while *S. guadalupensis* var. *subquadrata* resembles *Reticularia affinis* and *R. caroli*. The remaining Sicilian species have no Guadalupian equivalents, and *S. guadalupensis* var. *ovalis* is unrepresented in the Sicilian fauna.

Considered as a whole, the Sicilian Spiriferidæ appear to me more closely related to the Guadalupian than most of the faunas with which comparisons have been made. The Guadalupian fauna contains *Ambocœlia* and the Sicilian *Squamularia* sensu stricto, genera in each case not found in the other. A similar condition holds true of the Spirifers and Spiriferinas, each fauna having certain types peculiar to it. The Squamularias and especially the Martinias from Palermo are more highly differentiated than those from the Guadalupe Mountains and contain types at present unknown in the Guadalupian fauna.

In his paper on the fauna of the Carnic Fusulina limestone Schellwien cites the genera *Reticularia*, *Martinia*, *Spirifer*, and *Spiriferina* belonging to the Spiriferidæ. The form referred to *Reticularia lineata* probably is cognate to the Guadalupian species *Squamularia guadalupensis*. *Martinia frechi* of Schellwien is almost certainly an *Ambocœlia* related to *A. planiconvexa* var. *guadalupensis*. *Martinia semiplana* and *Martinia* cf. *glabra* appear to be without corresponding forms in the Guadalupian, which, on the other hand, contains *M. shumardiana*, not represented in the Carnic Fusulina limestone. *M. carinthiaca* of the latter probably corresponds to *M. subquadrata*, but it appears to some extent to be intermediate between the two Guadalupian species.

The Carnic Spirifers show many differences from the Guadalupian species. *Spirifer* cf. *striatus* and *S. fasciger* are probably represented by *Spirifer* sp. *b.*, while the remaining members of the genus, *S. fritschi*, *S. carnicus*, *S. carnicus* var. *grandis*, *S. trigonalis* var. *lata*, *S. zitteli*, and *S. zitteli* var., probably are without representatives in the Guadalupian unless in the same imperfectly known species.

Spiriferina coronæ belongs to the spinose group of Spiriferinas, which seems to be rare except in North America, and it is to be compared to *S. laxa* and *S. pyramidalis*, although specifically quite distinct from either. In configuration *S. hilli* and the forms grouped with it are probably even more similar, and it may be that they had a similar type of sculpture.

Distinctly more closely related than the foregoing are the Spiriferidæ of the Trogkofelschichten. In this fauna Schellwien recognizes species belonging to *Spirifer*, *Spiriferina*, *Martinia*, *Ambocœlia*, and *Squamularia*. The group of *Spirifer striatus*, comprising the single species *S. fasciger*, is represented in the Guadalupian, if at all, by *Spirifer* sp. *b*. To the group of *S. mosquensis*, also represented by a single species, there is probably no corresponding type in the Guadalupian. Some forms, referred to *S. fritchi*,[a] it is true, are very suggestive of *S. mexicanus*. The group of *S. trigonalis*, with three species, has, so far as known, no similar Guadalupian forms. The group of *S. duplicicosta*, containing three species, is represented in the Guadalupian by *S. mexicanus* and its allies, *Spirifer wynnei* and *S. tibetanus* var. *occidentalis* answering to *S. mexicanus* and *S. mexicanus* var. *compactus*, though the resemblance is not perhaps very close. The group of *S. battu* appears to be closely related to *S. sulcifer* Shumard. The group of *S. trigonalis*, with two species, is probably alien to the Guadalupian fauna, and the same is true of *S. quadriradiatus*, representing the group of *S. triradialis*. The form which Schellwien describes as *Spirifer bistritzæ* resembles *Spiriferina pyramidalis* in configuration, but appears to have no closely related form among the Guadalupian Spirifers.

The only *Spiriferina* in Schellwien's fauna is referred by him to *S. cristata* var. *fastigata*. The configuration is suggestive of *S. billingsi*, but the surface seems to be without the regular strong concentric lamellæ of Shumard's species.

The form identified by Schellwien as *Spirifer* (*Reticularia*) *lineatus* is closely allied to *Squamularia guadalupensis* var. *subquadrata*, but to *Spirifer* (*Reticularia*) sp., so far as known, there is no corresponding Guadalupian type; nor to *Spirifer* (*Reticularia*) *dieneri*, whose configuration is much the same as that of some of the shells which I have placed with Shumard's *Squamularia guadalupensis*, but with a different sculpture. *Spirifer* (*Reticularia?*) *stachei* seems to be quite distinct from any Guadalupian species.

Of the three species of *Martinia* recognized in the fauna of the Trogkofelschichten, two—*Spirifer* (*Martinia*) sp. undet. aff. *contractus* and *Spirifer* (*Martinia* or *Reticularia?*) sp. indet.—in their configuration somewhat suggest *Martinia rhomboidalis*, but the third species, *Spirifer* (*Martinia*) *macilentus*, is without Guadalupian representatives, while nothing corresponding to the Guadalupian *Martinia shumardiana* is found in Schellwien's fauna.

Schellwien places two of his species with *Ambocœlia*, but they are not, for the genus, closely related to *Ambocœlia planiconvexa* var. *guadalupensis*, and they lack to a considerable extent the usual configuration of the American Ambocœlias.

On the whole, while a resemblance certainly exists between the Guadalupian Spiriferidæ and those of the Trogkofelschichten it does not seem to me to be very close.

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[a] Abhandl. K.-k. geol. Reichsanstalt, vol. 16, part 1, 1900, p. 72, figs. 10, 11.

Gortani cites the following Spiriferidæ from the Carnic Alps: *Spirifer striatus*, *S. trigonalis* var. *bisulcatus*, *S. carnicus*, *S. lyra*, *S. lyra* var. *alpinus*, *Reticularia lineata*, *Martinia semiplana*, and *Spiriferina cristata* var. *fastigata*. The three Spirifers first mentioned appear to belong to types not found in the Guadalupian, and even *S. lyra* and the variety *alpinus*, as represented by Gortani's figures, carry but slight suggestion of *Spirifer mexicanus*. *Reticularia lineata* naturally resembles *Squamularia guadalupensis*, but it is doubtful if *Martinia semiplana* is closely related to either of the Guadalupian Martinias. The *Spiriferina*, as figured by Schellwien, has much the configuration of *Spiriferina billingsi*, but may not be really related to it.

In the Dyas of Germany, as described in Geinitz's well-known monograph, the Spiriferidæ are represented by *Spirifer*, *Spiriferina*, and *Ambocœlia*, *Squamularia* and *Martinia* of the Guadalupian being missing. *Spiriferina cristata*, if represented in the Guadalupian at all, appears to be related to *S. hilli* and its allies. *Spirifer alatus* is, so far as known, unrepresented in the Guadalupian, and so are also *S. schrenki* and *S. curvirostris*. The same is perhaps true of *S. rugulatus*, but *S. blasii* probably corresponds to *S. mexicanus* var. *Ambocœlia clannyana* is related to the Guadalupian *Ambocœlia*.

In spite of the resemblances which have been pointed out, the Spiriferidæ of the Guadalupian do not seem to be closely allied to those of the Dyas. The family is much better developed in the American fauna, and the types which the two possess in common are less numerous and considerable than those which are peculiar to each.

The same holds true of the Permian fauna of England, which is so closely related to the Dyas of Germany. *Spiriferina cristata* and probably *S. jonesiana* are without Guadalupian representatives unless it may be among the imperfectly known *S. hilli* and the forms related to it. *S. multiplicata* can probably be correlated with *S. billingsi*.

Spirifer alatus, *S. undulatus*, and *S. permianus*, the three species of *Spirifer* which King recognizes, have no Guadalupian representatives. King describes these shells as having a punctate structure, but as subsequent writers have not placed them with *Spiriferina*, but *Spirifer*, it has seemed necessary to consider them here as belonging to the latter genus. *Martinia clannyana* and *M. winchiana* of King are probably both Ambocœlias. *A. clannyana* is more closely related to *A. planiconvexa* var. *guadalupensis* than *A. winchiana*.

De Koninck cited, from Spitzbergen, in 1847, a *Spirifer* identified as *S. alatus* and a *Spiriferina* referred to *S. cristata*. The latter is possibly related to *S. hilli* and the other species of the same group, but the former is of a type not found in the Guadalupian.

From the south point of Spitzbergen Toula in 1874 cited five species of *Spirifer*—two undetermined, one identified as *S. striatus*, and two described as new under the titles *S. striatiparadoxus* and *S. wilczeki*. So far as these *Spirifers* are represented in the Guadalupian it is in the imperfectly known form *Spirifer* sp. *b*.

From the Hornsund Toula later cited *Spiriferina höferiana*, *Spirifer wilczeki*, and *S. striatus*, together with *Squamularia lineata* and *S. lineata* var. *elliptica?*. The last two may probably be compared with *Squamularia guadalupensis*. The two Spirifers are to be correlated with *Spirifer* sp. *b*, if at all. Regarding the

Spiriferina but little can be said with safety. It seems to be more nearly of the type of *S. hilli* than of *S. laxa* and *S. pyramidalis* or of *S. billingsi*.

From the west coast of Spitzbergen Toula, in another paper, cites *Spirifer* cf. *alatus*, *S. cameratus*, *S. wilczeki*, and *S. draschei*. The first species probably stands without any allied form in the Guadalupian. *S. cameratus* and *S. wilczeki* appear to be of the same type as the little known and possibly composite *Spirifer* sp. *b*. *S. draschei*, which possesses the general expression of the shells comprising Tschernyschew's genus *Spiriferella*, has certain broad points of resemblance to *S. mexicanus* var., but it can hardly be said that they represent each other in the different faunas in which they occur. In the same publication, from a point on the cape between the two arms of the North Fjord, Toula cites *Spirifer striatus*, *S. striatiparadoxus*, and *Spiriferina?* sp. The two Spirifers are possibly represented by *Spirifer* sp. *b*, but as to the *Spiriferina* nothing can be ventured.

On the whole, it can not be said that the Spiriferidæ of the faunas from Spitzbergen show more than a distant relationship to those of the Guadalupian.

The same is true of the fossils from Nova Zembla which Toula identified at about the same time. Of the seven Spirifers, *S. wilczeki* and *S. cameratus* are probably allied to *Spirifer* sp. *b*, but *S. mosquensis* var., *S. trigonalis*, *S. triangularis*, and *S. laminosus* appear to belong to types not found in the Guadalupian. *S. duplicicostata?* (not figured) may prove to be more or less closely related to *S. mexicanus*. The shell figured as *Spirifer lineatus* var. presents some resemblance to *S. mexicanus* var. *compactus*, but if, as one would infer from Toula's identification, it is a representative of *Squamularia* or *Reticularia* its generic relations are quite different, though, on the other hand, it can not be compared with *Squamularia guadalupensis*. I venture to say nothing relative to the form cited without description or figures as *Spiriferina cristata* var. *octoplicata* save that it may prove to be in a general way the representative of *S. hilli* and its allies.

Under the caption "Fossils from the shaly sandstone of the middle region" Stache cites, from the West Sahara, four species of *Spirifer*, but the fauna is evidently so much older than that under consideration and the four species are so unlike the Guadalupian forms (so far as their poor condition admits comparison at all) that I will pass them by without further notice. Nor do the few imperfect forms from Igidi merit in this connection more careful consideration.

Among the fossils from Peru described by D'Orbigny the Spiriferidæ are represented only by the genus *Spirifer*, to which two species are referred, *S. condor* and *S. pentlandi*. Neither appears to have related forms in the Guadalupian.

Toula also published a report on some fossils from the Carboniferous of Bolivia, citing *Spirifer striatus* var. *multicostatus* and *Spiriferina octoplicata* among the Spiriferidæ. These are possibly related to *Spirifer* sp. *b* and *Spiriferina hilli*, respectively.

In the Brazilian fauna which Derby described the Spiriferidæ are represented by the genera *Spirifer*, *Spiriferina*, *Squamularia*, and *Ambocœlia*. The two species of *Spirifer* cited are identified as *S. cameratus* and *S. opimus*. The former is probably represented by the Guadalupian *Spirifer* sp. *b*, but to the latter there is no corresponding type in the Guadalupian fauna. *Squamularia perplexa* and *Ambocœlia* *planiconvexa* are related to the Guadalupian species *S. guadalupensis* and *Ambocœlia planiconvexa* var. *guadalupensis*. *Spiriferina transversa* of Derby is but distantly related to the nearest Guadalupian species, *S. billingsi*, but *S. spinosa* is somewhat more close to *S. laxa* and *S. pyramidalis*.

These Brazilian Spiriferidæ do not indicate any close relationship with the Guadalupian fauna. In fact they rather suggest an affinity with Pennsylvanian or even Pottsville faunas of the Mississippi Valley. Nor do the other South American Spiriferidæ present more than a remote resemblance to those of the Guadalupian. Too scanty for the establishment of more than a provisional opinion, they appear to be more similar to the Hueconian than to the Guadalupian representatives of the family.

In the typical Pennsylvanian fauna of North America this family is characterized at the same time by its slight differentiation and its persistence. In great contrast to the highly differentiated Spirifers of the "Lower Carboniferous," collections from the Pennsylvanian contain, as a rule, but a single species, *S. cameratus*, usually present and often abundant. In the lower beds *S. opimus* (=*S. rockymontanus*) is also found. *S. cameratus* is probably represented in the Guadalupian by *Spirifer* sp. *b*, but *S. opimus* has no corresponding species. The imperfectly known *S. boonensis* and the very rare *S. fultonensis* are more or less allied to *S. opimus*, and, like it, are without Guadalupian representatives. *S. multigranosus* and *S. texanus*, closely related to each other, are also extremely rare. They probably have no corresponding type in the Guadalupian. I have omitted from consideration some western forms, five or six in number, which occur in association with faunas whose stratigraphic position with relation to one another is not known and whose facies is more or less different from the characteristic Pennsylvanian. These faunas are also, so far as known, different from the Guadalupian, and the species themselves differ from the Guadalupian Spirifers.

Of the Pennsylvanian Spiriferinas almost the same may be predicated as of the Spirifers. Practically the only species which occurs in the Pennsylvanian faunas of the typical area is *S. kentuckyensis*. *Spiriferina spinosa*, or a form extremely closely related, is found in the upper Carboniferous of the West, and it ranges at least into the Pottsville faunas of the typical Pennsylvanian. *S. spinosa* is somewhat closely related to *S. laxa* and *S. pyramidalis*, but the relationship between *S. kentuckyensis* and *S. billingsi* is certainly remote. In the West, aside from species more or less closely allied to *S. spinosa* and *S. kentuckyensis*, we have the large and striking species *S. pulchra*, quite distinct from any Guadalupian form yet discovered. All the western species, so far as known, occur in a different faunal association from the Guadalupian.

Squamularia perplexa, which represents *S. guadalupensis* in the Pennsylvanian fauna, is, for the genus, not closely allied to it. The same may be said of the correlated species *Ambocœlia planiconvexa* and *A. planiconvexa* var. *guadalupensis*. *Martinia* is conspicuous by its absence in the Pennsylvanian faunas. A species of *Martinia* occurs, though rarely, in the upper Mississippian, and the same species has been identified at a much higher horizon in the West. The originals on which the latter citation is based, however, prove on examination to belong to the genus *Squamularia*.

In view of their relatively close geographic position the Spiriferidæ of the Guadalupian fauna show really remarkable differences when compared with the Pennsylvanian. Even in the two genera *Ambocœlia* and *Squamularia*, where discriminable species are rare, there can be little doubt as to the different representation in the two faunas. *Martinia*, a fairly common form in the Guadalupian, is unknown in the Pennsylvanian. The common Guadalupian species of *Spirifer* have nothing even of the same general type in the Pennsylvanian, but it is in the genus *Spiriferina* that the most striking differences appear. Not only is this genus much more richly differentiated in the Guadalupian fauna, but many of the types (such as *S. billingsi*, *S. evax*, *S. sulcata*, and *S. welleri*) are without any species even related to them in the typical Pennsylvanian.

Genus SPIRIFER Sowerby.

The difficulty of properly grouping the Guadalupian Spirifers is enhanced by the fact that all but a few species, which are abundant and closely related to one another, are imperfectly known. For the present it seems best to recognize only three groups among them, one of which may be distinguished as the *cameratus* group, another as the *sulcifer* group, and the third as the *mexicanus* group.

To the *cameratus* group has been referred only the form here designated as *Spirifer* sp. *b*, and the association of these fossils with *S. cameratus* is open to some challenge. The salient characters of *S. cameratus* are these: It has a transverse shape and prolonged cardinal angles; the ribs are grouped into raised fascicles and crossed by sets of fine radiating and concentric liræ, producing a surface which, owing either to varying preservation or to real variation, in some specimens appears to be marked by radiating and concentric rows of elevated points or papillæ; there are well-developed dental plates in the ventral valve, which, however, are obscured by an extensive apical callosity. As elsewhere explained, it is possible that three varieties are embraced under the title *Spirifer* sp. *b*. All are known from very fragmentary material, but probably agree in having the fasciculated ribs and the transverse alate shape of *Spirifer cameratus*. Their internal structure is unknown. The sculpture is retained in only one example, where it appears to consist only of very faint concentric lines, and thus to be somewhat different from *S. cameratus*.

To the group of *Spirifer sulcifer* belong *S. sulcifer* itself and possibly also *Spirifer* sp. *a*. *S. sulcifer* is probably more closely related to *S. mexicanus* than a casual inspection of well-characterized examples would indicate. To a certain extent *Spirifer* sp. *a* is intermediate between them, while young examples of *Spirifer mexicanus* var. are very suggestive of *S. sulcifer*.

The group of Spirifers, of which *S. mexicanus* is a representative form, is interesting and in many respects peculiar. Internally these shells are characterized by possessing in the ventral valve remarkably large dental plates. It is probably true, as stated by Hall and Clarke, that these structures have comparatively little taxonomic value in this group of forms. Dental plates seem to have been developed in many species in which their presence is concealed by a shelly deposit which has filled the whole apical region. The absence of any such callosity in *S. mexicanus* allows the plates to be seen in their complete force, and makes them a rather striking if not a very important feature.

Externally, both on account of their configuration and also of their surface ornamentation, the shells of the *mexicanus* group differ widely from any American representatives of the genus hitherto known. Related as they probably are to certain groups of Asiatic and European forms, the Guadalupian species are nevertheless somewhat peculiar. The sculpture consists, macroscopically, of bifurcate and fasciculate ribs, and while this character would appear to ally these shells with *S. cameratus*, their configuration belies the relationship. The fasciculation differs from that of *S. cameratus* in that the ribs are raised or bundled only near the hinge line. Their grouping into fasciculi over the rest of the shell depends rather on spacing and community of origin than on elevation of the fascicles. The finer surface ornamentation in most specimens has been lost by exfoliation, but to judge by a few external molds and silicifications it probably consisted of concentric liræ, which are abundant and strong only near the anterior and lateral edges. These shells have a short hinge line and an ovate shape, the lateral passing into the cardinal outline almost without interruption. There is a deep though not sharply defined sinus in the ventral valve, but no corresponding elevation on the dorsal. The real limits of the fold, however, are clearly indicated by the spacing of the ribs. From these peculiarities it will be seen that if related to *S. cameratus* the type as seen in *S. mexicanus* is greatly modified.

In the group of *Spirifer mexicanus* I am including at present, aside from *S. mexicanus* itself, chiefly *S. mexicanus* var. *compactus* and *S. mexicanus* var. There is some uncertainty as to the proper disposition of the imperfectly known form which is here designated as *Spirifer* sp. *a*. In some respects it shows declared relationship with *S. mexicanus* through the variety *compactus*, and on the whole it has seemed best to place it in the present group, but, as before remarked, it may possibly prove more nearly allied to *S. sulcifer* than is at first plain.

SPIRIFER MEXICANUS Shumard.

Pl. XIII, figs. 1 to 6a.

1858. *Spirifer Mexicanus*. Shumard, Trans. Acad. Sci. St. Louis, vol. 1, p. 292 (date of volume, 1860). White Permian limestone: Guadalupe Mountains.
1859. *Spirifer Mexicanus*. Shumard, idem, p. 390, pl. 11, figs. 4a, 4b. White [Permian] limestone: Guadalupe Mountains.

Shell rather large, broad ovate, moderately gibbous in young age, extremely so in full-grown specimens; greatest gibbosity near the middle; length and breadth nearly equal; cardinal margin considerably less than the greatest width, which is found near the middle of the smaller valve; lateral margins rounded; front sinuate. Ventral valve (receiving valve) regularly arched, much more prominent than opposite one, having a deep, narrow sinus extending from beak to front; sides rounded; cardinal margin equal to about one-half the width of the valve; cardinal angles rounded and obtuse; beak prolonged, elevated, incurved, pointed at extremity; area small, triangular, concave, arcuated, longitudinally striated, sides forming an angle of about 76°, deltoid opening a little wider than long. Dorsal valve broad elliptical, regularly convex, gibbous in full-grown specimens; beak small, pointed, incurved, and slightly passing the cardinal border; area narrow, its margin gently arcuate. Surface marked with rounded, irregular, radiating, usually trifurcate ribs, which are indistinct on the lateral margins; they are separated by shallow furrows, and the number on the border amounts to from 18 to 24 on each side of the mesial sinus.

The dimension of a young specimen are: Length and width, 0.76; thickness, 0.48. Of a full-grown individual: Length and width, about 1.34; thickness, 0.98.

Abundant in the white Guadalupe limestone of Permian age, Guadalupe Mountains, New Mexico and Texas.[a]

The foregoing is Shumard's original description of this species, to which the material in my possession permits me to add few details. One rather striking feature of this shell is the absence of an elevated mesial fold on the dorsal valve, a circumstance which, conjoined with the strong angular sinus of the opposite valve, produces a deep indentation on the front margin. Although not elevated above the rest of the surface, the limits of the fold are indicated by sulci somewhat broader than those dividing the other ribs. The latter, while frequently bifurcated, are not grouped in elevated bundles or fascicles, except perhaps occasionally in young shells (Pl. XIII, fig. 6). In large examples this arrangement is inconspicuous. The minute surface ornamentation has been destroyed in my material. The best preserved surfaces have only a frosted appearance, without radiating or concentric striæ or pustules.

Spirifer mexicanus is not uncommon at station 2926 in the white limestone, from which most of my collection was obtained. But few of the specimens reached a size as great as the largest mentioned by Shumard, which was probably somewhat above the average.

The most distinctive features of this species are its short hinge and rounded cardinal angles; its rather flat dorsal valve, almost without an elevated fold, a fact which combined with the deep sinus of the ventral valve produces a strong emargination of the anterior outline; and the rather obscure ribs (more so on the dorsal than on the ventral valve), which, though grouped by reason of bifurcation, are scarcely bundled into elevated fascicles.

Horizon and locality.—Middle of Capitan formation, Capitan Peak (station 2926); base of Capitan formation, hill southwest of Guadalupe Point (station 2906); "dark limestone," Pine Spring (station 2930), Guadalupe Mountains, Texas.

SPIRIFER MEXICANUS var. COMPACTUS n. var.

Pl. XIII, figs. 7 to 9.

Associated with typical *Spirifer mexicanus*, though in somewhat less abundance, are some shells which I think should be discriminated as a variety, though they are more or less connected with the common type and probably do not constitute a distinct species. These fossils are more narrow and elongate in shape, with a stronger convexity. The ribs are somewhat coarser, and are usually simple. Except for the type, the specimens referred to this variety are more or less fragmentary, but show departures from it along several lines. Some of them surpass it considerably in size. In some the sinus is shallower and less strongly marked, and in others the ribs are fainter and almost obsolete. I should not fail to remark that the ribs of the dorsal valve are different from those of the ventral, are in fact almost the reverse of them, for while the ventral ribs are low, broadly rounded, and with

[a] Trans. Acad. Sci. St. Louis, vol. 1, 1856–1860, p. 292.

shallow, angular sulci, those on the dorsal valve are low, subangular, and with shallow, curved sulci. This character, as well as the others, is shown in the accompanying figures.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926).

SPIRIFER MEXICANUS var.

Pl. XXI, figs. 1 to 1b.

The collection made at station 2930, which probably consists chiefly of fossils from the "dark limestone," contains a form which departs in some ways from the typical *Spirifer mexicanus*, but my material is too scanty and imperfect to permit me to give a satisfactory diagnosis of it. Suffice it to say that it resembles Shumard's species in general appearance, differing chiefly in having the ribs grouped in raised fascicles, as in *S. cameratus*, and in having a larger delthyrium, with narrow areal borders. Possibly other distinctions sufficient to characterize a new species might be discovered if my material were more abundant and more perfectly preserved. Although the fasciculate surface of this shell is suggestive of *S. cameratus* and *S. texanus*, the short cardinal margin distinguishes it immediately from the former and emphasizes its apparent relation to the latter. The absence of an elevated fold on the dorsal valve and the presence of discrete dental plates in the ventral distinguish it, as well as the other forms of this group described from the Guadalupian fauna, from either of the species mentioned. In the bundling of the ribs this form is like the small specimen of *Spirifer mexicanus* represented by fig. 6 of Pl. XIII, but it retains this character to a much larger size.

Horizon and locality.—"Dark limestone" Pine Spring (station 2930) and hill southwest of Guadalupe Point (station 2924), Guadalupe Mountains, Texas. Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

SPIRIFER sp. *a*.

Pl. XXI, fig. 2.

Associated with *Spirifer mexicanus* var. at station 2930 is a dorsal valve which I can not content myself by identifying with any of the distinguished forms and which is at the same time almost too imperfect to justify description as a new species.

The shape is subcircular, the length being 13 mm. and the greatest width, which occurs about midway, 16.5 mm. The cardinal line is short. The plications are low, rounded, and separated by wide intervals. The fold is low, broad, and defined rather by other characters than by its elevation, though it is slightly elevated. It occupies nearly one-third of the shell. It has four plications, the two median ones being closer together than the lateral ones. The plications and intervals on the fold are somewhat finer than on the sides. There are about four lateral plications on each side, which, as well as the intervals of separation, decrease rapidly in size toward the hinge line. Surface ornamentation, so far as observed, consists of fine-growth lines.

Of the three species of *Spirifer* of the *mexicanus* group *Spirifer* sp. *a* is evidently closest to *S. mexicanus* var. *compactus*. It differs, however, chiefly in the small number and coarseness of its plications. In this respect it invites comparison with *S. sulcifer*, which Shumard describes from the Capitan limestone.

Horizon and locality.—"Dark limestone," Pine Spring, Guadalupe Mountains, Texas, (station 2930).

SPIRIFER SULCIFER Shumard.

Pl. XIII, figs. 10 to 10b.

1858. *Spirifer sulcifera.* Shumard, Trans. Acad. Sci. St. Louis, vol. 1, p. 293 (date of volume, 1860).
White [Permian] limestone: Guadalupe Mountains.

1859. *Spirifer sulciferus.* Shumard, idem, p. 391, pl. 11, figs. 3a, 3b, 3c.
White [Permian] limestone: Guadalupe Mountains, Texas and New Mexico.

This appears to be a very pretty little species, but, unfortunately, it is not represented in our collections. I can, therefore, only reproduce Shumard's figures and his original description, which is as follows:

Shell rather small, ovate, subpentagonal; length about one-fifth greater than the width; greatest transverse diameter near the middle; cardinal extremities slightly auriculated. Ventral valve (receiving valve) gibbous, more prominent than the opposite one, greatest convexity a short distance behind the beaks; mesial sinus distinct, commencing at the point of the beak and increasing gradually in breadth and depth to the front; area broad, triangular; lateral margins sharply rounded; deltoid aperture rather large, triangular; surface marked with six broad, rounded, prominent folds, those next to the sinus being double the size of the others; ribs bearing one or more shallow longitudinal sulci, which become entirely obsolete before reaching the beak; intervals marked with obscure longitudinal striæ. Dorsal valve semielliptical, convex, a little longer than wide; mesial fold moderately elevated, having a distinct median groove extending its whole length and on either side a broad sulcus, which bears one or more slender, slightly prominent, rounded ribs; intervals marked with longitudinal striæ, as in the opposite valve. Under a magnifying glass the surface exhibits very fine concentric lines of growth.

Dimensions.—Length, 0.66; width, 0.57; height, 0.39; length of dorsal valve, 0.48; height of same, 0.16.

Geologic position and locality.—White Guadalupe limestone occupying the same geological position as the preceding species.

While it is unfortunately true that no form referable to this species has been found in our collections, especially from the Capitan formation, which supplied the typical specimens, certain small examples which are varietally related to *S. mexicanus* show in some respects an unexpected resemblance.

I do not know to what extent a varietal name may be said to be preoccupied by a previously described species of the same genus, but Hall and Clarke's *Spirifer disjunctus* var. *sulcifer* bears that rather compromised relation to *Spirifer sulcifer* Shumard.

SPIRIFER sp. *b*.

?1859. *Spirifer cameratus.* Shumard (non Morton), Trans. Acad. Sci. St. Louis, vol. 1, p. 391 (date of volume, 1860).
[Permian] sandstone and white limestone: Guadalupe Mountain.

Under this title are included perhaps three varieties. One of these, from the Delaware Mountain formation of the Guadalupe section, has the appearance of *Spirifer cameratus*, of that type which has prominent fascicles of rather fine strongly raised ribs. The surface characters in this material have been lost. The shape was probably triangular and the hinge extended, though the cardinal angles may have been somewhat rounded. The largest specimen obtained had a transverse diameter of about 45 mm. If the fine surface sculpture now destroyed were the same as that of *Spirifer cameratus,* I do not see from the specimens at hand that the two forms can be distinct.

Among the silicified specimens from the Glass Mountains two types seem to be indicated. One of these, represented by a single specimen, resembles the form already described. It was transverse with an extended hinge line and probably pointed cardinal angles. This specimen, if complete, would have measured about 45 mm. across. Silicification has obscured the sculpture. At present neither radiating nor concentric lines can be seen, though toward the front margin there are traces of strong, regular, concentric lamellæ.

The third form, also from the Glass Mountains, may have had a subquadrate shape with a relatively short hinge line. Fasciculation is pronounced, and the ribs are subangular with broad somewhat flattened grooves between. The surface, which appears to be fairly well preserved in a silicified condition, shows only numerous faint, not very regular, concentric lines. Even if the shape of this shell proves to be the same as that of *Spirifer cameratus* it must be considered a distinct species, both on account of the character of the ribs and of the surface ornamentation. The character of the two other forms is too uncertain to permit so secure a judgment, but if the first is the same as *Spirifer cameratus,* which I am disposed to doubt, though solely because of the very different faunal association, it is improbable that it is the same as the third form.

Horizon and locality.—Delaware Mountain formation, Guadalupe Point, Guadalupe Mountains, Texas (station 2919). Delaware Mountain formation, southern Delaware Mountains, Texas (stations 2967, 3501). Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763).

Genus MARTINIA McCoy.

The Guadalupian Martinias, while fairly abundant, seem at present referable to but two species, each of which, if it were necessary to divide them into groups, would have to be referred to a separate division.

The generic determination is based on the configuration, conjoined to the absence in the interior of either valve of anything in the nature of septal plates. All of my specimens are more or less deeply exfoliated and are without any present evidence of possessing the characteristic punctate outer layer.

Many of the Guadalupian specimens occur as dissociated valves, some of which are difficult to distinguish from *Composita.* In the case of ventrals this distinction can be effected with some certainty by uncovering the area, but the discrimination in the case of dorsal valves is a much more delicate matter.

MARTINIA RHOMBOIDALIS n. sp.

Pl. XIII, figs. 11 to 14c.

Shell of medium size, length equal or greater than the breadth, according to age, young specimens being more elongate. Ventral valve strongly convex in the posterior portion, more flattened anteriorly. Hinge much shorter than the width below. Umbo inflated. Beak strongly elevated and incurved. General outline rhombic. Area well defined, not very high, chiefly occupied by the very wide foramen. Sinus extremely faint, often indicated by an indistinct linear depression.

Dorsal valve subcircular to subquadrate. Beak small, strongly incurved. Umbo inflated. From the central line the shell falls away rapidly, leaving a rounded subangular fold.

Surface apparently smooth, though the inner layers at least are marked by numerous more or less regularly distributed indistinct radiating striæ, which probably do not have the nature of surface ornamentation.

Among the Indian Martinias this species is most nearly like *M. elongata* Waagen. It is, however, a much larger shell, and has a pointed instead of a quadrate fold. Certain also of the many species described by Gemmellaro from Palermo resemble it, though few have the angular sinus of *M. rhomboidalis*. *Martinia variabilis* Gemmellaro, however, has this kind of a sinus and resembles *M. rhomboidalis* closely in other ways.

Horizon and locality.—Middle of Capitan formation, Captain Peak (station 2926); base of Capitan formation, hill southwest of Guadalupe Point (station 2906); Delaware Mountain formation, Guadalupe Point (station 2919), Guadalupe Mountains, Texas. Delaware Mountain formation, southern Delaware Mountains, Texas (stations 2935, 2962).

Martinia shumardiana n. sp.

Pl. XIII, figs. 15 to 15d.

Shell of medium size. Shape elongate, subpentagonal. Ventral valve highly convex, especially in the posterior portion. Beak elevated and incurved. Hinge line much shorter than the shell below. Area concave, moderately high, and well defined. Foramen extremely large. No perceptible sinus is found on the ventral valve, though the front is strongly produced.

Dorsal valve moderately convex, shape hexagonal. Beak small, elevated, incurved, projecting but little beyond the hinge line. Central portion elevated into a fold which is quadrate toward the front. Sides falling away rapidly and marking the limits of the fold by angular projections situated about one-third of the distance back from the anterior margin.

Surface probably smooth, but marked underneath by fine radiating raised lines.

The type specimen of this species is quite unlike *Martinia rhomboidalis*, though I expect to find intermediates. I have, indeed, referred to this species several examples which would better perhaps have been joined with the other. The length of one of these—a ventral valve—is 15 mm., while by another a length of 20 to 25 mm. is indicated. They differ from *M. rhomboidalis* chiefly in having a stronger fold and sinus, with the appearance of a more quadrate shape for these features. These are separate valves adhering to the matrix, more or less imperfect or crushed. For making comparisons, however, only shells retaining both valves in position, so that front and side views may be obtained, are adequate. It thus happens that it is frequently impossible, especially without laboriously uncovering each specimen, to satisfactorily discriminate the Martinias, Compositas, and Squamularias if the fossils are not very characteristic, or are imperfect, while in the young stages *Ambocœlia* is another factor of doubt.

Horizon and locality.—Middle of Capitan formation, Capitan Peak (station 2926); base of Capitan formation, hill southwest of Guadalupe Point (station 2906 ?), Guadalupe Mountains, Texas.

Genus SQUAMULARIA Gemmellaro.

As I have elsewhere pointed out,[a] Gemmellaro sought to establish the genus *Squamularia* on certain peculiarities observed by him in the brachia and in the surface ornamentation of some of his Sicilian forms. The surface ornamentation is said to consist of flexuous lamellose expansions; and apparently *Squamularia* bears the same relation to *Reticularia* in the matter of its surface ornamentation that *Athyris* does to *Cleiothyridina*. I am not convinced of the importance of the internal differences by which *Squamularia* is said to be distinguished from *Reticularia*, and Schellwien refers the genus to *Reticularia* as a synonym; but it is a fact that *Squamularia* is without dental plates, which, though the circumstance seems generally to have been overlooked, are extensively developed in *Reticularia*. All these differences combined seem to me satisfactorily to distinguish *Squamularia* from the true *Reticulariæ*. But *Reticularia* has been incorrectly used by most writers for species devoid of internal plates. In a recent paper I assigned these aseptate shells, which seem to belong entirely in the upper Carboniferous series, to Gemmellaro's genus, desiring rather more to emphasize their distinction from true *Reticularia* than to assert their identity with *Squamularia*. If the difference in external ornamentation between *Squamularia* and *Reticularia* is, as would appear, as marked as that between *Athyris* and *Cleiothyridina*, I believe that these upper Carboniferous forms can not properly be assigned to *Squamularia;* but as I have no material to represent the latter genus, the decision of this point will have to be left to others. For the present, therefore, I employ *Squamularia* in the sense in which *Reticularia* has usually been used. It would, then, include our common *Spirifer perplexus* as well as *S. guadalupensis*, also *Reticularia lineata*, *R. indica*, and *R. elegantula* of the Salt Range, and in general the upper Carboniferous *Reticulariæ* of most authors. It would appear, however, that these forms belong to a group distinct from the typical *Squamularia*.

But one species of *Squamularia* is known in the Guadalupian fauna, of which it is one of the most abundant types. It differs from most members of the genus so far known in that the spines are very small and appear to have been simple or even solid, instead of double-barreled. This form undergoes more or less variation, and possibly might be forced to represent several species; but the degree and character of difference seem to me to fail in warranting such discrimination. It will probably be advisable, however, to distinguish as varieties two deviations from the common type.

[a] Prof. Paper U. S. Geol. Survey No. 16, 1903, p. 387.

SQUAMULARIA GUADALUPENSIS Shumard.

Pl. XIV, figs. 4 to 11a.

1859. *Spirifer Guadalupensis.* Shumard, Trans. Acad. Sci. St. Louis, vol. 1, p. 391 (date of volume, 1860). White [Permian] limestone: Guadalupe Mountains.

Shumard's description of this species is as follows:

Shell of medium size, ovate, longer than wide, quite gibbous in full-grown specimens; hinge line less than the greatest width, which is found about the middle of the shell. Dorsal valve varying from elliptical to circular, evenly convex, exhibiting no trace of a mesial fold; beak incurved, passing a little beyond the cardinal margin. Ventral valve convex, much more gibbous than the opposite valve, without sinus, but in very old specimens flattened near the front; cardinal angles rounded; umbo prominent, rounded; beak prolonged, rather acute, incurved; area contracted, elevated, not very sharply defined; aperture large, triangular; length of sides and base nearly equal. Surface marked with moderately distinct concentric striæ, the edges of which were probably fringed with piliform spines, as in *S. lineata.*

This species may be compared with *S. lineata*, from which it differs in being much more gibbous, and in the absence of either sinus or mesial fold. The same characters will also distinguish our shell from *S. setigera*, Hall.

Locality.—White limestone, Guadalupe Mountains.

This is probably the most abundant species of the Guadalupian brachiopod fauna. As a large number of specimens have been passed in review, it is natural that a considerable amount of variation has been observed, and some paleontologists would have taken advantage of these deviations to distinguish a larger number of species than I have done. Shumard describes the length as greater than the width. In the prevailing type the length and width are nearly equal, while in some examples the width is the greater. Difference in these proportions, however, is usually compensated by difference in convexity, especially narrow specimens being more than ordinarily gibbous and especially transverse ones rather flat. An elongate shape seems to be produced in certain large and presumably old specimens by natural processes of growth, enlarging the shell more rapidly along the front than at the sides. Such a large elongate example is represented by figs. 1 and 1a of Pl. XIV, and I have discriminated it as a distinct variety. At the same time the younger stages of this specimen, as indicated by growth lines, do not depart from the usual. This particular example, in addition to its shape, possesses a rather unusually high ventral beak, but the direction and elevation of the ventral beak are characters in which no little variation is shown by different specimens.

A type which perhaps still more than the foregoing deserves recognition as a distinct species is represented by the subquadrate specimen shown by figs. 2 and 2a of Pl. XIV. This peculiarity of shape is largely dependent on the development of the sinus, which is entirely absent in some specimens, represented by a mere flattening in others, as described by Shumard, and very distinct though shallow in still others. It can often be detected on the front margin, even if apparently absent where only the curvature is observed. This type, also, I have thought best to discriminate as a distinct variety.

The area is small and usually not very well defined, except by strong longitudinal striations, and the delthyrium is large. The spires are rather long and slender and are directed almost vertically toward the hinge line.

The outer layer of the shell upon which the more delicate surface characters were formed is very thin and appears to have had a different structure from the rest, as it is often differently preserved. It usually exfoliates and is retained upon the matrix. It is difficult, under these circumstances, to determine precisely the nature and range of variation of the sculpture. Sometimes the exfoliated surface is marked by narrow, regular concentric bands defined by distinct grooves or striæ. Usually, however, concentric marking is inconspicuous, in some cases perhaps entirely absent. In a few instances the exfoliated shell is marked instead by fairly regular, fine, continuous, raised radiating lines. What the significance of this appearance may be I am at a loss to say. A small number of specimens retain the outer layers of the shell, and in these the surface is covered by more or less regular concentric sublamellose bands, from whose edges projected fringes of spines generally tangent to the curvature. The spines are very slender and closely crowded. From their small size it seems probable that they were not double-barreled, and in thin sections they appear to be solid. This type of surface ornamentation is distinctly different from that possessed by the Pennsylvanian species, *Squamularia perplexa*, which has much larger, less crowded, hollow, and compound spines not mounted on lamellose fillets. It is possible that this is the type of surface on which Gemmellaro's genus, *Squamularia*, was founded, for the concentric lamellæ are said to be short and to give rise to fimbriæ of spines. Gemmellaro's figures, however, represent them as distant and flexuous. It is not certain that all the Guadalupian shells possessed this kind of surface, but it can provisionally be ascribed to such exfoliated specimens as have strong concentric bands. Some of the others retain markings which may be interpreted as scars left by rather large spines arranged in concentric rows, as in *S. perplexa*. These markings degenerate in some cases into irregularly reticulating lines whose general direction is radial. They are quite distinct, however, from the continuous straight liræ mentioned above.

The size attained by this species is considerable. The largest ventral valve obtained, one belonging to the variety *ovalis*, must have had a length of 45 mm. and a width of 38 mm. A large dorsal valve has the length and width about equal—40 mm. This represents the maximum size of the species, so far as my observations extend.

Squamularia guadalupensis seems almost restricted to the white limestone of the Guadalupe Mountains. A single example, clearly belonging to the genus and probably to the same species, has been found in the Delaware Mountain sandstones below, and with it were associated a number of specimens whose imperfect condition and preservation render it impossible to determine whether they belong to *Squamularia*, *Martinia*, or even *Composita*.

In a general way this is a much larger species than our common *S. perplexa* of the Mississippi Valley, and usually it is less transverse. Specimens which are not readily distinguished by these characters are, however, not difficult to find. It is almost invariably true that the ventral beak of *S. guadalupensis* is smaller and less inflated and the foramen larger. A more important difference, at least in some cases, is found in the surface ornamentation, as already pointed out. In others this character has been obscured or appears to be the same. It is doubtful whether any of the forms making this group is specifically the same as *S. perplexa,* and unquestionably most of them are different.

S. guadalupensis appears to be the American representative of Waagen's *Reticularia indica.* Waagen's species is larger than the American form and probably would show other differences were it possible to make comparison directly by specimens. At all events, our *S. guadalupensis* has long priority of description.

Squamularia guadalupensis also more or less resembles several species of *Reticularia* described by Gemmellaro, which are distinguished by not very important differences of conformation. Somewhat similar differences appear among the numerous examples referred to *S. guadalupensis,* but it did not seem to me desirable to distinguish them as distinct species, even if that were practicable.

Horizon and locality.—Middle of Capitan formation, Capitan Peak (station 2926); base of Capitan formation, hill southwest of Guadalupe Point (station 2906); Delaware Mountain formation, Guadalupe Point (station 2919), Guadalupe Mountains, Texas. Delaware Mountain formation, southern Delaware Mountains, Texas (station 2962). Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763).

SQUAMULARIA GUADALUPENSIS var. SUBQUADRATA n. var.

Pl. XIV, figs. 2 to 3a.

This variety is fairly well distinguished from what, after some consideration, I think should be regarded as the typical form of *Squamularia guadalupensis,* by the development of a broad, moderately distinct sinus in the ventral valve, causing the shape to be somewhat more quadrate than oval. The dorsal valve does not develop an appreciable fold to correspond to the ventral sinus. Our specimens are too imperfectly preserved in that particular to indicate whether any differences in sculpture accompany those of configuration, but probably such is not the case. This form resembles *Reticularia caroli* and *R. affinis* of Gemmellaro's Sicilian fauna.

Horizon and locality.—Middle of Capitan formation, Capitan Peak (station 2926); base of Capitan formation, hill southwest of Guadalupe Point (station 2906), Guadalupe Mountains, Texas.

SQUAMULARIA GUADALUPENSIS var. OVALIS n. var.

Pl. XIV, figs. 1 and 1a.

This variety is perhaps a little more doubtful than the *subquadrata,* because there is some question as to whether it is really distinct from what I am now regarding as typical *Squamularia guadalupensis,* and also as to whether it is not itself typical *S. guadalupensis.* Shumard's description fits either form fairly well, but seems to exclude the variety *subquadrata,* because he distinctly states that a fold and sinus are absent. His description calls for a shell which is longer than wide, a feature found in the present form, but not in that which I am regarding the typical variety. On the other hand, what I have chosen for the typical variety is very much more common than any other and agrees more with the type of shell which Shumard's comparisons indicate that he was describing, since, for example, he says that *S. guadalupensis* differs from *Reticularia setigera* in being more gibbous and without either a fold or a sinus. It seems hardly probable that if Shumard had had a large elongate species like the type of *S. guadalupensis* var. *ovalis* he would have found no other difference from *Reticularia setigera*.

If, then, we disregard the probability that the common Guadalupian type, which differs from *Reticularia setigera* in being more gibbous and in lacking a fold and sinus, is that which Shumard described as *S. guadalupensis*, it still remains to consider whether the type represented by the specimens shown in my figure is distinct from it or not. It is larger and more elongate, to be sure, but the growth lines indicate that its younger stages would not differ in either size or shape. Another notable feature is the high, erect beak, but in the elongation and curvature of the beak considerable variation is shown by *S. guadalupensis*. It will be observed that exfoliation has brought to light certain fine radiating lines on the surface of the typical specimen of the present variety. This peculiarity is developed on a number of specimens and is not singular to the present form. I have been unable to determine whether this is connected with any particular variation in the sculpture of the exterior or is correlated with any peculiarities of configuration.

It hardly seems appropriate to regard the present form as identically the same as the smaller, more circular, variety, yet I have introduced a distinctive name with some hesitation. *Squamularia guadalupensis* var. *ovalis* is related to *Squamularia (Reticularia) waageni* Loczy, although I do not regard them as the same.

Horizon and locality.—Middle of Capitan formation, Capitan Peak (station 2926); base of Capitan formation, hill southwest of Guadalupe Point (station 2906), Guadalupe Mountains, Texas.

Genus AMBOCŒLIA Hall.

AMBOCŒLIA PLANICONVEXA var. GUADALUPENSIS n. var.

Pl. XIV, figs. 12 to 14a.

Shell rather long for the genus, ventral valve having length and breadth about equal. Hinge line shorter than the width in front. Area well defined, moderately high, strongly concave, directed to the plane of the shell edge at angles varying from 90° to about 135°. Delthyrium higher than wide. Convexity high. Curvature more or less flattened out along the anterior and lateral margins. Beak attenuate, prominent, strongly incurved. Sinus absent.

Dorsal valve very transverse, nearly flat. Hinge line long, straight. Sides and front evenly curved. Cardinal angles somewhat flattened. Beak depressed, obscure. Crural plates rather long, high, and prominent. Character of the area not ascertained. Surface characters unknown.

This form is very close indeed to our common *Ambocœlia planiconvexa* of the Mississippi Valley, and I am not satisfied as to the propriety of distinguishing it on the characters noted. The fact that this genus presents so few lines of specific differentiation, however, would tend to enhance the value of even slight variations, where found. The Guadalupian form averages slightly larger than *Ambocœlia planiconvexa*, though large specimens of the latter do not differ materially in this respect.

It is in the main more transverse; but here again is sometimes equaled by the Pennsylvanian type, young specimens of both being narrower and more subcircular than the larger ones. Perhaps the more constant and important differences consist in the fact that the area of the Guadalupian form is a little lower than in *Ambocœlia planiconvexa*, and the crural plates a little longer, stronger, and more closely proximate. In our collections this form is restricted to the limestones of the Guadalupian series, where, however, it is not rare. Shumard appears not to have found it; at all events he does not mention it. The largest specimen seen—a ventral valve—measures 11.5 mm. in length and 12.5 mm. in width.

Horizon and locality.—Middle of Capitan formation, Capitan Peak (station 2926) and peak north of Pine Spring (station 2902), Guadalupe Mountains, Texas. Delaware Mountain formation, southern Delaware Mountains, Texas (station 2936).

Genus SPIRIFERINA D'Orbigny.

Among the Spiriferinas thus far known in our American Carboniferous faunas two types can be distinguished. One of these is represented by *S. spinosa*, while to the other *S. transversa*, *S. kentuckyensis*, et al. belong. The differences are largely external, though Hall and Clarke remark[a] of *S. spinosa* that there is a solid calcareous deposition in the umbonal cavity of the apical valve, adding, however, that this probably occurs in other species also.

As is well known, the surface in one group is marked by regular transverse, imbricating lamellæ and by delicate hairlike spinules, in varying abundance and arrangement. In the other form concentric lamellæ are practically absent. When present, they are irregular and distant and occur chiefly near the margin. The surface in this case, however, is covered with relatively large spines, which, craterlike, seem to have been open at the top. The shell structure in this type is coarsely punctate, but there is an outer layer in *S. spinosa* rather thin, which is dense and impunctate and marked by delicate concentric lines. The development of the spines is possibly connected with this layer, because in the majority of cases when the latter is missing the spines also are gone, leaving the surface very smooth, even in the sulci, where they would be protected from erosion if it were supposed that the removal of the epidermal layer were due to this cause. Here and there, in shells whose outer layer has been lost, punctæ larger than the others are seen dotting the surface. I have not ascertained that these are connected with the spines, and they are usually less numerous than the spines in average specimens.

In the *spinosa* type, furthermore, or at least in *S. spinosa* itself, the plications are few and large, the fold and sinus being but slightly more prominent than the lateral plications and likewise simple. In the lamellose group, on the other hand, the plications are small and numerous, the fold and sinus strongly specialized, and the occurrence of a small but distinct mesial impression on the fold and a corresponding elevation in the sinus is so frequent as almost to establish a rule. The punctation in *S. spinosa* has already been described as coarse and spongy. In the other group considerable variation exists both as to size and abundance of perforations, and I

[a] Nat. Hist. New York, Pal., vol. 8, pt. 2, p. 53.

believe that this will be serviceable as a specific character. It seems probable that the epidermal layer, which is readily seen in well-preserved examples of *S. spinosa*, exists also in the lamellose forms; but, if so, it is not readily observed, being masked by the concentric lamellæ and the abundant spinules. All the forms which have come under my observation can be assigned to one group or the other; but it is possible that forms more intermediate in character than any I am aware of will be found.

Hall and Clarke derive the Spiriferinas from the lamellose-septate group of Spirifers,[a] and certainly a very close similarity exists, both in internal structure and external expression, between that group of Spirifers and *Spiriferina transversa*, *S. kentuckyensis*, and their allies, the chief difference lying in the punctate shell structure of the Spiriferinas. The other group of Spiriferinas (*S. spinosa* and *S. campestris*) show a much greater resemblance to certain of the ostiolate Spirifers, some of which are distinguished by a character noted by the same authors in *S. spinosa*, namely, an apical callosity. A different origin for these two groups of *Spiriferina* is thus suggested, but the ostiolate Spirifers are without the ventral septum, a very important character in *Spiriferina*. To attempt to derive the spinose group from the *ostiolati*, would therefore be rather fanciful.

Another but little known group of Spirifers having a spinose surface seems to come in with the early Mississippian. I refer to *Spirifer aciculifer* and *S. schucherti;* but it is not known whether they are septate and punctate and are the antecedents of *Spiriferina spinosa*, aseptate and impunctate and the survivors of the ostiolate Spirifers, or septate and impunctate, true Spirifers, but the stock from which *Spiriferina spinosa* was derived. It thus remains in doubt as to whether the *spinosa* group drew its ascent from the same or different stock from *Spiriferina transversa* et al.

No Devonian species of *Spiriferina* are known in North America, but the genus is abundant in rocks of Carboniferous age. The *spinosa* type does not appear below the Genevieve group (as defined by H. S. Williams) of the Mississippian, but continues into the Pennsylvanian, where it is represented by *Spiriferina campestris* White and *S. gonionotus* Meek, species which if not identical with *S. spinosa* are certainly very closely related. A number of species belonging to the lamellose group have been described from the Mississippian, but in the Pennsylvanian the representation seems to be reduced to *Spiriferina kentuckyensis* alone.

Both types of shells occur in the Guadalupian. Belonging to the same group as *S. transversa* and *S. kentuckyensis* is the common form *S. billingsi*, already described by Shumard, together with its allies, among which must be ranked *S. evax* and *S. sulcata*. To the *spinosa* group belong *S. laxa* and *S. pyramidalis*.

Several other Guadalupian species of *Spiriferina* are not so readily referred. *S. hilli* in its general appearance and in the development of a low plication in the ventral sinus seems to be allied to *S. kentuckyensis*. It does not possess the strongly and regularly lamellated surface of that species, and ought not, therefore, to be assigned immediately with the *lamellosæ*. It really seems to be more similar to *S. cristata* Schlotheim. The surface of that species appears to be finely papillose, and it is crossed by concentric lamellæ, which are, however, neither very regular nor con-

[a] Nat. Hist. New York, Pal., vol. 8, pt. 2, p. 53.

spicuous. This finely papillose appearance which is borne by the best specimens of *S. cristata* may be the result of preservation upon the punctate shell structure, or it may be due to the presence of minute spinules. At all events, I have not observed in that species either the large spines and impunctate outer layer of the *spinosæ* or the regular concentric imbrications of the *lamellosæ*. Waagen suggests of the Indian representatives of this species that only the outer layers are porous, the inner being solid. The general appearance of *S. cristata* is perhaps more like *S. spinosa* than *S. kentuckyensis;* but if the structure described by Waagen is true it can be grouped with neither of the species mentioned, and would probably form the nucleus of a different section, to which, on the whole, *Spiriferina hilli* would best be assigned.

The surface of *S. welleri* is, unfortunately, unknown, but in its configuration it appears to be almost unique among Carboniferous Spiriferinas in having the fold and sinus plicated, although it is true that a tendency to develop a biplicate fold is a character of *S. kentuckyensis* and its allies. While deep exfoliation has destroyed the surface of the very few examples of this species thus far obtained, it seems rather probable that if the surface had been strongly lamellose an intimation of the fact would be retained. On this account, and because of the rather coarsely punctate shell structure, I shall assign this species to the spinose group.

The latter character, though in the case of *S. campestris* (=*S. spinosa?*) and *S. kentuckyensis* sufficient to distinguish the two species without considering any other, can not be accepted without reserve as evidence between the two groups in question, though *S. billingsi* and *S. laxa* are distinguished in the same way, the former by having very fine punctation, the latter by coarse. While *S. laxa* and *S. pyramidalis* can without any very great incongruity be grouped with *S. spinosa*, a new element of importance is induced in *S. welleri*, which ought not to be placed in very close proximity to *S. spinosa*, because of its plicated fold and sinus. In the same way, while *S. billingsi* et al. resemble *S. kentuckyensis* in their lamellated surface, they differ so much in size and configuration that it hardly seems suitable to assemble them in the same group.

These forms under consideration might provisionally be divided into three sections—the *spinosæ*, the *lamellosæ*, and the *papillatæ*. The *spinosæ* would include the *spinosa* group, comprising *S. spinosa*, *S. campestris*, *S. gonionotus* (=*S. campestris?*), *S. laxa*, and *S. pyramidalis*, and the *welleri* group, consisting solely of the species of that name. The *lamellosæ* would include the *billingsi* group, consisting of *S. billingsi*, *S. evax*, and *S. sulcata*, and the *transversa* group, to which belong *S. transversa*, *S. kentuckyensis*, and most of our Mississippian Spiriferinas. From these, however, must be excepted *S. concentrica*, which besides some not very essential peculiarities of configuration and ornamentation seems to have possessed a shell structure resembling that of *S. cristata*. The outer layers in this species are rather sparsely punctate, while the inner ones, comprising most of the shelly substance, appear to be fibrous. This important difference should remove the species to a different group if not to a different section. The *papillatæ*, comprising those species having a papillose surface(?) with subordinate lamellose bands, would include the *cristata* group (*S. cristata*, together with the other species placed by Waagen in this group, namely, *S. multiplicata* and *S. nasuta*) and also probably my *S. hilli*.

The shell structure of *S. cristata* itself is, according to Waagen, impunctate, except for the outer layers, and the same condition, according to my observation, exists in *S. concentrica*, which I have referred provisionally to another group, viz, the *lamellosæ*. Possibly a more substantial arrangement of these species could be made on the basis of this character, two types of which are already apparent (one with impunctate outer portion and punctate inner—i. e., the *papillatæ*, and the other with impunctate inner and punctate outer portion), and it is possible that these divisions would depart somewhat from those here suggested by configuration and sculpture; but neither material nor time is at present available to me for the prosecution of this study.

Waagen groups his Indian shells under three divisions, but these are subordinate to those here under consideration. His group of *S. cristata* I have already mentioned as belonging to the *papillatæ*. I can not but believe that his association of *S. vercheri* under the title of the group of *S. transversa* is erroneous, for while *S. vercheri* has the shape of *S. transversa,* to judge by both his description and figure it lacks the heavy, regular, closely arranged, concentric lamellæ of McChesney's species, the ornamentation being in fact not unlike that of *S. cristata*. For this reason *S. vercheri* would more appropriately be transferred to the same division as *cristata*, but, in accordance with Waagen's judgment, to a different group. *S. ornata*, which alone represents his group of *S. insculpta*, is closely allied to *S. billingsi*, and can probably be assigned a position near it in the *lamellosæ*.

The abundance and variety of shells of this genus seem to be rather characteristic of the Guadalupian fauna. Waagen, as we have just seen, recognizes a number of species in the Productus limestone of India, but they show less variety than is observed in the American series of forms. The representation of the genus in the fauna of the Carnic Alps is altogether insignificant, but Gemmellaro describes a great diversity from the province of Palermo. It is a significant fact that *S. billingsi*, the most abundant species of the genus in the Guadalupe Mountains, has a close ally in the Indian Permian (*S. ornata*), while several of the forms described by Gemmellaro appear to be variants of this same type. The surface ornamentation in some specimens, and the configuration in others show points of difference more or less striking, but the family resemblance of his species with *S. ornata* Waagen and *S. billingsi* Shumard can not fail to be remarked.

SPIRIFERINA BILLINGSI Shumard.

Pl. XIII, figs. 16 to 19d, 21 to 21b, 24 to 24c; Pl. XIV, figs. 15 and 16.

1858. *Spiriferina Billingsii*. Shumard, Trans. Acad. Sci. St. Louis, vol. 1, p. 294 (date of volume, 1860).
White and dark [Permian] limestone: Guadalupe Mountains, and conglomerate at mouth of Delaware Creek, New Mexico.

1859. *Spiriferina Billingsii*. Shumard, idem, p. 391.
White and dark [Permian] limestone: Guadalupe Mountains.

Shell of moderate size, wider than long, gibbous, cardinal line less than the width of the shell, extremities rounded. Ventral valve gibbous, strongly arched, marked with a deep, moderately broad, angular sinus, extending from tip of beak to front, sides convex; beak prominent, prolonged, rather sharply incurved, extremity pointed; area well developed arcuate, broad triangular; lateral edges rounded, deltoid aperture large. Surface with from six to eight prominent rounded ribs on each side of the sinus; they are simple and gradually enlarged from the beak to the margins. Dorsal valve semi-elliptical, convex, having five or six prominent ribs on each side of the mesial fold, which is angulated, rather broad, and toward the front much elevated above the general convexity; cardinal line straight or very slightly angulated; beak scarcely passing the cardinal line. The surfaces of both valves are thickly studded with extremely fine granulæ and delicate lines of growth.

Dimensions.—Length, 0.74; width, 0.90; thickness, 0.58. Length of dorsal valve, 0.44; thickness of ventral valve, 0.36.

This species is very similar to *S. cristata* (Schlot. sp.), to which we at first were disposed to refer it. Our shell is, however, larger, the beak more elongated, and the area narrower and higher.

The specimens in the collection obtained by Dr. G. G. Shumard are from the white limestone of the Guadalupe Mountains, the dark limestone subordinate to the white limestone, and the Quaternary conglomerate at the mouth of Delaware Creek, New Mexico.

Dedicated to E. Billings, esq., paleontologist of the Geological Survey of Canada.

This is one of the more common species in the white limestone, yet the material obtained is less perfect than in the case of many of less abundance. Shumard's description, quoted above in full, is adequate, except in one point that it gives an erroneous conception of the surface, which is really marked by regular, strong, imbricating, concentric lamellæ, of which from 7 to 13 are found within the space of 5 mm. Some specimens indicate that the whole was covered with fine hairlike spines or setæ, which were especially abundant on the edges of the lamellæ. The entire ornamentation is usually lost by exfoliation, and is retained only in a few examples and on local areas. The granules mentioned by Shumard are simply the papillæ due to punctate shell structure, while the growth lines are probably lamellæ which have been nearly destroyed by exfoliation.

Shumard suggests a resemblance of this species with *Spiriferina cristata* Schlot., but a comparison is hardly necessary. The large size of the American form, its proportionately finer lateral plications, and the relatively great size of the fold and sinus distinguish it immediately. For similar reasons comparisons are hardly necessary with our common *Spiriferina kentuckyensis*. *Spiriferina billingsi* is quite similar to *S. ornata* Waagen, found in the Productus limestone of the Salt Range, but the American species, which in any event would have priority of date, should be distinguished with ease by reason of its smaller and more numerous lateral plications. Gemmellaro also has described from the province of Palermo a large number of species which resemble *S. billingsi* more or less closely. The Sicilian form, however, seems to be more richly modified even than the Guadalupian. Some of the species have no analogues in the latter fauna, showing developments partly of configuration not known there, and partly of surface ornamentation, which in some species, as the result of intersecting lines, takes on a tuberculose sculpture. *S. margaritæ* Gemmellaro, however, might readily pass for the American species.

S. billingsi proves to be a variable species, marked deviations from the dominant form manifesting themselves along several lines. Variation in the frequency of the imbricating lamellæ has already been mentioned. Some specimens have distinctly finer plications than the common form; others have them less prominent; and another group shows a tendency toward an abbreviation of the cardinal line, a subcircular form resulting therefrom. I have not found it practicable to distinguish many of these variations of the less degree from the main type. A few variations, represented usually by single specimens, have departed so widely from the central type that I have described them separately. Their connection in most cases with *S. billingsi* is obvious; but it is equally obvious that they should not be referred to the same species.

Horizon and locality.—Middle of Capitan formation, Capitan Peak (station 2926); "dark limestone," Pine Spring (station 2930); Delaware Mountain formation, Guadalupe Point (station 2931?), Guadalupe Mountains, Texas. Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969?). Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763?).

SPIRIFERINA BILLINGSI var. RETUSA n. var.

Pl. XIII, figs. 20 to 20d.

This form is associated with typical *S. billingsi*, but represents a variety which can be satisfactorily distinguished, though I at first included it with the normal type. While the beak of typical *S. billingsi* is produced and curved back over the area, in the present form it is short and erect. In addition to these peculiarities the costæ are considerably less strongly expressed.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926).

SPIRIFERINA EVAX n. sp.

Pl. XIII, figs. 22 to 22d.

Shell rather large. Ventral valve high. Area small, moderately high, concave, inclined backward at an angle of about 135°, defined by distinct ridges. Foramen large, occupying much of the area. Beak large, strongly incurved. Sinus large, deep, angular. Plications three, and possibly one or two additional very obscure ones, on either side.

Dorsal valve moderately convex, somewhat inflated in the posterior portion. Shape transverse, elliptical. Beak small, inconspicuous, strongly incurved, and not projecting. Fold large, high, and angular. Traces of about six large plications can be seen, all except three of them on each side being very faint.

Surface mostly exfoliated, but showing faint traces of regular concentric bands, indicating an ornamentation similar to that exhibited by *Spiriferina billingsi*.

This form is an extreme variation from typical *S. billingsi*, but can be distinguished by its contracted shape, large, faint plications, etc. Though I have referred to *S. billingsi* forms, with narrow shape and faint ribs, none have these characters combined and to so marked a degree as the specimen from which this description was taken.

Horizon and locality.—Middle of Capitan formation, Capitan peak (station 2926); base of the Capitan formation, hill southwest of Guadalupe Point (station 2906), Guadalupe Mountains, Texas.

SPIRIFERINA SULCATA n. sp.

Pl. XIII, figs. 23 to 23b.

This species is typically represented by a ventral valve, which shows the following characters:

Shell of medium size, strongly elevated. Shape, as determined by the outline of the margin, transverse, semicircular. Cardinal angles rounded. Area high, concave, much narrower than the shell in front; defined at the sides rather by difference in marking than by any sudden change in the direction of the inflected edges of the shell. Foramen large, occupying much of the areal surface. Beak strongly incurved. Sinus very narrow and relatively deep. There are about nine lateral ribs, which are so faint as to be inconspicuous.

Surface ornamentation largely lost by exfoliation. At present the surface appears nearly smooth, except for some delicate overlapping lamellæ near the anterior margin. Very faint traces of regular concentric lamellæ can be observed elsewhere on the surface, and it is probable that the ornamentation was similar to that of *Spiriferina billingsi.*

This form is evidently an extreme variety of the species last named, but the degree of difference is such that the two should hardly be referred to a single specific group. *S. billingsi* presents variations from the normal type in the way of narrower forms and those with finer or fainter ribs, but none having these characters combined or in the degree in which they are seen in *S. sulcata.*

I have provisionally referred to this species some small dorsal valves from station 2969, in the southern Delawares. They are somewhat coarsely silicified and do not show the punctation, which in the original specimen is very fine. They are subcircular in shape, with the width slightly exceeding the length in varying degrees. The plications are all rather fine and faint. The fold is simple, larger than the lateral plications, but not much elevated, though bounded by broader sulci. The surface is crossed by regular, fine, concentric lamellæ.

These shells appear to present a species of the general type of *Spiriferina billingsi* and rather closely allied to *S. sulcata*, but a satisfactory determination can not be made without more complete material.

Several very fragmentary specimens associated with them have been placed with *S. billingsi* for the time being. They indicate larger size, with more strongly developed fold and sinus and coarser concentric lamellæ.

Horizon and locality.—Middle of Capitan formation, Capitan Peak (station 2926); lower portion of Capitan formation, McKitterick Canyon (station 2932?), Guadalupe Mountains, Texas. Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969?).

SPIRIFERINA LAXA n. sp.

Pl. XXI, figs. 3 to 3b.

This species is based, primarily, on a ventral valve from the "dark limestone" (?) of the Guadalupe Mountains, and part of a dorsal valve from the same horizon is provisionally referred to the same species. The following characters have been noted:

Shell large; shape, as determined by the aperture of the ventral valve, transverse, semicircular. Width greatest at the hinge line or just below. Convexity of the ventral valve slight. Area rather high, nearly flat, strongly inclined backward, defined by angles from the rest of the surface. Cardinal angles slightly rounded. Foramen rather large; height greater than width. Beak at its extremity strongly bent over the area. Four large lax plications are found on either side of the sinus, separated by sulci of about equal force. The plications and sulci decrease rapidly in size and depth toward the sides, so that the final ones are very faint. The sinus is deeper than the sulci, but not strikingly so.

The surface is of the type of *Spiriferina spinosa*. The inner layers are very coarsely punctate. The superficial layer, which is, in this case, uncommonly thick, has a dense structure and is penetrated by pores terminating on the surface in spines or papillæ. These pores are somewhat larger than those of the shell beneath and very much less abundant. The difference in structure of the two layers is manifested by the fact that the inner one is silicified, while the outer still remains calcareous. A thin intermediate layer, which has delicate concentric markings, is indicated also.

Horizon and locality.—"Dark limestone," Pine Spring (station 2930) and Guadalupe Point (station 3762e?), Guadalupe Mountains, Texas. Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969?).

SPIRIFERINA PYRAMIDALIS n. sp.

Pl. XIV, figs. 20 to 21b.

This interesting form is known from but two somewhat imperfect specimens, although a few fragmentary and doubtful ones have been placed here. The shell is rather small and the shape transverse, semicircular, widest at the hinge line. The ventral valve is high, conical, the area broad, high, nearly flat, strongly defined by angles at its junction with the sides of the shell, nearly perpendicular to the plane of the edges or slightly inclined backward. Delthyrium large, much higher than wide. Sinus only slightly larger than the lateral sulci. There are four plications on each side of the sinus, the final one being smaller than the others. The plications and sulci are strong and subangular.

The dorsal valve is strongly convex and inflated at the umbo. The beak is small and depressed, strongly incurved. The cardinal angles are flattened and pointed. The fold is but slightly larger than the lateral plications, and all are strong and subangular. There are three lateral plications.

The surface is covered by a dense epidermal layer, which when not exfoliated conceals the punctate structure beneath. The punctæ are rather large and often separated by relatively long distances. The outer layer is marked by fine, closely and somewhat irregularly arranged lamellose concentric striæ. It seems to have been pierced by scattering pores of large size, which may have projected as spines or pustules similar to those of *Spiriferina spinosa*.

The shape of this shell and to a certain extent its structure strongly suggest the genus *Cyrtina*, but the absence of any deltidial covering removes the possibility of such a generic reference. The punctate shell and large septum prove its affinities to be with *Spiriferina*, in spite of the unusual configuration.

It is possible that I may have founded this species on young examples of *S. laxa*, to which it is certainly related in some ways, and of which the growth lines in the youthful stages indicate a resemblance in configuration. The two examples of *S. pyramidalis* so far found have nearly the same size, which is very much smaller than that of *S. laxa*. Both specimens are from the Capitan limestone, while *S. laxa* is represented in our collections only from the "dark limestone." The lateral extremities are angular and projecting, while those of *S. laxa* are rounded, and the ventral valve is relatively higher and more erect. The differences pointed out are not so striking in fact as the enumeration of them may suggest; but they are too important to warrant uniting the two forms until a greater connection between them is demonstrated than now appears.

Rather greater, however, is the resemblance which this species carries to the small specimen from the same horizon which I have considered as a young example of *S. welleri*. It differs in the flatter area and much more coarsely punctate shell structure; also, to a minor degree, in the character of the plications.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926). Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969?).

SPIRIFERINA HILLI n. sp.

Pl. XXX, figs. 15 to 15b.

Shell small, transverse. Ventral valve elevated. Area high, varying somewhat in its backward inclination to the edge of the shell; concave, clearly defined. Foramen rather narrow and high. Beak incurved. The sinus is broad but not very deep, and contains a low median plication. The lateral plications are four in number, the outer one on either side being indistinct.

Dorsal valve transverse, widest at the hinge line, moderately convex. Beak small, somewhat prominent, incurved. Fold slightly larger than the lateral plications, of which there are three on each side, and possibly a fourth that is very faint. The only dorsal valve observed is a small specimen which has a fold somewhat flattened, perhaps, but without a distinct groove.

Surface apparently smooth or slightly papillose and marked by a few strong lamellæ produced by unequal growth.

This shell is closely allied to *Spiriferina cristata*, but differs in several points, since the latter usually has higher, thinner plications and is without a median plication in the sinus. The specimen figured is higher and narrower than Schlotheim's species, but it is also higher and narrower than other specimens with which it is associated.

The foregoing description is based on a fossil from the Glass Mountains—the only specimen which is at present known to represent the species.

Horizon and locality.—Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763).

Spiriferina hilli var. polypleurus n. var.

Pl. XXI, figs. 4 to 4c.

A considerable number of specimens in our collection, mostly small and many of them fragmentary, have much the general aspect of *Spiriferina hilli*, and, like the type specimen, they are silicified and have been freed from the matrix by etching. The surface ornamentation seems to have been destroyed by this process, for at present the exterior shows only the porous shell and an occasional irregularity of increment. The loss of the sculpture has much enhanced the difficulty of determining the affinities of these forms, and they have been referred to their several species, often with considerable doubt. The sculpture of *S. hilli* itself is a matter of uncertainty—whether it had the dense outer layer of *S. laxa* and its allies, which seems usually to have escaped silicification and to have been lost in the etching process or possessed the superficial characters of *S. cristata*. Any consideration of *S. billingsi* and its allies is rendered almost unnecessary, for apparently they retain the characteristic lamellose sculpture in a silicified condition. The configuration of *S. hilli* at least suggests an affinity with *S. cristata*.

The different specimens above referred to, while having much the general expression of *S. hilli*, show variations more or less distinct in the character of the plications, and with one exception fail to possess any evidence of a median plication on the fold and sinus, a character whose presence in *S. hilli* tends to distinguish it more or less sharply from the *spinosæ* group and to ally it in some measure with *S. cristata*. On this account it has seemed best to refer most of these shells, more or less unsatisfactorily, it is true, to other groups.

If we adhere strictly to the characters possessed by the typical specimen of *S. hilli*, the representation must be at present confined to it alone; but, as before intimated, there is at least one other type which seems to be closely related, and in especial to be distinguished by possessing a median plication on the fold and sinus. A specimen of this sort is represented by figs. 4 to 4c of Pl. XXI. This example is larger than typical *S. hilli*, has a more transverse shape and more strongly marked, and slightly finer plications. Though it apparently stands in close relationship to *S. hilli*, I have found it necessary to regard the present specimen, in view of these differences, as representing a distinct variety. Besides the figured specimen this type is represented only by a young and doubtfully identified individual.

Horizon and locality.—"Dark limestone," Pine Spring, Guadalupe Mountains, Texas (station 2930). Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

Spiriferina welleri n. sp.

Pl. XIV, figs. 17 to 19b.

Ventral valve large, transverse, elevated. Shape, as determined by the aperture, transversely semicircular; widest at the hinge line. Area probably strongly inclined backward, well defined, high, concave above, nearly flat below. Foramen probably large, but higher than broad. Beak slender, incurved, especially at the tip.

Sinus broad and rather shallow. Lateral plications five on each side; moderately coarse and strong, but growing smaller and fainter toward the cardinal angles. The sinus bears a low plication on either side.

What appears to be the dorsal valve of this form is known chiefly from the artificial cast represented by fig. 18 of Pl. XIV. It is moderately convex, transverse, semicircular. Beak small, depressed. The fold is broad, marked by a strong central plication and two small depressed ridges branching from it, one on either side. Lateral plications seven in number.

Shell substance rather coarsely punctate. Surface ornamentation unknown, but probably consisting of an impunctate outer layer, with a few concentric lamellose striæ and possibly scattered poriferous pustules.

Spiriferina welleri is established principally on two shells, the one a dorsal and the other a ventral valve. The most obvious point of disagreement is in the number of lateral plications.

Since the description was formulated, however, there has come to hand an imperfect specimen retaining both valves in conjunction and preserving the surface characters in good condition. The width is 22 mm. and the length of the dorsal valve 13 mm. The dorsal valve has three rounded lateral plications, the early ones strong and the final ones faint. The fold and sinus are very high and angular, and bear on each side a small but very distinct lateral rib. The shell substance is coarsely punctate. There is a thin impunctate epidermal layer marked by fine concentric striæ and numerous large spiniform pustules. Toward the front a few subimbricating lamellæ are developed.

Spiriferina welleri appears to be somewhat rare in the white limestone of the Guadalupe Mountains, but is represented in our collection by a number of specimens, all of which are, unfortunately, more or less fragmentary and doubtfully identified. It is associated with *S. billingsi*, but it is not difficult to distinguish between the two species, even in fragments, since the punctation is much coarser in *S. welleri*. Of course the configuration and surface characters of mature forms distinguish them at once. The coarse punctation and the spinose surface distinguish this species from *S. kentuckyensis* and its allies and indicate that it belongs to an entirely different group. In some particulars it resembles *S. laxa*, but there should be no difficulty in distinguishing them if typical specimens are at hand.

A number of small examples, one of which is represented by figs. 19 to 19b of Pl. XIV, have been referred to this species. The specimen figured has almost precisely the characters of typical *S. welleri* in the immature portion of the shell. It was found at the same locality as typical *S. welleri*, but the typical form is not known in association with the other examples. Thus assembled, *S. welleri* includes a rather motley assortment of forms. First there are one or two specimens showing the typical characters; then there are a few small individuals from the same locality which represent, presumably, immature stages; and, finally, there is a series of small specimens from other localities more or less closely resembling the young stages but unassociated with typical mature shells. In the last category may be mentioned a poor specimen from station 2906, which may possibly belong to *S. hilli* var. *polypleurus*. It also includes a number of specimens from stations 2930 and 2969.

These much resemble *S. hilli* var. *polypleurus*, but differ in having coarser ribs and no median plication on the fold and sinus. They also resemble *S. pyramidalis*, but differ in being more finely punctate, in having the fold more prominent and the beak somewhat more tapering and more incurved. I am not sure but that these small forms, both from station 2926 and from the other localities, but especially from the latter, would better have been regarded as a distinct species, since it is not unlikely that a less incomplete knowledge would show differences now almost obscured. Most of the silicified specimens (from stations 2969 and 2930) have lost all trace of the original sculpture, but in one instance some large spinules are retained similar to those of *S. laxa* and *S. pyramidalis*.

Horizon and locality.—Middle of Capitan formation, Capitan Peak (station 2926); base of Capitan formation, hill southwest of Guadalupe Point (station 2906); "dark limestone," Pine Spring (station 2930?), Guadalupe Mountains, Texas. Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969?). Delaware Mountain formation, mountains northwest of Marathon, Tex. (station 3840?).

SPIRIFERINA WELLERI var. *a*.

Apparently from the upper beds of the Capitan formation a single large, somewhat crushed, specimen has come to hand which resembles typical *S. welleri* in all characters that can at present be observed, save that the fold and sinus seem to be unplicated. It appears not improbable that this may prove a distinct species, to which, and not to *S. welleri* itself, may belong some of the little shells referred to in the preceding description, but for the present no conclusion can be reached on this point.

This form is distinguished from *S. laxa* by its narrower, deeper, and more numerous plications.

Horizon and locality.—Top of Capitan formation, Guadalupe Mountains, Texas (station 3762a).

SPIRIFERINA WELLERI var. *b*.

This variety is founded on a small dorsal valve from Shumard's "dark limestone." The shape is semicircular, the width 10 mm. and the length 7 mm. The hinge line is just a little shorter than the width below. The configuration is marked by the exceedingly high, narrow character of its plications. The fold is not conspicuously larger than the lateral plications, of which there are three on each side and a fourth very faint one near the cardinal line. The surface ornamentation of this shell and apparently the outer layer have been lost, and it is impossible to determine just where its affinities most strongly lie. It is associated with the small shells doubtfully referred to *S. welleri*, but is distinguished by its very narrow, high plications. Its strongly elevated fold and fine punctation distinguish it from *S. pyramidalis*. It also, but remotely, resembles *S. hilli* and its variety *polypleurus*.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969?).

Family ATHYRIDÆ Phillips.

This family is represented in the Guadalupian fauna only by the genus *Composita*,[a] which comprises but four not very easily discriminable varieties.

The most characteristic Guadalupian species differs remarkably from the form, or group of forms, for which the name *Composita subtilita* is used in our Pennsylvanian faunas. Like the majority of brachiopods, the earlier Carboniferous Compositas, as is well known, have a more or less deep sinus in the ventral valve and a corresponding fold on the dorsal. In the Guadalupian fauna, however, a type is developed which has a sinus on the dorsal valve, as well as on the ventral, a circumstance which produces an emargination of the anterior outline. This condition is very striking in some specimens, though less marked in others, while a few examples have the relation of parts the same as in *Composita subtilita*. These I have discriminated as a variety distinct both from *C. emarginata* and from *C. subtilita*, which they closely resemble. The four species recognized in this report might, therefore, be divided into two groups, one characterized by having a sinus in the dorsal valve and including only *C. emarginata*, while the second, which might again be divided, would include *C. emarginata* var. *affinis* on the one hand and *C. mexicana* and *C. mexicana* var. *guadalupensis* on the other.

Thoroughly characteristic specimens of *C. emarginata* have been obtained only near the middle of the Capitan limestone. Even there, however, as well as in the "dark limestone" and the Delaware Mountain formation, by far the largest number of specimens are more or less intermediate between typical *C. emarginata* and *C. emarginata* var. *affinis*.

In the Salt Range Waagen recognized the genera *Spirigerella* and *Athyris*, the latter itself comprising two groups, subsequently distinguished by Hall and Clarke as distinct genera under the titles *Seminula* (*Composita*) and *Cleiothyris* (*Cleiothyridina*). Thus it appears at the outset that the genera *Spirigerella*, comprising ten Salt Range species, and *Cleiothyridina*, with seven, have no corresponding types in the Guadalupian.

In general appearance *Spirigerella* is much like *Composita*, and some of Waagen's species strongly resemble our common *C. subtilita* and its almost numberless mutations. The distinguishing characters from *Composita* seem to consist in a peculiar configuration of the ventral beak and a difference in the cardinal process and the way the primary lamellæ are attached to it. Not all of Waagen's species possess the distinctive configuration of the ventral beak to an equal degree, and I have been unable to investigate the internal structures of the Guadalupian species, which have, however, the outward expression of *Composita*. While the foregoing statement, therefore, may possibly be open to correction, it probably corresponds closely, if not exactly, to the facts.

The two Salt Range species which can be referred to *Composita*, are not, for the genus, closely allied to the Guadalupian forms. On the other hand, the striking Guadalupian species, *Composita emarginata*, has no corresponding type either among the two species of Salt Range Compositas or in general configuration among the species referred to *Spirigerella*.

[a] In this report the generic terms *Composita* and *Cleiothyridina* are substituted for *Seminula* and *Cleiothyris*, as suggested in a recent paper by Mr. Buckman (Ann. Mag. Nat. Hist., 7th ser., vol. 18, 1906, pp. 321-327).

In the Himalaya Diener cites from the "Permo-Carboniferous" fauna of Chitichun No. 1 three species of *Cleiothyridina* and three of *Spirigerella*. Some of the latter are not unlike certain of the Guadalupian Compositas in general expression, but I have no grounds for contradicting Diener's assignment of his material to *Spirigerella*. In his second paper on this fauna Diener cites a single athyroid, probably a *Cleiothyridina*.

The faunas of Kashmir and Spiti as described by Diener comprise three athyroids, two probably belonging to *Cleiothyridina* and the other identified as *Composita subtilita*. The latter may be compared with *Composita emarginata* var. *affinis* and with some of the varieties of the Pennsylvanian species with which Diener has identified it. In a subsequent paper on the faunas of Spiti the same author cites from the lower division a small athyroid under the title *Spirigera (Athyris)* cf. *roissyi*, which I would judge to be a *Composita*, though not one closely connected with the Guadalupian types. From the upper beds he cites two athyroid species, one apparently a *Cleiothyridina* and the other a *Composita* related to *C. mexicana*.

The Permian faunas of Kumaon and Gurhwal furnished, according to Diener's investigations, of the Athyridæ only species, two or three in all, belonging to the genera *Spirigerella* and *Cleiothyridina*. The same is true of the fauna from Malla Sangcha, in which a species of *Cleiothyridina* and one of *Spirigerella* are mentioned. In the Productus shales of the Lissar Valley but a single athyroid is known. This singular species, described by Diener as *Spirigera* (*Athyris*) *gerardi*, is found in both the faunas of Kashmir and Spiti and of Kumaon and Gurhwal. Whether it is a *Cleiothyridina* or an *Athyris* sensu stricto, as may possibly be the case, there is as yet nothing known in the Guadalupian fauna which at all resembles it. The same species, based on a very imperfect specimen, is doubtfully identified in the Productus shales of Byans.

Salter identifies *Athyris roissyi*, probably a *Cleiothyridina*, from Niti Pass and Davidson cites *Athyris subtilita* from the valley of Kashmir. The latter species is rather suggestive by its configuration of a *Spirigerella*, but if a *Composita* it may be compared with *C. emarginata* var. *affinis*.

From probably a much older horizon of the Carboniferous in Turkestan Romanowski cites *Spirigera ambigua* and *S. expansa*. The former, probably a *Composita*, resembles *C. mexicana* var. *guadalupensis*, while the latter is very likely a *Cleiothyridina*.

Considering the Athyridæ of the Salt Range and Himalayan regions as a whole, one can not say that much resemblance is shown to the faunas of the Guadalupe Mountains. *Cleiothyridina* and *Spirigerella* seem abundant and well differentiated in many places, whereas *Composita*, the only Guadalupian athyroid, is rare and often represented by types which are different from the Guadalupian Compositas and which in especial contain nothing comparable to *C. emarginata*, the only striking Guadalupian species.

From Lo Ping, in China, Kayser cites only *Athyris globularis*. Presumably the Chinese form is a *Composita*,[a] instead of a *Spirigerella* or a *Cleiothyridina*, and if so it somewhat resembles *Composita mexicana* var. *guadalupensis*. From the vicinity of

[a] Fliegel in revising this fauna places it under *Spirigera*.

Kantschoufu Loczy cites a species of *Cleiothyridina* and from the vicinity of Batang a species of *Spirigerella*. Thus the various imperfectly known faunas of China present little resemblance to the Guadalupian in respect to this family of brachiopods.

From Timor Beyrich cites a species of *Cleiothyridina* and one presumably of *Composita* which, identified as *Seminula glodularis*, is nevertheless extremely like our common American *Composita subtilita*. Perhaps *Composita mexicana* of the Guadalupian species comes nearest, but the resemblance is not close. Under the title *Spirigera protea* var. *subtilita* Martin cites from Timor a form which may be the same as the foregoing, but the specimen figured is so imperfect that one may not safely hazard an opinion. Roemer cites from the west coast of Sumatra *Terebratula subtilita*, the only athyroid found in his collection, and as Martin includes this citation in the synonymy of his form from Timor it seems likely that all three belong to the same species, one closely allied, if not identical, with *Composita subtilita*. In his paper on the fauna of Padang Fliegel subdivides the *Terebratula subtilita* of Roemer above referred to into *Spirigera* cf. *subtilita*, *Spirigera damesi* n. sp., and *S. pseudodielasma* n. sp. Neither Roemer nor Fliegel figures the form which Roemer refers to Hall's species, so that the general character can only be inferred. Probably the Sumatran shells exhibit the plasticity which is so troublesome a character of the American ones, and this may account for the great diversity shown by Fliegel's figures of both *Composita damesi* and *C. pseudodielasma*. A figured specimen referred to the former might very well pass as a narrow variety of *Composita subtilita*, while the two other figured specimens, each possessing apparently distinctive characters, present types which are more or less completely unlike any American varieties of *C. subtilita*. They also have no closely related Guadalupian species. In the case of *Composita pseudodielasma* also, one specimen might pass as a somewhat aberrant variety of *Composita subtilita*, but hardly the two others. Here too the Guadalupian fauna does not contain any form which may be called a correlated type, though the resemblance is closer than in the other species.

Rothpletz, in his work on the faunas of Timor and Rotti, cites *Spirigera roissyi* and *S. timorensis* as the only representatives of the Athyridæ. The former is a *Cleiothyridina* and the latter is certainly very suggestive of a *Spirigerella*. Even if a *Composita*, however, it is not especially close to any of the Guadalupian species.

In this group of Asiatic faunas *Composita* seems to be a frequent and abundant factor, but *Spirigerella* and *Cleiothyridina* also occur. Many of the Compositas appear to be of the general character of *C. subtilita* rather than of the Guadalupian species, but, on the other hand, present modifications which are not found in North America, so far as known.

The athyroids are represented in the Carboniferous fauna of New South Wales, according to De Koninck, by but a single species, identified as *Athyris planisulcata*. Its horizon in the Australian section seems to be in the lower beds.

Etheridge discriminates only three species belonging to the Athyridæ in the "Permo-Carboniferous" fauna of Queensland and New Guinea. He refers them to the genus *Athyris*. *A. roissyi* is a *Cleiothyridina*, and possibly the two other species belong to the same genus, in which case they represent a type as yet unknown in the Guadalupian. *Athyris randsi*, however, has the configuration of a *Composita*, and indeed it is compared by Etheridge to *Composita subtilita* of the Pennsylvanian. *Composita mexicana* of the basal Guadalupian most resembles it, if it is a *Composita.*

In the Russian section the fauna of the *Productus giganteus* zone may be safely neglected. The Moskovian fauna contains, so far as I have seen, only *Athyris ambigua,* which as represented by Trautschold's monograph is apparently a species of *Composita* related to, though probably distinct from our *C. subtilita.* It is about equally near *C. mexicana* also. The Athyridæ of the Gschelstufe show a surprisingly slight development. Tschernyschew cites only four species, three belonging to *Cleiothyridina* and the fourth referred to as *Athyris* (*Actinoconchus*) *planosulcata.* I do not know in what sense Tschernyschew is employing the term *Actinoconchus,* but his figures appear to represent a form which is not a *Composita.* Stuckenberg cites in addition *Athyris* cf. *ambigua,* which probably belongs to *Composita.*

Practically the same representation ranges up into the Artinsk. Tschernyschew mentions *A. pectinifera, A. roissyi,* and *A. planosulcata,* all found in the Gschelian also. Krotow cites *A. planisulcata, A. concentrica,* and *A. roissyi,* but other lists which I have seen supply no additional species.

From the Permian of Russia the only athyroids which I have seen recorded are three species of *Cleiothyridina* by Tschernyschew, Golowkinsky, and Netschajew. From this it would appear that the only type of athyroid which is found in the Guadalupian is either entirely absent from the Russian section or confined to the lower beds, while *Cleiothyridina,* which is so common in Russia and India, is so far as known entirely absent from the Guadalupian fauna. This absence of *Cleiothyridina* is in fact rather peculiar, since it is so persistent and often so abundant in other faunas, as will subsequently appear.

In strong contrast to the Russian athyroids are those of the fauna from Djoulfa, in Armenia, described by Abich. The group of *Cleiothyridina* is probably entirely lacking, for while Abich cites *Athyris roissyi* in this fauna, I believe that the shell called by that name belongs to a different group. A possible exception may also exist in the case of *Spirigera epigona,* which certainly has not the configuration of a *Cleiothyridina,* but in its lamellose growth lines contains a suggestion of the *Cleiothyridina* sculpture. The smooth athyroids, however, seem to be very abundant and to present an almost endless number of mutations. Abich distinguishes ten varieties, by separate headings in his text, including *A. epigona* and *A. roissyi,* and still others by subheadings or in the description of plates. Most of these species are represented with the appressed ventral beak characteristic of *Spirigerella,* but a few have the large, more erect beak and open foramen of *Composita.* It may be that both types are present. One or two species have a general configuration strongly resembling our *Composita subtilita,* nor are forms simulating Guadalupian species absent. The characteristic feature of *C. emarginata,* the possession of a well-marked sinus on both valves, appears in many of the Armenian forms, but so combined with other peculiarities that in no case can I find what I am able to regard as specific identity. On the other hand, many varieties occur in Armenia which are unknown in either the Pennsylvanian or Guadalupian faunas. Arthaber in reworking Abich's fauna made some changes in nomenclature and introduced some new matter, but the few remarks ventured above hold good in this connection also. Arthaber regards *Spirigerella* as only a subgenus of *Composita,* and while I have not read through his nine specific descriptions, he does not indicate in any conspicuous manner whether the Armenian species are to be considered as belonging to *Spirigerella* or not. His figures represent them as having the configuration of *Composita* rather more than those of Abich. If they are really Compositas, as seems not unlikely, the differentiation which this fauna manifests is certainly noteworthy.

In the fauna obtained at Balia Maaden Enderle has only one athyroid, which he identifies as *Spirigerella grandis?*. It has somewhat the appearance of *Composita mexicana* var. *guadalupensis*, but if a *Spirigerella* is, of course, quite a different thing.

That portion of Gemmellaro's work on the faunas of Palermo, in Sicily, which treats of the Athyridæ, has not come into my hands. In his paper on the fauna of the Carnic Fusulina limestone Schellwien identifies only one species of *Athyris*, which he cites as *Athyris?* cf. *planosulcata*. If really an athyroid, this little shell is probably a *Composita*, but not allied to any of the Guadalupian species. The fauna of the Trogkofelschichten contains, according to the same author, only *Spirigerella* sp. indet. aff. *pertumida* Diener. Even if a *Composita*, this form is hardly to be considered closely allied to any Guadalupian species, though it is nearest to *C. mexicana*.

The Dyas of Germany, like the Russian Permian, contains only two species of *Cleiothyridina*, as represented in Geinitz's monograph; and, similarly, *Cleiothyridina* (one species being cited by King) seems to be the only athyroid type of the English Permian.

This family has not been recoginzed, so far as I am aware, in the different collections which have been brought back from Spitzbergen, but Toula cites *Athyris ambigua* and *A. subtilita* from Nova Zembla, both species apparently being Compositas, and the former at least somewhat comparable to *C. mexicana* and *C. mexicana* var. *guadalupensis*.

From the Wadi-Draa, in the West Sahara, Stache cites *Athyris* cf. *subtilita*, *Athyris* cf. *archimedes*, and *Athyris* cf. *ambigua*, all small and possibly young forms, whose identification, even as athyroids, might, so far as the figures are concerned, be called in question. That compared with *Athyris ambigua* resembles the corresponding (dorsal) valve of *Composita mexicana*. What is apparently a species of *Cleiothyridina*—called ?(*Spirigera*) *Athyris* cf. *planosulcata*—is also cited from Igidi.

D'Orbigny has described from Bolivia *Composita peruviana* and *Cleiothyridina roissyi*. The former is very similar to our *Composita subtilita*, and has often been regarded as identical with it. Probably the same species is cited by Salter and Toula from Bolivia under the name of *Composita subtilita*. This form also to a considerable extent resembles *C. mexicana*.

Derby identified his Brazilian athyroids with *Composita subtilita* and *Cleiothyridina sublamellosa*, the former, of course, being related more or less to both *C. mexicana* and *C. emarginata* var. *affinis*.

In the Pennsylvanian of North America two types of athyroids are of common occurrence, a very variable *Composita*, to which Hall's term *Composita subtilita* is usually applied, and much less frequently a small *Cleiothyridina* which is most often called *C. suborbicularis*. Several specific appellations have been introduced for both types, and are in more or less current use, but merely as a matter of synonymy and not to designate distinct things. It is indeed possible, however, that more than a single species is included among the Pennsylvanian varieties of *Composita subtilita,* but their intergradation is so complete that no one, so far as I am aware, has been successful in discriminating them. Some of these varieties very closely approximate those of the Guadalupian fauna, with the exception of *C. emarginata.* In view of the fact that the different forms of *C. subtilita* are so slightly differentiated, *C. emarginata,* with its strongly marked characters, constitutes a notable feature in the Guadalupian fauna. The absence of *Cleiothyridina,* though its significance is at present uncertain, is also a peculiarity of the latter, to which attention has already been called, and which also forms an element of difference from the Pennsylvanian.

Genus COMPOSITA Brown.

Composita emarginata n. sp.

Pl. XV, figs. 1 to 5a.

Shell of medium size. Shape suboval to subpentagonal. Dorsal and ventral valves moderately and about equally convex. Ventral valve often marked by a shallow, depressed line, which can sometimes be traced to the beak. Toward the front it becomes lost in or spreads out into the sinus, which is broad, shallow, and somewhat quadrate. The dorsal valve also bears a sinus, which varies from a well-marked depression similar to that of the opposite valve to an indistinct flattening. Where the sinus is strong, a depressed line is sometimes seen in its upper portion and toward the beak. The effect of the double sinus is to produce an emargination of the front which is sometimes very striking. The ventral sinus is usually stronger than the dorsal, so that a slight fold is sometimes seen in a view of the front end.

The surface was probably for the most part smooth, with a few lamellose concentric elevations toward the front. Many specimens show, when exfoliated, rather distinct raised lines or liræ, which are sometimes easily seen, but usually are faint or absent. On the inside there is a low median septum in the dorsal valve, and two rather large discrete dental plates in the ventral.

This species is fairly abundant in the white limestone of the Guadalupe section. Well-characterized examples are clearly distinct from our common *Composita subtilita,* but they graduate more or less completely into forms which would probably be assigned to that species, so wide have its limits now become. *Composita* shows so few lines of specific evolution that differences, if at all well marked or constant, may be given unusual weight in the discrimination of species. For this reason, and because of the difference in the associated fauna, I have with some confidence described this as a new species. In addition to the configuration which distinguishes *C. emarginata* from *C. subtilita,* the size and distinctness of the dental plates may prove to be helpful in discriminating them, since in *C. subtilita* the apex is usually partly filled with shelly matter, uniting the septa with the lateral walls, and thickening the wall above. In the present species, as in *C. subtilita,* it is possible to distinguish several types, one of which is longitudinally and another transversely elongated, while in another the shell is more convex than usual. It is in these specimens that the dorsal sinus is most strongly developed.

I have also referred here a few specimens from the "dark limestone," but this material is too incomplete to render the determination satisfactory. This is still more true of the fragmentary collection from the yellow sandstones of the Delaware Mountain formation. Some of these fossils, from their broad shape, might be dorsal valves of *Squamularia guadalupensis*, rather than of *Composita*, but their surface is apparently smooth.

Horizon and locality.—Top of Capitan formation, Capitan Peak (station 2966); middle of Capitan formation, Capitan Peak (station 2926); base of Capitan formation, hill southwest of Guadalupe Point (station 2906); "dark limestone," Pine Spring (station 2930?); Delaware Mountain formation, Guadalupe Point (station 2919?), Guadalupe Mountains, Texas.

Composita emarginata var. affinis n. var.

Pl. XV, figs. 6 to 7b.

This form graduates more or less completely into *Composita emarginata*, but can hardly with propriety be referred to that species without some distinction of name. Practically the only difference that can be assigned is that the variety *affinis* is without any sort of a sinus on the dorsal valve or the emargination characteristic of the other form. There is no dorsal fold distinct from the regular transverse arching of the shell, nor is there any evidence of a sinus, or even of a mesial flattening.

In practice there are many specimens which, in view of their imperfect condition or their intermediate character, it is impossible to assign with confidence, either to *Composita emarginata* or its variety, but I have placed with the variety only such examples as showed a distinct upturning of the line of contact of the valves along the front margin, and at the same time were without the emargination which gives name to the other type. Thus determined, but comparatively few specimens have been placed with the variety *affinis*, and all of them are from the white limestone, while a large number of poorly characterized or transitional specimens are left with *C. emarginata*. It is possible that this species is represented in the material from the "dark limestone" and from the yellow sandstone below it, but the fossils at hand are too imperfect to permit me to determine their affinity to my satisfaction.

Had this form been found associated with the familiar fauna of the "Coal Measures" of the Mississippi Valley it would probably have been referred to *Composita subtilita* without any criticism of the identification; but it is not quite the same as typical *Composita subtilita*, and I am not without hope that the heterogeneous group of forms now referred to that species can be broken up along stratigraphic if not biologic lines.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926). Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969? and 3500?). Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763?).

Composita mexicana Hall.

1857. *Terebratula Mexicana.* Hall, Emory's Rept. U. S. and Mex. Boundary Survey, vol. 1, pl. 20, fig. 2.

Hall gave no description of this species in his first publication nor later, but his figures were not bad. The following description is based on the typical specimen and not on that from the Glass Mountains, which closely resembles it.

The size is small and the shape subpentagonal. The widest point is about two-fifths the length back from the front. The ventral beak is rather large and inflated; the sinus is narrow above, shallow and undefined below. The dorsal valve is rather convex, with the sides strongly reflexed so as to leave a rather narrow, very high fold.

Although the spires have not been seen, there can be little real doubt that *Terebratula mexicana* is a *Seminula* (*Composita*), as suggested by Schuchert.

This form, though related to *C. subtilita*, is rather more marked than most of the varieties which are united with that species. It seems to be abundant in the upper beds of the Hueco formation, and I have recognized it in the Guadalupian at a much higher level.

In this case it is represented by only one specimen from the Glass Mountains; this is in not very perfect condition, but aside from being somewhat less tumid agrees very closely with Hall's type.

Horizon and locality.—Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763).

Composita mexicana var. guadalupensis n. var.

Pl. XXIV, figs. 11 to 13b.

Of Hall's species I have only the type specimen with which to make comparison, but the form from the Guadalupe Mountains is represented by a number of specimens. These differ from *Composita mexicana* in being almost invariably less tumid, with the fold and sinus less strongly elevated. The fold is proportionately a little wider and not so strongly marked by a deflection of the shell on either side, so that the outline is less quadrate and more ovate. The difference in shape seems to be the result of the coincidental circumstances that the shell is flatter and the fold lower than in the original form. In these points it seems to differ from the Glass Mountains specimen identified as *Composita mexicana*.

Composita mexicana var. *guadalupensis* is perhaps the most abundant species in the black limestone at the base of the Guadalupe section. It is clearly distinct from *C. emarginata* of the Capitan limestone, but is more nearly related to the variety *affinis*, to typical *C. subtilita*, and to *C. mexicana*, especially to the latter. Loosely identified it might be referred to any of them.

Horizon and locality.—Basal black limestone, Guadalupe Point, Guadalupe Mountains, Texas (stations 2920 and 2967).

Family RETZIIDÆ Hall and Clarke.

The family Retziidæ is represented in the Guadalupian fauna by the single genus *Hustedia*. To that genus I have referred two readily distinguishable types of shells, one represented by *Hustedia meekana* and *H. papillata* and the other by *H. bipartita*. *H. meekana* has in every way the characteristic configuration of *Hustedia*, and the internal structures also are in agreement, so far as they have been made out. *H. papillata* is doubtfully distinct specifically from *H. meekana*, and *H. meekana* var. *trigonalis* is possibly only an abnormal young form. *H. bipartita*, on the other hand, departs rather strongly from the usual configuration of *Hustedia*, but nevertheless with but little doubt belongs to that genus.

In the Salt Range the Retziidæ have been discriminated by Waagen into two genera, one of which he describes as new, under the title *Uncinella*. It contains but a single species. Shells of the other group, comprising two species, are referred by Waagen to *Eumetria*, a genus at the time he wrote imperfectly known, but they can with safety be placed under the more recently founded *Hustedia*. *Uncinella* is not known in the Guadalupian fauna, but the two species of *Hustedia* correspond very closely to *H. meekana* and *H. papillata*. Indeed, it is possible that *H. indica* should not be regarded as a distinct species from *H. meekana*. If a distinction exists it may be found in the angularity and roundness of the plications. The Indian shells show on the interior the same character which is represented in Shumard's figures of *Hustedia meekana*, these being evidently based on much exfoliated specimens. I refer to the sulci, which appear flattened and striated on internal molds, while on the exterior they are deep and angular without striation. The third Guadalupian species, *H. bipartita*, has no correlated form in the Salt Range fauna.

In his second paper on the fauna of Chitichun No. 1 Diener records both *Hustedia* and *Uncinella*. *H. grandicosta* is apparently represented in the Guadalupian fauna by *H. papillata*, but *Uncinella* cf. *indica* has nothing to correspond. This author cites only *Hustedia* cf. *grandicosta* in his paper on the anthracolithic faunas of Kashmir and Spiti, but the form is very doubtfully identical with Davidson's species, and certainly distinct, so far as one may judge in view of its probable immaturity, from either *H. meekana* or *H. papillata*.

Were it not for the Guadalupian species *Hustedia bipartita*, like which there is nothing, so far as I am aware, in the faunas of the Salt Range or Himalaya, and the genus *Uncinella*, which is restricted to the latter, the Indian Hustedias would appear to present strong analogies to those of the Guadalupe Mountains, though the amount of significance which should attach to this circumstance is a different matter, seeing that *Hustedia* presents so few lines and such restricted limits of specific differentiation.

Kayser identifies with *H. compressa* Meek the *Hustedia* which occurs in the Chinese fauna from Lo Ping. It resembles *H. meekana* and *H. papillata*, but is probably distinct from either, especially from the former. Loczy cites what is probably the same species from Kantschoufu. He identifies it provisionally with *H. grandicosta*, and the figures would indicate a resemblance with *H. papillata* more than with *H. meekana*. Referred by Rothpletz to the same species is a form from Ajermati which much resembles *H. meekana*, especially certain small specimens from the "dark limestone," one of which is figured on Pl. XXI.

Among the "Permo-Carboniferous" fossils from Queensland and New Guinea described by Jack and Etheridge are two species representing the Retziidæ—*Retzia radialis* and *R.? lilymerensis*. The former is rather to be compared with *Hustedia papillata* than with *H. meekana* of the Guadalupian types. *Retzia? lilymerensis* certainly suggests by its configuration our Mississippian species of *Eumetria*. Etheridge, however, is in doubt whether the shell is punctate, and the absence of this structure would clearly debar it from the Retziidæ. He compares it with *Hemiptychina*, *Notothyris*, and *Dielasmina* of the Salt Range faunas, but to me it has more the appearance of *Uncinella*, which also simulates our Mississippian

Eumetrias. Etheridge, however, mentions the occurrence of three septal plates in the ventral valve, which is an arrangement suggestive of some of the terebratuloids and unlike *Hustedia* or *Uncinella*, especially the former. No species resembling *Retzia? lilymerensis* is known in the Guadalupian.

It is something of a surprise to find no species of *Hustedia* in the Moskovian fauna of the Russian section, which in most particulars shows so strong a resemblance to our Pennsylvanian. In the Gschelian, however, the genus seems to be not uncommon. Tschernyschew cites *H. remota* and *H. indica*, both of them related to the shells which I have assembled under the title *H. meekana*. Several of the figured specimens of *H. remota* suggest the exfoliated condition of Shumard's species with flattened interspaces and small intermediate ribs. One specimen referred to the same species also shows suggestion of a distinguishing character of *H. bipartita*. Nikitin cites *H. grandicosta* and *H. pseudocardium* from the same horizon, the two species being comparable to *H. meekana* and *H. papillata*, respectively, though it can hardly be said that we as yet know very well what *H. papillata* really is. A figure of an internal mold of *H. grandicosta* shows the same sort of broad striated intercostal spaces as *H. meekana*. Stuckenberg cites from this horizon *H. grandicosta* and *Hustedia* cf. *indica*, which would appear to correspond to *H. meekana* and *H. papillata*, respectively. I do not know on what ground Stuckenberg identified his fossils with the Indian species whose relation to the two Guadalupian ones, at least so far as the number and coarseness of the ribs is concerned, seems just the reverse of that indicated by the correspondingly named forms from the Gschel. Stuckenberg cites *H. grandicosta* from the Artinsk also, and from the Kungurstufe he notices *H. grandicosta*, *Hustedia* cf. *indica*, and *Hustedia permocarbonica*, the latter a new species which has no correlated Guadalupian form. Except for *Hustedia bipartita* of the Guadalupian, which even in view of the partial resemblance suggested by one of Tschernyschew's specimens can fairly be said to be without a corresponding Russian species, the Retziidæ of the Gschel and Artinsk appear to be distinctly related to those of the Guadalupian fauna. In the Russian Permian no shells belonging to the Retziidæ appear to be present.

The Sicilian fauna which Gemmellaro described from Palermo contains only one representative of the Retziidæ, *Hustedia ambigua*. While without much doubt a distinct species, *H. ambigua* is closely allied to *H. bipartita*, and is in fact the only type closely correlated with that species which I have come upon anywhere.

In his account of the fauna of the Trogkofelschichten, Schellwien cites of the Retziidæ only a single species of *Hustedia*, which he compares with *H. grandicosta*. It seems to resemble *H. mormoni* of our Pennsylvanian fauna and *H. papillata* of the Guadalupian species rather than *H. meekana*. In both the Dyas of Germany and the closely related Permian of England, species belonging to this family are, so far as I have seen, absent.

The absence of the Retziidæ from the Permian of Russia, the Dyas of Germany, and the Permian of England may to a certain extent be taken as evidence for assigning the Guadalupian fauna in which they occur to a different horizon. I can not but feel that the presence of the unusual type represented by *H. ambigua* in the Sicilian fauna and *H. bipartita* in the Guadalupian is another instance of the strong analogy which exists in many respects between these two faunas.

From Balia Maaden, in Asia Minor, Enderle cites only *Hustedia* cf. *grandicosta*, which if his identification is close would most likely be of the general type of *H. papillata*.

No fossils belonging to the Retziidæ are mentioned in the accounts which I have seen of fossils from Spitzbergen and Nova Zembla, except in a report on a fauna regarded as of Permian age, where Lundgren describes *Hustedia nathorsti*, which seems to be very closely related to *H. meekana*.

Of the accounts of the faunas of Central and South America the only one in which I have found note of any Carboniferous Retziidæ is that by Derby on Brazilian fossils. The form which he obtained is identified as *Retzia punctulifera* Shumard, a species which is generally regarded as a synonym of *Hustedia mormoni* Marcou. The Brazilian form certainly seems to be very closely related to the common Pennsylvanian species, and if it is to be compared at all to those from the Guadalupe Mountains is nearest to *H. papillata*.

Aside from the Guadalupian types, the North American upper Carboniferous species of *Hustedia*, which alone represents the Retziidæ at this horizon, are two in number—*H. mormoni* and *H. compressa*. *H. compressa* is restricted in its distribution to the Pacific coast, and is as yet imperfectly known, though probably more closely related to *H. meekana* than to *H. mormoni*. The latter species is very abundant in the Pennsylvanian rocks of the Mississippi Valley and has also a considerable western distribution. In view of the fact that *Hustedia* is not a genus which manifests much specific variety, the differences which exist between *H. mormoni* and *H. meekana* and *H. bipartita* are great and significant. *H. papillata* and *H. mormoni* are much more of a kind, though still probably distinct species.

Genus HUSTEDIA Hall and Clarke.

I have recognized three species of *Hustedia* in the Guadalupian fauna, two of which had already been described by Shumard. These are *Retzia papillata* and *Retzia meekana*. *Hustedia meekana* as originally described possessed the character, altogether unique in this genus, of having small subordinate plications on the sides of the principal ribs, which distinguished it at once from any known species of *Retzia*, *Eumetria*, or *Hustedia*. Our material, however, has conclusively demonstrated that this character belongs to the inside of the shell and is seen only where deep exfoliation has taken place. With this feature eliminated *H. meekana* becomes quite of the normal type and proves to be rather closely allied to *H. papillata*. *H. meekana*, however, is by far the commoner species and most of the fossils in our collections have been referred to it. Though some of the numerous examples belonging to *H. meekana* show more or less distinct deviations from the typical form, it did not seem to me practicable to employ these differences for the discrimination of other species, though a certain variety probably composed of abnormal individuals appeared deserving of mention if not of name. The type described as *H. bipartita*, however, is a new and rather striking species, though obviously related to *H. meekana*.

The hinge plate and crura have been observed in one specimen of *H. meekana*, the characters proving to be those of *Hustedia*.

HUSTEDIA MEEKANA Shumard.

Pl. XIV, figs. 22 to 26a; Pl. XXI, figs. 5 to 8a; Pl. XXIV, figs. 14 and 14a; Pl. XXIX, fig. 8; Pl. XXX, figs. 16 and 17.

1858. *Retzia* (?) *Meekana*. Shumard, Trans. Acad. Sci. St. Louis, vol. 1, p. 295 (date of volume, 1860). White and dark [Permian] limestone: Guadalupe Mountains; conglomerate at the mouth of Delaware Creek.

1859. *Retzia Meekiana*. Shumard, idem, p. 395, pl. 11, figs. 7a, 7b. White and dark limestone: Guadalupe Mountains; conglomerate at the mouth of Delaware Creek.

1897. *Hustedia* (?) *meekana*. Schuchert, Bull. U. S. Geol. Survey No. 87, p. 231.

Shell rather small, ovate, gibbous, length slightly greater than the width, valves nearly equally convex, umbonial slope flattened, anterior portion of sides and front regularly rounded, surface of each valve marked with from eight to ten prominent, radiating plications rounded for some distance from the beak, but becoming subangular toward the front; they expand very gradually from their origin to the borders and are separated by rather deep sulci, as wide as themselves. The sides of the ribs are each marked with three or more small ribs, which are usually quite distinct at the borders of the valves, but become obsolete before reaching the beaks; shell structure finely punctate. Ventral valve (receiving valve) without any trace of mesial sinus, greatest convexity near the middle; area very small; beak moderately prolonged, rounded, incurved. Dorsal valve elevated near the beak; umbo rounded, sides somewhat flattened; cardinal margin short; beak moderately prominent, strongly incurved.

Dimensions.—Length, 0.46; width, 0.42; height, 0.36.

Geologic position and locality.—The specimens of the collection are marked, white limestone, Guadalupe Mountains; dark limestone under white limestone, Guadalupe Mountains, and conglomerate near mouth Delaware Creek, New Mexico.[a]

Shumard cites this species from both the light and the dark limestone, and there can be little doubt that the form before me, which is very common in the white limestone of the Capitan formation, belongs to it. *Hustedia meekana* has always been anomalous in having liræ on the sides of the plications or on the bottoms of the grooves between them. Most of the specimens in our collections show this character rather strongly, and it will doubtless at first seem hardly credible that it is entirely the result of exfoliation. That all the specimens possessing striated ribs are deeply exfoliated there can be no doubt, while in a number of examples the thick shell has been broken away over only a part of the surface, which there exhibits the liræ, while the portions over which there is little or no exfoliation are simply plicated.[b] The best preserved surfaces show, aside from the plications, only faint incremental lines and occasional varices of growth. The plications are rather large, lax, and subangular, the grooves between them being the reverse of the plications themselves. In exfoliated specimens the grooves become flattened and broad toward the front, while the plications which rise between them are somewhat narrowed. Frequently, owing to the slightly deeper depression at the edges of the plication, the bottoms of the furrows are convex, resembling depressed alternating ribs. On the sides of the exfoliated plications are to be seen from one to three bifurcated liræ. There are as a rule nine plications on the dorsal valve and ten on the ventral. In this species, as in *H. mormoni*, the median rib in the dorsal valve becomes depressed toward the hinge line, so that in the umbonal region and in immature specimens the shell had to a certain extent a bilobate appearance.

Shumard does not compare his species with any other, and under his misconception as to the real surface characters comparisons were hardly necessary. There

[a] Trans. Acad. Sci. St. Louis, vol. 1, 1856–1860, p. 295.

[b] The same peculiarity of shell structure which has a simple plicated exterior and a plicated and striated interior is shown in some of Waagen's figures of *Eumetria*, and in figures by other authors of shells of this group.

can be no doubt that *H. meekana* is distinct from *H. mormoni*, as indeed the exfoliated shell would indicate. It is longer, with fewer, coarser, and broader plications. The beak is probably more elongate and pointed, and it is certainly more erect. Shumard's figures, which are not very accurate, misrepresent the shape of this species, which does not differ from that of *H. mormoni*. No specimens have been observed with the peculiar fanlike contour of his illustrations.

I have identified *Hustedia meekana* at several horizons and at a number of localities. The local lots present differences which give the species some range of variation, and it will be best to note the several occurrences separately. At nearly every horizon these variations tend to pass off without any appreciable break into types which it seems more or less inadvisable to regard as identically the same species as *H. meekana*, and which I have accordingly discriminated under distinctive titles. In some cases the types distinguished appear to me no more than abnormal individuals, but in others the differences are perhaps varietal or even more, for in a type so restricted as *Hustedia* it is necessary to assign more than ordinary importance to small variations in order to discriminate species at all.

H. meekana is very abundant in the "white limestone," where what may be regarded as the typical form occurs, and it has been obtained at three localities. It is probable that the specimens figured by Shumard were derived from this horizon. To examples preserved as they are, his description is particularly applicable, and upon them the foregoing observations are based.

The majority of our specimens from the "dark limestone" are small, a length of 9 mm. being about the maximum. There are seven, sometimes nine, plications on the dorsal valve, and eight or sometimes ten on the ventral. The plications are rather lax and subangular. Variation occurs in the curvature of the beak and in the proportions, broad and narrow varieties being found. Exfoliated shells show the same lateral striation as those from the white limestone. So far as I have made comparisons, these small specimens agree in every way with small examples of the typical *H. meekana*.

Associated with them are a few examples of a much larger size, which have a length of about 17 mm. They show large, rather lax plications, which when exfoliated have lateral striæ. Unfortunately, my specimens are fragmentary, and it is impossible to give accurately the number of plications. I think there are ten on the ventral valve. The size attained by these shells is distinctly greater than the form in the white limestone, of which 13 mm. represents perhaps the maximum length; but the other characters, so far as I have ascertained, are the same, and there is no justification under the evidence known to me for considering them distinct. At the same time comparisons are rendered difficult and unsatisfactory, both on account of the imperfect condition of part of my material and because that from the "dark limestone" is silicified and retains the external form, whereas most of the specimens from the white limestone have the thick shell exfoliated, whereby the character of the plications and sulci is materially changed. Similar large varieties occur in the Glass Mountains, as will subsequently be mentioned.

Hustedia meekana has not been identified in the Delaware Mountain sandstone. The single specimen of *Hustedia* found at that horizon has been referred to *H. papillata*.

In the black limestone at the base of the section *Hustedia* is fairly abundant. Some of the specimens represent a narrower form with somewhat fewer plications, and I at one time sought to distinguish them as a separate variety. More careful comparisons, however, have convinced me that such a distinction would not be justified.

The species is represented in abundance and variety in the Glass Mountains. Specimens attain a size of 16 mm.—nearly as great as those from the "dark limestone"—and range down to very immature dimensions. The plications are strong and subangular. Usually there are nine on the dorsal valve, but in a few instances, which have been referred to *H. papillata,* there are more. Exfoliated surfaces show indications of internal striæ. The beak varies from nearly erect to moderately incurved. There is no appreciable difference in specimens of the same size from this locality and from the white limestone of the Guadalupe Mountains.

Schuchert places this species with the genus *Hustedia,* and some of the specimens which have come to hand verify this reference.

Horizon and locality.—Top of Capitan formation (station 3762a); middle of Capitan formation, Capitan Peak (station 2926); base of Capitan formation, hill southwest of Guadalupe Point (station 2906); "dark limestone," Pine Spring (station 2930), Guadalupe Point (stations 3762b and 3762d), hill southwest of Guadalupe Point (station 2924); basal black limestone, Guadalupe Point (stations 2920 and 2967), Guadalupe Mountains, Texas. Delaware Mountain formation, southern Delaware Mountains, Texas (stations 2969 and 3500). Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763).

HUSTEDIA MEEKANA var. TRIGONALIS n. var.

Pl. XVI, fig. 12; Pl. XXI, figs. 9 to 9b.

Under this title I am including a few specimens indicating a rather scattered distribution, which are probably somewhat abnormal examples of *H. meekana.* They are all rather small, the longest being but little over 6 mm. in length. The shape is relatively very narrow and the ventral beak long and erect. The median rib of the dorsal valve is not smaller than the lateral ones, but it is almost undeveloped, its place being occupied by a deep longitudinal depression like a furrow, which produced an emargination of the anterior outline. There are about three lateral ribs. The ventral valve carries six to eight ribs of nearly equal size, but the median sulcus is often a little broader than those between the other ribs.

The long, erect ventral beak which is found in these shells is rather a character of immaturity, as is the nearly obsolete median rib of the dorsal valve. I am disposed to believe, therefore, that the representatives of this group are really only abnormal specimens of *H. meekana* which have retained neanic characters to an unusually advanced period and at the same time developed into a narrow or elongate form.

While I am doubtful about the real validity of this group as a distinct species or variety from *H. meekana,* it seems best provisionally to distinguish it.

This form somewhat suggests in its shape the Russian species *H. permocarbonica,* but here the resemblance ceases, as that type has a sinus in the ventral valve, with a small rib in it, almost the reverse of what is found in the Guadalupian form.

Horizon and locality.—Middle of Capitan formation, Capitan Peak (station 2926); base of Capitan formation, hill southwest of Guadalupe Point (station 2906); "dark limestone," Pine Spring (station 2930), Guadalupe Mountains, Texas.

Hustedia papillata Shumard.

Pl. XXX, figs. 18 to 18b.

1858. *Retzia papillata.* Shumard, Trans. Acad. Sci. St. Louis, vol. 1, p. 294 (date of volume, 1860). Dark [Permian] limestone: Guadalupe Mountains.
1859. *Retzia papillata.* Shumard, idem, p. 395, pl. 11, figs. 9a–9c. Dark [Permian] limestone: Guadalupe Mountains.
1897. *Hustedia* (?) *papillata.* Schuchert, Bull. U. S. Geol. Survey No. 87, p. 232.

Shell small, ovate, longer than wide, gibbous, front and sides rounded, valves nearly equally convex; surface marked with numerous extremely fine papillæ, each valve having 11 or 12 well rounded, prominent ribs, those on the sides curving rather strongly to the margins and their number increased by insertion; intervals between the ribs rather deep and as wide or wider than the ribs. Ventral valve without sinus, regularly convex, most prominent between the beak and the middle; cardinal edge straight and very short; area small, slightly arcuate, well defined by a sharply angulated margin; beak elongated, incurved extremity truncated, having a large circular foramen. Dorsal valve broad ovate, strongly and pretty regularly arcuate from beak to front; cardinal margin very short, straight, forming an obtuse angle with the sides; beak small, strongly incurved, and passing a little beyond the cardinal line.

Dimensions.—Length, 0.40; width, 0.32; thickness, 0.27. Length of dorsal valve, 0.36.

This shell differs from the *Retzia punctillifera* (*nobis*) in having fewer ribs, and a smaller cardinal area.

Its geological position is in the dark limestone immediately under the white limestone of the Guadalupe Mountains, New Mexico and Texas.[a]

Shumard cites this species only from the "dark limestone," at which horizon he also identified *H. meekana.* He does not institute comparisons of *H. papillata* with *H. meekana,* but with *Retzia punctillifera,* a form which is now generally considered a synonym of *H. mormoni.* The only characters distinguishing the two species that can be taken from Shumard's descriptions are the striated surface of *H. meekana* as contrasted with the papillose superficies of *H. papillata* and the number of plications, which are said to be 8 to 10 in the former species and 11 or 12 in the latter. The normal number in typical *H. meekana* is 9 on the dorsal and 10 on the ventral valve. Shumard's illustrations are represented by lines, and his *R. papillata* appears to have intermediate striæ equally with *R. meekana.* From the fact that he does not mention anything of the sort under *R. papillata,* and at the same time compares it with *R. punctillifera,* it is clear that these must have been absent. But in *H. meekana,* as I have elsewhere stated, this character is certainly the result of exfoliation. The papillose surface ascribed to *Hustedia papillata* is, without much doubt, the result of its punctate shell structure, and can not safely be used as a discriminating character. No surface of this sort not the result of structure has been observed on any of the specimens examined.

As a rule the brachiopods of the "dark limestone" are more or less silicified and do not easily exfoliate. Our specimens from this horizon, therefore, agree very well with Shumard's description, quoted above, except that the plications are fewer.

[a] Trans. Acad. Sci. St. Louis, vol. 1, 1856–1860, pp. 294-295.

They number the same as specimens from the white limestone. Even the two large specimens from this horizon do not show as many plications as *H. papillata,* and they are much larger than that species, which, as Shumard's measurements indicate, is somewhat smaller than *H. meekana.* A very few examples—two, to be more exact—can be distinguished from the others by having somewhat less deep and spreading and therefore more crowded and numerous ribs. They correspond very closely to Shumard's description and consequently have been referred to *H. papillata,* though I am in some doubt as to whether they should properly be considered more than a variety.

Some of the smaller silicified specimens from the Glass Mountains which are not exfoliated and in which the dorsal valve has 11 plications and the ventral 12 also answer Shumard's description of *H. papillata* almost exactly.

A single ventral valve from the Delaware Mountain formation appears to have the same characters as those from the "dark limestone" and has likewise been identified as *H. papillata.*

It may be that Shumard based his two descriptions on shells belonging really to the same species, in the case of *H. meekana* on specimens from the Capitan limestone, which are for the most part deeply exfoliated, and in the case of *H. papillata* on silicified and unexfoliated specimens from the "dark limestone." In this event *Hustedia papillata* would seemingly have to be used, as it precedes *H. meekana* on the page. This, however, is probably not the case.

So far as my observations go, my identifications being held closely to Shumard's descriptions, *H. papillata* is by far the rarer form.

Horizon and locality.—Base of Capitan formation, hill southwest of Guadalupe Point (station 2906?); "dark limestone," Pine Spring (station 2930); Delaware Mountain formation, Guadalupe Point (station 2919); basal black limestone, Guadalupe Point (station 2967?), Guadalupe Mountains, Texas. Delaware Mountain formation Comanche Canyon, Glass Mountains, Texas (station 3763).

Hustedia bipartita n. sp.

Pl. XXX, figs. 19 to 20a.

In discussing the species *Hustedia meekana* mention was made of the fact that in the dorsal valve a plication always occupied the median position, and that as it did not appear until later than those lateral to it, a slight depression is produced in the umbonal region by its imperfect development. In most examples the median rib becomes early in the growth of the shell as large as those beside it. In one line of evolution, however, it remains only slightly developed, probably until the shell reached mature size. This is the case in a few specimens from the Glass Mountains, in which the aborted development of the median plication is a rather striking feature. Correspondingly, on the ventral valve the two median plications retain their duplicate character for a long distance. Specimens having these characters appear to reach but a small size and have a rotund shape. The plications are coarse, high, and thin. There are nine on the dorsal valve and eight or ten on the ventral. The beak is rather small, pointed, and erect.

This form is closely allied to that described by Gemmellaro as *Retzia ambigua*, which is also probably a *Hustedia*.

Viewed as a final result, this form certainly merits recognition as a distinct species, while if looked at as a process, as the persistence of an immature condition to a mature size, it may perhaps appear worthy of only varietal distinction.

The occurrence of *H. bipartita*, as indicated by our collections, is sporadic, and in scarcely any place does it develop quite the typical variety, which is that found in the Glass Mountains. Some specimens referred here appear to be somewhat intermediate with *Hustedia meekana* var. Others seemingly are related to the typical variety in much the same manner that *H. papillata* is related to *H. meekana*, i. e., they have somewhat more numerous ribs. Incidentally the shape is less transverse and the ribs more rounded as well as more numerous.

Horizon and locality.—"Dark limestone," Pine Spring (station 2930?) and Guadalupe Point (station 3762e?), Guadalupe Mountains, Texas. Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969). Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763).

MOLLUSCA.

PELECYPODA.

The Guadalupian pelecypods show considerable diversity. I have discriminated no less than 45 species, representing 23 genera, as follows:

	Species.		Species.
Solenomya	1	Aviculipecten	9
Clinopistha	1	Acanthopecten	1
Edmondia	2	Euchondria?	1
Nucula	3	Pernipecten?	1
Leda	1	Plagiostoma	1
Yoldia	1	Limatulina	1
Parallelodon	3	Myoconcha	2
Bakewellia?	1	Protrete	1
Pteria	5	Astartella	1
Myalina	2	Cypricardinia?	1
Schizodus	1	Pleurophorus	2
Camptonectes?	3	Cleidophorus	1

As is usual in the case of Paleozoic material, it has been possible to observe generic characters in extremely few cases, and often more or less valid reason has been recognized for doubting the generic identification. The uncertainty which exists in this particular naturally renders comparisons with other faunas unsatisfactory.

One of the most noticeable features of the Guadalupian Pelecypoda is the differentiation exhibited by the Pectinidæ, which exceeds that of any of the faunas with which comparison has been made.

The Salt Range fauna described by Waagen shows a still more varied pelecypod differentiation than that of the Guadalupian, for he distinguishes 67 species, representing 33 genera. In relatively few cases do the pelecypods of the American and Indian faunas agree even generically, only about 9 out of the 23 Guadalupian or the 33 Salt Range genera being common to both. The genera recorded by Waagen are as follows:

	Species.		Species.
Spengleria	1	Macrodon	1
Eucharis	1	Dolabra	2
Cardiomorpha	1	Septifer	1
Allerisma	4	Lithodomina	1
Palæanatina	1	Lithodomus	1
Sphæriola	2	Modiola	1
Lucina	2	Mytilus	1
Loripes	2	Atomodesma	1
Cardium	1	Pseudomonotis	6
Astarte	1	Oxytoma	1
Gouldia	1	Avicula	1
Pleurophorus	4	Liebea	1
Cleidophorus	2	Lima	1
Schizodus	4	Aviculipecten	9
Myophoria	3	Pecten	5
Nuculana	1	Euchondria	1
Nucula	2		

The first 11 genera have, so far as known, no corresponding types in my fauna, though it is possible that Waagen's *Cardiomorpha indica* and the Guadalupian form doubtfully referred to *Clinopistha* may prove to be related. The absence of *Allerisma* from the Guadalupian fauna is a matter of note. The Salt Range shells do not present the most characteristic aspect of the genus (as seen in our *Allerisma subcuneatum*, etc.), and it may be that some of our Guadalupian types, such as *Edmondia? bellula*, are congeneric with them.

The presence in both of the widely spread genus *Pleurophorus* establishes a certain relationship in spite of the fact that the Guadalupian shells are in part too poorly preserved to stand a specific comparison. One can not determine in them the distinctions on which Waagen differentiates his division identified as *Cleidophorus*, yet, relying on resemblances to species which have been referred to one type or the other, both have been provisionally recognized. On the strength of their configuration one would be disposed to say that *Pleurophorus delawarensis* of the Guadalupian corresponded to *P. imbricatus* and *Cleidophorus trapezoidalis; Pleurophorus* sp. to *Pleurophorus subovalis*, and *Cleidophorus* aff. *C. pallasi* to *C. striatulus*, while the Indian *P. acutiplicatus* is quite without any Guadalupian analogue. The shell which I have described as *Protrete texana*, though of much smaller size, is somewhat suggestive of *Pleurophorus imbricatus*, but the resemblance is probably only superficial, as the doubtful *Lithodomus* appears to possess structures which indicate an entirely different generic relationship.

Schizodus securus can be compared rather with *S. rotundatus* than with the other Indian species of *Schizodus*, but is really not very close to any of them. It is probably better compared with the related group of species which Waagen places under *Myophoria*, though I doubt this relationship for the Guadalupian species, and my material is too scanty to permit me to determine the matter one way or the other. It greatly resembles *Myophoria cordissa* of Waagen in general outline.

Nuculana subacuta may be compared in a general way with the Guadalupian representative of the genus. The three Guadalupian Nuculas are more or less similar to the Indian shell which Waagen refers to *Nucula ventricosa* Hall. The other Indian representatives of the genus seem to be of a type at present not known in our fauna.

The single Indian species of *Macrodon*, with its very coarse ribs, represents a type which is apparently absent from the Guadalupian. *Dolabra*, which has two Indian representatives, also appears to be wanting, though *Edmondia? bellula* may possibly prove congeneric. Anything like *Septifer squama* is likewise alien to our fauna. *Lithodomina* has not been recognized among the Guadalupian fossils which I have studied, though it is possible that representatives of this genus may have been present among them, the imperfectly known *Pleurophorus* sp., for instance. While one species belonging to the Guadalupian fauna has been referred to the genus *Lithodomus*, the form so called is apparently not closely related to *L. atavus* of the Indian fauna and may turn out to have entirely different generic relations. Nothing resembling *Modiola transparens* is known in the Guadalupian, but it is not unlikely that Waagen's *Mytilus* and my *Myalina* may prove to belong to the same genus and to be not unrelated specifically. *Atomodesma* or any other form resembling *A. indicum* is alien to the known Guadalupian fauna.

Of *Pseudomonotis* Waagen recognizes 6 species, and speaks of its being greatly developed in the Salt Range; but after all the genus appears to be poorly represented, in individuals at least, when compared with the deposits called Permian in the Mississippi Valley. As compared with the Guadalupian, however, the genus may truly be said to be greatly developed, for in that fauna it is as yet entirely unknown.

Nothing like *Oxytoma atavum* is known from the Guadalupian fauna. *Avicula chidruensis* appears to be of the same general type as *Pteria richardsoni*, one at least of the two other Guadalupian species having no correlated form in the Salt Range. *Liebea* or any closely related type is unknown in the Guadalupian fauna, and *Limatulina striaticostata* is rather slightly connected with the single Salt Range *Lima*.

Waagen recognizes 9 species of *Aviculipecten* and 5 of *Pecten* in the Salt Range fauna, but the differences on which the two genera have been discriminated it has been impossible to establish among the fragmentary Guadalupian fossils, all of which have been placed with *Aviculipecten*. In several particulars a correspondence can be traced between the Guadalupian and the Indian forms: *Aviculipecten jabiensis* suggests *A. delawarensis; Pecten prototextorius* suggests *Aviculipecten* sp. *b* and *Aviculipecten* sp. *c; Pecten squamula* is possibly related to *Aviculipecten infelix*, etc. Shells of the type of *Aviculipecten derajatensis* and *A. pseudoctenostreon, Pecten asiaticus*, etc., are not found in the Guadalupian, while *Aviculipecten laqueatus*, not to mention *Acanthopecten* and *Camptonectes*, are not known in the Salt Range. Each of the two faunas contains a single species of *Euchondria*, and these resemble each other considerably, as must almost necessarily be the case in a genus whose species have so scanty a field of variation. In fine, the faunas of the Productus limestone and of the Guadalupe Mountains have a surprisingly limited common ground.

In his earlier paper on the fauna of Chitichun No. 1 Diener cites only one species of pelecypods, *Aviculipecten* aff. *jabiensis*, too small and characterless to be worth much in making comparisons. His later paper contains no mention of this group.

Only slightly more abundant were the forms in the faunas from Kashmir and Spiti studied by the same author. In his first paper on this fauna he cites *Modiola?* sp. ind., *Aviculipecten* sp. ind., and *Pecten* sp. ind., each of which has forms in the Guadalupian more or less comparable, so far as can be determined. In his second paper Diener cites from the lower division only four pelecypod species, but a much more abundant fauna from the upper division. Two of the lower forms are not figured. The *Myalina* cited as *Myalina* sp. ind. aff. *recurvirostris*, and the *Aviculipecten* cited as *Aviculipecten* sp. ind. ex aff. *A. hiemalis*, do not especially resemble Guadalupian species, though they are such as might appear at almost any horizon. From the upper beds Diener cites 9 species, only a very few of which, however, are related to those of the American fauna. *Oxytoma laticostatum* is non-Guadalupian, *Aviculipecten* sp. is indifferent, *Modiolopsis teplofi* is nearest to *Cleidophorus* aff. *C. pallasi*, and *Solemya biarmica* may represent our *Pleurophorus delawarensis;* but *Mytilus* sp. ind., *Conocardium* sp. ind. aff. *siculum*, *Goniomya* sp. ind. aff. *G. kasanensis*, *Myophoriopsis?kraffti*, and *Megalodus* sp. are all types unknown in the Guadalupian, except possibly *Myophoriopsis?kraffti*, which is not without suggestion of relationship to *Schizodus securus*.

Among the fossils from the Productus shales of Kumaon and Gurhwal the only pelecypod cited is *Aviculipecten hiemalis*. It is not a species with marked peculiarities, and is suggestive of several Guadalupian types, such as *A. guadalupensis* and *Aviculipecten* sp. *a*.

The same species is cited from Malla Sangcha, along with *Leiopteria* sp. (not figured) and *Lima* sp. ind. aff. *retifera*. The latter is not closely allied to *Limatulina striaticostata*.

Only three species are cited from the Productus shales of Byans. *Leda* cf. *speluncaria* is not unrelated to the Guadalupian *Leda*, but the *Goniomya* and the *Liebea* are alien types.

It is not necessary to particularize the few Carboniferous pelecypods cited from Turkestan by Romanowsky, for they are quite different from the Guadalupian representatives and are in quite different faunal associations; nor will it be necessary to mention especially the single pelecypod described by Salter in his paper on the fossils from Niti Pass, for *Aviculipecten hiemalis* has already been spoken of in connection with Diener's papers, and is one of those types which are without individuality save as to detail.

Kayser found 11 pelecypod species in his Lo Ping fauna. The 4 species of *Aviculipecten*, for *Avicula* sp. is probably to be reckoned in this group, do not offer a very satisfactory basis for comparisons with the Guadalupian fauna. *Aviculipecten sublaqueatus* is suggestive, in the general style of its sculpture, of the form referred by Kayser to *Aviculipecten mccoyi*. The other pectinoids are less like Guadalupian types. Nothing resembling *Myalina trapezoidalis* or *Pinna confutsiana* is known in our fauna, while the shell identified as *Macrodon carbonarius* is not closely allied to the Guadalupian Parallelodons. *Schizodus wheeleri* as identified by Kayser is more like *Schizodus securus* than the other Chinese representative of the genus, *S. lopingensis*. *Allerisma* and *Lucina* are unknown in the Guadalupian fauna, and the Lo Ping representatives are so imperfect that so far as one can tell from the figures they might belong to quite different genera. The *Lucina*, for example, suggests the pectinoid genus *Streblopteria*.

Loczy records a few pelecypod species in the fauna which he described from the vicinity of Kantschoufu. The form cited as *?Lima* cf. *haueriana* is not especially close to *Limatulina striaticostata*. That cited as *?Aviculipecten* cf. *exotica* appears to be related to *Acanthopecten carboniferus* of the Pennsylvanian fauna, a species which has been doubtfully recognized in that of the Guadalupe Mountains also. *Euchondria tenuilineata* as identified by Loczy resembles *Aviculipecten? infelix* and *Euchondria?* sp. of the Guadalupe faunas. *Gervilleia* aff. *longa* from Kantschoufu is probably congeneric with the Guadalupian species of *Pteria*, but specifically it is not closely related to them. The *Macrodon* resembling *M. tenuistriatus* of Meek is in a general way similar to *Parallelodon multistriatus*, and the *Cardiomorpha* is perhaps congeneric with the Guadalupian form resembling *Clinopistha radiata* var. *lævis*, but is different in its specific characters.

Among his "Permo-Carboniferous" fossils from the Lantsankiang Valley Loczy cites only one pelecypod, identified as *Pseudomonotis?* sp. indet. aff. *P. deplanata* Waagen. It is a very imperfect fragment, but the sculpture at least is of the same general type as in *Aviculipecten sublaqueatus*.

Loczy also cites a few species of pelecypods from faunas of doubtful geologic age. Such are *Posidonomya* sp. indet., *Allerisma?* cf. *perelegans*, *Anoplophora* sp. indet. aff. *brevis*, and *Myophoriopsis?* sp. The form compared with *Allerisma elegans* is suggestive of *Edmondia? bellula*, but the others appear to be unrelated to Guadalupian types.

In his paper on the faunas of Timor and Rotti Rothpletz cites only three species of pelecypods, all referred to the single genus *Atomodesma*. The only species figured is entirely unlike anything in my fauna.

Roemer cites from Timor two species of *Pecten* (not figured), one species of *Pinna*, one of *Conocardium*, and one of *Sanguinolites*, in all cases types not known in the Guadalupian.

Roemer's two species of *Pecten* were recorded by Fliegel as new, under the titles *Aviculipecten waageni* and *A. verbecki*. They are of the usual type, which has representatives in many provinces and at many horizons, such as *A. guadalupensis* and *Aviculipecten* sp. *a* of the Guadalupian fauna. A third species of *Aviculipecten* is also mentioned by this author, who again discusses Roemer's *Pinna*, together with his *Conocardium*, as well as another species of the same genus. Roemer's *Sanguinolites* is probably correctly placed under *Allerisma*, and another *Allerisma* is described, but these additions rather increase than diminish the differences which are manifested with the Guadalupian fauna.

The Pelecypoda of New South Wales, recorded in De Koninck's monograph, are of great variety and usually of extraordinary size. Not many of them, however, show any relationship with those of the Guadalupian fauna. With but few exceptions from the lower Carboniferous they were found, so far as I can ascertain, in the "Permo-Carboniferous" series, seldom in both, and while touching somewhat hastily on these I may disregard the others entirely.

Scaldia? lamellifera is probably non-Guadalupian, but it somewhat resembles *Edmondia* sp. Five Australian "Permo-Carboniferous" species are referred to *Sanguinolites*, most of them entirely dissimilar to anything known in the Guadalupian. *Clarkia myiformis* is non-Guadalupian. The two species of *Cardiomorpha* have nothing in the Guadalupian which appears to resemble them. *Edmondia*, with three species, is represented in the Guadalupian series, but for the most part by widely different forms. *Cardinia fragilis* is unlike anything known from the Guadalupian fauna. *Pachydomus* has not been recognized in the Guadalupian, and the eight Australian species are entirely unlike anything in that fauna. The same is true of the genus *Mæonia*, with three species. The three species of *Pleurophorus* are unlike the Guadalupian *Pleurophorus*. *Conocardium* (one species) is not known in the Guadalupian, nor *Tellinomya* (one species), nor *Mytilus* (two species).

The "Permo-Carboniferous" Aviculipectens of New South Wales comprise about 11 species, some of which, at all events, belong to Etheridge's genus *Deltopecten*. It could hardly be otherwise than that many of these pectinoid shells should be of the same general type in both faunas. Aside from a few forms which appear to be in poor condition and whose position among the pectinoids appears to be rather questionable, the most striking feature of the Australian representatives of the group is their large size. Perhaps the most noteworthy departure from the usual is found in *A. cingendus*, which is unlike anything in the Guadalupian. On the other hand, *A. laqueatus*, *A. sublaqueatus*, not to mention *Acanthopecten*, *Pernipecten*, and *Camptonectes*, have no kindred types in the "Permo-Carboniferous" of New South Wales.

Aphania, with two Australian species, is entirely non-Guadalupian, so far as known. Of the two species of *Pterinea*, *P. macroptera*, subsequently made the type of the genus *Merismopteria*, is non-Guadalupian, and *P. lata* only rather remotely resembles the Guadalupian Pterias. *Avicula sublunulata* somewhat suggests *Avicula* sp., but *A. decipiens* and *A. intumescens* are quite unlike any Guadalupian species, so far as known.

Although not properly mentioned here, the "Permo-Carboniferous" of New South Wales includes several species of *Conularia*, a genus unknown in the Guadalupian.

Considered as a whole, the "Permo-Carboniferous" pelecypods of New South Wales manifest surprisingly little relationship with those of the Guadalupian fauna. Not only are the genera largely different, but when cited under the same name the species appear to be unrelated. Even in point of size the two faunas are at opposite extremes, the Australian forms being of almost unprecedented largeness and the Guadalupian unusually small.

Etheridge discusses a large pelecypod fauna in his account of the "Permo-Carboniferous" fossils of Queensland and New Guinea, comprising 34 species, distributed as follows:

	Species.		Species.
Entolium	1	Pleurophorus	1
Euchondria	1	Astartella	1
Aviculipecten	5	Cypricardella	1
Deltopecten	1	Astartila	1
Pterinopecten	1	Eurydesma	2
Merismopteria	1	Conocardium	1
Mytilops?	2	Chænomya	4
Modiomorpha?	2	Edmondia?	1
Parallelodon	1	Sanguinolites	1
Nucula	1	Pachydomus	1
Nuculana	1	Mæonia	2
Solemya	1		

The single undetermined species of *Entolium* in a general way resembles *Pernipecten obliquus* of the Guadalupian. Etheridge's *Euchondria* is not figured, nor are three of the five species of *Aviculipecten.* All of the latter appear to have been of the usual type, more or less related to *A. guadalupensis* and *Aviculipecten* sp. *a.*

When I described the genus *Limipecten* a year or two ago I had not come upon Etheridge's description of *Deltopecten,* which seems generally to have been overlooked, at least in the works which I have consulted. It appears from Etheridge's description that *Deltopecten* and *Limipecten* were designed for the same pectinoid type, and the latter, accordingly, must, so far as is now known, give place to the name proposed by Etheridge. I still regard this as a good genus, contingent on *Aviculipecten* having the structures which have been ascribed to it. The longitudinal cartilage furrows of the hinge area which Etheridge mentions I would regard merely as accidental irregularities of growth. The hinge structures are not shown on Dana's specimens of *Pecten illawarensis,* the genotype of *Deltopecten,* but they are well exhibited on *P. leniusculus,* having all the characteristics of my *Limipecten.* It is expected that many other species now referred to *Aviculipecten* will prove to belong to *Deltopecten. D. illawarensis* is also one of the ordinary ribbed pectinoids which are found in most upper Paleozoic faunas. It appears to have a few large ribs and therefore to be more like *A. delawarensis* than *A. guadalupensis. Pterinopecten devisii,* on the other hand, is not like any of the Guadalupian species.

Merismopteria macroptera and the two species doubtfully referred to *Mytilops* have, so far as known, no Guadalupian equivalents.

Modiomorpha? daintreei and *Modiomorpha mytiliformis* contain suggestions of the Guadalupian forms referred to *Pleurophorus delawarensis* and *Cleidophorus* sp. aff. *C. pallasi* De Verneuil, but they may be really quite unrelated. *Parallelodon costellatus* is probably allied to *Parallelodon multistriatus.* The undetermined *Nucula* seems not to be closely related to the Guadalupian Nuculas, but *Nuculana* sp. is comparable to *Leda* sp., and *Solenomya* sp. to the Guadalupian *Solenomya.*

Pleurophorus randsi probably has no corresponding Guadalupian form. *Astartella? rhomboidea* is somewhat similar to *A. nasuta,* but *Cypricardella jackii, Astartila cytherea, Eurydesma cordatum, E. sacculus, Conocardium australe, Chænomya?*

etheridgei, *C.? carinata*, *C.? acuta*, *C.? bowenensis*, *Edmondia? obovata*, *Sanguinolites concentricus*, *Pachydomus globosus*, *Mæonia carinata*, and *Mæonia recta* have no corresponding forms in the Guadalupian fauna. In general, while a number of resemblances among the pelecypods can be pointed out, I doubt whether these indicate any real relationship between the two faunas.

Pelecypods are an important factor in the Russian faunas and dominate the later ones especially, almost to the exclusion of other types; but even in the Moskovian they are fairly well represented, if one may judge by Trautschold's description of that fauna.

Allerisma regulare, which closely resembles our *A. subcuneatum* or *terminale*, is unlike anything in the Guadalupian fauna, the absence from which of this familiar and common Pennsylvanian type is one of its peculiarities. Apparently the forms identified as *Sanguinolites undatus* and *S. tetraedrus* are also non-Guadalupian. *Anatina? attenuata*, *A.? deltoidea*, *Conocardium uralicum*, and *Arca argo* resemble none of the Guadalupian species yet known. *Modiola teplofi* can be compared with *Pleurophorus delawarensis*, but *Pinna flexicostata* again is a non-Guadalupian type.

That the three Pectens cited by Trautschold should have corresponding types in the Guadalupian is not to be wondered at. The one with unequal ribs and squamose concentric lamellæ (*Pecten segregatus*) is suggestive of *Aviculipecten sublaqueatus*. The costate type (*P. plicatus*) is comparable in a general way with *Aviculipecten guadalupensis* and *Aviculipecten* sp. *a*. The smooth form (*Pecten ellipticus*) suggests *Aviculipecten? infelix* and *Euchondria?* sp. Trautschold's *Avicula evanescens* appears to be a little pectinoid of the general type of *Pecten plicatus* of the same fauna.

In the Gschelian a pelecypod fauna in the aggregate large and varied seems to be present. The chief genera which I have found cited are *Pecten*, *Aviculipecten*, *Lima*, *Streblopteria*, *Entolium*, *Pseudomonotis*, *Placunopsis*, *Pseudoplacunopsis*, *Avicula*, *Myalina*, *Pteria*, *Bakewellia*, *Pinna*, *Schizodus*, *Myophoria*, *Allerisma*, *Edmondia*, *Pleurophorus*, *Cypricardinia?*, *Lithodomus*, *Macrodon*, *Astarte*, and *Conocardium*. Generically, at least, this list represents a fauna in a general way very similar to that of the Guadalupian, although some groups are found in each which are absent from the other. I have not found it practicable to compare the two faunas in point of their specific differentiation, because in most of the works consulted the pelecypods have been only listed. Stuckenberg, however, describes a fauna in which upward of 40 species are cited and which is perhaps representative of the horizon generally. The pectinoids, including *Pecten* and *Aviculipecten*, are rather unusually developed, comprising altogether 14 species. In the main they are pretty well connected with the Guadalupian representatives of *Aviculipecten*, *Streblopteria*, and *Euchondria*, though some types in each are peculiar, and in especial there is nothing among Stuckenberg's forms to compare with the Guadalupian species placed under *Camptonectes*. The three species of *Lima* are of a different type from *Limatulina striaticostata*. There is nothing in the Guadalupian to suggest the three Gschelian species of *Avicula*, which are probably not congeneric with our Pterias. This relation, however, may exist between the latter and Stuckenberg's *Pterinea aviculiformis*, which resembles the form from the Delaware Mountain formation called merely *Pteria* sp. *Bakewellia antiqua* is not figured, but presumably it resembles the Guadalupian shell doubtfully referred to *Bakewellia* and cited as *Bakewellia?* sp. The two species of *Pseudomonotis* and the two species of *Modiola* probably have no Guadalupian analogues, though *Pseudomonotis* cf. *tesselati* somewhat suggests *Aviculipecten sublaqueatus*, and *Modiola gigantea* resembles *Cleidophorus* sp. cf. *C. pallasi;* and I am not certain that *Myalina lamellosa* is very closely allied to *M. permiana?* or *M. squamosa?* of the Guadalupian fauna. *Macrodon kungurensis* seems to be related to *Parallelodon multistriatus*, but the six other Gschelian Macrodons probably have no corresponding forms. *Allerisma regularis* and *Allerisma* sp. belong to types not found in the Guadalupe Mountains. *Conocardium* cf. *hibernicum* and the two Gschelian species of *Cardiomorpha* are probably without Guadalupian equivalents, while the Guadalupian form nearest to *Solen* sp. is *Solenomya* sp., found in the black limestone at the base of the Guadalupian section.

Stuckenberg describes in the Artinsk a series of forms almost equally extensive. He discriminates 8 species of *Pecten* and *Aviculipecten*, most of which belong to groups that are represented in the Guadalupian also. *Aviculipecten kungurensis* of the one fauna and *A. laqueatus* of the other appear to belong to types which are not possessed in common. The two species of *Lima* are probably closely related to *Plagiostoma deltoideum*, but the two Artinskian Aviculas are quite distinct from the Guadalupian Pterias, even if they are congeneric with them. Much more closely allied to the latter, in general appearance at least, are Stuckenberg's Bakewellias, especially the one which he describes as *B. artiensis*. Even this, however, is not closely related in its specific characters, and if they really belong to *Bakewellia* their only representative in the Guadalupian is probably *Bakewellia?* sp., which is most closely similar, so far as one may infer, to the unfigured species identified as *Bakewellia antiqua*. *Liebea hausmanni* and the two species of *Pseudomonotis* are non-Guadalupian. *Modiolopsis pallasi* is presumably related to *Cleidophorus* aff. *C. pallasi*. Of the Macrodons, of which three species are cited, I will speak particularly only of *Macrodon?* cf. *parvulus*, which alone is figured. The illustration represents a form having an expression considerably different from that typical of the genus, and apparently the Artinskian species belongs to at least a different group from the Guadalupian Parallelodons.

Stuckenberg cites four species of *Nucula*, two of which are not figured. *N. artiensis* seems to belong to a different series from the Guadalupian species, but the others are more nearly related. *Leda speluncaria*, however, differs considerably from the imperfectly known Guadalupian *Leda*. Stuckenberg's three species of *Cardiomorpha* are represented by very imperfect material. I have referred no Guadalupian species to this genus, yet, as previously suggested, the form cited under *Clinopistha* may really belong there, in which case it would more nearly resemble *C. silvæ* than either of the other types figured by Stuckenberg. His *Schizodus* sp. is not much like *S. securus* of the present report, and the Guadalupian shell most resembling *Cardinia artiensis* and *C. plana* (but more particularly the former) is that which I have placed under *Clinopistha*, without any very important evidence for so doing.

From the Kungurstufe Stuckenberg also cites a considerable pelecypod fauna, comprising 22 species. Of the pectinoids, both *Pecten* and *Aviculipecten* are represented by one species, the two forms in question apparently being more or less closely allied to Guadalupian types (e. g., *Aviculipecten infelix* and *A. sublaqueatus*). *Lima* *kazanensis* is much less nearly allied to *Limatulina striaticostata* than is the other Russian *Lima*, *Plagiostoma permianum*, to *P. deltoideum*. *Bakewellia* has not been certainly recognized in the Guadalupian fauna, but the single putative species is probably more closely related to the *B. antiqua*, which Stuckenberg cites, than to the other species of *Bakewellia*. *Pterineopsis*, of which Stuckenberg cites one species, is non-Guadalupian. He recognized three species of *Modiolopsis* and one of *Modiola*. The corresponding Guadalupian shells are probably those which I have placed under *Pleurophorus* and *Cleidophorus*. *Modiolopsis teplowi* is very suggestive of *Pleurophorus delawarensis*, and *Modiolopsis pallasi* is probably equally near *Cleidophorus* sp. aff. *C. pallasi*, but *M. globosa* is different from any known Guadalupian species. Stuckenberg cites four species of *Macrodon*, but figures only two of them. *Macrodon* sp. appears to be closely related to *Parallelodon multistriatus*, but *M.* cf. *striatilamellosus* is alien to the American fauna.

The form identified as *Nucula trivialis* is not unlike one or another of the Guadalupian Nuculas, but *Leda speluncaria*, *Schizodus rossicus*, *S. truncatus*, and *S. obscurus* are all unlike the Guadalupian species of *Leda* and *Schizodus*. The genus *Allerisma* is not known in the Guadalupian fauna, and while the two Russian shells referred to it are far removed from the typical expression they also appear to have no corresponding types among the Guadalupian fossils.

Krotow has described an extensive pelecypod fauna from the Artinsk, one which comprises in fact no less than 79 species. Unfortunately for my purpose, most of Krotow's identifications are unfigured. Many of the species, however, have already been considered. Under *Lima* are included two species, *L. permiana*, which is of course closely allied to *Plagiostoma deltoideum*, and *Lima artiensis*, which has no known Guadalupian ally. *Pecten* receives 13 species, only two of which are figured. Neither of the latter recalls any of the Guadalupian pectinoids. *Aviculipecten* and *Streblopteria* are employed by Krotow as subgenera. The latter is cited with but one species and appears to be a non-Guadalupian type. To *Avicula* are referred nine species, mostly unidentified and all except one unfigured. That one, cited under *Pseudomonotis* as a subgenus, is unlike any Guadalupian form. Krotow places five species under *Bakewellia*, three of them unidentified and none of them figured. *B. antiqua* presumably resembles *Bakewellia?* sp. of the fauna under discussion, and the others most likely have the configuration at least of some of the Guadalupian Pterias. *Aucella* is represented by one species, now known as *Liebea hausmanni*. This type is unrepresented in the Guadalupian. The same is probably true of the two species of *Posidonomya* which Krotow cites without figures. As in the Guadalupian, the Myalinas seem to be imperfectly represented. Krotow cites only one unfigured species. *Pinna*, a genus which has not been found in the Guadalupian fauna, is represented in Krotow's Artinskian fauna by one species. *Arca*, of which Krotow uses *Macrodon* as a subgenus, comprises nine species, unfigured save in two instances. *Parallelodon* may be presumed to be the Guadalupian equivalent of these forms. Of the figured species *Arca substriata* somewhat suggests *Parallelodon* sp., but *A. substriata* var. *geinitziana* has no corresponding form in the Guadalupian. Krotow places four species under *Nucula*. *N. ufimskiana*, the only one figured is quite unlike any Guadalupian form. *Leda* receives two species without any figures. In *Schizodus* five species are placed. They are not figured, but at least the representation of the genus is much more extensive than in the Guadalupian. *Unio castor*, the single representative of the genus, is not figured, but presumably it has no Guadalupian representatives. *Cardinia* has four unfigured species. *Solemya* embraces two unfigured species more or less related, it may be supposed, to the Guadalupian Solenomyas. *Cleidophorus pallasi*, which alone represents *Cleidophorus*, probably is closely related to the Guadalupian shell called *Cleidophorus* sp. aff. *C. pallasi*. *Astarte* is the recipient of two species. *A. vallisneriana*, the only one figured, is not closely related to *Astartella nasuta*. *Lucina*, with two species, seems to be a type which is not found in the Guadalupe Mountains. To *Cypricardia* are referred two species. *Cypricardia* is not known in the Guadalupian, and the only species figured is not like any member of that fauna. *Goniomya*, with one species, is non-Guadalupian. *Cardiomorpha* has five species, none of which is figured. Probably the nearest related Guadalupian form would prove to be that which has been provisionally referred to *Clinopistha*. *Edmondia* includes but two species, neither of which is figured. *Sanguinolites* has two species and appears to be a type as yet unknown in the Guadalupe Mountains.

So little of Krotow's material is placed in an available form that it is difficult to estimate the real character of the fauna or to compare it with the Guadalupian. The resemblances impress me as being for the most part superficial or general without necessarily implying any intimate relationship.

Among the works consulted which deal with the Russian faunas several others treat of the Artinsk, but only to the extent of listing the species. Although some other genera and a good many additional species might have been obtained from these sources, it seemed best not to give consideration to data presented in this way.

The Permian fauna of Russia appears to be distinguished by its large and varied pelecypod representation, though this is to some extent an appearance relative to some of the other groups, such as the Brachiopoda. Tschernyschew cites 18 species in his paper on the Permian of the government of Kostroma. Two are referred to *Allerisma* and although they do not represent the most typical form of the genus they probably are not to be correlated with anything in the Guadalupian. *Edmondia murchisoniana* is of the same general type as *E. bellula* though distinctly different. *Astarte permocarbonica* closely resembles *Astartella nasuta*, but may not be closely related to it. Probably *Pleurophorus costatus* and *Pleurophorus? simplus* are less closely allied to *Pleurophorus delawarensis* than is *Solemya biarmica*. *Leda speluncaria* in a general way is comparable to the undetermined *Leda* from the Guadalupian, and *Macrodon kinganus* is possibly the Permian representative of *Parallelodon politus*. *Modiolopsis pallasi* and *Modiola simplicissima* are to be compared with *Cleidophorus* sp. aff. *C. pallasi*, the former much more than the latter. *Bakewellia cerathophaga* belongs to a genus which I have only doubtfully recognized in the Guadalupian fauna. Its shape suggests *Pteria* sp. perhaps more than *Bakewellia?* sp. Tschernyschew cites one species of *Aviculipecten* and three of *Pecten*, all of which appear to be more or less closely related to Guadalupian types. *Pseudomonotis speluncaria* is also among the species cited by Tschernyschew, but the genus *Pseudomonotis* is not known in the Guadalupian fauna.

Much more abundant and varied is the lamellibranch fauna cited by Netschajew from the eastern part of European Russia, which includes over 100 species. *Ostrea* *matercula* and *Prospondylus liebeanus* are entirely unlike anything known from the Guadalupian. *Lima retiferiformis* and *L. kasanensis* are somewhat similar to *Limatulina walcottianus*, and *L. permiana* is closely related to *Plagiostoma deltoideum*. Five species are referred to *Pecten* and six to *Aviculipecten*. Practically all of these can be compared with one or another of the Guadalupian Aviculipectens except possibly *Pecten sericeus*. Netschajew discriminates six species of *Pseudomonotis*, none of which, so far as known, have any Guadalupian representatives. The form described as *P. laticostata*, however, is almost surely an *Oxytoma*, while that called *P. elegantula* looks more like a brachiopod than a pelecypod. The genus *Liebea* is not known to occur in the Guadalupian fauna. Netschajew cites two species and if they have any related form there, which is rather unlikely, it must be looked for with *Myalina*. *Bakewellia* accommodates six of Netschajew's species, which at least simulate the forms referred by me to *Pteria*. *Bakewellia antiqua* is suggestive of the Guadalupian type cited as *Bakewellia?* sp. Several greatly resemble the form from the Delaware Mountain formation which I have called *Pteria* sp., and also *Pteria guadalupensis* from the Capitan formation; but one, *Bakewellia sulcata*, is more like *Pteria richardsoni*. In a general way the Permian Modiolas (one species) are suggestive of the Guadalupian shells which I have referred to *Pleurophorus* and *Cleidophorus*. *Modiolopsis teplovi* and *M. pallasi* show the greatest resemblance and *Modiolopsis globosus* the least. Two Macrodons form a feature of the fauna, identified as *M. striatus* and *M. kinganus*, but neither of them is very closely allied to Guadalupian species of *Parallelodon*, as one appears to be not quite smooth and the other to have pretty coarse ribs. The two Nuculas do not differ materially from the Guadalupian representatives of the genus. *Leda kasanensis*, rather than *L. speluncaria*, resembles the imperfectly known Guadalupian *Leda*. To *Palæomutela* Netschajew refers no less than 21 species. This type, like several others occurring in the Russian Permian, forms a peculiar group of shells not represented in the Guadalupian. *Oligodon*, which includes but three of Netschajew's species, is another of these. *Dolabra? mackrothi* seems to have no Guadalupian equivalent, and none of the three species of *Schizodus* appears to be at all related to *S. securus*. Another type alien, so far as known, to the Guadalupian fauna is *Naiadites*, to which Netschajew refers 18 of his Permian species. Still another of these peculiar shells is *Anthracosia*, though in this case the genus includes only a single species. Netschajew refers three species to *Solenomya*, only one of which (*S. normalis*) indicates much connection with the single Guadalupian species. *Pleurophorus simplus* is hardly a close relative of *P. delawarensis*, which, as already remarked, more nearly resembles the Russian *Modiolopsis*. *Astarte permocarbonica* and *A. wallisneriana* are probably represented in the Guadalupian by *Astartella nasuta*, which is much more nearly allied to the former than to the latter. The two Russian species of *Cardiomorpha* appear to have no corresponding Guadalupian types. Three species are referred by Netschajew to *Edmondia*. *Edmondia* aff. *striata* rather strongly suggests *E.? bellula*, but the two others seem to have no related Guadalupian species. *Solenopsis parvulus* is probably without a Guadalupian ally, though possibly related to *Solenomya* sp. *Goniomya* is an entirely non-Guadalupian type, so far as known, and so is *Crassiconcha*, of which one Permian species is described. Attention has already been called to the absence of *Allerisma* in the Guadalupian fauna, and the four Permian species cited by Netschajew are without representatives there.

Golowkinsky also describes a Permian fauna from Russia wherein 15 species are discriminated, most of which have also been cited in the works already discussed. *Solemya biarmica*, *Panopæa lunulata*, and *Osteodesma kutorgana* are non-Guadalupian types. The two species of *Schizodus* are rather unlike *S. securus*. *Nucula beyrichi* and *Arca kingiana* are related, but not closely, to Guadalupian species of *Nucula* and *Parallelodon*. A great variety of forms are referred by Golowkinsky to *Cleidophorus pallasi*, one or two of which are suggestive of *Pleurophorus delawarensis* and others naturally of *Cleidophorus* sp. aff. *C. pallasi* of the Guadalupian. *Modiola* sp. probably has no Guadalupian analogue. *Aucella hausmanni* is now recognized as belonging to the genus *Liebea* and is without any corresponding form in the Guadalupian fauna. The three species of *Gervillia* comprise the Permian Bakewellias and suggest the type which I have cited as *Pteria*. Two of them, *G. ceratophagus* and *G. antiqua*, more nearly resemble *Pteria guadalupensis* and *Pteria* sp. or *Bakewellia?* sp., respectively, while *Gervillia sulcata* can be compared with *Pteria richardsoni*. The species cited as *Avicula speluncaria* is generally regarded as a *Pseudomonotis*, a genus which has no known representatives in the Guadalupian. The shell identified as *Pecten sericeus* is so imperfect that it is impossible to compare it satisfactorily with the Guadalupian pectinoids.

It will hardly be necessary to consider in detail the Permian pelecypods described in the reports of Keyserling (Petschora-Land) and of Murchison, De Verneuil, and Keyserling, most of which have been cited in the works already discussed, but there must not be passed over without brief notice another reference to a group of forms which seems to be entirely unrepresented in the Guadalupian, but which constitutes an important element in the Permian fauna of Russia. I refer to the Anthracosiidæ and Amalitzky's monograph on the Russian Permian forms. This work discusses 13 species of *Carbonicola*, 6 species of *Anthracosa*, 27 species of *Palæomutela*, 3 species of *Oligodon*, and 12 species of *Naiadites*. These genera, with the 61 species included under them, have no equivalents, so far as known, in the American fauna.

Even aside from this extensive and peculiar group of forms, however, the Permian pelecypods of Russia seem to me to present as a whole no very close analogies with those of the Guadalupian fauna. Perhaps an almost equal degree of resemblance is shown by any of the preceding Carboniferous faunas of the same section.

The fauna described by Abich from Djoulfa, in Armenia, has thus far furnished but one species of pelecypod. Abich cited it as *Pecten* aff. *tortilis* Semen., but Arthaber has recently referred it to *Pseudomonotis*. It is doubtful if the Guadalupian fauna has any closely related form.

From Balia Maaden, in Asia Minor, Enderle has cited 4 species of pelecypods, namely, *Aviculipecten?* sp., *Schizodus* sp., *Pachydomus?* sp., and *Edmondia bittneri*. Only the *Schizodus* and the *Edmondia* have been figured. The former belongs to quite a different type from *Schizodus securus*, and the other is equally different from *Edmondia? bellula* or *Edmondia* sp.; in fact, it rather suggests so remotely related a species as *Myoconcha costulata*.

The Sicilian fauna from Palermo described by Gemmellaro comprises an extensive and varied suite of pelecypods. Forty-eight species are described, referred to the following genera:

	Species.		Species.
Edmondia	3	Avicula	1
Sanguinolites	1	Leiopteria	4
Conocardium	2	Rutotia	1
Allerisma	2	Pinna	2
Cleidophorus	3	Aviculipecten	6
Geinitzia	2	Streblopteria	3
Macrodon	4	Limatulina	2
Arca	2	Pecten	1
Pseudomonotis	4	Lima	2
Bakewellia	1	Anomia	1
Liebea?	1		

Gemmellaro's three species of *Edmondia* are of the general type of the Guadalupian form cited merely as *Edmondia* sp. He has nothing to compare with *Edmondia? bellula. Sanguinolites shumardii* is, so far as known, entirely alien to the fauna discovered by the geologist whose name it bears, and the genus *Conocardium* is also non-Guadalupian. I have not identified the genus *Allerisma* in the Guadalupian fauna, and while Gemmellaro's two species do not belong to the most characteristic section of the genus, neither appears to have a Guadalupian ally. I have identified the genus *Cleidophorus* among my fossils, but the single species recognized appears to belong to an entirely different group from Gemmellaro's. The genus *Geinitzia* is unknown in our fauna, but a certain resemblance, perhaps only superficial, appears to exist between the Geinitzias (not to mention Gemmellaro's peculiar species of *Cleidophorus,* which considerably resemble his Geinitzias) and the imperfectly known Guadalupian shells which I have referred to *Myoconcha.* Of Gemmellaro's four species of *Macrodon, M. whitei* and *M. latisinuatus* are quite different from the Guadalupian forms. His figures of *M. comptus* suggest the imperfectly known *Parallelodon* sp., and *M. multilamellatus,* with its almost invisible striæ, appears to be related on the one hand to *Parallelodon politus,* which is quite smooth, and on the other to *P. multistriatus,* which is finely lirate. Gemmellaro's two species of *Arca* resemble nothing yet found in the Guadalupian. I have not referred any Guadalupian species to *Pseudomonotis,* a genus which finds four representatives in the Sicilian fauna, but one of Gemmellaro's species (*Pseudomonotis fimbriata*) is suggestive of a form which it seemed best to me to identify with *Aviculipecten.* I refer to *A. sublaqueatus;* and *A. laqueatus* itself may possibly belong in the comparison. The single Guadalupian type doubtfully referred to *Bakewellia* is quite distinct from *B. elegans,* which suggests no relationship, either, with the Guadalupian Pterias. *Liebea? mediterrana* and *Avicula josephinæ* are non-Guadalupian.

It has not seemed to me appropriate to refer any Guadalupian shells to *Leiopteria,* but Gemmellaro's species have similar if not related forms in the Guadalupian fauna. The Guadalupian forms in question have been referred to the genus *Pteria,* but only the unidentified one from the Delaware Mountain sandstone much resembles the Sicilian Leiopterias, which to a limited extent have the configuration of *Bakewellia?* sp., which was also obtained from the Delaware Mountain. *Rutotia thyrrena* is not figured. The genus *Pinna* has as yet failed to appear among the Guadalupian faunas.

The Sicilian Aviculipectens are not very suggestive of those of the Guadalupe Mountains. *A. sicanus*, *A. bertrandi*, *A. densistriatus*, and *A. nitidus* probably have no closely related forms. *A. acanthicus* looks like our Pennsylvanian *Acanthopecten carboniferus*, which I have identified in the Guadalupian fauna also, and *A. janus* has points of resemblance with the same species as well as with *A. sublaqueatus*.

Gemmellaro's *Streblopteria pusilla* and *S. antinorii* resemble the Guadalupian species identified as *Euchondria?* sp. and *Aviculipecten infelix*, but may have no real relationship.

The two Sicilian species of *Limatulina* have little to do with the single Guadalupian species, and I am doubtful as to their belonging to that genus. *L. consanguinea* especially suggests to me one of the Pectinidæ, rather than the Limidæ. Among the Guadalupian pectinoids *Aviculipecten* sp. *a* most resembles it. *Pecten politus* has no closely allied Guadalupian species, so far as known. *Lima connectens* may be compared with *Plagiostoma deltoideum*, but probably is not closely related specifically. *Lima subretifera*, however, is far removed from the Guadalupian *Limatulina striaticostata*, while *Anomia prisca* is quite unlike any type known to occur in the Guadalupian.

Although the Sicilian fauna and that from the Guadalupe Mountains seem to have a considerable number of common genera they evince but little actual relationship. In many cases though the genus is the same the species belong to altogether different groups, while there is after all considerable difference in the generic types. On the part of the Guadalupian mention may be made of *Solenomya*, *Clinopistha*, *Nucula*, *Leda*, *Yoldia*, *Pteria* (in part), *Myalina*, *Schizodus*, *Camptonectes* (which has no parallel in any of the other faunas considered), *Lithodomus?*, *Astartella*, and others, depending on how accurately the generic titles indicate the exact relations of forms whose generic characters can often be only imperfectly deciphered. Some of these identifications of Guadalupian forms are decidedly open to question, but the absence from the Sicilian fauna of such characteristic Carboniferous genera as *Nucula*, *Leda*, *Myalina*, *Schizodus*, and *Astartella* is certainly worth remarking. On the other hand, this fauna contains a number of types which are alien to the Guadalupian, some more, some less, among which may be mentioned *Sanguinolites*, *Conocardium*, *Allerisma*, *Geinitzia*, *Arca*, *Pseudomonotis*, *Liebea*, *Rutotia*, *Pinna*, and *Anomia*.

I have been led to infer that Schellwien has never described this class of organisms as it occurs in the fauna of the Carnic Alps, but in a recent paper by Gortani from the same region a number of species belonging to this group have been cited. To the genera *Pecten* and *Aviculipecten* are attributed eight species, some of which are not figured. In view of this fact and of the rather unsatisfactory character of the illustrations it is difficult to make comparisons, but apparently there is little of a marked character in the Alpine pectinoids to distinguish them from the Guadalupian Aviculipectens. One of the species cited is *Aviculipecten carboniferus*, a characteristic species of our Pennsylvanian, which seems to have an identical or kindred form in the Delaware Mountain formation of the Guadalupian also. *Aviculipecten incarojanus* is a peculiar form for the genus, and rather suggests the type which I have placed with *Pteria,* resembling more or less *Pteria* sp. or *Pteria guadalupensis.* The form referred to *Pecten* (*Streblopteria*) *sericeus* De Verneuil is not figured, but presumably resembles one of several smooth pectinoid species in the Guadalupian fauna. *Pecten* (*Entolium*) cf. *aviculatus,* also not figured, is presumably related to *Pernipecten obliquus.* *Lima retiferiformis* appears to be rather widely different from the Guadalupian representative of the Limatulinas. *Liebea hausmanni* and *Myophoriopsis? carbonifera* are non-Guadalupian, so far as known, and *Schizodus pinguis* though not figured is considerably different from *S. securus.*

So poor are the figures of the two species of *Astarte* recognized in the report of Gortani that their characters are as much concealed as depicted, but they may be presumed to be more or less closely allied to *Astartella nasuta.* *Conocardium,* to which Gortani refers one species, is not known in the Guadalupian.

A pelecypod fauna of considerable extent is described by Geinitz from the Dyas of Germany. *Allerisma* is represented by *Allerisma elegans* King, but Geinitz's figures represent possibly two species. The type is not known in the Guadalupian. Two, possibly three, species appear to be represented by Geinitz's figures of *Panopæa lunulata.* One of them is suggestive of *Edmondia? bellula,* but no Guadalupian shells like the other forms are yet known. *Panopæa mackrothi* is suggestive of an *Edmondia,* of the same general type as *Edmondia* sp. of the Guadalupian. *Tellina dunelmensis* is not figured, but apparently it resembles *Edmondia? bellula,* superficially at least. *Solenomya biarmica* is related, though not closely, to the Guadalupian representative of the genus, but the type of *S. normalis* appears to be absent in our fauna. Several species of *Unio* and *Anodonta* may also probably be called non-Guadalupian. *Lucina minuta* is not figured, but is likewise an alien type. *Astarte vallisneriana* and *A.? tunstallensis* are presumably more or less related to *Astartella nasuta,* but the three species of *Schizodus* show wide differences from *S. securus.* *Arca kingiana* seems to correspond to *Parallelodon politus,* but *Arca striata,* while of the same general type as *Parallelodon multistriatus,* is considerably different. The two Nuculas cited by Geinitz, but more *N. beyrichi* than *N. wymmensis,* are not markedly different from the Guadalupian Nuculas, and *Leda speluncaria* exhibits a similar general resemblance to *Leda* sp. of our fauna. *Edmondia elongata* is hardly a nearly related form to *E.? bellula,* resembling rather *Edmondia* sp. More than a single species seems to be figured under each of the titles *Clidophorus pallasi, C. hollebeni,* and *Pleurophorus costatus,* and most of the types are not found in the Guadalupian. They resemble *Pleurophorus delawarensis* to only a limited degree, but *C. pallasi* especially is similar to *Cleidophorus* sp. aff. *C. pallasi.* One of Geinitz's figures of *Clidophorus paliasi* somewhat recalls *Myoconcha costulata.* *Aucella hausmanni,* now known to belong to the genus *Liebea,* is an unknown type in the Guadalupian. *Avicula speluncaria,* which is now generally cited as a *Pseudomonotis,* is also non-Guadalupian, and nothing resembling *A. kasanensis* has been obtained from that fauna. *A. lorata* is imperfectly known, as is also *A. keyserlingi,* though Keyserling's figures certainly suggest a form like our *Acanthopecten carboniferus,* which though described from the Pennsylvanian appears to occur in the Guadalupian fauna also. *A. pinniformis,* however, is a non-Guadalupian type.

Geinitz refers four species to *Gervillia.* Some at least of these belong to the genus *Bakewellia,* to which some of the Guadalupian Pterias which they suggest in general expression appear not to belong. *G. ceratophagus* and *G. sedgwickiana* are the species which especially resemble the Guadalupian Pterias, particularly Pteria sp. from the Delaware Mountain formation, and *Pteria guadalupensis*. *Gervillia antiqua* is more like the Guadalupian form described farther on as *Bakewellia?* sp. *G: murchisoni* is unlike any Guadalupian species, so far as I am aware, but suggests one from the Pennsylvanian which White described as *Anthracoptera polita* and which I subsequently thought might be a *Monopteria*. The Pectens appear to be much less multifariously represented, both in genera and species, in the Dyas. Geinitz cites three species of Pecten and one of *Lima*. Only one of the Pectens is a costate type, the others being smooth. *P. kokscharofi* resembles several Guadalupian species. *P. pusillus* and *P. sericeus*, by their lack of sculpture, also resemble several Guadalupian species, such as *Aviculipecten infelix* and *Euchondria?* sp., but whether there is any real relationship I am somewhat in doubt. The Guadalupian equivalent of *Lima permiana* is *Plagiostoma deltoideum*.

A very similar fauna is that of the Permian of England, from which King described a considerable number of pelecypods. The first two cited are *Pecten pusillus* and *Lima permiana*, which have just been mentioned. All the costate types of *Pecten* or *Aviculipecten* seem to be absent. *Pseudomonotis*, however, is represented by *P. speluncaria* (under which are included a great variety of forms and possibly several species), *P. radiata*, and *P. garforthensis*. None of these types is known to occur in the Guadalupian. *Mytilus squamosus*, however, is represented in that fauna by a form so closely related that I think them to be not improbably the same species, but *M. septifer* seems to have no corresponding type, unless possibly *Myoconcha* sp. proves to be such. *Edmondia murchisoniana* somewhat recalls *E. ? bellula*. King's species of *Bakewellia*, of which there are five, very strongly suggest the Guadalupian shells which I have referred to *Pteria*, although I have been unable recognize the characteristic structures of *Bakewellia* in my specimens. *B. ceratophaga* resembles to a greater or less degree *Pteria* sp. and *P. guadalupensis*, and *B. bicarinata* is similarly like *Pteria richardsoni*. *B. antiqua* rather strongly resembles the Guadalupian shell described as *Bakewellia?* sp., and in fact it was because of this resemblance that the reference to *Bakewellia* was made. *B. tumida* is less like any known Guadalupian species, while on the other hand no English Permian form seems comparable to *Pteria squamifera*.

King uses *Bissoarca* for the genus that is here called *Parallelodon*. *B. striata* and *B. tumida* are very much more coarsely ribbed than *Parallelodon multistriatus*, while *B. kingiana*, instead of being smooth, as described by De Verneuil, and therefore closely related to *Parallelodon politus*, is stated by King to be marked with incipient ribs. *Nucula tateiana* which is not figured, can hardly be considered different from the Guadalupian Nuculas, but *Leda vinti* certainly differs widely from the imperfect *Leda* known from that fauna. Of the two species of *Janeia*, *J. phillipsiana* may perhaps be compared with *Solenomya* sp., but *J. biarmica* is less distinctly related.

King's *Cardiomorpha modioliformis* suggests no Guadalupian species so much as that which I have described as *Cleidophorus* sp. aff. *C. pallasi*, or to a less degree *Myoconcha costulata*. *Pleurophorus costatus* is represented generically in the Guadalupian fauna but not by a species of the same group. None of King's four Permian species of *Schizodus* possesses a close specific relationship with the singular *S. securus*.

The two Astartes presumably are congeneric with *Astartella nasuta*, and *Astarte tunstallensis* resembles the Guadalupian species considerably in shape though not in sculpture. *Allerisma elegans* is a type, so far as known, which is non-Guadalupian. The Permian shell which King cites as *Psammobia? subpapyracea* has a general superficial resemblance to *Edmondia? bellula*, but it is doubtful whether any real relationship exists.

From the south point of Spitzbergen Toula cites four species of *Aviculipecten*. They show no marked departures from Guadalupian types. *Aviculipecten wilczeki*, which he described from the Hornsund, seems to be of the same general character as *A. laqueatus*. From Axel Island he cites two species of *Gervillia*, that which is figured resembling the Guadalupian species which I have called *Bakewellia?* sp. *Aviculipecten draschei* from the same locality is of a type which is common everywhere and at many horizons in the Carboniferous, so far as is now apparent.

Lundgren cited a considerable pelecypod fauna from the Permian of Spitzbergen, but unfortunately many of his species are unfigured. The fauna includes two species of *Pecten* and six of *Aviculipecten*, one of *Avicula*, two of *Pseudomonotis*, one of *Gervillia*, two of *Bakewellia*, two of *Leda*, one of *Myalina*, and one of *Allerisma*. Such of the Pectens and Aviculipectens as are figured have more or less nearly related types in the Guadalupe Mountains. *Avicula?* sp. is not figured, nor is one of the species of *Pseudomonotis*. The other impresses me as much more apt to be an *Aviculipecten* than a *Pseudomonotis*, but if correctly placed it would, so far as known, be without any corresponding Guadalupian form. *Gervillia?* sp. is unidentified and unfigured. *Bakewellia antiqua* and *Bakewellia* cf. *sedgwickiana*, also not figured, are related to the Guadalupian Pterias and to *Bakewellia?* sp. if to anything in that fauna. *Leda* sp. and *Leda?* sp. are not figured. *Myalina degeeri* is unlike the Myalinas of the Guadalupian, and *Allerisma?* sp., though not figured, is also probably non-Guadalupian.

From the Barents Islands, near Nova Zembla, Toula cites a number of pelecypods, two species of *Avicula*, three of *Aviculipecten*, one of *Mytilus*, one of *Leda*, one of *Schizodus*, one of *Allerisma*, one of *Pleurophorus*, one of *Sanguinolaria*, one of *Edmondia?*, and one of *Astarte*, but as they have little to do with the Guadalupian pelecypods and are associated with a different fauna, I will not comment on them in detail.

From Igidi, in the West Sahara, in association with a fauna which I take to be considerably older than the Guadalupian, Stache cites a few species of pelecypods, as *Pecten* cf. *P. mactatus* De Koninck, *Pecten* sp., ? *Gervillia* sp., and ?*Anthracosia* sp. The two latter are not figured, and only the first mentioned is suitable for consideration. The form in question resembles *Aviculipecten laqueatus* in its sculpture, but the shape is different.

Certainly our knowledge of South American pelecypods of the Carboniferous is very imperfect. I have found citations of only two species, which D'Orbigny described from Bolivia as *Pecten paradezii* and *Trigonia antiqua*, the latter probably being closely related generically and specifically to our American *Astartella vera*. The *Pecten* is of the same general type as some of the Guadalupian Aviculipectens, but the *Astartella* is widely different from *Astartella nasuta*.

The typical Pennsylvanian fauna as it stands in Weller's valuable bibliography contains slightly over 200 species of pelecypods, representing 48 different genera. A considerable number of these, it is true, have never been figured, and if they were known to-day would doubtless be found to belong to other genera than those under which they were first described and are now cited, and in some cases to be synonyms for other species. On the other hand, there have not been included in this enumeration a few species and genera which have been introduced since the bibliography was published.

The Guadalupian fauna contains but few generic types which do not occur in the Pennsylvanian, although the specific representation is so profoundly different. In fact, only four instances can be named—*Lithodomus*, *Plagiostoma*, *Camptonectes?*, and *Myoconcha*—in which it has been deemed necessary to refer the Guadalupian types entirely to non-Pennsylvanian genera. Yet it is rather likely that the difference is somewhat greater than this, for it should be remembered that the real generic characters have seldom been observed in Guadalupian forms, most of them having been referred, on the strength of configuration and general expression alone, to the genera with which I was familiar and to which they seemed in these particulars most closely related. As the genera familiar to me were naturally such as occur in our Pennsylvanian and Mississippian rocks, the generic list necessarily simulates that of our normal Pennsylvanian fauna, yet in some cases, where the specific type shows exceptional differences, it seems likely that if the generic characters could be known the forms would prove to belong to distinct if related genera. *Schizodus securus* is a case in point, and I rather expect that at some day data which are not now at hand will show that the genus is not *Schizodus*, but possibly *Myophoria* or some other.

The number of Pennsylvanian genera which are not found in the Guadalupian, to estimate which is a simple matter, amounts to something like 28, or over 50 per cent, but this fails to convey a true idea of the relations of the two faunas. Some of the genera, as, for instance, *Arca*, would almost certainly disappear from the enumeration if the Pennsylvanian forms representing them were at all known, while certain types are of such rare occurrence, even in the Pennsylvanian, that they can hardly be regarded as characteristic genera whose absence from the Guadalupian has any significance. It would not be unprofitable, however, to consider some of the fairly abundant and characteristic Pennsylvanian types whose absence from the Guadalupian may be regarded somewhat insignificant.

The first of these, alphabetically at least, is *Allerisma*. *A. terminale*, or *A. subcuneatum*, is a common and very characteristic species of our Pennsylvanian, and the entire absence of this type from the Guadalupian is certainly noteworthy. Neither the typical division of the genera nor those other species, some of which I have withdrawn into the newly erected genus *Pleurophorella*, have so far as known any representatives there. Shells belonging to the genera *Aviculipinna* and *Pinna* are not uncommon in local collections from the Pennsylvanian, and the absence of this type also is worthy of note. *Bakewellia* has not been certainly recognized in the Guadalupian, while shells referred to this genus are sometimes abundant in the later Carboniferous deposits of Kansas and Nebraska. Yet, just as I have been unable to detect the characterizing structures of *Bakewellia* in the Guadalupian Pterias, I have been unable to detect them in the common Pennsylvanian Bakewellias also, so that it is not improbable that *Pteria* (at least in part) of the one fauna corresponds to *Bakewellia* of the other. *Cardiomorpha* and *Clinopistha* are very abundant at certain horizons of the Pennsylvanian, frequently occurring in association. One or the other type, I am not entirely sure which, though I have identified it as *Clinopistha*, is represented in the lowest strata of the Guadalupian, but the other is not known there. *Conocardium* is not abundant in the Pennsylvanian, but its absence from the Guadalupian should not be overlooked in this place. *Monopteria* is another Pennsylvanian type which appears to be absent, and while it is not very common as a rule, it may be said to be one of the characteristic genera. *Pseudomonotis*, with which can almost certainly be included some of the types recorded as *Monotis*, is rather abundant at some of the higher horizons of the Carboniferous in the Mississippi Valley, and its absence in the Guadalupian, so far as known, is rather remarkable. *Chænomya* and *Sedgwickia*, closely related genera to *Allerisma*, though less abundant in the Pennsylvanian, show, with that genus, the fact of nonappearance in the Guadalupian.

Although in the main the generic representation of the Guadalupian and Pennsylvanian faunas appears to be nearly the same, but very few species occur in common, while in a few cases the specific types are very different. The single Guadalupian species of *Astartella* is not sufficiently different from the Pennsylvanian ones to cause much remark, and the same is true of the Pennsylvanian Aviculas, which with the Bakewellias may provisionally be regarded as equivalent to the Guadalupian Pterias. The type seems to be much more abundant in the Guadalupian, however, being, so far as my experience goes, for the most part rather rare in the Pennsylvanian. Among the pectinoids the representation in the main presents few striking differences, save that they are rather more abundant and highly differentiated in the Guadalupian. *Euchondria*, *Pernipecten*, *Aviculipecten*, *Acanthopecten*, and *Limatulina* occur in both faunas. The absence of *Pseudomonotis* from the Guadalupian has already been commented on, while the introduction of the singular type referred to *Camptonectes?* is one of this fauna's individual features. The specific representation of these genera, while different in the main, is too similar to evoke comment, except perhaps in the case of *Limatulina striaticostata*, which is widely different from the Pennsylvanian *Limatulina retifera*. The smooth type of *Lima* (*Plagiostoma*), represented in the Guadalupian by *P. deltoideum*, is, so far as known, absent from the Pennsylvanian. This type is a feature of the Permian faunas of Russia, Germany, and England. *Clinopistha* has closely allied types in both faunas, so far as can be made out, but the Guadalupian shell may not belong to the genus at all. *Cypricardinia* calls for no comment. *Edmondia* is apt to be pretty common in the Pennsylvanian, the prevailing type there being represented in the Guadalupian by a single imperfect specimen. No marked differences are shown by the genus *Parallelodon*, but *Myalina* again is a significant factor, as shells belonging to this genus are often common and of large size in the Pennsylvanian, but in the Guadalupian they are rare and small. The common Pennsylvanian type *M. subquadrata* is not represented in the other fauna. *Nucula* and *Nuculana* offer no striking differences, nor does *Pleurophorus* to any great extent, though the genus appears to be more plentiful and varied in the Pennsylvanian rocks, presenting certain types which are absent from the Guadalupian. *Schizodus* contains as marked elements of difference as almost any genus common to the two faunas. *Schizodus* is abundant and well differentiated in the Pennsylvanian, but in the Guadalupian only one rare species has come to hand, and it is so different from the Pennsylvanian types that I have a suspicion that it may belong to a different genus. *Solenomya* has furnished many more species to the Pennsylvanian fauna, but it is far from a common Pennsylvanian type, and the single imperfectly known Guadalupian species does not show any marked peculiarities. The same is true, though to a less degree, of the genus *Yoldia*.

In brief, for two faunas so closely situated geographically the Guadalupian fauna and that of the Pennsylvanian, together with the so-called Permian of the Mississippi Valley, show unusually marked differences, which must connote corresponding ones of geologic age, of environment, or of both. Possibly their proximity in geographic position finds expression in the generic similarity, while the strong specific unlikeness may be interpreted as due to chronologic succession. Although the Guadalupian pelecypods, as just said, unquestionably show important differences from the Pennsylvanian forms, their relationship to that fauna appears to me to be as close, perhaps even closer than to any other of the faunas which have come under observation.

Family SOLENOMYIDÆ Gray.

Genus SOLENOMYA Lamarck.

SOLENOMYA? sp.

This type is represented by two very fragmentary specimens from the black limestone at the base of the Guadalupe section. So far as can be ascertained, the shape and other characters indicate a relationship to the Solenomyas of the Pennsylvanian, but particularly to the form which Herrick described as *S. subradiata*. The shape is rather more symmetrically rounded behind than in the related species *S. radiata*, and the radiating lines are more indistinct. In one specimen, in fact, they can hardly be observed at all, and in the other they are also very faint though unmistakable. They are rather closely arranged and more numerous than in Herrick's species *S. subradiata*, so that if it prove to be really a member of this genus the form under consideration is very probably a new species.

Horizon and locality.—Basal black limestone, Guadalupe Point, Guadalupe Mountains, Texas (station 2967).

Genus CLINOPISTHA Meek and Worthen.

CLINOPISTHA? cf. C. RADIATA var. LÆVIS M. and W.

This type is represented by a specimen from the lowest horizon of the Guadalupe section. Its generic characters are entirely unknown, and even the shape has been more or less obscured by crushing. So far as can be determined, however, it is extremely suggestive of *Clinopistha radiata*, especially the variety which Meek and Worthen described as *lævis*. Radiating sculpture is entirely lacking and the thin shell is covered only by fine concentric striæ and occasionally others of greater breadth.

Horizon and locality.—Basal black limestone, Guadalupe Point, Guadalupe Mountains, Texas (station 2967).

Family GRAMMYSIIDÆ Fischer.

Genus EDMONDIA De Koninck.

EDMONDIA? BELLULA n. sp.

Pl. IX, figs. 22 to 22b.

Shell small, transverse, elliptical. Posterior end somewhat higher than the anterior. Beak of moderate size, subcentral, but distinctly anterior to the median line.

Surface nearly smooth; marked by a few rather faint but large concentric ridges.

This species most nearly resembles *Edmondia glabra* Meek, but besides being very much smaller it is somewhat differently shaped, and has smaller and less projecting umbones. It is perhaps the form cited by Shumard from this locality as *Edmondia suborbiculata.* This species Shumard gives to Swallow, but Swallow's species is named *Edmondia semiorbiculata,* and it is evident that *suborbiculata* was a clerical error on the part of Shumard, who also gave the page reference incorrectly (20 instead of 190). It would hardly be necessary to refer to these matters were it not for the fact that Weller's catalogue, though for the most part accurate, cites *suborbiculata* as Shumard's species, a circumstance which tends to give currency to a somewhat obvious error.

Edmondia semiorbiculata is certainly a similar species to that in hand, though I doubt if it be really the same. It is, however, impossible to arrive at a certain conclusion until both species are better known, especially that of Swallow, which has never been figured. The latter is evidently related to *Edmondia glabra,* and being near the same horizon may prove to be the same thing.

Horizon and locality.—Middle of Capitan formation, Capitan Peak (station 2926); Delaware Mountain formation, Guadalupe Point (station 2931?), Guadalupe Mountains, Texas.

EDMONDIA sp.

From the Delaware Mountain formation there is in our collection a single imperfect specimen of an *Edmondia,* which seems to belong to a species related to *E. aspinwallensis, E. nebraskensis, E. ovata,* and *E. subtruncata.* The shape is somewhat transverse and elliptical, the umbo inflated and projecting, and the surface marked by rather prominent, somewhat regular concentric ridges. The present material is inadequate to ascertain the specific relations.

Horizon and locality.—Delaware Mountain formation, Guadalupe Point, Guadalupe Mountains, Texas (station 2931).

Family NUCULIDÆ Adams.

Genus NUCULA Lamarck.

NUCULA sp. *a*.

Pl. XXIV, fig. 22.

This form is represented by three rather imperfect specimens from the lowest beds of the Guadalupe section. The size is rather small, the largest example having a width of only about 7 mm. The proportional height varies somewhat in different specimens, but is usually two-thirds to three-fourths the width. The beak is small and not very prominent. The posterior outline below the umbones projects rather strongly and is well rounded. The lower outline is gently convex, the anterior end strongly rounded, and the upper margin, more or less rectilinear, slopes strongly downward. The surface is marked by concentric striæ which are moderately fine, faint, and regular.

This little form resembles that which Meek found at Nebraska City, and which he hesitatingly identified as *Nucula beyrichi*. It is somewhat larger and perhaps a little more elevated in proportion to the width.

Horizon and locality.—Basal black limestone, Guadalupe Point, Guadalupe Mountains, Texas (station 2967).

NUCULA sp. *b*.

Pl. XXIII, fig. 8.

The specimen on which this species is established is an internal mold from the Delaware Mountain formation. It is somewhat small and transverse, the width being 6½ mm. and the height 4 mm. The beak is rather large and projecting, situated about one-fourth the width from the posterior margin. The upper and lower borders contract behind, the anterior and posterior extremities being strongly rounded.

The anterior teeth are rather numerous; about 14 can be counted. Sculpture unknown.

In addition to the specimens from the Delaware Mountain sandstone on which the foregoing description is based another example from the underlying black limestone has been assigned here. It is in a measure intermediate between the present species and *Nucula* sp. *a*, with which it occurs in association, being not quite as transverse as the one and distinctly more transverse than the other.

Horizon and locality.—Delaware Mountain formation, Guadalupe Point (station 2931); basal black limestone, Guadalupe Point (station 2967?), Guadalupe Mountains, Texas.

NUCULA sp. *c*.

Pl. XXIX, fig. 11.

This form is represented by a single somewhat imperfect specimen from the southern Delawares. The shape is subquadrate; the beak, situated almost terminally, is small and not much projecting. The superior margin is gently convex;

the posterior margin is nearly straight and directed almost perpendicularly to it. The lower margin is strongly bowed, and joins the anterior and posterior outlines in rather abrupt turns.

The surface is unknown, but probably was nearly smooth.

The type specimen is a left valve, and shows on the inside about 9 anterior and 6 posterior teeth.

This form is nearest that distinguished as *Nucula* sp. *a*, but is clearly a different species.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

Family LEDIDÆ Adams.

Genus LEDA Schumacher.

Leda sp.

In the black limestone at the base of the Guadalupe section has been found a single specimen of a species of *Leda*. It is an internal mold, and represents a small shell, which is very transverse, elongate, and tapering. The shape is suggestive rather of the variety *attenuata* than of the form commonly identified as *Leda bellistriata*, but it is even more attenuate. The length of the only specimen obtained is 12 mm., of which 8 mm. is anterior to the beak. The greatest height—that at the umbo—is 5.5 mm.

Horizon and locality.—Basal black limestone, Guadalupe Point, Guadalupe Mountains, Texas (station 2920).

Genus YOLDIA Moller.

Yoldia sp.

A single specimen represents this species, the source of which was in the black limestone at the base of the Guadalupe section. It is unfortunately too imperfect for illustration or description, but appears to be generically related to *Yoldia subscitula* and to resemble it in specific characters also. As compared with Meek's figure of *Y. subscitula* in his work on the paleontology of eastern Nebraska, the Guadalupian shell appears to be somewhat more broadly rounded behind and to have the anterior extension more tapering and less distinctly truncated. A shallow sinus indents the shell, beginning at the umbones and slightly sloping forward.

Horizon and locality.—Basal black limestone, Guadalupe Point, Guadalupe Mountains, Texas (station 2967).

Family PARALLELODONTIDÆ Dall.

Genus PARALLELODON Meek.

This generic name has been but little adopted by American writers, the shells which belong to it almost universally passing under *Macrodon* Lycett. When Lycett introduced the term for the molluscan type in 1845, however, it had already been preoccupied by *Macrodon* Müller, 1842, a genus of fishes. Meek called attention to this fact in 1866,[a] and suggested *Parallelodon* as a substitute. *Parallelodon* was taken up by De Koninck, but by few other authors, though recently it has again been revived by Hind.[b]

Macrodon is based on a type from the English Lias, and according to Hind shows certain subordinate differences of dentition from the Carboniferous Parallelodons, of which *P. delicatus* of the American Pennsylvanian must probably be taken as the type. Both because the term *Macrodon* was preoccupied, because *Macrodon* was based on a Mesozoic and *Parallelodon* on a Paleozoic type, and because they show certain differences in dentition, though these may be small, it seems to me highly advisable, especially in the case of Paleozoic species, to use the term *Parallelodon.*

The Guadalupian Parallelodons are three in number, and each species must probably be regarded as belonging to a distinct group. The two forms which can with reasonable certainty be included in the genus are quite distinct from the Pennsylvanian species, without, however, exhibiting any marked departures from the types prevalent in that period.

Parallelodon multistriatus n. sp.

Pl. XXXI, figs. 13 to 14a.

Shell of medium size. Configuration as in other members of the genus. Surface marked by a few lamellose, concentric lines and by numerous extremely fine radiating liræ. Of the latter about ten occur in the space of 2 mm. over the mesial third of the surface, but they increase in coarseness both posteriorly and anteriorly.

The types of this species are silicified shells from the Glass Mountains, both of them being unfortunately incomplete in the posterior portion. The configuration in this genus is so constant and the part that remains in the present specimens is so characteristic that I feel that the validity of the species is but little affected by the circumstance of their incompleteness. The configuration so far as known, for the reason given above and because it is well shown by the illustration, has not been described in detail. The generic characters and general aspect are those of *Macrodon.*

A single example from the Delaware Mountain formation has been identified with this species. In this case also only the anterior half of the shell is preserved. In the white limestone of the Capitan formation still another specimen has come to hand which is even more imperfect, and therefore has been referred here with some doubt. The surface is well shown, and presents about the anterior third to view. The striation of the anterior end of the portion preserved is relatively rather coarse, while that of the posterior end is scarcely to be seen without the aid of a glass. This specimen is large, and may not be specifically the same as those from the Delaware Mountain formation or as those from the Glass Mountains.

Parallelodon multistriatus is distinguished from *P. tenuistriatus* by the fine striæ which completely cover the surface. On the type specimen of *P. tenuistriatus* the upper posterior portion has a few moderately coarse ribs, the rest of the shell being without radiating sculpture, except for faint striæ near the lower margin,

[a] Proc. Chicago Acad. Sci., 1866, p. 17. [b] British Carb. Lam., Pal. Soc., 1896-1900, p. 125.

especially toward the middle and toward the anterior end. *Parallelodon obsoletus* is very close to *P. tenuistriatus*, and is distinguished by the same characters from the Guadalupian form. Very faint traces of fine radiating striæ can be seen near the lower margin of the type specimens of *P. obsoletus* also, and I doubt if it will be practicable to retain both species.

Horizon and locality.—Middle of Capitan formation, Capitan Peak (station 2926?); Delaware Mountain formation, Guadalupe Point (station 2931), Guadalupe Mountains, Texas. Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763).

Parallelodon politus n. sp.

Pl. IX, fig. 25.

Shell of medium size, transverse, strongly arched. Anterior end pointed, projecting. Posterior end obliquely truncate. Lower margin convex, gently curving upward at the posterior extremity, strongly curved at the anterior.

Surface without radiating striæ, but showing usually concentric ones of varying prominence and regularity.

The upper Carboniferous Parallelodons do not exhibit much diversity in shape, the distinguishing character being chiefly that of surface ornamentation. In this respect the present species differs from others of the genus, since it is entirely without traces of radiating striæ. An approach to this character is seen in *Parallelodon obsoletus*, in which the obvious striæ are confined to the area near the hinge line behind the umbones. Even in this species, however, very faint traces of ribs appear on other portions of the shell, though the absence of them was supposed by Meek to serve as a distinguishing character from *P. tenuistriatus*.

The type specimen of the species was derived from the Capitan formation. In the Delaware Mountain formation also some specimens were found in which no radiating striæ have been discovered, and it is supposed that these examples belong to the same species. The Delawarian specimens attain a considerable size, the largest having a transverse diameter of not less than 40 mm. These examples are preserved as partial internal molds, and it can not be asserted positively that the surface was entirely smooth, as in the specimens from the white limestone.

Horizon and locality.—Middle of Capitan formation, Capitan Peak (station 2926); Delaware Mountain formation, Guadalupe Point (station 2931), Guadalupe Mountains, Texas. Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969?).

Parallelodon? sp.

Pl. XXXI, fig. 15.

The general character of this form is shown by the figure. It is supposed to represent a species of *Parallelodon*, though the specimen is too imperfect to allow this fact to be made evident, while some features are a little unfavorable to such an identification.

The posterior wing is depressed and rather sharply defined from the elevated umbonal ridge, a condition which carries a certain suggestion of the Pteriidæ. The rather large ribs are coarsely crenulated, which gives them a nodulose appearance. This tendency is, however, not uncommon to *Parallelodon*, in which the ribs often have an interrupted look, especially where, as frequently happens, they become faint over the median third of the shell.

The nearest related species to the present one among our known Pennsylvanian forms is evidently *Parrallelodon obsoletus*, from which it appears to be distinguished by the strength of the umbonal ridge and the very marked crenulation of the ribs.

Horizon and locality.—Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763).

Family PERNIDÆ Zittel.

Genus BAKEWELLIA King.

BAKEWELLIA? sp.

Under this title are included a few imperfect specimens from the Delaware Mountain formation, which in a general way resemble the associated shells referred to *Pteria richardsoni*, but appear to differ from them (for of some of the differences I can not be quite sure) in being slightly less oblique, in having a smaller, less distinct and rounded anterior lobe, and in lacking a posterior alation. Instead, the posterior outline is nearly straight, meeting the cardinal line at an obtuse but distinct angle.

The hinge characters are best shown in a right valve preserved as an internal mold. There appears to have been a long linear posterior furrow, defined by projections both above and below. Of cardinal teeth there appear to have been two, with sockets possibly for three on the opposing valve. The anterior sockets were two in number, the upper one short and parallel to the hinge, the lower longer and strongly inclined downward. They inclose between them a prominent tooth, and connect behind with two of the cardinal sockets. In the left valve the only structure preserved is a posterior furrow similar to that in the other valve. It seems probable, therefore, that this structure indicates the position of a resilium rather than standing for a posterior tooth and socket.

Aside from being somewhat less oblique, this form much resembles *Bakewellia antiqua* as figured by King.[a] It has a similar rounded anterior end and is likewise not extended into a mucronate alation behind. The dentition also resembles that figured by King.[b] On the other hand, the condition of my material is not such as to permit me to determine whether any ligamental pits were present or not.

From present knowledge it seems hardly probable that this form belongs with the Pterias of the Guadalupian, though it resembles them superficially, and it is even regarded as not impossible that it is related to *Myoconcha costulata* var. *delawarensis*, *Pleurophorus delawarensis*, or *Cleidophorus* aff. *pallasi*, diverse as they are. Whether the relationship is that of belonging to the same genus, of being a variety of the same species, or of being young, abnormal, or imperfectly preserved individuals can not now be told.

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[a] King, W., Monograph of the Permian fossils of England, Palæontographical Society, 1850, pl. 14, figs. 28, 29.
[b] Idem, fig. 34.

While this material probably differs even generically from the several species of *Pteria*, it has been difficult to distinguish it from the associated form referred to *P. richardsoni*, since most of the material is imperfect. It resembles *Bakewellia parva* in its configuration, but is less oblique and possesses so different an articulus, so far as can be made out, that it probably belongs to a different genus.

Horizon and locality.—Delaware Mountain formation, Guadalupe Point, Guadalupe Mountains, Texas (station 2931).

Family PTERIIDÆ Meek.

Genus PTERIA Scopoli.

Shells of this type are unusually plentiful and varied in the Guadalupian fauna if that of the Pennsylvanian be taken as a standard. Four species have been obtained, whereas in an equal amount of Pennsylvanian material it is doubtful if one would have been present. This is not quite true, however, if the so-called Bakewellias of the Pennsylvanian be taken into account, since they are sometimes fairly abundant, though presenting but little variety.

In fact the Guadalupian shells which are here included under *Pteria* superficially resemble very closely some of the European species of *Bakewellia,* just as some of the smaller examples placed with *Pteria* sp. much resemble the small, poorly characterized Pennsylvanian *Bakewellia parva.* In the case of the latter species the best evidence I have been able to obtain indicates that the hinge is constructed differently from that in typical *Bakewellia.* Hinge structures are hardly to be observed in the Guadalupian shells, but in no case has the typical Bakewellian articulus been made out, and in some it appears to be absent.

On this account I have not felt justified in referring my species to *Bakewellia,* in spite of their resemblance in some cases to the European Bakewellias and the significance which by reason of their differentiation and abundance they might have in correlating the Guadalupian fauna. It is possible that this significance may yet be shown either by the present forms proving to be Bakewellias or by some of the European ones proving to belong to other genera.

PTERIA GUADALUPENSIS n. sp.

Pl. IX, figs. 20 and 20a.

This species is based on a left valve which has the following characters:

Shell small, very oblique. Anterior auricle small, defined by a shallow depression producing an inflexion in the growth lines and a sinus in the anterior outline. The body of the shell is much prolonged and is strongly convex transversely. It is abruptly and deeply depressed on the upper side of the umbonal ridge to the level of the posterior wing, which is flattened, produced, mucronate, and with a deep emargination below.

The surface is marked by fine, strong, and somewhat irregular concentric lamellæ.

This species most nearly resembles *Avicula longa* Geinitz,[a] from which it does not differ materially in outline. In this regard my specimen does not depart far-

[a] Carb. und Dyas in Nebraska, Dresden, 1866, pl. 2, fig. 15.

ther from Geinitz's figure of *A. longa* than does Meek's figure of the same species.[a] Geinitz, however, describes *A. longa* as nearly smooth, while the Guadalupian form is marked by rather strong lamellæ.

Horizon and locality.—Top of Capitan formation, Capitan Peak (station 2966); middle of Capitan formation, Capitan Peak (station 2926), Guadalupe Mountains, Texas.

PTERIA SQUAMIFERA n. sp.

Pl. XXXI, figs. 11 and 11a.

This species is founded on a left valve which has the following characters:

Shell small, strongly oblique. Umbonal ridge elevated, subangular, making an angle of 30° with the hinge line. Posterior wing large, flattened. Posterior outline between the umbonal ridge and the mucronate cardinal extremity deeply concave. The termination of the umbonal ridge is sharply rounded, the anterior outline gently curved, and the anterior superior angle rounded. A small groove, sharply defined and angular on its posterior side, limits an otherwise inconspicuous auricle and makes a slight sinus in the anterior outline.

The surface is marked by small convex scalelike projections which have a rather obvious concentric arrangement, being perhaps something in the nature of interrupted concentric laminæ. An obscure radiating arrangement can also be seen. On the posterior wing after becoming transformed into lamellose liræ, with a direction parallel to the outline, they die out almost entirely. They are abruptly revived on the hinge line, however, which is strongly crenulated. The anterior auricle seems to be without ornamentation, except irregular wrinkles.

The peculiar surface ornamentation of this species, in conjunction with the shape, render unnecessary comparisons with other American species.

Horizon and locality.—Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763).

PTERIA RICHARDSONI n. sp.

Pl. XXIX, fig. 14.

Shell small, strongly oblique. Posterior ear depressed, moderately wide, prolonged, pointed, defined in outline by a deep sinus. Umbonal slope subangular, slightly curved, addressed to the cardinal line at an angle of about 45°. Body of the shell narrow, strongly produced backward, limited in front by an angular rib nearly perpendicular to the hinge line, and abruptly raised on the anterior side by reason of a depressed area which it serves partially to define. The depressed area continues anteriorly for nearly half of a quadrant, when there is another abrupt elevation directed at about 45° to the hinge, the remaining portion of the anterior end being well rounded.

Surface where well preserved marked by more or less irregular, closely arranged, squamose concentric liræ.

This form is related to *Avicula sulcata* Geinitz.[b] The shape is rather similar but is less flattened below, while Geinitz's species has three costæ in front instead of two.

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[a] Final Rept. U. S. Geol. Survey Nebraska, etc., 1872, Pl. IX, fig. 9.
[b] Carb. und Dyas in Nebraska, Dresden, 1866, pl. 2, fig. 16.

The typical specimens were collected by Mr. Richardson in the limestones of the southern Delawares, but apparently the same species occurs in the Delaware Mountain formation of the Guadalupe section.

The forms so identified occur associated with the large specimens which have been described as *Pteria* sp., and I am not sure but that some of them are young shells of that species. At first I took them to be representatives of the genus *Bakewellia*, and, indeed, the question for all the Guadalupian Pterias, whether they should be referred to *Pteria* or *Bakewellia*, is in some dubitation, but what little of their structure is known does not agree especially well with *Bakewellia*.

These small Guadalupian forms range in size to a length along the umbonal ridge of 5 mm. or less. They vary somewhat in different characters, and especially in the degree in which the anterior lobe is defined by an abruptly sunken area. There is a suggestion in this that more than one species is represented, though intergradation is present to some extent, but my material is difficult to deal with owing to its imperfect and fragmentary condition. Some examples resemble our well-known *Bakewellia parva*.

I venture to record in this connection the observation of structures in *Bakewellia parva* which render it very doubtful if that species is really a representative of King's genus. *Bakewellia* is described by King as dimyarian, with a high area and plurality of cartilage pits, and several linear anterior and posterior teeth, like *Cucullæa*. The area is usually rather low in *Bakewellia parva*. In several instances I have ascertained the presence of a comparatively large triangular cartilage pit in each valve beneath the beak, but no trace of other similar structures has been seen along the cardinal line. The specimens most favorable for studying these characters were preserved as molds. In this condition on the right valve are to be found a long linear posterior ridge parallel to the hinge line, bounded by furrows, and a similar short one anterior to the umbones. These indicate on the shell itself a long posterior groove bounded by raised ridges, and a short anterior one of the same nature. Correspondingly, in the left valve there appear to have been a strong short linear anterior tooth and a long linear posterior tooth. The muscular equipment consists of a single large, strongly impressed scar similar in position to the anterior scar of *Bakewellia*. The pallial line traced backward from this becomes fainter until no longer seen, nor does it seem to lead to any posterior scar, the presence or position of which is unascertained. It seems probable, however, that a faint posterior scar really does exist, effecting a muscular arrangement analogous to that of *Bakewellia*.

Zittel's text-book of paleontology, American edition, gives a definition of *Bakewellia* which departs in many particulars from that of King. It is assigned to the Pernidæ, and should therefore be monomyarian, with the anterior adductor absent in the adult, with three to four denticulations under the beak, and a serial multivincular ligament. It is evident that *B. parva* is altogether different from this description. It is nearer the type of structure defined by King as *Bakewellia*, but I strongly distrust the propriety of leaving it with that genus at all, because it is alivincular instead of multivincular and because the denticulation is somewhat different and more simple. If, as I suspect, in spite of the fact that only one muscle scar has been observed, *Bakewellia parva* is dimyarian, it can hardly be placed with the Pteriidæ, where it would be natural to refer it.

Horizon and locality.—Delaware Mountain formation, Guadalupe Point, Guadalupe Mountains, Texas (station 2931?). Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

Pteria sp.

Pl. XXIII, fig. 1.

In the yellow sandstone of the Delaware Mountain formation a large aviculoid occurs, which is, however, too imperfectly known to permit its satisfactory discrimination, though probably it is new. The general shape is that of *Avicula longa* Geinitz, though the size is much greater and the posterior wing larger and possibly less extended(?). The surface ornamentation is not known. The present surface, which is that of a compressed mold, retaining in some degree both internal and external markings, shows only fine concentric striæ, which in some places give evidence of having been rather coarse, rounded, regular, and strong.

Horizon and locality.—Delaware Mountain formation, Guadalupe Point, Guadalupe Mountains, Texas (station 2931).

Family MYALINIDÆ Frech.

Genus MYALINA De Koninck.

This genus, the only Guadalupian representative of the Myalinidæ, is poorly represented, both in species and individuals, in our fauna. Two or three specimens of a very small species closely related to *M. squamosa* of the European Permian, and two large fragmentary examples of the general type of *M. permiana* of the Pennsylvanian, are all that have been found. In considerable contrast stand the Pennsylvanian and "Permian" of the Mississippi Valley, where the genus is often plentiful and the individuals of robust dimensions.

Myalina squamosa Sowerby?.

Pl. XVI, fig. 22; Pl. XXIX, fig. 15.

1829. *Mytilus squamosus.* Sowerby, Trans. Geol. Soc. London, 2d ser., vol. 3, p. 120.
[Permian]: Ferry Bridge, England.

1850. *Mytilus squamosus.* King, Mon. Perm. Foss. England, Pal. Soc., p. 159, pl. 14, figs. 1–7.
Permian: Ferry Bridge, Hampole, Tunstall Hill, Dalton-le-Dale, Humbleton Quarry, and Silksworth, England.

1859. *Myalina squamosa.* Shumard, Trans. Acad. Sci. St. Louis, vol. 1, p. 396 (date of volume, 1860).
White [Permian] limestone: Guadalupe Mountains.

This form is found equally in Shumard's dark and in his light limestone, though it seems to be more abundant in the latter. We have six specimens from the Capitan limestone, but they are all very fragmentary, while the single specimen from the dark limestone is more complete, and has therefore been used for illustration. It more nearly resembles certain Mississippian species, so far as its characters are known, than the common "Coal Measures" forms. It might pass for a young example of *M. perattenuata*, but seems especially near *M. squamosa* Sowerby as figured by King from the Permian of England. There seems to be no essential difference in shape, though the American species may have had a more nearly smooth surface, lacking perhaps the lamellose striæ which give name to the English one. Of this, however, I can not be certain, lacking English material with which to make comparison and being in some doubt about the normal type and range of variation shown by the American form because of its imperfect preservation. From the wide difference in the associated faunas in each case it seems a little improbable that there should be actual specific identity in this instance.

Two specimens from the southern Delawares have also been referred to this species. One of them has lost its surface characters, but the other, which is represented by fig. 15 of Pl. XXIX, is crossed by strongly projecting concentric lamellæ arranged at regular but ever increasing intervals.

Horizon and locality.—Middle of Capitan formation, Capitan Peak (station 2926); "dark limestone," Pine Spring (station 2930), Guadalupe Mountains, Texas. Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

Myalina permiana Swallow?

1858. *Mytilus* (*Myalina*) *Permianus.* Swallow, Trans. Acad. Sci. St. Louis, vol. 1 (date of volume, 1860) p. 187.
Permian (?): Kansas.

1864. *Myalina permiana.* Meek and Hayden, Pal. upper Missouri, Smithsonian Cont. Knowl. No. 172, p. 52, pl. 2, figs. 7a–7c.
Permian: Smoky Hill Fork of Kansas River and Cottonwood Creek, Kansas.

?1877. *Myalina Permiana.* Hall and Whitfield, Rept. U. S. Geol. Explor. 40th Par., vol. 4, p. 276, pl. 6, fig. 7.
"Permo-Carboniferous:" Foothills southeast of Salt Lake City, Wasatch Range, Utah.

?1881. *Myalina permiana.* White, Rept. U. S. Geog. Surv. W. 100th Mer., vol. 3, Suppl., Appendix, p. xxv, pl. 3, figs. 1a–1d.
Carboniferous: Coyote Creek, New Mexico.

1891. *Myalina permiana.* White, Bull. U. S. Geol. Survey No. 77, p. 28, pl. 4, figs. 16–19.
Permian: Godwin Creek and Military Crossing, Baylor County, Tex.; Camp Creek, Archer County, Tex.

From the Delaware Mountain formation two specimens of *Myalina* have come to hand, but they are in a much crushed and imperfect condition. The larger and more complete specimen closely resembles the shell figured by White as *M. permiana* and represented by fig. 18 of Pl. IV of his report on the Texas Permian,[a] but my material is so poor that I can not vouch for the identification. White identifies *M. aviculoides*, *M. perattenuata*, and *M. permiana* in this report, but I am disposed to question whether there was really more than one species in his material; certainly, whether the division made by him is correct. White's fossils are nearer to Meek's interpretation of *M. permiana* than to either of the other species with which he identifies them, but I am not altogether satisfied of the identity even in this case. My specimen, in having an extremely slight swelling of the outline under the beak, resembles White's examples of *M. perattenuata* more than Meek's, in which the shell recedes so that its outline seen from above overhangs the actual margin.

Horizon and locality.—Delaware Mountain formation, Guadalupe Point, Guadalupe Mountains, Texas (station 2931).

[a] Bull. U. S. Geol. Survey No. 77, 1891.

Family TRIGONIIDÆ Lamarck.

Genus SCHIZODUS King.

This genus, which is rather common at many localities in the upper Carboniferous of the Mississippi Valley, is represented in the Guadalupian by a single specimen, which is, moreover, of a strongly marked character, altogether different from the usual Pennsylvanian types.

SCHIZODUS SECURUS Shumard?

Pl. IX, fig. 24.

1859. *Axinus securus.* Shumard, Trans. Acad. Sci. St. Louis, vol. 1, p. 397 (date of volume, 1860). White [Permian] limestone, Guadalupe Mountains.

Shell compressed, length and height nearly equal; anterior margin gently curved, and about one-third shorter than the basal margin, which is gently rounded; posterior extremity rather sharply angulated; posterior slope obtusely subangular. Surface markings unknown.

Resembles *A. rotundatus*, Brown; but the valves of our species are more flattened, the buccal margin longer and not so strongly arched, and the beak is situated nearer the anterior extremity.

Locality.—White limestone, Guadalupe Mountains.

The foregoing is Shumard's characterization of this species, and it must be confessed to be rather incomplete, in view of the fact that it was not supplemented by figures. In the more recent collections but a single specimen has come to hand which can be said with any probability to represent *Axinus securus*, and this is, unfortunately, imperfect, owing to which circumstance, in connection with the briefness of the description, it is impossible to verify the identification or to amplify the description. So far, however, as Shumard does define the characters of his species, my specimen is in fairly complete agreement. The most marked feature of this form, whose general character can be seen from the illustration, is the sharpness of the umbonal ridge, the posterior face of which is actually concave toward the beak. This character is found to some extent in most members of the genus, but in none of our American species, so far as I am aware, to the same degree. Shumard appears to refer to this feature as the posterior slope, which he defines as "obtusely subangular," an expression which hardly seems to do justice to the fact, if my specimen belongs to his species.

This species would probably best be assigned to the well-known genus *Schizodus*.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926).

Family PECTINIDÆ.

The Pectinidæ are unusually well differentiated in the Guadalupian, perhaps not so much so as in the Pennsylvanian as a whole, but more than in most Pennsylvanian faunas of equal extent. The family comprises the genera *Camptonectes?*, *Aviculipecten*, *Acanthopecten*, *Euchondria*, and *Pernipecten*, types all of which occur in the Pennsylvanian also, with the very important exception of *Camptonectes?*. That singular and elegant type is an important element of individuality in the pelecypod fauna of the Guadalupian, whether comparisons are made with the Pennsylvanian or with known Carboniferous faunas of other parts of the world. The other genera whose presence in the Guadalupian is a matter of community with the Pennsylvanian are for the most part doubtfully determined. *Acanthopecten* is known but as a fragment, *Euchondria* has not been proved in its generic characters, and *Pernipecten* has by no means a typical expression. In the case of *Aviculipecten*, in both faunas there occur a number of forms whose internal structures are unknown and whose generic position with *Aviculipecten*, as against *Pecten*, *Deltopecten*, and possibly other genera, is yet to be demonstrated.

Genus CAMPTONECTES Agassiz?

This title is used for a peculiar group of forms which occurs in abundance in the Capitan formation of the Guadalupian series. Among its distinguishing characteristics the most striking are its forward obliquity, the large anterior and small posterior ear, the lack of definition of the posterior ear, and the surface ornamentation. The latter character proves to be very variable. It seems to consist primarily of nodes or papillæ which are arranged in curved diagonal lines outwardly concave. These nodes, which distinguish the surface of *C.? papillatus*, appear to have been connected with tubules traversing the shell at a strongly acute angle with the surface, and probably were continued outward into spines, which lay nearly flat along the shell in a radial direction.

With this character is probably connected an observation made on a shell related to those under consideration. In this instance the test was seen to be minutely and abundantly punctate, somewhat as in *Terebratula* or *Eumetria*. This is the only example in which punctation was observed, and it is on a much finer scale than the tubules in *C.? papillatus;* but as will later appear, this group shows wide variations in the scale of its ornamentation. Toward the circumference the rows of nodes tend to pass into continuous liræ, a circumstance which connects this species with *C.? sculptilis*. There the liræ tend to diverge pinnately from a median line, curving outward as they go. In *C.? asperatus* the two types of surface are more or less combined, but on a greatly reduced scale and with some modifications. Minute tubulous papillæ cover the surface, but over the peripheral portions tend to form continuous liræ, which, however, are not in two sets with a pinnate arrangement, but in multiple groups and with a zigzag direction. It is probably with an ornamentation of this type that the punctate shell above referred to is most easily to be compared. Another factor which may be of importance is that on internal molds of the right valve the anterior ear shows obscure traces of radiating ribs, which are not seen on the exterior.

These shells in some respects can be appropriately compared with McCoy's genus *Streblopteria*. The forward prolongation of the shell is a rather striking character of both, and still further agreement can be traced in the fact that the anterior ear is defined and the posterior undefined. On the other hand, the type species of *Streblopteria* is smooth, while these Guadalupian shells have the peculiar ornamentation above described. Furthermore, typical *Streblopteria* has a large posterior and a small anterior ear. This is one of the diagnostic characters mentioned by McCoy. Unfortunately, in the case of *Streblopteria*, as well as in *Camptonectes?*, no comparison can be made in the matter of internal characters.

Camptonectes seems to agree with the Guadalupian forms in having a large, well-defined anterior ear and small, undefined posterior ear. In some species, at least, it has the same forward prolongation. The characteristic external feature of *Camptonectes* consists, however, in the radiating liræ which diverge along a median line. This peculiar style of sculpture is repeated in *C.? sculptilis*, but the singular surface features of the other Guadalupian forms which are manifestly closely related to *C.? sculptilis* are unknown in *Camptonectes* proper. The punctate structure, which can hardly prove an erroneous observation, is altogether an anomalous character. Of the two genera considered, the Guadalupian forms appear to present points of closer similarity with *Camptonectes*. If the observations recorded here are established by further research, it seems certain, however, that they belong to a genus yet undefined.

These anteriorly projecting pectinoids have much in common with certain of the Pteriidæ, which will have to be brought into closer comparison when revision is made. One marked difference found in the Guadalupian shells is that they are rather conspicuously equivalve, while the Pteriidæ have one valve characteristically smaller than the other.

CAMPTONECTES? PAPILLATUS n. sp.

Pl. IX, figs. 3 and 3a.

The type specimen of this species is a left valve, and from it the following description is taken:

Shell small, rather oblique, and inclined forward. Convexity low and broad, hinge line short. Posterior ear probably small and undefined, anterior ear large and defined both by a notch in the outline and by being sharply depressed below the curvature of the body of the shell. The axis is curved, concave toward the anterior side. The surface is marked with papillæ, which increase in size proportionally to the dimensions of the shell. Over the upper half they are small, and the surface appears to be almost smooth. They have a sort of quincunx arrangement such that they tend to form two sets of curved lines intersecting at an acute angle. These lines are concave toward the anterior and posterior sides of the shell. Their curvature is greatest near the margins, especially near the lateral margins. In this region also the linear arrangement is more strongly marked, and tends to develop into connected ribs. The papillæ appear to have been the bases of small spines pointing radially and almost tangential to the surface.

In addition to the type specimen, four other examples have come to hand, all left valves. They are small and more or less imperfect both as to shape and surface ornamentation, and it can not be told with certainty whether they belong here or with *C.? sculptilis*. The right valve is unknown, though probably among a number of right valves whose surface has been destroyed by exfoliation representatives of this species are found. It is probable that the right valve is the counterpart of the other in surface and configuration.

Horizon and locality.—Middle of Capitan formation, Capitan Peak (station 2926); Delaware Mountain formation, Guadalupe Point (station 2931), Guadalupe Mountains, Texas.

CAMPTONECTES? SCULPTILIS n. sp.

Pl. IX, figs. 4 to 5a.

This species is manifestly related to *Camptonectes? papillatus*, and differs from it chiefly in having more strongly developed surface ornamentation. This is characteristically shown by the imperfect right valve serving as the original of fig. 4, and consists of two sets of curved liræ apparently developed pinnately along the median line. The liræ are not unlike the rows of pustules which form the surface ornamentation of *C.? papillatus*, and it will be recalled that in the latter they tend to develop into liræ near the margins of the shell. There can be no doubt, however, that the surface in the two typical examples under consideration is widely different, though it seems likely that intermediates occur. Several other specimens from the same horizon appear to have a surface marked like the imperfect example already mentioned, rather than like *C.? papillatus*, and they probably belong to the same species. Besides differing in surface ornamentation from *C.? papillatus*, they are more elongate and have the anterior ear somewhat differently shaped. These are, however, young examples, with somewhat obscured surface characters, and it is not certain that they represent the same species as the large and strikingly sculptured but imperfect specimen.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926).

CAMPTONECTES? ASPERATUS n. sp.

Pl. IX, figs. 1 to 2.

This species much resembles *Camptonectes? papillatus*, the chief difference being in the surface ornamentation. The shape appears to be almost identically the same, but as the typical examples are right valves there is a deep notch under the anterior ear. The surface is of the same character as in *C.? papillatus*, but on a very much finer scale. Apparently two types of surface are found to occur on the same shell, one consisting of intersecting rows of papillæ and the other of intersecting liræ. I am inclined to believe that the two kinds of surface are more or less alternating. The scale is so small in the case of this species that it is difficult to tell whether the lines are continuous or interrupted; and it seems probable that preservation might alter the appearance to some degree. The lines have a more or less zigzag appearance on a portion of the surface.

All of these specimens are right valves, and as they occur in the same beds with *C.? papillatus*, which is represented by left valves, the presumptive evidence is certainly considerable that they belong together. On the other hand, the surface ornamentation though of the same general character as in *C.? papillatus* is yet so different in effect that the greater probability seems to favor regarding them as distinct. Furthermore, in *C.? sculptilis* both valves seem to have the same and not different ornamentation, though this fact, which would be important if proved, can not be insisted on, because some uncertainty exists as to whether all the shells referred to *sculptilis* really are of the same species.

The fossils representing these species indicate that the two valves are practically equal, and that they have similar if not the same surface ornamentation. They contrast with *Aviculipecten,* where, as is well known, the right valve is distinctly flatter than the left and is frequently almost without ornamentation.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926).

Genus **AVICULIPECTEN** McCoy.

This genus is well represented in the Guadalupian fauna, nine varieties having been discriminated. In no instance have the generic characters been observed, so that I am unable to say definitely that any one species actually belongs to *Aviculipecten* and not to *Pecten,* to *Deltopecten,* or to some other. The reference to *Aviculipecten* has therefore been made solely on general resemblances and probabilities.

Waagen and some other authors have attempted to distinguish between the Carboniferous *Pecten* and *Aviculipecten* by the relative size of the ears, whether the anterior ear was larger than the posterior, or the reverse; but the decision in regard to this point naturally hinges on the matter of orientation, in determining which I have noted much difference of procedure among different authors, or even in different decisions of the same author. I have tried to base my own determinations on the rule that the byssal notch is under the anterior ear of the right valve. Where the byssal notch is well developed this rule has worked well, but sometimes, owing to imperfections in the specimens or to the ambiguous character of the notch itself, there has been much uncertainty. It seems to be true that in most of the Carboniferous pectinoids the right or lower valve, in addition to having the byssal sinus, is also distinguished from the upper one by its less convexity and different sculpture, being as a rule nearly smooth or but imperfectly marked. Consequently, when I found a shell with strongly developed sculpture and the usual convexity I have called it a left valve, especially if there was no byssal notch or only an ambiguous sinus under the anterior ear.

The sculpture, however, seems not to hold as a distinguishing character for some of the Guadalupian Pectinacea. The shells placed under *Camptonectes?,* while having a deep byssal notch in the lower valve, are apparently equivalve, both in convexity and sculpture, and the Limas have both equal convexity and sculpture and are without the byssal sinus.

From the foregoing remarks it will be apparent that the generic position of none of the Aviculipectens can be regarded as definitely determined, and therefore with this qualification I have omitted the query which should perhaps be placed after the generic title with all of them. These references to the genus, however, are probably as credibly based as is usual among Carboniferous pectinoids, where it is impossible, save in exceptional cases, to get at the hinge characters.

If I were to assemble these Guadalupian Aviculipectens into groups it would almost be necessary to assign each to a separate position. It would hardly be appropriate to refer *A. laqueatus* and *A. sublaqueatus* to the same group in the present state of our knowledge regarding them. The relations which *A. guadalupensis, Aviculi-*

pecten sp. *a*, *Aviculipecten* sp. *b*, *Aviculipecten* sp. *b* var., and *Aviculipecten* sp. *c* bear to one another can not be precisely determined, since in the first two the shape but not the detailed sculpture is known and in the last three the detailed sculpture but not the shape. Provisionally, therefore, *A. guadalupensis* and *Aviculipecten* sp. *a* may be placed in one group and *Aviculipecten* sp. *b*, *Aviculipecten* sp. *b* var., and *Aviculipecten* sp. *c* in another. *A. delawarensis* and *A. infelix* would also have to be regarded as representing separate groups.

AVICULIPECTEN GUADALUPENSIS n. sp.

Pl. XVI, figs. 20 and 20a.

Of this species but two specimens have come to hand, the smaller and more perfect of which is selected as the type. Its characters of surface configuration and size are shown by the figures. The other example is considerably larger, and its length must have been not less than 32 mm. Both specimens are alike in having a large (anterior) ear without a byssal sinus. The other ear is more or less imperfect in both cases, but probably is as represented in the figure—narrow and without any trace of a sinus. This fact, together with the strong convexity, highly raised sculpture, and sharp demarcation of the ear which is preserved, indicate that the valve is a left one, in spite of the circumstance that this identification places the prolongation on the anterior instead of the posterior side. Oriented in this way *Aviculipecten guadalupensis* has the following characters:

Shell elongate. Hinge line long, but less than the width below. Convexity strong. Posterior ear probably consisting of a narrow lateral band, undefined by a sinus in the outline. Anterior ear marked off by an angular groove rapidly increasing in depth toward the margin. The cardinal line is of course on a level with the rest of the surface, so that this ear is inclined at a strong angle to the general plane of the shell. The anterior side is larger and more projecting than the posterior. The surface is marked by moderately coarse, sharply defined ribs, separated by interspaces of about the same size. They increase by implantation, and where new ones exist an alternating arrangement is apparent. There are about 20 in all. They diminish in size and strength toward the sides, but two or three large and strong ones occur on the anterior ear. The finer surface ornamentation is not known.

I rely on the anterior prolongation found in this form and the curious oblique position of the anterior ear to distinguish it from other species.

Horizon and locality.—"Dark limestone," Pine Spring, Guadalupe Mountains, Texas (station 2930).

AVICULIPECTEN sp. *a*.

Pl. XVI, fig. 21.

Only the right (?) valve is known of this species, and it shows the following characters:

The size is rather small, the convexity moderate, the shape elongate, slightly oblique, and projecting forward. The posterior ear is depressed, rather strongly defined on the surface, probably without a distinct sinus in the outline. The anterior ear is larger than the posterior, well defined on the surface and in the outline.

The surface is crossed by moderately fine ribs, which bifurcate and occur in pairs. The interspaces, which have about the same width as the ribs, are not strongly depressed. The finer ornamentation is unknown.

The orientation of this shell is a matter of uncertainty. I have described it as a right valve, because what would be the anterior ear, though not very perfectly preserved, appears to be defined below by a rather deep sinus, not, however, as profound as is often the case. On the other hand, the strength of the sculpture, the convexity, and the inclination of the axis all suggest that it is a left valve. If it is a right one, however, it differs sharply from most Aviculipectens, since with them the axis inclines backward and the right valve is almost flat and almost smooth.

This shell was found associated with *Aviculipecten guadalupensis*, and if really a right valve may prove to be the complement of the type of that species. The configuration rather lends itself to that interpretation, but the character of the sculpture is more or less unfavorable.

Horizon and locality.—"Dark limestone," Pine Spring (station 2930); basal black limestone, Guadalupe Point (station 2967?), Guadalupe Mountains, Texas.

Aviculipecten delawarensis n. sp.

Pl. XXIII, figs. 2 and 2a.

The configuration of this specimen, which is without any well-marked byssal sinus, indicates that it is a left valve. On this supposition the following description is based:

The shell is small and the curvature well rounded. The hinge line is long, but not so long as the greatest width. The posterior ear is undefined, the surface being merely flattened, without being crossed by a limiting groove. The anterior ear is strongly depressed and sharply defined by a groove. The outline gently contracts on this side from the extremity of the hinge to the line of depression which marks the ear, below which it widens strongly again. A rather marked anterior expansion is thus produced.

The surface is crossed by large, low, ill-defined and widely spaced ribs, and by faint, more or less irregular concentric liræ resembling strong growth lines. There is some evidence indicating that toward the ears these are strengthened at nearly equal intervals into low ridges.

This shell is similar to *Aviculipecten? laqueatus*, but the hinge line is relatively shorter, the posterior ear is differently shaped, and the sculpture lacks the concentric ridges which cancellate the surface of that species. It is possible that it may prove to belong to a different genus. It has much the configuration of typical *Streblopteria*, but I hesitate to refer it to that genus because of its plicated surface, though it is true that McCoy includes radially ribbed species with *Streblopteria lævigata*.

Horizon and locality.—Delaware Mountain formation, Guadalupe Point, Guadalupe Mountains, Texas (station 2931).

Aviculipecten sp. *b*.

Pl. XXXI, fig. 8.

This species is discriminated on the basis of a fragment which shows the surface ornamentation almost perfectly, but from which the original shape can only be surmised. It was probably rather elongate and narrow beneath the auricles. The surface is well exhibited by the illustration and need not be described in detail, The ribs are relatively coarse and strongly elevated, nearly equal, but slightly alternating. About seven occur in 10 mm. On their crests are prominent vertical scale-like projections, six in 5 mm. The spaces between the ribs are deeply depressed, and have the same width. They are marked by rather regular, somewhat imbricating concentric lamellose liræ, which are much smaller than the scales surmounting the ribs, and entirely independent of them. A few small intermediate ribs of the same general character occur at the side of the larger ones.

Horizon and locality.—Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763).

AVICULIPECTEN sp. *b* var.

Pl. XXXI, fig. 9.

This species is evidently related to *Aviculipecten* sp. *b* and was found associated with it. The fragment representing it indicates a smaller and more highly arched species. The ribs, and especially the concentric rows of scales which occur upon them, are finer. There are more abundant indications of fine intermediate ribs, and therefore the intercostal spaces are filled by radiating lines of little scales obscuring the concentric liræ, which probably mark them, as in the other variety, and form the bases from which the scales are developed.

Horizon and locality.—Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763).

AVICULIPECTEN sp. *c*.

Pl. XXXI, fig. 10.

The ornamentation of this species is a development of the same character as in the two preceding ones, but somewhat removed from them. The ribs are in groups of three for the most part, the middle one much raised, with a smaller one on each side. The concentric rows of scales which surmount the ribs are smaller and less prominent, and the concentric liræ on the interspaces appear to consist of much smaller scales, which form fine radiating rows. The general character of the surface is shown by the figure.

Horizon and locality.—Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763).

AVICULIPECTEN INFELIX n. sp.

Pl. IX, figs. 9 to 10.

Of this type only five specimens are known. They all have essentially the same shape, so far as their preservation, which is for the most part poor, permits a comparison, and appear to represent the same valve, which I take to be the right one. On this supposition the following description can be given.

Shell small, length greater than breadth, erect or slightly inclined backward, cardinal line rather short. Ears nearly equal, quadrate, or somewhat extended.

They are defined by reentrant angles on the outline and by grooves on the surface. The groove defining the anterior ear is more marked than that of the posterior. While without the deep byssal notch and specialized configuration of the anterior ear which is found in some species, the one ear is considerably more sharply defined than the other, and on this account I have regarded it as being the anterior ear of the right valve. The convexity is low. The inferior margin is broadly rounded.

Except for indistinct concentric markings, the surface is plain, without radiating ribs on any portion.

The generic and specific relations of these shells are alike uncertain. Their erect shape, smooth surface, and nearly equal ears are unlike the typical characters of either *Pecten* or *Aviculipecten*. Either ear is too small and well defined to be the larger ear of *Streblopteria*. Possibly their closest allies are to be found in *Pseudamusium* and *Syncyclonema*. They are readily distinguished from the forms described under *Camptonectes?* by their outline, low convexity, and smooth surface. They more strongly resemble *Pernipecten? obliquus*, from which at first I did not successfully distinguish them. By reason of their somewhat different configuration and because they always lack the upturned superior lateral margins, which are so distinctive of *Pernipecten* and are more or less well shown in *P.? obliquus*, they appear to differ from the latter species.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926).

Aviculipecten laqueatus n. sp.

Pl. IX, fig. 11.

Only one specimen of this species has come to hand, which appears to be a left valve. Its characters are as follows:

The size is about medium, the convexity moderately high. The hinge line is long, as wide or a little wider than the width below. The ears are large, the anterior somewhat larger than the posterior, more strongly defined, and differently shaped. The outline is retracted below the ears, but widens again, especially on the anterior side, which appears to be somewhat projecting.

The surface is marked by regular, strong, concentric and radiating ridges, somewhat widely spaced, the concentric ones being more distant than the radiating. The effect of this ornamentation is to divide the surface into depressed panel-like areas, of which the length, especially toward the margins, is considerably in excess of the width. There are also sublamellose concentric liræ closely but somewhat irregularly arranged.

From the character of the ears this can hardly be a right valve. As a left valve it differs from typical *Aviculipecten* in having the anterior ear larger than the posterior, in having an anterior prolongation of the body of the shell, and in the character of its surface ornamentation. The anterior ear is unusually depressed and sharply defined, the limiting groove being so strongly reentrant that the body of the shell overhangs the oral angle.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926).

AVICULIPECTEN SUBLAQUEATUS n. sp.

Pl. IX, fig. 12.

The shape and general expression of this species are very like those of *Aviculipecten laqueatus*, but the size, as indicated by our fragmentary specimen, is much greater and there are important differences in the sculpture.

Only the left valve is known. The hinge line is long, the ears large and depressed, the anterior smaller than the posterior, and defined by both a deeper and a more abrupt descent from the arched portion of the shell. There is but a gentle sinus under the posterior ear.

The surface is marked by moderately strong ribs, spaced at nearly equal but wide intervals from one another. In the figured specimen there are but six of these, and they probably remained constant in number throughout the entire growth. Intermediate between the large ribs are other much finer ones. These increase in number with the size of the shell. There are also concentric lines somewhat more closely arranged than the larger ribs, so that the surface is divided into transverse panels. On the figured specimen, which is an internal mold, these concentric markings are distinct striæ, which have the upper side slightly more elevated than the lower. On the external cast they are seen to be produced not so much by lamellæ as by steplike differences in elevation of the shell surface, which are produced into squamose spines where they cross the ribs. The latter at such points tend to become nodose.

A large fragment referred to this species indicates a length of not less than 50 mm. It is conspicuously crossed by three rapidly diverging ribs, which at the margins are 15 mm. apart. They are coarse and marked at intervals of about 7 mm. by strong nodes. Between two of the large ribs there are from 10 to 20 more or less wavy radiating liræ of very much smaller size. In smaller specimens the radiating liræ are only five or six in number, and probably when very small they are reduced to a single one and are indistinguishable from the real costæ.

The nearest Guadalupian species to the present form is unquestionably *A. laqueatus*, which is distinguished by having more numerous ribs and concentric instead of radiating liræ. The concentric liræ are so distinct that it seems impossible that radiating ones, had they ever been present, could have been destroyed.

A. sublaqueatus resembles *A. mccoyi* somewhat closely, but is distinguished by its broader posterior ear and finer, more numerous and equal intermediate ribs. In these particulars it resembles *Acanthopecten carboniferus*, but of course is readily distinguished by its less numerous costæ.

Horizon and locality.—Middle of Capitan formation, Capitan Peak (station 2926?); base of Capitan formation, hill southwest of Guadalupe Point (station 2906), Guadalupe Mountains, Texas. Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763).

Genus ACANTHOPECTEN Girty.

ACANTHOPECTEN aff. A. CARBONIFERUS Stevens.

In the yellow sandstone of the Delaware Mountain formation (station 2931) was found a specimen representing part of a mold of the exterior of a shell probably belonging to a type closely allied to *Acanthopecten carboniferus* Stevens. The species was apparently considerably larger than *A. carboniferus*, with larger and more numerous ribs, of which about two came in the space of 5 mm. in the fragment preserved. The spinous concentric lamellæ, however, were more closely arranged, being from 2 to 2½ mm. apart. No further details are shown by the imperfect example.

Horizon and locality.—Delaware Mountain formation, Guadalupe Point, Guadalupe Mountains, Texas (station 2931).

Genus EUCHONDRIA Meek.

EUCHONDRIA? sp.

Pl. IX, figs. 8 and 8a.

Only one specimen of this form has thus far been found, and its general character is shown by the illustrations. It is uncertain whether it is a right or a left valve, as one of the ears is imperfect. The general appearance is that of right valves of *Camptonectes? papillatus* and *C.? asperatus;* and because the imperfection above alluded to may have destroyed the character which distinguishes right valves of those species, there is no way of telling that it is not one of them. The present specimen is nearly or quite an internal mold, so that the surface can not be used as a criterion. If it is a right valve, the posterior ear is distinctly larger and better defined in proportion to its size than that of typical examples of the species mentioned, though as the specimen is a very small and probably a young one, these departures from the typical character may really be due to immaturity. On the other hand, if the valve proves to be a left one, as its axial inclination might suggest, it is probably a *Euchondria* and related to the little shell which Waagen described as *E. subpusilla.*

In view of this uncertainty about very fundamental points I do not feel justified in giving this form a name, though if it is really congeneric with *E. subpusilla* there is little doubt that it represents a new species.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926).

Genus PERNIPECTEN Winchell.

PERNIPECTEN? OBLIQUUS n. sp.

Pl. IX, figs. 13 to 14a.

Shell small, elongate, nearly flat. Hinge line shorter than the width below. In the left (?) valve the two ears are nearly equal, small, and moderately well defined both in outline and by grooves on the surface. The shell expands considerably below them, and is gently inclined backward (?). The superior portion is more or less turned upward at the sides along two converging lines.

The surface is rather regularly marked by delicate concentric striæ.

Only one valve seems to be represented in our collections, and the foregoing description is applicable to about half a dozen specimens from the Capitan limestone, but all of them are, unfortunately, imperfect. The smooth surface, the low convexity, and the upturned margins of these shells seem to ally them with *Entolium* and *Pernipecten;* but the obliquity of the axis and the small extension of the ears, if, indeed, the shape is that which seems to be indicated by my imperfect material, are unusual among those forms.

The low convexity of these shells would distinguish them from any of the other pectinoids of this horizon except *Aviculipecten infelix,* even if the sculpture and conformation did not offer additional characters for discrimination.

A single imperfect example from the Delaware Mountain formation has been provisionally referred to the same species.

Horizon and locality.—Middle of Capitan formation, Capitan Peak (station 2926); Delaware Mountain formation, Guadalupe Point (station 2931), Guadalupe Mountains, Texas. Delaware Mountain formation, southern Delaware Mountains, Texas (station 2935).

Family LIMIDÆ Fischer.

This family is represented by two rather distinct types of shells. They are alike in having a high convexity, in being equivalve both in curvature and in sculpture, and in having a byssal sinus in neither valve. They differ in the fact that one is perfectly smooth and the other is adorned with radial sculpture, though the lateral portions are smooth. Both can be referred to the genus *Lima,* the former to the group which has been called *Plagiostoma,* the latter to *Limatulina.* Strictly speaking, *Plagiostoma* and *Limatulina* must be considered subgenera of *Lima,* but I have, for the sake of brevity, cited them independently, as if of full generic rank, a course which certainly would not have been adopted had the present work more of a systematic and less of a stratigraphic or faunal purpose.

To *Limatulina* will also have to be assigned our characteristic Coal Measures species *Limatulina retifera.* *Plagiostoma* is not yet known in the Pennsylvanian, but seems to be a frequently recurring factor in the German Dyas and the English Permian.

Genus PLAGIOSTOMA Sowerby.

PLAGIOSTOMA DELTOIDEUM n. sp.

Pl. IX, figs. 15 to 16a.

The two valves of this species are so alike that a description of one of them applies equally well to another, the necessary allowance being made for the reversal of the parts.

The general appearance of these shells is that of a *Nucula,* but the presence of two inconspicuous ears shows that the generic relations are widely different. The ears are not defined in any way, being merely a flattening and extension of the otherwise arched shell. The posterior ear especially is extremely small and ill defined. The anterior and posterior outlines are nearly straight, the latter being much longer than the former. The lower margin is broadly curved, and the axis is rather strongly inclined to the cardinal line. The surface is nearly smooth, being marked only by very obscure concentric striæ.

Two right and three left valves from the Capitan formation represent this species, while a single left valve from the black limestone at the base of the section has been provisionally referred to it. The latter specimen has a length of 10 mm., and is considerably larger than anything yet obtained from the Capitan. Its characters are imperfectly known, but it agrees with *P. deltoideum* in many points, the only differences detected being apparently unimportant.

Horizon and locality.—Middle of Capitan formation, Capitan Peak (station 2926); basal black limestone, Guadalupe Point (station 2920?), Guadalupe Mountains, Texas.

Genus **LIMATULINA** Wood.

LIMATULINA STRIATICOSTATA n. sp.

Pl. IX, figs. 17 to 19.

Although my material is both scanty and fragmentary, I have ventured to describe this species and give it a new name, because it is so interesting and pretty.

Shell small, rather strongly oblique, narrow, Hinge line short. Anterior side nearly straight, posterior side probably very much rounded.

The surface is marked with moderately strong, more or less angular plications, having broad, flattened spaces between them. Four or five plications occur within the linear distance of 2 mm., and the entire shell probably contained not far from 25. The whole is crossed by delicate, rigid, superficial, radiating liræ, and concentric markings, more or less obscure, which partake of the nature of growth lines. Both anterior and posterior sides are smooth, lacking plications and also, probably, superficial liræ.

Both valves appear to have the same characters of configuration, though of course in some cases reversed by being symmetrical.

This species resembles *L. retifera* in having a band on both sides devoid of plications. On this account, and also because there is little evidence that the valves gap behind, these species seem more closely allied to *Limatulina* than to *Lima* sensu stricto. At the same time I have not seen any traces of the area which distinguishes both of these genera. In fact, in some examples this structure seems to be wanting.

L. striaticostata is distinguished from *L. retifera* and many other members of the genus by the fine radial striation surmounting the ribs. The small specimen represented by fig. 19 shows these striæ very well preserved, but they are somewhat finer than in the other examples, a fact which, joined with this other—that the plications also are somewhat different—may indicate a varietal or even a specific difference.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926).

Family MODIOLOPSIDÆ Fischer.

Genus **MYOCONCHA** Sowerby.

This genus is represented by two species, only one of which is at all well known, and even of it our knowledge is only partial. Their reference to *Myoconcha*, therefore, is not made with any degree of confidence. Indeed, owing to the lack of definite knowledge on several features of importance I seem to see resemblances to two very distinct groups of pelecypods. The supposed relationship to the Modiolopsidæ is expressed in the generic reference above, but I am not sure that the affinities of these forms are really not with the Pleurophoridæ. They are more rapidly expanding than most species of *Pleurophorus,* which as a rule have the upper and lower margins more or less parallel, and their costæ are developed on the anterior instead of on the posterior half of the shell; but in some respects, both external and internal, they are very suggestive of *Pleurophorus.*

MYOCONCHA COSTULATA n. sp.

Pl. IX, figs. 21 to 21b.

In the Capitan limestone two specimens belonging to this species have been found. They seem to be alike in all characters observed, and the left valve, which is in better preservation, is taken as the type.

Shell small, subovate, strongly convex, very oblique, and inequilateral. Hinge line long, straight, shorter than the height, which is in turn shorter than the greatest diameter; that is, along the diagonal. Anterior and posterior sides nearly rectilinear, parallel, and directed to the hinge line at an angle of about 130°. Posterior-inferior outline broadly rounded. Umbo nearly terminal, but with a small anterior lobe.

The surface is crossed by a few coarse, obscure, radiating plications, which are largely confined to the anterior third of the shell. As the specimen is an internal mold, this feature was probably more distinct on the outside. Two angular lines of flexure radiating from the umbo divide the shell into three more or less equal parts. In the anterior one, two small and two large ribs occur, while the large, sharply defined muscle scar probably indicates a small anterior lobe. The middle division has a few almost invisible costæ, while the upper is without this feature altogether. In the mold there is a flattened, depressed band along the hinge line sharply separated from the rest of the shell. This band narrows gradually toward the umbo, and in a large specimen to be mentioned later it contains the impression of a long posterior tooth having a groove above it. I have seen no evidence of a cardinal tooth, a structure which real examples of the genus ought to possess.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926).

MYOCONCHA COSTULATA var. DELAWARENSIS n. var.

Pl. XXIII, fig. 3.

In the Delaware Mountain formation several specimens have been found which are evidently related generically to *Myoconcha costulata,* and they also resemble it in some specific characters. Two specimens especially deserve consideration, a third being too imperfect for further notice. Their shape would not distinguish them satisfactorily from *M. costulata,* but all three have a distinctly lower convexity and lack the radiating ribs of that species. In the larger specimen especially it would be expected that the ribs would be indicated had they ever been present, for the preservation is not so much that of an internal mold as in the one from the white limestone, and even clearly shows traces of irregular concentric striæ, though nothing in the nature of ribs can be detected. It is probable that other characters will appear when better examples are studied, and that even the shape of the variety *delawarensis* will be found to be distinguishable; but at present the low convexity and lack of ribs are relied on to discriminate this variety from *M. costulata.*

Horizon and locality.—Delaware Mountain formation, Guadalupe Point, Guadalupe Mountains, Texas (station 2931).

Family PLEUROPHORIDÆ Dall.

Genus ASTARTELLA Hall.

ASTARTELLA NASUTA n. sp.

Pl. XXIII, figs. 6 to 7a; Pl. XXXI, figs. 12 and 12a.

Shell rather small. Shape, exclusive of the anterior projection, nearly square, the upper and lower margins being approximately parallel, the posterior almost perpendicular to them, and all three nearly equal in length. The lower part of the anterior end is strongly projecting.

The surface is marked by strong, closely arranged, rather regular lamellæ. The internal characters are as in *Astartella vera.*

The typical specimen is a left valve from the Glass Mountains, but we have also two left valves from the Delaware Mountain formation of the Guadalupe section, which appear to belong to the same species. The shape is similar, and the surface, though preserved as an internal mold, is crossed by concentric corrugations, indicating the presence on the outside of projecting lamellæ. The surface ornamentation of this species is not unlike that of *A. concentrica* Conrad,[a] though for its size rather coarser and more crowded. It is distinguished from most species of *Astartella*, however, by its narrow shape, more nearly parallel superior and inferior margins, and its projecting or nasute anterior extremity. It more nearly resembles in shape *A. gurleyi*, from which it differs in being larger, more nasute, and in having the lamellæ of the surface much coarser and more projecting.

[a] Five species of *Astartella* are listed in Weller's catalogue, to which must be added a sixth—*Nuculites concentricus* Conrad (Jour. Philadelphia Acad. Nat. Sci., 1st ser., vol. 8, 1842, p. 248). This was correctly referred to *Astartella* by Meek as long ago as 1875 (Paleontology of Ohio, vol. 2, p. 341), but Conrad's publication being rare it seems to have been but little cited. Several of the six species are clearly valid, but others are more doubtful. There can be but little doubt in regard to *Astartella varica* and *A. gurleyi*. Recently (Prof. Paper U. S. Geol. Survey No. 16, 1903, p. 45) I suggested that the latter species might be a *Microdon*. An examination of characteristic examples from Danville has convinced me that that suggestion was without foundation in the case of the typical form, wnatever may be said with reference to the one from Colorado in connection with which the observation was made. *A. concentrica* Conrad, *A. concentrica* McChesney, *A. newberryi* Meek, and *A. vera* Hall are more in doubt. *A. concentrica* McChesney seems to be distinct from the other species, partly because of its shape, but more especially because of the surface ornamentation which McChesney describes. As the name was preoccupied by Conrad, *Astartella mcchesneyi* is proposed to replace it. Meek regarded *A. newberryi* as distinguished from *A. concentrica* Conrad by certain points in its configuration; but I believe that the two species will prove to be in fact the same. *A. concentrica, A. newberryi*, and *A. vera* resemble one another closely in shape, but probably a valid distinction can be based on the character of surface ornamentation. Hall's description applies equally well to the two other species mentioned, but it at once differs from his figures and from the observation of Meek, who compares *A. newberryi* with *A. vera*. In a varied collection examined by me a few shells agree with Hall's figure and differ from the majority of material in having the liræ more irregular and not so prominent, the points in which Meek states *A. vera* to differ from *A. newberryi*. It seems to me therefore that *A. vera* can be accepted as valid, on account of its surface characters. *A. concentrica* and *A. newberryi* will probably prove to be the same; and to the former, which has priority by many years, the rest, and by far the major portion, of our collection would belong. It is not impossible, however, that *A. concentrica, A. mcchesneyi, A. newberryi*, and *A. vera* will be resolved into one or into varieties of one species.

This species appears to be closely related to *Astarte permocarbonica* Tschernyschew of the Russian Permian.[a]

Horizon and locality.—Delaware Mountain formation, Guadalupe Point, Guadalupe Mountains, Texas (station 2931). Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763).

Genus CYPRICARDINIA Hall.

CYPRICARDINIA ? CONTRACTA n. sp.

Pl. IX, figs. 23 and 23a.

Shell small, highly inflated, subcuneate. Hinge line straight, about as long as the posterior margin, which is gently curved and merges at either end with the upper and lower borders. Beak near the anterior extremity, but with a very marked lobelike projection anterior to it.

Surface marked by regular, heavy, concentric, imbricating lamellæ, each of which bears indications of an independent set of coarse radiating ribs.

Of the interior of the shell but little is known. There was a relatively broad, flattened, more or less lamellar area along the hinge line, and a large deep muscle scar on the anterior lobe.

The general appearance of this shell somewhat suggests *Cypricardinia*, though the shape is more cuneate than in typical forms. The surface ornamentation, consisting of heavy overlapping lamellæ, with radial markings, is also very like *Cypricardinia*, but it is not probable that these markings are cancellate, as is frequently the case in that genus, nor do the internal characters agree very well with *Cypricardinia*, though they are too imperfectly known to be trusted. On the whole it seems rather unlikely that this shell will be found to be a true *Cypricardinia*, but it is impossible with the material at hand to ascertain its generic position. In its specific relations it is evidently quite distinct from *C. carbonaria*, the only Pennsylvanian member of the genus known at this time.

The type specimen of this species is a right valve from the white limestone of the Capitan formation, but two other specimens probably representing the same species—also right valves—have been found in the Delaware Mountain formation.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926).

Genus PLEUROPHORUS King.

PLEUROPHORUS DELAWARENSIS n. sp.

Pl. XXIII, fig. 4.

Shell large, very transverse. Upper and lower margins contracting toward the anterior end. Posterior superior angle about 130°. Posterior outline nearly straight above, broadly rounding to the lower margin. The latter is nearly straight, with perhaps a gentle sinus forward of the middle. Umbo moderately elevated. Anterior end below the beak projecting. Convexity (which may have been diminished by compression) low.

[a] Verhandl. Russ. k. min. Gesell. zu St. Petersburg, 2d ser., vol. 20, 1885, p. 276, pl. 15, fig. 10.

Surface without radial angulations, marked by fine concentric striæ.

The left valve on which this description is based is preserved as a partial internal mold, retaining some of the external as well as the internal characters. Since some of the concentric striæ are shown it is unlikely that radial ribs or angulations, had they ever been present, would have failed of preservation.

This species resembles both *Pleurophorus oblongus* and *P. subcostatus.* It is, however, much larger than either, and differently shaped, having also different surface characters from the species last mentioned.

Horizon and locality.—Delaware Mountain formation, Guadalupe Point, Guadalupe Mountains, Texas (station 2931).

PLEUROPHORUS sp.

At station 2964, in the southern Delawares, what is probably a species of *Pleurophorus* appears to be fairly abundant. My specimens are very imperfect, however. The form appears to resemble *P. calhouni* Meek and Hayden, but the specific as well as the generic relations are as yet almost conjectural.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (station 2964).

Genus CLEIDOPHORUS Hall.

There seems to be much diversity of opinion regarding the affinities of this genus. Perhaps the majority of writers have regarded it as related to *Pleurophorus*, and this was, I believe, the opinion of Hall himself. Dall, in the American Zittel, places it among the Ledidæ. Whatever may be the position of typical *Cleidophorus*, I am not without excellent precedent for referring to that genus the type of shell which is here placed there, and that, there can be no question, is not one of the Ledidæ.

CLEIDOPHORUS PALLASI var. DELAWARENSIS n. var.

Pl. XXIII, figs. 5 and 5a.

This form is represented by a small specimen from the Delaware Mountain formation preserved as an internal mold. The general shape is subtriangular. The cardinal line is slightly convex. The inferior outline is gently concave, or perhaps sigmoidal, and directed to the cardinal outline at an angle of about 45°. The posterior outline is also gently curved, very oblique, joining the inferior outline in a strong curve, and gradually merging into the cardinal outline. The anterior extremity is abruptly rounded, modified by the almost terminal beak and the small anterior lobe. The convexity is considerable, the umbonal ridge being near the lower border and the slope above much less abrupt than that below.

The surface appears to have been marked by concentric striæ, but ribs were probably absent, for they do not appear on the internal mold, as they probably would had they been present, since the shell appears to have been thin and delicate.

The character of the dentition is only partially known. The shell appears to have been thickened along the hinge line and to have borne a longitudinal groove, probably for a ligament. Posteriorly, parallel to this, and just below it, was a deep, narrow socket for a linear posterior tooth borne upon the left valve.

This form appears to be related to *Cleidophorus pallasi* De Verneuil from the Russian Permian, but is distinguished by slight differences in shape, which in view of its geographical and faunal occurrence seem to me to demand at least a varietal discrimination. The resemblance appears especially with De Verneuil's figures, other authors, such as Netschajew and Golowkinsky, having referred forms to that species in which the resemblance is less apparent. Some of Geinitz's figures of *C. pallasi* represent a shell with radiating ribs.

Horizon and locality.—Delaware Mountain formation, Guadalupe Point, Guadalupe Mountains, Texas (station 2931.)

INCERTÆ SEDIS.

Genus PROTRETE n. gen.

After much hesitation it has seemed necessary to introduce for the Guadalupian type here described a new generic name, for to have retained it under either of the several genera with which I thought at different times to assemble it would have been confessedly a makeshift.

The shape is more or less modiliform, very transverse, slightly higher in front than behind, but with subparallel upper and lower margins. The beaks are nearly terminal. The two valves are equal and closed all round. Just under the beaks, however, there is a tubular perforation excavated in the substance of both valves. The dentition is not known with certainty, but there appear to be neither cardinal nor anterior teeth. In the left valve the long hinge line is thickened and longitudinally indented by a median groove. This may be the position of a resilium. At the same time there is an obscure estucheon on the outside of the cardinal line, as if for an external ligament.

I had some thought that the tube which opens beneath the beaks in this form might be a depressed lunule, such as I have observed in *Pleurophorella*, but it seems to be a real opening into the interior of the shell. Even if it were a depression merely I would feel indisposed to refer this form to *Pleurophorella*, because of the absence of the characteristic sculpture of radial ribs and of papillæ.

Superficially this type resembles some of the Paleozoic shells which it has been customary to place with *Lithodomus*, but the anterior opening distinguishes it from that genus as well as from all others suggested by its shape. There is but little likelihood, however, that it belongs with *Lithodomus*, which is now regarded as a synonym of *Lithophagus*.

PROTRETE TEXANA n. sp.

Pl. XXIX, figs. 12 to 13.

Shell small, very transverse. Height of the typical specimen a little less than 4 mm., width a little more than 8 mm. Upper and lower margins subrectilinear, subparallel. The upper one is slightly convex and the lower slightly concave, and they converge gently toward the front. Anterior end abruptly rounded, posterior end very obliquely truncated, the outline above merging gradually into that of the cardinal line, below abruptly rounding into coincidence with that of the inferior margin. Umbones small, incurved, nearly terminal. Convexity greatest in front, flattening behind. Umbonal ridge poorly defined.

Surface marked by a few strong imbricating lamellæ.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

SCAPHOPODA.

This group, while beginning early in geologic time, is rare among most Paleozoic faunas and possesses little significance, not only on this account, but because the minute characters of the smaller end, on which chiefly the classification is based, can be observed in few specimens from that period.

In the Guadalupian fauna only one species of this group has come to hand. Its horizon is restricted to the Delaware Mountain formation, where it is moderately abundant. No sculpture is shown by the Guadalupian specimens, and it is not a certainty that they belong to White's species. There is, furthermore, some doubt as to whether *Dentalium canna*, as based on the typical specimens, is a *Lævidentalium* or a *Plagioglypta*. It is almost certainly not a *Dentalium* in the strict sense.

Scaphopods appear only very sporadically in the faunas with which I have compared that from the Guadalupe Mountains. In the Salt Range Waagen found one species of *Entalis* and fragments of two species of *Antale?*. The *Entalis* might well belong to the same genus as the Guadalupian form, except for the fact that it is slightly curved. It is distinguished by its gigantic size. Enderle found the same species at Balia Maaden. Stuckenberg cites *Dentalium* sp. from the Gschelian, but does not figure it. From the Artinsk he cites *Dentalium speyeri*, apparently a *Lævidentalium* or a *Plagioglypta* not closely related to the Guadalupian form. Krotow cites from the Artinsk, without figures, *Dentalium priscum* and *D. varicosum*. Netschajew cites *D. speyeri* and *Entalis* cf. *prisca* from the Russian Permian. Both species seem to resemble *Plagioglypta canna* in a general way, and *Entalis* cf. *prisca* may prove to be a *Plagioglypta*. Gortani cites this species (*Entalis prisca*) from the Carnic Alps. His figure is rather poor, but appears to represent a species related to *P. canna*. In the Dyas Geinitz found *Dentalium sorbii* and *D. speyeri*. The latter, which alone is figured, seems to be a smooth form like *P. canna*, but small and curved. King described from the English Permian *Dentalium sorbii*, apparently another form belonging to *Plagioglypta* or *Lævidentalium*.

In the Pennsylvanian a similar type of shell seems to be found in *Plagioglypta meekana*, but it is somewhat uncertain whether if the Guadalupian form were better known the relationship would be unquestioned. I have identified the Guadalupian species with *P. canna*, a type which is abundant in the Aubrey sandstone of Arizona and New Mexico, but the identification is a rather doubtful one. The Guadalupian specimens are poorly preserved and some of the characters of *P. canna* are not recognizable on them. The associated faunas are so different, furthermore, as to make me offer the identification with reserve.

Family DENTALIIDÆ Gray.

Genus PLAGIOGLYPTA Pilsbry.

PLAGIOLGYPTA CANNA White?

Pl. XXIII, figs. 11 to 13.

This species is fairly common in the Delaware Mountain formation, but thus far has not been obtained from any other horizon. The figures afford an idea of the characters shown by our specimens. It is a gradually tapering shell, nearly if not quite straight, and complete examples must have been of considerable size. The largest diameter shown is 9 mm. The surface was nearly smooth. None of the external molds show markings, and in this point they differ from the typical specimens, though the delicate sculpture found on the latter may easily have failed of being retained by the sandy matrix in which the Guadalupian specimens are held. Otherwise the Guadalupian form has every character of the types.

White restores this species as very distinctly curved, but the type specimens are seemingly straight, while the Guadalupian specimens, if they are correctly assigned to the species, indicate that the curve, if present at all, was imperceptible. White also both figures and describes the shell as superficially marked by obscure longitudinal lines. These markings, if present on the types, are at least so obscure that I can not see them. The slightly oblique encircling lines are plain, but I can detect no longitudinal markings which it would be safe to interpret as sculpture. On this account it would be well to remove this species from the genus *Dentalium*. In 1903 I referred it somewhat doubtfully to *Plagioglypta*, and in retaining the same usage in this place I retain also the same doubts. It may be a *Lævidentalium*.

Horizon and locality.—Delaware Mountain formation, Guadalupe Point, Guadalupe Mountains, Texas (station 2931).

AMPHINEURA

Family GRYPHOCHITONIDÆ Pilsbry.

Genus CYMATOCHITON Dall.

The Amphineura are usually rather rare in the Paleozoic, and consequently do not serve an important function in characterizing or correlating horizons. They seem to be abundant in the late Carboniferous of Europe, however, and with the latter the Guadalupian form serves as some sort of a link.

Stuckenberg and Krotow cite *Chitonellus antiquus* Howse from the Artinsk, but I have not seen the group recorded from the Russian Permian. In the Dyas of Germany, however, it appears to be represented. Geinitz cites four species of *Chiton* and three species of *Chitonellus*. The latter are entirely unrepresented in the known Guadalupian fauna, and the Chitons are not closely related to *Cymatochiton? texanus*.

The English Permian has furnished *Chiton loftusianus*, a form which is probably not congeneric with that from the Delaware Mountains. The latter, I may add, is doubtfully referred to *Cymatochiton*. The large size of the sutural laminæ, in addition to other peculiarities, makes its reference to that, or, in fact, to any of the genera known in the Carboniferous, somewhat questionable. With only a single plate, however, the determination of its generic relations can not be successfully accomplished.

In the Pennsylvanian fauna no Chitons have as yet been discovered.

CYMATOCHITON? TEXANUS n. sp.

Pl. XXIX, figs. 21 and 21a.

Of this type, which seems to be so common, relatively speaking, in the Permian of Europe, the Guadalupian collections have furnished but a single specimen. The shape is transversely pentagonal, the sides being short and nearly parallel. The two upper margins are slightly sigmoidal in outline and meet in an angle of about 90°. The lower margin also consists of two lines, nearly rectilinear, but slightly sigmoidal, and meeting in a gentle projection. Longitudinally the curvature of the plate is very slight, transversely it is rather strongly convex, the convexity, however, being in the nature of a dihedral angle whose sides are nearly flat. The sutural laminæ are very long. The surface appears to have been smooth.

The group of forms to which this species belongs is not at present known from the American Pennsylvanian, but is fairly abundant in the European Permian. From the species of the latter fauna which I have seen the present form differs in being less transverse and in having much longer sutural laminæ.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

GASTEROPODA.

While far less abundant than the brachiopods, gasteropods show an unusual diversity and play an unusually important rôle in the Guadalupian fauna. Forty-two varieties have thus far been distinguished, and as each new collection contains specimens which, though usually few in number, belong for the most part to undescribed species the measure of variations presented by this group has not yet been taken. The Pennsylvanian fauna in the aggregate also contains a large number of gasteropod species, but in individual collections they are certainly no more abundant than in the Guadalupian and tend much more to repeat a few common types.

The known Gasteropoda of the Guadalupian have been assigned to 15 genera, but by far the larger portion belong to the Pleurotomariidæ. According to the generic determinations made below, some of which are recognized as being doubtful, this group, embracing the genera *Murchisonia*, *Euconospira*, and *Pleurotomaria* itself (under which title are probably included representatives of several subgenera, although the information obtained regarding many of the forms is not such as to favor further subdivision) comprises 24 out of the 42 species. The Bellerophons, with three species belonging to the genera *Bellerophon* and *Bucanopsis*, and *Warthia* are unusually poorly represented. The remaining forms have been referred, one or two to each, to the following genera: *Patella*, *Naticopsis*, *Macrocheilina*, *Bulimorpha*, *Pseudomelania*, *Trochus?*, *Turbo?*, *Loxonema*, and *Euomphalus*.

The material examined naturally presents many degrees of preservation and affords a knowledge of the essential characters of species in varying measure. It has seemed to me desirable to make; so far as practicable, an adequate presentation of this division of the fauna, and so far as the data were at hand accounts more or less complete have been given of about 40 species, as previously remarked. At the same time a few varieties have been passed over. A considerable percentage of the species described have been left unidentified and unnamed, the data at hand in my judgment indicating differences from described species without conveying facts adequate for the establishment of new ones. Even in some cases where new names have been proposed, the specific characters have not been shown as clearly or as completely as I could wish.

In the Salt Range fauna Waagen recognized 34 gasteropod species, representing 16 genera, but in great contrast to the Guadalupian fauna nearly two-thirds of these, or 23 species, belong to the Bellerophontidæ.

In general the Salt Range and Guadalupian faunas have very little in common, most of the genera even being different. The two Salt Range species of *Euomphalus* are not very closely related to the two Guadalupian ones. The genus *Holopella* seems to be absent from the Guadalupian fauna. Waagen's *Macrocheilus* is the same as my *Macrocheilina*, and the single Indian species in its essential characters is not so very different from those of my fauna, though this genus at best does not show any very great differentiation. The genus *Naticopsis* finds one Guadalupian representative, which, specifically at all events, is distinct from either of the Salt Range species, but is somewhat related to *N. khurensis*. It is rather more suggestive of the single species which Waagen described under *Platystoma*. *Neritomopsis*, of which Waagen recognized two species, is not known in the Guadalupian, and the same is true of the genera *Phasianella* and *Margarita*. The four Pleurotomarias of the Salt Range fauna are related to certain of the numerous varieties from the Guadalupe Mountains, which present, however, many that are different. The single Salt Range species of *Murchisonia* also resembles in a very general way the two imperfectly known Guadalupian ones.

Waagen found nine species of *Bellerophon* in the Salt Range fauna, as against one in the Guadalupian. All are naturally of the same general type, some of the Salt Range species resembling the Guadalupian *B. crassus* more particularly and others less. Four species of *Bucania* are found in the Salt Range, comprising in part at least the same group for which I have employed the name *Bucanopsis*. *B. kattaensis*, *B. integra*, and *B. angustifasciata* appear to be of the same general type as the Guadalupian species. The fourth, *B. ornatissima*, has no Guadalupian equivalent. The peculiar Salt Range genera *Mogulia* and *Stachella*, together with *Euphemus*, a common type in our Pennsylvanian, are not known in the fauna of the Guadalupian Mountains, but the Salt Range genus *Warthia* has been identified there. On the other hand, the Guadalupian fauna contains representatives of *Patella*, *Bulimorpha*, *Pseudomelania*, *Turbo?*, *Trochus?*, and *Loxonema*, besides several types of *Pleurotomaria* not known in the Salt Range. Thus the comment with which this hasty comparison of the two faunas set out seems to be justified, for they do not appear to show a close relationship in point of the gasteropod class. The most noteworthy differences are the much greater development of the Pleurotomarias in the Guadalupian and the much greater development of the Bellerophons in the Salt Range fauna.

Gasteropods seem to be rare in the Himalaya, for Diener's reports contain scarcely any mention of them. I find an unidentified species of *Naticopsis* noted in his second paper on the Chitichun fauna No. 1, and a few species are cited from Malla Sangcha, the Lissar Valley, and Byans, as follows: From Malla Sangcha he records *Naticopsis khurensis*, *Bellerophon* sp. ind. aff. *polito* Waagen, and *Pleurotomaria* (*Mourlonia*) *hunica*. The two former seem to have no closely related species in the Guadalupian, but with the third *Pleurotomaria euglyphea* of the Delaware Mountain fauna may be compared. From the Lissar Valley Diener obtained a species of *Pleurotomaria* allied to *P. punjabica*, an undetermined species of *Naticopsis*, and an undetermined species of *Bellerophon*. The *Naticopsis* and *Pleurotomaria* seem to have related species in the Guadalupian, but this is less true in the case of the *Bellerophon*. From Byans only an undetermined species of *Pleurotomaria* is cited.

Among the fossils which Romanowsky described from Turkestan are a few Carboniferous gasteropods representing the genera *Bellerophon*, *Porcellia*, *Euomphalus*, and *Pleurotomaria*. For the most part these have themselves but little to do with any known Guadalupian species and are associated with different and apparently older faunas. In the case of *Euomphalus pentangulatus* there is at least some resemblance shown to the species which I have described as *E. sulcifer* var. *angulatus*.

In the Chinese fauna from Lo Ping the gasteropods appear to be surprisingly scarce. Kayser cites but a single species (*Macrocheilus* cf. *angulifer* White), with the possible exception of another identified as *Nautilus* or *Warthia*. The former probably has no allied Guadalupian form, but the latter may prove, when generically determined, to be correlated with the Guadalupian *Warthia*.

Loczy cites from the vicinity of Kantschoufu six gasteropods as *Bellerophon?* (*Bucania*) *incertus*, *Bellerophon* (*Tropidocyclus*) sp. indet., *Bellerophon* (*Euphemus*) cf. *urei*, *Straparollus* cf. *placidus*, *Loxonema szechényii*, and *Macrochilina kreitneri*. *Tropidocyclus* sp. indet., *Bellerophon* cf. *urei*, and *Straparollus* cf. *placidus* appear to have no related species in the Guadalupian, but the three others at least show some superficial resemblance to the Guadalupian species of *Bucanopsis*, *Loxonema*, and *Macrocheilina*. From the Lantsankiang Valley this author cites an undetermined species of *Pleurotomaria* whose relation to Guadalupian types of the genus can not be determined.

Contrasting with the rarity of this group in the Chinese faunas is its representation in that from Padang as described by Fliegel. This author found no less than 25 species, which he refers to the genera *Patella* (1 species), *Bellerophon* (5 species), *Euomphalus* (2 species), *Pleurotomaria* (6 species), *Murchisonia* (1 species), *Trochus* (1 species), *Naticopsis* (5 species), *Macrocheilus* (3 species), and *Loxonema* (1 species). *Patella anthracophila* is probably only remotely related to the Guadalupian species of *Patella*, if at all. The same is true to a certain extent of the Bellerophons as well, though the species are either not figured or else are represented by molds. *B. subcostatus* is somewhat clearly unrelated, or remotely related, to anything in the Guadalupian. The two species of *Euomphalus* have also little to do with the two found in the Guadalupian. The Pleurotomarias figured by Fliegel represent rather large types and do not show any noteworthy relationship to those of the American fauna. The single species of *Murchisonia* from Padang is too imperfectly known to furnish the basis for an opinion. If it resembles any of the Guadalupian shells, it is more like some of those which I have referred to *Pleurotomaria* than those placed under *Murchisonia.* The form identified as *Trochus? anthracophilus* has no related form in the Guadalupian fauna, unless possibly among some of the species placed with *Euconospira.* *Naticopsis subovata,* and to a less extent *N. sumatrensis,* may be compared with the Guadalupian *Naticopsis* sp., but *N. trautscholdi* has no allied forms in our fauna. The other species of *Naticopsis* are not figured. *N. elegantula,* at least, seems, like *N. trautscholdi,* to be non-Guadalupian. Two of the species of *Macrocheilus* resemble the Guadalupian Macrocheilinas, but the third, *Macrocheilus* (*Polyphemopsis*) *nitidulum* Meek and Worthen, is, so far as known, non-Guadalupian. The single species of *Loxonema* also seems to have only a general relationship with the Guadalupian shells referred to *Loxonema.* The gasteropods of the Padang fauna are not presented in such a way as to make comparisons either easy or satisfactory, but they do not appear to show any essential relationship with those of the Guadalupe Mountains.

The same fauna had been previously described by Roemer, who identified 11 species of gasteropods, which he assigned to the genera *Euomphalus, Pleurotomaria, Trochus, Macrocheilus, Murchisonia, Naticopsis, Patella,* and *Bellerophon.* *Euomphalus sumatrensis* is only remotely related to either of the two Guadalupian species of the genus. *Pleurotomaria orientalis* is probably not closely allied to any of the Guadalupian Pleurotomarias. *Trochus? anthracophilus* reminds one also of a *Euconospira,* and if it should prove to belong to the Pleurotomariidæ may be compared to *Euconospira obsoleta.* Of the two species of *Macrocheilus* only one is figured. This is the form which Fliegel subsequently identified as *Macrocheilus* (*Polyphemopsis*) *nitidulum* M. and W. It resembles the Guadalupian species cited as *Bulimorpha chrysalis* var. *delawarensis* in some measure; but it is probably not a *Bulimorpha,* and is distinct from the Guadalupian Macrocheilinas. The single species of *Murchisonia* recorded by Roemer is likewise not figured. The two Sumatran species of *Naticopsis* are represented in the Guadalupian, but not closely, by *Naticopsis* sp. It appears to be nearer to *Naticopsis brevispira.* Roemer's *Patella? anthracophila* I can not but suspect is not a *Patella* but a brachiopod, a *Crania,* or possibly a discinoid. At all events it is quite unlike the Guadalupian *Patella capitanensis.* *Bellerophon asiaticus* is too imperfectly known to enter into a comparison of the Guadalupian with the Sumatran gasteropods, which whether viewed through the pages of Roemer's report or those of Fliegel's appear to have no essential relationship with the American fauna.

The only species of gasteropod mentioned by Rothpletz in his paper on the fauna of Timor and Rotti is compared by him to *Straparollus permianus,* a type which seems to have no related form in the Guadalupian fauna.

A considerable number of gasteropods enter into De Koninck's account of the Carboniferous faunas of New South Wales, only a moiety of them being from the upper ("Permo-Carboniferous") beds. The others it will not be necessary to consider. *Platyceras altum* and *P. tenellum* are found in the lower beds and possibly in the upper. Nothing resembling them has been discovered in the Guadalupe Mountains.

A number of species are placed with *Pleurotomaria* and *Murchisonia.* As might be expected, a general resemblance exists between this group and the Guadalupian

Pleurotomarias, but nothing either sufficiently close as a whole or sufficiently marked in any particular to establish a relationship between the two faunas or any presumption of such. *Euomphalus oculus* and *E. catillus* are entirely unlike the Guadalupian species of *Euomphalus.* I find no trace of essential relationship between the two faunas in point of their gasteropod content.

Sixteen species of Gasteropoda are discriminated by Etheridge in the "Permo-Carboniferous" faunas of Queensland and New Guinea, referred to the following genera:

	Species.		Species.
Naticopsis	3	Yvania	1
Loxonema	1	Luciella?	1
Euomphalus	1	Murchisonia	1
Platyschisma	2	Bellerophon	1
Pleurotomaria	1	Bucania	1
Mourlonia	2	Porcellia	1

Etheridge's three species of *Naticopsis* are not figured (except a fragment of one of them), and in the Guadalupian also we have only imperfect specimens. *Loxonema* sp. appears to be related, though not closely, to the Guadalupian *Loxonema swallowianum.* Of *Euomphalus* the Queensland representation appears to have been very meager and, so far as I can make out, different from the Guadalupian species. Probably nothing as yet known in the Guadalupian can be compared with the two Australian species of *Platyschisma,* unless it be the imperfectly known form referred to *Naticopsis.* In configuration at least, *Pleurotomaria carinata,* as identified by Etheridge, resembles *Pleurotomaria discoidea* of the Guadalupian; but there is nothing in the Guadalupian which I would wish to compare with Etheridge's two species of *Mourlonia.* His figure of *Mourlonia? coniformis* is very bad, but represents perhaps a *Euconospira.* The poorly preserved *Yvania konincki* more or less resembles several Guadalupian types (perhaps *Pleurotomaria richardsoni* as much as any), but nothing very closely. *Luciella? grayi* is too imperfect and too poorly figured for the present comparisons. *Murchisonia carinata* probably is not closely allied to any Guadalupian form. *Bellerophon stanvellensis,* a type which recurs in so many faunas, is represented in the Guadalupian by *Bellerophon crassus?.* *Bucania textilis* is probably allied to the undetermined Guadalupian *Bucanopsis;* but to *Porcellia pearsi* I know of no corresponding Guadalupian form. On the whole I see but little real relationship between the Gasteropoda of the Guadalupian fauna and those described by Etheridge.

The gasteropods of the Moskovian are divided by Trautschold among the genera *Cerithium, Pleurotomaria, Murchisonia, Euomphalus, Macrocheilus, Chemnitzia, Nerita, Natica, Capulus,* and *Bellerophon.* As would naturally be expected, this fauna does not resemble that of the Guadalupian to any marked degree. The Moskovian species called *Cerithium ignoratum* by Trautschold is only remotely related to our *Loxonema swallowianum.* The identification of the two Pleurotomarias is queried, and neither species is figured. The only *Murchisonia* is likewise not figured. Of the two species of *Euomphalus,* one identified as *E. tabulatus* Phillips may be compared with one of the Guadalupian types. The single species of *Macrocheilus* is not similar to the corresponding Guadalupian Macrocheilinas. *Nerita ampliata*, which is not figured, and *Natica omaliana* probably have no Guadalupian representatives, unless in *Naticopsis*. The genus *Capulus* (or *Platyceras*) is not known in the Guadalupian, and the three Moskovian species seem to be without answering types. Only one of the four species of *Bellerophon* is figured, but that form, identified as *B. costatus*, is not closely related to the Guadalupian representatives of the genus. *B. urei*, another Moskovian species, belongs to a type which appears to be entirely lacking in our fauna.

Regarding the gasteropods of the Gschelstufe I have succeeded in procuring but a relatively small amount of data of a sort that could be used in the comparisons undertaken here. Stuckenberg cites 7 species of *Pleurotomaria*, 1 of *Murchisonia*, 1 of *Bellerophon*, 4 of *Straparollus*, 1 of *Euomphalus*, 1 of *Capulus*, 2 of *Naticopsis*, 1 of *Loxonema*, and 1 of *Macrocheilus*. While there are a number of pleurotomarioid types in the Guadalupian which are not represented among Stuckenberg's seven species, there are few of the latter which have not in the Guadalupian one or two species more or less closely related. The single representative of *Murchisonia* in Stuckenberg's fauna is less like the Guadalupian shells referred to that genus than certain of the Guadalupian Pleurotomarias, especially a poorly preserved form not mentioned specifically. *Bellerophon hiulcus* is not figured. *Straparollus* seems to be absent from the Guadalupian fauna. The single Gschelian *Euomphalus* is neither identified nor figured. *Capulus* is unknown in the Guadalupian, but *Naticopsis* sp. is more or less similar to one at least of the Gschelian forms and even shows a certain measure of resemblance to Stuckenberg's species of *Straparollus* and *Capulus*. The single Gschelian species of *Loxonema* is not at all like *L. swallowianum*, but the undetermined *Macrocheilus* from the Gschel very closely resembles *Macrocheilina* sp. *a* of the present report.

Nikitin's account of a Gschelian fauna comprises but a single gasteropod—*Euomphalus canaliculatus*—which is not closely related to either of the Guadalupian species. A few other generic types are recorded in lists, and one of these (*Omphalotrochus*) is important, since it seems to be sufficiently characteristic of one of the zones of the Gschelian to give a name to it. *Omphalotrochus* is not known in the Guadalupian fauna, but types, if not congeneric at least closely related, form a striking feature of one of the faunal zones of the underlying Hueco formation.

In his account of the Artinskian fauna Stuckenberg cites 28 species of gasteropods, belonging to the genera *Patella, Pleurotomaria, Murchisonia, Bellerophon, Straparollus, Capulus, Natica, Naticopsis, Loxonema, Macrocheilus, Turbo*, and *Vermetus*. Stuckenberg's *Patella artiensis* rather suggests to me a *Crania;* at all events it is not related to the Guadalupian *Patella*. The three which are figured of the five Pleurotomarias present no marked departure from Guadalupian types. The single species of *Murchisonia*, the five species of *Bellerophon*, and the single species of *Straparollus* are not figured. The only Guadalupian representative of the Gschelian *Natica* and *Naticopsis* appears to be *Naticopsis* sp., which is more similar in a general way to *Natica* cf. *minima* than to any of the others. Only two of the four species of *Loxonema* are figured, and they present no close relationship with *L. swallowianum*. Indeed, I am somewhat doubtful of the correctness of the assignment to this genus of *Loxonema conicum*. The figures rather suggest a *Pseudomelania* not unlike the

Guadalupian species, or a *Polyphemopsis*. The single Artinskian species of *Macrocheilus* is rather closely related to *Macrocheilina* sp. *a* of the present work. The shell referred to *Turbo obtusus* Brown is not figured. *Vermetus tschernyschewi* represents a type at present unknown in the Guadalupian.

From the Kungurstufe, Stuckenberg cites 3 species of *Pleurotomaria*, 2 of *Murchisonia*, 2 of *Bellerophon*, 3 of *Straparollus*, 1 of *Euomphalus*, 1 of *Natica*, and 1 of *Loxonema*. The Pleurotomarias would scarcely appear alien if they were found in the Guadalupian fauna. Neither of the Murchisonias is figured, and the single cut representing one of the two species of *Bellerophon* tells very little. *Straparollus* is not known in the Guadalupian, and the three species cited by Stuckenberg are unfigured. *Euomphalus* sp. has little to do with the Guadalupian representatives of the genus, so far as one can determine from the inferior illustrations; and, finally, *Loxonema phillipsi* is not figured.

Krotow described a rather extensive gasteropod fauna from the sandstones of the Artinsk, but unfortunately his text is in Russian and his citations for the most part unaccompanied by figures. His list embraces the following species:

	Species.		Species.
Natica	6	Straparollus	4
Capulus	5	Bellerophon	13
Loxonema	9	Porcellia	1
Subulites	1	Pleurotomaria	10
Macrocheilus	3	Murchisonia	2
Actæonina	1	Patella	2
Turbo	2		

Of the six species of *Natica* three are figured, but none of them exhibits any but a very slight relationship with *Naticopsis* sp., which must be regarded as the corresponding Guadalupian genus. The species of *Capulus* are all unfigured, but as the genus has not been recognized in our fauna, they are probably to be reckoned among the non-Guadalupian forms. Only two of the Loxonemas are figured. One of them is related to *L. swallowianum*, though remotely. The other, of an altogether different type, is marked with spiral liræ and would probably more correctly be placed with *Orthonema* or some other genus than with *Loxonema*. We probably have nothing in the Guadalupian to compare with it.

Subulites sp. is not figured, nor is either of the two species of *Macrocheilus*. *Actæonina* sp. nov., however, is not very dissimilar to my *Macrocheilina* sp. *a* in general appearance. Both species of *Turbo* are without figures, but it may at least be said that the genus probably occurs in both faunas. All the species of *Straparollus* are unfigured, with the exception of *S. variabilis*. This form seems to be congeneric with the Guadalupian species of *Euomphalus*, but to be very different in its specific relations. The Bellerophons are unfigured, with the exception of three species. *B. chaldinensis* may be compared with *Bucanopsis* sp., and *Bellerophon sphæroidalis* and *B. compressus* certainly suggest *Warthia americana*, though no real relationship may exist. Some of the unfigured Bellerophons are non-Guadalupian, such as *B. urei* and others. *Porcellia artiensis* also has no corresponding form. The only figured species of *Pleurotomaria* are *P. orientalis* and *P. dimorpha*. Both in a general may resemble some of the Guadalupian Pleurotomarias. Of the two species of

Murchisonia one is figured. It resembles neither the Murchisonias nor the Pleurotomarias of the Guadalupian. Only one of the two species of *Patella* is figured, and I suspect that it may possibly be a *Crania*. It has, at all events, nothing to do with *Patella capitanensis*.

In his account of the Permian fauna of the government of Kostroma Tschernyschew includes notices of only five gasteropods, most of which appear to have been in an imperfect condition. *Chemnitzia volgensis* and *Straparollus permianus* represent types which are apparently absent from the Guadalupian fauna. Some of the Guadalupian species referred to *Pleurotomaria* suggest Tschernyschew's *Turbo? burtasorum* in a general way, much more than does the Guadalupian form referred to the same genus. *Bellerophon decussatus* is probably non-Guadalupian, but *Murchisonia subangulata* is not unlike some of the Guadalupian Pleurotomarias, especially an unrecorded species, though possibly it is not related to the forms which I have here placed with *Murchisonia*.

Netschajew, however, found an abundant gasteropod fauna in eastern Russia, comprising no less than 44 species. *Lepetopsis golowkinskyi* appears to resemble the shell here described as *Patella capitanensis*, and they may prove to be congeneric also, as the interior of the Guadalupian species is not known. Seven species are referred to *Pleurotomaria*, but the Murchisonias, of which five species are recorded, also represent such types as I have included under that genus. While some of the Guadalupian Pleurotomarias belong to types not found in Netschajew's fauna, and some of his species, especially of *Murchisonia*, are types as yet unknown in the Guadalupian, the Permian Pleurotomarias and Murchisonias of Russia in a general way appear to resemble the Guadalupian Pleurotomarias very closely. Some of Netschajew's species of *Turbo* also resemble certain Guadalupian forms referred with more or less doubt to *Pleurotomaria*. Of the five species of *Bellerophon* two at least appear to be non-Guadalupian types (*B. urei* and *B. piktorskyi*), but *B. elegans* may be related to the imperfectly known species of *Bucanopsis*. As to the two remaining species nothing can be said, the figures being poor and the text in Russian. The genus *Turbo*, to which Netschajew refers six species, is represented in the Guadalupian by only one doubtfully determined species, which is much more closely related to *T. burtasorum* and *T. angulatus* than to the four other species. *Straparollus permianus*, *Euomphalus pawlowi*, and *Naticopsis permica* are types like which no Guadalupian species are known; but *Natica minima* suggests *Naticopsis* sp. of the present paper. *Naticopsis* sp. also resembles in some respects the form cited by Netschajew as *Capulus permocarbonicus*. This author refers twelve species to *Loxonema*, among which four different types, representing possibly as many different genera, can be discriminated. A few are of the normal *Loxonema* type, the whorls marked by strong longitudinal furrows. One of these resembles *L. swallowianum*. The majority of these Permian forms, however, appear to be entirely without sculpture, and such I would hardly approve of placing in the genus *Loxonema*. I have myself, however, provisionally placed in *Loxonema* a shell of this type which much resembles some of the Russian forms (e. g., *L. phillipsi* Howse). Another type (*Loxonema* sp.) is marked by revolving liræ and may prove to be an *Orthonema*, while still another (*Loxonema ornamentarium*) is ornamented with nodes and spiral lines. If the last two have any Guadalupian equivalents they will be found among the shells which I have placed with *Pleurotomaria*. Of the two Permian species of *Macrocheilus*, *M. permicus* appears to be closely related to *Macrocheilina* sp. *a*, *M. globosus* being as yet without a known equivalent. *Subulites permianus* also appears to be not remote from *Bulimorpha chrysalis* var. *delawarensis*.

Golowkinsky also includes some gasteropods in his paper on the Russian Permian fauna, citing six species. The single *Bellerophon*, an undetermined form, is too poor for comparison. *Turbinella volgensis* is probably non-Guadalupian, but *Turbo burtasorum* also, though its configuration is very suggestive of some of the Guadalupian Pleurotomarias, is probably to be compared only to *Turbo?* sp. of the Guadalupian, without apparently any close affinity. *Pleurotomaria divesouralica* is a type not found among the Guadalupian representatives of the genus, but *Murchisonia subangulata* is not unlike some of the Guadalupian Pleurotomarias. *Emarginula?* sp. suggests *Patella capitanensis*.

In conclusion I feel much hesitation at expressing a judgment regarding the relationship of the Guadalupian Gasteropoda with those of the Russian section. It appears to me neither very close nor very remote, greater perhaps with the Permian than with any of the other subdivisions.

In addition to the shells referred to above, Jakowlew has described an extensive series of gasteropods from the Donetz basin, including in fact over 50 species. The Bellerophons comprise but three species. *Euphemus* aff. *nodocarinatus* is, so far as known, a non-Guadalupian type. *Bucania makatikhæ* can be compared with *Bucanopsis* sp., but the other *Bucania* is unidentified and unfigured. *Worthenopsis* claims five species, one of them unfigured. Of the others, three species rather strikingly resemble certain of the Guadalupian Pleurotomarias, such as *P. richardsoni*, *P. arenaria*, and *P. delawarensis*. The remaining one, *W. netschajewi*, has no closely allied species in my fauna. Two species are assigned to *Rhaphistomella* and these also are in a general way like species of *Pleurotomaria* in the Guadalupian. *Pleurotomaria* is employed for six species, one of them unfigured. *P. antrina* and *P. kingi* seem to be alien types to the Guadalupian fauna, but *P. baranowkensis*, *P. præplatypleura*, and *P.? sibirtzewi* are more like Guadalupian species. *Rhineoderma nikitowkensis* is possibly to be compared with *Euconospira* sp. of the present work. To *Murchisonia* Jakowlew assigns nine species. These types are somewhat less common in the Guadalupian than those with lower spire, and I also have referred them to *Pleurotomaria*. Probably the subgenus which he distinguishes as *Glyphodeta* is not represented among the Guadalupian forms, but the other types may find more or less closely related species there. *Straparollus* is represented by but one species and is a type not known in the Guadalupian, but *Euomphalus* includes three not especially like those of our fauna. *Sosiolytes? vassilievkensis* is non-Guadalupian and probably *Turbonellina chatzepetovkensis*, unless some of the doubtful Guadalupian Pleurotomarias prove to have that relationship. *Portlockia rotundata* and *P. kamenkensis* have a superficial resemblance to the form which I have called *Pleurotomaria elderi*, but they may be quite unrepresented in my fauna. *Trachydomia wheeleri*, *Naticopsis kokeni*, and *Naticopsis tschernyschewi* are non-Guadalupian. *Tretospira*, of which Jakowlew recognizes two species, has not yet been discriminated in the Guadalupian fauna. The Russian fossil identified as *Loxonema peoriense* may be compared with *L. swallowianum*. The other Russian *Loxonema* is unfigured.

Of the two species of *Zygopleura* that which is figured might be regarded as congeneric with the imperfectly known *Loxonema swallowianum*, though not closely related specifically. *Macrocheilina intercalaris* as identified by Jakowlew, though very much larger, appears to be closely allied to the Guadalupian *Macrocheilina* sp. *b*. *Tuberculopleura*, represented by five Russian species, is probably alien to the Guadalupian, as are also the single species of *Omphaloptycha* and the genus *Promathildia*, to which Jakowlew refers four species, though possibly some of the Guadalupian shells provisionally assigned to other genera may show a closer relationship when they are better understood. In fact *Promathildia* aff. *kasanensis*, *P. biserixtuberculata*, and *P. anomala* in a general way are suggestive, respectively, of the Guadalupian shells cited under *Pleurotomaria* sp. *d*, *Pleurotomaria elderi*, and *Trochus?* sp. The Guadalupian gasteropods are known in too little detail to make satisfactory comparison with those of the Donetz basin, where finer distinctions are drawn than it has seemed practicable to make among the indifferently preserved specimens from the Guadalupe Mountains, and I hesitate to place on record any expression of opinion on this point. While they undoubtedly have a number of features in common I can not feel that they are more than moderately allied.

The only gasteropod found by Abich among his fossils from Djoulfa was an undetermined species of *Macrocheilus* (*Buccinum* in the text). It is a much larger species than *Macrocheilina* sp. *a*, but is almost too imperfect to compare in other particulars. Arthaber when he reworked this fauna identified this form as *Macrocheilus avellanoides* De Koninck without figuring it.

A somewhat more extensive gasteropod fauna was found by Enderle in Asia Minor, six species being recognized. They are in every case characterized by relatively enormous size. It seems probable from Enderle's figures that *Bellerophon attalicus* is a *Mogulia*, or possibly a *Warthia*, but even in the latter event it is only remotely related to *Warthia americana* of the present fauna. *Pleurotomaria? anatolica*, if a *Pleurotomaria* at all, may be compared in a general way at least to some of the very much smaller species of the Guadalupian. *Murchisonia stachei* is probably non-Guadalupian. *Murchisonia pergamena* is more like some of the Guadalupian species, but *Euomphalus* sp. and *Naticopsis arthaberi* have no corresponding forms.

A very extensive gasteropod fauna was that described by Gemmellaro from the Fusulina limestone of Sicily. It comprises, in fact, no less than 79 species, or almost twice as many as are at present known from the Guadalupian. They are distributed among the following genera:

	Species.		Species.
Cylindritopsis	5	Chrysostoma	3
Loxonema	7	Turbinilopsis	1
Strobeus	1	Turbonellina	2
Macrocheilus	9	Portlockia	1
Fossariopsis	2	Trachyspira	3
Naticopsis	8	Trochotoma	2
Nerita	2	Temnotropis	2
Platycheilus	3	Murchisonia	1
Trochus	1	Pleurotomaria	16
Sosiolytes	1	Bellerophon	9

It is not known whether the Guadalupian shells agree in the essential or generic characters, but some of them are certainly very suggestive of Gemmellaro's genus *Cylindritopsis*. I refer especially to *Macrocheilina* sp. *b* and *Bulimorpha chrysalis* var. *delawarensis*, which resemble *Cylindritopsis ovalis* or *C. inflata* and *C. conica*, respectively. As to Gemmellaro's genus, it seems to me it should be compared more closely with *Soleniscus* and *Bulimorpha*.

The genus *Loxonema* shows a much greater differentiation in Gemmellaro's fauna than in the Guadalupian, and the specific representation is very different in each, the Sicilian forms comprising nothing comparable to *L. swallowianum* and very little which resembles *L. inconspicuum*. Gemmellaro's *Strobeus elegans* resembles no Guadalupian species so much as *Bulimorpha chrysalis* var. *delawarensis*. That species also closely resembles his *Macrocheilus subulitoides*. Gemmellaro has subdivided his *Macrocheilus* very closely, and most of his species more or less resemble either *Macrocheilina* sp. *a* or *M. modesta*. *Macrocheilina* sp. *b*, which has already been compared to his *Cylindritopsis*, seems to be out of this range. A few of his species, such as *Macrocheilus barroisi*, are fairly distinct from any known Guadalupian forms. The two forms referred to the genus *Fossariopsis* are probably non-Guadalupian, the only species which at all resemble them being pretty remote.

Gemmellaro has also made a close division of his species of *Naticopsis*. They naturally do not exhibit very wide limits of variation, and while none of them departs very far from the imperfectly known Guadalupian species, only one or two closely resemble it. *Nerita palæomorpha* is probably non-Guadalupian, and so are *Nerita prisca* and the three species of *Platycheilus*. *Trochus adrianensis* is very different from the doubtful Guadalupian *Trochus* and different from anything in the fauna. *Sosiolytes* also is non-Guadalupian, as are the three species of *Chrysostoma*. *Turbinilopsis planorbiformis* and *Portlockia decorata* are not figured in my copy of Gemmellaro's work. The two species of *Turbonellina* are not related to any of the known Guadalupian species, and *Trachyspira*, with its three species, is also quite alien to the Guadalupian fauna.

Among the Pleurotomarias Gemmellaro recognizes a large number of species, and having more perfect material than the Guadalupian rocks have yet furnished he was able to make finer discriminations of genera or subgenera than I have found practicable. *Trochotoma*, to which he assigns two species, appears to be unrepresented among the Guadalupian Pleurotomarias. *Pleurotomaria discoidea* most resembles the two Sicilian shells which Gemmellaro has placed with *Temnotropis*. *Murchisonia sosiensis* is probably more or less related to several of the Guadalupian forms. Gemmellaro's Pleurotomarias, including the subgenus *Plocostoma*, have really but little in common with the Guadalupian Pleurotomarias. There are not many striking forms in either fauna, but I remark in that from Sicily the absence of *Euconospira* or anything comparable to *Pleurotomaria euglyphea*, *P. strigillata*, and many others, and in the Guadalupian the absence of types resembling the Sicilian *P. catherinæ* and *P. isomorpha*, while of the less conspicuous types the generality are considerably different in both faunas. An instance of rather marked resemblance seems to be found in *P. retroplicata* of the Sicilian and *P. richardsoni* of the American fauna.

Gemmellaro divides his Bellerophons into *Bellerophon*, *Waagenella*, and *Bucania*. Most of his species are, unfortunately, not figured in the copy of his work to which I have access. The Bellerophons are probably more or less like *B. crassus*, but *B. lamellosus* is rather different from and *B. cylindricus* is altogether unlike any Guadalupian form. *Bucania*, in like manner, presumably corresponds to *Bucanopsis*, but *B. sosiensis*, the only Sicilian species whose figure has been seen, is considerably different from *Bucanopsis* sp. of the Guadalupian. *Waagenella* has not been recognized in the Guadalupian fauna, and, on the other hand, *Warthia* seems to be unknown in the other.

On the whole I find but little resemblance between the Guadalupian gasteropods and those of the Sicilian fauna from Sosio. The latter, as just pointed out, contains a number of groups which, so far as known, are absent from the Guadalupian. On the other hand, some of the Guadalupian types are absent from the Sicilian fauna. The most notable of these is *Euomphalus;* but I may also mention *Patella*, *Euconospira*, and *Murchisonia* (not the name but the corresponding type). Where the same types occur in both faunas the Sicilian shells are in several instances, of which *Naticopsis* is a good example, much more plentiful and highly differentiated. In the case of the Pleurotomarias, which are extraordinarily differentiated in both but proportionately much more in the Guadalupian, the general representation in each is largely peculiar and distinct from the other.

Schellwien, as is well known, treated only the brachiopods and Foraminifera in his reports on the faunas of the Carnic Alps. Gortani, however, discusses upward of 30 species from this region in a paper recently published. Unfortunately, many of the species identified by this author are not figured, and the figures of the others are very unsatisfactory. Since the fauna, so far as can be determined, has very little in common with that of the Guadalupe Mountains, I will not pause to consider it in detail, resting content with pointing out a few of the more general differences, such as the presence of Bellerophons of the type of *B. de-angelisi*, *Mogulia?* sp., and *Euphemus* (2 species), the predominance of the high-spired over the low-spired Pleurotomarias, the presence of *Straparollus*, *Phymatifer*, and *Trachydomia*, and the differentiation of *Loxonema*, 5 species being noted, several of which, in point of their slender, many-whorled shape, are comparable with *L. swallowianum*, though I have not satisfied myself that they have the same sculpture.

In his monograph on the Dyas, Geinitz distinguishes 17 species of gasteropods, which are distributed among the following genera: *Paludina* (1 species), *Turbonilla* (4 species), *Turbo* (4 species), *Natica* (1 species), *Straparollus* (1 species), *Pleurotomaria* (4 species), and *Murchisonia* (2 species). The shell identified as *Paludina zwickaviensis* is non-Guadalupian, but *Turbonilla symmetrica* suggests *Macrocheilina modesta; T. phillipsi* and *T. altenburgensis* suggest *Loxonema inconspicuum;* and *Turbonilla roessleri* is more or less closely related to *Loxonema swallowianum*. *Turbo obtusus* is non-Guadalupian, but the three remaining species of this genus possess a superficial resemblance at least to certain of the forms which I have seen more or less reason for referring to *Pleurotomaria*. They do not show much resemblance to *Turbo?* sp. *Straparollus permianus* seems to have no related Guadalupian form. Geinitz's Pleurotomarias and Murchisonias are in part not figured and in part poorly figured, but most of the six species included in these two genera appear to have types more or less closely related in the Guadalupian.

From the Permian of England, King cites 19 gasteropod types, referred to the genera *Turbo* (5 species), *Rissoa* (3 species), *Loxonema* (3 species), *Macrocheilus* (1 species), *Euomphalus* (1 species), *Natica* (2 species), *Pleurotomaria* (4 species). The five species of *Turbo*, with one exception (*T. permianus*), have among the Guadalupian Pleurotomarias species of the same general character which may possibly prove on better knowledge more closely related than might be inferred from the present generic assignment. *Turbo mancuniensis* is also related to *Turbo?* sp. of the present work. The three Rissoas are probably non-Guadalupian. *Loxonema fasciatum*, but more specifically *Loxonema geinitzianum*, suggests the Guadalupian *Loxonema? inconspicuum*, while the imperfectly known *L. swedenborgianum* is comparable in a general way to *L. swallowianum*. The English species of *Macrocheilus*, *Euomphalus*, and *Natica*, however, appear to be without any closely allied form. The Pleurotomarias of the English Permian, while much less varied, have a few analogous forms in the Guadalupian, but on the whole it seems to me that only a moderate degree of relationship can be traced between the gasteropods of the two faunas.

From the south point of Spitzbergen, Toula cites an unidentified species of *Chemnitiza* and a small *Euomphalus*, neither of which is figured. From the cape between the two arms of North Fjord he cites *Pleurotomaria arctica* and an undetermined *Euomphalus*. The *Pleurotomaria* resembles *P. carinifera* of the present paper. Lundgren cites *Natica?* sp. and De Koninck a species of *Pleurotomaria* which he identifies as *P. verneuili*. This group accordingly appears to be rather sparsely represented in this Arctic fauna and to show no special relationship to the Guadalupian gasteropods. A much more extensive series was described by Toula from Nova Zembla, amounting in all to 22 species. The genera *Natica* (1 species), *Naticopsis* (1 species), *Chemnitzia* (2 species), *Loxonema* (1 species), *Euomphalus* (1 species), *Pleurotomaria* (5 species), *Murchisonia* (2 species), *Capulus* (3 species), and *Bellerophon* (5 species) are recorded. *Natica omaliana* more or less resembles *Naticopsis* sp. of the Guadalupian, but probably the *Naticopsis* has no corresponding form. *Chemnitzia hoferiana*, which alone of this genus is figured, suggests *Loxonema inconspicuum*, but *Loxonema brevis* is only remotely related to *L. swallowianum*. The single *Euomphalus* is not allied to the Guadalupian representatives of the genus. Such of the Pleurotomarias and Murchisonias as are figured show only slight relationship with Guadalupian species. Two of the species referred to *Capulus* are non-Guadalupian. The third is unfigured, while the fourth to some extent resembles *Naticopsis* sp. *Bellerophon hiulcus* and *B. decussatus* probably correspond to *B. crassus* and *Bucanopsis* sp., but *B. pulchellus* of Toula still more suggests the latter species. *B. carbonarius* is an unknown type in the Guadalupian.

Among his fossils from the West Sahara, Stache found only 2 species of gasteropods, one identified as *Pleurotomaria* sp. and the other as *?Straparollus* sp. cf. *permianus* King.

But few gasteropods are known from the Carboniferous of South America. Salter reported from Bolivia only a *Euomphalus* and a *Euphemus*, neither of which has allied forms in our fauna. From the same region D'Orbigny cited 5 species. *Solarium antiquum* and *Euomphalus perversus* are not especially close to the Guadalupian representatives of *Euomphalus*. *Pleurotomaria angulosa* is suggestive of *P. discoidea*, and *Natica buccinoides* and *N. antisiensis* are not closely related to the Guadalupian *Naticopsis*.

In the aggregate the American Pennsylvanian fauna shows a great diversity of gasteropod types, though as a rule in local collections they constitute one of the minor features. Rather in contrast to what was found in the Guadalupe Mountains, the Bellerophons are apt to be more common than the other gasteropods. In all, the Pennsylvanian fauna comprises over 150 species, distributed among 27 genera, but only a very few genera have 10 species or over. These are *Bellerophon* (including the groups *Euphemus*, *Patellostium*, etc.), *Loxonema*, *Murchisonia*, *Pleurotomaria*, and *Soleniscus*. On the other hand, 9 genera are represented by but a single species. All of these latter, together with some of the more extensively represented Pennsylvanian genera, are not known from the Guadalupe Mountains, but all those which in the typical Pennsylvanian areas are represented by numerous species occur also in the Guadalupian fauna. Among the more common Pennsylvanian types which are not known in the Guadalupian, mention may be made of *Euphemus*, *Patellostium*, *Capulus*, *Orthonema* (though some of the Guadalupian shells referred to other genera may belong there), *Sphærodomus*, and *Trachydomia*. In view of the fact that only *Patella* (1 species), *Warthia* (1 species), *Trochus?* (1 species), and *Pseudomelania* (1 species), are peculiar to the Guadalupian in this relation, it can not so much be said that this fauna is generically different from the Pennsylvanian as that it is less highly differentiated.

Perhaps in the case of two faunas so closely situated geographically, faunal differences are to be looked for rather in the degree of species than in that of genera, and I find that in only one instance have I been able to cite a Pennsylvanian gasteropod from the Guadalupian fauna. Although the faunal difference is thus strongly marked, the peculiarity of the Guadalupian fauna appears to me less noteworthy in the case of its gasteropod representation than in the case of its brachiopods. Very few of the Guadalupian gasteropods if they should be found in the Pennsylvanian fauna would appear especially alien to it, whereas if this should happen with very many of the brachiopods they would almost immediately be recognized as strangers. This may, however, be due to the fact that brachiopods are so much more abundant and completely known that their measure in the standard Pennsylvanian faunas may be said to be pretty well taken.

A considerable number of gasteropods have been described from the western areas of the United States, but they are too scattered geographically and stratigraphically to constitute in any sense what may as yet be spoken of as a fauna. The Guadalupian forms are as different from these, so far as known, as from the Pennsylvanian species.

Family PATELLIDÆ Carpenter.

Genus PATELLA Linnæus.

PATELLA CAPITANENSIS n. sp.

Pl. VIII, figs. 8 to 8b.

The typical and only known representative of this species is a small specimen having an elliptical aperture and a generally conical shape. The altitude is rather high and the apex about central. Length 5 mm., width 4 mm., height 3.5 mm. The surface is cancellated by radiating and annular liræ, of which the latter are distinctly finer. The radiating liræ are sometimes alternating and are more closely arranged on the ends than on the sides of the shell. On the ends they are separated by intervals nearly equal to those between the annular liræ. On the sides the intervals are considerably greater.

The generic position of this shell is a matter of some uncertainty, for I suppose that it might be a *Crania* nearly as well as a gasteropod. The rather strong elevation, the centrally situated and erect beak, and to some extent the sculpture are rather more suggestive of the gasteropod than of the brachiopod type. It seems probable, therefore, that the genus to which it belongs is *Patella* or a type closely related to it.

Horizon and locality.—Top of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2966).

Family PLEUROTOMARIIDÆ D'Orbigny.

Genus PLEUROTOMARIA Defrance.

Most of the Guadalupian shells referred to this genus are small, and to determine in them the presence of the characteristic slit band would require rather perfectly preserved material, so that the notch on the unbroken margin or the deflection of the growth lines could be made out. In the Guadalupian specimens these conditions are rather conspicuously lacking, since many of the forms are from the sandstone of the Delaware Mountain formation and are known only as molds of the interior, with which can be associated artificial impressions of the external mold. In many of the forms included under this title the presence of a slit band can be affirmed with some confidence, in others it is uncertain, and in still others it is rather doubtful. I suspect, therefore, that in addition to true representatives of the Pleurotomariidæ I may have included under this genus species which will subsequently find place among the Pyramidellidæ (or Pseudomelaniidæ), the Turbinidæ, the Trochonematidæ, or other families.

It may perhaps be asked why I did not withdraw the doubtful forms to the stations where my suspicions indicated that they should be placed. Several attempts to do so were in fact made, but in most cases it was possible to trace a connection, apparently a real connection, almost immediately into species in which the slit band was a fairly certain feature. It seemed best, therefore, to abandon such distinctions as I had sought to make, and to conclude that the data for a satisfactory or even a practicable treatment of these forms was not at hand. I would in fact have gladly relegated the investigation of them to another occasion, furnished, let us hope, with more adequate material, but that course was not seriously to be contemplated.

The genus *Pleurotomaria* in its broad sense has of recent years been greatly subdivided into generic or subgeneric groups. The Guadalupian shells referred to *Pleurotomaria* present certain broad variations which enable their separation into groups of related species, but if serious difficulties existed in the way of assigning these forms to the genus *Pleurotomaria* the determination of their subgeneric relationship was a still harder task, and only in the case of the more easily recognized *Euconospira* has it been attempted.

The classification of the Guadalupian Pleurotomarias which has commended itself to me, though at present it is only provisional, is as follows:

Group of *Pleurotomaria richardsoni*.

Pleurotomaria richardsoni.

Group of *Pleurotomaria carbonaria*.

Pleurotomaria mica.
Pleurotomaria multilineata.
Pleurotomaria putilla.

Group of *Pleurotomaria euglyphea*.

Pleurotomaria euglyphea.
Pleurotomaria? sp. c.

Group of *Pleurotomaria discoidea*.

Pleurotomaria discoidea.

Group of *Pleurotomaria strigillata*.

Pleurotomaria strigillata.
Pleurotomaria texana.
Pleurotomaria sp. d.
Pleurotomaria neglecta.
Incertæ sedis.

Group of *Pleurotomaria? arenaria*.

Pleurotomaria? arenaria.
Pleurotomaria? arenaria var. monolifera.
Pleurotomaria? planulata.
Pleurotomaria? cf. P.? planulata.

Group of *Pleurotomaria? delawarensis*.

Pleurotomaria? delawarensis.

Group of *Pleurotomaria? carinifera*.

Pleurotomaria? carinifera.
Pleurotomaria? carinifera var.

Group of *Pleurotomaria? elderi*.

Pleurotomaria? elderi.

It is the last four groups especially whose relationship to the Pleurotomariidæ is in doubt.

PLEUROTOMARIA RICHARDSONI n. sp.

Pl. VIII, figs. 9 and 9a.

This species consists of about four volutions. The spire is rather low, the body whorl occupying nearly two-thirds of the height. The exterior of the peritreme is divisible into three zones, on the basis of sculpture. The most prominent portion is a broad carina situated slightly above the peripheral line, on which was located the slit band. It is strongly elevated, defined above and below by distinct channels, the one beneath being somewhat the larger, and indented by a gentle sulcus. The two rims of the carina make sharp revolving liræ. The space between the channel which forms the upper limit of the carina, and the suture of the preceding volution, is convex and occupied by a row of large circular nodes, which are, however, lacking on the final portion of the body chamber. Below the carina the peritreme is also convex and is marked as far as visible by strong rounded liræ, about nine in number, separated by deep rounded sulci of approximately the same width. The volutions are embracing to the extent of concealing all of the revolving liræ except the uppermost—that which is just below the carina.

Height of typical specimen 6½ mm; diameter slightly less than 5 mm.

This seems to be one of the commoner gasteropods of the Capitan limestone, for although it did not occur in our earlier collections a small lot obtained by Mr. Richardson at a later date contained four or five specimens. It is closely allied to *Pleurotomaria subsinuata* Meek and Worthen of the Pennsylvanian. It is a much smaller form and differs in at least one detail rather markedly, since just below the suture it carries a single row of large nodes, while the Pennsylvanian form is represented as having a double row of small ones.

Horizon and locality.—Top of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2966). Delaware Mountain formation, southern Delaware Mountains, Texas (station 2964?). Delaware Mountain formation, Comanche Canyon, Glass Mountains, Texas (station 3763?).

PLEUROTOMARIA MICA n. sp.

Pl. VIII, figs. 12 to 12c.

This species is represented in our collection by a single specimen. Its size is extremely small, since it has a transverse diameter of but 3.5 mm., but the number of volutions (three) and the well-developed surface ornamentation indicate that it is nearly if not quite mature. The spire is low and the umbilicus probably partly closed. The band is concave and rather narrow. It is situated above the middle of the peritreme, perhaps one-third the way down from the suture. It is crossed by coarse transverse crenulations(?). Above and below the band the surface is traversed by fine, coarsely arranged, revolving liræ. The peritreme section is nearly circular, and each volution embraces the preceding one nearly up to the slit band.

This species belongs to the *carbonaria* group, and its nearest ally in the present fauna is *Pleurotomaria multilineata*. I am unwilling to refer it to that species, however, because the peritreme section is more nearly circular, the spire lower, the size much smaller, and the band crenulated. In shape it much resembles *P. beckwithana,* but the spire is lower and the band situated above the median line and crenulated. Of all the species known to me the lower Carboniferous *P. subglobosa* presents perhaps the closest resemblance. It has a lower spire and probably shows other differences which the figures alone of Hall's species do not permit me to distinguish.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926).

Pleurotomaria multilineata n. sp.

Pl. XXIII, figs. 25 to 25d.

Shell rather small. Spire low, consisting of four or five volutions. Umbilicus small, partly closed. Peritreme section generally transversely elliptical, somewhat flattened on the upper exterior side and concave on the upper interior side. The flattening produces a sort of angulation, beneath which is a shallow sulcus. This occupies a nearly median position and is apparently the slit band.

The surface is marked by a large number of fine revolving liræ. These are thin and sharp, with interspaces wider than the liræ themselves. One or two slender revolving lines can be seen on the slit band also. There are about seven above the slit band, and probably not less than 15 or 20 below it. They become much finer toward the umbilicus.

This species apparently belongs to the group which includes *Pleurotomaria broadheadi, P. beckwithana, P. carbonaria, P. newportensis,* and perhaps other American Pennsylvanian species; but it seems to be distinct from any yet described. *P. broadheadi, P. carbonaria,* and *P. newportensis* are larger species, and all have a higher spire, a somewhat differently shaped peritreme section, and more or less different ornamentation. As a rule the band is farther from the suture, and has many more liræ intervening.

Horizon and locality.—Delaware Mountain formation, Guadalupe Point, Guadalupe Mountains, Texas (station 2931).

Pleurotomaria putilla n. sp.

Pl. VIII, figs. 11 to 11b.

Shell very small. Spire high, consisting of five or six volutions. Umbilicus probably closed. Peritreme section nearly circular. Strongly concave on the upper inner side by reason of adjustment to the preceding volution; gently concave about halfway between the outer median line and the suture. Convex above and below. Surface marked by moderately distant, sharp, revolving lines. These do not become appreciably finer in the umbilical region, but are fainter and perhaps finer in the depressed portion of the peritreme above the peripheral line. I am not sure that this form possessed a slit band, but if so its position was probably in this region. I have observed nothing in the revolving liræ elsewhere that indicates that the spaces between them served this function.

This description was drawn up from the typical specimen, which was obtained near the middle of the Capitan limestone. An additional example has come to hand from the southern Delawares. If really belonging to different species these two specimens, in spite of certain minor differences, are so closely similar that a specific separation would under the existing evidence be quite unjustifiable. The position of the slit band, which is obscure in the typical specimen, is clearly shown in the other. It consists of a sulcus, rather large for the size of the specimen, situated well up from the peripheral line, not far below the suture. A gentle concavity and the absence of revolving liræ have been noticed in the typical specimen at about this position.

Of the species recognized in this report *Pleurotomaria? strigillata* is in general appearance one of the closest to the present form. The mere difference in size would appear in this case sufficiently great to be of importance, and this is further augmented by such differences as the position of the slit band above the peripheral line. The persistence in arrangement and size of the striæ of the smaller form seems also to mark a difference. This shell is probably a *Pleurotomaria* of the *carbonaria* type, but it is so similar to *Cyclonema leavenworthanum* of the St. Louis group of Hall that where the slit band is obscured it might almost be taken for the same species. I know of no upper Carboniferous form which calls for serious comparison.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926). Delaware Mountain formation, southern Delaware Mountains, Texas (station 2935?).

PLEUROTOMARIA EUGLYPHEA n. sp.

Pl. XXIII, figs. 22 to 23b.

Shell rather large. Spire low, consisting of five or six volutions. Umbilicus large, open. Peritreme section transversely oval; somewhat concave on the upper inner side. There is a median concave band whose position is peripheral. It is bounded above by a heavy, flat-topped revolving ridge, just above which, separated by a shallow depression, is a revolving line. The lower margin of the band is formed by an elevation which enters below into the regular curvature of the peritreme. The surface above the slit band is marked by more or less regular, transverse, angular folds, which are slightly convex and strongly inclined backward. Below the band the surface is marked by fine, somewhat crowded, revolving liræ and by equally fine transverse liræ, which appear to pass upward onto the band, and possibly also onto the ridge above it.

So far as I have been able to ascertain, this species has no closely allied forms in the upper Carboniferous of the United States. Perhaps the species most suggestive of it is *Pleurotomaria swallowiana* of the St. Louis group of Hall, but the resemblance is too slight and the difference of horizon too wide to occasion any possibility of their being confused. *P. valvatiformis* of the "Lower Coal Measures" also remotely suggests it, but the resemblance is slight, the Guadalupian form seeming in fact to be a nearly unique type.

Horizon and locality.—Delaware Mountain formation, Guadalupe Point, Guadalupe Mountains, Texas (station 2931).

PLEUROTOMARIA? sp. *c*.

This division is established for a small shell from the Capitan limestone preserved as an internal mold. The general shape is discoid. The diameter is 7 mm. and the height about 4 mm. The spire, which consists of four volutions, rises gradually about as in *Pleurotomaria euglyphea*, or a little less rapidly. The umbilicus appears to have been large and open. The peritreme section approaches the circular, but is wider than it is high. It is concave on its upper portion just inside the suture, owing to apposition with the preceding volution. The upper part of the peritreme exterior to the suture in mature volutions is flattened and inclined downward. The peripheral portion is also slightly flattened, its direction being nearly parallel with the axis, though slightly inclined away from it. The under portion, which is likewise somewhat flattened, slopes gradually upward to the axis. The specimen, which seems to be preserved as an internal mold, retains no striæ or other surface ornamentation and has no marked angulation. The flattened areas merge into one another, so that the peritreme seems at first sight to be round, and the specimen is suggestive of a small *Straparollus*, such as *S. quadrivolvis* of the St. Louis group of Hall. The rise of the spire, however, is distinctly greater than it is said to be in *S. quadrivolvis*.

Since all the upper Carboniferous euomphaloids known to me are complanate, it seems rather more probable that the present specimen was a *Pleurotomaria*, to which supposition the shape of the peritreme is not unfavorable, although no slit band can be seen in its present preservation. It may possibly be an *Omphalotrochus*.

Horizon and locality.—Base of Capitan formation, hill southwest of Guadalupe Point, Guadalupe Mountains, Texas (station 2906).

PLEUROTOMARIA DISCOIDEA n. sp.

Pl. VIII, figs. 13 to 13d.

Shell small. Spire low, consisting of three or four volutions. Umbilicus probably small and partly closed. Peritreme section transversely elliptical, somewhat pointed at either end. In the older portion of the peritreme, however, there is a tendency for the outer end to become inflated, broader than the interior, and with a flattened periphery. The inner superior surface is gently concave. The outer superior surface is gently convex near the suture and gently concave below. There is a median carina, which appears to bear a row of nodes. Below the carina the curvature is broad and regular to the subangular inner margin, but its lower limit is fixed by a rather narrow sulcus, which probably carries the slit band. The surface above the carina appears to have been fairly smooth. That below it, including the sulcus, is marked by somewhat indistinct closely arranged revolving lines.

I know of no species with which this can profitably be compared.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926).

PLEUROTOMARIA STRIGILLATA n. sp.

Pl. XXIV, figs. 21 and 21a.

Shell of medium size. Spire high, consisting of six or seven volutions. Umbilicus small (?). Peritreme section concave on the inner superior side; otherwise nearly circular.

Surface marked by rounded revolving channels separated by sharp and slender ridges. The median channel is larger than the others, and along its center runs a sharply elevated line. Below the median one occur about thirteen others, which become increasingly narrow toward the umbilicus. The sculpture of the upper part of the peritreme to the suture seems to consist of three rather large channels, with thin, sharp intervening ridges. The lowest of these, that just above the median channel, probably represents the slit band, for here the growth lines are stronger than over the rest of the surface and have a concave or reentrant direction. Elsewhere they are faint and transverse or convex. Just below the suture there was developed a row of elongated nodes. There are traces of these on the typical specimen, which is defaced at this point, and they form a prominent feature of other associated specimens probably belonging to the same species.

Like some other Guadalupian types, this has species in the American upper Carboniferous allied to it, but I have found none with which it can with propriety be identified. Among the similar forms may be mentioned *Pleurotomaria giffordi*, *P. humerosa*, and *P. subsinuata*, of which *P. humerosa* is by far the nearest. *P. humerosa* shows, however, a lower spire and has the revolving ridges somewhat differently arranged.

Horizon and locality.—Delaware Mountain formation, Guadalupe Point (station 2931 ?); basal black limestone, Guadalupe Point (stations 2920 and 2967), Guadalupe Mountains, Texas.

PLEUROTOMARIA TEXANA n. sp.

Pl. XXIX, figs. 17 to 17c.

Shell small, consisting of about five volutions. Spire moderately high, approximately equal to the height of the body whorl. Umbilicus rather large and open. Peritreme section nearly circular and marked by a number of high, thin revolving liræ. The slit band apparently occupies a deep, broad sulcus, which traverses the peripheral line and is divided by a raised median lira, smaller in every way than those on the rest of the surface. Above the slit band and sulcus three of the liræ are found, and below, seven. The channels which divide the uppermost lira from the suture on one hand and from the second lira on the other are wider than those between others of the liræ.

Pleurotomaria texana recalls *P. strigillata* more than any other Guadalupian species, and is distinguished chiefly by the much lower elevation of the spire. It also recalls *P. richardsoni* in its general proportions, but the details of the sculpture are so distinct that it is hardly necessary to point out the differences. Among Pennsylvanian species, *P. humerosa* is probably the most closely related. *P. texana* differs from it in the arrangement of the liræ, which cover all the surface and of which one on the peripheral line is more or less atrophied.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

PLEUROTOMARIA NEGLECTA n. sp.

Pl. VIII, figs. 10 to 10c.

Shell small. Spire moderately high, consisting of about five volutions. Umbilicus probably closed. Peritreme section nearly circular, except for deformation resulting from apposition with the preceding volution. Surface marked by revolving sulci, separated by angular liræ. One of the former, distinctly wider and deeper than the others, occurs just below the peripheral line, and probably represents the slit band. Below the slit band are five or six relatively coarse revolving liræ, and above it about the same number of finer, less distinct ones.

This species is manifestly related to *Pleurotomaria strigillata*, and I hesitated considerably about separating them. In view, however, of the widely different horizons which they hold, and certain differences which appear to exist between them, it did not seem desirable to group both under one specific name. Shells of the present species having the same number of volutions are much smaller than *P. strigillata*, and the spire is perhaps a little more depressed. The slit band is slightly lower, and is not divided by a median line. The striæ above and below the band are relatively more heavy. The ornamentation of the smaller form, however, is very fine, and, especially above the band, is not clearly shown by my specimens. While it is possible that a complete knowledge would do away with some of the differences noted, I believe it would indicate still others and establish a specific distinction.

This form also resembles *Pleurotomaria putilla*, but it is much larger, has a somewhat more rapidly expanding spire, a distinct slit band, and relatively much coarser revolving liræ.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926).

PLEUROTOMARIA sp. *d*.

Shell rather small. Spire high, consisting of about five volutions. The peritreme section is in general nearly circular, but is concave on the upper portion inside the suture conforming to the previous volution. There is a broad, well-defined, flattened or more or less concave revolving band, whose center is on or perhaps a little below the peripheral line and whose direction is nearly parallel to the axis. This is probably the characteristic slit band. The distance between the upper limit of this zone and the suture is nearly twice as great as the width of the zone itself and the shell there is distinctly flattened. Each whorl embraces the preceding one so far that the width of the peripheral band is greater than the distance between its lower edge and the suture of the embracing volution. This lower portion also may be flattened or slightly concave. The whole surface is marked by sharp, slender, rather distant revolving lines. Two prominent ones, close together, on the upper margin of the peripheral zone may contain between them the slit band.

This form in some ways resembles *Pleurotomaria multilineata*, but is much more tapering. It has some points in common with *P.? arenaria*. It is more tapering than that species also, and has a much more nearly circular peritreme section. The closest species, however, is *P. delawarensis*. The only prominent difference is that the present form has not a revolving groove below the broad vertical band.

Horizon and locality.—Delaware Mountain formation, Guadalupe Point, Guadalupe Mountains, Texas (station 2931).

Pleurotomaria? arenaria n. sp.

Pl. XXIII, figs. 26 and 26a.

Shell of medium size. Spire rather high. Umbilicus probably small, possibly deep. Peritreme section approaching the hexagonal. Upper exterior face gently concave, sloping downward. Lateral face gently concave, parallel to the axis. Upper interior surface concave, sloping downward. The remainder of the perimeter is completed by a semicircular curve. The external suture is at or a little below the lower limit of the vertical or lateral face, the lateral outline of the spire showing a series of steplike descents, the upper surfaces sloping downward and the angles well marked. The junction of the upper and lateral faces on the exterior is marked by a fairly prominent carina, and another carina less strong and less persistent marks the junction of the lateral and lower faces.

The upper exterior face is crossed by sharply elevated, threadlike revolving liræ, of which there were about eight or ten. Those near the suture are stronger and more distant from one another than the lower ones, and are strongly nodulose, the corresponding nodes on adjacent liræ sometimes being connected, so that prominent though short-lived ribs are formed extending downward from the suture. The lateral face carries about four revolving liræ, with apparently a low lira midway between each two more elevated ones, and the lower surface was probably traversed with rather coarse revolving lines.

This species is found in moderate abundance in the sandstones of the Delaware Mountain formation, from which the typical specimen was derived. A similar form occurs also in the black limestone beneath, but it appears to be a distinct variety.

Pleurotomaria? arenaria shows some points of resemblance with *P. brazosensis*, *P. marcouiana*, *P. grayvillensis*, and *P. subconstricta*, but I have not been able to find among the described American species any one with which it can be identified. It possibly belongs to the group of Pleurotomarias for which the term *Phanerotrema* has been proposed; but the height and irregular outline of the spire are rather foreign to that genus. Further than this its generic position is uncertain.

This species appears to be closely related to *Pleurotomaria strigillata* of the underlying black limestone, and it is not always easy to distinguish specimens, which are usually presented in the form of molds. The two forms are, however, believed to be distinct. The present form is more strongly carinate and has fainter and finer revolving liræ and less distinct transverse ribs descending from the suture. By analogy with *P. strigillata* the slit band, if present, is situated not on the principal carina, but just above it.

Horizon and locality.—Delaware Mountain formation, Guadalupe Point, Guadalupe Mountains, Texas (station 2931).

PLEUROTOMARIA? ARENARIA var. MONOLIFERA n. var.

This variety occurs in the same beds as *Pleurotomaria strigillata,* but though resembling it to some extent appears to be more nearly related to *P.? arenaria.* The revolving liræ are perhaps a little stronger, the elongated ends or short wrinkles which descend from the suture are apparently absent, while the upper carina is ornamented by a row of strong nodes or tubercles.

My material of this variety is hardly suitable for illustration, but apparently shows the characters mentioned so unmistakably that it has seemed best to discriminate it under a distinct varietal name. Analogizing *P.? arenaria* with *P. strigillata* I was led to conclude that the zone immediately above the upper carina was the most probable position for the slit band in the latter species. If the present variety is indeed closely related to *P.? arenaria,* the occurrence of the row of nodes on the carina is hardly compatible with the occurrence of the slit band also on that feature, and to a certain extent supports the belief that it follows along its upper margin.

Horizon and locality.—Basal black limestone, Guadalupe Point, Guadalupe Mountains, Texas (station 2920).

PLEUROTOMARIA? PLANULATA n. sp.

Pl. XXIII, figs. 27 to 27c.

Shell rather small. Umbilicus closed (?). Spire low, consisting of about three volutions. Peritreme section in the mature portion subtriangular. The upper surface is broad, flattened, and nearly horizontal. The lateral portion is gently convex, nearly parallel to the axis. Its junction with the upper surface is formed by an angulation, and a similar sudden change of direction accompanies its return to the axial line. The lower surface consists of an area which is nearly parallel to the upper surface, and one which toward the axis has a more rapid upward direction. The inner portion of the upper surface is somewhat impressed by the volution against which it lies.

The upper and the lower surfaces are marked by heavy, sharp, rather distant revolving ridges, of which six or seven occur on the upper and probably an equal or somewhat greater number on the lower. The lateral portion is traversed by two, possibly three, revolving sulci, of which the lowest is indistinct. By these it is divided into four (or possibly but three) large rounded liræ, inclusive, of course, of those which bound it above and below.

Of the Guadalupian species thus far discovered, this in a general way most resembles *Pleurotomaria discoidea.* It can readily be distinguished, however, by its different peritreme section (especially because it has a flattened peripheral portion), and its heavier revolving liræ, which have, moreover, a different arrangement. Its real relations are probably with *P. arenaria,* although its much lower spire gives it at first an altogether different appearance. I know of no Pennsylvanian species with which it is likely to be confused.

Horizon and locality.—Delaware Mountain formation, Guadalupe Point, Guadalupe Mountains, Texas (station 2931).

Pleurotomaria cf. P. ? planulata.

Under this title is included a small and imperfect specimen from the southern Delawares which in general appearance is very similar to *Pleurotomaria planulata.* The spire is a little more elevated and the angle between the upper and lateral surfaces less rounded. The chief distinction, however, is found in the fact that the specimen under consideration, which I see no warrant for calling an internal mold, is without revolving liræ. Traces of the liræ are distinct on the typical specimen, which is certainly an internal mold in sandstone. Were it not for the apparent lack of sculpture upon the present specimen it might be provisionally identified as *P. planulata.*

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

Pleurotomaria? delawarensis n. sp.

Pl. XXIII, figs. 28 to 30.

Shell small. Spire high, consisting of about six volutions. Umbilicus probably small. Peritreme section subpolygonal, with flattened peripheral surface. Slightly inflated just below the suture, then gently concave to the first angulation or carina. This is followed by a rather broad concave band, succeeded by a second carina. The second carina is followed by another, somewhat narrow concave band, then a third angulation, indistinct on its lower side, after which the convexity is regular to the upper interior surface, where it is strongly concave. The upper exterior portion slopes rapidly downward, the two sulci on the lateral surface being nearly parallel to the axis. The suture of each whorl with that which succeeds it, seems to fall on or a little below the line of the third carina. A little below the suture a strongly raised revolving line is found, and another just a little above the first carina. In each of the two lateral sulci one or two fine liræ appear to be developed, while a considerable number of similar ones appear on the lower portion. The slit band, if present, may have been situated just above the upper carina, between the latter and the revolving line which follows immediately above. This, however, is merely a surmise.

In many ways this form may be looked at as a lofty variety of *Pleurotomaria? planulata,* which is probably its nearest related Guadalupian species.

Pleurotomaria? delawarensis appears to have no very close allies in the American "Coal Measures," except perhaps among those species which can not be handled to advantage until they have been authoritatively figured.

Horizon and locality.—Delaware Mountain formation, Guadalupe Point, Guadalupe Mountains, Texas (station 2931).

Pleurotomaria? carinifera n. sp.

Pl. XXIII, figs. 24 to 24b.

Shell rather small. Spire moderately high, consisting of four volutions. Umbilicus probably small or closed. Peritreme section somewhat rhombic. There is a large, high carina situated slightly above the median line. Immediately above and below the carina lie broad, shallow sulci, the surface resuming its convex curvature toward the axis in both directions, so that both external surfaces have a sigmoid curve in cross section. The upper inner side is strongly concave and the remainder of the surface around to the sulcus below the carina nearly regularly curved. The surface, so far as known, is without revolving liræ.

This species is quite distinct from any of the other Guadalupian forms, nor can I find anything in the Carboniferous faunas of the Mississippi Valley with which it is necessary to make comparison. It seems to be nearest allied to *Pleurotomaria discoidea*, found in the Capitan limestone, but has a higher spire, a stronger carina, and a more gibbous peritreme section. It is also without revolving liræ.

Horizon and locality.—Delaware Mountain formation, Guadalupe Point, Guadalupe Mountains, Texas (station 2931).

PLEUROTOMARIA? CARINIFERA var.

Pl. XXIX, fig. 19.

This variety is represented by a single imperfect specimen apparently closely related to *Pleurotomaria carinifera*, but how near, or to what degree the differences are constant and important, it is impossible at present to determine. Like the typical specimen of *P. carinifera*, that under consideration is an internal mold, but while the other was a mold in sandstone the present one is a mold in limestone. The number of volutions and the elevation of the spire can not be determined, but the spire may have been a little more elevated than in the typical variety. The peritreme section in its essential particulars is the same in both, but in the present specimen the carina is much more angular and defined above and below by much fainter sulci. In fact the surface above the carina is nearly flat and but slightly sigmoidal. Below the carina there is a broad and very slight depression, separated by an extremely faint angulation from the regular convexity of the lower portion.

On an unexfoliated fragment of the shell near the suture line are preserved two widely spaced, narrow though very slightly elevated revolving liræ, and possibly other portions of the surface were similarly ornamented. While no revolving lines have been preserved on the single external mold of *Pleurotomaria? carinifera* thus far found, I am not altogether satisfied that they were entirely absent.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (station 2964).

PLEUROTOMARIA? ELDERI n. sp.

Pl. XXIX, fig. 18.

This type is represented by a single small individual which has a height along the axis of about 6 mm., though the rather large oblique aperture increases the total length appreciably. The spire is gradually tapering and the apical angle is about 45°. There are about seven volutions. The umbilicus is closed. The peritreme section is nearly circular. A revolving sulcus, broader than any others which traverse the surface, probably marks the position of the slit band. It is situated about on the median line. Above the sulcus, between it and the preceding suture, occur three rather prominent revolving liræ. These and the one which forms the lower limit of the sulcus made by the slit band are rather strongly and relatively coarsely nodose. The upper one is smaller than the others and relatively widely distant from them. The lower portion of the peritreme is marked by five or six revolving liræ, which probably diminish in size and prominence, leaving the lowest parts almost smooth.

This form appears to be distinct from any of the other Guadalupian species. It is possible that it does not possess the characteristic slit band of *Pleurotomaria* and that its relations may be with an altogether different genus. *Pleurotomaria? elderi* is somewhat on the general plan of the Pennsylvanian Murchisonias, but differs from any species known to me from the Pennsylvanian, whether belonging to that genus or not.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

Genus EUCONOSPIRA Ulrich.

EUCONOSPIRA OBSOLETA n. sp.

Pl. VIII, figs. 14 to 14b.

Shell large, spire low, consisting of four or five volutions, or possibly more. Umbilicus rather large. Peritreme rhombic in section. The upper external surface gently convex and sloping downward. The upper internal surface gently concave and sloping downward. The lower surface at first sloping downward and later resurgent. Slit band narrow, peripheral, distinct, not concealed by succeeding volutions, though the suture occurs immediately below.

Surface nearly smooth. Entirely without revolving lines, but having faint, regular, transverse liræ. These are rather coarse, though obscure on the upper surface, where they are gently convex and swung strongly backward from the suture. On the under side they are minute, regular, and resemble growth lines. Here also they are directed backward from the slit band, but are several times gently flexed.

While this species agrees in many of its characters with *Euconospira*, I doubt if it is correctly referred to that genus. Its general expression rather recalls a much earlier type—the genus *Liospira*. The absence of revolving striæ and the comparatively large umbilicus are distinctly alien to *Euconospira*. Nevertheless I feel hardly justified in referring this species to *Liospira*, which seems to have become extinct long before Carboniferous time, and its real affinities in the Pleurotomariidæ are still a matter of doubt.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926).

Euconospira halliana Shumard.

1859. *Pleurotomaria Halliana.* Shumard, Trans. Acad. Sci. St. Louis, vol. 1, p. 399 (date of volume, 1860).
White [Permian] limestone: Guadalupe Mountains.

Shell depressed, conical, tapering rapidly to the apex; spire short; spiral angle 90°; volutions five or six, convex, slightly depressed below the middle and gently expanding at base; last volution occupying more than half the total length, gibbous, its exterior edge sharply carinated, under surface flattened convex; umbilicus deep infundibuliform; form of aperture unknown.

The under surface of the body volution is marked with several sharp revolving, threadlike lines; other surface markings unknown.

Resembles in general form *P. Verneuilii* of Geinitz.

Dimensions.—Length, 0.35; width, 0.38.

Locality.—White limestone, Guadalupe Mountains.

This species, Shumard's description of which is quoted above, has not been recognized among the more recent collections from the Guadalupe Mountains, and is probably distinct from *Euconospira* sp. from the southern Delawares.

Euconospira sp.

This species is represented by a single specimen having a somewhat broadly conical shape. The basal diameter is 5½ mm., the height 4 mm. or a little over. The base is rather strongly concave. The sloping external side of each volution is gently convex, and consequently the suture is slightly depressed. The lateral surface of the peritreme is marked by seven moderately coarse, strong, revolving liræ. The same sort of sculpture appears to extend to the introverted basal portion. The position of the slit band has not been observed, but it probably lies on the angle between the basal and lateral areas of the peritreme.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (station 2935).

Genus MURCHISONIA D'Archiac et De Verneuil?.

Murchisonia is often employed to include the high-spired slit-bearing spiral gasteropods, just as the low-spired species are distinguished as *Pleurotomaria* in the broad sense. While to a certain extent convenient, this is hardly a satisfactory way to divide that extensively diversified group; and, furthermore, if restricted to its typical species *Murchisonia* represents a type which is very different from most of the forms referred to it and which, without having seen specimens, I would be disposed to doubt as belonging with *Pleurotomaria* at all.

The shells for which the name *Murchisonia* is here used are very different from typical *Murchisonia,* and my only excuse for employing that term for them is that they are different from the Guadalupian Pleurotomarias, that they are doubtfully slit-bearing, and that others have used *Murchisonia* in the same sense.

Murchisonia? sp. *a*.

Pl. XXIX, fig. 20.

Under this title are included two small specimens, the larger of which has a length of 8 mm. and a diameter below of a little over 2 mm. The shape is thus very slender and tapering and consists of about eight volutions. The most obvious feature is a very prominent rounded carina, which seems to occupy a median position on the outer periphery of the peritreme. Aside from this the lateral surface is much flattened and the volutions so closely joined that they appear to form a continuous elongated cone. Between the recurrences of the carina the surface is marked by fine liræ, of which there appear to be five or six. The umbilicus is closed. So far as I can make out from the material at hand, the lower half of each volution, which is rounded and of some height, is enveloped by the succeeding one as far as the carina.

This species resembles *Murchisonia terebra* probably more than any other American species, but is clearly distinct from it. There is no closely related form in the Pennsylvanian, so far as I am aware.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

MURCHISONIA? sp. *b*.

The material representing this form is very imperfect, and I can do no more than make a brief mention of it. In a general way it is similar to the foregoing, but is less gradually tapering. The height is 5 mm. and the diameter at the base is 2 mm. The volutions number four or five. There appears to be a well-marked carina, as in *Murchisonia?* sp. *a;* but the other characters of sculpture are unknown. Not only is the spire in the present form less elevated, but the lower portions of the whorls are more prolonged.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

Family BELLEROPHONTIDÆ McCoy.

Genus BELLEROPHON Montfort.

BELLEROPHON CRASSUS Meek and Worthen.

Pl. XXIX, fig. 16.

1860. *Bellerophon crassus.* Meek and Worthen, Proc. Philadelphia Acad. Nat. Sci., p. 458.
Lower "Coal Measures:" Pittsburg, St. Clair County, Ill.

1866. *Bellerophon crassus.* Meek and Worthen, Rept. Geol. Survey Illinois, vol. 2, p. 385, pl. 31, figs. 16a, 16b.
Lower "Coal Measures:" Pittsburg, St. Clair County, Ill.

1875. *Bellerophon crassus.* White, Rept. U. S. Geog. Survey W. 100th Mer., vol. 4, p. 157, pl. 12, fig. 1a. (Whole volume published in 1877.)
Carboniferous: Camp Cottonwood, near Spring Mountain, Nev.

1884. *Bellerophon crassus.* White, Thirteenth Rept. Geol. Survey Indiana, p. 157, pl. 33, figs. 1, 2.
Upper "Coal Measures:" Sullivan and Posey counties, Ind.

1886. *Bellerophon crassus* (var.)? Heilprin, Ann. Rept. Second Geol. Survey Pennsylvania for 1885, p. 457.
Upper "Coal Measures:" Mill Creek limestone, Wilkesbarre, Pa.

1886. *Bellerophon crassus* (var.)? Heilprin, Proc. and Coll. Wyoming Hist. and Geol. Soc., vol. 2, pt. 2, p. 277.
Upper "Coal Measures:" Mill Creek limestone, Wilkesbarre, Pa.

?1887. *Bellerophon* (cf. *crassus*). Herrick, Bull. Sci. Lab. Denison Univ., vol. 2, p. 20, pl. 5, fig. 6.
"Coal Measures:" Flint Ridge, Ohio.

1891. *Bellerophon crassus.* White, Bull. U. S. Geol. Survey No. 77, p. 26.
Permian: Military Crossing, Baylor County, Tex.

1895. *Bellerophon crassus.* Keyes, Rept. Missouri Geol. Survey, vol 5, p. 151, pl. 50, figs. 1a, 1b. (Date of imprint 1894.)
Upper "Coal Measures:" Kansas City and Lexington, Mo.

1896. *Bellerophon crassus.* Smith, Leland Stanford Junior Univ., Publ. Cont. Biol. Hopkins Seaside Lab., No. 9, p. 39.
Lower "Coal Measures:" Conway County, Ark.

1896. *Bellerophon crassus.* Smith, Proc. Am. Phil. Soc., vol. 35, p. 249.
Lower "Coal Measures:" Conway County, Ark.

1897. *Bellerophon crassus.* Ulrich, Final Rept. Geol. Nat. Hist. Survey, Minnesota, vol. 3, pt. 2, p. 853.
"Coal Measures."

1899. *Bellerophon crassus.* Girty, Nineteenth Ann. Rept. U. S. Geol. Survey, pt. 3, p. 592.

1903. *Bellerophon crassus.* Girty, Prof. Paper U. S. Geol. Survey No. 16, p. 468.
Hermosa and Rico formations: San Juan region, Colo.
Maroon formation: Crested Butte district, Colo.
Weber formation and Robinson limestone: Leadville district, Colo.

In spite of differences in the associated fauna so great as to establish an a priori probability that the form under consideration is distinct from that which is found in the Pennsylvanian of the Mississippi Valley, I do not feel justified from the evidence in hand in referring it to a different species. It is true, however, that Bellerophons of this type seem to possess few lines of differentiation and that we find species very closely similar to one another occurring at the widest geographical intervals and at very different horizons in the Carboniferous

In the case of the Guadalupian material our collections contain but three specimens, only one of which is in a fairly perfect state of preservation. The outer surface is very regularly arched and the aperture is almost exactly twice as wide as high, having an elliptical shape with broadly curved ends. The slit band is narrow, about 1 mm. wide or a little more, and considerably elevated and rounded. The surface is marked by rather strong, regularly arranged, sublamellose transverse liræ, which are slightly curved, with the convex side forward. They are nearly transverse and perpendicular to the slit band, only very slightly bending backward in its vicinity. In crossing the slit band they are as strongly elevated as on the lateral areas. About nine occur in a distance of 5 mm.

Bellerophon crassus is not a very rare species in the typical Pennsylvanian, but well-preserved specimens are seldom to be had, the ordinary method of occurrence being as internal molds. I have had but a limited number of specimens with which to compare the Guadalupian forms, but such as have been seen indicate a considerable range of variation, part of which is without much doubt a matter of maturity in the specimens. The shape seems to be fairly constant, though the external curvature is perhaps more broadly rounded in mature and more acutely arched in young individuals. In some specimens the transverse liræ are nearly perpendicular to the slit band; in others they are more oblique to it or make a deeper reentrant angle in the outline of the lip. The slit band is apt to be depressed, especially in older specimens, but it may be fairly elevated and rounded. It is sometimes nearly smooth and at others crossed by lamellæ equally with the sides.

The Guadalupian form, unless it develops similar variations, which I have no means of ascertaining, differs from certain forms of *B. crassus* in having the slit band more elevated and crossed by strong sublamellose liræ and in having the liræ and growth lines more directly transverse. From other specimens it presents no appreciable differences which I have been able to ascertain.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (stations 2935 and 2964).

Genus BUCANOPSIS Ulrich.

BUCANOPSIS sp.

Pl. XXIII, figs. 14 to 14b.

Bellerophons, belonging apparently to the genus *Bucanopsis*, are not rare in the Guadalupian fauna, but so far none has been obtained except in the Delaware Mountain formation. The fossils from this horizon, especially the gasteropods and pelecypods, are preserved as molds in such a manner that often, probably through compression, external sculpture is retained more or less clearly upon the internal mold. This is the condition of the Bellerophons under consideration. Their external characters are seldom, if ever, clearly shown upon the internal mold, however, and I find on examination that an inadequate number of external molds have been preserved to properly study this group. Nevertheless, two very distinct species have been discriminated, one of which, that at present under consideration, appears to belong to the genus *Bucanopsis*. It has a broad flattened dorsum and large open umbilici. The aperture flares but slightly and is indented above by a deep notch. The slit band is slightly elevated and rather broad. The surface is marked by very numerous fine revolving liræ, separated by intervals wider than themselves. No transverse decussating liræ have been observed, yet the revolving liræ have a nodose appearance and may, in fact, consist of rows of small elevations instead of continuous lines.

Horizon and locality.—Delaware Mountain formation, Guadalupe Point, Guadalupe Mountains, Texas (station 2931).

Genus WARTHIA Waagen.

WARTHIA AMERICANA n. sp.

Pl XXIII, figs. 15 to 17b.

This species is a narrower form than the foregoing, and the larger specimens obtained are considerably smaller. In young examples, especially, the dorsum is pointed or helmet-shaped. The shell does not appear to have been much expanded at the sides, and the umbilici were probably closed. The aperture was strongly emarginate above, the reentrant angle terminating in a not very distinct notch.

The surface appears to have been devoid both of transverse and revolving liræ and of a slit band. No trace of sculpture or slit band can be found on either external or internal molds. Furthermore, a small silicified specimen from the southern Delawares, which probably belongs to the same species and without much doubt to the same genus, also presents only a smooth surface to the eye, without either liræ or band.

It seems very probable, therefore, in spite of the unsatisfactory preservation of my specimens, that we have here a form which departs widely from the type of Bellerophons common in our Pennsylvanian faunas. I think that it can with reasonable assurance be assigned to Waagen's genus *Warthia*. It seems to differ from *Mogulia*, which also is without a slit band, in having the outer lip with a deep angular notch and the surface smooth instead of crossed by heavy transverse bands.

Of the Indian Warthias the present species most resembles *W. polita*, but is still narrower. It is rather more closely allied to the form from New South Wales originally described as a *Bellerophon*, but subsequently placed by De Koninck under *Goniatites* because he could find no slit band. This species, *Bellerophon micromphalus*, will probably prove to be a *Warthia*. *W. americana* appears to have a relatively wider aperture and to be more expanded near the umbilici.

Mention has already been made of a small specimen from the southern Delawares which probably belongs with *Warthia americana*. It differs somewhat distinctly being more flaring at the sides in the umbilical region, but as probably all the specimens from Guadalupe Point are more or less broken, particularly on the most projecting portions, I am disposed to believe that the best of them more or less misrepresents the shape of the aperture. A relatively small amount broken from the shell as it projects near the umbilici would cause an appreciable difference in the outline.

Horizon and locality.—Delaware Mountain formation, Guadalupe Point, Guadalupe Mountains, Texas (station 2931). Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969?).

Family EUOMPHALIDÆ De Koninck.

Genus EUOMPHALUS Sowerby.

EUOMPHALUS SULCIFER n. sp.

Pl. XVI, figs. 23 to 24a.

Shell rather small, nearly complanate, consisting of four or five volutions. Upper surface almost flat or slightly concave, lower surface moderately concave.

The upper surface of the peritreme is generally flat. Near the outer margin it is abruptly indented by a deep, narrow sulcus, the marginal portion of the upper surface forming a strong carina, which has, however, a nearly vertical direction. The suture is well defined. Peripherally the peritreme is flattened and inclined inward from the upper rim. It seems to bear in the older whorls a shallow indistinct depression. The under side is more convex than the upper and converges with it in the direction of the axis. The peripheral rim is somewhat angulated and just within the angulation runs a shallow groove. The under side of the peritreme therefore resembles the upper, but with characters less strongly marked. These modifications of the surface are, however, nearly all due to thickening of the shell, the internal sections being to all intent circular. The surface is also marked by rather strong transverse lines and toward the aperture by indistinct, more or less regular annulations.

I have assigned this species to *Euomphalus*, though it seems to display many transitional characters to the genus *Discohelix*.

Euomphalus sulcifer and the variety next to be described are quite different from any known Pennsylvanian representatives of the genus.

Horizon and locality.—"Dark limestone," Pine Spring (station 2930); basal black limestone, Guadalupe Point (station 2920), Guadalupe Mountains, Texas.

EUOMPHALUS SULCIFER var. ANGULATUS n. var.

Pl. XVI, figs. 25 and 25a.

This variety is distinguished from the shell figured on the same plate. It differs from the normal type by having the channel which traverses the upper surface of the peritreme expanded and bounded on its inner side by a sharp carina, the inner upper portion of the peritreme being concave. This channel also slopes downward so that the peripheral carina, instead of being vertical, is directed more nearly outward.

The variety *angulatus* has the appearance of being very distinct from *Euomphalus sulcifer*, to which at the same time it is obviously related. My series of specimens, being rather limited, does not permit me to determine how far the two types pass into one another, and I have described the second merely as a variety of the first.

There seems to be little danger of confusing these forms with any known species of *Euomphalus* or *Straparollus*. The only one known to me which resembles them at all closely is *E. exortivus* Dawson, from the Carboniferous limestone of Nova Scotia. Dawson's species is rather nearer the variety *angulatus*, but the wide difference in geologic age and the sharp angular carina of the Guadalupian form serve as adequate distinctions.

Horizon and locality.—"Dark limestone," Pine Spring, Guadalupe Mountains, Texas (station 2930).

Family TURBINIDÆ Adams.

Genus TURBO Linnæus.

TURBO GUADALUPENSIS Shumard.

1859. *Turbo Guadalupensis*. Shumard, Trans. Acad. Sci. St. Louis, vol. 1, p. 398 (date of volume, 1860). Dark [Permian] limestone: Guadalupe Mountains.

Cast elongate ovate; spire conical, tapering more gradually to the apex than we usually find in species of this genus; spiral angle, 470; volutions four or five, moderately convex, last one slightly ventricose, longer than the spire; suture linear, distinct; aperture ovate (?); surface marked with numerous obscure, closely set, revolving lines, which are wider than the spaces between.

Dimensions.—Length, 0.85; width, 0.48.

The collection contains merely a single finely preserved cast of this species. In general form, it resembles some of the recent species of *Limnæa*.

Locality.—Dark limestone, Guadalupe Mountains.

The above is Shumard's description of this species, which appears not to have been obtained in the more recent Guadalupian collections.

TURBO? sp.

This type is represented by a single imperfect specimen having much the proportions and general appearance of *Pleurotomaria richardsoni*, but with somewhat different sculpture and apparently without a slit band. The body whorl occupies over half the entire height. The spire is rather low and the umbilicus closed. The outer half of the peritreme section may be compared to a similar portion of a regular hexagon. A deep channel traverses the median line, bounded above by a carina which for the size of the shell is strongly elevated and broadly rounded. The carina corresponds in position to the carina of *Pleurotomaria richardsoni*, but instead of being flattened on top and bearing the slit band, it is sharply rounded and marked by coarse and somewhat oblique crenulations. The carina is followed above by a strong sulcus, between which and the suture appears to be a raised band with vertically elongated nodes. A carina nearly equal to that above the median sulcus defines its lower limit, beneath which are about four strong liræ diminishing in size and prominence toward the axis. Part of the lower portion, and probably the whole, is crossed by moderately coarse, strong, sharply elevated, oblique liræ, probably continuous with the crenulations on the top of the carina.

This form, of which the principal characters, so far as shown by my not very perfect specimen, have been hastily sketched above, is clearly distinct from *P. richardsoni*, though much resembling it in a general way. It is possible, however, that it may be one of the Pleurotomarias, though this seems at present less probable.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

Family TROCHIDÆ Adams.

Genus TROCHUS Linnæus.

TROCHUS? sp.

From the white limestone of the Capitan formation has been obtained a single specimen, very imperfect, which at the same time differs strongly from any of the forms described from this horizon and yet is too imperfect to establish as new. The spire was high, but the approximate number of volutions can not be ascertained. The diameter of the largest whorl is 5 mm. and its height about 2.5 mm. The under side of the peritreme is flattened and slightly inclined downward from the axis, causing the lower side of the shell to be slightly concave. The lateral surface of the peritreme is distinguished from the basal by an acute angulation, and is itself slightly dihedral. The lower half is nearly flat, not quite parallel to the axis, but inclined toward it. The upper half is also nearly flat and inclined to the axis at an angle of about 45°. The union of the two surfaces is marked by a sharp revolving ridge, between which and the basal angulation another sharp ridge is found with an intermediate position. The lower half of the lateral surface of the peritreme, therefore, appears to be marked by three nearly equal revolving angular liræ.

No other surface ornamentation has been preserved besides the three ridges, and it is uncertain whether or not either of the two depressed bands between them functioned as a slit band. I am very doubtful about this species belonging to the Pleurotomarias, and it seems at present to be more nearly related to *Trochus*.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926).

Family NERITOPSIDÆ Fischer.

Genus NATICOPSIS McCoy.

NATICOPSIS sp.

Pl. XXIII, figs. 18 to 19b.

This form is represented in our collections by but two specimens, both from the Delaware Mountain formation. One of them is rather small, and as both are preserved as molds and the larger is distorted by pressure I feel that it would not be safe either to identify them with known species or to describe them as new, especially in a genus where the discrimination of species depends to so large a degree on configuration.

The general character can be seen by the illustrations, for the form is one of those in which few marked peculiarities exist. The size is rather small, the spire low, the peritreme rapidly enlarging, and the final volutions large and inflated.

This form seems to resemble *Naticopsis dispassa* Dawson, but the figure of that species given by its author is so wretched that only the general character can be ascertained from it. It also resembles another lower Carboniferous species, *Naticopsis carleyana*, but differs in having the body whorl broader and not so high. By a similar character it differs from *Naticopsis nana*, having a less inflated body whorl. Some of the other species of *Strophostylus* are of the same general type; but their much greater size renders it difficult to compare my fossil with them. I am uncertain whether this form is rightly a *Naticopsis* or a *Strophostylus*.

Horizon and locality.—Delaware Mountain formation, Guadalupe Point (station 2931); basal black limestone, Guadalupe Point (station 2967), Guadalupe Mountains, Texas.

Family PYRAMIDELLIDÆ Gray.

Genus ZYGOPLEURA Koken.

ZYGOPLEURA SWALLOWIANA Shumard.

1859. *Chemnitzia Swalloviana.* Shumard, Trans. Acad. Sci. St. Louis, vol. 1, p. 399 (date of volume, 1860).

White [Permian] limestone: Guadalupe Mountains.

Shell subulate, very gradually tapering to the apex; spinal angle 12°; volutions about 15 (?) very gently convex; suture well marked, excavated; surface of volutions ornamented with longitudinal, arched folds which do not cross the suture; aperture unknown.

The collection contains but a single specimen of this shell, which is imperfect.

Locality.—White limestone, Guadalupe Mountains.[a]

My material of this species is somewhat imperfect, and were it not that the form defined by Shumard, whose description is not very full, is characterized by the extremely large number of volutions, I would feel much doubt about referring my shells to it.

[a] Trans. Acad. Sci. St. Louis, vol. 1, 1856-1860, p. 399.

The larger of the two specimens at hand has a height of 13 mm. The diameter at the base is 4 mm. and at the top about 0.5 mm. The spire is thus seen to be very high and tapering. There are about 12 volutions existing, while several are clearly missing at the top. The suture lines are nearly horizontal. The peritreme section is about circular, the shape being little if at all modified in each volution by the apposition of those above and below. The diameter of the peritreme at the larger end is slightly in excess of 2 mm. The surface may have been smooth, or differently marked, but appears to have possessed rather narrow vertical corrugations, of which a considerable number occur on a single volution.

The smaller specimen has a height of but 7.5 mm., with a basal diameter of but 2 mm. The apex is produced nearly to a point, and there are about ten volutions. The surface of this specimen is not preserved.

The foregoing notes are taken from specimens which are preserved for the most part as internal molds. The sutures, therefore, appear much more deeply indented than it was probable was really the case. I believe, however, that the suture line was really distinctly depressed.

There can be little doubt that neither the shell described by Shumard nor that here subsumed under the name proposed by him, if they are not the same, is a *Chemnitzia*. They appear to be congeneric with or at least to resemble the group of upper Carboniferous species for which the name *Loxonema* is used.

Horizon and locality.—Middle of Capitan formation Capitan Peak, Guadalupe Mountains, Texas (station 2926).

Genus **LOXONEMA** Phillips.

LOXONEMA? INCONSPICUUM n. sp.

Pl. XXIV, fig. 19.

I have but a single specimen of this form, of which, on account of its small size and not very perfect preservation, a complete description can not be given. The size is small and the shape long and slender, the length being 3 mm. and the width of the lowest whorl 1 mm. or a little less. The volutions number six, or possibly seven. The convexity of the whorls is considerable. The peripheral line is situated from one suture about one-third the entire distance to the next below, and at this point the outline is in fact rather abruptly deflected. The suture is depressed.

The surface appears to be entirely smooth.

This species resembles *Loxonema cerithiiforme*, but the whorls are higher and less numerous, and there are no little nodes along the lines of suture. It is also related to *L. peoriense*, but is much smaller and with a larger apical angle.

Horizon and locality.—Basal black limestone, Guadalupe Point, Guadalupe Mountains, Texas (station 2967).

Genus **PSEUDOMELANIA** Pictet.

PSEUDOMELANIA sp. *a*.

This species is represented by a mere fragment, which it would scarcely be worth while to mention separately, except that it is rather exceptional in its characters. Of the two volutions preserved, one has a height of a little less than 5 mm., while that above it is a little over 3 mm. The whorls are without ornamentation, almost flat laterally. What may be discriminated as the lateral and lower portions are about equal in height and are distinguished by an angulation marking the limit to which each volution is enveloped by that which succeeds it. The suture is very slightly depressed. The larger diameter is about 5 mm. and the taper very gradual. The spire, therefore, must have been extremely high and in shape regularly conical, and the number of volutions was without doubt large. The body whorl appears to have been relatively small. The general appearance of these fragments is that of a *Pseudomelania*, a genus which is thought to extend back into the Carboniferous period.

This shell is quite unlike anything else in the collection, and I can recall no form resembling it among our Carboniferous faunas.

Horizon and locality.—Delaware Mountain formation, Guadalupe Point, Guadalupe Mountains, Texas (station 2931).

PSEUDOMELANIA? sp. *b*.

I include here only a single small, imperfect specimen which appears to possess the following characters:

The shape is very small and slender, with many volutions. Height about 6 mm., diameter below a little less than 2 mm. Volutions about nine in number. The peripheral surface of the volutions is so flattened and their line of union so ill defined that in my poorly preserved example they are individually indistinguishable. The lower part of the peritreme is nearly flat, so that the volutions are but very slightly embracing. In this respect, as in size, the present form is in distinct contrast to the foregoing one.

It very closely resembles in a general way the smaller of the two specimens identified as *Loxonema swallowianum*, but seems to have a much flatter lateral surface and somewhat less rounded basal portion. It also appears to be without the sculpture which is presumably a character of the small example of *Loxonema*. I am somewhat in doubt whether this may not be an imperfect example of the form cited as *Murchisonia?* sp. *a*.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

Genus **BULIMORPHA** Whitfield.

BULIMORPHA CHRYSALIS var. DELAWARENSIS n. var.

Pl. XXIII, fig. 21.

This variety, of which our collection contains but a single specimen, is in general form spindle-shaped, the moderately high spire consisting of five or possibly six volutions, and the body whorl occupying about half the whole length. In configuration it appears to be intermediate between *Bulimorpha bulimiformis* of the "Lower Carboniferous" and *B. chrysalis* of the "Upper Carboniferous." It seems to be a little less elongate than the Mississippian species, the spire especially being not quite so tapering. On the other hand, the body chamber is a little more inflated than in the Pennsylvanian form. The difference, however, is not large, and had the form under consideration been found in association with the usual fauna of the "Coal Measures" of the Mississippi Valley I would probably have neglected it.

Horizon and locality.—Delaware Mountain formation, Guadalupe Point, Guadalupe Mountains, Texas (station 2931).

Genus MACROCHEILINA Bayle?

The few imperfect shells included under this title are probably congeneric with those with which Phillips's term *Macrocheilus* is commonly associated. When Phillips introduced *Macrocheilus* in 1841, the name had already been anticipated by *Macrocheilus* Kirkby, 1838, proposed for a genus of insects. Long afterwards, in 1879, Bayle, on the strength of this fact, wished to replace *Macrocheilus* Phillips by the term *Duncania*, but finding that also preoccupied for a genus of corals, finally, in 1880, substituted *Macrocheilina*. While most authors have retained the more familiar name, I do not at present see how that course can be justified.

When first suggesting the term *Macrocheilus*, Phillips did not give a generic description, but only introduced it tentatively for some shells which had previously been included under *Buccinum*. The first species mentioned and the first species described in connection with *Macrocheilus* is *M. brevis*, which must probably be taken as the type.

Now, most of the Buccinidæ are highly ornamented species and *Macrocheilus brevis* has a row of large nodes near the suture, with apparently other nodes on the body whorl, presenting, in fact, an appearance very different from the Carboniferous shells which it is customary to refer to *Macrocheilus*. Bayle's *Duncania* was associated with *Buccinites arculatus* Schlotheim as the typical species, and in this case, also, no description was given. *Macrocheilina* was simply substituted for *Duncania*.[a]

Buccinites arculatus is a large shell in Schlotheim's figure, with a shoulder just below the suture and a suggestion of nodes along it, in configuration considerably different from most of the shells from the American Carboniferous referred to *Macrocheilus*.

So far as I have investigated the subject, it seems to me that *Macrocheilus* must in any event yield place to *Macrocheilina;* but, on the other hand, it seems doubtful if more than a very few of the Carboniferous species of *Macrocheilus* can properly be retained under *Macrocheilina*. As, however, I am in no position to indicate the proper disposition of the shells which I would exclude from *Macrocheilina*, including, of course, the Guadalupian species at present under consideration, I have retained Bayle's name for them, but in a provisional manner.

The three species included under *Macrocheilina* in the present instance are imperfectly known, and it is not certain that they are congeneric with one another. *Macrocheilina? modesta* and *Macrocheilina* sp. *a* are more comparable to *M. arculata*, while *Macrocheilina* sp. *b*, with its low spire and large and deeply embracing whorls, appears to belong to at least a different group of species.

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[a] Jour. de Conch., ser. 3, vol. 20, p. 241.

Macrocheilina? modesta n. sp.

Pl. XXIV, fig. 20.

Our collections contain only one specimen of this shell, which is of very small size and fusiform shape, rather rapidly enlarging. The length is slightly less than 3 mm. and the width below about half the length. The volutions number four to four and one-half. The whorls are moderately convex and the suture depressed. The aperture is oval, longer than wide, and nearly parallel to the axis. The surface is smooth.

Horizon and locality.—Basal black limestone, Guadalupe Point, Guadalupe Mountains, Texas (station 2967).

Macrocheilina? sp. *a*.

Pl. XXIII, fig. 20.

Shell of medium size, consisting probably of seven or eight volutions. Spire moderately high, the body whorl comprising about half the entire length. The volutions are somewhat flattened, and the final one is rather elongated. The sutures are moderately depressed. It is uncertain whether this shell possessed the fold on the columella, which is one of the characters of *Soleniscus*, for the preservation is that of an internal mold and the aperture is complicated by crushing, but if this character was present it was probably strongly marked.

This species resembles several found in the "Coal Measures" of the Central and Eastern States, but the single specimen preserved in our collections is so imperfect that its relations to other forms can not be precisely ascertained. It is somewhat like *S. altonensis*, but the spire was probably higher and the body whorl not so large. *S. fusiformis* also resembles it, but probably has a higher spire. *S. hallanus* appears to be very similar indeed, and I would feel disposed to refer the Guadalupian shell to that species pending a fuller knowledge of its characters were it not that the entirely different faunal association in which it occurs would, a priori, afford evidence against its being the same species. *S. humilis* has a proportionately larger body whorl, though in general rather similar. *S. newberryi* is another closely related species. It probably has a higher spire, but this portion of my specimen being lost this character can only be surmised. *S. paludiniformis* is similar, but only in a general way, and as the Guadalupian form, all of whose characters are not known, occurs at a different horizon and is associated with a very different fauna the propriety of ignoring these differences is doubtful.

Horizon and locality.—Delaware Mountain formation, Guadalupe Point, Guadalupe Mountains, Texas (station 2931).

Macrocheilina? sp. *b*.

The only specimen representing this species is very small, with a large body whorl. The general shape of the whole is fusiform, regularly tapering at both ends. The entire height is only about 3 mm., of which the spire, consisting of three volutions, occupies only one-fifth. The width is a little less than 2 mm.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (station 2964).

CEPHALOPODA.

The Cephalopoda form an interesting and characteristic, often an abundant, feature of the later epochs of the Paleozoic. The small number which it has been possible to include in the present report has accordingly been somewhat of a disappointment. It seems probable, however, that this group may be even abundant at some horizons and some localities of the Guadalupian, for Mr. Richardson, limited as to time and conveyance, obtained a far more plentiful and varied representation than our party, with its more leisurely movements and its more primary purpose of making collections. It is a rather singular fact that none of the ammonoids, to which group the foregoing remarks chiefly apply, have as yet been found in the upper or Capitan formation of the Guadalupian. All the material thus far obtained is from the basal black limestone and from the Delaware Mountain formation of the Guadalupian section, and from corresponding beds in the southern Delawares.

Known Cephalopoda of the Guadalupian comprise only the following genera: Among the Nautiloidea, *Orthoceras* (1 species), *Foordoceras* (2 species); among the Ammonoidea, *Gastrioceras* (2 species), *Paraceltites* (1 species), *Agathoceras* (1 species), *Peritrochia* (1 species), and *Waagenoceras* (1 species).

The Salt Range fauna has furnished, according to Waagen, 4 species of *Orthoceras,* 1 species of *Gyroceras,* 9 species of *Nautilus,* 2 species of *Sageceras,* 2 species of *Xenodiscus,* 2 species of *Arcestes,* and 1 species of *Cyclolobus.* The ammonoids of the Guadalupian are almost entirely different from those of the Salt Range fauna, having, in fact, not one genus in common. The nautiloids form a less satisfactory medium of comparison. In the Salt Range the order was more highly differentiated and many of the species more robust. *Foordoceras shumardianum* probably belongs to the same group as the two Indian species, *Nautilus wynnei* and *N. transitorius.* The other Salt Range groups appear not to be represented here. The *Gyroceras* is non-Guadalupian, as are the two species of annulated *Orthoceras.* The two smooth species are more like that from the Delaware Mountain formation.

In his first paper on the Carboniferous of Chitichun Diener cites only *Popanoceras trimurti,* which is of course non-Guadalupian. In his second paper on this fauna he records *Nautilus hunicus, Xenaspis carbonaria,* and *Cyclolobus walkeri.* No appreciable relationship with the Guadalupian is indicated by these forms.

In his second paper dealing with the Spiti fauna Diener cites from the upper division *Xenaspis* cf. *carbonaria, Cyclolobus* cf. *oldhami, Cyclolobus insignis, C. kraffti, C. haydeni, Orthoceras* sp., and *Nautilus* sp. The only point of contact between the Cephalopoda of this fauna and those of the Guadalupe Mountains is in the *Orthoceras,* for the species of *Nautilus* probably belong to different groups.

The only cephalopod which Diener found in his fauna from Kumaon and Gurhwal is *Orthoceras* sp. It is of the same general type as *Orthoceras guadalupense.*

A number of cephalopods are known from the Permian Productus shales of Byans. Diener mentions *Hyattoceras* nov. sp. ex aff. *H. cummingsi, Adrianites* sp. ind., *Gastrioceras* sp. ind. ex aff. *G. marianum, Brancoceras?* sp. ind., *Nomismoceras smithi, Pericyclus* sp. ind., and *Lilinthicoceras* sp. ind. This list of forms is generically far different from the Guadalupian. The species of *Hyattoceras* (which may possibly be congeneric with *Waagenoceras cummingsi*) and *Gastrioceras* are not related specifically to the Guadalupian species of *Waagenoceras* and *Gastrioceras*.

On the whole only a remote relationship appears to exist between the Guadalupian Cephalopoda and those of the Salt Range and Himalaya. The Guadalupian forms, so far as known, may be somewhat less abundant, varied, and possibly more primitive. It seems probable, however, that further collecting would modify some of these conclusions and perhaps all of them. Both faunas contain this group in less abundance and variety than some which enter into these comparisons.

The only cephalopods cited by Romanowsky from Turkestan are *Nautilus dunganensis* and *Goniatites crenistria*. Neither species appears to have any related Guadalupian form.

The Lo Ping fauna contains, according to Kayser, only four species of *Nautilus* and three species of *Orthoceras*. The absence of ammonoids is a noteworthy circumstance. One of the *Nautili* is possibly a *Bellerophon* (*Warthia*), and the others are not closely related to the Guadalupian species of *Foordoceras*. Of the Orthocerata two species belong to the annulated type and are, so far as known, non-Guadalupian. The other is possibly a *Dentalium*, and at all events its relation to the Guadalupian species of *Orthoceras* can not be made out.

Loczy found few cephalopods and no ammonoids among the Chinese faunas which he studied. From Kantschoufu he records *Cyrtoceras* an *Orthoceras* sp. indet., *? Nautilus* (*Discites*) sp. indet., *? Nautilus kayseri*, and *Nautilus* (*Temnocheilus*) *waageni*. These forms appear not to be related to the Guadalupian Ammonoidea, and this is the only Carboniferous fauna in which Loczy found any cephalopods at all.

Roemer's paper on the Carboniferous fauna from the west coast of Sumatra cites the following: *Nautilus tuberosus*, *Nautilus* sp., *Orthoceras undatum*, and *Goniatites listeri*. None of these appears to be related to the Guadalupian Cephalopoda. In writing about this fauna in 1901 Fliegel cites these forms as *Orthoceras orientalis*, *Temnocheilus hayi*, *Pleuronautilus sumatrensis*, and *Pleuronautilus loczyi*.

Beyrich cites no Cephalopoda, but Rothpletz describes from Timor and Rotti *Orthoceras* sp., *Nautilus* sp., *Arcestes megaphyllus Arcestes tridens*, and *Arcestes persulcatus*. They seem to be unrelated to the Guadalupian representatives of this class.

The Cephalopoda of the "Permo-Carboniferous" of Queensland and New Guinea as described by Etheridge are rather few in number and are referred to *Nautilus* (2 species), *Orthoceras* (several species), *Gyroceras* (1 species), and *Goniatites* (4 species). Only one of the species of *Nautilus* is figured. As its sutures are unknown and as its sculpture and configuration are so much more like the ammonoids than the nautiloids, it would with greater probability have been placed with the latter group. It resembles several Guadalupian ammonoid species, but as its sutures, and therefore its generic position, are unknown, further comparison need not be made. Only two of the five or six species of *Orthoceras* are figured. One belongs to an entirely different group from the Guadalupian form, but the other is of the same general type, though much larger. The form described as *Gyroceras dubium* n. sp. resembles some of the Guadalupian ammonoids, but like the *Nautilus* its suture is unknown and its generic position problematical. Among the *Goniatites* recognized by Etheridge is *G. micromphalus,* originally described by Morris as a *Bellerophon.* Apparently no specimen thus far found shows any traces of septa, but De Koninck referred it to *Goniatites,* because he was unable to discover traces of a slit band, a feature usually determinable on most Bellerophons, even when preserved as molds. In the Salt Range of India, however, Waagen obtained a type of *Bellerophon* in which that structure is missing (*Warthia*). It is probable, therefore, that Morris's species must be returned to the Bellerophontidæ, and it may even prove to be a representative of the genus *Warthia.* In general appearance this form, which was obtained from the Bowen River coal field, is suggestive more of *Warthia americana* than of any other Guadalupian type. The remaining species of *Goniatites* are imperfectly known. Their suture lines have not been determined and their generic position is consequently uncertain. No effective comparisons can therefore be made with the Guadalupian ammonoids, and I see no relationship between them, the Australian forms apparently representing older, or at all events more primitive, types, so far as can be determined.

In his monograph on the Carboniferous faunas of New South Wales, De Koninck recognizes only two species of *Goniatites,* both from the "Permo-Carboniferous" division. *G. micromphalus,* as suggested above, is probably a *Bellerophon,* to which genus it was originally referred. The same may in fact be true of the second species, for its suture is not known, nor in fact is it certain that it was divided by partitions. *Orthoceras* is represented by *O. striatum,* a species perhaps of the same general character as *O. guadalupense.*

Trautschold identifies only a few cephalopods in the Russian Moskovian, referring them to *Nautilus tuberculatus, N. clitellarius, N. subsulcatus, N. eccentricus, N. oxystomus, Orthoceras ovale,* and *O. polyphemus.* None of these is related to the Guadalupian species except *Orthoceras polyphemus.*

The only records of the occurrence of this group in the Gschelian stage have been in lists, where I have seen recorded three or four species of *Orthoceras* and three or four species of *Nautilus,* together with the ammonoid genera *Agathoceras* and *Pronorites.* The ammonoids appear to be much less well developed than those of the Guadalupian, but further comment than this would not be justified.

In considering the cephalopods of the Artinsk one recurs at once to Karpinsky's monograph on "Die Ammoneen der Artinskstufe." By title this work of course excludes the Nautiloidea. It treats of 3 species of *Pronorites,* 3 species of *Parapronorites,* 4 species of *Medlicottia,* 2 species of *Propinacoceras,* 6 species of *Gastrioceras,* 1 species of *Glyphioceras,* 1 species of *Paralegoceras,* 3 species of *Agathoceras,* 13 species of *Popanoceras,* 2 species of *Thalassoceras,* and 1 species of *Paraceltites.* This list indicates a facies considerably different from the Guadalupian, the only genera in common being *Agathoceras, Paraceltites,* and *Gastrioceras. Agathoceras texanum* is closely related to *A. uralicum,* but the Guadalupian species of *Gastrioceras* belong to a different group from those treated by Karpinsky. The most abundantly represented of the Russian genera (*Popanoceras*) does not occur among the known Guadalupian cephalopods, and there seems to be slender relationship between the two faunas in this respect.

Stuckenberg, besides listing several species of *Gastrioceras, Pronorites, Popanoceras,* and *Medlicottia* from the Artinsk and the associated Kungurstufe, cites also *Nautilus* and *Orthoceras.* These last when figured do not appear to be closely allied to the Guadalupian *Orthoceras* and *Nautilus.*

Krotow's account of the fauna of the Artinsk sandstone notes 4 species of *Orthoceras,* 1 species of *Cyrtoceras,* 3 species of *Nautilus,* 11 species of *Goniatites,* 3 species of *Waagenia,* and 3 species of *Medlicottia.* Of the two figured species of *Orthoceras* one resembles *O. guadalupense* and one does not. The species of *Cyrtoceras* is not figured, but presumably is non-Guadalupian, as is the only illustrated species of *Nautilus.* Krotow uses *Gastrioceras, Glyphioceras, Popanoceras,* and *Pronorites* as subgenera of *Goniatites. Gastrioceras jossæ* appears to be more or less closely related to the Guadalupian species of *Gastrioceras,* but otherwise the Guadalupian ammonoids and those recorded by Krotow from the Artinsk are different.

The cephalopods of the Russian Permian seem practically confined to the Nautiloidea. Tschernyschew cites from the Government of Kostroma *Nautilus freieslebeni* and *N. cornutus.* The former, which alone is figured, appears to be unlike the Guadalupian *Foordoceras. N. cornutus* is the only cephalopod cited from the Permian by Golowkinsky, and is also not closely allied to the Guadalupian Nautiloids. Netschajew records the same species, together with unidentified and unfigured ones.

In addition to the works above discussed, which deal with the Russian cephalopods, it remains to speak of a few others. Marie Tzwetaev, in 1888, described the cephalopods of the upper portion of the Carboniferous limestone of central Russia, recognizing 1 species of *Gastrioceras,* 16 species of *Nautilus,* and 4 species of *Orthoceras.* The single *Gastrioceras* does not belong to the same group as the Guadalupian species. The only *Nautilus* which can be compared with the Guadalupian *Foordoceras* is *N. tschernyschewi,* and many of the others are widely different. Of the Orthocerata none is really close to *Orthoceras guadalupense,* the nearest being probably *O. laterale.*

Jakowlew also described some Russian Cephalopoda, namely, 2 species of *Metacoceras,* 3 species of *Temnocheilus,* 1 species of *Pteronautilus,* 1 species of *Asymptoceras,* 1 species of *Cœlonautilus,* 1 species of *Discites,* and 1 species of *Orthoceras. Metacoceras variabile* and *M. trigonotuberculatum* are not unlike the Guadalupian forms which I have referred to *Foordoceras.* The remainder of the *Nautili,* together with the single species of *Orthoceras,* are not related to the Guadalupian representatives of these groups.

Lastly, De Verneuil, recording no cephalopods from the Permian, describes as from the Carboniferous 2 species of *Orthoceras,* 4 species of *Nautilus,* and 10 species of *Goniatites.* Both the Orthoceratites are of the same general type as *O. guadalupense,* but none of the *Nautili* is closely related to the Guadalupian *Foordoceras. Goniatites jossæ* and to a less degree *G. marianum* are somewhat closely related to the two Guadalupian species of *Gastrioceras,* but the other *Goniatites* have no corresponding forms.

In conclusion, the Cephalopoda do not indicate a close relationship between the Guadalupian fauna and that of any horizon of the Russian section. Because no ammonoids are known from the Russian Permian, the relationship, such as is manifested at all, is rather with the Artinskian stage.

This group appears well represented in the fauna from Djoulfa, in Armenia, described by Abich. This author cites *Goniatites striatus*, *Ceratites djoulfensis*, *C. intermedius*, *C. tropitus*, *C. trochoides*, *C. pessoides*, *Nautilus eccentricus*, *N. propinquus*, *N. parallelus*, *N. convergens*, *N. concavus*, *N. dolerus*, *N. dorso-armatus*, *N. pichleri*, *N. tubercularis*, *N. dorsoplicatus*, *N. armeniacus*, *Orthoceras annulatum*, *O. cribrosum*, *O. transversum*, *O. bicinctum*, *O. margaritatum*, and *O. turitellum*. The form identified as *Goniatites striatus* does not seem to be closely allied to the Guadalupian species of *Gastrioceras*, while the five species of *Ceratites* are widely different from anything in that fauna. Among the numerous species which Abich places under *Nautilus* the only ones which are comparable to the Guadalupian *Foordoceras* are *Nautilus tubercularis* and to a less degree *N. pichleri*. Some of the other species are widely different. Nearly all of the six Armenian varieties of *Orthoceras* belong to the annulated type, which is unknown as yet in the Guadalupian.

When Arthaber discussed the Djoulfa fauna, a few years ago, he made a number of changes in the generic appellations, but added relatively few new species to those described by Abich, although combining some of them. Thus, instead of *Nautilus* alone, he gives us *Nautilus*, *Pleuronautilus*, and *Cœlonautilus*, while among the ammonoids we have *Gastrioceras*, *Hungarites*, and *Otoceras*. In its ammonoids the Armenian fauna is widely different from the Guadalupian, for the species of *Gastrioceras* in each are not closely related. The Orthocerata and the nautiloids are more varied and in the main considerably different.

The Fusulina limestone of Palermo has furnished a much more extensive cephalopod fauna than the Guadalupian is known to contain. Gemmellaro has distinguished among the nautiloids no less than 18 species, representing the genera *Trematodiscus* (1 species), *Pleuronautilus* (1 species), *Endolobus* (1 species), *Gyroceras* (1 species), and *Orthoceras* (14 species). The nautiloids are but distantly related to those of the Guadalupian fauna. Gemmellaro's species of *Orthoceras* for the most part resemble *O. guadalupense* in being small, gradually enlarging, without constrictions, and with a centrally situated siphuncle. They show more or less extensive differences in the height of the chambers and in the sculpture, a character which I have been unable to observe, my specimens occurring as molds. Some of Gemmellaro's species, such as *O. adrianense*, *O. paternoi*, and *O. subtriangulare*, are non-Guadalupian, so far as known. Two species (*O. obliquesulcatum* and *O. œhlerti*) are not figured in my copy of Gemmellaro's report, but the latter is also non-Guadalupian. Though some of the Sicilian Orthocerata doubtless resemble the Guadalupian species rather closely, they are in strong contrast with the latter, by reason of their much greater abundance and differentiation. The nautiloids, on the other hand, while possibly no more abundant, are more varied and different.

In his first paper on the Sicilian ammonoids Gemmellaro discriminated in all 54 species, belonging to the following genera:

	Species.		Species.
Waagenoceras	2	Daraelites	1
Hyattoceras	3	Thalassoceras	4
Popanoceras	4	Paraceltites	2
Stacheoceras	11	Agathoceras	3
Adrianites	6	Doryceras	4
Medlicottia	5	Clinolobus	1
Propinacoceras	3	Gastrioceras	3
Parapronorites	1	Glyphioceras	2
Sicanites	2		

In an appendix published subsequently he discusses or describes the following:

	Species.		Species.
Waagenoceras	1	Paraceltites	2
Hyattoceras	2	Agathoceras	1
Popanoceras	1	Doryceras	1
Stacheoceras	1	Gastrioceras	1
Adrianites	7	Brancoceras	1

The two Guadalupian species of *Gastrioceras* belong to the same group as the Sicilian forms *G. zitteli* and *G. roemeri*. *G. sosiense* and *G. waageni* have as yet no cognate Guadalupian species. *Paraceltites elegans* is closely allied to several Sicilian species of *Paraceltites*. *Agathoceras texanum*, however, presents several points of difference from the Sicilian forms, so as to raise some doubt whether they do not at least belong to another section of the genus. The single Guadalupian species of *Waagenoceras* is related to the Sicilian representatives of the genus. Although, so far as known, much less varied, the Guadalupian Ammonoidea appear to be closely related to those from Palermo, more closely than to any fauna yet brought to light. With the exception of *Peritrochia* all the Guadalupian genera occur in Sicily.

The cephalopods of the Trogkofelschichten have not yet, so far as I have discovered, been described, and the only record from that section which I have come upon was made by Gortani, who cites from the Carnic Alps only *Orthoceras* cf. *calamus* De Kon.

In the Dyas, as in the Russian Permian, the cephalopods are represented only by the Nautiloidea. Geinitz cites two species of *Nautilus* and one of *Orthoceras*. The two nautiloids are quite unlike those of the Guadalupian fauna, but the *Orthoceras* is of the same general type. Similarly, in the English Permian King records only two species of *Nautilus*, and both belong to different groups from the Guadalupian *Foordoceras*.

The only Arctic cephalopod which I have seen mentioned is *Orthoceras* sp. cited by Toula from Nova Zembla. It resembles *O. guadalupense*.

From Igidi, in the West Sahara, Stache cites an undetermined *Orthoceras* of a different type from *O. guadalupense*.

No records of this group having been found from South or Central America from horizons which concern the present investigation, it remains only to speak of the cephalopods of the Pennsylvanian and Permian of North America. Weller lists the Pennsylvanian Ammonoidea under the following genera:

	Species.		Species.
Asymptoceras	3	Metacoceras	6
Coloceras	1	Nautilus	16
Cyrtoceras	4	Orthoceras	12
Discites	1	Phacoceras	1
Domatoceras	5	Tainoceras	3
Endolobus	1	Temnocheilus	6
Ephippioceras	2	Thrincoceras	? 2

To offset these, the Guadalupian fauna, so far as known, presents but two species of *Foordoceras* and one species of *Orthoceras*. *Orthoceras guadalupense* belongs to a group which is found the world over, at various horizons. *O. rushense* may be mentioned as a related Pennsylvanian species, and there are others. The genus *Foordoceras*, to which the Guadalupian species have been referred, is chiefly Indian in its distribution and has not been recognized in the Pennsylvanian. It may prove, however, that *Foordoceras shumardianum* has cognate species in the Pennsylvanian, especially among the unfigured types of *Nautilus*.

The ammonoids of the Pennsylvanian include the following genera, according to the recently published monograph of J. P. Smith:

	Species.		Species.
Pronorites	1	Gonioloboceras	1
Medlicottia	1	Dimorphoceras	1
Schuchertites	1	Milleroceras?	1
Prolecanites	1	Agathoceras	1
Glyphioceras	1	Popanoceras	3
Goniatites	3	Shumardites	1
Gastrioceras	12	Waagenoceras	2
Paralegoceras	4	Neoicoceras	1
Schistoceras	4		

There are in addition three species whose generic position could not be determined. From this list it would appear that the ammonoids of the Guadalupian fauna are much less differentiated than those of the Pennsylvanian and not very different generically, three out of the five Guadalupian genera occurring in the Pennsylvanian also. As regards the former point, except possibly for the higher beds of the Carboniferous in Texas, my experience would show that ammonoids are much more abundant and varied in the Guadalupian than in a corresponding amount of material from the Pennsylvanian. Regarding the other particular, the generic comparison is perhaps a little misleading, for while the Guadalupian species of *Waagenoceras* is closely related to *W. cumminsi*, the Guadalupian *Gastrioceras* and *Agathoceras* probably belong to different specific groups from the Pennsylvanian congeners.

On the whole, the Cephalopoda of the Guadalupian do not seem to indicate a close relationship with the Pennsylvanian. Such as is suggested lies distinctly between the Guadalupian and the younger beds of the Carboniferous as developed in the Texas region.

Family ORTHOCERATIDÆ Broderip.

Genus ORTHOCERAS Breynius.

ORTHOCERAS GUADALUPENSE n. sp.

Pl. XXIII, figs. 10 to 10b.

Shell circular in cross section, small, slender, gradually tapering. Siphuncle rather large, central. Septa moderately concave, about 2 mm. apart.

The single fragmentary specimen obtained has a length of 11 mm., with a diameter of about 5.5 mm. above and 4.75 mm. at the lower end. Five chambers are included within this measurement of 11 mm., together with the convexity of one chamber. The surface was possibly marked by faint concentric striæ, but appears on casts of the exterior to be smooth.

Horizon and locality.—Delaware Mountain formation. Guadalupe Point, Guadalupe Mountains, Texas (station 2931).

Family TAINOCERATIDÆ Hyatt.

Genus FOORDOCERAS Hyati.

FOORDOCERAS SHUMARDIANUM n. sp.

Pl. IX, figs. 26 to 27a.

Shell rather small, somewhat rapidly enlarging. The transverse section is more or less that of a rectangle, with the width slightly greater than the height. The sides are flattened and nearly parallel. They are marked by well-defined pilæ, which appear to be slightly curved, with the concave side directed toward the aperture. The pilæ terminate above in nodes and the distance between them is about the same as their own length. The ventral arch is broad, the chief curvature occurring at the abdominal angle. There is also a distinct umbilical shoulder which, where the shell is not exfoliated, is marked by an abrupt change in direction. The angle thus produced is emphasized by slight depressions above and below. The depressed zone is narrow, not so broad as either the umbilical or lateral zones, which are about equal in width.

The venter is marked by fine but distinct transverse lines, the direction of which indicates the presence of a rather deep, broad hyponomic sinus. On the lateral and umbilical zones these appear to become slightly stronger, more regularly arranged and sublamellose. On these areas also they are crossed by revolving lines, which are both fainter and finer than the transverse ones.

The flexures of the sutures are all gentle. The entire ventral area is occupied by a broad, shallow lobe; a low saddle falls upon the abdominal shoulder; a second shallow lobe occurs on the lateral zone, while from the umbilical shoulder to the edge of the depressed zone the suture is practically straight.

The siphuncle is nearly central in the mature portion of the shell, but becomes more ventral in the earlier stages.

This species seems to belong to the group for which Hyatt proposed the term *Foordoceras*, and which is found chiefly in the Salt Range of India. It probably is a member of the *Goliathus* section, as recognized by Hyatt, but differs in having a proportionately narrower venter and a more distinct umbilical shoulder. The shape is in fact more like the *transitorius* section, but it does not have the depressed median belt along the venter which characterizes that division. The Indian shells are not described as having the surface ornamentation possessed by the present species, but the revolving lines which are its most peculiar feature are confined to the sides, where they might easily be concealed.

Horizon and locality.—Middle of Capitan formation, Capitan Peak, Guadalupe Mountains, Texas (station 2926).

FOORDOCERAS SHUMARDIANUM var. PRÆCURSOR n. var.

Pl. XXV, figs. 15 to 15b.

This species is related to the preceding and has, in fact, about the same general aspect. A careful inspection, however, reveals differences which render it impossible to consider them the same. The septa are somewhat more closely arranged. There is no sharply defined umbilical shoulder, and the growth lines, which are clear and very elegant over the small area of surface preserved in my specimen, show a considerably deeper hyponomic sinus. Like the foregoing, this species is marked on the umbilical and lateral zones with transverse and revolving lines, which produce a reticulated surface ornamentation.

Horizon and locality.—Basal black limestone, Guadalupe Point, Guadalupe Mountains, Texas (stations 2920 and 2967).

Family PRONORITIDÆ Smith.

Genus PERITROCHIA n. gen.

This term is proposed for a shell from the black limestone, whose generic characters appear to be the following: Shell subglobose. Whorls deeply embracing, so that the umbilicus is nearly or quite closed. Aperture indented to nearly half its height by the preceding volution, and strongly lunate. Of the suture, the ventral lobe is bifid, possibly trifid. The lateral lobes are numerous, at least four on each side. The first lateral lobe is bidentate; the other lobes and saddles are simple, with rounded ends. The surface is without nodes or keels and apparently with only obscure growth lines.

It is with much hesitation that I have introduced a new generic name for this Guadalupian type and only after many comparisons with known genera. The most closely related genus is *Pronorites*. The suture of *Pronorites* is almost exactly that of *Peritrochia*, save that there is a tendency in the lobes toward a pointed, linguiform shape. The shape of the shell in *Pronorites*, however, is discoidal and the whorl section elongate and subquadrate, while the shell in *Peritrochia* is globose and the whorl section transverse and lunate. The umbilicus in one is wide and in the other closed.

PERITROCHIA EREBUS n. sp.

Pl. XXV, figs. 9 to 11.

Shell small, compressed-spherical. Whorls highly arched, deeply embracing. Abdomen somewhat narrowly rounded. Aperture lunate. Umbilicus minute or closed. Surface smooth, apparently without either striæ, nodes, or carinæ. Ventral lobe bifid, possibly trifid. The first lateral lobe is bifid; the remaining lobes and saddles small, rounded, rather deep, with straight sides. There are five lateral saddles on each side, and possibly a sixth small one in the extreme umbilical region. The character of the ventral lobe is not known with certainty.

This species is common in the black limestone, but has not yet been found at any other horizon.

Horizon and locality.—Basal black limestone, Guadalupe Point, Guadalupe Mountains, Texas (station 2920).

Family PROLECANITIDÆ Hyatt.

Genus PARACELTITES Gemmellaro.

PARACELTITES ELEGANS n. sp.

Pl. XXV, figs. 12 to 14.

The general shape of this species is discoidal, much compressed. The growth is extremely evolute, each whorl embracing the preceding one to the extent of only about one-sixth. The general shape of a section across one of the volutions is elliptical, with the length about twice the breadth. The outer end is, however, slightly narrower than the inner, which, in addition to being expanded, is indented below by contact with the preceding whorl. The largest specimen noted is 25 mm. in diameter.

The sutures are rather simple. There is a siphonal lobe whose character has not been completely determined. In some specimens it appears to be merely flattened, in others to be slightly elevated at its base and indented so as to form two denticles. Again, it sometimes appears to have three denticles. Probably there are two denticles, for the best preserved and clearest specimens seem to have this structure, the other appearances being due to preservation. There are two lateral saddles and two lateral lobes, both lobes and saddles being simple and rounded. The saddles are a little broader than the lobes, and all decrease in strength laterally. Owing to the small area of contact between the volutions, the internal sutures are simple. There is a lateral saddle, half of which is external and half internal, and an antisiphonal lobe, which is narrower than the siphonal one and possibly not denticulate.

The surface is entirely devoid of revolving lines and is probably smooth except for rather regularly arranged transverse plications, which begin at the umbilicus and extend nearly to the ventral surface. Sometimes they have a slightly sigmoid curvature. The plications vary somewhat in closeness of arrangement in different specimens and on the mature or senile portions appear to become at the same time finer, more closely arranged, and less strongly marked.

There can be no doubt that the present form belongs to the genus *Paraceltites*, and it is even closely related to Gemmellaro's species. The resemblance is strongest with *P. hoeferi* and *P. halli*, but *P. elegans* can hardly, I believe, be regarded as identical with either of them. One difference which can be named is the more nearly transverse direction of the plications in *P. elegans*, while in the Sicilian species they slope forward.

Horizon and locality.—Basal black limestone, Guadalupe Point, Guadalupe Mountains, Texas (station 2967). Middle of Delaware Mountain formation, Delaware Mountains, Texas (station 2968).

Family GLYPHIOCERATIDÆ Hyatt.

Genus GASTRIOCERAS Hyatt.

GASTRIOCERAS? SERRATUM n. sp.

Pl. XXIII, figs. 9 to 9d.

Shell small, discoidal. Umbilicus wide, open. Ventral surface broad and flattened, aperture subelliptical, gently concave below, slightly embracing the preceding whorls at the sides.

Surface marked laterally by very prominent, oblique, somewhat curved angular ridges. The main portion of the ventral surface is free from these projections, but is crossed by a number of fine revolving striæ, which extend onto the lateral ridges. There are also annular constrictions, about three in a volution, which are not straightly transverse, but are gently concave across the venter, then bent sharply backward at the sides, following the oblique direction of the lateral ridges.

The suture has been made out with some precision, but yet is not known in every detail. The siphonal saddle is small and presumably bidentate. There are two lobes and two saddles on each side, both lobes and saddles being rounded and rather weak. The second lateral lobe occurs at the margin of the ventral surface, the rather narrow side of the whorl being occupied by a lateral saddle. The lobes are conspicuously narrower than the saddles. The sutures appear to be independent of the lateral ridges, the second lateral saddle occurring just in front of or just behind a ridge indifferently.

In its specific relations this form is clearly distinct from any American species as yet described, and is more closely allied to types which occur in the late Carboniferous or Permian of Europe.

Horizon and locality.—Delaware Mountain formation, Guadalupe Point, Guadalupe Mountains, Texas (station 2931). Delaware Mountain formation, southern Delaware Mountains, Texas (station 3500?).

GASTRIOCERAS sp.

Pl. XXIX, figs. 22 and 22a.

The adult form is discoidal, the whorls probably moderately evolute and crescentic in cross section. The umbilicus is large and open. The sutures are unknown.

The sculpture consists of strong, transverse plications which extend a short distance up from the umbilicus, and strong, coarse, revolving liræ which are chiefly developed over the ventral surface. In the specimen figured, which has a diameter of 35 mm., there are three plications in 5 mm. and about five revolving liræ in the same distance. The liræ are strong and abruptly elevated. Constrictions appear to be wanting.

As the suture is not known, there is still some doubt as to the generic position of this form, though with great probability it can be assigned to *Gastrioceras*. It resembles several Pennsylvanian forms, especially *G. branneri*, but differs from any of them in having the strong revolving liræ. In this respect it resembles some of the forms described by Gemmeliaro from the Sicilian Permian. Although probably a new species, I feel that it will be unwise to designate it by a new name without better material and more complete data.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (station 2968).

Family POPANOCERATIDÆ Hyatt.

Genus AGATHOCERAS Gemmellaro.

In this generic group but one species is included, the relations lying more with *Agathoceras* than with any genus with which I have made comparisons. There are several important differences, however, between the present form and typical *Agathoceras*. One of these resides in the sculpture, in which respect the Guadalupian species, while possessing a certain sort of revolving liration, has nothing of this nature to compare with the strong revolving liræ of the Sicilian species. Again, as to the sutures, while the lobes and saddles are about the same in number in both types, and simple, both the flexures are rounded in *A. texanum*, whereas in typical *Agathoceras* the lobes are linguiform and pointed, only the saddles being rounded.

Forms more like the present have been figured by Karpinsky from the Russian Artinsk. Several of his species are represented with the lobes as well as the saddles rounded, and *A. krotowi* is figured with one less saddle than typical *Agathoceras*, a condition which appears to exist in the present species. Finally, the sculpture in *A. stuckenbergi* seems to be more like the Guadalupian *A. texanum* than that of the Sicilian forms.

Agathoceras texanum n. sp.

Pl. XXV, figs. 8 and 8a.

The shell in this species is rather thick, discoidal, strongly involute, with a small umbilicus. The whorls are broadly crescentic in cross section and deeply embracing. Constrictions are apparently absent. There is a rather high, narrow, siphonal saddle, followed by three lateral saddles and three lateral lobes, a fourth lateral lobe lying just on the umbilical shoulder. The internal sutures are unknown. The lobes and saddles are all simple and all rounded, though perhaps not quite symmetrically so. The siphonal saddle is lower and narrower than the other saddles, and the adjacent lobes are narrower than the other lobes, but otherwise the lobes and saddles are approximately equal, gradually losing in height and becoming relatively broader toward the umbilicus.

The surface is without transverse plications or strong revolving lines. It has, however, a delicate sculpture, different from that of typical Sicilian *Agathoceras*, but somewhat resembling that of a species from the Artinsk. It is crossed transversely by delicate, very finely zigzag lines, from which discontinuous liræ extend alternately forward and back, uniting corresponding points in the adjacent transverse lamellæ. There results a surface somewhat suggesting that of a tile roof.

Horizon and locality.—Basal black limestone, Guadalupe Point, Guadalupe Mountains, Texas (station 2967).

Family CYCLOLOBIDÆ Zittel.

Genus WAAGENOCERAS Gemmellaro.

WAAGENOCERAS CUMMINGSI var. GUADALUPENSE n. var.

Pl. XXIX, figs. 23 to 26.

This species appears to be abundant at station 2965, in the Delaware Mountains, but unfortunately our material is in such a condition that to study it satisfactorily is not possible. Although preserved in limestone, the original shell substance appears to have been macerated in a way which is frequently observed in a shaly matrix, with the result that the sutures are not as a rule preserved, and not only is this true of the outside of specimens which have weathered out from the rock, but even when these are broken open nothing is seen. One or two specimens in which the sutures are preserved are either worn, crushed, or immature.

The general shape appears to be that of the genus *Waagenoceras*, specimens having a flattened, subglobose shape, with crescentic whorl section. The whorls are strongly embracing, leaving but a narrow umbilicus. Evidently the suture was strongly complicated, but in the best specimens it is difficult to follow the individual sutures consecutively. There appear to have been six saddles and seven lobes, or possibly more, on the external portion of mature shells. All the lobes and saddles appear to be strongly digitate.

The shell having in every instance been removed the character of the surface can not be determined. No evidence of sculpture of any description remains, not even of constrictions, a fact which is somewhat against the identification as *Waagenoceras*, and it is doubtful if this feature could have been lost in all instances through erosion.

The Guadalupian form appears to be rather closely related to *Waagenoceras cummingsi* White. It is a smaller form, with narrower umbilicus and certain appreciable differences in the suture. The sutures are more closely arranged, the lobes and saddles probably more numerous, the lobes less deeply digitate, and the saddles more symmetrically rounded.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (station 2965).

ARTHROPODA.

CRUSTACEA.

Crustacea are poorly represented in the Guadalupian, a condition which is apt to prevail in the higher faunas of the Carboniferous. I have found only one species of *Bairdia*, one of the *Argillæcia*, and one of *Cythere*(?) among the ostracods, and two species of trilobites (*Anisopyge perannulata* and *A. antiqua*). The latter representatives of a primitive group are in general of more than usual interest, and these Guadalupian forms particularly so, since they appear to constitute a hitherto unrecorded modification of the type. They are, furthermore, rather abundant at the horizon which they especially characterize.

It is a matter of some interest that this group is very rare in the fauna of the Salt Range in India. Thus far no trilobites are known from that region, and only one specimen representing the ostracods, referred to the genus *Cythere*, has been obtained.

Trilobites are known in the Himalayan region, however, as Diener cites a species of *Phillipsia* in his paper on the fauna of Kashmir and Spiti. It is very different from the Guadalupian trilobites. Again, from the Chitichun fauna No. 1 a new species of *Phillipsia* and a new genus and species, *Cheiropyge himalayensis*, were described by the same author. Neither form is related to the trilobites of the Guadalupian.

In the Lo Ping fauna Kayser described *Phillipsia obtusicauda*, a singular type, very different from the Guadalupian trilobites. In the fauna from Kantschoufu Loczy found *Phillipsia kansuensis*, and in that from Tschungtjen, province of Yünnan, *Phillipsia* sp. indet. Neither of these forms, so far as can be told, shows any significant relationship with the two Guadalupian species of *Anisopyge*.

Beyrich found a small trilobite amongst his fossils from Timor and Rotti, which he described as *Phillipsia? parvula*. Roemer described *Phillipsia sumatrensis* from Padang, on the west coast of Sumatra. This species belongs to Gemmellaro's recently established genus *Pseudophillipsia*, and is strongly different from *Anisopyge*. It was placed by Fliegel in the genus *Griffithides*, and appears to be rather common. When compared with those of Roemer, Fliegel's figures show some differences in the configuration of the glabella which seem important.

Etheridge cites but a small number of Crustacea from the "Permo-Carboniferous" of Queensland and New Guinea, the list comprising one ostracod (*Beyrichia varicosa*) and of the trilobites three species of *Phillipsia* and one of *Griffithides*. These forms are not related, save in the most general way, to the Guadalupian Crustacea.

The Crustacea of the Carboniferous fauna of New South Wales consist of ostracods and trilobites. The ostracods comprise but two species, referred to the genera *Polycope* and *Entomis*, neither of which has been recognized in the Guadalupian. The three species of trilobites came from the lower portion of the Carboniferous series and do not concern this discussion.

Trautschold's monograph on the fauna of the Russian Moskovian contains citation of three species of *Phillipsia*, related in no instance to the Guadalupian trilobites.

From the Gschelian *Phillipsia* or *Griffithides gruenewaldti* is cited by several authors. Stuckenberg records *Phillipsia gruenewaldti*, *Phillipsia* cf. *roemeri*, and *Brachymetopus* sp.

In the Artinsk Stuckenberg found *Phillipsia gruenewaldti*, *Phillipsia* cf. *roemeri*, and *Bairdia curta*. The Kungurstufe furnished him only *Bairdia* sp. Krotow cites from the Artinsk *Cythere* sp., *Estheria subconcentrica*, *Estheriella trapezoidalis*, and *E. oblonga*. In another paper this author cites *Phillipsia gruenewaldti*, *Cythere curta*, and *Kirkbya permiana* from the Artinsk.

From the Permian of Russia Netschajew records only Ostracoda and Phyllopoda, including 6 species of *Bairdia*, 6 species of *Cythere*, and 1 species of *Leaia*. It would appear, so far as one may judge from these incomplete data, that in the Russian section trilobites of the ordinary Carboniferous type persisted into the Artinsk and were replaced in the Permian by bivalve Crustacea, which, though of sporadic occurrence at lower horizons, are there much more numerous. Very different are the conditions in the Guadalupian, where the trilobites are fairly common, but are not of the ordinary Carboniferous type, where ostracods are rare and where phyllopod Crustacea, which seem to be abundant in the Russian Permian, are not known at all. This difference, however, may be taken to indicate difference of environment as well as, or instead of, difference of geologic age, for *Estheria* and *Leaia* usually occur in impure or brackish-water sediments, a set of conditions which is also strongly implied for the Permian by the abundance of nonmarine pelecypods.

The Guadalupian Crustacea present important differences from those of the fauna which Gemmellaro described from Palermo. The Sicilian Crustacea, in fact, are much more extensively developed and play a much more important part in the fauna than do the Guadalupian forms. Of the trilobites Gemmellaro cites 2 species of *Proetus*, 4 of *Phillipsia*, 1 of *Griffithides*, and 1 of *Pseudophillipsia*. The macrouran decapods are also represented by the genus *Palæopemphix* (3 species), and the brachyourans by *Paraprosopon* (1 species), and *Oonocarcinus* (3 species). Of the ostracods, Gemmellaro cites *Cypridinella* (2 species), *Cypridellina* (1 species), *Cypridella* (2 species), *Cypridina* (4 species), *Philomedes* (1 species), *Entomoconchus* (1 species), *Entomis* (2 species), and *Beyrichia* (1 species). No matter whether we consider the trilobites or the ostracods, they are much less differentiated in the Guadalupian fauna, while the decapods are not known there at all.

I have failed to find any account of the Crustacea of the Carnic Alps, save that given by Gortani, and his fauna is, I believe, older than that of the Trogkofelschichten, which is especially interesting in the present comparisons. Unfortunately the Trogkofel Crustacea have not been described. Gortani cites a species of *Phillipsia*, one of *Griffithides*, and one of *Brachymetopus*. His figures are poor, but the species appear to have no close connection with *Anisopyge* of the Guadalupian.

In the German Dyas again the Crustacea are an important factor in the fauna. Geinitz cites *Hemitrochiscus* (1 species) and *Prosoponiscus* (1 species) among the decapods Much more abundant are the ostracods, of which 26 species are cited, 25 being referred to *Cythere* and 1 to *Kirkbya*.

In the English Permian trilobites have not been found, but ostracods are fairly abundant. King recognizes ten species of *Cythere*, *Bairdia*, etc. He also describes two species of phyllocarid Crustacea under the titles *Dithyrocaris permiana* and *D. glypta*. The Guadalupian fauna differs from the English Permian in the presence of trilobites, the absence of phyllocarids, and the more rare occurrence of ostracods, although the character of the latter is, so far as it goes, much the same.

From Nova Zembla Toula cites *Phillipsia gruenewaldti;* that species, however, is but remotely related to the Guadalupian Anisopyges.

Stache found only *Cythere* sp. in the Carboniferous limestone of the West Sahara (Igidi).

A great variety of Crustacea have been described from the American Pennsylvanian, although they are seldom abundant or varied at any one place. Among the trilobites there have been discriminated 3 species of *Griffithides*, 5 of *Phillipsia*, and 1 of *Proetus*. Apparently these are all generically distinct from the Guadalupian trilobites. The other groups of Crustacea, according to Weller's bibliography, subsequently described forms being neglected, make up a long list, as follows:

	Species.		Species.
Acanthotelson	2	Dipeltis	1
Anthrapalæmon	1	Dithyrocaris	1
Belinurus	1	Eurypterus	5
Beyrichia	1	Leaia	2
Ceratiocaris	1	Paleocaris	1
Cryptozöe	1	Prestwichia	3
Cyclus	1	Rachura	1
Cythere	2		

This is very different from the Guadalupian fauna, although chiefly in the way of greater differentiation. The phyllocarids, the limuloids, and the decapods, all represented in the Pennsylvanian, are lacking in the Guadalupian, although as they are but rarely encountered in the former their apparent absence in the latter does not carry much weight, at least until the Guadalupian has been far more extensively collected.

Order TRILOBITA.

Family PROETIDÆ Barrande.

Genus ANISOPYGE n. gen.

This seems to be one of the last survivors of the trilobite group, and while it can almost certainly be referred to the Proetidæ, it probably represents a genus distinct from any of those at present recognized as belonging to that family. From among the numerous peculiarities already shown by our imperfect knowledge of this form it is difficult to discriminate precisely the characters of generic importance from those which are specific and individual. Some of the seemingly more important, however, which may be regarded as discriminating it in a generic way, are here set forth. In the cephalon are to be noted the low convexity, the wide border, the glabella much enlarged in front and divided by strong marginal furrows, and the absence of genal angles. These characters appear singly in other genera of the Proetidæ, but not, I believe, in combination. A character which seems to be peculiar to the present form is the limitation of the fixed cheeks to the eye lappets. In the pygidium the folding under of the border, the development of a smooth band along the edges of the axis, the great number of the axial lobes and their independence of the lateral lobes, are the important characters, unknown, so far as I am aware, at least to the degree here present, in others of the Proetidæ. The entire lack of connection between the lateral and axial lobes shown by the large and variable number of the one and the small and constant number of the other, the separation of which by the development of an unsegmented band on the axis must perhaps be regarded as a correlated phenomenon, is an interesting case of specialization in this organ.

Without much doubt *Phillipsia* is the nearest related of the Proetidæ to the present type, and I am not sure to what degree the latter is entitled to discrimination. In the cephalon the glabella is distinctly more pyriform than in typical *Phillipsia* or in the majority of species, and the fixed cheeks are more reduced in size, but the lines of the facial suture are essentially the same and also the furrows of the glabella. The failure to extend the genal angles into spines is not unknown in *Phillipsia*, though most of the species seem to have spines. I do not know to what extent the structure of the eye, which appears to be solid on the exterior side and faceted only on the interior, will afford distinctive characters. It may prove important. *Phillipsia* has 9 thoracic segments and the present genus, so far as known, but 7, a difference, even if corroborated, of no very great degree. In the pygidium the differences are perhaps as marked as anywhere. The axial and the lateral segments in *Phillipsia* are very nearly the same in number, and they are in fair correspondence. It is only toward the tip of the pygidial axis that the segments multiply more rapidly than the lateral ones. Woodward describes the axis of the pygidium of *Phillipsia* as composed of 12 to 16 segments. The axis of the typical species of *Anisopyge* contains about 30 segments, and there is a very striking discrepancy between the segments of the axis and those of the pleural regions, a discrepancy emphasized by the presence of an unsegmented band along either side of the axis.

On account of these differences it did not seem desirable to retain under *Phillipsia* Shumard's Guadalupian fossil described as *P. perannulata*. *Pseudophillipsia*, which Gemmellaro described from a fauna in many ways much resembling that of the Guadalupe Mountains, is a still more strongly differentiated genus.

In one respect *Anisopyge* is very similar to the Himalayan genus *Cheiropyge*, i. e., in the very unequal segmentation of the axial and lateral portions of the pygidium. The fact that in *Anisopyge* the pygidium is surrounded by a broad, smooth band, while in *Cheiropyge* the lobes are extended so as to give this number a denticulate outline, is an important difference. Comparisons of other portions of the carapace are impossible because only the pygidium of the Himalayan form is known. It is evident, however, that the two types do not represent the same genus.

ANISOPYGE PERANNULATA Shumard.

Pl. XVI, figs. 14 to 19.

1858. *Phillipsia perannulata*. Shumard, Trans. Acad. Sci. St. Louis, vol. 1, p. 296 (date of volume, 1860).
White [Permian] limestone: Guadalupe Mountains, New Mexico.

1859. *Phillipsia perannulata*. Shumard, idem, p. 388, pl. 11, fig. 10.
White [Permian] limestone: Guadalupe Mountains, Texas and New Mexico.

1887. *Phillipsia perannulata.* Vodges, Ann. New York Acad. Sci., vol. 4, p. 84.
Carboniferous: Guadalupe Mountains, New Mexico.

Pygidium deltoid, as wide as long, elevated; border narrow, smooth, inflected behind, outer edge sinuate, inner edge obtusely subangulated, the anterior two-thirds marked with a shallow furrow; posterior extremity narrow, very strongly arched; axial lobe elevated, nearly as wide as one lateral lobe, tapering very gradually from front to posterior extremity, which is bluntly rounded and nearly terminal; axial rings from 28 to 30, rounded, distinct on the dorsum, becoming obsolete on the sides, margins sinuate, surface of each ring studded with a single row of 4 or 5 granules, the granules of 1 ring alternating with those of the adjoining ones, transverse furrows much narrower than the rings and not deeply impressed; lateral lobes arched, somewhat flattened superiorly; segments 8, subangulated, simple, gently arched forward, posterior ones directed obliquely backward, the last one being nearly parallel with the longitudinal axis; transverse furrows deep and rather broad; surface of rings garnished with a row of distinct granules.

Dimensions.—Length and width, 0.74; height, 0.28.

Geologic formation and locality.—White limestone of Guadalupe Mountains, New Mexico. The collection of the expedition contains several examples of the pygidium of this species.

Shumard based this species on the only part known to him, the pygidium, his description of which is quoted above. From more or less perfect material recently collected it is possible to add to his description that of the cephalon and the probable number and character of the thoracic segments.

The general shape of the cephalon is semicircular. The suture is as usual in this family, except as specified below. The glabella is moderately convex and strongly expanded in front, occupying almost the whole cranidium. The border is wide, narrowing at the sides, separated from the glabella by a distinct though not deep furrow, which indents the otherwise even curve made by a longitudinal section through the glabella and border. The neck ring and the posterior portion of the glabella are strongly depressed. The fixed cheeks are limited to the rounded, flaplike projections at the sides of the glabella near its posterior end, which fit into the concave side of the ocular crescent. These flaps are in this species suberect. The glabella bears three, possibly four, marginal furrows, which are slightly curved. Beginning with the posterior one, which is strongly inclined backward, the furrows decrease in length, strength, and obliquity toward the front. The triangular space inclosed between the first lateral furrow and the neck furrow, i. e., the first lobe of the glabella, is elevated centrally into a pointed node or pustule. The second lateral lobe is narrow. It terminates in a second projection, similar to the first, though larger. The third lateral lobe terminates in a third monticule of about the size of the first, but less pointed and less clearly defined. Just in front of the end of the third lateral furrow a fourth small, low elevation is to be seen, with possibly a fourth short indistinct furrow, marginally in front of it. Located centrally in a transverse line with the knobs which terminate the second lateral lobes, another strongly elevated knob occurs. Behind the line thus formed, the glabella is much depressed. The neck ring is broad and is produced laterally into two rather strong, slender, tapering strips. The surface of the border is marked by lines running parallel but not conforming to its margins. The surface of the rest of the cranidium is nearly smooth, being marked by rather indistinct, scattered pustules, which are obvious only on the posterior half, especially on the neck ring.

The free cheeks have a generally triangular shape. They are cut squarely off at the genal angle, not prolonged into spines. The eye is large, reniform, and strongly elevated. Its facets are obscure on the outside but strongly marked on the inside. A broad border surrounds the posterior and lateral side of the free cheek. On the inner side of the lower margin the border becomes gradually narrower, leaving room for the strip which projects from the neck ring. The border is rather strongly convex, as is also the inner portion, the two areas being defined by strongly marked furrows parallel to the margins. In the case of the lower furrow it is parallel to the margin of the cephalon as a whole, the suture, which forms the lower outline of the free cheek, being oblique to it. The inner area defined by the furrows has an approximately triangular shape, its inner angle, however, being strongly truncated by the eye with its surrounding grooves. The lateral border of the free cheek is marked by longitudinal lines, the inner area by a few pustules of rather large size. In one specimen these are restricted to the portion of the area anterior to the eye, in others they are distributed more evenly, though rather sparsely, over the whole.

The pygidium has already been described by Shumard. Some additional facts are furnished by our material. As indicated by his description, the border of the pygidium is somewhat peculiar. Toward the front it is flat and spreading, forming part of the regular transverse expansion. Toward the back its lower border rather suddenly begins to turn inward, so that at the extremity it is doubled under the rest of the shell. In the process about halfway down the side the border often becomes somewhat concave, with a ridge above and one blow. The upper ridge becomes more and more pronounced, as the lower part of the border becomes more and more restricted, until at the posterior extremity it forms the real terminus of the shell. Viewed from above, therefore, the posterior end appears to be without a border, it having been turned under and concealed by the parts lying above. This allows the axis to reach nearly or quite to the posterior outline and gives this end a pinched and pointed appearance. Another feature mentioned by Shumard is that the axial segments did not persist to the primary dorsal furrows, but are regularly limited by a depressed line parallel to these furrows, so that the axis is edged by a rather distinctly defined plain band. There are eight lateral lobes, the number on large and small specimens alike seeming to be constant. The number of axial lobes seems to vary according to size, though this may be only apparent, as in small specimens the terminal ones become so minute and faint that it is impossible to count them with accuracy.

In only one specimen, and that a rather young one, is the number of thoracic segments indicated. In this case the pygidium is preserved with seven of the free segments attached to it, but as the cephalon is missing some of these segments may have been lost with it.

Horizon and locality.—Middle of Capitan formation, Capitan Peak (station 2926); base of Capitan formation, hill southwest of Guadalupe Point (station 2906); "dark limestone," Pine Spring (station 2930); Delaware Mountain formation, Guadalupe Point (station 2931); basal black limestone, Guadalupe Point (station 2967), Guadalupe Mountains, Texas. Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

ANISOPYGE? ANTIQUA n. sp.

Pl. XXIV, figs. 23 to 26.

This species, which is discriminated especially for some specimens obtained from the black limestone at the base of the Guadalupian section, is less completely known than *A. perannulata*. In the present case we have a number of pygidia and an imperfect head shield.

The cephalon is almost too imperfect for detailed description. So far as known it does not differ materially from that of *A. perannulata*. The glabella appears to be pyriform, and it has three distinct lobes, with possibly a fourth obscure one.

The pygidium is subsemicircular, wider than long, strongly arched. The axis is very strongly elevated, divided into about 16 well-marked segments, each of which is crossed by a row of pustules. The segments lose distinctness along the margins of the axis, where there occurs a moderately well-defined band on which they are rather obscure. The lateral segments are not as strongly marked as those on the axis and appear to number but seven. There is a broad smooth band around the whole pygidium, which narrows and becomes more vertical behind, so that the end of the axis is almost terminal.

This species is readily distinguishable from *A. perannulata* by the greater width of the pygidium, which has much fewer segments on the axis. The lateral segments also stand more perpendicular, those of *A. perannulata*, especially the posterior ones, pointing strongly backward.

Horizon and locality.—Basal black limestone, Guadalupe Point, Guadalupe Mountains, Texas (station 2967).

Order OSTRACODA.

Family CYTHERIDÆ Zenker.

Genus CYTHERE Müller.

CYTHERE? sp.

Pl. XVI, figs. 13 and 13a.

Our collections contain only one specimen of this species, and it is somewhat broken. The general shape is oval, a little higher at one end than the other. The lower margin is convex, somewhat more strongly rounded behind. The upper margin is more nearly straight, especially in the middle, more curved at the ends, and slightly converging forward with the base. The convexity is high, being especially inflated just posterior to the middle, behind which it is well rounded, but descends more rapidly to the anterior extremity. The surface appears to be delicately roughened or pitted.

More perfect material representing this species will be necessary before a complete and accurate description can be framed, the foregoing being, however, the best that I could make under the circumstances.

Horizon and locality.—"Dark limestone," Pine Springs, Guadalupe Mountains, Texas (station 2930).

Family CYPRIDÆ Zenker.

Genus BAIRDIA McCoy.

BAIRDIA aff. B. PLEBEIA Reuss.

Pl. XXV, figs. 16 and 16a.

This species also is represented in our collections by a single silicified specimen, apparently a right valve. The size is small, about $1\frac{1}{3}$ mm. in width, and the height is less than half that amount. The shape is irregular, pointed at both ends, but more acute and produced behind than before. The upper outline is strongly convex in the middle and slightly concave at both ends. The lower margin is nearly straight in the middle, bending upward at both ends but more at the anterior than at the posterior, and meeting the upper outline more or less abruptly. The convexity is rather strong and inflated toward the middle, with the ends depressed. The surface is apparently smooth.

This species resembles *Bairdia plebeia* Reuss of the German and English Permian more than any with which I have compared it. It seems to be different, but with only one valve of the Guadalupian shell and no specimen of the European one with which to compare it, I feel unable to arrive at a conclusion on this point.

Horizon and locality.—Basal black limestone, Guadalupe Point, Guadalupe Mountains, Texas (station 2920).

Genus ARGILLŒCIA Sars.

ARGILLŒCIA sp.

Pl. XXVIII, figs. 12 and 12a.

Of this species our collection contains only one valve, which has so symmetrical a shape that I am unable to determine which end is anterior and which posterior, and whether it is a right or a left valve. It so much resembles the English Carboniferous form which Jones and Kirkby described as *Argillœcia æqualis*[a] that I have provisionally referred it to the same genus, though it is clearly distinct in its specific relations.

The shape is regularly elliptical, with broadly and equally rounded ends. The width, which is almost exactly 2 mm., is about twice the height. What must be regarded as the lower margin is nearly straight, while the upper is gently convex. The two margins diverge very slightly toward one end. The convexity is moderate, rather flattened over the mesial portion, and strongest about the margin. The shell is flexed somewhat more abruptly along the lower than the upper border, which occasions the straight outline in the one and the curved outline in the other. Transversely, however, the convexity appears to be symmetrical, without one end higher than the other. The surface is smooth.

Horizon and locality.—Delaware Mountain formation, southern Delaware Mountains, Texas (station 2969).

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[a] Ann. Mag. Nat. Hist., ser. 5, vol. 18, 1886, p. 263, pl. 9, figs. 6a, 6b.

REGISTER OF LOCALITIES.

2902. Guadalupe Mountains, Texas. Peak on north side of Pine Spring Canyon. Well up in the Capitan limestone; probably the lower portion of the upper third.
B. F. Hill and G. H. Girty, October 5, 1901.

2903. Guadalupe Mountains, Texas. Escarpment on east side of road at the entrance to Guadalupe Canyon. About 700 feet above the basal black limestone in the Delaware Mountain sandstone.
G. H. Girty, September 29 and October 31, 1901.

2905. Guadalupe Mountains, Texas. Summit of El Capitan and just below. Top of the Capitan limestone.
G. H. Girty, September 27, 1901.

2906. Guadalupe Mountains, Texas. In foothill ridge about 3 miles southwest of Guadalupe Peak; about one-fourth mile northwest of No. 2924 and 150 feet higher up. Lower portion of the Capitan limestone.
G. H. Girty, October 2, 1901.

2919. Guadalupe Mountains, Texas. Near station 2920 and 300 feet above it, in a notch in a long ridge. About 250 feet above the basal black limestone, in the Delaware Mountain sandstone. Calcareous phase of sandstone.
G. H. Girty, October 1, 1901.

2920. Guadalupe Mountains, Texas. Small canyon among foothills about 2 miles south of Guadalupe Peak. Near top of the basal black limestone.
B. F. Hill and G. H. Girty, October 1, 1901.

2924. Guadalupe Mountains, Texas. In foothill ridge about 3 miles southwest of Guadalupe Peak. Upper portion of the "dark limestone."
G. H. Girty, October 2, 1901.

2926. Guadalupe Mountains, Texas. Just below knob on crest of spur running northward from El Capitan. Part of material from horizon above or below. About 1,000 feet below summit of El Capitan and the top of the Capitan limestone.
B. F. Hill and G. H. Girty, September 22 and 27, 1901.

2930. Guadalupe Mountains, Texas. Chiefly float, almost entirely from north side of Pine Spring Canyon, from two spurs embracing the spring. Supposed to be from the "dark limestone" immediately above the sandstones of the Delaware Mountain formation; some of it in place.
G. H. Girty, September 26 and October 6, 1901.

2931. Guadalupe Mountains, Texas. West side of road at entrance to Guadalupe Canyon. Lower half of the Delaware Mountain sandstone; opposite to station 2903 and at about the same horizon, possibly above.
G. H. Girty, October 3, 1901.

2932. Guadalupe Mountains, Texas. McKitterick Canyon, about 10 miles northeast of Pine Spring. Low down in the Capitan limestone.
G. H. Girty, October 4, 1901.

2935. Van Horn quadrangle. One-half mile south of tank in draw that cuts the southern Delawares; about 7 miles north of Jones's ranch. Delaware Mountain formation.
G. B. Richardson, September 21, 1903.

2936. Van Horn quadrangle. Low hills one-half mile west of Jones's ranch. Delaware Mountain formation.
G. B. Richardson, September 21, 1903.

2957. Top of the Delaware Mountains, 27 miles northeast of Van Horn. Delaware Mountain formation.
G. B. Richardson, October 16, 1903.

2962. Van Horn quadrangle, 2½ miles east of tank in draw that cuts the southern Delawares. Delaware Mountain formation.
G. B. Richardson, September 22, 1903.

2963. West front of Delaware Mountains, about 2 miles south of El Capitan. 750 feet above the basal black limestone in the Delaware Mountain formation.
E. H. Elder, August 14, 1903.

2964. Limestone Mountain, southern extremity of the Delawares, 10 miles northwest of Kent and 15 miles northeast of Plateau. Delaware Mountain formation.
G. B. Richardson, October 13, 1903.

2965. Van Horn quadrangle. Top of Delaware Mountains, 30 miles northeast of Van Horn. Delaware Mountain formation.
G. B. Richardson and E. H. Elder, October 16, 1903.

2966. Guadalupe Mountains, Texas. Top limestone of El Capitan. Same as station 2905.
G. B. Richardson, August 13, 1903.

2967. Low hills, about 2 miles south of El Capitan. Basal black limestone below Delaware Mountain sandstone.
E. H. Elder, August 14, 1903.

2968. Base of Hogue trail up Delaware Mountains. West base of mountains 18 miles south of Capitan Peak. Black limestone near middle of the Delaware Mountain formation.
G. B. Richardson, October 28, 1903.

2969. Van Horn quadrangle, about 30 miles northeast of Van Horn, in the Delaware Mountains. Same as station 3500. Delaware Mountain formation.
G. B. Richardson, September 23, 1903.

3500. Van Horn quadrangle. About 15 miles north of Jones's ranch, Delaware Mountains, 4800-foot hill. Same locality as station 2969. Delaware Mountain formation.
G. B. Richardson, September 23, 1903.

3501. Van Horn quadrangle. Limestone ridge 1½ miles east of Jones's ranch, about 9 miles north of Plateau. Delaware Mountain formation.
G. B. Richardson, September 24, 1903.

3762. "Trans-Pecos, Texas. Guadalupe Mountains. Upper limestone." Supposed to be the top of the Capitan limestone.
R. T. Hill, August 13, 1900.

3762a. "Trans-Pecos, Texas. Guadalupe Mountains. Upper limestone." Supposed to belong in the "dark limestone."
R. T. Hill, August 13, 1900.

3762b. "Trans-Pecos, Texas. One mile east of Guadalupe Peak. Altitude 6,000 feet." Supposed to belong in the "dark limestone."
R. T. Hill, August 13, 1900.

3762c. "Trans-Pecos, Texas. Guadalupe Peak. Upper limestone." Supposed to belong in the "dark limestone."
R. T. Hill, August 13, 1900.

3762d. "Trans-Pecos, Texas. Guadalupe Mountains." Supposed to belong in the "dark limestone."
R. T. Hill, August 13, 1900.

3762e. "Trans-Pecos, Texas. Guadalupe Mountains. Upper limestone." Supposed to belong in the "dark limestone."
R. T. Hill, August 13, 1900.

3763. "Big Bend, Texas. Comanche Canyon, Glass Mountains, 17 miles northeast of Marathon, Tex." Supposed to represent the Delaware Mountain formation.
R. T. Hill, November 3, 1899.

3764. The recorded locality is the vicinity of the Diablo Mountains, Texas, but this is probably a mistake. The material to which this label actually applies and with which the present lot is probably mixed appears to be that mentioned in Von Streeruwitz's report (Ann. Rept. Geol. Survey Texas for 1892, 1893, p. 170), and sent to the National Museum by E. T. Dumble, January 18, 1892.

3840. "Big Bend region. Mountains northwest of Marathon, Tex." Supposed to be the same horizon as station 3763 and to represent the Delaware Mountain formation.
R. T. Hill, September 25, 1899.

PLATES IV TO XXXI.

PLATE IV.

PLATE IV.

MISCELLANEOUS.

ORTHOTETES Fischer de Waldheim (pp. 186 et seq.).

FIG. 1. This is fig. 4a of Fischer de Waldheim's Oryctographie (1830 ed., pl. 20), and was repeated in the 1837 edition (pl. 20, fig. 4a). In the first instance the legend was merely *Orthotetes*, but in the second there was added the statement that it was the interior of the lower valve, the cut above being the flattened hinge plate seen from above. (For the original description of the figures see pp. 186–189 of the present report.) This figure has usually been referred to as representing a dorsal valve, but when taken in connection with the hinge plate, with the descriptions, and with subsequent figures, it is quite evidently a ventral valve.

FIG. 1a. This was fig. 4b of pl. 20 in both editions of the Oryctographie. In the first edition there was no description relating to it, but in the 1837 edition it was said to be the dorsal canal of the valve shown by 4a (1 of this plate).

FIG. 1b. This figure does not appear in the 1830 edition of the Oryctographie, but was introduced in the 1837 edition. It was there described as the upper valve of *Orthotetes* n. g., and constituted fig. 4e of pl. 20. In view of the configuration one can not help believing that this also is a ventral valve, an interpretation which would fit well with Fischer's conception of the genus at that time. He conceived it, in fact, to be a pelecypod related to *Pedum*. It is probable that he had two ventral valves in mind, rather than two dorsals, or than a dorsal and a ventral, because the latter combination shows too conspicuously the inequivalve character of the shell for Fischer to compare it to *Pedum*, which is of course one of the Pectinidæ, while *Pedum* has a high area and cartilage pit, not at all like the structure or the configuration of the dorsal valve of *Orthotetes*, but superficially not dissimilar to the ventral valve. Fischer's description and figures seem to bear out these inferences. This figure and 1b are not reproduced in Fischer's treatise of the year 1850.

ORTHOTETES RADIATUS Fischer de Waldheim (pp. 189 et seq.).

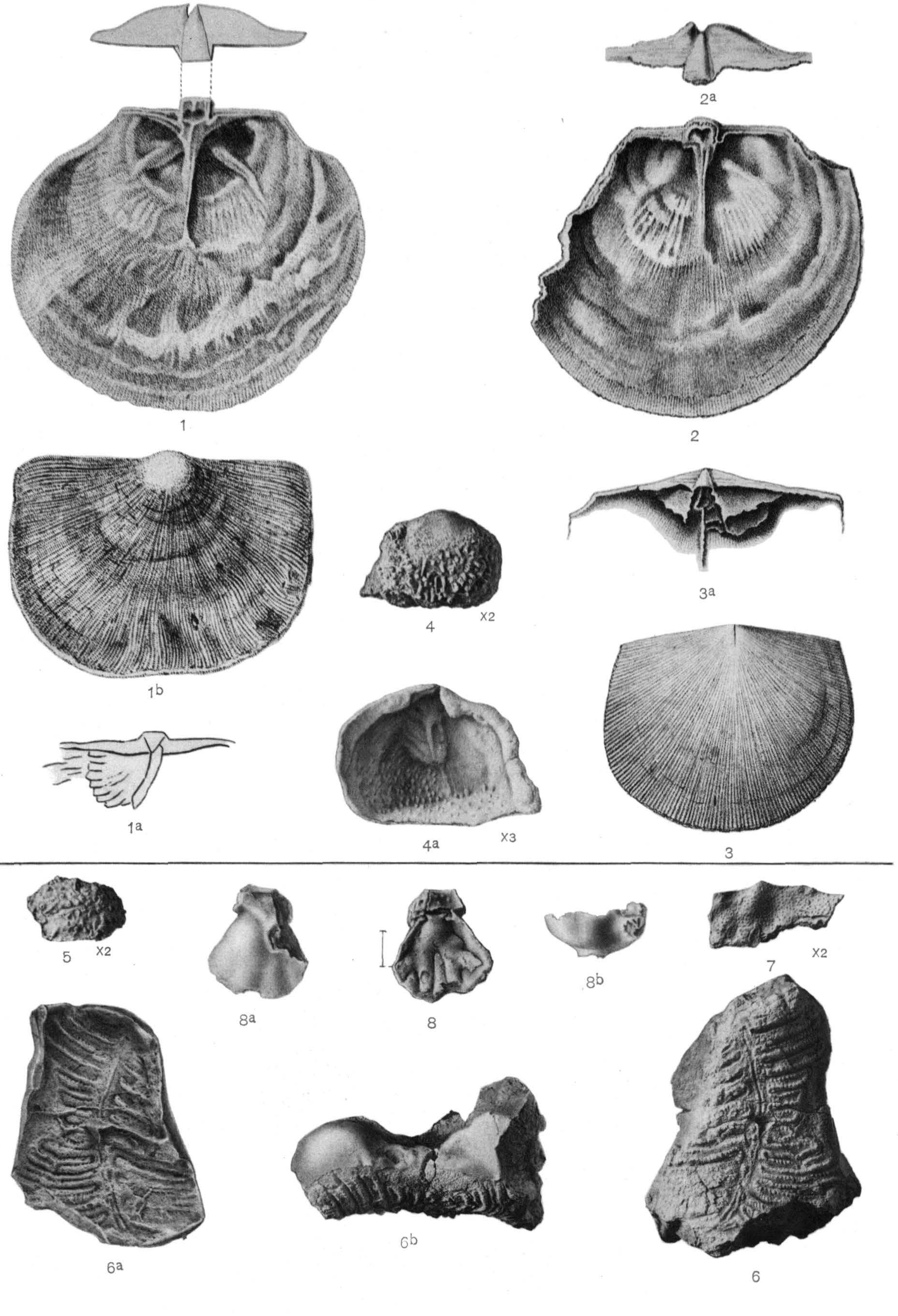
FIG. 2. This figure was fig. 3 of pl. 10 of Fischer's final discussion of the genus in 1850 (see p. 189 of the present work). This is evidently a better drawing of the original of fig. 1 (4a of the Oryctographie), with which the genus *Orthotetes* was first illustrated. In this place, for the first time, the generic term is supplied with a specific name. *Orthotetes radiatus* is, therefore, the species on which the genus was originally based, and it had the internal structures of Waagen's *Derbya*, probably of his camerate division (see Fischer's descriptions).

FIG. 2a. This figure was not named or described by Fischer in 1850, but it evidently represents the upper cut of fig. 1 (fig. 4a of pl. 20 in the Oryctographie), and without much question belongs to *Orthotetes radiatus*.

ORTHOTETES SOCIALIS Fischer de Waldheim (pp. 189 et seq.).

FIG. 3. This is a reproduction of the figure used by Fischer in 1850 to illustrate his species *Orthotetes socialis* (it was there fig. 4 of pl. 10), which from his description apparently belongs to the septate division of Waagen's *Derbya*.

FIG. 3a. This was fig. 1 of pl. 10 of Fischer's work on *Orthotetes* published in 1850. He gave no name or description for it at that time, but it seems probable that it represents the area and interior of *Orthotetes socialis*. (See pp. 189 et seq. of the present work for Fischer's text and a discussion of it).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8b
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6b
6a
6

STROPHALOSIA CORNELLIANA Derby (p. 276).

FIGS. 4 and 4a. A representative ventral valve from Brazil.
4. Exterior view, × 2.
4a. Interior view, × 3. On the inside of the shell is shown a peculiar thickening which suggests that of *Richthofenia permiana* Shumard.
"Coal Measures:" Itaituba, Brazil.

CAPITAN FORMATION, GUADALUPE MOUNTAINS.

STROPHALOSIA CORNELLIANA Derby (p. 276).

FIG. 5. A ventral valve from Texas referred to this species.
Exterior, seen from above, × 2.
Capitan formation, hill southwest of Guadalupe Point (station 2906).

LEPTODUS GUADALUPENSIS n. sp. (p. 213).

FIGS. 6 to 6b. A ventral valve. The specimen represented by this figure is a mold of the interior, the shell having been more or less completely removed by exfoliation. This is the usual condition in Capitan specimens.
6. View of the lower side.
6a. Impression of the same, presenting the parts in their natural topographic relations.
6b. Side view, showing how the lateral expansions tend to arch over the interior of the shell.
Capitan formation, Capitan Peak (station 2926).
FIG. 7. A portion of the shell showing the papillose or punctate surface.
Seen from above, × 2.
Capitan formation, Capitan Peak (station 2926).

LEPTODUS AMERICANUS n. sp. (p. 212).

FIGS. 8 to 8b. A young example of this species attached to a branching bryozoan (probably *Acanthocladia*), showing both valves in conjunction.
8. Seen from above, × 3.
8a Seen from below, × 3.
8b. Seen from the side, × 3.
Capitan formation, hill southwest of Guadalupe Point (station 2906).

PLATE V.

PLATE V.

CAPITAN FORMATION, GUADALUPE MOUNTAINS.

FUSULINA ELONGATA Shumard (p. 62).

FIG. 1. A specimen of the normal character.
Section taken longitudinally, but somewhat oblique, showing the appearance usually seen in thin sections made at random, × 10.
Capitan formation, Capitan Peak (station 2905).

FIG. 2. A small or young specimen broken at one end, as is often the case.
Longitudinal section passing through the large initial cell, × 10.
Capitan formation, Capitan Peak (station 2905).

FIG. 3. A medium-sized specimen somewhat larger than the last.
Transverse section through the large initial cell, × 10.
Capitan formation, Capitan Peak (station 2905).

FIG. 4. Rock fragment showing occurrence.
Seen from above. This is a natural weathered surface and shows not only how abundant the organisms really are, but how they are oriented alike, for all the sections are transverse.
Capitan formation, Capitan Peak (station 2905).

FIG. 5. Rock fragment showing occurrence.
Seen from above. In this view the specimens are seen longitudinally and their abundance and tendency to point in the same direction are shown similarly to fig. 4.
Capitan formation, Capitan Peak (station 2905).

FUSULINELLA sp. *a* (p. 65).

FIG. 6. A small foraminifer supposed to belong to the genus *Fusulinella*.
A thin section probably perpendicular to the axis, but situated near one end of it, × 10.
Capitan formation, Capitan Peak (station 2905).

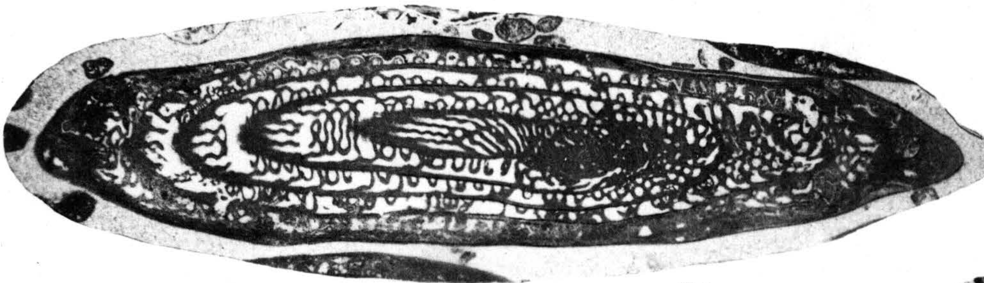
GUADALUPIA? sp. (p. 85).

FIG. 7. An organism of small size, rather abundant at this horizon and doubtfully spongoid.
Thin section transverse to the axis (if the initial shape was cylindrical), × 10.
Capitan formation, Capitan Peak (station 2905).

FIG. 8. Another example similar to the last.
Transverse section, × 10. This section, like the preceding, illustrates how most of the fossils at this horizon are enveloped in a coating of dolomite (?).
Capitan formation, Capitan Peak (station 2905).

FIG. 9. Another appearance seen in thin sections; supposed to belong to the same organism as the foregoing.
A section more nearly tangential, × 10.
Capitan formation, Capitan Peak (station 2905).

FIG. 10. A thin section oriented like the preceding, × 10.
Capitan formation, Capitan Peak (station 2905)



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1

X10

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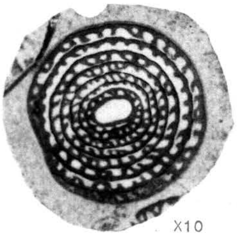

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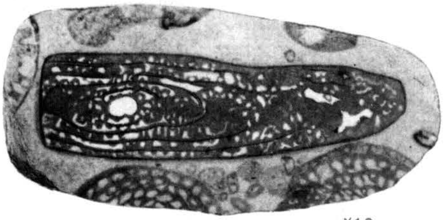

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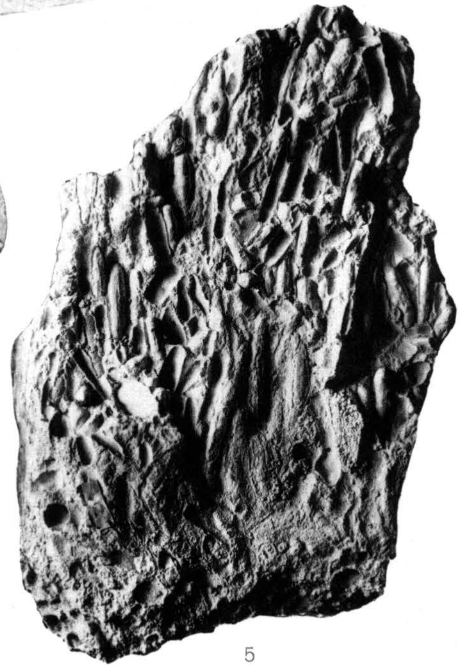

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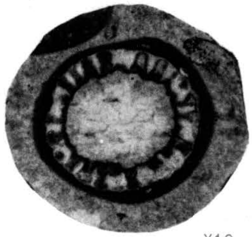

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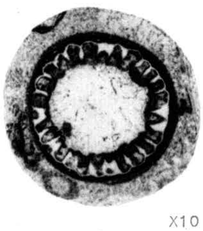

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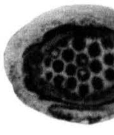
8

13

12

X10

9



X10

10

X10

11

FIG. 11. A small organism having a structure resembling the foregoing but on a much more minute scale. It may be a radiolarian.
Section partly tangential and partly through the organism, × 10.
Capitan formation, Capitan Peak (station 2905).

GUADALUPIA CYLINDRICA var. ROBUSTA n. var. (p. 83).

FIG. 12. A specimen in which the structure is largely obscured.
Side view.
Capitan formation, Capitan Peak (station 2905).

GUADALUPIA DIGITATA n. sp. (p. 84).

FIG. 13. The typical and only specimen.
Side view.
Capitan formation, Capitan Peak (station 2902).

PLATE VI.

PLATE VI.

CAPITAN FORMATION, GUADALUPE MOUNTAINS.

GUADALUPIA ZITTELIANA n. sp. (p. 80).

FIGS. 1 to 1d. The typical specimen. The convexity suggests that this sponge is a cylindrical body broken at the sides, but while broken away above for an indefinite distance the lateral outlines are very nearly those of the entire organism.

1. Side view.

1a. Tangential section through the outer layer, × 5.

1b. Tangential section through the outer layer, × 5. The section is more or less diagonal. Along the upper margin a spicular network is shown, more distinct than in 1a. In the center are the transversely cut ends of several mural tubes.

1c. Tangential section through the mural tubes, × 5.

1d. Section longitudinally through the mural tubes, × 5.

Capitan formation, Capitan Peak (station 2926).

FIGS. 2 to 2b. A small specimen referred with doubt to this species. Both upper and lower surfaces are retained.

2. Side view.

2a. Upper side from which the dermal layer has been partially eroded.

2b. Lower side showing thickened area of attachment.

Capitan formation, Capitan Peak (station 2926).

GUADALUPIA CYLINDRICA n. sp. (p. 81).

FIGS. 3 to 3c. The typical specimen.

3. Transverse section across the organism, cutting the mural tubes more or less longitudinally. The interior is partially filled by an irregular cystose growth which is probably intrinsic. The dark dots in the walls of the mural tubes may be sections through spicules, × 5.

3a. Longitudinal section through the organism, longitudinal also through the mural tubes. Here too is shown the partial filling of the interior by irregular cystose structures. A few of the tubes in this, as in the preceding section, will be observed to be crossed by diaphragms, × 5.

3b. Tangential section very near the periphery. The spicular network of the outer layers is shown and the transversely cut ends of some of the mural tubes, × 5.

3c. Side view of the nearly characterless specimen from whose upper end the foregoing sections were made.

Capitan formation, Capitan Peak (station 2926).

GUADALUPIA CYLINDRICA var. CONCRETA n. var. (p. 82).

FIGS. 4 to 4b. The typical specimen.

4. Side view.

4a. End view, showing the area of attachment to some striated organism, possibly a *Productus*.

4b. View of upper surface, showing the tubes in part bifoliate and in part radiating from different centers.

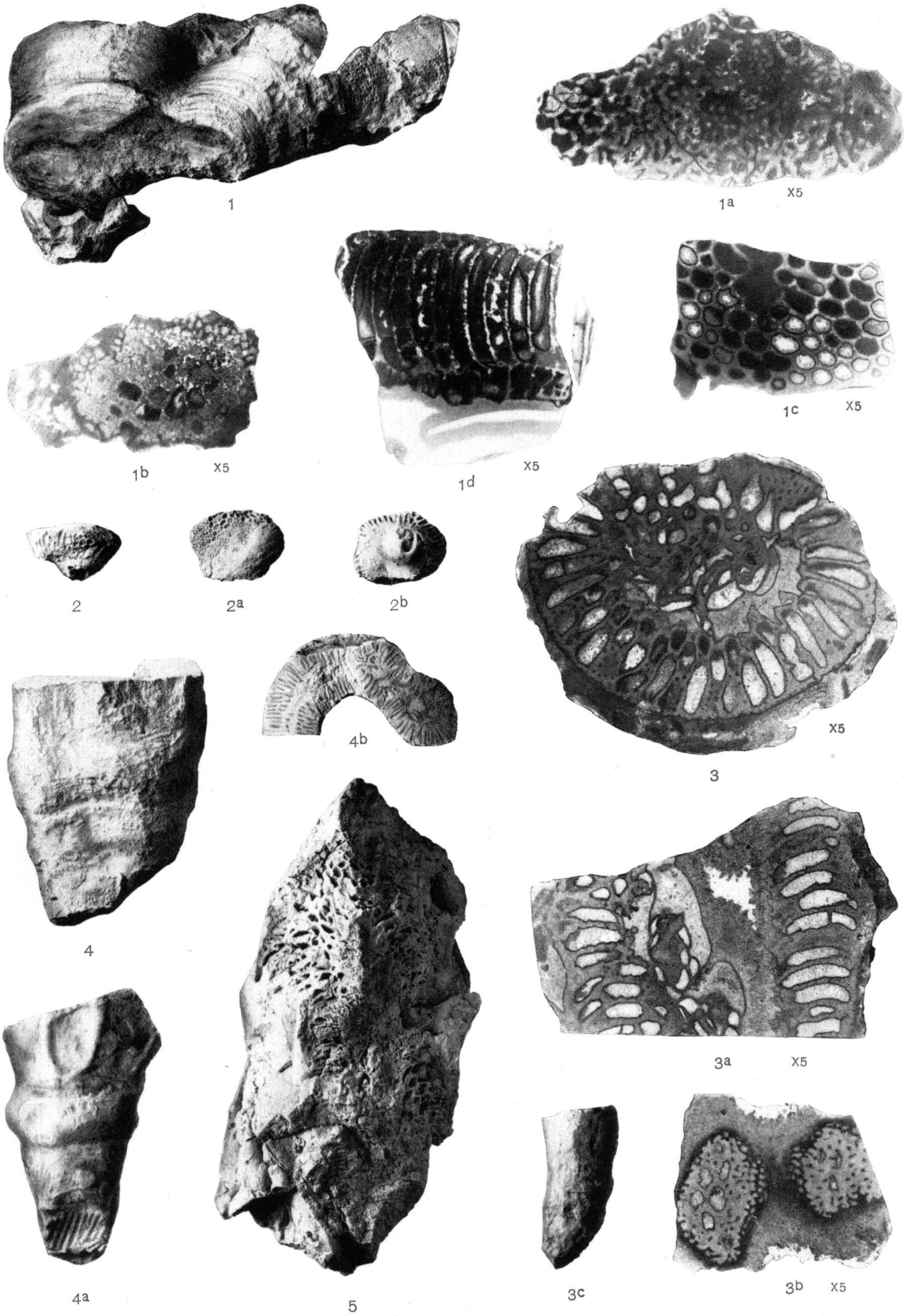
Capitan formation, Capitan Peak (station 2926).

GUADALUPIA sp. (p. 84).

FIG. 5. An organism of doubtful affinities embedded in rock.

Side view.

Capitan formation, peak north of Pine Spring (station 2902).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3 X5
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4a
5
3c
3b X5

PLATE VII.

PLATE VII.

CAPITAN FORMATION, GUADALUPE MOUNTAINS.

CYSTOTHALAMIA NODULIFERA n. sp. (p. 89).

FIG. 1. A specimen embedded in rock.
Polished section through a branch nearly parallel to the axis and near the surface, showing the irregularly cystose internal structure, × 3.
Capitan formation, Capitan Peak (station 2966).

FIG. 2. Fragment of a specimen with ostia and nodular surface.
Side view.
Capitan formation, Capitan Peak (station 2966).

FIG. 3. A larger specimen with prominent spoutlike ostia and less distinctly nodular surface.
Side view.
Capitan formation, Capitan Peak (station 2966).

STEINMANNIA AMERICANA n. sp. (p. 92).

FIGS. 4 and 4a. The typical and only specimen.
4. Side view showing the annular growth and porous structure.
4a. Opposite side, forming a natural section somewhat diagonal but in a general way longitudinal. The construction of superposed discoidal chambers is well shown.
Capitan formation, Capitan Peak (station 2926).

CYSTOTHALAMIA? sp. (p. 91).

FIG. 5. A specimen which is apparently an internal cast, referred to this genus with much doubt.
Side view.
Capitan formation, Capitan Peak (station 2926).

SOLLASIA? sp. (p. 93).

FIG. 6. A specimen referred with doubt to this genus.
Side view, × 2.
Capitan formation, Capitan Peak (station 2926).

AMBLYSIPHONELLA GUADALUPENSIS n. sp. (p. 91).

FIG. 7. The typical specimen embedded in limestone.
Natural section longitudinally through the specimen, showing the distinctive characters.
Capitan formation, Capitan Peak (station 2966).

FIGS. 8 and 8a. Another specimen referred to this species, from the same locality as the type.
8. Transverse section.
8a. Side view of exterior. The surface characters may be in part extrinsic.
Capitan formation, Capitan Peak (station 2966).

GUADALUPIA FAVOSA n. sp. (p. 83).

FIG. 9. The typical specimen, from which the outer layer has been largely removed.
Side view.
Capitan formation, Capitan Peak (station 2926).

ANTHRACOSYCON FICUS var. CAPITANENSE n. var. (p. 72).

FIG. 10. The typical specimen.
Side view.
Capitan formation, Capitan Peak (station 2926).

VIRGULA NEPTUNIA n. sp. (p. 74).

FIG. 11. Specimen embedded in limestone.
Fracture surface, × 5.
Capitan formation, Capitan Peak (station 2926).
FIG. 12. A partly weathered specimen which may be taken as the type.
Natural section more or less transverse, × 5.
Capitan formation, Capitan Peak (station 2926).

VIRGULA RIGIDA n. sp. (p. 74).

FIG. 13. The typical specimen.
Side view.
Capitan formation, Capitan Peak (station 2926).

VIRGULA RIGIDA var. CONSTRICTA n. var. (p. 75).

FIG. 14. The typical specimen.
Side view.
Capitan formation, Capitan Peak (station 2926).
FIG. 15. A specimen placed with doubt in this variety.
Side view.
Capitan formation, Capitan Peak (station 2926).

PSEUDOVIRGULA TENUIS n. sp. (p. 76).

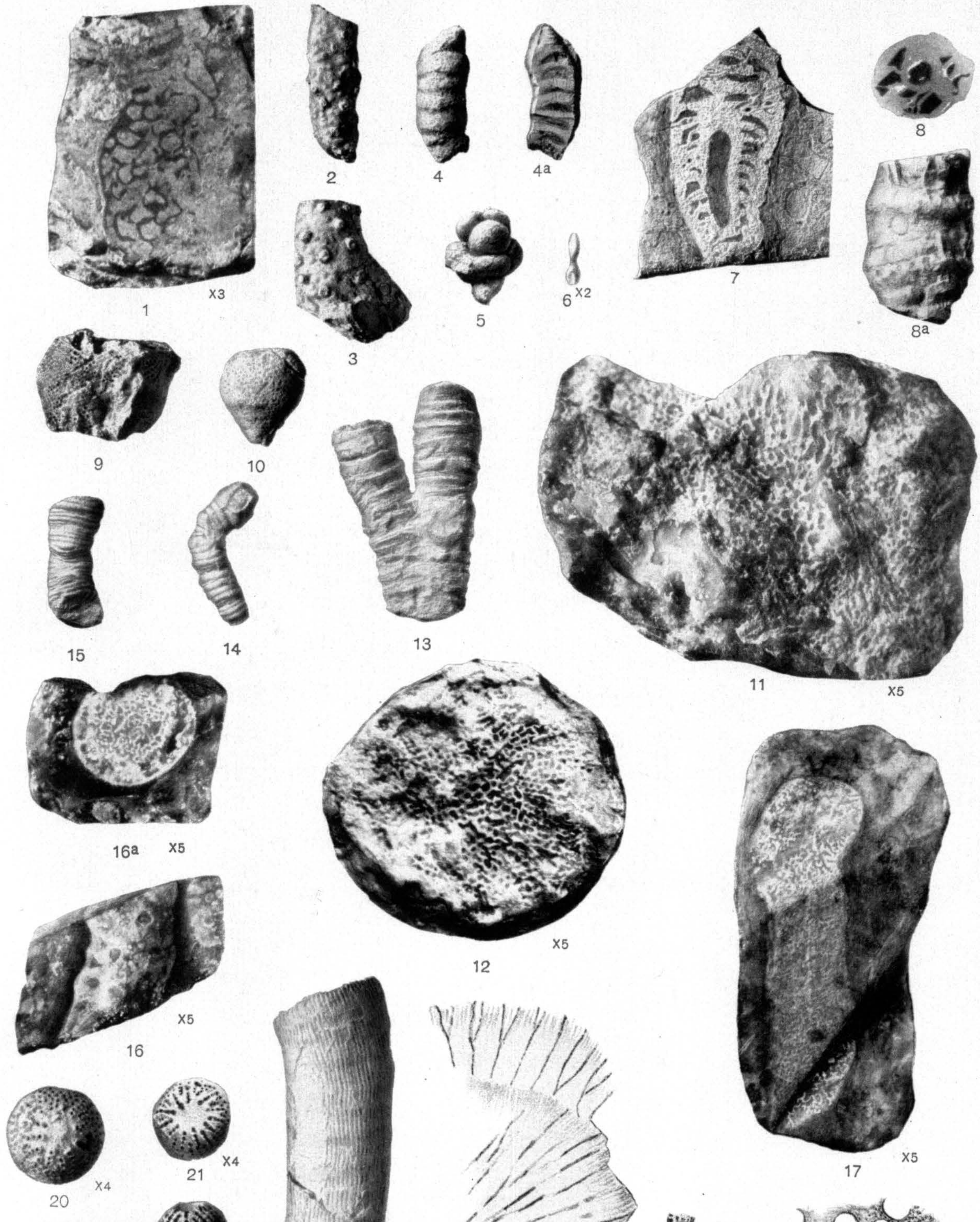
FIG. 16 and 16a. The typical specimen, a small fragment embedded in limestone.
16. Side view showing the large ostia, × 5.
16a. Transverse section showing the spicular network of the central portion and an irregular outer zone, probably adventitious, in which the spicular structure is not developed, × 5.
Capitan formation, Capitan Peak (station 2926).
FIG. 17. Another specimen referred with some doubt to this species.
Section in part longitudinal and in part transverse, × 5.
Capitan formation, Capitan Peak (station 2926).

CAMPOPHYLLUM TEXANUM Shumard? (p. 102).

FIG. 18. A crushed specimen, the only one of the sort found. It is referred with doubt to Shumard's species.
Side view.
Capitan formation, Capitan Peak (station 2926).

DOMOPORA? TERMINALIS n. sp. (p. 120).

FIGS. 19 to 19b. A colony showing the construction of superposed layers.
19. Longitudinal section, × 20.
19a. Tangential section through a portion of the same specimen, ×35.
19b. Tangential section, × 20.
Capitan formation, Capitan Peak (station 2926).
FIGS. 20 and 20a. A globose specimen.
20. Viewed from above, × 4.
20a. Side view, × 4.
Capitan formation, hill southwest of Guadalupe Point (station 2906).
FIGS. 21 and 21a. A more slender elongate specimen.
21. Viewed from above, × 4.
21a. Side view, × 4.
Capitan formation, hill southwest of Guadalupe Point (station 2906).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20a
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X35
19b
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PLATE VIII.

PLATE VIII.

CAPITAN FORMATION, GUADALUPE MOUNTAINS.

Acanthocladia guadalupensis n. sp. (p. 149).

Fig. 1. A very robust specimen referred to this species. The poriferous side is concealed, though a row of spines down the sides of the pinnules can be seen.
Nonporiferous side.
Capitan formation, Capitan Peak (station 2926).

Acanthocladia sp. (p. 152).

Figs. 2 and 2a. A small specimen belonging to an undetermined species, but one apparantly different from *A. guadalupensis*.
2. Poriferous side, natural size in outline.
2a. Same, × 4.
Capitan formation, Capitan Peak (station 2926).

Goniocladia americana n. sp. (p. 154).

Figs. 3 to 3c. A large fragment of a frond, exposing the nonporiferous side.
3. Zoarium, natural size.
3a. Section across the frond where several branches become confluent, × 3.
3b. Tangential section about halfway through the frond, × 3.
3c. Portion of the nonporiferous side enlarged to show the shape of the highly angular branches, × 3.
Capitan formation, Capitan Peak (station 2926).

Fenestella capitanensis n. sp. (p. 134).

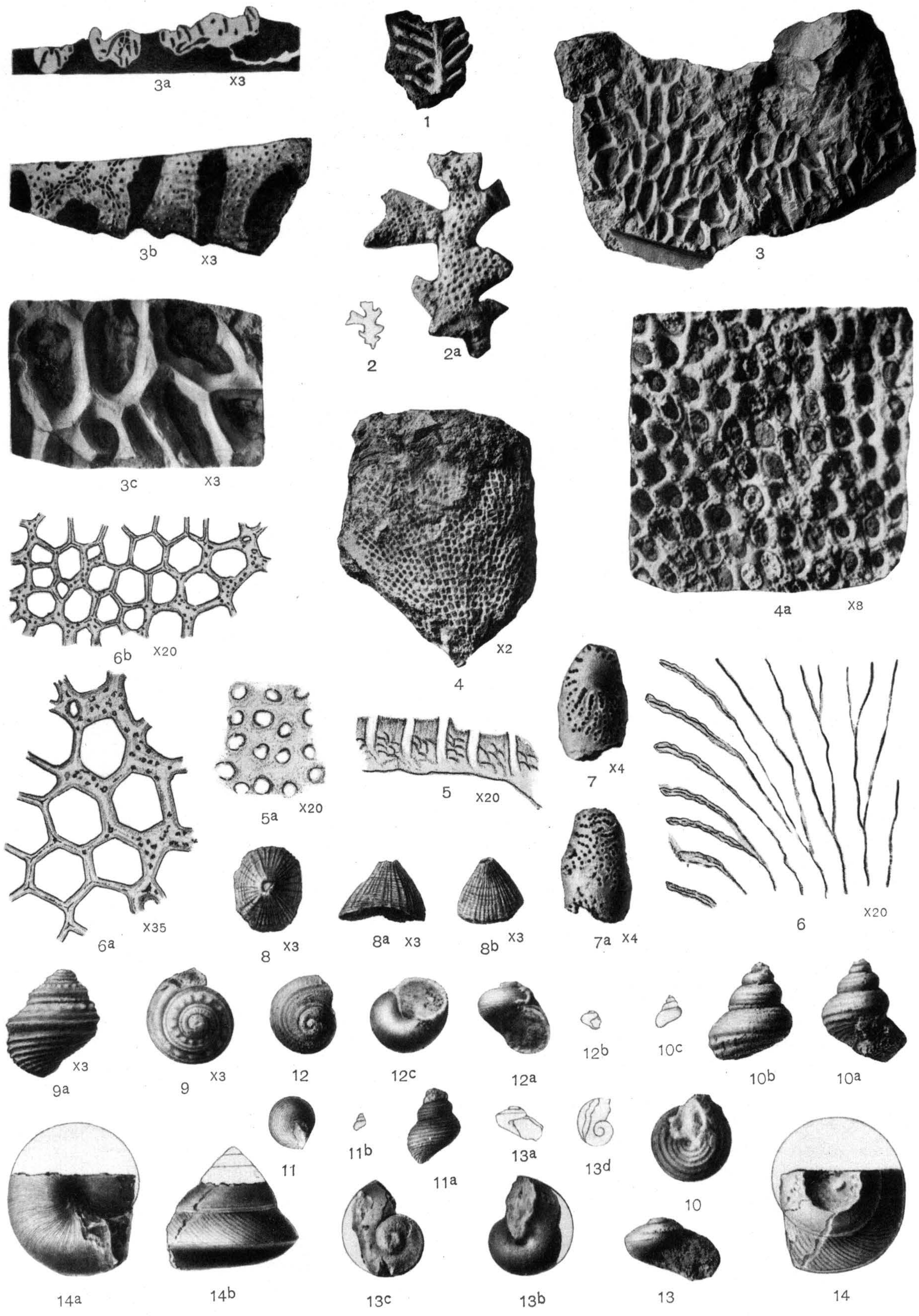
Figs. 4 and 4a. The type specimen, a frond with the poriferous face embedded in rock.
4. Side view of frond, × 2.
4a. Portion of the same, × 8. Though more or less damaged by exfoliation the small nodes developed at the junction of the branches and dissepiments can here and there be seen.
Capitan formation, Capitan Peak (station 2926).

Fistulipora guadalupæ n. sp. (p. 126).

Figs. 5 and 5a. The type specimen.
5. Longitudinal section, × 20.
5a. Transverse section, × 20.
Capitan formation, Capitan Peak (station 2966).

Stenopora polyspinosa var. richardsoni n. var. (p. 129).

Figs. 6 to 6b. The type specimen.
6. Longitudinal section, × 20.
6a. Transverse section, × 35.
6b. Transverse section, × 20.
Capitan formation, Capitan Peak (station 2966).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8a X3
8b X3
7a X4
9a X3
9 X3
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12c
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12b
10c
10b
10a
11
11b
11a
13a
13d
10
14a
14b
13c
13b
13
14

DOMOPORA? OCELLATA n. sp. (p. 122).

FIGS. 7 and 7a. Terminal portion of a branch. There are two maculæ opposite each other, but not a terminal one.
7. Side view showing one of the maculæ, × 4.
7a. Side view of the adjacent quadrant, showing sides of two maculæ, × 4.
Capitan formation, hill southwest of Guadalupe Point (station 2906).

PATELLA CAPITANENSIS n. sp. (p. 465).

FIGS. 8 to 8b. A small specimen serving as the type.
8. Seen from above, × 3.
8a. Side view, × 3.
8b. End view, × 3.
Capitan formation, Capitan Peak (station 2966).

PLEUROTOMARIA RICHARDSONI n. sp. (p. 467).

FIGS. 9 and 9a. A well-preserved specimen selected as the type.
9. Seen from above, × 3.
9a. Side view, × 3.
Capitan formation, Capitan Peak (station 2966).

PLEUROTOMARIA NEGLECTA n. sp. (p. 472).

FIGS. 10 to 10c. Specimen preserved as a partial mold of the interior.
10. View of the under side, × 3.
10a. Side view, × 3, showing the aperture.
10b. Side view, × 3.
10c. Same, natural size in outline.
Capitan formation, Capitan Peak (station 2926).

PLEUROTOMARIA PUTILLA n. sp. (p. 468).

FIGS. 11 to 11b. The typical specimen.
11. View of the lower side, × 4.
11a. Side view, × 4.
11b. Same, natural size in outline.
Capitan formation, Capitan Peak (station 2926).

PLEUROTOMARIA MICA n. sp. (p. 467).

FIGS. 12 to 12c. The typical specimen.
12. View of the upper side, × 4.
12a. Side view, × 4.
12b. Same, natural size in outline.
12c. View of the lower side, × 4.
Capitan formation, Capitan Peak (station 2926).

PLEUROTOMARIA DISCOIDEA n. sp. (p. 470).

FIGS. 13 to 13d. A somewhat imperfect specimen on which the species is founded.
13. Side view, showing the aperture, × 2.
13a. Same, natural size in outline.
13b. View of the lower side, × 2.

FIG. 13c. View of the upper side, × 2.
13d. Same, natural size in outline.
Capitan formation, Capitan Peak (station 2926).

EUCONOSPIRA OBSOLETA n. sp. (p. 477).

FIGS. 14 to 14b. A rather well-preserved fragment.
14. Seen from above.
14a. Seen from below.
14b. Side view.
Capitan formation, Capitan Peak (station 2926).

PLATE IX.

PLATE IX.

CAPITAN FORMATION, GUADALUPE MOUNTAINS.

CAMPTONECTES? ASPERATUS n. sp. (p. 434).

FIGS. 1 to 1b. A right valve.
1. Side view, × 5.
1a. Same, natural size in outline.
1b. Same, × 2, for comparison with figs. 3 and 3a.
Capitan formation, Capitan Peak (station 2926).

FIG. 2. An imperfect right valve with well-preserved surface.
Side view, × 5.
Capitan formation, Capitan Peak (station 2926).

CAMPTONECTES? PAPILLATUS n. sp. (p. 433).

FIGS. 3 and 3a. A left valve.
3. Side view, × 2.
3a. Same, natural size in outline.
Capitan formation, Capitan Peak (station 2926).

CAMPTONECTES? SCULPTILIS n. sp. (p. 434).

FIG. 4. An imperfect right valve having well-preserved surface ornamentation.
Side view, × 2.
Capitan formation, Capitan Peak (station 2926).

FIGS. 5 and 5a. A young left valve partially exfoliated, supposed to belong to the same species.
5. Side view, × 2.
5a. Same, natural size in outline.
Capitan formation, Capitan Peak (station 2926).

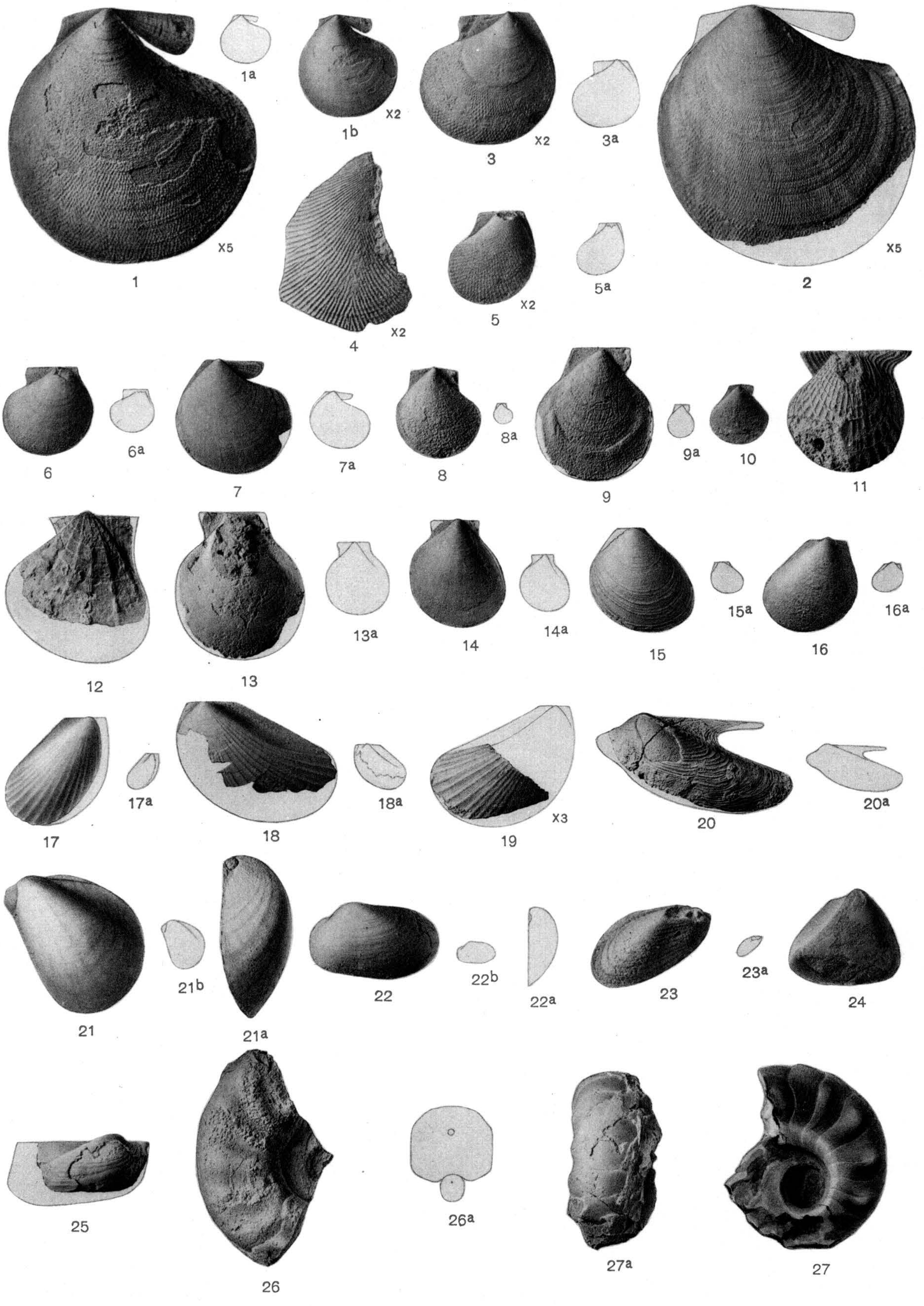
CAMPTONECTES? sp. (pp. 433–434).

FIGS. 6 and 6a. An internal mold of a left valve belonging probably either to *C.? asperatus* or *C.? papillatus*.
6. Side view, × 2.
6a. Same, natural size in outline.
Capitan formation, Capitan Peak (station 2926).

FIGS. 7 and 7a. An internal mold of a right valve belonging probably either to *C.? asperatus* or *C.? papillatus*.
7. Side view, × 2.
7a. Same, natural size in outline.
Capitan formation, Capitan Peak (station 2926).

EUCHONDRIA? sp. (p. 441).

FIGS. 8 and 8a. Probably a young specimen and of doubtful affinities.
8. Side view, × 4.
8a. Same, natural size in outline.
Capitan formation, Capitan Peak (station 2926).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22b
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23a
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26a
27a
27

AVICULIPECTEN INFELIX n. sp. (p. 438).

FIGS. 9 and 9a. A small, left? valve.
9. Side view, × 4.
9a. Same, natural size in outline.
Capitan formation, Capitan Peak (station 2926).
FIG. 10. A larger left? valve.
Side view, natural size.
Capitan formation, Capitan Peak (station 2926).

AVICULIPECTEN LAQUEATUS n. sp. (p. 439).

FIG. 11. A left valve.
Side view, natural size.
Capitan formation, Capitan Peak (station 2926).

AVICULIPECTEN SUBLAQUEATUS n. sp. (p. 440).

FIG. 12. Imperfect left valve preserved as an internal mold.
Side view.
Capitan formation, hill southwest of Guadalupe Point (station 2906).

PERNIPECTEN? OBLIQUUS n. sp. (p. 441).

FIGS. 13 and 13a. A left? valve, larger than the original of fig. 14 and less complete.
13. Side view, × 2.
13a. Same, natural size in outline.
Capitan formation, Capitan Peak (station 2926).
FIGS. 14 and 14a. A small left? valve in which the ears are defective.
14. Side view, × 2.
14a. Same, natural size in outline.
Capitan formation, Capitan Peak (station 2926).

PLAGIOSTOMA DELTOIDEUM n. sp. (p. 442).

FIGS. 15 and 15a. A right valve.
15. Side view, × 3.
15a. Same, natural size in outline.
Capitan formation, Capitan Peak (station 2926).
FIGS. 16 and 16a. A left valve.
16. Side view, × 3.
16a. Same, natural size in outline.
Capitan formation, Capitan Peak (station 2926).

LIMATULINA STRIATICOSTATA n. sp. (p. 443).

FIGS. 17 and 17a. A left valve.
17. Side view, × 3.
17a. Same, natural size in outline.
Capitan formation, Capitan Peak (station 2926).
FIGS. 18 and 18a. A broken right valve showing the characters of this species.
18. Side view, × 3.
18a. Same, natural size in outline.
Capitan formation, Capitan Peak (station 2926).
FIG. 19. Fragment of another left valve which has the surface well preserved. The sculpture is somewhat finer than on the foregoing and the species may possibly be different.
Side view, × 3.
Capitan formation, Capitan Peak (station 2926).

Pteria guadalupensis n. sp. (p. 426).

Figs. 20 and 20a. A left valve.
20. Side view, × 2.
20a. Same, natural size in outline.
Capitan formation, Capitan Peak (station 2926).

Myoconcha costulata n. sp. (p. 444).

Figs. 21 to 21b. A left valve.
21. Side view, × 3.
21a. Anterior view with the specimen somewhat tilted backward, × 3.
21b. Side view, natural size in outline.
Capitan formation, Capitan Peak (station 2926).

Edmondia? bellula n. sp. (p. 420).

Figs. 22 to 22b. A left valve.
22. Side view, × 3.
22a. Anterior view in outline, ×3.
22b. Side view, natural size in outline.
Capitan formation, Capitan Peak (station 2926).

Cypricardinia? contracta n. sp, (p. 446).

Figs. 23 and 23a. A right valve somewhat broken about the beak. Like most of the pelecypods from this horizon the preservation is that of an internal mold which yet retains some of the external characters.
23. Side view, × 4.
23a. Same, natural size in outline.
Capitan formation, Capitan Peak (station 2926).

Schizodus securus Shumard? (p. 431.)

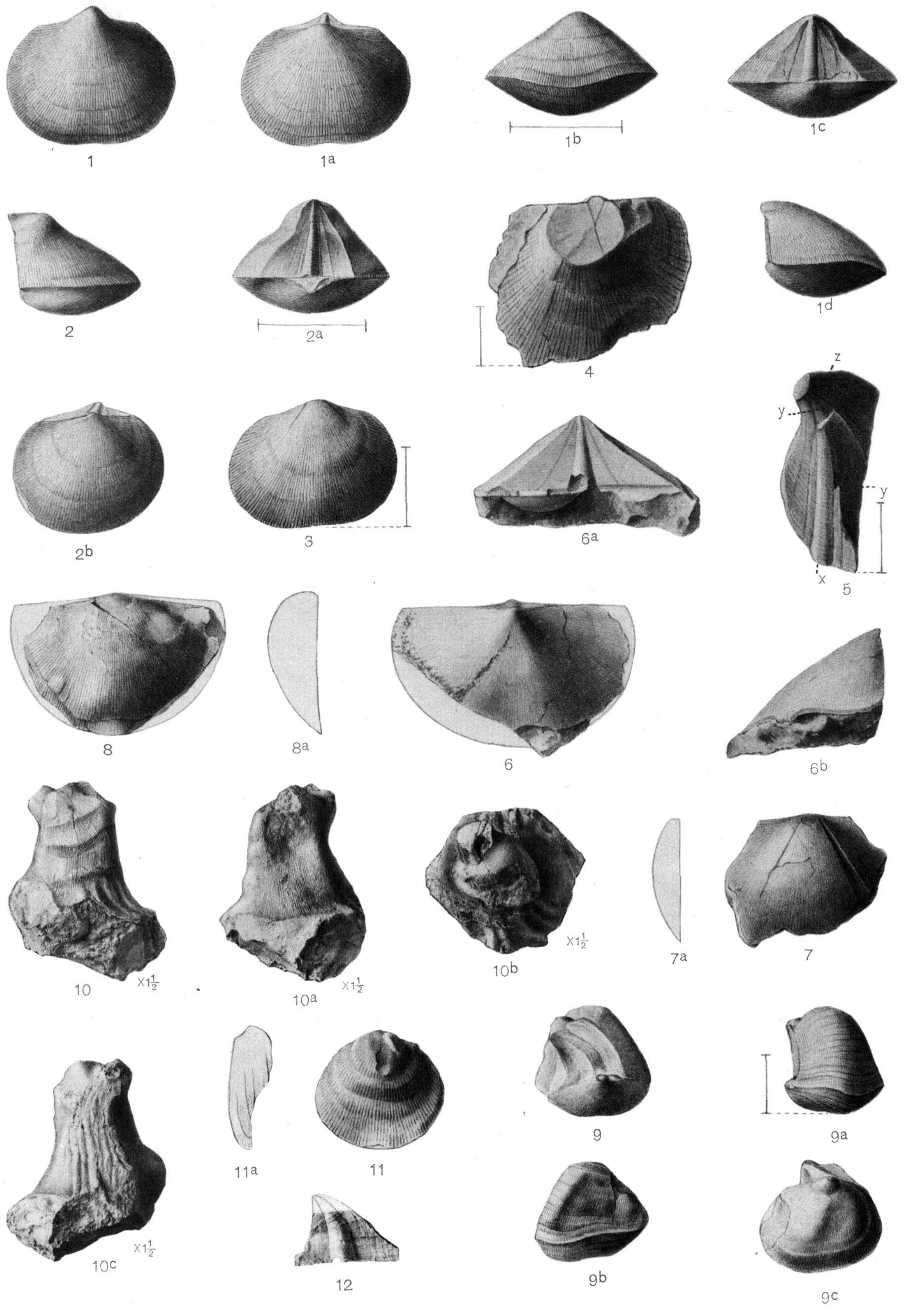
Fig. 24. An imperfect right valve referred to Shumard's species.
Side view, natural size.
Capitan formation, Capitan Peak (station 2926).

Parallelodon politus n. sp. (p. 424).

Fig. 25. A fragmentary right valve having the shell in part preserved.
Side view, natural size.
Capitan formation, Capitan Peak (station 2926).

Foordoceras shumardianum n. sp. (p. 497).

Figs. 26 and 26a. A fragment of nearly complete size.
26. Side view.
26a. Transverse section through two whorls.
Capitan formation, Capitan Peak (station 2926).
Figs. 27 and 27a. A small and somewhat imperfect specimen.
27. Side view.
27a. View of the ventral surface.
Capitan formation, Capitan Peak (station 2926).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6b
10 X1½
10a X1½
10b X1½
7a
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10c X1½
11a
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9a
9b
9c

PLATE X.

PLATE X.

CAPITAN FORMATION, GUADALUPE MOUNTAINS.

ORTHOTETES GUADALUPENSIS n. sp. (p. 199).

FIGS. 1 to 1d. The type specimen retaining both valves in conjunction. All the figures × 1½. It was not found possible to represent quite faithfully the fineness of the liræ and their rounded shape.

1. Ventral view.
1a. Dorsal view.
1b. Anterior view.
1c. Posterior view.
1d. Side view.

Capitan formation, Capitan Peak (station 2926).

FIGS. 2 to 2b. A similar but somewhat irregular specimen retaining both valves. All the figures × 1½.

2. Side view.
2a. Posterior view.
2b. Dorsal view.

Capitan formation, Capitan Peak (station 2926).

FIG. 3. A dorsal valve from which the shell has been largely exfoliated, so that the socket plates can be seen.

Seen from above, × 1½.
Capitan formation, Capitan Peak (station 2926).

FIG. 4. A ventral valve with the apex ground down to show the septal arrangement, × 3. The typical camerate structure is seen, but as the specimen was somewhat distorted the septum is not quite central.

Capitan formation, Capitan Peak (station 2926).

FIG. 5. Fragment of a ventral valve which has been broken along the dental plates and septum. *x*, Pseudodeltidium; *y*, *y*, converging dental plates; *z*, median septum.

Specimen viewed obliquely downward and to the right, × 3.
Capitan formation, Capitan Peak (station 2926).

ORTHOTETES DECLIVIS n. sp. (p. 200).

FIGS. 6 to 6b. A ventral valve taken as the type of the species. The figures of this species are not enlarged, so that its size relative to the preceding type is misrepresented.

6. Seen from above.
6a. Posterior view.
6b. Side view.

Capitan formation, Capitan Peak (station 2926).

FIGS. 7 and 7a. A fragmentary dorsal valve supposed to belong to this species, with the shell partially removed to show the long socket plates.

7. Seen from above.
7a. Side view in outline.

Capitan formation, Capitan Peak (station 2926).

FIGS. 8 and 8a. A somewhat imperfect dorsal valve referred to this species.

8. Seen from above.
8a. Side view in outline.

Capitan formation, hill southwest of Guadalupe Point (station 2906).

ORTHOTETES DISTORTUS n. sp. (p. 201).

FIGS. 9 to 9c. The type specimen preserving both valves in conjunction. The extremely fine liration can not be accurately represented on figures of this size. All figures nearly × 2.

9. Posterior view.
9a. Side view.
9b. Anterior view.
9c. Dorsal view.
Capitan formation, Capitan Peak (station 2926).

ORTHOTETES DISTORTUS var. CAMPANULATUS n. var. (p. 202).

FIGS. 10 to 10c. A ventral valve; the typical specimen. All figures × 1½.

10. Anterior view, showing the great length of the septum.
10a. Side view.
10b. Seen from above.
10c. Posterior view.
Capitan formation, Capitan Peak (station 2926).

DERBYA sp. *a* (p. 184).

FIGS. 11 and 11a. A ventral valve provisionally referred to this species. The shell has been much exfoliated, partially obscuring the sculpture.

11. Seen from above.
11a. Side view in outline.
Capitan formation, Capitan Peak (station 2926).

DERBYA sp. *b* (p. 185).

FIG. 12. A fragmentary ventral valve.
Posterior view.
Capitan formation, Capitan Peak (station 2966).

PLATE XI.

PLATE XI.

CAPITAN FORMATION, GUADALUPE MOUNTAINS.

DERBYA sp. *a* (p. 184).

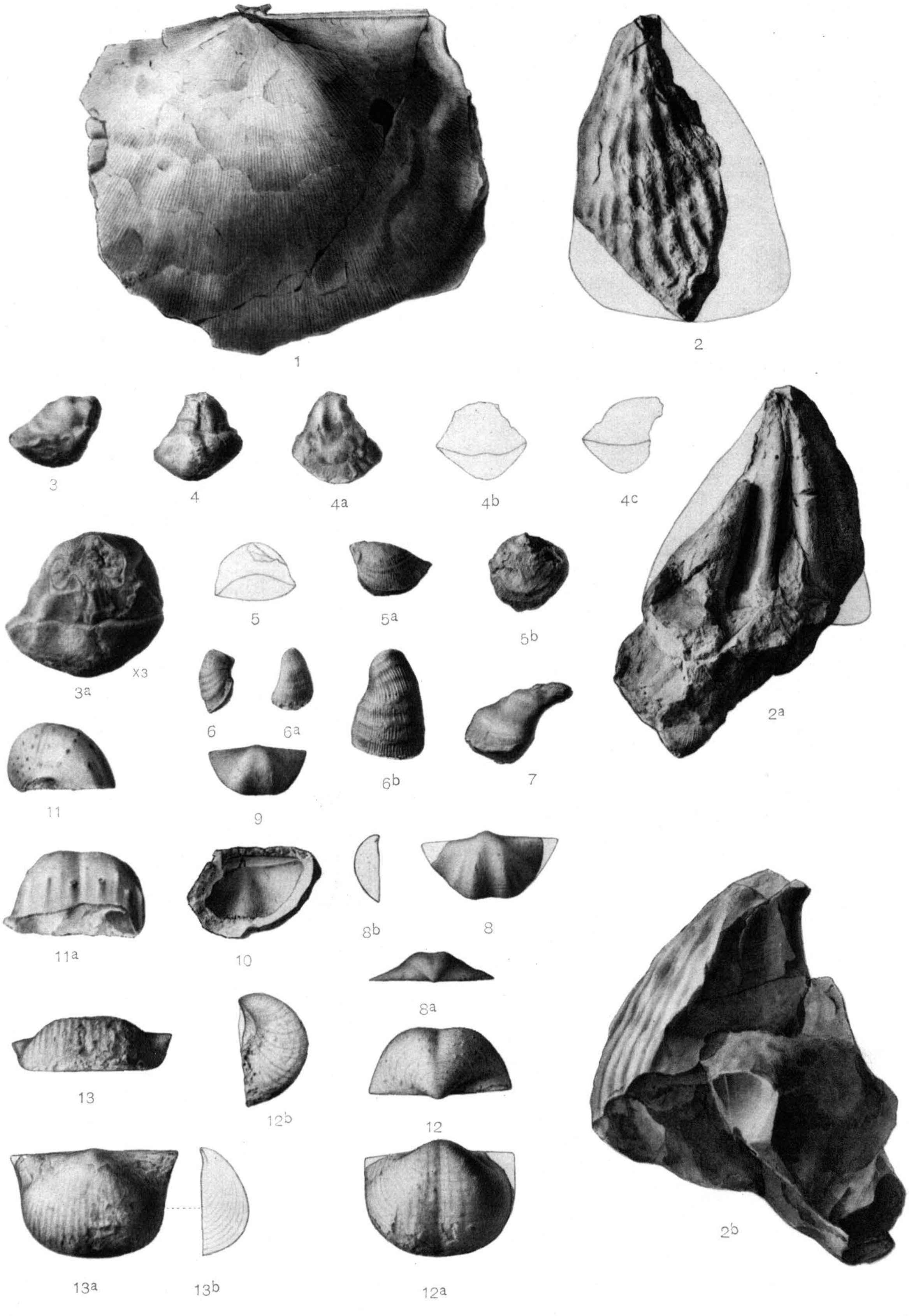
FIG. 1. A large dorsal valve considerably exfoliated and broken around the edges.
Seen from above. The cardinal process, owing to its direction, is considerably foreshortened in this view.
Capitan formation, Capitan Peak (station 2926).

GEYERELLA AMERICANA n. sp. (p. 204).

FIGS. 2 to 2b. An imperfect ventral valve which has lost part of the left side, the fracture passing along the dental plate and septum.
2. Anterior view.
2a. Posterior view.
2b. Side view, in which the dental plate and septum are exposed by the fracture.
Capitan formation, Capitan Peak (station 2926).

STREPTORHYNCHUS GREGARIUM n. sp. (p. 177).

FIGS. 3 and 3a. An imperfect specimen retaining both valves in position.
3. Side view.
3a. Posterior view, × 2. Owing to the fracture there can here be seen the dental callosities, without real dental plates or septum.
Capitan formation, Capitan Peak (station 2926).
FIGS. 4 to 4c. An imperfect specimen with both valves.
4. Posterior view, somewhat tilted backward.
4a. Anterior view, somewhat tilted forward.
4b. True front view in outline.
4c. Side view, in outline.
Capitan formation, Capitan Peak (station 2926).
FIGS. 5 to 5b. A specimen having a low altitude and regular growth.
5. Anterior view in outline.
5a. Side view.
5b. Dorsal view.
Capitan formation, Capitan Peak (station 2926).
FIGS. 6 to 6b. A small distorted ventral valve.
6. Side view.
6a. Front view.
6b. Front view, × 2.
Capitan formation, Capitan Peak (station 2926).
FIG. 7. An elongate specimen of irregular growth.
Side view.
Capitan formation, Capitan Peak (station 2926).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13b
12a
2b

Chonetes hillanus n. sp. (p. 228).

Figs. 8 to 8b. A rather large ventral valve.
8. Seen from above.
8a. Posterior view.
8b. Side view in outline.
Capitan formation, Capitan Peak (station 2926).

Fig. 9. A somewhat smaller ventral valve.
Seen from above.
Capitan formation, Capitan Peak (station 2926).

Fig. 10. A cast taken from an imperfect natural mold of a dorsal valve.
Seen from above.
Capitan formation, Capitan Peak (station 2926).

Productus latidorsatus n. sp. (p. 264).

Figs. 11 and 11a. A slightly imperfect ventral valve.
11. Side view.
11a. Anterior view.
Capitan formation, Capitan Peak (station 2926).

Figs. 12 to 12b. A ventral valve of the usual size and configuration. Some examples show finer and more distinct ribs.
12. Posterior view.
12a. Seen from above.
12b. Side view.
Capitan formation, Capitan Peak (station 2926).

Figs. 13 to 13b. A dorsal valve showing for the most part the inside of the shell. This specimen is marked by rather fine, obscure costæ.
13. Anterior view.
13a. Seen from above.
13b. Side view in outline.
Capitan formation, Capitan Peak (station 2926).

PLATE XII.

PLATE XII.

CAPITAN FORMATION, GUADALUPE MOUNTAINS.

PRODUCTUS SEMIRETICULATUS var. CAPITANENSIS n. var. (p. 254).

FIGS. 1 and 1a. An imperfect ventral valve of rather small size. No restoration has been made in these figures.
1. Seen from above.
1a. Side view in outline.
Capitan formation, Capitan Peak (station 2926).

FIG. 2. A somewhat imperfect dorsal valve.
Visceral area.
Capitan formation, Capitan Peak (station 2926).

FIGS. 3 to 3b. A somewhat imperfect dorsal valve of the usual type.
3. Seen from above.
3a. Seen from the front so that the flattened visceral surface lies in the plane of sight.
3b. Side view in outline.
Capitan formation, Capitan Peak (station 2926).

PRODUCTUS OCCIDENTALIS Newberry (p. 262).

FIGS. 4 to 4c. A ventral valve referred to this species.
4. Seen from above.
4a. Posterior view.
4b. Anterior view.
4c. Side view.
Capitan formation, Capitan Peak (station 2926).

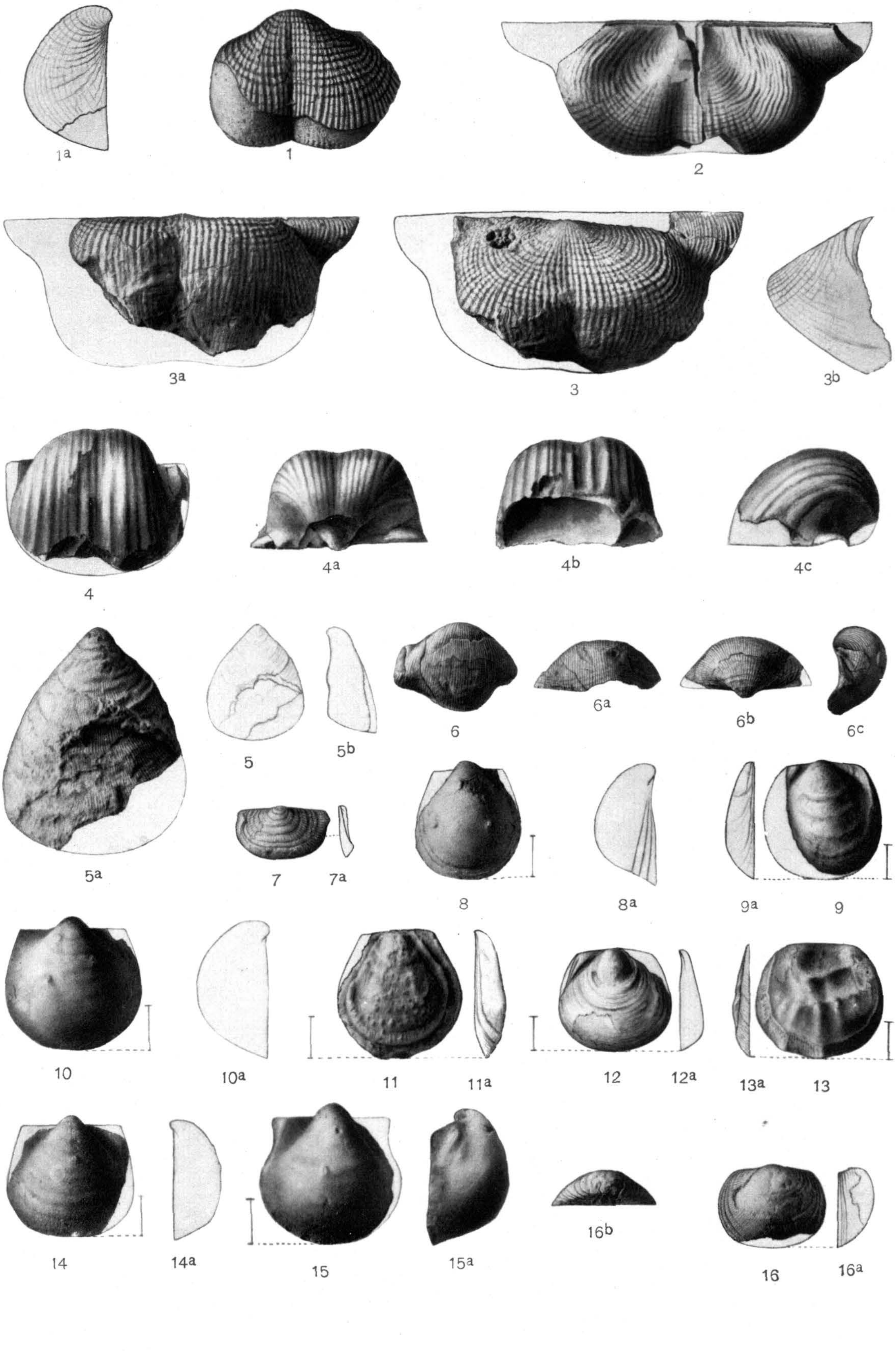
PRODUCTUS PINNIFORMIS n. sp. (p. 272).

FIGS. 5 to 5b. A specimen showing part of the ventral valve and, where it is broken away, probably part of the dorsal valve beneath.
5. Seen from above, in outline.
5a. Same, $\times$ 2.
5b. Side view in outline.
Capitan formation, Capitan Peak (station 2926).

PRODUCTUS WAAGENIANUS n. sp. (p. 253).

FIGS. 6 to 6c. A ventral valve. It was not possible in these figures to represent the liration as sufficiently fine.
6. Seen from above.
6a. Anterior view.
6b. Posterior view.
6c. Side view.
Capitan formation, Capitan Peak (station 2926).

FIGS. 7 and 7a. A dorsal valve.
7. Specimen seen from above.
7a. Side view in outline.
Capitan formation, Capitan Peak (station 2926).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12a
13a
13
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14a
15
15a
16b
16
16a

PRODUCTUS? PILEOLUS Shumard (p. 270).

FIGS. 8 and 8a. An imperfect ventral valve largely reduced to an internal mold which shows traces of structures similar to the submarginal callosity of *Marginifera*.
8. Seen from above, × 3.
8a. Side view in outline, × 3.
Capitan formation, Capitan Peak (station 2926).

FIGS. 9 and 9a. A dorsal valve preserved almost as an external mold.
9. Seen from above, × 3.
9a. Side view in outline, × 3.
Capitan formation, Capitan Peak (station 2926).

FIGS. 10 and 10a. A ventral valve.
10. Seen from above, × 3.
10a. Side view in outline, × 3.
Capitan formation, Capitan Peak (station 2926).

FIGS. 11 and 11a. Interior of dorsal valve, showing indications of structures suggesting the submarginal ridges of *Marginifera*.
11. Seen from above, × 3.
11a. Side view, × 3.
Capitan formation, Capitan Peak (station 2926).

FIGS. 12 and 12a. A dorsal valve preserved more or less as a mold of the outside.
12. Seen from above, × 3.
12a. Side view in outline, × 3.
Capitan formation, Capitan Peak (station 2926).

FIGS. 13 and 13a. A dorsal valve referred with some doubt to this species. The preservation is to some extent that of an external mold. The characters of most of the surface are external, but a band around the margin shows internal markings.
13. Seen from above, × 3.
13a. Side view, × 3.
Capitan formation, Capitan Peak (station 2926).

FIGS. 14 and 14a. An imperfect ventral valve.
14. Seen from above, × 3.
14a. Side view in outline, × 3.
Capitan formation, Capitan Peak (station 2926).

FIGS. 15 and 15a. A ventral valve which shows a peculiar downward prolongation of the lateral portions of the shell, best seen in figure 15a. Traces of the same structure appear to be retained in the case of the specimen represented by figures 14 and 14a, and may have been lost from other examples.
15. Seen from above, × 3.
15a. Side view, × 3.
Capitan formation, Capitan Peak (station 2926).

AULOSTEGES MEDLICOTTIANUS var. AMERICANUS n. var. (p. 278).

FIGS. 16 to 16b. The typical and only specimen, a ventral valve.
16. Seen from above.
16a. Side view in outline.
16b. Posterior view.
Capitan formation, Capitan Peak (station 2926).

PLATE XIII.

PLATE XIII.

CAPITAN FORMATION, GUADALUPE MOUNTAINS.

Spirifer mexicanus Shumard (p. 360).

Figs. 1 and 1a. A ventral valve of medium size.
1. Seen from above. The ribs are represented as a little too strong, and their assemblage into groups is not quite clear enough.
1a. Side view in outline.
Capitan formation, Capitan Peak (station 2926).

Figs. 2 to 2d. A characteristic specimen of medium size.
2. Dorsal view.
2a. Ventral view.
2b. Side view in outline.
2c. Posterior view.
2d. Anterior view.
Capitan formation, Capitan Peak (station 2926).

Figs. 3 and 3a. A small specimen similar to the last.
3. Dorsal view.
3a. Side view in outline.
Capitan formation, Capitan Peak (station 2926).

Figs. 4 to 4b. A small specimen.
4. Dorsal view.
4a. Ventral view.
4b. Side view in outline.
Capitan formation, Capitan Peak (station 2926).

Figs. 5 and 5a. A small specimen.
5. Ventral view. The ribs are represented as a little too strong.
5a. Side view in outline.
Capitan formation, Capitan Peak (station 2926).

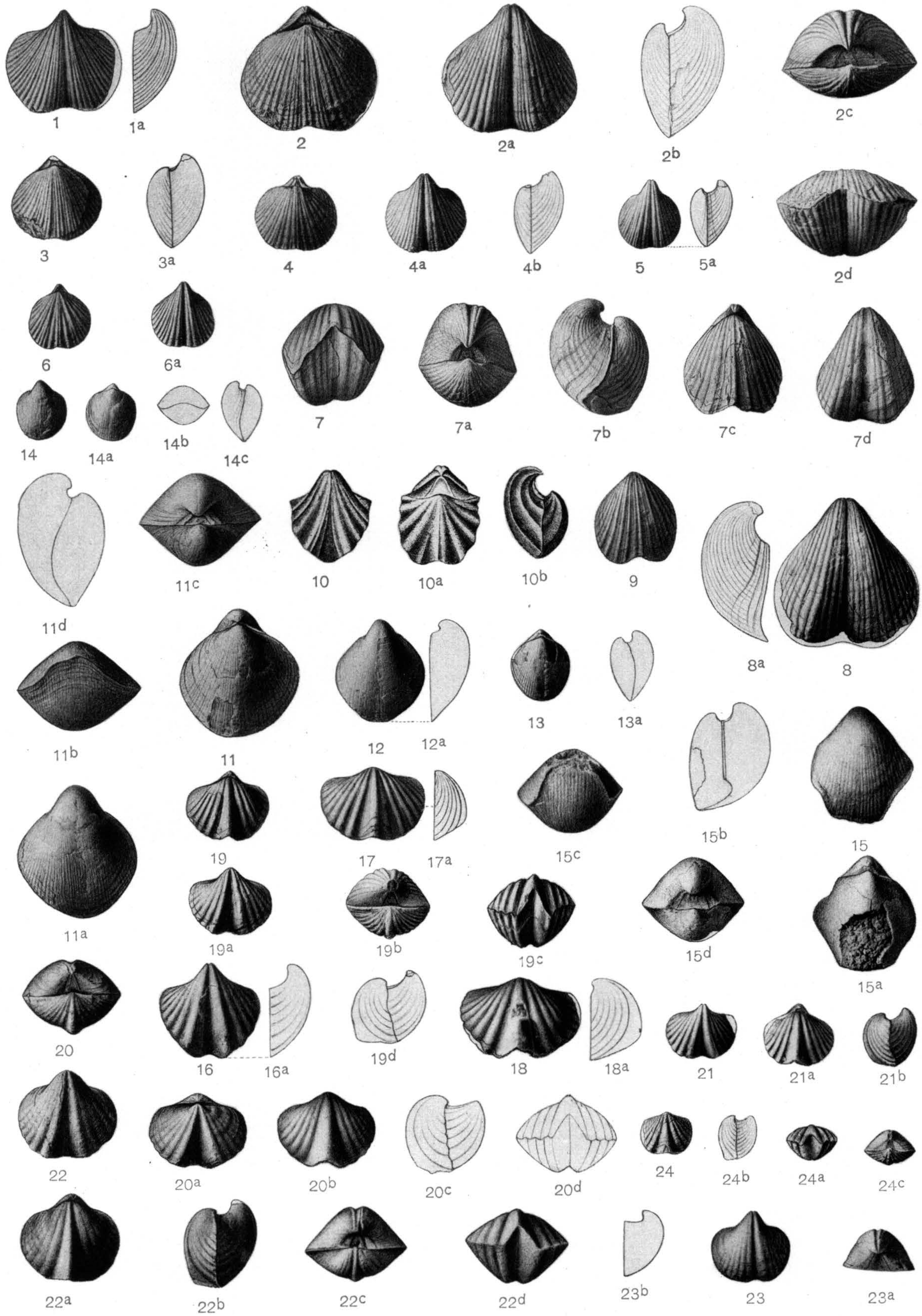
Figs. 6 and 6a. A small specimen, with the ribs more fasciculate than usual.
6. Dorsal view. The ribs are represented as too strong.
6a. Ventral view. The ribs are scarcely represented as sufficiently fasciculate.
Capitan formation, Capitan Peak (station 2926).

Spirifer mexicanus var. compactus n. var. (p. 361).

Figs. 7 to 7d. The typical specimen.
7. Anterior view.
7a. Posterior view.
7b. Side view.
7c. Dorsal view. The ribs are represented as a little too distinct.
7d. Ventral view. Here also the ribs are a little too distinct.
Capitan formation, Capitan Peak (station 2926).

Figs. 8 and 8a. A large ventral valve referred with some doubt to this species.
8. Seen from above.
8a. Side view in outline.
Capitan formation, Capitan Peak (station 2926).

Fig. 9. A small dorsal valve.
Seen from above. The ribs are shown as somewhat too strong.
Capitan formation, Capitan Peak (station 2926).


1 1a 2 2a 2b 2c
3 3a 4 4a 4b 5 5a 2d
6 6a 7 7a 7b 7c 7d
14 14a 14b 14c
11c 10 10a 10b 9
11d 8a 8
11b 11 12 12a 13 13a
19 17 17a 15c 15b 15
11a 19a 19b 19c 15d 15a
20 16 16a 19d 18 18a 21 21a 21b
22 20a 20b 20c 20d 24 24b 24a 24c
22a 22b 22c 22d 23b 23 23a

SPIRIFER SULCIFER Shumard (p. 363).

FIGS. 10 to 10b. Copies of Shumard's figures of this species.
10. Dorsal view.
10a. Ventral view.
10b. Side view.
Capitan formation, Guadalupe Mountains.

MARTINIA RHOMBOIDALIS n. sp. (p. 364).

FIGS. 11 to 11d. A medium-sized and representative specimen. The radiating striæ which result from exfoliation are represented as too distinct in the different views where they appear.
11. Dorsal view.
11a. Ventral view.
11b. Anterior view.
11c. Posterior view.
11d. Side view in outline.
Capitan formation, Capitan Peak (station 2926).

FIGS. 12 and 12a. A ventral valve of somewhat smaller size.
12. Seen from above.
12a. Side view in outline.
Capitan formation, Capitan Peak (station 2926).

FIGS. 13 and 13a. A young specimen with both valves.
13. Dorsal view.
13a. Side view in outline.
Capitan formation, Capitan Peak (station 2926).

FIGS. 14 to 14c. A very young example.
14. Ventral view.
14a. Dorsal view.
14b. Anterior view in outline.
14c. Side view in outline.
Capitan formation, Capitan Peak (station 2926).

MARTINIA SHUMARDIANA n. sp. (p. 365).

FIGS. 15 to 15d. The type specimen.
15. Ventral view. In this figure and in figure 15c the striation found on the inner layers of the shell is represented as somewhat too distinct.
15a. Dorsal view.
15b. Side view in outline.
15c. Anterior view.
15d. Posterior view.
Capitan formation, Capitan Peak (station 2926).

SPIRIFERINA BILLINGSI Shumard (p. 374).

FIGS. 16 and 16a. A characteristic ventral valve.
16. Seen from above.
16a. Side view in outline.
Capitan formation, Capitan Peak (station 2926).

FIGS. 17 and 17a. A characteristic dorsal valve.
17. Seen from above.
17a. Side view in outline.
Capitan formation, Capitan Peak (station 2926).

FIGS. 18 and 18a. A somewhat larger and different dorsal valve.
18. Seen from above.
18a. Side view in outline.
Capitan formation, Capitan Peak (station 2926).

FIGS. 19 to 19d. A rather small specimen retaining both valves in conjunction.
19. Dorsal view.
19a. Ventral view.
19b. Posterior view.
19c. Anterior view.
19d. Side view in outline.
Capitan formation, Capitan Peak (station 2926).

SPIRIFERINA BILLINGSI var. RETUSA n. var. (p. 376).

FIGS. 20 to 20d. The typical specimen.
20. Posterior view.
20a. Ventral view.
20b. Dorsal view.
20c. Side view in outline.
20d. Anterior view in outline.
Capitan formation, Capitan Peak (station 2926).

SPIRIFERINA BILLINGSI Shumard (p. 374).

FIGS. 21 to 21b. A small specimen.
21. Ventral view.
21a. Dorsal view.
21b. Side view in outline.
Capitan formation, Capitan Peak (station 2926).

SPIRIFERINA EVAX n. sp. (p. 376).

FIGS. 22 to 22d. The typical and only specimen.
22. Ventral view.
22a. Dorsal view.
22b. Side view.
22c. Posterior view.
22d. Anterior view.
Capitan formation, Capitan Peak (station 2926).

SPIRIFERINA SULCATA n. sp. (p. 377).

FIGS. 23 to 23b. The typical specimen, a ventral valve.
23. Seen from above.
23a. Posterior view.
23b. Side view in outline.
Capitan formation, Capitan Peak (station 2926).

SPIRIFERINA BILLINGSI Shumard (p. 374).

FIGS. 24 to 24c. A young specimen, in which the concentric lamellæ are not regularly developed.
24. Dorsal view.
24a. Anterior view.
24b. Side view in outline.
24c. Posterior view.
Capitan formation, Capitan Peak (station 2926).

PLATE XIV.

PLATE XIV.

CAPITAN FORMATION, GUADALUPE MOUNTAINS.

Squamularia guadalupensis var. ovalis n. var. (p. 369).

Figs. 1 and 1a. A large but imperfect specimen representing an unusual type.
1. Ventral view.
1a. Side view in outline.
Capitan formation, Capitan Peak (station 2926).

Squamularia guadalupensis var. subquadrata n. var. (p. 369).

Figs. 2 to 2b. A specimen representing another variety characterized by having a perceptible ventral sinus and a subquadrate shape.
2. Ventral view.
2a. Dorsal view.
2b. Side view in outline.
Capitan formation, Capitan Peak (station 2926).

Figs. 3 to 3b. Another specimen with a sinus, somewhat intermediate between the foregoing and the usual type.
3. Ventral view.
3a. Dorsal view.
3b. Side view in outline.
Capitan formation, Capitan Peak (station 2926).

Squamularia guadalupensis Shumard (p. 367).

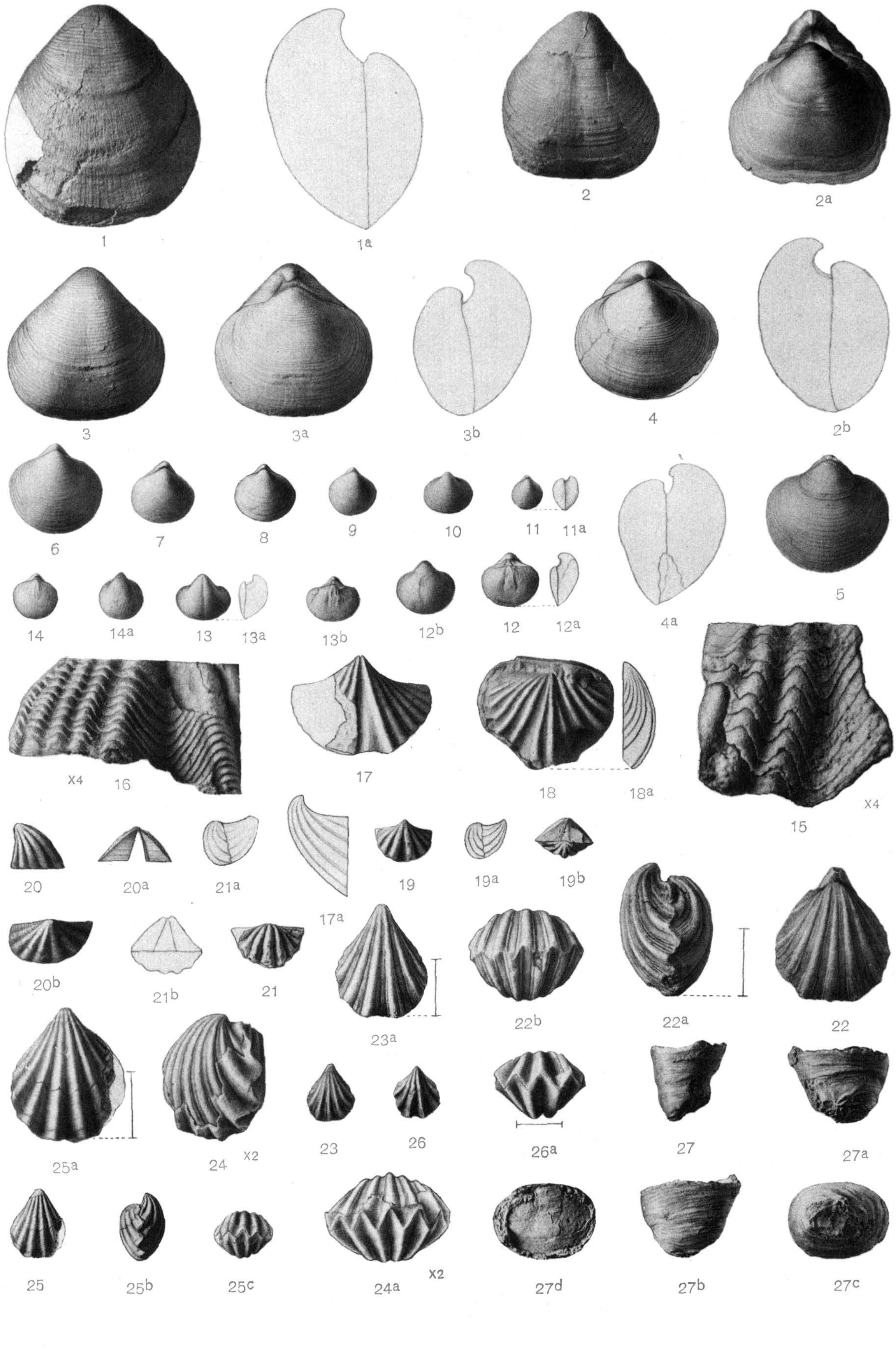
Figs. 4 and 4a. A specimen of the usual type.
4. Dorsal view.
4a. Side view in outline.
Capitan formation, Capitan Peak (station 2926).

Fig. 5. A malformed individual.
Dorsal view.
Capitan formation, Capitan Peak (station 2926).

Figs. 6 to 11a. Specimens of diverse sizes and proportions. The original of fig. 10 is unusually transverse and that of figs. 11 and 11a unusually convex.
Capitan formation, Capitan Peak (station 2926).

Ambocœlia planiconvexa var. guadalupensis n. var. (p. 370).

Figs. 12 to 12b. A characteristic specimen.
12. Dorsal view.
12a. Side view in outline.
12b. Ventral view.
Capitan formation, Capitan Peak (station 2926).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13a
13b
12b
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12a
4a
X4
16
17
18
18a
15
X4
20
20a
21a
19
19a
19b
17a
20b
21b
21
23a
22b
22a
22
25a
24
X2
23
26
26a
27
27a
25
25b
25c
24a
X2
27d
27b
27c

FIGS. 13 to 13b. A somewhat smaller though still representative specimen.
13. Ventral view.
13a. Side view in outline.
13b. Dorsal view. The exfoliation of the shell in this, as in the preceding specimen, has brought to view more or less distinct traces of the internal structure.
Capitan formation, Capitan Peak (station 2926).

FIGS. 14 and 14a. An unusually narrow specimen which has more the configuration of *Ambocœlia planiconvexa* itself.
14. Dorsal view.
14a. Ventral view.
Capitan formation, Capitan Peak (station 2926).

SPIRIFERINA BILLINGSI Shumard (p. 374).

FIG. 15. Portion of the surface, × 4.
Capitan formation, Capitan Peak (station 2926).

FIG. 16. Portion of the surface of another specimen, × 4. The sculpture here is seen to be a little finer than in fig. 15. Traces of setæ, not shown in the figure, are preserved along the edges of the lamellæ.
Capitan formation, Capitan Peak (station 2926).

SPIRIFERINA WELLERI n. sp. (p. 380).

FIGS. 17 and 17a. An imperfect ventral valve.
17. Seen from above.
17a. Side view in outline.
Capitan formation, Capitan Peak (station 2926).

FIGS. 18 and 18a. Dorsal valve. An impression from a natural mold which, as the matrix is limestone, still retains some of the shell adherent.
18. Seen from above.
18a. Side view in outline.
Capitan formation, Capitan Peak (station 2926).

FIGS. 19 to 19b. A specimen retaining both valves in conjunction, supposed to represent a young stage of this species.
19. Ventral view.
19a. Side view in outline.
19b. Posterior view.
Capitan formation, Capitan Peak (station 2926).

SPIRIFERINA PYRAMIDALIS n. sp. (p. 378).

FIGS. 20 to 20b. A characteristic ventral valve.
20. Side view.
20a. Posterior view.
20b. Seen from above.
Capitan formation, Capitan Peak (station 2926).

FIGS. 21 to 21b. A specimen retaining both valves in place.
21. Dorsal view.
21a. Side view in outline.
21b. Posterior view in outline.
Capitan formation, Capitan Peak (station 2926).

HUSTEDIA MEEKANA Shumard (p. 394).

FIGS. 22 to 22b. A characteristic specimen preserved in the same way as Shumard's type. The thick shell has been exfoliated so that the condition is almost that of an internal mold.

22. Dorsal view, × 2.
22a. Side view, × 2.
22b. Anterior view, × 2.
Capitan formation, Capitan Peak (station 2926).

FIGS. 23 and 23a. A smaller, somewhat differently shaped specimen preserved in the same way.

23. Dorsal view.
23a. Same, × 2.
Capitan formation, Capitan Peak (station 2926).

FIGS. 24 and 24a. A specimen in part of which the shell is almost perfect, showing large, simple plications, and in part almost completely exfoliated, showing smaller striated plications.

24. An oblique side view, × 2.
24a. Anterior view, × 2.
Capitan formation, Capitan Peak (station 2926).

FIGS. 25 to 25c. A specimen in which the shell has been exfoliated little if at all.

25. Ventral view.
25a. Same, × 2.
25b. Side view.
25c. Anterior view. The plications in this case are rounder and a little lower than in the foregoing specimen.
Capitan formation, Capitan Peak (station 2926).

FIGS. 26 and 26a. A small, rotund example having the shell only partly exfoliated.

26. Ventral view.
26a. Anterior view, × 2.
Capitan formation, Capitan Peak (station 2926).

RICHTHOFENIA PERMIANA Shumard (p. 283).

FIGS. 27 to 27d. A short, rapidly expanding example preserving the dorsal valve in place. Others are much more slender.

27. Side view.
27a. Anterior view.
27b. Posterior view.
27c. Lower side, showing cysts.
27d. Upper side, showing dorsal valve.
Capitan formation, Capitan Peak (station 2926).

PLATE XV.

PLATE XV.

CAPITAN FORMATION, GUADALUPE MOUNTAINS.

COMPOSITA EMARGINATA n. sp. (p. 388).

FIGS. 1 to 1c. A strongly characterized example of this species.
1. Ventral view.
1a. Dorsal view.
1b. Side view in outline.
1c. Anterior view.
Capitan formation, Capitan Peak (station 2926).

FIGS. 2 to 2c. A specimen similar to the foregoing, but with the characters less strongly developed.
2. Dorsal view.
2a. Ventral view.
2b. Side view in outline.
2c. Anterior view.
Capitan formation, Capitan Peak (station 2926).

FIGS. 3 to 3b. A slightly malformed specimen in which the sinus of the dorsal valve is very faint. There is an obscure emargination of the front outline.
3. Dorsal view.
3a. Side view in outline.
3b. Anterior view in outline.
Capitan formation, Capitan Peak (station 2926).

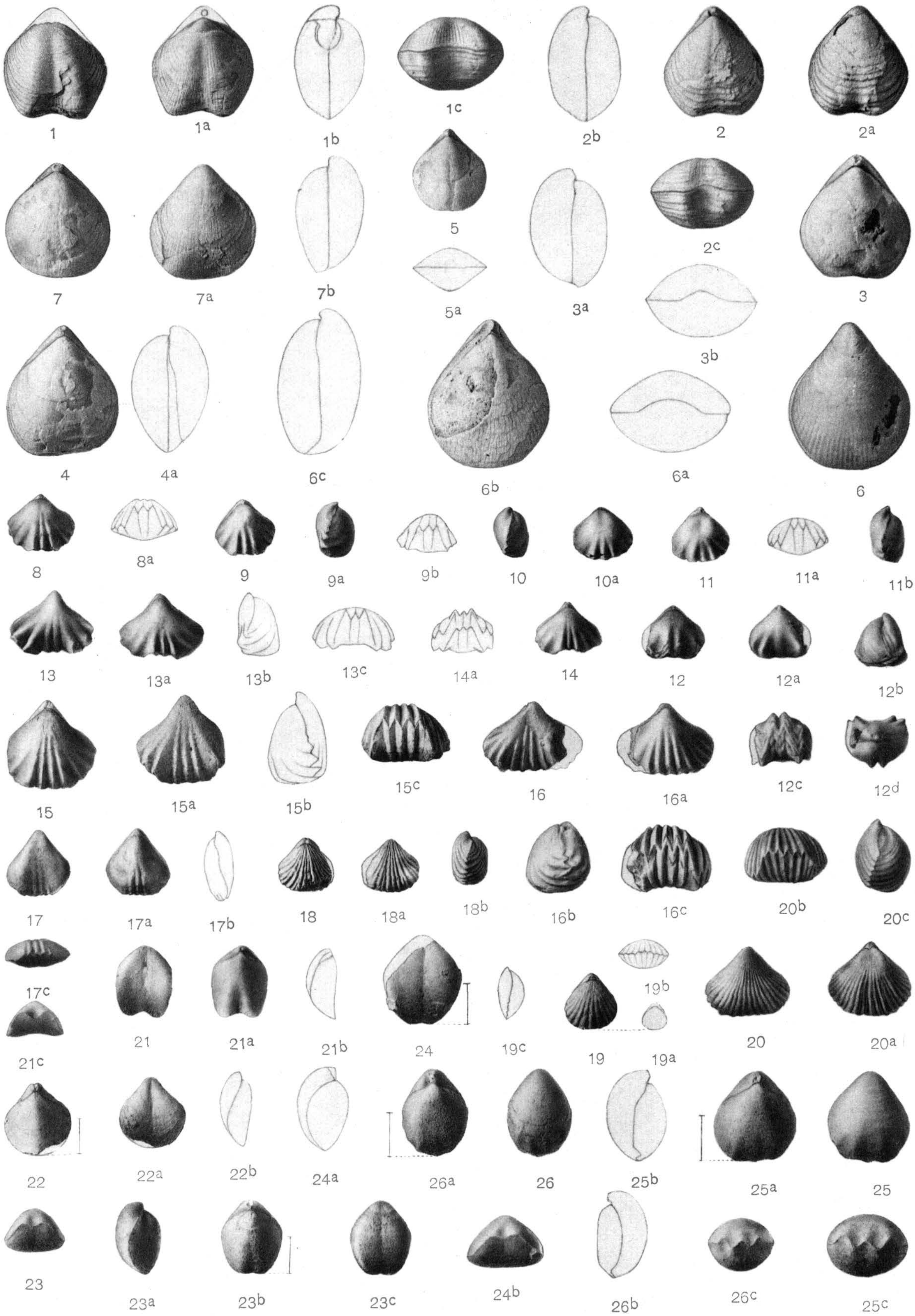
FIGS. 4 and 4a. A specimen in which a well-marked sinus is developed in neither valve. The dorsal valve is flattened and slightly depressed medially, and the anterior outline is straight. This form departs strongly from typical *C. emarginata* as shown by figs. 1 to 1c, at least in degree, and differs to no great extent from the variety *affinis*. Varieties of *C. subtilita* do not materially differ from it.
4. Dorsal view.
4a. Side view in outline.
Capitan formation, Capitan Peak (station 2926.)

FIGS. 5 and 5a. A young example in which the two sinuses are represented by slightly depressed lines. The front outline is somewhat straight, but in the front view there is no fold and sinus.
5. Dorsal view.
5a. Front view in outline.
Capitan formation, Capitan Peak (station 2926).

COMPOSITA EMARGINATA var. AFFINIS n. var. (p. 389).

FIGS. 6 to 6c. A large and somewhat imperfect example.
6. Ventral view.
6a. Anterior view in outline.
6b. Dorsal view.
6c. Side view in outline.
Capitan formation, Capitan Peak (station 2926).

FIGS. 7 to 7b. A smaller specimen having similar characters.
This form does not differ materially from varieties of *C. subtilita*.
7. Dorsal view.
7a. Ventral view.
7b. Side view in outline.
Capitan formation, Capitan Peak (station 2926).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PUGNAX SWALLOWIANA Shumard (p. 314).

FIGS. 8 and 8a. A characteristic specimen.
8. Dorsal view.
8a. Anterior view in outline.
Capitan formation, Capitan Peak (station 2926).
FIGS. 9 to 9b. Another similar specimen.
9. Dorsal view.
9a. Side view.
9b. Anterior view in outline.
Capitan formation, Capitan Peak (station 2926).
FIGS. 10 and 10a. A somewhat differently shaped specimen with faint lateral plications.
10. Side view.
10a. Dorsal view.
Capitan formation, Capitan Peak (station 2926).
FIGS. 11 to 11b. A specimen similar to the last, with rounded outline and less distinct and angular plications.
11. Dorsal view.
11a. Front view in outline.
11b. Side view.
Capitan formation, Capitan Peak (station 2926).
FIGS. 12 to 12d. A specimen referred to this species with only two plications on the fold.
12. Dorsal view.
12a. Ventral view.
12b. Side view.
12c. Anterior view.
12d. Posterior view.
Capitan formation, Capitan Peak (station 2926).

PUGNAX ELEGANS n. sp. (p. 315).

FIGS. 13 to 13c. A characteristic specimen.
13. Ventral view.
13a. Dorsal view.
13b. Side view in outline.
13c. Anterior view.
Capitan formation, Capitan Peak (station 2926).
FIGS. 14 and 14a. Another similar specimen.
14. Dorsal view.
14a. Anterior view in outline.
Capitan formation, Capitan Peak (station 2926).

PUGNAX SHUMARDIANA n. sp. (p. 316).

FIGS. 15 to 15c. A specimen naturally deformed but otherwise nearly perfect.
15. Dorsal view.
15a. Ventral view.
15b. Side view in outline.
15c. Anterior view.
Capitan formation, Capitan Peak (station 2926).
FIGS. 16 to 16c. A small tumid specimen referred to the same species.
16. Ventral view.
16a. Dorsal view.
16b. Side view.
16c. Anterior view.
Capitan formation, Capitan Peak (station 2926).

FIGS. 17 to 17c. A young specimen referred to this species.
17. Ventral view.
17a. Dorsal view.
17b. Side view in outline.
17c. Anterior view.
Capitan formation, Capitan Peak (station 2926).

RHYNCHONELLA? LONGÆVA n. sp. (p. 322).

FIGS. 18 to 18b. The typical specimen, somewhat imperfect but showing both valves in conjunction.
18. Dorsal view.
18a. Ventral view.
18b. Side view.
Capitan formation, Capitan Peak (station 2926).
FIGS. 19 to 19c. A young example from the same locality, supposed to belong to the same species.
19. Dorsal view, × 2.
19a. Same, natural size in outline.
19b. Anterior view, × 2.
19c. Side view in outline, × 2.
Capitan formation, Capitan Peak (station 2926).

RHYNCHONELLA? INDENTATA Shumard (p. 321).

FIGS. 20 to 20c. A specimen from the same horizon as Shumard's type and answering very closely to his description.
20. Ventral view.
20a. Dorsal view.
20b. Anterior view.
20c. Side view.
Capitan formation, Capitan Peak (station 2926).

HETERELASMA SHUMARDIANUM n. sp. (p. 338).

FIGS. 21 to 21c. The type specimen.
21. Ventral view.
21a. Dorsal view.
21b. Side view in outline.
21c. Anterior view.
Capitan formation, Capitan Peak (station 2926).
FIGS. 22 to 22b. A small specimen supposed to be a young example of this species.
22. Dorsal view, × 2.
22a. Ventral view, × 2.
22b. Side view in outline, × 2.
Capitan formation, Capitan Peak (station 2926).

HETERELASMA VENUSTULUM n. sp. (p. 339).

FIGS. 23 to 23c. The typical specimen.
23. Anterior view, × 2.
23a. Side view, × 2.
23b. Dorsal view, × 2.
23c. Ventral view, × 2.
Capitan formation, Capitan Peak (station 2926).
FIGS. 24 to 24b. A larger and relatively broader specimen
24. Ventral view, × 2.
24a. Side view in outline, × 2.
24b. Anterior view, × 2.
Capitan formation, Capitan Peak (station 2926).

NOTOTHYRIS SCHUCHERTENSIS n. sp. (p. 336).

FIGS. 25 to 25c. The typical specimen.
25. Ventral view, × 2.
25a. Dorsal view, × 2.
25b. Side view in outline, × 2.
25c. Anterior view, × 2.
Capitan formation, Capitan Peak (station 2926).

NOTOTHYRIS SCHUCHERTENSIS var. OVATA n. var. (p. 336).

FIGS. 26 to 26c. The typical specimen.
26. Ventral view, × 2.
26a. Dorsal view, × 2.
26b. Side view in outline, × 2.
26c. Anterior view, × 2.
Capitan formation, Capitan Peak (station 2926).

PLATE XVI.

PLATE XVI.

CAPITAN FORMATION, GUADALUPE MOUNTAINS.

DIELASMA SULCATUM n. sp. (p. 332).

FIGS. 1 to 1c. The ventral beak is somewhat crushed, causing it to appear probably a little broader and less erect than normal.

1. Dorsal view.
1a. Ventral view.
1b. Side view in outline.
1c. Anterior view.
Capitan formation, Capitan Peak (station 2926).

DIELASMA CORDATUM n. sp. (p. 331).

FIGS. 2 to 2c. The flattening of the anterior half of the dorsal valve has been a little exaggerated by compression.

2. Anterior view.
2a. Ventral view.
2b. Dorsal view.
2c. Side view in outline.
Capitan formation, Capitan Peak (station 2926).

DIELASMA SPATULATUM n. sp. (p. 330).

FIGS. 3 to 3c. The typical specimen.

3. Dorsal view.
3a. Ventral view.
3b. Side view in outline.
3c. Anterior view in outline.
Capitan formation, Capitan Peak (station 2926).

FIGS. 4 to 4c. A small specimen provisionally referred to this species.

4. Ventral view.
4a. Dorsal view.
4b. Side view in outline.
4c. Anterior view in outline.
Capitan formation, Capitan Peak (station 2926).

DIELASMA PROLONGATUM n. sp. (p. 331).

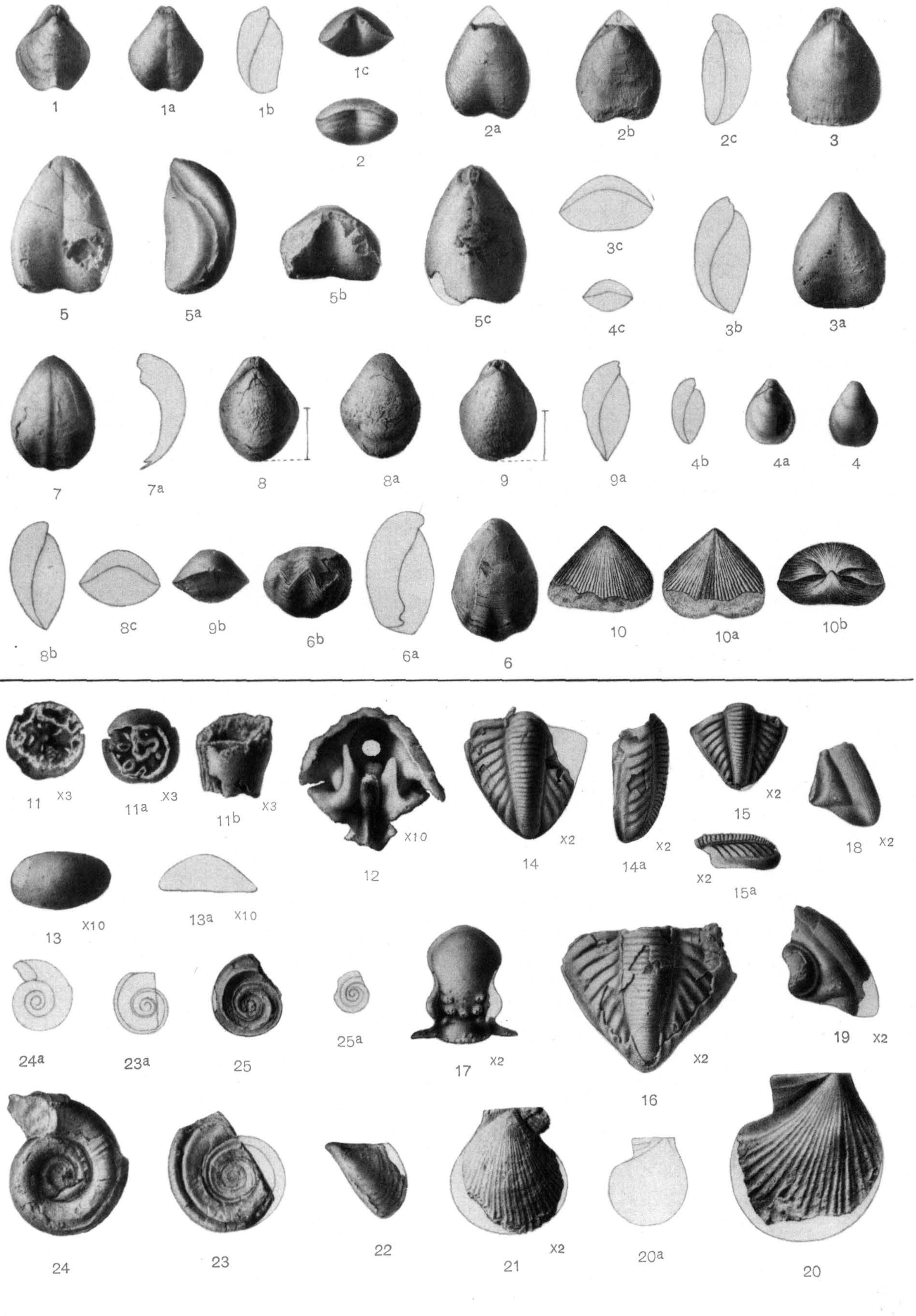
FIGS. 5 to 5c. A somewhat imperfect specimen serving as the type.

5. Ventral view.
5a. Side view.
5b. Anterior view.
5c. Dorsal view.
Capitan formation, McKitterick Canyon (station 2932).

DIELASMINA GUADALUPENSIS n. sp. (p. 333).

FIGS. 6 to 6b. The type specimen, retaining both valves but somewhat distorted by crushing.

6. Ventral view.
6a. Side view in outline.
6b. Anterior view. Owing to breakage and perhaps compression, the right side of the specimen is thicker than the left, as shown here.
Capitan formation, Capitan Peak (station 2926).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15 X2
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18 X2
13 X10
13a X10
24a
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25a
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19 X2
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21 X2
20a
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FIGS. 7 and 7a. A ventral valve with more persistent sinus.
7. Seen from above.
7a. Side view in outline.
Capitan formation, Capitan Peak (station 2926).

DIELASMA? SCUTULATUM n. sp. (p. 332).

FIGS. 8 to 8c. The typical specimen.
8. Dorsal view, × 2.
8a. Ventral view, × 2.
8b. Side view in outline, × 2.
8c. Anterior view in outline, × 2.
Capitan formation, Capitan Peak (station 2926).
FIGS. 9 to 9b. A second specimen of somewhat different shape.
9. Dorsal view, × 2.
9a. Side view in outline, × 2.
9b. Anterior view, × 2.
Capitan formation, Capitan Peak (station 2926).

RHYNCHONELLA? GUADALUPÆ Shumard (p. 323).

FIGS. 10 to 10b. The typical specimen, from which the anterior portion has apparently been broken away (after Shumard).
10. Dorsal view.
10a. Ventral view.
10b. Posterior view.
Capitan formation, Guadalupe Mountains.

"DARK LIMESTONE," GUADALUPE MOUNTAINS.

POLYSIPHON MIRABILIS n. sp. (p. 87).

FIGS. 11 to 11b. A silicified specimen used as the type.
11. Seen from above, × 3.
11a. Seen from below, × 3.
11b. Side view, × 3.
"Dark limestone," Pine Spring (station 2930).

HUSTEDIA MEEKANA var. TRIGONALIS n. var. (p. 396).

FIG. 12. Fragment of the apical portions of the two valves, showing the internal structures.
View looking obliquely downward upon the interior, × 10.
"Dark limestone," Pine Spring (station 2930).

CYTHERE? sp. (p. 509).

FIGS. 13 and 13a. An imperfect right valve.
13. Side view, × 10.
13a. Ventral view in outline, × 10.
"Dark limestone," Pine Spring (station 2930).

ANISOPYGE PERANNULATA Shumard (p. 506).

FIGS. 14 and 14a. An imperfect pygidium.
14. Seen from above, × 2. The uncompensated fragment at the top (left side of figure) appears to be one of the pleura.
14a. Side view, × 2.
"Dark limestone," Pine Spring (station 2930).

FIGS. 15 and 15a. A small but nearly perfect pygidium.
15. Seen from above, × 2.
15a. Side view, × 2.
"Dark limestone," Pine Spring (station 2930).

FIG. 16. An unusually wide pygidium, probably rendered so by compression.
Seen from above, × 2.
"Dark limestone," Pine Spring (station 2930).

FIG. 17. A fairly perfect cranidium.
Seen from above, × 2.
"Dark limestone," Pine Spring (station 2930).

FIG. 18. An imperfect free cheek.
Seen from above, × 2.
"Dark limestone," Pine Spring (station 2930).

FIG. 19. A nearly perfect free cheek.
Seen from above, × 2.
"Dark limestone," Pine Spring (station 2930).

AVICULIPECTEN GUADALUPENSIS n. sp. (p. 436).

FIGS. 20 and 20a. A left valve, about half mature size.
20. Side view, × 2.
20a. Same, natural size in outline.
"Dark limestone," Pine Spring (station 2930).

AVICULIPECTEN sp. *a* (p. 436).

FIG. 21. A left (?) valve. If a right valve instead of a left, this may be the complementary valve of the foregoing species.
Side view, × 2.
"Dark limestone," Pine Spring (station 2930).

MYALINA SQUAMOSA Sowerby? (p. 429).

FIG. 22. A left valve preserved for the most part as an internal mold
Side view.
"Dark limestone," Pine Spring (station 2930).

EUOMPHALUS SULCIFER n. sp. (p. 482).

FIGS. 23 and 23a. An imperfect specimen.
23. Upper side, × 2.
23a. Same, natural size in outline.
"Dark limestone," Pine Spring (station 2930).

FIGS. 24 and 24a. A second specimen showing the lower side.
24. Lower side, × 2.
24a. Same, natural size in outline.
"Dark limestone," Pine Spring (station 2930).

EUOMPHALUS SULCIFER var. ANGULATUS n. var. (p. 483).

FIGS. 25 and 25a. The type specimen.
25. Upper side, × 2.
25a. Same, natural size in outline.
"Dark limestone," Pine Spring (station 2930).

PLATE XVII.

PLATE XVII.

"DARK LIMESTONE," GUADALUPE MOUNTAINS.

FUSULINA ELONGATA Shumard (p. 62).

FIG. 1. A specimen broken at one end.
Side view, × 3, showing the bluntly rounded shape of the ends.
"Dark limestone," Pine Spring (station 2930).

FIG. 2. A specimen incomplete at both ends.
Side view, × 3, showing the closely arranged and somewhat irregular sutures.
"Dark limestone," Pine Spring (station 2930).

FIG. 3. A somewhat large, complete, symmetrical specimen.
Side view, natural size.
"Dark limestone," Pine Spring (station 2930).

FIG. 4. A smaller, much distorted specimen, also practically complete.
Side view, natural size.
"Dark limestone," Pine Spring (station 2930).

FIG. 5. A large, somewhat contorted specimen. This and some of the preceding specimens illustrate the tendency of these forms to exfoliate concentrically and to break up into segments. The latter is not necessarily connected with fracture of the rocks, for many specimens are broken in situ.
Side view, natural size.
"Dark limestone," Pine Spring (station 2930).

FIG. 6. Transverse section, × 20. This section does not pass through the initial cell. It seems to indicate that the specimens were eroded or exfoliated before fossilization. The wall structure and method of formation of the shell are unusually well shown.
"Dark limestone," Pine Spring (station 2930).

FIG. 7. Longitudinal section, × 20. The section does not pass through the initial cell and is of course incomplete at both ends. The highly contorted character of the partition walls is shown.
"Dark limestone," Pine Spring (station 2930).

FIG. 8. Transverse section through the initial cell, × 10.
"Dark limestone," Pine Spring (station 2930).

SPIRILLINA aff. S. PLANA Möller (p. 69).

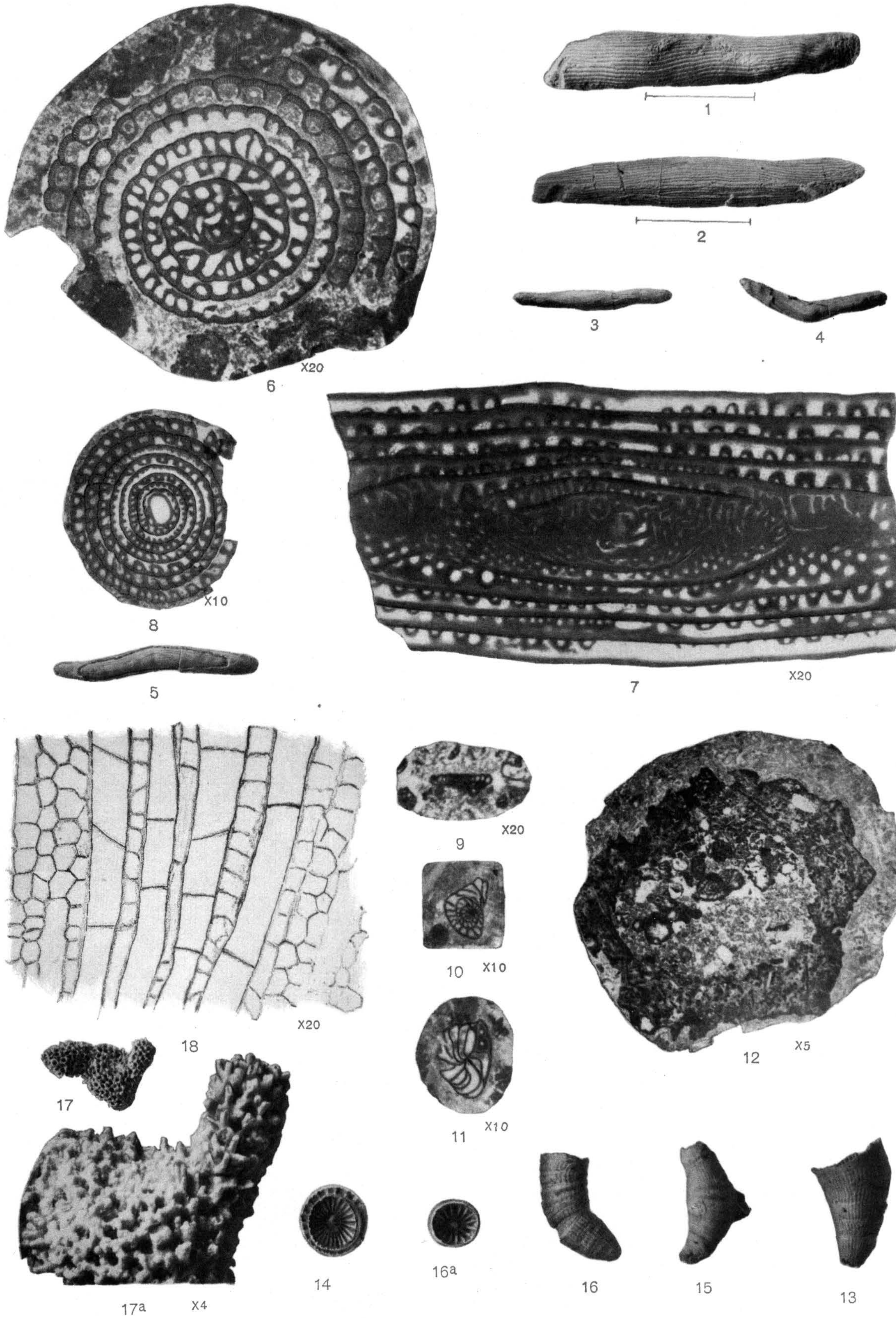
FIG. 9. Section through or parallel to the axis, × 20.
"Dark limestone," Pine Spring (station 2930).

ENDOTHYRA sp. *b* (p. 67).

FIG. 10. Section somewhat oblique to the axis, × 10.
"Dark limestone," Pine Spring (station 2930).

ENDOTHYRA sp. *a* (p. 67).

FIG. 11. Section oblique to the axis, showing the perforated partition which closes the aperture, × 10.
"Dark limestone," Pine Spring (station 2930).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SPONGE, undetermined.

FIG 12. A body having fairly distinct outlines in thin section and apparently a spicular constitution to a considerable extent. The spicules are uniaxial and are not very distinct in the figure.
Thin section, × 5.
"Dark limestone," Pine Spring (station 2930).

LINDSTRŒMIA PERMIANA n. sp. (p. 97).

FIG. 13. A somewhat rapidly enlarging specimen.
Side view.
"Dark limestone," Pine Spring (station 2930).
FIG. 14. View of the calice, which in this case happens to be double by reason of a cessation and later a renewal of growth. The calice is really considerably deeper than it has been possible to represent in this view.
"Dark limestone," Pine Spring (station 2930).

LINDSTRŒMIA PERMIANA var. (p. 99).

FIG. 15. A pathologic specimen. A small example is growing attached at the right and may have occasioned the abnormal condition of the larger individual, which began to contract in size from the point at which the small one became attached.
Side view.
"Dark limestone," Pine Spring (station 2930).

LINDSTRŒMIA CYLINDRICA n. sp. (p. 99).

FIGS. 16 and 16a. The type specimen.
16. Side view.
16a. View of the calice, which is really deeper than it has been possible to show in the figure.
"Dark limestone," Pine Spring (station 2930).

CLADOPORA SPINULATA n. sp. (p. 102).

FIGS. 17 and 17a. A specimen with well-preserved spines.
17. Side view of corallum.
17a. Part of same, × 4.
"Dark limestone," Pine Spring (station 2930).

FISTULIPORA GRANDIS var. GUADALUPENSIS n. var. (p. 125).

FIG. 18. The typical specimen. (For tangential section see Pl. XXV, fig. 7.)
Longitudinal section, × 20.
"Dark limestone," Pine Spring (station 2930).

PLATE XVIII.

PLATE XVIII.

"DARK LIMESTONE," GUADALUPE MOUNTAINS.

DOMOPORA? TERMINALIS n. sp. (p. 120).

FIGS. 1 and 1a. A small but characteristic specimen.
1. Seen from above, × 4.
1a. Side view in outline, × 4.
"Dark limestone," Guadalupe Point (station 3762b).

FIG. 2. A specimen in which the terminal macula is obscure. This is probably due to the fact that the outer portion of the zoarium has been broken away.
View of the upper end, × 4.
"Dark limestone," Guadalupe Point (station 3762b).

FIGS. 3 and 3a. A characteristic specimen.
3. Seen from above, × 4.
3a. Side view, × 4.
"Dark limestone," Guadalupe Point (station 3762b).

FIGS. 4 and 4a. A budded specimen in which the second growth has twin maculæ.
4. Seen from above, × 4.
4a. Side view, × 4.
"Dark limestone," Guadalupe Point (station 3762b).

FIGS. 5 and 5a. A specimen in which budding is unusually pronounced.
5. Side view, × 4.
5a. Seen from above, × 4.
"Dark limestone," Guadalupe Point (station 3762b).

FIGS. 6 and 6a. A specimen with triple maculæ, referred with some doubt to this species. It may be an initial colony of *D. ocellata*.
6. Side view, × 4.
6a. Seen from above, × 4.
"Dark limestone," Guadalupe Point (station 3762b).

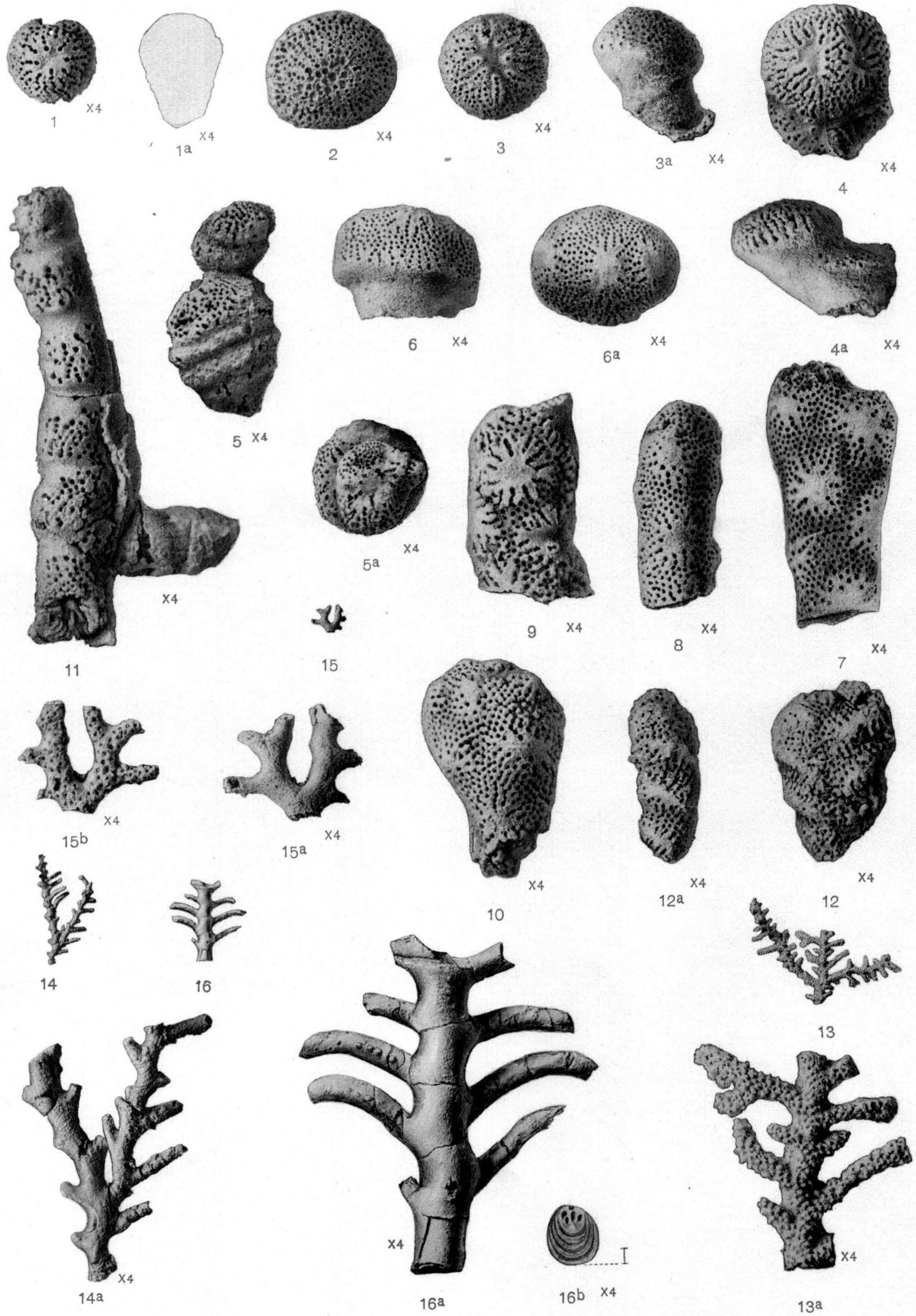
DOMOPORA? OCELLATA n. sp. (p. 122).

FIG. 7. A fine and very characteristic specimen, apparently showing incipient bifurcation.
Side view, × 4.
"Dark limestone," Guadalupe Point (station 3762b).

FIG. 8. A characteristic specimen representing a portion of a branch.
Side view, × 4.
"Dark limestone," Pine Spring (station 2930).

FIG. 9. A specimen with projecting maculæ, a condition which is possibly connected with silicification and etching.
Side view, × 4.
"Dark limestone," Pine Spring (station 2930).

FIG. 10. A tumid specimen referred to this species. The shape is possibly due to incipient branching.
Side view, × 4.
"Dark limestone," Pine Spring (station 2930).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15a X4
15b X4
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16a X4
16b X4
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DOMOPORA? CONSTRICTA n. sp. (p. 123).

FIG. 11. The typical specimen. I am not certain whether the apparent branching is a real feature or is due to a parasitic growth.
Side view, × 4.
"Dark limestone," Pine Spring (station 2930).

DOMOPORA? VITTATA n. sp. (p. 123).

FIGS. 12 and 12a. A fragment from near a branching point.
12. Side view, × 4.
12a. Side view, × 4.
"Dark limestone," Pine Spring (station 2930).

ACANTHOCLADIA GUADALUPENSIS n. sp. (p. 149).

FIGS. 13 and 13a. The typical specimen, silicified and etched.
13. Poriferous side.
13a. Portion of the same, × 4, showing the spinose surface.
"Dark limestone," Pine Spring (station 2930).
FIGS. 14 and 14a. Another specimen similarly preserved.
14. Nonporiferous side.
14a. Same, × 4. The irregularities of surface seen in this view seem to be the result of chalcedonic replacement.
"Dark limestone," Pine Spring (station 2930).

ACANTHOCLADIA sp. (p. 152).

FIGS. 15 to 15b. A silicified specimen of uncertain affinities.
15. Nonporiferous side.
15a. Same, × 4.
15b. Poriferous side, × 4.
"Dark limestone," Guadalupe Point (station 3762e).

ACANTHOCLADIA GUADALUPENSIS n. sp.? (p. 149).

FIGS. 16 to 16b. A large specimen showing only the nonporiferous side.
16. Nonporiferous side.
16a. Same, × 4, showing the nodose pinnules.
16b. Cross section, × 3, showing the heavy basal plate.
"Dark limestone," Pine Spring (station 2930).

PLATE XIX.

PLATE XIX.

"DARK LIMESTONE," GUADALUPE MOUNTAINS

STENOPORA GRANULOSA n. sp. (p. 128).

FIGS. 1 to 1c. The typical specimen.

1. Tangential section, showing granular bands in walls, × 20.
1a. Same, more highly magnified, × 35.
1b. Tangential section, showing granular acanthopores, × 20.
1c. Vertical section, showing the irregular moniliform character of the walls and the absence of tabulæ, × 20.

"Dark limestone," Pine Spring (station 2930).

LEIOCLEMA SHUMARDI n. sp. (p. 131).

FIGS. 2 to 2d. The typical specimen.

2. Tangential section, showing zoœcia, mesopores, and acanthopores, × 35.
2a. Same, × 20.
2b. Vertical section through spreading base, showing tabulated mesopores, × 20.
2c. Vertical section of a branch, showing the thickened tissue on the walls in the mature region which has obscured the tabulated mesopores, × 20.
2d. Vertical section of walls, showing tabulated acanthopores, × 50.

"Dark limestone," Pine Spring (station 2930).

FENESTELLA HILLI n. sp. (p. 134).

FIGS. 3 and 3a. A silicified specimen.

3. Nonporiferous side, × 8.
3a. Poriferous side, × 8.

"Dark limestone," Guadalupe Point (station 3762e).

FENESTELLA SPINULOSA Condra? (p. 137).

FIGS. 4 and 4a. A silicified specimen resembling this species.

4. Nonporiferous side, × 8.
4a. Poriferous side, × 8.

"Dark limestone," Pine Spring (station 2930).

FENESTELLA GUADALUPENSIS n. sp. (p. 135).

FIG. 5. A silicified specimen.

Nonporiferous side, × 8.

"Dark limestone," Pine Spring (station 2930).

POLYPORA MEXICANA Prout? (p. 143).

FIGS. 6 to 6b. A silicified specimen referred to this species.

6. Nonporiferous side, natural size.
6a. Poriferous side, × 5.
6b. Nonporiferous side, × 5.

"Dark limestone," Guadalupe Point (station 3762e).

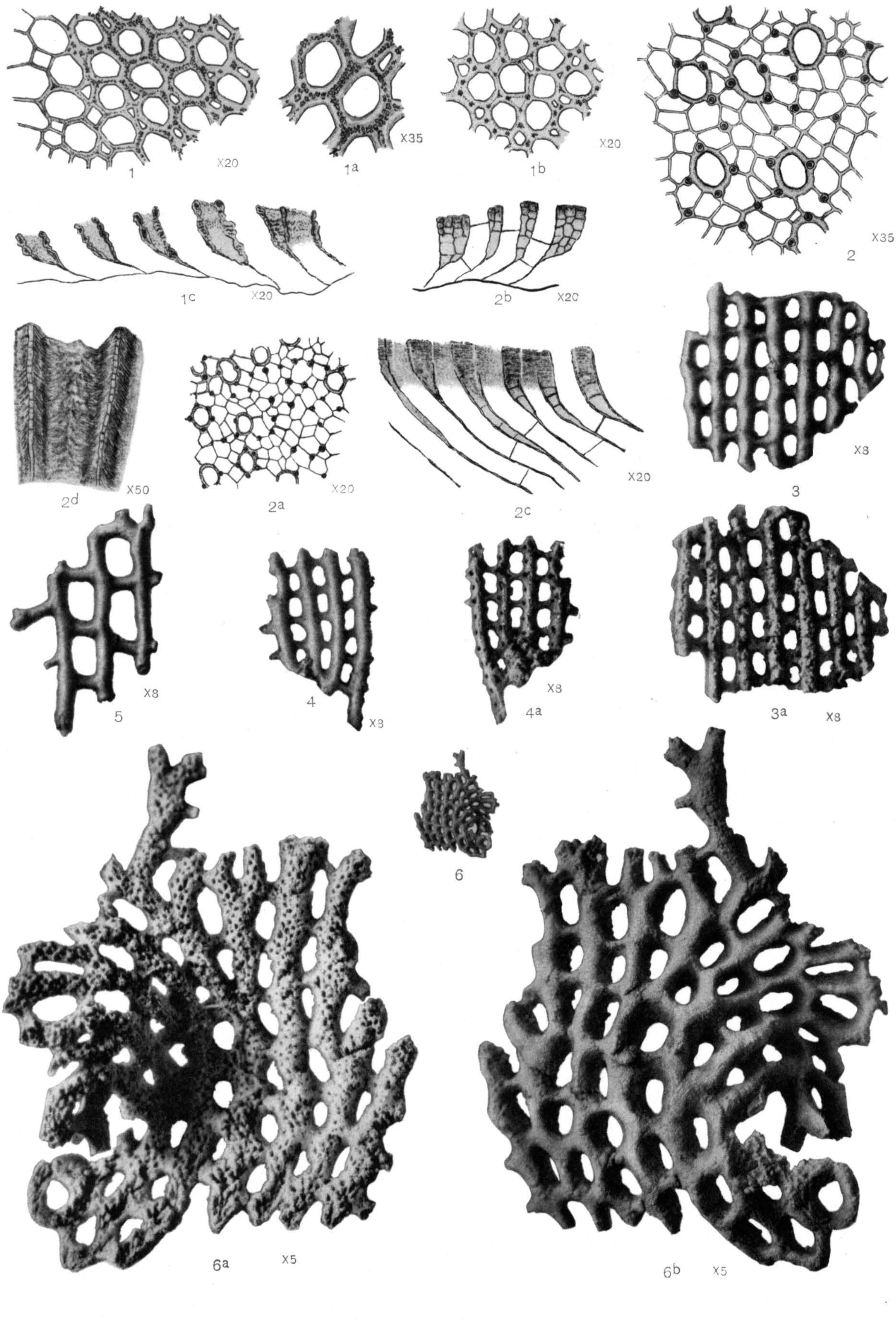

1 X20
1a X35
1b X20
2 X35
1c X20
2b X20
2d X50
2a X20
2c X20
3 X8
5 X8
4 X8
4a X8
3a X8
6
6a X5
6b X5

PLATE XX.

PLATE XX.

"DARK LIMESTONE," GUADALUPE MOUNTAINS.

CHONETES PERMIANUS Shumard (p. 226).

FIGS. 1 and 1a. A ventral valve of medium size.
1. Seen from above.
1a. Side view in outline.
"Dark limestone," Pine Spring (station 2930).

FIGS. 2 and 2a. A small specimen.
2. Dorsal view, showing area of the opposite valve.
2a. Side view in outline.
"Dark limestone," Pine Spring (station 2930).

FIGS. 3 and 3a. A small ventral valve.
3. Seen from above.
3a. Side view in outline.
"Dark limestone," Pine Spring (station 2930).

CHONETES SUBLIRATUS n. sp. (p. 228).

FIGS. 4 and 4a. A somewhat imperfect ventral valve taken as the type of this species.
4. Seen from above.
4a. Side view.
"Dark limestone," Pine Spring (station 2930).

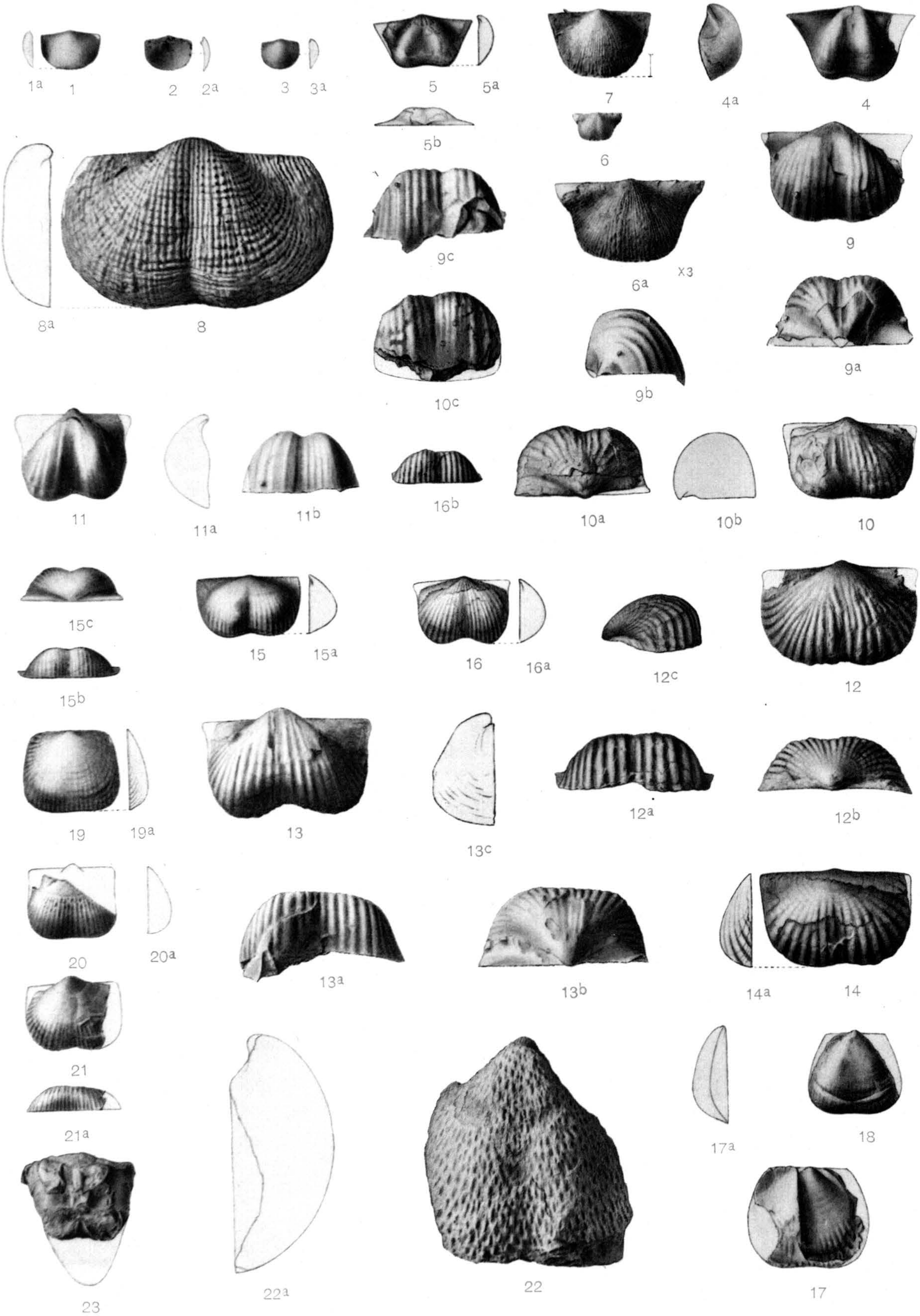
FIGS. 5 to 5b. A younger example referred to the same species. The sinus and convexity are less marked, but the shape is even more quadrate.
5. Seen from above.
5a. Side view in outline.
5b. Posterior view in outline.
"Dark limestone," Pine Spring (station 2930).

FIGS. 6 and 6a. A young ventral valve referred to this species.
6. Seen from above.
6a. Same, × 3. The concentric lines which are a feature of the original do not appear upon this figure.
"Dark limestone," Pine Spring (station 2930).

FIG. 7. A still younger ventral valve referred here.
Seen from above, × 3. The concentric liræ found on the original are not shown by this figure.
"Dark limestone," Pine Spring (station 2930).

PRODUCTUS SEMIRETICULATUS var. CAPITANENSIS n. var. (p. 254).

FIGS. 8 and 8a. A large ventral valve which has been considerably deformed by compression.
8. Seen from above.
8a. Side view in outline.
"Dark limestone," Pine Spring (station 2930).


1a
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2
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5b
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8a
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9c
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X3
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10c
9b
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11a
11b
16b
10a
10b
10
15c
15b
15
15a
16
16a
12c
12
19
19a
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13c
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12b
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20a
13a
13b
14a
14
21
21a
17a
18
23
22a
22
17

PRODUCTUS POPEI Shumard (p. 257).

FIGS. 9 to 9c. A characteristic ventral valve of the type referred to Shumard's species.
9. Seen from above.
9a. Posterior view.
9b. Side view.
9c. Anterior view.
"Dark limestone," Pine Spring (station 2930).

FIGS. 10 to 10c. Another ventral valve similar to the last.
10. Seen from above.
10a. Posterior view.
10b. Side view in outline.
10c. Anterior view.
"Dark limestone," Pine Spring (station 2930).

FIGS. 11 to 11b. A ventral valve referred to this species with some doubt.
11. Seen from above.
11a. Side view in outline.
11b. Anterior view.
"Dark limestone," Pine Spring (station 2930).

PRODUCTUS POPEI var. OPIMUS n. var. (p. 258).

FIGS. 12 to 12c. A somewhat imperfect ventral valve selected as the typical specimen.
12. Seen from above.
12a. Anterior view.
12b. Posterior view.
12c. Side view.
"Dark limestone," Pine Spring (station 2930).

FIGS. 13 to 13c. A ventral valve somewhat deformed by compression, which has exaggerated the depth of the sinus.
13. Seen from above.
13a. Anterior view.
13b. Posterior view.
13c. Side view in outline.
"Dark limestone," Pine Spring (station 2930).

FIGS. 14 and 14a. A dorsal valve belonging to this species.
14. Seen from above.
14a. Side view in outline.
"Dark limestone," Pine Spring (station 2930).

PRODUCTUS INDENTATUS n. sp. (p. 259).

FIGS. 15 to 15c. A typical ventral valve.
15. Seen from above.
15a. Side view in outline.
15b. Anterior view.
15c. Posterior view.
"Dark limestone," Pine Spring (station 2930).

FIGS. 16 to 16b. Another ventral valve showing the characters of the species.
16. Seen from above.
16a. Side view in outline.
16b. Anterior view.
"Dark limestone," Pine Spring (station 2930).

Productus limbatus n. sp. (p. 272).

Figs. 17 and 17a. An imperfect specimen showing both valves.
17. Seen from above.
17a. Side view in outline.
"Dark limestone," Pine Spring (station 2930).

Fig. 18. Another ventral valve, referred to this species.
Seen from above.
"Dark limestone," Pine Spring (station 2930).

Productus sp. *d* (p 273).

Figs. 19 and 19a. A dorsal valve referred to this species.
19. Seen from above.
19a. Side view in outline.
"Dark limestone," Pine Spring (station 2930).

Figs. 20 and 20a. An imperfect ventral valve.
20. Seen from above.
20a. Side view in outline.
"Dark limestone," Pine Spring (station 2930).

Figs. 21 and 21a. Another imperfect ventral valve, slightly larger than the last and somewhat more closely ribbed.
21. Seen from above.
21a. Anterior view.
"Dark limestone," Pine Spring (station 2930).

Aulosteges guadalupensis Shumard (p. 277).

Figs. 22 and 22a. An imperfect ventral valve resembling that upon which the species was founded.
22. Seen from above.
22a. Side view in outline.
"Dark limestone," Pine Spring (station 2930).

Richthofenia permiana Shumard (p. 283).

Fig. 23. A specimen which has been reduced by exfoliation almost to the condition of an internal mold. Posterior view, slightly tilted. Above is the dorsal valve; below, the cystose portion; in the center, the pseudodeltidium and other structures exposed by exfoliation.
"Dark limestone," Pine Spring (station 2930).

PLATE XXI.

PLATE XXI.

"DARK LIMESTONE," GUADALUPE MOUNTAINS.

SPIRIFER MEXICANUS var. (p. 362).

FIGS. 1 to 1b. An exfoliated and otherwise imperfect ventral valve.
1. Seen from above. The fasciculation is hardly distinct enough in this figure.
1a. Side view in outline.
1b. Cardinal view in outline.
"Dark limestone," Pine Spring (station 2930).

SPIRIFER sp. *a* (p. 362).

FIG. 2. A dorsal valve of uncertain relations.
Seen from above. In this figure the ribs are represented as somewhat too distinct.
"Dark limestone," Pine Spring (station 2930).

SPIRIFERINA LAXA n. sp. (p. 377).

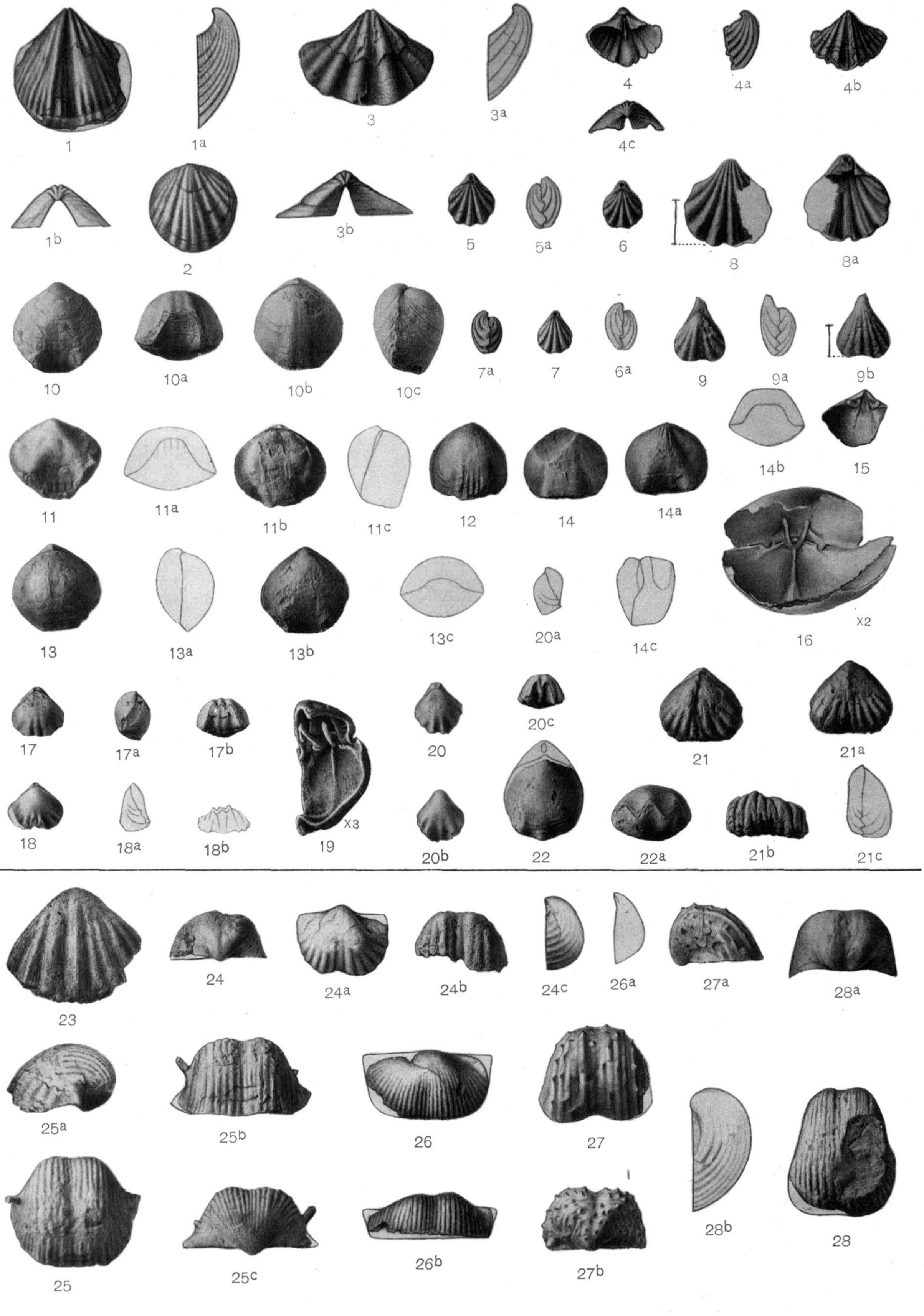
FIGS. 3 to 3b. A ventral valve. The greater portion of the shell preserved consists only of the punctate, silicified inner layer, to which are adhering fragments of the dense outer layer and more extensive areas of an intermediate layer.
3. Seen from above.
3a. Side view in outline.
3b. Cardinal view.
"Dark limestone," Pine Spring (station 2930).

SPIRIFERINA HILLI var. POLYPLEURUS n. var. (p. 380).

FIGS. 4 to 4c. A ventral valve.
4. View of the interior.
4a. Side view in outline.
4b. View of the exterior.
4c. Cardinal view.
"Dark limestone," Pine Spring (station 2930).

HUSTEDIA MEEKANA Shumard (p. 394).

FIGS. 5 and 5a. A small specimen. A much larger size is attained by others from the same locality.
5. Dorsal view.
5a. Side view in outline.
"Dark limestone," Pine Spring (station 2930).
FIGS. 6 and 6a. A similar specimen.
6. Dorsal view.
6a. Side view in outline.
"Dark limestone," Pine Spring (station 2930).
FIGS. 7 and 7a. A narrow specimen.
7. Dorsal view.
7a. Side view.
"Dark limestone," Pine Spring (station 2930).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10a
10b
10c
7a
7
6a
9
9a
9b
11
11a
11b
11c
12
14
14a
14b
15
13
13a
13b
13c
20a
14c
16
X2
17
17a
17b
20
20c
21
21a
18
18a
18b
19
X3
20b
22
22a
21b
21c
23
24
24a
24b
24c
26a
27a
28a
25a
25b
26
27
28b
28
25
25c
26b
27b

FIGS. 8 and 8a. A silicified ventral valve figured to show the difference of character in the two sides.
8. External view, × 2, showing the large simple plications.
8a. Interior view, × 2, showing the ribs flattened on top and striated at the sides.
"Dark limestone," Pine Spring (station 2930).

HUSTEDIA MEEKANA var. TRIGONALIS n. var. (p. 396).

FIGS. 9 to 9b. A specimen with pronounced characters.
9. Dorsal view, × 2.
9a. Side view in outline, × 2.
9b. Ventral view, × 2.
"Dark limestone," Pine Spring (station 2930).

PUGNAX? BISULCATA var. GRATIOSA n. var. (p. 312).

FIGS. 10 to 10c. A perfect specimen with three large indistinct ribs on the fold.
10. Ventral view.
10a. Anterior view.
10b. Dorsal view.
10c. Side view.
"Dark limestone," Pine Spring (station 2930).

PUGNAX? BISULCATA Shumard (p. 310).

FIGS. 11 to 11c. A slightly crushed specimen which has four indistinct plications in the sinus. Those on the fold can hardly be seen at all.
11. Ventral view.
11a. Anterior view in outline.
11b. Dorsal view.
11c. Side view in outline.
"Dark limestone," Pine Spring (station 2930).
FIG. 12. A distorted specimen in which the plications are rather sharp.
Dorsal view.
"Dark limestone,"? Pine Spring (station 2930).

PUGNAX? BISULCATA var. SEMINULOIDES n. var. (p. 312).

FIGS. 13 to 13c. A characteristic specimen.
13. Dorsal view.
13a. Side view in outline.
13b. Ventral view.
13c. Anterior view in outline.
"Dark limestone," Pine Spring (station 2930).
FIGS. 14 to 14c. A small specimen with a quadrate fold, partly preserved as an internal mold.
14. Dorsal view.
14a. Ventral view preserving some of the muscular impressions.
14b. Anterior view in outline.
14c. Side view in outline.
"Dark limestone," Pine Spring (station 2930).
FIG. 15. Posterior portion of a ventral valve referred to this variety with doubt.
View of the interior.
"Dark limestone," Pine Spring (station 2930).
FIG. 16. A preparation showing the interiors of both valves, × 2. The low septum and crura of the dorsal valve are very plain, but the two small dental plates of the ventral valve are not well shown.
View of the interior.
"Dark limestone," Pine Spring (station 2930).

Pugnax swallowiana Shumard? (p. 314).

Figs. 17 to 17b. A specimen from the "dark limestone" provisionally referred to Shumard's species.
17. Dorsal view.
17a. Side view.
17b. Anterior view.
"Dark limestone," Pine Spring (station 2930).

Figs. 18 to 18b. A specimen of slightly different shape.
18. Dorsal view.
18a. Side view in outline.
18b. Anterior view in outline.
"Dark limestone," Pine Spring (station 2930).

Fig. 19. An imperfect specimen probably belonging to the same species.
View of the interior, × 3, slightly tilted backward and to one side.
"Dark limestone," Pine Spring (station 2930).

Pugnax bidentata n. sp. (p. 318).

Figs. 20 to 20c. A specimen referred with some doubt to this species. It may be only an aberra example of the foregoing.
20. Dorsal view.
20a. Side view in outline.
20b. Ventral view.
20c. Anterior view.
"Dark limestone," Pine Spring (station 2930).

Pugnax pinguis n. sp. (p. 319).

Figs. 21 to 21c. A somewhat crushed example.
21. Dorsal view.
21a. Ventral view.
21b. Anterior view.
21c. Side view in outline.
"Dark limestone," Pine Spring (station 2930).

Dielasmina guadalupensis n. sp. (p. 333).

Figs. 22 and 22a. An example apparently belonging to the same species that occurs in the Capitan.
22. Dorsal view.
22a. Anterior view.
"Dark limestone," Pine Spring (station 2930).

DELAWARE MOUNTAIN FORMATION, GUADALUPE MOUNTAINS.

Enteletes sp. *d* (p. 299).

Fig. 23. A specimen supposed to be a dorsal valve.
Seen from above.
Delaware Mountain formation, Guadalupe Point (station 2919).

Productus sp. *a* (p. 260).

Figs. 24 to 24c. A ventral valve.
24. Posterior view.
24a. Specimen seen from above.
24b. Anterior view.
24c. Side view.
Delaware Mountain formation, Guadalupe Point (station 2919).

PRODUCTUS TEXANUS n. sp. (p. 259).

FIGS. 25 to 25c. A ventral valve.
25. Specimen seen from above.
25a. Side view.
25b. Anterior view.
25c. Posterior view.
Delaware Mountain formation, Guadalupe Point (station 2903).

FIGS. 26 to 26b. A dorsal valve referred to this species.
26. Seen from above.
26a. Side view in outline.
26b. Anterior view.
Delaware Mountain formation, Guadalupe Point (station 2903).

PRODUCTUS WALCOTTIANUS n. sp. (p. 269).

FIGS. 27 to 27b. A ventral valve.
27. Seen from above.
27a. Side view.
27b. Posterior view.
Delaware Mountain formation, Guadalupe Point (station 2903).

FIGS. 28 to 28b. An imperfect specimen preserved as an internal mold. Though obtained from nearly the same horizon as the type, it is referred to the same species with doubt.
28. Seen from above.
28a. Posterior view.
28b. Side view in outline.
Delaware Mountain formation, Guadalupe Point (station 2931).

PLATE XXII.

PLATE XXII.

DELAWARE MOUNTAIN FORMATION, GUADALUPE MOUNTAINS.

Productus guadalupensis n. sp. (p. 261).

Figs. 1 to 1c. The typical ventral valve.
1. Anterior view.
1a. Posterior view.
1b. Side view in outline.
1c. Seen from above.
Delaware Mountain formation, Guadalupe Point (station 2919).

Figs. 2 and 2a. Another ventral valve, imperfect but having the characteristic shape.
2. Posterior view.
2a. Side view.
Delaware Mountain formation, Guadalupe Point (station 2919).

Figs. 3 and 3a. Internal mold of a ventral valve referred to this species with some doubt.
3. Seen from above.
3a. Side view.
Delaware Mountain formation, Guadalupe Point (station 2931).

Productus signatus n. sp. (p. 263).

Figs. 4 to 4b. An imperfect ventral valve preserved as an internal mold.
4. Specimen seen from above.
4a. Anterior view.
4b. Side view in outline.
Delaware Mountain formation, Guadalupe Point (station 2931).

Productus sp. *e* (p. 266).

Figs. 5 and 5a. External mold of a dorsal valve, all that at present is known of this form.
5. Specimen seen from above.
5a. Side view in outline.
Delaware Mountain formation, Guadalupe Point (station 2931).

Richthofenia permiana Shumard (p. 283).

Figs. 6 to 6b. A specimen preserved as an internal mold.
6. Anterior view, showing the impression of the "septum."
6a. Posterior view, showing the impression of the pseudodeltidium.
6b. Side view in outline.
Delaware Mountain formation, Guadalupe Point (station 2931).

Fusulina elongata Shumard (p. 62).

Fig. 7. A section, × 10, probably situated near the center of a specimen, for at the right is what appears to be the initial cell, but strongly oblique, since the length is so short relative to the width. Labyrinthine structure like that found near the ends is, however, shown.
Delaware Mountain formation, Guadalupe Point (station 2903).

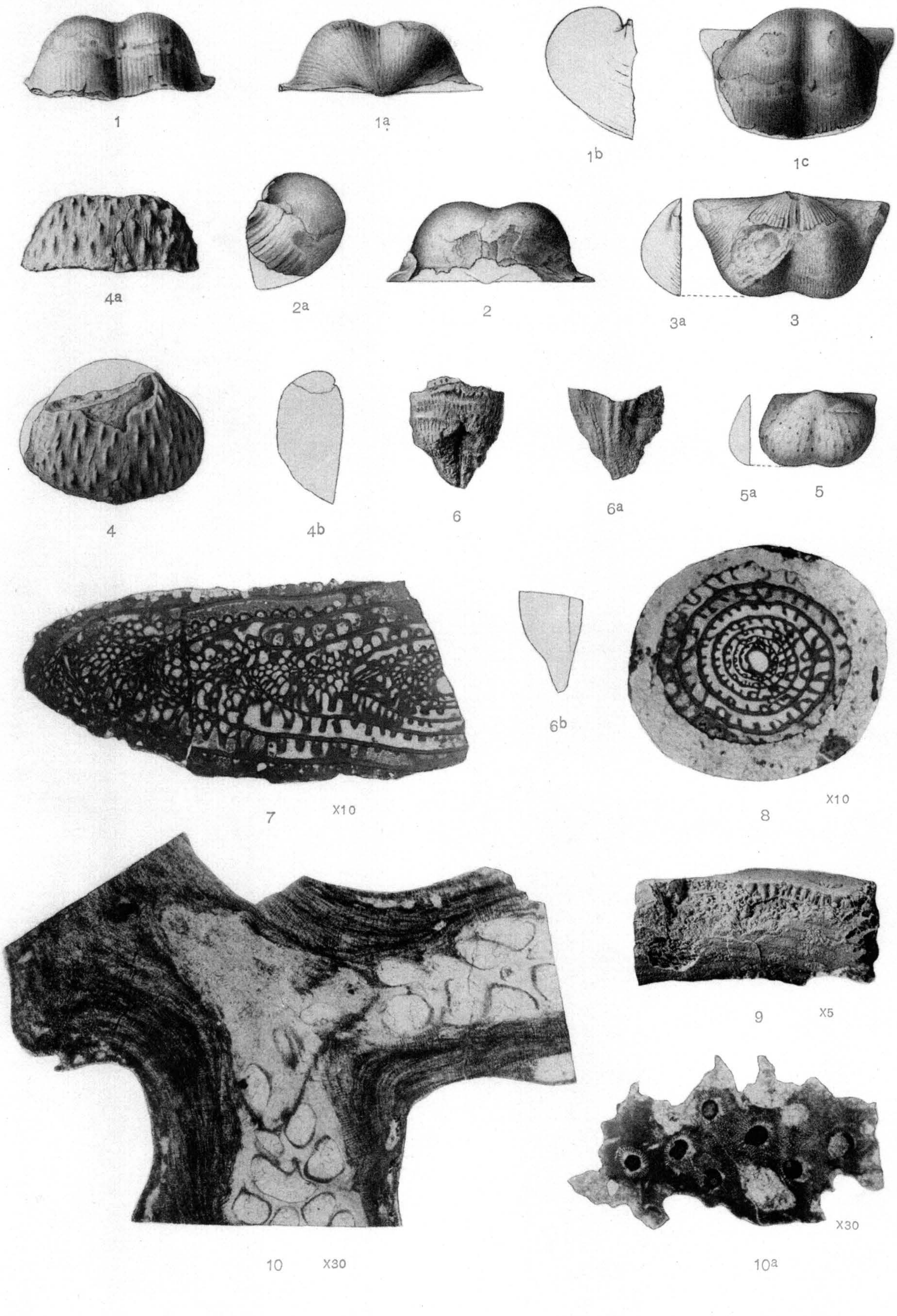

1
1a
1b
1c
4a
2a
2
3a
3
4
4b
6
6a
5a
5
6b
7 X10
8 X10
9 X5
10 X30
10a X30

FIG. 8. A transverse section through the initial cell, × 10.
Delaware Mountain formation, Guadalupe Point (station 2903).

FIG. 9. A fragmentary specimen, showing the fluted walls.
Side view, × 5.
Delaware Mountain formation, Guadalupe Point (station 2931).

ACANTHOCLADIA GUADALUPENSIS n. sp. (p. 149).

FIGS. 10 and 10a. A specimen from the Delaware Mountain sandstone apparently belonging to this species.
10. Section about midway between the two surfaces, showing finely tubulose test, × 30.
10a. Section parallel tc and just below the celluliferous surface, showing the radiating and transverse tubules, × 30.
Delaware Mountain formation, Guadalupe Point (station 2903).

PLATE XXIII.

PLATE XXIII.

DELAWARE MOUNTAIN FORMATION, GUADALUPE MOUNTAINS.

PTERIA sp. (p. 429).

FIG. 1. An imperfect left valve.
Side view.
Delaware Mountain formation, Guadalupe Point (station 2931).

AVICULIPECTEN DELAWARENSIS n. sp. (p. 437).

FIGS. 2 and 2a. A left valve.
2. Side view, × 2.
2a. Same, natural size, in outline.
Delaware Mountain formation, Guadalupe Point (station 2931).

MYOCONCHA COSTULATA var. DELAWARENSIS n. var. (p. 444).

FIG. 3. A large left valve somewhat crushed and imperfect.
Side view.
Delaware Mountain formation, Guadalupe Point (station 2931).

PLEUROPHORUS DELAWARENSIS n. sp. (p. 446).

FIG. 4. An internal mold of a left valve.
Side view.
Delaware Mountain formation, Guadalupe Point (station 2931).

CLEIDOPHORUS PALLASI var. DELAWARENSIS n. var. (p. 447).

FIGS. 5 and 5a. A right valve.
5. Side view, × 2.
5a. Same, natural size, in outline.
Delaware Mountain formation, Guadalupe Point (station 2931).

ASTARTELLA NASUTA n. sp. (p. 445).

FIGS. 6 and 6a. Internal mold of a left valve.
6. Side view, × 2.
6a. Same, natural size, in outline.
Delaware Mountain formation, Guadalupe Point (station 2931).
FIGS. 7 and 7a. Internal mold of a right valve.
7. Side view, × 2.
7a. Same, natural size, in outline.
Delaware Mountain formation, Guadalupe Point (station 2931).

NUCULA sp. *b* (p. 421).

FIG. 8. Internal mold of a left valve.
Side view, × 2.
Delaware Mountain formation, Guadalupe Point (station 2931).

GASTRIOCERAS? SERRATUM n. sp. (p. 500).

FIGS. 9 to 9d. A mold in fine sandstone.
9. View of ventral surface, × 2.
9a. Opposite view, × 2. One of the sutures is seen above at the left.
9b. Side view, × 2.
9c. Same, natural size, in outline.
9d. Suture line, × 2.
Delaware Mountain formation, Guadalupe Point (station 2931).

ORTHOCERAS GUADALUPENSE n. sp. (p. 497).

FIGS. 10 to 10b. The typical specimen.
10. Side view.
10a. Opposite side, eroded and showing concavity of sutures.
10b. End view.
Delaware Mountain formation, Guadalupe Point (station 2931).

PLAGIOGLYPTA CANNA White? (p. 450).

FIG. 11. A large specimen which tapers very little.
Side view.
Delaware Mountain formation, Guadalupe Point (station 2931).
FIG. 12. A smaller specimen in which the taper is more apparent.
Side view.
Delaware Mountain formation, Guadalupe Point (station 2931).
FIG. 13. A small specimen with gradual but obvious taper.
Side view.
Delaware Mountain formation, Guadalupe Point (station 2931).

BUCANOPSIS sp. (p. 481).

FIGS. 14 to 14b. A partial internal mold, somewhat distorted by compression.
14. Front view.
14a. Side view.
14b. Impression taken from a natural mold, showing the surface of one of the earlier volutions. The mold was not very good and the sculpture of the impression is probably less distinct than the original surface, × 2.
Delaware Mountain formation, Guadalupe Point (station 2931).

WARTHIA AMERICANA n. sp. (p. 481).

FIGS. 15 and 15a. A partial internal mold of a large specimen.
15. Side view.
15a. Anterior view, somewhat tilted backward.
Delaware Mountain formation, Guadalupe Point (station 2931).
FIGS. 16 and 16a. A specimen of the usual size preserved as a mold of the interior.
16. Outline of apertural view.
16a. Side view.
Delaware Mountain formation, Guadalupe Point (station 2931).
FIGS. 17 to 17b. A very young specimen preserved as a mold of the interior.
17. Side view, × 4.
17a. Same, natural size, in outline.
17b. Apertural view in outline, × 4.
Delaware Mountain formation, Guadalupe Point (station 2931).

NATICOPSIS sp. (p. 485).

FIGS. 18 to 18d. A young specimen supposed to belong to this species. It is preserved as a mold of the interior and has not been compressed.
18. Apertural view, $\times$ 2.
18a. View of opposite side, $\times$ 2.
18b. Same, natural size, in outline.
18c. Seen from above, $\times$ 2.
18d. Same, natural size, in outline.
Delaware Mountain formation, Guadalupe Point (station 2931).

FIGS. 19 to 19b. A larger specimen similarly preserved and somewhat distorted by pressure.
19. Seen from above.
19a. Side view.
19b. Apertural view.
Delaware Mountain formation, Guadalupe Point (station 2931).

MACROCHEILINA sp. *a* (p. 489).

FIG. 20. Specimen preserved as a partial internal mold.
Side view.
Delaware Mountain formation, Guadalupe Point (station 2931).

BULIMORPHA CHRYSALIS var. DELAWARENSIS n. var. (p. 487).

FIG. 21. Specimen preserved as a mold of the interior.
Side view.
Delaware Mountain formation, Guadalupe Point (station 2931).

PLEUROTOMARIA EUGLYPHEA n. sp. (p. 469).

FIGS. 22 to 22c. An impression made from a mold of the exterior.
22. Side view, $\times$ 2.
22a. Same, natural size, in outline.
22b. Seen from above.
22c. Same, natural size, in outline.
Delaware Mountain formation, Guadalupe Point (station 2931).

FIGS. 23 to 23b. A partial internal mold of the same specimen.
23. Seen from above.
23a. Seen from below.
23b. Side view.
Delaware Mountain formation, Guadalupe Point (station 2931).

PLEUROTOMARIA? CARINIFERA n. sp. (p. 475)

FIGS. 24 to 24b. A specimen preserved as a partial internal mold.
24. Side view, $\times$ 3.
24a. Same, natural size, in outline.
24b. Seen from above, $\times$ 3.
Delaware Mountain formation, Guadalupe Point (station 2931).

PLEUROTOMARIA MULTILINEATA n. sp. (p. 468).

FIGS. 25 to 25d. A specimen preserved as a partial internal mold.
25. Seen from above, $\times$ 2.
25a. Same, natural size, in outline.

FIG. 25b. Side view, × 2.
25c. Same, natural size, in outline.
25d. Umbilicus and adjacent surface from an impression of the external mold of the same specimen, × 2.
Delaware Mountain formation, Guadalupe Point (station 2931).

PLEUROTOMARIA ARENARIA n. sp. (p. 473).

FIGS. 26 and 26a. A nearly perfect specimen preserved as a partial internal mold.
26. Side view.
26a. Enlargement of portion of the surface of the same specimen, taken from an impression of the external mold, × 3. The area presented is the upper portion of one of the whorls with the side of that above.
Delaware Mountain formation, Guadalupe Point (station 2931).

PLEUROTOMARIA? PLANULATA n. sp. (p. 474).

FIGS. 27 to 27c. A specimen preserved as a partial internal mold.
27. Side view, × 3.
27a. Same, natural size, in outline.
27b. Seen from above, × 3.
27c. Seen from below, × 3.
Delaware Mountain formation, Guadalupe Point (station 2931).

PLEUROTOMARIA? DELAWARENSIS n. sp. (p. 475).

FIGS. 28 to 28b. A specimen preserved as a partial internal mold.
28. Side view, × 2.
28a. Same, natural size, in outline.
28b. Artificial impression from the external mold of the same specimen, showing part of the lower whorl, × 3.
Delaware Mountain formation, Guadalupe Point (station 2931).
FIGS. 29 to 29b. Another specimen similarly preserved.
29. Side view, × 2.
29a. Same, natural size, in outline.
29b. Artificial impression of an external mold of part of same, × 3.
Delaware Mountain formation, Guadalupe Point (station 2931).
FIG. 30. An impression of part of an external mold of another specimen, which shows revolving lines on the upper portion of the peritreme, a character which seems obscured in the others.
Side view, × 3.
Delaware Mountain formation, Guadalupe Point (station 2931).

PLATE XXIV.

PLATE XXIV.

BASAL BLACK LIMESTONE, GUADALUPE MOUNTAINS.

ANTHRACOSYCON FICUS n. sp. (p. 72).

FIGS. 1 and 1a. The type specimen.
1. Side view.
1a. View of the upper surface.
Basal black limestone, Guadalupe Point (station 2920).

FIG. 2. Portion of a fragmentary specimen showing the spicular structure more clearly than the type, $\times 10$.
Basal black limestone, Guadalupe Point (station 2920).

STENOPORA GRANULOSA n. sp.? (p. 129).

FIGS. 3 to 3c. A specimen doubtfully referred to this species.
3. Transverse section, $\times 20$.
3a. Portion of same more highly magnified, showing the concentrically constructed acanthopores, and the granular band through the median portion of the walls, $\times 35$.
3b. Portion of same somewhat more highly magnified to show the structure of the walls, $\times 40$.
3c. Longitudinal section, $\times 20$.
Basal black limestone, Guadalupe Point (station 2967).

ENTELETES sp. *c* (p. 297).

FIGS. 4 and 4a. A rather large dorsal valve in which the plication is still indistinct.
4. Seen from above.
4a. Seen from the side.
Basal black limestone, Guadalupe Point (station 2920).

FIGS. 5 and 5a. A small dorsal valve showing incipient plications.
5. Seen from above, $\times 2$.
5a. Same, natural size.
Basal black limestone, Guadalupe Point (station 2920).

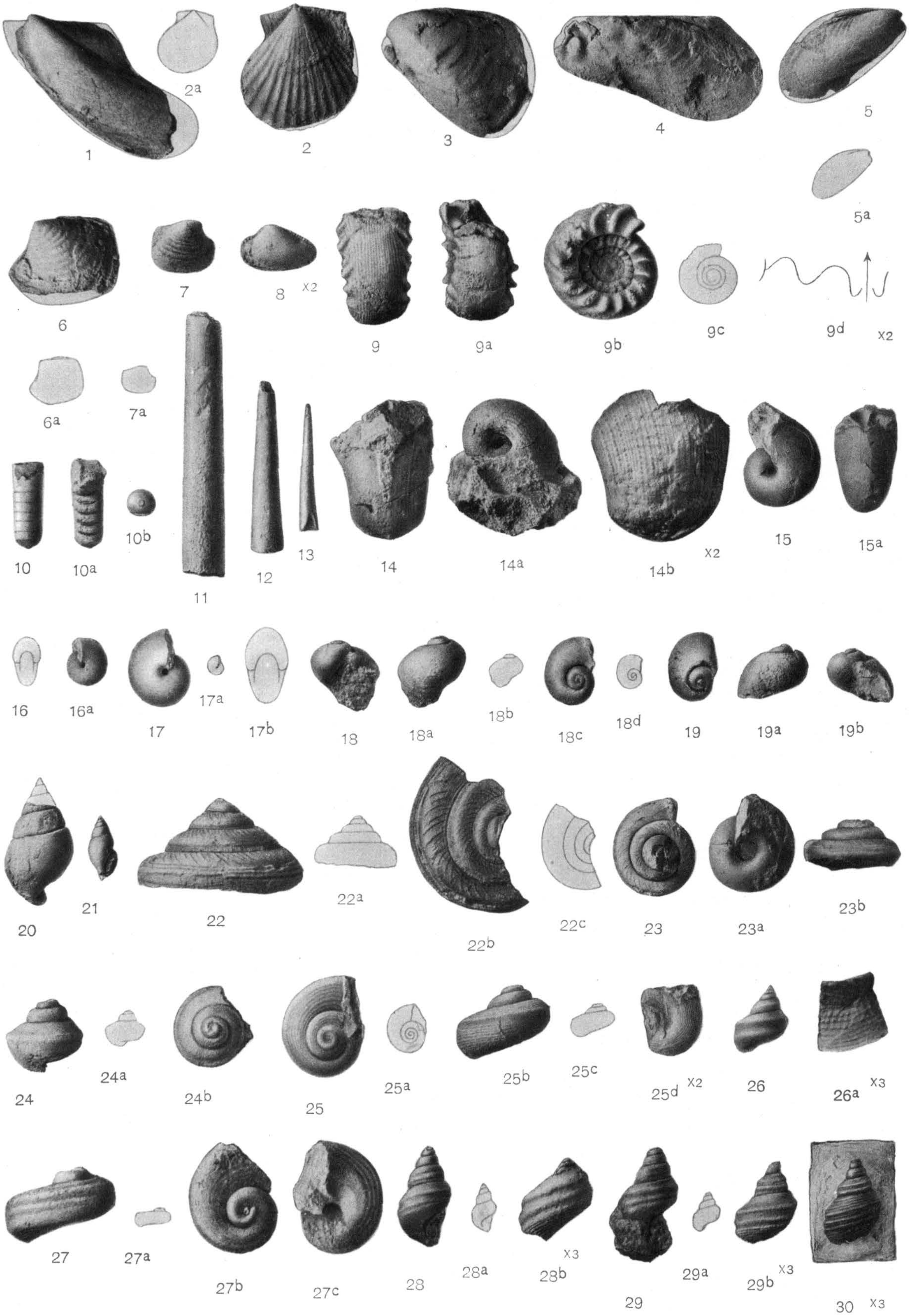
MEEKELLA MULTILIRATA n. sp. (p. 208).

FIGS. 6 to 6b. A decorticated ventral valve.
6. Seen from above.
6a. Side view.
6b. Posterior view.
Basal black limestone, Guadalupe Point (station 2967).

MEEKELLA ATTENUATA n. sp. (p. 205).

FIG. 7. An imperfect dorsal valve.
Seen from above.
Basal black limestone, Guadalupe Point (station 2967).

FIGS. 8 and 8a. A young ventral valve in which the plications have just begun to develop.
8. Seen from above.
8a. Side view in outline.
Basal black limestone, Guadalupe Point (station 2967).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25a
25b
25c
25d x2
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28b x3
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29b x3
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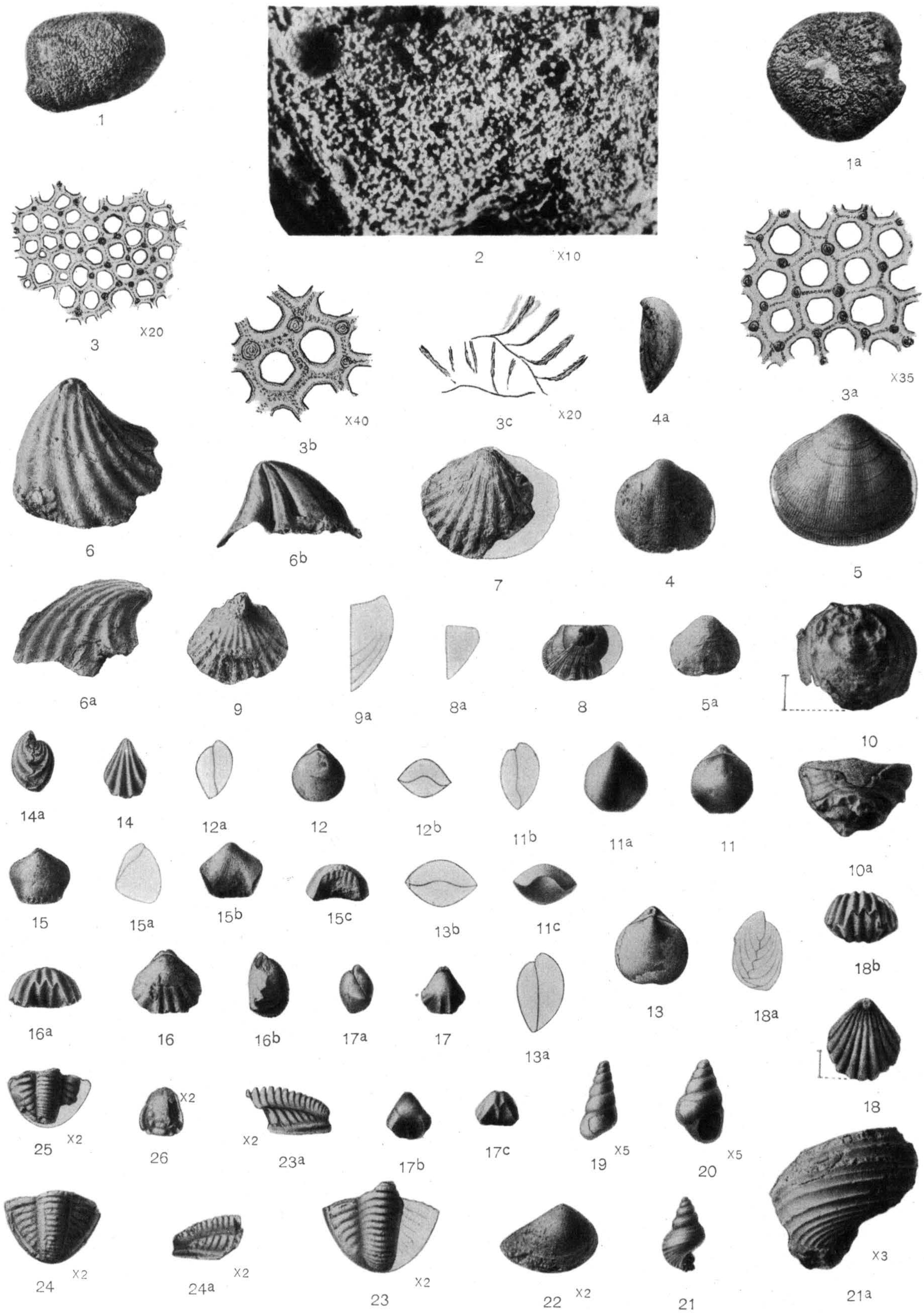
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14a
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11b
11a
11
10a
15
15a
15b
15c
13b
11c
18b
16a
16
16b
17a
17
13a
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18a
18
25 X2
26 X2
23a X2
17b
17c
19 X5
20 X5
24 X2
24a X2
23 X2
22 X2
21
21a X3

FIGS. 9 and 9a. A larger ventral valve with more angular plications somewhat more early developed.
9. Seen from above.
9a. Side view in outline.
Basal black limestone, Guadalupe Point (station 2967).

RICHTHOFENIA PERMIANA Shumard (p. 283).

FIGS. 10 and 10a. A very young example referred to this species.
10. Seen from below, showing the cystose structure when exfoliated, $\times 3$.
10a. Posterior view, $\times 3$. The sinus in the outline of the shell looks less like a break in the orignal than in the figure, and is probably very nearly the actual margin, as indicated by growth lines.
Basal black limestone, Guadalupe Point (station 2967).

COMPOSITA MEXICANA var. GUADALUPENSIS n. var. (p. 390).

FIGS. 11 to 11c. A specimen of the usual size and character.
11. Dorsal view.
11a. Ventral view.
11b. Side view in outline.
11c. Anterior view.
Basal black limestone, Guadalupe Point (station 2920).
FIGS. 12 to 12b. A small specimen similar to the last.
12. Dorsal view.
12a. Side view in outline.
12b. Front view in outline.
Basal black limestone, Guadalupe Point (station 2920).
FIGS. 13 to 13b. A large, not very characteristic specimen.
13. Dorsal view.
13a. Side view in outline.
13b. Front view in outline.
Basal black limestone, Guadalupe Point (station 2920).

HUSTEDIA MEEKANA Shumard (p. 394).

FIGS. 14 and 14a. A narrow variety, rather characteristic of this horizon.
14. Ventral view.
14a. Side view.
Basal black limestone, Guadalupe Point (station 2920).

PUGNAX NITIDA n. sp. (p. 313).

FIGS. 15 to 15c. The type specimen.
15. Dorsal view.
15a. Side view in outline.
15b. Ventral view.
15c. Anterior view.
Basal black limestone, Guadalupe Point (station 2920).

PUGNAX OSAGENSIS Swallow (p. 317).

FIGS. 16 to 16b. The type from the black limestone referred to this species.
16. Dorsal view.
16a. Anterior view.
16b. Side view.
Basal black limestone, Guadalupe Point (station 2920).

PUGNAX BIDENTATA n. sp. (p. 318).

FIGS. 17 to 17c. The typical specimen.
17. Dorsal view.
17a. Side view.
17b. Ventral view.
17c. Front view.
Basal black limestone, Guadalupe Point (station 2920).

PUGNAX? PUSILLA n. sp. (p. 319).

FIGS. 18 to 18b. The type specimen.
18. Dorsal view, × 3.
18a. Side view in outline, × 3.
18b. Anterior view, × 3.
Basal black limestone, Guadalupe Point (station 2967).

LOXONEMA? INCONSPICUUM n. sp. (p. 486).

FIG. 19. The type specimen.
Side view, × 5.
Basal black limestone, Guadalupe Point (station 2967).

MACROCHEILINA? MODESTA n. sp. (p. 489).

FIG. 20. The type specimen.
Side view, × 5.
Basal black limestone, Guadalupe Point (station 2967).

PLEUROTOMARIA STRIGILLATA n. sp. (p. 471).

FIGS. 21 and 21a. The typical specimen, the upper portion more or less restored from a second specimen.
21. Side view.
21a. Lower whorl enlarged to show sculpture, × 3.
Basal black limestone, Guadalupe Point (station 2920).

NUCULA sp. *a* (p. 421).

FIG. 22. A left valve whose proportional height is above the average.
Side view, × 2.
Basal black limestone, Guadalupe Point (station 2967).

ANISOPYGE? ANTIQUA n. sp. (p. 509).

FIGS. 23 and 23a. A large but imperfect pygidium.
23. Seen from above, × 2.
23a. Side view, × 2.
Basal black limestone, Guadalupe Point (station 2967).
FIGS. 24 and 24a. A medium-sized pygidium.
24. Seen from above, × 2.
24a. Side view, × 2.
Basal black limestone, Guadalupe Point (station 2967).
FIG. 25. A small, imperfect pygidium.
Seen from above, × 2.
Basal black limestone, Guadalupe Point (station 2967).
FIG. 26. Fragment of a cranidium.
Seen from above, × 2.
Basal black limestone, Guadalupe Point (station 2967).

PLATE XXV.

PLATE XXV.

DELAWARE MOUNTAIN FORMATION, DIABLO MOUNTAINS.

LEPTODUS AMERICANUS n. sp. (p. 212).

FIGS. 1 and 1a. A cluster of several specimens growing attached to one another.
1. Seen from below.
1a. Seen from above.
Delaware Mountain formation, Diablo Mountains (station 3764).

FIGS. 2 and 2a. An isolated ventral valve.
2. Seen from above. The changing structure of the brachial ridges is well shown in this example.
2a. Seen from below.
Delaware Mountain formation, Diablo Mountains (station 3764).

FIGS. 3 and 3a. A dorsal valve.
3. Outer (?) surface.
3a. Inner (?) surface.
Delaware Mountain formation, Diablo Mountains (station 3764).

MEEKELLA ATTENUATA n. sp. (p. 205).

FIGS. 4 to 4d. A slightly imperfect silicified specimen used as the type.
4. Ventral view.
4a. Dorsal view.
4b. Side view in outline.
4c. Anterior view.
4d. Side view, × 2, showing through the break the dental plates of the ventral valve and the cardinal process of the dorsal valve.
Delaware Mountain formation, Diablo Mountains (station 3764).

CLADOPORA? TUBULATA n. sp. (p. 104).

FIGS. 5 and 5a. Fragment of a zoarium.
5. Side view.
5a. Same, × 2.
Delaware Mountain formation, Diablo Mountains (station 3764).

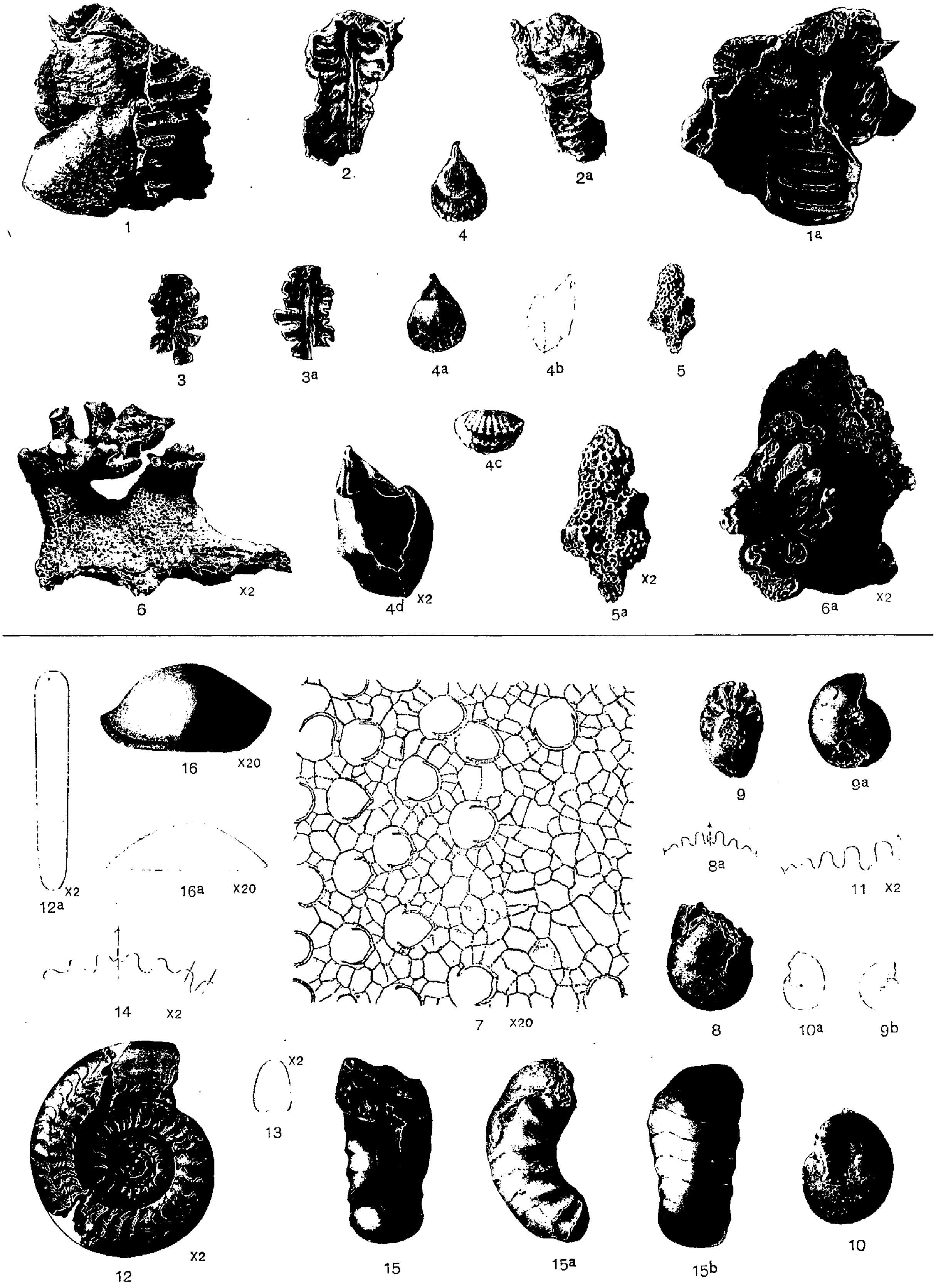
THAMNISCUS DIGITATUS n. sp. (p. 148).

FIGS. 6 and 6a. Specimen attached to a colony of *Fistulipora*.
6. Seen from the side, × 2.
6a. Seen from above, × 2.
Delaware Mountain formation, Diablo Mountains (station 3764.)

DELAWARE MOUNTAIN FORMATION, GUADALUPE MOUNTAINS.

FISTULIPORA GRANDIS var. GUADALUPENSIS n. var. (p. 125).

FIG. 7. The typical specimen (see Pl. XVII, fig. 18.)
Transverse section, × 20.
Delaware Mountain formation, Guadalupe Point (station 2919).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3a
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4b
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6 X2
4c
4d X2
5a X2
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16 X20
16a X20
7 X20
9
9a
8a
11 X2
14 X2
8
10a
9b
12 X2
13 X2
15
15a
15b
10

BASAL BLACK LIMESTONE, GUADALUPE MOUNTAINS

Agathoceras texanum n. sp. (p. 501)

Figs. 8 and 8a. The type specimen.
8. Side view.
8a. Suture.
Basal black limestone, Guadalupe Point (station 2967).

Peritrochia erebus n. sp. (p. 499).

Figs. 9 to 9b. A rather small specimen.
9. Apertural view, × 2.
9a. Side view, × 2.
9b. Same, natural size in outline.
Basal black limestone, Guadalupe Point (station 2920).
Figs. 10 and 10a. The largest specimen found.
10. Side view, × 2.
10a. Same, natural size in outline.
Basal black limestone, Guadalupe Point (station 2920).
Fig. 11. The type specimen.
Suture line, × 2.
Basal black limestone, Guadalupe Point (station 2920).

Paraceltites elegans n. sp. (p. 499).

Figs. 12 and 12a. An exfoliated specimen.
12. Side view, × 2.
12a. Ventral view, in outline, × 2.
Basal black limestone, Guadalupe Point (station 2967).
Fig. 13. Fragment of another specimen.
Cross section of a whorl, × 2.
Basal black limestone, Guadalupe Point (station 2967).
Fig. 14. Another specimen.
Suture line, × 2.
Basal black limestone, Guadalupe Point (station 2967).

Foordoceras shumardianum var. præcursor n. var. (p. 498).

Figs. 15 to 15b. The typical specimen.
15. Dorsal aspect of fragment.
15a. Side view.
15b. Ventral aspect.
Basal black limestone, Guadalupe Point (station 2920).

Bairdia aff. B. plebeia Reuss (p. 510).

Figs. 16 and 16a. A silicified right valve.
16. Side view, × 20.
16a. Ventral view in outline, × 20.
Basal black limestone, Guadalupe Point (station 2920).

PLATE XXVI.

PLATE XXVI.

DELAWARE MOUNTAIN FORMATION, DIABLO MOUNTAINS.

ENTELETES sp. *c* (p. 297).

FIGS. 1 to 1b. A small ventral valve referred to this species.
1. Exterior.
1a. Side view in outline.
1b. Interior, × 3.
Delaware Mountain formation, Diablo Mountains (station 3764).

FIGS. 2 to 2b. Dorsal valve of figs. 1 to 1b.
2. Exterior.
2a. Side view in outline.
2b. Interior, showing dental plates, cardinal process, etc., × 3.
Delaware Mountain formation, Diablo Mountains (station 3764).

ENTELETES ANGULATUS n. sp. (p. 295).

FIGS. 3 and 3a. A somewhat incomplete ventral valve. An imperfection on the umbo discloses the closely arranged septum and dental plates.
3. Seen from above.
3a. Side view in outline.
Hueco formation, Diablo Mountains (station 3764).

ENTELETES DUMBLEI n. sp. (p. 295).

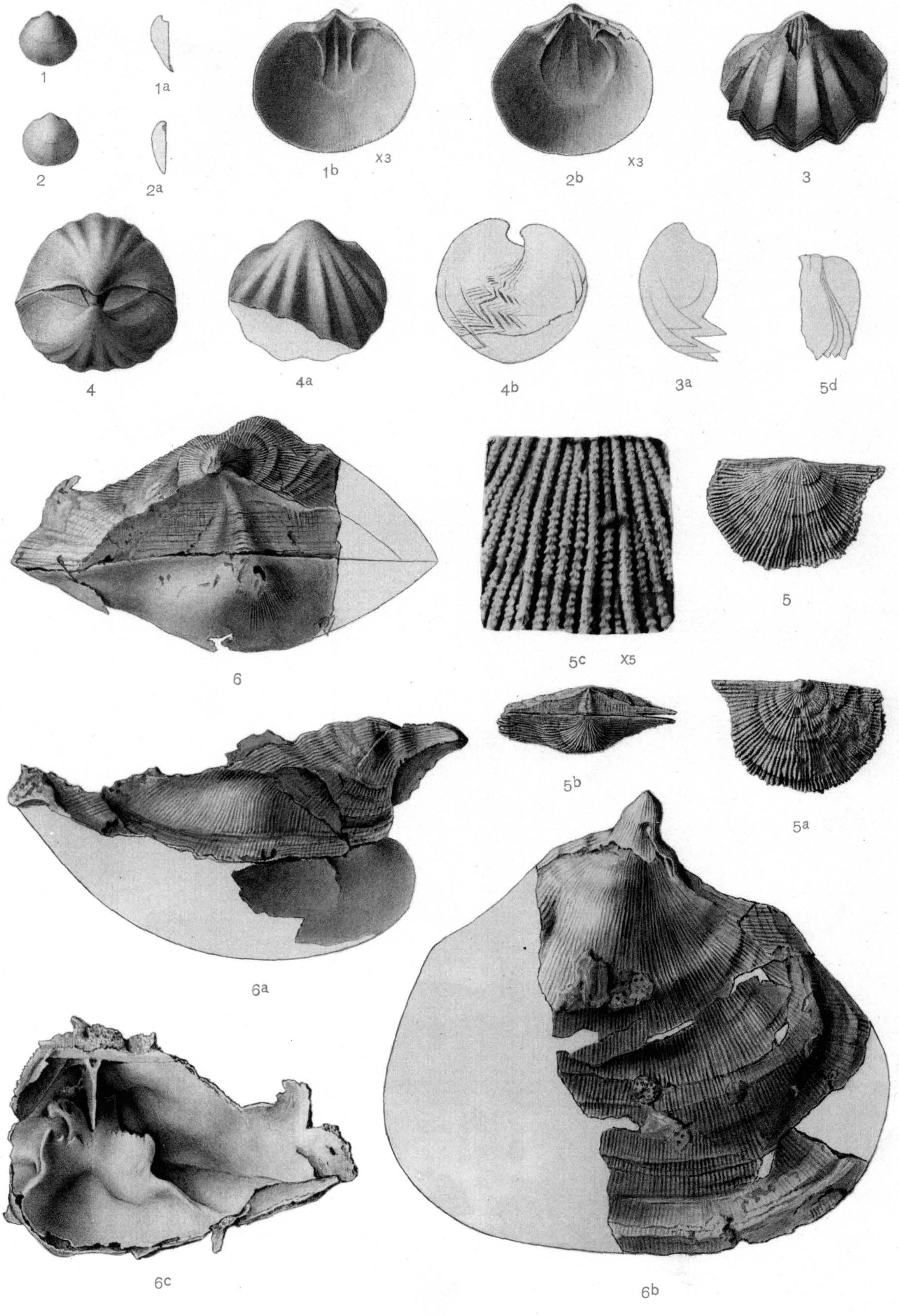
FIGS. 4 to 4b. An imperfect but well-preserved example showing both valves in position.
4. Posterior view. The specimen was here posed so that the ventral valve was below.
4a. Ventral view.
4b. Side view in outline.
Hueco formation, Diablo Mountains (station 3764).

DERBYA? CRENULATA n. sp. (p. 183).

FIGS. 5 to 5d. A well-preserved specimen retaining both valves in position.
5. Dorsal view.
5a. Ventral view.
5b. Posterior view.
5c. Surface, × 5.
5d. Side view in outline.
Delaware Mountain formation, Diablo Mountains (station 3764).

DERBYA NASUTA n. sp. (p. 182).

FIGS. 6 to 6c. An imperfect specimen with both valves in position.
6. Posterior view.
6a. Side view.
6b. Ventral view.
6c. View of the interior from the front backward. Above is the ventral valve with its median septum; below, the dorsal valve with its hinge plate and cardinal process. The cardinal process is deeply divided, the septum of the ventral valve passing between the two forks. The cardinal process in this case is a little asymmetrical, and this feature is enhanced in the drawing by the view being taken slightly to one side. Upon the left the tooth and socket are shown, partly concealed by portions of the hinge plate which project before and above them.
Delaware Mountain formation, Diablo Mountains (station 3764).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5
5b
5a
6a
6c
6b

PLATE XXVII.

PLATE XXVII.

DELAWARE MOUNTAIN FORMATION, SOUTHERN DELAWARE MOUNTAINS.

FUSULINA ELONGATA Shumard (p. 62).

FIG. 1. A silicified specimen so preserved as to show the fluted and interlocking radial walls.
Side view, × 4.
Delaware Mountain formation, southern Delaware Mountains (station 2957).

FIG. 2. A silicified specimen more nearly perfect than the foregoing.
Side view, natural size.
Delaware Mountain formation, southern Delaware Mountains (station 2957).

LINGULINA? sp. (p. 69).

FIG. 3. A thin section supposed to cut longitudinally through the organism, × 10.
Delaware Mountain formation, southern Delaware Mountains (station 2964).

ENDOTHYRA sp. *c* (p. 68).

FIG. 4. A thin section supposed to pass through the axis, × 10.
Delaware Mountain formation, southern Delaware Mountains (station 2964).

FUSULINELLA sp. *b* (p. 66).

FIGS. 5 and 5a. A silicified specimen.
5. Side view, × 10.
5a. View perpendicular to the axis, × 10.
Delaware Mountain formation, southern Delaware Mountains (station 2969).

SPIRORBIS TEXANUS n. sp. (p. 112).

FIG. 6. Portion of a loosely coiled or irregularly sinuous specimen.
Side view, × 4.
Delaware Mountain formation, southern Delaware Mountains (station 2969).

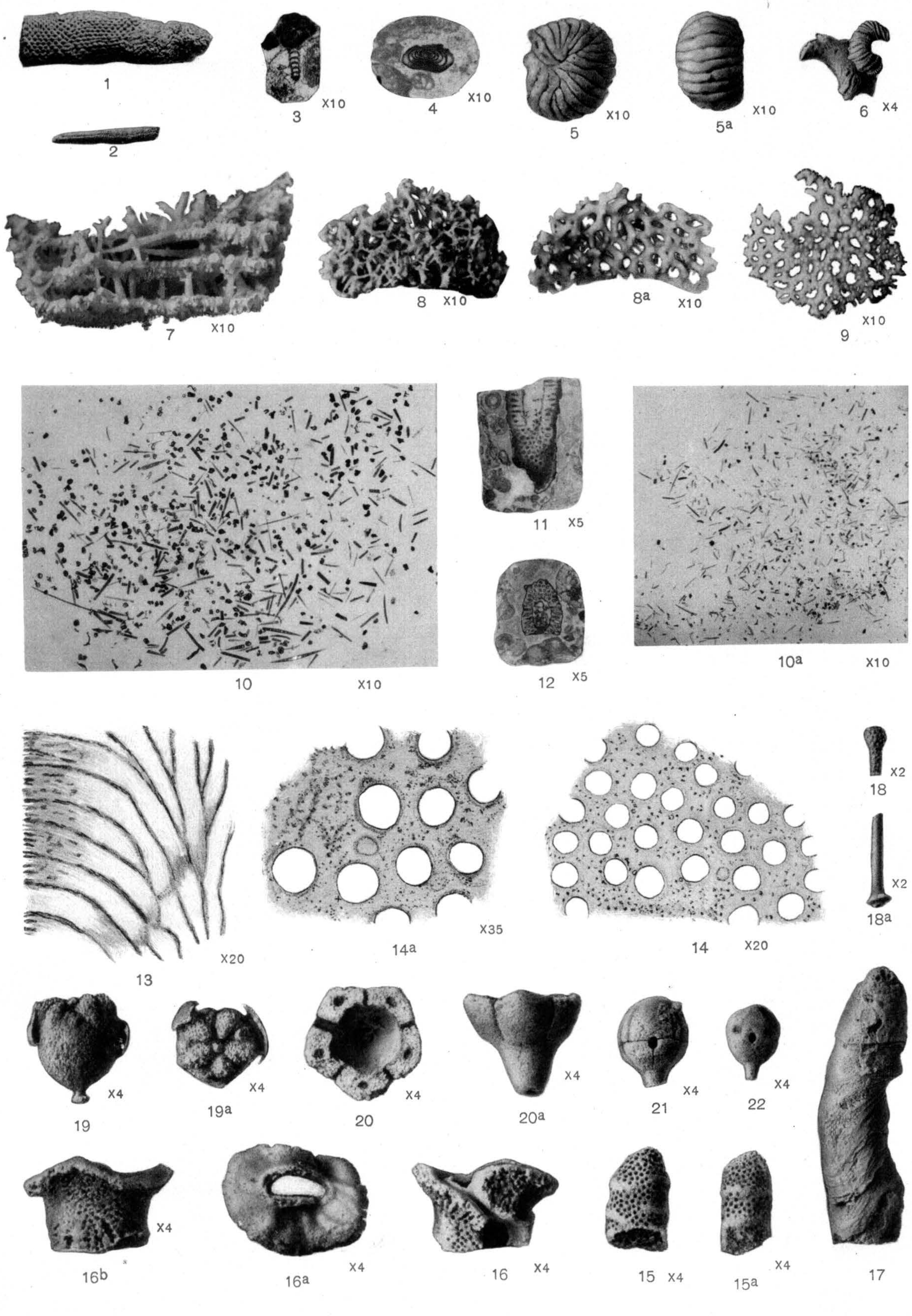
STROMATIDIUM TYPICALE n. sp. (p. 77).

FIG. 7. A specimen with several layers connected.
Side view, showing the pillar rays and the edges of the walls, × 10. In the middle of the upper portion of the figure a large hexact appears to be in place.
Delaware Mountain formation, southern Delaware Mountains (station 2969).

FIGS. 8 and 8a. A group of amalgamated mural rays.
8. View of one side, showing a covering of entangled spicular outgrowths, × 10.
8a. View of the other side, which is slightly nodose, × 10.
Delaware Mountain formation, southern Delaware Mountains (station 2969).

FIG. 9. Another group of consolidated spicules.
Side view, showing nodose surface, × 10.
Delaware Mountain formation, southern Delaware Mountains (station 2969).

FIGS. 10 and 10a. Material provisionally referred to this species.
10. Loose acicular spicules associated with this species and possibly belonging to the same organism, × 10. Assembled with other material as freed by etching.
10a. Another thin section of smaller sized spicules similarly prepared, × 10.
Delaware Mountain formation, southern Delaware Mountains (station 2969).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14 X20
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18a X2
19 X4
19a X4
20 X4
20a X4
21 X4
22 X4
16b X4
16a X4
16 X4
15 X4
15a X4
17

GUADALUPIA? sp. var. (p. 86)

FIG. 11. Fossil of doubtful affinity provisionally referred to this genus.
Thin section through a stem somewhat oblique to the axis, × 5.
Delaware Mountain formation, southern Delaware Mountains (station 2964).

FIG. 12. Another specimen similar to the last.
Thin section through a stem strongly oblique to the axis, × 5.
Delaware Mountain formation, southern Delaware Mountains (station 2964).

DOMOPORA? OCELLATA n. sp. (p. 122).

FIG. 13. A specimen referred to this species but not identified with certainty.
Longitudinal section, × 20.
Delaware Mountain formation, southern Delaware Mountains (station 2957).

FIGS. 14 and 14a. A specimen referred to this species, possibly the same as the foregoing.
14. Tangential section, × 20.
14a. Same, × 35.
Delaware Mountain formation, southern Delaware Mountains (station 2957).

DOMOPORA? VITTATA n. sp. (p. 123).

FIGS. 15 and 15a. Terminal portion of a branch in which the maculæ are somewhat less prominently developed than the type.
15. Side view, showing the ends of two sets of maculæ, × 4.
15a. Side view, showing the elongated maculæ, × 4.
Delaware Mountain formation, southern Delaware Mountains (station 2969).

DOMOPORA? INCRUSTANS n. sp. (p. 124).

FIGS. 16 to 16b. The type specimen.
16. Side view, showing the junction of the two ends, × 4.
16a. Upper side, showing the surface covered with an epitheca, × 4.
16b. Opposite side to 16, × 4.
Delaware Mountain formation, southern Delaware Mountains (station 2969).

FISTULIPORA GRANDIS var. GUADALUPENSIS n. var (p. 125).

FIG. 17. An unusually elongated specimen, showing the form in which this species usually grows. The surface is more or less overlaid with a delicate investment which tends to cover and conceal the zoœcial apertures.
Side view.
Delaware Mountain formation, southern Delaware Mountains (station 2969).

ARCHÆOCIDARIS sp. *b* (p. 110).

FIGS. 18 and 18a. Fragments of radioles possibly belonging to the same specimen.
18. Distal portion, × 2.
18a. Proximal portion, × 2.
Delaware Mountain formation, southern Delaware Mountains (station 2969).

CŒNOCYSTIS RICHARDSONI n. sp. (p. 108).

FIGS. 19 and 19a. A specimen in which the outer and the inner surfaces were silicified, the intervening portion having been removed by etching. The outer layer has largely broken away, showing some of the internal structures.
19. Side view, × 4.
19a. View of the upper end, × 4.
Delaware Mountain formation, southern Delaware Mountains (station 2969).

FIGS. 20 and 20a. Basal cup of a large specimen.

20. View of the upper surface, showing the large channel of the anal pore and the four smaller channels of the auxiliary pores, together with depressions on the apices of the five pentagonal plates, × 4.

20a. Side view, showing the almost completely consolidated plates, × 4.

Delaware Mountain formation, southern Delaware Mountains (station 2969).

FIG. 21. A small, nearly perfect specimen.

View of the anal side, × 4.

Delaware Mountain formation, southern Delaware Mountains (station 2969).

FIG. 22. A small specimen.

View of the anal side, showing the obscurely pentahedral shape of the dome and the dimples at the bases of the dihedral angles and the summits of the pentagonal plates.

Delaware Mountain formation, southern Delaware Mountains (station 2969).

PLATE XXVIII.

PLATE XXVIII.

DELAWARE MOUNTAIN FORMATION, SOUTHERN DELAWARE MOUNTAINS.

POLYPORA sp. *a* (p. 145).

FIGS. 1 and 1a. Part of a silicified frond.

1. Nonporiferous side, × 5. The sculpture is for the most part the result of chalcedonic replacement, partly concealing the longitudinal striæ.

1a. Poriferous side, × 5. The zoarium is of course deeply decorticated.

Delaware Mountain formation, southern Delaware Mountains (station 2969).

POLYPORA sp. *b* (p. 145).

FIG. 2. Part of a silicified frond.

Nonporiferous side, × 5. The nodular surface is due to silicification.

Delaware Mountain formation, southern Delaware Mountains (station 2969).

POLYPORA sp. *c* (p. 146).

FIG. 3. A small silicified fragment.

Nonporiferous side, × 5. In this case also the striated sculpture has been more or less masked by chalcedonic replacement.

Delaware Mountain formation, southern Delaware Mountains (station 2969).

POLYPORA sp. *d* (p. 147).

FIG. 4. A small silicified fragment.

Nonporiferous side, × 5.

Delaware Mountain formation, southern Delaware Mountains (station 2969).

FENESTELLA sp. *e* (p. 141).

FIGS. 5 and 5a. A silicified fragment.

5. Poriferous side, × 8, showing the high keel with its two alternating rows of large nodes. These are possibly exaggerated by silicification.

5a. Nonporiferous side, × 8.

Delaware Mountain formation, southern Delaware Mountains (station 2969).

FENESTELLA sp. *a* (p. 139).

FIG. 6. A fragment of a silicified frond.

Nonporiferous side, × 8.

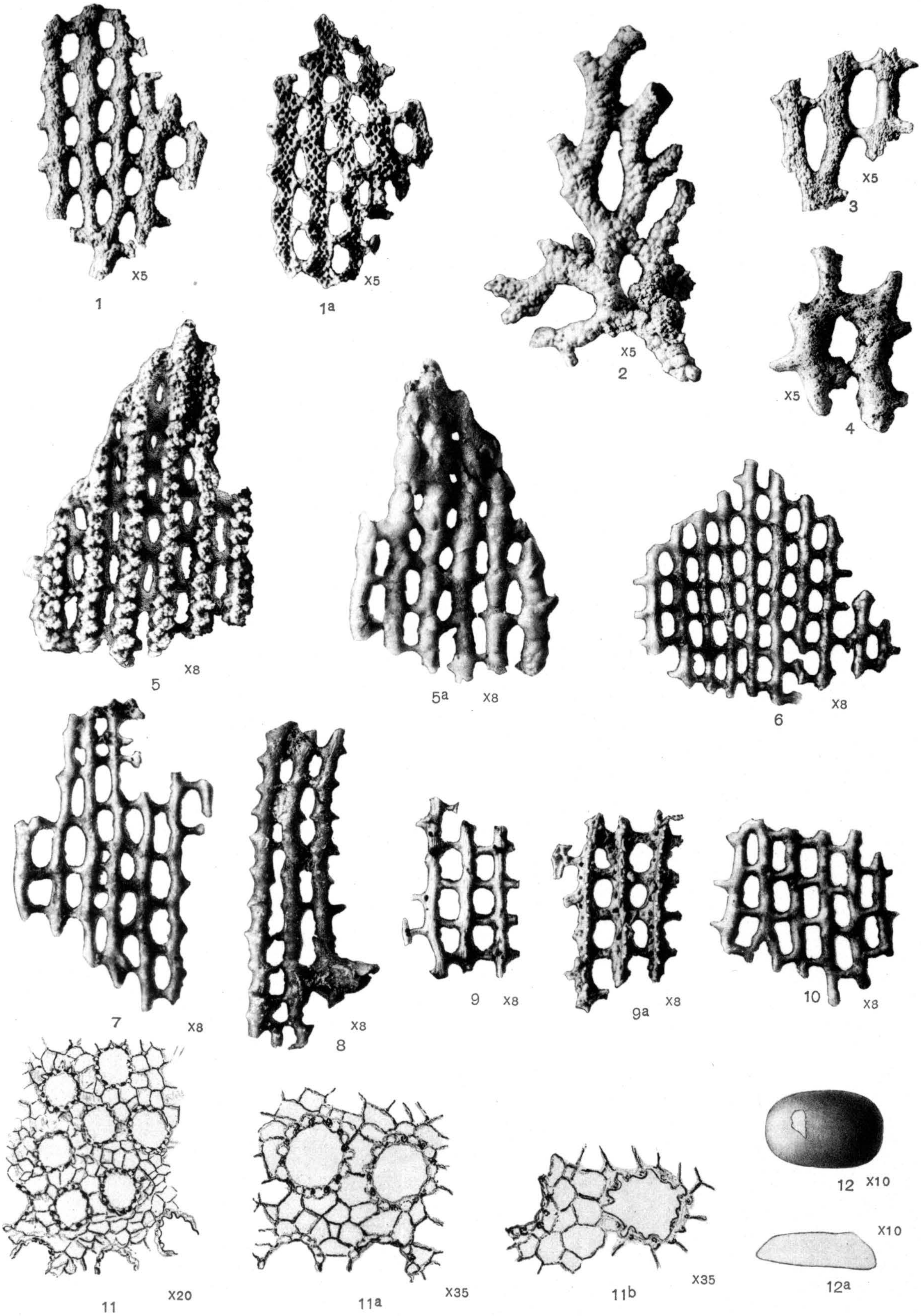
Delaware Mountain formation, southern Delaware Mountains (station 2969).

FENESTELLA sp. *c* (p. 140).

FIG. 7. Fragment of a silicified frond.

Nonporiferous side, × 8.

Delaware Mountain formation, southern Delaware Mountains (station 2969).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X8
8
9 X8
9a X8
10 X8
11
X20
11a
X35
11b
X35
12 X10
X10
12a

FENESTELLA sp. *f* (p. 141).

FIG. 8. Fragment of a silicified frond.
Nonporiferous side, × 8.
Delaware Mountain formation, southern Delaware Mountains (station 2969).

FENESTELLA TEXANA n. sp. (p. 138).

FIGS. 9 and 9a. A small silicified fragment.
9. Nonporiferous side, × 8.
9a. Poriferous side (the position being accidentally inverted in the illustration), × 8.
Delaware Mountain formation, southern Delaware Mountains (station 2969).

FENESTELLA sp. *b* (p. 139).

FIG. 10. Fragment of a silicified frond.
Nonporiferous side, × 8. By an oversight the specimen was posed upside down.
Delaware Mountain formation, southern Delaware Mountains (station 2969).

ACTINOTRYPA? SERA n. sp. (p. 155).

FIGS. 11 to 11b. Thin section of the only fragment found.
11. Transverse section, × 20.
11a. Portion of same, × 35.
11b. Another portion of same, × 35. The single cell shown in this figure more nearly resembles typical *Actinotrypa*, but it is of unusual construction; the others are as represented by the other drawings.
Delaware Mountain formation, southern Delaware Mountains (station 2962).

ARGILLŒCIA sp. (p. 510).

FIGS. 12 and 12a. A silicified specimen.
12. Side view, × 10.
12a. Outline of transverse curvature, × 10.
Delaware Mountain formation, southern Delaware Mountains (station 2969).

PLATE XXIX.

PLATE XXIX.

DELAWARE MOUNTAIN FORMATION, SOUTHERN DELAWARE MOUNTAINS.

CHONETES PERMIANUS Shumard (p. 226).

FIG 1 A silicified specimen showing some of the spines
Dorsal view, × 4 The roughness of the surface is due to the enlargement of slight imperfections in the silicification
Delaware Mountain formation, southern Delaware Mountains (station 2936)

FIG 2 A large silicified specimen
Ventral view
Delaware Mountain formation, southern Delaware Mountains (station 2936).

STREPTORHYNCHUS PERATTENUATUM n. sp. (p 180).

FIGS 3 to 3c Specimen retaining both valves in conjunction and attached by its apex to another organism
3 Anterior view, × 2
3a Posterior view, × 2 The specimen in this figure and the preceding one is represented in a detached condition
3b Dorsal view, × 2
3c Side view, × 2
Delaware Mountain formation, southern Delaware Mountains (station 2962).

PRODUCTUS sp. *d* (p. 273).

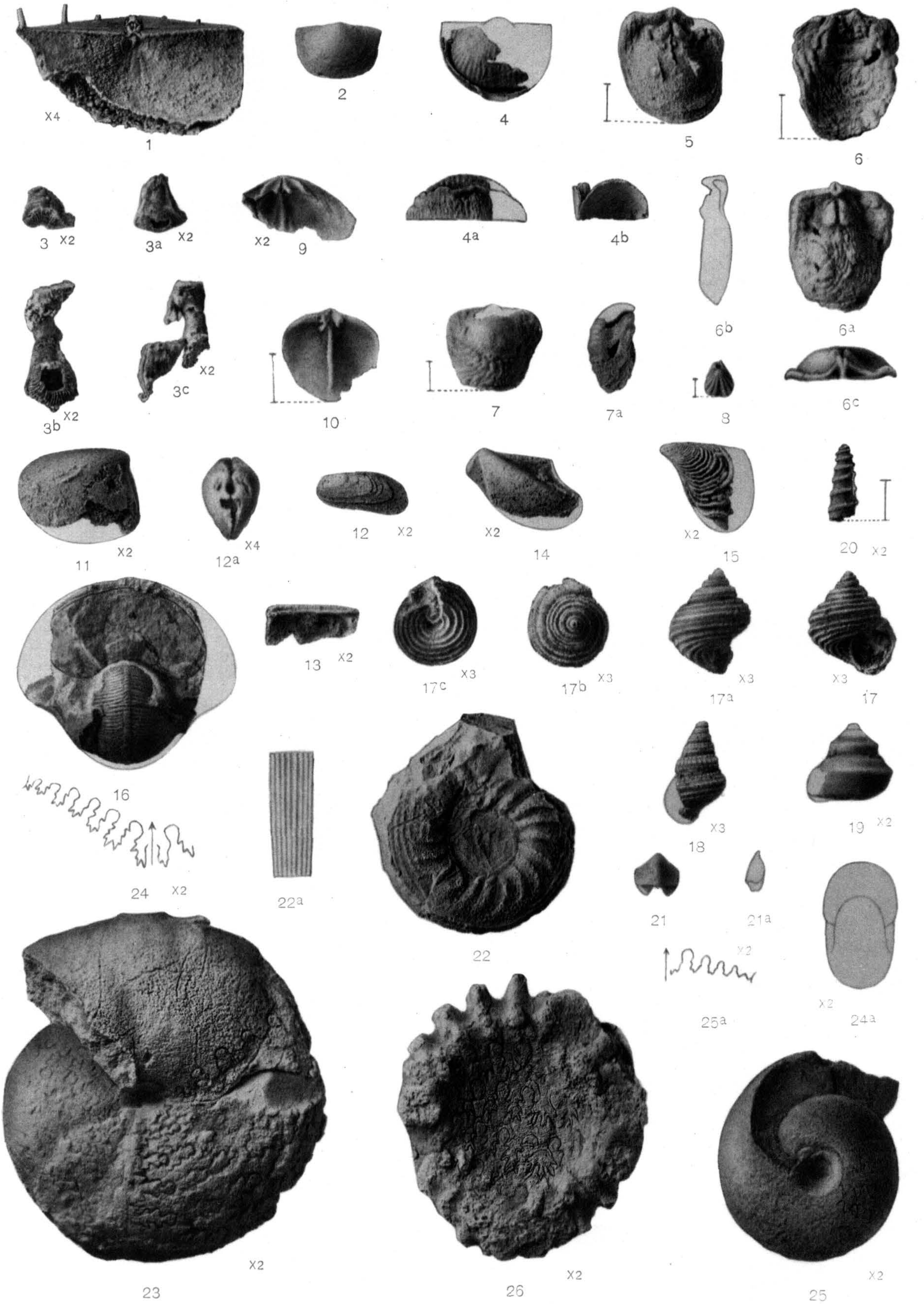
FIGS 4 to 4b Ventral valve of a specimen referred to this species The reflexed portion is part of the same valve
4. Seen from above
4a Anterior view
4b Side view
Delaware Mountain formation, southern Delaware Mountains (station 2969)

PRODUCTUS? PILEOLUS Shumard (p 270).

FIG 5 A silicified dorsal valve
View of the interior, × 3
Delaware Mountain formation, southern Delaware Mountains (station 2969)

FIGS 6 to 6c Another silicified dorsal valve
6 View of the exterior, × 3 The irregularities of the surface are due to chalcedonic replacement
6a View of the interior showing the singular muscular imprints, × 3.
6b Side view in outline, × 3
6c Posterior view, × 3
Delaware Mountain formation, southern Delaware Mountains (station 2969)

FIGS 7 and 7a An imperfect specimen retaining both valves in conjunction
7 Ventral view, × 3 The surface markings are the result of chalcedonic silicification
7a Side view, × 3
Delaware Mountain formation, southern Delaware Mountains (station 2969)


X4
1
2
4
5
6
3 X2
3a X2
X2 9
4a
4b
6b
6a
3b X2
3c X2
10
7
7a
8
6c
11 X2
12a X4
12 X2
X2 14
X2 15
20 X2
16
13 X2
17c X3
17b X3
17a X3
17 X3
24 X2
22a
22
18 X3
19 X2
21
21a
25a X2
X2 24a
23 X2
26 X2
25 X2

HUSTEDIA MEEKANA Shumard (p. 394).

FIG. 8. A very young specimen.
Dorsal view × 2.
Delaware Mountain formation, southern Delaware Mountains (station 2969).

PUGNAX? BISULCATA var. SEMINULOIDES n. var.? (p. 312).

FIG. 9. Posterior portion of a dorsal valve.
Interior view, × 2, showing the character of the hinge plate. The crura are broken off. Different individuals show slight modifications of this structure.
Delaware Mountain formation, southern Delaware Mountains (station 2969).

HETERELASMA SHUMARDIANUM n. sp.? (p. 338).

FIG. 10. A silicified dorsal valve whose specific position is somewhat doubtful.
View of the interior, × 2.
Delaware Mountain formation, southern Delaware Mountains (station 2969).

NUCULA sp. *c* (p. 421).

FIG. 11. An imperfect left valve.
Side view, × 2.
Delaware Mountain formation, southern Delaware Mountains (station 2969).

PROTRETE TEXANA n. sp. (p. 448).

FIGS. 12 and 12a. A specimen retaining both valves in conjunction.
12. Side view, × 2.
12a. Anterior view, × 4, showing the small opening just below the beaks.
Delaware Mountain formation, southern Delaware Mountains (station 2969).
FIG. 13. A fragmentary left valve.
View of the interior, × 2. The ligamental groove shows above, and at the front the channel of the little anterior aperture.
Delaware Mountain formation, southern Delaware Mountains (station 2969)

PTERIA RICHARDSONI n. sp. (p. 427).

FIG. 14. A fairly perfect left valve.
Side view, × 2.
Delaware Mountain formation, southern Delaware Mountains (station 2969).

MYALINA SQUAMOSA Sowerby? (p. 429).

FIG. 15. A silicified left valve preserving the surface.
Side view, × 2.
Delaware Mountain formation, southern Delaware Mountains (station 2969).

BELLEROPHON CRASSUS Meek and Worthen (p. 479).

FIG. 16. The least imperfect specimen found.
Apertural view.
Delaware Mountain formation, southern Delaware Mountains (station 2935).

Pleurotomaria texana n. sp. (p. 471).

Figs. 17 to 17c. A nearly perfect silicified specimen.
17. Side view, showing aperture, × 3.
17a. Side view, × 3.
17b. View from above, × 3.
17c. View from below, × 3.
Delaware Mountain formation, southern Delaware Mountains (station 2969).

Pleurotomaria? elderi n. sp. (p. 476).

Fig. 18. A silicified specimen selected as the type.
Side view, × 3.
Delaware Mountain formation, southern Delaware Mountains (station 2969?).

Pleurotomaria? carinifera var. (p. 476).

Fig. 19. A fragmentary specimen.
Side view, × 2.
Delaware Mountain formation, southern Delaware Mountains (station 2964).

Murchisonia? sp. *a* (p. 478).

Fig. 20. An undetermined fragment.
Side view, × 2.
Delaware Mountain formation, southern Delaware Mountains (station 2969).

Cymatochiton? texanus n. sp. (p. 451).

Figs. 21 and 21a. One of the valves.
21. Seen from above.
21a. Side view in outline.
Delaware Mountain formation, southern Delaware Mountains (station 2969).

Gastrioceras sp. (p. 500).

Figs. 22 and 22a. A considerably eroded specimen.
22. Side view.
22a. Portion of the ventral surface.
Delaware Mountain formation, southern Delaware Mountains (station 2968).

Waagenoceras cumminsi var. guadalupense n. var. (p. 502).

Fig. 23. A medium-sized but eroded and flattened specimen.
Side view, × 2.
Delaware Mountain formation, southern Delaware Mountains (station 2965).
Figs. 24 and 24a. A small specimen.
24. Suture line, × 2.
24a. Front view in outline, × 2.
Delaware Mountain formation, southern Delaware Mountains (station 2965).
Figs. 25 and 25a. A young specimen.
25. Side view, × 2.
25a. Suture line, × 2. This appears to be less mature than the suture from 24, which was of about the same stage or smaller. Possibly a slight amount of erosion has served to decrease the depth of the convolutions.
Delaware Mountain formation, southern Delaware Mountains (station 2965).
Fig. 26. Another specimen.
View of the inner side of a fragment showing the internal sutures, × 2.
Delaware Mountain formation, southern Delaware Mountains (station 2965).

PLATE XXX.

PLATE XXX.

DELAWARE MOUNTAIN FORMATION, GLASS MOUNTAINS.

ENTELETES GLOBOSUS n. sp. (p. 294).

FIGS. 1 and 1a. A crushed specimen retaining both valves, which clearly show its dorsisinuate character.
1. Dorsal view.
1a. Side view.
Delaware Mountain formation, Glass Mountains (station 3763).

ENTELETES sp. *a* (p. 296).

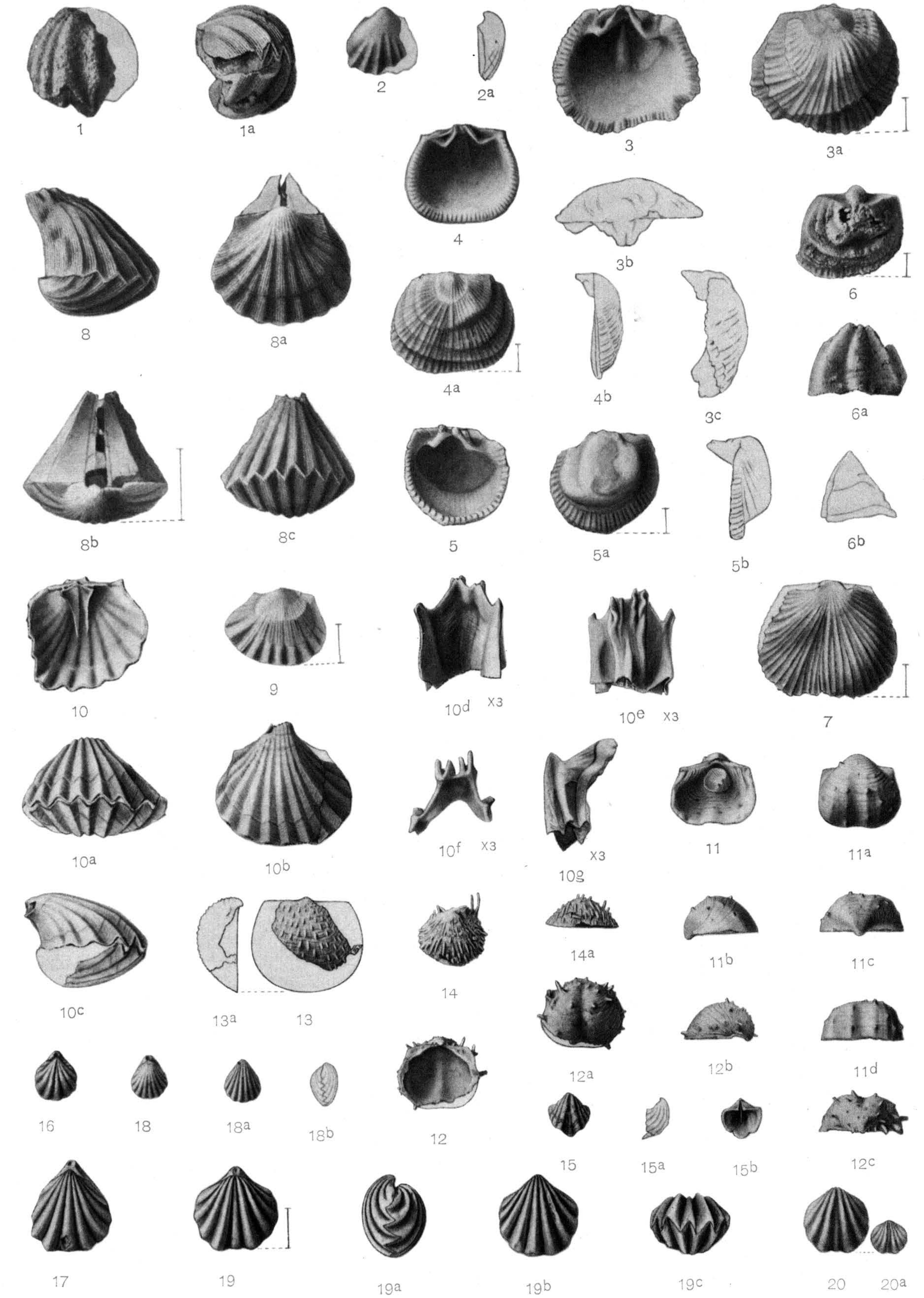
FIGS. 2 and 2a. A fragmentary ventral valve.
2. Seen from above.
2a. Side view in outline.
Delaware Mountain formation, Glass Mountains (station 3763).

STREPTORHYNCHUS PYGMÆUM n. sp. (p. 178).

FIGS. 3 to 3c. A large dorsal valve of moderate convexity.
3. Interior view, × 4. Here are to be seen the powerful cardinal process, median septum, and crenulated margins, all of which seem to indicate shell thickening and advanced age.
3a. View of the exterior, × 4.
3b. Posterior view in outline, showing the cardinal process, × 4.
3c. Side view in outline, × 4.
Delaware Mountain formation, Glass Mountains (station 3763).
FIGS. 4 to 4b. A small dorsal valve of moderate convexity.
4. Interior view, × 4.
4a. Exterior view, × 4.
4b. Side view in outline, × 4.
Delaware Mountain formation, Glass Mountains (station 3763).
FIGS. 5 to 5b. A small dorsal valve of irregular growth and great convexity.
5. View of the interior, × 4.
5a. View of the exterior, × 4.
5b. Side view in outline, ×4.
Delaware Mountain formation, Glass Mountains (station 3763).
FIGS. 6 to 6b. A ventral valve which very plainly shows a large scar of attachment.
6. Seen from above, × 4.
6a. Posterior view, × 4.
6b. Side view in outline, × 4.
Delaware Mountain formation, Glass Mountains (station 3763).
See also fig. 11.

STREPTORHYNCHUS? sp. *a* (p. 180).

FIG. 7. A small dorsal valve of undetermined species.
View of exterior, × 4.
Delaware Mountain formation, Glass Mountains (station 3763).


1
1a
2
2a
3
3a
4
3b
8
8a
6
4a
4b
3c
6a
8b
8c
5
5a
5b
6b
10
9
10d X3
10e X3
7
10a
10b
10f X3
X3
10g
11
11a
10c
13a
13
14
14a
11b
11c
12a
12b
11d
16
18
18a
18b
12
15
15a
15b
12c
17
19
19a
19b
19c
20
20a

MEEKELLA SKENOIDES n. sp. (p. 206).

FIGS. 8 to 8c. The type specimen, which is smaller than some fragments associated with it and probably belonging to the same species.

8. Side view, × 2.

8a. Dorsal view, × 2. The plications are hardly represented as sufficiently angular.

8b. Posterior view, × 2.

8c. Anterior view, × 2.

Delaware Mountain formation, Glass Mountains (station 3763).

FIG. 9. A small dorsal valve from the same station as the foregoing, which shows the surface characters more perfectly.

View of the exterior, × 2.

Delaware Mountain formation, Glass Mountains (station 3763).

MEEKELLA DIFFICILIS n. sp. (p. 207).

FIGS. 10 to 10g. The type specimen preserved in a silicified condition.

10. Interior of the ventral valve, showing the two dental plates and what look like two additional plates almost parallel to the area.

10a. Front view of both valves.

10b. Ventral valve, seen from above.

10c. Side view of both valves.

10d. Cardinal process supposed to belong to this specimen, seen from the lower or internal side, × 3.

10e. Same, seen from the upper or external side, × 3.

10f. Terminal view, × 3.

10g. Side view, × 3.

Delaware Mountain formation, Glass Mountains (station 3763).

PRODUCTUS SUBHORRIDUS var. RUGATULUS n. var. (p. 267).

FIGS. 11 to 11d. A specimen retaining both valves in conjunction.

11. Dorsal view, showing an attached ventral valve of *Streptorhynchus pygmæum*.

11a. Ventral view.

11b. Side view.

11c. Posterior view.

11d. Anterior view.

Delaware Mountain formation, Glass Mountains (station 3763).

FIGS. 12 to 12c. A ventral valve freed by etching.

12. View of the interior.

12a. View of the exterior.

12b. Side view.

12c. Posterior view.

Delaware Mountain formation, Glass Mountains (station 3763).

PRODUCTUS MEEKANUS n. sp. (p. 263).

FIGS. 13 and 13a. A fragmentary but otherwise well-preserved ventral valve.

13. Seen from above.

13a. Side view in outline.

Delaware Mountain formation, Glass Mountains (station 3763).

STROPHALOSIA HYSTRICULA n. sp. (p. 275).

FIGS. 14 and 14a. The only specimen found, a ventral valve.

14. Seen from above.

14a. Anterior view.

Delaware Mountain formation, Glass Mountains (station 3763).

SPIRIFERINA HILLI n. sp. (p. 379).

FIGS. 15 to 15b. A ventral valve.
15. View of the exterior.
15a. Side view in outline.
15b. View of the interior.
Delaware Mountain formation, Glass Mountains (station 3763).

HUSTEDIA MEEKANA Shumard (p. 394).

FIG. 16. A small, somewhat crushed specimen.
Dorsal view.
Delaware Mountain formation, Glass Mountains (station 3763).
FIG. 17. A large silicified specimen.
Dorsal view.
Delaware Mountain formation, Glass Mountains (station 3763).

HUSTEDIA PAPILLATA Shumard (p. 397).

FIGS. 18 to 18b. A rather small specimen referred to this species.
18. Dorsal view.
18a. Ventral view.
18b. Side view in outline.
Delaware Mountain formation, Glass Mountains (station 3763).

HUSTEDIA BIPARTITA n. sp. (p. 398).

FIGS. 19 to 19c. The typical specimen.
19. Dorsal view, × 2.
19a. Side view, × 2.
19b. Ventral view, × 2.
19c. Anterior view, × 2.
Delaware Mountain formation, Glass Mountains (station 3763).
FIGS. 20 and 20a. A dorsal valve similar to the last.
20. Seen from above, × 2.
20a. Same, natural size.
Delaware Mountain formation, Glass Mountains (station 3763).

PLATE XXXI.

PLATE XXXI.

DELAWARE MOUNTAIN FORMATION, GLASS MOUNTAINS.

RICHTHOFENIA PERMIANA Shumard (p. 283).

FIGS. 1 and 1a. A silicified ventral valve deformed by compression.
1. External view, somewhat oblique to the posterior side.
1a. View looking obliquely into the interior against the cardinal side. At the back near the center is seen the inner side of the area and pseudodeltidium. On either hand are two longitudinal ridges or "dental callosities," which end naturally at about the same level, indicating the position of the opercular dorsal valve. In the present specimen the thinner portions of the shell above have mostly been broken away. In front, opposite the pseudodeltidium, is the rather broad ridge which forms the septum, if so it may be called.
Delaware Mountain formation, Glass Mountains (station 3763).

FIGS. 2 to 2b. Another ventral valve similarly preserved.
2. Exterior view of the posterior side.
2a. Side view in outline.
2b. View of the interior looking obliquely downward against the posterior side. The parts shown are the same as in 1a. Symmetrically placed at the back are the two dental callosities ending above at the same level. Between them are the area and pseudodeltidium, while in front, directly opposite, is the "septum."
Delaware Mountain formation, Glass Mountains (station 3763).

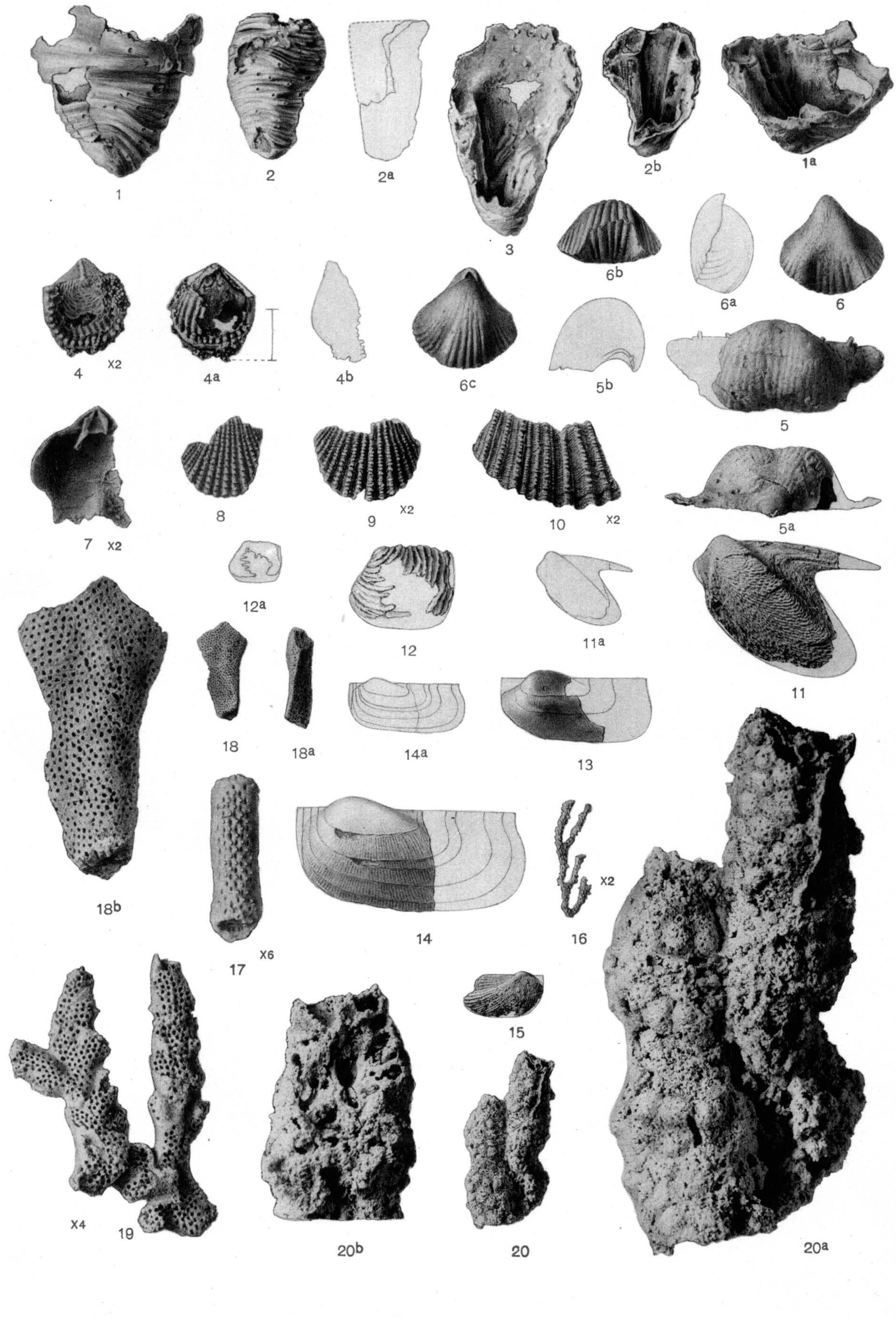
FIG. 3. Another similar specimen.
View looking obliquely downward into the interior against the left side. In this case the broadly rounded "septum" is at the right. At the left and in the background is a dental callosity with its naturally finished upper end. A projection at this level can be traced more or less clearly to the opposite side. In the foreground, at a much lower elevation and consequently at an earlier and less developed stage, is the second dental callosity, with the area and pseudodeltidium between them.
Delaware Mountain formation, Glass Mountains (station 3763).

AULOSTEGES MAGNICOSTATUS n. sp. (p. 278).

FIGS. 4 to 4b. An imperfect silicified specimen showing both valves.
4. Dorsal view, $\times$ 2.
4a. Ventral view, $\times$ 2.
4b. Side view in outline, $\times$ 2.
Delaware Mountain formation, mountains northwest of Marathon (station 3840).

PRODUCTUS GUADALUPENSIS var. COMANCHEANUS n. var. (p. 261).

FIGS. 5 to 5b. A ventral valve.
5. Seen from above.
5a. Posterior view.
5b. Side view in outline.
Delaware Mountain formation, Glass Mountains (station 3763).


1
2
2a
3
2b
1a
6b
6a
6
4 x2
4a
4b
6c
5b
5
7 x2
8
9 x2
10 x2
5a
12a
12
11a
11
18
18a
14a
13
18b
17 x6
14
16 x2
15
x4 19
20b
20
20a

CAMAROPHORIA VENUSTA n. sp. (p. 303).

FIGS. 6 to 6c. The type specimen, preserving both valves in conjunction.
6. Ventral view.
6a. Side view in outline.
6b. Anterior view.
6c. Dorsal view.
Delaware Mountain formation, Glass Mountains (station 3763).

NOTOTHYRIS sp. (p. 337).

FIG. 7. An imperfect dorsal valve.
View of the interior, showing the perforated hinge plate, × 2.
Delaware Mountain formation, Glass Mountains (station 3763).

AVICULIPECTEN sp. *b* (p. 437).

FIG. 8. An imperfect left (?) valve.
View of the exterior, showing the sculpture.
Delaware Mountain formation, Glass Mountains (station 3763).

AVICULIPECTEN sp. *b* var. (p. 438).

FIG. 9. An imperfect left (?) valve.
View of the exterior, × 2, showing the sculpture.
Delaware Mountain formation, Glass Mountains (station 3763).

AVICULIPECTEN sp. *c* (p. 438).

FIG. 10. Fragment of a left (?) valve.
Exterior view, × 2, showing sculpture.
Delaware Mountain formation, Glass Mountains (station 3763).

PTERIA SQUAMIFERA n. sp. (p. 427).

FIGS. 11 and 11a. A somewhat imperfect left valve.
11. Seen from above, × 2.
11a. Same in outline, natural size.
Delaware Mountain formation, Glass Mountains (station 3763).

ASTARTELLA NASUTA n. sp. (p. 445).

FIGS. 12 and 12a. An imperfect left valve, silicified and etched.
12. Seen from above, × 2.
12a. Same in outline, natural size.
Delaware Mountain formation, Glass Mountains (station 3763).

PARALLELODON MULTISTRIATUS n. sp. (p. 423).

FIG. 13. An imperfect left valve.
Seen from above.
Delaware Mountain formation, Glass Mountains (station 3763).
FIGS. 14 and 14a. A smaller left valve.
14. Seen from above, × 2.
14a. Same in outline, natural size.
Delaware Mountain formation, Glass Mountains (station 3763).

PARALLELODON? sp. (p. 424).

FIG. 15. An imperfect right valve of doubtful affinities.
Seen from above.
Delaware Mountain formation, Glass Mountains (station 3763).

THAMNISCUS sp. (p. 148).

FIG. 16. A silicified specimen.
Poriferous side, × 2.
Delaware Mountain formation, mountains northwest of Marathon (station 3840).

RHOMBOPORA aff. R. LEPIDODENDROIDES Meek (p. 153).

FIG. 17. A silicified specimen.
Side view, × 6.
Delaware Mountain formation, mountains northwest of Marathon (station 3840).

MEEKOPORA sp. (p. 127).

FIGS. 18 to 18b. A fragmentary specimen.
18. Seen from the side.
18a. Seen edgewise.
18b. Side view, × 3.
Delaware Mountain formation, Glass Mountains (station 3763).

DOMOPORA? HILLANA n. sp. (p. 124).

FIG. 19. Frond.
Seen from the side, × 4.
Delaware Mountain formation, Glass Mountains (station 3763).

CYSTOTHALAMIA NODULIFERA n. sp. (p. 89).

FIGS. 20 to 20b. Two silicified specimens.
20. Seen from the side.
20a. Same, × 3.
20b. A natural section obliquely across one of the specimens, ×3.
Delaware Mountain formation, Glass Mountains (station 3763).

INDEX.

Names in *italic* are synonyms; figures in **black face** refer to descriptions; figures in *italic* denote illustrations.

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