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UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

PALEONTOLOGY

OF THE

MALONE JURASSIC FORMATION OF TEXAS

BY

FRANCIS WHITTEMORE CRAGIN

WITH

STRATIGRAPHIC NOTES ON MALONE MOUNTAIN AND THE SURROUNDING REGION NEAR SIERRA BLANCA, TEXAS

BY

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DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
Washington, D. C., February 4, 1903.

SIR: I transmit herewith, for publication as a bulletin of the Survey, a manuscript entitled "Paleontology of the Malone Jurassic Formation of Texas," by Francis Whittemore Cragin. Professor Cragin prepared a large part of this paper in 1899, beginning the work while he was a graduate student in Johns Hopkins University, Baltimore, and continuing it here under my supervision in accordance with authority obtained from you at the time. I have inserted a sketch of the stratigraphy of the region and have prepared the accompanying map, using data furnished by Professor Cragin for the portion of the region referred to in his text.

I may add that Professor Cragin's collection of Malone fossils is now the property of the United States National Museum.

Very respectfully,

T. W. STANTON, *Paleontologist.*

Hon. CHARLES D. WALCOTT,
Director United States Geological Survey.

PALEONTOLOGY OF THE MALONE JURASSIC FORMATION OF TEXAS.

By F. W. Cragin.

INTRODUCTION.

SCOPE OF INVESTIGATION.

This paper embodies the paleontological and some geological results of recent studies in the Jurassic of El Paso County, Tex. It is in part the outgrowth of one of briefer scope, prepared in 1897–98 from collections and data obtained by me in a reconnaissance made in 1897, and supplemented by some of the results of the earlier work of Messrs. Taff, Wyschetzki, and Goodell, as explained below. In its present form it includes also the study of two collections made by Dr. T. W. Stanton, of the United States Geological Survey, as noted more particularly elsewhere herein.

GEOGRAPHY OF THE REGION.

In El Paso County, a few miles north of the Rio Grande and 75 to 80 miles southeast of El Paso, is a narrow ridge known as Malone Mountain. Its trend is nearly north-northwest and south-southeast, and is nearly continuous with that of the northwestern end of the Quitman Mountains, from which it is separated by an interval of less than a mile. At the eastern base of the mountain, near its northern end, on the joint line of the Southern Pacific and Texas Pacific railways is the flag station of Malone, which has an elevation of 4,262 feet above sea level.[a] Also on this line of railway, and between 2 and 3 miles west of the north end of Malone Mountain, is Finlay station. As shown by the Fort Hancock sheet of the Topographic Atlas of the United States, in preparation by the United States Geological Survey, the mountain rises to somewhere over 5,050 feet above sea level, and so has a relative altitude of about 800 feet. On either side of the mountain ridge are hills that are geologically related to the mountain.

[a] Gannett, Henry, Dictionary of altitudes in the United States, third edition: Bull. U. S. Geol. Survey No. 160, 1899.

HISTORY OF GEOLOGICAL STUDIES.

The geological observations made along this part of the Rio Grande Valley in the fifties by the Mexican Boundary and Pacific Railway surveys were but cursory, and did not specifically include the Malone district, and the first serious geological study within the district was made in 1890 by the Geological Survey of Texas, under Mr. E. T. Dumble. In that year Mr. J. A. Taff, then attached to Mr. W. H. von Streeruwitz's Trans-Pecos division of that survey, studied Malone Mountain, and Mr. Ralph Wyschetzki, of the same division, collected a few fossils from the hills northeast of it. In the second annual report of the same survey, issued in 1891, Mr. Taff published and discussed a section of Malone Mountain and described, with scant allusion to its paleontology, an essential part of the Malone formation, consisting of limestone, gypsum, and flagstone of Malone Mountain, which he called the "Malone beds." He thus virtually recognized the formation, his name for which, as the earliest proposed for it, is here retained; but he erred in placing it in the Washita Cretaceous division together with his Etholen and Yucca beds, which are typically seen in a part of the Etholen Knobs and Yucca Mesa, and are of Glen Rose age. Mr. Taff also correlated the sandstone and oyster-shell breccia of the Etholen Knobs with the Malone formation, but these, like the Etholen breccia-conglomerates and the Yucca beds, belong to the Glen Rose alternating beds.

In 1893 I described[a] the better part of a small collection of fossils which Mr. Wyschetzki had obtained from the hills northeast of Malone Mountain. Disregarding for the moment a strong suspicion that these fossils were Jurassic, I described them as Cretaceous, since the time and material then available were too limited for a conclusive study, and since it was thought that the small Malone fauna then known had one species in common with the Cretaceous, in *Trigonia taffii*, which occurred with undoubted Cretaceous fossils on Bluff Mesa and was supposed to have been found in the Malone district also.[b] But I resolved to take up the question at the first opportunity that should offer.

[a] A contribution to the invertebrate paleontology of the Texas Cretaceous: Fourth Ann. Rept. Geol. Survey Texas, pt. 2, pp. i–iv, 139–246, and Pls. XXIV–XLVI.

[b] The material thus treated included six new species, which were described under the following names: *Anatina tosta, Cucullœa transpecosensis, Cyprina streeruvitzii, Trigonia vyschetzkii, Trigonia taffii,* and *Venus malonensis.* It was afterwards found that *Trigonia taffii* does not occur at all in the Malone formation, but is a fossil of the Glen Rose alternating beds, to which Bluff Mesa belongs. The type material of *Trigonia taffii* was described (loc. cit., p. 214) as having come in part from Bluff Mesa and in part from the locality of *Trigonia vyschetzkii,* east of Malone. It is now, however, practically certain that the nearly complete valve from Bluff Mesa alone represented *Trigonia taffii,* and that all of the fragmental material which was supposed to belong to this species, and which was from the Malone locality, belonged—as part of it which I recently had opportunity of reexamining certainly does—to *T. vyschetzkii.* All of the very diligent collecting done at the Malone locality by Doctor Stanton and myself, while showing the occurrence of *T.*

No opportunity for further investigation of the Malone fauna was presented until 1895. In March of that year the late Mr. Robert W. Goodell, assisted by his father, Mr. R. R. Goodell, made a journey to Guaymas, Mexico, to obtain recent marine invertebrates from some rich collecting grounds on which I had worked in the winter of 1882–83. In returning, he very kindly undertook to visit Sierra Blanca and Quitman mountains, Bluff and other mesas, and the hills north to east of Malone, to seek further evidence concerning the age of the rocks that had yielded the Wyschetzki collection. From the Sierra Blanca Mountains and several other of the elevations visited, which did not include Malone Mountain, the Messrs. Goodell brought back a large number of fossils, all of which were of the Comanche series save those from the hills a mile and a half east of Malone station. Those from the latter locality included, besides several of the species obtained there by Mr. Wyschetzki in 1890, some specimens which the writer recognized as specifically identical with the Mexican Jurassic fossil, *Pleuromya inconstans* Castillo and Aguilera, and one example of an undescribed Trigonia of the Jurassic section Undulatæ. A restudy of *Trigonia vyschetzkii*, of which the Messrs. Goodell had obtained new material, led me to the conclusion that the affinities of that fossil also were Jurassic rather than Cretaceous. In 1896–97, therefore, I prepared a brief paper on the "Discovery of marine Jurassic rocks in southwestern Texas," assigning to the Malone formation a stratigraphic place somewhat different from that given to the original "Malone beds" of Mr. Taff, and announcing its Jurassic age. This article, which included, from the field notes of Mr. Robert W. Goodell, the latter's section of the hills northeast of Malone station, was published in the Journal of Geology, Volume V, pages 813–820.

It was noted in this article that a comparison of the observations of Mr. Goodell with those of Mr. Taff seemed to show petrographical grounds for a formational correlation of the hills northeast of Malone station with the Malone beds of Malone Mountain. Such correlation, for a part of these hills and a part of the mountain, was confirmed paleontologically by me in August, 1897, when I visited El

vyschetzkii in profusion, has failed to yield a single fragment of the *T. taffii*. On the other hand the fauna with which *T. taffii* is associated was examined by Doctor Stanton and by me in 1897, both by a joint excursion to Bluff Mesa and by our independent examinations of the W. F. Cummins Red Bull Canyon collection in the museum of the Geological Survey of Texas, and was found to include, with some species hitherto undescribed, others of the Glen Rose Cretaceous.

In 1894 Mr. Cummins made a collection of fossils, including *Trigonia taffii*, near the southern end of the Quitman Mountains, labeling it "Mule Canyon." An excursion to Mule Canyon was made by Doctor Stanton and myself in 1897, but the fossiliferous rocks in its vicinity were found to contain Cretaceous fossils unlike those collected by Mr. Cummins. Further search by Doctor Stanton in 1898 resulted in his discovering the locality of the Cummins collection, which was found to be Red Bull Canyon, the designation, "Mule Canyon," having been used by Mr. Cummins on his labels through some inadvertence.

Paso County, Tex., and found that certain fossils were common to the locality a mile and a half east of Malone station and to the southeastern quarter of Malone Mountain, and in September of that year and in the summer of the year following, for the mountain in general and its western foothills, by Dr. T. W. Stanton, who found for these and the eastern foothills an essentially common fauna.

I arrived at Sierra Blanca station August 19, 1897, and remained till September 7, reconnoitering in several directions from that station as headquarters and giving the greater part of my time to the Malone district. I examined parts of the eastern slope of Malone Mountain, from which also I obtained a few fossils, and observed, from the southern part of the mountain crest, the general relations of the western foothills. But it was to the eastern hills, as including the locality that had yielded the interesting fossils to Mr. Wyschetzki and the Messrs. Goodell, that I gave chief attention; and from these hills I made a large collection of fossils. The western slope and foothills of the mountain I was unable to explore for lack of time.

On September 2 Doctor Stanton reached Sierra Blanca and joined me in exploring and collecting for a few days, both in Cretaceous localities and in the eastern part of the Malone district. Doctor Stanton remained in the field after my departure and carried reconnaissance further westward than I had, examining the western slope and foothills of Malone Mountain and making a section of the mountain. In the summer of 1898, with more time and better facilities at his disposal than had been available to either of us in 1897, Doctor Stanton returned to this part of Texas and made additional collections and a comprehensive examination of the Malone and contiguous territory. Later, with the consent of the Director of the United States Geological Survey, Doctor Stanton very generously turned over to me for study and description all of the marine fossils collected by him from the Malone formation in his two expeditions. Doctor Stanton's geological observations will be given by himself in another connection herewith.

The types collected in the Malone district by the Geological Survey of Texas in 1890 and described in the fourth annual report of that survey have in part been loaned to the United States Geological Survey by Doctor Dumble and used in preparing this paper. Most of the species thus early collected are represented by ampler material from later collections. The more important of the specimens of the Goodell Malone collection, which were given to me by Mr. Robert W. Goodell in 1897, and my Malone collection, made in the latter year, have recently become the property of the United States National Museum and, first studied in the summer of 1898, have been restudied in connection with the other material. The material on which these

paleontological studies are based therefore includes, with the exception of three or four mislaid specimens, all of the marine fossils that have hitherto been collected in Texas from rocks of the Malone formation.

GEOLOGY OF THE REGION.

All of the fossils described in this paper are from Malone Mountain and neighboring hills, and from within a few miles of the railway stations of Malone and Finlay. The greater number were obtained from east of the mountain, in the range of low hills which, in my article on "Discovery of marine Jurassic rocks in southwestern Texas," I called the Malone Hills.

Beginning about half a mile north of Malone station, and in part too low to be indicated by the contour lines, with 50-foot intervals, used in the general topographic map of this region, these hills extend, trending at first about eastward and later more southeasterly, as a practically continuous Jurassic outcrop through the Neocene, for a distance of a mile and a half. At a mile to nearly a mile and a half from the station they include a line of three connected hills (*C*, *D*, and *E*, on Pl. I, in order of distance from the station), which may be called the Trio. As best observed on the southeastern quarter of hill *E*, the Trio geological section comprises three natural subdivisions, the lower, middle, and upper of which respectively may be designated as Theta, Iota, and Kappa.

The Theta subdivision of this section consists chiefly of sandstone, with occasional courses of more or less sandy varying to relatively pure indurated limestone and some clay. The sandstone and clays are of a gray and yellowish-brown color, sometimes varying to purple and red. The purer of the limestone layers have a bluish-black color, weathering to gray or brown. Bedded and irregular seams of white cleavable calcite, sometimes several inches thick, here traverse the Theta in its upper part. The base of the Theta is not exposed.

A short distance southeast of hill *E* is a very low truncate mound (*F*), from which the Kappa subdivision had been removed by erosion before the prevalence of the Neocene waters which have so widely mantled the lower levels of this region with tufaceous cements and conglomerates. The mound is gently synclinal in structure and consists of a few feet of Iota conglomerates rising rather abruptly from gentle basal slopes. A Theta outcrop of only a few acres, lying chiefly in the interval between hill *E* and the Truncate mound, but extending also around the latter except on its east to southeast quarter, and embracing so much of the basal slopes of both elevations as has been denuded of its Neocene mantle, is by far the richest collecting ground in the Malone district. This interval is of anticlinal structure, the strata increasing their dip from either the neighboring base

of the Trio or that of the Truncate mound toward a common line, the axis of a closed fold, where they stand nearly vertical, and where is the shallow beginning of a small draw that deepens to the northward. This pinching and change of dip make difficult a close estimate of the thickness of upper Theta strata here exposed, but it does not seem probable that less than about 250 feet of these can have been involved in the exposed portion of either limb of the fold.

If we except obscure vestiges of fossils in the Kappa limestones and fragments of Paleozoic fossils (partly corals) in the pebbles of the Iota conglomerates, the fossils at this locality are confined to the Theta subdivision.

A very few forms, two or three of them identifiable as the commonest Malone species, were collected in the upper part of the Theta, chiefly in one bed of slight thickness, at a spot near the southwestern base of hill *C*, at the south border of the flat, saddle-like interval that separates the Trio from the west-northwestward continuation (*A*, *B*) of this hill range. In the immediate vicinity of this minor occurrence of fossils, and stratigraphically lower, is a small exposure of gypsum. This locality is only about half a mile west and a little north of the principal collecting ground above described.

The Iota subdivision of the Trio section consists distinctively of coarse conglomerates, in six or more beds 1 to 8 feet thick, separated by layers of relatively soft sandstone. Many of the pebbles and cobbles in these conglomerates are of iron-stained chert and siliceous limestone; some are evidently of Paleozoic derivation, and a few are of white quartz. In the southeastern slope of the east hill of the Trio the thickness of the Iota is about 50 feet. In the Truncate mound a considerable part of the original thickness has been removed. The dip of the Iota, like that of the other and generally much disturbed members of the Malone formation, is extremely variable in amount and direction. In the Trio and the Truncate mound it is usually from 15° to 25°, but exceeds the latter amount in places. On the southeastern slope of the Trio its direction is a few degrees west of north; in the east and west walls of the Truncate mound it is, respectively, west and east.

At the isolated hill (*G*) south of the railway, between one-half and three-fourths of a mile southeast of the main fossil-bearing locality, no fossils were found, nor any Malone rocks lower than Iota, though the typical succession of conglomerates of the latter subdivision is shown there, blanketed by Neocene at its base.

The Kappa, which forms the upper portion of the Trio—about 40 feet in hill *E*—is of hard, massively bedded, bluish-black, calcite-seamed limestone, charged with irregular segregations or impregnations of silica and iron. Much of it is cleft into large, rectangular

blocks by weathering along joint planes and bed planes in such a manner that it is not always very obvious which set of planes represents the dip except as this is indicated by underlying strata. It is impossible to say what thickness it may have had here formerly, as an unknown part of it has been removed by erosion.

At its base in the Trio the Kappa limestone presents a zone several feet thick, composed almost wholly of spherical, oval, or somewhat irregular concretions, from 1 to 3 or 4 inches or occasionally more in diameter. They consist of alternating lighter and darker layers, each a few millimeters thick, and sometimes weather uniformly with the matrix, being then seen in section, or are harder than the inclosing rock, when they are weathered out as pebbles, splitting sometimes into hemispheres which show the concentric layers. This is only an exaggerated sort of pisolitic structure. It is probable that this horizon, like others of the Malone formation, is variable, and that pisolitic structure is only locally developed in it. This rock is very probably similar to the pisolitic limestone conglomerate mentioned by Mr. Taff as constituting No. 9 of his Malone Mountain section.[a]

A reconnaissance was made of the western segment (*A*, *B*) of the Malone Hills, consisting chiefly of limestone and gypsum, with sandstone at its western end (as described by Mr. Robert W. Goodell in connection with his section of the Malone Hills)[b] and at least one remnant of conglomerate at its southern border; also of a ridge of quartzitic sandstone, apparently below the adjacent gypsum, and which forms an eastern foothill of Malone Mountain at the southern end of the mountain, and of portions of the eastern slope and summit of the mountain. But as these were for the most part only cursorily examined, and yielded no fossils except at one locality in the eastern slope of the mountain, no attempt will here be made to correlate positively their stratigraphic subdivisions with those observed at and southeast of the Trio.

Provisionally, however, it may be said that if the gypsum near the southwestern base of hill *C* represents the same horizon as the heavy bed that traverses the western segment of the Malone Hills, and if the latter is but a reappearance of the great gypsum bed the upper limit of whose outcrop disappears by descending northerly from the southern east front of Malone Mountain, then the following inferences would apparently be reached:

(1) That the same gypsum, though not exposed there, probably underlies the highly fossiliferous sandstones and limestones of the Theta at the east end of the Trio and at the Truncate mound.

(2) That the well-stratified limestones and the massive remnant of conglomerate lying above this gypsum and bordering it on the south

[a] Second Ann. Rept. Geol. Survey Texas, pp. 722, 723. [b] Jour. Geol., vol. 5, p. 817.

in the western segment of the Malone Hills would represent the Theta and the Iota in that quarter.

(3) That the conglomerates above the gypsum in the east face of Malone Mountain, at the southern end of the mountain and at the transverse anticline a mile farther north, would represent, in part at least, the Iota.

(4) That the Theta in the eastern slope of the mountain at its southern end would, if present, belong about at the summit of the gypsum, and that it either has been removed by erosion during the formation of the conglomerates or is possibly represented there by the upper part of the gypsum itself.

The fossils obtained by me from the eastern slope of the mountain were found in a ravine at the base of the mountain, in a horizon of impure limestone, at the passage from conglomerates like those of the Iota to limestones like those of the Kappa, forming part of an obliquely transverse anticline about a mile north of the southern end of the mountain; those collected at the latter locality by Doctor Stanton were obtained in part from limestones somewhat higher in the anticline.

DISTRIBUTION OF FOSSILS IN MALONE DISTRICT.

A large number of the fossils herein described will be found recorded as having been collected by Doctor Stanton at a number of points on or near Malone Mountain, especially on the western slope and foothills. The great majority of these had previously been found at the notable locality east of Malone, but several will be found listed from the mountain or its western foothills only. Among these are the Nautilus, a few other Mollusca, and the two echinoderms.

How prolific the Malone formation is in fossils at the several collecting stations, and how much the original Malone Hills locality excels the others, may be seen by the following lists:

OCCURRENCE OF SPECIES BY LOCALITIES.

LOCALITY NO. 1.—*Theta subdivision of the Trio section in the Malone Hills, 1½ miles east of Malone railway station.*

Astrocœnia maloniana.
Serpula gordialis.
Serpula sp. (large).
Serpula sp. (small, with annular, filiform costellæ).
Berenicea maloniana.
Ostrea sp.
Gryphæa mexicana.
Exogyra subplicifera.
Plicatula sportella.
Lima (Radula) interlineata.
Lima (Ctenostreon) riograndensis.
Pecten insutus.
Gervillia corrugata.
Mytilus nuntius.
Modiola maloniana.
Pinna quadrifrons.
Arca? dumbli.

Arca taffii.
Cucullæa catorcensis.
Cucullæa texticostata.
Cucullæa transpecosensis.
Leda? navicula?.
Trigonia calderoni.
Trigonia conferticostata.
Trigonia goodellii.
Trigonia munita.
Trigonia proscabra.
Trigonia rudicostata.
Trigonia vyschetzkii.
Astarte? craticula.
Astarte? isodontoides.
Astarte malonensis.
Astarte microphyes.
Astarte posticalva.
Ptychomya stantoni.
Lucina? mexicana.
Lucina potosina.
Lucina potosina, var. metrica.
Unicardium semirotundum.
Unicardium transversum.
Cyprina coteroi.
Cyprina? streeruvitzii.
Tapes? cuneovatus.
Pholadomya marcoui.
Pholadomya paucicosta.
Pholadomya præposita.
Pholadomya tosta.
Pleuromya inconstans.
Pleuromya inconstans, var. curta.
Anatina obliquiplicata.
Anatina pliculifera.
Thracia? maloniana.
Martesia? maloniana.
Pleurotomaria circumtrunca.
Turbo? beneclathratus.
Delphinula stantoni.
Nerita nodilirata.
Nerita peroblata.
Vermetus cornejoi.
Natica bilabiata.
Natica inflecta.
Natica williamsi.
Chemnitzia goodellii.
Nerinea circumvoluta.
Nerinea goodellii.
Nerinella stantoni.
Cerithium arcuiferum.
Actæonina? maloniana.
Oppelia? fallax.
Olcostephanus malonianus.
Perisphinctes felixi.
Perisphinctes potosinus.
Perisphinctes schucherti?.
Aspidoceras alamitocensis.
Pycnodont fish tooth.
Cycloid fish scales.
Enaliosaur (fragments of bones, indicating animal of considerable size).

LOCALITY No. 2.—*South border of flat saddle, west of the Trio, about a mile east of the Malone railway station.*

Trigonia vyschetzkii.
Astarte malonensis.
Pleuromya inconstans?.

LOCALITY No. 3.—*Anticline in east slope of Malone Mountain, about a mile north of the southern end.*

Holectypus? sp.
Serpula gordialis.
Gryphæa mexicana.
Exogyra subplicifera (probable casts of).
Modiola maloniana.
Cucullæa catorcensis.
Leda? navicula.
Astarte malonensis.
Unicardium semirotundum.
Unicardium transversum.
Pleuromya inconstans.
Martesia maloniana.
Turritella burkarti.
Chemnitzia goodellii?.
Nerinella stantoni.
Selachian (fin spine of indeterminate genus).

LOCALITY No. 4.—*About a mile*[a] *east of the railway station of Finlay; apparently about the same horizon as the locality next below mentioned.*

Gryphæa mexicana.
Lima interlineata.
Pecten insutus.
Modiola geniculata.
Modiola maloniana.
Trigonia calderoni.
Trigonia proscabra?.[b]
Astarte malonensis.
Unicardium transversum.
Chemnitzia goodellii.
Nerinella stantoni.

LOCALITY No. 5.—*Foothills near the railroad, at northwestern end of Malone Mountain, a little over 2 miles east-southeast of Finlay station, not more than 200 feet above the gypsum bed; total exposure above gypsum bed here 540 feet; fossils all from middle hundred feet.*

Cucullæa castilloi.
Lucina potosina, var. metrica.
Lucina planiuscula.
Unicardium semirotundum.
Pholadomya paucicosta.
Nerita finlayensis.
Natica finlayensis.
Natica inflecta.
Nautilus naufragas.
Oppelia fallax?.
Perisphinctes schucherti.

LOCALITY No. 6.—*First high ridge west of Malone Mountain, about 2 miles west of Malone station, in No. 13 of Doctor Stanton's Malone Mountain section.*

Gryphæa mexicana.
Pecten insutus.
Trigonia munita.
Astarte malonensis.
Pleuromya inconstans.

LOCALITY No. 7.—*West of the north part of Malone Mountain, about 2 miles southwest of Malone station, in No. 13 of Doctor Stanton's Malone Mountain section.*

Gryphæa mexicana.
Pecten insutus.
Astarte malonensis.
Unicardium semirotundum.
Pleuromya inconstans.
Martesia maloniana.
Chemnitzia goodellii.
Nerinella stantoni.
Nautilus burkarti?.
Perisphinctes clarki.

LOCALITY No. 8.—*At same locality as the preceding, but from a horizon 220 feet higher, viz, No. 25 of Doctor Stanton's Malone Mountain section.*

Pygurus sp.
Gryphæa mexicana.
Pinna quadrifrons.
Pleuromya inconstans.

LOCALITY No. 9.—*West base of Malone Mountain, a short distance north of the southern end.*[c]

Gryphæa mexicana.
Exogyra potosina (broadly triangular phase).
Gervillia cinderella.
Gervillia? riograndensis.
Pinna quadrifrons.
Pholadomya cf. marcoui.
Pleuromya inconstans.
Pleuromya inconstans, var. curta.
Corbula? maloniana.

[a] Something more than this distance, a little south of east.

[b] A cast; it may possibly represent *T. præstriata.*

[c] On this collecting station, having previously referred in his field notes to a fresh-water limestone 75 to 100 feet below a quartzitic conglomerate at top of Malone Mountain a short distance north of its southern end, Doctor Stanton comments as follows: "In the field this was believed to be between the fresh-water horizon and the quartzitic conglomerate above mentioned. It is certainly several hundred feet above a horizon of the *Gryphæ mexicana* and Nerinea."

LOCALITY No. 10.—*Foothill west of Malone Mountain, about 2 miles north of its southern end; possibly same horizon as that of the preceding locality.*

Gryphæa mexicana.
Exogyra potosina (narrower phase).
Pecten insutus.
Pinna quadrifrons.
Astarte malonensis?.
Lucina potosina, var. metrica.
Pleuromya inconstans.
Perisphinctes aguilerai.

LOCALITY No. 11.—*Near southern end of Malone Mountain, west face, near top; stratigraphic relation obscure.*

Trigonia munita.
Nerinea goodellii.

LOCALITY No. 12.—*Conglomerate on west face and near top of Malone Mountain.*

Trigonia goodellii? (cast, larger than other specimens of this sp.)

LOCALITY No. 13.—*East slope of Malone Mountain near the southern end; 200 or 300? feet above the gypsum.*

Gryphæa mexicana.
Trigonia præstriata.
Oppelia fallax?.
Perisphinctes clarki.

AGE OF MALONE FAUNA.

The affinities of its fauna clearly refer the Malone formation to the Jurassic. The only evidence that at first thought might seem discordant is the occurrence of the genus Ptychomya, which, with one or two doubtful exceptions, has not been recorded hitherto from rocks older than the Cretaceous. But when it is remembered that, of the Cretaceous Ptychomyas, only one species occurs later than the Lower Cretaceous (Neocomian and Gault) and that this one, the *Pt. zitteli* of the western Alps, is from the Turonian, no species occurring in the higher (Senonian and Danian) stages of the Cretaceous, the occurrence of one or two species of Ptychomya in the upper part of the Jurassic is only that which it would be reasonable to anticipate. This genus occurs at Chillan, Chile, in rocks of debatable age, and it is thought by Doctor Steinmann to have been derived there possibly from the same bed that yielded his *Trigonia transitoria*, from which *T. vyschetzkii* is scarcely distinguishable. The *T. transitoria* occurs also at Caracoles, Bolivia, where, on the basis of the kind of rock attached to the specimen, Doctor Steinmann supposes it to hail from the Lower Cretaceous; but nearly all of the Mesozoic fossils that he lists from Caracoles he considers Jurassic.

The sections *Undulatæ* and *Costatæ*, to which several of the Malone Trigonias belong, are exclusively Jurassic,[a] and, if we except *Tri-*

[a] By Pictet and Campiche (Pal. Suisse; Terr. Cret. de St. Croix, p. 360. 1866) and Stoliczka (Pal. Indica; Cret. Fauna S. Ind., vol. 3, p. 311. 1871), the section *Undulatæ* is said to include some Cretaceous species, but by later authorities it is cited as exclusively Jurassic. Thus it occurs, according to Zittel's Handbuch (1881–1885) "Nur in Jura;" and according to Steinmann and Döderlein's Elemente (1890), "Oberer Lias—Oberer Malm."

gonia præstriata—represented by a single somewhat imperfect mold—none of the Malone Trigonias agree perfectly with generic sections hitherto known from Cretaceous rocks, exclusively.[a] The genus Trigonia is moreover generally considered one of the best of the Lamellibranch genera for purposes of stratigraphic diagnosis.

But it is to the ammonites that we must look for the strongest evidence of geologic age, these being generally regarded as the most critical of molluscan fossils as guides to stratigraphic correlation. And here, too, the evidence is clearly conclusive of Jurassic age. Though several of the genera are common to the Jurassic and Cretaceous systems, all of the known European analogues in species and subgeneric groups are Jurassic. The ammonitic genus of most frequent occurrence in the Malone is Perisphinctes, which is common to the two systems, but is almost exclusively Jurassic. Of the 366 known species of this genus[b] only four, described by Neumayr and Uhlig from the upper Neocomian of Saltzgitter,[c] are Cretaceous; and these belong to a group which the Perisphinctes species of the Malone formation do not at all approach. On the contrary, the species of Perisphinctes to which those of Malone show the closest affinities are those of the Tithonian.

It should be noted that while some of the molluscan fossils other than ammonites seem to indicate Kimmeridgian, or earlier than Tithonian age, this is more or less offset by the presence of the ordinarily Cretaceous genus Ptychomya.

LOCALITIES OF RELATED FAUNAS.

The only localities which present rocks known to correspond more or less closely with those of the Malone formation are in Mexico.

In the descriptive part of this paper it is noted that some of the fossils of the Malone formation are identical with some of those of the Alamitos beds, described by Castillo and Aguilera as occurring at the Sierra de Catorce in San Luis Potosi, and that others agree with species described by Doctor Felix from the Cerro de Titania in Oaxaca. The number of forms at present known to be common to the Malone and the Alamitos is so considerable that there can be little doubt that these two names represent approximately the same horizon. The ammonites of the Alamitos, like those of the Malone, are of Titonian affinities.

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[a] Doctor Stanton, however, places *Trigonia proscabra* in the Scabræ, and questions whether *T. calderoni* be not referable to that section also rather than to the Undulatæ.

[b] In the body of his recent Monograph of Perisphinctes, Siemiradzki treats 363 species of this genus. In its supplement, of a large number of additional alleged new species cited as described by De Rias and Tornquist in 1898, he identifies all but three with species previously known, so that the number of species recognized by Siemiradzki in the early part of 1899 was 366.

[c] Ueber Ammoniten aus den Hilsbildungen Norddeutschlands; Paleontographica, Bd. XXVII, 1881.

The number of fossils known from the Jurassic of the Cerro de Titania is small, but indicates, so far as it goes, a position high in the upper Jurassic series, as shown by Doctor Felix; and it is at least worthy of note that of the few lamellibranchs known from these rocks, *Exogyra subplicifera* and *Gryphæa mexicana* occur also at Malone, *Astarte microphyes* may be the same as *A. brexiacola*, and the large *Trigonia sologureni*, known only from the cast, may yet prove to be identical with the Malone species, *T. vyschetzkii*, when the details of its shell come to light.

Besides the Malone district, the Sierra de Catorce, and the Cerro de Titania, several other localities in Mexico have yielded fossils of the Malone formation. Thus a Perisphinctes, supposed to be related to the European *P. balderus*, is apparently common to the Theta and the Alamitos and is reported from Tutotepec also, in the State of Puebla, by Castillo and Aguilera; and by the same writers *Perisphinctes mazapilensis* and *Haploceras mazapilensis* are recorded from the Alamitos and from the Sierra de Zuloaga, in Zacatecas.

A number of Mexican Jurassic localities besides those here mentioned are given in Aguilera's "Sinopsis de Geología Mexicana;"[a] but these are little known, and at some of them the rocks belong, at least in part, to the lower Jurassic. It is, however, interesting to note that the Jurassic district of Malone is in the continuation of the belt along which are scattered all or nearly all of the Jurassic tracts shown on the geological map of Mexico of 1897 published with Nos. 4–6 of the Boletin del Instituto Geológico de Mexico.

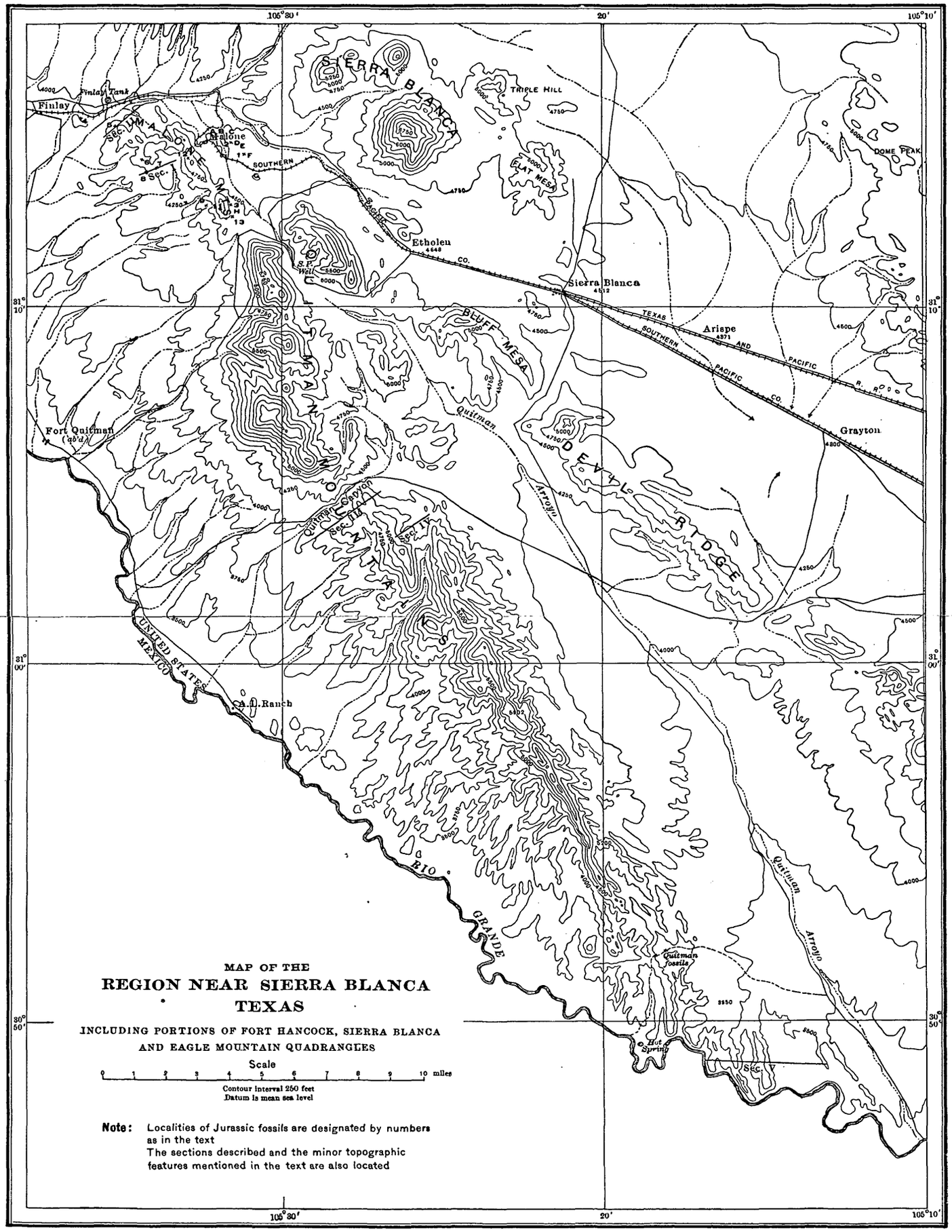
It is not improbable that rocks nearly related to the Malone occur in South America. As shown in the discussion of that species, *Trigonia vyschetzkii* is very close to the Andean form, *T. transitoria* Steinmann, a species whose precise geological position has hitherto been doubtful, but which the evidence from the Malone district tends to show probably belongs to the upper Jurassic.

ACKNOWLEDGMENTS.

I wish to acknowledge my indebtedness to all of those mentioned elsewhere herein as having contributed directly or indirectly to the success of this study. The kind services of the Messrs. Goodell were of especial value, as furnishing the first fairly conclusive indication of the Jurassic age of the Malone formation. To the Hon. Charles D. Walcott, Director of the United States Geological Survey, and to Mr. Charles Schuchert, Curator of Invertebrate Paleontology in the United States National Museum, I am indebted for important aid. I am under obligations also to Mr. John N. Gilcrease, Mr.

[a] In Bosquejo, Geología de Mexico: Boletin del Instituto Geologico de Mexico, Nos. 4–6, pp. 187–250.

Charles M. Wilson, and Mr. John W. Williams for favors rendered while I made headquarters at Sierra Blanca, and particularly to Mr. Williams, who showed much interest in the Malone investigation, assisted in collecting, and facilitated the field work in every possible way, contributing in no small measure to its success. I deem it but simple justice to Doctor Stanton, and at the same time a pleasure, to state that I owe very much indeed to his full and generous cooperation in promoting every desired use of the collections under his charge, and in holding at my service a splendid knowledge of Mesozoic conchology and its literature and methods. And, finally, it is also due to Prof. William Bullock Clark, head of the geological department of Johns Hopkins University, to add that without his efficient planning of it as a whole, this contribution to American Jurassic paleontology could have been undertaken at this time, if at all, only under far greater limitations, both as to scope and as to facilities for research.



MAP OF THE

REGION NEAR SIERRA BLANCA TEXAS

INCLUDING PORTIONS OF FORT HANCOCK, SIERRA BLANCA AND EAGLE MOUNTAIN QUADRANGLES

Scale

0 1 2 3 4 5 6 7 8 9 10 miles

Contour interval 250 feet
Datum is mean sea level

Note: Localities of Jurassic fossils are designated by numbers as in the text
The sections described and the minor topographic features mentioned in the text are also located

STRATIGRAPHIC NOTES ON MALONE MOUNTAIN AND THE SURROUNDING REGION NEAR SIERRA BLANCA, TEX.

By T. W. STANTON.

GENERAL REMARKS.

It has been deemed advisable to supplement Professor Cragin's paleontological paper by a brief account of the general geology of the region in which his Jurassic fauna occurs. The data here presented were obtained in 1897 and 1898 during two reconnaissance trips undertaken for the purpose of unraveling the obscure Cretaceous section of the Sierra Blanca region and, if possible, of determining the stratigraphic relations of the Malone Jurassic with the Cretaceous, as well as of making collections from all of the fossiliferous horizons of the region. The stratigraphy of the Cretaceous was determined fairly well, several fossiliferous horizons in the Jurassic of Malone Mountain were established, and interesting collections of fossils were obtained from both the Cretaceous and the Jurassic, but the rocks of the two systems were not found associated in the same continuous section, and their stratigraphic relations were not definitely determined.

In 1897 two weeks were spent at Sierra Blanca station examining the outcrops within a few miles of that station and one excursion was made 25 miles southward, to the Rio Grande. In 1898 a month was spent in the region working with a wagon and camp outfit, but even then many points could not be conveniently reached nor thoroughly studied because, on account of the scarcity of water and of roads, camping places were limited in number. The area examined comprises parts of the Fort Hancock, Sierra Blanca, and Eagle Mountain quadrangles, as mapped by the United States Geological Survey, extending from the Finlay Mountains on the north to the Rio Grande on the south and from the western foothills of Malone and Quitman mountains to Devils Ridge and Eagle Mountain on the east.

The region as a whole is characterized by rugged hills, ridges, and mountain masses rising abruptly from broad valley plains which are filled to an unknown depth with coarse Tertiary (?) deposits that obscure the structure of the older rocks beneath them. The general strike of the uplifted strata is northwest and almost all the smaller hills and ridges are monoclinal, with beds generally dipping southwest. In describing the Cretaceous deposits of this region in 1891, Mr. J. A. Taff[a] thought that the beds exposed north of the Sierra Blanca station are the oldest and that successively newer beds are found to the southwest except that there is some repetition by faulting. This opinion was based on the general posture and geographic relations of the beds and on the lithologic similarity of certain conglomerates and limestones in the Jurassic and the Cretaceous. The characteristics of the faunas involved were then practically unknown. It will be shown, however, that the real succession of strata is very different from that given in Mr. Taff's published section, the oldest Mesozoic rocks being found in Malone Mountain. Mr. Taff briefly discussed the folding and faulting that is common throughout the region and that is doubtless often present under the débris of the valleys as well as in the mountain masses. It would require much more time and study than has yet been given to this area to work out all its details of structure, which is further complicated by many intrusive masses of igneous rock in all the larger uplifts except Malone Mountain.

MALONE MOUNTAIN AND THE JURASSIC.

The strata bearing the Jurassic fauna described by Professor Cragin have been found only in Malone Mountain and the adjacent valleys. The Malone Mountain uplift extends from the Southern Pacific Railway near Finlay station about 5 miles in a southeasterly direction and ends abruptly a few hundred yards from the northwesterly extremity of the Quitman Mountains. Malone station, which is 13 miles by rail from Sierra Blanca station, is at its eastern base a little north of the middle. From this direction the mountain looks like a simple unbroken ridge, but on the southwest side it is deeply dissected by both transverse and longitudinal valleys.

The general structure seems to consist of a syncline along or east of the crest of the principal ridge, with an anticline in the valley and subordinate ridges of the west slope. There are also several minor folds, often beautifully shown, and doubtless some faulting. Toward the southern end of the mountain a small anticline is developed on the eastern slope. Mr. Taff has published a figure of the Malone Mountain section[b] showing these general structural features. He has

[a] Second Ann. Rept. Geol. Survey Texas, pp. 714–738. [b] Idem, Pl. XXVII.

also described[a] the succession of strata in the middle section of the mountain, which agree in the main with my observations, though both structure and exposures vary greatly in different parts of the uplift.

The most complete section that I observed, in which the thicknesses were estimated with some care, extends across the mountain from a point on the east side about one-half mile south of Malone station. The eastern face of the mountain shows an apparent thickness of about 1,200 feet of blue and gray limestones, with a few intercalated beds and bands of conglomerate and sandstone, the beds all dipping strongly westward with increasing dips until they become vertical on the crest. On the west slope there is a succession of limestones, conglomerates, and gypsum beds, nearly vertical and not well exposed, and farther down these are apparently repeated with a westerly dip, overlain by conglomerates, limestones, etc., fairly well exposed and not much disturbed in the lower ridges to the west. The gypsum beds and the limestones immediately associated with them appear to be the oldest rocks exposed. The following section begins with what was supposed to be the lowest gypsum bed, but on account of complex structure and obscure exposures the succession and thickness of the first five members are somewhat uncertain.

Section of Jurassic beds on west side of Malone Mountain, near Malone station (Section I of map).

	Feet.
1. Gypsum, not well exposed, about	100
2. Calcareous conglomerate, almost vertical	45
3. Mostly covered; limestone below, gypsum above (dip variable, westward), about	200
4. Altered and fissured limestone	125
5. Gypsum, not well exposed	100
6. Siliceo-calcareous shale	40
7. Limestone	20
8. Covered (shale?)	100
9. Blue limestone, with traces of fossils	2
10. Covered	15
11. Arenaceous limestone	1
12. Covered	10
13. Blue limestone, with the Malone fauna	2
14. Covered	10
15. Limestone	1
16. Covered	8
17. Thin-bedded limestone and shales	20
18. Calcareous conglomerate	15
19. Limestone with Pleuromya and Gryphæa	15
20. Covered	10
21. Calcareous conglomerate	15

[a] Idem, pp. 722–723.

	Feet.
22. Limestone with fragmentary fossils (Ammonites, etc.)	10
23. Calcareous conglomerate	15
24. Covered	100
25. Limestone with Gryphæa, Pinna, Trigonia, etc	15
26. Covered in talus slope	150
27. Thin-bedded brown sandstone with bands of conglomerate and containing a small Ostrea, Nerinea, and a few other fossils, poorly preserved	25
28. Massive, gray, calcareous sandstone	10
29. Gray limestone forming a prominent ridge	±250
30. Brown conglomerate, composed mostly of quartzite and chert pebbles	40
31. Blue limestone	100

This is uncomformably overlain by the unconsolidated Tertiary or Pleistocene conglomerates of the plains on the west.

The main ridge of Malone Mountain on the line of this section seems to be made up of Nos. 29, 30, and 31, with perhaps some higher beds, all repeated by the synclinal fold.

Nos. 13 and 25 each yielded fossils, some of which are specifically identical with forms occurring at Professor Cragin's principal locality for the Malone Jurassic fauna, and the fossils mentioned in other bands (Nos. 9, 19, 22, and 27) evidently belong to the same fauna.

Some bands in the limestone No. 29 yielded a few fossils that seem to be fresh-water forms—small, simple gasteropods, resembling Viviparus. Similar forms were seen in No. 31 also.

Near the south end of Malone Mountain the same horizon in No. 29 yielded some small bivalves with the external features of Unio associated with the gasteropods. Conglomerate No. 30 of the section, however, contains marine fossils, including Ammonites, Exogyra, and several other genera. These were not found on the line of the section above described, but the conglomerate is a prominent, easily recognized horizon exposed at many points along the entire length of the mountain, and the fossils, usually in the form of imprints and fragments, were seen at several places both north and south of the section, especially toward the southern end of the mountain. In the western foothills of the mountain, 1 to 2 miles north of the southern end, there are exposures of a conglomerate believed to be the same as No. 30, and in the uppermost bands of the limestone immediately beneath it collections were obtained containing Exogyra, Pinna, Pecten, Pleuromya, Perisphinctes, etc., which Professor Cragin has assigned to the Malone fauna (see p. 19).

At the end of the northwest spur of Malone Mountain, at the point where it approaches the railroad, there are large exposures of gypsum that almost certainly belong to the gypsiferous horizons in the section just described, though they are separated from them by struc-

tural breaks.[a] In the following section the estimated thicknesses of the gypsum and the beds overlying are not closely accurate, because the exposures are very incomplete and the dips are variable and not easily determined.

Section near northwest end of Malone Mountain about 2 miles southeast of Finlay station (Section II of map).

	Feet.
1. Gypsum	100 or more.
2. Mostly covered about	200
3. Limestones with conglomerate layers alternating with softer shaly bands. Several fossiliferous horizons with Malone fauna (see lists, p. 18)	75
4. Limestones passing into calcareous conglomerate	15
5. Limestone with a few Malone fossils	15
6. Calcareous conglomerate	6
7. Covered (shales and limestone)	20
8. Calcareous conglomerate	10
9. Blue limestone dipping 20° SW., with echinoids and large Nerinea seen in section on weathered surface	6
10. Blue limestone and shale passing under the plain	200

There can be little doubt that the fossiliferous beds in this section are on very nearly the same horizons as those in the section west of Malone station.

The most prolific locality for Malone Jurassic fossils, and the only one not directly connected with the mountain itself, is in the low hills in the valley about 1½ miles east of Malone station. The exposures are comparatively small and the dips variable, so that the stratigraphic details either as to thickness or succession can not be determined with certainty. Professor Cragin gives his observations on this locality fully in another place (pp. 13–17).

It is not possible to make a definite correlation of the fossiliferous beds here with any single horizon in the Malone Mountain sections, but it is most probable that they belong not more than 300 feet above the main gypsum beds.

At this point the Malone Jurassic beds are closer to fossiliferous Cretaceous beds of determined horizon than at any other place observed in the region. About 3 miles to the east, near the southwest base of Sierra Blanca, there are exposures of Washita beds with *Nodosaria texana* and *Gryphæa mueronata* (?), and the same horizon occurs a little farther away along the railroad between Etholen Hills and Quitman Mountains.

Mr. Taff correlated portions of the Malone Mountain section with exposures in the conical hills near Etholen about 5 miles west of

[a] Mr. Taff assigned these gypsum exposures, as well as those at the southeast end of the mountain, to a higher horizon (see pp. 725 and 736 of his report), but they all have the same relations to the fossiliferous horizon bearing the Malone fauna.

Sierra Blanca station, and in Bluff and Yucca mesas near the same station, but I was unable to confirm these correlations. The strata in the "Etholen Knobs" may possibly belong here, but the other localities almost certainly show only Cretaceous beds.

THE CRETACEOUS.

Cretaceous rocks have a great development in this region and represent the three main divisions of the Comanche series—the Trinity, Fredericksburg, and Washita—as well as a part of the Upper Cretaceous. Lithologically the section differs greatly from that of Central Texas, where the Comanche series has been most studied, and there are also considerable differences in the vertical range of some of the common species, so that it is impracticable to recognize many of the minor formations and horizons that have been studied. The general faunal succession is the same in both regions, and it is usually not difficult to classify the beds by means of the fossils as Trinity, Fredericksburg, or Washita, though it was difficult and sometimes impossible to assign each exposure to its exact position in the general section, because many of them are relatively small and isolated, and the structure is complicated by folds, faults, and igneous intrusions. The most complete sections are to be found in the Quitman Mountains, especially toward the southern end and in the lower hills farther south on the Rio Grande, in the southern extension of the same line of uplift.

Quitman Mountains.—This range begins at a point on the railroad 8 miles west of Sierra Blanca station and extends in a southeasterly direction about 25 miles, the uplifted beds continuing as low ridges in the same direction and crossing the Rio Grande 6 or 7 miles beyond the end of the main range. At its northern end it is composed mainly of igneous rocks—granites and porphyries—with Cretaceous beds in the adjacent foothills on the north and east, but south of Quitman Canyon, a drainage channel that cuts straight across the range about 10 miles south of its northern end, the mountain mass is composed of Cretaceous sediments, with only occasional igneous intrusions. The axis of the range is for a number of miles almost parallel with the Rio Grande, which flows about 6 miles to the southwest, while on the other side is the flat valley of Quitman Arroyo, 4 to 10 miles wide, separating the Quitman Mountains from Devils Ridge and Eagle Mountains. Sections taken at different points across this range vary greatly in extent. The one published by Taff in the report cited was taken near Quitman Canyon (Section III of map), and shows the strata with variable steep dips mostly to the west, but sometimes reversed. Near the eastern end of the section is a heavy bed of limestone, forming part of Taff's "Bluff bed," filled with *Orbitolina texana* and a

few other forms, followed by a band of hard limestone containing numerous specimens of Requienia. Then comes the "Quitman bed," composed of sandstones, clays, and thin beds of limestone, with a thickness of 330 feet, succeeded on the west by a great series of sandstones and siliceous limestones, the "Mountain bed," with an apparent thickness of about 4,000 feet. The western end of the section was thought to be the top, and the entire section was referred to the Washita division of the Comanche series. My studies of more complete sections farther south in the same range, especially the one near the Rio Grande, led to the conclusion that the beds at Quitman Canyon and for a long distance southward are mostly overturned, and that the oldest rocks are on the west side of the mountains.

The Mountain bed, consisting mostly of coarse, varicolored sandstones, forms the western portion of the mountain all the way to the Rio Grande at Hot Springs, where it dips to the east instead of to the west. Its apparent great thickness may be due in part to folding and faulting. It has yielded only imperfectly preserved Ostrea and a few other forms that are insufficient for its correlation with established formations.

The Quitman bed has a similar distribution along the higher (western) slope of Quitman Mountain. Its fauna shows a different facies from any assemblage in the Central Texan section, including *Exogyra quitmanensis*, *Trigonia taffii*, *Trigonia stolleyi* (?), *Remondia*, and a considerable number of forms that will be described in a monograph of the Comanche fauna. Although some of the species show relationship with later faunas the stratigraphic and paleontologic evidence as a whole is thought to justify its assignment to the Trinity division. The best localities found for collecting this fauna are on Quitman Mountain about 1 mile south of Quitman Canyon, and on the trail from Quitman Arroyo to Hot Springs, about 3¼ miles from the springs.

The Orbitolina limestone for many miles forms the crest of the Quitman Mountains, with a bold escarpment on the east and a steep slope corresponding with the dip on the west. Its characteristic foraminifera, *Orbitolina texana* (Roemer), occurs only in the Glen Rose beds of the Trinity division in Central Texas. Another species of the same horizon that occurs with it in the Quitman Mountains is the large *Natica prægrandis* Roemer, which is usually treated as a synonym of *N. pedernalis*. The Orbitolina limestone has here a thickness of at least 250 feet, and farther south on the Rio Grande it appears to be still thicker, and the Orbitolina again appears in a thinner limestone about 300 feet higher.

On the eastern slope of the mountain 1 to 2 miles south of Quitman Canyon there are exposures of several hundred feet of limestones, clays, and sandstones dipping toward the mountain and apparently

underlying the Orbitolina limestone (Section IV of map). The succession from the Orbitolina limestone eastward down the mountain is as follows:

	Feet.
1. Alternating thin beds of sandstone and clay, with occasional bands of limestone; *Exogyra texana* near the middle	200
2. Alternations of limestone and covered spaces	200
3. Sandstone	8
4. Covered	15
5. Sandstone with *Actæonella dolium*	15
6. Argillaceous limestones, clays, and some arenaceous bands, with occasional layers containing *Exogyra texana*	300
7. Limestone in several massive beds interstratified with more or less argillaceous nodular beds; some of the harder bands full of *Caprina occidentalis* Conrad	75

Farther east some of these beds are repeated, dipping eastward. It is evident that these beds are in part the equivalent of those described by Taff as occurring in Flat Mesa, 4 miles north of Sierra Blanca, and that they should be included in the Fredericksburg division.

About 10 miles south of Quitman Canyon and less than 2 miles south of the northern boundary of the Eagle Mountain quadrangle the east face of the mountain shows a similar section, and at its base there are small exposures of Washita beds with *Schlœnbachia vespertina* and a few other forms, dipping toward the mountain and thus giving additional evidence of overturning and faulting.

The Rio Grande section.—Still farther south, near the Rio Grande, the upper part of the section is much more complete and more simple, furnishing the key to the sections already discussed, which are parallel with it across the same line of uplift. The eastern end of the section is about 1 mile north of the Rio Grande in the first hills west of the board valley of Quitman Arroyo. Here the beds are sharply folded and a prominent ridge shows an anticline consisting of argillaceous limestone belonging to the Washita division.

The western limb of the anticline dips 70° to 80° west, and the exposure is as follows:

Section in hills just west of Quitman Arroyo, about 1 mile north of the Rio Grande (Section V of map).

	Feet.
1. Argillaceous limestone, weathering in nodular form, with bands of harder limestone	200
2. More massive limestone, much seamed and fissured	30
3. Dark, fissile shale, with occasional bands of impure brown limestone, underlying a valley about 1 mile wide. Dips at first steep to the west, becoming variable and much less toward the middle of the valley and again steep to the west on the west side of the valley. *Inoceramus labiatus* and a few other Upper Cretaceous fossils were found west of the middle of the valley; thickness apparently several thousand feet.	

	Feet.
4. Massive limestone, probably same as No. 2	30
5. Argillaceous limestone with some bands of clay and sandstone; fossils: *Nodosaria texana, Enallaster texanus, Neithea texana, Exogyra arietina, E. drakei* var., *Plicatula incongrua*, and other Washita forms	300
6. Heavy-bedded limestone (40 feet) forming a cliff, followed by argillaceous nodular limestone (30 feet), which yielded *Enallaster texanus, Gryphæa corrugata, Lima wacoensis, Neithea texana*, and *Schlœnbachia vespertina*	70
7. Similar limestones with dip not less than 45° westward	300
8. More argillaceous light-gray limestone, interstratified with dark clay shales; one of the limestone bands yielded *Epiaster whitei, Terebratula* (*Kingena*) *wacoensis, Gryphæa washitaensis* (?), *Plicatula incongrua*, and *Schlœnbachia vespertina*, and another band farther west yielded *Epiaster whitei, Schlœnbachia acutocarinata, S. serratescens*, and *Hamites fremonti*	300
9. Dark clays with brownish calcareous bands; *Exogyra texana* abundant	50
10. Covered	100
11. Limestone, very heavy-bedded above, with increasing bands of argillaceous limestone below; Requienia and a small conical Foraminifera abundant; *Exogyra texana* also occurs	300
12. Shales, limestones, and bands of brown sandstone, not well exposed	250
13. Argillaceous limestone, with some harder bands containing "Caprina" and Requenia	75
14. Generally more massive limestone with some bands of brown sandstone. Also contains "Caprina," Ostrea, etc	350
15. Quartzitic sandstone with thinner bands of clay shale and impure limestone, dipping steeply westward	400
16. Hard, blue limestone, full of *Orbitolina texana*	60
17. Sandstone and impure limestone with some clay	40
18. Sandstones and clays	250
19. Thin-bedded passing into massive limestone, full of *Orbitolina texana*; at least	300

The steep western surface of No. 19 forms the eastern wall of the canyon of the Rio Grande at this point.

So far there has been no apparent serious break in the section, but the beds now become complexly faulted and folded. A short distance north No. 19 is cut off by a fault, and on the west, across the river, the same bed seems to be repeated in several postures.

It is evident that the eastern portion of the section crosses a syncline, so that in passing from No. 1 to No. 5 the same beds are all crossed twice. In the rest of the section, while there may be some repetition of beds due to small faults, there are no anticlines nor synclines, and the fossils show that in general the beds are successively older toward the west. No. 3 is Upper Cretaceous, of the age of the Fort Benton; Nos. 4 to 8 are Washita; Nos. 9 to 14, and probably 15, are Fredericksburg; and Nos. 16 to 19 belong to the Trinity. As the dips are all steep to the west it follows that all the

beds from No. 4 to No. 19, inclusive, are overturned. It will be seen also that the succession of rocks and fossils is similar to that found on the east slope of the mountains near Quitman Canyon, and that there is no place for the great sandstone series of the "Mountain bed" within the Washita division. It must be older than the Orbitolina limestone.

Eagle Mountains.—These mountains, which lie 10 miles east of the southern end of Quitman Mountain, are composed mostly of igneous rocks, but sediments are exposed on their flanks. My examinations were along only the western base, where there are some exposures of Fredericksburg limestone and shales and apparently some Trinity limestones. Mr. Taff reports Upper Cretaceous and the Orbitolina limestone on the other side of the mountains, and fossils in the collection of Prof. W. F. Cummins, at Dallas, indicate the presence of upper Washita beds "1 mile north of gap in Eagle Mountains."

Sierra Blanca.—This group of conical peaks, about 6 miles northwest of the railroad station of the same name, is also composed of igneous rocks with Cretaceous sediments around the base. On the southwest side of the main peak there are fossiliferous exposures of Fredericksburg age noteworthy for containing *Exogyra texana* and *Nodosaria texana* in the same bed. The same association is found in the Finlay Mountains also. Beds of about the same age with *E. texana* and *Actæonella dolium* occur in Flat Mesa, about 4 miles east.

In the saddle between the main peak and the north peak of Sierra Blanca there are considerable exposures of very fossiliferous Washita beds with many characteristic species.

Finlay Mountains.—These hills begin about 4 miles north of the north end of Malone Mountain and 6 miles northwest of the main peak of Sierra Blanca and extend several miles to the north and northwest. They were rather hastily examined in the hope of finding an extension of the Malone beds, but the only fossiliferous beds seen belong to the Fredericksburg division of the Cretaceous, including the horizon of *Actæonella dolium.* There are many intrusive masses of igneous rocks and at one locality a considerable development of a coarse calcareous conglomerate whose relations were not definitely determined, though it seemed to belong to the Cretaceous.

Other localities.—Other exposures in the neighborhood of Sierra Blanca station were examined, especially Bluff Mesa and Devils Ridge, without very definite paleontological results. The top of Bluff Mesa, 3 miles southwest of Sierra Blanca, is composed of Orbitolina limestone, and it is probable that the underlying beds belong within the Trinity division.

The Orbitolina limestone, the Quitman bed, and a considerable thickness of Fredericksburg beds are well exposed in the neighbor-

hood of the abandoned "A L Ranch" on the Rio Grande west of Quitman Mountains, in the small triangular area bounded by the river and the Eagle Mountain and Fort Hancock quadrangles. The Fredericksburg beds are especially well exposed about 2 miles down the river from the ranch, in the small canyon locally known as the "Cajoncito." The next prominent ridge, 3 or 4 miles to the east, shows Washita shales and limestones, with intervening dark shales that may belong to the Upper Cretaceous.

These details of the stratigraphy and distribution of the Cretaceous in this region are given for the purpose of emphasizing the peculiarities and the isolation of the Malone beds.

DESCRIPTIONS OF THE SPECIES.

CŒLENTERATA.

ANTHOZOA.

Several coralla of the massive shape and a segment of a digitiform branch, which in my preliminary manuscript on the Malone fauna I had described as two species of Astrocœnia, were eventually submitted to Mr. T. Wayland Vaughan, who is engaged in a special study of the Neozoic corals, for more detailed study than I could give them. Of these, Mr. Vaughan has very kindly furnished the following description:

Genus ASTROCŒNIA M. Edwards and Haime.

ASTROCŒNIA MALONIANA sp. n.

Pl. II, figs. 1–3.

"Professor Cragin has submitted to me for study and description 9 specimens of an Astrocœnia collected by him 1½ miles east of Malone, Tex. The original substance of the skeleton has been transformed in the process of fossilization into a bluish limestone; the skeletal elements are now represented by crystalline calcite and the interspaces are filled by the same mineral. The result of these chemical changes is to make a study of the thin sections of the specimens very unsatisfactory. No minute structural features could be deciphered, and very often even the grosser ones of the individual corallites are obliterated or can be discovered only with difficulty.

"Apparently only one species is represented in the collection, but there is a central or type form around which the other specimens can be grouped. The type form will be described first.

"The corallum is a gibbous mass, with a flat base having a rather large surface; the upper surface is rather uniformly rounded or thrown into numerous mammillæ. The intergradation between these two types of upper surface can be seen in the specimens before me. When the mammillate character has reached its maximum development the external appearance of the corallum is identical with that of the common recent West Indian *Porites astreoides* Lamarck. The dimensions of two large specimens, both of which possess the mammillate upper surface, are:

	mm.	mm.
Greatest breadth	113	96
Least breadth	95	82
Height	52	56

"The above represents the type form of the corrallum. There is one specimen, with a mammillate surface, which shows no place for attachment, and other specimens show a tendency to form low columns.

"The corallites are polygonal, usually hexagonal, are crowded together, and are joined by their directly fused walls. The wall between adjoining corallites is usually thin, but in some instances it may be rather thick, in extreme cases almost 1 mm. When the wall is thin, its upper edge is acute; when it is thick, it is flattened between adjoining calices. The depth of the calicular cavity is so variable that it possesses no value in the specific diagnosis; it is sometimes deep and sometimes very shallow in the same colony. The diameter of the calices vary in the same colony from 1.5 to 2.5 mm. The minimum diameter for a calice is 1 mm. and the maximum is about 3 mm., or a very little less. The number of septa is 16 or 20. There are either 8 or 10 principal septa, with smaller ones between. At their margins the septa are usually rather thin, but deeper down in the corallite are secondarily thickened. The septa are thicker peripherally at the wall and are also thickened around the columella. The septa of adjoining corallites meet end to end or alternate with each other. In transverse sections of corallites dissepiments are very rarely present. No further information can be given concerning the endotheca. The columella is small, low, weak, and styliform. Below the bottom of the calice it is strengthened by having the thickened inner terminations of the principal septa fuse around it. Gemmation takes place in the angle between adjoining corallites.

"There is another specimen not included in the above. It is an Astrocœnia, apparently growing in digitate branches. There is not enough material to warrant naming and describing it."

ECHINODERMATA.

ECHINOIDEA.

HOLECTYPOIDA.

Genus HOLECTYPUS Desor.

HOLECTYPUS? sp.

An echinoid fragment indicating a test shaped as in this genus, but with the details too poorly preserved to allow a satisfactory description or an absolute generic identification, was obtained by Doctor Stanton from an anticline on the east slope of Malone Mountain, about 1 mile north of the southern end.

SPATANGOIDA.

Genus PYGURUS Agassiz.

PYGURUS sp.

Among the specimens submitted by Doctor Stanton is a fragment of the test of a sea-urchin of the genus Pygurus. It includes the main part of the aboral half of an ambulacrum. The genus is clearly determined by the form of the ambulacrum and the form and arrangement of the pores, as well as by the character of the tubercles and by the discoidal form of the test, the latter form being indicated by the flatness of the part preserved. The ambulacrum has the biconcave outline that characterizes the upper part of that of Pygurus. The pores of the outer row are very long and slit-like, widened slightly toward the outer end, and subhorizontal to more or less oblique; those of the inner row more ringent, compressed dot-like or hyphen-like, and oblique, their width being considerably less and their length considerably more than that of any of the circumtubercular courts on the neighboring part of the ambulacrum. The ambulacral plates are exceedingly narrow; the imperforate part of each, in the widest part of the ambulacrum, being about ten times as long (transverse) as wide (parallel to the course of the ambulacrum) and ornamented with 1 to 3 small perforated tubercles, each of which is set in a round, depressed court. The distribution of these tubercles is irregular, but they are so few and so feebly developed on the inner ends of the plates as to give the ambulacrum the aspect of having a median plain zone, to which the seams between the plates give a transversely striated appearance.

Measurements.—Maximum width of ambulacrum 16, of which the two pore belts each occupy 3.5 and the imperforate tract 9 mm.; length and width of imperforate part of an ambulacral plate in broadest part of ambulacrum, respectively, 4.5 and 0.43 mm.; length of outer slit-like pores in broadest part of ambulacrum 2 mm., which is about one-fourth of the width of a semiambulacrum.

Occurrence.—West side of Malone Mountain, about 2 miles southwest of Malone station, in No. 25 of Doctor Stanton's Malone Mountain section; with *Gryphæa mexicana*, *Pleuromya inconstans*, *Pinna quadrifrons*, etc.

VERMES.

ANNELIDA.

TUBICOLA.

Genus SERPULA Linnæus.

SERPULA GORDIALIS Schlotheim.

Pl. II, figs. 5–6.

A round-tubed, nearly smooth, irregularly constricted, at first spirally coiled, then contorted Serpula, probably the same as that noted by Doctor Felix[a] from the upper Jurassic rocks of the Cerro de Titania in the State of Oaxaca, Mexico, and referred by him to Schlotheim's *S. gordialis*, is the commonest tubicolan of the Malone fauna, having been found at the anticline in the eastern base of Malone Mountain (in both Doctor Stanton's collections and mine), and at the locality 1½ miles east of Malone station. The largest tubes observed measure about 2.7 mm. in diameter, 1 to 2 mm. being a more common size.

SERPULA sp.

Pl. II, fig. 4.

Not rare at the locality last mentioned is a large Serpula, apparently differing from *S. gordialis* chiefly in size, but perhaps also having a less constantly or less intricately contorted habit. As there found, it attains a diameter of at least 8 mm.

SERPULA sp.

A single specimen of a third and well-marked species of Serpula was obtained from the same locality, but was lost in the laboratory when it had received only preliminary study. The following are its characters so far as they were noted:

Tube considerably smaller than an average one of *Serpula gordialis*, straight, round, and at least in part terete, its exterior ornamented with close, uniform or nearly uniform, prominent, filiform, encircling costellæ, so that its appearance recalls one of the smaller of the wound wires in the lower register of a piano; an ornamentation which contrasts strikingly with the plain to feebly and irregularly constricted exterior of the two other known Serpulæ of this district.

[a] Beiträge Geol. u. Pal. Mex., pt. 3, p. 175.

MOLLUSCOIDEA.

BRYOZOA.

DIASTOPORIDÆ.

Genus BERENICEA Lamouroux.

BERENICEA MALONIANA sp. n.

Pl. II, fig. 7.

Colonies incrusting, sometimes confluently associated, unsymmetrically flabelliform, apparently without a tattered or incised border; cells numerous, several hundred in a colony, tubular, arising as if separately in quincunx-radial order from the smooth or finely porous membrane-like stock which separates them by intervals for the most part about equal to themselves, the lower part of each cell being embedded and subhorizontal, the outer part rising obliquely and becoming gradually free or nearly so, being wholly free at the very extremity only; free surface of cells plain or at most only finely striate; oral extremity contracted, the aperture small and round.

Measurements.—Breadth of colony, 12 mm.; of cell, 0.2 mm.; of oral aperture, about 0.1 mm.; greatest exposed length of cells between twice and thrice their breadth.

Occurrence.—The type specimen covers between a fourth and a third of one of the larger whorls of a *Nerinea goodellii* and parts of the two whorls preceding and following, and is met by another similarly radiating colony of which only a border portion is preserved, the line of contact of the two colonies being heaved up into a ridge. It is from the locality 1½ miles east of Malone station.

In the partially embedded cells and in the resulting apparent separation of the tubes from each other this species resembles *Berenicea microstoma* Mich., as illustrated in fig. 6b of Pl. I of Reuss's "Bryozoen, Anthozoen und Spongiarien des Braunen Jura von Balin bei Krakau,"[a] but it lacks the undulatory transverse furrows of that species and has the tubes less strongly inflated and proportioned much as in the *B. tenera* Reuss. The last-named species is, however, very different in having the tubular cells visibly in contact instead of separated by a conspicuous basal stratum that conceals their deeper and contiguous parts.

[a] Denkschr. k. Akad. Wiss., Math.-Nat. Classe, vol. 27. Wien, 1867.

MOLLUSCA.

PELECYPODA.

OSTREIDÆ.

Genus OSTREA Linnæus.

OSTREA sp.

Three imperfect valves of an ovate, thin-shelled ostreid, about 1½ inches in greatest dimension, lie partly embedded on a piece of blue limestone obtained from the Theta, 1½ miles east of Malone station, and may represent Ostrea as distinguished from Exogyra and Gryphæa. They are, however, incomplete in the region of the beaks and their precise relationship therefore remains somewhat uncertain. The inflation is moderate and due almost wholly to the strongly incurved border, the remainder of the valve being rather flat.

Since in general aspect they recall species of Ostrea in the stricter, and certainly at least represent it in the broader generic sense, while they do not seem referable to any of the hitherto described Ostreidæ of the Malone Jurassic, they are here provisionally listed as above.

GRYPHÆA MEXICANA Felix.

Pl. III, figs. 1–6.

Gryphæa mexicana Felix, 1891, Beitr. Geol. u. Pal. Mex., pt. 3, p. 178, pl. 27, figs. 30, 30a.

Shell rather small, more or less inequilateral and cuneate; adductor scar elongate, lightly impressed; margins of the valves not crenulated internally, the right valve very much smaller than the left, rounded-triangular, usually flat or exteriorly in part concave, thickened in the dorsal part; left valve triangular to crescentic-triangular, deeply excavated, strongly arched on the dorsal region, the posterior part more prominently so than the anterior, its beak high-arched, strongly incurved and rather bluntly (seldom freely) hooked, usually swinging a little backward, its posterior side strongly flattened or concave, the passage thence to the outer side more or less angulated or sometimes elevated as an obtuse fold, a similar but smaller flattening or concavity being often present on the shorter, anterior side, exterior side usually convex—sometimes flattish or concave—antero-posteriorly and either without bordering sulci or provided with an anterior or posterior sulcus or with both; the growth-lines sometimes acute and imbricated, especially on the anterior and posterior slopes, but on the exterior slope often more commonly thickened at irregular intervals into obtuse wave-like elevations and often here also swung upwards into a broad sinus. In specimens of smaller and

medium sizes at least, the left valve is often ornamented with fine, radiating raised lines, including more conspicuous ones, which are rather remote, and numerous closely arranged, almost microscopically fine ones, there being usually 2 to 7 of the latter in each of the intervals between the former. This ornamentation is usually well expressed in very young examples, and these present considerable resemblance in form as well as sculpture to certain species of Plicatula, but in the arched valve, held beak upward and seen in exterior view, the longer side will appear on the right in the young Gryphæa and on the left in Plicatula, since the arched valve is the left in Gryphæa and the right in Plicatula and the posterior side of the shell is longer than the anterior in both genera. A very similar ornamentation is seen on the arched valve of Meek and Hayden's Black Hills Jurassic form, *Gryphæa calceola* var. *nebrascensis*. In exceptional specimens, *G. mexicana* approaches the latter species in form also, tending to a uniform antero-posterior convexity, even the posterior flattening being slight. Much more common than this, however, is the occurrence of specimens with anterior and posterior sides both strongly flattened or concave.

Measurements.—Specimens of an ordinary size give height, 43 mm.; length, 32 mm.; breadth, 17 mm.; but considerably larger specimens are often found.

Occurrence.—Common at several levels below the Iota conglomerates, a mile and a half east of Malone station, where scores were collected, and less so a few feet above similar conglomerates in an anticline in the east flank of Malone Mountain; in the latter locality associated with *Pleuromya inconstans*, *Modiola maloniana*, *Astarte malonensis*, *Exogyra subplicifera?* and *Serpula gordialis*. The species was also collected by Doctor Stanton, both at these and at the following localities: About a mile east of Finlay station; west side of Malone Mountain, west and also south of west from Malone station (at the last-named locality in Nos. 13 and 25 of his Malone Mountain section); from foothills west of Malone Mountain, about 2 miles north of its southern end; at the west base of the mountain, near its southern end; and from the east slope of the mountain, near its southern end, 200 or 300 (?) feet above the gypsum.

One of the most striking features of *G. mexicana* is the posterior flattening of the left valve, a feature of which is much more strongly expressed in this shell than in any other species of Gryphæa with which I am acquainted.

The prevailing size of the shell is not the same at all localities, some specimens of the largest average size coming from the west side of Malone Mountain; but at no locality in the Malone district does the shell average so small as the Oaxaca examples figured by Doctor Felix.

Genus EXOGYRA Say.

EXOGYRA SUBPLICIFERA Felix.

Pl. IV, figs. 1–4.

Exogyra subplicifera Felix, 1891, Beitr. Geol. u. Pal. Mex., Pt. III, p. 177, pl. 27, figs. 6, 7.

From locality 1½ miles east of Malone station, and associated with most of the commoner fossils described in this paper, were collected 19 specimens, besides 8 obtained by Doctor Stanton. Two somewhat doubtful casts were also found, with *Gryphæa mexicana*, *Astarte malonensis*, etc., just above the beds of conglomerate, at the eastern base of Malone Mountain, in the anticline about 1 mile north of the southern end of the mountain.

The shells occur both free, or nearly so, and attached by nearly the whole of the left valve. The largest example from the Malone Hills has a length of 35 mm., but some of the smaller ones agree nearly in size with the Mexican specimens described and figured by Doctor Felix from the Cerro de Titania. The right valve has the beak strongly recurved laterally, and sometimes has the anterior dorsal border drawn across the umbonal cavity so as to form more or less of a cul de sac, and in the more nearly free examples is rather thin, deeply excavated, and ornamented with numerous imbrications which present distally an obtuse angle on the summit of convexity, and in some of the young examples may have 1 to 4 faintly expressed radial folds on the basal part. In young specimens the right valve is more or less triangular, broad across the distal part, and a little produced at the base; in the adult it usually becomes auriform.

The following is a translation of the original description by Doctor Felix, relating to the right valve, which is exceedingly characteristic and on which alone the species was established:

It is of auriform—sometimes rather elongate, sometimes more broadened—contour, like the Cretaceous *Exogyra auricularis* Brongn. sp., which has been regarded by Coquand as a variety of his *E. plicifera*. On its inner surface it bears a variable number, mostly 5 to 8, of transverse folds, which are in strong relief, but do not extend across the entire shell breadth, by which sculpture it is especially distinguished from related forms. It may be taken for granted that if adult examples show this sculpture on their inner side, free or only umbonally adnate individuals will show it on their outer surface in at least as distinct a manner as the Cretaceous *E. plicifera* Coqu. possesses it.

The length of the specimen in the middle amounts to 15 mm.

EXOGYRA POTOSINA C. and A.

Pl. III, fig. 7; Pl. IV, fig. 7.

Exogyra potosina Castillo and Aguilera, 1895, Faun. Foss. Sierra d. Catorce, p. 3, Pl. II, fig. 9.

Doctor Stanton's collection contains six specimens that are referred to this species. All are larger than the Mexican type specimen fig-

ured by Castillo and Aguilera. Three, of which one closely resembles the example of "*E. subnodosa* Münster," figured in Goldfuss's *Petrafacta germaniæ* (Pl. LXXXVI, fig. 8), are from the foothills west of Malone Mountain, about 2 miles north of the southern end of the mountain, there associated with *Gryphæa mexicana*, *Pinna quadrifrons*, *Pleuromya inconstans*, etc. The three others, representing a variety of more broadly triangular outline, are from the west base of the mountain, only a short distance north of its southern end. The latter station, according to Doctor Stanton's notes, may or may not represent the same horizon as the former and "is certainly several hundred feet above a horizon of *Gryphæa mexicana* and Nerinea."

The specimen, above compared to *E. subnodosa*, has a convexity of about 40 mm. and a lateral profile whose greatest extent, from beak to anterior part of base and extent transverse to the same, are respectively 86 and 55 mm. Corresponding dimensions in one of the larger and broader specimens from the second station above specified are respectively and approximately 39, 93, and 73 mm.

The following is a translation of Castillo and Aguilera's description of *Exogyra potosina:*

Shell elongated, oblique, laterally curved, of semilunar contour. Right[a] valve inflated, its major convexity situated near the umbo, incurved like the shells of Gryphæa; provided with an obtuse crest that traverses the shell in its entire length forming a curve concentric with the anterior margin; beak little free and gently recurved laterally. Left valve operculiform, depressed, and adapted to the concavity which the right valve forms; beak rudimentary. Surface provided with growth-laminæ more marked in the left valve, which is entirely lamellar; on the right valve are perceived two pliciform nodules, obtuse and imperfect, upon the indistinct crest of the shell. Length, 57 mm.

Castillo and Aguilera further describe the shell as intermediate between Exogyra and Gryphæa, noting that it approaches the latter genus both in the general form of the two valves and by preponderance of the vertical over the lateral curvature of the umbonal region. In the Texas specimens, however, at least sometimes, the lateral curvature seems to preponderate.

It is possible that the narrower and broader forms represent two species; but this does not seem probable, and they are here provisionally regarded as mere phases of one.

Exogyra potosina in the Sierra de Catorce, has been recorded only from relatively high beds, which Castillo and Aguilera have considered as Cretaceous. It apparently occurs only high in the Malone district also; but some of its associates in the latter district are apparently identical with the lower occurring *Pleuromya inconstans* (of the Theta and Alamitos); *Gryphæa mexicana* (of the Theta and Jurassic of Oaxaca); *Pecten insutus*, *Pinna quadrifrons*, *Lucina*

[a] Left, of authors generally, who regard the operculiform valve as the right in the inequivalve forms of this genus.

metrica, and *Astarte malonensis* (*?*) (of the Theta)—forms which are themselves the common associates of *Trigonia calderoni* (Theta and Alamitos); *Astarte microphyes* (Theta and Jurassic of Oaxaca), etc.

SPONDYLIDÆ.

Genus PLICATULA Lamarck.

PLICATULA SPORTELLA sp. n.

Pl. III, figs. 8, 9.

Shell small, well inflated by the convexity of the broadly rounded, somewhat inequilateral and twisted, broadly attached right valve; left valve nearly flat, its margin rather thick; both valves strongly plicated to the correspondingly crenulated margins, the ribs about 10 on each valve; ribs of the left valve with broadly rounded summits, the furrows between them narrow, those of the right valve with narrower, more widely separated summits, and separated by round-bottomed furrows; surface of ribs and furrows on both valves crossed with imbricated growth lines.

Measurements.—Height, 8 mm.; length, 10 mm.; breadth, 5 mm.

Occurrence.—Malone Hills, 1½ miles east of Malone station. The type and only specimen is attached to a shell of *Nerinea goodellii*.

LIMIDÆ.

Genus LIMA Bruguière.

LIMA INTERLINEATA sp. n.

Pl. IV, figs. 5, 6.

Shell small, obliquely oval, the anterior border straight or very slightly convex, the oval being more elongate than that of *Lima crenulicosta* Roemer, and the lateral profile more nearly approaching that of *L. wacoensis* Roemer; the convexity of the valves, however, agreeing more nearly with *crenulicosta*, and the beaks somewhat more elevated than in either of those species; either valve ornamented with about 22 radiating ribs; the ribs tectiform, having two faces that meet at an angle considerably greater than a right angle; the ribs separated by intervals about as wide as themselves, the middle of each interval marked by a raised line, or, in the case of a few of the posterior intervals, by two to three such lines. It belongs to the subgenus Radula.

Measurements.—Length and breadth of the oval, respectively, 16 and 12 mm.

Occurrence.—Represented by a right valve and several fragments from locality 1½ miles east of Malone station, and, of Doctor Stanton's collecting at same locality, by a left valve with moderately

prominent anterior ear. Doctor Stanton also obtained a fragment from about a mile south-southeast of Finlay station.

LIMA (CTENOSTREON) RIOGRANDENSIS sp. n.

Pl. V, fig. 4.

Shell large and thick, equivalve, somewhat inequilateral, or obliquely round-oval (the base swung somewhat forward), ventricose, anteriorly gaping, radially large-ribbed; ribs broad and low-convex, about 11 or 12 in number on each valve, separated by flat-concave intervals about as broad as themselves; the surface marked with sinuous-concentric growth lines and coarse, laminated imbrications which present convexities upward and downward on the ribs and intervals respectively, the laminated imbrications in places thickened so as to nearly fill the shallow intervals. The ears of the type are broken off. The presence of a byssal sinus is indicated by the direction of the growth lines on the basal remnant of the anterior ear.

Measurements.—Height about 125 mm.; length about the same; breadth, 80.5 mm. The thickness of the shell varies from about 7 mm. on the basal slope to about 13 mm. in the dorsal region.

Occurrence.—Only the single type specimen is known. This was found on the upper part of the Theta outcrop, 1½ miles east of Malone station, associated with specimens of *Trigonia vyschetzkii*, *Astarte malonensis*, etc.

The species seems to considerably exceed in size *Ct. proboscidea* Sby., of the Oxford. The only Ctenostreon that has hitherto been known from North American rocks is an undescribed species reported by Hyatt from the lower Jurassic of Taylorsville, Cal.

PECTINIDÆ.

Genus PECTEN Klein.

PECTEN (CAMPTONECTES) INSUTUS sp. n.

Pl. IV, figs. 11, 12.

Shell pyramidal-subcircular, somewhat inequilateral, with greater anterior than posterior extent, inequivalve; left valve having a fair degree of convexity; right valve flattish-convex; beaks rather pointed, not rounded in well-preserved specimens, the right one but slightly inflated; anterior straight or slightly concave and posterior usually slightly convex (sometimes in part incipiently concave); dorsal margins of body of either valve making a right angle, or often considerably less than a right angle, with each other; anterior ear large, its hinge, or crest line, about twice as long as that of the posterior ear, and its anterior margin reaching about three-fourths as far

in advance of the beaks as does the anterior margin of the valve itself, its byssal sinus angular or subangular; surface of both valves ornamented with numerous fine, closely set, rounded to flattened, radial, linear costellæ, separated by narrower, serially punctate, striæform grooves, and crossed by concentric growth lines, of which some at irregular intervals are more or less strongly imbricated; punctations commonly approaching the form of a circumflex accent, sometimes appearing dot-like, very closely ranked.

Measurements.—Height, 39 mm.; length, 34 mm.; breadth, 10 mm. (right valve 3, left 7).

Occurrence.—About 50 specimens were collected, in the Malone Hills, 1½ miles east of Malone station, the species ranging nearly throughout the fossiliferous Theta there exposed; in foothills about 1 and 2 miles a little south of east from Finlay station; at a point about 2 miles west of Malone station; about three-quarters of a mile farther south (all of the four last-named localities representing the same or nearly the same horizon, No. 13 of Doctor Stanton's Malone Mountain section); and at the anticline in the east slope of Malone Mountain, nearly a mile north of its southern end.

Before obtaining a copy of Felix and Lenk's Beiträge zur Geologie und Palaeontologie der Republik Mexico I had characterized and named in manuscript the above-described common Malone fossil, giving it the specific name *insutus*, in allusion to the peculiar stitched appearance of the seams between the ribs. Its ornamentation closely resembles that of the *Lima comatulicosta*, described in that work, from the upper Jurassic of Mexico. It differs, however, in several respects from that form, as described and figured by Doctor Felix.[a] It is provided with ample ears, of which the anterior is several times the larger; it is inequivalve; its beaks, instead of being rounded, as described and figured by Doctor Felix in his *Lima comatulicosta*, are, when perfectly preserved, rather pointed; and, finally, its outline is less obliquely or anteriorly elongated, sometimes even approaching in the body of the valves an equilateral or circular outline with a pyramidal summit, though usually rather oblique and somewhat elevated.

The break possibly indicated at the position for an ear in fig. 5 (loc. cit.) of *Lima comatulicosta*, the apparent identity of the costal and intercostal ornamentation of the Malone Pecten with that shown in figs. 1, 1a, 3, 3a of the Cerro de Titania shell, and the fact that, unless the *Pecten insutus* be it, the *Lima comatulicosta* is not known from the Malone district, while its appearance there might reasonably be expected (since at least two[b] of the seven lamellibranchs described by Doctor Felix from the Upper Jurassic of the Cerro de Titania

[a] Beiträge, etc., in Palaeontographica, vol. 37, p. 178, Pl. XXVII, figs. 1, 1a, 3, 3a, 5.
[b] *Exogyra subplicifera* and *Gryphæa mexicana*.

have been found to be common to both localities), are circumstances which at one time led me to regard the alleged Lima as probably identical with the common Pecten of Malone. But that the differences of form are considerable, as above shown; that Doctor Felix gives two figures of *Lima comatulicosta* which agree essentially with each other in all respects in which either differs from *Pecten insutus;* that he compares his fossil with a European species of Lima[a] from the coral rag, and that the peculiar intercostal punctation is known to occur both in Lima and in Pecten, are considerations in view of which the assumption that the Mexican fossil has been wrongly referred to Lima is not warranted.

The radially ornamented outer layer of this shell rapidly weathers off, leaving a shiny black surface, so that sometimes the shell appears smooth or bears only subdued concentric markings.

The specimen figured represents the more circular phase of the species and shows the beaks less pointed than they appear in most examples.

AVICULIDÆ.

Genus GERVILLIA Defrance.

GERVILLIA CORRUGATA sp. n.

Pl. IV, figs. 8–10.

Shell inequivalve, very inequilateral, obliquely elongated and curved; hinge provided with several cartilage-pits, the one anterior to the beaks being relatively small; the left valve crescentic as viewed from above, sigmoid as viewed from without, its beak curved forward, inward, and downward, its postero-basal part curved backward, upward, and inward; the right valve (including beak) flattened, its posterior umbonal slope monoclinally angulated, the steep and narrow post-umbonal slope, separating the anterior, anteroposteriorly flat-convex, proximo-distally flat or slightly concave main part of the valve from the relatively depressed posterior wing; anterior wing small or of moderate size, that of the left valve a little contorted, posterior wing rather large, its angle drawn out posteriorly to a point, owing to the strong emargination of its posterior border; umbo of left valve radially corrugated, the adjoining part of the left posterior wing similarly ornamented on a smaller scale, remainder of left and the right valve marked with ordinary growth-lines.

Measurements.—Height,[b] 25 mm.; length, 38 mm.; breath, 12 mm. Portions of several large specimens indicate at least twice these dimensions.

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[a] *L. comatula* Buvignier.

[b] Height and length taken as usual, perpendicular and parallel to the hinge-line.

Occurrence.—As yet known only from the Malone Hills, 1½ miles east of Malone station, and only moderately common in the lower part of the Theta beds of that locality, occuring with several of the smaller species of Gastropoda. *Gryphæa mexicana*, which ranges much higher, is also one of its commoner associated fossils. Twenty-three imperfect specimens and fragments were collected.

GERVILLIA CINDERELLA sp. n.

Pl. V, fig. 1.

Shell subequivalve, moderately inflated, somewhat flattened on the flank, falciform, the basal region being much produced posteriorly, its terminal part tapering; basal margin long, straight, convex; posterior border concave; flank-region limited supero-posteriorly and in part anteriorly by an abruptly rounded shoulder, the surface being drawn steeply in to the base of the wing; posterior shoulder continuous from the beak to the upper part of the posteriorly produced basal region, its axis gently curved with concavity looking upward and backward; anterior wing inflated above, concave and more distinct from the body of the valve below; posterior wing large, falcate (?) (largely broken off in the type), surface bearing delicate concentric growth lines.

Measurements.—Height, 32 (plus several) mm.; length, about (probably a little more than) 57 mm.; breadth, 19 mm.

Occurrence.—One specimen, wanting the cardinal region, was found by Doctor Stanton in the horizon of the broader phase of *Exogyra potosina* at the west base of Malone Mountain, a short distance north of the southern end.

GERVILLIA ? RIOGRANDENSIS sp. n.

Pl. V, figs. 2, 3.

Another species of lamellibranch, here provisionally referred to Gervillia, was found at the west base of Malone Mountain, associated with *G. cinderella*. It is represented by a cast, of which considerable of the upper posterior region has been removed by weathering, and which bears fragments of the shell of the left valve. The form is less elongate and more compressed than that of *G. cinderella;* the anterior border is concave, the ventral border slightly so, the adjoining lower part of the flanks being slightly hollow, owing to the strong compression of the ventral region. As compared with *G. cinderella*, the antero-ventral border is more prominent and regularly rounded. The shoulder separating the flank from the posterior wing appears, from the cast of part of it, to have been much more gently molded, and this wing seems to have had much greater development in its lower part; surface, as impressed on the mold of a shell fragment, marked with

fine growth lines, of which some, occurring at short subregular intervals on the distal parts, are more strongly imbricated than others.

Measurements.—Height, about 40 mm.; length, 38 mm. (plus 5?); breadth, 17 mm.

Occurrence.—Known only by the above-described specimen, associated with *Gervillia cinderella*, *Exogyra potosina*, *Pleuromya inconstans*, etc.

MYTILIDÆ.

Genus MYTILUS (Linn.) Brug.

MYTILUS NUNTIUS sp. n.

Pl. VI, figs. 4, 5.

Shell small, equivalve (or slightly tortuous-inequivalve?), rather compressed, the right or left profile arched cuneate-oblong, considerably less attenuated anteriorly than that of the somewhat similarly proportioned recent species, *Mytilus afer* Gmelin, the angle made by the anterior margins of the cast being about three-fourths of a right angle; beaks terminal, subacute, gradually and moderately deflected upward, directed much more forward than upward; valves apparently smooth or marked only with concentric growth lines.

Measurements.—Length (oblique) of lateral profile, 21 mm.; breadth of same, 10 mm.; breadth of shell, about 6 mm.

Occurrence.—A single well-preserved cast, bearing thin remnants of the shell, was found among the lower occurring fossils (*Gervillia corrugata*, *Pleurotomaria circumtrunca*, etc.) of the Theta 1½ miles east of Malone station. A form without trace of shell, observed on the matrix of a *Trigonia vyschetzkii* from the same locality, probably represents a valve of the same Mytilus and indicates for it a somewhat larger size.

Though the longitudinal axis of this shell is arcuate, the arching is so gentle that the outline approaches that of the straighter-profiled *Mytilus afer*, as figured by Tryon,[a] more than one of such strongly curved forms as *sublævis*, *eduliformis*, and *decussatus*.

Genus MODIOLA Lamarck.

MODIOLA MALONIANA sp. n.

Pl. VI, figs. 1, 2.

Shell of moderate size in its genus, oblong-trapezoid, gently arched, broadest near the middle, the anterior and posterior regions rather narrow and elevated, the height being greatest at or in advance of the posterior fourth; beaks small and only moderately elevated above the hinge line, placed close together, nearly or quite in contact anteriorly, their dorsal summits forming rather narrow longitudinal ridges from

[a] Struct. and Syst. Conchol.

either of which there proceeds to the posterior part of the basal margin a low, broadly rounded, umbonal swell, below which in the intermediate region the flanks are concave; surface nearly plain, marked only with ordinary growth lines, some of which are imbricated.

Measurements.—Height across umbonal region, 11 mm.; same at highest section of the shell, 12.5 mm.; length, 37.5 mm.; breadth, 11 mm. Another example attains a length of 43 mm.

Occurrence.—The type is from locality 1½ miles east of Malone station, which has yielded two other specimens. I have found a single example also, associated with *Pleuromya inconstans*, *Astarte malonensis*, *Exogyra subplicifera ?*, *Gryphæa mexicana*, and *Serpula gordialis*, at the eastern base of Malone Mountain, in the transverse anticline 1 mile from its southern end, just above conglomerates. Two additional specimens were obtained by Doctor Stanton, one from the anticline just mentioned and one from about 1 mile east of Finlay station.

MODIOLA GENICULATA sp. n.

Pl. VI, fig. 3.

Shell small among its congeners, much shorter and higher relative to its breadth than *M. maloniana*, geniculate-trapezoid, the vertically expanded posterior half of the shell being rather suddenly deflected downward and backward so that its axis makes an angle of about 45° with the horizontal cardinal border of the vertically smaller anterior half; breadth less than the height, greatest about the middle; beaks moderately raised, little inflated; flanks concave in the mid region below the umbonal convexity; surface apparently marked only with the ordinary growth lines.

Measurements.—Height, 16 mm.; height of section across middle, 12.5 mm.; length, 25.5 mm.; breadth, estimated from convexity of one valve, 10 mm.

Occurrence.—A single left valve was collected by Doctor Stanton about 1 mile east of Finlay station.

PINNIDÆ.

Genus PINNA Linnæus.

PINNA QUADRIFRONS sp. n.

Pl. VII, figs. 1–8.

Shell of medium size in its genus, elongate-cuneate; anterior region inflated, in cross section bicuspidately round-oval to quadrate-oval; posterior region rather compressed, in cross section nearly rhombic; valves meeting by their ventral margins at an acute and more or less compressed or cariniform angle and by their dorsal margins at a somewhat similar angle; from their anterior, more convex part, be-

coming at first feebly and then, on the middle and posterior region, strongly and abruptly obtuse-angulated along a radial line a little above the middle, so that either valve presents two slopes—a dorsal, which is flat or in part feebly concave, and a somewhat wider ventral, which retains some convexity even on the posterior part; dorsal slope of either valve ornamented with 10 to 15 compressed and gently elevated radial costellæ, which are separated by intervals wider than themselves and obliquely scored by numerous growth lines that give the costellæ a more or less granulated or crenulated appearance; ventral slope marked only with strong, pliciform, for the most part very oblique growth lines. The summit of the supra-median angle is the locus of a linear hingelike plait, or gore, by whose ready erosion the valves are often cleft, especially along the middle and posterior region, each into two valvelike segments, so that broken specimens which include only that region appear not only tetragonal and quadrilateral, but also quadrivalvate.

Measurements.—Height (across larger end), 56 mm.; breadth (across same), 30 mm.; length, 240 mm.; all approximate.

Occurrence.—One and a half miles east of Malone station. This is one of the most abundant fossils of the Theta subdivision in that locality and ranges nearly throughout the known fossiliferous thickness of it. It usually occurs in sections varying in size from less than 1 inch to 4 or 5 inches long, of which about 80 were here obobtained. Some have been subjected to pressure in such a manner as to make them nearly square in cross section. Doctor Stanton also obtained several on the west side of Malone Mountain, as follows: One in No. 25 of his Malone Mountain section, 2 miles south of west Malone station; 2 from a foothill about 2 miles northwest of the southern end of the mountain, and 6 from the west base of the mountain, a short distance north of its southern end. Part of those (casts) from the last-named locality are more than usually compressed, rapidly expanded, and somewhat curved, and at first sight suggest a distinct species or variety; but others are of intermediate form and some bear shell remnants with seemingly characteristic *quadrifrons* ornamentation, so that, while individual variation may have played a part, the exceptional form should probably be attributed chiefly, if not wholly, to the distortive influence of the orogenic forces that have acted upon the matrix containing them.

ARCIDÆ.

Genus ARCA Linnæus.

ARCA TAFFII sp. n.

Pl. VI, figs. 7, 8.

Shell small, ventricose, broader than high, of moderate length; beaks strongly arched, inrolled, and brought into contact; posterior

slope angulated and strongly flattened (radially costate?); anterior slope a little excavated on the upper part, separated from the outer slope by a rounded shoulder, ornamented with a few strongly elevated radial costæ separated by comparatively wide intervals, in each of which is a feebler linear costella; outer slope flattened, radially costate, becoming closely cancellated on the middle and strongly so on the ventral part; ventral margin straight, not crenulated. There are 20 of the costæ on the outer slope, small, with their rounded summits subgranulated by the cancellation, and separated by intervals of about their own width. On the summit of the umbo the axis of flattening is inclined forward.

Measurements.—Height, 10.5 mm.; length, 19 mm.; breadth, 12 mm.

Occurrence.—One and a half miles east of Malone station; represented by only one example.

The ornamentation of the posterior slope is concealed in the type specimen. A radiately costate ornamentation upon it is inferred from the fact that the species seems to agree subgenerically with Gray's Calloarca as described and figured in Tryon's Structural and Systematic Conchology. A slight inequality of the valves in the umbonal region is doubtless a distortion due to stratigraphical disturbance. The specimen does not disclose the characters of either the hinge or the ligamental area.

ARCA? DUMBLI sp. n.

Pl. VI, fig. 6.

Shell small, only moderately inflated, rather elongate-trapezoidal, the anterior side short and subvertically truncate, the posterior long and obliquely truncate; the base gently convex; the moderately elevated beaks situated at the rear limit of the anterior third; anterior slope small, concave, wing-like, with supero-anterior corner nearly a right angle, separated from the outer slope by a posterior umbonal angulation, which becomes obsolete distally; posterior slope concave, separated from the outer by a strong, proximally subacute, distally obtuse shoulder-like angulation, the two apposed concave slopes forming together a sort of wing with obtuse corner; the anterior slope ornamented with a few narrow, distally obtuse radial folds, the outer slope with ordinary and strong concentric growth-lines, radial lines, if originally present here, having been feeble and obliterated by weathering in the types, the posterior slope and the summit of its limiting angle having numerous radiating raised lines and striæ.

Measurements.—Height, 16.5 mm.; length, 30 mm.; breadth, about 12 mm.

Occurrence.—One and a half miles east of Malone station; represented by 5 specimens.

The hinge characters of this shell are unknown. While the general form permits little doubt that it is one of the Arcidæ, there is less certainty of its generic position, and it is placed only provisionally under Arca.

The species is named for Mr. E. T. Dumble, late State geologist of Texas.

Genus CUCULLÆA Lamarck.

CUCULLÆA? TEXTICOSTATA sp. n.

Pl. VI, figs. 9, 10.

Shell ventricose, short, subtriangular, somewhat pointed inferoposteriorly, rounded anteriorly, the posterior slope flattened and making an angle with the outer slope; beaks well inflated and elevated; entire surface marked in a crowded manner with radiating linear costellæ and in large part with erect concentric lines of imbrication, of which the latter are the finer and more crowded (seen to advantage only when magnified), and the former the more conspicuous and more persistent under weathering. A considerable part of the surface when magnified appears woven, like cloth or miniature basket work, except for the alternating arrangement seen in the latter. This woven ornamentation resembles that seen in *Arca taffii*, the radial costellæ being, however, much finer and more numerous than in that anteriorly and posteriorly otherwise ornate and altogether differently shaped arcid.

Measurements.—Height, about 29 or 30 mm. (?); length, 34 mm.; breadth, 24 mm.

Occurrence.—One specimen and a fragment of a second; 1½ miles east of Malone station.

In the absence of any knowledge of the hinge of this shell it is not possible to be sure whether it is a Cucullæa or an Arca. The ornamentation—primarily radial and secondarily cancellated—is of a type more common in the latter genus; but the species is put provisionally in Cucullæa, under the subgenus Trigonarca, on account of its triangular form.

CUCULLÆA TRANSPECOSENSIS Cragin.

Cucullæa transpecosensis Cragin, 1893; Fourth Ann. Rept. Geol. Survey Texas, pt. 2, p. 175.

The genus Cucullæa is not represented by abundance of individuals in any of its species in the rocks of the Malone formation in Texas, and so rare is the massive and ventricose *C. transpecosensis* that, despite careful collecting for many days at the locality which yielded Messrs. von Streeruwitz and Wyschetzki the type, the latter still remains the only specimen known of this species.

As it has not been practicable to restudy the type, the original account of the species is here reproduced, which is as follows:

Shell large and thick, ventricose (subrhomboidal?); beaks large, remote from the anterior extremity, their summits very obtuse as viewed from the side or from above, their apices less compressed and less free than in *C. terminalis* or *C. gratioti*;[a] anterior dorsal border prominent and compressed, subaliform, the surface included between it and the [anterior[b]] line of the beaks being ornamented with raised radial lines, posterior dorsal angle (apparently) shorter and lower than the anterior, posterior umbonal slope prominently angulated, the angulation succeeded on the inner side by a pronounced sulcus, which is in turn limited on its inner side by another angulation less prominent than the first; hinge-area broad, divaricate-grooved; anterior lateral denticles four (and one rudimentary), long, strong, and horizontal, their abruptly deflected inner termination being relatively very short. Mesial and posterior denticles unknown.

Occurrence.—Collected by Mr. von Streeruwitz about 1 mile northeast[c] of Malone, El Paso County, with *Venus malonensis*[d] and other forms, as mentioned under that species. Comanche series.[e]

In size this shell apparently exceeds the other known species of Cucullæa from the Comanche series of Texas.

CUCULLÆA CATORCENSIS C. and A.

Cucullæa (*Trigonarca*) *catorcensis* Castillo and Aguilera, 1895, Bol. Com. Geol. Mex., No. 1, p. 5, Pl. IV, figs. 1, 4, and 5.

Two small Cucullæa casts, of medium ventricosity, obtained below the Iota conglomerates, 1½ miles east of Malone station, and two from above similar conglomerates in the eastern base of Malone Mountain, in the anticline about 1 mile north of its southern end, are referred to the young of this species.

The following is a translation of Castillo and Aguilera's description of *Cucullæa catorcensis*, as given (loc. cit.) in their "Fauna Fosil de la Sierra de Catorce:"

Shell bulky, very convex, of quite variable contour, oval in the young examples, subquadrangular in those which are more developed, and subtrapezoidal in the adults. Beaks broad, very prominent and little removed from one another, situated in the anterior third and nearly terminal in the adult examples, provided with a carina on the anal side. Buccal region very much more short than the anal, rounded on the extremity, a little excavated near the cardinal border

[a] *C. terminalis* Con. and *C. gratioti* Hill, of the Comanche Cretaceous.

[b] Reads "posterior," by error, in the original.

[c] The same locality is herein generally called "1½ miles east of Malone station," and is perhaps a little short of the latter distance, so far as occurrence of the larger number of the fossils is concerned. I have understood that all of the fossils obtained from this spot in 1890 were actually collected by Mr. Wyschetzki; and if so, the name of Mr. von Streeruwitz was probably put on the label in view of his having been in charge of the trans-Pecos division of the Texas survey.

[d] *Astarte malonensis* of the present writing.

[e] For explanation of the manner in which the few fossils known from this locality in 1893 were at that time placed in the Comanche series, see Introduction. Instead of "Comanche series," read Malone formation.

with which it forms an acute angle. Anal region obliquely truncate on its extremity, excavated or concave in the vicinity of the beaks, limited by a well-marked carina which traverses the shell from the beak down to the posterior extremity at its junction with the inferior border of the shell; the carina is quite acute near the beak and becomes more obtuse in proportion as it recedes from it; the umbonal region, thus circumscribed by the umbonal crest, forms a sort of corselet, quite marked and excavated. Middle region of the shell convex and in the form of a triangle limited by the anal crest and the other less developed which separates it from the buccal region; the major convexity of the shell is just adjoining the anal crest and near the beaks. Ligamental area not very much excavated and of regular dimensions. Cardinal border straight, in some specimens nearly as long as the shell, but in others much shorter; anterior border obliquely rounded; inferior border nearly straight and parallel to the cardinal border, joining by means of a curve with the posterior border, which is oblique, slightly curved, and in the young forms nearly parallel to the anterior border. Surface of the shell provided with concentric lines of growth which have suffered interruptions and constitute more or less prominent corrugations.

Length, 60.62 mm.; breadth with relation to the length, 0.58.

Locality: Arroyo de Alamitos, on the Alamitos rancho, in the Sierra de Catorce.

By breadth ("ancho") in the above is meant the dorso-ventral dimension called height by some writers. The lateral breadth, called thickness ("espesor") in the "Fauna Fosil," is not stated.

The massiveness of this shell, its ventricose form, its broad beaks, and the demarcation of the middle from the posterior umbonal slope by a cariniform angulation, are features which might seem to indecate that *Cucullæa catorcensis* should be referred to the Texan *C. transpecosensis;* but the very prominent and subterminal beaks, and (so far as the description indicates) the absence of a second, or inner, angulation on the posterior corselet and of raised radial lines on the anterior umbonal slope in *C. catorcensis*, appears to sufficiently distinguish the latter as a valid species.

CUCULLÆA CASTILLOI sp. n.

Pl. VI, figs. 11, 12.

Shell of moderate size in the genus, short-trapezoidal; ventricosity of medium degree, greatest considerably above the middle; anterior side short, rounded; posterior side straight, obliquely truncate; base gently convex; the infero-posterior part of the shell somewhat pointed, owing to a prominent, rapidly rounded shoulder that runs from either beak to the junction of the ventral with the posterior border, separating the outer convex slope from the posterior slope, which latter is strongly and concavely depressed, being strongly inflected near the shoulder and turning outward again about midway of its extension toward the posterior border, to form a prominent

and sharp keel by union with the corresponding border region of the opposite valve; anterior umbonal slope only feebly angulated or shouldered; beaks narrow, high-arched, approximated, placed slightly in advance of the middle third; flank region marked with concentric growth lines; posterior slope finely and closely striate.

Measurements.—Height, 39 mm.; length, about 48 mm.; breadth, about 34 mm.

Occurrence.—Two examples were collected by Doctor Stanton in foothills at the northwest end of Malone Mountain, about 2 miles east-southeast of Finlay station. Neither shows the ornamentation of the anterior slope.

The species is named for the late Prof. Antonio del Castillo, founder-director of the Geological Institute of Mexico.

NUCULIDÆ.

Genus LEDA Schumacher.

LEDA? NAVICULA sp. n.

Pl. VI, fig. 13.

Shell fairly well inflated, elongate-ovate, anteriorly not shortened, posteriorly produced and gradually narrowed or subrostrate; the anterior subhorizontal and posterior gently declined parts of the dorsal side each forming a small concavity adjoining the beak, anterior side rounded, base long and straight-convex for the greater part, its posterior part ascending obliquely; beak small and little salient, placed a little back of the anterior third.

Measurements.—Height, 11.5 mm.; length, 25 mm.; breadth, about 10 mm.

Occurrence.—A cast of a left valve was found embedded in the rock fragment bearing one of the specimens of *Unicardium semirotundum* collected by Doctor Stanton at the anticline on the east slope of Malone Mountain about 1 mile north of its southern end.

A cast of a small, posteriorly produced lamellibranch, which was supposed in the field to be one of the Nuculidæ and which may have been a Leda, was observed in Theta a mile and a half east of Malone station. It was accidentally destroyed in attempting to remove it from the matrix. A rough sketch of it, preserved in my notes, indicates a shell similar in form to that above described, but smaller. It may be referred to *Leda? navicula*, but is represented as having the margins crenulated, while this character, if it belonged to the latter species, can not be distinguished in the type as preserved.

TRIGONIIDÆ.

Genus TRIGONIA Brug.

TRIGONIA VYSCHETZKII Cragin.

Pl. VIII, figs 1, 2; Pl. IX, figs. 1–3.

Trigonia vyschetzkii Cragin, 1893, Fourth Ann. Rept. Geol. Survey Tex., pt. 2. p. 215; and, 1897, Jour. Geol., vol. 5, No. 8, pp. 816, 817.

Cf. *Trigonia sologureni* Felix, 1891, Beitr. Geol. u. Pal. Mex., pt. 3, p. 179, Pl. XXVII, figs. 2, 2a.

Shell large, of moderate convexity, transversely subquadrate; postero-dorsal side straight; anterior and posterior sides truncate; base gently curved; beaks only moderately arched; area flattened, occupying about one-fourth of the valve, bordered above and below by a tuberculated ridge or angulation, and traversed by a median groove which is accompanied by a third such ridge less developed than those of the border, a large distal part of it obliquely crossed in most instances by numerous strong, more or less irregular and interrupted folds, or ornamented on the proximal part with rows of tubercles by whose increasing confluence on the intermediate and distal parts the folds are produced, the tubercular endings of these folds usually descending across the entire outer slope of the bounding ridge, and in some cases even passing a little beyond it; escutcheon depressed, crossed with a series of transverse, somewhat oblique, straight, or in part slightly curved, tubercular costellæ; preäreal surface ornamented with about 15 gently curved nodose costæ, which are subvertical near the infraäreal ridge and make with the latter at first an acute and then approximately a right angle, descending for the most part obliquely, though steeply, to the base; the costæ attenuated and simpler near the area, becoming resolved into irregularly more and more robust nodes as they recede from it, the posterior and intermediate costæ thus enlarging throughout, while a few of the shorter anterior ones, turning forward at their lower ends across the flattened front of the shell, are here again reduced to nearly simple ridges which dwindle and disappear before reaching the valve margin; nodes mostly close ranked, commonly 12 to 16 on the larger ribs of adult shells, rounded, often more or less compressed so as to trend with the growth lines, a rib often having a single very large node near the basal margin of the valve especially thus elongated; intervals between the costæ coarsely concentrically striate. The separation of the siphonal currents is indicated, as in the Clavellatæ and Scabræ, by a ridge on the interior of the shell. The ornamentation shows considerable mutability, and a variety occurs in which the entire area is covered with small compressed tubercles. In one specimen the costellæ of the escutcheon are simple.

Measurements.—Approximately, height, 76 mm.; length, 87 mm.; breadth, 50 mm. Two very young examples have these dimensions, respectively, 16, 17, 10, and 25, 27, 15 mm.

Occurrence.—So far as the collections show, this Trigonia does not occur in the Malone district, except in the Malone Hills and in the Theta subdivision of the Trio section. In these, however, 1½ miles east of Malone station, it becomes numerically one of the commonest fossils of the Malone formation. In the rich collecting tract there, on the basal slopes of the Truncate mound and the southeast base of hill *C* of the Trio, and especially on the western basal slope of the former, it was found by scores, in one or two places being agglomerated in beds, mingled more or less with other fossils. Between 75 and 100 specimens of it are represented from this tract. But if the shells of other Malone fossils, as here preserved, prove fragile under the rigorous temperature changes of a plateau climate, that of *Trigonia vyschetzkii* is so especially, and of the large number collected many are in half-released fragments, and comparatively few make even tolerably fair cabinet specimens. I also found this fossil about half a mile west-northwest of this locality on the south side of the flat saddle that separates the Trio from the low gypsum-parted ridge which continues the hill range in that direction.

The series of quadrate pits mentioned by Lycett[a] and cited by Steinmann[b] as occurring posteriorly on the interior of the valve near the ventral margin in Quadratæ, is lacking in *T. vyschetzkii.* The form differs from that of the Quadratæ and agrees with that of the Clavellatæ in being considerably longer than high, yet agrees with Quadratæ and differs from Clavellatæ in being quadrilateral instead of subtriangular. In having the escutcheon ornamented and in some—usually slight—tendency which the areal folds manifest to infringe on the general surface below the limiting angle, on the posterior region, the shell agrees with the Quadratæ.

The *T. vyschetzkii* is thus seen to be closely related to the South American *T. transitoria* Steinm., upon which and the related *T. herzogi* Hausmann, of South Africa, Steinmann, in 1882, proposed to add *Pseudo-Quadratæ*[c] to the previously known sections of Trigonia. Its profile is usually less elongate and the ornamentation, especially that of the area and escutcheon, less coarse than in *T. transitoria*, the folds of the area descending the lower slope of the limiting angle, but descending only a little (sometimes not at all) below it on the posterior region.

Normal casts of *Trigonia vyschetzkii* are differently proportioned from that which—from Tlaxiaco, Mexico—Doctor Felix figures as

[a] Mon. Brit. Foss. Trigon., p. 100.
[b] Neues Jahrb. für Mineral., 1882, vol. 1, p. 221.
[c] Loc. cit., pp. 219–228, Pls. VII–IX.

the type of his *T. sologureni*,[a] a shorter, more elevated, and much more ventricose form being indicated for the latter species. But the cast of *T. vyschetzkii*, in one or two of our specimens, somewhat approaches that of *T. sologureni* in form, while several species of fossils are common to Malone and Tlaxiaco; so that it is desirable to compare actual shells of these two species with one another as well as with the shell of *T. transitoria*.

TRIGONIA GOODELLII Cragin.

Pl. X, figs. 1, 2.

Trigonia goodellii Cragin, 1897, Jour. Geol., vol. 5, p. 816.

Shell of about medium size in its genus, produced ovate, ventricose; valves thick; beaks situated near the rear limit of the anterior fourth, low, strongly inflated, in contact, their posterior slope strongly angulated to form the limiting angle of the area; area flattened, nearly plain, having numerous fine oblique growth lines, with a few small folds crossing it near and concentric to the beaks, these folds being continuous of and making an angle with those in front of the area, some low tubercles along the marginal angles, and a faint mesial sulcus; escutcheon bearing only inconspicuous folds which radiate from the ligament, those of the proximal part being nearly transverse to the length of the escutcheon and continuous with those of the corresponding part of the area; general ornamentation consisting of a series of ribs, which on the posterior part of the preäreal surface are large, obtuse, and plain or subtuberculated, separated by round-bottomed valleys of about their own width, and descend almost vertically (the earlier ones more obliquely forward) from the inferior border of the area, increasing in size each to an elbow-like angle, at which they turn abruptly forward, becoming reduced in size to costellæ in front of these elbows and partially resolved each into a series of small tubercles, these costellæ being accompanied each by one or two similar ones in the intervals between them, the costellæ diminishing gradually in size and swinging into the course of ordinary growth lines on the anterior region, and there becoming continuous and like strong reversed imbrications, each presenting its acute and more elevated border dorsad. The series of costal elbows radiates at first downward and then obliquely downward and backward from the beaks.

Measurements.—Height, 42 mm.; length, about 58 to 60 (plus?) mm.; breadth, 35 mm.

[a] Versteinerungen aus dem oberen Jura des Cerro de Titania bei Tlaxiaco im Staat Oaxaca, 1891, Beitr. Geol. u. Pal. Mex., pt. 3, Palaeontographica, vol. 37, p. 179, Pl. XXVII, figs. 2, 2a.

Occurrence.—One and a half miles east of Malone station. Besides the original example which the Messrs. Goodell discovered, and from which the illustration and measurements have been taken, 17 other imperfect specimens and fragments were obtained at this locality, some of them indicating dimensions perhaps a fourth larger than those of the type.

It will be seen from the description that the ornamentation of *T. goodellii* is variable. This, however, is true of most Trigonias, and not least so of those of the section, Undulatæ, to which this species belongs.

None of the Old World Undulatæ known to me corresponds very closely with *T. goodellii.* Several of those from the Great Oölite, which is so rich in Undulatæ, bear more or less resemblance to it; but the strict analogue, if found, may be expected to occur in the Tithonian.

The species was named after the late Mr. Robert Wood Goodell, whose kind services in assisting me to determine the age of the Malone formation I have particularly acknowledged in my article on the "Discovery of marine Jurassic rocks in southwestern Texas," the paper in which the species was first briefly characterized and named.

A Trigonia cast, showing nothing of the ornamentation, but indicating the general form of *T. goodellii*, having still larger dimensions than any of the above, and belonging not improbably to this species, was obtained by Doctor Stanton from conglomerate on the west face and near the top of Malone Mountain. It gives the following measurements: Height, 62 mm.; length, 72 mm.; breadth, 46 mm.

TRIGONIA CALDERONI (C. and A.).

Pl. IX, figs. 4–6.

Goniomya calderoni Castillo and Aguilera, 1895, Bol. Com. Geol. Mex., No. 1, p. 9, Pl. V, figs. 17, 18.

Shell elongate-trapezoid, very inequilateral, moderately inflated, the region of greatest convexity extending from the umbones downward and backward; anterior region relatively short and of considerable height relative to the posterior, the anterior contour rounded: posterior region strongly produced backward and inclined a little upward, gradually and strongly tapered toward its extremity, which is obliquely truncate and looks backward and upward, its flanks more or less flattened; base gently convex below the beaks, ascending thence anteriorly in an easy convex curve and posteriorly slowly in a long and nearly straight line; beaks but moderately elevated, their apices curved inward and somewhat backward and downward; escutcheon rather large and long, plain; area of moderate width, flattened, traversed lengthwise by a mesial groove, and transversely linear-plicate,

the plicules separated by striæ; preäreal surface ornamented with two sets of ribs, of which the anterior ribs are acute, upwardly-imbricate, remote, subhorizontal, with gentle sigmoid flexure, presenting a slight upward convexity below the beaks and a downward one farther forward, and alternately reach the more anterior ribs of the other set; posterior ribs thicker, more obtuse, and more narrowly intervaled than the anterior, nearly straight, and directed steeply downward and backward from the limiting angle of the area, the proximal of these being the more nearly vertical and the distal and independent ones more oblique, the intermediate ones being the longest. Slight irregularities sometimes appear in the course of the anterior ribs, each of which, in one example, bears a small dorsally directed angle at the summit of its infraumbonal convexity.

Measurements.—One of the Texan examples, which has a length of 58 mm., indicates for the shell in part restored, a height of 32 mm. and a breadth of 23 mm., approximately.

Occurrence.—The Malone formation yields this fossil rather sparingly. Eleven specimens and characteristic fragments are represented. Eight of these are from the Malone Hills, 1½ miles east of Malone station; the others were collected about a mile east of Finlay station.

In the character of the preäreal ornamentation, the species presents considerable resemblance to *Trigonia sulcataria* Lamarck, as figured by Lycett on Pls. XXVI and XXVIII of his British Fossil Trigoniæ, a species which has been referred to the Undulatæ, but is shown by Lycett to belong to the Scabræ. The plain escutcheon, however, at once separates *T. calderoni* from the Scabræ, and the same and all of the other external characters refer it to the Undulatæ.

TRIGONIA PROSCABRA sp. n.

Pl. X, figs. 3–6.

Shell small, crescentic-ovate or subsemicircular, the upper border strongly excavated, anteriorly inflated, gradually becoming more compressed toward the posterior extremity; beaks somewhat produced and recurved; escutcheon large, broader than the area, ornamented with rather remote, coarse, but not very strongly elevated, oblique costellæ; area flattened, narrow, transversely linear-plicate, traversed by a mesial depressed line, and bounded both above and below by a row of tubercles, those of the lower row surmounting a distinct limiting ridge and larger than those of the preäreal costæ opposite whose terminations they are placed; the areal plications, though fine and numerous, are mostly separated by intervals wider than themselves; preäreal surface denticulate-costate, the denticles

cuneïform, each consisting of a superior, compressed, tuberculiform head and an attenuated cariniform process which dwindles to a point below, crossing the longer and gentler posterior costal slope, but not crossing the fundus of the intercostal valley quite to the base of the comparatively abrupt anterior costal face. The costæ are moderately interspaced, becoming rather widely intervaled when the shell attains the adult size. A small flattened tract formed by the conjoined antero-dorsal margins, is minutely wrinkled transversely to the margins, as the earlier ribs, before reaching the margin, become suddenly reduced and changed to minute linear folds, paralleled in their intervals by similar folds, of which there are two in each interval.

Measurements.—Height, about 30 mm.; length, 36 mm.; breadth, 21 mm. One specimen, represented by a considerable part of a right valve, indicates, with a breadth of about the same or a millimeter less, a height and length 2 or 3 mm. greater. Young examples are relatively shorter, or more elevated, one such example having height 20 mm.; length, 20 mm.; breadth, 14 mm.

Occurrence.—One and a half miles east of Malone station. About 35 specimens are represented, many of them only by fragments. A crushed specimen from this locality has the costal and areal ornamentation exceptionally well preserved and shows an almost spinous prominence of the denticles. A cast, representing the anterior two-thirds of a right valve on which the costæ are indicated as plain undulations, obtained by Doctor Stanton about 1 mile east of Finlay station, is supposed to belong to this species, but may represent *T. præstriata.*

Trigonia proscabra presents points of resemblance especially to two of the sections of its genus, and does not agree entirely with either. It may be regarded as one of the Clavellatæ which, both as to form and preäreal ornamentation, has assumed the habit of a common phase of the Scabræ. In having an ornamented escutcheon it differs from the typical Clavellatæ, though not from the Pseudoquadratæ—which are intermediate between Clavellatæ and Quadratæ. In having the area bounded on each side by a row of tubercles and below by a pronounced limiting ridge it resembles the Clavellatæ.

TRIGONIA PRÆSTRIATA sp. n.

Pl. X, fig. 7.

Shell small, crescentic-ovate, only moderately inflated; area strongly and closely striated in a direction oblique to its length, bounded below by a rather strongly compressed and prominent limiting ridge or angulation; preäreal ribs about 12 or 14 in number, coarse, remote, and strongly elevated, descending divergently and for the most part

more or less vertically, and increasing rather rapidly in size from the limiting angulation to the ventral and anterior borders, about twice as wide as the plain, flattish-concave intervals between them, their summits obtuse and strongly and a little obliquely cross-striated in such a manner that the striation is visible if the ribs are viewed tangentially from in front, but invisible if so viewed from behind.

Measurements.—Height, 21 mm.; length, 30 mm.; breadth, 10 mm.; approximately.

Occurrence.—A single mold, representing the greater part of a right valve in excellent detail, is the type and only known specimen. It was obtained by Doctor Stanton on the east slope of Malone Mountain, near its southern end, 200 or 300 feet above the gypsum bed that there forms the mountain's base. It lacks the escutcheon, the upper part of the area, and the umbonal apex, but the exterior characters of nearly all of the rest of the shell may be readily observed either in the mold or on the gutta-percha squeeze taken from it. The species is referred to the section Scabræ.

TRIGONIA MUNITA sp. n.

Pl. X, figs. 8–11.

Shell ovate-pyramidal, of medium or rather large size among its congeners, moderately ventricose, rather elevated; valves thick; area strongly flattened, separated from the preäreal surface by a very large and prominent, obtuse, somewhat imbricated radial costa, preceded by a furrow, the areal surface being ornamented with two rather strong, not widely separated, cariniform radial costæ, which are separated from each other by an interval that is rather narrow as compared with that between either costa and the corresponding areal border, and several similar but smaller costellæ or rays, there being at least two such rays in the anterior interval; preäreal surface ornamented with (25 to 30?) strongly and rather abruptly elevated concentric ribs, which resemble low walls, terminate almost abruptly at the preäreal furrow, and are in large part only about half as wide as the flattish-concave intervals between them.

Measurements.—These can not be exactly given, owing to the imperfection of the material, but about the following dimensions are apparently indicated in one instance: Height, 70 mm.; length, 75 mm.; breadth, 42 mm. In another the height is about 80 mm.

Occurrence.—Represented by three very imperfect specimens and a number of characteristically ornamented fragments. One of the specimens were obtained by Doctor Stanton near the south end of Malone Mountain, west face, near top, and another west of the mountain, about 2 miles west of Malone station. The remainder of the material is from the locality 1½ miles east of Malone station. All of

the known material represents the adult condition, or at least rather large sizes of the shell, unless the two specimens described under the head of *Trigonia rudicostata* should be interpreted as the young of *T. munita*. This species with the two that follow belongs to the section Costatæ.

TRIGONIA RUDICOSTATA sp. n.

Pl. XI, figs. 1, 2.

Shell small, ovate-pyramidal, nearly straight (slightly convex) on the postero-dorsal, broadly convex on the ventral, and less broadly so on the anterior side, inflation intermediate in degree; beaks situated at rear limit of the anterior fourth, prominent and acute at the compressed and transversely placed summit, excavated on the posterior side, turned inward and somewhat backward; area nearly flat, shallow-concave on its proximal part, wide, making with the preäreal surface an angle greater than a right angle, and separated from it by a compressed, prominent radial costa, which is larger than any other costa of the shell, the area posterior to this costa being ornamented with 4 or 5 similar but narrower and smaller rays, between each two of which are 3 to 5 still smaller, strongly elevated, linear rays or costellæ, the intercostellar spaces being at least as wide as, or for the most part wider than, the rays themselves, preäreal surface ornamented with about 25 strongly elevated, round-topped ribs which parallel the basal margin and are mostly slightly wider than the intervals between them. There are 7 of the horizontal or concentric ribs in the lower half in one specimen and 10 on the lower 10 mm. in another.

Measurements.—Height, 23 mm.; length, 27 mm.; breadth, 16.5 mm.

Occurrence.—The two specimens in the collections were obtained 1½ miles east of Malone station.

Although the material thus far available for study indicates between *T. rudicostata* and *T. munita* differences of both radial and concentric ornamentation too marked to be ignored, it is quite possible that new material from localities known or yet to be discovered may show that these differences are due to conditions of age or individual variation; for it is noteworthy that, except the types of *T. rudicostata*, no Costatæ even approaching what we should predicate for the young of *T. munita*, have been found.

TRIGONIA CONFERTICOSTATA sp. n.

Pl. XI, fig. 3.

Shell small, subtriangular, of the section Costatæ, apparently more elevated than *T. rudicostata;* posterior area costellate with

linear rays, of which there are 5 to 7 smaller in the shallow-concave interval between each two of the larger; a large radial rib anteriorly limiting the area; preäreal surface ornamented with about 40 strongly elevated concentric ribs which are much finer than those of *T. rudicostata* and between one and a half times and twice as numerous, and are separated by intervals prevailingly narrower than themselves. In a specimen smaller than the largest, but which nearly corresponds in size with the type of *T. rudicostata*, there are 15 ribs on the lower 10 mm. of height of the valve, as compared with 10 on the same part of the height in the said example of *T. rudicostata*. As against 7 ribs included in the lower half of *T. rudicostata*, there are in one specimen of *conferticostata* not less than 12, and in another 14 in the corresponding half.

Measurements.—The dimensions can not be accurately given. The height of the largest specimen is about 33 mm. An apparently crushed and abnormally elongated specimen gives approximately: Height, 25 mm.; length, 29 mm.; breadth, 15 mm.

Occurrence.—The species is represented by one nearly complete shell, two considerable portions of valves, and a few fragments; from locality 1½ miles east of Malone station. The shell fragment collected in 1895 by the Messrs. Goodell, and which I referred to in volume 5 of the Journal of Geology (p. 817) as "possibly a Trigonia of the section Costatæ," is of this species.

ASTARTIDÆ.

Genus ASTARTE Sowerby.

ASTARTE BREVIACOLA sp. n.

Pl. XI, fig. 4.

Cf. *Astarte microphyes* Felix, 1891, Beitr. Geol. u. Pal. Mex., pt. 3, p. 179, Pl. XXVII, fig. 31.

The locality 1½ miles east of Malone station yielded frequent examples of this fossil. They agree fairly well with Doctor Felix's description of *Astarte microphyes*, but not with his figure. As regards the peculiar disposition of the ribs which is given for *A. microphyes*, the tendency to posterior angular bending is well shown in most specimens of the Malone Astarte, but a tendency to anterior angular bending is little or in some cases apparently not at all expressed. If the Cerro de Titania and the Malone specimens are referable to one and the same species, *microphyes*, as seems hardly possible, the form of that species is not quite correctly shown in the original figure, as the anterior part of the dorsal line, instead of sloping like the posterior part, is strongly excavated just in front of the beaks in all of the Malone specimens in which this part of the

shell is shown. The triangular-ovate to quinquelateral outline presents dorsally a nearly straight incline back of the beaks and is strongly excavated in front of them; has a long, gently convex base, and is posteriorly or infero-posteriorly truncate, and narrowly rounded anteriorly. The shell is quite strongly compressed, and the ribs of either valve reach 11 in number. The ribs are coarse, strongly elevated, gently compressed, and separated by round-bottomed intervals a little wider than themselves. Of more than 60 specimens collected from east of Malone, a single one, among the young examples, is quite ventricose, gapes slightly in the interval between two of the subdistal ribs, and exposes there a double and interlocking set of strong denticles like those of the internal margins of the adult shell.

Measurements.—The specimen figured has the following dimensions: Height, 10 mm.; length, 14 mm.; breadth, 4 mm. In less perfect examples a height of 12 mm. and a length of 16 mm. are indicated.

ASTARTE MALONENSIS Cragin.

Pl. XI, figs. 10, 11; Pl. XII, figs. 1–3.

Venus malonensis Cragin, 1893, Fourth Ann. Rept. Geol. Survey Texas, pt. 2, p. 216, Pl. XXXV, figs. 1 and 2; and Jour. Geol., vol. 5, p. 817.

Shell rather large, thick-valved, moderately ventricose, or sometimes slightly compressed, inequilateral, broadly and variably subovate; the dorsal side flattish-convex behind the beaks and excavated in advance of them; the anterior side rounded or slightly subtruncate from being a little prominent in its upper part; the posterior side rather narrowly convex; the base broadly convex; beaks only moderately elevated, approximate, their summits varying from subcentral to a position just back of the anterior third; lunule and escutcheon deeply and abruptly impressed, especially the former, which is narrow-cordate; cardinal teeth 2–2, unstriated, the central of the right valve being much larger than the anterior and the posterior of the left valve being larger than the central;[a] a posterior remote, horizontal, pliciform lateral tooth in either valve fitting into a corresponding groove in the other; pallial line sinuate, its impress on the best-preserved casts crossed by faint radial plications; pallial sinus ample, its anterior and posterior limbs, respectively, subvertical and subhorizontal (the latter a little ascending), its fundus obtuse; valve margins crenulated within; shell ornamented with numerous subequal to unequal concentric, coarsely linear pliciform growth lines, whose sequence is usually interrupted by remote and more elevated folds,

[a] The cardinal teeth are here regarded as 3 in each valve, but with 1 in each valve obsolete.

imbrications, or constrictions that tend to mark off the surface into regular stages.

Measurements.—The type measurements—height, 72 mm.; length, 83 mm.; breadth, 55 mm.—are those of a rotund-ovate example. The height is often somewhat less in proportion to the length. Adult specimens of average inflation have the breadth equal to about two-thirds of the height. The maximum known size is indicated by an imperfect specimen, which has a height of 79 mm.

Occurrence.—This is one of the commonest and most conspicuous of the fossils of the Malone formation. It ranges through all of the fossiliferous part of the Theta subdivision that is exposed in the Malone hills, occurring not only at the principal collecting ground, a mile and a half east of Malone station, but also west of the Trio. About 90 specimens were collected at the former locality. Examples were obtained from the west side of the north end of Malone Mountain, at the same horizon and locality that yielded the specimens of Nautilus; from the first high ridge west of Malone Mountain, about 2 miles west of Malone station, and from a locality about 1 mile east of Finlay station. A probable example was obtained by Doctor Stanton from the western foothills, 2 miles north of the southern end of Malone Mountain, and a distorted one was found by me on the anticline in the east side of the mountain, about a mile from its southern end.

Rotund-ovate, transverse-ovate, and oblique or rhombic-ovate are all more or less closely approached by the lateral profile of this shell as preserved, which also in some cases is nearly equilateral. A part of this variation, but evidently not all of it, is to be attributed to the dynamical stresses to which the Malone rocks have been subjected. In young examples the form is usually more oblong, less equilateral, and less compressed, and the concentric ribbing becomes more pronounced and regular, approaching the type of ornamentation commonly seen in medium-sized and small species of Astarte.

The species seems to be sufficiently near the Jurassic section, Cœlastarte, of Böhm.[a] It differs from *Astarte excavata* Sby., the best known representative of that section, in being less strongly inequilateral and in having none of the cardinal teeth striated. The central cardinal of the right valve, while it is the largest tooth of the shell, is relatively smaller than that of *A. excavata* as figured by Böhm. In form it approaches the sinupalliate species *Astarte neocomiensis* d'Orb, from which it differs by hinge details and its crenulated margins.

Stoliczka[b] observes:

[a] Cœlastarte und Heteropis, Ber. Naturf. Ges. Freiburg, i. B. Bd. 7, 1893, pp. 169–178. Pl. VIII.

[b] Cret. Pelecypoda of Southern India, p. 285. Memoirs of the Geological Survey of India. Palæontologia Indica, vol. 3, Calcutta, 1871.

Eriphyla especially seems to be largely represented among the fossil Astarte, as recorded at the present time, and probably all the species which have an indication of a posterior pallial sinus belong to the former genus. They can scarcely be referred to Astarte, for the single anal opening which the animal of this last possesses lies behind the posterior muscular scar, but not below it, where the formation of a sinus, if present, must be due to the development of muscles supporting a branchial siphon, or at least a special branchial opening. Neither of these are, however, present in Astarte.

But so gradual is the transition from none to a well-marked pallial sinus that it seems impossible in practice to distinguish Eriphyla from Astarte clearly by this criterion.

ASTARTE POSTICALVA sp. n.

Pl. XI, figs. 5, 6.

Shell small, thin, triangular-ovate, of intermediate convexity; beaks rather prominent and pointed, directed somewhat forward, anteriorly excavated, placed near and usually back of the limit of the anterior third; posterior slope a little flattened; anterior three-fourths (to four-fifths) of shell ornamented with numerous linear concentric costellæ, which are separated in strong relief by deep striæ about half as wide as themselves; the flattened posterior fourth or fifth forming a sort of area which is plain, or marked with ordinary growth lines only, and is separated from the preäreal surface by a very obtuse or rounded radial angulation which is not of itself a discrete and salient feature, but consists merely of the rather abruptly curved transition from the outer to the flattened posterior slope of the shell. The costellæ are deflected at their posterior ends, vanishing rather rapidly, but not abruptly, as they approach the plain area.

Measurements.—Height, 13 mm.; length, 15 mm.; breadth, 10 mm. A valve of another specimen has a height of about 14 mm. and a length of 17 mm.

Occurrence.—Not infrequent 1½ miles east of Malone station. Twenty-one specimens were collected.

ASTARTE? ISODONTOIDES sp. n.

Pl. XI, figs. 8, 9.

Shell small, gibbous, inequilateral, oblong-ovate, the dorsal line gently declivous and slightly convex back of the beaks and very feebly excavated in front of them; base nearly straight; anterior side rounded; posterior side obliquely truncated; beaks low, in contact, situated near the anterior third, an obtuse umbonal ridge or inflation extending from their summits to the postero-ventral margin, and the greatest breadth of the shell being, by reason of such infla-

tion, near the anterior limit of the posterior third; flanks and postumbonal slopes more or less flattened; ligament external, short; surface of shell concentrically striate, or ornamented with numerous strong linear elevations whose development varies, and is more regular on the proximal part of the shell, while on the distal part there are one or two excavated zones bounded by high lines. The lines run nearly straight for a considerable part of their course parallel to the base, turning upward more shortly at the posterior than at the anterior end of it.

Measurements.—Height, 13 mm.; length (restored), about 18 mm.; breadth, 10 mm.

Occurrence.—A mile and a half east of Malone station. Only 1 specimen of the typical form was obtained. Of 3 others believed to be only young and compressed examples of the species, 2 are more or less complete right valves, 1 of which shows a ligamental groove and a strongly denticulated inner margin; and the third is a shell quite flattened out. All three of these young examples agree with the proximal and differ from the distal part of the type shell in having a tendency to a rather uniform and close development of the concentric linear costellæ.

The specific name refers to some resemblance which the shell presents in form to that of Isodonta, as represented by the type of that genus, *I. deshayesii* Buv.

ASTARTE? CRATICULA sp. n.

Pl. XI, fig. 7.

Shell small, rather ventricose, subovate, strongly depressed along a narrow zone near the posterior cardinal border from the beaks to the posterior extremity; beaks well inflated, moderately elevated, placed somewhat in advance of the middle and back of the anterior third; postero-dorsal flattened area separated from the rest of the shell by a radial angulation and itself divided into two concave zones by a radial cariniform angulation; the general surface of the valves ornamented rather closely with regular, blunt-topped, concentric costellæ, which are in strong relief and separated by intervals of about their own width. The ornamentation of this shell recalls the genus Trigonia.

Measurements.—Estimated measurements only can be given, the margins of both valves of the type being imperfect. The apparent approximate dimensions are: Height, 22 mm.; length, 28 mm.; breadth, 17 mm.

Occurrence.—The only specimen obtained is from the locality 1½ miles east of Malone station.

CRASSATELLIDÆ.

Genus PTYCHOMYA Agassiz.

PTYCHOMYA STANTONI sp. n.

Pl. XII, figs. 4–6.

Shell small, compressed, cuneate-ovate or trapezoid-ovate, a little excavated at the front of the beaks; the anterior side short, rounded; the posterior side long; the dorsal margin having a gentle and nearly straight descent back of the beaks for a considerable distance and then declining more rapidly, so that the posterior side of the shell is obliquely truncate above; the base nearly straight in its median and major portion; the posterior umbonal slope forming with the outer slope a gentle shoulder; valves thick, their margins crenulated within; beaks very little salient; lunule cuneate-lanceolate, deeply excavated; surface ornamented with a considerable number of ribs which form an anterior nearly vertical series of upwardly directed chevrons below the beaks, and a posterior oblique series of nearly closed, distally directed angles whose apices lie on the umbonal shoulder; on the posterior part of the shell the ribs pursue a nearly straight course backward and downward to the basal and posterior margins, though arranged in two converging sets, in each of which they are slightly divergent; on the anterior region they are subhorizontal, curved forward and upward, and often minutely undulated or zigzagged. The sides of the subumbonal chevrons, exclusive of the part that forms the usually more or less cuspidate apex, diverge at an angle which is right or sometimes slightly acute in the earlier ribs and becomes quite obtuse in the later ones. The ribs are generally linear-compressed and separated by broader concave intervals, but in occasional specimens, and especially on the posterior region, are more obtuse, with the intervals equaling or distally exceeding them.

Measurements.—A nearly complete right valve indicates: Height, 16.5 mm.; length, 31 mm.; breadth, 8 or 9 mm. An internal cast of a right valve gives: Height, 18 mm.; length, 32 mm.

Occurrence.—Twenty-three specimens, in part only fragments, with the characteristic ornamentation, are in hand. All are from the locality 1½ miles east of Malone station, and most, if not all, from the lower part of the Theta beds there outcropping.

In pattern of ornamentation and in size *Ptychomya stantoni* comes nearest to *Pt. complicata* Tate, from which it differs in having the beaks less anteriorly placed and the posterior truncation very oblique instead of nearly square; the position of the beaks and the line of chevrons below them is as in *Pt. koeneni* Behrendsen. The general form has some resemblance to the latter species, but its lateral profile departs more from a regular oval and tends toward a cuneate. It

differs from *Pt. koeneni* also by its much smaller size, and in the absence of small downward-pointing chevrons at the apices of the middle and lower of the large upward-pointing ones.

The species is named after Doctor Stanton, who first recognized its genus on seeing it in my collection at Sierra Blanca, Tex., he having previously ascertained that *Pholadomya ragsdalei* Nobis belongs also to Ptychomya. Doctor Stanton has recently shown me two casts of the latter species on which the hinge characters of the left valve, as described and figured by Pictet and Campiche,[a] are well displayed.

The Ptychomyæ hitherto described, so far as known to me at this time (1899), are as follows:

Ptychomya robinaldina (d'Orbigny), 1843, Pal. Fr., Terr. Cret., vol. 3, p. 75, pl. 264, figs. 10–13.

Ptychomya solita (d'Orbigny), 1851, Rev. et Mag. de Zoöl., 2d series, vol. 3, p. 381, pl. 10, figs. 3, 4.

Ptychomya sp. Unnamed. Described and figured, 1857, by Pictet and Renevier in Pal. Suisse, Terr. Aptien de la Perte du Rhône, et Ste. Croix, p. 90, pl. 11, figs. 2a, 2b, 3a, 3b, as of *Pt. robinaldina* (d'Orb.), but removed from the latter by Pictet and Campiche in 1866 (Pal. Suisse, Foss. Terr. Cret. Ste. Croix, p. 357), and placed near *Pt. neocomiensis* (de Loriol) either as a variety of the latter or a distinct species.

Ptychomya buchiana (Karsten), 1858, Geognost. Verhältn. des Westl. Columb., Bericht 32 ste Versamml. Deutsch. Naturf. u. Ärtze, p. 113, Pl. V, figs. 7a, 7b.

Ptychomya neocomiensis (de Loriol), 1861, Descr. des Anim. Foss. du Mont Salève, p. 71, pl. 9, figs. 1–4.

Ptychomya dœdalea Coquand, 1866, Mon. Pal. de l'Étage Aptien de l'Espagne, p. 127, Pl. XX, figs. 1, 2.

Ptychomya germani Pictet and Campiche, 1866, Pal. Suisse, Terr. Cret. de Ste. Croix, p. 354, Pl. CXXVII, figs. 7, 8.

Ptychomya complicata (Tate), 1867, Quart. Jour. Geol. Soc. London, vol. 23, Pt. I, p. 160, Pl. IX, fig. 8.

Ptychomya zitteli Dames, 1873, Zeitschr. Deutsch. Geol. Gesellsch., vol. 25, p 380, Pl. XII, figs. 1, 2.

Ptychomya sp. Unnamed. Described and figured, 1882, by Franz Toula in Denkschr. Kais. Akad. Wissensch. Mat.-Nat. Cl., Bd. XLIV, 2te Abth., p. 35, Pl. IV, fig. 18. Regarded by Toula as probably identical with *Pt. neocomiensis*, though he notes differences. It seems to me to be separated by its strongly arched principal costæ and dorsal border, as well as by its size.

Ptychomya koeneni Behrendsen, 1892, Zeitschr. Deutsch. Geol. Geselsch., vol. 44, p. 23, Pl. II, fig. 4, and pl. 3, figs. 8a, 8b.

Ptychomya ragsdalei (Cragin), 1895, Colorado College Studies, V, p. 58.

In addition to the above, a species of Ptychomya has been reported by G. Steinmann[b] as occurring in the Cordilleras at Chillan, Chile, possibly in the same bed with *Trigonia transitoria* Steinmann. This Trigonia occurs also at Caracoles, Bolivia, from an unknown horizon

[a] Pal. Suisse, Terr. Cret. de Ste. Croix, p. 351, Pl. CXXVII, figs. 9d, 9e.

[b] Neues Jahrbuch f. Min., etc., 1882, vol. 1, p. 224.

that, on the ground of the kind of rock attached to the specimen, Professor Steinmann regards as probably Lower Cretaceous, though nearly all of the Mesozoic fossils that he lists from Caracoles he considers Jurassic. I am not aware that the Chillan Ptychomya has been specifically named or described.

The orbicular, toothless, divaricately ornamented shell described by Lycett[a] as *Ptychomya? agassizii*, and the elongate *Pandora? æquivalvis* Deshayes[b] and *Crassatella cornueliana* d'Orb.[c] which have been referred to Ptychomya by some paleontologists, are here, following Stoliczka,[d] excluded from the genus.

The size of the shell in Ptychomya seems to have been less in the earlier history of the genus and to have reached its maximum in the Gault. The relation of size to time is indicated in the following table, in which an attempt has been made to group the species roughly in accordance with their relative geological position, known or supposed:

Table showing sizes of species of Ptychomya at various geological epochs.

Species.	Length.	Geological position.	Locality.
	mm.		
zitteli	90	Turonian	Western Alps.
ragsdalei	105	Upper part of Denison stage	Northern Texas.
buchiana	120	Gault	United States of Colombia.
dædalea	110	Aptian	Spain.
(Unnamed)	80	Aptian	Switzerland.
solita	80	(? Upper part of) Lower Cretaceous	United States of Colombia.
(Unnamed)	67	Uppermost Neocomian (probably fide Toula).	Western Balkans.
neocomiensis	60	Lower and middle Neocomian	France, Switzerland.
koeneni	57	Neocomian[e]	Argentine Cordilleras.
robinaldina	35	Lower and middle Neocomian[f]	France, Switzerland, England.
germani	40	Lower Neocomian (Valangian)	St. Croix, Switzerland.
complicata	31.7	Lower Neocomian? (Jurassic?)	Cape of Good Hope.
stantoni	32	Malone	Southwestern Texas.

[a] Proc. Cotteswold Naturalists' Club, vol. 1, p. 69, Pl. II, figs. 6, 6a.

[b] Mem. Soc. Géol. de France, vol. 5, p. 4, pl. 3, figs. 7a, 7b.

[c] Pal. fr., Terr. Crét., vol. 3, p. 74, pl. 264, figs. 7–9.

[d] See Cret. Fauna Southern India, vol. 3, p. 294.

[e] Behrensden compares his species with the lower and middle Neocomian species, *germani* and *robinaldina*.

[f] Morris and E. Forbes have recorded this species from the lower Greensand; but these records are early ones (1845 and 1854) and not improbably refer to *Pt. neocomiensis*, which was not established till 1861. A species close to *Pt. neocomiensis*, and perhaps not specifically distinct from it, was referred to *robinaldina* by Pictet and Renevier as late as 1857 to 1866. See remarks in above list of hitherto-described Ptychomyæ.

LUCINIDÆ.

Genus LUCINA Brug.

LUCINA POTOSINA C. and A.

Pl. XIII, figs. 4, 5.

Lucina potosina Castillo and Aguilera, 1895, Bol. Com. Geol. Mex., No. 1, p. 6, Pl. IV, figs. 2, 3, and 6; and Pl. V, figs. 11 to 14.

Five specimens from the locality 1½ miles east of Malone station seem to agree sufficiently well in size and form with the small, transverse and rather inflated Sierra de Catorce shells that constitute the type variety of *Lucina potosina.*

The following is a translation of Castillo and Aguilera's description of the species:

Shell transversely oval, relatively compressed, inequilateral. Buccal region longer than the anal, uniformly rounded at its extremity and nearly of the same width as the anal. Lunule well developed, rather deep and generally wider in the right valve. Anal region nearly of the same breadth as the buccal, rounded at its extremity, more inflated than the buccal region. Ligamental area narrow, deep, and elongated, occupying the whole length of the anal region. Cardinal border slightly concave on the buccal side and straight or gently convex on the anal side. Umbones subcentral, contiguous, and a little inclined to the buccal side. Ventral or lower border little curved, joined to the anterior and posterior borders by arcs of more pronounced curve than its general curvature. Flanks convex, more inflated below the beaks where the major convexity is found; this diminishes gradually toward the borders. Surface adorned with delicate concentric costellæ, little salient and separated by plain intervals four to six times wider than the costellæ. Length, 19, 20.5, 21 mm.; breadth, in relation to the length, 0.79, 0.80, 0.85; thickness, in relation to the length, 0.47, 0.48, 0.48.

The exact geological position of *Lucina potosina* at its type locality is not known, as the records are somewhat conflicting. Castillo and Aguilera state, on page 8 of the above-cited bulletin, that the types of this species and of *Cyprina coteroi* were found associated with Alamitos fossils, but were petrified in flint, believed to have been derived from the flint-bearing limestones of their "grupo superior," that overlie the sandstones of the Cieneguita (Lower Cretaceous) as the Cieneguita in turn overlies the Alamitos (Upper Jurassic). On page 49 of the same they omit *Cyprina coteroi*, but include *Lucina potosina* in the list of fossils of the grupo superior, and state that *Schloenbachia af. inflata* is the only fossil found in the limestones of the grupo superior, ascribing *Lucina potosina* and the other fossils of the grupo superior to calcareous and marly shale below the limestone, in the base of the grupo. Finally, on page 50, *Cyprina coteroi* is given as one of the fossils of the Alamitos beds, which are Upper Jurassic. In view of the confusion that has arisen regarding the original stratigraphic source of these fossils, and the further fact that the actual collecting of them seems to have been from among the fossils of the Alamitos, there would appear to be some uncertainty as to their

having come from the flint-bearing limestones of the grupo superior, notwithstanding the flinty character of their fossilization and a possibility, at least, that both species may have come from some minor intercalation or segregation of siliceous matter in either the Cieneguita or the Alamitos beds.

LUCINA POTOSINA var. METRICA var n.

Pl. XIII, figs. 6–10.

Lucina metrica Cragin, 1898, Jour. Geol., vol. 5, p. 817.
Lucina potosina ? Cragin, 1898, loc. cit., p. 817 (footnote) and p. 819.

Shell equivalve, compressed or little inflated, flattish-lenticular, suborbicular, yet tending somewhat to a four- or five-sided outline, usually a little transverse, but often not markedly so, sometimes about equilateral, for the most part slightly, and in exceptional cases considerably, inequilateral; valves thin; postero-dorsal region somewhat especially compressed in contrast with the gently inflated umbonal region in front of it, the concavity here being counterbalanced by a feebler compression of the antero-dorsal region; beaks very small and depressed, subcentral, usually placed a little back of the middle; surface ornamented with widely and regularly interspaced, strongly and abruptly elevated, linear-compressed, concentric costellæ. The spaces between the latter are about six times as wide as the costellæ themselves, flat, marked only with numerous and fine crowded, concentric growth lines; and are remarkable for the regularity of their breadth, which increases distally with almost imperceptible increments, but shows occasional variations.

Measurements.—Height, 34 mm.; length, 35 mm.; breadth, 10 mm. in a specimen of the commoner and intermediate size, much smaller specimens being similarly proportioned. For the same dimensions, an example of average adult size and an exceptionally large one give, respectively, 41, 45, 14, and 54, 59, 16 mm.

Occurrence.—A mile and a half east of Malone station. One of the more abundant fossils there occurring, but less common than the *Pleuromya inconstans*. More than 200 specimens are represented. A few examples were also obtained in foothills at the northwest end of Malone Mountain, about 2 miles east-southeast of Finlay station, and west of the mountain, 2 miles north of its southern end.

The height of the shell in *L. potosina*, var. *metrica* is commonly from 90 to 97 per cent of the length, which, however, it may occasionally equal. The breadth averages less than 30 per cent of the length; in 10 measured specimens it averages 29.46, the minimum being 25.5, and the maximum being 32 per cent. The corresponding ratios given by Castillo and Aguilera for typical *potosina* are height as percentage of length 0.79 to 0.85, and breadth as percentage of length 0.47 to 0.48.

From all of the data above given it is seen that the shell of var. *metrica* attains a much larger size than that of var. *potosina*, is considerably less inflated, and has a less transverse (i. e., more elevated) and more nearly equilateral contour.

Lucina potosina, var. *metrica* is not only a pronounced variety of its species but it is the largely preponderating representative both of its species and of its genus in the Upper Jurassic of western Texas.

As is usually found to be the case where very large numbers of a species of fossil are available for study, *L. potosina* presents considerable individual variation. Seven or eight specimens from locality 1½ miles east of Malone, represent a third variety of the species, which is apparently only an individual phase, though rather a striking one, of var. *metrica*. They show the following characters: The shell is about as large as the largest examples of the ordinary form of *metrica;* transversely broad-oval, inclining to subquadrate; inequilateral; inflated throughout, though unequally so, the valves being radially warped or flexuous, and especially swollen on the umbonal slope, on either side of which are two broad and shallow concave radial zones, the anterior one of which passes downward and the posterior one downward and backward; a second and smaller convex radial zone being developed in front of the anterior concave one. The beaks are more inflated than those of the typical form of var. *metrica*. The basal margin of the shell is a little prominent and receding opposite the convex and concave zones, respectively. Corresponding with the general contour of the shell, the concentric linear costellæ, which in the common phase of var. *metrica*, have an almost uniform downward convexity in the postero-basal part of their course, assume in this phase a nearly straight or slightly upward convex trend for a considerable distance in this part of their course, swinging upward rather suddenly anterior and posterior to it. The approximate dimensions are: Height, 45 mm.; length, 50 mm.; breadth, 20 mm.

This phase, then, is distinguished from the ordinary phase of var. *metrica* by its size, average adult examples of the latter being considerably smaller, by its greater and more pervasive inflation, strongly flexuous valves, and more transverse and inequilateral contour. A tendency toward this form is seen in some of the smaller examples of the other phase of *metrica*.

LUCINA ? EMARGINATA sp. n.

Pl. XIII, figs 1, 2.

Cf. *Cyprimeria ? mexicana* Castillo and Aguilera, 1895, Bol. Com. Geol. Mex., No. 1, p. 9, Pl. V, fig. 3.

Shell suborbicular, compressed, though less so than that of *Lucina potosina*, var. *metrica*, the breadth being equal to about half of the

height; anterior, ventral, and posterior sides rounded; dorsal side abruptly and emarginately excavated before the beaks to a point distant one-fourth of the shell length, where it joins the anterior side in an obtuse angle, the posterior part of the dorsal side declining in a nearly straight line, with some convexity near the beaks, to a point two and a half times as remote, where it makes an obtuse angle with the posterior border; beaks low, with apex curved forward; lunule large, about twice as long as wide, abruptly and rather deeply impressed; margins entire; surface ornamented with rather coarse, rounded, subdued, concentric costellæ separated by equal or narrower intervals, each costella making an irregular and gentle undulatory flexure as it approaches the posterior part of the dorsal margin.

Measurements.—In an accidentally somewhat compressed specimen, height, 21 mm.; length, 22 mm.; breadth, 7 mm. In a second example, height, 20 mm.; length, 19 mm.; breadth, 10 mm. In a third, height, 32 mm.; length, 30.5 mm.; breadth about 16 mm.

Occurrence.—Three examples were obtained from the locality 1½ miles east of Malone station.

In the absence of a satisfactory knowledge of the hinge details, the species is here placed in the genus *Lucina* because of the abruptly excavated and rather deep lunule, the lunule in *Cyprimeria* being feebly excavated or lacking.

LUCINA PLANIUSCULA sp. n.

Pl. XIII, fig. 3.

Shell of intermediate size for *Lucina*, thick-valved, broadly suboval, rather inflated, the breadth equal to more than half of the height, height equaling about five-sixths of the length, moderately inequilateral, the posterior side being between three-fourths and four-fifths as long as the anterior, the latter but little contracted; beaks little prominent; surface nearly plain, ornamented with inconspicuous, concentric raised lines and striæ, which on the major part of the surface are more or less obsolete, but are more distinct on the anterior and posterior marginal regions, the raised lines on the latter being very fine and intervaled on the upper part, becoming coarser and more crowded below.

Measurements.—Height, 26.5 mm.; length, 31 mm.; breadth, 15 mm.; in another example, height, 28 mm.; length, 31 mm.

Occurrence.—Four shells and about a dozen casts of this fossil were collected in foothills in the northwest end of Malone Mountain, about 2 miles east-southeast of Finlay station.

From *Lucina coetoi* C. and A., the *L. planiuscula* appears to differ chiefly by its more strongly inflated and much less strongly inequilateral shell and its plainer ornamentation.

Genus UNICARDIUM d'Orbigny.

UNICARDIUM ? SEMIROTUNDUM sp. n.

Pl. XII, figs. 9–11.

Shell thin, pyramido-suborbicular, moderately inequilateral, well inflated, the height nearly equal to the length; beaks large and prominent, pyramidal, submedian, placed a little nearer to the anterior than to the posterior extremity, curved inward and slightly forward, so that the anterior cardinal border is more concave than the posterior; anterior and posterior borders rather short; base evenly and rather broadly rounded; surface marked only with fine concentric growth lines, most of which are rather feebly, a few more strongly, impressed.

Measurements.—Height, 21 mm.; length, 22 mm.; breadth, 13 mm. Height in another nearly like-proportioned example about 25 mm.

Occurrence.—Twelve specimens were collected by Doctor Stanton at the following four localities: A mile and a half east of Malone station; anticline in east base of Malone Mountain about 1 mile north of its southern end; west of Malone Mountain, nearly 2 miles south of west from Malone station, in No. 13 of his Malone Mountain section; and in foothills at the northwestern end of Malone Mountain, a little over 2 miles east-southeast of Finlay station, here also apparently in No. 13. Four examples were also collected by me at the first of the localities above named.

The species shows some resemblance in form to *U. varicosum* Sowerby, but has larger and more elevated umbones and, for the body of the valves, a more rotund contour.

UNICARDIUM ? TRANSVERSUM sp. n.

Pl. XII, figs. 7, 8.

Shell thin, well inflated, transversely subovate, the height equaling 0.77 to 0.87 of the length; the posterior moiety of the shell narrower and considerably longer than the anterior, and the anterior part of the cardinal border more concave than the posterior; base broadly and unequally rounded; beaks prominent, yet less so than those of *Unicardium semirotundum*, in contact; surface smooth, marked only with fine concentric growth lines, which disappear under slight weathering. While the form of the shell is persistently transverse or subovate, the position of the beaks is widely variable, as shown by the umbonal fractions below, in which the numerator and denominator, respectively, denote the distances in millimeters of the umbonal summits from the anterior and posterior ends of the shell in four specimens selected at random. That this variability, how-

ever, is in part due to the orogenic movements which the matrix has undergone is indicated both by other variation in the form and by the discrepancy sometimes shown in the relative position of the two beaks of a single shell.

Measurements.—Height, 26 mm.; length, 34 mm.; breadth, 21 mm. Same dimensions from a left valve, respectively; height, 24 mm.; length, 29.5 mm.; breadth (by doubling the convexity of one valve), 15 mm. Umbonal fractions, $\frac{13}{18}$, $\frac{25}{42}$, $\frac{14}{17}$, $\frac{10}{19}$.

Occurrence.—Fourteen specimens were collected from the locality 1½ miles east of Malone station; one from the anticline on the eastern slope of Malone Mountain nearly 1 mile north of the southern end; and one also upward of 1 mile east of Finlay station.

CYPRINIDÆ.

Genus CYPRINA Lamarck.

CYPRINA COTEROI C. and A.

Pl. XIII, figs. 11, 12.

Cyprina (*Venilia*) *ceteroi* Castillo and Aguilera, 1895, Bol. Com. Geol. Mex., No. 1, p. 8, Pl. V, figs. 4 to 10.

Shell thin, triangular-ovate, inequilateral, ventricose, the height generally equaling one and a third to nearly one and a half times the breadth and about seven-eighths of the length; posterior slope flattened and separated from the rest of the shell by a low crest, or angulation, which runs from the posterior side of the beaks to the somewhat pointed infero-posterior end of the shell; beaks situated between the middle and the anterior third, strongly inflated, high arched, pyramidal, incurved, somewhat anteriorly deflected, and nearly, if not quite, in contact; pallial line entire; general surface ornamented with ordinary concentric growth lines and at remote intervals with resting stages marked by moderate imbrication and groove, which descend across the posterior flattened area and turn suddenly forward at the posterior angulation.

Measurements.—Height, 34 mm.; length, 41 mm.; breadth, 27 mm.

Occurrence.—Four (and two doubtful) specimens, from locality 1½ miles east of Malone station.

There is some doubt as to the true horizon of the type specimens of this fossil. See remarks as to same on page 72, under *Lucina potosina*.

CYPRINA? STREERUVITZII Cragin.

Pl. XIV, figs. 1, 2; Pl. XV, fig. 1.

Cyprina (Roudairia?) streeruvitzii Cragin, 1893, Fourth Ann. Rept. Geol. Survey Texas, pt. 2, p. 180, Pl. XXXVI, figs. 3 to 5, and Pl. XL, fig 2.

Cyprina streeruvitzii has been found only in the Theta, and can hardly be called an abundant fossil. Notwithstanding its large size and the fact that special search was made for it at its type locality, 1½ miles east of Malone station, the most prolific lamellibranch field known in the Malone formation, only 11 incomplete specimens and casts were found, and none of these is as good as the specimen collected there by Mr. Wyschetzki, the topographer of Mr. Von Streeruwitz's party, in 1890. They were all, or nearly all, obtained from the west slope of the Truncate mound.

They add little to our knowledge of the species.

The cast, owing to its narrow, very elevated, and strongly arched beaks, bears considerable resemblance to that of *Cyprina texana* Conrad. Its posterior area is outwardly bounded by an obtusely compressed, prominent ridge, interior to which is a round-bottomed sulcus, followed by another radial elevation and depression within. The casts of the anterior adductor scar are exceedingly prominent. An undersized though apparently normally proportioned cast has the height 73 mm.; breadth, 64 mm., and length approximately 80 mm. The largest example of the shell has the beaks broken off, but has a length of about 124 mm. Another specimen of the shell presents a height of about 106 mm.

Attached to some of the specimens by the stony matrix are characteristic parts of *Trigonia vyschetzkii*, *T. proscabra*, *Lima interlineata*, *Astarte breviacola*, *Mytilus nuntius*, *Serpula gordialis*, and other fossils.

There remains some doubt as to the genus of this shell, as the hinge characters have not been observed. The following is the original description of the species:

> Shell large, triangular, the anterior and posterior sides of the outline being subdirect, the basal convex, height and length of shell about equal, exceeding the breadth; beaks prominent, situated somewhat in advance of the middle, posteriorly flattened or concave, their summits turned inward and forward till tangent or subtangent above the downward, outward, and backward curled apices, the latter overhanging a large and deeply impressed heart-shaped lunule, which is higher than wide, and is bounded by a moderate slope, the margins of the valves immediately below the lunule forming no such keel as is seen in *Cyprina roemeri*, the anterior termination of the shell being, on the contrary, very obtuse; posterior slope in either valve bicarinate, having, in addition to the primary angulation which abruptly separates the discal from the posterior slope, a second and similar radial angulation at a position which is at

first about two-thirds of the distance from the primary angulation to the posterior shell-margin, and which at length reaches that margin at rather more than two-thirds of the distance from the beaks to the distal extremity of the primary angulation; intercarinal areæ concave, that included by the secondary carinæ forming an escutcheon, those included between the primary and the secondary carinæ continuous with the posterior flattening of the umbonal summits; entire exterior of the shell presenting numerous strong concentric growth lines and divided off on the disk into rather broad, subequal, concentric zones by narrow, low, and, in part, obsolescent concentric ribs. Valves thick.

Measurements.—Height, 88 mm.; length (approximately), 93 mm.; breadth, 74 mm.

VENERIDÆ.

Genus TAPES Megerle.

TAPES? CUNEOVATUS sp. n.

Pl. XIII, fig. 13.

Shell gently compressed, thin, cuneate-ovate; the convex-tapered posterior side narrowly rounded at the end; anterior side rounded; base gently convex; dorsal margin rather abruptly excavated at front of beaks; breadth contained about one and a half times in height; height about one and a half in length; beaks placed at posterior limit of anterior third; surface finely concentric striate.

Measurements.—Height, 17 mm.; length, 24.5 mm.; breadth, 10 or 12 mm.

Occurrence.—A mile and a half east of Malone station; represented by a right valve complete as to form, but with the larger part of the shell removed by weathering, enough, however, remaining to show the character of the ornamentation.

PHOLADOMYIDÆ.

Genus PHOLADOMYA Sowerby.

PHOLADOMYA TOSTA (Cragin).

Pl. XV, figs. 2, 3.

Anatina tosta Cragin, 1893, Fourth Ann. Rept. Geol Survey Texas, pt. 2, p. 168.

Pholadomya tosta Cragin, 1897, Jour. Geol., vol. 5, p. 817.

Shell large among its congeners, moderately ventricose, very inequilateral, oblong, with rounded extremities and long, straight-convex to feebly sigmoid base, pointed-ovate in cross section; the anterior region short; the posterior region long and somewhat narrowed, its cardinal margin feebly concave; beaks low-arched, in contact, placed at about a fifth (sometimes less) of the shell length from the anterior end; entire shell presenting fine growth lines and irregularly intervaled, coarser, concentric imbrications, which on an anterior small

and a supero-posterior larger area constitute the only markings, all of the shell except these terminal areas being crossed by radiating ribs, of which there are about 20 on either valve. The ribs are narrowly compressed and rather strongly elevated (cariniform), often with irregularly crinkled summits, and some of them are pressed backward so that the posterior slope is comparatively gentle, while the anterior is steep or overhangs, giving them somewhat the appearance of imbrications; they are unequally remote and separated by broad, flattish-concave intervals; and one of the posterior ribs is usually higher and larger than the others, the two or three that are yet posterior to this, and a few of the anterior ribs, being less pronounced than the others. The anterior part of the base is gently convex, becoming straighter and gradually a little rising posterior to a point between the middle and the posterior end, and again apparently a little descending or prominent opposite the largest one of the posterior ribs, the base describing thus a feebly sigmoid curvature. The latter feature is not seen in all specimens, and may be due to mechanical distortion.

Measurements.—The two largest specimens average about 50 mm. in height. The breadth is apparently about three-fourths of the height, and the height about half of the length.

Occurrence.—Twenty-five specimens are represented from locality 1½ miles east of Malone station.

PHOLADOMYA MARCOUI sp. n.

Pl. XVI, figs. 1, 2.

Shell of medium or small-medium size in its genus, very inequilateral, short-oblong or ovate-oblong, more or less rounded at both extremities, ventricose; posterior cardinal border slightly excavated; the posterior region convex-cuneately compressed, gaping narrowly at the upper posterior border; beaks situated near the anterior end, elevated about as in *Pholadomya candida* Sby., or *P. glabra* Ag.;[a] surface, except small anterior and posterior dorsal portions, ornamented with a few (about 6?) remote, feebly expressed, or obsolescent, cariniform, radial ribs, the posterior one of which is directed nearly straight backward (slightly downward), and also unevenly marked with coarse concentric growth lines.

Measurements.—Height, 36 mm.; length, 56 mm.; breadth, 32 mm.

Occurrence.—A mile and a half east of Malone station. This Pholadomya seems to be less common than either *P. tosta* or *P. dumbli.* Ten examples were obtained.

This or a closely related form was found with *Exogyra potosina,*

[a] Referring here to the species as presented in pls. 108 and 109 of Tryon's Structural and Systematic Conchology.

etc., at the western base of Malone Mountain, a short distance north of its southern end, the cast bearing indications of feeble ribs about as in *marcoui*, but this form—perhaps modified by orogenic movements of the matrix—being longer, lower, and smaller-calibered than it is normally in the latter species.

The species is named for the late Mr. Jules Marcou.

PHOLADOMYA PAUCICOSTA Roemer?

Pl. XVI, figs. 5, 6.

Pholadomya paucicosta F. A. Roemer, 1836. Versteinerungen des Norddeutschen Oölithgebirges, p. 131, Pl. XVI, fig. 1.

Form stout, curved-cuneate-pyriform; the umbonal region widely inflated transversely to the length of the shell; anterior region shortened almost back to the large, prominently elevated, tangent umbones, which are thus made almost terminal; the anterior margin slightly gaping; posterior region widened in the median plane, compressed, most strongly so in the upper part, which tends to a keel-like form and gapes considerably; base drawn upward rapidly in the anterior part, so that, in connection with the very salient beaks, the whole anterior (including umbonal) moiety of the shell has an upturned appearance; surface ornamented with coarse, unequal, concentric, costelliform growth plications and furrows and apparently with 4 or 5 low folds radiating from the beaks forward and downward to the basal margin.

Measurements.—The dimensions can be given only roughly. They appear to average, for the larger specimens: Height, 52 mm.; length, 61 mm.; breadth, 48 mm.

Occurrence.—Not rare in the Malone Hills, a mile and a half east of Malone station. Among 26 specimens there collected the mechanical distortion has been such that no two are quite alike. There is, however, a central phase about which they are grouped and to which several of them closely approximate, affording a sufficiently correct idea of the normal form; and so different is the shell from any other found in these beds that it can be recognized in any of its false shapes, though the radial markings are rarely well preserved and often not shown at all. A specimen was obtained by Doctor Stanton near the railroad, about 2 miles east-southeast from Finlay station, in the northwestern foothills of Malone Mountain.

Accepting for the European Upper Jurassic *Pholadomya paucicosta* Roemer, the wide range of specific variation indicated for it by Moesch,[a] it seems impossible to separate the above-described Malone species from it.

[a] Monographie der Pholadomyen. In Abhandl. Schweiz. pal. Gesell., vols. 1 and 2.

PHOLADOMYA PRÆPOSITA sp. n.

Pl. XVI, figs. 3, 4.

Shell small for its genus, cuneate-oblong, arched somewhat downward, very broad across the antero-dorsal or umbonal region, the breadth at least equal to the height, convex-cuneately narrowed toward the base and rear; anterior side rather truncate; base gently convex; beaks anterior, terminal, projecting forward a little beyond the rest of the shell, directed forward and upward, then arched strongly inward, the apices curved a little backward, somewhat compressed as if by gentle pressure on the anterior (or inferior) and posterior (superior) sides; surface with faint concentric markings and several remote, low, slender, cariniform costellæ which radiate from the summit of the beaks, the anterior 6 (or more) obliquely crossing the inferior (anterior) umbonal slope to the base. The anterior part of the base is sharply and even a little biconcavely compressed, and a limited anterior region of the shell is free from the cariniform rays.

Measurements.—Height, 22 mm.; breadth, 22.5 mm. In a second specimen, height, 20 mm.; breadth, 20 mm. The length of these specimens (at least more than 31 mm.) can not be exactly given, as they are posteriorly broken off. A third, with only remnants of the shell, but nearly normal as to shape, gives, height, 20 mm.; breadth, 20 mm.; length, 34 mm. A fourth example, too much weathered on the flanks to give the breadth, has a height of 24 mm., and a length of 43 mm.

Occurrence.—Four examples from locality 1½ miles east of Malone station.

Genus PLEUROMYA Agassiz.

PLEUROMYA INCONSTANS C. and A.

Pl. XVII, figs. 1–5; Pl. XVIII, figs. 1–3.

Pleuromya inconstans Castillo and Aguilera, 1895, Bol. Com. Geol. Mex., No. 1, p. 10, Pl. V, figs. 15, 16, and Pl. VI, figs. 1 to 4.

Pleuromya inconstans Cragin, 1897, Jour. Geol., vol. 5, p. 817, footnote, and p. 819.

Though outnumbered at many points by its associates, this is the most generally distributed fossil of the Malone formation. It ranges through the entire Theta subdivision of the Malone hills (Trio) section, or so much of it as is exposed at the locality 1½ miles east of Malone station, whence several hundred specimens were obtained. It was also collected by me in the lower part of limestones overlying conglomerate in the anticline at the eastern base of Malone Mountain, about 1 mile from the southern end, and was, I believe, found in poorly preserved examples in the gap west of the Trio, with *Trigonia*

ryschetzkii and *Astarte malonensis*. The material collected by Doctor Stanton includes part of that from the first two of these and also specimens from the following localities: Two miles west and also about the same distance south of west of Malone station (here in Nos. 13 and 25 of his Malone Mountain section); foothill west of Malone Mountain, 2 miles north of its southern end; and west base of the mountain, near its southern end.

On the anterior part of the umbonal region of this shell there descends to the base a zone of constriction, as if the shell, when plastic, had been pinched, making the valves there gently concave and the base a little reëntrant, a feature which is often pronounced, though sometimes scarcely perceptible. When viewed from below, the base is usually seen to be twisted, presenting a more or less decided right-and-left sigmoid flexure. The right hinge margin overlaps the left. The shell gapes narrowly at the posterior end.

This fossil well sustains the reputation of the Pleuromyas for variability, meriting its specific name even better, if possible, in Texas than in Mexico. Manifold shades of form present themselves—some natural, others dynamical modifications of these—but all seem to intergraduate, and the specific place of many of them becomes indeterminable the moment an attempt is made to group them in more than one species. For this reason and because some of the specimens agree perfectly with those described and figured by Castillo and Aguilera from the Upper Jurassic of San Luis Potosi as *Pleuromya inconstans*, all are referred to that species.

The cuneate, the subcylindrical, and the Gresslya-like variations that have been recorded from the Sierra de Catorce, all are represented in the collections from the Malone district also. What appears to be the central phase for the latter district may be described as follows: The posterior terminal region of the shell is usually somewhat narrowed, sometimes strongly so, and is recurved or obliquely upturned; the anterior margin descends in a convex oblique line to an obtusely pointed or narrowly rounded corner in which it meets the horizontal or often somewhat downward-deflected anterior prolongation of the base. The anterior end thus presents a "Roman-nosed," or "hook-nosed," appearance, and the shell as a whole, viewed laterally, presents a sigmoid flexure, while the basal margin presents such flexure whether viewed from the side or from below. This is by far the most abundantly represented form of the species in the Malone district, and it attains the largest size. That it also occurs in the Sierra de Catorce is indicated by Castillo and Aguilera's very excellent and comprehensive description of the species, of which a translation is here added:

Shell inequilateral, of variable form, sometimes truncate on the anterior border, sometimes with this same border salient; the general dominant form is ovate

trigonal. Buccal region little developed, extremely small compared with the anal region; excavated below the beaks, with its extremity rounded in some individuals, in others obliquely truncated, and salient in its lower part, which is continuous with the ventral border forming an obtuse angle. Beaks situated in the anterior third of the shell, varying their position in the different individuals from nearly terminal to subcentral; broad, convex, sometimes presenting two obtuse keels, one on each side of the apex of the beak. Anal region very large, convex, or depressed, narrowed toward its extremity, which is rounded. Dorsal border straight or slightly concave on the anal side, considerably excavated on the buccal side. Ventral border nearly straight, feebly raised at the extremities, but notably more at the anal side. Flanks sometimes very convex, giving to the shell a cylindrical form, and sometimes depressed so that they make it cuneiform; the greater convexity is always in the anterior part of the shell and below the beaks. Surface ornamented with concentric furrows which contrast with the fine lines of growth. Length, 34 to 63 mm.; breadth with relation to the length, 0.47 to 0.64; thickness with relation to the length, 0.31 to 0.43.

Castillo and Aguilera supplement this description with the following remarks:

We possess of this species only molds and imperfect examples, but these show the ornamentation of the shell and its very feeble thickness. The variation in the characters of this species is not limited merely to the contour and the other details of form of the shell, but is also manifested in the mode of occurrence of the shell, which is equivalve in the more convex forms and evidently becomes more and more inequivalve in so far as it reaches forms in which the right valve is more elevated than the left in such a manner that the dorsal border before and behind the beaks passes over the dorsal border of the opposite valve, exactly as in the Gresslyas, to which genus these forms could be referred without hesitation if they were found isolated, as to some extent the umbonal crests of which we have spoken above would make this position of the shell in the genus Gresslya more proper, since the obtuse furrow which is found along the umbonal crests somewhat resembles the oblique furrow which the molds of the Gresslyas present in the right valve and which in these corresponds to the internal lamina. Fortunately we have met with abundant examples which have permitted us to follow all the variations of the shell, forming a series whose extremes, taken without the intermediate forms, could without hesitation be referred to the genera Pleuromya and Gresslya, respectively.

PLEUROMYA INCONSTANS var. CURTA var. n.

Pl. XVIII, fig. 4; Pl. XIX, figs. 1, 2.

Cuneate-oblong to cuneate-ovate, much shorter than the lengths of *Pleuromya inconstans* that prevail in the Theta member of the Malone formation, and rather compressed; the narrowly gaping posterior region of the shell slightly recurved, obliquely truncate; anterior region closed; ventral margin gently and evenly convex; dorsal margin much less excavated before the beaks than that of *Pleuromya peregrina* d'Orbigny; beaks more nearly terminal than in that species, often unequally elevated, the right being the higher, as seen in some

species of Pleuromya and more commonly in Gresslya, the casts, however, lacking the pronounced right dorsal groove of the latter genus.

Occurrence.—In the horizon of *Exogyra potosina*, *Gervillia cinderella*, etc., at the west base of the southern part of Malone Mountain, and in the Theta member of the Malone Hills, 1½ miles east of Malone station. The types are from the former locality. At both places the type variety of *Pleuromya inconstans* as figured by Castillo and Aguilera also occurs, but in the former situation *curta* is common, while in the latter it is rare.

This form, so far as is indicated by the known material from the Malone Mountain locality, does not intergraduate with *Pleuromya inconstans*, and may represent a distinct species; but at the locality in the Malone Hills some of the forms of the multivariant *inconstans* seem to lead up to it, and it is therefore here considered a variety of that species. Its general proportions are not unlike those of the Callovian species *Pleuromya peregrina* d'Orb., from which it is distinguished by the recurved posterior region, the position of the beaks, and the less decidedly excavated anterior dorsal margin.

A Gresslya-like specimen of Pleuromya from the locality east of Malone station, whose form resembles somewhat that of *G. gregaria* Goldfuss, is provisionally considered as a mechanical deformation of this variety, though it may be such of one of the shorter examples of the variety *inconstans*, or even be specifically distinct.

ANATINIDÆ.

Genus ANATINA Lamarck.

ANATINA OBLIQUIPLICATA sp. n.

Pl. XVI, figs. 7, 8.

Shell among the smaller species of its genus, relatively compressed, inequilaterally elongate-oblong, rounded anteriorly, attenuated back of the beaks; the gaping posterior side shorter than the large and closed anterior; the shell somewhat pinched or concave on the ventral part in advance of the beaks (the ventral margin a little tortuous?); beaks small, low, situated near the limit of the anterior third; surface of the thin valves ornamented with concentric growth lines, and on the anterior region with a series of coarse and prominent, oblique undulatory folds which are nearly straight and trend about equally upward and forward. The folds are obtuse at summit and are separated by subequivalent round-bottomed intervals; the distal 5 occupy the valve to a distance of about 14 mm. from its antero-ventral margin.

Measurements.—Height, 23 mm.; length, 53 mm.; breadth, 14 mm. Beaks placed at 30 mm. from the anterior extremity.

Occurrence.—Eight specimens from locality 1½ miles east of Malone station.

ANATINA? PLICULIFERA sp. n.

Pl. XVI, figs. 9, 10.

Shell of small medium size in the genus, oblong, anteriorly rounded, posteriorly truncate, strongly compressed, moderately gaping at anterior and posterior extremities; the posterior region relatively little contracted; beaks low, narrowly compressed with the shell itself, situated about at the posterior limit of the anterior third of the shell; surface ornamented with strong, subequal, concentric plicules and grooves.

Measurements.—Height, 29 mm.; length, 49 mm.; breadth, 14 mm.

Occurrence.—A mile and a half east of Malone station. Represented by only one specimen.

There is some appearance of an anterior radial angulation of the shell, directed forward and downward to the anterior extremity; but the condition of preservation of the type is such as makes it impossible to determine whether this is really a feature of the shell or not.

Genus THRACIA Leach.

THRACIA? MALONIANA sp. n.

Pl. XIX, fig. 6.

Shell very thin, inequilateral, compressed, commonly about the size of *Thracia incerta* Agassiz,[a] sometimes larger, inclined to be more posteriorly produced, or heel-like, at the lower anterior border, trapezoid-ovate; posterior side narrowly gaping in the upper part; beaks of moderate size and elevation, situated about as in the *T. incerta*, their posterior slope angulated; surface marked with parallel, moderately elevated, compressed linear, or cariniform, concentric plicules separated by partly equal and partly unequal intervals of two or three times their own width.

Measurements.—Of considerably the largest example, height, 43 mm.; length, about 60 mm.; breadth, about 20 mm. Of a more common size, height, 37 mm.; length, 49 mm.; breadth, 18 mm.

Occurrence.—Six specimens, all casts, two of which show characteristic traces of the markings, were collected 1½ miles east of Malone station.

[a] As figured in Zittel's Handbuch, vol. 3, fig. 186.

MYIDÆ.

Genus CORBULA Bruguière.

CORBULA ? MALONIANA sp. n.

Pl. XIX, fig. 7.

This name is provisionally proposed for a small, transverse, triangular-ovate, moderately ventricose cast of a right valve belonging apparently to this genus, but unknown as to hinge or shell, obtained by Doctor Stanton from the same horizon that yielded the broadly triangular examples of *Exogyra potosina*, at the west base of Malone Mountain, a short distance north of its southern end. The height is about six-tenths of the length; the posterior end is slightly produced or pointed; the beak is pyramidal; the pallial line is coarse and strongly impressed. The species should possibly be referred to Neæra.

Measurements.—Height, 5 mm.; length, a little more than 8 mm.; breadth indicated for cast (that of the left valve being restored), about 4 mm.

PHOLADIDÆ.

Genus MARTESIA Leach.

MARTESIA MALONIANA sp. n.

Pl. XIX, figs. 3–5.

The types of this species are two casts of compressed-conoidal shape, with portions of the shell, in matrix. They are straight (not at all arcuate) and taper rapidly from the large anterior region. The compression is scarcely expressed in the umbonal region, but increases posteriorly. The base is rectilinear. Radiating downward from either beak to the base are two remote, transversely striated furrows, of which the anterior is the wider and the posterior is the more deeply impressed.

The markings seen on the casts are apparently an index of those peculiar to the shell. The casts do not indicate the character of the accessory plates.

Measurements.—The casts measure, height, 11 mm.; breadth, 10 to nearly 11 mm.; length, upward of 15 mm.; the posterior extremity of each being broken off.

Occurrence.—Obtained by Doctor Stanton in No. 13 of his Malone Mountain section, on the west side of Malone Mountain, south of west from Malone station. Besides the types, a considerable number of less satisfactorily preserved casts and fragments of casts were collected in their borings in fossil wood, at the same locality.

A cast of Martesia referred to this species, obtained at the anticline in the east side of Malone Mountain about 1 mile north of its southern end, shows a more posteriorly produced form than might be inferred from the above-described types, indicating that a considerable length has been broken off from each of the latter.

Borings presumed to have been those of Martesia were also found 1½ miles east of Malone station.

GASTROPODA.

PLEUROTOMARIIDÆ.

Genus PLEUROTOMARIA Defrance.

PLEUROTOMARIA CIRCUMTRUNCA sp. n.

Pl. XIX, figs. 8, 9.

Shell conical, consisting of 5 to 6 flattened or in part concave whorls, the slope of spire nearly straight, that of the entire shell, however, concave, owing to the form of the body whorl; spire acute; sutures lightly impressed, bordered by a low elevation above and below; body whorl concave above the peripheral zone, its periphery canaliculate-truncate, or having two low, abrupt angulations with a narrow, shallow-concave belt between them (and which, in the poorly preserved and sometimes more or less distorted specimens commonly found at the type locality, occasionally appears like a merely flat truncation); surface of the entire shell ornamented with fine, crowded, revolving raised lines, so minute as to be scarcely visible to the naked eye, and of which (in one of the types) there are 11 on the peripheral canal of the body whorl. The aspect of the peripheral canalicular truncation is outward and slightly downward.

Measurements.—Height, 20 mm.; breadth, 19 mm.; angular divergence of the slopes (excluding the body whorl), 66°.

Occurrence.—One and a half miles east of Malone station, in the lower part of the Theta subdivision of the section there exposed; with *Delphinula stantoni*, *Turbo? beneclathratus*, *Natica williamsi*, *Nerita nodilirata*, *Gervillia corrugata*, etc. Represented by eleven examples.

TROCHIDÆ.

Genus TURBO Linnæus.

TURBO ? BENECLATHRATUS sp. n.

Pl. XIX, figs. 10, 11.

Shell rather small, turbinate-conical, composed of about 4 ventricose whorls; spire and body whorl about equal in height; body whorl

flattened and angulated on its upper part, the flattened zone being rather narrow and adjacent to the suture; aperture subovate; outer lip thin (?); inner lip covered with a calcareous callus, which is so arched as to indicate the presence of a low fold or tooth-like protuberance below; entire surface ornamented with a regular, open lattice-work of narrow, strongly elevated, transverse ribs, which are crossed by similar but somewhat more delicate revolving ones, the points of intersection being slightly protuberant to subtubercular, and the rectangular included intervals being gently concave and each marked by several raised growth lines.

Measurements.—Height, 19.5 mm.; breadth, 17 mm.

Occurrence.—A mile and a half east of Malone station; with *Gryphæa mexicana*, *Pleurotomaria circumtrunca*, *Natica williamsi*, etc. Known only by a single specimen, which has the base and the margin of the outer lip broken off. It is possible that specimens with the apertural characters well preserved might show this shell to belong to Purpurina.

Genus DELPHINULA Lamarck.

DELPHINULA STANTONI sp. n.

Pl. XIX, figs. 12–14.

Shell rather small, conoidal-turbinate, narrowly umbilicate, consisting of 4½ ventricose whorls, thick, especially in the vicinity of the peristome; spire about equal to the body whorl in height; aperture circular or nearly so; whorls rather closely ornamented with revolving lines of crowded and small but prominent granules, each granule shown, when the ornamentation is well preserved, to consist of a stout hood-like imbrication; body whorl flattened above in a rather broad zone that looks upward and outward, and is externally limited by an angulation that is marked by a line of relatively coarse and prominent hood-like imbrications, below which, in a narrow zone, the surface of the whorl is again somewhat flattened and looks outwardly, a second line of relatively coarse and prominent granules traversing the flattened upper slope of the body whorl, just below the suture. Between the upper and lower lines of coarse imbrications there are two lines of the smaller ones, and between the lower and the umbilical border there are nine.

Measurements.—Height, 16 mm.; breadth, 13 or 14 mm.; angular divergence of slopes, 80°.

Occurrence.—A mile and a half east of Malone station, in the lower exposed part of the Theta; associated with *Natica williamsi*, *Pleurotomaria circumtrunca*, *Gervillia corrugata*, *Gryphæa mexicana*, and many other, especially of the smaller of the Malone fossils. Five

specimens were collected, four of them by Doctor Stanton, after whom the species is named.

NERITIDÆ.

Genus NERITA Linnæus.

NERITA NODILIRATA sp. n.

Pl. XX, figs. 1–4.

Shell thick, composed of 2½ to 3 whorls, its very obtuse-apexed interior cast loosely coiled and making only about a revolution and a half; body whorl obtusely angulated above the middle, somewhat concave above the angulation and again convex above the concave zone; spire very small, rising but little above the body whorl; aperture semilunar; peristome considerably thickened below; columellar area broadly flattened and overspread with a callus; whorls transversely trenchant-striate, or marked with close and abruptly elevated transverse lines, and bearing tubercular or noded ribs; exposed parts of the spire whorls and the corresponding (upper) part of the body whorl bearing rather remote, compressed, transverse ribs, each of which bears 2 remote nodes (the lower node being at the locus of angulation in the body whorl and just above the inferior suture in spire whorls), these ribs continued as simple ridges across the lower part of the whorls in very young shells, but on the body whorl of older ones giving place to 4 or 5 revolving interrupted ribs or rows of low, elongate granules or tubercles.

Measurements.—Height, 27 mm.; breadth, 30 mm.; these dimensions representing considerably less than the maximum size. The two largest specimens at hand, though too imperfect for exact measurement, indicate dimensions between one-third and one-half greater.

Occurrence.—Especially abundant, with *Natica williamsi* and other Gasteropoda, in lower strata of the exposed part of the Theta, between the Trio and the Truncate mound, being represented in my collection by 54 specimens.

The species belongs to the subgenus Lissochilus.

NERITA FINLAYENSIS sp. n.

Pl. XIX, fig. 15.

General form somewhat like that of *N. nodilirata*, both body whorl and spire, however, a little more elevated; whorls few; body whorl with an even, obtuse, revolving angulation near the middle, the same being obsolete near the aperture, where the shell is almost evenly

rounded, and gradually becoming noticeable as it recedes from it at half a turn from the aperture; the same angulation apparently continued on the lower part of the spire whorls; base of first spire whorl rising abruptly from the upper margin of the body whorl, the suture thus being strongly indicated; surface of shell devoid of transverse (vertical) ribs or nodes, plain, crossed with finer and coarser growth lines.

Measurements.—Height, about 20 mm.; breadth, 18.5 mm.

Occurrence.—One specimen, obtained in foothills at the northwest end of Malone Mountain, about 2 miles east-southeast from Finlay station.

NERITA PEROBLATA sp. n.

Pl. XIX, figs. 16, 17.

Shell obliquely-depressed oval, consisting of 2 whorls; spire involved, or rising but feebly above the adjoining whorl border; body whorl rapidly increasing its centrifugal expansion with spiral distance from its origin, convex on its outer and lower parts, flattish on an upper zone which is limited below by an obsolescent spiral ridge; aperture semicircular; inner lip without teeth, bearing a thick, flat-surfaced callus; outer lip with simple acute border; surface of shell plain, presenting, besides the obsolescent spiral ridge, only growth lines, some of which, more pronounced than the others and occurring at irregular intervals, constitute coarse constrictions and ridges which are conspicuous also on parts of the cast from which the shell has been removed. Of the outer lip in the type only the lower border is preserved, but this shows the simple and acute character above described.

Measurements.—Height, 41 mm. (of which the spire occupies barely 2); breadth, 44 mm.; height of aperture, 35 mm.; greatest (obliquely centrifugal) diameter of same, 29 mm.

Occurrence.—Known only by one example, which was associated with *Nerita nodilirata*, etc., 1½ miles east of Malone station.

Max Schlosser[a] comments on the Jurassic forms of this genus as follows, translated:

> The Jurassic Neritas are distinguished from the typical by the imperfect (*Nerita chromatica* Zitt.) or wholly obsolete toothing of the inner lip (*Nerita zitteli, neumayri*). The outer lip is always simple with cutting border. As the only departure from this, one observes a greater or less thickening. On the inner lip appears a mostly very strong, often indeed high-arched callus. The general habit, however, agrees so well with the recent forms that the erection of a new subgenus appears inadvisable.

[a] Die Fauna der Kelheimer Diceras-Kalkes: Palaeontographica, vol. 28, p. 93.

TURRITELLIDÆ.

Genus TURRITELLA Lamarck.

TURRITELLA BURKARTI sp. n.

Pl. XX, fig. 5.

Shell turreted, of moderate size for a Turritella, consisting of numerous whorls, which are greatly convex, wider than high, and medially carinate by virtue of the ornamentation, bearing four granulated, revolving raised lines, of which one, much larger and more prominent than the others, and more decidedly cariniform, crosses the middle of the whorl, while 2 of the 3 smaller and subequal ones are placed, respectively, just below and just above the upper and lower limiting suture, the remaining one being placed between the uppermost one and the large carina, and nearer to the former than to the latter, so that the 3 intervals increase serially from uppermost to the lowermost. Aperture unknown.

Measurements.—The type and only known specimen includes four largely embedded whorls within a span of 14 mm. The largest one of these whorls has a height of 4.5 mm. and an exposed breadth of 5.5 mm., which is less than the true breadth, only about a third of each whorl being free from the matrix.

Occurrence.—In the anticline on the east slope of Malone Mountain, nearly 1 mile north of its southern end; collected by Doctor Stanton.

The species is named after a former traveler in Mexico, Mr. Joseph Burkart, who, as quoted from his "Aufenhalt und Reisen in Mexico in den Jahren 1825 bis 1834" by Castillo and Aguilera, on page V of their Fauna Fosil, has recorded a Turritella (identified as to genus by Professor Goldfuss) as collected by him in the Mineral de Catorce some three-quarters of a century ago. The species collected by him may, by no means improbably, have corresponded in geological age and in kind with the Malone species above briefly described.

VERMETIDÆ.

VERMETUS CORNEJOI Castillo and Aguilera ?.

Pl. XX, fig. 6.

Vermetus (*Burtinella*) *cornejoi* Castillo and Aguilera, 1895, Bol. Com. Geol. Mex., No. 1, p. 12, Pl. VI, figs. 5, 6, and 7.

Eight specimens of Vermetus, from the Theta, 1½ miles east of Malone station, are referred to this species. They show only the inner

whorls and only one of them approaches in size the smallest one of the types figured from the Sierra de Catorce by Castillo and Aguilera. The cavity is oval in cross section, and its lesser diameter is equal to about four times the thickness of its wall.

The following is a translation of the specific diagnosis:

Shell small, free in the adult state, tubular, inrolled planorbiform, sinistral, last whorl unrolled. Tube rugose, bearing two spiral carinæ at the base, the exterior more prominent than the interior, inclosing between them a narrow furrow. Aperture circular or slightly oval. Surface furnished with sinuous growth lines and quite pronounced on the upper part of the whorls, less so on the inferior part.

NATICIDÆ.

Genus NATICA (Adanson) Lamarck.

NATICA WILLIAMSI sp. n.

Pl. XX, figs. 7, 8.

Shell of medium size in its genus, imperforate; whorls 5; spire small, short, and concave, giving it an apiculate aspect when well preserved, its height about one-fifth of that of the entire shell; body whorl large, obliquely inverted pyriform, flattish on the region below the weakly impressed suture, the greatest convexity being somewhat above the middle of the whorl; inner lip and columellar region covered with a layer of callus; aperture rather long and narrow, narrowing gradually upward, rounded below, subacute above.

Measurements.—Height, 40 mm.; breadth, about 30 mm. Other specimens, not allowing precise measurement, indicate about one and a half times these dimensions.

Occurrence.—A mile and a half east of Malone station, associated with *Natica inflecta*, *Nerita nodilirata*, etc. At this locality it is one of the commonest of the Malone Gastropoda. Nearly a hundred specimens are in hand, most of them poorly preserved owing to weathering.

This shell is named for Mr. John W. Williams, who in 1897 was prospecting in the Quitman Mountains not far from Malone, and whose exceedingly kind and thoughtful interest in my work, displayed in many practical ways, contributed not a little in that year to the pleasure as well as the success of my explorations in the Malone district.

In its low and concave spire and feebly impressed suture, and a tendency to greater breadth in the upper part of the body whorl, the shell recalls Actæonella and constitutes an unusual phase of Jurassic Amauropsis.

NATICA INFLECTA sp. n.

Pl. XX, figs. 11, 12.

Shell of medium or rather small size in its genus, smaller than *Natica williamsi*, consisting of about 5 whorls, imperforate, of rather stout or medium elevated habit; the spire not concave, much more elevated than that of the above-mentioned species, its height being about two-fifths of that of the shell, composed of convex, well-rounded whorls, separated by sutures which are deeply and rather suddenly impressed, a narrow upper border of the whorls being gently and subhorizontally flattened; aperture narrow, or elevated, considerably less so, however, than that of *N. williamsi*, narrowly rounded below, obtusely pointed above; columella slightly produced, inner lip and spindle callus-plated; surface smooth or crossed only with ordinary growth lines.

Measurements.—Height, 35 mm.; breadth, 27 mm.; height of spire, 14 mm. A second example has dimensions about 75 per cent greater.

Occurrence.—A mile and a half east of Malone station; with *Natica williamsi*, from which the species is readily distinguished. The writer obtained only three shells of *N. inflecta*, one of which, a young example, has the body whorl crossed with alternating dark and light bands, parallel with the growth lines. An example was obtained by Doctor Stanton at the same locality, and one by him in foothills at the northwest end of Malone Mountain, about 2 miles east-southeast from Finlay station.

The species seems to stand close to the English Oxfordian form, *N. arguta* Phil., and is referred to the subgenus Amauropsis, to which all of the Naticæ now known from the Malone formation seem to belong.

NATICA FINLAYENSIS sp. n.

Pl. XX, figs. 15, 16.

Shell of medium size in its genus, subovate, imperforate; whorls about 5, moderately convex, those of the spire broad and low; body whorl large, elevated, oblique; spire more than a third and considerably less than half of the height of the shell, higher than the spire of *Natica williamsi*, lower than that of *N. inflecta;* suture much more strongly impressed than that of the former and much less so than that of the latter species; aperture elevated, arcuate-pyriform, pointed above, rounded below; inner lip not free-margined, and apparently with little callus, concave below, convex above; surface plain.

Measurements.—Height (approximately), 42 mm.; breadth, 30 mm.

Occurrence.—The type and only known example was obtained by Doctor Stanton in foothills at the northwest end of Malone Mountain, a little over 2 miles east-southeast from Finlay station.

NATICA BILABIATA sp. n.

Pl. XX, figs. 9, 10.

Shell rather small, consisting (apparently) of about 3½ strongly convex whorls; without umbilicus; provided with a narrow, elongate, and shallow cleft formed by the eversion of the inner lip; spire short, its height much less than that of the aperture; suture well impressed; aperture obliquely ovate, about two-thirds as high as the entire shell; outer lip simple; inner lip everted, thickened below, its border quite free in the middle region, where it pursues a nearly straight course and constitutes the outer bound of the small umbilical cleft; exterior smooth except for the numerous ordinary growth lines.

Measurements.—Height, about 21 mm.; breadth 18 mm.

Occurrence.—One specimen, from the same fragment of limestone that bore one of the types of *Unicardium semirotundum;* 1½ miles east of Malone station. Collected by Doctor Stanton.

PYRAMIDELLIDÆ.

Genus PSEUDOMELANIA Pictet.

PSEUDOMELANIA GOODELLII sp. n.

Pl. XXI, fig. 10.

Shell large, turreted, consisting of numerous smooth, flattened, upwardly-imbricated whorls, of which the lower spire whorls are nearly twice as wide as high; shell substance thick, sometimes showing, parallel with the height (length) of the shell, numerous rather narrow, unequal, or subequal, alternating dark and light bands, of which there are perhaps as many as 50 of either shade on each whorl.

Measurements.—Breadth of body whorl in largest specimen, 50 mm.; breadth of first spire whorl, 43 mm.; height of same, 21 mm. The shell in this specimen apparently had a height of 170 to 180 mm. In a second example, with body whorl 44 mm. in breadth, the shell height is about 165 mm.

Occurrence.—This, the largest of the Gastropoda known from the Malone formation, is only moderately common; and all of the material of it obtained is more or less fragmentary, though collectively affording a fair knowledge of the species. The above description of it, based on all of the material now known, supersedes an earlier one in manuscript made by me at a time when my knowledge of the

species was derived solely from an imperfect specimen, which was from the locality 1½ miles east of Malone station. Besides a fragment from the locality just named, Doctor Stanton's collections include material of this shell from the following localities: From No. 13 (the Nautilus horizon) of his Malone Mountain section, on the west side of the mountain, southwesterly from Malone station; and from about 1 mile east of Finlay station, one of the specimens from the last-named locality being in rock with *Trigonia calderoni*. A poorly preserved portion of probably this fossil was also found by Doctor Stanton in the anticline in the eastern slope of Malone Mountain nearly 1 mile north of its southern end.

The species is named after the late Mr. Robert W. Goodell.

NERINEIDÆ.

Genus NERINEA Defrance.

NERINEA GOODELLII sp. n.

Pl. XXI, figs. 1–3.

Shell turriculate to cylindrical-turriculate, not exceedingly attenuate; walls thin, the outer one bearing internally one prominent, thin, and acute fold which extends scarcely half way across the chamber; columella rather slender, in part hollow, bearing 2 thin folds both smaller than the outer fold; whorls apparently 17 or more, low, usually as much as one and a half times and sometimes about twice as wide as high, concave, the opposed borders of successive whorls tending to form a low cariniform ridge with linear suture on the summit line, the surface of each whorl ornamented with 3 or 4 linear, raised, revolving lines and ordinary oblique, somewhat sinuous growth lines. Of the three internal folds, the upper columellar one, which descends from the junction of the upper wall of the chamber with the columella, is the smallest and thinnest, yet is quite salient.

Measurements.—Breadth of largest whorls reaching 14 mm.; angular divergence of slopes 5° or 6° to 8°.

Occurrence.—Common in the limestone layers, and less so in the sandstone, at various levels in the Theta, 1½ miles east of Malone station; exceedingly abundant in some of the lower layers. Weathered-out specimens usually occur in segments of two or three to a dozen or more whorls. Besides the numerous specimens in my collection, which include some natural longitudinal sections, I have examined four specimens, one of which is an artificial section, submitted by Doctor Stanton. Several poor weathered sections were obtained near the south end of Malone Mountain, from a locality which yielded also a specimen of *Trigonia munita*.

I have not been able to ascertain the maximum height of this shell, nor with certainty the number of whorls; but in 1 specimen only 4 mm. in breadth and about 17 mm. in height there are 15 whorls preserved, while probably 2 or 3 minute ones have been dissolved away at the summit.

The revolving lines of ornamentation on this shell are very delicate and commonly are not seen at all on weathered specimens.

In its internal ridges, as well as in the form of its whorls, the species resembles the Corallian form, *N. goodhallii* Sowerby.[a] It is named for the Messrs R. R. and R. W. Goodell, in recognition of their joint exploration of the Malone, an account of which has been given elsewhere.

For comparison with *Nerinea goodellii*, Doctor Stanton has handed the writer some fragments and fragmental prepared sections of a Nerinea "broken from the hand specimen that bears the larger of the types of *Trigonia taffii* Cragin."[b] These resemble *N. goodellii* superficially, but appear to lack revolving lines and to present sectional details which seem to refer them to a different species, although the unsatisfactory state of their preservation forbids full assurance that their internal characters are all correctly understood. In the Nerinea from Bluff Mesa the fold on the outer wall is relatively thicker and more obtuse and is altogether larger than in *N. goodellii*, extending a little more than half way across the chamber; the lower columellar fold is also coarser than that of *N. goodellii*. The upper columellar fold is not very clearly indicated; if present at all it is apparently obsolescent, or at least much smaller than that of *N. goodellii*.

NERINEA CIRCUMVOLUTA sp. n.

Pl. XXI, figs. 4, 5.

Shell cylindrical-turriculate; walls thin, with one outer and two columellar folds situated as in the much more common *Nerinea goodellii*, all of the folds delicate, the outer one less so than the other two; columella solid, rather slender; whorls flat or only very slightly concave, one and a fourth times as high as wide, apparently at least as numerous as in *N. goodellii*, presenting an imbricated appearance at the suture, as if the outer wall of each whorl slightly overlapped

[a] Described and figured in exterior and in section by James de Carle Sowerby, in Dr. William Henry Fitton's "Observations on some of the strata between the Chalk and the Oxford Oölite in the southeast of England;" Trans. Geol. Soc. London, 2d ser., vol. 4, 1836. Sowerby's figures (12 of Pl. XXIII, loc. cit.) represent it as several times larger than the shell here described as *goodellii*. The figures 1294 of the fourth edition of Dana's Manual are partial and much reduced copies of Sowerby's figures, but, unlike the latter, represent the shell as thick-walled.

[b] The large valve from Bluff Mesa, which is the real type of this Trigonia. See remarks on *Trigonia taffii* on page 10.

the whorl next above; suture subtended by a narrow, plain band, which is itself limited below by a delicate striæform groove; surface ornamented only with growth lines, which are for the most part vertical, becoming strongly recurved as they near the upper border of the whorl.

Measurements.—A fragment 6.5 mm. wide at the lower end has 5 whorls in a height of 29 mm.

Occurrence.—The species is based on several segments collected and a longitudinal section prepared by Doctor Stanton, and which are from the locality 1½ miles east of Malone station.

Genus NERINELLA Sharpe.

NERINELLA STANTONI sp. n.

Pl. XXI, figs. 6–9.

In 1898 Doctor Stanton very kindly communicated a specimen of Nerinella, partly cut in longitudinal section, which he had obtained while collecting with me during the previous year from the same beds, 1½ miles east of Malone station, that yielded *Nerinea goodellii.*

It is exceedingly attenuated and, within 53 mm., includes 20 concave whorls from a number that must obviously have been much greater in the complete shell. The chamber has no columellar fold, but its outer wall presents a simple, short, and rather obtuse fold at about mid height. The whorls are crossed by numerous delicate growth lines and are ornamented with 4 equidistant, spiral, cariniform lines on the main part, besides 2 which are so close to the whorl borders as often to be difficultly distinguishable.

I find in my own collection, made 1½ miles east of Malone, a few incomplete and more or less weathered specimens of this fossil. One of these supplements Doctor Stanton's specimen as to the upper part of the spire, showing 16 additional whorls, with apparently a very few still to be added at the apex. Another represents a basal portion considerably broader than the larger end of Doctor Stanton's specimen, so that the number of whorls in this shell can be little, if at all, short of 50. The greatest breadth shown by any of these specimens is between 5 and 6 mm. The height of the shell is roughly estimated at about 100 mm.

This fossil is also recognized in material obtained by Doctor Stanton at the following places: In No. 13 of his Malone Mountain section, about 2 miles southwest of Malone station, on the west of the mountain; in about the same horizon something over 1 mile east of Finlay station, and in the anticline at the east base of the mountain, about a mile from its southern end.

CERITHIIDÆ.

Genus CERITHIUM Adanson.

CERITHIUM ARCUIFERUM sp. n.

Pl. XX, fig. 13.

Shell small, turriculate, many whorled; spindle solid; mouth subquadrate; surface of the gently convex whorls ornamented with numerous fine revolving lines and with coarse transverse folds, or ribs, the latter strongly arched backward, the summit and more prominent portion of the arch being on the lower and more prominent portion of the whorls. Of the revolving lines there are about 17 on the first spire whorl, and of the arcuate folds there are about the same number on the body whorl.

Measurements.—Breadth, 7 mm.; angular divergence of slopes on the lower part of the shell, 21° or 22°.

Occurrence.—A mile and a half east of Malone station; with *Nerita vodilirata*, *Pleurotomaria circumtrunca*, etc. Only a single specimen lacking the lower end of the spindle and the upper part of the spire has been found.

Owing to the incompleteness of the lower extremity of the shell in the type the basal canal is not shown, but its presence in the complete shell and a reference to the genus *Cerithium* are indicated by the character of the spindle and the general habit of the shell, the latter being apparently that of the subgenus *Cerithinella*.

ACTÆONIDÆ.

Genus ACTÆONINA d'Orbigny.

ACTÆONINA ? MALONIANA sp. n.

Pl. XX, fig. 14.

Whorls 4 or 5; body whorl large, about three-fourths as wide as high in the cast, its sides gently convex; spire small, evidently not much exceeding one-fifth of the body whorl in height; aperture high and narrow, somewhat broadened below, and the inner lip apparently without fold; general surface as indicated by a preserved basal fragment, marked with delicate revolving grooves or striæ, the striæ separated by intervals wider than themselves.

Measurements.—Height (approximately), 14.5 mm.; breadth, 10 mm.

Occurrence.—Known only by a cast bearing two fragments of the shell; obtained by Doctor Stanton 1½ miles east of Malone station.

When viewed from above, the cast presents a somewhat squared form, due apparently to the accident of rock pressure.

CEPHALOPODA.

NAUTILOIDEA.

Genus NAUTILUS Breyn.

NAUTILUS BURKARTI C. and A.?

Pl. XXII, fig. 1.

Nautilus burkarti Castillo and Aguilera, 1895, Bol. Com. Geol. Mex., No.1, p. 12, Pl. XXI, fig. 3.

I provisionally refer to this species an imperfect specimen of Nautilus of inflated form obtained by Doctor Stanton in No. 13 of his Malone Mountain section, on the west side of the mountain southwest of Malone station. The dimensions are much larger than those indicated by Castillo and Aguilera's figure and description of *N. burkarti*, which are perhaps those of a young example.

The Malone Mountain specimen gives the following measurements: Height of shell, 123 mm.; height of last whorl, 67 mm.; breadth of the latter, as restored, 86 mm. The height of the last whorl is therefore about 54.5 per cent and its breadth about 70 per cent of the height of the shell, as against 55 and 64, given as corresponding percentages for the type-specimen.

The following is a translation of the original description of the species:

Shell extremely inflated; spire composed of few whorls which cover more than three-fourths of the whorls preceding; flanks quite convex and attaining their greatest thickness near the umbilicus, whence they descend gradually toward the siphonal region, which is quite rounded; umbilicus narrow, deep, and funnel-shaped; aperture very much invaded by the spire whorl, wider than high, rounded on the upper part; surface nearly smooth, destitute of tubercles, bearing only marked growth lines, which make it slightly rough on some parts.

Diameter	49.00 mm.
Breadth of the last whorl in relation to the diameter	.55
Thickness of the last whorl in relation to the diameter	.64
Diameter of the umbilicus to the diameter	.23

NAUTILUS NAUFRAGUS sp. n.

Pl. XXIII, fig. 3, Pl. XXIV, fig. 3.

Shell involute, somewhat compressed; volutions deeply embracing, increasing rapidly in size, narrowed on the feebly convex flanks from

a region of maximum, yet moderate inflation, near the umbilicus, to the rather narrowly rounded periphery; septa about 24 to each turn, the sutures feebly waved or sigmoid; umbilicus narrow, filled with a shelly columella; surface of shell smooth. The position of the siphuncle has not been determined.

Measurements.—The greatest diameter of the larger specimen is about 122 mm. The height of the largest preserved part of the body-chamber in its median plane is about 50 mm. The height of the same part of the body-chamber over all, or measured on a tangent to the flank from the level of its umbilical border to the level of the periphery, is about 71 mm. (66 on one flank, 76 on the other flank, in the specimen as preserved, the umbilical axis having an oblique position, due to crushing). The original breadth of the same part of the body chamber, allowing for crushing, was apparently not less than 60 mm.

Occurrence.—Two imperfect specimens of this shell were collected by Doctor Stanton in foothills near the railroad, at the northwest end of Malone Mountain, about 2 miles east-southeast from Finlay station, the horizon not more than 200 feet above the gypsum bed.

AMMONOIDEA.

Genus OPPELIA Waagen.

OPPELIA ? FALLAX (C. and A.).

Pl. XXII, figs. 2, 3.

Placenticeras fallax Castillo and Aguilera, 1895, Bol. Com. Geol. Mex., No. 1, p. 17, Pl. VIII, figs. 1, 2.

This large, plain, compressed, and obtusely lenticular ammonite is rather common in the limestone portions of Theta subdivision of the Trio section, 1½ miles east of Malone station, but has been obtained thence in fragmentary specimens only.

The following is a translation of the original specific description:

Shell compressed, narrowly umbilicate. Spire composed of not very numerous embracing whorls, which almost completely hide the previous whorls. Flanks feebly convex, descending gradually toward the umbilical border and with the same regularity toward the siphonal region, which is rounded and a little more narrow than the flanks; the greatest thickness of the shell is on the umbilical border. Umbilicus very narrow and deep, with vertical walls, with uncarinated border. Aperture very high, considerably invaded by the spire whorl, rounded in the upper part, of nearly elliptical form. Surface of the shell smooth on the last whorls, bearing in the earlier whorls fine lines of growth. Diameter, 104 mm.; breadth of the last whorl in relation to the diameter, 0.54; thickness of the last whorl in relation to the diameter, 0.32; diameter of the umbilicus in relation to the diameter, 0.16.

To the above description Castillo and Aguilera add the following remarks:

> We place this species in the genus *Placenticeras*, notwithstanding that by its form it could be considered as a *Phylloceras*, by the characters of the sutural line which, though imperfectly visible in one of the specimens of our collection, does not present the saddles terminated by the roundels characteristic of the *Phylloceras*, only ramifications and subdivisions similar to those of the *Placenticeras*.

As it makes some departures from the characters belonging to most of its congeners, this ammonite may seem at first sight almost as much of an anomaly in the genus *Oppelia* as it was supposed to be in *Placenticeras*. But the suture, which has the lobes and saddles very few instead of many,[a] and has the first lateral lobe contrastingly the largest, sufficiently distinguishes it from the latter genus and relates it to *Oppelia* and *Haploceras*, with which also agree its involute, narrowly umbilicated shell, its rounded venter, its rather compressed lenticular form, and the absence of periodical constrictions. It seems indeed to have its closest affinities and to belong among the round-ventered, phylogerontic forms of *Oppelia* which occur in the latest Jurassic rocks, in which this genus makes its final appearance; the venter, in *O. fallax*, being rounded both on the outer and on the inner whorls.

The Malone *Oppelia* bears considerable resemblance to the Tithonian species, *O. waageni* Zittel, having about the same outward form and being of large size; but it apparently lacks a vestige of even such feebly expressed, coarse lateral ribs, or undulations, as are seen on that shell, and is more critically distinguished from it by the characters of the suture. The first lateral saddle is much narrower in the Malone ammonite than in *Oppelia waageni*, and the first lateral lobe—which is quite unsymmetrically branched in the latter shell—presents an almost symmetrical branching in *O. fallax*. In this last-mentioned character, *O. fallax* departs from the condition most common in *Oppelia* and approaches the usual condition in *Desmoceras*, from which genus it is separated by the absence of constrictions. The siphonal lobe is about half as long as the first lateral lobe and ends in two small branches on either side.

Though commonly represented from the Malone district by whorl fragments of dimensions not or little exceeding those given by Castillo and Aguilera for the examples from the Sierra de Catorce, the shell attains a much larger size. One specimen, of which considerable portions were collected 1½ miles east of Malone station, has in the largest preserved cross section of the body chamber, a height of about 145 and a breadth of at least 93 mm., while the diameter of

[a] My attention was first called to the few-lobed suture, as inconsistent with *Placenticeras*, by Doctor Stanton.

the coil (a large part of whose periphery is preserved) must have considerably exceeded a foot. The specific identification is tentative, as it is based on the comparison of imperfect specimens with Castillo and Aguilera's description and figures. The specimen figured is a young individual and the only one in the collection that shows more than a fragment of a complete volution.

Genus OLCOSTEPHANUS Neumayr.

OLCOSTEPHANUS MALONIANUS sp. n.

Pl. XXIV, figs. 1, 2.

Shell large and moderately involute, consisting of massive whorls which are at least as high as or a little higher than wide, with flattish-convex flanks and broadly rounded periphery, about one-fourth of the height of each inner whorl embraced within the whorl next outer; umbilical costæ not at all resembling compressed tubercles, but heavy, long, and truly rib-like, traversing the lower and middle parts of the flank from the lower border to between half and two-thirds the height of the whorl, giving place at their upper ends to numerous compressed, narrowly round-topped costellæ which are fascicled mostly in threes at their origin, but are uniformly distributed upon the periphery of the whorls, over which they pass without interruption, swinging very little forward; suture strongly dissected, the two lateral lobes and saddles large and complexly branching, the external one especially so. The body chamber is unknown.

Measurements.—The largest known whorl section (which is in the septate portion of the shell) has the height and breadth about 110 and 105 mm.; an inner one about 58 and 57 mm., respectively.

Occurrence.—Only a few parts of whorls, most if not all of which belong to one specimen, were collected at the locality 1½ miles east of Malone station.

The species is intermediate in general proportions between the two species of *Olcostephanus* known from the Alamitos beds—which seem to correspond in some measure with the Malone formation—in Mexico: *O.* "af. *portlandicus* de Loriol" and *O. potosina* of Castillo and Aguilera.

Genus PERISPHINCTES Waagen.

PERISPHINCTES CLARKI sp. n.

Pl. XXIX, figs. 1, 2.

Shell large, discoidal, many whorled, broadly umbilicated; involution more than one-half; whorls ovate, the outer ones elevated or narrow-ovate in cross section, narrowed toward the venter, which is

rather narrowly rounded; the flanks flattish-convex; umbilical border rounded; the wall of the outer whorl sloping rather gently to the next whorl within it, that of the inner whorls descending somewhat more steeply below; inner whorls ornamented with strongly elevated, moderately close, but not crowded, dichotomous ribs whose branches separate at about the middle of the flank and continuously cross the venter, the lateral ribs not noticeably enlarged on the umbilical border, this ornamentation becoming gradually changed to large low undulations on the outer whorls and almost vanishing before the (presumably plain or nearly plain) body chamber is reached; septal line with two strong lateral lobes, which are rather strongly dissected, and a deep suspensive lobe; the first lateral lobe large, twice or more than twice as long as the second, longer than the siphonal lobe, and having three strong terminal branches of which the outer is subtended by a smaller branch; the second lateral lobe pinnate, not distinctly branched at summit; a noticeable lobe, similar to the second lateral lobe, but slenderer and about two-thirds as long, stands between the first lateral and the siphonal lobe; suspensive lobe consisting of one tall pinnate lobe, with strongly trifid summit, which is outwardly preceded by a trio consisting of a small lobe flanked on either side by a lobule and is inwardly followed by two obtuse lobes the inner of which is very low and often 3-denticled. This description of the septal line relates to the later septa, the preceding ones being somewhat simpler.

Measurements.—Height of largest cross section of whorl preserved in the type, 85 mm.; breadth of same, 54 mm.; span of umbilicus opposite same section, 90 mm.

Occurrence.—The type represents a considerable and wholly septate part of the form and was obtained by Doctor Stanton from No. 13 of his Malone Mountain section on the west side of the mountain, about 2 miles southwesterly from Malone station. He obtained a fragment also on the east slope of the mountain near its southern end, about 200 or 300 feet above the heavy bed of gypsum which there forms the base of the mountain; and a poorly preserved specimen and fragment from foothills near the railroad, at the northwest end of Malone Mountain, a little over 2 miles east-southeast of Finlay station, not more than 200 feet above the gypsum bed of that locality.

It is not unlikely that this is the same species as that figured and briefly described from the Tithonian of Mexico as "*Perisphinctes sp.* (?)" by Castillo and Aguilera,[a] and compared by them in its ribbing with *P. lictor*, *P. haliarchus*, and *P. polygyratus*. The septal line bears considerable resemblance to that of the latter species, which, from the White Jura Beta, Quenstedt[b] figures under the name of "*Ammonites triplicatus albus.*"

[a] Fauna Fosil de la Sierra de Catorce, p. 35, Pl. XIX.
[b] Die Ammoniten des Schwäbischen Jura, pl. 100, fig. 8.

The species is named for Dr. Wm. Bullock Clark, professor of geology in Johns Hopkins University and director of the Maryland geological survey.

PERISPHINCTES AGUILERAI sp. n.

Pl. XXVIII, figs. 1, 2.

Shell large, discoidal; umbilicus large, spanning more than a third of the diameter of the shell, rather shallow, its wall descending almost vertically from a rounded border; whorls little involute, each concealing only between a fourth and a fifth of its predecessor, about three-fourths as broad as high, broadest in the lower third, their flanks flattened-convex, the venter rounded, apparently a little tectiform on the outer whorl; ornamented with very numerous compressed ribs, which arise independently at the umbilicus, have a somewhat backward inclination in ascending the umbilical wall, and cross the flanks with a gentle forward inclination and slight sigmoid flexure, bifurcating at about the mid flank into parallel branches that sweep strongly forward on the ventral region so that those of opposite sides meet on the periphery at nearly a right angle; the ribs, and especially the ventral ones, close, yet narrower than the round-bottomed intervals between them, the ventral ribs of the inner whorls being very fine, those of the outer whorls large, though still compressed and strongly elevated; septal line strongly dissected, apparently not differing from that of Perisphinctes, though hitherto observed only in part, the saddles at least not ending in roundels such as characterize the Phylloceratidæ.

Measurements.—Outer whorl attaining at least a height of 107 mm. and a breadth of 84 mm. The cross section of a smaller whorl has the same dimensions, 57 and 50 mm.

Occurrence.—Seven fragments of this species were obtained by Doctor Stanton from the foothills west of Malone Mountain, about 2 miles north of the southern end of the latter. The horizon is regarded by him as probably the same as one that yielded him specimens of the *Exogyra*, herein identified as *E. potosina* (narrow phase).

The species is named for Señor José G. Aguilera, director of the geological institute of Mexico.

PERISPHINCTES POTOSINUS C. and A.

Pl. XXIII, fig. 1.

Perisphinctes potosinus Castillo and Aguilera, 1895, Bol. Com. Geol. Mex., No. 1, p. 31, Pl. XVII, fig. 1 and Pl. XXIV, fig. 2.

Among the specimens from the locality 1½ miles east of Malone station is a fragment of a Perisphinctes belonging to the series of

P. contiguus Catullo, and that seems to agree sufficiently with the description and illustrations of *P. potosina* C. and A. The lateral ribs, in form, size, interspacing, and manner of trifurcation, are those of *P. contiguus*, from which the Malone sheil differs in the more anteriorly inclined lateral ribs and in having the ventral ribs distinctly curved forward as they approach the periphery, on which they are slightly extinguished. The last-named feature, however, is not a specific difference; for while the ventral ribs in *P. contiguus* are usually uninterrupted, a slight peripheral attenuation of them is noted by Toucas [a] as occurring in some varieties of this species in the Carpathians.

The fragment agrees in size with an intermediate part of the outer whorl of *P. contiguus* or *P. potosinus*, and the cross section of whorl which it indicates is about three-fourths as broad as high, measuring 24 mm. in height and 18 or 19 mm. in breadth.

Siemiradzki [b] refers to *P. potosinus* as apparently identical with *P. kokeni* Behrendsen,[c] but there seem to me to be considerable differences between the two species. These differences, if we accept the description and the figure of the adult (Pl. XVII, fig. 1) and exclude the smaller and doubtfully pertinent figure (Pl. XXIV, fig. 2) given by Castillo and Aguilera of their *Perisphinctes potosinus*, are as follows:

P. kokeni.	*P. potosinus.*
Involution $\frac{1}{3}$.	Involution $\frac{2}{3}$ to $\frac{3}{4}$.
Whorls broader (thicker) than high.	Whorls higher than broad.
Whorl cross section quadrilaterally rounded.	Whorl cross section flat-sided ovate.
Venter flatly rounded.	Venter rounded.
Lateral ribs bifurcate.	Lateral ribs bifurcate, the larger number becoming trifurcate on the last whorl.
Simple part of lateral ribs rather slender.	Simple part of lateral ribs rather stout.

PERISPHINCTES FELIXI C. and A.

Pl. XXIII, fig. 2.

Perisphinctes felixi Castillo and Aguilera, 1895, Bol. Com. Geol. Mex., No. 1, p. 25, Pl. XVI, fig. 1.

A species of Perisphinctes apparently not distinct from *P. felixi* C. and A., but intermediate in some of its characters between the latter and the closely allied, if indeed really distinct *P. lauri* C. and A., is represented from the locality 1½ miles east of Malone station by a specimen showing part of three successive whorls.

The whorls are rounded in cross section, having their height and

[a] Bull. Soc. Geol. France, 3d ser., Vol. XVIII, p. 582.
[b] Monogr. Beschr. Perisphinctes, p. 170.
[c] Zeitschr. d. Deutsch. Geol. Gesellsch., Bd. 43, p. 406, pl. 24, figs. 1 and 2. 1891.

breadth about equal (25 mm.), yet having their greatest breadth in the lower part. The involution is between $\frac{1}{3}$ and $\frac{1}{2}$. The ribs are heavy and inclined forward; mostly bifurcate at about the middle of the flank, but in one instance a rib is seemingly bidichotomous, the first bifurcation taking place on the umbilical border. The ventral ribs pass over the periphery without interruption, but are curved forward as they approach the median line so as to make a very obtuse angle, at which many of them suffer a very slight weakening. The specimen does not show the largest part of the last whorl, a fact to which the almost uniformly bifurcate character of the ribbing is probably due.

Doctor Stanton also has collected at this locality a small specimen that apparently represents the inner whorls of the same species. This has many of the ribs once bifurcate, the others simple.

The following is a translation of the original description of the species:

Shell discoidal, spire composed of embracing whorls of nearly round cross section, visible in the umbilicus in a third of its width, having its major thickness near the umbilical border; flanks convex, descending gradually toward the umbilicus; siphonal region perfectly rounded. Umbilicus small, rather deep, its border not angulated. Surface covered with 46 to 48 strong, equal costellæ which bifurcate, some at the middle of the flanks and others a little earlier; of the former some trifurcate and the latter undergo a second bifurcation, which takes place at the same distance from the umbilicus as that of the other costellæ; three or four ribs remain simple; all cross the siphonal region forming a slight forward inflection. Aperture a little higher than wide, a little invaded by the whorl of the spire and rounded above. Three narrow constrictions [*surcos*] are seen, shallow and parallel to the costellæ. Diameter 60 mm., 75 mm.; breadth [height] of the last whorl with relation to the diameter 0.38, 0.38; thickness of the last whorl with relation to the diameter 0.38, 0.38; diameter of the umbilicus with relation to the diameter 0.35, 0.33.

PERISPHINCTES SCHUCHERTI sp. n.

Pl. XXV, fig. 1; Pl. XXVI, figs. 1–3; Pl. XXVII, fig. 1.

Shell discoidal, moderately involute, each whorl embracing about a third of its predecessor; the umbilicus strongly excavated, its span equaling about a third of the corresponding diameter of the shell; whorls laterally compressed, even the earlier ones being much higher than wide, the flanks flattened-convex, narrowed toward the siphonal side, which is rounded, umbilical border rounded above, descending almost sheerly below to the surface of the inner whorls; septal line with two lateral lobes, of which the first is large, ample-trunked and longer than the siphonal lobe, and ends in three branches, the second lateral lobe being well developed and considerably more than half as long as the first, suspensive lobe (*nahtlobus*) of intermediate steepness, presenting one conspicuously large auxiliary lobe; ribs gently

inclined forward on the flanks, somewhat enlarged on the umbilical border, those of the earlier whorls very close and bifurcating or sometimes trifurcating at about the middle of the flank into feebly diverging smaller ones, an occasional rib remaining simple and then being usually accompanied by a short, independent rib, corresponding with one of those produced by bifurcation, this ornamentation becoming gradually obsolete on the greater part of the height of the flanks and also on a narrow median zone in the more mature portion of the shell, which portion is also usually encircled with large shallow constrictions at remote intervals; the ventral ribs about equal to the intervals between them.

Measurements.—The maturer aspects of the shell are represented only by fragments; the cross section of one of which has a height of 47 mm. and a breadth of 27 mm.

Occurrence.—The type material consists of several imperfect specimens and various fragments, all collected by Doctor Stanton in foothills near the railroad, at the northwest end of Malone Mountain, about 2 miles east-southeast of Finlay station. Material obtained on the west side of Malone Mountain, from No. 13 of Malone Mountain section, includes a very doubtful fragment of this species from about 2 miles west of Malone station, and a specimen, also doubtful, and a fragment from a point about three-fourths of a mile farther south. That collected 1½ miles east of Malone station includes a fragment which not improbably belongs to this species.

The septal line of *P. schucherti* is of the same general pattern as that of *P. inconditus* Font., as figured by de Loriol,[a] but differs from it by its broader first lateral lobe and in other details. The shell of *P. schucherti* also differs from that of *P. inconditus* in that the latter has trifurcate and even sometimes quadrifurcate ribs, the ribbing on the flanks of the inner whorls being very much closer in *P. schucherti* than in either *inconditus* or *balderus*.

The second specimen above mentioned is larger and less compressed than the others and has the ribs less inclined forward on the venter, and on part of the shell almost radially directed. I am uncertain whether it belongs to *P. schucherti* or is the young of a larger species. The ribs are, however, obsolete on the flanks, and the specimen is therefore referred here provisionally. It gives the following measurements: Greatest diameter, 125 mm.; span of umbilicus, 50 mm.; height of outer whorl in intermediate part, 45 mm.; breadth of same, 30 mm. It is without constrictions, and in form and character of ventral ribbing bears a resemblance to *Olcostephanus potosinus* C. and A., a fossil from which in other respects it widely differs.

The species is named for Mr. Charles Schuchert, curator of invertebrate paleontology in the United States National Museum.

[a] Foss. d. Baden, Pl. XI, fig. 1c.

Genus ASPIDOCERAS Zittel.

ASPIDOCERAS ALAMITOCENSIS C. and A.

Pl. XXVII, fig. 2.

Aspidoceras alamitocensis Castillo and Aguilera, 1895, Bol. Com. Geol. Mex., No. 1, p. 43, Pl. XXIII.

A portion of a shell which appears quite identical with this bulky ammonite was obtained 1½ miles east of Malone station. It includes about a fourth of a volution, belonging mostly to the septate part of the shell, but including also a small posterior fraction of the body chamber. The septal line is imperfectly shown, but the lateral lobes and saddles are large and coarsely dissected, the saddles having obtuse, the lobes having sharply pointed terminal divisions; and the auxiliaries (not visible in our specimen) are few, or at least not present beyond a narrow umbilical tract of the whorl. Of the two rows of tubercles, only one—that which borders the umbilicus—is shown, owing to the condition of the specimen. Traces of low ribs separated by broad and shallow valleys and crossing the broadly rounded outer side of the whorl, are distinguishable. The specimen indicates a shell at least as large as the largest of the Alamitos specimens whose dimensions are given by Castillo and Aguilera. In the matrix with it are several imperfect specimens of *Exogyra subplicifera.*

VERTEBRATA.

As compared with the rich invertebrate fauna, the known vertebrate fauna of the Malone formation is pitifully meager.

Besides a few ill-preserved and problematical structures which may pertain to Vertebrata, the Malone Hills, 1½ miles east of Malone station, have yielded two cycloid fish scales, between circular and quadrate in outline and a little smaller in area than a 1-cent piece; one well-preserved hemispherical tooth, about the size of a checkerberry, of a Pycnodont; and a number of fragments of bones of rather large swimming reptiles, which are probably in part those of Enaliosaurs.

The east slope of Malone Mountain, a mile north of its southern end, has yielded Doctor Stanton a shark's spine of indeterminate genus.

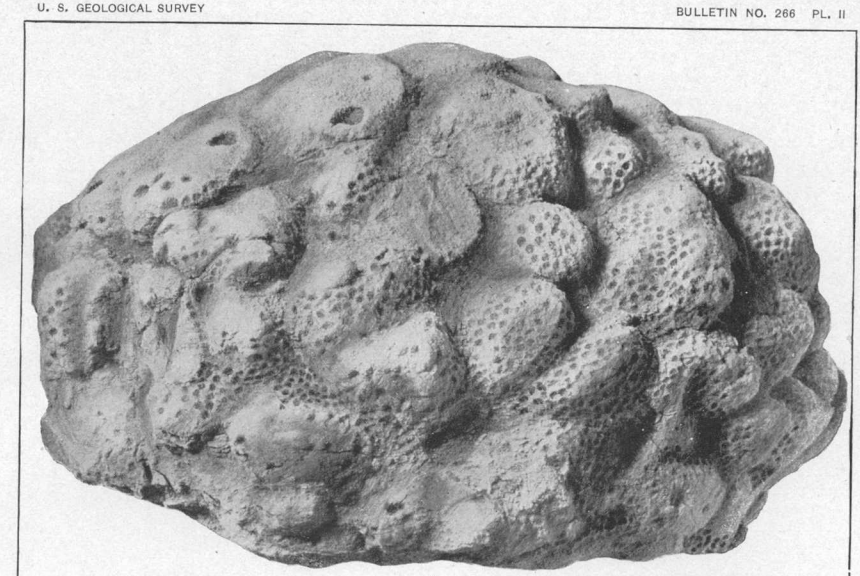
While the Upper Jurassic rocks of Potosi, Oaxaca, etc., Mexico, have yielded a considerable number of invertebrates—some now known, others not yet known, from Texas—they have apparently yielded no vertebrate remains of record whatsoever; and the above brief notices therefore apparently embrace all that is known of the Vertebrata of the Upper Jurassic in Texas and Mexico.

PLATES.

PLATE II.

PLATE II.

FIGS. 1–3. ASTROCŒNIA MALONIANA Vaughan, sp. n. (p. 34).
Figs. 2, 3. Coralla of natural size showing variation in mode of growth.
Fig. 3. Several corallites from fig. 2, enlarged 6 diameters.
FIG. 4. SERPULA sp. (p. 37).
Cross sections of tubes.
FIGS. 5, 6. SERPULA GORDIALIS Schlotheim (p. 37).
Several specimens growing on Astrocœnia maloniana.
FIG. 7. BERENICEA MALONIANA sp. n. (p. 38).
Enlarged 3 diameters.



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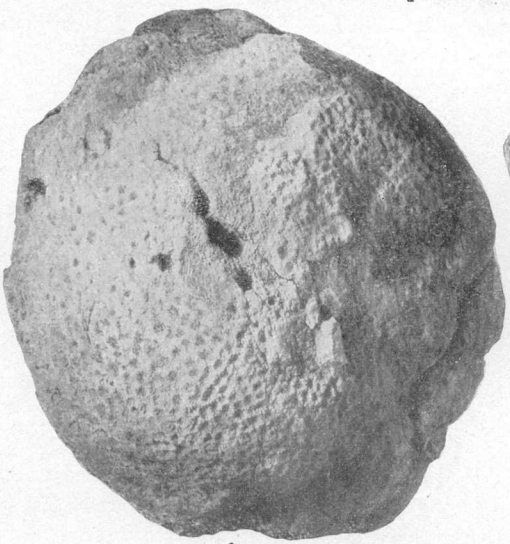

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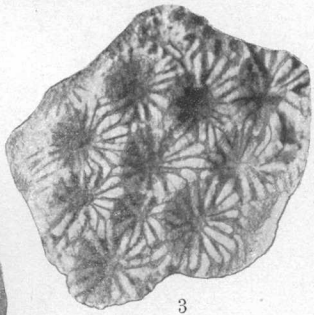

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MALONE JURASSIC INVERTEBRATES.

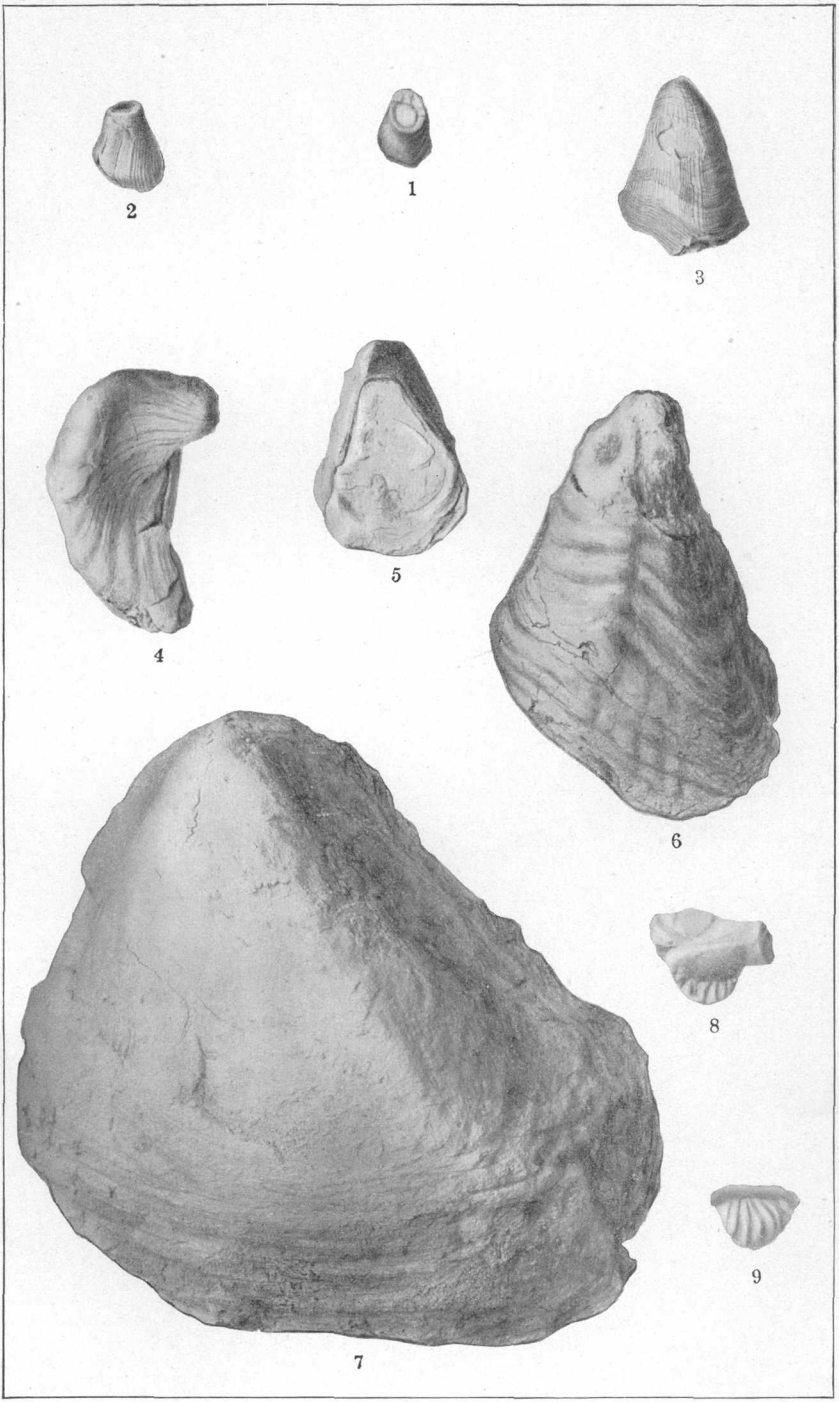
PLATE III.

PLATE III.

FIGS. 1–6. GRYPHÆ MEXICANA Felix (p. 39).
Fig. 1. Young specimen, natural size.
Fig. 2. Young striated individual, enlarged 1½ diameters.
Figs. 4–6. Mature specimen.

FIG. 7. EXOGYRA POTOSINA Castillo and Aguilera (p. 41).
See Pl. IV for additional figure.

FIGS. 8, 9. PLICATULA SPORTELLA sp. n. (p. 43).
Two views of the imperfect type specimen.



MALONE JURASSIC INVERTEBRATES.

PLATE IV.

PLATE IV.

FIGS. 1–4. EXOGYRA SUBPLICIFERA Felix (p. 41).

FIGS. 5, 6. LIMA INTERLINEATA sp. n. (p. 43).

Fig. 5. Type specimen, natural size.

Fig. 6. Part of sculpture, enlarged 3 diameters.

FIG. 7. EXOGYRA POTOSINA Castillo and Aguilera (p. 41).

See Pl. III, fig. 7.

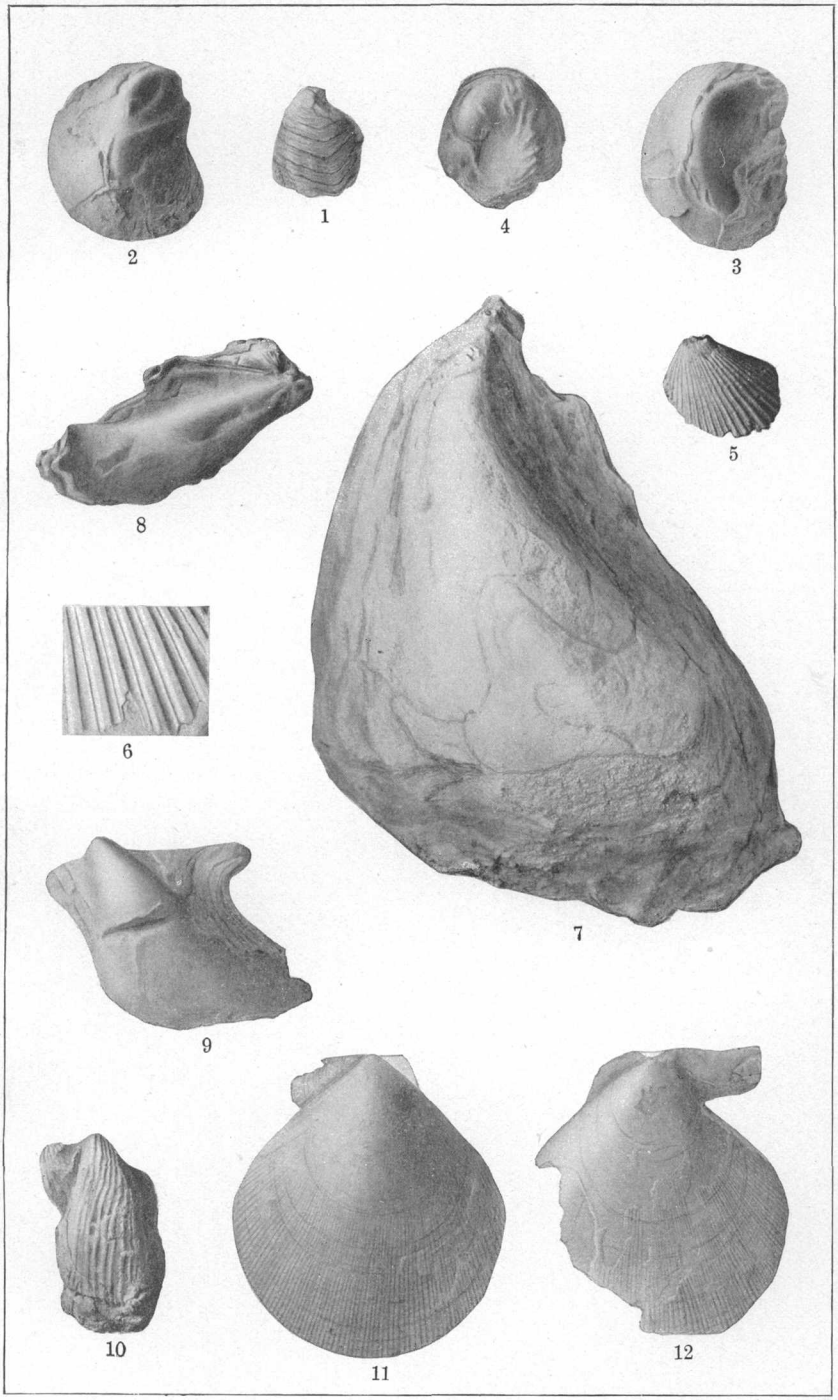
FIGS. 8, 9, 10. GERVILLIA CORRUGATA sp. n. (p. 46).

Fig. 8. Right valve with most of the shell exfoliated.

Fig. 9. Left valve of another specimen in same state of preservation.

Fig. 10. Small distorted left valve showing strong sculpture of umbo.

FIGS. 11, 12. PECTEN INSUTUS sp. n. (p. 44).



MALONE JURASSIC INVERTEBRATES.

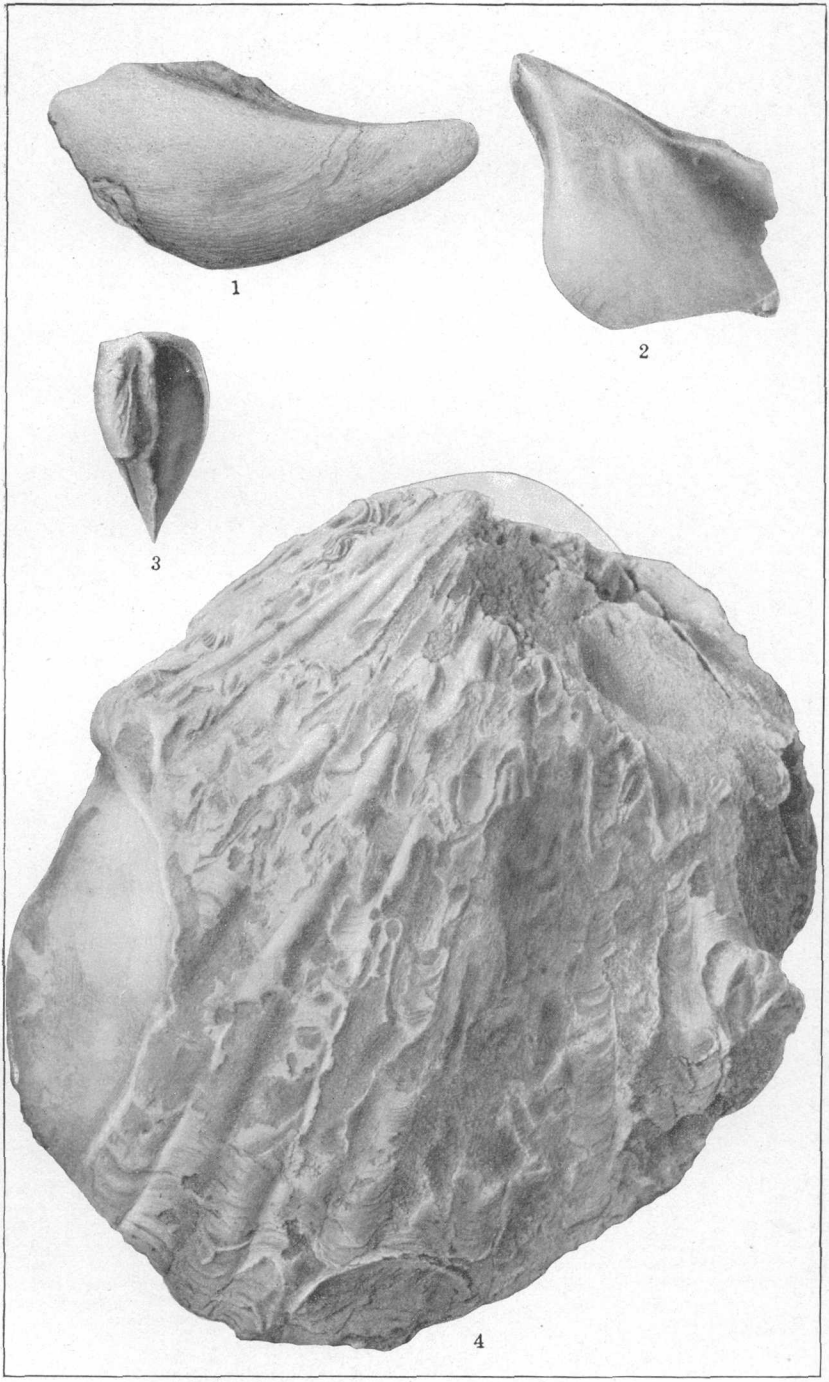
PLATE V.

PLATE V.

FIG. 1. GERVILLIA CINDERELLA sp. n. (p. 47).

FIGS. 2, 3. GERVILLIA ? RIOGRANDENSIS sp. n. (p. 47).
Side and profile views of the type specimen.

FIG. 4. LIMA (CTENOSTREON) RIOGRANDENSIS sp. n. (p. 44).

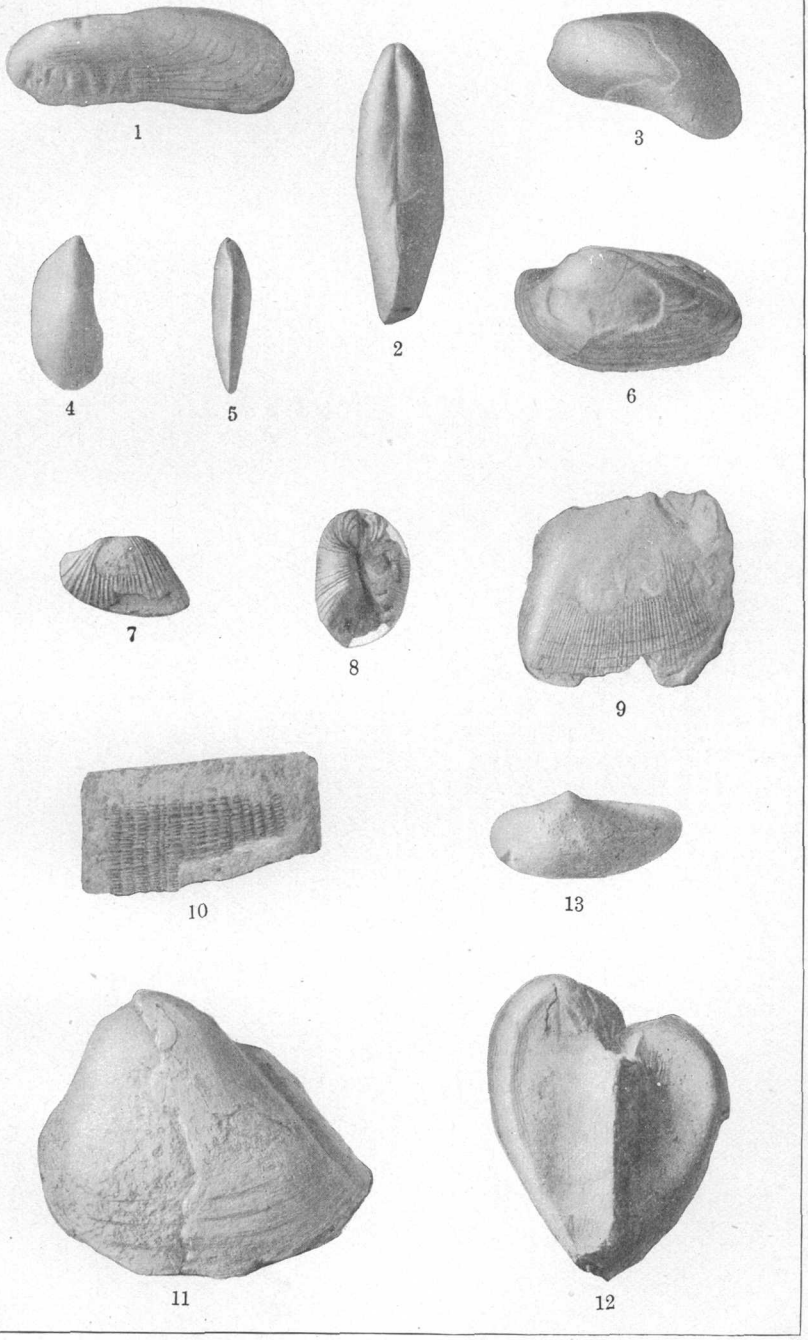


MALONE JURASSIC INVERTEBRATES.

PLATE VI.

PLATE VI.

FIGS. 1, 2. MODIOLA MALONIANA sp. n. (p. 48).
Side and profile views of the type specimen.
FIG. 3. MODIOLA GENICULATA sp. n. (p. 49).
FIGS. 4, 5. MYTILUS NUNTIUS sp. n. (p. 48).
Side and profile views of the type specimen.
FIG. 6. ARCA DUMBLI sp. n. (p. 51).
FIGS. 7, 8. ARCA TAFFII sp. n. (p 50).
Side and profile views of the type specimen.
FIGS. 9, 10. CUCULLÆA ? TEXICOSTATA sp. n. (p 52).
Fig. 9. The imperfect type specimen.
Fig. 10. Portion of surface enlarged.
FIGS. 11, 12. CUCULLÆA CASTILLOI sp. n. (p 54).
Side and profile views of the type specimen.
FIG. 13. LEDA ? NAVICULA sp. n. (p. 55).

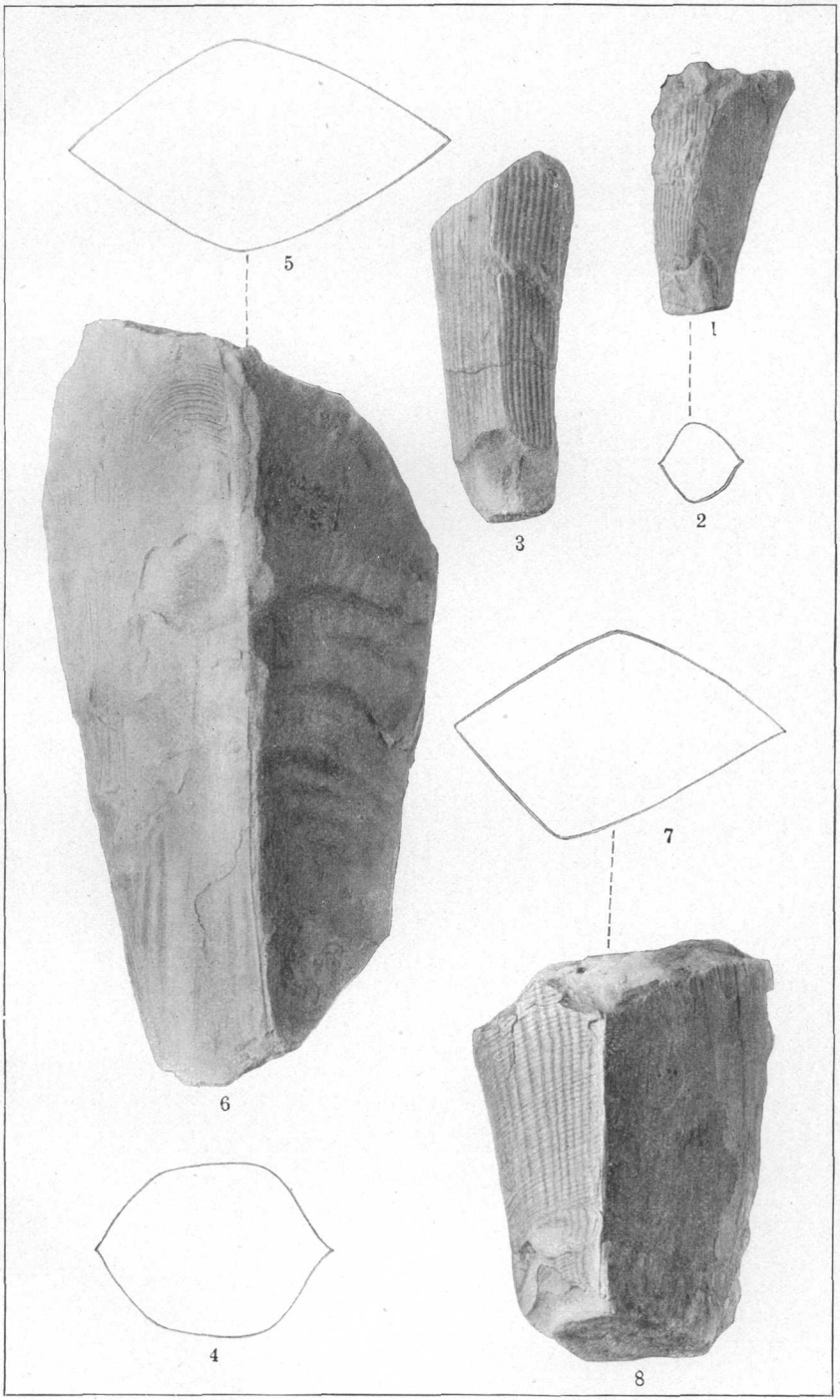


MALONE JURASSIC INVERTEBRATES.

PLATE VII.

PLATE VII.

FIGS. 1–8. PINNA QUADRIFONS sp. n. (p. 49).

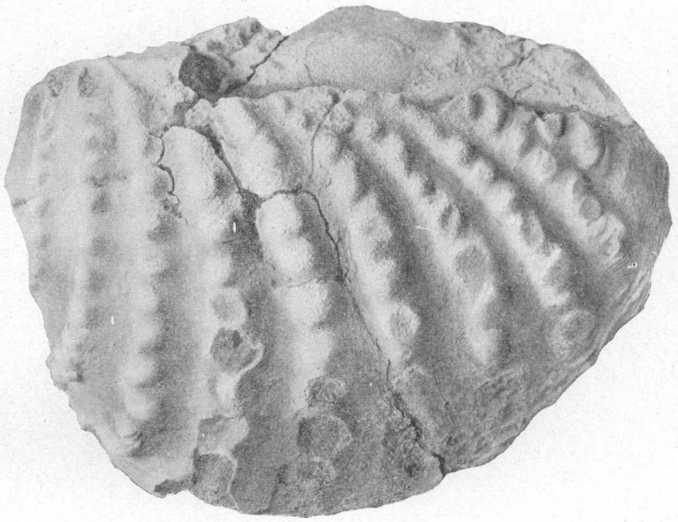


MALONE JURASSIC INVERTEBRATES.

PLATE VIII.

PLATE VIII.

FIGS. 1, 2. TRIGONIA VYSCHETZKII Cragin (p. 56).
See Pl. IX, fig. 3, for anterior view of specimen represented by fig. 1.



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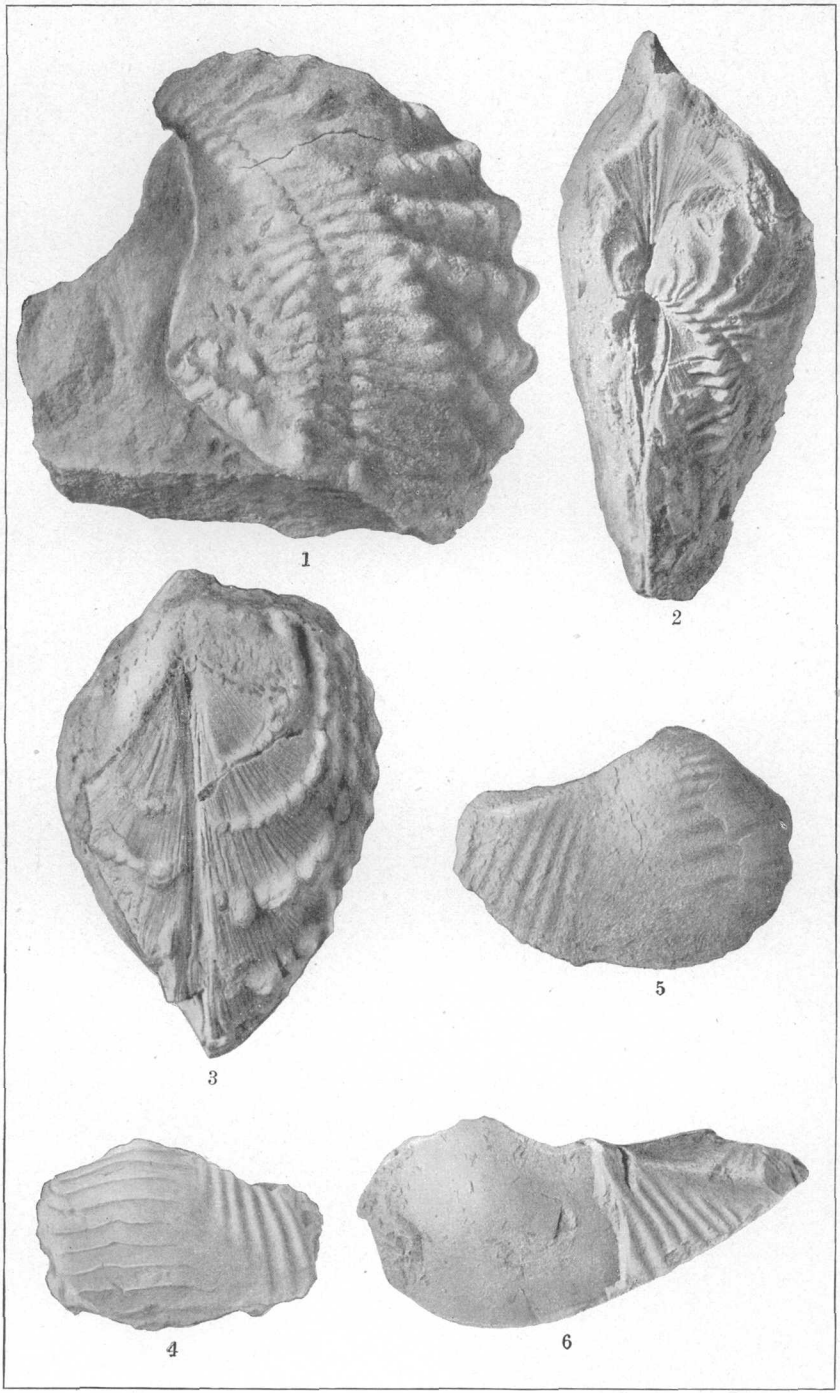
MALONE JURASSIC INVERTEBRATES.

PLATE IX.

PLATE IX.

FIGS. 1–3. TRIGONIA VYSCHETZKII Cragin (p. 56).
See Pl. VIII, fig. 1, for side view of fig. 3.
FIGS. 4–5. TRIGONIA CALDERONI (Castillo and Aguilera) (p. 59).

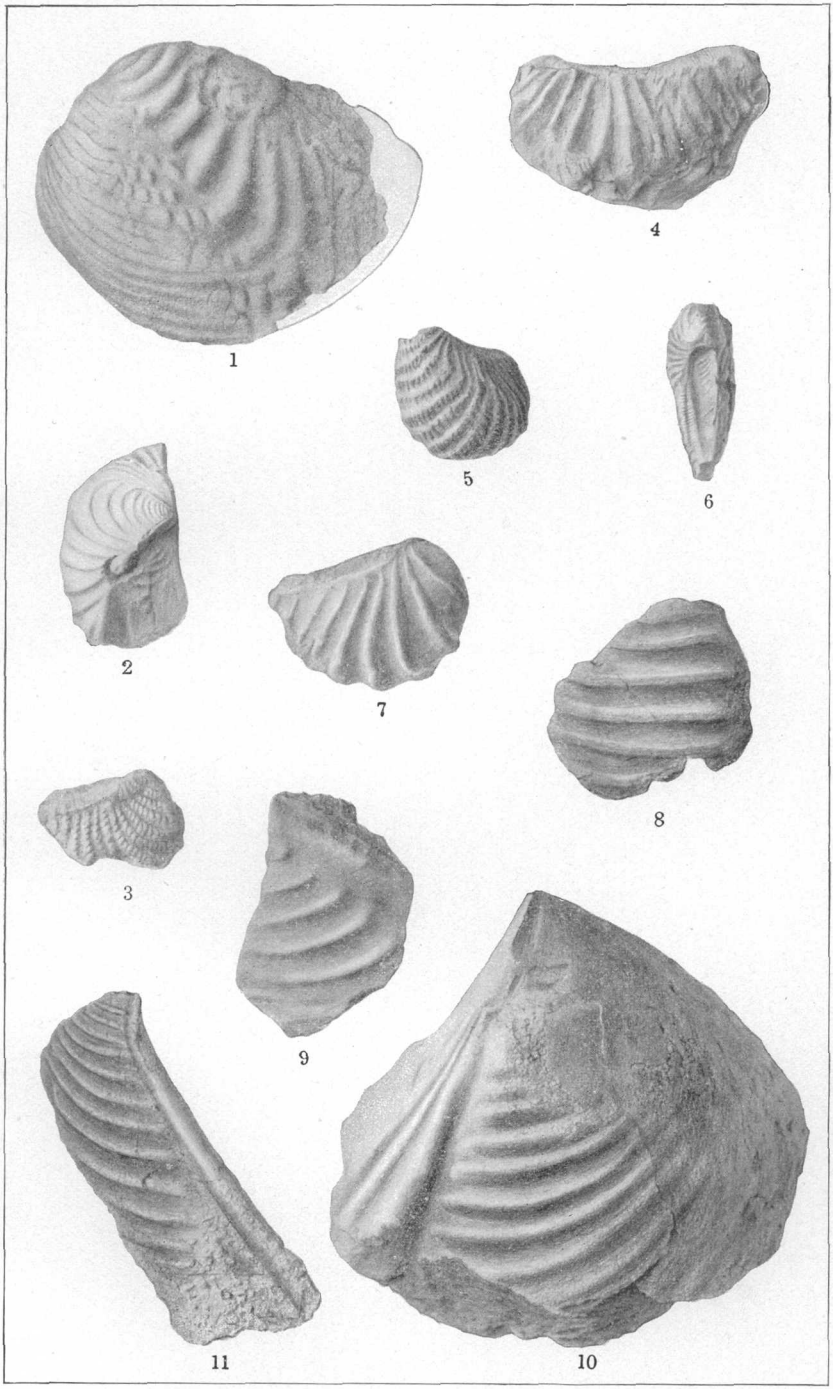


MALONE JURASSIC INVERTEBRATES.

PLATE X.

PLATE X.

FIGS. 1, 2. TRIGONIA GOODELLII Cragin (p. 58).
FIGS. 3–6. TRIGONIA PROSCABRA sp. n. (p. 60).
FIG. 7. TRIGONIA PRÆSTRIATA sp. n. (p. 61).
FIGS. 8–11. TRIGONIA MUNITA sp. n. (p. 62).

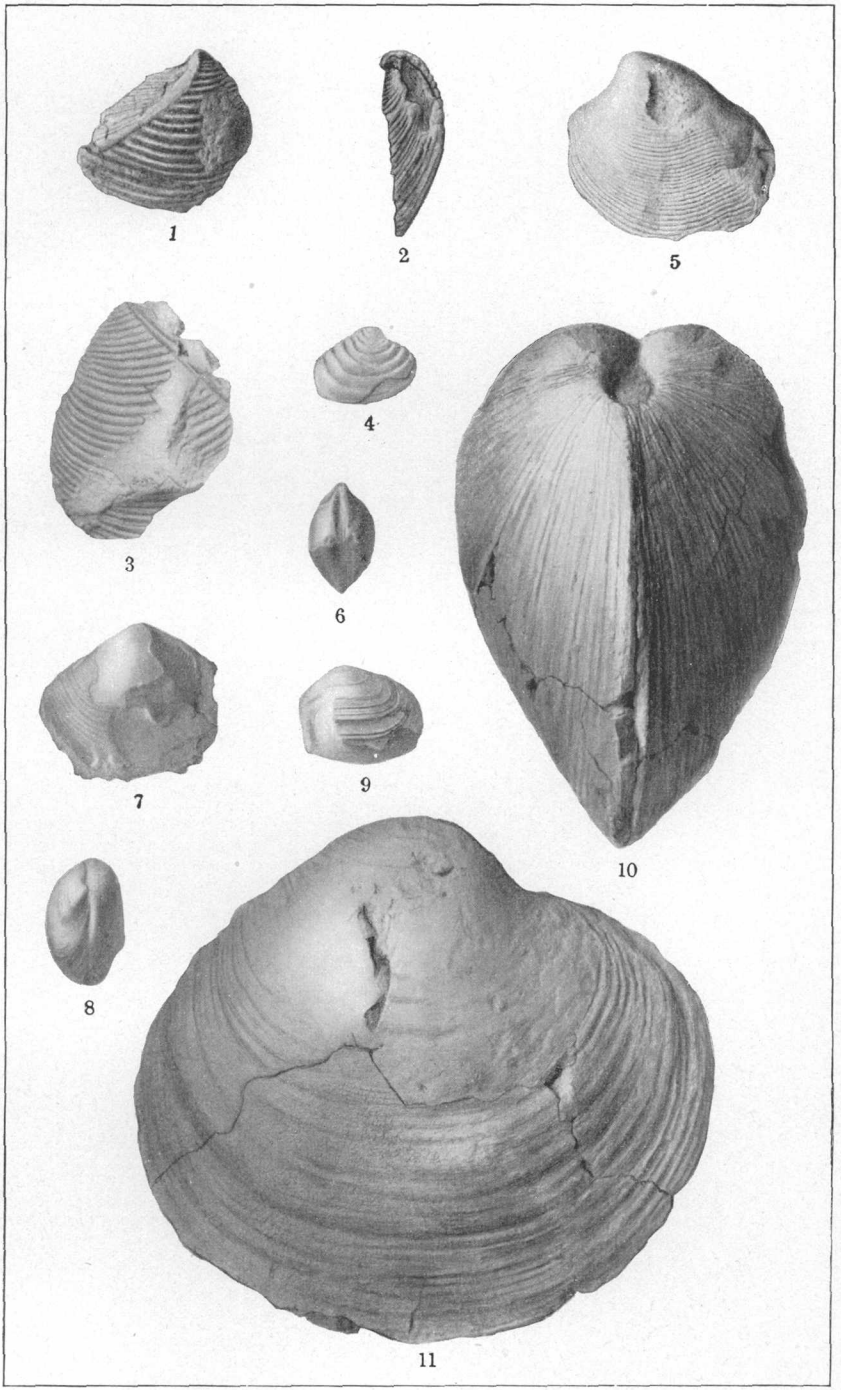


MALONE JURASSIC INVERTEBRATES.

PLATE XI.

PLATE XI.

FIGS. 1, 2. TRIGONIA RUDICOSTATA sp. n. (p. 63).
Side and profile views of the type specimen.
FIG. 3. TRIGONIA CONFERTICOSTATA sp. n. (p. 63).
FIG. 4. ASTARTE BREVIACOLA sp. n. (p. 64).
FIGS. 5, 6. ASTARTE POSTICALVA sp. n. (p. 67).
Fig. 5. Left valve of type enlarged 2 diameters.
Fig. 6. Dorsal view of another specimen.
FIG. 7. ASTARTE CRATICULA sp. n. (p. 68).
FIGS. 8. 9. ASTARTE? ISODONTOIDES sp. n. (p. 67).
FIGS. 10, 11. ASTARTE MALONENSIS Cragin (p. 65).
See Pl. XII for additional figures.

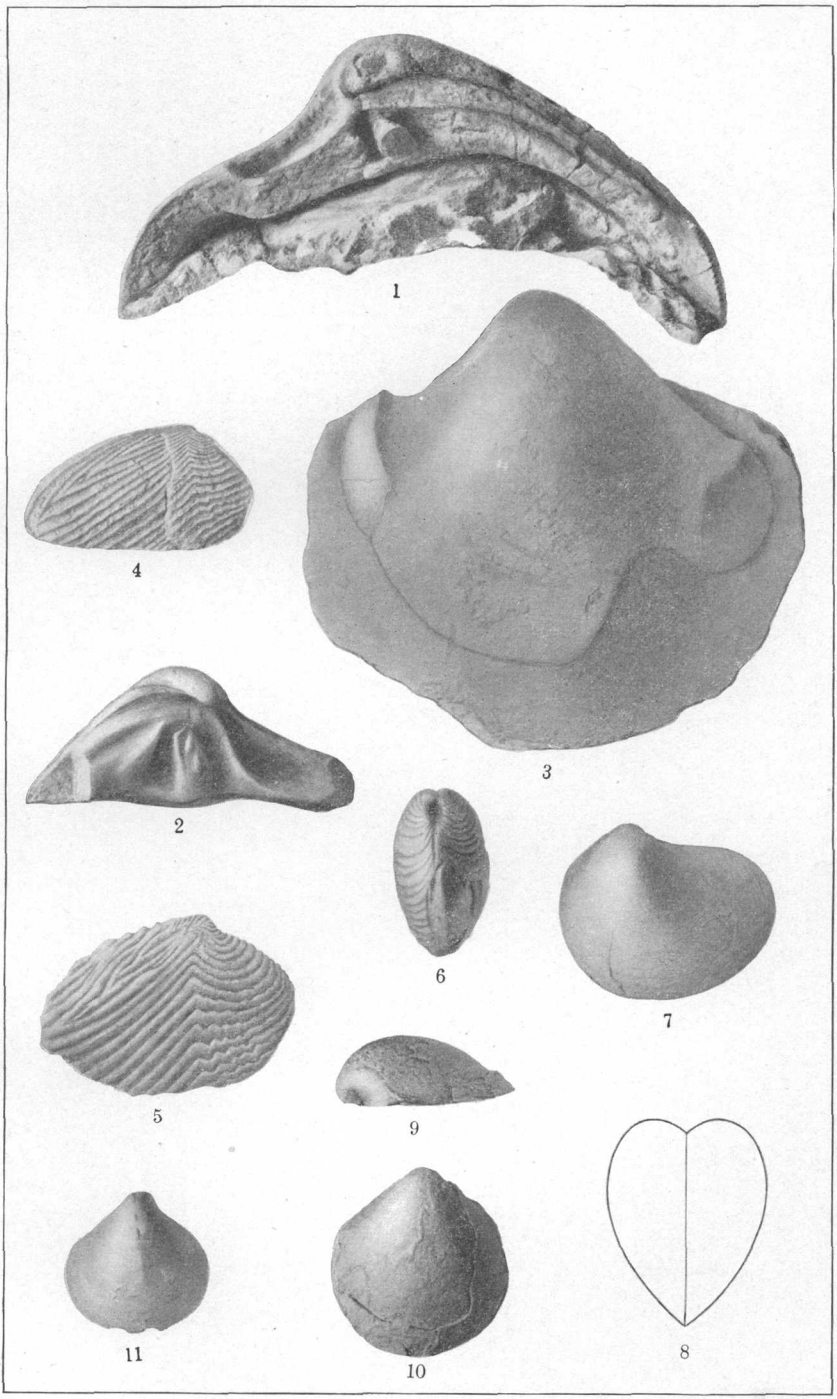


MALONE JURASSIC INVERTEBRATES.

PLATE XII.

PLATE XII.

FIGS. 1–3. ASTARTE MALONENSIS Cragin (p. 65).
See Pl. XI for additional figures.
FIGS. 4–6. PTYCHOMYA STANTONI sp. n. (p. 69).
Fig. 4. Natural size.
Figs. 5, 6. Another specimen enlarged 1½ diameters.
FIGS. 7, 8. UNICARDIUM ? TRANSVERSUM sp. n. (p. 76).
FIGS. 9–11. UNICARDIUM ? SEMIROTUNDUM sp. n. (p. 76).

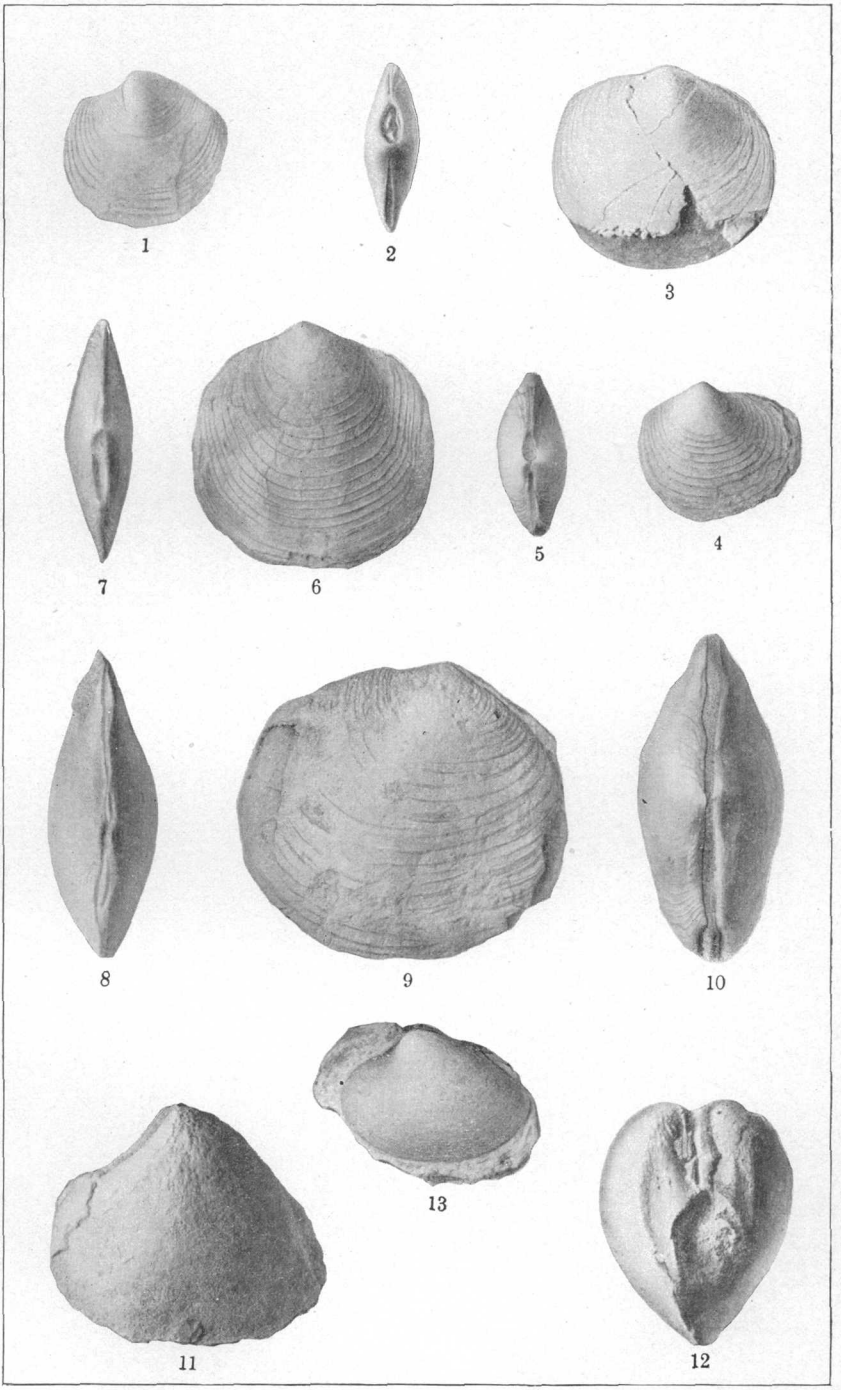


MALONE JURASSIC INVERTEBRATES.

PLATE XIII.

PLATE XIII.

FIGS. 1, 2. CYPRINA STREERUVITZII Cragin (p. 78).
FIG. 3. LUCINA PLANIUSCULA sp. n. (p. 75).
FIGS. 4, 5. LUCINA POTOSINA Castillo and Aguilera (p. 72).
FIGS. 6–10. LUCINA POTOSINA var. METRICA var. n. (p. 73).
FIGS. 11, 12. CYPRINA COTEROI Castillo and Aguilera (p. 77).
FIG. 13. TAPES CUNEOVATUS sp. n. (p. 79).

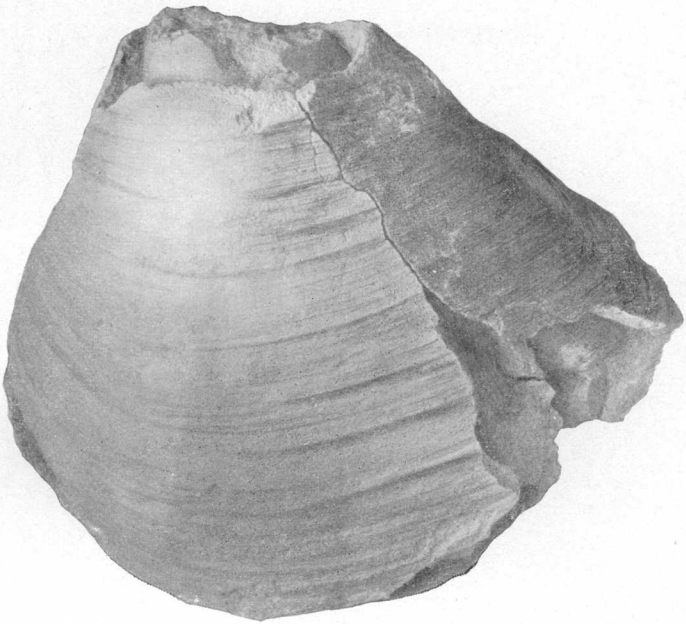


MALONE JURASSIC INVERTEBRATES.

PLATE XIV.

PLATE XIV.

FIGS. 1, 2. CYPRINA STREERUVITZII Cragin (p. 78).
Two views of type specimen in collection of Geological Survey of Texas.
See Pl. XV, fig. 1, for additional figures of same specimen.



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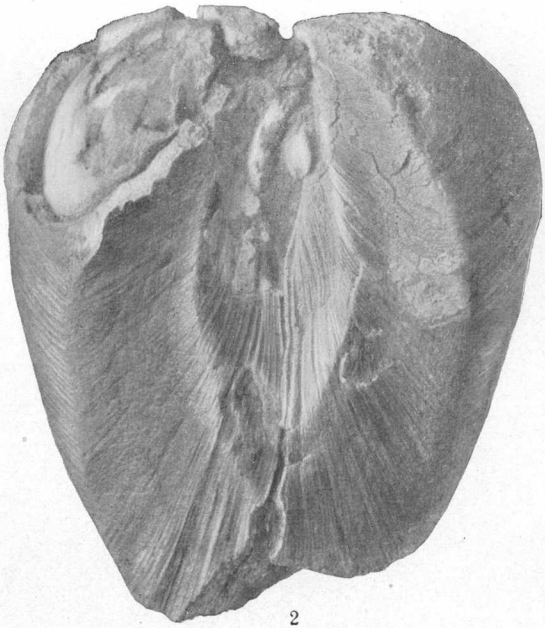

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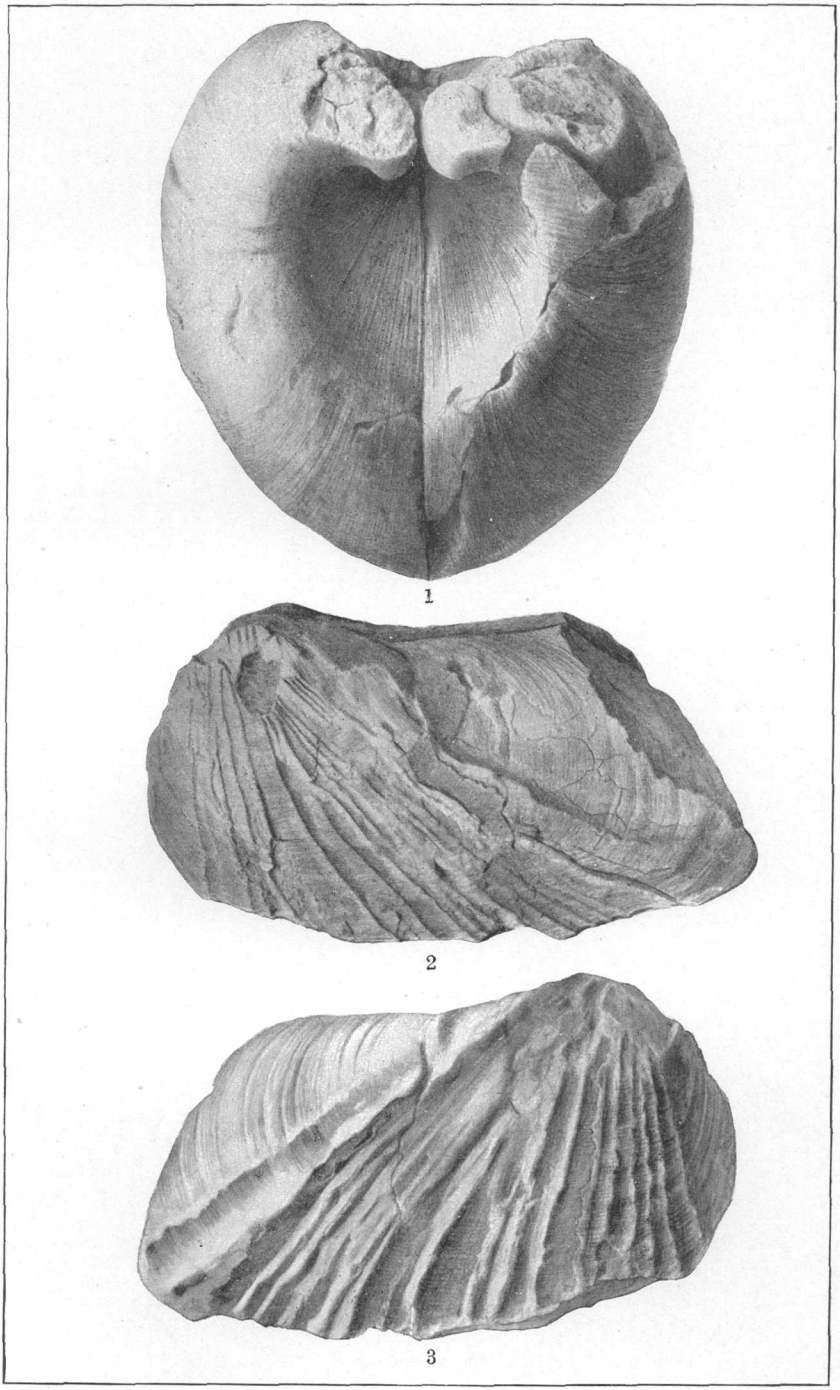
MALONE JURASSIC INVERTEBRATES.

PLATE XV.

PLATE XV.

FIG. 1. CYPRINA ? STREERUVITZII Cragin (p. 78).
See Pl. XIV for other views of same specimen.
FIGS. 2, 3. PHOLADOMYA TOSTA sp. n. (p. 79).
Opposite views of the same specimen.



MALONE JURASSIC INVERTEBRATES.

PLATE XVI.

PLATE XVI.

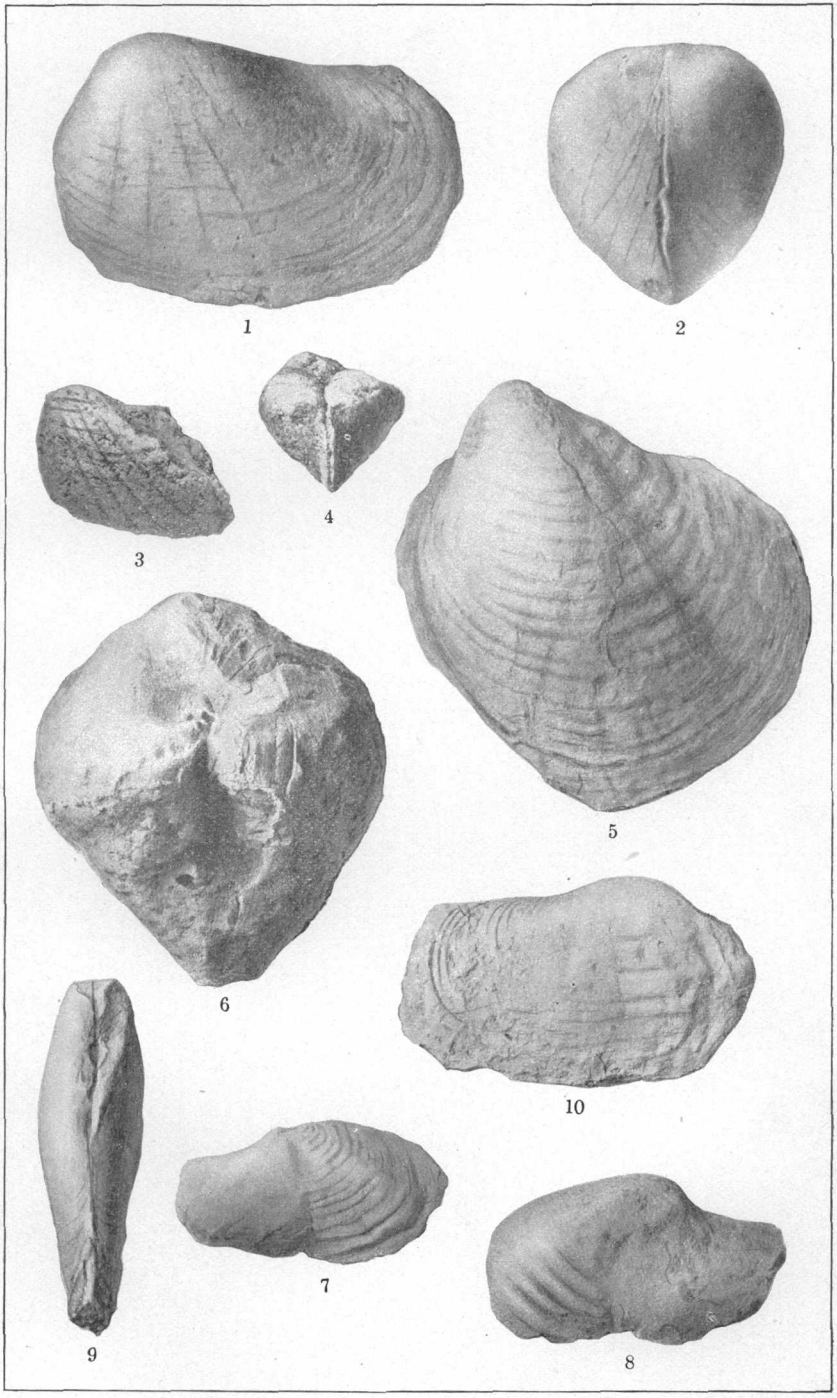
FIGS. 1, 2. PHOLADOMYA MARCOUI sp. n. (p. 80).
Side and anterior views of the same specimen.

FIGS. 3, 4. PHOLADOMYA PRÆPOSITA sp. n. (p. 82).
Two views of the same specimen.

FIGS. 5, 6. PHOLADOMYA PAUCICOSTA Roemer? (p. 81).
Side and dorsal views of the same specimen.

FIGS. 7, 8. ANATINA OBLIQUIPLICATA sp. n. (p. 85).

FIGS. 9, 10. ANATINA ? PLICULIFERA sp. n. (p. 86).

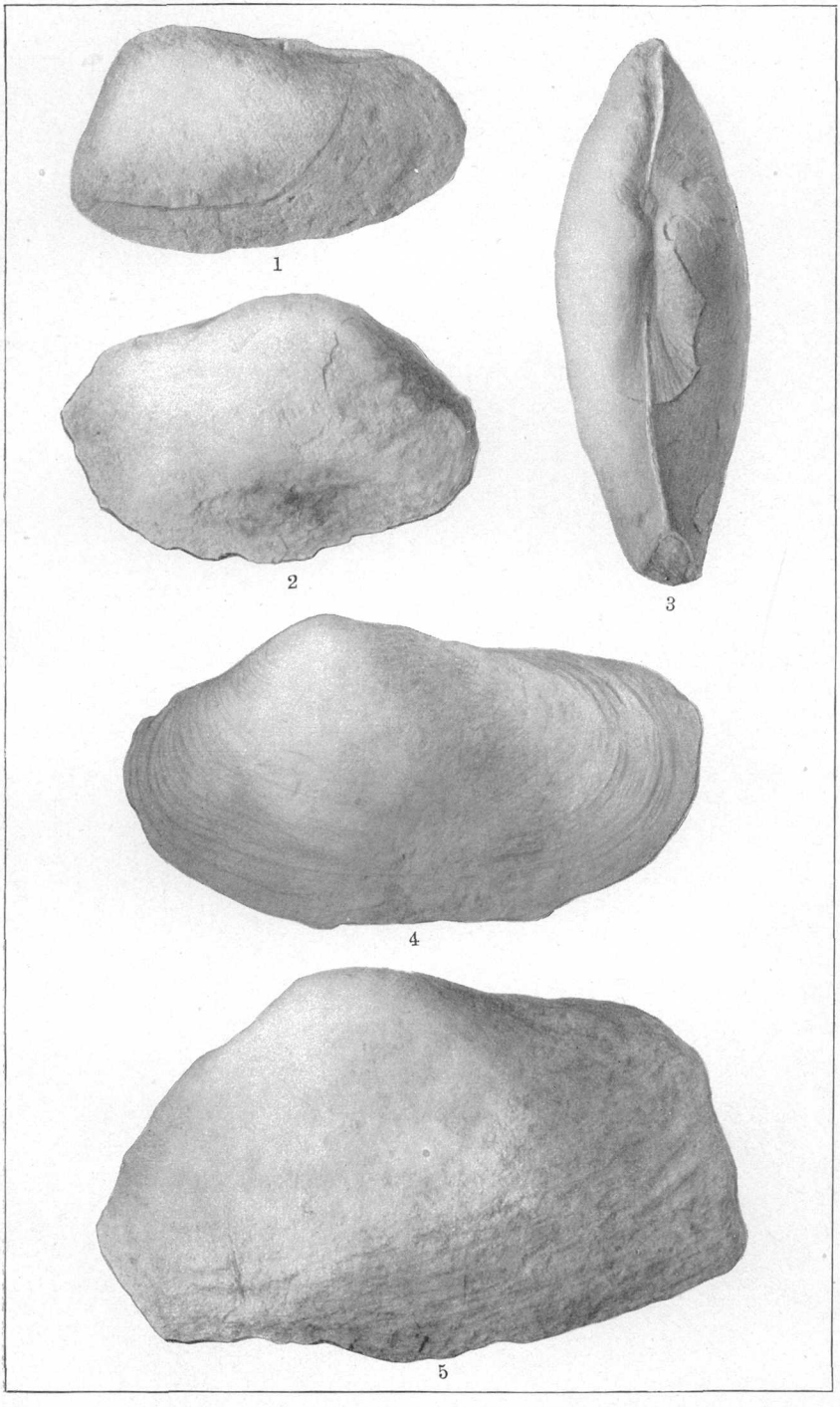


MALONE JURASSIC INVERTEBRATES.

PLATE XVII.

PLATE XVII.

FIGS. 1–5. PLEUROMYA INCONSTANS Castillo and Aguilera (p. 82).
See Pl. XVIII for additional figures.



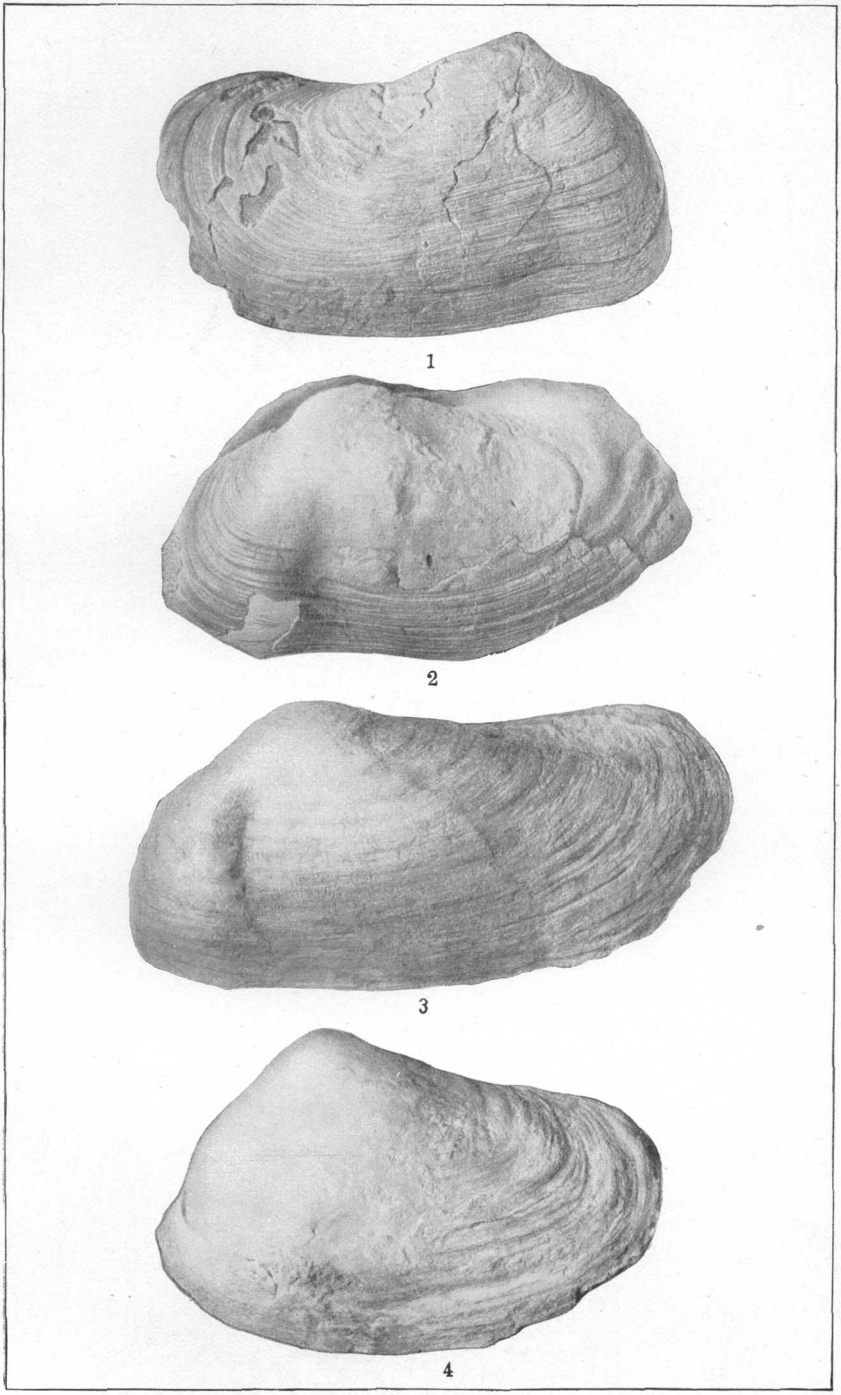
MALONE JURASSIC INVERTEBRATES.

PLATE XVIII.

PLATE XVIII.

FIGS. 1–3. PLEUROMYA INCONSTANS Castillo and Aguilera (p. 82).
See Pl. XVII for additional figures.

FIG. 4. PLEUROMYA INCONSTANS var. curta var. n. (p. 84).
See Pl. XIX for additional figures.



MALONE JURASSIC INVERTEBRATES.

PLATE XIX.

PLATE XIX.

FIGS. 1, 2. PLEUROMYA INCONSTANS var. curta var. n. (p. 84).
See Pl. XVIII for additional figure.

FIGS. 3–5. MARTESIA MALONIANA sp. n. (p. 87).
Figs. 3, 4. Side and dorsal views of the same specimen.
Fig. 5. Anterior view of another specimen.

FIG. 6. THRACIA ? MALONIANA sp. n. (p. 86).

FIG. 7. CORBULA MALONIANA sp. n. (p. 87).

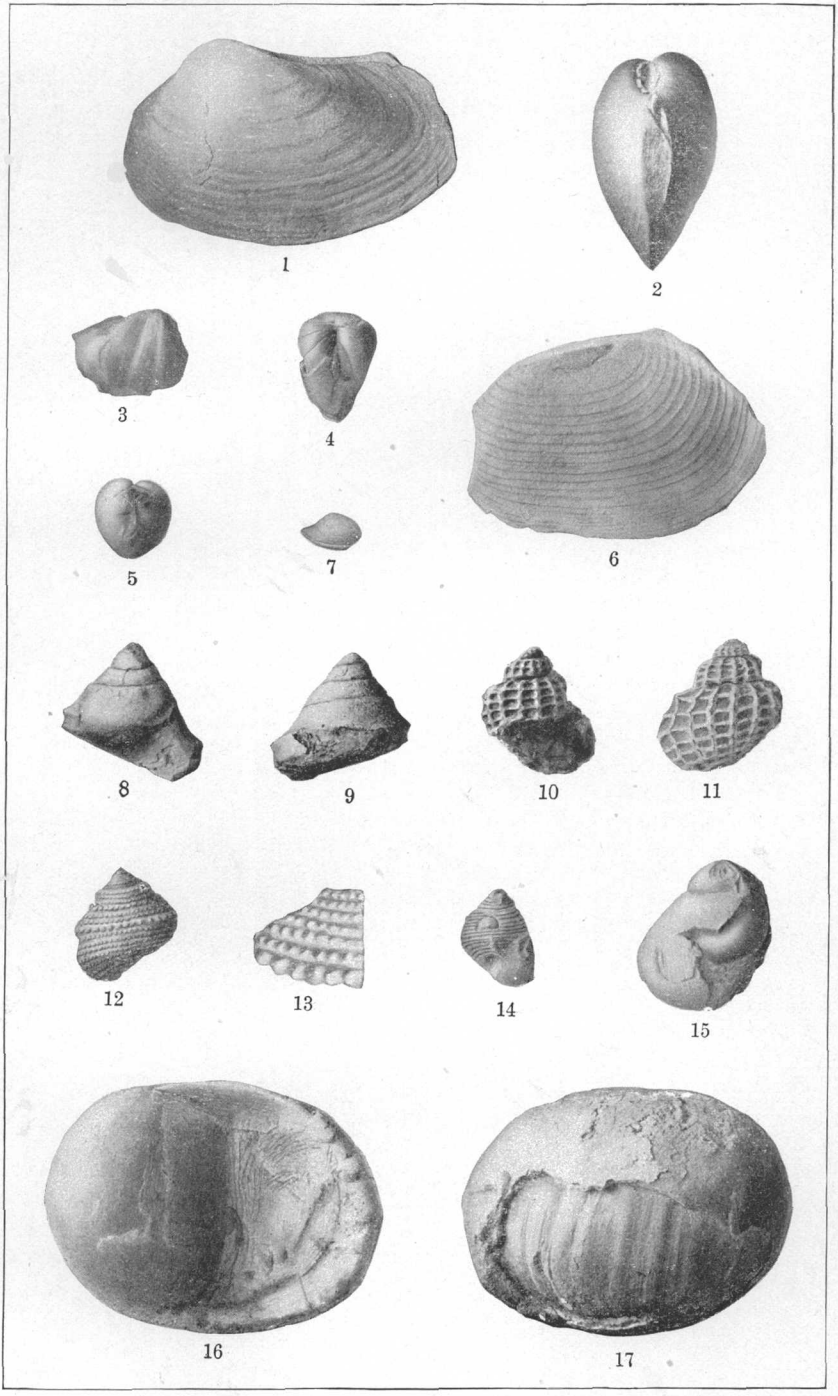
FIGS. 8, 9. PLEUROTOMARIA CIRCUMTRUNCA sp. n. (p. 88).
Two views of the same specimen.

FIGS. 10, 11. TURBO BENECLATHRATA sp. n. (p. 88).
Two views of the type.

FIGS. 12–14. DELPHINULA STANTONI sp. n. (p. 89).
Fig. 12. Dorsal view slightly restored.
Fig. 13. Enlargement of part of surface sculpture of same specimen.
Fig. 14. Aperture view of a small weathered specimen.

FIG. 15. NERITA FINLAYENSIS sp. n. (p. 90).

FIGS. 16, 17. NERITA PEROBLATA sp. n. (p. 91).
Two views of the type.



MALONE JURASSIC INVERTEBRATES.

PLATE XX.

PLATE XX.

FIGS. 1–4. NERITA NODILIRATA sp. n. (p. 90).

Fig. 1. Apical view of a medium specimen.

Fig. 2. Aperture view of another specimen viewed obliquely from the base so that the spire is concealed.

Fig. 3. Dorsal view of a young individual.

Fig. 4. Apical view of an internal cast.

FIG. 5. TURRITELLA BURKARTI sp. n. (p. 92).

FIG. 6. VERMETUS CORNEJOI Castillo and Aguilera (p. 92).

FIGS. 7, 8. NATICA WILLIAMSI sp. n. (p. 93).

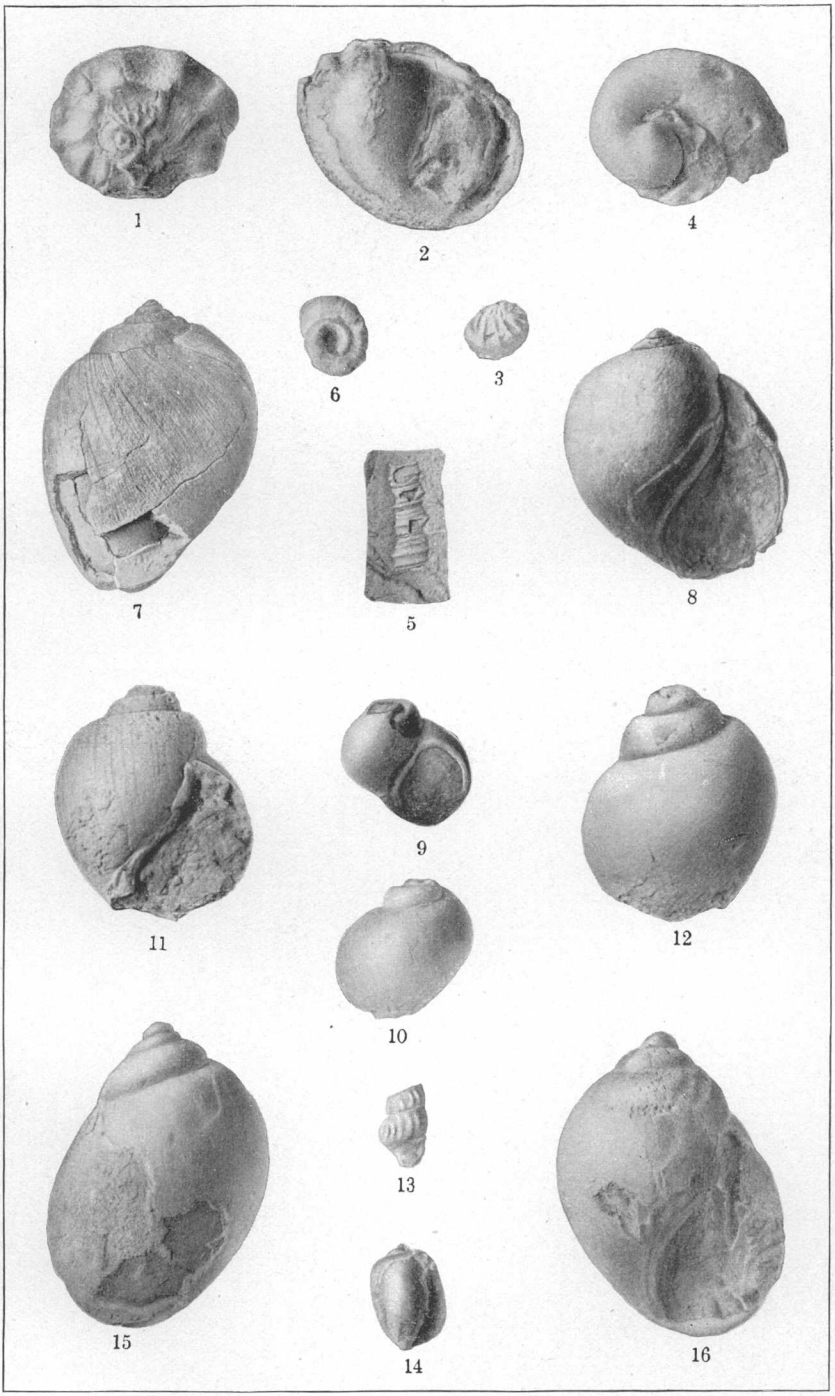
FIGS. 9, 10. NATICA BILABIATA sp. n. (p. 95).

FIGS. 11, 12. NATICA INFLECTA sp. n. (p. 94).

FIG. 13. CERITHIUM ARCUIFERUM sp. n. (p. 99).

FIG. 14. ACTÆONINA ? MALONIANA sp. n. (p. 99).

FIGS. 15, 16. NATICA FINLAYENSIS sp. n. (p. 94).



MALONE JURASSIC INVERTEBRATES.

PLATE XXI.

PLATE XXI.

FIGS. 1–3. NERINEA GOODELLII sp. n. (p. 96).

FIGS. 4, 5. NERINEA CIRCUMVOLUTA sp. n. (p. 97).

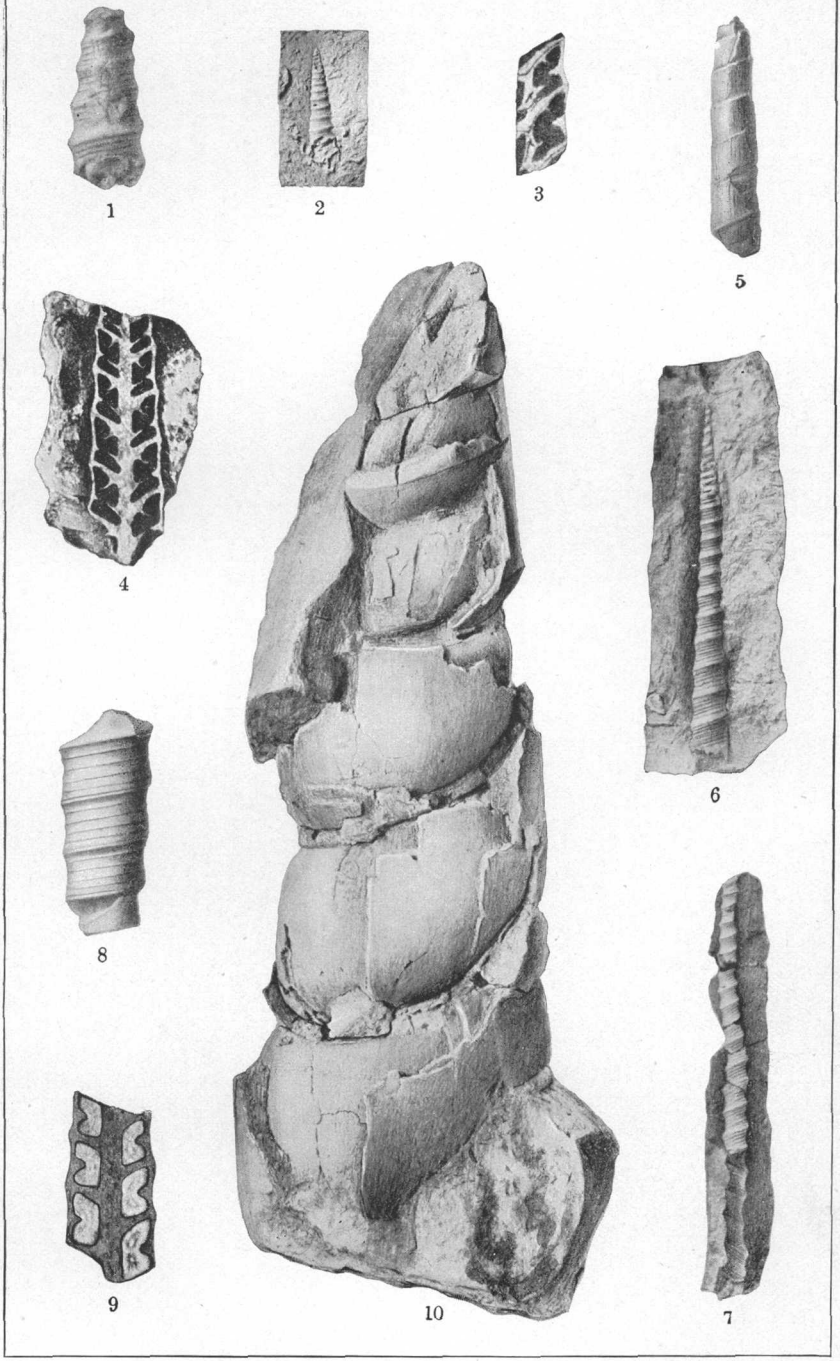
Fig. 4. Longitudinal section enlarged 2 diameters.

FIGS. 6–9. NERINELLA STANTONI sp. n. (p. 98).

Fig. 8. Fragment enlarged 3 diameters.

Fig. 9. Longitudinal section of same fragment enlarged.

FIG. 10. PSEUDOMELANIA GOODELLII sp. n. (p. 95).

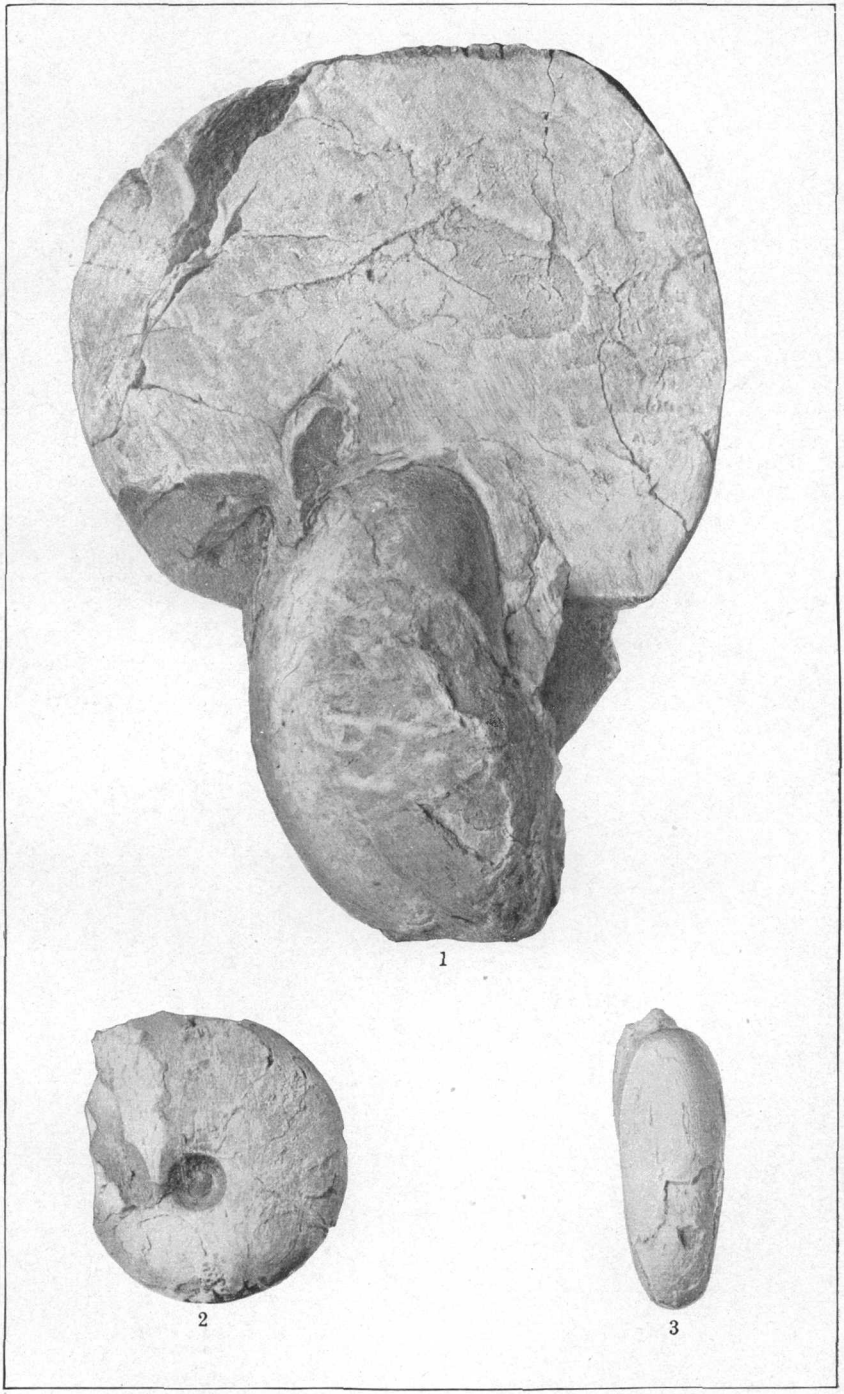


MALONE JURASSIC INVERTEBRATES.

PLATE XXII.

PLATE XXII.

FIG. 1. NAUTILUS BURKARTI Castillo and Aguilera (p. 100).
FIGS. 2, 3. OPPELIA ? FALLAX Castillo and Aguilera (p. 101).

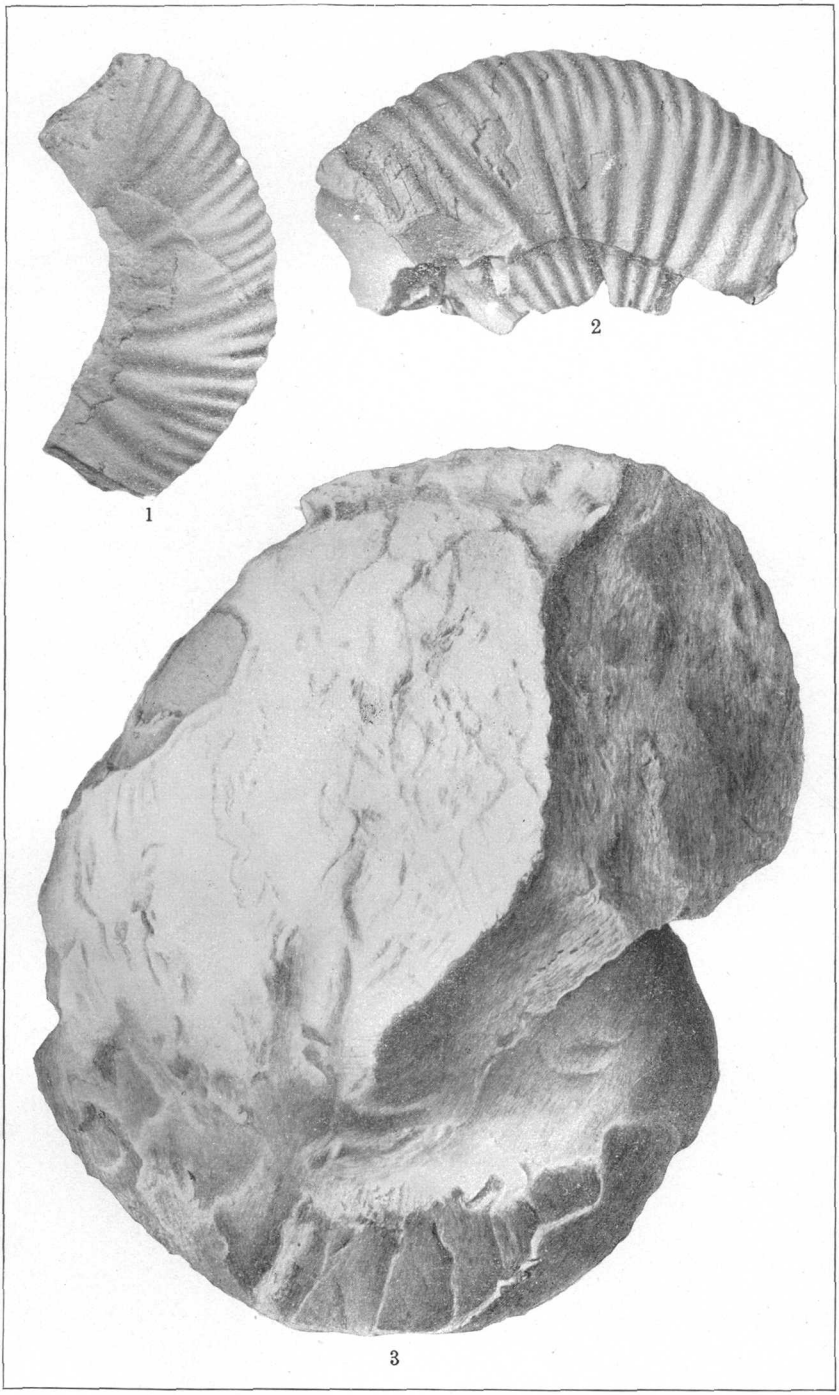


MALONE JURASSIC INVERTEBRATES.

PLATE XXIII.

PLATE XXIII.

FIG. 1. PERISPHINCTES POTOSINUS Castillo and Aguilera (p. 105).
FIG. 2. PERISPHINCTES FELIXI Castillo and Aguilera (p. 106).
FIG. 3. NAUTILUS NAUFRAGUS sp. n. (p. 100).
See Pl. XXIV, fig. 3.



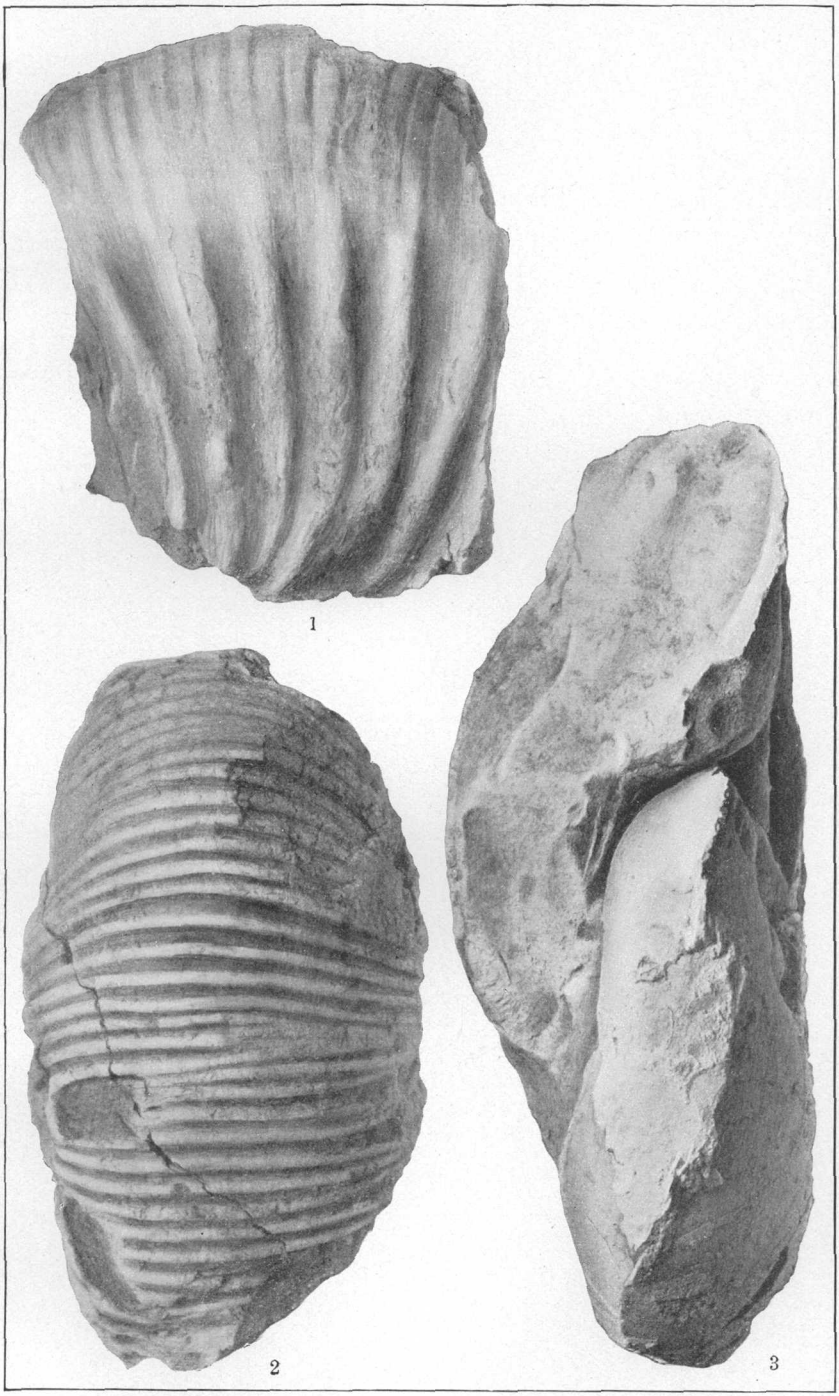
MALONE JURASSIC INVERTEBRATES.

PLATE XXIV.

PLATE XXIV.

FIGS. 1, 2. OLCOSTEPHANUS MALONIANUS sp. n. (p. 103).
Lateral and ventral views of two fragments.

FIG. 3. NAUTILUS NAUFRAGUS sp. n. (p. 100).
Ventral view of specimen represented by Pl. XXIII, fig. 3.

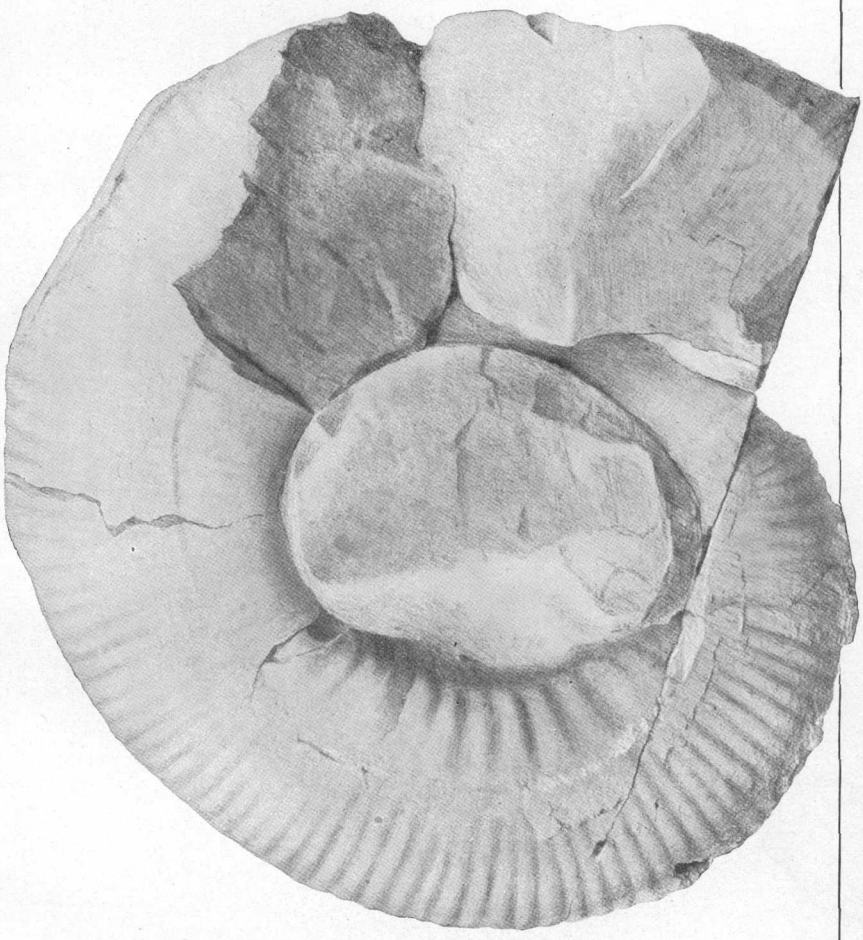


MALONE JURASSIC INVERTEBRATES.

PLATE XXV.

PLATE XXV.

FIG. 1. PERISPHINCTES SCHUCHERTI sp. n. (p. 107).
See Pls. XXVI and XXVII for additional figures.



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MALONE JURASSIC INVERTEBRATES.

PLATE XXVI.

PLATE XXVI.

FIGS. 1–3. PERISPHINCTES SCHUCHERTI sp. n. (p. 107).

Fig. 1. Ventral view of specimen figured on Pl. XXV.

Fig. 2. Side view of smaller specimen.

Fig. 3. Part of suture showing first and second lateral lobes from another specimen enlarged 3 diameters.

See Pl. XXVII for additional figure.

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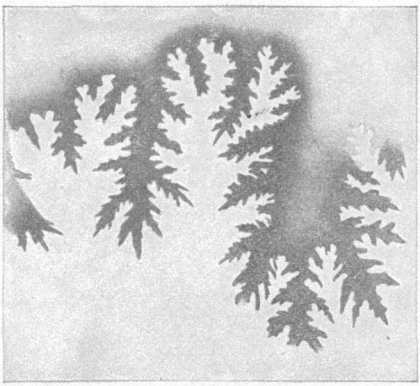

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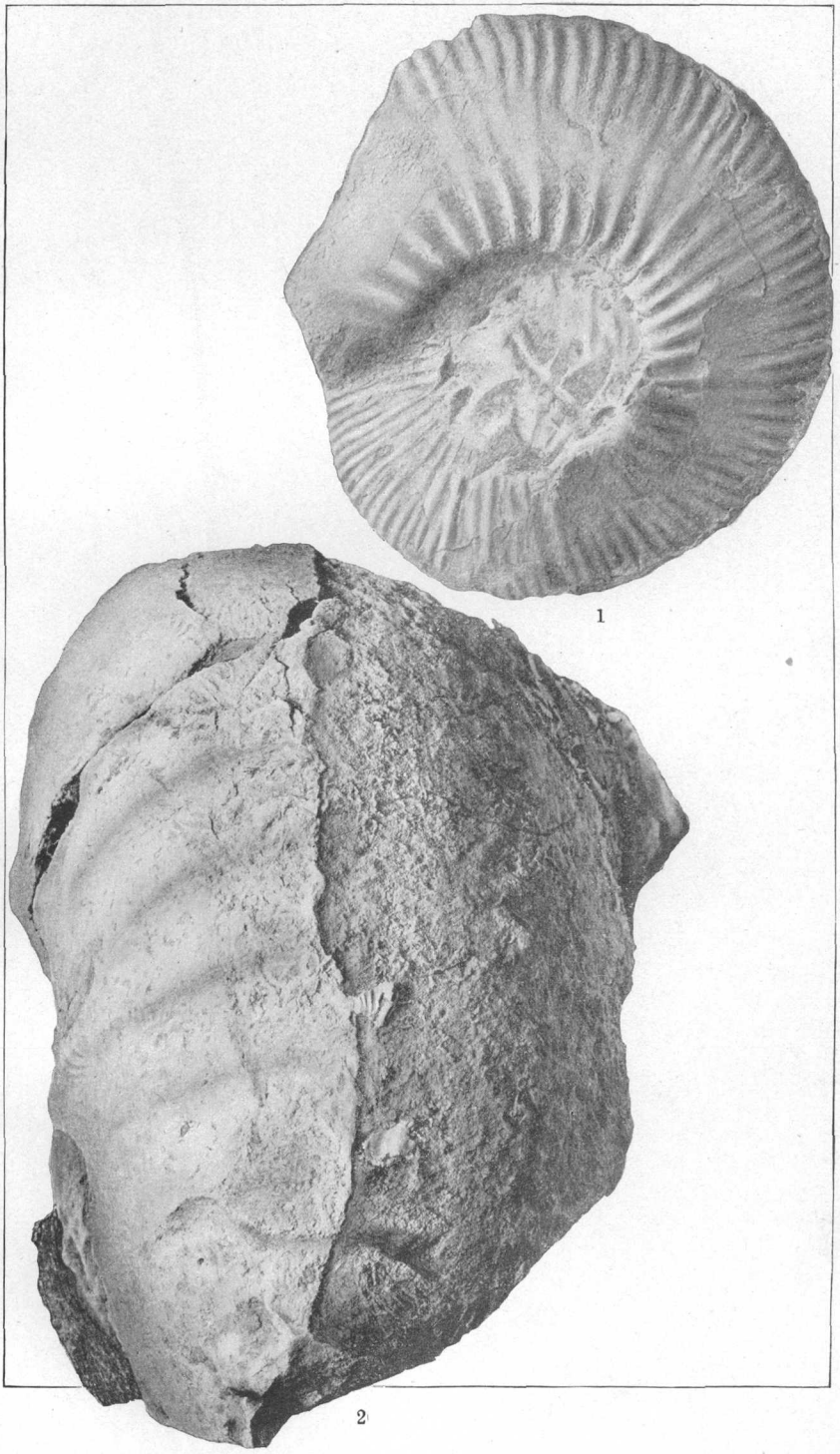
MALONE JURASSIC INVERTEBRATES.

PLATE XXVII.

PLATE XXVII.

FIG. 1. PERISPHINCTES SCHUCHERTI sp. n. (p. 107).
See Pls. XXV and XXVI for additional figures.

FIG. 2. ASPIDOCERAS ALAMITOCENSIS Castillo and Aguilera (p 109).
Ventral view of a fragment.



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MALONE JURASSIC INVERTEBRATES.

PLATE XXVIII.

PLATE XXVIII.

FIGS. 1, 2. PERISPHINCTES AGUILERAI sp. n. (p. 105).

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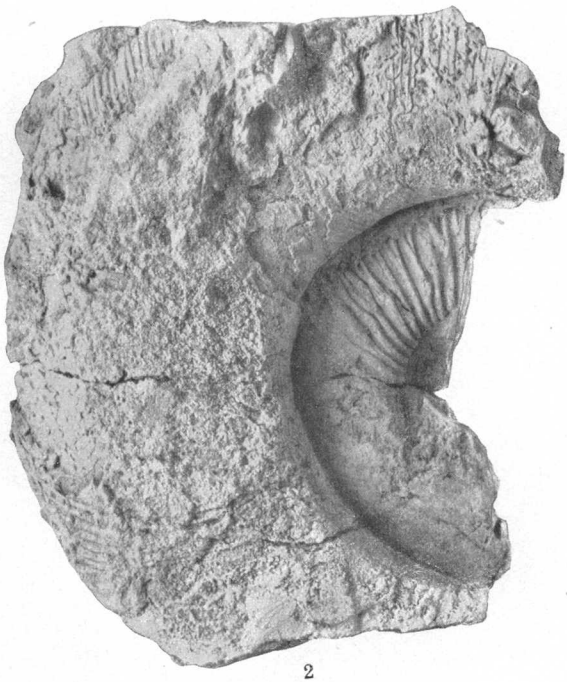

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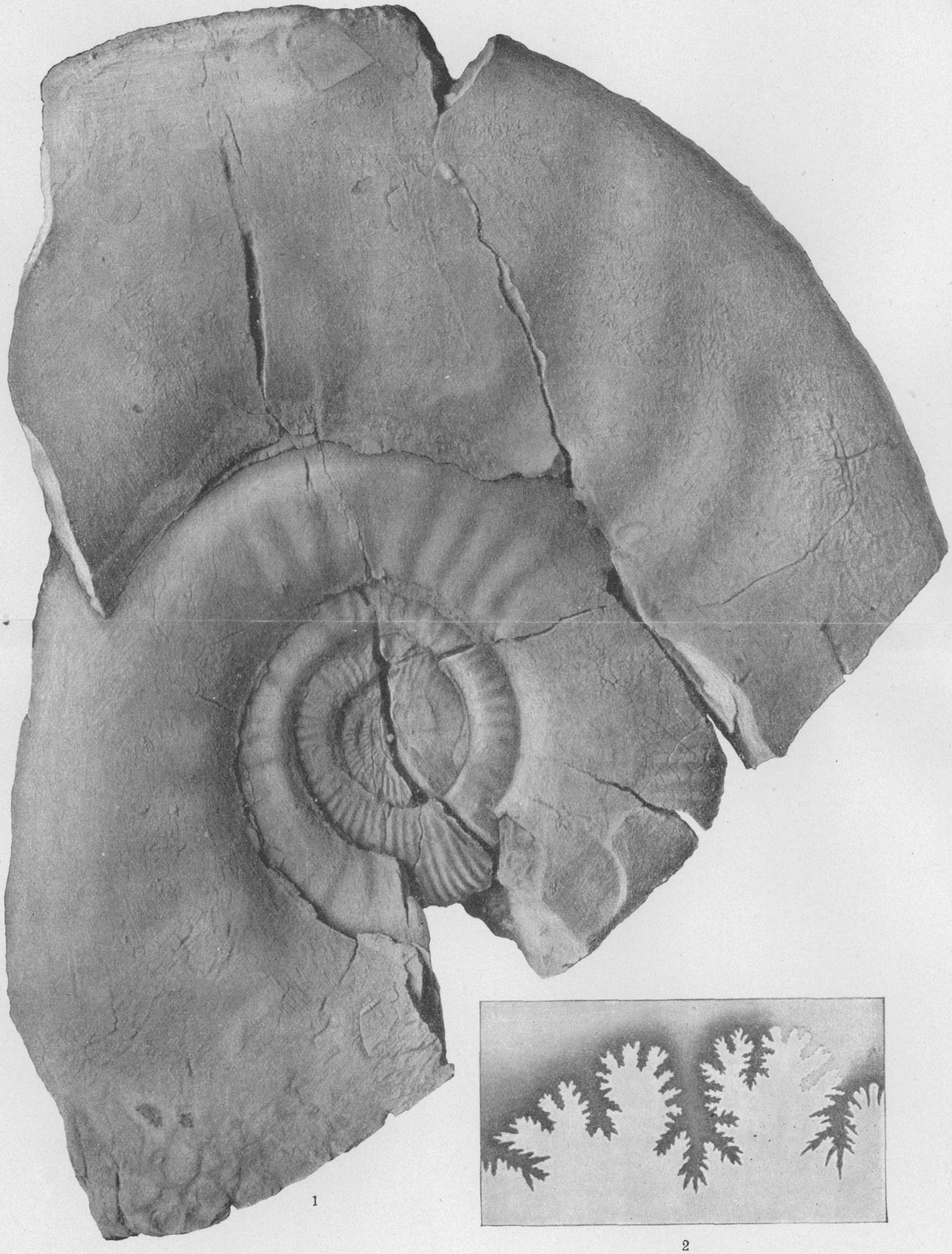
MALONE JURASSIC INVERTEBRATES.

PLATE XXIX.

PLATE XXIX.

FIGS. 1, 2. PERISPHINCTES CLARKI sp. n. (p. 103).
Fig. 1. A large imperfect specimen.
Fig. 2. Septum of same, somewhat weathered.



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MALONE JURASSIC INVERTEBRATES.

INDEX.

[Names in italic are synonyms; figures in black-face type denote pages on which species are described; figures in italic refer to illustrations.]