THE AMERICAN SPECIES OF ORTHOPHRAGMINA AND LEPIDOCYCLINA.

By JOSEPH A. CUSHMAN.

INTRODUCTION.

Orbitoid Foraminifera, on account of their short stratigraphic range, have proved to be excellent horizon markers, and, because of their wide geographic distribution, they are valuable in correlation. The genus *Orbitoides*, as now restricted, is found exclusively in deposits of Cretaceous age; *Orthophragmina* appears to be confined to the Eocene; but *Lepidocyclina* ranges through the upper Eocene and Oligocene.

In the present paper are described all the known American species of *Orthophragmina* and *Lepidocyclina*. The species are listed below in groups according to the geologic formations in which they are found. The relative ages of the formations are shown in the accompanying correlation table, which is copied from a paper by T. W. Vaughan.[1] As stated in the footnote to the table, I am not in accord with Douvillé regarding the age of the limestone on Haut Chagres and near David, Panama, but regard it as Eocene because it contains two species of *Orthophragmina*. However, two of the three species of *Lepidocyclina* found near David (*L. panamensis* and *L. duplicata*) occur also near Tonosi, Panama, associated with fossils characteristic of the middle Oligocene, the age of the lower part of the Culebra formation; and *L. chaperi*, described originally from Haut Chagres, occurs in the Culebra formation at a higher horizon.

American species of Orthophragmina and Lepidocyclina.

EOCENE.

Ocala limestone:
- Orthophragmina flintensis Cushman.
- georgiana Cushman.
- mariannensis Cushman.
- mariannensis var. papillata Cushman.
- vaughani Cushman.
- americana Cushman.

Ocala limestone—Continued.
- Lepidocyclina georgiana Cushman, n. sp.
- fragilis Cushman, n. sp.
- pseudocarinata Cushman, n. sp.
- cookei Cushman, n. sp.
- attenuata Cushman, n. sp.
- floridana Cushman, n. sp.
- pseudomarginata Cushman, n. sp.
- ocalana Cushman, n. sp.
- ocalana var. subdecorata Cushman, n. var.
- hilli Cushman, n. sp.?

Jackson formation:
- Lepidocyclina mortoni Cushman, n. sp.

St. Bartholomew limestone:
- Orthophragmina marginata Cushman.
- antillea Cushman.
- Lepidocyclina antillea Cushman.

Brito formation (Nicaragua):
- Orthophragmina hayesi Cushman, n. sp.
- flintensis Cushman.
- georgiana Cushman.

David, Panama:
- Orthophragmina minima Cushman.
- antillea Cushman.
- Lepidocyclina macdonaldi Cushman.
- panamensis Cushman.
- duplicata Cushman.

Haut Chagres, Panama:
- Lepidocyclina chaperi Lemoine and R. Douvillé.

Cuba:
- Orthophragmina cubensis Cushman.
- pustulata Cushman.
- crassa Cushman.
- sculpturata Cushman.
- subtaramellei Cushman.
- Lepidocyclina perundosa Cushman.
- subraulinii Cushman.

California:
- Orthophragmina clarki Cushman, n. sp.

OLIGOCENE.

Marianna limestone:
- Lepidocyclina mantelli (Morton).

Byram calcareous marl:
- Lepidocyclina supera (Conrad).

Chattahoochee formation:
- Lepidocyclina chattahoocheënsis Cushman, n. sp.

Antigua formation:
- Lepidocyclina undulata Cushman.
- undosa Cushman.
- gigas Cushman.
- favosa Cushman.
- canellei var. yurnagunensis Cushman.

[1] The biologic character and geologic correlation of the sedimentary formations of Panama in their relation to the geologic history of Central America and the West Indies: U. S. Nat. Mus. Bull. 103, table facing p. 595, 1919.

Culebra formation:
Lepidocyclina canellei Lemoine and R. Douvillé.
panamensis Cushman?
chaperi Lemoine and R. Douvillé.
Tonosi, Panama (in beds of the age of the Culebra formation):
Lepidocyclina panamensis Cushman.
duplicata Cushman.
Emperador limestone:
Lepidocyclina vaughani Cushman.
panamensis Cushman?
Cuba:
Lepidocyclina schlumbergeri Lemoine and R. Douvillé.
marginata (Michelotti).
kempi (O'Connell).
morgani Lemoine and R. Douvillé.
crassata Cushman.
canellei var. yurnagunensis Cushman.
sumatrensis (Brady).
San Rafael formation, Mexico:
Lepidocyclina gigas var. mexicana Cushman, n. var.

AMERICAN SPECIES OF ORTHOPHRAGMINA.

The genus *Orthophragmina* includes those species of orbitoid Foraminifera in which the chambers of the equatorial band are rectangular. Many of the species are stellate, with produced angles, or, if circular, have a stellate, raised ornamentation. Others, however, have the circular form with variously ornamented surfaces. The genus so far as known in America and Europe seems to be limited to the formations of Eocene age, and in America at least it is largely confined to the upper Eocene.

The structure of the test of *Orthophragmina* is essentially the same as that of *Lepidocyclina*, which is diagrammatically figured on page 56. An equatorial band of chambers, which are rectangular in horizontal section, occupies the middle portion. At either side are the lateral chambers, usually polygonal in outline, and placed one above another in vertical columns. These columns are here and there separated by the pillars, masses of compact shelly material arising from the wall of the equatorial chambers and thence extending to the surface. The pillars are especially developed in the thicker central region and increase in diameter toward the surface, where they usually appear as rounded knobs or pustules extending a slight distance above the general surface of the test. Their function seems to be to give strength to the thickened portion of the test.

The lateral chambers and in many species the equatorial chambers also average much smaller than those of most species of *Lepidocyclina*. In vertical section the lateral chambers of *Orthophragmina*, where they are not separated by pillars, have a zigzag line between adjacent columns, and usually this line serves when once seen to distinguish the genus in rock sections.

Very little has been known of the American species except references to them in papers by H. Douvillé. In 1917 I described several species from the Ocala limestone of Georgia and Florida.[1] Those species are included in the present paper with additional records for their distribution. Also the material from Cuba, St. Bartholomew, Panama, Nicaragua, and California has been added, so that the 17 species and varieties here described cover a wide region. There are many other species, but they are not represented by identifiable material. In southern Europe, especially in France and Italy, as many as 10 or 12 species are listed from single localities, showing that in all probability the number of American species will be greatly increased in future work. This paper should therefore be looked upon as only a pioneer attempt at making a basis on which a larger study of the American species can be built.[2]

Orthophragmina cubensis Cushman.

Plate VII, figures 1, 2.

Orthophragmina cubensis Cushman, Carnegie Inst. Washington Pub. 291, p. 52, pl. 9, fig. 3; pl. 10, figs. 2-4, 1919.

Test small, lenticular, comparatively thick; thickness in the center greatest, about three-fifths the diameter; circular, gradually thinning toward the periphery but without a definite border; periphery rounded; surface with numerous rather large papillae in the center, gradually smaller toward the periphery.

In vertical section the test, owing to the straightness of the slope from center to periphery, is almost diamond shaped; pillars of the center very heavy, thick, increasing rapidly in diameter toward the surface, the peripheral ends projecting above the adjacent lateral chambers; equatorial chambers of the same height, the band hardly increasing in diameter from center to periphery, very small; lateral

[1] U. S. Geol. Survey Prof. Paper 108, pp. 115-124; pls. 40-44, 1917.

[2] A species of *Orthophragmina* recognized after this paper was in type is described in a manuscript now awaiting publication in Prof. Paper 128.

Tentative correlation table of the Tertiary marine sedimentary formations of Panama.

[By Thomas Wayland Vaughan.]

American time subdivisions.		Panama.	Jamaica.	Other Antilles.	Mexico and Central America.	Southeastern United States.	European time subdivisions.
Pliocene.		Toro limestone.	Manchioneal formation. Kingston formation.	Pliocene of Guantanamo, Cuba.	Pliocene of Yucatan and Limon, Costa Rica.	Waccamaw marl, Nashua marl, and Caloosahatchee marl (nearly contemporaneous).	Sicilian. Astian. Plaisancian.
Miocene.	Upper.					Yorktown formation, Duplin marl, and Choctawhatchee marl (nearly contemporaneous).	Pontian. Sarmatian.
						St. Marys formation.	Tortonian.
						Choptank formation.	
						Calvert formation. / Marks Head marl.	
	Middle.	Gatun formation.		La Cruz marl (Cuba). / Upper horizon in Martinique. / Upper horizon in Santo Domingo.	Gatun formation (Costa Rica). / Pacific coast of Nicaragua. / Exposures on Isthmus of Tehuantepec.		Helvetian.
	Lower.		Bowden marl.	Marl at Baracoa, Cuba. / Lower horizon in Martinique. / Zones G, H, and I in Santo Domingo.		Alum Bluff formation. Shoal River marl member. Oak Grove sand member. Chipola marl member.	Burdigalian.
Oligocene.	Upper.	Emperador limestone. / Culebra formation. Upper part of Culebra.		Anguilla formation (Anguilla) and beds at many localities in Cuba.	San Rafael formation.	Chattahoochee formation. Tampa formation.	Aquitanian. Chattian.
	Middle.	Culebra formation. Lower part of Culebra and limestone at Tonosi.		Coral reef at Guantanamo, Cuba. / Antigua formation (Antigua). / Pepino formation (Porto Rico). / Lower horizon in Santo Domingo.			Rupelian.
	Lower.	Limestone with *Orthophragmina* on Haut Chagres[a] and limestone at David (contemporaneous). / Bohio conglomerate.[b]	Montpelier white limestone.		Deposits with *Pecten* aff. *P. poulsoni* and large, discoid orbitoids.	Vicksburg group. Byram calcareous marl. Marianna limestone. Red Bluff clay.	Lattorfian (Sannoisian).
Eocene.	Upper.		Cambridge formation. Richmond formation.	St. Bartholomew limestone (St. Bartholomew). Widely distributed in Cuba; also in Haiti.	Brito formation of Nicaragua (typical Brito). / Frio clay. Fayette sandstone.	Jackson formation. Ocala limestone.	Ludian (Priabonian). Bartonian.
	Middle.	Eocene of Tonosi.			Near the Texas border. Claiborne group.	Claiborne group. Gosport sand. Lisbon formation. Tallahatta buhrstone.	Auversian.[c] Lutetian.
	Lower.				Wilcox formation.	Wilcox group. Hatchetigbee formation. Bashi formation. Tuscahoma formation. Nanafalia formation.	Ypresian.[c] Sparnacian.[c]
					Midway formation.	Midway group. Naheola formation. Sucarnochee clay. Clayton limestone.	Thanetian.[c] Montian.[c]

[a] Reported by H. Douvillé and referred to "Stampien inférieur"=Vicksburgian=Lattorfian; Cushman thinks these deposits should be referred to the upper Eocene and placed opposite the St. Bartholomew limestone in the table.

[b] May belong stratigraphically somewhat higher.

[c] Correlation proposed by E. W. Berry.

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chambers in vertical columns, up to 20 or more in a column in the thickest central portion, the individual chambers at least four or five times as wide as high in section.

Horizontal sections show the rectangular chambers of the equatorial region several times as long as wide, the lateral chambers forming an irregular network about the sections of the pillars, often several columns of vertical chambers between the pillars.

Diameter, 1.5 to 3.5 millimeters.

Type specimens from U. S. G. S. station 3475, Boston mine, near Santiago, Cuba; collected by A. C. Spencer.

This seems to be a common Cuban species, occurring in material from several stations as follows:

3448. Limestone from hillside south of Ponupo manganese mine, La Maya, near Santiago; T. W. Vaughan, collector.

6117. Boulder from the band of limestone on hill east of railroad and south of Cristo, near Santiago; C. W. Hayes, collector.

6118. Limestone near railroad on trail to mines south of Cristo; C. W. Hayes, collector.

6119. Isabella and Boston manganese mine, near Santiago; C. W. Hayes, collector.

6120. Loose material, Santiago Province, exact locality unknown.

6122. Greensand limestone, Boston manganese mine, 3 miles east of Cristo, Santiago Province; A. C. Spencer, collector.

6123. Resting on ore bed, 4 to 6 feet thick, Ponupo manganese mine, Santiago Province; A. C. Spencer, collector.

6124. Foraminiferal limestone, Ponupo manganese mine, Ponupo, Santiago Province; R. T. Hill, collector.

6125. Railroad cut near San Nicolas manganese mine, west of San Luis, Santiago Province; C. W. Hayes, collector.

7666. Sierra Guaso, northeast of Guantanamo; N. H. Darton, collector, 1916.

The embryonic chambers of this species so far as seen are unequal in size and very comparable to those seen in the subgenus *Nephrolepidina* of *Lepidocyclina*, the larger one kidney shaped and partly embracing the smaller.

In its general characters this species suggests *O. douvillei* Schlumberger, but it differs in several essential details.

Specimens of what is apparently the megalospheric form of this species are abundant in material from the Pilar mine, Oriente Province, Cuba; E. F. Burchard, collector. Some of these are figured in Plate VII, figure 1.

Orthophragmina minima Cushman.

Plate VII, figure 3.

Orthophragmina minima Cushman, U. S. Nat. Mus. Bull. 103, p. 97, pl. 41, fig. 1, 1918.

Test circular, very small, slightly more than 2 millimeters in diameter; thickness somewhat less than half the diameter; central portion very strongly umbonate, nearly rounded to a point about two-thirds of the distance from the center to the periphery; from this point to the periphery the surface is nearly flat; surface of the test comparatively smooth.

The horizontal section through the equatorial chambers shows very fine hexagonal chambers and the embryonic chambers nearly equal in size.

Plate VII, figure 3, shows well the contour of the test in vertical section, the strongly curved central umbonate portion making up two-thirds or more of the width, and the peripheral flange with its nearly parallel sides. The chambers are very small except the embryonic central chambers, which are nearly equal and have a straight division line between. The lateral chambers are in vertical columns, but the test is without pillars. In the central region there may be more than 20 chambers in a vertical column, and even on the peripheral flange there are usually three or four chambers in a column on each side of the equatorial chambers.

Type specimen from U. S. G. S. station 6512, in the big white limestone from the river bed above the ice plant near David, Panama; D. F. MacDonald, collector.

This is a very small species, yet it has an abundance of very fine chambers. There is an exceptional development of lateral chambers in the region of the periphery.

Orthophragmina clarki Cushman, n. sp.

Plate VII, figures 4, 5.

Test circular, much compressed; central portion somewhat raised and slightly umbonate; surface finely granular or papillate; the papillae of the central umbonate region largest and most conspicuous, but others scattered over the remainder of the surface except at the extreme periphery, where they are lacking; slope of the test very gradual from umbo to periphery.

Equatorial chambers typical of the genus, elongate, rectangular, those of the outer annuli

1½ to 2 times as long as broad; annuli somewhat irregular in width, as is usual in the genus.

The vertical section shows the pillars, which are represented at the surface by the papillae, and the narrow band of equatorial chambers.

Type specimens from northeast side of Domengine Creek, near corner of the SW. ¼ sec. 29, T. 18 S., R. 15 E., Mount Diablo base and meridian, Calif., in Meganos group (Eocene); Dr. Bruce L. Clark, collector.

This may be the species referred to *O. pratti* by Douvillé.[1] His specimens were from the peninsula of California.

Orthophragmina pustulata Cushman.

Plate VII, figure 6.

Orthophragmina pustulata Cushman, Carnegie Inst. Washington Pub. 291, p. 55, pl. 9, figs. 6, 7; pl. 10, fig. 1, 1919.

Test circular, lenticular, thickest in the middle, thence gradually thinning toward the periphery, which is without a carina or thinner portion; thickness about one-fifth the diameter; surface finely pustulose; papillae larger and more numerous near the central region, thence gradually decreasing in size and number toward the periphery.

The vertical section shows the general form; equatorial band very thin, increasing hardly at all toward the periphery; pillars numerous, somewhat thicker toward the surface.

The horizontal section shows the equatorial chambers elongate, rectangular, length about three times the breadth; annuli irregular in width; pillars irregularly rounded, remote, largest in center, decreasing gradually in size toward the periphery; intermediate space filled with the irregularly polygonal lateral chambers.

Diameter 3.5 to 5 millimeters.

Type specimen a section from station 3567, lowermost 100 feet of Tertiary running in above serpentine, northwest of Recreo, Matanzas Province, Cuba; A. C. Spencer, collector. Specimens also apparently of this species were obtained at station 3448, in limestone on hillside south of Panupo manganese mine, La Maya, near Santiago, Cuba; T. W. Vaughan, collector.

This is a larger, flatter species than *O. cubensis* and is easily distinguished in the sections.

[1] Compt. Rend., vol. 161, p. 410, 1915.

Orthophragmina crassa Cushman.

Plate VIII, figures 1, 2.

Orthophragmina crassa Cushman, Carnegie Inst. Washington Pub. 291, p. 53, pl. 9, figs. 4, 5; pl. 10, figs. 2, 4, 1919.

Test circular, lenticular, very thick in comparison with the diameter; central portion broadly convex, thence straight or even slightly concave to the rather acute periphery; surface fairly smooth, with a few raised ends of pillars making it slightly papillate.

The vertical section shows the general shape; in some specimens thickness at least two-thirds the diameter; central portion broadly rounded, with numerous large pillars, increasing in diameter toward the surface; lateral chambers very numerous, about three times as wide as high; usually at least two columns between each two adjacent pillars, even in the center; over 30 chambers in the center in some of the columns are indicated; equatorial chambers increasing very slowly in height toward the periphery but more rapidly than in most species, so that the equatorial band at the periphery may be double the width near the center; embryonic chamber comparatively large, elongate in this section.

The horizontal section shows the usual elongate, rectangular equatorial chambers; the pillars subpolygonal, largest in the center, thence smaller toward the periphery; intermediate lateral chambers irregularly polygonal.

Diameter, 3.5 to 5.5 millimeters.

Type specimen from station 6122, greensand limestone, Boston manganese mine, Santiago Province, Cuba; A. C. Spencer, collector. The species also appears to be present at the following stations:

3475. Boston mine near Santiago, Cuba; A. C. Spencer, collector.

6117. Boulder from band of limestone on hill east of railroad and south of Cristo, near Santiago, Cuba; C. W. Hayes, collector.

6118. Fossil limestone near railroad, on trail to mines south of Cristo, Cuba; C. W. Hayes, collector.

6119. Isabella and Boston manganese mine, Cuba; C. W. Hayes, collector.

6123. Ponupo manganese mine, resting on ore bed 4 to 6 feet thick, Santiago Province, Cuba; A. C. Spencer, collector.

6124. Foraminiferal limestone, Ponupo manganese mine, Cuba; R. T. Hill, collector.

6125. Railroad cut near San Nicolas manganese mine, west of San Luis, Cuba; C. W. Hayes, collector.

Orthophragmina sculpturata Cushman.

Plate VIII, figures 3–7.

Orthophragmina sculpturata Cushman, Carnegie Inst. Washington Pub. 291, p. 54, pl. 9, figs. 8, 9, 1919.

Test circular, somewhat sellaeform, in many specimens very slightly so; central portion considerably thickened and occupying one-third to one-quarter the diameter of the test; peripheral portion much flattened and comparatively thin; exterior of central thickened portion, when well preserved, beautifully sculptured, with comparatively few raised papillae, between which the surface is depressed and reticulated as in *O. marthae* Schlumberger; peripheral thin portion of the test usually smooth when the surface is well preserved.

Vertical sections show thickening up to 1.5 millimeters in the central portion, while the periphery may be but 0.25 millimeter in thickness. Equatorial chambers small, increasing hardly at all in diameter from the center to the periphery; central embryonic chambers not well shown in the sections but at least six to eight times the diameter of adjacent equatorial chambers. Peripheral portion without pillars; central portion with very strong pillars, thick, with a diameter of one-third to one-half their length and increasing very slightly in diameter toward the surface; lateral chambers in columns between the pillars, very thin compared to their breadth. Central portion of the outline decidedly undulate from the projecting ends of the pillars.

Horizontal sections show very numerous equatorial chambers, elongate, several times as long as broad; lateral chambers in section appearing as polygonal lighter spaces surrounding in a single row the solid, opaque, circular elliptical, or irregularly polygonal pillar sections; toward the periphery, where the pillars are wanting, forming an irregular network—the same arrangement as in *O. dispansa* Sowerby.[1]

Diameter, 5 to 7 millimeters.

Type specimen 3478, from Nuevitas, Cuba; A. C. Spencer, collector. Sections were also obtained in material from the Cadiz mine, Oriente Province, Cuba; E. F. Burchard, collector.

This species in general appearance resembles *O. marthae* Schlumberger, especially in its characteristic surface ornamentation, but the vertical section seems to be verydi fferent from that figured by Schlumberger.

[1] Schlumberger, Soc. géol. France Bull., sec. 4, vol. 3, pl. 12, fig. 51, 1904.

Orthophragmina hayesi Cushman, n. sp.

Plate VIII, figures 8–10.

Test small, lenticular, circular, comparatively thick in the center, thence gradually becoming thinner and at the peripheral portion in the adult extending out into a broad, thin flange; central disk with numerous deep pits, circular or polygonal, usually four or five in the central region of larger size, the surrounding ones gradually smaller as they are more distant from the center; remainder of the surface reticulate, from the lateral chambers as they come to the exterior.

Equatorial chambers of the usual rectangular form of this genus.

Vertical sections (Pl. VIII, fig. 10) show the large number of lateral chambers in each column and the flangelike peripheral portion not shown in the exterior views of the worn specimens (figs. 8, 9).

Type specimens (U. S. N. M. No. 32820) from U. S. G. S. station 6411, Brito formation, coast about 2 miles northwest of Brito Harbor, Nicaragua; C. W. Hayes, collector.

Orthophragmina marginata Cushman.

Plate IX, figures 1, 2.

Orthophragmina marginata Cushman, Carnegie Inst. Washington Pub. 291, p. 56, pl. 1, fig. 2; pl. 2, fig. 4, 1919.

Test circular, lenticular; central portion strongly raised and umbonate; regularly curved down to the broad peripheral flange, which is again thickened near the peripheral margin; surface comparatively smooth, very slightly granular but not at all papillate.

In vertical section the central portion is seen to be strongly biconvex, not much wider than either part of the surrounding margin-like thinner portion, again thickening toward the extreme peripheral margin, which is rounded. Equatorial chambers small, in the center very narrow but increasing slightly although gradually toward the periphery, where they are not more than 0.1 millimeter in height. The chambers are convex on the peripheral side, almost semicircular in some specimens. Lateral chambers very small and often difficult to distinguish even with an enlargement of 20 diameters (Pl. IX, fig. 2). In the central portion there are large numbers of layers of the lateral chambers, often 30 to 40 on either side of the equatorial band. This number decreases as the

convexity becomes less, and over the flattened margin there are but six to eight layers of lateral chambers. At the border this number is somewhat increased, but it falls off again at the extreme outer margin. There are traces of pillars in the central umbonate region, but they are not prominent.

Diameter of type specimen 12 to 14 millimeters.

Type specimen and others from U. S. G. S. station 6924, from the St. Bartholomew limestone at point on northwest side of St. Jean Bay, St. Bartholomew, Leeward Islands; collected by T. W. Vaughan. The St. Bartholomew limestone is of upper Eocene age, according to Vaughan.

There are sections which resemble this closely in the material from U. S. G. S. station 6512, in the big white limestone from the river bed above the ice plant near David, Panama; collected by D. F. MacDonald.

Orthophragmina flintensis Cushman.

Plate IX, figures 3–6.

Orthophragmina flintensis Cushman, U. S. Geol. Survey Prof. Paper 108, p. 115, pl. 40, figs. 1, 2, 1917.

Test small, circular, much compressed; slightly thickened in the central portion, thence gradually sloping to the periphery; surface slightly pustulate but not papillate, almost smooth in some specimens; the raised pustules generally in concentric lines.

The horizontal section shows very narrow rectangular chambers in the equatorial band and the embryonic chambers with one small and spherical, almost entirely surrounded, except at one side, by the much larger second chamber.

Diameter, about 5 millimeters.

The type locality is U. S. G. S. station 7117, in the lower portion of the Ocala limestone, in bluff on west bank of Flint River $1\frac{3}{4}$ miles above the Georgia Southwestern & Gulf Railway bridge near Oakfield, Lee County, Ga.; upper bed, No. 2 of section; C. W. Cooke, collector. Other stations mentioned with the original description are mostly along Flint River in Georgia, in fine-grained light-colored limestone. It also occurs at station 3626, in a similar fine-grained limestone at Philema, Lee County, Ga.; T. W. Vaughan, collector.

A specimen which seems identical with this species was obtained at station 6408, in the Brito formation, on the Pacific coast of Nicaragua, 2 miles northwest of Brito Harbor; C. W. Hayes, collector. This specimen shows the size and exterior well, while others show the equatorial chambers. With this is a species of *Operculina*, which also occurs with it in Georgia, and a specimen of *O. georgiana*, as noted under that species (p. 45).

Orthophragmina floridana Cushman.

Plate IX, figure 7.

Orthophragmina floridana Cushman, U. S. Geol. Survey Prof. Paper 108, p. 116, pl. 40, fig. 3, 1917.

Test circular, much flattened, of medium size; central region very slightly raised and umbonate, thence gradually sloping toward the periphery; whole test very thin; surface ornamented throughout with fine but distinctly raised, almost spinose papillae, arranged in concentric lines parallel to the peripheral margin.

Equatorial chambers in horizontal section very narrowly rectangular.

The vertical section shows 8 to 10 lateral chambers in a vertical column in the central portion, the walls convex on the side nearer the surface, the whole series convex at each papilla instead of parallel to the equatorial series, the papillae being formed by the local convexity of the lateral chambers rather than by pillars as in some other species.

Diameter of adult specimens, 10 to 14 millimeters.

The type locality is U. S. G. S. station 6768, in soft white Ocala limestone on Chipola River at wagon bridge half a mile east of Marianna, Fla., No. 1 of section; C. W. Cooke, collector. The species is abundant at this locality. Additional records are the following:

7192. Same locality as the type station, No. 3 of section; C. W. Cooke, collector, a single horizontal section in hard limestone.

8259. About 6 miles southeast of Campbellton and 12 miles northwest of Marianna, on road to Cottonwood, Ala., half a mile from its intersection with the Marianna-Campbellton road, in Jackson County, Fla.; C. W. Cooke, collector. Abundant in soft Ocala limestone.

7125. West bank of Flint River in Baker County about 3 miles below Dewberry Ferry (Baconton Landing) and about 13 miles above Newton, Ga.; a single spocimen of small size; J. E. Brantly and C. W. Cooke, collectors.

Orthophragmina georgiana Cushman.

Plate X, figure 1.

Orthophragmina georgiana Cushman, U. S. Geol. Survey Prof. Paper 108, p. 117, pl. 41, figs. 2, 3; pl. 42, fig. 3; pl. 43, figs. 2, 3, 1917.

Test typically almost square, the angles slightly projecting and the sides slightly concave near the angles, convex in the center, small; diameter usually about 6 millimeters for adult specimens; diagonals of the square occupied by raised radial areas with a central umbonate mass a little more than a millimeter in diameter; intermediate triangular areas thin and flat; entire surface with very numerous, evenly distributed, prominent papillae, those of the central umbo and the middle line of the radial ridges slightly larger than those of the rest of the surface.

The horizontal section shows the equatorial chambers elongate, rectangular, those of the radial portions more crowded than those of the intermediate flattened areas.

In vertical section the lateral chambers are most numerous over the radial and umbonal regions.

The type locality for this species is station 3387, Ocala limestone at Red Bluff, on Flint River 7 miles above Bainbridge, Decatur County, Ga.; T. W. Vaughan, collector. It was recorded also from several stations along Flint River in Georgia and from station 7348, on left bank of Suwannee River about a mile above Troy Springs, Fla.; C. W. Cooke, collector.

Additional records include stations in Georgia, Florida, and Alabama, as follows:

3758. Camp Perry, Fla.; S. W. McCallie, collector; a few specimens.

3760. On Georgia Southern & Florida Railway half a mile south of Tivola, Ga.; S. W. McCallie, collector.

6161. Flint River, Bainbridge, Ga.; L. W. Stephenson, collector.

6747. Steamboat Point, on west side of Sepulga River at sharp bend near middle of sec. 20, T. 3 N., R. 13 E., Escambia County, Ala.; C. W. Cooke, collector; specimens fairly common with other Ocala limestone species.

6785. Atlantic Coast Line Railroad at Dutton's phosphate spur, one-half to three-fourths mile south of Herlong's Station, Columbia County, Fla.; T. W. Vaughan and C. W. Cooke, collectors; specimens rare but typical.

7127. East bank of Flint River, one-fourth mile below Norman's Ferry, Mitchell County, Ga.; loose blocks excavated from channel; C. W. Cooke, and J. E. Brantly, collectors.

8259. About 6 miles southeast of Campbellton and 12 miles northwest of Marianna, on road to Cottonwood, Ala.; half a mile from its intersection with the Marianna-Campbellton road, Jackson County, Fla.; C. W. Cooke, collector.

A single specimen of this species was found at station 6408, in the Brito formation on the Pacific coast of Nicaragua, 2 miles northwest of Brito Harbor; C. W. Hayes, collector. This occurs with two other Georgia species, as noted under *O. flintensis*.

Orthophragmina subtaramellei Cushman.

Plate X, figures 2, 3.

Orthophragmina subtaramellei Cushman, Carnegie Inst. Washington Pub. 291, p. 53, pl. 10, fig. 2; pl. 15, figs. 1–3, 1919.

Test stellate, usually with five arms, occasionally six; arms well distinguished from the central body and extending outward freely, thickest in the central region, thence gradually sloping to the angles between the arms and gradually merging into the median axis of the arms; the arms themselves thickest in the middle, thence sloping to the sides, which are thin and angled; ends of the arms round-pointed; surface with numerous granulations, more pronounced in the central portion.

Vertical sections show the general shape, the equatorial band of chambers increasing slightly if at all from the center to the periphery, pillars well developed, especially in the central region, but not numerous, usually several columns of lateral chambers between them.

Diameter, 1.5 to 2 millimeters.

The type locality for this species is station 6122, greensand limestone, Boston manganese mine, Santiago Province, Cuba. According to the sections obtained, the species evidently also occurs at the following stations:

3475. Boston mine, near Santiago, Cuba; A. C. Spencer, collector.

6119. Isabella and Boston manganese mine, Santiago Province, Cuba; C. W. Hayes, collector.

6123. Ponupo manganese mine, Santiago Province, Cuba, resting on ore bed 4 to 6 feet thick; A. C. Spencer, collector.

6124. Foraminiferal limestone, Ponupo manganese mine; R. T. Hill, collector.

6125. Railroad cut near San Nicolas manganese mine, west of San Luis, Cuba; C. W. Hayes, collector.

7666. Sierra Guaso, northeast of Guantanamo, Cuba; N. H. Darton, collector.

This species is very close to *O. taramellei* Munier-Chalmas but is decidedly smaller, all the specimens seen from Cuba being less than 2 millimeters in diameter between the tips of the arms.

The specimens from station 6120 are weathered out and are numerous and of greenish color.

O. taramellei was described from Villa Lady Bruce (Biarritz); Monte Spilecco (Vicentin); and Schönegg, near Kressenburg.

Orthophragmina antillea Cushman.

Plate X, figures 4, 5.

Orthophragmina antillea Cushman, Carnegie Inst. Washington Pub. 291, p. 55, pl. 1, fig. 1; pl. 2, figs. 2, 3; pl. 4, figs. 2, 4, 1919.

Test flattened, octagonal, surface with eight raised ribs radiating from the central, somewhat raised umbo to the periphery; triangular areas between, thin and flattened; umbonal area raised and rounded, with definite pillars appearing as differences in coloration in the type; radial ribs with numerous raised areas and pillars scattered along their whole length.

Vertical sections show the greater diameter of the equatorial chambers at irregular intervals and the irregular, almost serrate character of the upper and lower surfaces due to the fine projections of the surface, especially along the ribs.

Horizontal sections through the equatorial chambers were obtained only in small fragmentary bits but enough to show the typical rectangular chambers of the genus.

Diameter, about 12 millimeters.

Type specimen from U. S. G. S. station 6895, spur on southeast side of bay northwest of St. Jean Bay, St. Bartholomew, Leeward Islands; T. W. Vaughan, collector. Sections apparently of this species came from station 6924, point on northwest side of St. Jean Bay, St. Bartholomew, Leeward Islands; T. W. Vaughan, collector. Specimens are very numerous in these sections, but the surface does not weather out well in the material examined.

There appear to be from five to eight layers of superimposed lateral chambers, as shown in the sections. A few of the smallest specimens show the embryonic chambers, but they are not well preserved. Plate X, figure 5, shows the general characters of the vertical section. Occasional oblique sections show the rectangular equatorial chambers characteristic of *Orthophragmina*. Sections very similar to those figured are included in material from station 6512, in the big white limestone from the river bed above the ice plant near David, Panama, collected by D. F. MacDonald.

The species is close to *O. mariannensis* Cushman from the Ocala limestone at Marianna, Fla.

The type specimen is the one mentioned by Vaughan[1] as *Orbitoides* sp., "large, stellate form."

Orthophragmina mariannensis Cushman.

Plate XI, figure 1.

Orthophragmina mariannensis Cushman, U. S. Geol. Survey Prof. Paper 108, p. 116, pl. 40, fig. 5; pl. 42, fig. 2; pl. 44, 1917.

Test flattened, conspicuously stellate, the angles extending out acutely with curved reentrants, of medium size; central region umbonate, from which extend 8 to 11 (typically 8) raised ribs, running to the peripheral angles; umbo and ribs finely papillate; depressed areas between flat and rather remotely and finely papillate except toward the periphery, where the papillae are slightly more conspicuous.

The horizontal section shows much elongated rectangular equatorial chambers, the lateral chambers irregularly polygonal in section.

Vertical section with the embryonic chambers very unequal; distinct pillars between the vertical columns of lateral chambers, increasing in diameter toward the surface.

Diameter, 15 to 18 millimeters.

Abundant at the type locality, station 6768, Ocala limestone on Chipola River at wagon bridge half a mile east of Marianna, Fla.; No. 1 of section; C. W. Cooke, collector. A single specimen was recorded from station 3387, Ocala limestone at Red Bluff, on Flint River, 7 miles above Bainbridge, Decatur County, Ga.; T. W. Vaughan, collector. Additional stations are as follows:

7097. East bank of Flint River above old factory at bend three-fourths mile northeast of Atlantic Coast Line Railroad station at Bainbridge, Ga.; C. W. Cooke and W. C. Mansfield, collectors.

8259. About 6 miles southeast of Campbellton and 12 miles northwest of Marianna, on road to Cottonwood, Ala., half a mile from its intersection with the Marianna-Campbellton road, Jackson County, Fla.; C. W. Cooke, collector.

[1] Vaughan, T. W., Carnegie Inst. Washington Year Book No. 13, for 1914, p. 359.

Orthophragmina mariannensis Cushman var. papillata Cushman.

Plate XI, figure 2.

Orthophragmina mariannensis Cushman var. *papillata* Cushman, U. S. Geol. Survey Prof. Paper 108, p. 117, pl. 43, fig. 1; pl. 44, 1917.

Variety differing from the typical form of the species in the much more prominent, higher ribs, which are semicylindrical and very strongly papillate; number of ribs also slightly greater than in the typical form; a few specimens have 8, but 9 to 12 or even 16 ribs are more common.

The type station for this variety is the same as that for the species, station 6768. It was also recorded from stations along the Flint River in Georgia. Additional records for this variety are as follows:

7130. East bank of Flint River, 6 miles above Bainbridge, Decatur County, Ga.; C. W. Cooke and J. E. Brantly, collectors; a single very typical specimen.

8259. About 6 miles southeast of Campbellton and 12 miles northwest of Marianna, on road to Cottonwood, Ala., half a mile from its intersection with the Marianna-Campbellton road, Jackson County, Fla.; C. W. Cooke, collector.

Orthophragmina vaughani Cushman.

Plate XI, figure 3.

Orthophragmina vaughani Cushman, U. S. Geol. Survey Prof. Paper 108, p. 118, pl. 43, figs. 4, 5, 1917.

Test flattened, small, 8 to 10 millimeters in diameter, quadrate or octagonal in outline, stellate; main ornamentation consisting of a central raised umbonate portion with four radiating raised areas to the main angles of the test, broad and rather low, about halfway to the periphery considerably increasing in height and width, finely papillate toward the center, much more coarsely so toward the periphery; intermediate spaces much depressed, with a smooth U-shaped area near the inner angle next to the raised portions; the peripheral part raised and strongly papillate, the peripheral portion of this raised area at the margin strongly convex or even bluntly angled.

The ornamentation of this species is unique. It is evidently a rare species, being known only from the type locality, U. S. G. S. station 3387, Ocala limestone at Red Bluff, on Flint River 7 miles above Bainbridge, Decatur County, Ga.; T. W. Vaughan, collector.

Orthophragmina americana Cushman.

Plate XI, figure 4.

Orthophragmina americana Cushman, U. S. Geol. Survey Prof. Paper 108, p. 116, pl. 40, fig. 4; pl. 41, fig. 1; pl. 42, fig. 1.

Test large, flattened; peripheral margin with a series of projecting angles corresponding to the peripheral terminations of the radiately arranged raised ornamentation or thickenings; peripheral margin between the projecting angles very thin; central region with a thickened umbo 2 millimeters or more in diameter, from which radiate the raised riblike areas to the peripheral angles; these ribs high and narrow at their inception, lower and wider as they approach the periphery; ribs up to 20 in number; some starting from the umbo, others initiated later, arising independently in the intermediate areas, usually not symmetrically placed; surface comparatively smooth; surface indications of pillars usually inconspicuous or lacking.

In vertical section the equatorial chambers are rectangular, the area of the raised radial portions consisting of more numerous lateral chambers in the columns, curving about the axis at the rib at either side, those of the intermediate depressed areas parallel with the equatorial layer and few in number.

In horizontal section the equatorial chambers are rectangular, four or five times as long as wide, those of the axis of the radial portions narrower than those of the intermediate depressed areas.

The type locality for the species is U. S. G. S. station 6768, Ocala limestone on Chipola River at wagon bridge a quarter of a mile east of Marianna, Fla.; No. 1 of section; C. W. Cooke, collector. Another station is 3387, Ocala limestone at Red Bluff, on Flint River 7 miles above Bainbridge, Decatur County, Ga.; T. W. Vaughan, collector. Other specimens came from station 8259, Ocala limestone about 6 miles southeast of Campbellton and 12 miles northwest of Marianna, on road to Cottonwood, Ala.; half a mile from its intersection with the Marianna-Campbellton road, Jackson County, Fla.; C. W. Cooke, collector.

This is a fine species, one of the largest of the genus.

PLATES VII-XI.

PLATE VII.

Orthophragmina cubensis Cushman (p. 40).

FIGURE 1. Rock section showing several specimens, × 20, mostly of the megalospheric form. Pilar mine, Oriente Province, Cuba.

FIGURE 2. Vertical section probably of a microspheric specimen, × 20. Cuba (U. S. G. S. station 3448).

Orthophragmina minima Cushman (p. 41).

FIGURE 3. Vertical section, × 20, showing general outline and numerous very fine chambers. White limestone in river bed above ice plant, David, Panama (U. S. G. S. station 6512).

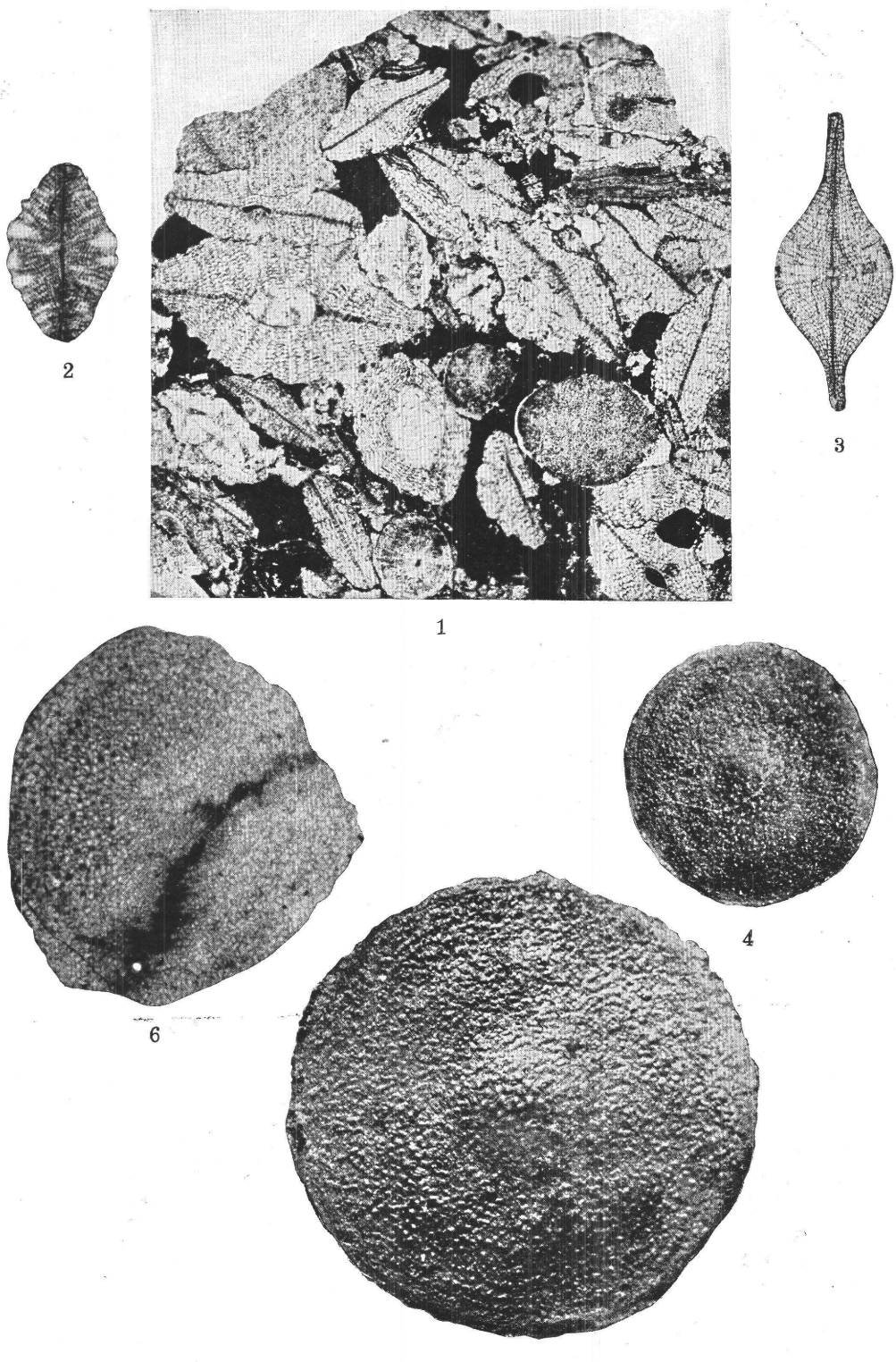
Orthophragmina clarki Cushman (p. 41).

FIGURE 4. Exterior view of partly grown specimen, × 10.

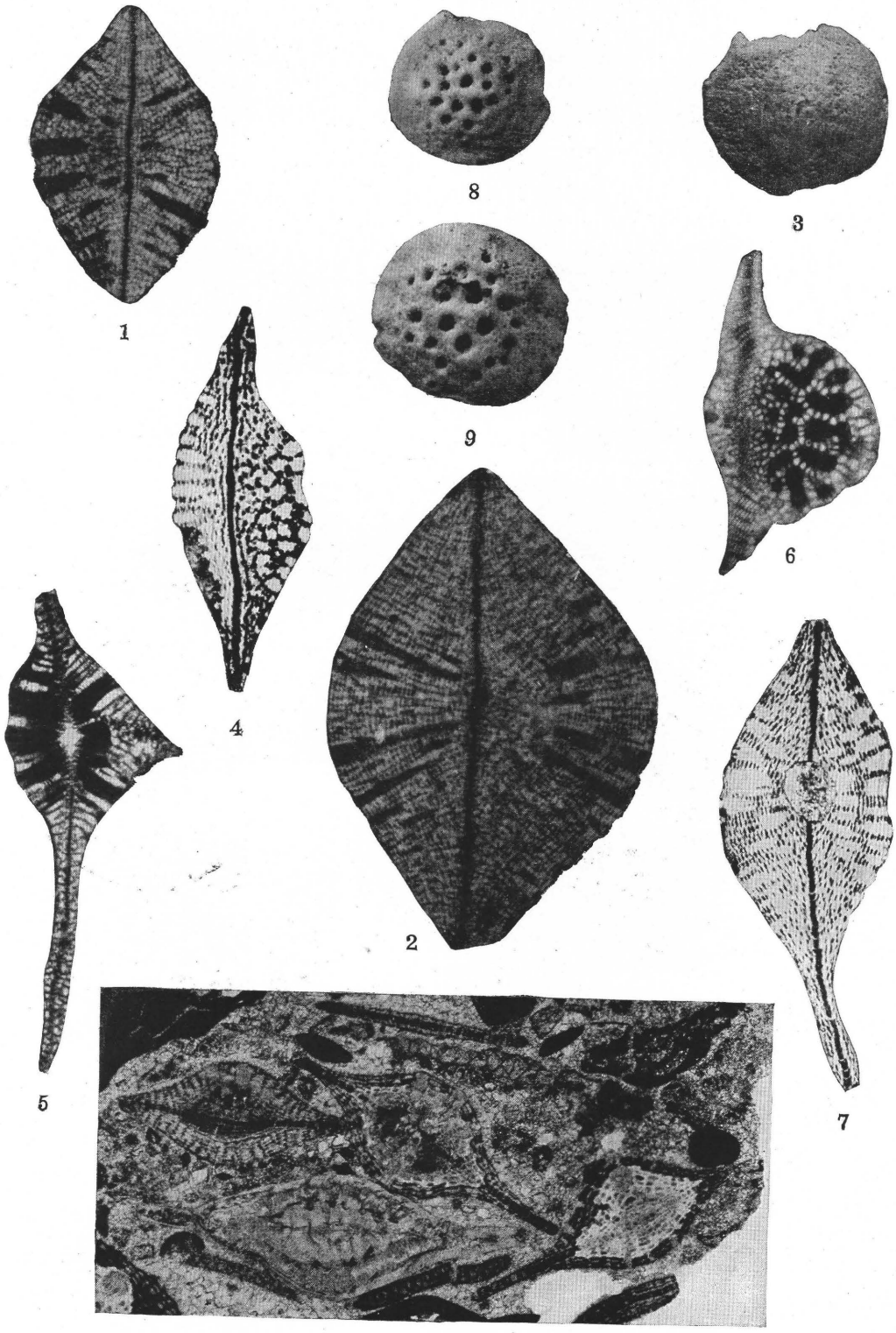
FIGURE 5. Exterior view of adult specimen, × 10. Both specimens from the Eocene of California (Meganos group of Clark).

Orthophragmina pustulata Cushman, n. sp. (p. 42).

FIGURE 6. Slightly oblique section showing equatorial chambers, pillars, and lateral chambers, × 20. Cuba (U. S. G. S. station 3567).



AMERICAN SPECIES OF ORTHOPHRAGMINA.



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AMERICAN SPECIES OF ORTHOPHRAGMINA.

PLATE VIII.

Orthophragmina crassa Cushman (p. 42).

FIGURE 1. Vertical section, × 20, showing general thick form, equatorial band, large number of lateral chambers, and the pillars.

FIGURE 2. Vertical section of larger specimen, × 20. Both specimens from Cuba (U. S. G. S. station 6122).

Orthophragmina sculpturata Cushman (p. 43).

FIGURE 3. Exterior view showing the few pillars of the central portion and reticulate peripheral portion, × 5. Cuba (U. S. G. S. station 3478).

FIGURE 4. Slightly oblique section, × 20. Gloria mine, Oriente Province, Cuba. The black of the chamber cavities is due to infiltrated manganese in this and the specimen of figure 7.

FIGURE 5. Vertical section showing heavy pillars, × 20. Cuba (U. S. G. S. station 3478).

FIGURE 6. Oblique section showing the large pillars, each surrounded by a single series of small lateral chambers, × 20. Cuba (U. S. G. S. station 3478).

FIGURE 7. Vertical section, × 20, probably of megalospheric specimen, showing the structures shown in figure 6 but at right angles, the elongate large pillars, and vertical rows of lateral chambers (in black). Same locality as figure 4.

Orthophragmina hayesi Cushman, n. sp. (p. 43).

FIGURES 8, 9. Exterior views of two specimens, × 20, showing the deep pits of thecentral region and the reticulate pattern over the remainder of the surface. These and the following from the Brito formation (Eocene) of Nicaragua.

FIGURE 10. Vertical sections showing the peripheral flange as developed in adult specimens, × 20.

PLATE IX.

Orthophragmina marginata Cushman (p. 43).

FIGURE 1. Exterior view of partly broken specimen, × 5. St. Jean Bay, St. Bartholomew, Leeward Islands (U. S. G. S. station 6924).

FIGURE 2. Vertical section, × 20, of half a specimen from the same locality.

Orthophragmina flintensis Cushman (p. 44).

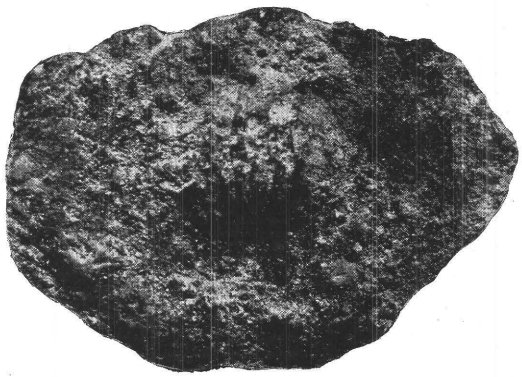
FIGURE 3. Exterior view, × 10, of specimen from the Brito formation of Nicaragua (U. S. G. S. station 6408).

FIGURE 4. Sectional horizontal view of type specimen, × 20, showing proloculum and second chamber, which nearly encircles it, and the annular rings of narrowly rectangular chambers. Ocala limestone of Georgia (U. S. G. S. 7115).

FIGURES 5, 6. Vertical sections, × 20, showing the numerous enlargements along the line of equatorial chambers and the pillars ending in the papillae of the surface. Nicaragua (U. S. G. S. station 6408).

Orthophragmina floridana Cushman (p. 44).

FIGURE 7. Surface view of type specimen, × 8. Ocala limestone of Florida (U. S. G. S. station 6768).



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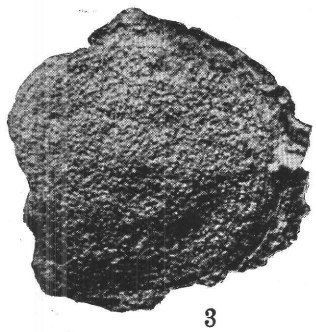

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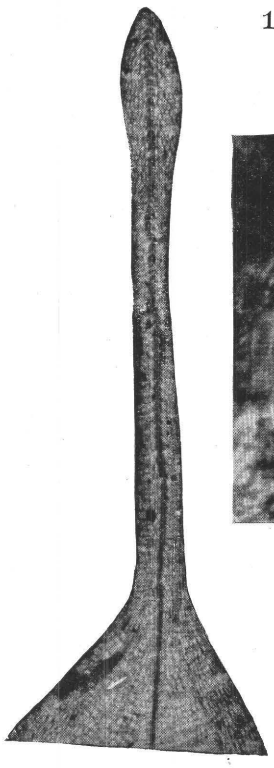

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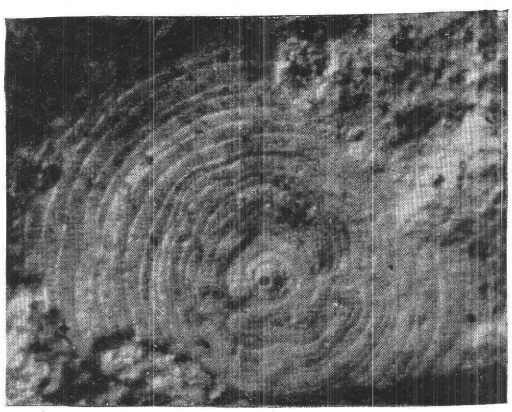

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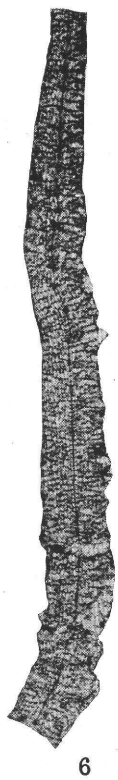

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AMERICAN SPECIES OF ORTHOPHRAGMINA.

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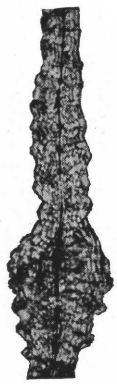

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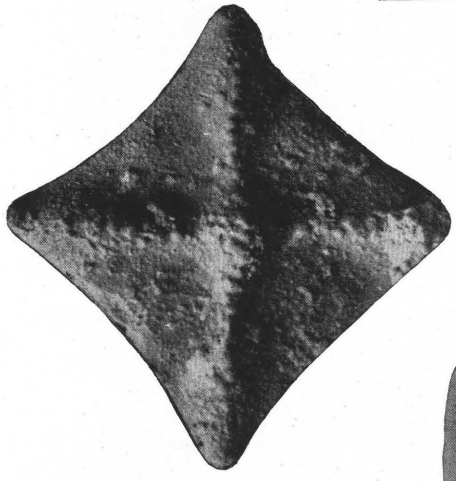

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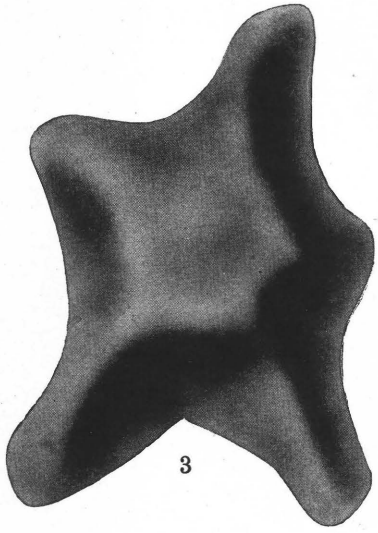

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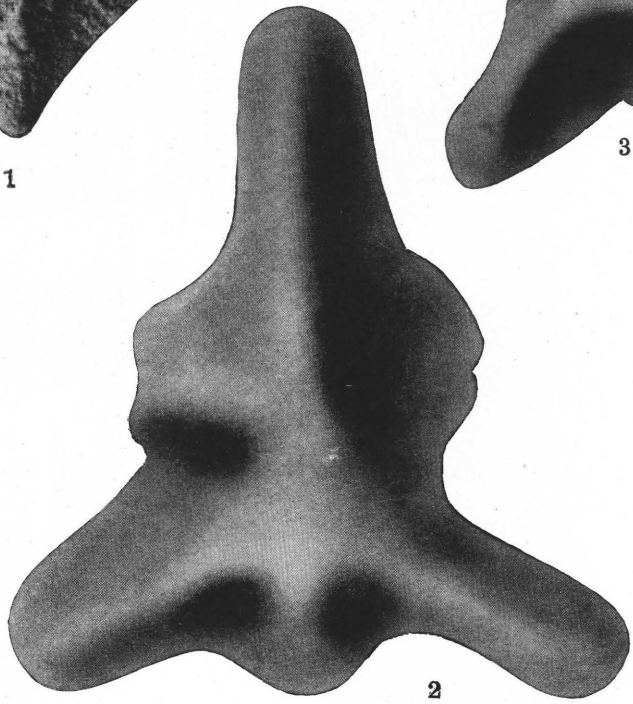

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AMERICAN SPECIES OF ORTHOPHRAGMINA.

PLATE X.

Orthophragmina georgiana Cushman (p. 45).

FIGURE 1. Surface view of type specimen, × 8. Ocala limestone of Georgia (U. S. G. S. station 7348).

Orthophragmina subtaramellei Cushman (p. 45).

FIGURES 2, 3. Surface views × 20, Boston manganese mine, Santiago Province, Cuba (U. S. G. S. station 6120).

Orthophragmina antillea Cushman (p. 46).

FIGURE 4. Surface view of type specimen, × 5. St. Jean Bay, St. Bartholomew, Leeward Islands (U. S. G. S. station 6895).

FIGURE 5. Portion of vertical section, × 20. Same locality as figure 4.

PLATE XI.

Orthophragmina mariannensis Cushman (p. 46).

FIGURE 1. Surface view of specimen, × 4. Ocala limestone of Florida (U. S. G. S. station 6768).

Orthophragmina mariannensis var. papillata Cushman (p. 47).

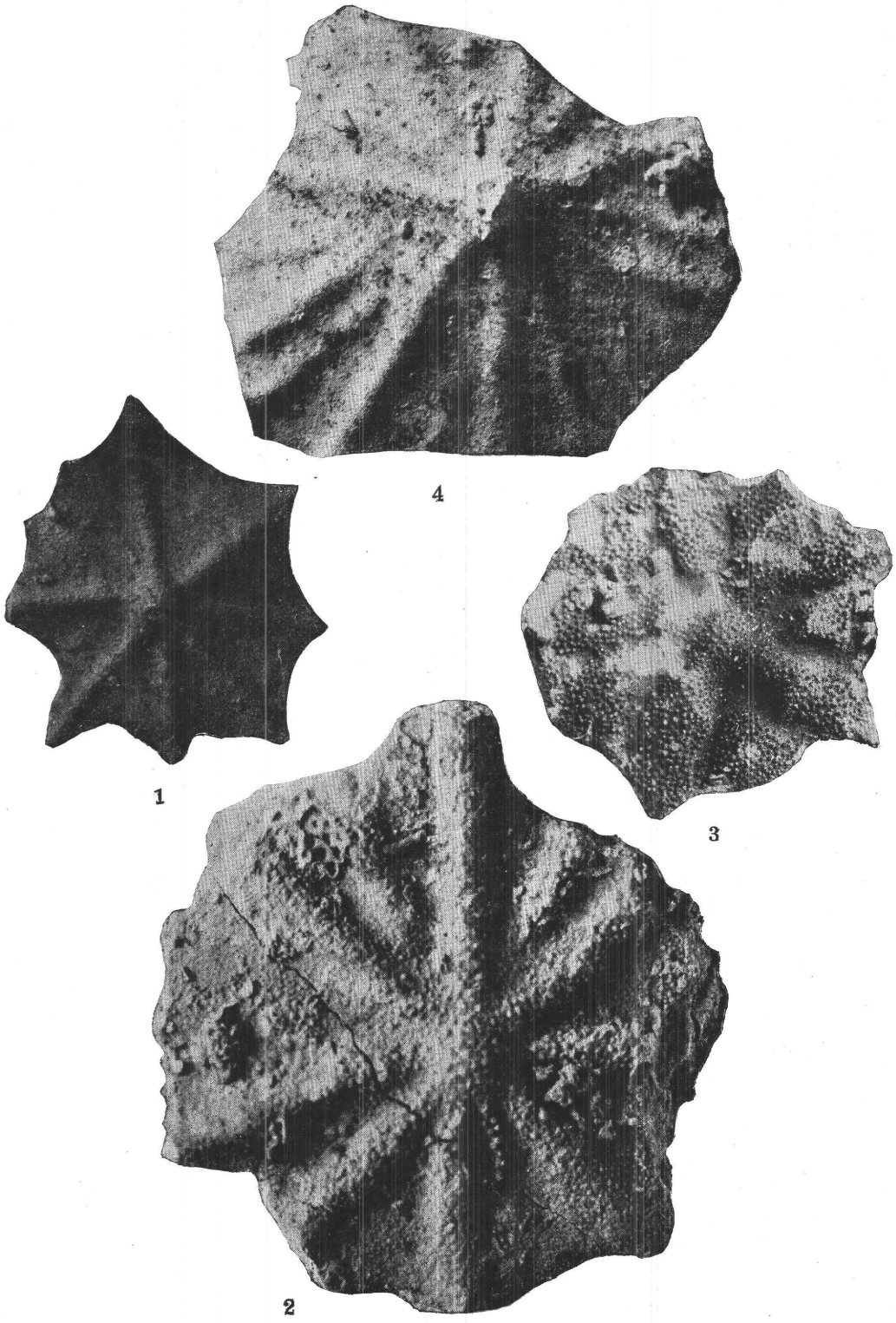
FIGURE 2. Surface view of specimen, × 6. Ocala limestone of Georgia (U. S. G. S. station 7126).

Orthophragmina vaughani Cushman (p. 47).

FIGURE 3. Surface view of type specimen, × 8. Ocala limestone of Georgia (U. S. G. S. station 3387).

Orthophragmina americana Cushman (p. 47).

FIGURE 4. Surface view of type specimen, × 4. Ocala limestone of Florida (U. S. G. S. station 6768).



AMERICAN SPECIES OF ORTHOPHRAGMINA.

AMERICAN SPECIES OF LEPIDOCYCLINA.

Although numerous species and varieties of orbitoid Foraminifera from many parts of the world have been described, almost nothing has been published on the American species. In 1833 Morton [1] described *Nummulites mantelli*, which was later taken by Gümbel in 1868 as the type of a subgenus of *Orbitoides* that he named *Lepidocyclina*. This is now recognized as a genus, and *L. mantelli* (Morton) is the type species. In 1865 Conrad [2] published a brief description of *Orbitolites supera*, which may now be known as *Lepidocyclina supera* (Conrad). These are the only species of orbitoid Foraminifera from the Coastal Plain region of the United States of which descriptions had been published prior to the publication of my paper on orbitoid Foraminifera of the genus *Orthophragmina* from Georgia and Florida,[3] in 1917. Two species of *Lepidocyclina* from Panama (*L. canellei* and *L. chaneri*) were described by Lemoine and R. Douvillé [4] in 1904, and H. Douvillé [5] has recently described two species from Trinidad (*L. pustulosa* and *L. tobleri*).

Several works refer to American species under names which were erroneously applied to them, but most of these species do not even belong to the genus *Lepidocyclina*.

From the collections of the United States Geological Survey, especially those obtained by T. Wayland Vaughan and C. Wythe Cooke, there has been placed in my hands a mass of material representing the Eocene and Oligocene deposits of the Atlantic and Gulf Coastal Plain of the United States. In addition I have examined collections from Panama obtained by Mr. Vaughan and the geologist of the Panama Canal Commission, Donald F. MacDonald; from Antigua and St. Bartholomew, by Mr. Vaughan; from Cuba, by Messrs. Vaughan, Darton, Hayes, Spencer, and Meinzer; and from Mexico, by E. T. Dumble, geologist for the Southern Pacific Railroad. These collections, with miscellaneous lots from many other localities, contain a great many specimens of *Lepidocyclina* and are representative of many regions.

A study of the collections shows that this general region contains a few widely distributed species which have already been found elsewhere, but by far the largest number of the species are undescribed, although some of them show relationships with species from other areas.

As a rule the species seem to have a very short vertical range and may therefore be used as index fossils for those formations in which they occur. The stratigraphy of the Coastal Plain region is now well coordinated, and it is possible to place the species very definitely, but in many other regions the detailed stratigraphy is not fully known, and comparisons are more difficult.

It is evident that in America *Lepidocyclina* is found both in the upper Eocene and in the lower and middle Oligocene as now understood. The detailed structure and the biologic relations of the various species are interesting but are reserved for discussion in a future paper.

In general the habitat in which *Lepidocyclina* was first developed was in fairly quiet waters of a tropical temperature and probably at depths less than 25 fathoms. The associated genera, *Operculina*, *Heterostegina*, *Carpenteria*, and *Gypsina*, are, so far as their living representatives show, characteristic of such conditions.

As an aid in understanding the structure of *Lepidocyclina* for one not used to the terminology the accompanying diagrammatic figure of a vertical section has been introduced. The structure involves two distinct masses of calcareous material—that belonging to or originating from the median layer (stippled in the figure) and that belonging to the lateral layers (solid black in the figure). In the central region are the embryonic chambers, one or more, in the megalospheric form of any species usually large and rounded. Surrounding these, usually in a single plane, are numerous equatorial chambers, shown in the diagram as two series on opposite sides of the embryonic chambers increasing in height from the center toward the periphery. Above and below this band of equatorial chambers, and usually covering them except near the periphery, are the numerous lateral chambers, usually seen in vertical section piled one above another in vertical col-

[1] Am. Jour. Sci., vol. 23, p. 291, pl. 5, fig. 9, 1833.
[2] Acad. Nat. Sci. Philadelphia Proc., No. 2, p. 74, 1865.
[3] Cushman, J. A., U. S. Geol. Survey Prof. Paper 103, pp. 115-124, pls. 40-44, 1917.
[4] Soc. géol. France, Paléontologie, Mém. 32, 1904.
[5] Compt. Rend., 1917, pp. 843, 844, figs. 1-6.

umns. In many species pillars are developed, usually solid masses of calcareous material originating at the wall of the horizontal series and extending to or toward the surface of the test. These pillars in some species rise above the surface and form the pustules or papillae of the surface ornamentation.

A horizontal section such as shown in Plate XXIX, figure 3, is made at right angles to that shown in the diagram and passes through the plane of the equatorial chambers. Such a section shows that the equatorial chambers in this genus have typically a hexagonal form, although this may often be modified to an ogival form or in certain species even to the rhomboid. Thus a horizontal section will discriminate this genus from the other orbitoid genus, *Orthophragmina*, with which it occurs, as in *Orthophragmina* the equatorial chambers are elongate and rectangular.

Undoubtedly other species will be found when more geologic work is done in the different areas, and probably more careful detailed collecting will show that special varietal forms of the various species occur at different horizons. Most of the species represented in the collections now available are here described, so that the information thus far obtained may be used as a basis for further work and in helping to solve problems of stratigraphic correlation. It is hoped that this paper may be followed by a paper giving some of the interesting facts of structure and biologic relations that are shown by the species of this genus.

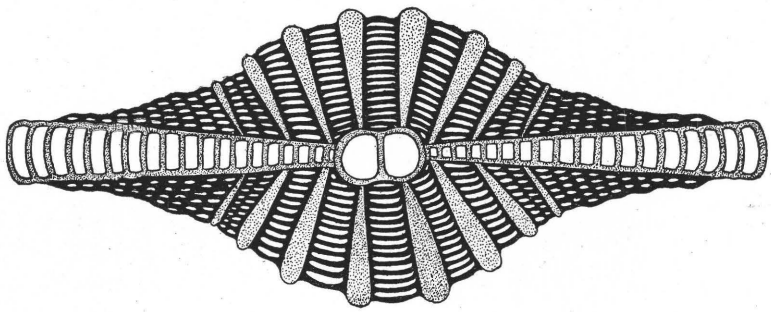


FIGURE 3.—Diagrammatic vertical section of *Lepidocyclina*. Material of the wall of the embryonic chambers (the two large ones in the center), of the equatorial chambers (the two central bands passing to right and left), and the pillars in light stipple. Walls of the lateral chambers in solid black. Areas of the chamber spaces white.

Of the Coastal Plain species the following seem to be characteristic of certain formations:

Chattahoochee formation (middle Oligocene):
- L. chattahoocheensis.

Byram calcareous marl (lower Oligocene):
- L. supera.

Marianna limestone (lower Oligocene):
- L. mantelli.

Ocala limestone (upper Eocene):
- Especially in Florida:
  - L. ocalana.
  - L. ocalana var. subdecorata.
  - L. floridana.
  - L. pseudocarinata.
  - L. pseudomarginata.
  - L. attenuata.
  - L. fragilis.
  - L. cookei.
- Especially in Georgia:
  - L. georgiana.

Jackson formation (upper Eocene):
- Especially in Louisiana:
  - L. mortoni.

By means of the subjoined key it may be possible to identify American material that is sufficiently well preserved.

Key to the American species of Lepidocyclina.

Test of two distinct portions, a central thickened portion and a very thin peripheral portion:
- Central portion deeply pitted:
  - Pits few and large, test strongly sellaeform, diameter 15 to 18 millimeters ..... *L. favosa.*
  - Pits numerous and small, test slightly sellaeform, diameter 15 to 25 millimeters. ..... *L. chattahoocheënsis.*
- Central portion smooth ..... *L. pseudocarinata.*
- Central portion papillate:
  - Papillae fine, central area small .. *L. attenuata.*
  - Papillae coarse, central area large .... *L. cookei.*

Test comparatively thin with small central umbo:
- Test of medium size, flat, diameter 20 to 35 millimeters:
  - Surface smooth ..... *L. mantelli.*
  - Surface papillate ..... *L. hilli.*
- Test large, diameter 50 to 100 millimeters:
  - Umbo small, surface slightly papillate, lateral chambers few, only 6 in a vertical column pillars small and scattered ..... *L. undulata.*
  - Umbo prominent:
    - Surface papillate, pillars numerous, lateral chambers 20 or more in a vertical column ..... *L. georgiana.*

Test comparatively thin with small central umbo—Con.
Test large, diameter 50 to 100 millimeters—Contd.
Umbo prominent—Continued.
Surface reticulate or smooth, pillars few lateral chambers 7 to 10 in a vertical column.....*L. gigas.*
Test small, diameter 8 to 20 millimeters:
Pillars absent, lateral chambers few, 4 to 6.....*L. fragilis.*
Pillars present, lateral chambers numerous:
Embryonic chambers subequal, equatorial chambers hexagonal.....*L. chaperi.*
Embryonic chambers very unequal, equatorial chambers rhomboid....*L. vaughani.*
Test thickened at center, not distinctly umbonate but gradually thinning toward the periphery:
Test very strongly sellaeform:
Pillars numerous, test small, diameter usually 4 to 8 millimeters.....*L. floridana.*
Pillars few, test small, diameter usually 8 to 12 millimeters.....*L. perundosa.*
Pillars absent, test larger, diameter usually 25 millimeters or more.....*L. undosa.*
Test not greatly thickened, slightly sellaeform:
Centrally papillate, pillars largely in the central region:
Diameter 25 to 35 millimeters.....*L. schlumbergeri.*
Diameter 12 to 15 millimeters.....*L. pseudomarginata.*
Surface finely papillate throughout:
Lateral chambers 10 to 12.....*L. supera.*
Lateral chambers 7 to 8.....*L. mortoni.*
Surface smooth or reticulate, lateral chambers 15 to 20.....*L. ocalana.*
Test not sellaeform, lenticular:
Diameter 20 to 30 millimeters, center pustulate, pillars numerous, increasing gradually in diameter to the surface.....*L. subraulinii.*
Diameter 10 to 15 millimeters, center pustulate:
Pillars numerous, increasing to full diameter in first third of length, then uniform to the surface, not thickened at periphery.....*L. marginata.*
Periphery much thickened....*L. duplicata.*
Diameter less than 10 millimeters:
Diameter 8 to 9 millimeters, chamber walls very thick.....*L. crassata.*
Chamber walls thin, pillars absent:
Surface smooth or reticulate, lateral chambers 10 to 12.....*L. canellei.*
Surface centrally pustulate, lateral chambers 6 to 10.....*L. sumatrensis.*
Chamber walls thin, pillars present:
Center pustulate, reticulate between, diameter 2 to 5 millimeters, embryonic chambers reniform, lateral chambers 10.....*L. morgani.*
Center pustulate, smooth between, diameter 5 to 7 millimeters, embryonic chambers reniform.....*L. macdonaldi.*
Center pustulate, embryonic chambers several, unequal.....*L. panamensis.*
Center papillate, lateral chambers 6 to 7.....*L. antillea.*

Lepidocyclina mantelli (Morton) Gümbel.

Plates XII–XIV.

Nummulites mantelli Morton, Am. Jour. Sci., vol. 23, p. 291, pl. 5, fig. 9, 1833; Synopsis of organic remains of the Cretaceous group, p. 45, pl. 5, fig. 9, 1834.

Orbitoides (*Lepidocyclina*) *mantelli* (Morton) Gümbel, K.-bayer Akad. Wiss. Abh., vol. 10, p. 718, 1868 (1870).

Orbitoides mantelli D'Orbigny, in Lyell, Geol. Soc. London Quart. Jour., vol. 4, p. 11, 1847 (1848); Prodome de paléontologie, vol. 2, p. 406, No. 1296, 1850.

Carpenter, Geol. Soc. London Quart. Jour., vol. 6, p. 32, pl. 6, figs. 20, 21, 31, 1850.

Carpenter, Parker, and Jones, Introduction to the study of the Foraminifera, pp. 298, 300, pl. 20, figs. 5, 6, 8, 11, 1862.

Bütschli, in Bronn, Klassen und Ordnungen des Thier-Reichs, p. 215, pl. 12, fig. 22, 1880; in Steinmann, Elemente de Paläontologie, vol. 1, p. 36, fig. K, 1888.

De Gregorio, Annales géol. paléont., vol. 8, p. 261, pl. 46, figs. 16, 17, 1890.

Lepidocyclina mantelli Lemoine and R. Douvillé, Soc. géol. France Mém., Paléontologie, No. 32, p. 10, pl. 1, fig. 4; pl. 2, fig. 18; pl. 3, figs. 7, 12, 1904.

Orbitoides mantelli mut. *umbrellopsis* De Gregorio, Annales géol. páleont., vol. 8, p. 262, pl. 46, figs. 21–26, 1890.

Test thin, flattened, circular, often slightly undulate; adults from 25 to 35 millimeters in diameter, in exceptional specimens 41 millimeters; central region slightly protuberant on both sides of the test, the umbo thus formed being limited to the central portion and only 2 to 3 millimeters in diameter; surface smooth in well-preserved specimens, or slightly pustulate, owing to the irregular elevation of the outer walls of adjacent lateral chambers; in eroded specimens irregularly scrobiculate; young specimens with the central umbonal protuberance more marked than in adults.

The horizontal section (Pl. XIII) shows the irregular hexagonal equatorial chambers, the annuli very irregular in width; lateral chambers also generally hexagonal or at least polygonal, without pillars; embryonic chambers of the megalospheric form, two subequal, the dividing wall straight.

Vertical sections (Pl. XII, figs. 4, 5) show the band of equatorial chambers increasing somewhat in height toward the periphery, where they make up almost the entire thickness of the test; the lateral chambers broad and low, several times as broad as high, overlapping instead of in regular vertical columns, and thus showing the absence of pillars; embryonic chambers of the megalospheric form,

showing their subequal form and straight dividing wall.

Morton's *Nummulites mantelli* was taken by Gümbel as the type species of his genus *Lepidocyclina*, and it is therefore especially important to fix this species very definitely. Fortunately, as already noted, although no type specimen is available, the published data, though meager, are nevertheless sufficient. Morton's description,[1] "Flattened, thin, becoming sharp at the edge, and having a central pustuloid elevation, diameter from half an inch to an inch and a half," combined with the figure, is enough to determine this species, which is "innumerable in the whitish loose-grained limestone near Claiborne, Ala."

The diameter given by Morton, half an inch to an inch and a half, and by Lemoine and R. Douvillé, 25 to 35 millimeters, gives the maximum size almost exactly. In fact, where there is an abundance of the material it is most striking to see the very slight range of diameter of well-developed specimens away from 35 millimeters. As may be supposed, from what is known of the life history of recent Foraminifera, the great mass of adult fossil Foraminifera represent not animals that have died from usual causes but individuals that have divided their cell contents in the reproductive process and left the test empty. This process, taking place at a certain stage in the life history of the individual, leaves an abundance of empty tests of adults and comparatively few tests of young individuals in the same bottom sample, and therefore accounts for the great abundance of individual tests of the maximum adult size.

In 1890 De Gregorio [2] gave four "mutations" of "*Orbitoides mantelli*." His figures 16 and 17 are copied from the originals of Morton, and of the other illustrations, figures 21 to 26, which show the "mutation" (text) or "var." (explanation of plate), called by De Gregorio "*umbrellopsis*," represent the typical *L. mantelli*. Figures 21 to 23 are not well characterized but are sufficiently so, and figures 24 to 26 are very typical of the early stages of *L. mantelli*. The description, "Papyracea, dilatata, exilis, in medio utroque latere vix subtuberculata," certainly adds nothing to distinguish this from typical *L. mantelli*. Moreover, De Gregorio leaves no form for the typical, dividing all his material into the four "mutations." Therefore it seems reasonably certain that var. *umbrellopsis* De Gregorio is but a synonym. Of the other three "mutations," the figures of which are evidently much enlarged from small specimens, little need be said here except that they evidently are neither *L. mantelli* nor forms of that species.

As is shown by the records, *L. mantelli* is characteristic of certain definite horizons near the base of the Oligocene in Alabama, parts of Mississippi, and northwestern Florida. From all the material examined it seems to occur usually alone, without other species of its group, a peculiarity that distinguishes it from certain species of similar size in the upper Eocene.

It has been suggested that the absence of pillars in this and other species is evidence of a primitive character, but this I do not think necessarily true. *L. mantelli* occurs geologically later than other species that show very strongly developed pillars, and, as noted in the description of *L. georgiana*, a condition lacking pillars may follow an early development in which pillars were characteristic. From this evidence, and the fact that the umbo in the adult shows a tendency to flatten, it would seem that *L. mantelli* may be really a senescent species rather than a primitive one.

In every lot of material in which the species occurs in considerable numbers a very few specimens are found which exceed the normal maximum diameter of 35 millimeters. These range from 38 to 41 millimeters, and their rarity, together with their larger size, seems to indicate that they are the microspheric form of the species. The embryonic chambers are not shown clearly, although present in the larger specimens (Pl. XIII; Pl. XIV, fig. 1). Lemoine and R. Douvillé record the occurrence of both microspheric and megalospheric forms but give no data as to their relative size.

In the American literature the name "*Orbitoides mantelli*" has covered many things, and it is evident from the material in various collections that the name has been used very loosely. The list of stations given here will serve to check those references in the literature in which they are mentioned. References to other sta-

[1] Am Jour. Sci., vol. 23, p. 291, 1833.

[2] Annales géol. paléont., vol. 8, pp. 261, 262, pl. 46, figs. 16–32, 1890.

tions from which I have not seen material should be checked from collected material if it is extant.

H. Douvillé[1] figures sections of *L. mantelli* that appear to show very small pillars near the equatorial chambers, which become obsolete very early in their development. Such a structure would tend to show the senescent rather than primitive character of this species.

Instead of *L. mantelli* initiating the appearance of *Lepidocyclina* in America in the upper Eocene, as stated by Douvillé, the species comes relatively high in the series and is a characteristic or index fossil of the Marianna limestone, which in the areas where it is most definitely developed is the middle formation of the Vicksburg group of the lower Oligocene, as shown by Cooke[2] in his correlation table.

L. mantelli, like most of the other species of the genus, was not very long lived, and is confined in great numbers to a narrow horizon.

A few of the following records may need revision, as the material is poor, but most of them are well characterized.

In his original description Morton gives the following sentence: "Innumerable in the whitish loose-grained limestone near Claiborne, Ala." Although Morton's type specimen does not seem to be extant, it is very easy to determine from his very short description and the rather crude figure coupled with the above sentence just what *L. mantelli* is. Various other species have been referred to it from time to time, and these references need correction. Typical *L. mantelli* has been obtained at the following stations from which I have seen material:

298. Marianna limestone, St. Stephens Bluff, Tombigbee River, Ala.; L. C. Johnson, collector.

301. Marianna limestone (?), Gainestown, Clarke County, Ala.; L. C. Johnson, collector.

306. Marianna limestone (?), Feagin, Covington County, Conecuh River, Ala.; L. C. Johnson, collector.

2397. Marianna limestone, near residence of Bush Slaughter, 7 miles southwest of Claiborne, 2 miles east of Howards Landing, Monroe County, Ala.; Frank Burns, collector.

2956. Marianna limestone (?) "*Orbitoides papyraceus*," 2 miles southwest of Whatley Station, Clarke County, Ala.; Frank Burns, collector, 1897.

3296. Marianna limestone, north side of Salt Mountain, 5 miles south of Jackson, Clarke County, Ala. (below coral-reef horizon); T. W. Vaughan, collector, 1898.

5609. Marianna limestone, St. Stephens Bluff, Tombigbee River, Ala.; T. W. Vaughan, collector, 1908.

5619. Oligocene (Vicksburg group), 2 miles west of Nero, Monroe County, 5 miles north of Mero's (Blackshire Headquarters), south bank of Lovetts Creek, Ala.; G. C. Matson, collector, 1910.

6702. Marianna limestone, hillside a quarter of a mile east of Alabama, Tennessee & Northern Railroad, 2½ miles north of Millry, Washington County, Ala.; C. W. Cooke, collector.

6710. Marianna limestone, St. Stephens Bluff, Tombigbee River, Ala.; bed 7 of section, soft white "chimney rock"; C. W. Cooke, collector.

6711. Marianna limestone, St. Stephens Bluff, Ala.; bed 4 of section; C. W. Cooke, collector.

6716. Marianna limestone, ravine east of road about three-quarters of a mile north of Monroeville, Monroe County, Ala.; C. W. Cooke, collector.

6717. Marianna limestone, 1 mile north of Monroeville, Monroe County, Ala.; C. W. Cooke, collector.

6721. Marianna limestone, gully south of station at Drewry, Monroe County, Ala.; C. W. Cooke, collector.

6728. Marianna limestone, road from Perdue Hill to Claiborne, Monroe County, Ala.; exposed in gully west of road, bed 1 of section (bottom 250 feet above Alabama River); C. W. Cooke, collector.

6729. Marianna limestone, road from Perdue Hill to Claiborne, Monroe County, Ala.; bed 3 of section; C. W. Cooke, collector.

6732. Marianna limestone, Murder Creek at bridge east of Castleberry, Conecuh County, Ala.; bed 1 of section; C. W. Cooke, collector.

6733. Marianna limestone, bed 2 of same section as 6732.

6748. Marianna limestone, west bank of Conecuh River at bend about a quarter of a mile below mouth of Sepulga River, Escambia County, Ala.; C. W. Cooke, collector.

6750. Marianna limestone, Rock House Bluff, right bank of Conecuh River, near line between secs. 28 and 29, T. 3 N., R. 14 E., Covington County, Ala.; talus from upper bed; C. W. Cooke, collector.

7164. Glendon limestone member of Marianna limestone, Jackson-Rockville road, 200 yards north of Salt Creek, Clarke County, Ala.; bed 3 of section; C. W. Cooke, collector.

7208. Marianna limestone, Whitsett's quarry, about 3 miles south of Cullomburg, Ala.; beds 2-4 of section; C. W. Cooke and W. C. Mansfield, collectors.

7238. Marianna limestone, Murder Creek at bridge east of Castleberry, Ala.; bottom of bed 1 of section; C. W. Cooke and W. C. Mansfield, collectors.

The specimens from the following stations seem to be *L. mantelli:*

119. Tertiary, Bogue Homo rocks and prairies, Jasper County, Miss.; L. C. Johnson, collector.

259. Vicksburg group, about middle beds of the bluff in hard marlstone, Vicksburg, Miss.; Burns, collector.

334. Vicksburg group, south side of Eucutta Creek, Wayne County, Miss., on a high hill 5 miles west of Shubuta, Clarke County, Miss.

337. Vicksburg group, Heidelberg, Jasper County, Miss., sec. 25; L. C. Johnson, collector.

2636. Oligocene, Wayne County, Miss.; Burns, collector.

[1] Compt. Rend., 1918, p. 263.

[2] Cooke, C. W., Washington Acad. Sci. Jour., vol. 8, p. 187, 1918.

4331. Two miles above Byram, on Pearl River, Miss.; ledge about middle of the formation; A. F. Crider, collector.

6548. Marianna limestone, rock quarry 4 miles east of Brandon, Rankin County, Miss., south of Rankin on Alabama & Vicksburg Railway; T. W. Vaughan, collector.

6644. Marianna limestone, Goodwater Creek, 3 miles southeast of Vossburg, Miss.; C. W. Cooke, collector.

6645. Marianna limestone, roadside on hill in sec. 2, 1½ miles south-southeast of Heidelberg, Jasper County, Miss.; beds 1–5 of section; C. W. Cooke, collector.

6767. Marianna limestone, west side of Marianna, Fla.

Lepidocyclina hilli Cushman, n. sp.

Plate XV, figure 1; Plate XVI, figure 2.

Test circular, flat, thin; central portion elevated slightly more on one side than on the other; gradually sloping from the thickened center to the peripheral portion, which is flat; umbonal region in the very center strongly papillate, with a few large papillae about which may be as many as eight of the lateral chambers, forming a concentric series of reticulations; papillae smaller as the distance from the center of the test increases.

A vertical section near the edge shows the equatorial chambers about three times as high as broad; lateral chambers numerous, very low and broad, in vertical columns.

Type specimen (U. S. N. M. No. 135220) from the Guallava sandstone of Costa Rica, collected by R. T. Hill. Specimens from U. S. G. S. station 6722 (Ocala limestone, old quarry three-fourths mile west and three-fourths mile north from Monroeville, Ala.), collected by C. W. Cooke, seem to be close to this species.

In its general form *L. hilli* strongly resembles *L. mantelli* (Morton), but the slope from the central umbo is carried out over a wider area and the large papillae of the center with the smaller ones over a large part of the surface will at once distinguish it from that species. The umbonal region with the depressed concentric series of reticulations about the large papillae suggests *L. morgani*, which is in other respects very different.

Lepidocyclina undulata Cushman.

Plate XV, figures 2–5.

Lepidocyclina undulata Cushman, Carnegie Inst. Washington Pub. 291, p. 65, pl. 3, figs. 1a, 2, 8, 9; pl. 15, fig. 5, 1919.

Test large, slightly papillate, lenticular; the umbonate region scarcely if at all raised; whole test undulate or saddle-shaped, often bent nearly double.

Vertical sections (Pl. XV, fig. 4) of this species show pillars very constant but of small diameter scattered throughout the central half of the test and a few toward the peripheral portion; equatorial chambers fairly high and with a series of 6 to 8 rather large perforations in the peripheral wall; lateral chambers thick-walled and rather large, comparatively few, usually not more than six in a vertical column.

Equatorial chambers (Pl. XV, figs. 2, 3) hexagonal in horizontal section.

Diameter in the largest specimens apparently exceeding 100 millimeters when complete.

The type locality for this species is U. S. G. S. station 6863, High Point, Antigua, Leeward Islands; collected by T. W. Vaughan. Specimens were abundant at this station. Other material from Antigua apparently referable to this species was obtained at stations 6858, Wetherell Point; 6874, Blizzards Mill; (?) 6880, west side of Otto's estate, west side of Golden Grove road; 6881, bluff on north side of Willoughby Bay; and 6942, boulders on south side of Monks Hill, Falmouth.

This seems to be the largest known species of *Lepidocyclina*, being larger than *L. elephantina*. The material here figured from station 6881 (Pl. XV, fig. 5) is for the most part composed of smaller specimens which may possibly belong to another species but which have the saddle-shaped form of the larger specimens. The specimens make up a large proportion of the mass of the rock.

Lepidocyclina georgiana Cushman, n. sp.

Plate XVI, figure 1; Plate XVII, figures 1–3; Plate XVIII, figures 1, 2.

Test large, flattened, or slightly undulate or sellaeform; largest specimens measuring 70 millimeters in diameter, more general run of specimens 25 to 50 millimeters; central region in young and medium-sized specimens prominently umbonate, in the largest ones much less so; surface in the earlier stages scrobiculate toward the margins, becoming rather strongly papillate toward the center and especially on the umbonal region; umbo small, usually less than 5 millimeters in diameter.

The horizontal section (Pl. XVIII, fig. 1) shows the chambers of the equatorial band

either hexagonal or with the peripheral angle changed to an even convex curve; walls of medium thickness; annuli irregular.

In vertical section (Pl. XVI, fig. 1) the equatorial chambers increase in height toward the periphery, where they are at least four times as high as their diameter; lateral chambers compressed, broad and low in the central region with as many as 20 chambers in each column but soon diminishing in number toward the periphery of the test, the outer third of the region with but one to three chambers superimposed, the thin test being made up largely of the high equatorial chambers; pillars mostly in the umbonal region, thence gradually decreasing in number toward the periphery of the test; in section, narrow wedge-shaped, the distal end broadest and somewhat convex, gradually tapering toward the proximal end, usually showing longitudinal laminations in section, in some specimens with the greatest width in the central region and thinning again toward the periphery.

Type specimen from U. S. G. S. station 7097, Ocala limestone, on the east bank of Flint River above the old factory at bend three-quarters of a mile northeast of the Atlantic Coast Line Railway station at Bainbridge, Ga.; C. W. Cooke and W. C. Mansfield, collectors. It has also been collected in the Ocala limestone at the following stations:

3387. Red Bluff, on Flint River 7 miles above Bainbridge, Ga.; T. W. Vaughan, collector.

7099. East bank of Flint River about half a mile above Red Bluff, Decatur County, Ga.; C. W. Cooke, collector.

8259. About 6 miles southeast of Campbellton and 12 miles northwest of Marianna, on road to Cottonwood, Ala., half a mile from its intersection with the Marianna-Campbellton road, Jackson County, Fla.; C. W. Cooke, collector.

At all four of these stations *L. georgiana* is accompanied by *Orthophragmina georgiana* Cushman. At station 8259 a single specimen was noted, not well characterized but referred here provisionally.

Specimens of *L. georgiana* occur at the following stations:

3382. Hales Landing on Flint River, 7 miles below Bainbridge, Ga.; T. W. Vaughan, collector.

3383. Blue Springs, Ga.; exterior molds of specimens apparently *L. georgiana*; T. W. Vaughan, collector.

3390. Below Plant System wharf, Bainbridge, Ga., T. W. Vaughan, collector.

3397. Back of old factory about 1½ miles above Bainbridge, Ga. (same locality as station 7097); T. W. Vaughan, collector.

4974. West side of St. Andrews Bay Road, southwest of Chipley, Fla.; G. C. Matson, collector.

7082. Hales Landing, west bank of Flint River 7 miles southwest of Bainbridge, Ga.; T. W. Vaughan, C. W. Cooke, and W. C. Mansfield, collectors.

7126. East bank of Flint River at Dry Bread Shoals, Mitchell County, Ga., 8½ or 9 miles below Newton, from lumps blasted from the channel; C. W. Cooke, collector.

7130. East bank of Flint River 6 miles above Bainbridge, Ga.; C. W. Cooke and J. E. Brantly, collectors.

7149. East bank of Flint River below wagon bridge at Bainbridge, Ga.; W. C. Mansfield, collector.

8331. Old gristmill on Aycock Creek, 100 yards above crossing of Twilight Road, 3 miles southwest of Boykin station, Miller County, Ga.; C. W. Cooke, collector.

In the region about Marianna, Fla., *L. georgiana* occurs at the following stations:

7194. Ocala limestone, soft cream-colored limestone, bed 4 of section, at mouth of cavern 200 yards southwest of wagon bridge over Chipola River east of Marianna, Fla.; C. W. Cooke and W. C. Mansfield, collectors. In this part of the section it occurs with other typical Ocala species of *Lepidocyclina*.

7195. Bed 5 of same section, white limestone, apparently has this species.

7199. Same locality, contact of beds 4 and 5; W. C. Mansfield, collector.

Specimens from station 7242, bottom of bed 5 of section on west bank of Chipola River at wagon bridge half a mile east of Marianna, Fla., collected by W. C. Mansfield, are apparently *L. georgiana* but are not sufficiently well characterized to make the determination absolute. An interesting assemblage, among which are specimens that may be referred to *L. georgiana*, was found at station 7672, on Chipola River at Louisville & Nashville Railroad, three quarters of a mile east of Marianna, Fla., by C. W. Cooke.

This is the large species referred to in the literature on Georgia, especially as *Orbitoides papyracea*, mainly on earlier identifications of R. M. Bagg, jr. The *O. papyracea* of later authors following Gümbel and Boubée is really an *Orthophragmina*, for which the name *O. pratii* Michelin must be used according to Schlumberger. Our material is *Lepidocyclina*, and the name *O. papyracea* as used in the literature in references to the following places should be *L. georgiana* Cushman: Albany, Ga., west end of wagon bridge[1]; limestone at Red Bluff,

[1] Vaughan, T. W., in Veatch, Otto, and Stephenson, L. W., Georgia Geol. Survey Bull. 26, p. 317, 1911.

7 miles above Bainbridge, Ga.[1]; bluff on east side of Flint River back of old factory about 2 miles above Bainbridge, Ga.[2], Hales Landing, on Flint River 7 miles below Bainbridge, Ga.[2] I have seen and checked material from all these localities.

The species is a very large one in at least some of its individuals, but the range in size is very considerable, and it may be very likely that the largest specimens are the microspheric form of the species and the smaller ones the megalospheric. The material is not sufficiently well preserved to permit a study of the embryonic chambers in detail.

There is evidently a progressive development in form of the test and character of the ornamentation of the surface. In the smaller, younger specimens the umbonal portion is strongly raised and the whole test is prominently papillate, although the umbonal portion shows the papillae most prominently. In older specimens the papillae are largely limited to the central region and the umbonal region of the test is not nearly so much raised in comparison as in the young. This character is similar to that seen in the young of *L. mantelli* and already noted.

At the following Georgia stations T. W. Vaughan collected molds of the exterior, probably of *L. georgiana:* 3618, west end of wagon bridge, Albany; 3624, 1 mile east of Americus; 3625, 2 miles east of Americus. A single specimen showing equatorial chambers of a *Lepidocyclina*, which may be *L. georgiana*, was obtained at Saffold, Early County, Ga. The rock is very hard and filled with pits, indicating possibly in part a small nummulite. This material is similar to that obtained at station 7094, on the west bank of Flint River at the Atlantic Coast Line Railroad bridge at Bainbridge, which also has the same character.

A specimen from station 4959, Rich Hill, Crawford County, Ga., collected by L. W. Stephenson, may be the young of this species.

L. georgiana is characteristic of the Ocala limestone occurring at many stations with several species of *Orthophragmina*.

The following additional stations in Georgia have furnished material which, though not inwardly well preserved, probably should be referred to *L. georgiana:*

3293. Left bank of Flint River at Bainbridge, Decatur County; A. H. Brooks, collector.

3380. Base of bluff at Little Horseshoe Bend, just below the mouth of Blue or Russell Spring, Flint River, Decatur County; T. W. Vaughan, collector.

3768. Twelve miles north of Bainbridge and 3 miles west of Flint River; S. W. McCallie, collector.

6110. Steamboat landing, Bainbridge.

6159. Red Bluff, Flint River; L. W. Stephenson, collector.

6160. Flint River, north of Blue Spring, 4 miles below Bainbridge, Decatur County; L. W. Stephenson, collector.

6161. Flint River at Bainbridge; L. W. Stephenson, collector.

7082. Hales Landing, west bank of Flint River, 7 miles southwest of Bainbridge; T. W. Vaughan, C. W. Cooke, and W. C. Mansfield, collectors.

7098. Red Bluff, Flint River, 7 miles above Bainbridge; C. W. Cooke, collector.

7106. Flint River at mouth of Spring Creek, Sumter County, 2 miles above Seaboard Air Line Railway bridge; C. W. Cooke and J. E. Brantly, collectors.

7127. East bank of Flint River in Mitchell County, a quarter of a mile below Normans Ferry, in loose blocks excavated from channel; C. W. Cooke and J. E. Brantly, collectors.

7129. East bank of Flint River 1 mile below Windell's Landing, about 6 miles above Red Bluff; C. W. Cooke, collector.

The species is also present in Alabama at station 6747, in the Ocala limestone at Steamboat Point, on the west side of Sepulga River at sharp bend near middle of sec. 20, T. 3 N., R. 13 E., Escambia County; C. W. Cooke, collector.

In its gross appearance *L. georgiana* is suggestive of *L. gigas* Cushman, from Antigua, but the papillate character is much more clearly shown in *L. georgiana* and is correlated in the vertical section with the numerous pillars.

The largest specimens of *L. georgiana* seem to show definite senescent characters in the loss of the papillate character of the surface, which becomes much smoother in the adult, and in the relatively less prominent umbo in the larger specimens. The senescent feature is especially shown in the pillars, which in the younger specimens are conical, the outer end being the widest, whereas in the largest specimens they become smaller in the outer portion and as a result in section are somewhat fusiform.

Some of the external molds of the specimens, especially those obtained 3 miles southwest of Boykin station, Miller County, Ga., by C. W. Cooke, show even more clearly than the specimens themselves the relative abundance and distribution of the external papillae formed by the distal ends of the pillars.

[1] Vaughan, T. W., in Veatch, Otto, and Stephenson, L. W., Georgia Geol. Survey Bull. 26, pp. 320, 329, 1911.

[2] Idem, p. 332.

This is by far the largest species of the Coastal Plain and is surpassed in size only by *L. elephantina* Munier-Chalmas, of Europe, and *L. undulata* Cushman, of Antigua.

Lepidocyclina gigas Cushman.

Plate XIX, figures 1–4.

Lepidocyclina gigas Cushman, Carnegie Inst. Washington Pub. 291, p. 64, pl. 1, figs. 3–5; pl. 5, fig. 4, 1919.

Test large, flattened, somewhat lenticular, circular in outline; central portion slightly umbonate; thence gradually thinning toward the periphery, which is bluntly angular; surface generally flat and smooth, occasionally slightly undulating.

The vertical section shows the equatorial chambers increasing somewhat in height from the central area toward the periphery, the peripheral end of each chamber slightly convex toward the exterior; lateral chambers broad and low, in vertical columns, usually from 7 to 10 in each column in the central portion of the test outside the umbo, thence gradually decreasing in number toward the periphery. Pillars are developed at irregular intervals but are few in number and of very small diameter.

Horizontal sections (Pl. XIX, fig. 4) show the hexagonal equatorial chambers, the annular rows of which are very uneven in size, and the subequal embryonic chambers.

Diameter of largest specimens 80 millimeters or more.

The type locality for this species is U. S. G. S. station 6862, Antigua, Leeward Islands, lower bed at Hodges Bluff; T. W. Vaughan, collector. Specimens from this locality are numerous and very fine. Material that is poorer but apparently specifically the same occurs at stations 6854, Rifle Butts, and 6857, on the southwest side of Wetherell Mill, both in Antigua.

This species is very near to *L. elephantina* Munier-Chalmas, but the two early chambers do not seem to be at all alike, those of *L. elephantina* being very dissimilar in size and shape, whereas those of *L. gigas* so far as made out seem to be much more nearly equal, as is usual in American species of *Lepidocyclina*. Plate XIX, figure 4, shows the two early chambers of this species.

This is a very fine and large species and seems to be abundant at the type station.

Lepidocyclina gigas Cushman var. mexicana Cushman, n. var.

Plate XIX, figure 5; Plate XX, figures 1, 2; Plate XXI, figures 1–3.

Test differing from the typical *L. gigas* in the somewhat smaller size and the comparatively greater thickness at the umbo; the surface is apparently more reticulate, but this may be due to the different conditions of preservation in the two areas.

Diameter of the test as much as 50 millimeters or more; thickness in the umbonal region, 7 millimeters.

The vertical section (Pl. XIX, fig. 5) is very similar to that of *L. gigas*, but has a rather less number of lateral chambers, and the whole test except the umbonal region is somewhat thinner.

Type specimen and others from Mexico collected by E. T. Dumble. The type, from the Meson formation, Meson, Vera Cruz, Mexico, is referred to by Dumble [1] under the name "*Orbitoides papyracea*." Large specimens that seem very similar occur in the material collected by Dumble from the San Rafael formation at Cerro Cortado, Topila Hills, 15 miles southwest of Tampico. Some of the Topila Hills material contains other species, but they are not sufficiently well preserved for positive determination at present.

Lepidocyclina fragilis Cushman, n. sp.

Plate XXII, figures 1, 2.

Test of medium size, 10 to 12 millimeters in diameter, very thin, flattened or very slightly sellaeform; central portion very slightly thickened but usually forming no definite umbo distinguishable from the remainder of the test; surface very smooth except where eroded and at the periphery, where the walls of the equatorial chambers form a slight reticulation of the surface; whole test thin and fragile; thickness usually about 1 millimeter or less.

The horizontal section shows the equatorial chambers to be hexagonal and with fairly thick walls. Embryonic chambers not seen.

The vertical section shows the equatorial band of chambers unusually low throughout, increasing very little from center to periphery; the chambers toward the center thin-walled

[1] Dumble, E. T., California Acad. Sci. Proc., 4th ser., vol. 8, p. 147, 1918.

and broader than high; those toward the periphery are thick-walled, slightly higher than wide, and the vertical walls slightly convex and thickened; lateral chambers very low and broad, in central region with not more than six chambers in a vertical column, generally lessening in number toward the periphery, where there may be but one or even none. No pillars apparent.

Type specimens from U. S. G. S station 7194, Ocala limestone, at mouth of cavern about 200 yards southwest of wagon bridge over Chipola River, east of Marianna, Fla.; bed 4 of section; C. W. Cooke and W. C. Mansfield, collectors. Specimens also occur at the following stations:

3760. Tivola tongue of Ocala limestone on Georgia Southern & Florida Railroad half a mile south of Tivola, Ga.; S. W. McCallie, collector.

6747. Ocala limestone at Steamboat Point on west side of Sepulga River at sharp bend near middle of sec. 20, T. 3 N., R. 13 E., Escambia County, Ala.; C. W. Cooke, collector.

7337. Left bank of Suwannee River above bridge of Florida Railway, Suwannee County, Fla., northeast of Mayo; C. W. Cooke, collector.

7348. Left bank of Suwannee River about 1 mile above Troy Springs, Fla.; C. W. Cooke, collector.

This is a very thin species and consequently fragile. The outer equatorial chambers, which are unprotected by the lateral chambers, have thickened walls that give greater strength to this thin peripheral portion.

The species seems to be characteristic of Ocala limestone.

Lepidocyclina chaperi Lemoine and R. Douvillé.

Plate XXII, figures 3, 4.

Lepidocyclina chaperi Lemoine and R. Douvillé, Soc. géol. France, Paléontologie, Mém. 32, p. 14, pl. 2, fig. 5, 1904. Cushman, U. S. Nat. Mus. Bull. 103, p. 92, pl. 35, figs. 1–3; pl. 36, 1918.

Test of medium size, diameter from 8 to 20 millimeters, circular in outline, somewhat saddle-shaped; central portion slightly thickened, thence gradually and evenly thinning toward the periphery; surface where well preserved slightly papillate, usually roughened by erosion, toward the periphery often somewhat reticulately depressed above the equatorial chambers.

Vertical section usually curved; lateral chambers numerous, breadth much greater than height, columns separated by distinct pillars, comparatively few except in the central region, where there are a few larger than the others; embryonic chambers of the double type, the two chambers nearly equal in size and separated by a straight common wall.

The horizontal section shows similar conditions of the embryonic chambers and distinctly hexagonal equatorial chambers.

Lemoine and R. Douvillé described this species from Panama (Haut-Chagres, San Juan). The specimens figured came from U. S. G. S. station 6025, from marl at the south end of Bohio Ridge switch, on the relocated line of the Panama Railroad, collected by T. W. Vaughan and D. F. MacDonald, and from station 6019–*f*, on the west side of the Gaillard Cut near Las Cascadas. These specimens seem to represent the microspheric form of this species.

A specimen from station 6526, Chiriqui, Canal Zone, shows a section which from its general proportions seems to suggest strongly *L. chaperi*.

H. Douvillé[1] records this species from Salt Mountain, Ala., but the material from the higher levels at this locality seems to be referable to *L. supera* (Conrad).

Lepidocyclina vaughani Cushman.

Plate XXII, figure 5.

Lepidocyclina vaughani Cushman, U. S. Nat. Mus. Bull. 103, p. 93, pl. 37, figs. 1–5; pl. 36, 1918.

Test of medium size, 10 millimeters or more in diameter, flat; surface somewhat umbonate in the central portion, gradually sloping to the peripheral portion, the outer half of which is nearly flat. Wall smooth except for fine papillae. The peripheral portion of the test when well preserved is typically much thickened, the edge thick and squarely truncated.

The horizontal section shows the peculiarity of the chambers, many of which, especially those of the outer peripheral portion, are rhomboid; those of the inner portion are more typical and hexagonal. These are shown especially well on the sections of the larger specimens, those of the smaller specimens showing only the regular hexagonal character of the earlier chambers.

No very good vertical sections were obtained in the thin sections, but several accidental sections show the characters well. The embry-

[1] Compt. Rend., 1918, pp. 264, 265.

onic chambers are rather large, of the usual American type, of two nearly equal chambers, lateral chambers in vertical columns with a very few rather well developed pillars.

Type specimen from station 6021, from the Emperador limestone in cuttings of the Panama Railroad near Caimito Junction, Panama, U. S. N. M. catalogue No. 324739, collected by T. W. Vaughan and D. F. MacDonald. Specimens were abundant in this light-gray to cream-colored sandy limestone. Specimens were also abundant in the collection from station 6673, at the same locality, obtained later by MacDonald. Specimens that are apparently the same species are abundant in a fossiliferous limy sandstone collected by MacDonald at station 6255, half a mile south of Miraflores station on the wagon road to Panama.

One of the most characteristic features of this species is the much thickened peripheral border, the increase toward the extreme edge being very rapid, leaving the periphery itself sharply truncate. This gives the appearance in hand specimens of a sharply defined outline and in sections of the limestone is still more striking when vertical sections are seen.

Specimens from Georgia (U. S. G. S. station 7095, east bank of Flint River at old factory 2 miles above Bainbridge, occurring in chert and embedded in clays referred to the Chattahoochee formation; W. C. Mansfield, collector) have very much the characters of *L. vaughani*, especially in the chambers of the horizontal section. None of the specimens show the periphery well, so that its characteristic form is not available for comparison.

Lepidocyclina chattahoocheënsis Cushman, n. sp.

Plate XXIII, figures 1–4; Plate XXIV, figures 1, 2.

Test of medium size, flattened or somewhat undulate; largest specimens measuring 25 millimeters in diameter, most specimens less, 16 to 22 millimeters; central region much thickened, prominently umbonate, making up about one-third of the test, nearly 5 millimeters through in the center of the thickened region in large specimens; the thin flattened peripheral border usually smooth or very finely papillate; the umbonate central region pitted with numerous small depressions.

The horizontal section shows the chambers of the equatorial band either hexagonal or with the peripheral angle an even convex curve; walls rather thin; annuli somewhat irregular in thickness.

In vertical section (Pl. XXIII, fig. 4) the equatorial chambers increase in height toward the periphery, where they are at least three times as high as their diameter; lateral chambers compressed, broad and low, somewhat convex in the central region, where there are as many as 40 chambers in the central columns, diminishing in number toward the periphery, where in the flattened flangelike portion there are from 3 to 5 chambers superimposed, not together equaling the height of the equatorial chambers at the periphery. Pillars in the umbonal region strongly developed, wedge-shaped in section, the distal ends broadest and projecting beyond the lateral columns of chambers, giving the characteristic pitting of the surface.

Type specimen a vertical section from U. S. G. S. collection 3392, from the Chattahoochee formation at Glenns Well, 5 miles southeast of Bainbridge, Ga., collected by T. W. Vaughan. Specimens apparently identical with this species were obtained in material from the following localities:

3388. Upper fossiliferous horizon, Red Bluff on Flint River, 7 miles above Bainbridge, Ga.; T. W. Vaughan, collector.

3397. Old factory about 1½ miles above Bainbridge, Ga.; T. W. Vaughan, collector.

3647. Five miles south of Jackson, Ala.; T. W. Vaughan, collector.

7074. Coralliferous flint, Hales Landing, west bank of Flint River, 7 miles southwest of Bainbridge, Ga.; T. W. Vaughan, C. W. Cooke, and W. C. Mansfield, collectors.

? 7075. East bank of Flint River just above Lamberts Island, about 10½ miles below Bainbridge, Ga.; C. W. Cooke and W. C. Mansfield, collectors.

7133. Silicified fragments, lower end of Fort Scott bluff, west bank of Flint River, about 12 miles above River Junction, Decatur County, Ga.; C. W. Cooke, collector.

In some of its characters this species resembles *L. favosa* Cushman, from Antigua, but it is less undulate and its umbonal region is not so prominent nor so distinctly reticulate as in *L. favosa*. *L. favosa* does not attain so large a size as *L. chattahoocheënsis*. The number of lateral chambers in the central columns in the species here described is unusually large.

Lepidocyclina favosa Cushman.

Plate XV, figure 5 (B).

Lepidocyclina favosa Cushman, Carnegie Inst. Washington Pub. 291, p. 66, pl. 3, figs. 1, 2b; pl. 15, fig. 4, 1919.

Test of medium size, compressed, strongly undulate or saddle-shaped; the central portion umbonate, much curved, thick; the remainder of the test thin and flangelike; central umbonate mass with an ornamentation of polygonal areas caused by rounded raised ribs; remainder of the test fairly smooth, but in most specimens irregularly eroded.

The vertical section shows numerous distinct pillars in the umbonate region, broad at the exterior and narrowing to a point near the equatorial chambers; flattened peripheral portion with few indistinct pillars.

Diameter, 15 to 18 millimeters for typical specimens.

The type locality for this species is U. S. G. S. station 6881, Antigua, Leeward Islands, bluffs on north side of Willoughby Bay.

This is a very strikingly ornamented species and hardly likely to be mistaken for any other, especially with its very strong saddle shape in addition. It was not seen in any other material from the Antigua formation but is very abundant at this station, as the photograph (Pl. XV, fig. 5) will show.

Lepidocyclina pseudocarinata Cushman, n. sp.

Plate XXIV, figures 3, 4.

Test of medium size, 18 millimeters in diameter in the largest specimen, generally without sellaeform curves; central portion thickened but only slightly convex; the thickened portion occupying about two-thirds of the surface of the test; peripheral portion flattened and thin, the change from the thickened center abruptly marked; surface smooth except for scrobiculations due to the erosion of the surface.

The horizontal section shows the equatorial band of chambers hexagonal.

The vertical section shows the equatorial band of chambers increasing gradually in size toward the periphery, where the height is three to four times the width; walls thick, very slightly convex; lateral chambers numerous in the central portion, rapidly diminishing in numbers at the point where the abrupt change occurs from the central thickening to the thin periphery; outer surface curved; inner surface flattened, not greatly compressed; lateral chambers over the peripheral carina usually wanting; the entire border almost completely formed by the equatorial band.

Type specimen from U. S. G. S. collection 6810, Ocala limestone, Cummer Lumber Co.'s phosphate plant No. 10, 1 mile northwest of Newberry, Fla.; C. W. Cooke, collector. It was also found at the following stations in Florida:

5031. Ocala, Marion County; G. C. Matson, collector.

6790. 300 feet south of the Alachua Manufacturing Co.'s plant at south edge of Alachua, Fla.; H. Gunter and C. W. Cooke, collectors.

6812. Cummer Lumber Co.'s phosphate plant No. 6, 1¼ miles south of Newberry; C. W. Cooke, collector.

6814. Quarry of Franklin Phosphate Co., 1½ miles northwest of Newberry, Alachua County; C. W. Cooke, collector.

7194. Ocala limestone, mouth of cavern about 200 yards southwest of wagon bridge over Chipola River east of Marianna; bed 4 of section; C. W. Cooke and W. C. Mansfield, collectors.

7341. Left bank of Suwannee River at Branford, Suwannee County; C. W. Cooke, collector.

7349. Left bank of Suwannee River about half a mile below Fort McComb; C. W. Cooke, collector.

7367. Willow Sink, 1⅓ to 2 miles west of Chiefland, Levy County; C. W. Cooke, collector.

In Georgia specimens from two localities appear to be identical with this:

6160. Flint River north of Blue Spring, 4 miles below Bainbridge; L. W. Stephenson, collector.

7097. East bank of Flint River above old factory at bend three-quarters of a mile northeast of Atlantic Coast Line Railroad station at Bainbridge; C. W. Cooke and W. C. Mansfield, collectors.

This species may be distinguished from most of the other species of the Ocala limestone by its carinate appearance and from the only other species of the same formation that has this same character, *L. cookei*, by its smooth or irregularly scrobiculate surface when eroded, as contrasted with the very papillate surface of *L. cookei*. It will probably be found to have a wider geographic range than is here indicated, but it is not a common species in comparison with *L. ocalana* or *L. floridana*, with which it is associated.

Lepidocyclina cookei Cushman, n. sp.

Plate XXIV, figures 5, 6.

Test rather small, 10 millimeters in diameter in the largest specimen, thick, very convex in the central portion, at the periphery extending out into a thin border, the transition rather sharply marked; surface very strongly papil-

late over the whole central portion; the thin periphery smooth except for erosion and the reticulate markings formed by the walls of the equatorial chambers.

Sections were not made, as the species seems to be very rare, but accidental breaks show that the equatorial chambers are hexagonal and of uniform size, the height increasing as usual toward the periphery but not excessively so; lateral chambers wanting over the thin periphery; numerous pillars are indicated by the closely set papillae of the surface of the thickened central portion.

Type specimen from U. S. G. S. station 6812, Ocala limestone, Cummer Lumber Co.'s phosphate plant No. 6, 1¼ miles south of Newberry, Fla.; C. W. Cooke, collector. The only other specimen known is from station 4965, half a mile southwest of Fort White, Fla.; G. C. Matson, collector.

From the available material the species seems to be rare in the Ocala limestone, but probably it has a wider range than is indicated by these records.

Lepidocyclina attenuata Cushman, n. sp.

Plate XXIV, figures 7, 8.

Test of medium size, in all specimens examined close to 12 millimeters in diameter, plane or slightly sellaeform; central portion strongly umbonate, the thickened portion occupying about one-fourth the diameter; remainder of the test thin; central portion finely papillate; peripheral portion smooth or scrobiculate where eroded. Chambers of the equatorial zone hexagonal.

The vertical section shows the equatorial chambers low in the central portion and increasing rapidly in height toward the periphery until at the edge they are three to four times as high as broad, outer wall convex; lateral chambers very numerous in the thickened umbonal region, where there are 20 to 25 chambers in a vertical column, rapidly decreasing in numbers as the edge of the umbo is reached, thence gradually reduced toward the periphery, chambers low and broad, several times as wide as high; walls comparatively thin; pillars numerous, slender, increasing gradually in diameter toward the surface.

Thickness of umbonal region 3 millimeters in a test 12 to 13 millimeters in diameter.

Type specimen from U. S. G. S. station 6814, quarry of Franklin Phosphate Co., 1½ miles northwest of Newberry, Alachua County, Fla.; C. W. Cooke, collector.

Other Florida specimens were obtained at the following stations:

4974. Six miles southwest of Chipley, on west side of St. Andrews Bay road; G. C. Matson, collector.

5031. Ocala, Marion County; G. C. Matson, collector.

6824. East bank of Suwannee River at Seaboard Air Line Railway bridge opposite Ellaville, Fla., bed 1 of section; C. W. Cooke, collector.

7194. Mouth of cavern about 200 yards southwest of wagon bridge over Chipola River east of Marianna; bed 4 of section; C. W. Cooke and W. C. Mansfield, collectors.

7199. Contact of beds 4 and 5 of same section· W. C. Mansfield, collector.

7348. Left bank of Suwannee River about 1 mile above Troy Springs; C. W. Cooke, collector.

U. S. N. M. No. 112507, Richards quarry, Ocala.

It is apparently present in Georgia at station 3380, base of bluff at Little Horseshoe Bend, just below mouth of Blue or Russell Spring, Flint River, 4 miles below Bainbridge, Decatur County; T. W. Vaughan, collector.

It may be distinguished from the other species of the Ocala limestone by the prominent umbonate portion, occupying but a quarter of the diameter of the test, and the large proportion of flattened periphery.

Lepidocyclina floridana Cushman, n. sp.

Plate XXV, figures 1, 2.

Test small, thin, very sellaeform; usual size of specimens from 4 to 8 millimeters in diameter; sellaeform condition very regular, the bending of the test being somewhat greater in measurement than half the diameter of the test. In a specimen measuring 7 millimeters in diameter the entire deviation from the plane through the center is as much as 4 millimeters; surface appearing smooth to the unaided eye but with slight magnification shown to be finely papillate from the projection of the ends of the vertical pillars, especially in the central part of the test but more or less so over the whole test.

The horizontal section shows the chambers of the equatorial band with the characteristic hexagonal shape, those near the periphery with the outer border convexly curved, annuli irregular.

The vertical section shows the chambers of the equatorial band in the central part square in section, the height about equaling the width

but gradually increasing toward the peripheral portion of the test, where the chambers become about three times as high as their width, and the walls, instead of being straight, are convexly curved toward the periphery of the test; lateral chambers much compressed, broad and low, eight or nine in a vertical column in the central region, diminishing very evenly in number toward the periphery, where there is but a single chamber on each side of the test. Pillars numerous, rather evenly distributed, very slightly increasing in diameter toward the surface, only slightly laminated, coming slightly above the surface at the distal ends, causing the papillate surface.

Type specimen from U. S. G. S. station 6805, Ocala limestone, at plant of Oakhurst Lime Co. (plant No. 2, Florida Lime Co.), south of Atlantic Coast Line Railroad, 2 miles southeast of Ocala, Fla.; C. W. Cooke, collector. Material containing this species has been collected at the following stations in Florida:

329. Deep wells at Padlock, Suwannee County; L. C. Johnson, collector.

362. Fort White, Suwannee County; L. C. Johnson, collector.

3629. Alachua; T. W. Vaughan, collector.

4965. Half a mile southwest of Fort White; G. C. Matson, collector.

4974. Six miles southwest of Chipley, on west side of St. Andrews Bay road; G. C. Matson, collector.

6717. Fort White.

6789. North side of Alachua-High Springs public road, 1 mile west of North Alachua station, Atlantic Coast Line Railroad, Alachua County; T. W. Vaughan, collector.

6790. Three hundred feet south of Alachua Manufacturing Co.'s plant at south edge of Alachua; H. Gunter and C. W. Cooke, collectors.

6804. Quarry No. 1, Florida Lime Co., on southwest edge of Ocala; C. W. Cooke, collector.

6807. Plant No. 3, Florida Lime Co., 6½ miles north of Ocala, at Zuber, Marion County; C. W. Cooke, collector.

6808. Quarry one-eighth of a mile southeast of Martin station, Atlantic Coast Line Railroad, 9 miles north of Ocala; H. Gunter and C. W. Cooke, collectors.

6810. Cummer phosphate plant No. 10, 1 mile northwest of Newberry; C. W. Cooke, collector.

6812. Cummer Lumber Co.'s phosphate plant No. 6, 1¼ miles south of Newberry; C. W. Cooke, collector.

6814. Quarry of Franklin Phosphate Co., 1½ miles northeast of Newberry; C. W. Cooke, collector.

6858. Near Alachua.

7126. East bank of Flint River at Dry Bread Shoals, Mitchell County, 8½ or 9 miles below Newton, from lumps blasted from the channel; C. W. Cooke, collector.

7194. Mouth of cavern about 200 yards southwest of wagon bridge over Chipola River, east of Marianna; bed 4 of section; C. W. Cooke and W. C. Mansfield, collectors.

7338. Suwannee River at Dowling Springs, Suwannee County; C. W. Cooke, collector.

7348. Left bank of Suwannee River about 1 mile above Troy Springs; C. W. Cooke, collector.

7349. Left bank of Suwannee River about half a mile below Fort McComb; C. W. Cooke, collector.

7354. Manatee Spring, Levy County, C. W. Cooke, collector.

7367. Willow Sink, 1⅓ to 2 miles west of Chiefland, Levy County; C. W. Cooke, collector.

U. S. N. M. No. 112507. Richards quarry, Ocala; Joseph Willcox, collector.

In Alabama the species has been found at station 6747, Steamboat Point, on west side of Sepulga River, at sharp bend near middle of sec. 20, T. 3 N., R. 13 E., Escambia County; C. W. Cooke, collector.

Lepidocyclina perundosa Cushman.

Plate XXVI, figure 1.

Lepidocyclina perundosa Cushman, Carnegie Inst. Washington Pub. 291, p. 63, pl. 11, fig. 8, 1919.

Test very much curved in two directions, so that the two planes of each set are nearly parallel to one another and nearly at right angles to those of the other set, strongly "saddle-shaped"; surface smooth when well preserved but usually somewhat cancellate, owing to erosion.

A vertical section is difficult to obtain on account of the very much doubly curved shape of the test but shows no pillars, the lateral chambers about three times as long as high, central chamber large, equatorial chambers increasing gradually in size toward the periphery, height and breadth of equatorial chambers about equal.

Owing to the shape of the test the horizontal section is only fragmentary, but it shows chambers roughly triangular with the outer surface convexly curved.

Diameter, 8 to 12 millimeters.

Type specimen, section (U. S. N. M. No. 328194) from station 3478, Nuevitas, Cuba; A. C. Spencer, collector.

This is a very sellaeform species about one-half the size of *L. undosa* Cushman, from Antigua.

Lepidocyclina undosa Cushman.

Plate XXV, figure 3.

Lepidocyclina undosa Cushman, Carnegie Inst. Washington Pub. 291, p. 65, pl. 2, fig. 1a, 1919.

Test of medium size, much compressed, strongly undulate or saddle-shaped, not at all umbonate, thin throughout; surface slightly granulate, otherwise smooth, where worn usually netted by the walls of the chambers.

Vertical sections show apparently an entire absence of pillars throughout; equatorial chambers nearly square in section, walls straight; lateral chambers very numerous, low and broad, very thin-walled, 12 to 15 in a vertical column in the thicker portions of the test.

Horizontal sections show typical hexagonal equatorial chambers.

Diameter as much as 25 millimeters or more.

Type material (U. S. N. M. No. 328198) from Antigua, Leeward Islands, U. S. G. S. station 6869, Long Island, T. W. Vaughan, collector. The species is very abundant in this material, making up a large proportion of the rock mass. Specimens are associated with *Heterostegina*.

This may be distinguished from other species of *Lepidocyclina* by its saddle-shaped test, the flat, nonumbonate center, the finely netted surface in worn specimens, and the absence of pillars in the vertical section, with the thin-walled chambers.

Lepidocyclina schlumbergeri Lemoine and R. Douvillé.

Lepidocyclina schlumbergeri Lemoine and R. Douvillé, Soc. géol. France, Paléontologie, vol. 12, Mém. 32, p. 14, pl. 1, fig. 10; pl. 2, fig. 6, 1904.
Cushman, Carnegie Inst. Washington Pub. 291, p. 57, 1919

Test large, compressed, lenticular, thickest in the central region, from which it gradually thins out toward the periphery, somewhat flexuous and slightly saddle-shaped; surface fairly smooth or somewhat finely granular, the granules representing the ends of the small pillars; surface often uneven, owing to the raised peripheral walls of the lateral chambers.

The vertical section shows the general shape, thin, gently curving from the center to the periphery, slightly curved; the pillars numerous and comparatively small, a very few larger pillars in the central region; vertical columns of lateral chambers with numerous low, flattened chambers making up each column.

The horizontal section shows hexagonal chambers, but more numerous equatorial ones with the outer wall convexly curved, walls rather thick.

Diameter, 25 to 35 millimeters.

Lemoine and R. Douvillé regard this as a mutation of *L. dilatata*. They record this species especially from Spain at four localities. In Cuba it has been found at stations 7512, Ocujal; 7518, south side of Los Melones Mountain near west end; 7522, Mogote Peak; 7543, limestone outcrop, east side of Yateras River; 7664, north slope of La Piedra, northeast of Jamaica, northeast of Guantanamo, collected by N. H. Darton.

Lepidocyclina pseudomarginata Cushman, n. sp.

Plate XXVI, figures 2–4.

Test of medium size, 12 to 15 millimeters in diameter, slightly sellaeform; central portion thickened and occupying nearly half the diameter of the entire test, entire thickness about one-fourth the whole diameter of the test; peripheral portion thin; central thickened portion strongly papillate from the projecting ends of the pillars, which gradually decrease in number as the thinner peripheral portion is approached; line of demarcation not abrupt; papillae of the central portion very numerous and rather evenly distributed.

Equatorial chambers hexagonal, showing at the surface only on the extreme periphery; the remainder of the thin portion toward the center covered with one or more layers of lateral chambers.

Type specimen from U. S. G. S. station 3683, Archer, Fla.; W. H. Dall, collector. A very small specimen (U. S. N. M. No. 136425) may be the young of this species. It is from Johnson's sink, Levy County, Fla.; L. C. Johnson, collector. Other specimens were obtained at the following stations:

7194. Ocala limestone, Marianna, Fla.; bed 4 of section, at mouth of cavern; C. W. Cooke and W. C. Mansfield, collectors.

7338. Suwannee River at Dowling Springs, Suwannee County, Fla.; C. W. Cooke, collector.

This species resembles *L. marginata*, but the central region is much more finely papillate, the number of papillae being double that in *L. marginata*. It seems to be a rare species in the Ocala limestone.

Lepidocyclina supera (Conrad) H. Douvillé.

Plate XXVI, figures 5–7.

Orbitolites supera Conrad, Acad. Nat. Sci. Philadelphia, Proc., No. 2, p. 74, 1865.
Orbitoides supera Conrad, Am. Jour. Sci., 2d ser., vol. 43, p. 31, 1867.
Lepidocyclina supera (Conrad) H. Douvillé, Compt. Rend., 1918, pp. 263, 264, figs. 6–8, 11.

Test flattened or slightly sellaeform, typically circular in outline but occasionally irregular,

with lobes at one side or elongated oval; thickest in the central region but not distinctly umbonate, gradually decreasing in thickness to the periphery; surface apparently smooth but with slight enlargement becoming papillate, the papillae, which are the ends of the pillars rounded and projecting above the general surface slightly, or where the test is eroded becoming more prominent. Diameter as much as 18 millimeters in adult specimens; thickness about 2 millimeters.

The horizontal section shows the chambers of the equatorial band to be irregularly hexagonal, the chambers with thick walls, the annuli irregular, occasionally much crowded, the chambers then compressed and elongate oval; embryonic chambers not seen.

The vertical section shows the equatorial band to be unusually thin, increasing somewhat in thickness toward the periphery, where the height of the chambers is 2 to 2½ times the radial width; lateral chambers numerous, 10 to 12 in a column in the thickest portion of the test, thence decreasing gradually in number toward the periphery; chambers very much compressed, 6 to 8 times as wide as high, elliptical, the walls thick, usually much thicker than the chamber itself; pillars very numerous, increasing rapidly in diameter toward the surface, most numerous in the thicker central portion but in lesser numbers scattered over the surface well toward the periphery.

Conrad describes this species from the upper bed at Vicksburg (hence probably the specific name *supera*) in the following words:

> Smaller than the preceding [*L. mantelli*] and comparatively thicker without the raised central point. Diameter thirteen-twentieths of an inch. This species is readily distinguished by the convex center and is limited to the Oligocene strata.

L. supera seems to be a characteristic species of the upper part of the lower Oligocene, now known as the Byram calcareous marl. It has been found at the following stations in Mississippi:

259. Vicksburg.

2664. Vicksburg; C. W. Johnson, collector.

3722. Vicksburg, bluff just above the second sawmill on the river, horizon No. 2 from the top; T. W. Vaughan, collector.

3729. Top of bluff opposite second sawmill, Vicksburg; T. W. Vaughan, collector.

5623. West bank of Pearl River, Byram, Hinds County; G. C. Matson, collector.

6449. Upper fossiliferous zone, Confederate Avenue, 600 to 700 feet north of the bridge over Glass Bayou, Vicksburg; C. W. Cooke, collector.

6454. Pearl River just above bridge at Byram; C. W. Cooke, collector.

6458. Rock quarry 4 miles east of Brandon, south of Rankin, on Alabama & Vicksburg Railway, Rankin County; T. W. Vaughan, collector.

6648. Chickasawhay River at wagon bridge a quarter of a mile west of Woodward and 2 miles northwest of Waynesboro County; C. W. Cooke, collector.

The following localities in Alabama seem to have this species:

3646. Salt Mountain, Clarke County, near the top of the series; T. W. Vaughan, collector.

3648. Salt Mountain, near top of the hill; T. W. Vaughan, collector.

H. Douvillé [1] has recorded *L. supera* from Vicksburg and Byram, Miss., from a locality southeast of Claiborne on Conecuh River, Ala., and from Bainbridge, Ga. I have had much material from Bainbridge but have had no material that seemed to fit this species. The embryonic chambers of a specimen from Bainbridge, figured by Douvillé, are very thick walled and seem much more like some of the Ocala species. Douvillé gives *L. supera* as occurring in the "upper Jackson-*Zeuglodon* bed."

The species there that is superficially like *L. supera* in some respects is that here described as *L. mortoni*.

So far as the material I have had shows, *L. supera* is confined to the Byram marl and formations of equivalent age.

Lepidocyclina mortoni Cushman, n. sp.

Plate XXVII, figures 1–4; Plate XXVIII, figures 1, 2.

Test flattened, usually somewhat sellaeform, thin; central portion thickest but not umbonate; surface very finely papillate throughout, the papillae most numerous in the central portion. Diameter as much as 20 millimeters; thickness slightly more than 1 millimeter.

The horizontal section shows the chambers of the equatorial band hexagonal in general, but the peripheral portion more commonly a convex curve instead of a sharp angle; embryonic chambers subequal in the megalospheric form, thick-walled.

The vertical section shows the chambers of the equatorial band very low, in the center slightly wider than the height but toward the periphery slightly larger and slightly higher

[1] Compt. Rend., 1918, pp. 264, 265.

than the width, walls thick and at right angles, not showing the convexity of the outer wall so common in most species; lateral chambers seven or eight in a column in the thickened central portion, broad and low, the outer wall usually convex, making the chamber cavity roughly lunate, the walls of the inner chambers nearest the equatorial chambers often much thickened and the chamber cavity reduced to mere slits, the walls often double the thickness of the entire equatorial band at that point, the walls of the outer layers much thinner and the chamber cavities somewhat wider but not proportionately so; pillars very numerous, more or less irregular, often anastomosing, especially toward the surface.

Type specimen from the Jackson formation at U. S. G. S. station 2638, bluff at Montgomery, Grant Parish, La.; T. W. Vaughan, collector, 1894. The species is represented by abundant specimens from the marl at this place. The same species was collected at station 4270, at the same locality, by T. W. Vaughan, in 1900. Very similar specimens occur at the following stations:

7161. Ocala limestone, roadside 500 feet east of Jones Field Branch, sec. 35, T. 8 N., R. 3 E., 5 miles southeast of Whatley, Ala.; C. W. Cooke, collector.

7377. Jackson formation, bluff on south side of Suck Creek, Clarke County, Miss., about three-quarters of a mile from mouth (in the NE. ¼ sec. 3, T. 10 N., R. 7 E., in "*Zeuglodon* bed"; E. N. Lowe and C. W. Cooke, collectors.

Both microspheric and megalospheric forms of the test occur. The pillars are peculiar in their anastomosing condition and are shown in the horizontal section (Pl. XXVII, fig. 3).

Lepidocyclina ocalana Cushman, n. sp.

Plate XXVIII, figures 3, 4; Plate XXIX, figures 1–3.

Test of medium size, flattened, usually slightly sellaeform; usual diameter of specimens from 16 to 18 millimeters, with the range of adult specimens from 15 to 21 millimeters; the two sides of the tests differing; one side typically prominently umbonate in the central portion, thence gradually sloping to the periphery; the opposite side thickened in the center but not umbonate, evenly curved from one side to the other; the umbonate side showing more clearly the sellaeform shape than the more evenly curved side; surface typically smooth or somewhat scrobiculate from unequal erosion of the outer layer of lateral chambers.

The horizontal section shows the chambers of the equatorial band usually with the outer portion of each chamber convexly curved, on the whole hexagonal, walls comparatively thick, thinner near the periphery; annuli irregular; embryonic chambers subequal, thick-walled.

In vertical section the chambers of the equatorial zone increase but very slightly in height toward the exterior; lateral chambers much compressed, broad and very low, from 15 to 20 in a vertical column in the umbonal region but rapidly diminishing in number toward the periphery. Pillars very numerous, more so in the central region but well distributed throughout the test except at the peripheral portion, in section wedge-shaped, distal end broadest, thence tapering gradually to the center, usually showing longitudinal laminations in section, outer end flat or very slightly convex, not coming above the adjacent lateral chambers and therefore not causing a papillate surface, as is so usual with a species in which the pillars are numerous; in some specimens the pillars seem to become obsolete before the surface is reached.

Type specimen from U. S. G. S. station 6804, Ocala limestone, quarry No. 1, Florida Lime Co., Ocala, Fla.; C. W. Cooke, collector. Tests of this species have been found also at the following stations:

322. Quarry of chimney rock near railroad half a mile west of Gainesville, Fla.; L. C. Johnson, collector.

329. U. S. N. M. catalogue No. 136397, Fort White, Fla.; L. C. Johnson, collector.

355. Bennett's bone bed, Nixon, Levy County, Fla.; L. C. Johnson, collector.

362. Fort White railroad station, Suwannee County, Fla.; L. C. Johnson, collector.

365. U. S. N. M. catalogue No. 136425, Johnson's lime sink, Levy County, Fla.; L. C. Johnson, collector.

378b. Near the "sink" 2 miles south of Gainesville, Fla.; L. C. Johnson, collector.

380. Vicinity of Gainesville and Arredonda, Alachua County, Fla.; L. C. Johnson, collector.

2284. Martin station, Marion County, Fla.; W. H. Dall, collector, 1891.

2325. Fort White, Columbia County, Fla.

3629. Alachua, Fla.; T. W. Vaughan, collector.

3682. Six miles southwest of Gainesville, Fla.; Weatherby, collector.

3683. Archer, Fla.; W. H. Dall, collector.

3685. Martin's station, Fla.; W. H. Dall, collector.

3688. Richard's quarry, Ocala, Fla.; Joseph Willcox, collector.

3781. Bank of Allapaha River, Statenville, Echolls County, Ga.; S. W. McCallie, collector.

4965. Half a mile southwest of Fort White, Columbia County, Fla.; G. C. Matson, collector.

5030, 5031. Ocala, Marion County, Fla.; G. C. Matson, collector, 1908.

6717. Fort White, Fla.

6747. Steamboat Point, on west side of Sepulga River at sharp bend near middle of sec. 20, T. 3 N., R. 13 E., Escambia County, Ala.; C. W. Cooke, collector.

6785. Dutton's phosphate spur, on Atlantic Coast Line Railroad, one-half to one-fourth mile south of Herlong station, Fla.; T. W. Vaughan and C. W. Cooke, collectors.

6789. North side of Alachua-High Springs public road, 1 mile west of Alachua station, Atlantic Coast Line Railroad, Alachua County, Fla.; T. W. Vaughan, collector.

6790. Three hundred feet south of Alachua Manufacturing Co.'s plant, south edge of Alachua, Alachua County, Fla.; H. Gunter and C. W. Cooke, collectors.

6803. Hilltop on land of Evans Hale, 2 miles west of Arredonda and 1 mile north of Kanapaha station, Alachua County, Fla.; H. Gunter and C. W. Cooke, collectors.

6805. Plant of Oakhurst Lime Co., (plant No. 2, Florida Lime Co.), south of Atlantic Coast Line Railroad 2 miles southeast of Ocala, Fla.; C. W. Cooke, collector.

6807. Plant No. 3, Florida Lime Co., 6½ miles north of Ocala, at Zuber post office, Marion County, Fla.; C. W. Cooke, collector.

6808. Quarry one-eighth of a mile southeast of Martin station, Atlantic Coast Line Railroad, 9 miles north of Ocala, Fla.; H. Gunter and C. W. Cooke, collectors.

6810. Cummer phosphate plant No. 10, 1 mile northwest of Newberry, Fla.; C. W. Cooke, collector.

6812. Cummer Lumber Co.'s phosphate plant No. 6, 1½ miles south of Newberry, Alachua County, Fla.; C. W. Cooke, collector.

6814. Quarry of Franklin Phosphate Co., 1½ miles northwest of Newberry, Alachua County, Fla.; C. W. Cooke, collector.

6858. Near Alachua, Fla.

7082. Hales Landing, west bank of Flint River 7 miles southwest of Bainbridge, Ga.; T. W. Vaughan, C. W. Cooke, and W. C. Mansfield, collectors.

7097. East bank of Flint River above old factory at bend three-fourths of a mile northeast of Atlantic Coast Line Railroad station at Bainbridge, Ga.; C. W. Cooke and W. C. Mansfield, collectors.

7126. East bank of Flint River at Dry Bread Shoals, Mitchell County, Ga.; 8½ or 9 miles below Newton, from lumps blasted from the channel; C. W. Cooke, collector.

7194. Mouth of cavern about 200 yards southwest of wagon bridge over Chipola River, east of Marianna, Fla.; bed 4 of section; C. W. Cooke and W. C. Mansfield, collectors.

7195. Same locality as 7194, bed 5 of section; C. W. Cooke and W. C. Mansfield, collectors.

7242. West bank of Chipola River at wagon bridge east of Marianna, Fla.; bottom of bed 5 of section; W. C. Mansfield, collector.

7337. Left bank of Suwannee River above bridge of Florida Railway, northeast of Mayo, Suwannee County, Fla.; C. W. Cooke, collector.

7338. Suwannee River at Dowling Springs, Suwannee County, Fla.; C. W. Cooke, collector.

7341. Left bank of Suwannee River, at Branford, Suwannee County, Fla.; C. W. Cooke, collector.

7345. East bank of Suwannee River 2¼ miles above Branford, Suwannee County, Fla.; C. W. Cooke, collector.

7349. Left bank of Suwannee River about half a mile below Fort McComb, Fla.; C. W. Cooke, collector.

7360. Rock quarry east of Atlantic Coast Line Railroad about 3½ miles south of Floral City and about 1½ miles north of Pineola, Fla.; C. W. Cooke, collector.

7365. Pineola, Citrus County, 5 miles south of Floral City, Fla.; C. W. Cooke, collector.

7367. Willow Sink, 1½ to 2 miles west of Chiefland, Levy County, Fla.; C. W. Cooke, collector.

7672. Ocala limestone, Chipola River at Louisville & Nashville Railroad, three-fourths mile east of Marianna, Fla.; C. W. Cooke, collector.

U. S. N. M. No. 112507. Richards quarry, Ocala, Fla.; Joseph Willcox, collector.

U. S. N. M. No. 137924. Archer, Fla.; W. H. Dall, collector.

Specimens from U. S. G. S. station 7689 (Tivola tongue of Ocala limestone, Tivola, Ga.; C. W. Cooke, collector) are evidently this species with the variety *subdecorata*, described below.

Both the species and its variety seem to be highly characteristic of the Ocala limestone in west-central Florida and are very abundant. The development and subsequent reduction of pillars seem to indicate senescent characters even in the upper Eocene. The species seems to be to a great extent replaced in Georgia and elsewhere by the very much larger *L. georgiana*, unless it occurs there at different horizons.

Lepidocyclina ocalana Cushman var. subdecorata Cushman, n. var.

Plate XXVIII, figure 5.

Variety differing from the typical species in its usually thinner, more distinctly umbonate test, and surface with prominent papillae, even near the periphery.

In most material in which typical *L. ocalana* occurs this variety also is present. In size and general characters the two are similar, but the variety is distinctly papillate throughout, a character which may be accompanied by the thinner and more umbonate test. As a rule this is not as common as the typical form, but in one or two lots of material it seems to be fairly common while the typical form is rare or absent.

It was noted in material from the following stations:

365. Johnsons Sink, Levy County, Fla.; L. C. Johnson, collector.

3629. Ocala limestone, Alachua County, Fla.; T. W. Vaughan, collector.

4965. Half a mile southwest of Fort White, Columbia County, Fla.; G. C. Matson, collector.

4974. Six miles southwest of Chipley, Fla., on west side of St. Andrews Bay road; G. C. Matson, collector.

6789. North side of Alachua-High Springs public road, 1 mile west of North Alachua station on Atlantic Coast Line Railroad, Alachua County, Fla.; T. W. Vaughan, collector.

6804. Quarry No. 1, Florida Lime Co., on southwest edge of Ocala, Fla.; C. W. Cooke, collector.

6807. Plant No. 3, Florida Lime Co., 6½ miles north of Ocala, at Zuber post office, Marion County, Fla.; C. W. Cooke, collector.

6808. Quarry one-eighth of a mile southeast of Martin station, Atlantic Coast Line Railroad, 9 miles north of Ocala, Fla.; H. Gunter and C. W. Cooke, collectors.

6810. Cummer Lumber Co.'s phosphate plant No. 10, 1 mile northwest of Newberry, Alachua County, Fla.; C. W. Cooke, collector.

6812. Cummer Lumber Co.'s phosphate plant No. 6, 1¼ miles south of Newberry, Alachua County, Fla.; C. W. Cooke, collector.

7338. Suwannee River at Dowling Springs, Suwannee County, Fla.; C. W. Cooke, collector.

Specimens from station 7689 (Tivola, Ga.; C. W. Cooke, collector) seem to be this variety.

Lepidocyclina subraulinii Cushman.

Plate XXX, figures 1–6.

Lepidocyclina subraulinii Cushman, Carnegie Inst. Washington Pub. 291, p. 62, pl. 11, figs. 6, 7; pl. 12, figs. 5, 6, 1919.

Test circular, much thickened in the central portion, which occupies about one-third the diameter of the test; peripheral portion much flattened, thin; thick central portion irregularly papillate, peripheral portion smooth, showing almost no tendency to become saddle-shaped.

The vertical section shows the general thickness, central lenticular body, and thin periphery, central portion with very numerous pillars increasing in diameter toward the surface; lateral chambers crowded between the pillars, very numerous in the vertical columns and much wider than high; equatorial chambers increasing in diameter toward the periphery, the outer margin convex and with a series of fine pores.

The horizontal section shows the equatorial chambers, which are polygonal, the outer margin strongly convex; pillars subpolygonal with the lateral chambers making irregular polygonal meshes between, toward the periphery, making up the entire test as the pillars decrease in number.

Diameter as much as 24 millimeters; thickness in center 4.5 millimeters.

The type locality of this species is U. S. G. S. station 3478, Nuevitas, Cuba, collected by A. C. Spencer. Other specimens that apparently belong to this species occur at station 7666, Sierra Guaso, northeast of Guantanamo, Cuba, collected by N. H. Darton.

In diameter and general shape this species suggests *L. raulinii* Lemoine and R. Douvillé, but it has very definite pillars and a papillose surface at the center.

Certain specimens collected by E. T. Dumble from the Meson formation at San Jose de las Rusias, Mexico, seem very close to this species.

Lepidocyclina marginata (Michelotti) Lemoine and R. Douvillé.

Plate XXXI, figures 1–2.

Nummulites marginata Michelotti, Soc. ital. sci. Mem., vol. 22, p. 297, pl. 3, fig. 4, 1841.

Lepidocyclina marginata (Michelotti) Lemoine and R. Douvillé, Soc. géol. France, Paléontologie, vol. 12, Mém. 32, p. 16, pl. 1, fig. 7; pl. 2, figs. 7, 9, 11, 20; pl. 3, figs. 3, 8, 9, 13, 1904.

Cushman, Carnegie Inst. Washington Pub. 291, p. 60, pl. 12, figs. 1, 2, 1919.

Test of small or medium size, lenticular, thickest in the central region, thence tapering gradually to the periphery, which in the adult forms a thin flange about the thicker central portion; central portion with numerous prominent pustules, rather evenly placed and of good size, representing the outer end of the pillars, flange smooth except for roughness caused by weathering.

The vertical section shows the general shape already noted, the numerous pillars giving an undulate outline to the central thickened region, pillars rather crowded at the center but separating toward the periphery, increasing very rapidly in diameter in the first quarter or third of their length, thence keeping about the same diameter to the surface; lateral chambers in single columns between the pillars; equatorial band of chambers rather narrow and thin, increasing in height toward the periphery.

The horizontal section shows the equatorial chambers to be in general hexagonal, occasionally with the peripheral portion convexly curved; the lateral chambers also hexagonal,

especially in the central region, where they are compressed by the pillars.

Diameter as much as 12 or 15 millimeters, but usually less.

Lemoine and R. Douvillé record this species from Italy and Spain. It was noted from the following localities in Cuba:

7512. Ocujal.

7513 (?). Orbitoidal limestone, outcrop where Palmer trail joins Ocujal trail.

7518. South side of Los Melones Mountain near west end.

7519. Orbitoidal limestone from drift near top of landslide next north of Los Melones.

7521. Limestone at top of Mogote Peak.

7522(?). Mogote Peak.

7543. Limestone outcrop on east side of Yateras River.

7664. North slope of La Piedra, northeast of Jamaica, northeast of Guantanamo, N. H. Darton, collector.

Lemoine and R. Douvillé had only the microspheric form of the species, but the Cuban material contains megalospheric specimens. The embryonic chambers are rather thick-walled and unequal in size.

Lepidocyclina morgani Lemoine and R. Douvillé.

Plate XXXIII, figures 12–14.

Lepidocyclina morgani Lemoine and R. Douvillé, Soc. géol. France, Paléontologie, vol. 12, Mém. 32, p. 17, pl. 1, figs. 12, 15, 17; pl. 2, figs. 4, 12; pl. 3, fig. 2, 1904. Cushman, Carnegie Inst. Washington Pub. 291, p. 59, pl. 11, figs. 1–3, text fig. 7, 1919.

Lepidocyclina cf. *L. marginata* H. Douvillé, Soc. géol. France Bull., 3d ser., vol. 18, p. 1001, 1900.

Test small, discoidal, much thickened in the central portion, from which it tapers rather rapidly to the subacute periphery; central protuberant portion with a series of large pustules ranging from 5 to 12 or more in number, of which one is usually central; reticulate between, the margins stellate; periphery of the test thin and slightly reticulated by the walls of the equatorial chambers.

Vertical sections show the general form and curvature of the surface of the test, the few pillars in the central region rapidly increasing in diameter toward the surface; lateral chambers with the outer wall convex, averaging about three times as wide as the height in the central region, with as many as 10 chambers in the vertical columns; equatorial chambers not increasing rapidly in height, those at the periphery not more than double the height near the center.

Horizontal sections show the embryonic chambers, which are unequal, the larger one partially surrounding the smaller, as in the subgenus *Nephrolepidina* of H. Douvillé, and the equatorial chambers more or less diamond shaped also as in that subgenus. In other specimens the outer wall of the chamber is convex.

Diameter, 2 to 5 millimeters.

Specimens seemingly identical with this species were found by O. E. Meinzer at the following stations in Cuba:

7513. Limestone outcrop where Palmer trail joins Ocujal trail.

7516. West end of Los Melones Mountain.

7543. Limestone outcrop on east side of Yateras River.

7554. South of El Jigue, 5 miles above mouth of Yateras River on west side.

Specimens probably of this species but sections not as perfect as might be desired were obtained from stations 7519, limestone from drift near top of landslide next north of Los Melones, and 7522, Megote Peak.

Lemoine and R. Douvillé record this species from four localities in Aquitaine—Abesse, Mimbaste, St.-Etienne-d'Orthe, and Le Mandillott; from four localities in Spain—Baena, Pont du Guadalquivir, Sella, and Peñaguila; and from Madagascar. The stage is indicated as Aquitanian but not definitely given.

It is a very distinctive species and the Cuban specimens seem to differ in no essential characters from those figured by Lemoine and R. Douvillé.

Exteriors of specimens from station 7664, north slope of La Piedra, northeast of Jamaica, northeast of Guantanamo, Cuba, are shown in Plate XXXIII, figures 12 and 13.

Lepidocyclina crassata Cushman.

Plate XXXI, figures 3–6.

Lepidocyclina crassata Cushman, Carnegie Inst. Washington Pub. 291, p. 61, pl. 11, figs. 4, 5, 1919.

Test of medium size, lenticular, comparatively thick in the center, thence tapering toward the sides; central portion convex, changing to a concave curve toward the periphery; surface irregularly pustulate, especially where somewhat weathered.

The vertical section shows the general shape, convex at the center, broadly rounded, thence contracting rapidly toward the periphery, where the curve is concave, to the rather poorly developed peripheral border; height or thickness of the test about one-third the diameter; embryonic chamber large and very thick walled, often

showing one or two accessory chambers also thick walled and rather conspicuously perforate; young specimens show that for a time the embryonic chamber is the greater part of the test; equatorial band of chambers rather large, even at the beginning, the outer wall convex and coarsely perforate; lateral chambers comparatively thick walled, several times as broad as high, somewhat lenticular in section, highest in the middle, thence tapering toward the sides; a comparatively small number of pillars in the central part originating in the wall of the embryonic chamber and extending to the surface.

The horizontal section shows the equatorial chambers regularly hexagonal, fairly thick walled, those of various annuli of very different sizes.

Diameter as much as 9 millimeters, maximum height 3 millimeters or more.

The type locality for this species is U. S. G. S. station 7513, orbitoidal limestone, outcrop where Palmer trail joins Ocujal trail, Cuba. Specimens are also numerous in material from stations 7512, Ocujal; 7519, orbitoidal limestone from drift near top of landslide next north of Los Melones; 7521, limestone at top of Mogote Peak.

This is a very heavy, thick-walled species throughout, and in section may be easily distinguished from any of the other Cuban or West Indian species.

Lepidocyclina canellei Lemoine and R. Douvillé.

Plate XXXII, figures 1–5.

Lepidocyclina canellei Lemoine and Douvillé, Soc. géol. France, Paléontologie, Mém. 32, p. 20, pl. 1, fig. 1; pl. 3, fig. 5, 1904.

Cushman, U. S. Nat. Mus. Bull. 103, p. 91, pl. 34, figs. 1–6, 1918.

Test comparatively small, diameter of largest specimens slightly less than 4 millimeters, thickness a little more than one-fourth the diameter; circular in outline, central portion somewhat raised and evenly rounded, near the periphery flattened or even slightly concave; surface in well-preserved specimens finely granular or even finely papillate but not strongly so, often appearing smooth to the unaided eye. In worn specimens the surface appears as a series of regular hexagonal, honeycomb-like reticulations due to the edges of the lateral chambers.

In vertical section the lateral chambers are seen to be arranged in vertical columns, one directly above another, from the equatorial chambers to the surface, about 12 chambers in each vertical column in the central region, the lateral walls hardly thicker than the upper or lower surfaces. Chamber of adjacent columns arranged alternately; no distinct columns present. Equatorial chambers gradually increasing in size toward the periphery, single throughout, extending peripherally beyond the lateral chambers and in surface view in well-preserved specimens appearing as a hexagonal reticulation. Embryonic chambers nearly equal in size, nearly semicircular in section, their common wall straight.

The horizontal section shows the equatorial chambers regularly hexagonal; those toward the periphery the largest. Embryonic chambers similar to those shown in the vertical view.

Lemoine and R. Douvillé described and figured this species from Peñablanca, Panama, and also noted it from Martinique and Angola. The material from Panama recorded by Dall and by Bagg [1] as *Orbitoides forbesi* Carpenter (catalogue No. 135216, U. S. N. M.) is *Lepidocyclina canellei* Lemoine and R. Douvillé. Figures 1, 3, 4, and 5 in Plate XXXII are from material collected by Hill at Bohio, Panama, where it is very abundant. This is the same station as 6027 of Vaughan and MacDonald (orbitoidal marl, a quarter of a mile northwest of Bohio railroad station). In this material *L. canellei* is very abundant and makes up a considerable proportion of the marl.

Specimens in the collection of the U. S.N. M. (catalogue No. 107158) from the Oligocene of of Trinidad (*Leda* bed, Naparina), collected by Guppy, are also very evidently *Lepidocyclina canellei.*

Specimens of *L. canellei* were very abundant at station 6891, foraminiferal limestone at Balamonas, Canal Zone, where they were collected by D. F. MacDonald.

A limestone at station 6892, 450 feet south of switch at Mamei, Canal Zone, contains numerous specimens also collected by MacDonald, of a *Lepidocyclina* which in general shape in section resembles *L. canellei,* but the material is very cherty and the finer structure is not well preserved.

[1] Hill, R. T., The geologic history of the Isthmus of Panama: Harvard Coll. Mus. Comp. Zool. Bull., vol. 28, pp. 272, 275, 1898.

A few small weathered specimens from station 6019*a*, Gaillard Cut, opposite Las Cascadas, and from station 6023, along the relocated line of the Panama Railroad at Rio Frijol, seems to belong to this species also. They occur in the Culebra formation.

Lepidocyclina canellei Lemoine and R. Douvillé var. yurnagunensis Cushman.

Plate XXXII, figures 6, 7; Plate XXXIII, figures 1–9.

Lepidocyclina canellei Lemoine and R. Douvillé var. *yurnagunensis* Cushman, Carnegie Inst. Washington Pub. 291, p. 57, pl. 12, figs. 7, 8, text figs. 6a, 6b, 1919.

Test differing from the typical form of the species mainly in the form of the lateral chambers, which are somewhat broader and with the upper wall decidedly arched; embryonic chambers either two, subequal or very unequal, or several, the equatorial chambers hexagonal or obscurely diamond shaped.

Type material from U. S. G. S. station 7548, flexure 2 miles south of Yurnaguna, Cuba; collected by O. E. Meinzer.

At this station the material is composed largely of this species, as is shown by the section in Plate XXXII, figure 7. None of these sections happens to be exactly vertical. The variety shows the embryonic characters of all three of H. Douvillé's subgenera—equal chambers, as in the type from Panama, *Isolepidina* (Pl. XXXIII, fig. 4); unequal, one small, the other partly encircling and kidney shaped, as in *Nephrolepidina* (Pl. XXXIII, figs. 5–8); and with two irregular large embryonic chambers and two or more small ones, as in *Pliolepidina* (Pl. XXXIII, fig. 9). The last-mentioned condition is also shown in Plate XXXII, figure 6.

In gross appearance, color, and general characters this material very strikingly resembles that from Bohio, Panama, the type locality for *L. canellei*.

Specimens of this variety seem to be present in the Antiguan material from Hodges Bluff (U. S. G. S. station 6862) and Rifle Butts (U. S. G. S. station 6854).

Other Cuban localities are stations 7516, west end of Los Melones Mountain, and 7543, limestone on the east side of Yateras River; O. E. Meinzer, collecter.

Lepidocyclina sumatrensis (H. B. Brady) Jones and Chapman.

Plate XXXIII, figures 10, 11.

Orbitoides sumatrensis H. B. Brady, Geol. Mag., 2d ser., vol. 2, p. 536, pl. 14, fig. 3, 1875; Jaarb. Mijn. Ned. Oost.-Indië, vol. 7, pt. 2, p. 165, pl. 2, fig. 3, 1878.
Newton and Holland, Ann. and Mag. Nat. Hist., 7th ser., vol. 3, p. 259, pl. 10, figs. 7–12, 1899.
Lepidocyclina sumatrensis Jones and Chapman, in Andrews, A monograph of Christmas Island, London, p. 244, pl. 20, fig. 6, 1900.
Newton and Holland, Tokyo Coll. Sci. Jour., vol. 27, art. 6, p. 11, pl. 1, fig. 7, 1903.
Lemoine and R. Douvillé, Soc. géol. France, Paléontologie, vol. 12, Mém. 32, p. 18, pl. 1, fig. 14; pl. 2, fig. 15; pl. 3, fig. 6, 1904.
Cushman, Carnegie Inst. Washington Pub. 291, p. 60, pl. 12, figs. 3, 4, 1919.

Test small, discoidal, thickened in the central portion, from which it tapers gradually to the subacute periphery; central protuberant portion more or less pustulate throughout, but these protuberant spots of small size and covering the larger part of the area more or less evenly; surface otherwise smooth; periphery thin.

Vertical sections show the general form and curvature of the test, pillars entirely lacking, lateral chambers with the outer surface convex, three or four times as wide as high; 6 to 10 chambers in a vertical column.

Horizontal sections show the embryonic chambers, which are unequal, the larger curved about the smaller semicircular one; equatorial chambers irregularly hexagonal or lozenge shaped.

Diameter, 2 to 5 millimeters.

L. sumatrensis has been found in Cuba at the following stations:

7513. Limestone outcrop where Palmer trail joins Ocujal trail; O. E. Meinzer, collector.

7516. West end of Los Melones Mountain; O. E. Meinzer, collector.

7519. Limestone from drift near top of landslide next north of Los Melones; O. E. Meinzer, collector

7543. Limestone outcrop on east side of Yateras River; O. E. Meinzer, collecter.

7554. South of El Jigue, 5 miles above mouth of Yateras River, on west side; O. E. Meinzer, collector.

7664. North slope of La Piedra, northeast of Jamaica, northeast of Guantanamo; N. H. Darton, collector.

This species was described by Brady from Sumatra. It is recorded elsewhere in the east from Formosa and the East Indies, and Lemoine and R. Douvillé record it from Italy, Spain, and France.

In Cuba it occurs usually in company with *L. morgani*, and in this connection it is interesting to note that both species are listed by Lemoine and R. Douvillé from all four of the stations in Spain and from three of the four stations in France.

This species may easily be distinguished from *L. morgani* by its lack of pillars. The pustulate appearance of *L. sumatrensis* is due to the convex surface of the lateral chambers, those of adjacent columns being of unequal height at the surface. A figure, evidently of this species, by Miss O'Connell [1] shows a vertical section at the left. The specimen came from a limestone quarry at Arroyo Seboruco, 12 miles from Felton, Cuba.

Lepidocyclina macdonaldi Cushman.

Plate XXXIV, figures 1–3.

Lepidocyclina macdonaldi Cushman, U. S. Nat. Mus. Bull. 103, p. 94, pl. 40, figs. 1–6, 1918.

Test circular, rather small, about 5 to 7 millimeters in diameter, thickest in the central region, thence gradually sloping to the periphery, which for a short distance in from the edge is nearly flat; wall rather smooth except the central portion of the umbonal region, which has a few pustule-like raised spots at the surface ends of the vertical pillars.

The vertical section shows the test widest in the middle, gently sloping nearly to the periphery, edges nearly parallel for a short distance to the peripheral edge or even slightly increasing in thickness. Lateral chambers in the central portion in definite vertical columns, occasionally slightly overlapping. Equatorial chambers not increasing very rapidly in height in megalospheric specimens, those at the periphery hardly more than double the height of those near the center of the test. Embryonic chambers in the megalospheric form large, usually of two nearly equal chambers, but in oblique cutting these may appear somewhat unequal. (See Pl. XXXIV, fig. 2.)

Horizontal sections show chambers somewhat similar to those of *L. vaughani* but with the inner half of two walls at nearly right angles, the outer wall broadly rounded. The oblique section (Pl. XXXIV, fig. 3) shows the pillars.

The type locality for this species is U. S. G. S. station 6523, orbitoidal limestone 2 miles north of David, Panama, collected by D. F. MacDonald, Specimens were abundant at this station, occurring with *L. panamensis* and *L. multiplicata*.

[1] Kemp, J. F., Am. Inst. Min. Eng. Trans., vol. 51, fig. 6, 1916.

Lepidocyclina panamensis Cushman.

Plate XXXIV, figures 4–6.

Lepidocyclina panamensis Cushman, U. S. Nat. Mus. Bull. 103, p. 94, pl. 39, figs. 1–6; pl. 42, 1918.

Test circular, small; central portion very strongly umbonate, thick, rapidly decreasing in thickness peripherally; peripheral portion thin and flattened; the raised central portion only one-third to one-fifth the entire diameter, which ranges from 3 to 6 millimeters, with occasional specimens, perhaps representing the microspheric form, 10 or 12 millimeters in diameter; surface smooth except for the umbonal portion, which has a few large pustule-like projections marking the ends of the internal pillars.

The vertical section shows very peculiar embryonic chambers, not the usual type for American species, but with a broad and much flattened central chamber two to four times as broad as high and a compressed, partly encircling chamber, in section usually cut on the opposite sides of the central chamber. These central chambers in section are nearly as wide as the whole umbonal portion of the test. In some specimens there seems to be an irregular mass of three or four more or less nearly spherical chambers. Lateral chambers usually about twice as wide as high, the outer wall often somewhat arched toward the exterior of the test, arranged in vertical columns. Pillars not distinct except in the central portion, where there are a few strong ones increasing rather rapidly in diameter toward the periphery, usually about 9 or 10 chambers in a vertical column in the center of the umbilical region. The peripheral region has but a thin coating of lateral chambers, the last-formed layer present only on the outer half of the periphery and often none at all present on the last quarter of the test toward the periphery, the surface being made up by the upper and lower walls of the equatorial chambers. Equatorial chambers numerous, comparatively broad, the peripheral wall convex outward toward the periphery, the chambers at least as wide as high.

In horizontal section the equatorial chambers appear usually somewhat irregularly hexagonal

near the center, more or less rhomboid toward the periphery, with the outer peripheral wall curved.

So far as described material is concerned this is an unusual form for American species of *Lepidocyclina*, especially in its embryonic chambers.

Type specimen, vertical sections (U. S. N. M. catalogue No. 324741). The species is fairly abundant at stations 6586 *e* and 6587, near the mouth of Tonosi River, Panama; D. F. MacDonald, collector. It was also collected by MacDonald at station 6512, in the river bed at David, Panama.

Lepidocyclina antillea Cushman.

Plate XXXV, figures 4, 5.

Lepidocyclina antillea Cushman, Carnegie Inst. Washington Pub. 291, p. 63, pl. 3, fig. 3, 1919.

Test compressed, circular, rather evenly biconvex, lenticular; central portion highest, thence gradually thinning toward the periphery; central area strongly papillate; remainder of the surface less strongly so.

The vertical section shows equatorial chambers increasing in height toward the periphery, those of the central region measuring less than 0.1 millimeter, those of the periphery as much as 0.5 millimeter in height; outer wall of the equatorial chambers very squarely truncated.

Lateral chambers not numerous, in the central thickened region only 6 or 7 chambers in a column, and this number is gradually reduced toward the periphery. Central region and whole test in lesser degree marked by very heavy and numerous pillars, greatest width near the outer end, thence gradually tapering toward the center; outer ends rounded, forming the papillae of the surface. In the central region the surface area occupied by the pillars is greater than that taken up by the lateral chambers.

In horizontal section, or at least in the somewhat broadly oblique section, the equatorial chambers are of the curved *Lepidocyclina* form instead of the more typical hexagonal shape.

Diameter of test averages about 5 millimeters.

The type locality for this species is U. S. G. S. station 6897, conglomerate and sandstone below upper limestone bed, Anse Ecaille side of point between Anse Ecaille and Anse Lézard, St. Bartholomew; T. W. Vaughan, collector. Material apparently weathered out from the matrix is abundant here and also at station 6897 *b*, point between Colombier Point and bay next to St. Jean Bay, St. Bartholomew; T. W. Vaughan, collector. Hand specimens showing sections of this heavy-pillared species were abundant in a hard, cherty material at stations 6902, in the southeast section of the southwest side of the island near Negre Point, St. Bartholomew, at an elevation of 360 feet, and 6903, N. 67° E. from summit of Negre Point across low saddleback of point, at an altitude of 220 feet.

This species is related in many ways to *Lepidocyclina macdonaldi* Cushman, from the white limestone at David, Panama. The general vertical section is much more heavily pillared in *L. antillea*, although the figure, not being exactly central, shows this much less strongly than many of the weathered sections in hand specimens. The material from the white limestone at David, Panama (U. S. G. S. station 6512), referred to as *L. panamensis*, may belong to *L. antillea*, and also the sections resembling *L. macdonaldi*.

Lepidocyclina duplicata Cushman.

Plate XXXV, figures 1–3.

Lepidocyclina duplicata Cushman, U. S. Nat. Mus. Bull. 103, p. 96, pl. 41, figs. 2–4, 1918.

Test of medium size, 10 to 14 millimeters in diameter, very much thickened in the umbonal region, usually the thickness about one-half the diameter; central portion without the flattened periphery, subspherical, thinning rapidly toward the periphery, then thickening again at the margin, which is doubly plicate in some of the best-preserved specimens. Surface of the umbonal portion studded with numerous fine papillae marking the surface terminations of the pillars; peripheral portion nearly smooth.

The vertical section shows the embryonic chambers as very small, apparently microspheric in the specimens sectioned, appearing spiral, as is usual in the microspheric form. Lateral chambers numerous, flattened or lenticular, the numerous pillars as wide as or wider than the intermediate columns of chambers, especially in the central portion; rapidly increasing in size toward the surface. Equa-

torial chambers very small near the center, gradually increasing in size toward the periphery, where they become multiple instead of single, as is usually the case, and make three or four vertical series, each with numerous fine apertural pores on the outer convex wall.

The horizontal section shows the increase in size of the equatorial chambers, which toward the center seem hexagonal and toward the periphery almost rhomboid, with the outer half convex.

Of somewhat similar character in respect to the duplication of equatorial chambers are *L. multipartita* (Martin), from Java, and *L. insulæ natalis* var. *inequalis* (Jones and Parker), from Christmas Island.

Type specimen, U. S. N. M. catalogue No. 324742. Specimens were very abundant, weathered out of an orbitoid limestone, 2 miles north of David, Panama; D. F. MacDonald, collector. They occur also with other species of *Lepidocyclina* at station 6586*e*, near the mouth of Tonosi River; D. F. MacDonald, collector.

Lepidocyclina kempi (O'Connell) Cushman.

Orbitoides kempi O'Connell, Am. Inst. Min. Eng. Trans., vol. 51, p. 13, figs. 5, 6, 1916.

Under the name *Orbitoides kempi* Miss O'Connell figured sections from a limestone quarry at Arroyo Seboruco, 12 miles from Felton, Cuba. Although the description is not very clear, the figured section (fig. 5) shows the species to belong to the genus *Lepidocyclina*. Measurements given are, total diameter, 7+ millimeters; central thickness, 2.5 millimeters. The general characters that can be made out from the description and figures would seem to indicate that it may very probably be *L. marginata* (Michelotti). This suggestion is strengthened by the fact that in figure 6 appears a vertical section, very evidently of *L. sumatrensis* Brady, a species, so far as seen in the Cuban material I have examined, occurring with *L. marginata* in four out of eight stations. I have refrained from placing this definitely as a synonym of *L. marginata* until specimens are available for comparison.

PLATES XII-XXXV.

PLATE XII.

Lepidocyclina mantelli (Morton) Gümbel (p. 57).

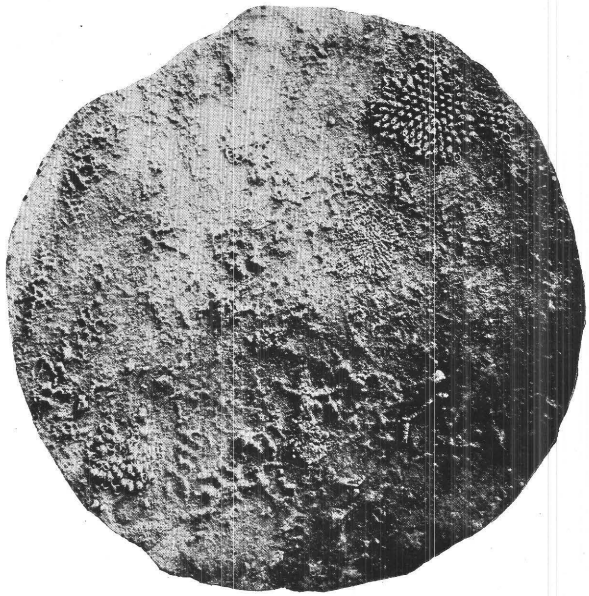
FIGURE 1. Surface view, × 2, megalospheric form. St. Stephens Bluff on Tombigbee River, Ala. (U. S. G. S. station 298).

FIGURE 2. Surface view, × 2, microspheric form. West bank of Conecuh River at bend about a quarter of a mile below mouth of Sepulga River, Escambia County, Ala. (U. S. G. S. station 6748).

FIGURE 3. Surface view, × 2, microspheric form. 7 miles west of Claiborne, 2 miles east of Howards Landing, Monroe County, Ala. (U. S. G. S. station 2397).

FIGURE 4. Transverse section, × 10, showing the very slight increase in the height of the equatorial chambers. Limestone 6 miles southeast of Shubuta, on Carson Creek, Miss. (U. S. G. S. station 2636).

FIGURE 5. Transverse section, × 15. North side of Salt Mountain, 5 miles south of Jackson, Clarke County, Ala. (U. S. G. S. station 3296).



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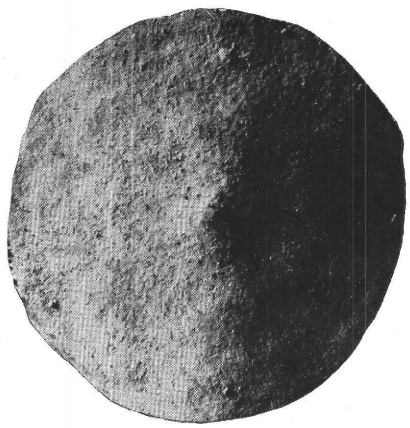

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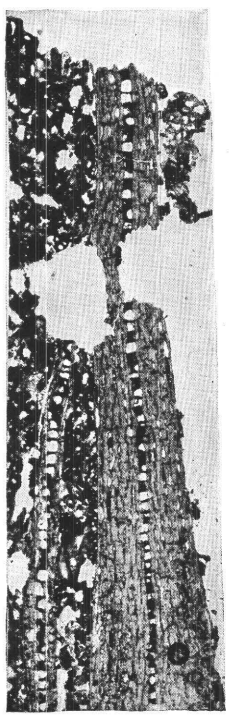

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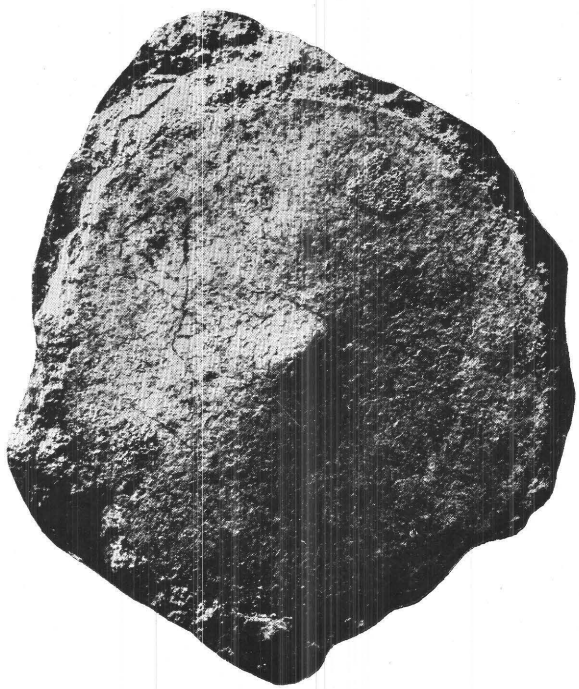

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AMERICAN SPECIES OF LEPIDOCYCLINA.

AMERICAN SPECIES OF LEPIDOCYCLINA.

PLATE XIII.

Lepidocyclina mantelli (Morton) Gümbel (p. 57).

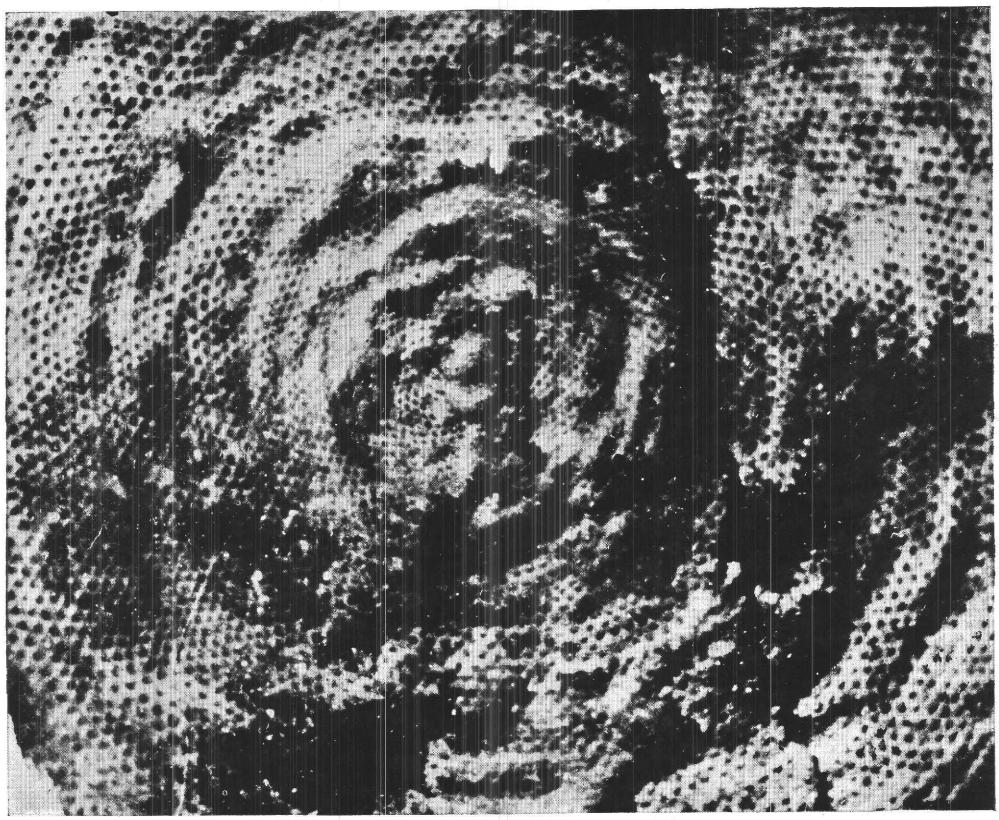
Accidental section of microspheric specimen, × 9, showing the equatorial chambers and the irregular width of the annuli. White limestone 2 miles southwest of Whatley Station, Clarke County, Ala. (U. S. G. S. station 2956).

PLATE XIV.

Lepidocyclina mantelli (Morton) Gümbel (p. 57).

FIGURE 1. Accidental section as in Plate XIII, with the central chambers of the microspheric form, × 18 (U. S. G. S. station 2956).

FIGURE 2. Accidental section of megalospheric form, × 9, showing the two subequal embryonic chambers. Same locality as figure 1.



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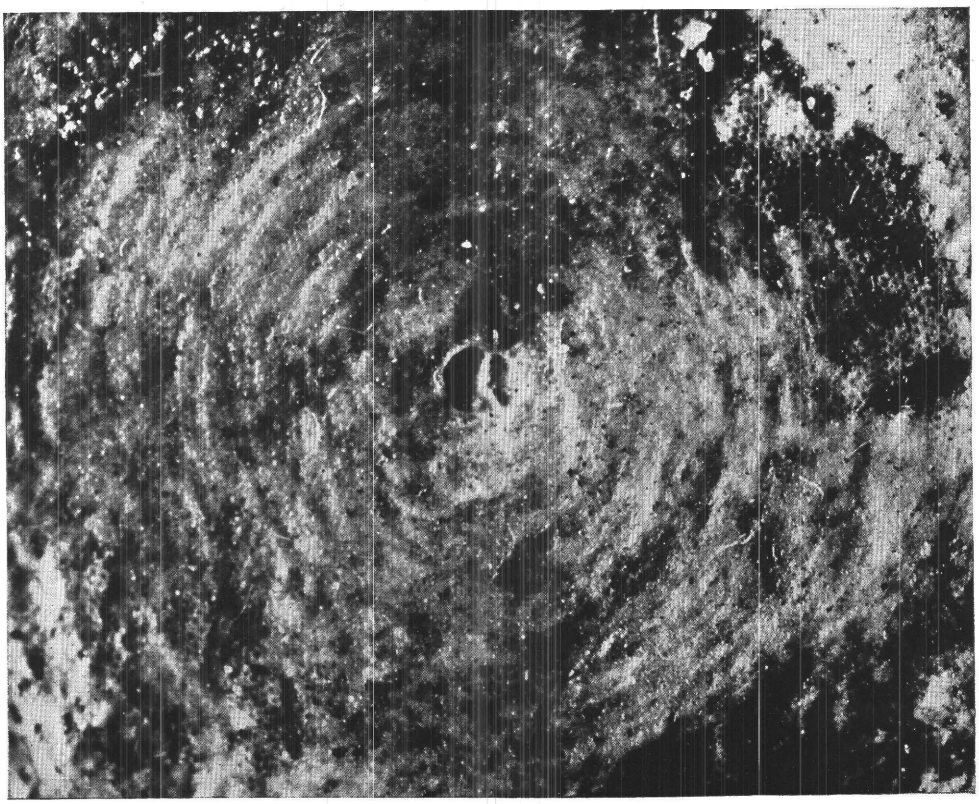

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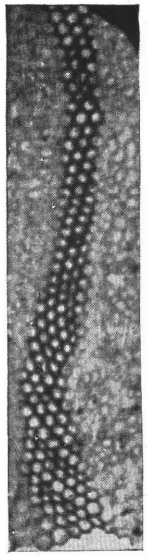
AMERICAN SPECIES OF LEPIDOCYCLINA.



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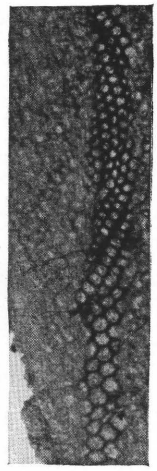

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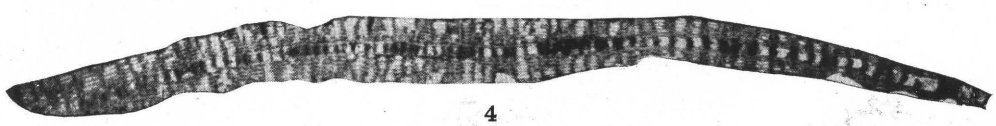

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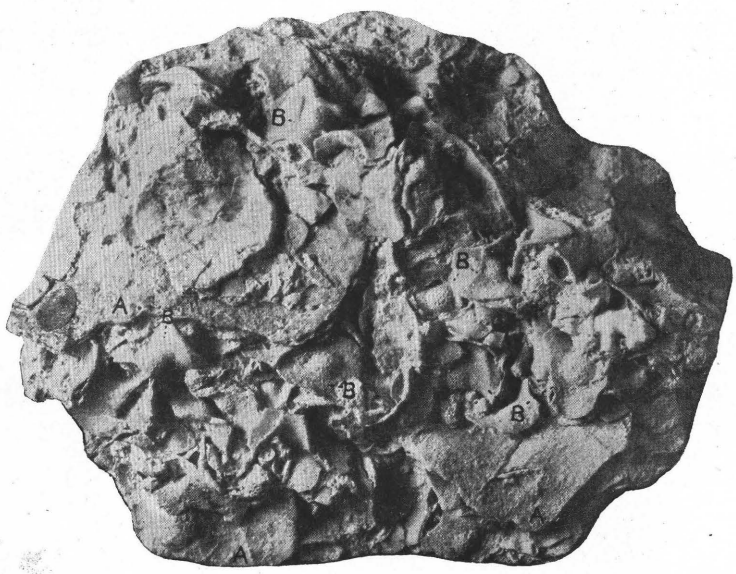

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AMERICAN SPECIES OF LEPIDOCYCLINA.

PLATE XV.

Lepidocyclina hilli Cushman n. sp. (p. 60).

FIGURE 1. Surface view of type specimen, × 5, from the Guallava sandstone of Costa Rica (U. S. N. M. No. 135220).

Lepidocyclina undulata Cushman (p. 60).

FIGURE 2. Portion of section showing the equatorial chambers, × 20, from lower bed at Hodges Bluff, Antigua, Leeward Islands (U. S. G. S. station 6862).

FIGURE 3. Similar section, × 20, from Rifle Butts, Antigua, Leeward Islands (U. S. G. S. station 6854).

FIGURE 4. Vertical section, × 20 (U. S. G. S. station 6862).

FIGURE 5. Rock specimen, natural size, largely made up of *Lepidocyclina undulata* (A) and *L. favosa* (B). Bluffs on north side of Willoughby Bay, Antigua, Leeward Islands (U. S. G. S. station 6881).

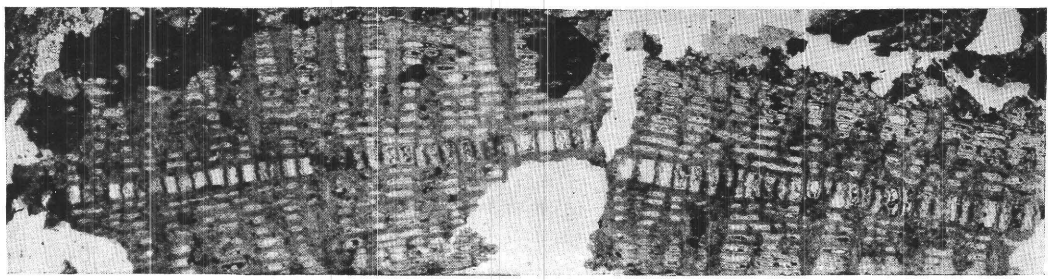
PLATE XVI.

Lepidocyclina georgiana Cushman, n. sp. (p. 60).

FIGURE 1. Vertical section, × 15, showing the pillars of the central portion. Ocala limestone, east bank of Flint River 6 miles above Bainbridge, Ga. (U. S. G. S. station 7130).

Lepidocyclina hilli Cushman, n. sp. (p. 60).

FIGURE 2. Surface view of type specimen, × 15, showing the reticulate character of the exterior with the few pillars of the central portion. Guallava sandstone of Costa Rica.



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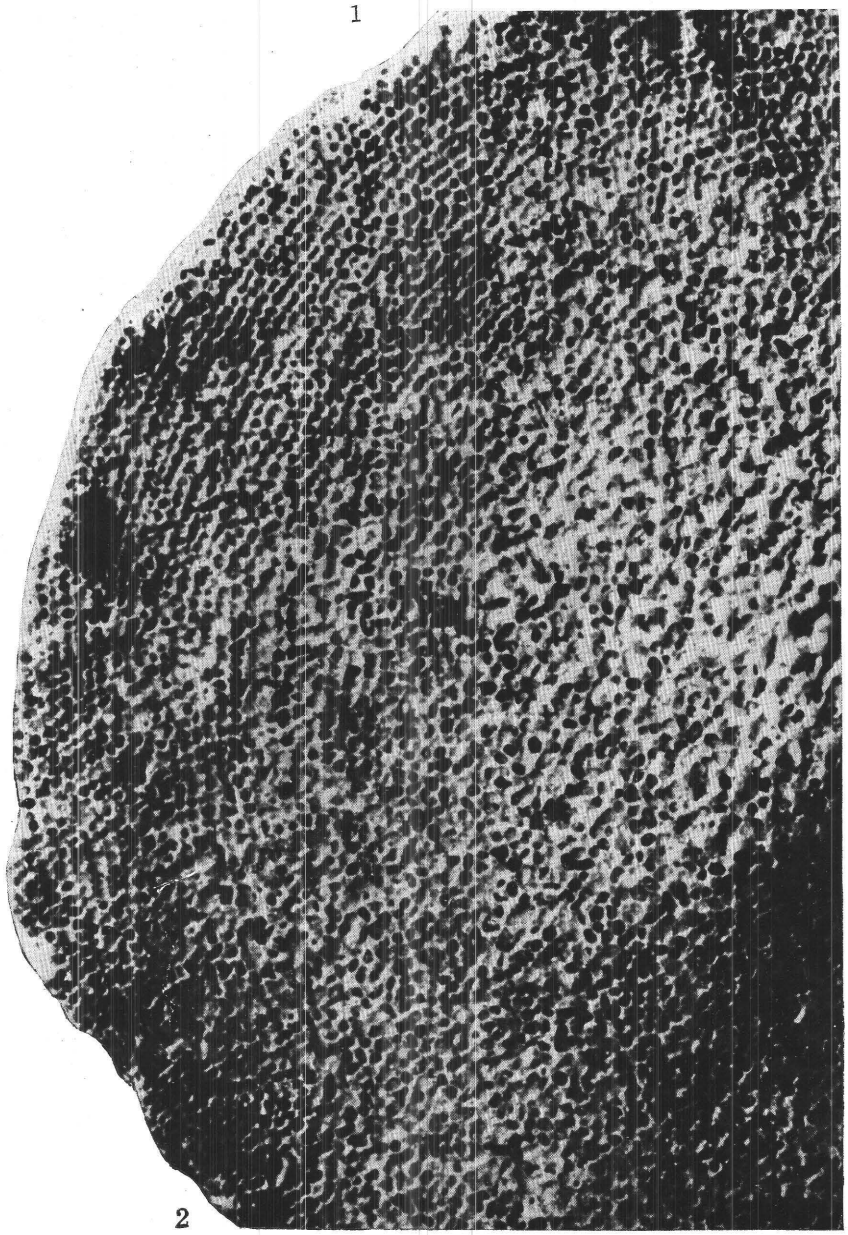

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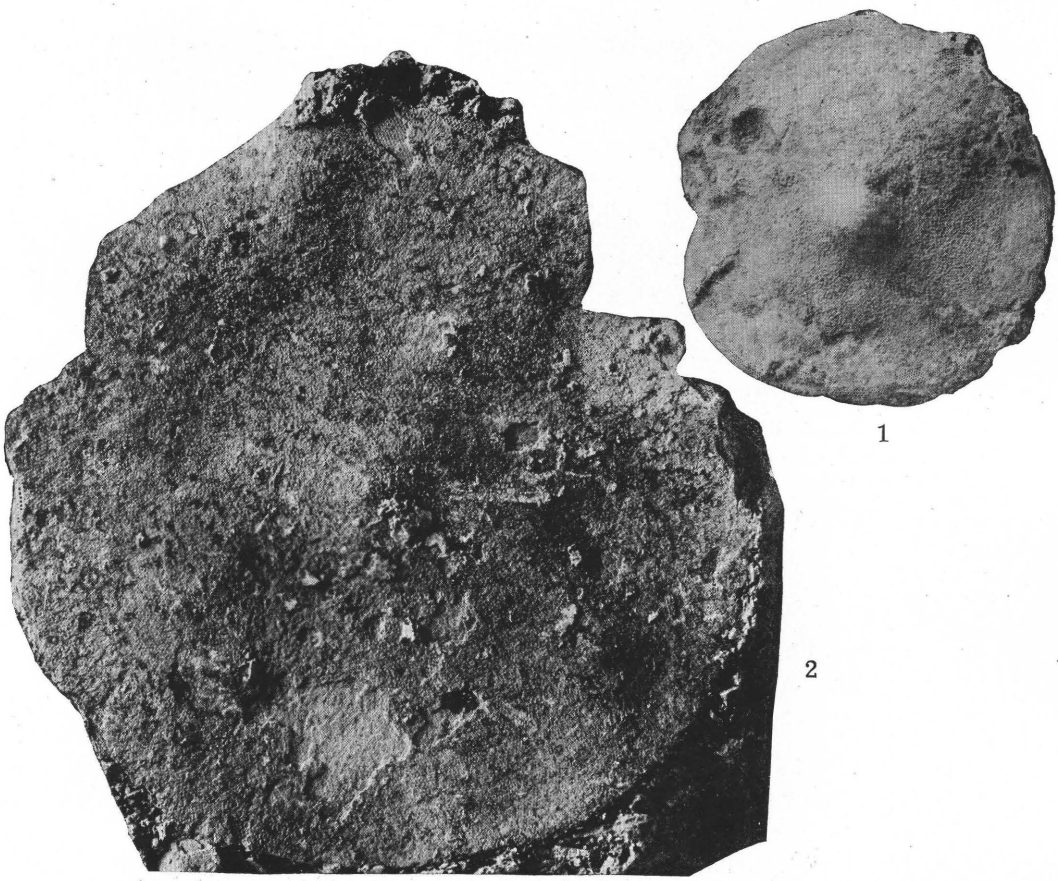
AMERICAN SPECIES OF LEPIDOCYCLINA.



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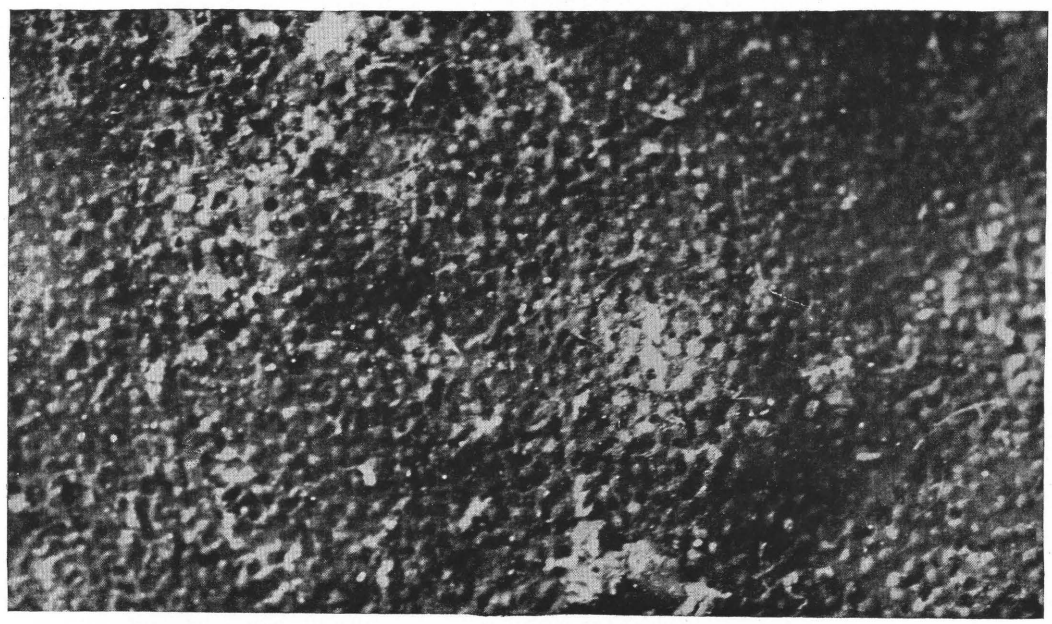

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AMERICAN SPECIES OF LEPIDOCYCLINA.

PLATE XVII.

Lepidocyclina georgiana Cushman, n. sp. (p. 60).

FIGURE 1. Surface view of megalospheric specimen, × 2. Higher umbo than in larger microspheric specimen (fig. 2). Ocala limestone, east bank of Flint River 6 miles above Bainbridge, Ga. (U. S. G. S. 7130).

FIGURE 2. Surface view of microspheric specimen, × 2. Ocala limestone.

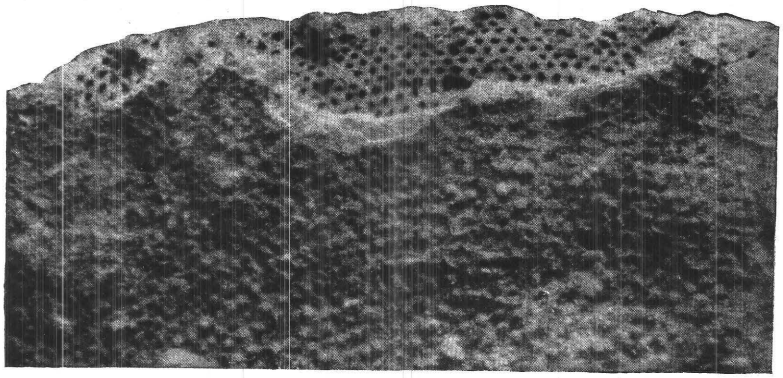
FIGURE 3. Surface details of umbonal portion, × 10. Ends of pillars appear as pustule-like projections. Ocala limestone, Red Bluff, on Flint River 7 miles above Bainbridge, Ga. (U. S. G. S. station 3387).

PLATE XVIII.

Lepidocyclina georgiana Cushman, n. sp. (p. 60).

FIGURE 1. Peripheral portion of specimen showing the surface ornamentation and near the edge the section of the equatorial chambers, × 10. Flint River, Bainbridge, Ga. (U. S. G. S. station 6161).

FIGURE 2. Very large specimen, exterior, × 2, showing the umbo and in places the equatorial chambers. Ocala limestone at Red Bluff, on Flint River 7 miles above Bainbridge, Ga. (U. S. G. S. station 3387).



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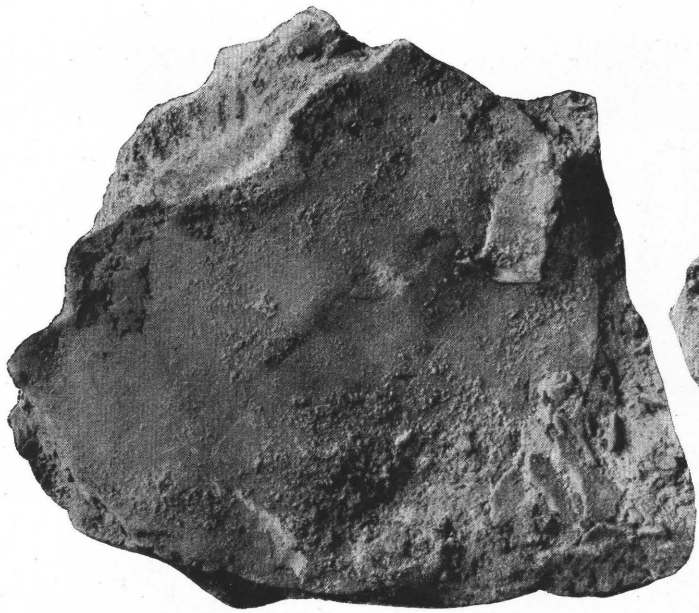
AMERICAN SPECIES OF LEPIDOCYCLINA.



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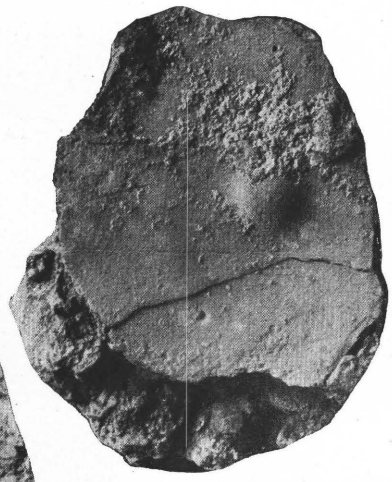

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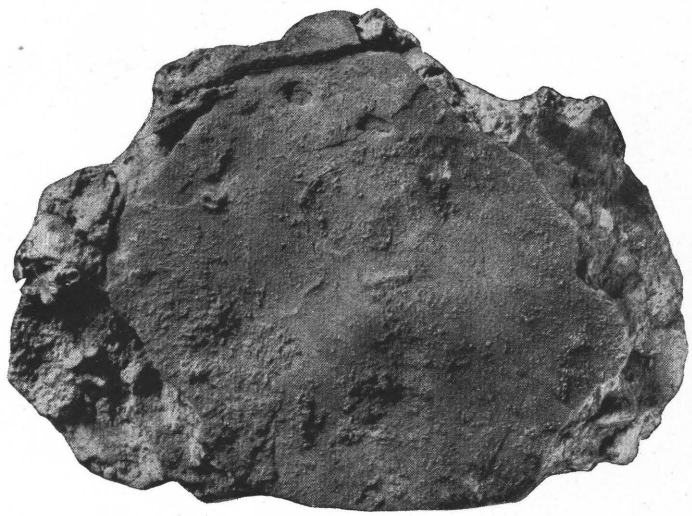

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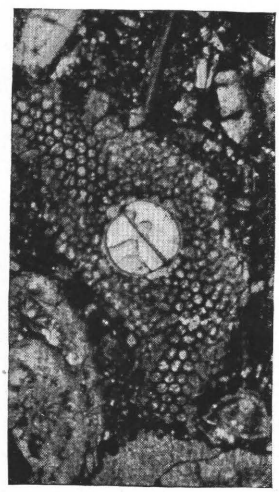

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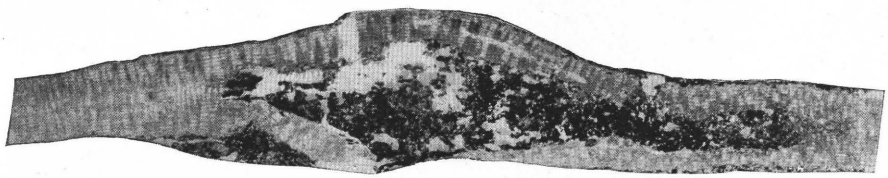

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AMERICAN SPECIES OF LEPIDOCYCLINA.

PLATE XIX.

Lepidocyclina gigas Cushman (p. 63).

FIGURES 1, 2. Surface views of microspheric specimens, with the umbonal portion not greatly raised, natural size. Lower bed, Hodges Bluff, Antigua, Leeward Islands (U. S. G. S. station 6862).

FIGURE 3. Surface view of megalospheric specimen with prominent umbo, natural size. Same locality as figures 1, 2.

FIGURE 4. Section showing the subequal embryonic chambers and the hexagonal equatorial chambers, × 20. Rifle Butts, Antigua, Leeward Islands (U. S. G. S. station 6854).

Lepidocyclina gigas var. mexicana Cushman, n. var. (p. 63).

FIGURE 5. Transverse section, × 5. Meson formation, Meson, Vera Cruz, Mexico.

PLATE XX.

Lepidocyclina gigas var. mexicana Cushman, n. var. (p. 63).

FIGURE 1. Surface view of type specimen, × 2. Meson formation, Meson, Vera Cruz, Mexico.
FIGURE 2. Surface view of portion of same specimen, × 15, showing pitted, reticulate pattern produced by the erosion of the surface.

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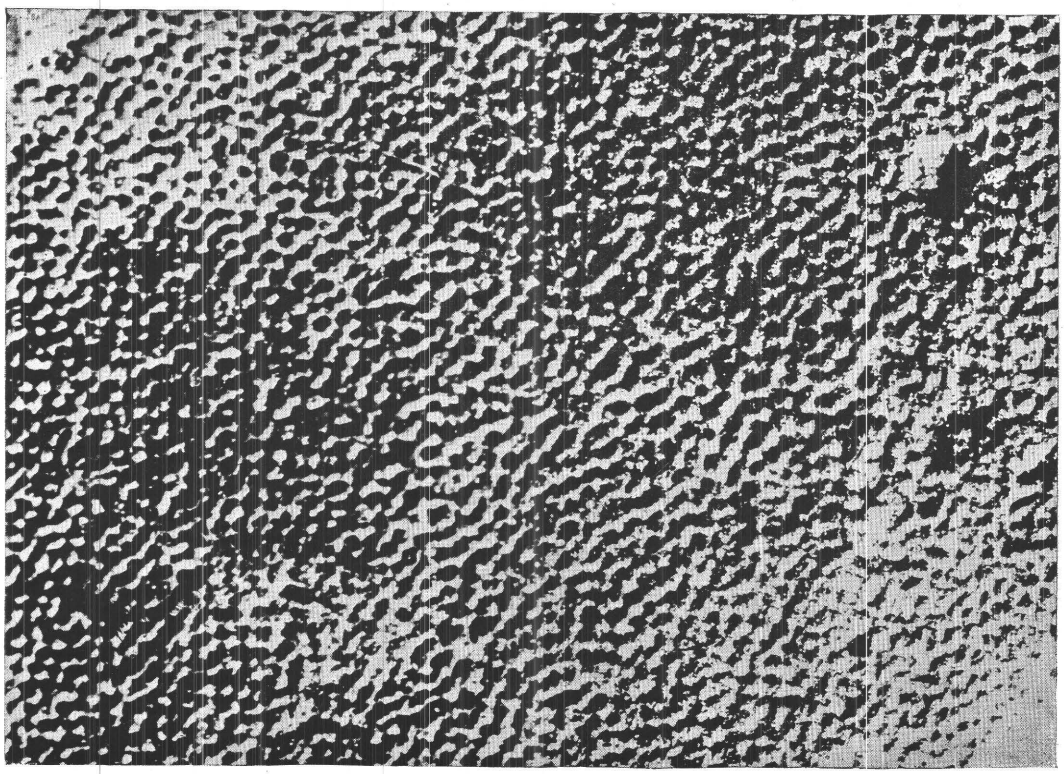

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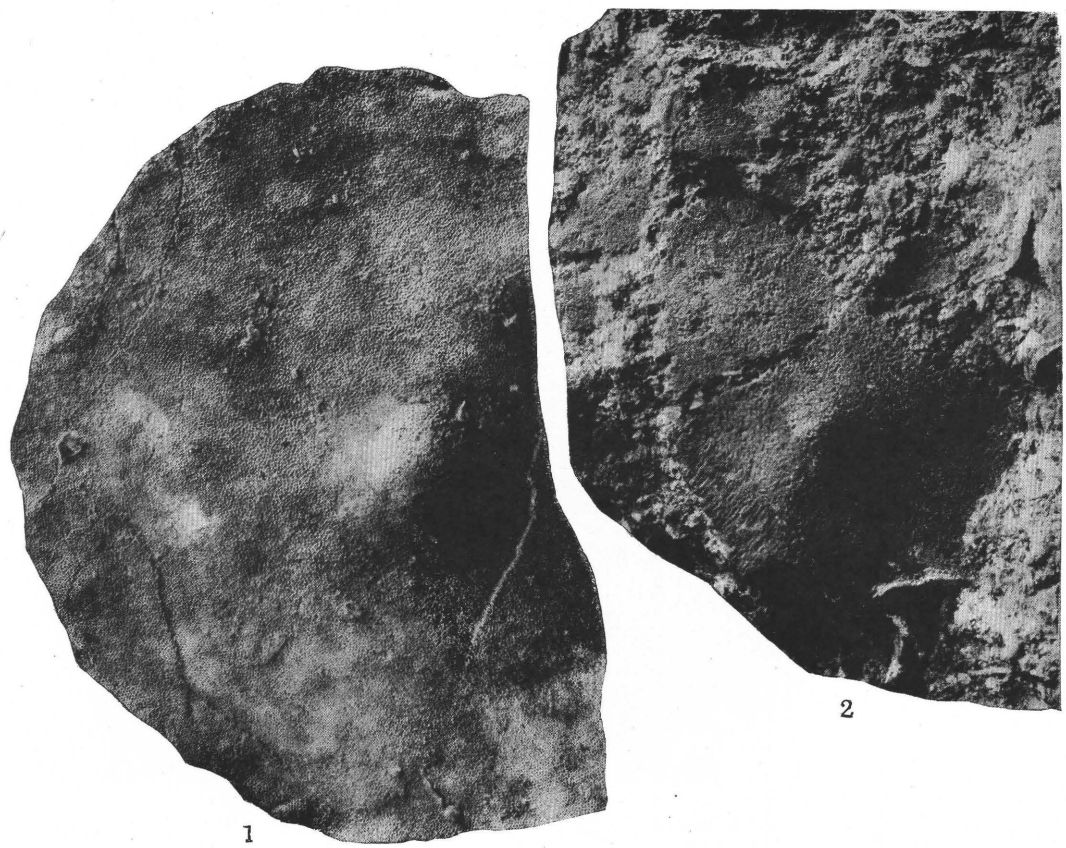
AMERICAN SPECIES OF LEPIDOCYCLINA.



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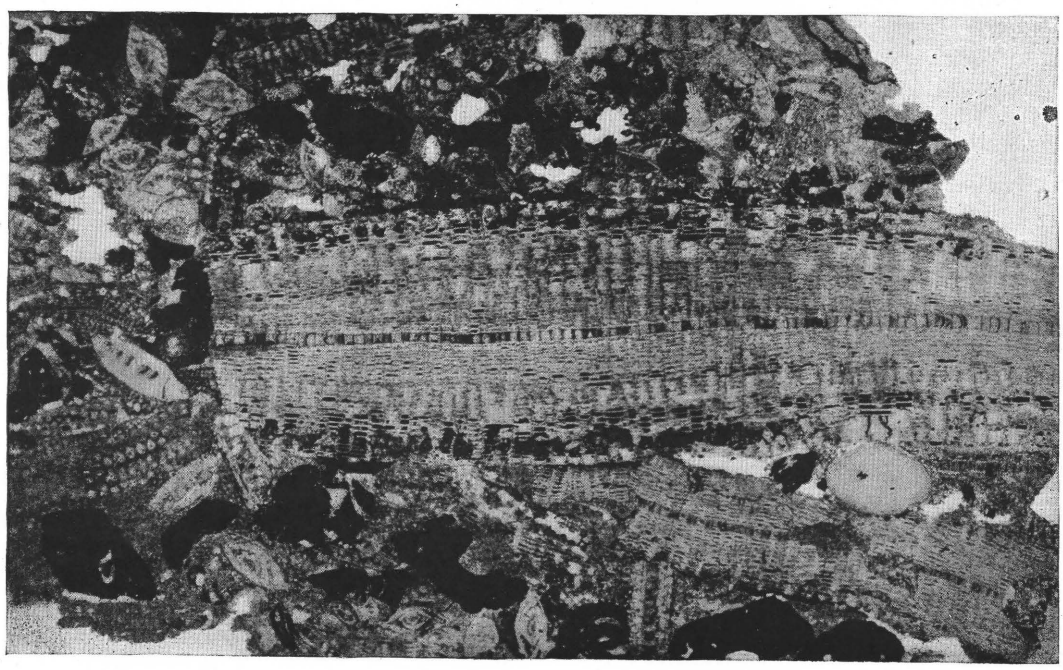

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AMERICAN SPECIES OF LEPIDOCYCLINA.

PLATE XXI.

Lepidocyclina gigas var. mexicana Cushman, n. var. (p. 63).

FIGURE 1. Surface view, × 2. Meson formation, Meson, Vera Cruz, Mexico.
FIGURE 2. Surface view, × 2. San Rafael formation, Topila Hills, near Tampico, Mexico.
FIGURE 3. Vertical sections, × 10. San Rafael formation, Cerro Cortado, Topila Hills, Mexico.

PLATE XXII.

Lepidocyclina fragilis Cushman, n. sp. (p. 63).

FIGURE 1. Surface view, × 5. Ocala limestone at mouth of cavern, 200 yards southwest of wagon bridge over Chipola River east of Marianna, Fla. (U. S. G. S. station 7195).

FIGURE 2. Surface view of portion of specimen, × 10. Ocala limestone, left bank of Suwannee River above bridge of Florida Railway, Suwannee County, Fla. (U. S. G. S. station 7337).

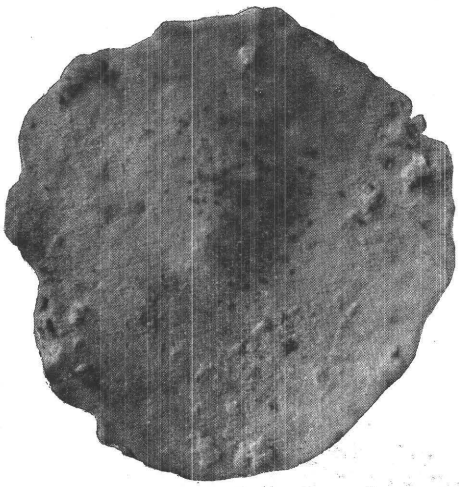
Lepidocyclina chaperi Lemoine and R. Douvillé (p. 64).

FIGURE 3. Surface view, × 5. Upper part of Culebra formation, Panama Railroad, southern switch, Bohio Ridge, Panama (U. S. G. S. station 6025).

FIGURE 4. Portion of horizontal section, showing early chambers of the microspheric form, × 20. West side of Gaillard Cut near Las Cascadas, Panama (U. S. G. S. station 6019*f*).

Lepidocyclina vaughani Cushman (p. 64).

FIGURE 5. Specimen showing equatorial chambers and umbo, × 10. Emperador limestone in cuttings of the Panama Railroad near Caimito Junction, Panama (U. S. G. S. station 6021).



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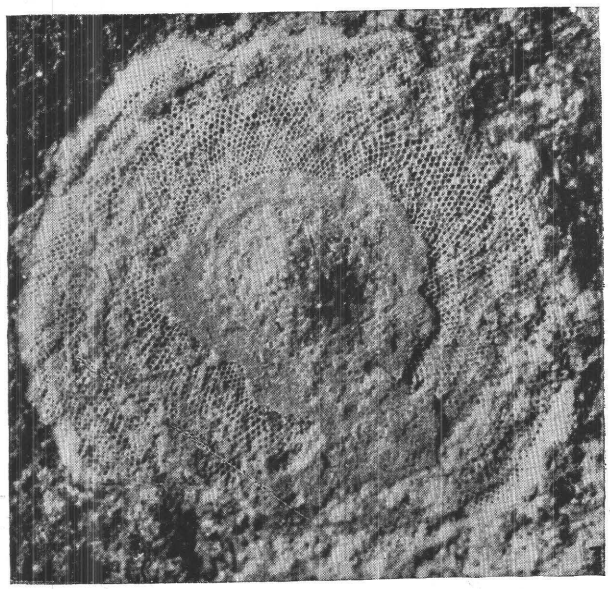

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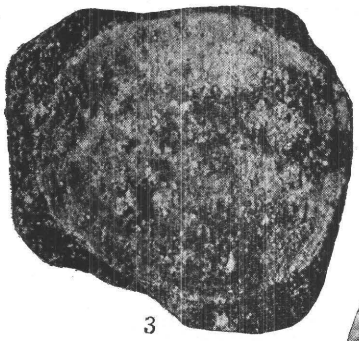

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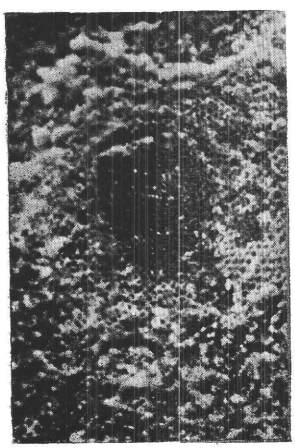

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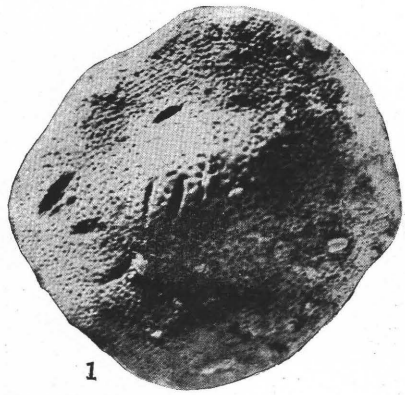
AMERICAN SPECIES OF LEPIDOCYCLINA.



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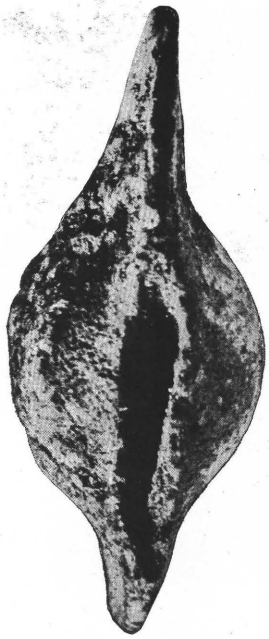

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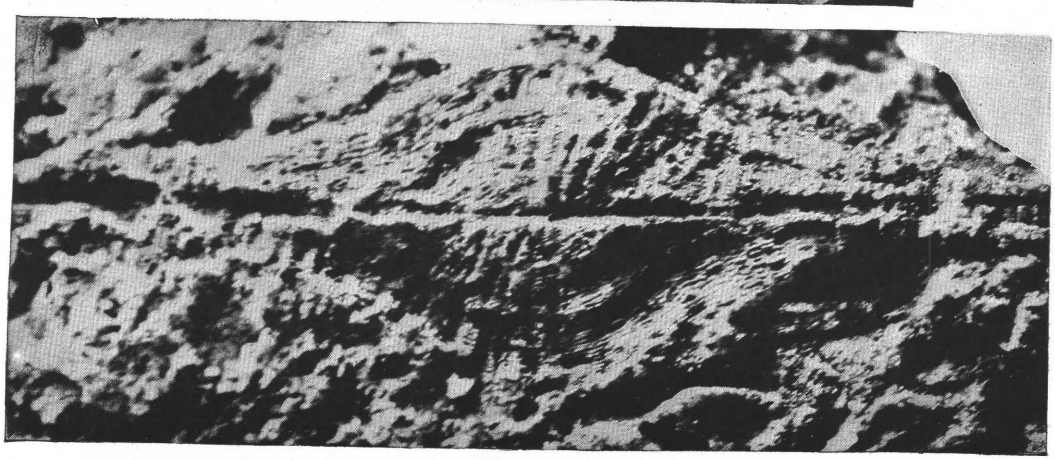

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AMERICAN SPECIES OF LEPIDOCYCLINA.

PLATE XXIII.

Lepidocyclina chattahoocheënsis Cushman, n. sp. (p. 65).

FIGURE 1. Surface view, × 5. Five miles south of Jackson, Ala. (U. S. G. S. station 3647).

FIGURE 2. Surface view of central portion of same specimen, showing the pitted umbonal region, × 10.

FIGURE 3. Edge view of weathered specimen, × 5. Old factory about 1½ miles above Bainbridge, Ga. (U. S. G. S. station 3397).

FIGURE 4. Vertical section of weathered specimen, × 10. Chattahoochee formation at Cato Glenn's well, 4¾ miles southeast of Bainbridge, Ga.

PLATE XXIV.

Lepidocyclina chattahoocheënsis Cushman, n. sp. (p. 65).

FIGURE 1. Surface view, × 5. Chattahoochee formation, Red Bluff on Flint River, 7 miles above Bainbridge, Ga. upper fossiliferous horizon (U. S. G. S. station 3388).

FIGURE 2. Central portion of same specimen, × 10.

Lepidocyclina pseudocarinata Cushman, n. sp. (p. 66).

FIGURE 3. Surface view, × 5. Ocala limestone, left bank of Suwannee River at Branford, Suwannee County, Fla. (U. S. G. S. station 7341).

FIGURE 4. Surface view of type specimen, × 5. Ocala limestone, Cummer Lumber Co.'s phosphate plant No. 6, 1¼ miles south of Newberry, Fla. (U. S. G. S. station 6812).

Lepidocyclina cookei Cushman, n. sp. (p. 66).

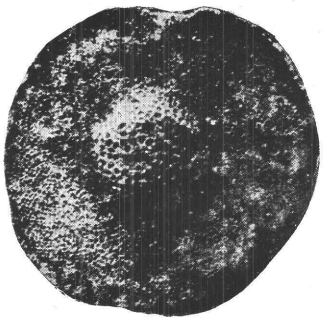
FIGURE 5. Surface view of type specimen, × 5. Ocala limestone (U. S. G. S. station 6812).

FIGURE 6. Central portion of same specimen, × 10.

Lepidocyclina attenuata Cushman, n. sp. (p. 67).

FIGURE 7. Surface view, × 2. Ocala limestone, Richards quarry, Ocala, Fla.

FIGURE 8. Surface view of type specimen, × 5. Ocala limestone, quarry of Franklin Phosphate Co., 1½ miles northwest of Newberry, Alachua County, Fla. (U. S. G. S. station 6814).



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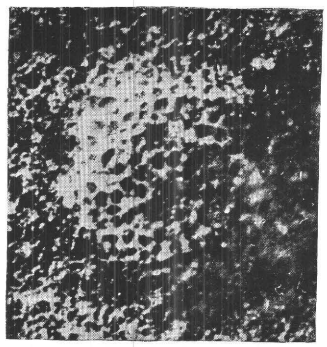

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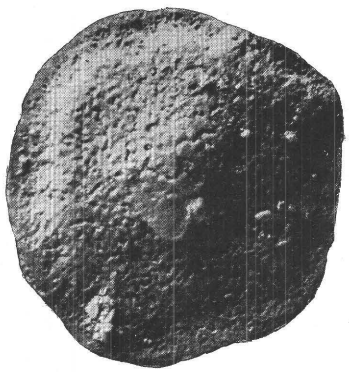

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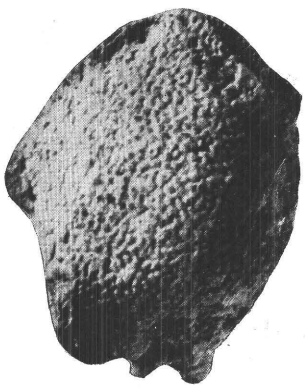

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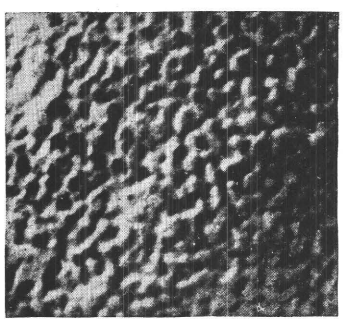

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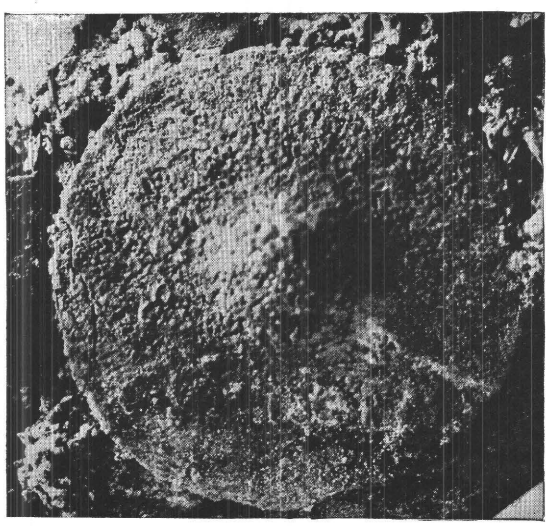

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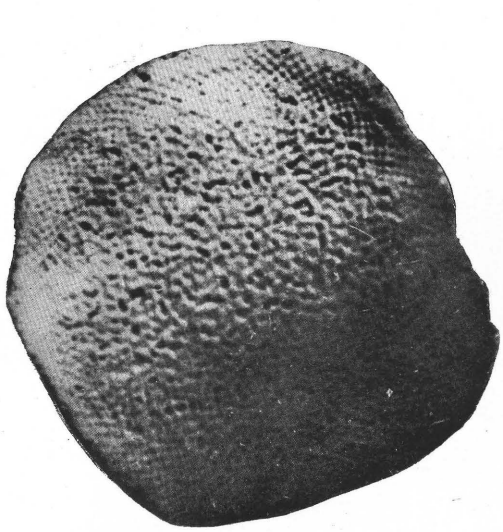
AMERICAN SPECIES OF LEPIDOCYCLINA.



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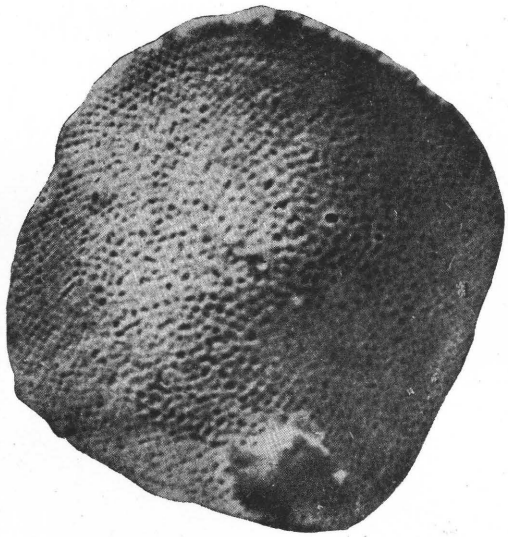

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AMERICAN SPECIES OF LEPIDOCYCLINA.

PLATE XXV.

Lepidocyclina floridana Cushman, n. sp. (p. 67).

FIGURE 1. Surface view of type specimen, × 10, showing reticulate surface without pillars and strong saddle shape. Ocala limestone, quarry one-eighth mile southeast of Martins Station, 9 miles north of Ocala, Fla. (U. S. G. S. station 6808).

FIGURE 2. Surface view of similar specimen, × 10, from same locality.

Lepidocyclina undosa Cushman (p. 68).

FIGURE 3. Rock specimen largely composed of *Lepidocyclina undosa*, from Long Island, Antigua, Leeward Islands (U. S. G. S. station 6869).

PLATE XXVI.

Lepidocyclina perundosa Cushman (p. 68).

FIGURE 1. Section through the embryonic chamber and portions of two sides of the saddle-shaped test, × 10. Nuevitas, Cuba (U. S. G. S. station 3478).

Lepidocyclina pseudomarginata Cushman, n. sp. (p. 69).

FIGURE 2. Surface view of young specimen with the peripheral portion not greatly developed, × 5. Ocala limestone, Suwannee River at Dowling Springs, Suwannee County, Fla. (U. S. G. S. station 7338).

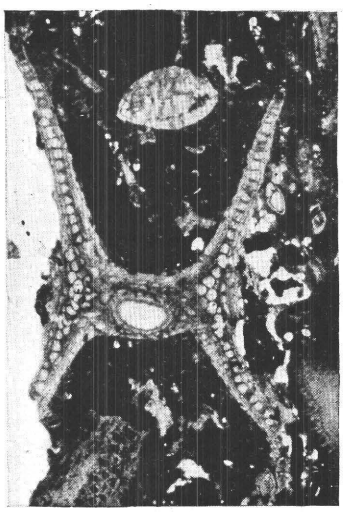
FIGURE 3. Surface view of type specimen, × 5. Ocala limestone, Archer, Fla. (U. S. G. S. station 3683).

FIGURE 4. Central portion of same specimen, × 10.

Lepidocyclina supera (Conrad) H. Douvillé (p. 69).

FIGURE 5. Surface view, × 2. Byram marl, bluff just above the second sawmill on the river, horizon No. 2 from the top, Vicksburg, Miss. (U. S. G. S. station 3722).

FIGURES 6, 7. Aberrant specimens, × 2. Byram calcareous marl, west bank of Pearl River, Byram, Hinds County, Miss. (U. S. G. S. station 5623).



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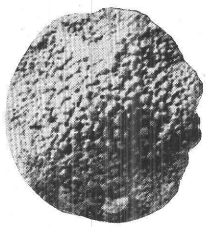

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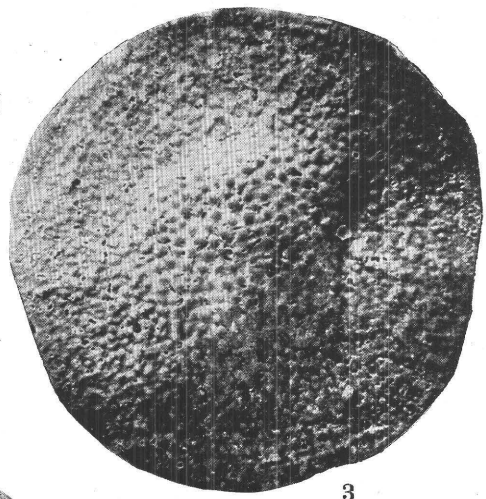

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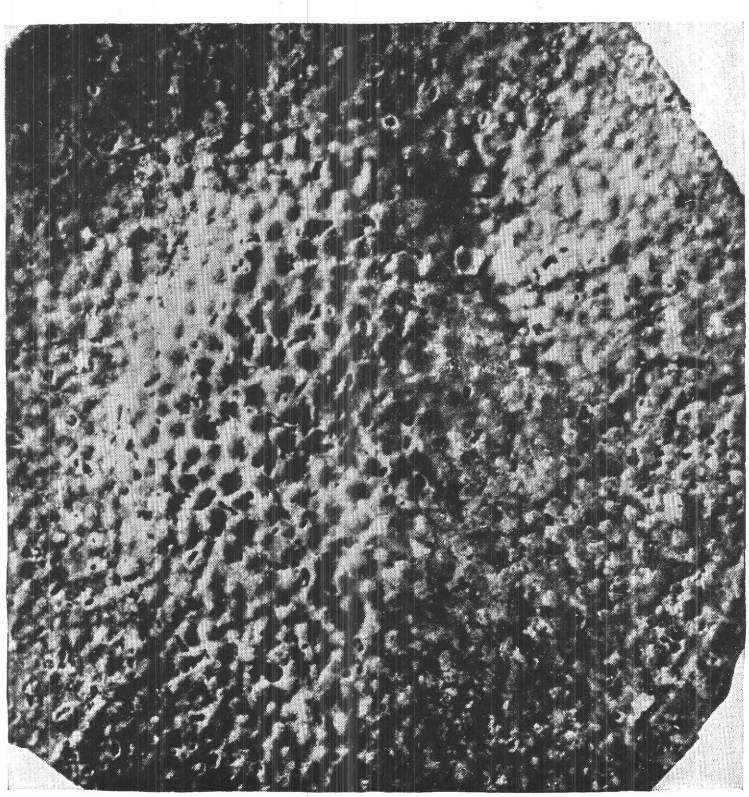

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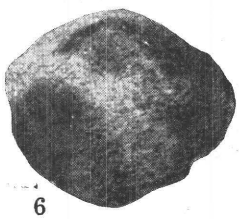

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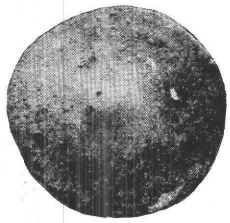

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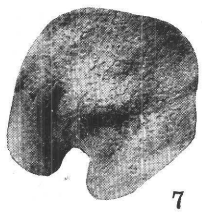

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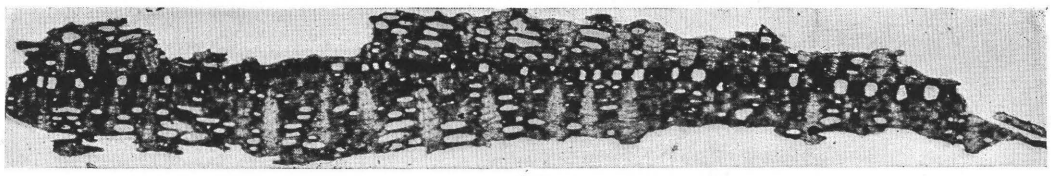
AMERICAN SPECIES OF LEPIDOCYCLINA.



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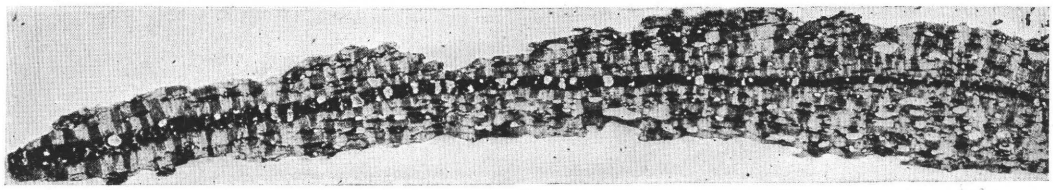

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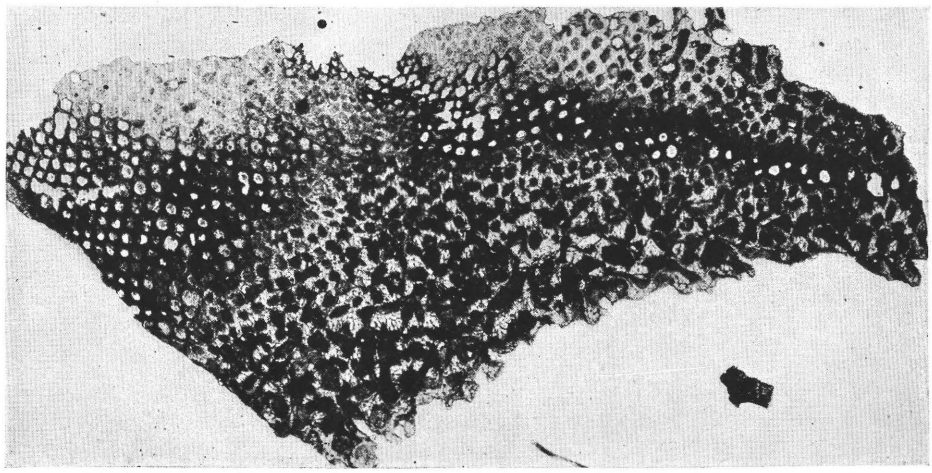

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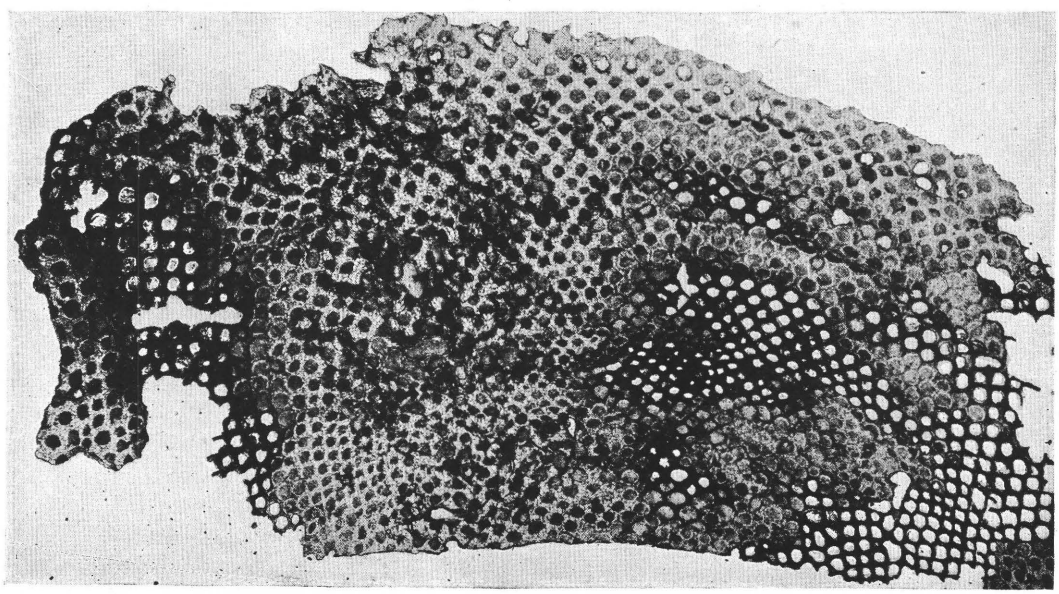

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AMERICAN SPECIES OF LEPIDOCYCLINA.

PLATE XXVII.

Lepidocyclina mortoni Cushman, n. sp. (p. 70).

FIGURE 1. Vertical section, × 20, showing the numerous large, wedge-shaped pillars.
FIGURE 2. Vertical section, × 15, showing the very heavy walls and the comparatively small chamber spaces.
FIGURE 3. Oblique section, × 20, showing the relative arrangement of pillars and chambers.
FIGURE 4. Horizontal section, × 20, showing the equatorial chambers.

All specimens from bluff at Montgomery, Grant Parish, La. (U. S. G. S. station 4270).

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PLATE XXVIII.

Lepidocyclina mortoni Cushman, n. sp. (p. 70).

FIGURE 1. Enlarged surface view, × 10, showing the surface distribution of the ends of the pillars. Bluff at Montgomery, Grant Parish, La. (U. S. G. S. station 4270).

FIGURE 2. Surface view of same specimen, × 2.

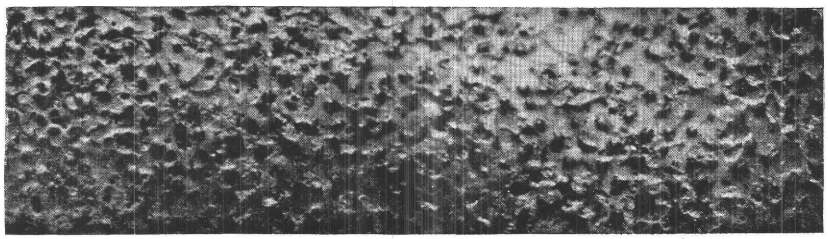
Lepidocyclina ocalana Cushman, n. sp. (p. 71).

FIGURE 3. Surface view of type specimen, × 2. Ocala limestone, quarry No. 1, Florida Lime Co., Ocala, Fla. (U. S. G. S. station 6804).

FIGURE 4. Portion of the surface of another specimen, × 10. Johnson's lime sink, Levy County, Fla. (U. S. G. S. station 365).

Lepidocyclina ocalana var. subdecorata Cushman, n. var. (p. 72).

FIGURE 5. Surface view of type specimen, × 2. Johnson's lime sink, Levy County, Fla. (U. S. G. S. station 365).



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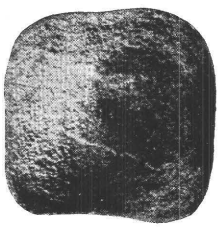

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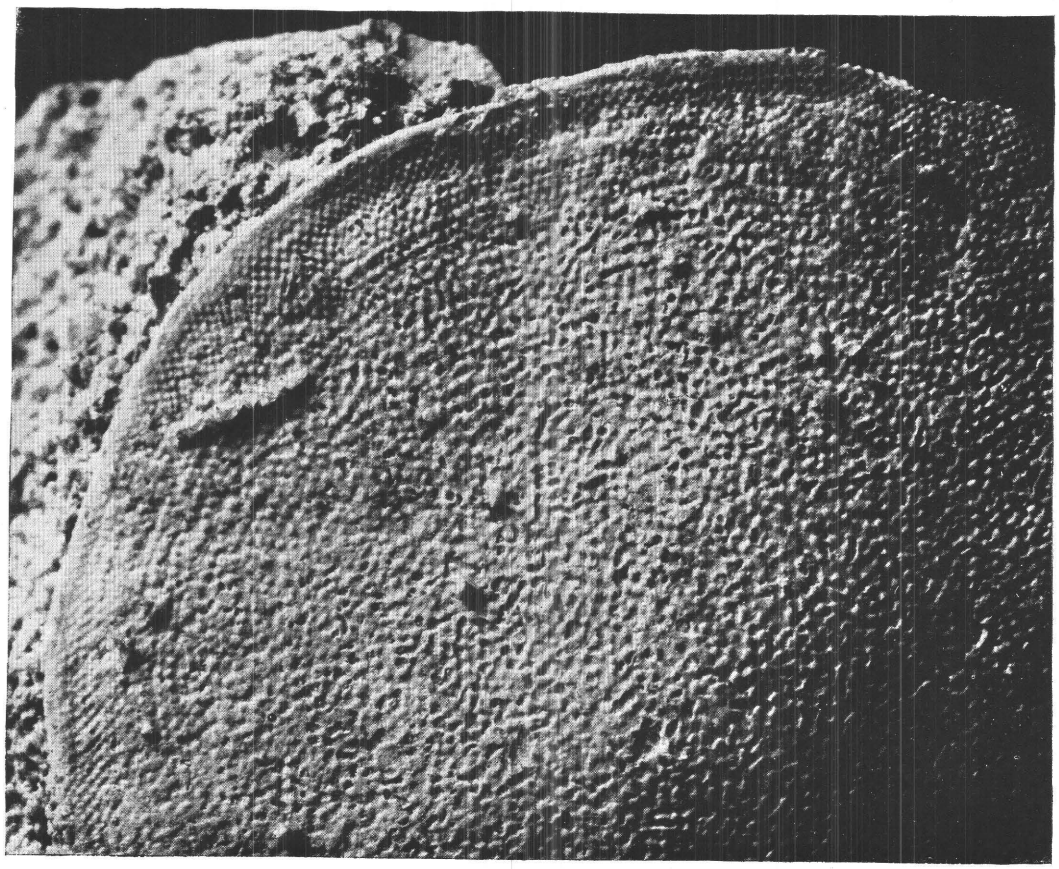

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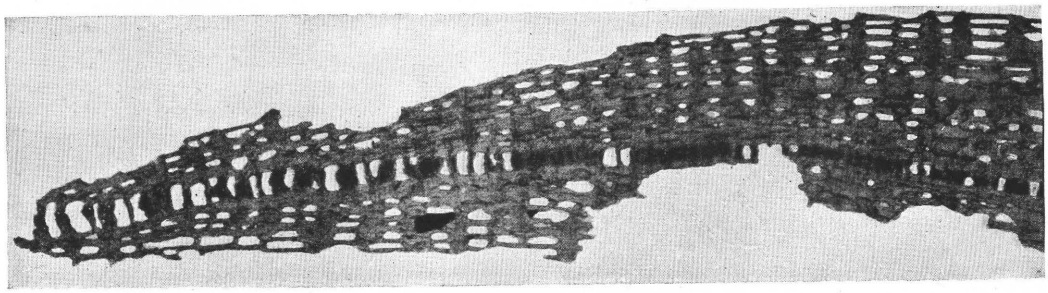
AMERICAN SPECIES OF LEPIDOCYCLINA.



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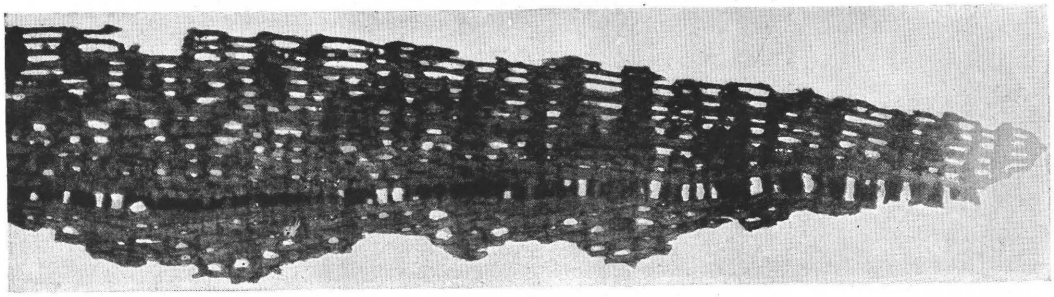

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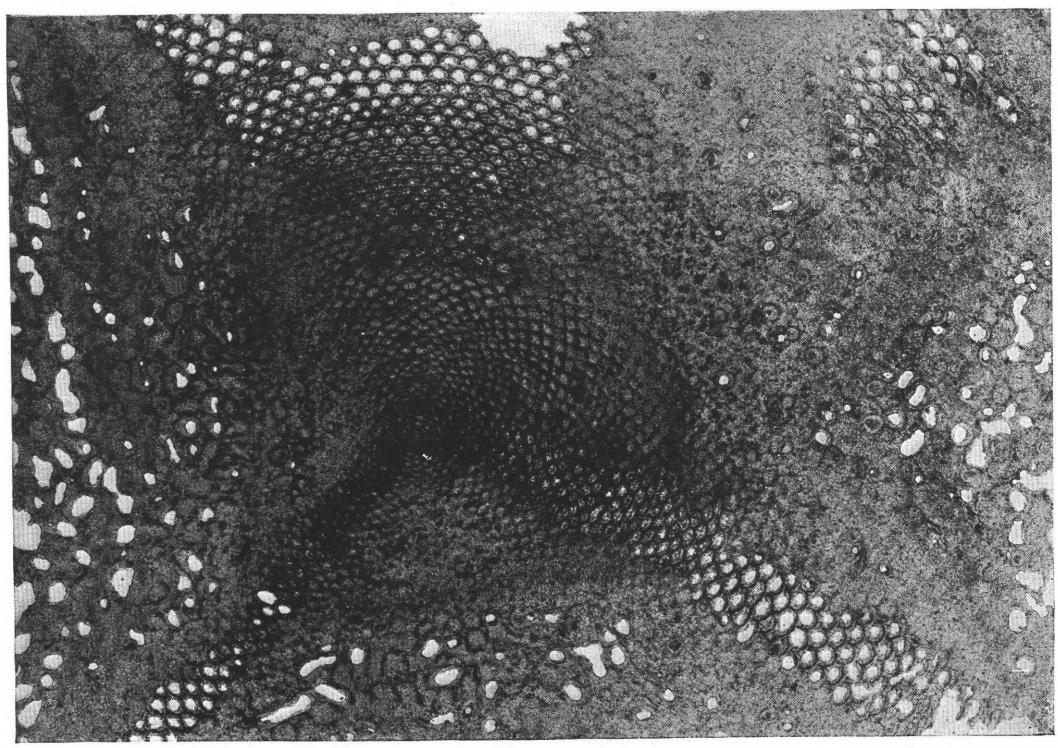

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AMERICAN SPECIES OF LEPIDOCYCLINA.

PLATE XXIX.

Lepidocyclina ocalana Cushman, n. sp. (p. 71).

FIGURE 1. Vertical section, × 20. Ocala limestone, plant No. 3, Florida Lime Co., 6½ miles north of Ocala, at Zuber post office, Marion County, Fla. (U. S. G. S. station 6807).

FIGURE 2. Opposite half of same section.

FIGURE 3. Horizontal section, × 20, of microspheric form of the species from same locality.

PLATE XXX.

Lepidocyclina subraulinii Cushman (p. 73).

FIGURE 1. Surface view of type specimen, × 5. Nuevitas, Cuba (U. S. G. S. station 3478).

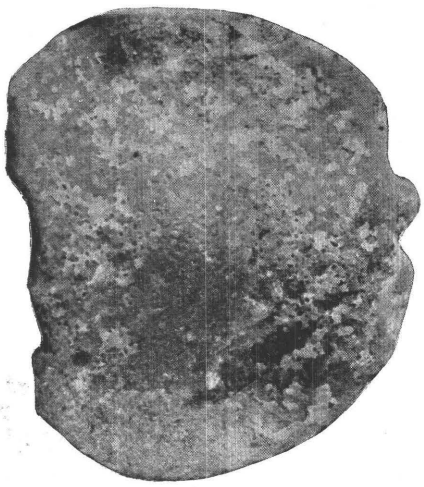
FIGURE 2. Slightly oblique section, showing a few of the equatorial chambers and the pillars and lateral chambers, ×20 Limestone at Sierra Guaso, Cuba (U. S. G. S. station 7666).

FIGURE 3. Portion of vertical section, × 20, showing equatorial and lateral chambers and the numerous pillars. Same locality as figure 2.

FIGURE 4. Portion of vertical section, × 15. Meson formation, San Jose de las Rusias, Mexico.

FIGURE 5. Larger portion of same specimen, × 10.

FIGURE 6. A few of the outer chambers in vertical section × 20, showing the perforations in the peripheral wall of the equatorial chambers. Same locality as figure 4.



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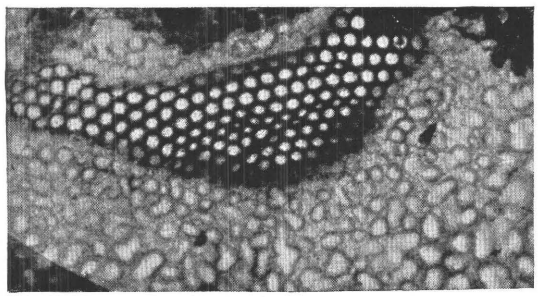

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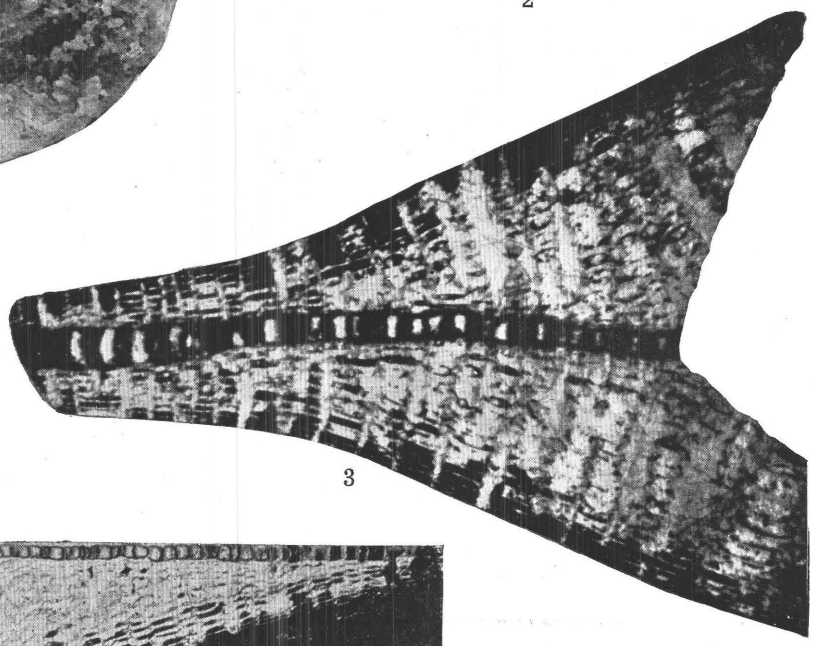

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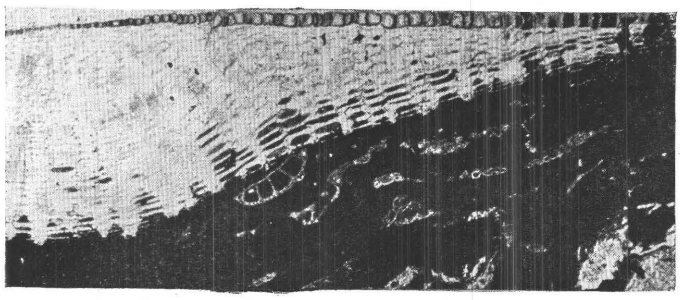

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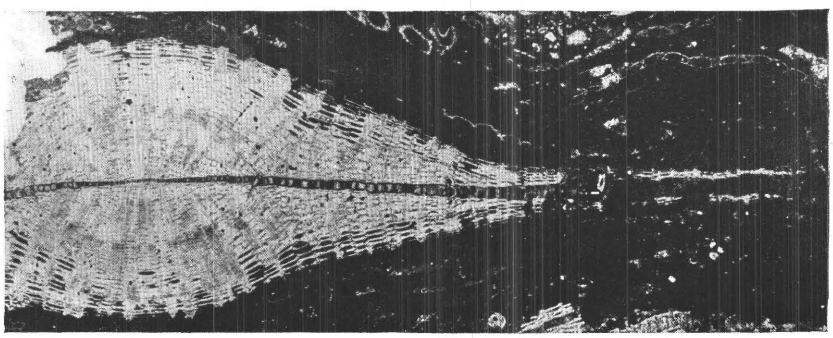

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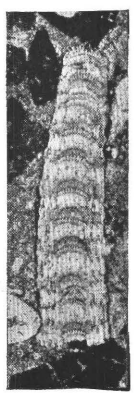

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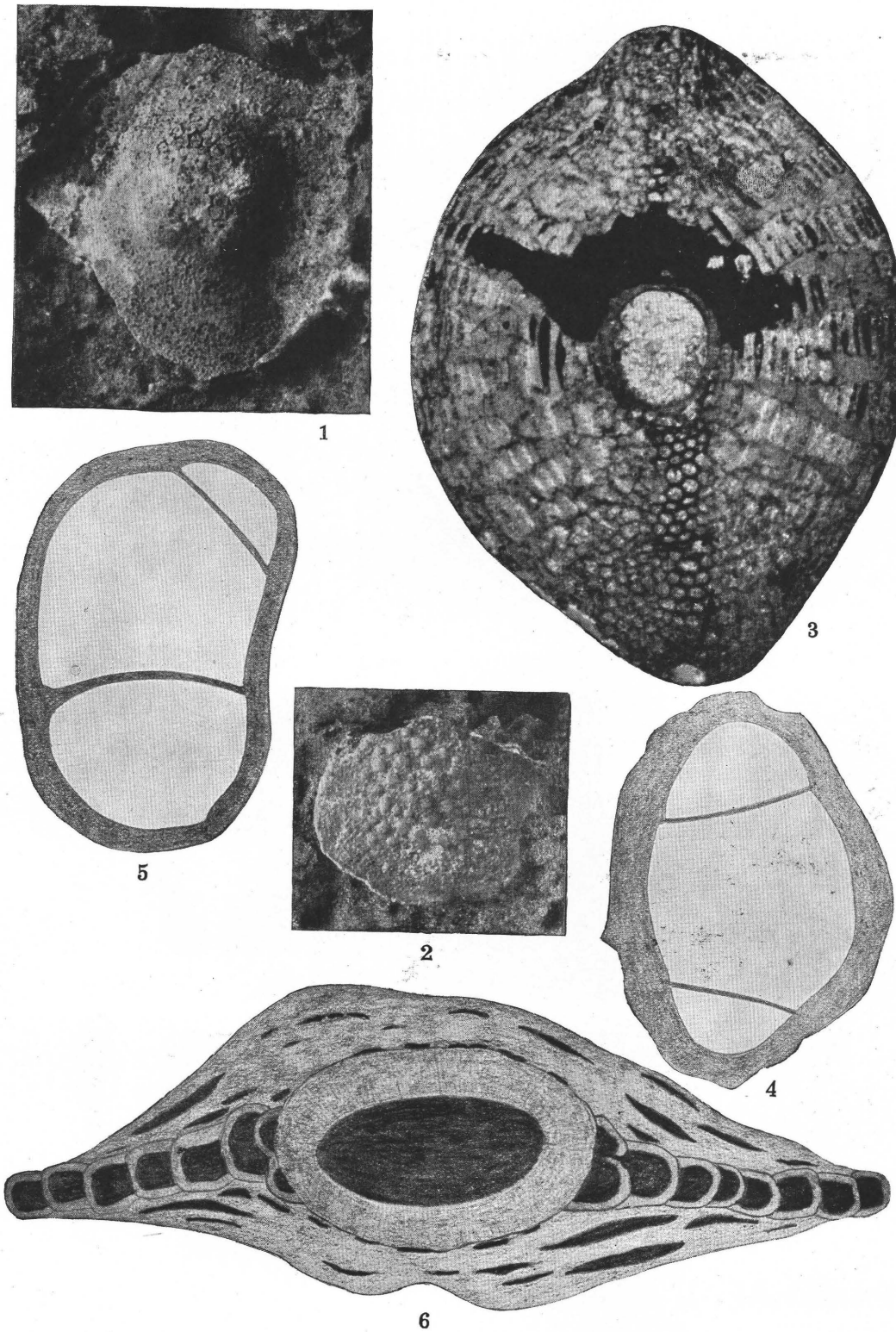
AMERICAN SPECIES OF LEPIDOCYCLINA.



AMERICAN SPECIES OF LEPIDOCYCLINA.

PLATE XXXI.

Lepidocyclina marginata (Michelotti) Lemoine and R. Douvillé (p. 73).

FIGURE 1. Surface view of specimen, × 5. Limestone on south side of Los Melones Mountain, near west end, near Guantanamo, Cuba (U. S. G. S. station 7518).

FIGURE 2. Surface view of smaller specimen, × 5, from same locality.

Lepidocyclina crassata Cushman (p. 74).

FIGURE 3. Oblique section, × 20. Orbitoidal limestone outcrop where Palmer trail joins Ocujal trail, near Guantanamo, Cuba (U. S. G. S. station 7513).

FIGURES 4, 5. Embryonic chambers, showing the thick wall and thinner ones of the subdivisions, × 60. Sections of limestone from drift near top of landslide next north of Los Melones, Cuba (U. S. G. S. station 7519).

FIGURE 6. Vertical section of young specimen, × 40, from same locality.

PLATE XXXII.

Lepidocyclina canellei Lemoine and R. Douvillé (p. 75).

FIGURE 1. View of exterior, × 10. Bohio, Panama (U. S. N. M. catalogue No. 135216).

FIGURE 2. Horizontal section, × 20, showing hexagonal equatorial chambers and irregularities in the annuli due to repairs by the animal of breakage in the test. West side of Gaillard Cut near Las Cascadas, Panama (U. S. G. S. station 6019*a*).

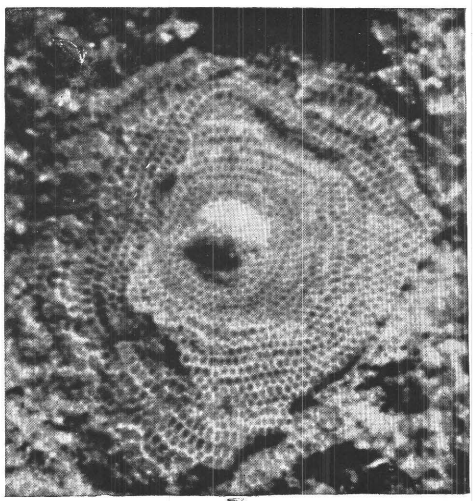
FIGURES 3, 4. Vertical sections, in figure 3, through the embryonic chambers, shown in figure 4, at one side. Bohio, Panama.

FIGURE 5. Slightly oblique section, × 20, showing narrow zone of equatorial chambers and two broader zones of lateral chambers, the latter without pillars. Bohio, Panama.

Lepidocyclina canellei var. yurnagunensis Cushman (p. 76).

FIGURE 6. Slightly oblique section, × 20, showing the embryonic chambers (*Pliolepidina* of Douvillé). Flexure 2 miles south of Yurnaguna, Cuba (U. S. G. S. station 7548).

FIGURE 7. Section of limestone, × 20, showing abundance of specimens of this variety. Same locality as figure 6.



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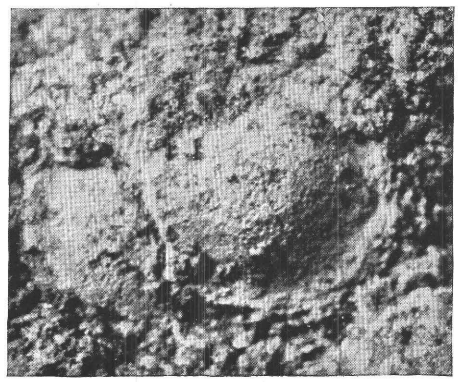

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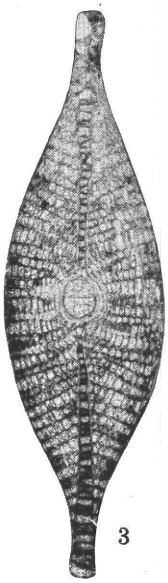

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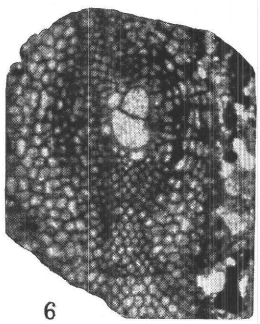

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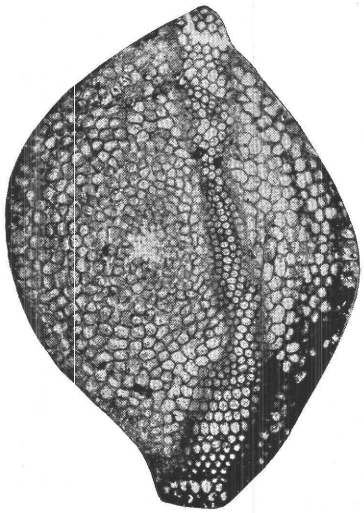

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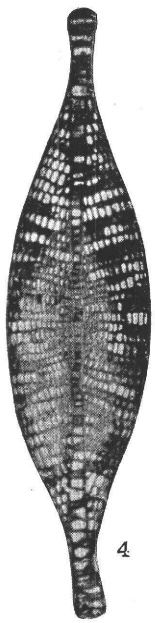

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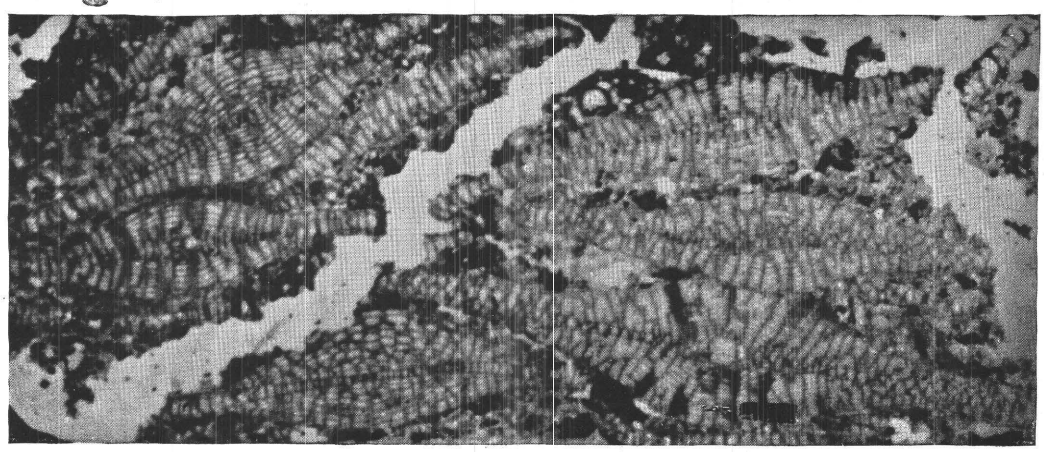

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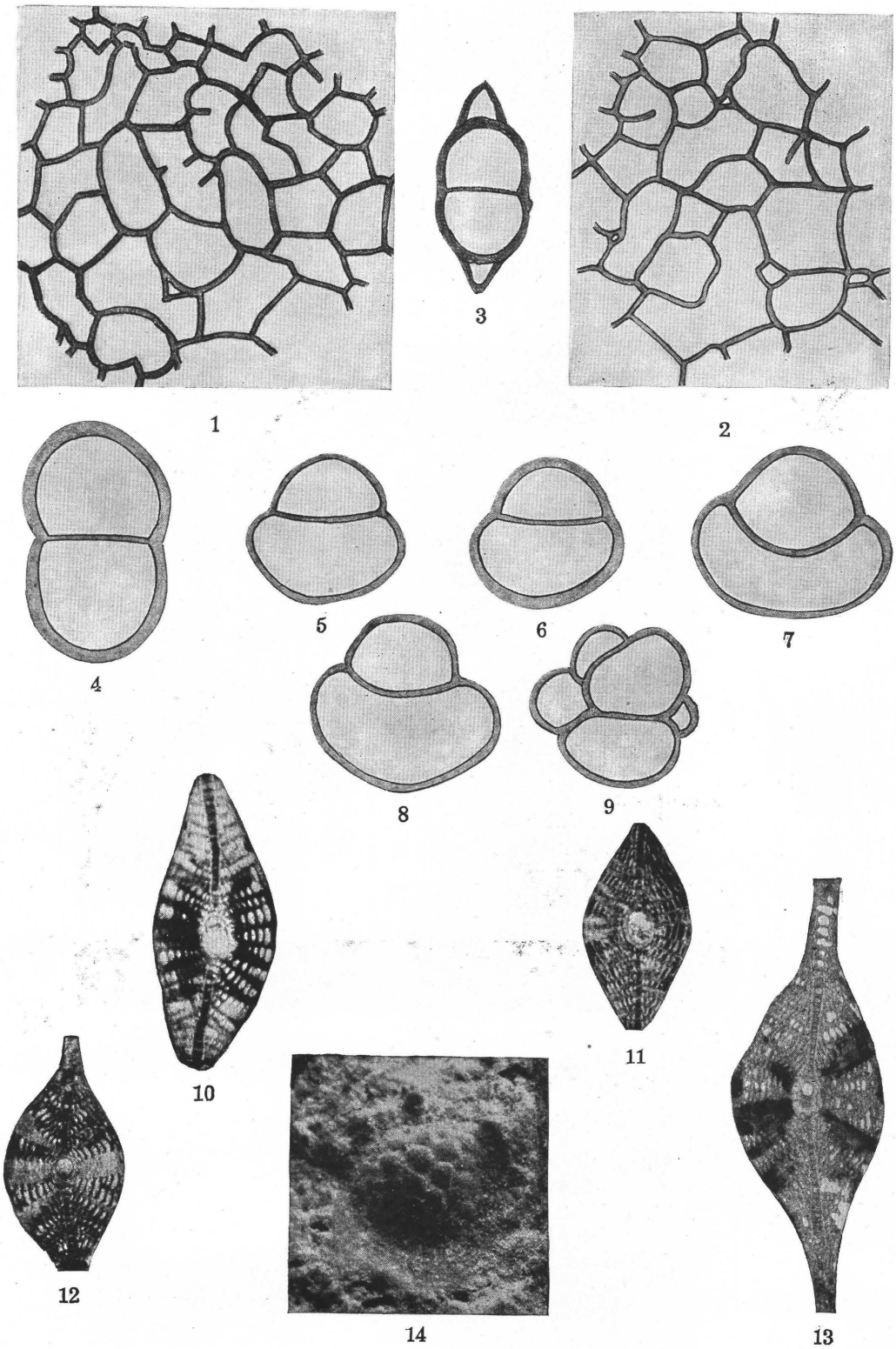
AMERICAN SPECIES OF LEPIDOCYCLINA.



AMERICAN SPECIES OF LEPIDOCYCLINA.

PLATE XXXIII.

Lepidocyclina canellei var. yurnagunensis Cushman, n. var. (p. 76).

FIGURE 1. Lateral chambers, × 85. Type locality, flexure 2 miles south of Yurnaguna, Cuba (U. S. G. S. station 7548).
FIGURE 2. Lateral chambers, × 85, closely resembling those of this variety (fig. 1). Hodges Bluff, Antigua, Leeward Islands (U. S. G. S. station 6862).
FIGURE 3. Embryonic chambers with the early equatorial chambers, × 85. Type locality (U. S. G. S. station 7548).
FIGURE 4. Embryonic chambers, × 85 (*Isolepidina* form of Douvillé). Type locality.
FIGURE 5. Embryonic chambers, × 85 (*Nephrolepidina* form of Douvillé). Type locality.
FIGURE 6. Similar chambers, × 85. Limestone from east side of Yateras River, Cuba (U. S. G. S. station 7543).
FIGURE 7. Similar chambers, × 85. Rifle Butts, Antigua, Leeward Islands (U. S. G. S. station 6854).
FIGURE 8. Similar chambers, × 85. Hodges Bluff, Antigua (U. S. G. S. station 6862).
FIGURE 9. Embryonic chambers, × 85 (*Pliolepidina* form of Douvillé). Limestone on east side of Yateras River, Cuba (U. S. G. S. station 7543).

Lepidocyclina sumatrensis (H. B. Brady) Jones and Chapman (p. 76).

FIGURES 10, 11. Vertical sections, × 20. Limestone at west end of Los Melones Mountain, Cuba (U. S. G. S. station 7516).

Lepidocyclina morgani Lemoine and R. Douvillé (p. 74).

FIGURE 12. Surface view, × 8. North slope of La Piedra, northeast of Guantanamo, Cuba (U. S. G. S. station 7664).
FIGURE 13. Vertical section, × 20. Same locality as figure 12.
FIGURE 14. Portion of vertical section, × 20. Limestone on east side of Yateras River, Cuba (U. S. G. S. station 7543).

PLATE XXXIV.

Lepidocyclina macdonaldi Cushman (p. 77).

FIGURE 1. Exterior view, × 10, showing pillars appearing at the surface as raised areas. Limestone 2 miles north of David, Panama (U. S. G. S. station 6523).

FIGURE 2. Vertical section, × 20, showing embryonic chambers. Same locality as figure 1.

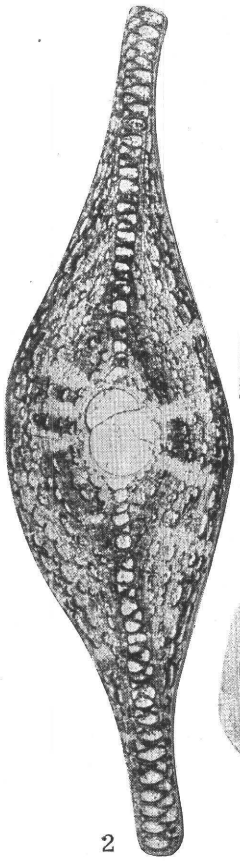
FIGURE 3. Oblique section, × 20, showing equatorial and lateral chambers with pillars. Same locality.

Lepidocyclina panamensis Cushman (p. 77).

FIGURE 4. Embryonic chambers of megalospheric form showing spiral indications, × 85. Limestone 2 miles north of David, Panama (U. S. G. S. station 6523).

FIGURE 5. Vertical section of megalospheric embryonic chambers, × 85. Near mouth of Tonosi River, Panama (U. S. G. S. station 6586*e*).

FIGURE 6. Section showing four specimens, all with the embryonic chambers sectioned, × 20. Same locality as figure 5.



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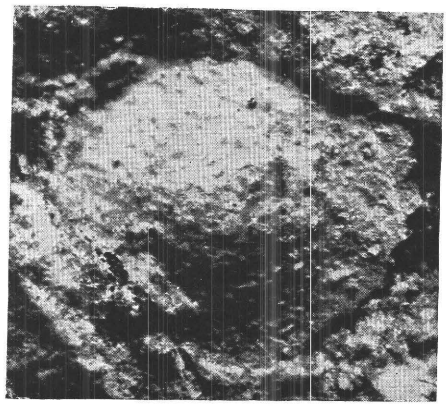

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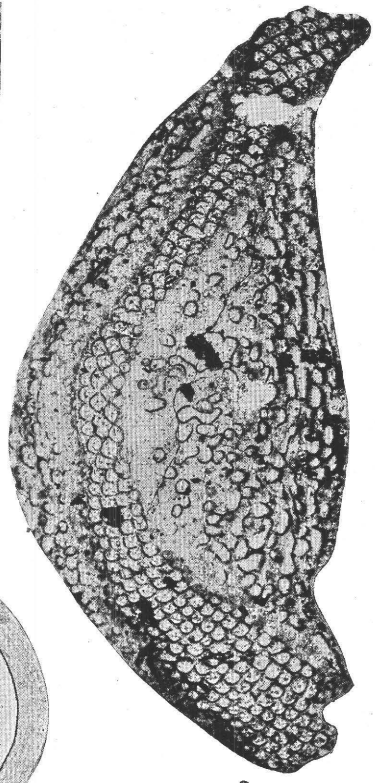

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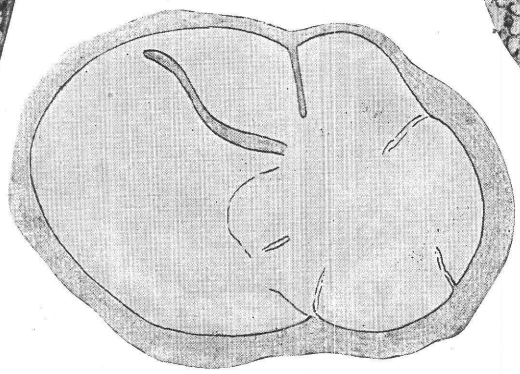

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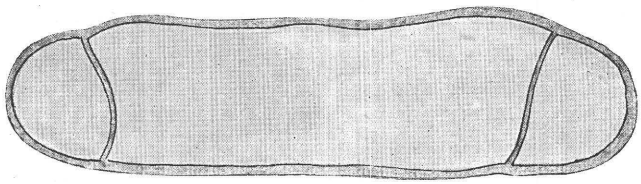

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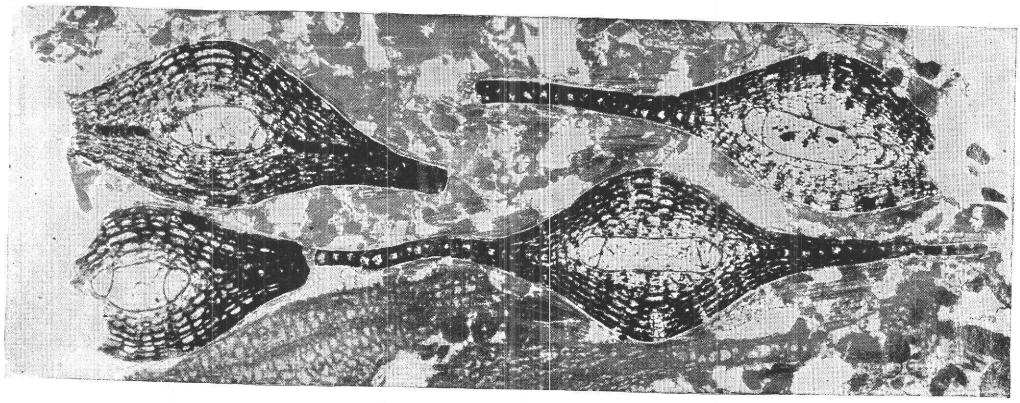

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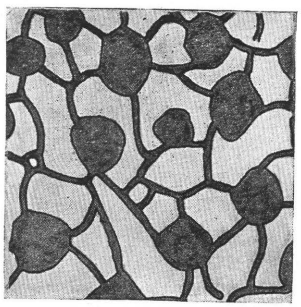
AMERICAN SPECIES OF LEPIDOCYCLINA.



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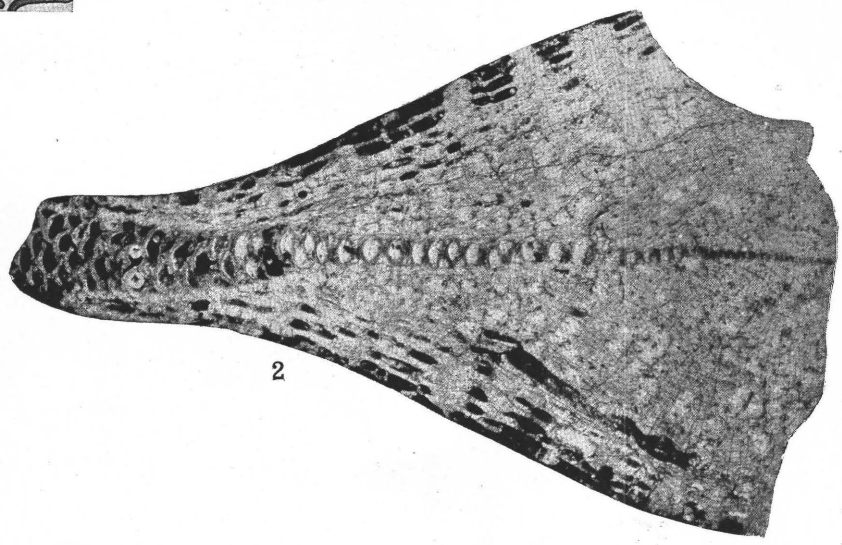

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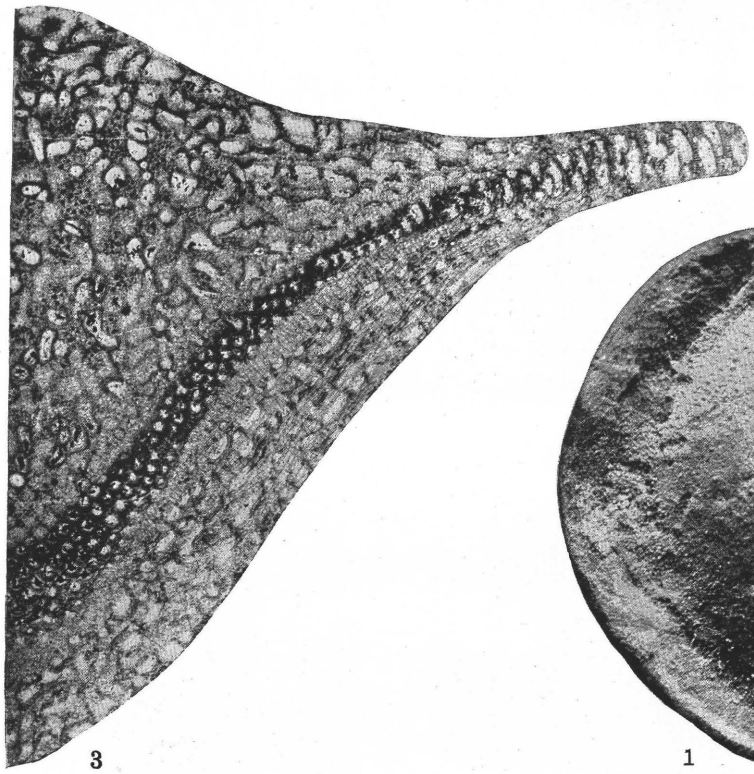

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AMERICAN SPECIES OF LEPIDOCYCLINA.

PLATE XXXV.

Lepidocyclina duplicata Cushman (p. 78).

FIGURE 1. Exterior view of type, × 5, showing raised center and depressed area inside the raised periphery. Limestone 2 miles north of David, Panama (U. S. G. S. station 6523).

FIGURE 2. Portion of vertical section, × 20, showing great increase in width of equatorial zone, multiplication of the chambers toward the periphery, heavy pillars, and wide lateral chambers. Same locality as figure 1.

FIGURE 3. Portion of oblique section, × 20, showing pillars and lateral chambers with a few equatorial chambers having perforate peripheral walls. Same locality.

Lepidocyclina antillea Cushman (p. 78).

FIGURE 4. Vertical section, × 20, north 67° east from summit of Negre Point across low saddleback of point, St. Bartholomew, Leeward Islands (U. S. G. S. station 6903).

FIGURE 5. Distribution of pillars and lateral chambers in horizontal section, × 60. Same locality as figure 4.