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# CRETACEOUS AND TERTIARY FORAMINIFERA FROM SOUTHERN SANTA CLARA PROVINCE, CUBA

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ABSTRACT

Foraminiferal faunas of Upper Cretaceous, upper Eocene, Oligocene, and Miocene age from southern Santa Clara province, Cuba, are described. *Lepidorbitoides rutteni*, *L. rutteni* var. *armata*, *L. palmeri*, and *L. macgillavryi* are new forms from Upper Cretaceous beds. A doubtful species belonging to the Peneroplidae is discussed. Species that until now have been considered to be of upper Eocene age only and other species of Oligocene age only, have been found together. *Lepidocyclina tschoppi* is a new species of the transitional beds between upper Eocene and Oligocene. The synonymy of *Lepidocyclina favosa* and *L. formosa* is discussed. Several species that are combined by some authors are here separated. *Lepidocyclina* (*Eulepidina*) *petri* is a new species of Oligocene age.

The material here described was collected in March and April, 1933, during a geological survey by some geologists from Utrecht with Prof. L. M. R. Rutten. The geological results will be published later; given

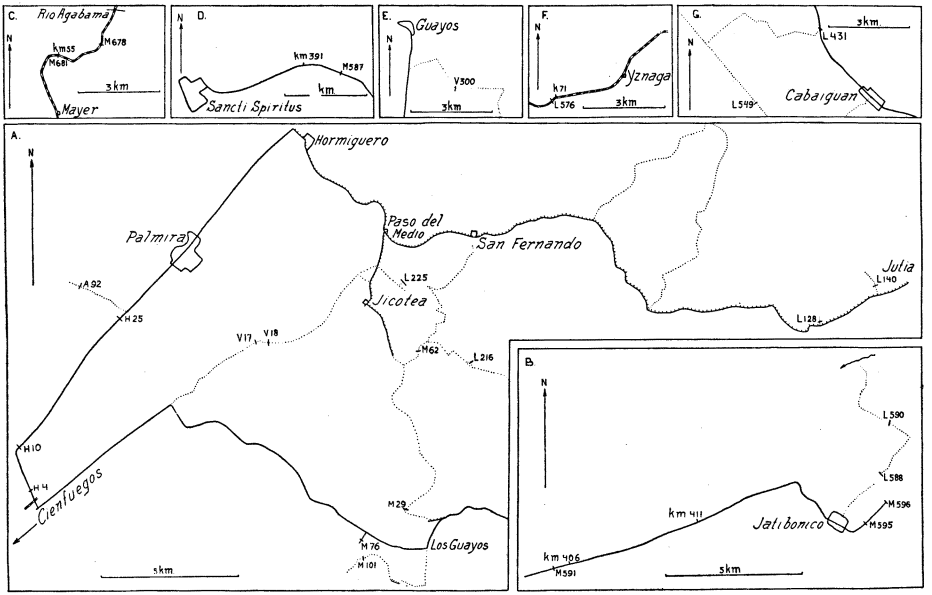


FIG. 1–A—Sketch map of the neighborhood of Cienfuegos and San Fernando.
B—Sketch map of the neighborhood of Jatibonico.
C, F—Sketch maps of parts of the railway from Placetas to Trinidad through the Sierra de Trinidad.
D—Sketch map of the Carretera Central near Sancti Spiritus.
E—Sketch map showing V 300 near Guayos on the Carretera Central.
G—Sketch map from the neighborhood of Cabaiguan.

here are notes on the Foraminifera, which range in age from Upper Cretaceous to Miocene. They were obtained from weathered limestones and white marls at localities indicated on accompanying sketch maps (fig. 1). Locs. L 229 and L 232, not shown on the maps, are situated respectively on the east bank of Ramirez River near its mouth, and at Punto Barril on Cienfuegos Bay. The letters L, M, H, and V, preceding the field numbers, indicate respectively the collectors L. Rutten, M. Rutten, H. Mac Gillavry, and L. Vermunt. All the specimens here described are in the Mineralogical-Geological Institute of Utrecht University, Holland. The numbers preceded by D indicate thin-sections in this Institute.

The faunas found at the different localities, their geological ages, and the mode of occurrence of the different species are indicated on the five accompanying tables.

*Upper Cretaceous Foraminifera from Santa Clara province, Cuba*

| Localities | M 29 | M 62 | M 76 | M 101 | L 128 | L 140 | L 225 | V 300 |
|---|---|---|---|---|---|---|---|---|
| (?) *Archaias rutteni* (Palmer) | — | — | — | — | r | — | — | — |
| *Camerina vermunti* Thiadens, n. sp. | — | — | — | — | a | — | — | c |
| *Camerina* sp. C | — | — | — | — | c | — | — | — |
| *Orbitoides browni* (Ellis) | c | c | c | c | — | r | a | c |
| *Orbitoides palmeri* Gravell | r | — | — | — | r | — | c | — |
| *Orbitoides apiculata* Schlumberger | — | — | — | r | — | — | r | — |
| *Lepidorbitoides rutteni* Thiadens, n. sp. | — | — | — | — | a | c | — | — |
| *Lepidorbitoides rutteni* var. *armata* Thiadens, n. var. | — | — | — | — | a | — | — | — |
| *Lepidorbitoides macgillavryi* Thiadens, n. sp. | — | — | — | — | a | r | — | — |
| *Lepidorbitoides palmeri* Thiadens, n. sp. | — | — | — | — | a | — | — | — |

r = rare; c = common; a = abundant.

*Upper Eocene Foraminifera from Santa Clara province, Cuba*

| Localities | M 678 | M 681 | L 216 | L 431 | L 549 | V 17 |
|---|---|---|---|---|---|---|
| *Dictyoconus fontabellensis* Vaughan | — | c | c | c | c | — |
| *Camerina petri* M. Rutten | — | — | — | — | — | c |
| *Camerina* sp., cf. C. *parvula* Cushman | r | — | — | — | — | — |
| *Camerina* sp. D | a | — | — | — | — | — |
| *Lepidocyclina mortoni* Cushman | c | c | — | — | — | r |
| *Lepidocyclina pustolosa* H. Douvillé | — | a | — | — | — | — |
| *Lepidocyclina trinitatis* H. Douvillé | — | — | — | — | — | c |
| *Lepidocyclina* sp. | a | — | — | — | — | — |
| *Helicolepidina spiralis* Tobler | a | c | — | — | — | c |
| *Discocyclina blumenthali* Gorter and Van der Vlerk | c | — | — | — | — | — |
| *Discocyclina vermunti* Rutten | c | r | — | — | — | r |
| *Discocyclina* sp | — | — | c | — | c | — |

r = rare; c = common; a = abundant.

*Foraminifera of transitional beds between upper Eocene and Oligocene from Santa Clara province, Cuba*

| Localities | L 588 | L 590 |
|---|---|---|
| *Lepidocyclina maracaibensis* Hodson | c | — |
| *Lepidocyclina mortoni* Cushman | a | c |
| (?) *Lepidocyclina supera* (Conrad) | c | — |
| *Lepidocyclina tschoppi* Thiadens, n. sp. | c | — |
| *Lepidocyclina weeksi* Hodson | r | — |
| *Lepidocyclina formosa* Schlumberger | a | c |
| *Helicolepidina spiralis* Tobler | c | — |

r = rare; c = common; a = abundant.

*Oligocene Foraminifera from Santa Clara province, Cuba*

| Localities | H 25 | L 229 | M 587 | M 596 | H 4 | H 10 |
|---|---|---|---|---|---|---|
| *Camerina* sp. A | — | r | — | — | — | — |
| *Camerina* sp. B | — | r | — | — | r | c |
| *Planularia* sp. | — | r | — | — | — | — |
| *Lepidocyclina formosa* Schlumberger | c | a | c | c | — | — |
| *Lepidocyclina undosa* Cushman | — | a | — | — | — | — |
| *Lepidocyclina marginata* (Michelotti) | — | a | — | — | — | — |
| *Lepidocyclina petri* Thiadens, n. sp. | — | — | a | — | — | — |

r = rare; c = common; a = abundant.

*Oligocene-Miocene Foraminifera from Santa Clara province, Cuba*

| Localities | M 591 | M 595 | L 232 |
|---|---|---|---|
| *Archaias adunca* (Fichtel and Moll) | r | a | a |
| *Amphisorus matleyi* Vaughan | c | a | — |
| *Miogypsina hawkinsi* Hodson | — | a | a |

r = rare; c = common; a = abundant.

Among results of this study the following may be noted: (1) The occurrence of *Camerina* in Upper Cretaceous rocks of Cuba is remarkable in my opinion. The species are all very small and are ornamented with one or several knobs or are smooth. (2) Eulepidine lepidocyclinas, which until now have been thought to occur only in Oligocene beds of the Antillean region, are here reported in association with typical Eocene forms, such as *Helicolepidina spiralis* and *Lepidocyclina mortoni*. (3) Question as to existence of truly generic differences between *Sorites* and *Amphisorus* has been raised by my study of the common Miocene form *Amphisorus*. (4) A species which closely resembles *Archaias adunca* has been found in Cretaceous sediments. (5) Gigantic and twinned nucleoconchs have been found in specimens of *Orbitoides browni* and *Lepidorbitoides rutteni*.

## SYSTEMATIC DESCRIPTIONS

### Genus PLANULARIA Defrance, 1824

#### PLANULARIA sp.

Plate 16, figures 2, 3

Test of medium size, flat, bilaterally symmetrical, semicircular, involute, composed of one and a half to two whorls that increase rapidly in width, the last containing 18 chambers; sutures, marginal cord and central knob of white shell material, sutures strongly curved backward in the first whorl, straight in the last whorl except on the periphery where they are curved backward; measurements of the last chamber, radial 0.6 mm., tangential 3.3 mm. Embryonal apparatus consists of one large subspherical chamber measuring 520$\mu$. Diameter of the test, 3.75 mm. $\times$2.55 mm.; thickness 0.55 mm.

*Occurrence.*—Only two specimens have been found. These are from Loc. L229, Oligocene, Santa Clara province, Cuba. Figured specimens, Min.-Geol. Inst., Utrecht, D15972, D15973.

### Genus DICTYOCONUS Blanckenhorn, 1900

#### DICTYOCONUS FONTABELLENSIS (Vaughan)

Plate 16, figure 13

*Cushmania fontabellensis* VAUGHAN, *1928*, Jour. Paleontology, vol. 1, p. 282, pl. 44, fig. 3.

*Dictyoconus fontabellensis* (VAUGHAN), *1932*, Jour. Paleontology, vol. 6, pp. 97, 98, pl. 14, figs. 6, 7.

The base of this species is flat, or in some cases slightly convex at the periphery. Apertures at the base large (pl. 16, fig. 13). Thickness of the basal chamber walls is about 70$\mu$. Marginal trough divided into two to four cellules. Platforms in center near the base separated 140$\mu$–170$\mu$ and at the periphery 180$\mu$. Height, 1.1 to 1.6 mm., diameter of base 1.6 to 2.0 mm.

*Occurrence.*—Upper Eocene, Santa Clara province, Cuba. Hypotypes, Min.-Geol. Inst., Univ. Utrecht, D15464, D15495.

### Genus CAMERINA Bruguière, 1792

#### CAMERINA VERMUNTI Thiadens, n. sp.

Plate 16, figures 1, 11, 12; Text-figures 2C, 3A, E

Test small, circular, symmetrical or asymmetrical with regard to the equatorial plane, involute; composed of three to three and one-half whorls that increase regularly in width, the last containing 19 to 23 chambers; surface smooth, with or without a central knob, sometimes striate; sutures radiate. Embryonic apparatus consists of one spherical chamber, 60$\mu$ to 90$\mu$. Septa straight, radiating, rather thick, clearly double. Chambers trapezoid, radial diameter twice the tangential (in last whorl 300$\mu$ $\times$150$\mu$). Aperture unknown. The vertical section is difficult to obtain because of recrystallization and secondary filling of the test. A median groove occurs on the edge (text-fig. 3A, E), as found also by Vermunt in material of Pinar del Rio. Only three of fifteen thin sections of the loose material show it, but thin sections of solid rock show it very well. The marginal wall is generally damaged and recrystal-

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EXPLANATION OF PLATE 15

(All specimens from Santa Clara province, Cuba)

FIGS. *1*, *7*—(?)*Archaias*, (?)*Meandropsina*, (?)*Fallotia*, or another genus of the Peneroplidae. *1*, External view, $\times$16.7. *7*, Horizontal section $\times$23.6. Upper Cretaceous. (p. 98)

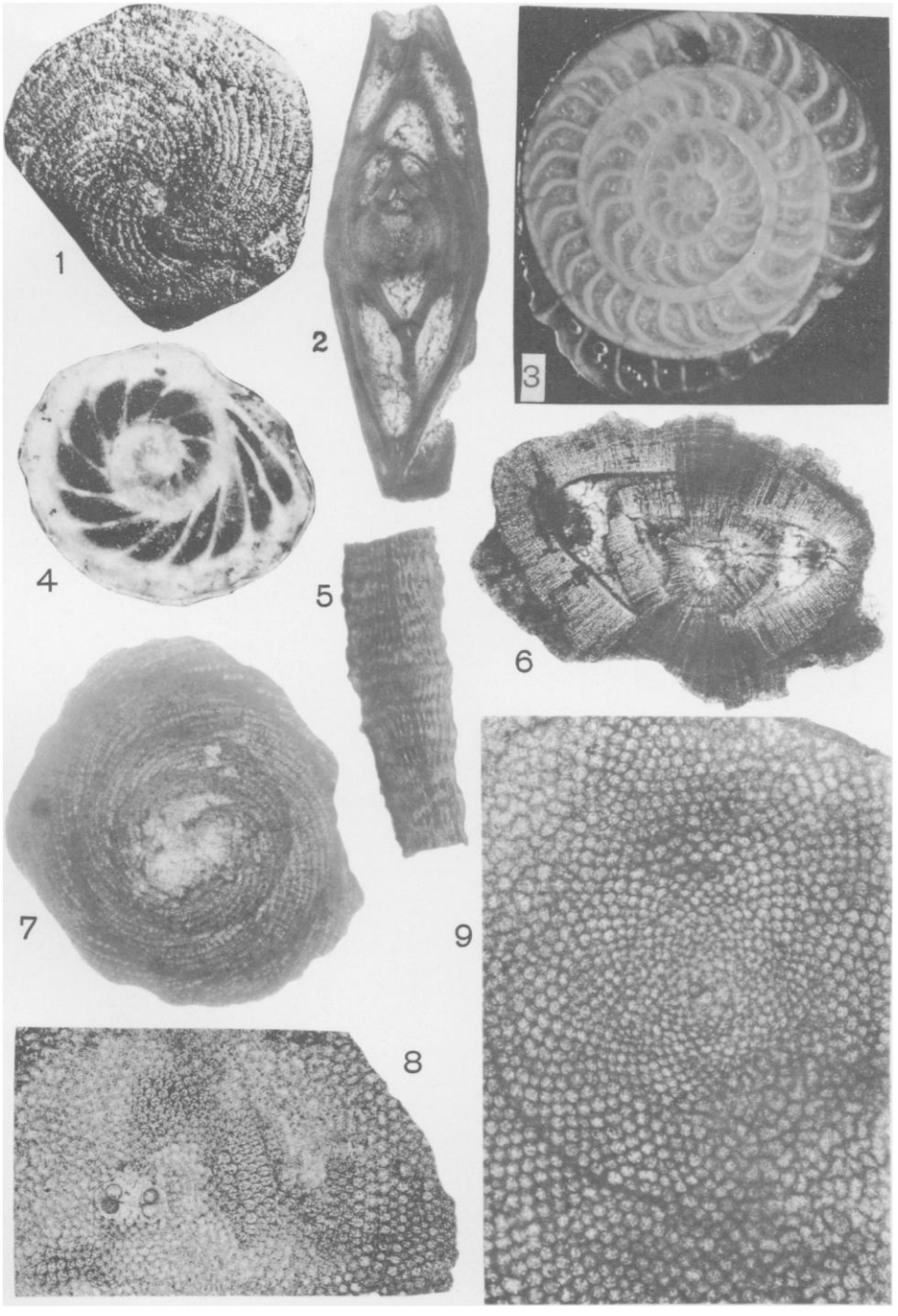
*2*—*Camerina* sp. A. Vertical section, $\times$31. Oligocene. (p. 95)

*3*—*Camerina* sp. B. Horizontal section, $\times$18. Oligocene. (p. 95)

*4*—*Camerina* sp. C. Horizontal section, $\times$19.5. Upper Cretaceous. (p. 95)

*5*, *8*, *9*—*Lepidorbitoides* (*Lepidorbitoides*) *rutteni* Thiadens, n.sp. *5*, Vertical section, $\times$37. *8*, Horizontal section showing a twinned nucleoconch, $\times$24.5. *9*, Horizontal section, $\times$32. Upper Cretaceous. (p. 100)

*6*—*Camerina* sp. cf. *C. parvula* (Cushman). Vertical section, $\times$48. Upper Eocene. (p. 95)




Thiadens, Cretaceous and Tertiary Foraminifera

lized. Measurements and number of whorls are indicated in text-fig. 2C.

*Remarks.*—The straight radiating septa and the median groove on the edge are characteristic for this species. It differs from *C. dickersoni* Palmer in the greater thickness of its test and the form of its septa. *C. cubensis* Palmer, which typically is ornamented by many knobs, is also quite different from *C. vermunti*. The species is named in honor of Mr. L. W. J. Vermunt.

*Occurrence.*—Upper Cretaceous, Loc. L 128 (type locality, see sketch map A) near Abra de Castillon, 13 km. east-southeast of San Fernando, Santa Clara province, Cuba. Syntypes, Min.-Geol. Inst., Univ. Utrecht., D15917–D15952.

### CAMERINA sp. cf. C. PARVULA (Cushman)

Plate 15, figure 6; Plate 16, figure 8

*Nummulites parvula* CUSHMAN, *1919*, Geol. Pal. West Indies, Contr., p. 51, figs. 3–6.
*Camerina* sp. cf. *C. parvula* GRAVELL, *1933*, Smithsonian Misc. Coll., vol. 89, pp. 14, 15, pl. 1, fig. 6.

Tests small, thick, lenticular, center marked by clear shell material which may be raised sometimes forming a knob; composed of three whorls, the last containing about 19 chambers measuring 370$\mu$ (radial) $\times$180$\mu$ (tangential); walls strongly curved. Surface striate. Embryonic apparatus consists of one spherical chamber 148$\mu$ in diameter. Vertical section shows one large central pillar and thick walls (190$\mu$).

*Remarks.*—This species differs from *C. parvula* only in the number of chambers.

*Occurrence.*—Upper Eocene, Santa Clara province, Cuba. Figured specimens Min.-Geol. Inst., Univ. Utrecht, D15898–D15903.

### CAMERINA sp. A

Plate 15, figure 2

Test small (diameter, 2.7 mm., thickness, 0.74 mm.), lenticular, involute, composed of three whorls, surface smoth, no pillars; only the vertical section known. This form is characterized by a large median keel, measuring 260$\mu$ in the last whorl. The initial chamber is large and subspherical, 0.3 mm. in diameter.

*Remark.*—Only one specimen at hand.

*Occurrence.*—Oligocene, Santa Clara province, Cuba. Figured specimen, Min.-Geol. Inst., Univ. Utrecht, D15894.

### CAMERINA sp. B

Plate 15, figure 3; Text-figures 3B, D

Test small (diameter, 2.6 mm., thickness, 0.9 mm.), lenticular, involute, composed of about four to five whorls, the last one containing 28 septa; surface smooth; sutures radiating from center, bending backward on periphery. The form of the chambers is very characteristic, the septa showing a marked backward inclination of 110 to 140 degrees at three-fourths of the height of the chamber; septa from the outer side of the inner wall come down at an angle of 90 degrees, reaching the inner side of the outer wall with an angle of 20 to 50 degrees. Chambers twice as high as long. Septa rather thick and clearly double. Initial chamber subspherical.

*Remarks.*—Although this is probably a new species, it has not been named because the material, consisting of only 14 specimens, is too poor for adequate specific characterization.

*Occurrence.*—Oligocene, Locs. L 229, H 4, and H 10 (map A), Santa Clara province, Cuba. Figured specimens, Min.-Geol. Inst., Univ. Utrecht, D15895–D15897, D16065–D16076.

### (?)CAMERINA sp. C

Plate 15, figure 4; Plate 16, figures 7, 10

Test small, thick, umbonate, with indistinct margin, completely involute, with two whorls that increase rapidly in height, the last containing 13 chambers; surface smooth. Septa straight, directed strongly backward, rather thick, double. Vertical sections show that the walls are thick and lamellar. The last chamber measures 740$\mu$ (radial) $\times$180$\mu$ (tangential). The last chamber of the first whorl measures 300$\mu$ (radial) $\times$220$\mu$ (tangential). Diameter of test, 1.6 to 2.8 mm. Thickness, 0.7 to 1.5 mm.

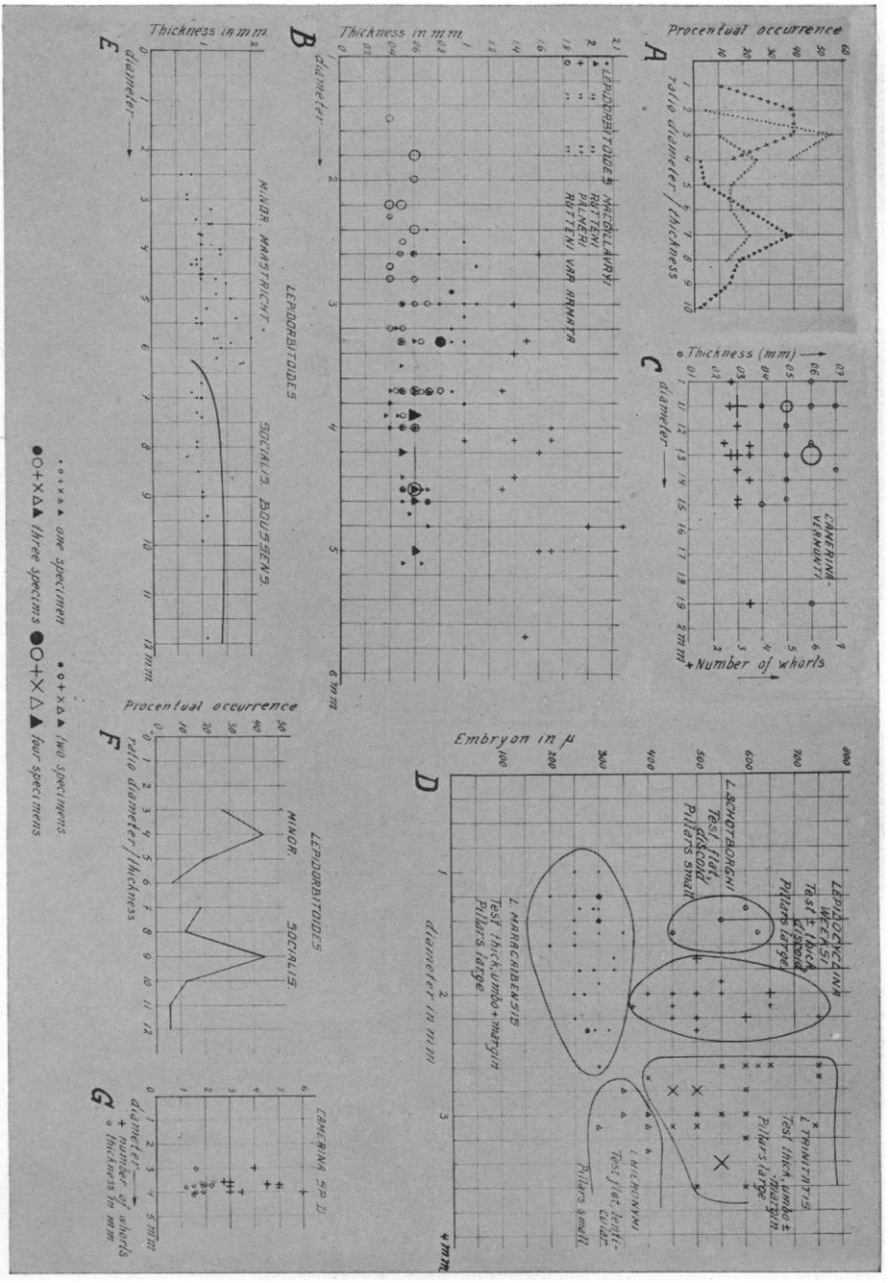



FIG. 2.—Diagrams showing measurements of species of *Camerina*, *Lepidocyclina* and *Lepidorbitoides*.

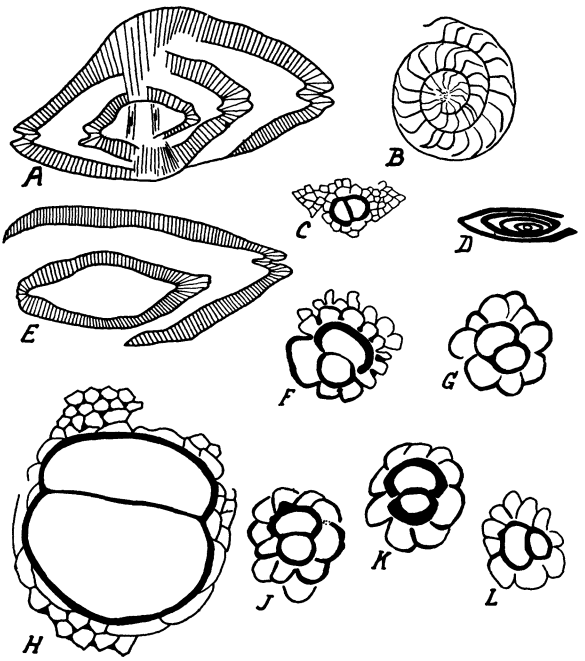
*Remarks.*—I refer this form to the genus *Camerina* because of its thickness and its highly involute character.[1]

*Occurrence.*—Upper Cretaceous, Loc. L 128 (map A), Santa Clara province, Cuba. Hypotypes, Min.-Geol. Inst., Univ. Utrecht, D15885–D15893.

[1] According to information from Dr. T. Wayland Vaughan this form is identical with *Operculinoides antiguensis* Vaughan and Cole (U. S. Nat. Mus., Proc., in press).

CAMERINA sp. D
Text-figure 2G

Test of medium size, lenticular, completely involute, composed of four to six whorls with 24 chambers in the fourth whorl, chambers strongly curved backward, shorter tangentially than radially, in the last whorl measuring 0.37 mm. (tangential) ×0.6 mm. (radial); surface smooth, sutures of clear shell material not always visible. Lateral and vertical sections show a large central column.




EXPLANATION OF TEXT-FIGURE 3

(All specimens from Santa Clara province, Cuba.)

*A, E—Camerina vermunti* Thiadens, n.sp. *A*, Vertical section, ×51. *E*, Vertical section, ×58. Upper Cretaceous. (p. 94)

*B, D—Camerina* sp. B. *B*, Horizontal section, ×9. *D*, Vertical section, ×9. Oligocene. (p. 95)

*C—Lepidocyclina* (*Lepidocyclina*) *maracaibensis* Hodson. Horizontal section, ×21. Transition beds, upper Eocene-Oligocene. (p. 103)

*F, J—Lepidorbitoides* (*Lepidorbitoides*) *rutteni* Thiadens n.sp. *F*, Horizontal section, ×45. *J*, Horizontal section, ×52. Upper Cretaceous. (p. 100)

*G, L—Lepidorbitoides* (*Lepidorbitoides*) *rutteni* var. *armata* Thiadens., n. var. *G*, Horizontal section, ×50. *L*, Horizontal section, ×47. Upper Cretaceous. (p. 101)

*H—Lepidocyclina* (*Lepidocyclina*) *tschoppi* Thiadens, n.sp. Horizontal section, ×23. Transition beds, upper Eocene-Oligocene. (p. 103)

*K—Lepidorbitoides* (*Lepidorbitoides*) *macgillavryi* Thiadens, n.sp. Horizontal section, ×52. Upper Cretaceous. (p. 101)

Walls and marginal cord thick. Embryon consists of one subspherical chamber in macrospheric forms. Microspheric forms also have been found. Measurements of test, diameter 3 to 4 mm.; thickness 1.6 mm. to 2.3 mm.

*Remarks.*—This species is related to *C. petri* M. Rutten, but differs in the form of its chambers.

*Occurrence.*—Upper Eocene, Loc. M 678 (map C), Santa Clara province, Cuba. Figured specimens, Min.-Geol. Inst., Univ. Utrecht, D15904–D15916.

## Family PENEROPLIDAE (?)

### Genus ARCHAIAS, FALLOTIA, MEANDROPSINA, or another genus of this family

Plate 15, figures 1, 7

(?)*Meandropsina rutteni* PALMER, *1934*, Soc. cubana hist. nat., Mem., vol. 8, no. 4, pp. 252–255, pl. 12, fig. 2, text-figs. 15, 15A.

The five specimens here discussed probably belong to the Peneroplidae but it is not proved that they are porcellaneous. Test small, lenticular, circular, planispiral, bilaterally symmetrical, completely involute. The form and arrangement of the chambers are the same as in *Archaias*, the chambers being divided into chamberlets by delicate partitions, but whether the partitions join the concave face of the succeeding chambers is not determinable. Annular chambers have not been seen.

*Measurements of specimens*

| | | | | | |
|---|---|---|---|---|---|
| Diameter (mm.) | 2.4 | 2.6 | 1.8 | 2.25 | 1.85 |
| Thickness (mm.) | 0.4 | 0.6 | 0.5 | 0.6 | 0.6 |
| Number of whorls | ? | ? | ? | ? | 3.5 |
| Chambers in the last whorl | 29 | ? | ? | ? | 26 |

Undoubtedly this is the same form as Palmer (1934) describes, as follows:

Test very thin-walled and delicate, porcellaneous?; small in size seldom exceeding 2.2 mm. in diameter with a thickness of 1 mm.; oval in side view, bilaterally symmetrical, completely involute, compressed. Periphery narrow and rounded. Umbonal region slightly depressed. Surface smooth and without ornamentation. Suture lines very broadly curved and slightly depressed, 20 to 25 narrow chambers in the final whorl subdivided by numerous (more than 60 in the last formed chambers) delicate partitions into chamberlets. The partitions of the chambers are in two series, a primary series which appears to join the concave face of the succeeding septum and a secondary series extending approximately half way to the contiguous septum. Apertures not discernible. Meandering superficial layers absent. In horizontal section a specimen measuring 2 mm. in diameter and comprising three whorls has a small spherical initial chamber measuring 0.066 mm. The vertical section shows the test to be completely involute.

The generic determination of this form is difficult. Palmer says at the bottom of text-figure 15A that the secondary partitions at the bottom are superficial and do not appear in sections, which is remarkable. If later on it should appear that these secondary partitions really exist, this could well be the basis for establishing a new genus. I am inclined to doubt their existence, however, and to regard these "secondary partitions" as superficial ornamentations. There are several objections to Palmer's reference of this form to *Meandropsina*. (1) The meandering superficial layers, typical of *Meandropsina*, never have been found. Palmer obviates this difficulty by assuming that we have only young forms, as described by Schlumberger (1899). (2) In that case, however, neither Palmer nor I have found adult specimens; although, as Palmer says, fragments are almost invariably present in large collections of the Upper Cretaceous from Cuba. (3) We have to do with forms with complete partitions, as is evident from Palmer's description. With regard to this feature we encounter the following inconsistency. Schlumberger states in the original description of the genotype of *Meandropsina* that the chambers are subdivided into chamberlets by incomplete septa, but his figure (Schlumberger, 1899, pl. 9, fig. 11) undoubtedly shows complete septa in several places. A new description of the type material is needed to determine whether *Meandropsina* has complete or incomplete septa. The same

difficulty occurs in the case of *Fallotia* H. Douvillé, of which I have not seen a horizontal section showing the incomplete septa to which Douvillé (1902, table, p. 305) refers. It seems improper to identify the form here discussed as *Meandropsina* since the typical meandering lateral chambers of this genus are lacking, and since there is no sufficiently unambiguous description of the genotype. Should *Meandropsina* and *Fallotia* have incomplete septa, then our form should be classed with *Archaias*. It strikingly resembles *A. adunca* (Fichtel and Moll), but differs from it in the number of chambers and chamberlets. If *Meandropsina* and *Fallotia* have complete septa, then it is possible that our form belongs to either of them, with preference for *Fallotia* because of the first two objections raised by me above.

*Occurrence.*—Upper Cretaceous, Loc. L 128 (map A), Santa Clara province, Cuba. Figured specimens, Min.-Geol. Inst., Univ. Utrecht, D16083–D16086.

## Genus ORBITOIDES d'Orbigny, 1847

### ORBITOIDES PALMERI Gravell

*Orbitoides palmeri* GRAVELL, *1930*, Jour. Paleontology, vol. 4, pp. 269, 270, pl. 22, figs. 1–10.

Our forms agree well with the description and figures given by Gravell. In some cases the test is biconically symmetrical and almost lenticular.

*Occurrence.*—Upper Cretaceous, Santa Clara province, Cuba. Hypotypes, Min.-Geol. Inst., Univ. Utrecht. D15516–D15522.

## Genus LEPIDORBITOIDES Silvestri, 1909

M. G. Rutten (1935) has shown that *Orbitocyclina* and *Lepidorbitoides* are synonyms, for stolons occur in *Lepidorbitoides minor*. It is possible, as suggested by Tan Sin Hok (1934), that the genotype of *Lepidorbitoides* (*L. socialis*) lacks stolons and, therefore, doubt might be expressed concerning acceptance of this synonymy. M. G. Rutten, however, has recently studied *L. socialis* from Boussens, the type locality of the genotype, and has shown the existence of stolons in this form. These can be seen in Rutten's photographs, one of which is printed here (pl. 19, fig. 9). Vaughan (1936) has found also that *L. socialis* has six stolons to each chamber. The synonymy is thus definitely proved.

Tan Sin Hok (1934) has pointed out in figures by Vaughan and M. Rutten a difference in the arrangement of the periembryonal chambers in *L. minima* and *L. minor*, the former having only one and the latter two *Hauptauxiliarkammern*. Whether these features are of generic significance I cannot say. All but one of my specimens studied have two *Hauptauxiliarkammern* (text-figure 3F, G, J, K, L).

It is desirable to discuss the validity of the two European species *L. socialis* and *L. minor*. Schlumberger (1901, 1902) described *Orbitoides socialis* and *O. minor* as two Upper Cretaceous species. Silvestri (1907) created for *O. socialis* the new genus *Lepidorbitoides*. Recognizing the *Lepidorbitoides* character of *O. minor*, H. Douvillé considered this form to be only a variety of *L. socialis* and he named it *Lepidorbitoides socialis* race *minor*. He considered that between *L. socialis* and *L. socialis* race *minor* there is only a difference in dimensions.

In the paleontological collection of the Min.-Geol. Inst., Univ. Utrecht, we have type material of *L. socialis* from the Maastrichtian beds near Boussens (France) and of *L. minor* from the Maastrichtian of Maastricht (Holland), and in addition we have specimens of *L. minor* from the Maastrichtian of La Feza in the Sierra del Cadi, northern Spain (Boissevain, 1934). I have studied this material and have come to the conclusion that various differences that are of specific value distinguish these two forms. These differences are shown in the following table (see also pl. 16, figs. 4, 5, and text-figures 2E, F, for differences in shape).

*Comparison of characters of* Lepidorbitoides socialis *and* L. minor

| *Lepidorbitoides socialis* | *Lepidorbitoides minor* |
|---|---|
| Flat; diameter, 6.7 to 11.9 mm., thickness 0.7 to 1.1 mm. | Lenticular; diameter, 2.5 to 6.3 mm., thickness 0.6 to 2.0 mm. |
| Equatorial chambers hexagonal, radial diameter longer than tangential. | Equatorial chambers never hexagonal, radial diameter as long as tangential, spatulate or ogival. |
| Lateral chambers 37$\mu$ high, higher than their horizontal walls. | Lateral chambers 25$\mu$ high, as high as their walls. |
| Pillars varying little in diameter (110$\mu$ to 145$\mu$). | Pillars varying in diameter, thickest in the center (100$\mu$ to 180$\mu$). |
| Embryonic apparatus: first chamber 140$\mu$ to 180$\mu$, second chamber 175$\mu\times$240$\mu$ to 185$\mu\times$370$\mu$. | Embryonic apparatus: first chamber 148$\mu$, second chamber 148$\mu\times$229$u$. |
| (Occurs in southern France.) | (Occurs in Holland and northern Spain.) |

## Subgenus LEPIDORBITOIDES Silvestri, 1909

### LEPIDORBITOIDES (LEPIDORBITOIDES) RUTTENI Thiadens, n. sp.

Plate 15, figures 5, 8, 9; Plate 17, figure 5; Plate 19, figure 8; Text-figures 2A, B; 3F, J

Test of medium size, flat, circular, symmetrical and sometimes asymmetrical with regard to the equatorial layer (in the latter case saucer-shaped), discoid, slightly thicker in the center than on the periphery. Surface smooth, reticulate, no pillars. Lateral chambers open, thick-walled, five to nine layers, in vertical section measuring 25$\mu\times$70$\mu$ to 50$\mu\times$100$\mu$. Equatorial chambers hexagonal to short-hexagonal and spatulate to truncate, arranged on concentric circles. Measurements 140$\mu$ (radial) $\times$110$\mu$ (tangential), 95$\mu\times$110$\mu$ and 74$\mu\times$74$\mu$. On vertical section the equatorial layer increases in height from 26$\mu$ in the center to 90$\mu$ on the periphery. Embryonic apparatus of the *Lepidorbitoides*-type, one small subspherical primary chamber followed by a larger reniform second one, together measuring 90$\mu\times$110$\mu$ to 260$\mu\times$290$\mu$, average 120$\mu\times$180$\mu$. The two initial chambers are followed by six to ten chambers, gradually diminishing in size, but all larger than the other equatorial chambers, spirally arranged. In one specimen a twinned embryon is found. Measurements of the test: diameter 3

### EXPLANATION OF PLATE 16

(All specimens from Santa Clara province, Cuba, except figs. 4 and 5)

FIGS. *1, 11, 12*—*Camerina vermunti* Thiadens, n.sp. *1*, External view, $\times$14. *11, 12*, Both horizontal sections, $\times$20. Upper Cretaceous. (p. 94)

*2, 3*—*Planularia* sp. External views, $\times$14.2. Oligocene. (p. 94)

*4*—*Lepidorbitoides* (*Lepidorbitoides*) *minor* Schlumberger. External view of topotype, $\times$4.27. Maastrichtian beds, Maastricht, Holland. (p. 100)

*5*—*Lepidorbitoides* (*Lepidorbitoides*) *socialis* (Leymerie). External view of topotype, $\times$4.27. Maastrichtian beds, near Boussens, France. (p. 100)

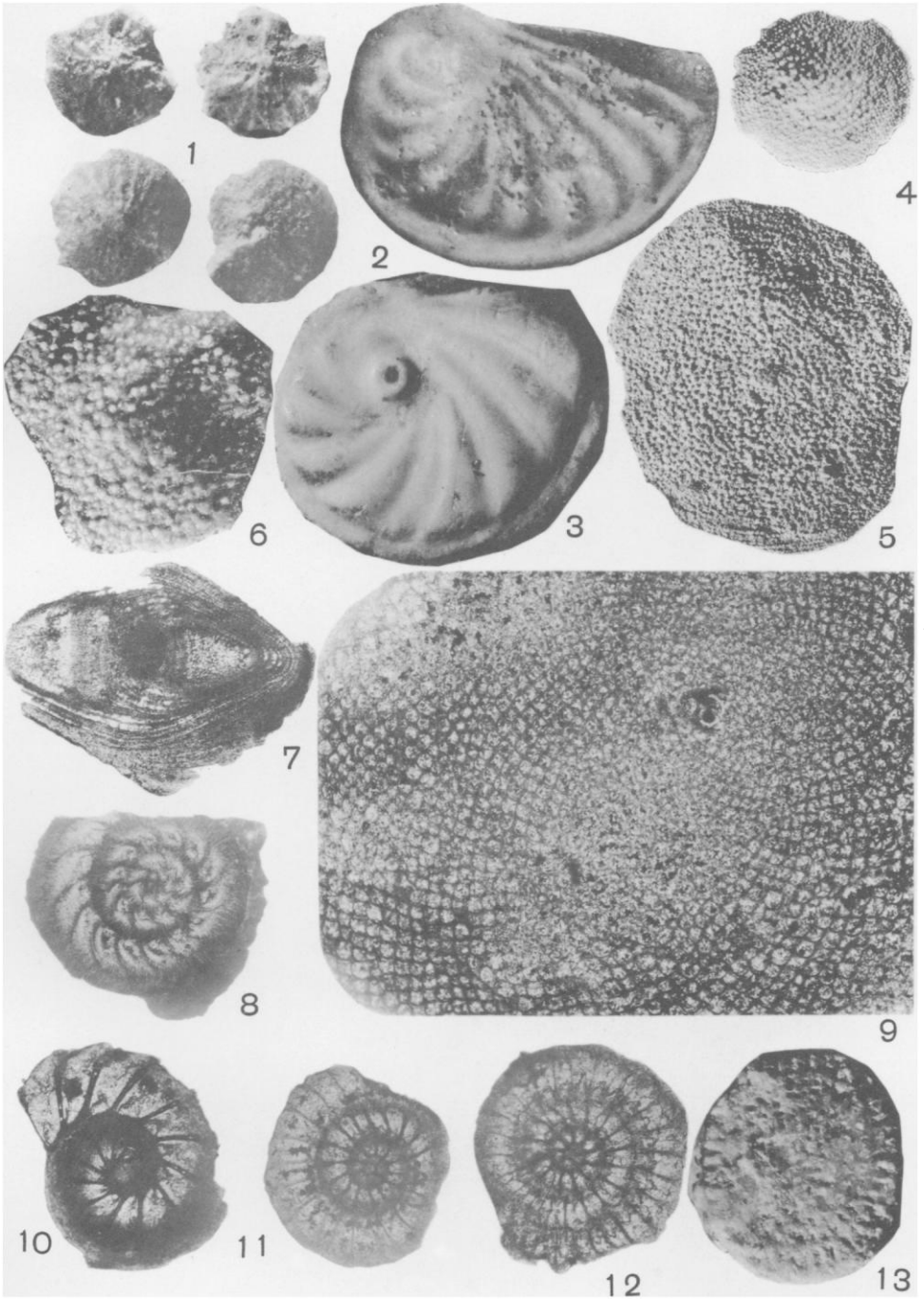
*6*—*Lepidorbitoides* (*Lepidorbitoides*) *rutteni* var. *armata* Thiadens, n. var. External view, $\times$14. Upper Cretaceous. (p. 101)

*7, 10*—*Camerina* sp. C. *7*, Vertical section, $\times$50. *10*, Horizontal section, $\times$22. Upper Cretaceous. (p. 95)

*8*—*Camerina* sp. cf. *C. parvula* (Cushman). Horizontal section, $\times$21. Upper Eocene. (p. 95)

*9*—*Lepidorbitoides* (*Lepidorbitoides*) *macgillavryi* Thiadens, n. sp. Horizontal section, $\times$34. Upper Cretaceous. (p. 101)

*13*—*Dictyoconus fontabellensis* (Vaughan). Outside of the base with apertures, $\times$18. Upper Eocene. (p. 94)




Thiadens, Cretaceous and Tertiary Foraminifera

mm. to 5 mm. (see also text-fig. 2B), average 4.2 mm.; thickness, 0.4 mm. to 0.7 mm., average 0.6 mm.

*Remarks.*—This species is distinguished from all known species of *Lepidorbitoides* by its flatness and small size in combination with the hexagonal equatorial chambers and the absence of pillars. It is named in honor of Prof. L. M. R. Rutten.

*Occurrence.*—Upper Cretaceous, Loc. L 128 (map A) type locality, near Abra de Castellon, 13 km. east-southeast of San Fernando, Santa Clara province, Cuba. Syntypes, Min.-Geol. Inst., Univ. Utrecht, D15779–D15810.

LEPIDORBITOIDES (LEPIDORBITOIDES) RUTTENI var. ARMATA Thiadens, n. var.
Plate 16, figure 6; Text-figures 2A, B; 3G, L

This variety is characterized by a fine to coarse papillate surface, the papillae being the ends of pillars. The papillae are thickest in the center, diminishing in diameter towards the periphery (100–90–80–70–60$\mu$). Lateral chambers are fissiform, arranged in vertical rows, measuring 25$\mu$ × 100$\mu$.

*Occurrence.*—Upper Cretaceous, Loc. L 128 (map A), type locality, near Abra de Castellon, 13 km. east-southeast of San Fernando, Santa Clara province, Cuba. Syntypes, Min.-Geol. Inst., Univ. Utrecht, D15811–D15852.

LEPIDORBITOIDES (LEPIDORBITOIDES) PALMERI Thiadens, n. sp.
Plate 17, figures 2, 9, 10; Text-figures 2A, B

Test of medium size, lenticular, or with a low, broad umbo and narrow margin. Surface smooth, in some cases very finely papillate, with small obscure pillars. Lateral chambers in vertical section rectangular, rather open, measuring 40$\mu$ × 90$\mu$, arranged in vertical rows. There are about 13 layers. Equatorial chambers hexagonal and spatulate, arranged on concentric circles, measuring 60$\mu$ to 110$\mu$ (radial) × 110$\mu$ (tangential). In vertical section the height of the equatorial layer increases from 60$\mu$ to 110$\mu$. Embryonal apparatus is typical for the genus, containing a smaller subspherical primary chamber (140$\mu$ to 230$\mu$) and the larger reniform second one (210$\mu$ to 300$\mu$) The initial chambers are followed by several chambers of diminishing diameter arranged in a spiral. All of these are larger than the other equatorial chambers. Measurements of the test, diameter 3 mm. to 5 mm., thickness, 1 mm. to 2 mm. Embryon, 220$\mu$ × 300$\mu$ to 340$\mu$ × 370$\mu$ (see also text-fig. 2A, B).

*Remarks.*—This form differs from *L. minor* in the absence of large regularly distributed pillars, and the form of its equatorial chambers; from *L. socialis* in its smaller size and its thickness; from *L. rutteni* and its variety *armata* in its thickness and its larger embryon, and from *L. minima* and *L. nortoni* in the form of the equatorial chambers. This species is named in honor of Mrs. Dorothy K. Palmer.

*Occurrence.*—Upper Cretaceous, Loc. L 128 (map A), type locality near Abra de Castellon, 13 km. east-southeast of San Fernando, Santa Clara province, Cuba. Syntypes, Min.-Geol. Inst., Univ. Utrecht, D15867–D15883.

LEPIDORBITOIDES (LEPIDORBITOIDES) MACGILLAVRYI Thiadens, n. sp.
Plate 16, figure 9; Plate 17, figure 7; Plate 19, figure 4; Text-figures 2A, B; 3K

Test small, thickest in the center and thinning quickly towards the periphery, flat conical, symmetrical with respect to the equatorial plane. Surface smooth, reticulate in the very center, in some cases bearing superficial papillae but showing no pillars. Lateral chambers open, thin-walled, rectangular, arranged in vertical rows; 15 lateral layers. Equatorial chambers ogival to diamond-shaped, on intersecting curves, the diagonal measuring about 74$\mu$ near the periphery. The equatorial layer increases in height from 25$\mu$ to 110$\mu$. Embryonic apparatus of the *Lepidorbitoides*-type. A small subspherical primary chamber and

a larger reniform, slightly embracing, second one. Embryonic apparatus small, measuring 150μ × 190μ. The initial chambers are followed by about eight chambers, larger than the other equatorial chambers and arranged in a spiral. Measurements of the test, diameter, 2.4 mm. to 3.7 mm., thickness, 0.8 mm. to 1.1 mm.

*Remarks.*—This form differs from the above described species and *L. socialis* in having diamond-shaped equatorial chambers. It differs from *L. minor* in the absence of pillars and the smaller embryon; from *L. nortoni* and *L. minima* in its greater thickness and the absence of small pillars. This species is named in honor of Mr. H. J. Mac Gillavry.

*Occurrence.*—Upper Cretaceous, Loc. L 128 (map A), type locality near Abra de Castellon, 13 km. east-southeast of San Fernando, Santa Clara province, Cuba. Syntypes, Min.-Geol. Inst., Univ. Utrecht, D15853–D15866.

Genus LEPIDOCYCLINA Gümbel, 1868

This genus has been divided by van de Geyn and van der Vlerk (1935) into the two genera *Lepidocyclina s.s.* and *Orbitoina*. This division is founded on the number of stolons of the equatorial chambers, *Orbitoina* (the genotype of which they did not designate) having four stolons in arcuate, ogival and lozenge-shaped equatorial chambers, and *Lepidocyclina s.s.* having six stolons in mostly hexagonal and spatulate equatorial chambers. It is often difficult to find stolons, and probably because of this fact the authors have not looked over all species of *Lepidocyclina s.l.* in order to determine the number of stolons. Van de Geyn and van der Vlerk have not proved that the presence of arcuate, ogival and lozenge-shaped equatorial chambers always corresponds with the occurrence of four stolons, nor have they shown that hexagonal and spatulate equatorial chambers occur only in forms with six stolons. Tan Sin Hok (1934) described *L. papuliformis* with arcuate equatorial chambers with four stolons in the center of the test and spatuliform equatorial chambers with six stolons toward the periphery. It is difficult to reconcile this with the new classification of van de Geyn and van der Vlerk. The form of the embryonic apparatus and the age of the species cannot support the two proposed new genera, since there are isolepidine forms with arcuate and hexagonal chambers that occur in Eocene as well as Oligocene beds. Since these objections can be made for the present, it seems premature to accept this new classification. Also, van de Geyn and van der Vlerk (1934, 3d chap.) have combined several "species," but "they did not think it necessary to document (their) reasons for eliminating or combining species" (p. 228). In view of this fact I have discussed my specific determinations where it was needed.

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EXPLANATION OF PLATE 17

(All specimens from Santa Clara province, Cuba)

FIGS. *1, 3*—*Lepidocyclina* (*Lepidocyclina*) *tschoppi* Thiadens, n.sp. *1*, Horizontal section, ×21. *3*, Vertical section, ×32. Transition beds, upper Eocene-Oligocene. (p. 103)

*2, 9, 10*—*Lepidorbitoides* (*Lepidorbitoides*) *palmeri* Thiadens, n.sp. *2*, Vertical section, ×17.7 *9*, Horizontal section, ×21. *10*, External view, ×11.6. Upper Cretaceous. (p. 101)

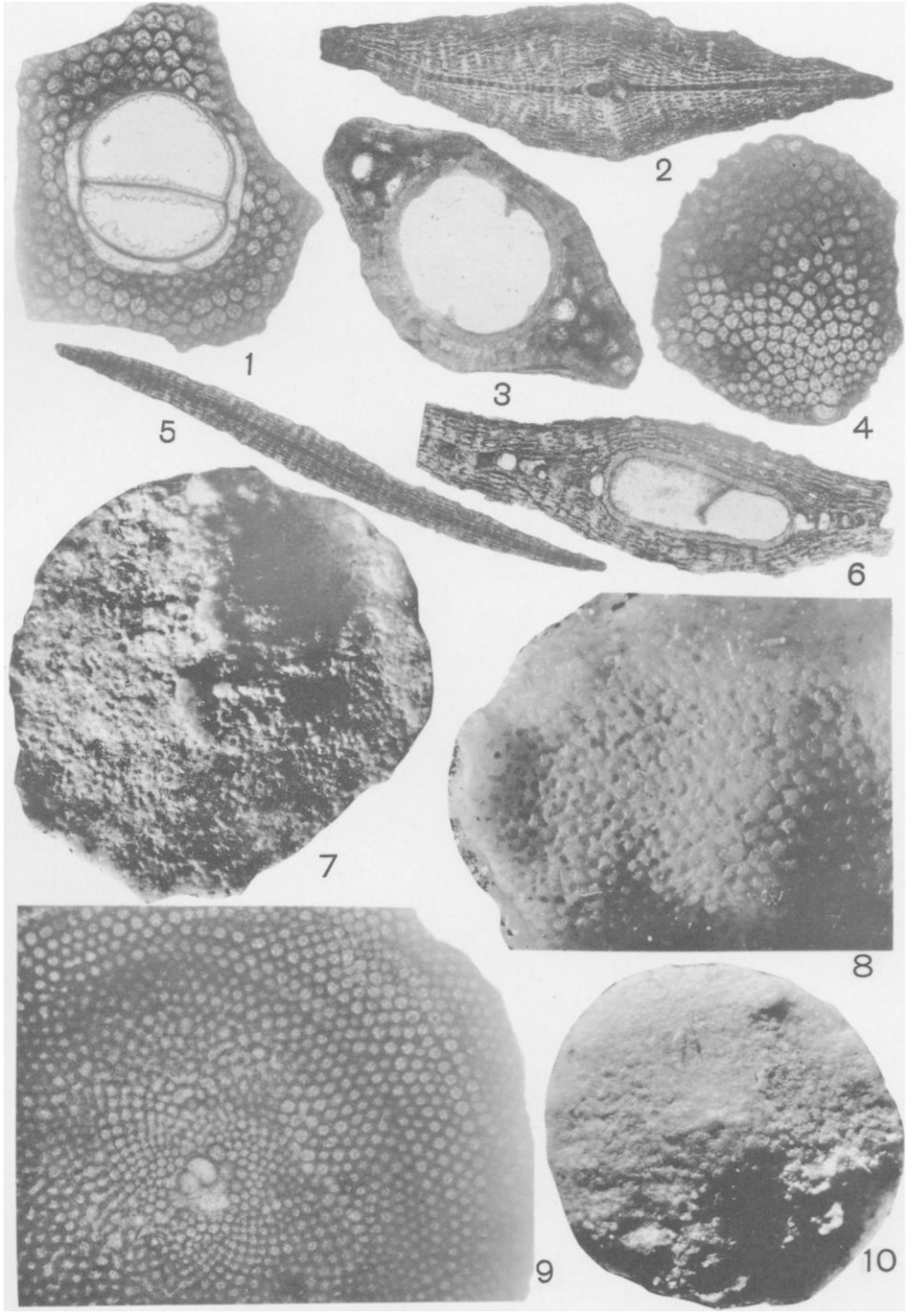
*4*—*Miogypsina hawkinsi* Hodson. Horizontal section, ×20. Oligocene-Miocene. (p. 107)

*5*—*Lepidorbitoides* (*Lepidorbitoides*) *rutteni* Thiadens, n.sp. Vertical section, ×20.7. Upper Cretaceous. (p. 100)

*6*—*Lepidocyclina* (*Neprolepidina*) *fragilis* Cushman var. *cubensis* Thiadens, n. var. Vertical section, ×18.7. Transition beds, upper Eocene-Oligocene. (p. 104)

*7*—*Lepidorbitoides* (*Lepidorbitoides*) *macgillavryi* Thiadens, n. sp. External view, ×11.7. Upper Cretaceous. (p. 101)

*8*—*Lepidocyclina* (*Eulepidina*) *undosa* Cushman. External view, ×15. Oligocene. (p. 106)




Thiadens, Cretaceous and Tertiary Foraminifera

Subgenus LEPIDOCYCLINA Gümbel, 1868

LEPIDOCYCLINA (LEPIDOCYCLINA) MARACAIBENSIS Hodson

Text-figures 2D; 3C

*Lepidocyclina maracaibensis* HODSON, *1926*, Bull. Am. Paleontology, vol. 12, no. 47, p. 24, pl. 6, figs. 2–4.—RUTTEN and VERMUNT, *1932*, K. Akad. Wetensch. Amsterdam, Proc., vol. 35, no. 2, p. 236, pl. 1, fig. 9; pl. 3, fig. 2.

Test small, thick, umbonate, with a small margin; surface papillate to pustulose; pillars polygonal, measuring in diameter 120$\mu$ to 200$\mu$, average 150$\mu$. The equatorial chambers are diamond-shaped or ogival and lie on intersecting curves, measuring 40$\mu$ to 60$\mu$ (radial) $\times$60$\mu$ (tangential). Embryonic apparatus of the isolepidine type, two equal to subequal chambers (diameter, 0.18 mm. $\times$0.27 mm. to 0.37 mm. $\times$0.4 mm.), sometimes followed by two to ten chambers larger than the other equatorial chambers. Measurements of the test: diameter, 1.3 mm. to 1.6 mm. (average 1.85 mm.), thickness, 0.5 mm. to 1.4 mm. (average 1.0 mm.).

*Remarks.*—There are three specimens with very heavy pillars (diameter 450$\mu$), which I identify as *Lepidocyclina* cf. *maracaibensis*, all the other characteristics being the same as the above mentioned.

*Occurrence.*—Transitional beds between upper Eocene and Oligocene, Santa Clara province, Cuba. Hypotypes, Min.-Geol. Inst., Univ. Utrecht, D15528–D15541.

LEPIDOCYCLINA (LEPIDOCYCLINA) MORTONI Cushman

*Lepidocyclina mortoni* CUSHMAN, *1920*, U. S. Geol. Survey, Prof. Paper 125-D, pp. 70, 71, pl. 27, figs. 1–4; pl. 28, figs. 1, 2.—GRAVELL and HANNA, *1935*, Jour. Paleontology, vol. 9, no. 4, pp. 337–339, pl. 31, figs. 1–11; pl. 32, figs. 1–4. Not *Lepidocyclina mortoni* M. RUTTEN, *1935*, Jour. Paleontology, vol. 9, no. 6, pp. 538, 539.

The Cuban specimens agree well with the extensive description given by Gravell and Hanna. Selliform, with or without umbo. Measurments of the test: diameter up to 10 mm.; thickness up to 2 mm., mostly about 1.2 mm. This form greatly resembles *L. supera* (Conrad, 1865). M. Rutten (1936) found this species in upper Eocene beds. The two species are different in the form of the equatorial chambers, *L. mortoni* having ogival chambers arranged in intersecting curves and *L. supera* spatulate to short-hexagonal chambers arranged in concentric circles. Van de Geyn and van der Vlerk (1934) erroneously combined these two species.

*Occurrence.*—Upper Eocene and the transitional beds between upper Eocene and Oligocene, Santa Clara province, Cuba. Hypotypes, Min.-Geol. Inst., Univ. Utrecht, D15551–D15569, D16095–D16098.

LEPIDOCYCLINA (LEPIDOCYCLINA) TSCHOPPI Thiadens, n. sp.

Plate 17, figures 1, 3; Plate 18, figure 6; Plate 19, figure 1; Text-figure *3H*

Test small, very thick, lenticular and in some cases with an umbo and small margin. Surface papillate, pillars (70$\mu$ in diameter) difficult to see. Lateral chambers irregular and thin-walled, on vertical section difficult to distinguish, as the thickness of the lateral layers on either side of the equatorial layer is only 180$\mu$ in the center and decreases toward the periphery. There are at least two layers. The equatorial chambers are hexagonal and spatulate [140$\mu$ (radial) $\times$110$\mu$ (tangential), thickness of the wall 25$\mu$]. Embryonic apparatus very large, of the lepidocycline s.s. type, two equal to subequal chambers with a 25$\mu$ thick wall. The ratio of the volume of the very large embryon to the remainder of the test is typical for this species.

*Measurements of* Lepidocyclina (Lepidocyclina) tschoppi *Thiadens, n. sp.*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Diameter (mm.).... | 1.7 | 1.85 | 2.0 | 2.22 | 2.22 | 2.22 | 2.6 | 2.7 |
| Thickness (mm.)... | 0.9 | 1.4 | 0.8 | 1.1 | 1.2 | 1.4 | 1.2 | 1.1 |
| Embryon (mm.).... | 0.6 | 0.9 | 0.9 | 0.96 | 1.0 | 0.8 | 1.1 | 0.7 |
| | $\times$0.7 | $\times$1.0 | $\times$0.95 | $\times$0.96 | $\times$1.1 | $\times$0.9 | $\times$1.2 | $\times$1.1 |

The embryon is followed by about four large, long, narrow chambers.

*Remarks.*—This species is different from all known species of the genus, being characterized by its enormous embryon in proportion to the rest of the test. This species is named in honor of Dr. H. J. Tschopp.

*Occurrence.*—Transitional beds between upper Eocene and Oligocene. Type locality L 588 (map B), 2.5 km. northeast from Jatibonico, Santa Clara province, Cuba. Syntypes, Min.-Geol. Inst., Univ. Utrecht, D15583–D15590.

LEPIDOCYCLINA (LEPIDOCYCLINA) WEEKSI Hodson

Text-figure 2*D*

*Lepidocyclina weeksi* HODSON, *1926*, Bull.Am. Paleontology, vol. 12, no. 47, p. 23, pl. 6, figs. 6–8.—RUTTEN and VERMUNT, *1932*, K. Akad. Wetensch Amsterdam, Proc., vol. 35, no. 2, p. 235, pl. 1, fig. 6.

I have two specimens of this species. They have no umbo and are discoidal. Measurements: diameter, 2.0 mm. to 2.1 mm.; thickness, 0.5 mm. to 0.8 mm.; embryon, 0.37 mm. to 0.33 mm. ×0.4 to 0.7 mm.

Papillate, equatorial chambers ogival and diamond-shaped, arranged on intersecting curves.

*Remarks.*—Van de Geyn and van der Vlerk have combined under the name *L. trinitatis* H. Douvillé the following: *L. trinitatis*, *L. hieronymi* (Rutten and Vermunt), *L. schotborghi* (Rutten and Vermunt), *L. weeksi* Hodson, and others. I have restudied the material of these four species available in Utrecht, and have combined the results in a diagram, in which I also placed *L. maracaibensis* Hodson.

My opinion is that as long as no one has been able to restudy large collections from different localities and work them out statistically, it is not permissible to combine the four above-mentioned species. Therefore, for the present I maintain *L. weeksi.*

*Occurrence.*—Transitional beds between upper Eocene and Oligocene, Santa Clara province, Cuba. Hypotypes, Min.-Geol. Inst., Univ. Utrecht, D15953–D15954.

Subgenus NEPHROLEPIDINA H. Douvillé, 1911

LEPIDOCYCLINA (NEPHROLEPIDINA) FRAGILIS Cushman, var. CUBENSIS Thiadens, n. var.

Plate 17, figure 6; Plate 18, figure 7

The difference between the new variety and *L. fragilis* is to be found in the form of the equatorial chambers, *L. fragilis* having rather thick-walled isodiametrical to flat-hexagonal and ogival equatorial chambers, and the new variety having very constantly equatorial chambers of an elongated hexagonal form with a larger radial than tangential diameter, measuring 200μ (radial) ×148μ (tangential) to 150μ ×120μ.

*Occurrence.*—Transitional beds between upper Eocene and Oligocene, Santa Clara province, Cuba. Syntypes, Min.-Geol. Inst., Univ. Utrecht, D15955–D15971.

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EXPLANATION OF PLATE 18

(All specimens from Santa Clara province, Cuba.)

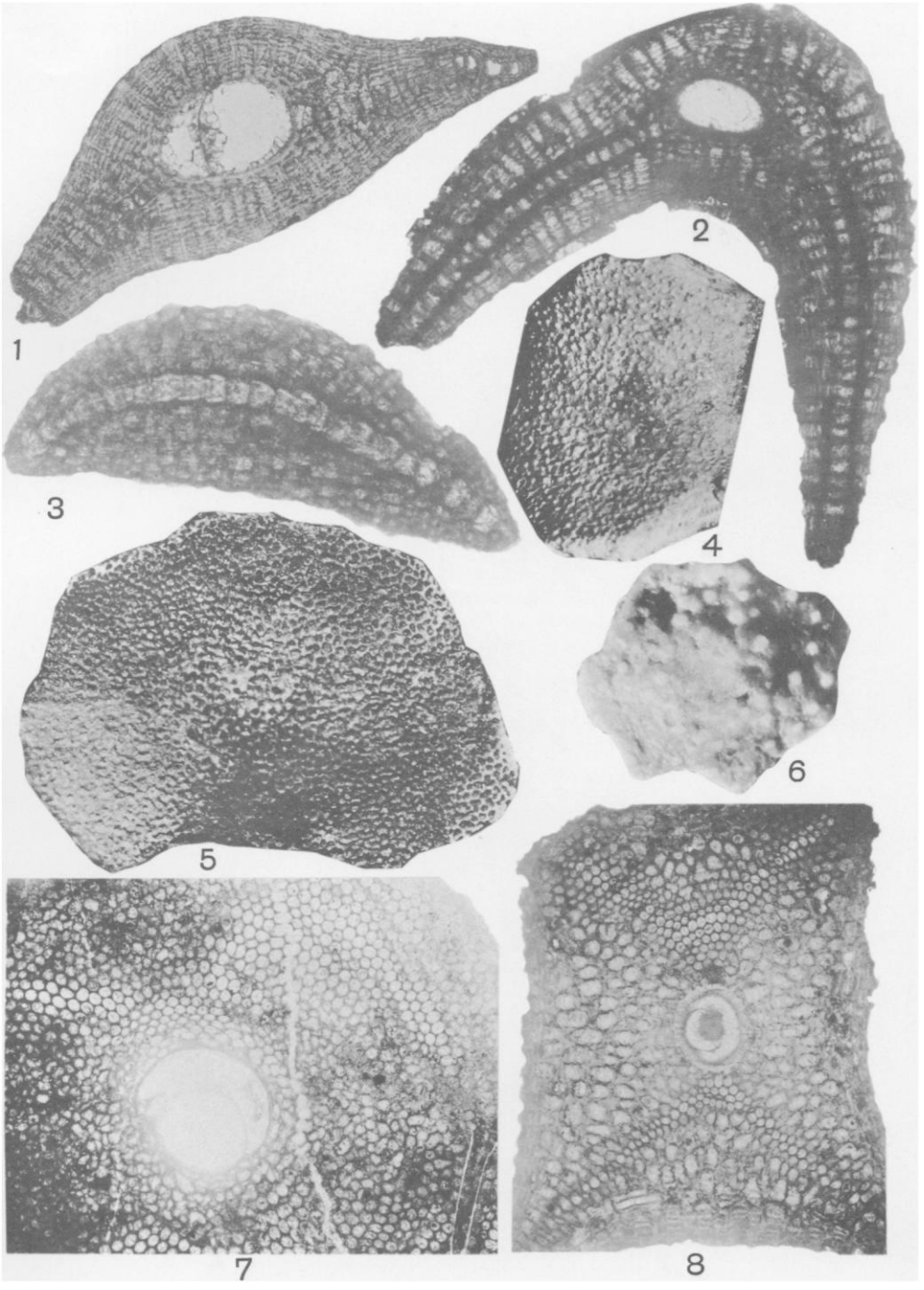
FIGS. *1, 5*—*Lepidocyclina* (*Eulepidina*) *petri* Thiadens, n.sp. *1*, Vertical section, ×23.7. *5*, External view, ×10. Oligocene. (p. 107)

*2, 4, 8*—*Lepidocyclina* (*Nephrolepidina*) *undosa* Cushman. *2*, Vertical section, ×11. *4*, External view, ×6.3. *8*, Horizontal section, ×11. Oligocene. (p. 106)

*3*—*Miogypsina hawkinsi* Hodson. Vertical section, ×33. Oligocene-Miocene. (p. 107)

*6*—*Lepidocyclina* (*Lepidocyclina*) *tschoppi* Thiadens, n.sp. External view, ×10. Transition beds, upper Eocene-Oligocene. (p. 103)

*7*—*Lepidocyclina* (*Neprolepidina*) *fragilis* Cushman var. *cubensis* Thiadens, n. var. Horizontal section, ×13.8. Transition beds, upper Eocene-Oligocene. (p. 104)




Thiadens, Tertiary Foraminifera

## Subgenus EULEPIDINA

### LEPIDOCYCLINA (EULEPIDINA) FORMOSA Schlumberger

*Lepidocyclina formosa* SCHLUMBERGER, *1902*, Geol. Reichs-Mus. Leiden Samml., ser. 1, Band 6, pp. 251, 252, pl. 7, figs. 1–3.—H. DOUVILLÉ, *1924*, Soc. géol. France, Mém. 2 (n. sér.), p. 49, pl. 6, fig. 4, p. 79, text-figs. 69, 70 *a*, *b* and *c*.

*Lepidocyclina favosa* CUSHMAN, *1919*, Carnegie Inst. Washington, Pub. 291, p. 66, pl. 3, figs. 1b, 2; pl. 15, fig. 4.—VAUGHAN, *1933*, Smithsonian Misc. Coll., vol. 89, no. 10, pp. 37–41, pl. 17, figs. 1–3; pl. 18, figs. 1–4; pl. 19, figs. 1–4; pl. 20, figs. 1–3; pl. 21, figs. 1, 3; pl. 29, fig. 4.—VAN DE GEYN and VAN DER VLERK, *1935*, Leidsche Geol. Med., Deel 7, afl. 2, pp. 234, 235, 249.

The material from Santa Clara province, Cuba, gives occasion for some remarks. The most striking feature is the coarse reticulate surface of the umbo. There are no pillars. The embryonal apparatus is mostly typical eulepidine; sometimes, however, tending to the nephrolepidine type.

*Remarks.*—In the original description Schlumberger sketches the test of *Lepidocyclina formosa* as consisting in the middle of a thick cushion with four rays.

On voit au centre une loge initiale sphérique de 0.6 mm. de diamètre complètement enveloppée d'une seconde loge sphérique de 1 mm. de diamètre. Les loges équatoriales qui les entourent ont un contour nettement demicirculaire. . . . Les loges latérales audessus et audessous sont traversées par le très nombreux piliers massifs réciproquement réunis par des nombreuses anastomoses et réservant entre eux des plages occupées par des loges laterales superposées en ligne droite, très surbaissées et séparées par de très minces parois. Les piliers se prolongent jusqu'à la surface extérieure où ils se terminent par des boutons saillants arrondis. . . . Dimensions. L'individu Fig. 2, a 18 mm. environ entre les extrémités des rayons, tandis que le corps central n'a que 6 mm. de côté et une épaisseur au milieu d'environ 2 mm. (Fig. 3).

Douvillé (1905) proved that the test is not stellate but saddle-shaped.

Douvillé (1912 and 1924), L. Rutten (1912 and 1914), and van der Vlerk (1925) proved that the vertical walls of the lateral chambers are very thick and that there are no pillars.

The original description of *L. favosa* Cushman follows:

Test of medium size, compressed, strongly undulate or saddle-shaped, the central portion umbonate, much curved and thick; the remainder of the test thin and flange-like; central umbonate mass with an ornamentation of polygonal areas formed by raised ribs; remainder of the test very smooth but irregularly eroded in most cases. Vertical section with 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 mm. for typical specimens.

Vaughan (1924) says that *L. favosa* is of the eulepidine type, with short spatulate to short hexagonal equatorial chambers, while *L. formosa* should have longer spatulate equatorial chambers. However, van der Vlerk (1925, figs. 27, 28) shows *L. formosa* with short hexagonal and short spatulate equatorial chambers, and in the Cuban specimens of "*L. favosa*" we have in some cases "long" hexagonal chambers. Vaughan (1926) mentions pillars for *L. favosa*. He separates the two species in three features, but these are not valid; for *L. formosa* is selliform and has a margin also (Vide Schlumberger, 1902, figs. 2, 3); the size of *L. favosa* also may be very large and is variable. Vaughan (1933) mentions pillars for *L. favosa*. M. G. Rutten (1935) thinks it probable that *L. favosa* has no pillars since he could find none in his material nor in the figures published by Vaughan. He thinks it probable that pillars are always absent in this species. The same conclusion can be made in connection with my material. The literature on the two discussed species and examples of *L. formosa* from Borneo and "*L. favosa*" from Cuba that are available in Utrecht show that there is not enough difference between the two species to warrant their separation.

Nuttall (1926) says that the specific difference between *L. formosa* and *L. ephippioides* Jones and Chapman (1900) is based on the form of the embryonic apparatus. If it should appear, as Yabe believes (1929), that *L. ephippioides* is also of the eulepidine type, then there is no specific difference between the two last mentioned species and we should be obliged to combine the three species under the name *L. ephippioides*, this being the oldest. Van de Geyn and van der Vlerk (1935) have already combined *L. favosa* and *L. formosa*.

In two places *L. formosa* is associated with *Helicolepidina spiralis* and *L. mortoni*. So we have transitional beds between upper Eocene and Oligocene.

*Occurrence.*—Transitional beds between upper Eocene and Oligocene, Santa Clara province, Cuba. Hypotypes, Min.-Geol. Inst., Univ. Utrecht, D15606–D15669, D16102, D16103.

### Lepidocyclina (Eulepidina) undosa Cushman

Plate 17, figure 8; Plate 18, figures 2, 4, 8

*Lepidocyclina undosa* Cushman, *1919*, Carnegie Inst. Washington, Pub. 291, p. 65, pl. 25, fig. 1a.

*Lepidocyclina (Nephrolepidina) undosa* Vaughan, *1924*, Geol. Soc. America, Bull., vol. 35, pp. 798, 820, pl. 34, figs. 5–7.

Test of medium to large size, strongly selliform, not umbonate. The whole surface beautifully papillate. The papillae are the ends of pillars which have near the surface a diameter of 90$\mu$ at the periphery, and 180$\mu$ in the center. Lateral chambers lenticular and rectangular arranged on vertical rows measuring 74$\mu$ (vertical) $\times$185$\mu$ (horizontal). Pillars between these two rows. There are about 10 layers. Equatorial chambers are hexagonal and spatulate arranged on concentric circles. Equatorial chambers 84$\mu$ (radial) $\times$110$\mu$ (tangential), 150$\mu$ $\times$150$\mu$, 180$\mu$ $\times$130$\mu$. Height 220$\mu$ – 290$\mu$. Embryonic apparatus is of the eulepidine type, large, thick-walled (thickness, 70$\mu$ to 150$\mu$). Measurements: diameter 6 mm. to 10.5 mm., average 9 mm; thickness, 1.48 mm. to 3.6 mm., average 2.2 mm.; embryon 0.92 mm. to 1.85 mm.

*Remarks.*—We found only eulepidine forms. No trace of transition to the nephrolepidine type has been found. However, as our material was compared with topotypes of the species sent to us by Dr. T. Wayland Vaughan, we are sure of our determination. This form, having pillars, being eulepidine and strongly saddle-shaped, is different from all known Eulepidinas. *L. petri*, n.sp., is not strongly saddle-shaped and does not have a typical eulepidine, large, thick-walled embryon, and is smaller in size.

*Occurrence.*—Oligocene. Type locality L 229 on the east bank of Ramirez River near its mouth (Cienfuegos Bay), Santa Clara province, Cuba. Syntypes, Min.-Geol. Inst., Univ. Utrecht, D15670–D15687.

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### Explanation of Plate 19

(All specimens from Santa Clara province, Cuba, except fig. 9.)

Figs. *1*—*Lepidocyclina (Lepidocyclina) tschoppi* Thiadens, n.sp. Vertical section, $\times$22. Transition beds, upper Eocene-Oligocene. (p. 103)

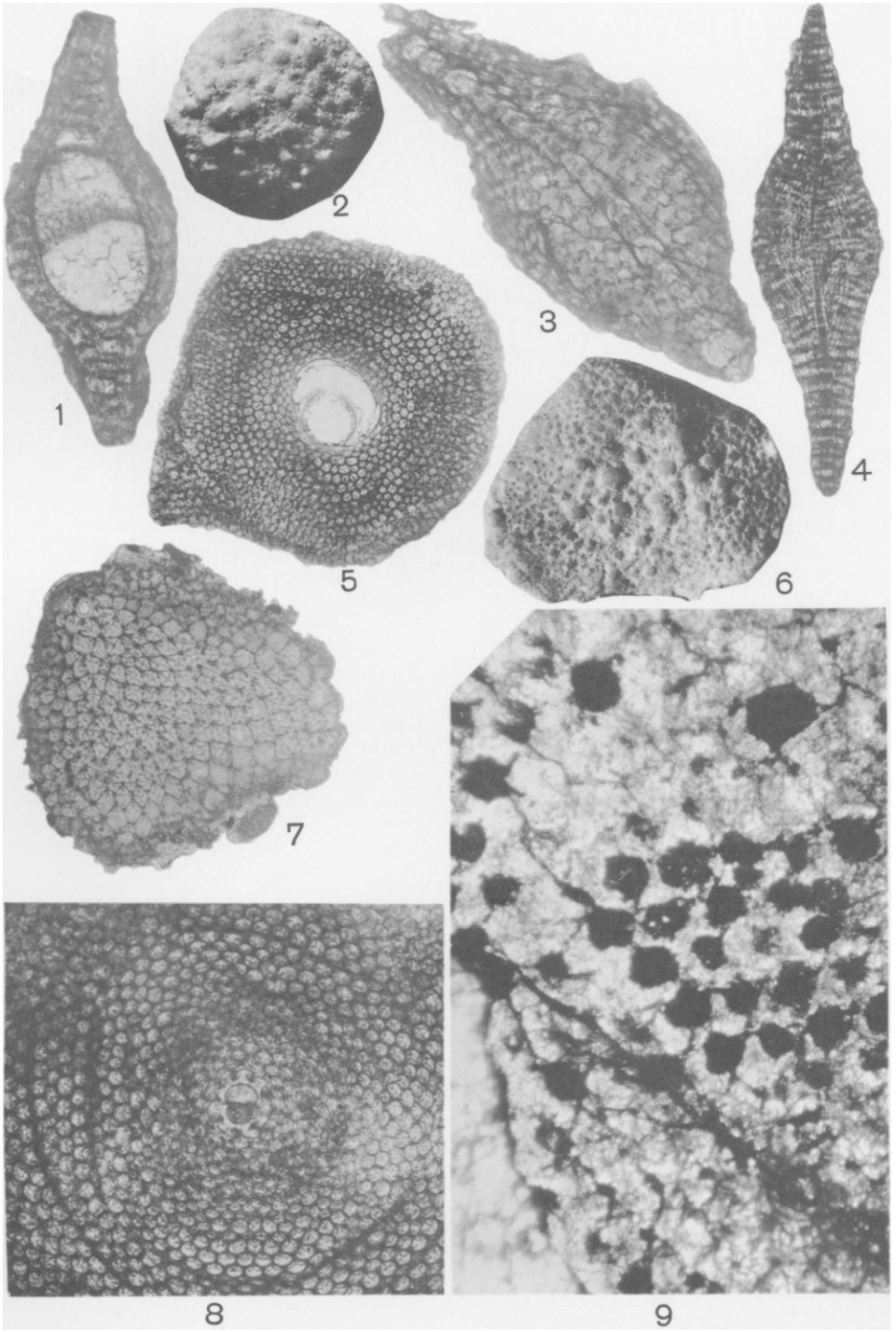
*2, 3, 6, 7*—*Miogypsina hawkinsi* Hodson. *2*, External view, $\times$20. *3*, Vertical section, $\times$33. *6*, External view, $\times$20. *7*, Horizontal section, $\times$20. Oligocene-Miocene. (p. 107)

*4*—*Lepidorbitoides (Lepidorbitoides) macgillavryi* Thiadens, n.sp. Vertical section, $\times$29.5. Upper Cretaceous. (p. 101)

*5*—*Lepidocyclina (Eulepidina) petri* Thiadens, n.sp. Horizontal section, $\times$12. Oligocene. (p. 107)

*8*—*Lepidorbitoides (Lepidorbitoides) rutteni* Thiadens, n.sp. Horizontal section, $\times$32. Upper Cretaceous. (p. 100)

*9*—*Lepidorbitoides (Lepidorbitides) socialis* (Leymerie). Horizontal section showing stolons, $\times$110. Maastrichtian beds near Boussens, France. Photo by M. G. Rutten. (p. 100)




Thiadens, Cretaceous and Tertiary Foraminifera

LEPIDOCYCLINA (EULEPIDINA) PETRI
Thiadens, n. sp.
Plate 18, figures 1, 5; Plate 19, figure 5

Test of medium size, lenticular, in some cases slightly selliform. Surface finely papillate. On tangential section small pillars are visible (diameter 75$\mu$). Lateral chambers low, arranged on vertical rows. There are 10 to 17 layers. Pillars developed from the equatorial layer to the surface or only near the surface. Equatorial chambers hexagonal and spatulate arranged in concentric circles measuring 120$\mu$ (radial) $\times$110$\mu$ (tangential) to 180$\mu \times$150$\mu$. Equatorial layer slowly increases in height in the center 90$\mu$ to the periphery 220$\mu$. The embryonic apparatus consists of two chambers, the type being a transition from nephrolepidine to eulepidine, mostly nearest the eulepidine type. The embryon is large (diameter, 0.5 mm. $\times$0.9 mm. to 1.15 mm. $\times$1.15 mm.), and has a common thick wall, (thickness, 25$\mu$ to 37$\mu$). Measurements of the test: diameter 4.2 mm. to 7.5 mm.; thickness, 1 mm. to 2.2 mm.

*Remarks.*—This species is closely related to *L.* (*Eulepidina*) *formosa*. The pillars, however, are an obviously different feature. For differences with *L.* (*Eulepidina*) *undosa* see the remarks under that species.

*Occurrence.*—Oligocene, type locality Loc. M 587 (map B), 5.5 km. east of Sancti Spiritus, Santa Clara province, Cuba. Syntypes, Min.-Geol. Inst., Univ. Utrecht, D15688–D15710.

Genus MIOGYPSINA Sacco, 1893

MIOGYPSINA HAWKINSI Hodson
Plate 17, figure 4; Plate 18, figure 3;
Plate 19, figures 2, 3, 6, 7

*Miogypsina hawkinsi* HODSON, *1926*, Bull. Am. Paleontology, vol. 12, no. 47, pp. 28, 29, pl. 7, fig. 9; pl. 8, figs. 1, 2.

Test is rather variable in form, small, flat discoid, lenticular, symmetrical and asymmetrical with regard to the equatorial plane, in some cases saucer-shaped, triangle to fan-shaped. Sometimes there is a curve in the margin opposite the apical side. Surface papillate to coarse papillate, the papillae being the ends of pillars (diameter of the pillar 50$\mu$ (on periphery) to 150$\mu$ (in center)). The pillars are as far apart from each other as their diameter. Both microspheric and macrospheric specimens are found, the former being larger and flatter. On vertical section the pillars appear to be conical. Lateral chambers are lenticular to rectangular, arranged in vertical rows, alternating with the chambers of the adjacent rows, thick-walled, roofs and floors cribriform. Equatorial chambers diamond-shaped, arranged on intersecting curves, isodiametrical (diameter 125$\mu$). Vertical section shows in the equatorial layer slightly curved horizontal walls (thickness 25$\mu$), and vertical walls convex in the direction opposite to the initial chambers. The equatorial chambers alternate with adjacent lateral chambers. The macrospheric forms have an embryon apparatus consisting of two chambers subequal, apically situated on the periphery. The larger one on the margin of the equatorial layer measures 0.2 mm. $\times$0.27 mm. to 0.18 mm. $\times$0.12 mm. in diameter; the smaller first initial chamber, lying inside the larger second one, measures 0.18 mm. $\times$1.23 mm. to 0.12 mm. $\times$0.12 mm. The initial chambers are followed by four to six chambers cyclically arranged around the inner side of the embryon. Measurements of the test: diameter, 2.25 mm. $\times$2.55 mm; thickness, 0.76 mm.

*Remarks.*—This species is characterized by its dimensions, apically situated embryon with four to six accessory chambers, and rather coarse papillate surface. It closely resembles *M. bracuensis* Vaughan. In looking over the descriptions of *M. bracuensis* and *M. hawkinsi* the only differing feature I could find is the coarseness of the papillae and pillars, the former having minute papillae and the latter having coarse ones.

*Occurrence.*—Oligocene-Miocene, Santa Clara province, Cuba. Hypotypes, Min.-Geol. Inst., Univ. Utrecht, D15711–D15731, D16104–D16107.

Genus DISCOCYCLINA Gümbel, 1868

Subgenus DISCOCYCLINA Gümbel, 1868

DISCOCYCLINA (DISCOCYCLINA) BLUMENTHALI Gorter and van der Vlerk

*Discocyclina blumenthali* GORTER and VAN DER VLERK, *1932*, Leidsche Geol. Med., Deel 4, afl. 2, p. 111, pl. 16, figs. 2–4.

Test lenticular; surface papillate, the papillae measuring 60$\mu$ to 100$\mu$, the distance between the pillars two to three times their diameter, very regularly spread over the whole surface. Embryonal apparatus with diameter 325$\mu$ to 500$\mu$.

*Occurrence.*—Upper Eocene, Santa Clara province, Cuba. Hypotypes, Min.-Geol. Inst., Univ. Utrecht, D15747–D15762.

Subgenus ASTEROCYCLINA Gümbel, 1868

DISCOCYCLINA (ASTEROCYCLINA) VERMUNTI M. Rutten

*Discocyclina (Asterocyclina) vermunti* M. RUTTEN, *1935*, Jour. Paleontology, vol. 9, no. 6, p. 542, pl. 61, figs. 4, 5; pl. 62, fig. 7.

My material agrees with the description given by M. Rutten. There are two to six heavy pillars in the center and smaller ones on the periphery (measuring respectively 260$\mu$ and 80$\mu$). Embryonal apparatus consists of two subequal chambers, the larger one almost embracing the smaller one. Embryon measures 210$\mu$ $\times$230$\mu$, is surrounded by a ring of square thick-walled chambers (wall 54$\mu$ thick) larger than the adjacent equatorial chambers. Measurements of the test: diameter, 2 mm. to 4.5 mm., thickness, 1.2 mm. to 2.0 mm.

*Occurrence.*—Upper Eocene, Santa Clara province, Cuba. Hypotypes, Min.-Geol. Inst., Univ. Utrecht, D15763, D16108–D16110.

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