EOCENE DISCOCYCLINIDÆ AND OTHER FORAMINIFERA FROM CUBA

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The junior author collected and sent for analysis five samples, four from Habana Province and one from Oriente Province, Cuba. They are from the following localities:

1. Cut in road from Managuaco to Nazareno, Habana Province (Bermudez station 720).

2. Cut at Finca "La Coronela," on road from Habana to Rancho Boyeros, Habana Province (Bermudez stations 1266, 1266A and 346).

3. Four and one-half kilometers west of Guisa, Oriente Province; base of Charco Redondo formation.

In the letter transmitting these samples, Bermudez noted that they contain a form which he believed to represent a new genus, and which he stated he had observed in association with *Eoconuloides wellsi* Cole and Bermudez[1] from almost all of the Cuban provinces. This form is described herein as *Boreloides cubensis* Cole and Bermudez, n. gen. and n. sp. Moreover, Bermudez reported that these samples represented presumably the early middle Eocene.

In a later letter concerning samples 1266, 1266A, and 346 Bermudez stated: "These are from the low cut in the Habana to Rancho Boyeros highway. The beds at this cut are very sloping and consist of interbedded clay shale and gritty, calcareous, fine to coarse-grained conglomerate; small pebbles of clay shale were noted. The fauna from the clay shale is in the preparations

[1] Cole, W. Storrs, and Bermudez, Pedro J.: Bull. Amer. Paleont., vol. 28, No. 113, 1944, pp. 10-12, pl. 1, figs. 4-10.

1266A and 346 and it appears to be lower Eocene (Wilcox in age). The fauna of the gritty calcareous conglomerate contains some species of middle Eocene or perhaps better basal middle Eocene age of a shallow water facies.——— The smaller fauna of sample 346 contains among others: *Angulogerina naranjoensis* Cushman and Bermudez, *Nonion micrus* Cole and *Globorotalia aragoensis* Nuttall. These species have been observed always in samples of lower Eocene age which are lower than the Universidad formation."

The sample from station 1266 contained a number of larger Foraminifera, whereas the samples from the other stations contained fewer of these. The samples from 4.5 kilometers west of Guisa represented a consolidated limestone which could be studied only by random thin sections. Therefore, the present article is based largely on an analysis of the larger Foraminifera from station 1266 with notes on the occurrence of the same species at the other stations.

The fauna from station 1266 contains the following species:

Boreloides cubensis Cole and Bermudez, n. gen. and n. sp.
Coskinolina floridana Cole
Cymbalopora cushmani Cole and Bermudez, n. sp.
Dictyoconus americanus (Cushman)
cookei (Moberg)
Discocyclina (*Asterocyclina*) *habanensis* Cole and Bermudez, n. sp.
(*Discocyclina*) *barkeri* Vaughan and Cole
mestieri Vaughan
, sp.
Eoconuloides wellsi Cole and Bermudez
Lituonella, sp.
Miscellanea antillea (Hanzawa)
tobleri Vaughan and Cole
Pseudophragmina (*Proporocyclina*) *cedarkeysensis* Cole
cushmani (Vaughan)
Vaughanina cubensis D. K. Palmer

Of these, *Vaughanina cubensis* was described by the late Mrs.

D. K. Palmer[2] from the Upper Cretaceous of Habana Province and more recently reported from the Upper Cretaceous of Mexico[3] and Florida.[4] As this species has been known heretofore only from the Upper Cretaceous either the range must be extended or the occurrence of this species in the present population must be ascribed to reworking. The authors favor the latter explanation.

Discocyclina (*Discocyclina*) *barkeri*, *D.* (*D.*) *mestieri* and *Miscellanea antillea* have been reported from deposits assumed to be either Paleocene or lower Eocene in age in Trinidad[5] and Barbardos. Of these *D.* (*D.*) *mestieri* is known from Barbados[6], *Pseudophragmina* (*Proporocyclina*) *cushmani* in our material is represented by only two specimens, but these in most of their features seem so similar to the description and figures given by Vaughan[7] that the Cuban specimens are referred to this species with only slight hesitation. This species was described from the lowest portion of the Guayabal formation of the State of Veracruz, Mexico. The Guayabal formation is approximately the equivalent of the Lisbon horizon of the lower Claiborne of the Gulf States.

Coskinolina floridana, *Dictyoconus cookei*, *D. americanus* and *Pseudophragmina* (*Proporocyclina*) *cedarkeysensis* occur in Florida[8] in deep wells in sediments which are either middle or high lower Eocene age.

If the occurrence of *Vaughanina cubensis* may be assumed to be due to reworking, the dominant aspect of the fauna is Eocene rather than Paleocene. The presence of *Dictyoconus* of the *americanus* type and of *P.* (*Proporocyclina*) *cushmani* causes and the other two are common to Barbados and Trinidad.

[2] Palmer, Dorothy K.: Mem. Soc. Cubana Hist. Nat., vol. 8, No. 4, 1934, pp. 241-243.

[3] Barker, R. Wright, and Grimsdale, Thomas F.: Ann. and Mag. Nat. Hist., ser. 10, vol. 14, 1937, p. 173.

[4] Cole, W. Storrs: Florida Geol. Survey, Bull. 26, 1944, p. 57.

[5] Vaughan, T. Wayland, and Cole, W. Storrs: Geol. Soc. Amer., Sp. Paper 30, 1941, pp. 33-35, 57, 58.

[6] Vaughan, T. Wayland: Geol. Soc. Amer., Mem. 9, 1945, p. 19.

[7] Vaughan, T. Wayland: Geol. Soc. Amer., Mem. 9, 1945, pp. 94, 95, pl. 38, figs. 1-3a.

[8] Cole, W. Storrs: Florida Geol. Survey, Bull. 26, 1944, pp. 25-27.

us to place the fauna of station 1266 in the middle Eocene with the suggestion that the elements not in accord with this assignment are the result of reworking or these have been given incorrect age assignments elsewhere.

Although many more samples from Cuba will have to be analyzed before the exact ranges of the various forms are known with certainty, it is of interest to record this fauna because it shows elements in common with Florida, Barbados, and Trinidad. Detailed studies of the larger Foraminifera of Cuba have been neglected, but there is a wealth of knowledge to be gained from this area as an analysis of these few samples demonstrates.

DESCRIPTION OF GENERA AND SPECIES

Family VALVULINIDÆ

Genus LITUONELLA Schlumberger, 1905

Lituonella, sp. Plate 1, fig. 4

Only one specimen was recovered. The external shape resembled that of certain small specimens of *Lituonella floridana* Cole. As the internal features would have been of considerable importance in assigning this specimen, an axial section was made. The state of preservation was such that the internal features do not show. The section is published simply to record the presence of this genus in association with the other genera recovered.

Locality.—1266.

Genus COSKINOLINA Stache, 1875

Coskinolina floridana Cole Plate 1, figs. 1-3, 7, 9

Coskinolina cookei Moberg, 1928, (part), Florida Geol. Survey, 19th Ann. Rept., pp. 166-168, pl. 3, fig. 6 (not figs. 1-5, 7, 8).

Coskinolina floridana Cole, 1941, Florida Geol. Survey, Bull. 19, pp. 24, 25, pl. 3, figs. 1-7; pl. 4, figs. 1-9; pl. 5, figs. 1-5, 11; pl. 18, fig. 9.

Coskinolina floridana Cole, 1942, Florida Geol. Survey, Bull. 20, p. 21, pl. 4, figs. 4, 5.

Coskinolina floridana Cole, 1945, Florida Geol. Survey, Bull. 28, p. 97, pl. 12, figs. 2, 6, 8.

It is comparatively easy to distinguish *C. floridana* in axial sections, but it resembles *Dictyoconus cookei* (Moberg) in horizontal section in that they both have vertical plates subdividing the chambers of the marginal trough. The horizontal sections

of the Cuban specimens (figures 2, 3, Plate 1) should be compared with the sections of the specimens from Florida assigned to this species (see particularly: figure 7, plate 4 of Florida Geol. Survey, Bulletin 19).

Localities.—1266; 720.

Genus **DICTYOCONUS** Blanckenhorn, 1900

Dictyoconus americanus (Cushman) Plate 1, fig. 8, possibly fig. 5

Conulites americana Cushman, 1919, Carnegie Inst. Washington, Pub. 291, p. 43, text fig. 3.

Dictyoconus americanus Cole, 1942, Florida Geol. Survey, Bull. 20, pp. 21-24, pl. 3, figs. 12, 13; pl. 6, figs. 1-9; pl. 7, figs. 1-5; pl. 16, figs. 14, 15 (references and synonymy).

Dictyoconus americanus Cole, 1944, Florida Geol. Survey, Bull. 26, pp. 36, 37, pl. 4, figs. 1-6; pl. 8, figs. 12, 13; pl. 18, fig. 11.

Dictyoconus americanus Cole, 1945, Florida Geol. Survey, Bull. 28, p. 97, pl. 12, fig. 3.

The one horizontal section available seems to be typical in that the chambers of the marginal trough are subdivided by three vertical plates, a longer one between two short ones.

The axial section, figure 5, has the general shape of this species, but the marginal chambers are not subdivided by the usual long and two short horizontal plates. The state of preservation, however, is poor and it may be that the plates were destroyed.

Dictyoconus cookei (Moberg) Plate 1, fig. 6

Coskinolina cookei Moberg, 1928, Florida Geol. Survey 19th Ann. Rept., pp. 166-168, pl. 3, figs. 1-5, 7, 8 (not fig. 6).

Dictyoconus cookei Cole, 1941, Florida Geol. Survey, Bull. 19, pp. 26, 27, pl. 3, figs. 11-13; pl. 5, figs. 6-10, 12, 13; pl. 6, figs. 1-8; pl. 18, fig. 12.

Dictyoconus cookei Cole, 1942, Florida Geol. Survey, Bull. 20, pp. 24, 25, pl. 3, fig. 10; pl. 4, fig. 8.

Dictyoconus cookei Cole, 1945, Florida Geol. Survey, Bull. 28, pp. 97, 98, pl. 12, figs. 1, 7, 9.

The single horizontal plate which projects into the chambers of the marginal trough serve to distinguish this species. Examination of the figure given of this specimen shows the horizontal plate in several of the chambers.

Family **CAMERINIDÆ***

Genus **MISCELLANEA** Pfender, 1934

Miscellanea antillea (Hanzawa) Plate 2, figs. 10, 11

Pellatispirella antillea Hanzawa, 1937, Jour. Paleont., vol. 11, p. 116,

* This family name is here retained notwithstanding the recent substitution of *Nummulites* for *Camerina*. (See Opinion 192, International Commission on Zoological Nomenclature, 1945.)

pl. 20, figs. 8-10; pl. 21, fig. 1.

Miscellanea antillea Vaughan and Cole, 1941, Geol. Soc. Amer., Sp. Paper 30, pp. 33-35, pl. 4, figs. 1-4; pl. 6, figs. 3, 3a.

Ranikothalia antillea Caudri, 1944, Bull. Amer. Paleont., vol. 28, No. 114, p. 22, pl. 1, figs. 4, 5; pl. 3, fig. 15; pl. 4, fig. 21; pl. 5, figs. 23, 25.

Miscellanea antillea Vaughan, 1945, Geol. Soc. Amer., Mem. 9, pp. 27 29, pl. 3, figs. 1-10; pl. 4, fig. 1.

Numerous specimens assigned to this species were found. As these specimens appear typical in every respect only one median and one transverse section was made. A description of these sections follows:

The median plane of a specimen with a height of 2.86 mm. and a width of 2.5 mm. shows 2½ coils with 21 chambers in the final volution. The initial chamber is subcircular with diameters of 300 x 240 μ and the second chamber has diameters of 300 x 260 μ. The distance across both chambers is 420 μ. The chamber walls are nearly straight and radial.

The transverse section of a specimen with a height of 2.3 mm. and a thickness of 1.08 mm. shows well-developed pillars on each side of the embryonic chambers. These pillars are fused to make bosses on the surface of the test. The individual pillars have surface diameters of 100 to 200 μ. The surface diameter of the group of pillar ends which form the bosses is 0.56 mm. on one side of the test and 0.4 mm. on the other.

Localities.—1266; 720.

Remarks.—This species was described from specimens collected at Cap Haitien, Haiti, and has been reported since from Trinidad and Barbados.

Miscellanea tobleri Vaughan and Cole Plate 3, figs. 1, 2

Miscellanea tobleri Vaughan and Cole, 1941, Geol. Soc. Amer., Sp. Paper 30, pp. 35, 36, pl. 4, figs. 5-7; pl. 7, fig. 1.

Ranikothalia tobleri Caudri, 1944, Bull. Amer. Paleont., vol. 28, No. 114, pp. 22, 23, pl. 5, figs. 22, 26?

Miscellanea tobleri Vaughan, 1945, Geol. Soc. Amer., Mem. 9, pp. 29, 30.

This species is represented in the present collection by one specimen only. This specimen was ground on one side to show the median plane. A description follows: Test of medium size with a height of 4.6 mm. and a width of 4.2 mm., thickness approximately 1.6 mm. Surface ornamentation consists of a group of closely spaced papillæ in the central area of the test beyond which there are radiating raised ridges of clear shell

material to the periphery of the test. The papillate area has a diameter of approximately 1.8 mm. and the individual papillæ have diameters of about 140 μ.

The median plane is composed of 3½ coils with 31 chambers in the final volution. The chamber walls are straight and radial until near their distal ends where they are slightly recurved. The specimen is a megalospheric form.

The type locality of this species in Trinidad is supposed to be upper Eocene, but as Vaughan[9] has stated this determination must be rechecked.

Locality.—1266.

Family **ALVEOLINELLIDÆ**

Genus **BORELOIDES** Cole and Bermudez, new genus

Genotype.—*Boreloides cubensis* Cole and Bermudez, new species.

Test subspherical to fusiform, planispiral, involute, very slight increase in height in the coils; chambers divided into a single series of chamberlets by revolving partitions; basal wall thick and with low, conical projections on the outer side; embryonic apparatus bilocular; apertural face developed, but the apertures were not observed.

There is a resemblance between *Borcloides* and *Fasciolites* Parkinson, 1811, in that they both possess a thickened basal layer to the chambers. The representatives of *Fasciolites* are much larger with small chamberlets, and the basal wall is devoid of the conical projections which appear in *Boreloides.*

Boreloides cubensis Cole and Bermudez, n. sp.

Plate 2, figs. 1-9; Plate 7, fig. 5

Test small, subspherical to fusiform, surface ornamentation variable, in some specimens the surface is smooth, in others there is a mesh formed by small, shallow polygonal pits with low, thin intervening ridges, and in others the surface is covered by small, slightly raised pustules. Measurements of the length and diameter at the center of seven specimens follow:

Specimen	Length	Diameter at center
1	1.26 mm.	0.8 mm.
2	1.34	0.98

[9] Vaughan, T. Wayland: Geol. Soc. Amer., Mem. 9, 1945, p. 29.

3	1.4	0.9
4	1.44	1.04
5	1.56	0.9
6	1.56	1.06
7	1.66	0.96

Sections through the center at right angles to the long axis show a bilocular embryonic apparatus surrounded by several coils of chambers to make the complete test. The initial chamber is circular to subcircular with an internal diameter of about 100 μ. The second chamber has internal diameters of about 80 by 120 μ. The distance across both chambers is about 200 μ.

There are from two to three coils with 16 to 20 chambers following the embryonic chambers. The revolving wall is thick, heavy and has on the outer side small raised areas which produce the pustules on the surface of the test. The chamber walls are thin, straight, and radial. The chambers are divided into chamberlets by revolving partitions.

Many specimens have a narrow apertural face, but the state of preservation was such that the exact nature of the apertures could not be ascertained.

Localities.—1206; 720; 4.5 kilometers west of Guisa, Oriente Province.

Family **CYMBALOPORIDÆ**

Genus **CYMBALOPORA** Hagenow, 1851

Cymbalopora cushmani Cole and Bermudez, n. sp.

Plate 3, figs. 6-8; Plate 7, fig. 3

Test small, conical, with a deeply excavated umbilicus, surface smooth, unornamented, except for a mesh of intersecting sutures which are convex toward the periphery of the test. In the present specimens these can be observed only when the specimen is wet. At the apex of the test there appears to be a small rotaloid coil which is followed by the chambers being arranged annularly in a widening set of rings. The walls are coarsely perforated.

A vertical section of a specimen with a basal diameter of 1.0 mm. and a height of 0.36 mm., shows that the test is composed of a single layer of chambers except at the apex. The dorsal walls are perforated by numerous, rather coarse pores which have diameters of about 3 μ. The walls along the umbilicus and

between the chambers are transversed infrequently by similar pores. No projections or platelike structures were observed into the chambers from the walls.

A transverse section near the base (figure 9, Plate 3) shows the chambers in plan have a rude rectangular shape and that they are devoid of any secondary structures. A transverse section (figure 5, Plate 3) near the apex shows two rows of chambers because of the position of the section with regard to the curvature of the test. As noted in the description of the vertical section, the outer wall is coarsely perforate, whereas the inner walls are solid, or transversed by very infrequent perforations.

Localities.—1266; 720.

Remarks.—The details of the structure of the walls are shown by figure 3, Plate 7. It was noted that the walls surrounding the embryonic chambers of *Eodictyoconus* show the same type of structure.

Cole and Bermudez[10] in creating the genus *Eodictyoconus* assumed from the general structure of the test that these forms were related to *Dictyoconus* which is placed in the family Valvulinidæ.

Restudy of the original specimens of *Eodictyoconus* with certain specimens from Nuevitas, Cuba, demonstrates that *Eodictyoconus* has the same type of wall and structure of this wall around the embryonic chambers as do the specimens referred to *Cymbaloporα*. The structure of the wall around the embryonic chambers of *Eodictyoconus* is shown by figure 2, Plate 7.

Thus, *Eodictyoconus* should be referred to the family Cymbaloporidæ.

This species is named in honor of Dr. Joseph A. Cushman who has contributed largely to the knowledge of American smaller Foraminifera.

Family **ORBITOIDIDÆ**

Genus **VAUGHANINA** D. K. Palmer, 1934

Vaughanina cubensis D. K. Palmer Plate 3, figs. 10-13

Vaughanina cubensis D. K. Palmer, 1934, Mem. Soc. Cuba Hist. Nat., vol. 8, p. 240, pl. 12, fig. 5; pl. 13, figs. 2, 4; text figs. 2, 3.

[10] Cole, W. Storrs, and Bermudez, Pedro J.: Bull. Amer. Paleont., vol. 28, No. 113, 1944, pp. 6-10.

Vaughanina cubensis Vaughan and Cole, 1943, Jour. Paleont., vol. 17, No. 1, pp. 98-100, pl. 17, figs. 3, 4; pl. 18, figs. 1-10.
Vaughanina cubensis Cole, 1944, Florida Geol. Survey, Bull. 26, p. 57, pl. 3, fig. 11; pl. 21, figs. 6, 7.

This Cretaceous species has been reported from Cuba, Mexico, and Florida. The specimens in the samples under discussion are typical in every respect to the topotype specimens studied by Vaughan and Cole in the redescription of this species.

These specimens represent reworked forms from the Cretaceous into the Eocene, or the range of the genus and species must be extended. It should be noted that specimens do not appear broken or worn, and the state of preservation is similar to the associated specimens. Numerous specimens were present in the samples.

Locality.—1266.

Family **DISCOCYCLINIDÆ**

Genus **DISCOCYCLINA** Gümbel, 1870

Subgenus **DISCOCYCLINA** Gümbel, 1870

Discocyclina (Discocyclina) barkeri Vaughan and Cole

Plate 4, figs. 1-5; Plate 5, figs. 7-10

Discocyclina (Discocyclina) barkeri Vaughan and Cole, 1941, Geol. Soc. Amer., Sp. Paper 30, pp. 57, 58, pl. 18, figs. 4-7; pl. 21, figs. 1, 2.
Discocyclina (Discocyclina) barkeri Vaughan, 1945, Geol. Soc. Amer., Mem. 9, pp. 31, 32, pl. 6, figs. 1-10.

Numerous small specimens are assigned to this species. The following measurements were made from vertical sections:

Specimen	1	2	3	4
Diameter	1.66 mm.	1.7 mm.	1.14 mm.	1.5 mm.
Thickness	0.72 mm.	0.68 mm.	0.5 mm.	0.6 mm.
Layers of lateral chambers	11 to 12	11	8	8

The equatorial layer is pronounced in vertical sections made from specimens of this species. The initial chamber may be embraced partially by the second chamber (figure 10, Plate 5) or may be surrounded by the second chamber almost entirely (figure 5, Plate 4). Vaughan has noted this feature in his report on the forms from Barbados.

There is considerable variation in the pillars. In the illustration of the types, certain individuals have heavy pillars, whereas other specimens have small, light pillars. In the Cuban specimens illustrated in this article the specimen shown by figure 7,

Plate 5, has small, weak pillars with the lateral chambers arranged in regular tiers and open. The specimens illustrated by figures 1-4, Plate 4, have in general stronger pillars and the lateral chambers are not so regularly arranged. In certain of these, two particularly strong pillars occur, one on each side of the equatorial layer (figures 3, 4, Plate 4).

In the original and subsequent description of this species all these forms were considered to represent but one species, and this practice is followed here. It should be indicated, however, that in sorting the Cuban specimens into lots for sectioning the specimens represented by figures 7, 8, Plate 5, were separated from the others. A separate description of these specimens was made which follows:

Test small, lenticular, surface covered with small polygonal pits at the corners of which occur minute papillæ, diameter, about 1.2 mm.; thickness, about 0.56 mm.

The embryonic apparatus consists of a small, circular initial chamber with a diameter of about 50 μ which is partially embraced by a larger chamber with diameters of 40 x 90 μ. The distance across both chambers is 90 μ. The periembryonic chambers could not be seen.

The radial chamber walls are complete, alternate in position in adjacent annuli and have the annular stolon on the proximal side of the radial chamber walls. There is a slight increase in size of the equatorial chambers from the center of the test to the periphery. Chambers at the center of the test have radial diameters of 10 μ and tangential diameters of 20 μ, those at the periphery have radial diameters of 20 μ and tangential diameters of 20 μ. The height of the equatorial layer is virtually constant, about 20 μ, excluding roofs and floors.

The lateral chambers are open and arranged in regular, definite tiers with 10 chambers to a tier on each side of the equatorial layer. Lateral chambers near the surface and over the embryonic chambers have a length of 40 μ, a height of 20 μ, and the thickness of the floors and roofs is 4 μ.

Minute pillars occur at the ends of the lateral chambers. These pillars are nearly cylindrical with surface diameters of 20 to 30 μ.

Inasmuch as the illustrations demonstrate the characters of the species clearly, further description is not necessary.

Localities.—1266; 720.

Occurrence.—This species was reported first from Soldado Rock and later from the blocks in the Joes River mudflows of Barbados.

Discocyclina (Discocyclina) mestieri Vaughan

Plate 4, figs. 6-10; Plate 3, fig. 3; possibly Plate 7, fig. 4

Discocyclina (Discocyclina) mestieri Vaughan, 1945, Geol. Soc. Amer., Mem. 9, pp. 37, 38, pl. 12, figs. 1-6.

Test small, circular with a strongly inflated central area which slopes regularly to a narrow rim. Surface ornamentation consists of an apical group of strong, projecting papillæ which grade outwards into smaller papillæ which are nearly flush with the surface of the test. The brim is devoid of papillæ. The smallest megalospheric specimen measured has a diameter of 1.84 mm. and a thickness of 0.84 mm.; the largest megalospheric individual measured has a diameter of 2.88 mm. and a thickness of 1.86 mm. The single microspheric individual available has a diameter of 3.6 mm. and a thickness of 1.2 mm.

The embryonic apparatus consists of a smaller, subcircular chamber with diameters of 160 x 220 μ which is almost surrounded by a larger chamber with diameters of 220 x 360 μ. At the point of attachment of the two chambers the wall of the inner chamber forms the outer boundary of the embryonic chambers for a distance of 100 μ.

The annuli of equatorial chambers are irregular in plan. The radial chamber walls in adjacent annuli alternate in position and the annular stolon is on the proximal side of the chambers. Equatorial chambers near the center of the test are nearly square with radial diameters of about 30 μ and tangential diameters of about 25 μ. The equatorial chambers at the periphery are larger and rectangular with radial diameters of about 80 μ and tangential diameters of about 20 to 30 μ. As the annuli are irregular there is considerable difference in size of the equatorial chambers within one zone of the test. The measurements given are average ones.

Measurements of three vertical sections follow:

Specimen	1	2	3
Diameter	1.84 mm.	2.2 mm.	2.88 mm.
Thickness	0.84 mm.	0.92 mm.	0.86 mm.
Number of lateral chambers on each side of equatorial layer	8	12, one side 25 16, the other	
Embryonic chambers:			
Length	320 μ	160 μ	220 μ
Height	220 μ	120 μ	180 μ
Height of equatorial layer:			
At center	20 μ	20 μ	20 μ
At periphery	20 μ	30 μ	20 μ
Length of lateral chambers	60-90 μ	60-120 μ	120 μ
Height of lateral chambers	5 μ	5 μ	10 μ
Thickness of roofs and floors	20-30 μ	20 μ	20 μ
Surface diameter of pillars	120-220 μ	60-120 μ	40-140 μ

The opening of the lateral chambers is slitlike between thick roofs and floors. The chambers are in places arranged in rather regular tiers, elsewhere they overlap from one tier to another.

Locality.—1266.

Remarks.—In the preliminary study of these specimens certain features recalled *D.* (*Discocyclina*) *californica* Schenck[11]. However, that species is a larger, more robust form with more lateral chambers to a tier. The Cuban specimens more nearly resemble *D.* (*Discocyclina*) *mestieri* described by Vaughan from random thin sections made from blocks in the Joes River mudflows of Barbados where it occurs in association with *D. barkeri.*

A larger, more robust specimen (figure 4, Plate 7) without a rim is assigned tentatively to this species which appears to be a somewhat variable one from the specimens assigned without question.

Discocyclina (Discocyclina ?), sp. Plate 7, figs. 1, 8

The genus *Hexagonocyclina* was created by Miss Caudri[12]

[11] Schenck, Hubert G.: Trans. San Diego Soc. Nat. Hist., 1929, vol. 5, No. 14, pp. 224-227, pl. 27, figs. 3, 4, 6; pl. 28, figs. 2-6; pl. 29; pl. 30, figs. 2, 3.

[12] Caudri, C. M. Bramine: Bull. Amer. Paleont., vol. 28, No. 114, 1944, pp. 12, 13.

with *Discocyclina cristensis* (Vaughan) as the genotype. One of the characteristics of this genus was the possession of hexagonal-shaped equatorial chambers. Vaughan[13] restudied *D. cristensis* and decided that it is generically correctly placed under *Discocyclina*. He recommends that *Hexagonocyclina* be placed as a synonym of *Discocyclina*.

Two species are known to possess such hexagonal equatorial chambers, namely, *D. cristensis* (Vaughan) and *D. meandrica* Caudri. One horizontal section in the present collection had equatorial chambers of hexagonal shape. Unfortunately this was the only specimen found. It is figured for future reference.

Subgenus **ASTEROCYCLINA** Gümbel, 1870

Discocyclina (Asterocyclina) habanensis Cole and Bermudez, n. sp.

Plate 5, figs. 1-6

Test stellate, with five or six rays. There is a small central umbo with a diameter of about 0.5 mm. which is thickly studded with strong, raised papillæ with diameters of about 100 μ. From this umbo the raised rays radiate. The rays are narrower at their juncture with the umbo and gradually widen as they approach the periphery of the test and project slightly beyond the general periphery. The rays are ornamented with small, very slightly raised papillæ. The interray areas are flat and unornamented. Diameter, about 2.8 mm.; thickness at center 0.5 to 0.6 mm.

The embryonic chambers are nephrolepidine type with a small, subcircular initial chamber with diameters of 40 x 55 μ partially embraced by a larger chamber with diameters of 30 x 80 μ. There is a ring of periembryonic chambers, the main chambers of which are two long, narrow, curved chambers whose ends meet at a line drawn through the center of the embryonic chambers at right angles to the partition between the two embryonic chambers. The other ends of these principal periembryonic chambers extend beyond the ends of the chamber wall separating the initial from the second chamber. Three smaller chambers complete the ring of periembryonic chambers.

The equatorial chambers in the interray areas are small and

[13] Vaughan, T. Wayland; Geol. Soc. Amer., Mem. 9, 1945, pp. 74-76.

nearly square with diameters of about 20 μ. The equatorial chambers in the rays are rectangular. Those near the periphery in a ray have radial diameters of about 55 μ and tangential diameters of about 20 μ. The equatorial layer is thin, about 5 μ high and virtually constant from the center to the periphery of the test.

There are about 10 lateral chambers to a tier on each side of the equatorial layer at the center of the test. The openings of these chambers are slitlike between fairly thick roofs and floors. There is a regular decrease in the number of lateral chambers from the center of the test toward the periphery. The interray areas have about three layers of lateral chambers over the equatorial layer. Some of the lateral chambers are in regular tiers, but more commonly there is irregularity and overlap. Lateral chambers over the center of the test and at the outside have a length of about 60 μ, a height of 5 μ and are between floors and roofs 5 to 15 μ thick.

Heavy, wedge-shaped pillars occur in the central area. These pillars have a surface diameter of 120 to 160 μ.

Locality.—1266.

Remarks.—This species differs from *D.* (*Asterocyclina*) *barbadensis* Vaughan by possessing more appressed lateral chambers and stronger pillars.

Genus **PSEUDOPHRAGMINA** H. Douvillé, 1923

Subgenus **PROPOROCYCLINA** Vaughan and Cole, 1940

Pseudophragmina (Proporocyclina) cedarkeysensis Cole

Plate 7, figs. 6, 7

Pseudophragmina (*Proporocyclina*) *zaragosensis* Cole, 1942, Florida Geol. Survey, Bull. 20, pp. 46-48, pl. 13, figs. 1-5; pl. 14, figs. 1-5 (not *Discocyclina zaragosensis* Vaughan, Proc. U. S. Nat. Museum, vol. 76, art. 3, pp. 13, 14, pl. 4 figs. 1-3, 1939).

Pseudophragmina (*Proporocyclina*) *cedarkeysensis* Cole, 1944, Florida Geol. Survey, Bull. 26, pp. 81-83; pl. 2, fig. 13; pl. 18, fig. 9; pl. 26, figs. 1-4; pl. 27, figs. 1, 2.

Discocyclina (*Discocyclina*) *blanpiedi* Cole, 1944, Florida Geol. Survey, Bull. 26, p. 75, pl. 3, fig. 3; pl. 6, fig. 19; pl. 26, fig. 8; pl. 27, fig. 4; pl. 28, figs. 3-5 (not *Discocyclina blanpiedi* Vaughan, Jour. Paleont., vol. 10, No. 4, pp. 254-256, pl. 41, fig. 1-7, 1936).

Certain specimens from the Hilliard Turpentine Company well, Nassau County, Florida, were assigned to *Discocyclina* (*Discocyclina*) *blanpiedi* Vaughan by Cole. The assignment of these

specimens to this species was incorrect inasmuch as they belong to the genus *Pseudophragmina*, subgenus *Proporocyclina*. *D. blanpiedi* is in the subgenus *Discocyclina*.

Restudy of these specimens leads to the belief that they represent thinner representatives of the species *cedarkeysensis*. A vertical section from the Hilliard Turpentine Company well from a depth of 1745-1752 feet is figured on Plate 7, figure 7, for comparison with an isolated specimen in the Cuban collection.

The Cuban specimen although more compressed than any specimens observed by the senior author appears to have the same features as *cedarkeysensis*. Therefore, this specimen is tentatively assigned to this species.

Pseudophragmina (Proporocyclina) cushmani (Vaughan)
Plate 6, figs. 1-4; Plate 7, fig. 9

Discocyclina cushmani Vaughan, 1929, Proc. U. S. Nat. Museum, vol. 76, art. 3, pp. 11-13, pl. 3, figs. 1-4.
Pseudophragmina (Proporocyclina) cushmani Vaughan, 1945, Geol. Soc. Amer., Mem. 9, pp. 94, 95, pl. 38, figs. 1-3a.

Test circular in plan with a small, pronounced, sharply defined, circumvallate, dome-shaped umbo outside of which there is a flat, thin rim. Surface ornamentation consists of small papillae on the umbo and rim. Only two specimens were available for measurements. One of these has a semidiameter of 2 mm., the other has a diameter of 2.7 mm. with a thickness through the center of the umbo of 0.66 mm. The umbo on this specimen has a diameter of 0.9 mm. and the thickness of the rim is 0.34 mm.

The embryonic apparatus is nephrolepidine in type. The initial chamber is nearly circular with a diameter of 60 μ. The distance across both chambers is 140 μ. In the available vertical section the embryonic chambers have a length of 200 μ and a height at the highest portion of 120 μ.

The annular stolons are on the distal side of the radial chamber walls. The radial chamber walls are in alignment and some of them are slightly wavy. Many of the radial chamber walls bifurcate nearly at their proximal ends. Near the center the

equatorial chambers are either square with radial and tangential diameters of about 20 μ, or tangentially elongated with radial diameters of about 20 μ and tangential diameters of 30 to 40 μ. At the periphery the equatorial chambers are radially elongate with radial diameters of 100 μ and tangential diameters of about 20 μ. The equatorial layer is thin, with the internal height of the equatorial chambers about 5 μ. There is no increase in height of the equatorial layer toward the periphery of the test.

The lateral chambers are slitlike, appressed, between thick roofs and floors. On each side of the equatorial layer at the center of the test there are about 12 layers of lateral chambers, but in the rim portion of the test there are only five layers of lateral chambers. Between pillars the lateral chambers are in regular tiers, but elsewhere they overlap and are irregular in arrangement. The average length of a lateral chamber is 40 μ. These chambers have a height of about 5 μ. Roofs and floors have a thickness of about 20 μ.

Wedge-shaped pillars are irregularly scattered throughout the test. Those in the umbonal area have diameters from 80 to 100 μ and those in the rim have diameters from 60 to 100 μ.

Locality.—1266.

Remarks.—*P.* (*Proporocyclina*) *cushmani* has a very distinctive shape with the small, pronounced umbo surrounded by a depressed area and a wide, relatively thin brim. The major difference between the type specimens and the Cuban forms referred to this species is that in the specimens from Cuba the lateral chambers are more appressed and the roofs and floors of these chambers are slightly thicker. As there is variation in this feature there does not seem to be sufficient distinction to separate the Cuban forms from the typical.

Pseudophragmina (Proporocyclina) habanensis Cole and Bermudez, n. sp.
Plate 6, figs. 5-8

Test evenly lenticular, thickest in the center and sloping regularly to the bluntly rounded periphery. Surface ornamentation consists of small, very slightly raised papillæ which are scattered rather regularly over the surface of the test except for a narrow peripheral zone. The diameter of megalospheric individuals is from 1.8 mm. to 2.7 mm. and the thickness at the center is from

0.48 mm. to 0.88 mm. Measurement of the three vertical sections illustrated are:

	Plate 6, figure 5	Plate 6, figure 6	Plate 6, figure 7
Thickness	0.62 mm.	0.48 mm.	0.88 mm.
Diameter	2.0 mm.	2.14 mm.	2.7 mm.

The embryonic apparatus consists of a circular initial chamber which is partially embraced by a second, reniform chamber. A specimen with a diameter of 1.8 mm. has an initial chamber with an internal diameter of 60 μ and a second chamber with internal diameters of 55 x 140 μ. Another specimen with a diameter of 1.6 mm. has an initial chamber with an internal diameter of 100 μ and a second chamber with internal diameters of 80 x 180 μ. In vertical section the embryonic chambers have a height of 120 μ and a length of 240 μ in one specimen and a height of 80 μ and a length of 220 μ in another.

The equatorial chambers have wavy, radial chamber walls with the annular stolon on the distal side. The radial chamber walls are in alignment. Equatorial chambers near the periphery have radial diameters of about 40 μ and tangential diameters of 20 to 30 μ. In vertical sections the equatorial layer is relatively thin, but pronounced. At the center the equatorial chambers have an internal height of about 20 μ. There is a very slow and slight increase toward the periphery in the internal height of the equatorial layer. At the periphery the height is usually about 40 μ, but one specimen had chambers with a height of 50 μ.

The laterals over the center may be from 8 to 14 in number, a specimen with a thickness of 0.48 mm. has 8 on each side of the embryonic apparatus, another with a thickness of 0.62 mm. has 11 and the third with a thickness of 0.88 mm. has 14. The opening of the lateral chambers is low, appressed near the equatorial layer, but the opening becomes higher toward the periphery. Normal, peripheral lateral chambers at the center have a length of 80 to 100 μ. The chambers may have an internal height of 10 to 20 μ with floors and roofs of a thickness of 5-10 μ. The chambers with the greatest height have the thinnest floors and roofs. The lateral chambers are in regular tiers between the pillars, but elsewhere they overlap.

Pillars are irregularly present. In some specimens they appear on one side of the equatorial layer and not on the other.

The surface diameter of the pillars is from 80 to 120 μ.

Locality.—1266.

Remarks.—The equatorial section of this species resembles that of *P. (Proporocyclina) tobleri* Vaughan and Cole.[14] The chief differences are those of the vertical sections. The equatorial layer of *tobleri* appears as virtually a line and the lateral chambers are more appressed with thicker roofs and floors than those of *habanensis*. *P. tobleri* does not possess pillars according to the type description.

The Cuban specimens were at first referred to *P. tobleri*, but on detailed analysis it was decided to create a new species, noting, however, the similarity between typical *tobleri* and the forms under discussion.

The type locality of *tobleri* was thought to be uppermost Eocene, overlying the typical Jacksonian of Soldado Rock. Recently, Miss Caudri[15] has suggested that *P. tobleri* and its associated species may represent a reworked fauna at Soldado Rock and that their actual occurrence is fairly low in the Eocene.

[14] Compare figure 8, Plate 6 with figure 3, plate 22, Geol. Soc. Amer., Sp. Paper 30, 1941.

[15] Caudri, C. M. Bramine: Bull. Amer. Paleont., vol. 28, No. 114, 1944, pp. 35, 36.

EXPLANATION OF PLATE 1 (14)

Figure — Page

1-3, 7, 9. **Coskinolina floridana** Cole — 6
Fig. 1, portion of an axial section to illustrate the chambers of the marginal trough; 2, 3, horizontal sections; 7, 9, axial sections; 1-3, 7, 9, ×37.

4. **Lituonella**, sp. — 6
Axial section, ×37.

5, 8. **Dictyoconus americanus** (Cushman) — 7
Fig. 5, an axial section of a specimen which possibly represents this genus and species; 8, horizontal section of a specimen which shows the characteristics of this species; 5, 8, ×37.

6. **Dictyoconus cookei** (Moberg) — 7
Axial section showing certain of the chambers of the marginal trough area with single horizontal plates extending into the chambers, ×37.

All specimens are from station 1266 unless specified in the explanation of the plate. Thin sections and all the photomicrographs were made in the Cornell University Paleontological Laboratory by the senior author.

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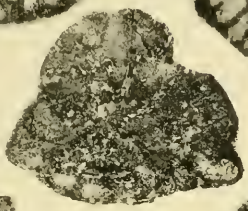

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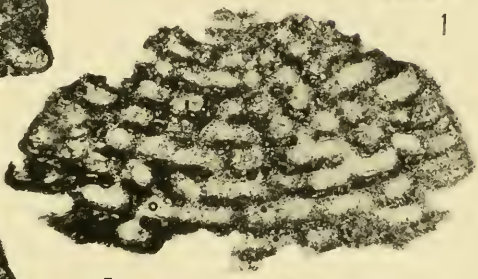

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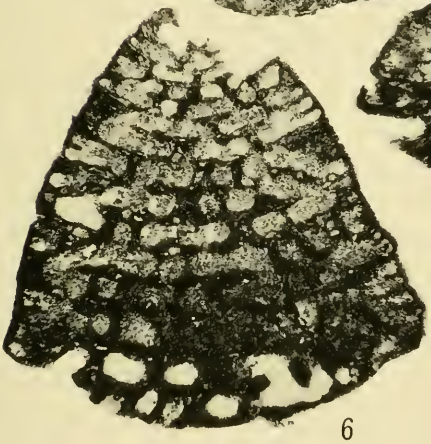

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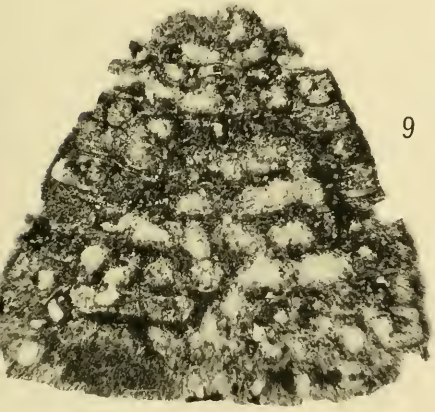

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EXPLANATION OF PLATE 2 (15)

Figure		Page
1-9.	**Boreloides cubensis** Cole and Bermudez, n. gen. and n. sp. Fig. 1, external view of the holotype (Cole Collection, No. 410); 2, 7-9, transverse sections; 3-5, axial sections; 1, ×15; 2-9, ×37.	9
10,11	**Miscellanea antillea** (Hanzawa) Fig. 10, median section; 11, transverse section; 10, ×16; 11, ×37.	7

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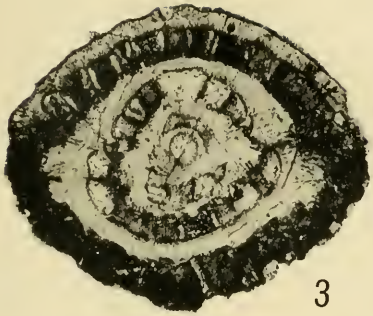

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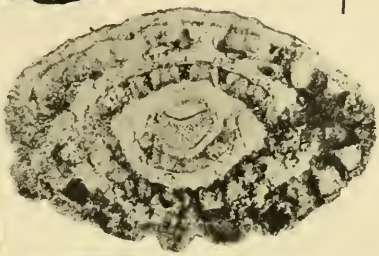

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EXPLANATION OF PLATE 3 (16)

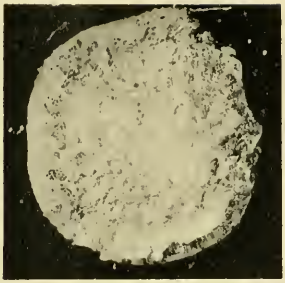
Figure — Page

1, 2. **Miscellanea tobleri** Vaughan and Cole — 8
Fig. 1, external view to illustrate the ornamentation; 2, median section of the same specimen; 1, 2, ×7.

3. **Discocyclina (Discocyclina) mestieri** Vaughan — 14
External view to show the apical crown of papillæ and the general shape, ×15.

4-9. **Cymbalopora cushmani** Cole and Bermudez, n. sp. — 10
Figs. 4, 8, axial sections; 5, 6, 9, transverse sections; 5, section near the apex of the test; 6, 9, sections near the base of the test; 7, external views of two specimens, the specimen on the left shows the ventral view and the specimen to the right illustrates the dorsal view of the holotype (Cole Collection, No. 409); 4, 5, 6, 8, 9, ×37; 7, ×15.

10-13. **Vaughanina cubensis** D. K. Palmer — 11
Fig. 10, horizontal section to illustrate the embryonic apparatus and the general pattern of the equatorial section; 11-13, vertical sections; 10-13, ×37.



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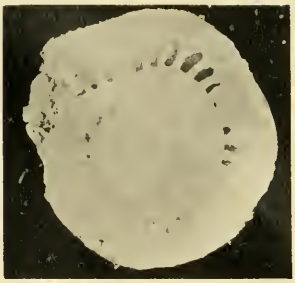

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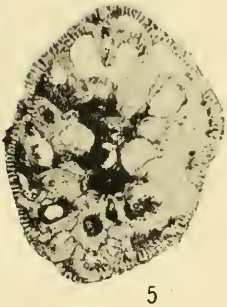

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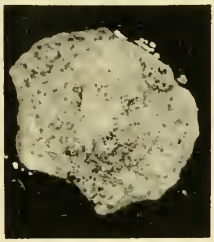

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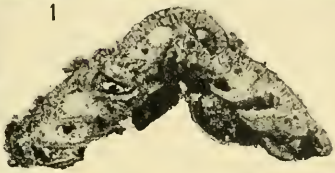

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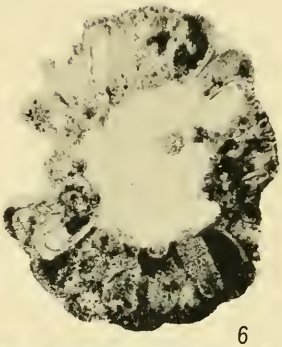

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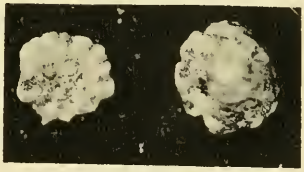

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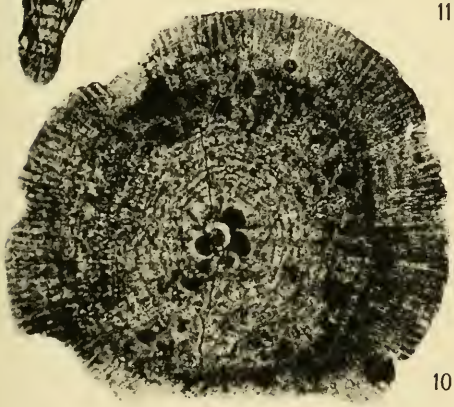

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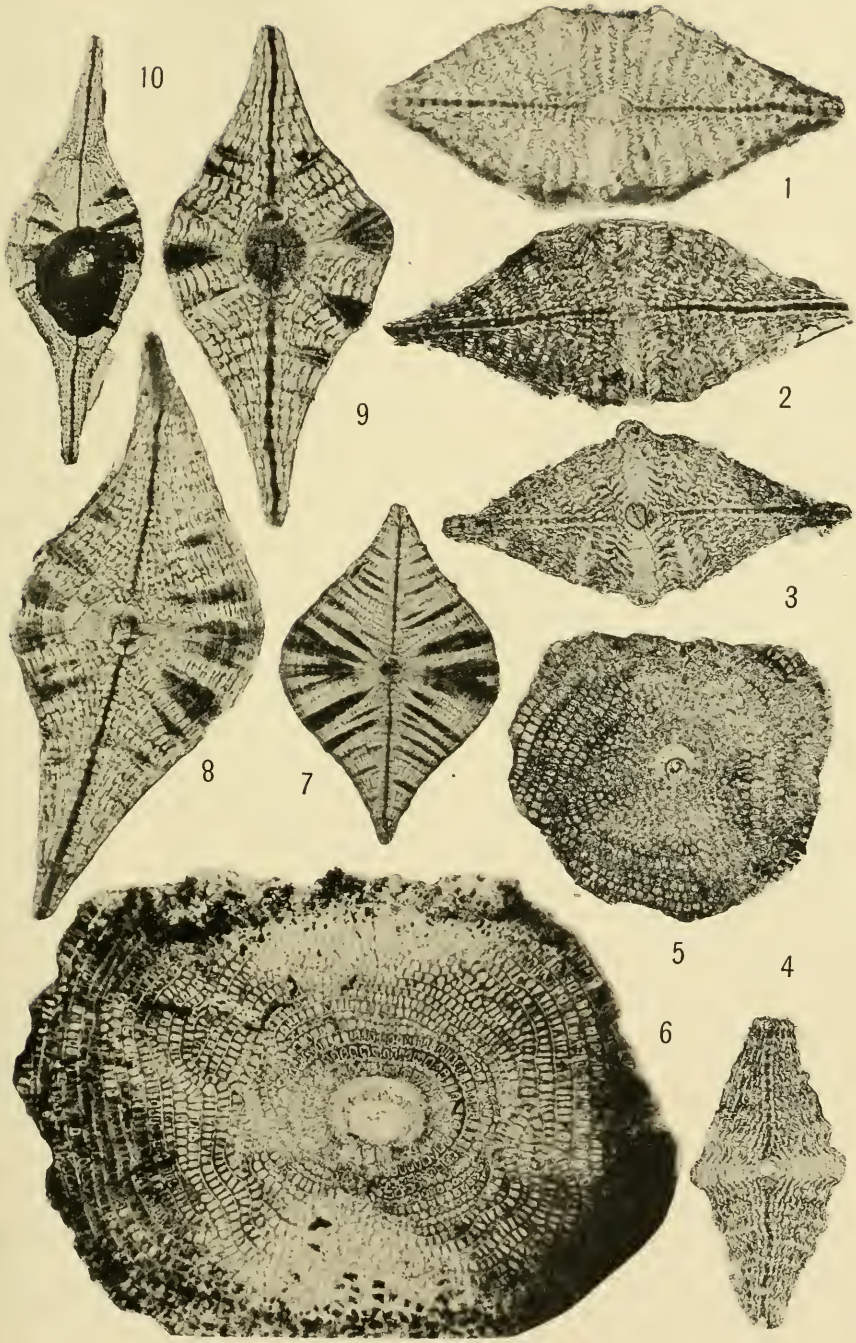
EXPLANATION OF PLATE 4 (17)

Figure Page

1-5. **Discocyclina (Discocyclina) barkeri** Vaughan and Cole 12
Figs. 1-3, 4, vertical sections; 5, horizontal section; 1-5, ×37.

6-10. **Discocyclina (Discocyclina) mestieri** Vaughan 14
Fig. 6, horizontal section; 7-10, vertical sections; 7-9, sections of megalospheric individuals to illustrate slight differences in cross-section, shape, and number of lateral chambers; 10, microspheric individual; 6, 8, 9, ×37; 7, 10, ×16.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EXPLANATION OF PLATE 5 (18)

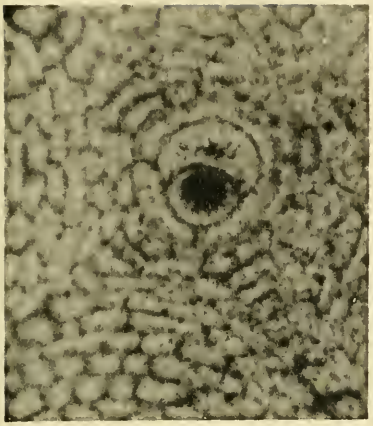
Figure — Page

1-6. **Discocyclina (Asterocyclina) habanensis** Cole and Bermudez, n. sp. 16

Fig. 1, embryonic apparatus of fig. 6 enlarged; 2, external view of the holotype (Cole Collection, No. 406) to illustrate the central, papillate umbo and the five distinct and one faint ray; 3, 4, vertical sections; 5, 6, horizontal sections; 1, ×170; 2, ×15; 3-5, ×37; 6, ×16.

7-10. **Discocyclina (Discocyclina) barkeri** Vaughan and Cole 12

Fig. 7, vertical section of a specimen with open lateral chambers and small pillars (compare with figure 5, plate 18, Geol. Soc. Amer., Sp. Paper 30); 8, horizontal section, the second chamber partially embraces the first; a crack in the calcite filling gives the impression of a divided second chamber in the illustration; 9, horizontal section; 10, enlargement of the embryonic apparatus of the specimen figured as 9; 7-9, ×37; 10, ×170.



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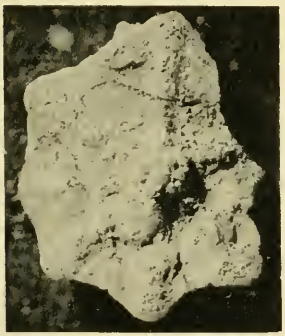

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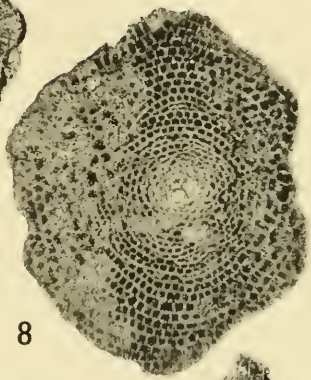

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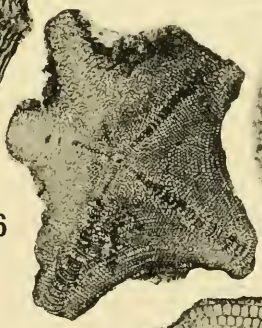

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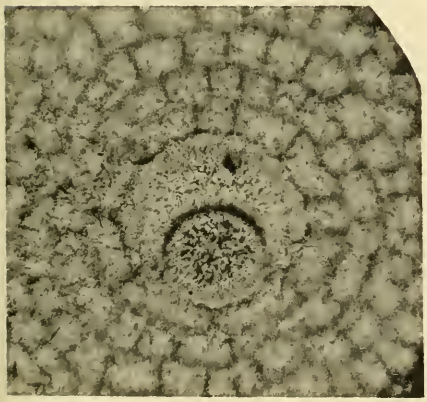

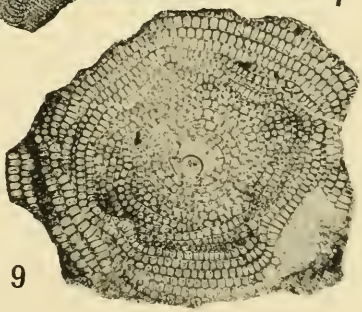

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EXPLANATION OF PLATE 6 (19)

Figure — Page

1-4. **Pseudophragmina (Proporocyclina) cushmani** (Vaughan) — 18

Figs. 1, 2, horizontal sections to illustrate the embryonic apparatus and the equatorial chambers which have their radial walls in alignment and are wavy; 1, is an enlargement of a portion of fig. 2; 3, 4, vertical sections; 4, is an enlargement of fig. 3; 1, 4, ×37; 2, 3, ×16.

5-8. **Pseudophragmina (Proporocyclina) habanensis** Cole and Bermudez, n. sp. — 19

Fig. 8, horizontal section of a paratype (Cole Collection, No. 407); 5-7, vertical sections; 7, a slightly larger specimen than represented by figs. 5 and 6, but apparently the same species; 5, paratype (Cole Collection, No. 408); 5-8, ×37.

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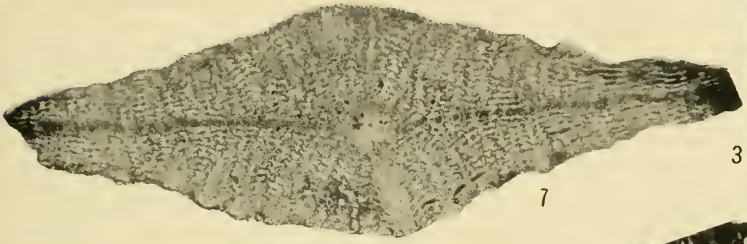

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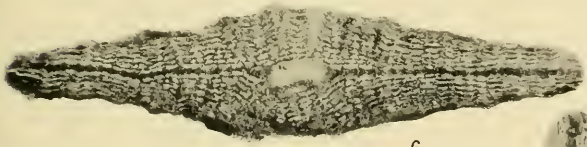

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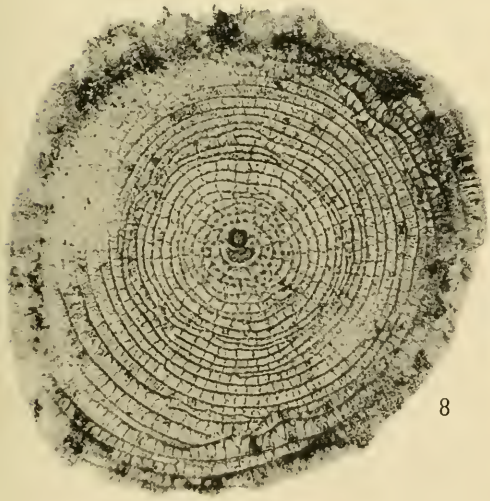

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EXPLANATION OF PLATE 7 (29)

Figure Page

1, 8. **Discocyclina (Discocyclina?), sp.** 15
Fig. 1, enlarged portion of 8 to illustrate the hexagonal shape of the equatorial chambers; 8, median section; 1, ×170; 8, ×37.

2. **Eoäictyoconus cubensis** (Cushman and Bermudez) 11
A portion of the embryonic apparatus and the wall surrounding it to illustrate the similarity in the structure of the wall with that of *Cymbalopora cubensis* Cole and Bermudez, n. sp. This specimen came from Nuevitas, Cuba. 2, ×170.

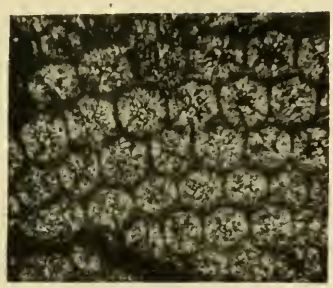
3. **Cymbalopora cubensis** Cole and Bermudez, n. sp. 10
A portion of the wall of the specimen, ×170, illustrated as figure 8, Plate 3, of this article to demonstrate the coarsely perforate structure of the wall.

4. **Discocyclina (Discocyclina) mestieri** Vaughan 14
Vertical section of an inflated specimen which has many of the characteristics of *mestieri*; ×37.

5. **Boreloides cubensis** Cole and Bermudez, n. gen. and n. sp. 9
External view of three specimens; ×15.

6, 7. **Pseudophragmina (Proporocyclina) cedarkeysensis** Cole 17
Figs. 6, 7, vertical sections; 7, specimen from the Hilliard Turpentine Company well, Nassau County, Florida, at a depth of 1745-1752 feet introduced for comparison with the single section, fig. 6, available from Cuba which seems to be the same species; 6, 7, ×37.

9. **Pseudophragmina (Proporocyclina) cushmani** (Vaughan) 18
Enlargement, ×170, of a portion of the vertical section illustrated as figure 3, Plate 6, of this article to show the equatorial layer and lateral chambers in detail.



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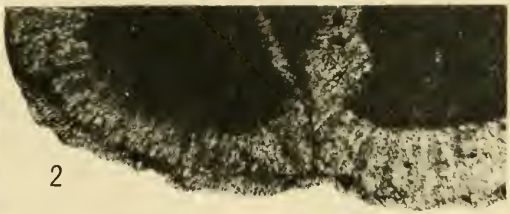

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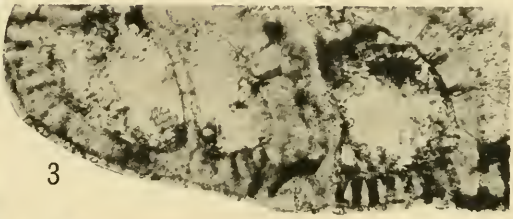

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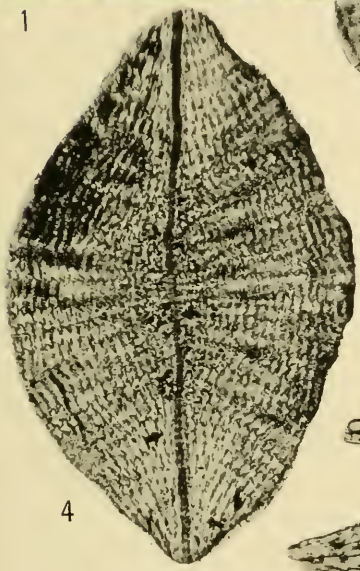

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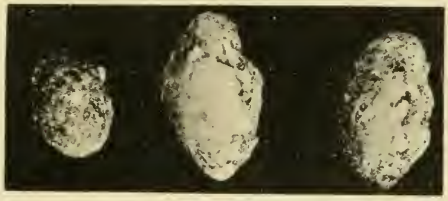

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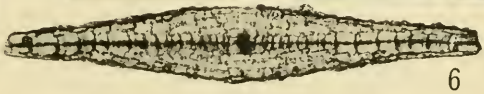

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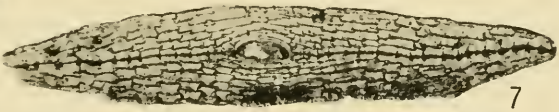

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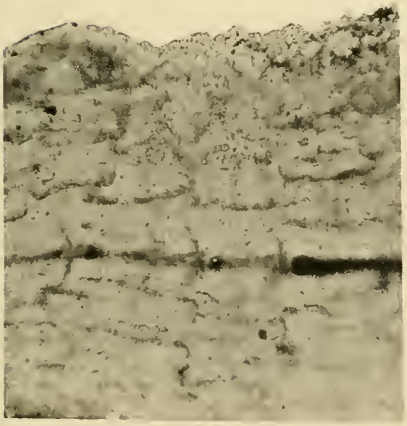

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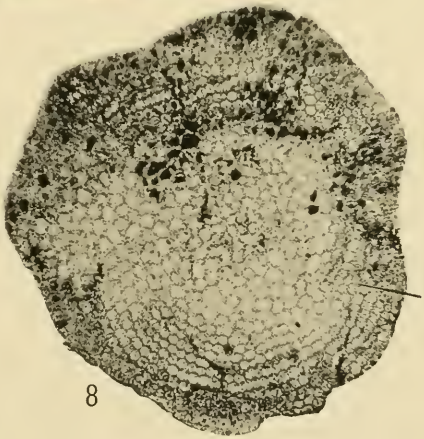

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