CONTRIBUTIONS
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CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH

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151. BRONNIMANNELLA, TAPPANINA, AND TRACHELINELLA, THREE NEW FORAMINIFERAL GENERA FROM THE UPPER CRETACEOUS

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Studies of Upper Cretaceous Foraminifera, both from the Northern Apennines (Italy) and from the collections in the U. S. National Museum were made by the writer during her recent stay in Washington, D.C. In the foraminiferal faunas investigated by the writer, three well known species of the family Heterohelicidae Cushman were considered to be sufficiently distinct as to require new generic names. Leaving aside for the present any discussion of the inconsistency of this somewhat heterogeneous family of Cushman, only the description and illustration of the new genera are given here.

Acknowledgments. The present study was made possible by a grant from the Italian Research Council and a Fulbright travel award, which allowed the writer to visit Washington, D. C. The writer wishes here to acknowledge her gratitude to all the authorities concerned in those awards. The writer is much indebted to Dr. Alfred R. Loeblich, Jr., for his aid and assistance during her stay and work in the U. S. National Museum and also to Dr. Helen Tappan Loeblich who has kindly read the manuscript, giving many suggestions.

Illustrations for the present paper are camera lucida drawings made by Lawrence Isham, Scientific illustrator, U. S. National Museum.

SYSTEMATIC DESCRIPTIONS

Family HETEROHELICIDAE Cushman

Subfamily HETEROHELICINAE Cushman

Genus **Bronnimannella** Montanaro Gallitelli, new genus

Plate 7, figs. 1, 2

Bronnibrownia Montanaro Gallitelli, 1955, Accad. Sci. Lett. Arti Modena, ser. 5, vol. 13, pp. 5, 10, 12 (*nomen nudum*).

Type species.—*Gümbelina plummerae* Loetterle, 1937.

Diagnosis.—Test calcareous, generally coiled in the early stage, later biserial, cuneiform, chambers rapidly increasing in size as added. Later chambers increase very rapidly in thickness and become comparatively strongly compressed laterally, so that the original proportion of breadth to thickness is inverted, reaching an extreme of 1:4. The last chamber may be deflected from the normal biserial alignment and become nearly central in position. Aperture broad, becoming almost linear in the most appressed forms. Aberrant forms may have an additional smaller aperture at the top of the last chamber.

Types and occurrence.—Holotype from the Upper Cretaceous, Niobrara formation, along the north bluff of the Smoky Hill River, 1 mile west and 12 miles north of Arnold, Kansas.

Hypotype of figure 1 (Cushman Coll. 24384) from the Upper Cretaceous, Upper Taylor, in a road cut, 0.9 mi. N. of Lake City, Delta County, Texas.

Hypotype of figure 2 (U.S.N.M. P4478) from the Upper Cretaceous, Upper Taylor, on Brushy Creek, 2.3 miles W. by N. of Coupland, Williamson County, Texas.

Discussion.—The new generic name is dedicated to Bronnimann, who with Brown, first noted distinctive generic characters in *"Gümbelina" plummerae.*

The early stage suggests the relationship with *Heterohelix* but in the mature test there occurs a gradual but complete change in the proportion of breadth to thickness.

Certain specimens of this species were identified by Cushman as *Pseudotextularia varians* Rzehak. However, the form of the test is constantly very appressed, with extreme specimens having the proportion of breadth to thickness of 1:5. Possibly another species could be separated from *Bronnimannella plummerae* (Loetterle), representing the maximum lateral constriction, but a careful investigation of several hundred specimens of the species *plummerae* did not show any

sharp discontinuity between the moderately and strongly compressed specimens, although the two extremes look quite different in shape. The ornamentation consists of similar axial ridges, sometimes more prominent in the young stage and the initial coil is frequent, both in the less and in the more compressed forms. Also the deflection of the final chamber to a central position is found in specimens of both extremes of the lateral compression.

In conclusion, constant characters of this genus are 1) a distinctive lateral compression of the test, of great or lesser intensity, culminating in an inversion of the usual proportion of breadth: thickness as known for the Heterohelicidae; and 2) a biserial arrangement of the adult chambers.

Bronnimannella differs from *Ventilabrella* in the inversion of the proportions of lateral compression of the test, and also because of the absence of chamber proliferation. *Pseudotextularia* is separated from the present genus in the conical shape (proportion of breadth: thickness = 1:1) and in having a crown of chamberlets at the top of the test.

The perfect preservation and the normal increase in the young stage of all the specimens exclude the possibility of mechanical deformation of the test during fossilization.

Kikoïne (1948, pl. 1, figs. 5 and 8) figured specimens of this genus from the Upper Cretaceous of Hendaye and Gan (Southern Pyrenees). He interprets the specimen of his fig. 8 as a new variety of *"Gümbelina" striata* (Ehrenberg), *G. striata* var. *deformis* Kikoïne, and noted that this variety represents "l'aboutissement de l'evolution de *G. Plummerae*", and that only the ornamentation (sic) of the variety is comparable with the species *striata*. The figures given by Kikoïne clearly show his form to be identical with *Bronnimannella plummerae*, which leads us to consider his variety invalid and to correct the specific identification.

Subfamily BOLIVINITINAE Cushman

Genus **Tappanina** Montanaro Gallitelli, new genus

Plate 7, figs. 3, 4.

Tappanina Montanaro Gallitelli, 1955, Accad. Sci. Lett. Arti di Modena, ser. 5, vol. 13, p. 18. (*nomen nudum*).

Type species.—*Bolivinita selmensis* Cushman, 1933.

Diagnosis.—Test biserial, rectangular or rhomboidal or deformed in transverse section. Chambers depressed cuneiform, apparently concave on the broad sides, more or less inflated laterally, with a well developed and sometimes fringed or lamellar carina, which is horizontal or arched on the lateral margin, then deflected and paralleling the long axis of the chambers. Sutures thin, depressed, straight or arched. Wall calcareous, finely perforate. Surface appears rough when carinae are strongly developed. Aperture narrow, elongate, at the center of the base of the last chamber. Range: Upper Senonian to Paleocene.

Discussion.—The cuneiform shape of the adult chambers, with laterally sub-horizontal or arched carinae, the deflection of the carinae on the broader faces, giving a rectangular transverse section to the test, and the independence of the carinae from the sutures are constant characters of this genus. Variable characters are the lateral convexity of the chambers, the development of the carinae and the more or less angular deflection at the beginning of the broader faces, and the deformation of the test in section, from rectangular to rhomboidal or elliptical.

The group of forms allied to the type species, *"Bolivinita" selmensis,* have fundamentally different characters than do either *Bolivinita* Cushman or *Bolivinitella* Marie. The presence of strong horizontal carinae, the narrow and deep sutures, the degeneration of the four axial lamellar sutural costae characteristic of *Bolivinita* and *Bolivinitella* into discontinuous thickenings and the character of the aperture are distinctive elements peculiar to the genus *Tappanina.*

Neither Cushman nor later authors who examined specimens of this widespread species (*Tappanina selmensis* has been found in the Upper Cretaceous and Paleocene of Europe also) recognized the actual distinction between the lateral thin sutures and the strongly developed horizontal arched carinae, which are relatively close to the preceding suture, and which give the tectiform appearance to the test.

The description of *"Bolivinita" selmensis* given by Cushman is as follows: "test minute, gently tapering from the subacute initial end, broad faces distinctly concave, the narrow sides strongly convex; chambers distinct, increasing gradually in size as added; sutures distinct; somewhat limbate; wall smooth, very finely perforate, especially in the middle of the chambers on the flattened faces; aperture narrow, at the inner margin of the last-formed chamber". An analogous description is

given for the very similar *"Bolivinita" costifera* (Cushman, 1931, Contr. Cushman Lab. For. Research, vol. 13, p. 105, pl. 15, fig. 15): "Test small. about twice as long as broad, gradually tapering slightly to the apertural end, periphery broadly rounded, strongly serrate in front view, in transverse section somewhat rhomboid, broader faces flattened or concave; chambers very distinct, increasing gradually in size as added, earlier ones flattened or compressed, later ones concave on the broader faces and convex on the periphery, greatly increasing in thickness; sutures distinct, slightly curved in early stage, more strongly so in the adult, slightly limbate; wall smooth and polished, except for the basal angle of the chamber in the adult which has a sharp angle which may develop into a raised costa-like ridge; aperture narrow, elongate, at the base of the inner margin of the apertural face". The holotypes of both the species *selmensis* and its variety *costifera* are here refigured, together with specimens from other localities, in order to show their true generic characters. (Plate 7, figs. 3, 4, and 5-7).

Tappanina is named in honor of Mrs. Helen Tappan (Mrs. A. R. Loeblich), Washington, D.C., in recognition of her contributions to the knowledge of Cretaceous Foraminifera.

Tappanina selmensis (Cushman)

Plate 7, figs. 3, 4.

Bolivinita selmensis Cushman, 1933, Contr. Cushman Lab. Foram. Research, vol. 9, p. 58, pl. 7, figs. 3, 4; Cushman, 1946, U. S. Geol. Surv. Prof. Paper 206, pp. 114-115, pl. 49, fig. 1 (not fig. 2).—Brotzen, 1948, Sver. Geol. Undersok., ser. C, n. 493, p. 56, pl. 9, fig. 7, text fig. 16.

Test minute, biserial, tapering to the initial end, slender in microspheric forms, nearly rectangular in transverse section. Broad faces generally somewhat concave in the adult stage, narrow sides convex and horizontally carinate. Chambers distinct, 8 to 11 in number, increasing gradually in size as added, flattened or compressed, biserially arranged with angle approximately 120°, tectiform in the narrow sides, somewhat carinate lengthwise on the broader faces. Sutures deep, narrow, less prominent in the adult stages because of the strong development of the carinae. The carinae are horizontal or arched or irregularly undulate at the narrow sides, sometimes fringed. Carinae absent in the earliest stage on the broad faces developed in the adult stage, and always forming a distinct angle with the lateral carinae. Final chamber more or less inflated. Aperture narrow, at the base of the final chamber, elongated perpendicular to the preceding suture.

Types and occurrence.—Holotype (Cushman Coll. 19043) from the Upper Cretaceous Selma chalk; New Corinth highway, 13.5 miles S. of Selmer, McNairy County, Tennessee.

Stratigraphic and geographic distribution.—Upper Cretaceous, Serramazzoni, Northern Apennines, Italy; Campanian: Selma chalk, New Corinth highway, Tennessee. Maestrichtian: Arkadelphia, Arkansas; Aguja formation, Mexico (*"Eouvigerina excavata"* Cushman, syn.); Ilskaja, Apscheron, Naltschick, Caucasus (*"Bolivinita" exigua* Glaessner); Kolby Gaard Marl, Denmark (hypotypes U.S.N.M. P.479); Bruderndorf, Wien, Austria (*"Bolivinita" exigua*); Siegsdorf, Bavarian Alps (*"Bolivinita" exigua*). Danien: Sweden.

Paleocene: Midway group. Alabama; Naheola formation, Mississippi; Ystad, Klagshamn, Tygelsjo, Sweden.

Discussion.—The generic description is based on the characters of the holotype of *"Bolivinita" selmensis* which is here refigured. The holotype of *"Eouvigerina" excavata* Cushman, which has also been refigured here, consists of a specimen of *Tappanina selmensis* with the last chamber broken and thus simulating a neck. This confirms the doubt of Brotzen about the validity of the species *excavata.* Only a "paratype" of the species *selmensis,* figured by Cushman and refigured by Brotzen (1948, text figure 16, specimen on the left) is perhaps a true *Bolivinita,* characterized by the slender test, sutures and sculpture, but the absence of other specimens compels a further investigation as to the existence of a toothplate.

Brotzen proposed a list of synonyms for *selmensis*: *B. crawfordensis* Jennings, *B. exigua* Glaessner, *B. "costerifera"* (read *"costifera"*) Cushman. However, after examining many paratypes and hypotypes from the Kemp Clay, the writer believes *Tappanina costifera* to be a valid form although closely related to the type species. *Bolivinita exigua* Glaessner from Upper Cretaceous of the Caucasus appears from the figures and descriptions to be a synonym of *T. selmensis. B. crawfordensis* Jennings of the lower Eocene of New Jersey cannot be satisfactorily compared with *T. selmensis* because of the insufficient description and figure of the former.

Genus **Trachelinella** Montanaro Gallitelli, new genus

Plate 7, figs. 8-10

Trakelina Montanaro Gallitelli, 1955, Accad. Sci. Lett. Arti Modena, ser. 5, vol. 13, p. 5 (*nomen nudum*).

Type species.—*Bolivina watersi* Cushman, 1927.

Diagnosis—Test calcareous, finely perforate, elongate, flaring gradually, commonly twisted as much as 90°, thickest in median line; periphery subacute, generally carinate, or more rarely serrate. First chamber with a basal spine and occasionally two opposing median costae; adult chambers strongly arched. Sutures narrow, arched, deep. Wall calcareous, perforate, smooth. Sculpture well developed, with prominent, rough, somewhat spinose carinae, aligned along the major extension and inflation of the chambers and consequently strongly arched, in general fused at the lateral margins, which become carinate or serrate. Aperture terminal, round or slightly elliptical, with a short neck and a lip. No apertural internal teeth visible, at a magnification of more than 200 diameters.

Type, horizon and locality.—Holotype (U.S.N.M. No. 6119) from the Navarro, Upper Cretaceous (Maestrichtian), Core A-D-1 (Sun Oil Co.), East of Richlands, Navarro County, Texas. Figured hypotypes (U.S.N.M. Nos. P 4480a, b) Upper Cretaceous (Maestrichtian) Upper Navarro, Pit of Seguin Tile and Brick Co., at McQueeny, Guadalupe County, Texas.

Many specimens referred by Cushman to *Bolivina watersi* (namely Cushman Coll. nos. 21477, 32882, 32881, 32886, 32888, 21470), belong to other species, and are true *Bolivina.*

Discussion.—This genus is very abundant in the Upper Navarro, Kemp clay. The holotype of *"Bolivina" watersi* Cushman is a specimen with the apertural neck broken, giving an erroneous *Bolivina*-like appearance. A short apertural neck is visible at high magnification on one of the two broad faces of this specimen.

This abundant species cannot be placed in *Bolivina,* due to the presence of a well developed neck. The apertural neck may relate this form to the Eouvigerininae. The oblique axis of the new genus, the short neck at the base of the last chamber, and the biserial arrangement of the chambers also suggest a relationship with *Bolivinitella,* although the latter genus has a peculiar rectangular section, concave broader faces, and four vertical lamellar costae, features not characteristic of the present genus.

Derivation of name.—From the Greek *trachelos,* neck.

EXPLANATION OF PLATE 7

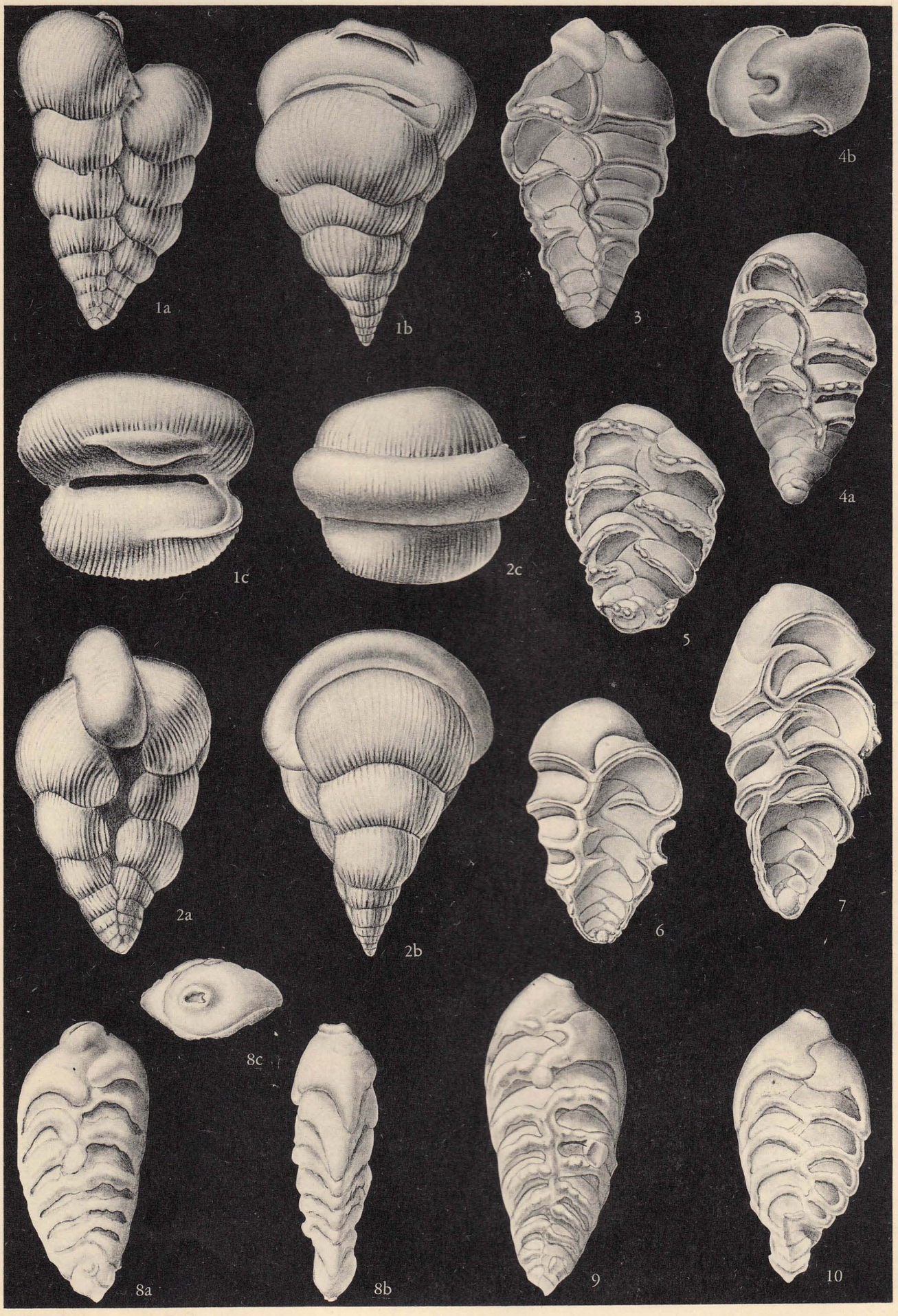
FIGS. PAGE

1,2. *Bronnimannella plummerae* (Loetterle). a, side views; b. edge views; c, top views. 1, Hypotype (Cushman Coll. 24384), from the Upper Taylor of Texas, showing usual appearance of the laterally compressed and very thick test, and elongate, almost linear aperture. x99. 2, Hypotype (U.S.N.M.P4478) from the Upper Taylor of Texas, showing the nearly centrally placed final chamber, commonly found in this species. x79 35

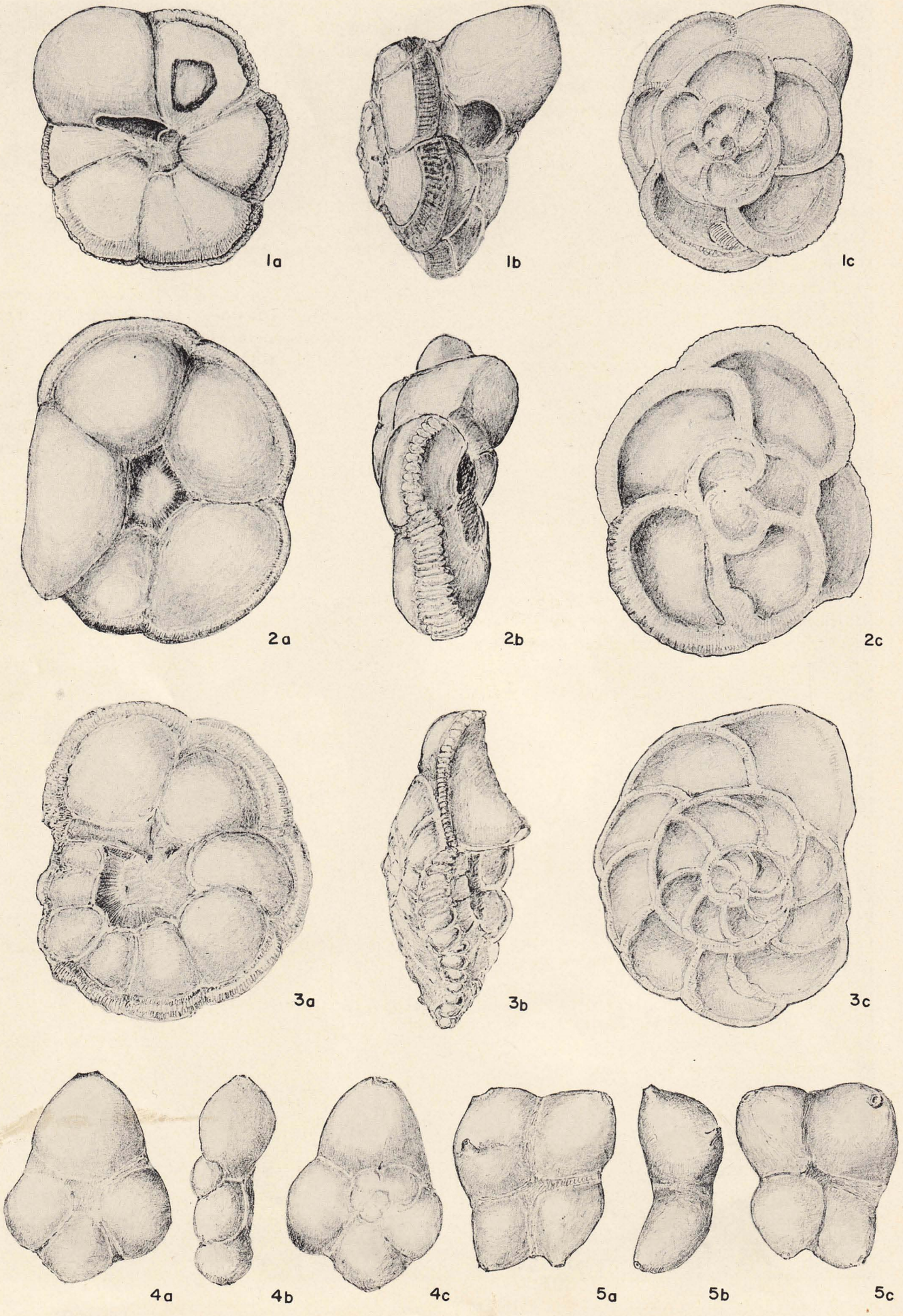
3,4. *Tappanina selmensis* (Cushman). 3, Holotype of *Eouvigerina excavata* Cushman (Cushman Coll. 35717) from the Midway of Alabama. In reality this is *Tappanina selmensis* with a broken final chamber simulating a neck. 4a, Side view of holotype of *Tappanina selmensis* (Cushman), Cushman Coll. 19043, from the Selma Chalk of Tennessee. 4b, top view, x 126 37

5-7. *Tappanina costifera* (Cushman). 5, Side view of hypotype from the Cretaceous of Serramazzoni, northern Apennines, Italy. 6, Side view of hypotype (Cushman Coll. 62196) from the Cretaceous at 1360-1370 feet in Ohio Oil Co. Larry G. Hammond Well No. 1, Salisbury, Maryland. 7, Side view of holotype (Cushman Coll. 24012) from the Arkadelphia clay, 5½ mi. N. E. of Hope, Hempstead County, Arkansas. All x 126 37

8-10. *Trachelinella watersi* (Cushman). 8a, 10, Side views of hypotype (U.S.N.M.P 4480a,b) from the Upper Navarro of Texas. 8b, edge view. 8c, top view, showing terminal aperture. 9, Side view of holotype (Cushman Coll. 6119) from the Upper Cretaceous Navarro of Texas. All x 126 38



Gallitelli: Bronnimannella, Tappanina, and Trachelinella



Küpper: California Upper Cretaceous Pelagic Foraminifera

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EXPLANATION OF PLATE 8

FIGS. PAGE

1 a-c *Globotruncana* (*Praeglobotruncana*) *stephani* (Gandolfi) *turbinata* Reichel, Loc. GGCM, Colusa County, California. 43

2 a-c *Globotruncana* (*Praeglobotruncana renzi*) (Thalmann & Gandolfi) ssp. *primitiva* Küpper, n. ssp., Loc. GGCM, Colusa County, California. 43

3 a-c *Globotruncana,* n.sp. indet.
Loc. DF3 Glenn County, California. 44

4 a-c *Schackoina* sp. cf. *S. gandolfii* Reichel
Loc. DC6, Glenn County, California. 44

5 a-c *Schackoina cenomana* (Schacko) *bicornis* Reichel
Loc. DC6, Glenn County, California 44

Magnification of all figures about 105 x

CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH

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52. UPPER CRETACEOUS PELAGIC FORAMINIFERA FROM THE "ANTELOPE SHALE", GLENN AND COLUSA COUNTIES, CALIFORNIA

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INTRODUCTION

Pelagic Foraminifera belonging to the genera *Globotruncana* and *Schackoina* are described from the "Antelope Shale". They indicate an Upper Cenomanian age (basal Upper Cretaceous) for this formation, which previously was assigned by various authors to either the Lower or Upper Cretaceous without fossil evidence for such an age assignment.

The author is indebted to Dean Milow and Gray Robinson for the material described in this report. Thanks are due to the Shell Foundation for fundamental research in Geology at Stanford University for financial assistance.

STRATIGRAPHY AND LOCATION

The Foraminifera herein described were collected from strata which are usually referred to as the "Antelope Shale", so called in the Guidebook of the Northern California Geological Society (Pacific Section of the A.A.P.G.) Spring, 1954, where it was indicated to be a provisional name used by Taliaferro. Kirby (1943) refers to these strata as "Horsetown Formation in the Shasta Group"; recent unpublished studies of J. Lawton (Stanford University) have resulted in the introduction of a new formational name for this particular unit: "the Fiske Creek Formation". In the following discussion the author uses the term "Antelope Shale" as the most suitable published name, although it is a junior homonym of the "Antelope Formation" (Miocene), subsurface, Kern County, California, described by Noble (1940).

The age of the "Antelope Shale" is disputed. According to Taliaferro (1943), the Horsetown "Stage" in the Shasta "Group" is Lower Cretaceous, which in his usage means younger than Jurassic and older than Upper Albian. Kirby (1943) favors a lower Cretaceous age for the Horsetown without further specification. These age assignments are apparently based on the evidence presented by Anderson (1938, 1943). In 1954 (N.C.G.S., Spring Field Trip, Guide Book) the "Antelope Shale" was for the first time separated from the "Horsetown Group" and correlated with Goudkoff's (1945) Upper Cretaceous "Delevanian" Stage.

This study is based on material from three localities and, although the faunistic composition varies from sample to sample, the pelagic foraminifers indicate that they are late Cenomanian in age. The other Foraminifera do not have such a wide geographic distribution and therefore cannot be used with the same degree of accuracy for correlation purposes.

The samples from which Forminifera were obtained are from the following localities on the Lodoga Quadrangle, California, map of the United States Geological Survey:

Loc. GGCM: 325 feet South, 500 feet West of the North East corner of Sec. 8, T. 17 N., R. 4 W., Mt. Diablo base meridian, Colusa County, California, elevation 325 feet, 1680 feet stratigraphically below the base of the Venado sandstone.

Fauna:

Globotruncana (*Praeglobotruncana*) *stephani* (Gandolfi) *turbinata* (Reichel)

Globotruncana (*Praeglobotruncana*) *renzi* (Thalmann & Gandolfi) ssp. *primitiva* Küpper, ssp. nov.

Globotruncana spp. poorly preserved flat forms, not determinable.

Loc. DF3 : 1050 feet North and 100 feet East of the South West corner of Sec. 20, T. 19 N., R. 4 W., Mt. Diablo base meridian, Glenn County, California, elevation 310 feet, stratigraphically about 2820 feet below the base of the Venado sandstone.

Fauna:

Schackoina cenomana (Schacko) *bicornis* Reichel

Schackoina sp. cf. *S. gandolfii* Reichel

Loc. DC 6: 1000 feet North, 2250 feet East of the South West corner of Sec. 2, T. 18 N., R. 5 W., Mt. Diablo base meridian, Glenn County, California, elevation 560 feet, stratigraphic location about 1650 feet below the base of the Venado sandstone.

Fauna:

Globotruncana (*Praeglobotruncana*) *stephani* (Gandolfi) *turbinata* (Reichel)
Globotruncana, n.sp. indet.
Globotruncana spp. poorly preserved flat forms, not determinable.

AGE

The stratigraphic distribution of the genera and species herein described is not only well known, but they have also been used with considerable success for interregional correlation. Both genera are restricted to the Cretaceous. Stages within this system can be recognized if specific determinations are made.

The stratigraphic distribution of the more common species of the genera *Globotruncana* and *Schackoina* in the stratigraphic interval Aptian—Coniacian is summarized in text figure 1.

According to the literature, *Schackoina* appears for the first time in the Aptian, develops a maximum of species in the Cenomanian; younger species are exceedingly rare. *Schackoina* is not very commonly reported, but this is probably due to its very small size. However, present available information seems to be sufficient to give at least an approximate idea of the stratigraphic distribution of the various species, but the ranges given on textfig. 1 are based on a few observations only. Most of the species need very careful investigation as to their stratigraphic ranges.

The genus *Globotruncana* with its different subgenera and numerous species is much better known stratigraphically than *Schackoina.* More than 20 years of intensive work on this genus is available and some of the more reliable stratigraphic results are summarized in textfig 1.

COMPARISONS

Within California there is only one described faunule with which an exact comparison is possible. C. C. Church (1952) reported on some Foraminifera from the "Franciscan" Calera limestone type locality, Rockaway Beach, San Mateo County, California. In this small faunule the following species were described in some detail:

Globotruncana (*Rotalipora*) *apenninica apenninica* (Renz)
Globotruncana (*Praeglobotruncana*) *stephani* (Gandolfi) *turbinata* (Reichel)
Schackoina cenomana (Schacko) (nomenclature corrected)

Another faunule from the Calera limestone collected near New Almaden, Santa Clara County, was recently reexamined by Küpper (1955) and yielded an entirely different faunule:

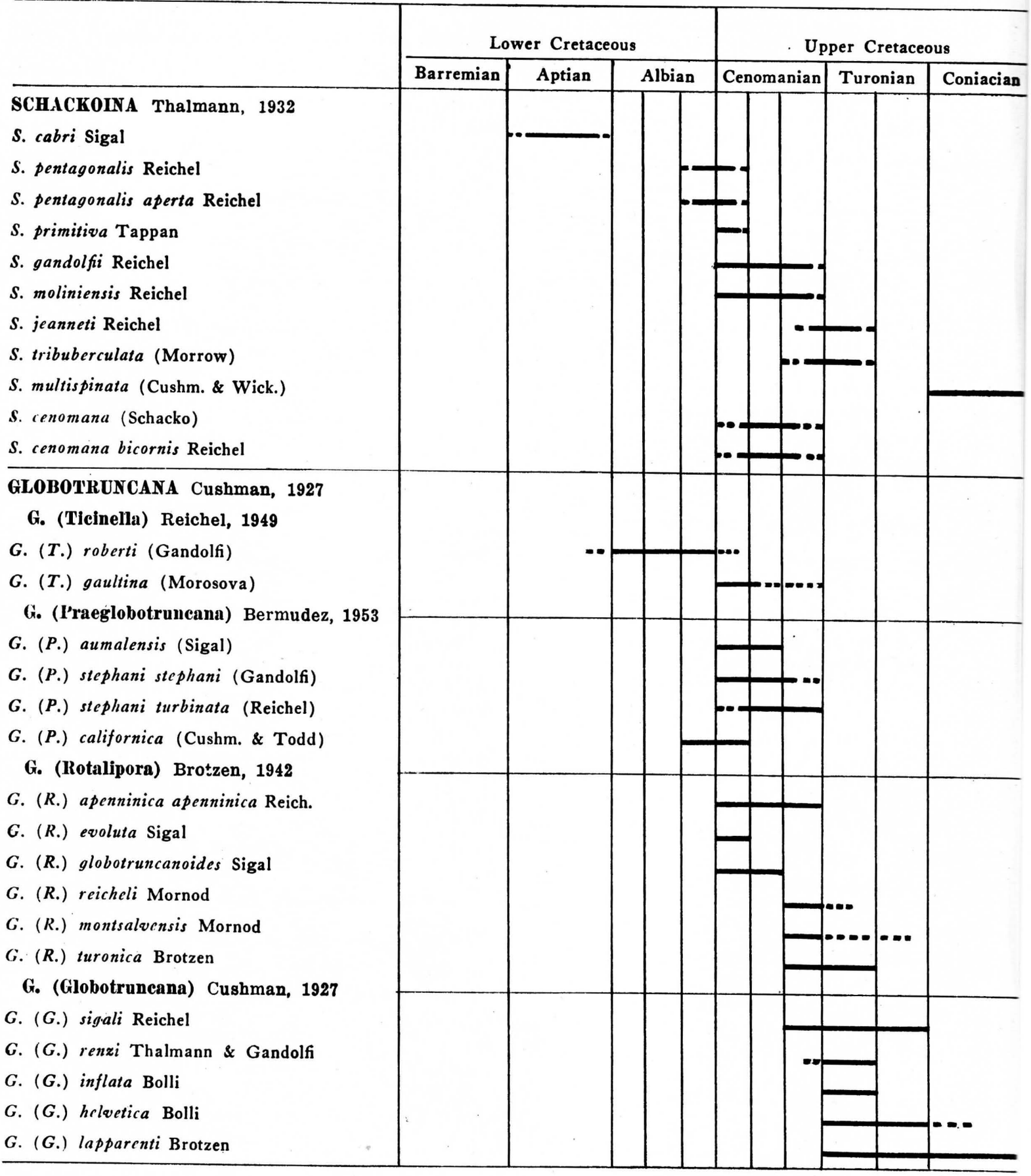
Globotruncana (*Rotalipora*) *globotruncanoides* Sigal
Globotruncana (*Rotalipora*) *apenninica apenninica* (Renz)
Globotruncana (*Rotalipora*) *evoluta* Sigal
Globotruncana (*Thalmanninella*) sp.
Globotruncana (*Praeglobotruncana*) *aumalensis* (Sigal)
Globotruncana (*Praeglobotruncana*) *stephani stephani* (Gandolfi)
Globotruncana (*Praeglobotruncana*) *californica* (Cushman & Todd)
Planomalina buxtorfi (Gandolfi)
Globigerina sp.

This assemblage is characteristic of the early Cenomanian, so that there seem to be within the Calera limestone unit different assemblages which provide evidence that this lithologic unit is not homogeneous.

Both in the "Antelope Shale" and the Calera limestone type locality the species *Globotruncana* (*Praeglobotruncana*) *stephani* (Gandolfi) *turbinata* (Reichel), has been observed. Although the absolute range (biozone) of this species is usually indicated as comprising all of the Cenomanian and the basal Turonian, it is abundantly developed only in the Upper Cenomanian with a rather characteristic association of *Praeglobotruncana,* while the *Globotruncana, s.s.* species, such as the double keeled forms of the *linnei* and *lapparenti* groups, make their first appearance in the basal Turonian.

The *Schackoina* from the Calera limestone type locality has the same stratigraphic distribution as the species noted from the "Antelope Shale".

The faunule from near New Almaden, recently redescribed by this author proved to be older than the faunule from Rockaway Beach. The faunules from the "Antelope Shale" indicate an age equivalent to that of the Calera limestone type locality. This indicates that part of the "Franciscan" Calera Limestone and the "Antelope Shale" are of the same age. On the other hand there is ample evidence that the Calera limestone can be differentiated into zones and that further work with this viewpoint in mind, might result in a more satisfactory understanding of some Californian formations.



TEXT FIG. 1

Stratigraphic distribution of the more common genera, subgenera, and species (*Schackoina* and *Globotruncana*) in the interval from Aptian to Coniacian.

SYSTEMATICS

A synopsis of the systematics of the subfamily Globotruncaninae was given recently by Küpper (1955). However, changes must be made in respect to the position of *Praeglobotruncana* Bermudez and *Rotundina* Subbotina. During a visit to the U. S. National Museum*, Washington, D. C., the generic type of *Praeglobotruncana* (*Globorotalia delrioensis* Plummer), was examined. The apertural characters are exactly the same as of *Globotruncana stephani* Gandolfi. Thus *Rotundina* Subbotina 1953 becomes a junior synonym of *Praeglobotruncana* Bermudez 1952. The inclusion of *Globotruncana* (*Rotalipora*) *apenninica* (Renz) in *Praeglobotruncana* is not correct. (Bermudez, 1952, pl. 27, fig. 4). Bolli also suggested the synonymy of the two genera (personal communication Aug. 8, 1955).

Family GLOBOROTALIIDAE

Subfamily **Globotruncaninae**

Genus **Globotruncana** Cushman 1927

Contrib. Cushman Lab. Foram. Res., vol. 3, p. 91

Genotype: *Pulvinulina arca* Cushman 1926, Contrib. Cushman Lab. Foram. Res., vol. 2, p. 23, pl. 3, fig. 1, (by original designation.) Mendez Shale, Upper Cretaceous, Mexico.

Diagnosis: Test calcareous perforate, trochoid, chambers separated either by depressed or elevated sutures, periphery with one, two or no keel at all. The umbilicus is open, mostly covered with a flat or arched plate. Apertures ventral, interiomarginal aperture inter- or extra-umbilical, accessory apertures are interumbilical, sutural or entirely lacking.

Subgenus **Praeglobotruncana** Bermudez, 1952

Est. Foram. Rotalif., Bol. Geol., vol. II, no. 4, p. 52.

Subgenotype: *Globorotalia delrioensis* Plummer, 1931, Bull. Univ. Texas, no. 3101, p. 199, pl. 13, fig. 2a-c, by original designation, Del Rio Formation, Texas.

Synonymy: *Rotundina* Subbotina, 1953, Fossil Foram. U.S.S.R., Moscow, p. 164.
Rotundina Subbotina, Küpper, 1955, Contrib. Cushman Found. Foram. Res., vol. VI, pt. 3, p. 113.

Diagnosis: with or without one keel, interiomarginal aperture is interumbilical, no accessory aperture.

*) The assistance and hospitality of A. R. Loeblich and Helen Tappan are gratefully acknowledged.

Globotruncana (Praeglobotruncana) stephani (Gandolfi) **turbinata** (Reichel)

Pl. 8, fig. 1. a-c

1942 *Globotruncana apenninica beta* n. var. Gandolfi, Riv. Ital. Pal. 48, p. 119, fig. 41: 2a-b.
1950 *Globotruncana stephani* (Gandolfi) var. *turbinata* n. var. Reichel, Eclog., geol. Helv., vol. 42, p. 609.
1950 *Globotruncana stephani* (Gandolfi 1942) var. *turbinata* n. var. Reichel, Eclog.. geol. Helv., vol. 42, p. 588, pl. 15, figs. 18 a-j, 19, 20, textfig. 11 : 1-3.
1954 *Globotruncana stephani* Gandolfi *turbinata* Reichel, 1949, Hagn & Zeil, Eclog. geol. Helv., vol. 47, p. 34, pl. II, fig. 2, pl. V., fig. 3, 4.

This species is easily recognized by its high and very distinct spire. The spire is distinctly raised back to the earliest chambers on the dorsal side. On the ventral side the six inflated chambers connect into a wide umbilicus. The interiomarginal aperture is large and almost circular in outline. The keel is single and very prominent; in the side view ribs are indicated. The last formed chamber does not have a keel.

Stratigraphic distribution: The absolute range of this subspecies is generally given as Cenomanian—lower Turonian. However, as mentioned before, it is most abundant in the upper Cenomanian. Specimens from younger and older strata are not typically developed. The association with other forms is an important criterion when using this form for age determinations.

Occurrence: Loc. GGCM, Colusa Co.; Loc. DC 6; Glenn Co.; California.

Dispository: Hypotype, Stanford Univ., Paleo. Type Coll. No. 8322.

Globotruncana (Praeglobotruncana) renzi (Thalmann & Gandolfi) ssp. **primitiva** Küpper, ssp. nov.

Pl. 8, fig. 2 a-c.

Holotype: Pl. 8, fig. 2 a-c, Stanford Univ. Paleo. Type Coll. No. 8323.

Derivatio nominis: primitiva—primitive, because of the relationship with *Globotruncana* (*Praeglobotruncana*) *renzi renzi* (Thalmann & Gandolfi) of which it is a more primitive relative.

Locus typicus: Loc. GGCM, Colusa County. California, (for detailed description see above).

Stratum typicum: Upper Cenomanian, "Antelope Shale".

Diagnosis: A subspecies of *Globotruncana* (*Praeglobotruncana*) *renzi* (Thalmann & Gandolfi) characterized by its rapidly opening spiral, the possession of a single prominent keel and depressed sutures on the ventral side.

Description: Outline slightly elongate, shape distinctly truncate. Dorsal side with rapidly opening spiral, well developed raised sutures and only slightly inflated chambers. The dorsal side is almost flat. On the ventral side 5 chambers are present, all inflated, separated by distinctly depressed sutures. The umbilicus is deep, no apertures are observable, other than a very narrow slit at the base of the last formed chamber within the umbilicus. The terminal chamber is elongate and unkeeled. The keel is broad and very distinct; a peculiar development is a strong ribbing which can be clearly observed in a lateral view.

Comparisons: The relationship with *Globotruncana* (*Praeglobotruncana*) *renzi renzi* (Thalmann & Gandolfi) is obvious when comparing the dorsal side of the two subspecies. There is hardly any difference between those two forms in this respect. On the ventral side, however, we have in the new subspecies distinctly depressed sutures, whereas the typical form has limbate sutures, clearly raised and continuing along the margin, thus forming a normal second keel. This is in complete agreement with the stratigraphic distribution of the two subspecies.

Globotruncana, n. sp. indet.

Pl. 8, fig. 3 a-c

A single specimen of what appears to be a new species of *Globotruncana* was found in the sample from Loc. DC 6. The apertural details could not be observed, therefore an assignment to any of the subgenera is impossible.

Description: Outline ellipsoidal, shape rather flat with a sharp keel, dorsal side with closely coiled spiral, chambers slightly inflated, separated by elevated sutures. Ventral side: nine chambers form the ventral side of the test. They are strongly keeled towards the margin, a thin keel is developed around the umbilicus. The sutures are almost radial. The terminal chamber bears a distinct keel. The umbilicus is deep, no apertures have been observed.

Relationships: A remote similarity in general appearance with *Globotruncana* (*Rotalipora*) *globotruncanoides* Sigal can be pointed out, but this relationship cannot be further substantiated until more and better material is available.

Occurrence: Loc. DC 6, Glenn County, California.

Depository: Hypotype, Stanford Univ. Paleo. Type Coll. No. 8324.

Family HANTKENINIDAE

Genus **Schackoina** Thalmann 1932

Eclog. geol. Helv., vol. 29, p. 289 (as subgenus of *Hantkenina*).

Genotype: *Siderolina cenomana* Schacko 1896, Archiv. Ver. Freunde Natw. Mecklenburg, Jg. 50, p. 166-168, pl. IV, fig. 3-5 (by original designation as subgenoholotype). Cenomanian, Germany.

Description: In the early part of the test, slightly trochoid, later planispiral and sometimes involute, chambers with one or more tubular extensions, often many times the size of the main part of the test, which are usually called spines. Aperture a narrow slit at the base of the ultimate chamber.

Schackoina sp. cf. **S. gandolfii** Reichel

Pl. 8, fig. 4 a-c

Description: Shape quadrangular, chambers slightly inflated, four chambers in the last whorl. On the dorsal side the earlier whorls are clearly visible, comprising approximately one more volution, and four chambers are discernible. The umbilicus on the ventral side of the test is covered with sediment. Only on the ultimate chamber was it possible to observe a point of detachment where a spine was broken off. The previous chambers do not show such points of detachment, although this may be due to the preservation. The only difference therefore between our specimens and the typical *S. gandolfii* Reichel is the dubious lack of spines on the three penultimate chambers.

Occurrence: Loc. DF3, Glenn Co., California.

Dispository: Hypotype, Stanford Univ. Paleo. Type Coll. No. 8325.

Schackoina cenomana (Schacko) **bicornis** Reichel

Pl. 8, fig. 5 a-c

1947. *Schackoina cenomana bicornis,* n. subsp., Reichel, Eclog. geol. Helv., vol. 40, no. 2, pp. 400-402, textfig. 4: a-g; 6:4, 7:4; 8:b, 9:a,b.d,g, 10:8,9.

A single specimen has been found which corresponds with the material Reichel described. Only four chambers are observable on both the dorsal and ventral sides. The earlier parts are covered with adhering sediment which could not be re-

moved. Each of the four last chambers bear one spine; the ultimate chamber only has a small second spine developed. This second spine is smaller than on the type material, but the specimens are nevertheless considered conspecific.

Occurrence: Loc. DF3, Glenn County, California.

Depository: Hypotype, Stanford Univ. Paleo. Type coll. No. 8326.

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CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
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153. EORUPERTIA IN THE EOCENE OF VENEZUELA*

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ABSTRACT. Rare, fragmentary specimens of the large foraminifer *Eorupertia* occur in impure indurated limestones of middle and upper Eocene age in Venezuela. The specimens are noted in the Misoa and Churuguarita formations from Estado Zulia, in the upper part of the Punta Carnero group from Isla de Margarita, and in the Tinajitas formation from Estado Anzoátegui. Only random thin sections of *Eorupertia* can be obtained from the Venezuelan material. The genus is usually associated with orbitoids, *Operculinoides, Amphistegina,* and various genera of calcareous algae. The depositional environment, therefore, is interpreted to be indicative of warm, actively circulating, normally saline, shallow marine waters.

This represents the first published description of the presence of *Eorupertia* in the Western Hemisphere. The age of the genus in Venezuela is restricted to middle and upper Eocene, as it is in Central and Southern Europe, the Middle East and Japan.

INTRODUCTION

Studies of thin sections by Creole paleontologists and the writer during the past several years have revealed the presence of rare specimens of the foraminifer *Eorupertia.* The specimens are found in sandy and shaly indurated limestones,

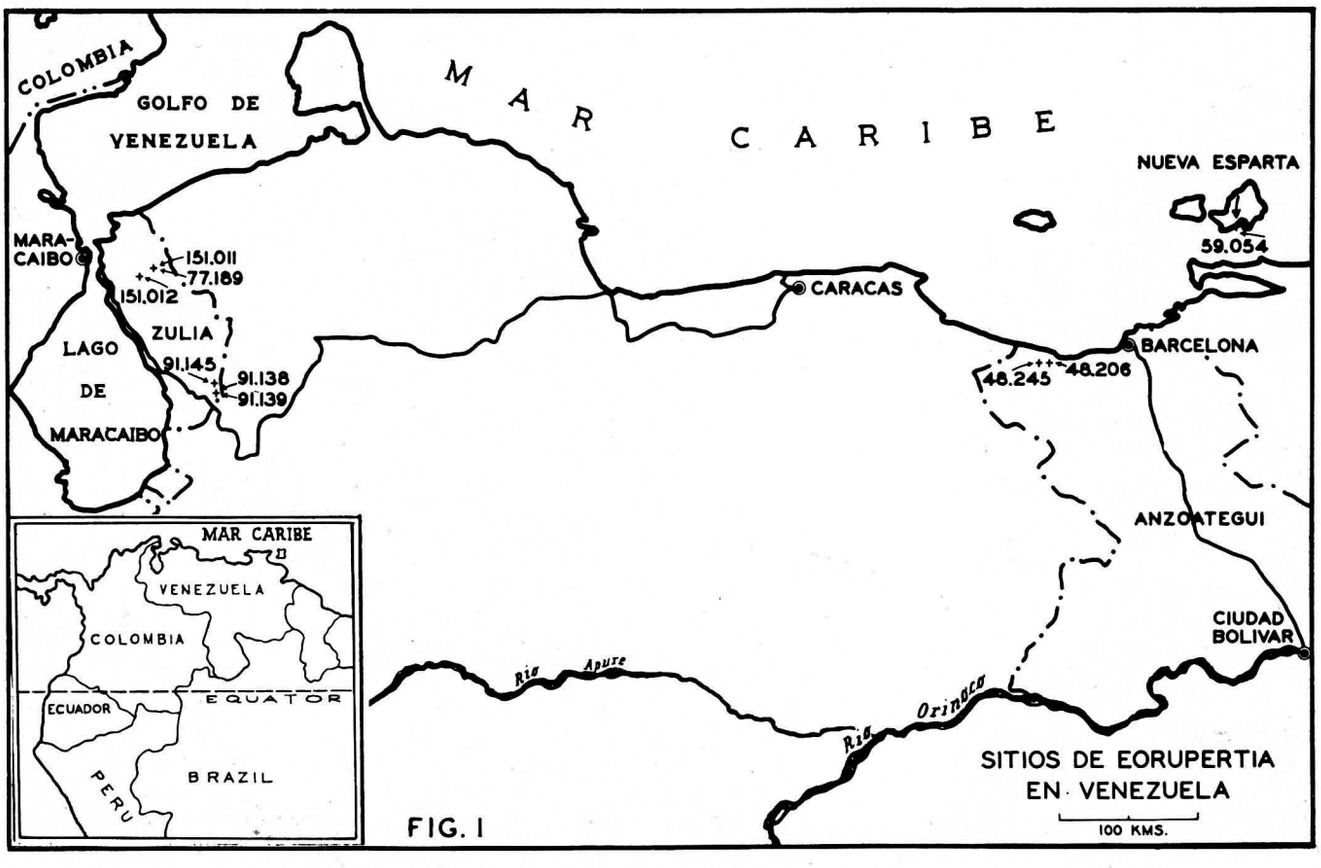


FIG. 1

* Published with the permission of Creole Petroleum Corporation, Caracas, Venezuela.

and, so far, all have been fragmentary and incomplete. The consolidation of the matrix rock does not favor the recovery of free individuals, and thin sections of unoriented specimens only have been observed to date.

The lack of free or well preserved examples precludes specific identification within the genus. *Eorupertia* spp. are noted in middle and upper Eocene formations from Estado Zulia in Western Venezuela, and in upper Eocene sediments from Isla de Margarita and Estado Anzoátegui in Eastern Venezuela (see fig. 1). In all, 18 distinct occurrences in 9 different samples are described. The genus commonly is associated with lepidocyclinid and miliolid foraminifera, echinoid spines and a few genera of calcareous algae. The thick perforate test wall, characteristic of *Eorupertia,* is especially evident in the Venezuelan thin sections.

Detailed descriptions follow, giving the localities of the samples, the observed features of the specimens and their dimensions.

DETAILED DESCRIPTIONS

WESTERN VENEZUELA

Creole Serial Sample 91,138; collector G. J. Gaenslen.

Formation: Misoa.

Age: Middle to upper Eocene.

Locality: Rio San Juan, Estado Zulia, 21 kms. N. 79°E. from Mene Grande oil-field. Coordinates (approximate) S. 89,840; E. 97,760 (Maracaibo base O.0). See fig. 2.

Recovery: Three broken and/or incomplete specimens described from two thin sections of the sample and illustrated as figures 1, 2 and 3 of Plate 9.

Slide 1, Specimen 1, Plate 9, Fig. 1: Oblique section through hollow, central tube, embryonic chambers, two chambers of inner whorl and 4 chambers of outer whorl. Nucleoconch bilocular, chambers subcircular, remaining chambers kidney-shaped to subcircular. Wall of embryonic chambers thin, perforate; test wall of remaining chambers thick, perforate by sharply outlined tubular-shaped pores arranged perpendicularly to curvature of wall. About one-half of inner portions of septa non-perforate, outer portions merging with test wall and also pierced by pores; septa straight to gently curved. Outside surface smooth.

Dimensions (in microns):

Protoconch	60 x 52
Deuteroconch	60 x 52
Chamber no. 3	74 x 67
Chamber no. 4	185 x 111
Chamber no. 5	207 x 118
Chamber no. 6	185 x 133
Chamber no. 7	281 x 170
Chamber no. 8	303 222
Chamber no. 9	659 x 340
Thickness wall chamber no. 6	30
Thickness septum between chamber no's. 5 and 6	12
Diameter central tube	52
Diameter pore in wall chamber no. 5	7
Diameter specimen	1.11 x 1.00

Figured specimen: U.S.N.M. No. P5077.

Note: For all specimens dimensions of chambers and tube are always longest inside measurements. Diameters of specimens refer to maximum dimensions through centers.

Slide 1, Specimen 2, Plate 9, Fig. 2: Oblique section, 4 chambers visible forming portions of an inner and outer whorl; chamber outlines varying from heart-shaped to nearly rectangular to reniform. Test wall thick, coarsely perforate, some pores wider than adjacent intervening portions of wall structure. Visible parts of septa non-perforate, but becoming coarsely perforate towards junction with test wall; some septa with dark median partition; septa of both sets of chambers of each whorl do not extend across chamber cavity, possibly because of angle of section or preservation. Canals (?) at junctions of septa with chamber walls. Outside surface smooth.

Dimensions (in microns):

Chamber no.1	237 x 215
Chamber no. 2	252 x 163
Chamber no. 3	688 x 370
Chamber no. 4	407 x 400
Thickness wall chamber no. 4	74
Thickness septum between chamber nos. 3 and 4	74
Diameter pore in wall chamber no. 4	7
Width gap in septum between chamber nos. 1 and 2	52
Width gap in septum between chamber no's. 3 and 4	260

Figured specimen: U.S.N.M. No. P5077.

Slide 2, Specimen 3, Plate 9, Fig. 3: Oblique section, bilocular nucleoconch and portions of inner and outer whorls visible. Embryonic chambers nearly circular, remaining chambers kidney-shaped.

Protoconch separted from deuteroconch by gently curved, thin, imperforate septum. Test wall of all chambers coarsely perforate. Only visible septum (between chamber no's. 4 and 5) non-perforate. Coil loose so that lumen is developed between two whorls. Passageways may be present at inner end of septum between chamber no's. 3 and 4, and between 5 and 6, and at base of test wall of deuteroconch.

Dimensions (in microns):

Protoconch 104 x 104
Deuteroconch 111 x 104
Chamber no. 3 59 x 52
Chamber no. 4 170 x 133
Chamber no. 5 259 x 207
Chamber no. 6 259 x 133 (broken)
Thickness wall chamber no. 4 30
Diameter pore in wall chamber no. 4 7
Thickness septum between chamber no's. 1 and 2 7
Width passageway at base of deuteroconch 37

Figured specimen: U.S.N.M. No. P5078.

Associated Microfauna: *Amphistegina, Helicolepidina, Lepidocyclina, Quinqueloculina, Textularia, Lithothamnium,* echinoid spines.

Lithology: Limestone-impure, gray weathering yellow to brown, dense, non-crystalline, argillaceous, fossiliferous, some veinlets calcite, some disseminated very fine grains to granules of subrounded, colorless to milky quartz.

Creole Serial Sample 91,138; collector G. J. Gaenslen.

Formation: Misoa.

Age: Middle to upper Eocene.

Locality: Same as for sample 91,138. see fig. 2.

Recovery: Two broken and/or incomplete specimens described from two thin sections of the sample and illustrated as figures 4 and 5 of Plate 9.

Slide 3, Specimen 4, Plate 9, Fig. 4: Oblique section revealing part of one chamber of nucleoconch, three chambers of inner whorl and two chambers of outer whorl. Protoconch and deuteroconch probably semicircular, chambers of inner whorl triangular, subrectangular and trapezoidal; those of outer whorl subrectangular and kidney-shaped. Wall of embryonic chamber thin and apparently non-perforate. Test wall of other chambers thick and coarsely perforate; outer surface slightly pectinate; 4 visible septa non-perforate, gently curved. A lumen may be present between inner and outer whorls.

Dimensions (in microns):

Embryonic chamber (broken) 30 x 22
Chamber no. 2 89 x 59
Chamber no. 3 118 x 59
Chamber no. 4 96 x 74

EXPLANATION OF PLATE 9

FIGS. PAGE

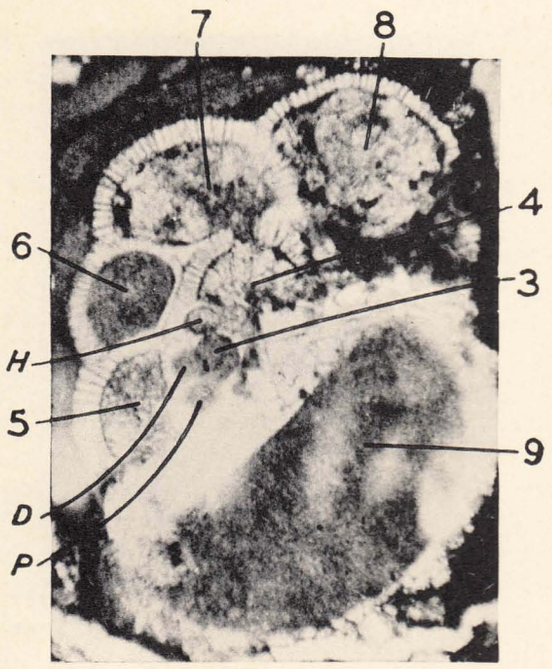
1. Specimen no. 1, U.S.N.M., no. P5077. Oblique section showing chamber arrangement, coarse pores in test wall, hollow central axis, H. protoconch, P. deuteroconch, D. X60. 49

2. Specimen no. 2, U.S.N.M., no. P5077. Oblique section of four chambers with thick, coarsely perforate test wall, canals, C, median dark partition, M. X55. 49

3. Specimen no. 3, U.S.N.M., no. P5078. Oblique section illustrating protoconch, P, deuteroconch, D, lumen area between whorls, L. X60. 49

4. Specimen no. 4, U.S.N.M., no. P5079. Oblique section showing thick, coarsely perforate test wall, non-perforate septa, broken initial chamber, P. X60. 50

5. Specimen no. 5, U.S.N.M. no. P5080. Oblique section showing coarse pores in thick test wall, median dark partition, M, and canals, C, in septum. X55. 51



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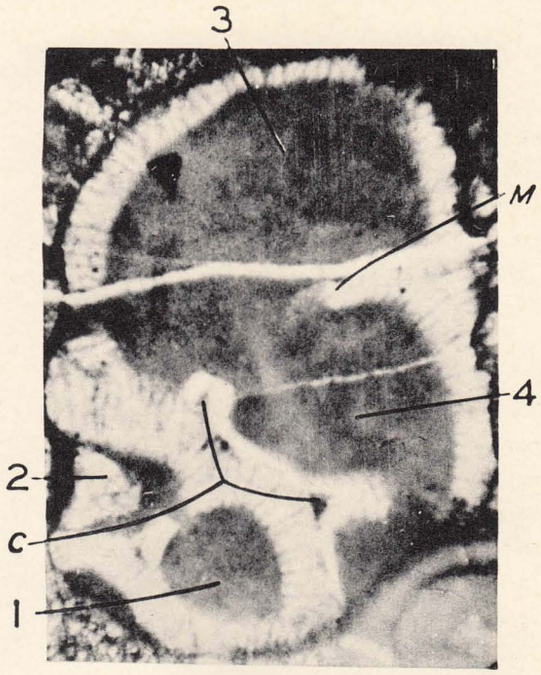

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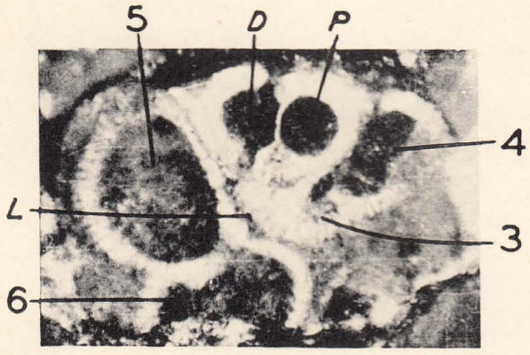

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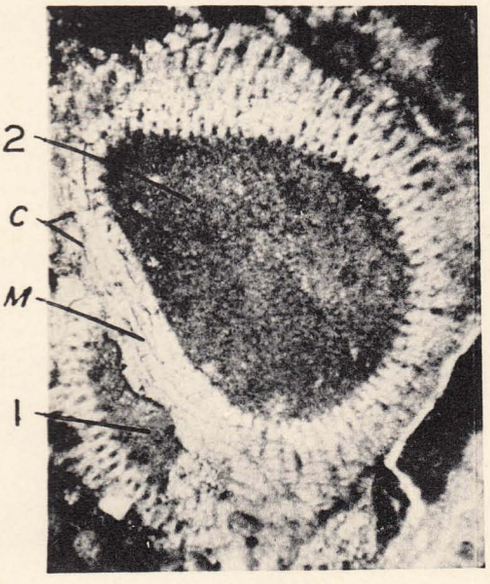

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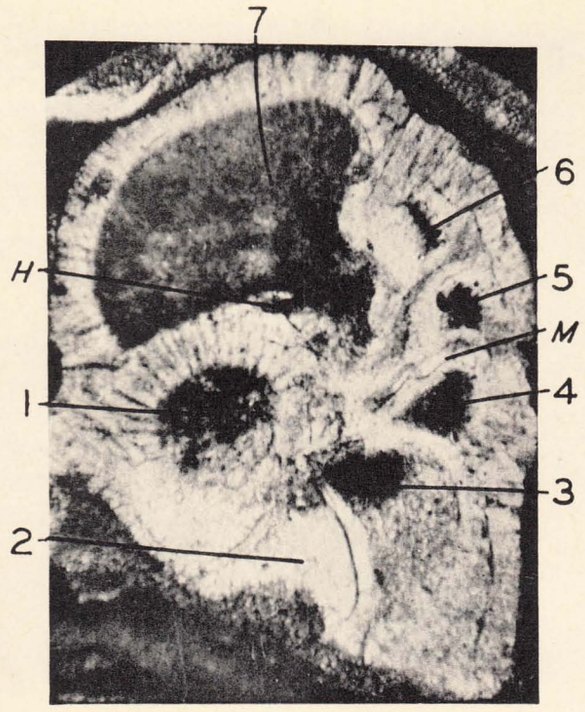

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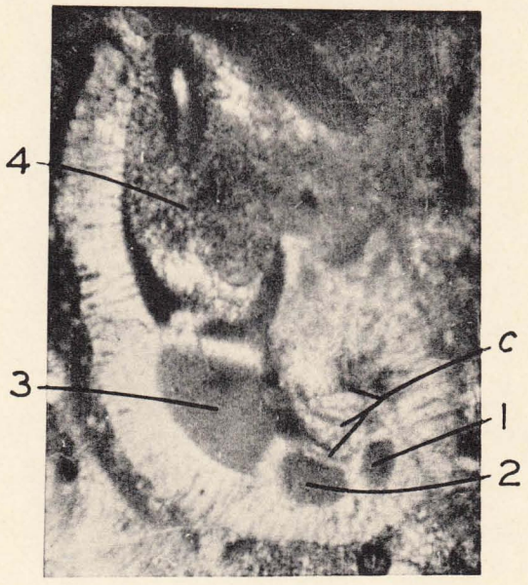

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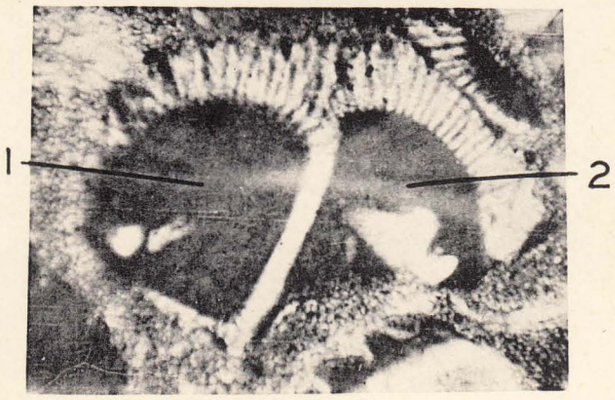

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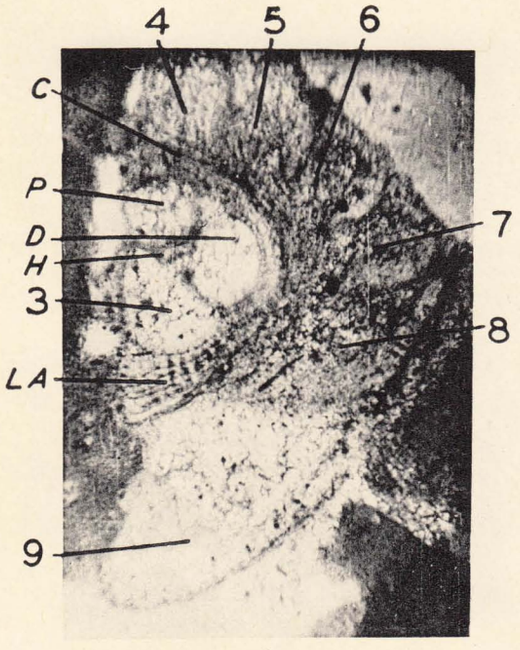

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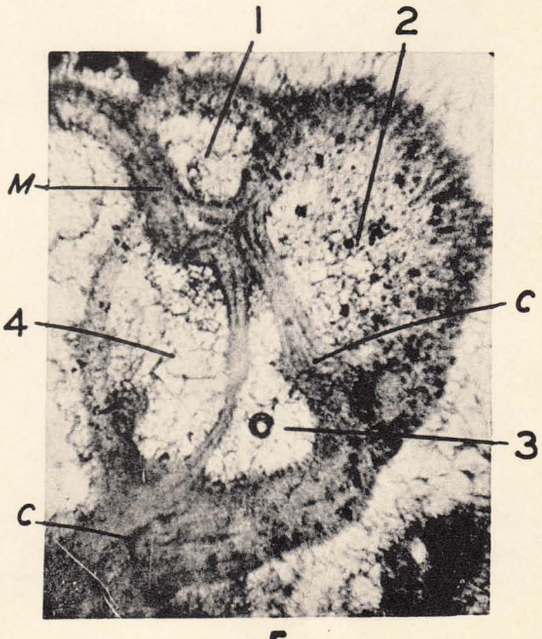

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Chamber no. 5 229 x 163
Chamber no. 6 496 x 170
Thickness wall embryonic chamber 15
Thickness wall chamber no. 5 74
Thickness septum between chamber no's. 3 and 4 15
Thickness septum between chamber no's. 5 and 6 (probably cut obliquely) 59
Diameter pore in wall chamber no. 6 7

Figured specimen: U.S.N.M. No. P5079.

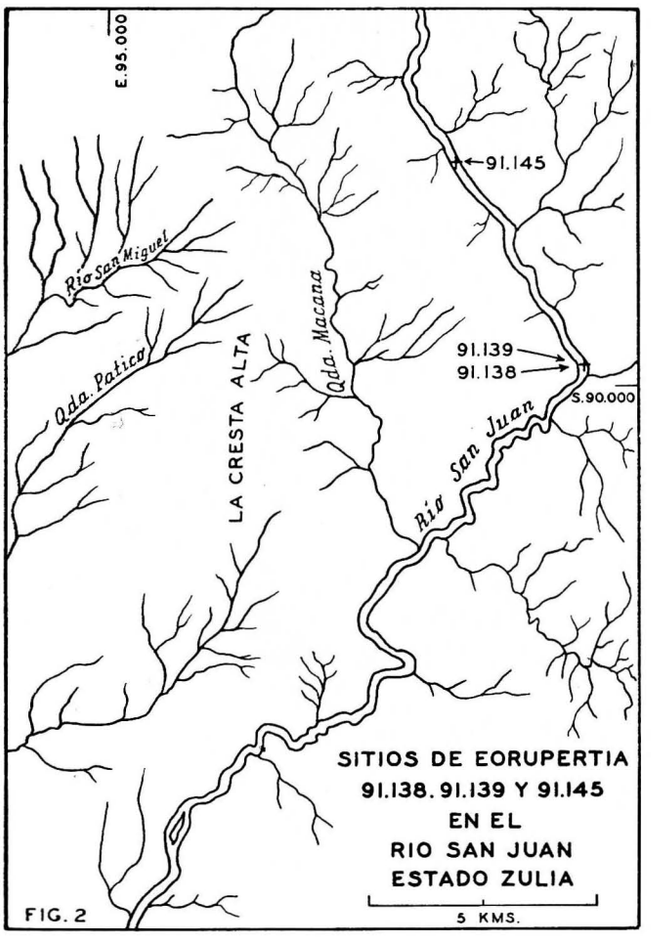
Slide 4, Specimen 5, Plate 9, Fig. 5: Oblique section of two chambers probably in distal portion of specimen. Chambers kidney-and pear-shaped. Test wall thick, coarsely perforate, pores sometimes wider than interporiferous zones. Single septum non-perforate, with median dark partition and canals.

Dimensions (in microns):
Chamber no. 1 451 x 111
Chamber no. 2 673 x 488
Thickness wall chamber no. 2 141
Thickness pore in wall chamber no. 1 7
Thickness septum 126

Figured specimen: U.S.N.M. No. P5080.

Associated Microfauna: *Amphistegina, Lepidocyclina, Linderina, Operculinoides, Quinqueloculina,* algal fragments, echinoid spines.

Lithology: Limestone-impure, gray weathering tan and yellow, dense, fossiliferous, argillaceous, abundant disseminated, colorless to milky white, very fine-grained to sand-sized quartz.



Creole Serial Sample 91,145; collector G. J. Gaenslen.

Formation: Misoa (float sample).

EXPLANATION OF PLATE 10

FIGS. PAGE

1. Specimen no. 6, U.S.N.M., no. P5081. Oblique section showing two whorls, coarse perforations in thick test wall, non-perforate septa with dark median partition, M, probable hollow central axis, H. X55. 52

2. Specimen no. 8, U.S.N.M., no. P5083. Oblique section showing coarse pores in thick test wall, canals, C, in central shell mass and in wall at base of chamber no. 2. X60. 53

3. Specimen no. 7, U.S.N.M., no. P5082. Horizontal section showing thick, coarsely perforate test wall, non-perforate septum. X55. 52

4. Specimen no. 9, U.S.N.M., no. P5084. Oblique section showing coarse pores lamellae, LA, and canals, C, in thick test wall of inner whorl, protoconch, P, deuteroconch, D, part of outline of hollow central axis, H, imperforate septa. Note reticulate pattern in test wall. X55. 53

5. Specimen no. 10, U.S.N.M., no. P5085. Oblique section illustrating coarse perforations in thick test wall, canals, C, in test wall and septa, median dark partition, M. Note that canals and partition do not meet. X55. 53

Age: Middle to upper Eocene.

Locality: Near head waters of Rìo San Juan, 20.3 kms. N. 75°E. from Mene Grande oil-field. Coordinates (approximate) S. 87.560; E. 96,420 (Maracaibo base 0,0). See fig. 2.

Recovery: Three broken and/or incomplete specimens described from three thin sections of the sample and shown as figures 1, 2 and 3 of Plate 10.

Slide 5, Specimen 6, Plate 10, Fig. 1: Oblique section showing 7 chambers increasing rapidly in size, two chambers forming inner whorl, remainder outer whorl. First two chambers semicircular, chambers 3 through 6 roughly triangular, last chamber reniform in shape. Test wall thick, coarsely perforate, apparently locally lamellar. Septa strongly developed, non-perforate, usually curved gently backwards, some with dark median partitions. Surface smooth.

Dimensions (in microns):

Chamber no. 1 222 x 185
Chamber no. 2 266 x 155
Chamber no. 3 281 x 207
Chamber no. 4 318 x 192
Chamber no. 5 163 x 111
Chamber no. 6 259 x 89
Chamber no. 7 562 x 333
Thickness wall chamber no's. 1 and 7 96 and 89 respectively
Thickness septum between chamber no's. 3 and 4 37
Diameter central tube 30
Diameter pore in wall chamber no. 7 15
Diameters specimen 1.29 x 0.92 mm.

Figured specimen: U.S.N.M. No. P5081.

Slide 6, Specimen 7, Plate 10, Fig. 3: Horizontal section of two partial chambers, tear-drop in shape. Test wall thick, gently convex, very coarsely perforate, pores often as wide or wider than interporiferous parts of wall. Single septum nearly straight, imperforate except at extremities where it joins test wall.

Dimensions (in microns):

Chamber no. 1 458 x 437
Chamber no. 2 518 x 326 (broken)
Thickness test wall chamber no. 1 111
Thickness septum 37
Thickness pore in wall chamber no. 1 11

Figured specimen: U.S.N.M. No. P5082.

Slide 7, Specimen 8, Plate 10, Fig. 2: Oblique section of 4 chambers, subcircular to trapezoidal in shape, and of central mass of shell material. Test wall gently convex, thick, coarsely perforate. Septa gently curved to straight, imperforate. Canals present in wall at base of chamber no's. 1 and 2, and possibly in central shell mass.

Dimensions (in microns):

Chamber no. 1 74 x 52
Chamber no. 2 119 x 81
Chamber no. 3 251 x 178
Chamber no. 4 420 x 289
Thickness wall chamber no. 4 104
Thickness septum between chamber no. 3 and 4 30
Diameter pore in wall chamber no. 4 7

Figured specimen: U.S.N.M. No. P5083.

Associated Microfauna: *Acervulina, Amphistegina, Globorotalia, Guembelina, Helicostegina, Lepidocyclina, Operculinoides, Quinqueloculina, Textularia, Trochammina,* algal fragments, bryozoan fragments, echinoid fragments, molluscan fragments.

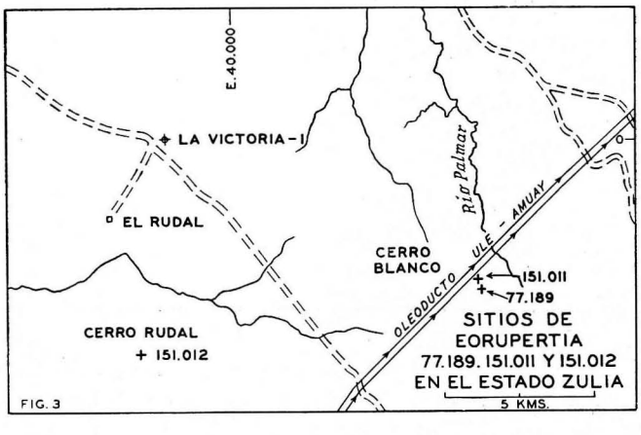
Lithology: Limestone-impure, gray, indurated, argillaceous, very sandy, abundantly studded with colorless to milky white, subrounded to subangular quartz grains up to 5 mm. in diameter.
Creole Serial Sample 77,189; collector R. Laforest.

Formation: Churuguarita.

Age: Upper Eocene.

Locality: Cerro Blanco, a small hill along Ulé-Amuay pipe-line road 1.1 kms. S. 26°W from intersection of pipe-line road with Rìo Palmar, Estado Zulia. Coordinates (approximate) S. 4630; E. 48,340. (Maracaibo base 0,0). See fig. 3.

Recovery: Two incomplete and/or broken specimens on two thin sections illustrated as figures 4 and 5 of Plate 10.



Slide 8, Specimen 9, Plate 10, Fig. 4: Oblique section revealing inner and outer whorls and cutting two embryonic chambers. Besides embryonic apparatus, one chamber in inner whorl, 6 in outer whorl. Nucleoconch bilocular; protoconch nearly circular, deuteroconch elliptical, third chamber half-moon shaped; outer portions of first 4 chambers of outer whorl broken, but chambers probably subtriangular to subrectangular in shape. Test wall of chambers of inner whorl rather sharply curved, thick, coarsely perforate, showing lamellar structure and possibly canals; diameter of pores slightly greater than thickness of lamellae; pores and lamellar layers making recticulate pattern. Test wall of outer whorl badly preserved but thick and suggesting coarse perforations. Septa non-perforate, gently curved backwards, some with dark median partition; inner ends of septa between deuteroconch and chamber no. 3, between chamber no's 5 and 6, and 6 and 7, not extending completely across chambers, leaving passageways between chambers.

Dimensions (in microns):

Protoconch 133 x 118

Deuteroconch 163 x 133

Chamber no. 3 200 x 126

Chamber no. 4 178 x 141 (to broken outer edge)

Chamber no. 5 185 x 141 (to broken outer edge)

Chamber no. 6 222 x 141 (to broken outer edge)

Chamber no. 7 259 x 118 (to broken outer edge)

Chamber no. 8 296 x 111

Chamber no. 9 407 x 237

Thickness wall deuteroconch and chamber no. 9 59 and 74 respectively

Thickness lamella in wall chamber no. 3 7

Diameter pore in wall chamber no. 3 11

Thickness septum between chamber no's. 5 and 6 22

Width opening between deuteroconch and chamber no. 3 30

Width passageway between chamber no's. 5 and 6 67

Diameters specimen 1.12 x 0.67 mm.

Figured specimen: U.S.N.M. No. P5084.

Slide 9, Specimen 10, Plate 10, Fig. 5: Oblique section of part of specimen showing 4 chambers, septa and thick perforate test wall. Chambers elliptical, semicircular and elongate-triangular in shape. Test wall thick, with possible canals, coarse perforations distinctly visible only outside chamber no. 2; wall gently indented at junctions with septa. Septa imperforate, sharply defined, gently curved backwards; those between last two chambers apparently enclosing as many as 3 linear non-branching canals; median dark septal partitions also present, not connected with canals.

Dimensions (in microns):

Chamber no. 1 170 x 163

Chamber no. 2 355 x 274

Chamber no. 3 355 x 170

Chamber no. 4 370 x 229

Thickness wall chamber no. 3 148

Diameter pore in wall chamber no. 2 11

Thickness septum between chamber no's. 3 and 4 37

Figured specimen: U.S.N.M. No. P5085.

Associated Microfauna: *Acervulina (?), Asterocyclina, Discocyclina, Lepidocyclina, Marginulina, Operculinoides, Amphiroa,* algal fragments.

Lithology: Limestone-cream, white, rarely tan, indurated, orbitoidal, with abundant white clay cementing material.

Creole Serial Sample 151,011; collector T. Dzilsky.

Formation: Churuguarita.

Age: Upper Eocene.

Locality: At Km. 43, Cerro Blanco, 50 m. east of pipe-line road between Ulé and Amuay, Estado Zulia. Coordinates (approximate) S. 4,500; E. 48,200 (Maracaibo base O, O). See fig. 3.

Recovery: Oblique section of broken and/or incomplete specimen illustrated as figure 1 of Plate 11.

Slide 10, Specimen 11, Plate 11, Fig. 1: Oblique section through embryonic chambers and those of single whorl surrounding nucleoconch on one side. Embryonic arrangement bilocular consisting of two nearly circular chambers separated by thin straight distinct partition; deuteroconch larger than protoconch. Chambers of surrounding whorl indistinct because of fracturing and recrystallization, but probably enlarging rapidly, circular- to nearly crescent-shaped. Test wall enclosing both nucleoconch and chambers of first whorl thick, packed with distinct, very numerous coarse perforations

arranged perpendicularly or nearly so to periphery and extending across entire thickness of wall; trace of lamellae in test wall. Only two septa of outer whorl visible in section, non-perforate, curved gently backwards, not extending across to wall of nucleoconch and leaving a distinct gap.

Dimensions (in microns):

Protoconch 141 x 96
Deuteroconch 163 x 148
Chamber no. 3 429 x 215
Thickness partition between protoconch and deuteroconch 7
Thickness wall deuteroconch and chamber no. 3 74 and 185 respectively
Thickness proximal septum of chamber no. 3 37
Thickness pore in wall chamber no. 3 7
Thickness opening between distal septum of chamber no. 3 and outer wall protoconch 74
Diameters specimen 1.48 x 0.74 mm.

Figured specimen: U.S.N.M. No. P5086

Associated Microfauna: *Amphistegina, Lepidocyclina, Operculinoides,* algal fragments.

Lithology: Limestone-tan weathering yellowish brown, indurated, finely crystalline, abundantly splotched with white orbitoids, slightly limonitic and hematitic.

Creole Serial Sample 151,012; collector B. R. Natera.

Formation: Churuguarita.

Age: Upper Eocene.

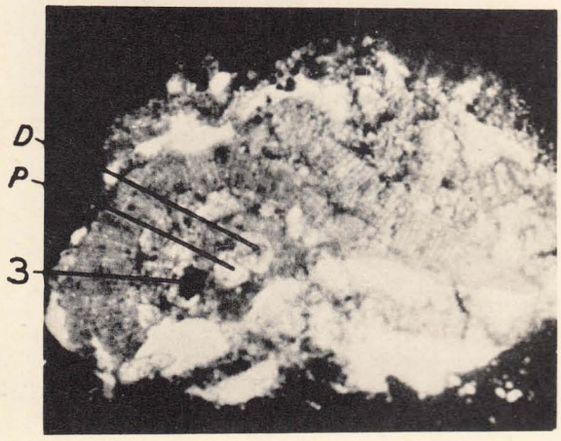
Locality: Cerro Rudal, Estado Zulia, about 7.1 kms. S. 7°W. from Well La Victoria-1. Coordinates (approximate) S. 7,000; E. 37,000 (Maracaibo base 0,0). See fig. 3.

Recovery: Three oblique sections of partial whorls of two specimens and complete whorl of third specimen, illustrated as figures 2, 3 and 4 of Plate 11.

Slide 11, Specimen 12, Plate 11, Fig. 2: Oblique section of 5 chambers, oval, nearly crescent and nearly rectangular in shape, increasing gradually in size. Initial chambers not visible. Test wall thick and coarsely perforate where well preserved. Septa distinct, non-perforate, earlier ones curved gently backwards, later ones nearly straight; all but one septum not extending completely across to wall of initial portion of specimen, gaps thus forming chamber passageways and lumen area.

EXPLANATION OF PLATE 11

FIGS.		PAGE
1.	Specimen no. 11, U.S.N.M., no. P5086. Oblique section of badly preserved specimen showing numerous pores in thick test wall, protoconch, P, deuteroconch, D. X30.	53
2.	Specimen no. 12, U.S.N.M., no. P5087. Oblique section showing thick, perforate test wall, distinct non-perforate septa, passageways, G, between chambers, lumen area, L. X68.	54
3.	Specimen no. 13, U.S.N.M., no. P5087. Oblique section revealing thick, perforate text wall with lamella, LA, non-perforate septa. X60.	55
4.	Specimen no. 14, U.S.N.M., no. P5087. Oblique section showing thick test wall with coarse pores, non-perforate septa, protoconch, P, deuteroconch, D, lumen area, L, canal, C. X55.	55



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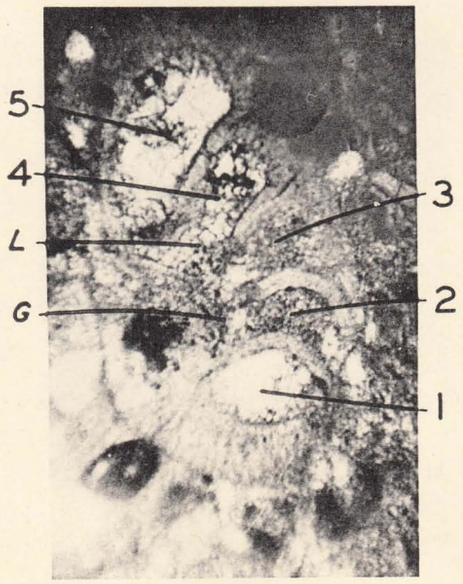

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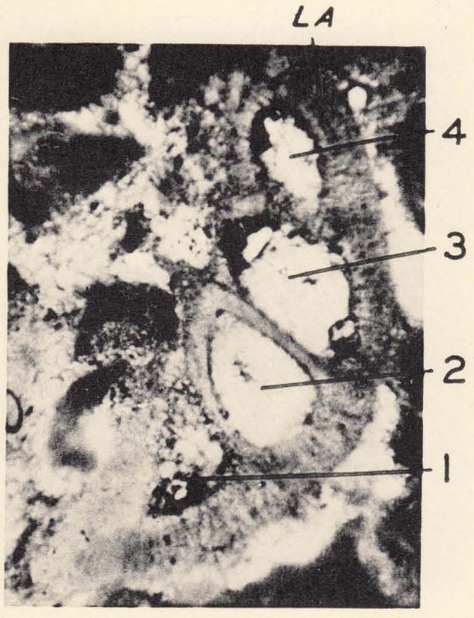

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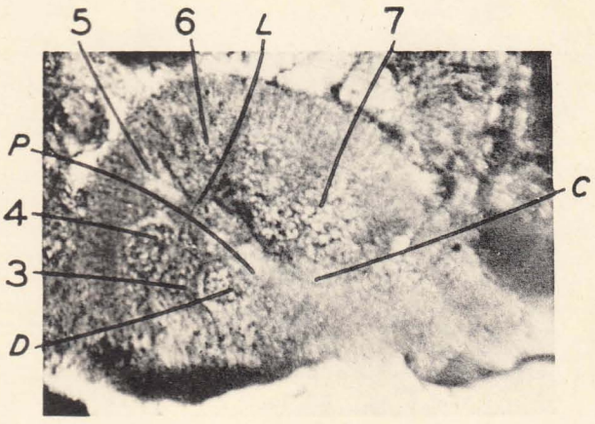

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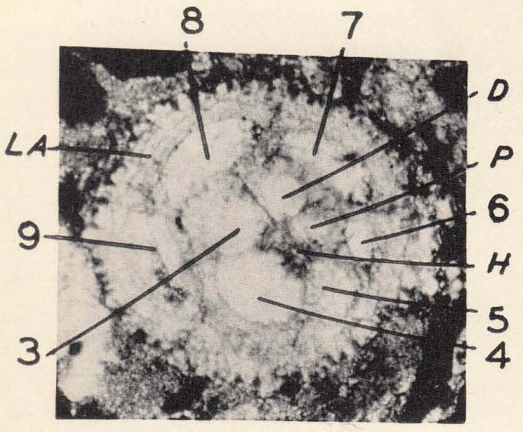

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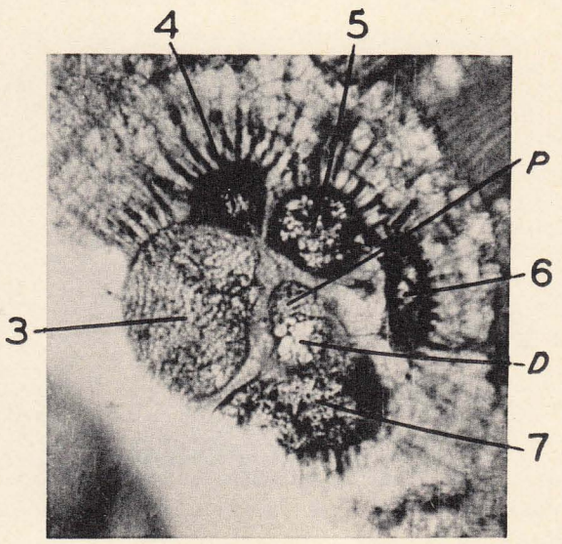

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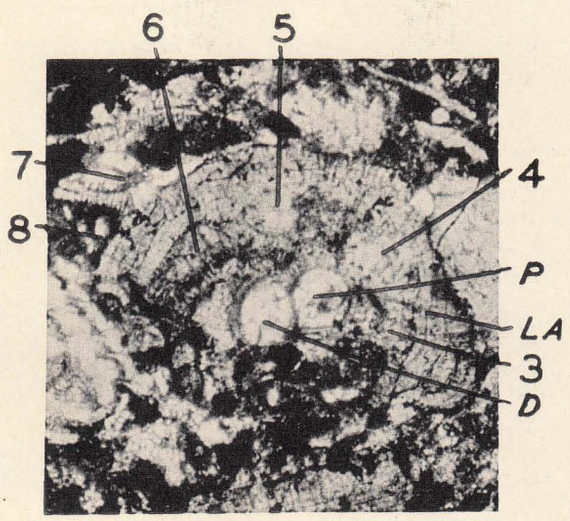

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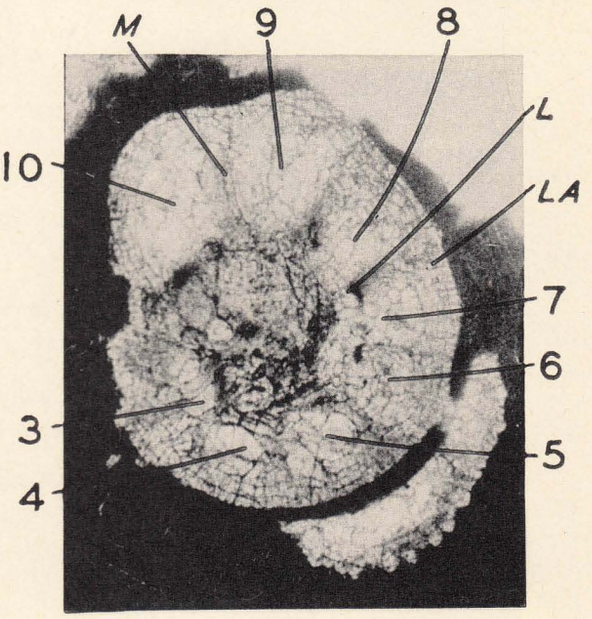

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Dimensions (in microns):
Chamber no. 1 192 x 126
Chamber no. 2 215 x 74
Chamber no. 3 192 x 96
Chamber no. 4 244 x 89
Chamber no. 5 311 x 133
Thickness wall chamber no. 1 111
Thickness septum between chamber no's. 3 and 4 44
Width gap between above septum and wall of chambers of initial portion 44
Diameter pore in wall chamber no. 5 7
Diameters specimen 0.88 x 0.56 mm.
Figured specimen: U.S.N.M. No. P5087.

Slide 11, Specimen 13, Plate 11, Fig. 3: Oblique section of partial whorl of 4 chambers, varying from oval- and heart-shaped to semicircular to tear-drop. Test wall thick, perforate, lamellar, slightly indented to junctions with septa. Septa distinct, non-perforate, curved very gently backwards.

Dimensions (in microns):
Chamber no. 1 170 x 81
Chamber no. 2 237 x 170
Chamber no. 3 281 x 163
Chamber no. 4 178 x 89
Thickness wall chamber no. 3 89
Thickness septum between chamber no's. 2 and 3 22
Diameter pore in wall chamber no. 1 7
Diameters specimen 1.02 x 0.38 mm.
Figured specimen: U.S.N.M. No. P5087.

Slide 11, Specimen 14, Plate 11, Fig. 4: oblique section of large specimen, at least 7 chambers visible, forming a complete whorl. Chambers varying in shape from nearly circular to sub-rectangular to nearly elliptical, enlarging gradually, final two chambers not distinct. Embryonic apparatus not well defined, probably bilocular, large. Wall surrounding protoconch thick, perforate; around deuteroconch thin but sharply defined, perforations not visible. Test wall thick, coarsely perforate lamellar. Septa distinct, non-perforate, curved gently backwards, first three apparently not extending completely across to wall of protoconch so that passageways and lumen are developed between inner ends of septa and protoconchal wall; suggestion of canals in septa.

EXPLANATION OF PLATE 12

FIGS. PAGE

1. Specimen no. 15, U.S.N.M., no. P5088. Horizontal section showing thick, coarsely perforate test wall with lamellae, LA, non-perforate septa, hollow central axis, H. X26. 56

2. Specimen no. 16, U.S.N.M., no. P5089. Oblique section showing extremely thick, coarsely perforate test wall, imperforate septa. Chamber no. 3 probably recrystallized. X65. 56

3. Specimen no. 17, U.S.N.M., no. P5090. Oblique section illustrating thick, perforate test wall, non-perforate septa, protoconch, P, deuteroconch, D, lamellae, LA, in test wall. X25. 57

4. Specimen no. 18, U.S.N.M., no. P5091. Horizontal section showing thick, perforate test wall with lamellae, LA, non-perforate septa with median dark partition, M, lumen area, L. Note pustulose periphery in broken portion of test wall. X27. 58

Dimensions (in microns):

Protoconch 52 x 44
Deuteroconch 118 x 81
Chamber no. 3 96 x 74
Chamber no. 4 111 x 59
Chamber no. 5 67 x 37
Chamber no. 6 104 x 89
Chamber no. 7 185 x 155
Thickness wall protoconch 30
Thickness wall chamber no. 7 81
Thickness septum between chambers no's. 4 and 5 15
Thickness pore in wall chamber no. 7 7
Diameters specimen 0.74 x 0.52 mm.

Figured specimen: U.S.N.M. No. P5087.

Associated Microfauna: *Lepidocyclina, Operculinoides, Textularia, discocyclinids, Archaeolithothamnium, Lithothamnium,* algal fragments, bryozoan fragments, echinoid spine fragments, molluscan fragments.

Lithology: Limestone-coquina, white with slight yellow staining, algal, subangular vitreous quartz grains up to 1 mm. in diameter common.

EASTERN VENEZUELA

Creole Serial Sample 59,054; collector A. N. Dusenbury, Jr.

Formation: Punta Carnero Group; 2nd orbitoidal limestone bed from top of section about 2 to 3 feet thick, cropping out as a small bluff.

Age: Upper Eocene.

Locality: About 200 m. north from south shore Isla de Margarita, 4.8 kms. N. 54°E. from Punta Carnero, Estado Nueva Esparta. Coordinates (approximate) N. 84,250; E. 78,650 (Barcelona base 0,0). See fig. 4.

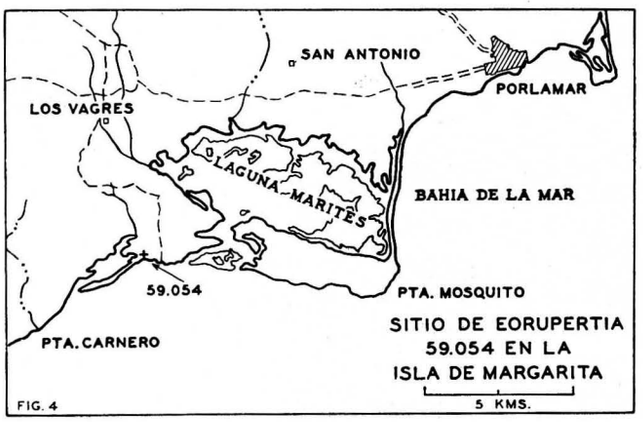
Recovery: Horizontal and oblique sections of two incomplete and broken specimens distributed on two thin sections illustrated as figures 1 and 2 of Plate 12.

Slide 12, Specimen 15, Plate 12, Fig. 1: Horizontal section showing 5 chambers in inner whorl and 4 in outer whorl, chambers rapidly increasing in size. First 4 chambers of inner whorl surround hollow, internal tube nearly circular in section; chambers of inner whorl semicircular to subcircular, those of outer whorl low and elliptical. Embryonic apparatus bilocular, separted by thin but distinct straight partition. Test wall of both inner and outer whorls thick, coarsely perforate, probably lamellar, usually slightly indented at junctions with septa. Septa thick, imperforate, curved gently backwards. Surface pectinate because of coarse pores.

Dimensions (in microns):

Protoconch 126 x 74
Deuteroconch 155 x 155
Chamber no. 3 244 x 207
Chamber no. 4 340 x 266
Chamber no. 5 252 x 155
Chamber no. 6 148 x 118
Chamber no. 7 414 x 155
Chamber no. 8 451 x 185
Chamber no. 9 392 x 162
Thickness wall protoconch 74
Thickness wall chamber no's. 3 and 8 111 and 163 respectively
Thickness partition between protoconch and deuteroconch 7
Thickness septum between chamber no's. 3 and 4 30
Thickness septum between chamber no's. 8 and 9 74
Diameter central tube 37
Diameter pore in wall chamber no. 8 37
Diameters specimen 1.26 x 1.21 mm.

Figured specimen: U.S.N.M. No. P5088.



Slide 13, Specimen 16, Plate 12, Fig. 2: Oblique section large specimen showing single whorl composed of protoconch (?) and deuteroconch (?) and 5 chambers increasing in size fairly rapidly; one chamber cavity recrystallized, chambers semicircular, subcircular, elliptical and rounded triangular in shape. Bilocular embryonic apparatus. Test wall thick, coarsely perforate, pores arranged at right angles to periphery. Septa gently curved backwards, sharply delineated, non-perforate.

Dimensions (in microns):

Protoconch 67 x 52
Deuteroconch 89 x 81
Chamber no. 3 (recrystallized, probably more than one chamber represented) 289 x 222
Chamber no. 4 141 x 133
Chamber no. 5 163 x 155
Chamber no. 6 207 x 74
Chamber no. 7 185 x 126 (broken)
Thickness wall chamber no. 6 111
Thickness septum between chamber no's. 4 and 5 15
Diameter pore in wall chamber no. 5 7
Diameter specimen 0.81 x 0.59 mm.

Figured specimen U.S.N.M. No. P5089.

Associated Microfauna: *Amphistegina, Fabiania, Lepidocyclina, Linderina, Operculinoides,* discocyclinids, algal and bryozoan fragments.

Lithology: Limestone-tan with grayish tinge, indurated, calcite crystals abundant, orbitoidal, algal. Creole Serial Sample 48,206; collector Gustavo Rivero, N.

Formation: Tinajitas.

Age: Upper Eocene.

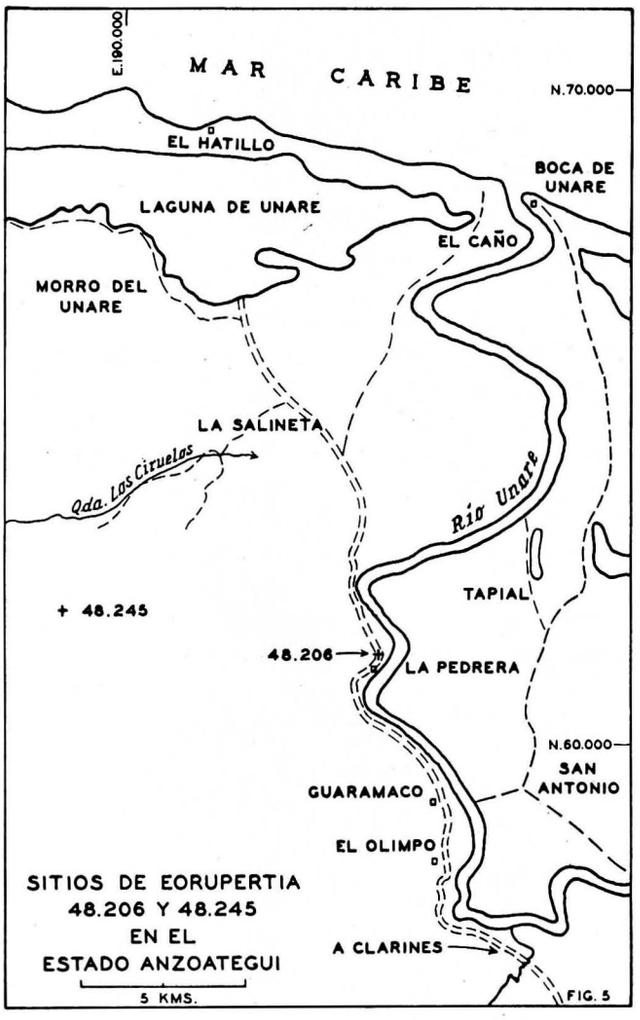
Locality: Along trail on west side of Rìo Unare, Estado Anzoátegui; 11.4 kms. N. 26°W. from Clarines and 7.5 kms. S. 15°W. from mouth of river. Coordinates (approximate) N. 61,380; E. 193,720 (Barbacoas base 0,0). See fig. 5.

Recovery: Oblique section of broken specimen ilustrated as figure 3 of Plate 12.

Slide 14, Specimen 17, Plate 12, Fig. 3: Oblique section large broken specimen, but revealing bilocular nucleoconch surrounded by whorl of at least 4 chambers and two chambers of succeeding whorl. Embryonic chambers nearly circular, remaining trapezoidal, elliptical to elongate elliptical. Partition separating embryonic chambers very gently curved, non-perforate. Test wall thick, coarsely perforate. Septa non-perforate, curved gently backwards, first three not reaching to wall of protoconch; proximal septum of chamber no. 3 with median dark partition.

Dimensions (in microns):

Protoconch 222 x 207
Deuteroconch 222 x 192
Chamber no. 3 222 x 67
Chamber no. 4 348 x 244
Chamber no. 5 318 x 192
Chamber no. 6 370 x 104 (broken)
Chamber no. 7 925 x 185 (broken)



Chamber no. 8 348 x 244 (broken)
Thickness partition between embryonic chambers 15
Thickness wall protoconch 30
Thickness wall chamber no. 4 96
Thickness septum between chambers no's. 3 and 4 15
Diameter pore in wall chamber no. 5 7
Diameters specimen 1.33 x 1.22 mm.

Figured specimen: U.S.N.M. No. P5090.

Associated Microfauna: *Amphistegina, Anomalina, Cibicides, Discocyclina, Dorothia, Gaudryina, Globorotalia* (?), *Helicostegina, Lepidocyclina, Operculinoides, Textularia,* algal fragments.

Lithology: Limestone-medium gray weathering cream and limonitic yellow, indurated, non-crystalline, orbitoidal and algal, impure, containing abundant glauconite, some milky, subrounded quartz fragments up to 2 mm. in diameter.
Creole Serial Sample 48,245 (float); collector Gustavo Rivero, N.

Formation: Tinajitas.

Age: Upper Eocene.

Locality: Along trail south of Morro del Unare, 14.7 kms. N. 42°W. from Clarines, Estado Anzoátegui. Coordinates (approximate) N. 62,100; E. 189,120 (Barbacoas base 0,0). See Fig. 5.

Recovery: Oblique section specimen illustrated as figure 4 of Plate 12.

Slide 15, Specimen 18, Plate 12, Fig. 4: Horizontal section large specimen consisting of 10 chambers, earliest chambers not distinct, visible chambers rectangular, subcircular, semicircular and reniform in outline. Test wall thick, perforated by numerous linear pores arranged perpendicularly to wall; wall probably lamellar but greatly recrystallized; periphery of wall usually slightly indented at junctions with septa; possibly pustulose. Septa thick, non-perforate, curved gently backwards, with median dark layer, earlier septa not extending completely across to wall surrounding initial chambers thus outlining lumen area.

Dimensions (in microns):

Chamber no. 1	89 x 81
Chamber no. 2	104 x 59
Chamber no. 3	148 x 74
Chamber no. 4	185 x 104
Chamber no. 5	289 x 185
Chamber no. 6	340 x 229
Chamber no. 7	346 x 252
Chamber no. 8	326 x 296
Chamber no. 9	407 x 355
Chamber no. 10	496 x 404
Thickness wall chamber no. 10	111
Thickness septum between chamber no's. 2 and 3	59
Thickness septum between chamber no's. 9 and 10	66
Width lumen area opposite chamber no. 5	59
Diameter pore in wall chamber no. 9	7
Diameters specimen	1.60 x 1.42 mm.

Figured specimen: U.S.N.M. No. P5091.

Associated Microfauna: *Lepidocyclina, Operculinoides, Amphiroa, Archaeolithothamnium,* algal fragments.

Lithology: Limestone-gray with tan tinge, indurated, algal, non-crystalline.

REMARKS

The preceding descriptions indicate that the thin sections of all the specimens from Venezuela assigned to *Eorupertia* possess the thick, coarsely perforate test wall characteristic of the genus. The embryonic apparatus, when well preserved, is bilocular. Thin sections of three specimens (no. 1 in 91,138; no. 6 in 91,145; no. 15 in 59,054) apparently reveal the hollow, central axis typical of the genus. Lamellar structure in the test wall is discernible in thin sections of nearly half of the specimens. A lumen area between the whorls can be seen in thin sections of four specimens (no. 3 in 91,138 no. 4 in 91,139 no. 12 in 151,012 no. 18 in 48,245), while canals seem to be developed in thin sections of five specimens (no. 5 in 91,139; no. 8 in 91,145; no's. 9 and 10 in 77,189; no. 14 in 151,012). Median dark septal partitions are visible in thin sections of nearly half of the specimens.

The thickness of the test wall ranges from .03 mm. to .18 mm. and averages .10 mm. The measured septal thickness ranges from .007 mm. to .13 mm. and averages .04 mm. The average diameters of all measurable specimens along the greatest dimensions are 1.15 x 0.86 mm.

In none of the thin sections from Venezuela is there a bunching or grouping of the pores. Although the pores piercing the test wall may be coarsely developed, they do not interrupt the surface of the wall to the extent that pustules or tubercles are characteristically developed.

CONCLUSIONS

The genus *Eorupertia* heretofore has not been described from the Western Hemisphere, and its occurrence in Venezuela, therefore, warrants recording in the literature. Although only imperfect specimens are described in the present paper, by its publication other paleontologists may be stimulated to report on additional and possibly better preserved material from Venezuela.

Eorupertia spp., in Venezuela, are restricted to beds of middle to upper Eocene age. Because it is so limited stratigraphically, the genus is a valuable guide fossil in this country, as it is in France, Poland, Bavaria, Austria, Italy, Turkey, Iraq and Japan. In the material examined, the upper Eocene forms tend to be larger in size and coil dextrally. The specimens from the Venezuelan middle Eocene are smaller and do not show a preferential direction for coiling.

Eorupertia spp., in Venezuela, are found commonly in association with orbitoid and miliolid foraminifera, *Operculinoides, Amphistegina,* calcareous algae and echinoid spines. In these cases at

least, the presence of the genus may be interpreted as indicative of warm, normally saline, actively circulating, shallow marine waters characteristic of a reefal environment. The occasional occurrence, however, of arenaceous and small, rotaloid, calcareous foraminifera infers that *Eorupertia* may also tolerate a slightly deeper and muddier habitat.

ACKNOWLEDGMENTS

The original impetus for this paper was provided by Dr. Hans E. Thalmann and Klaus Küpper, who in 1954, pointed out to the writer that the genus *Eorupertia* had as yet not been described from the Americas. The writer also appreciates the discussions with Peter H. Ronai and his painstaking work in reading the manuscript and translating Hagn's paper on *Eorupertia cristata* (Gümbel). Dr. Pedro J. Bermúdez generously provided specimens of *Eorupertia* from Cuba for comparison purposes. Lee B. Gibson and Ramón Avila gave freely of their time and advice in photographing the specimens. Carlos Fuenmayor and Héctor Ferrer, of Creole's reproduction section, helped considerably in drafting and reproducing the maps and photographs, and Filiberto A. Sánchez patiently typed several proofs of the paper. To each of these individuals sincere appreciation is extended.

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CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
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VOLUME VII, PART 2, APRIL, 1956

154. UPPER CRETACEOUS ORBITOIDAL FORAMINIFERA FROM CUBA.

PART V. HISTORBITOIDES, N. GEN.

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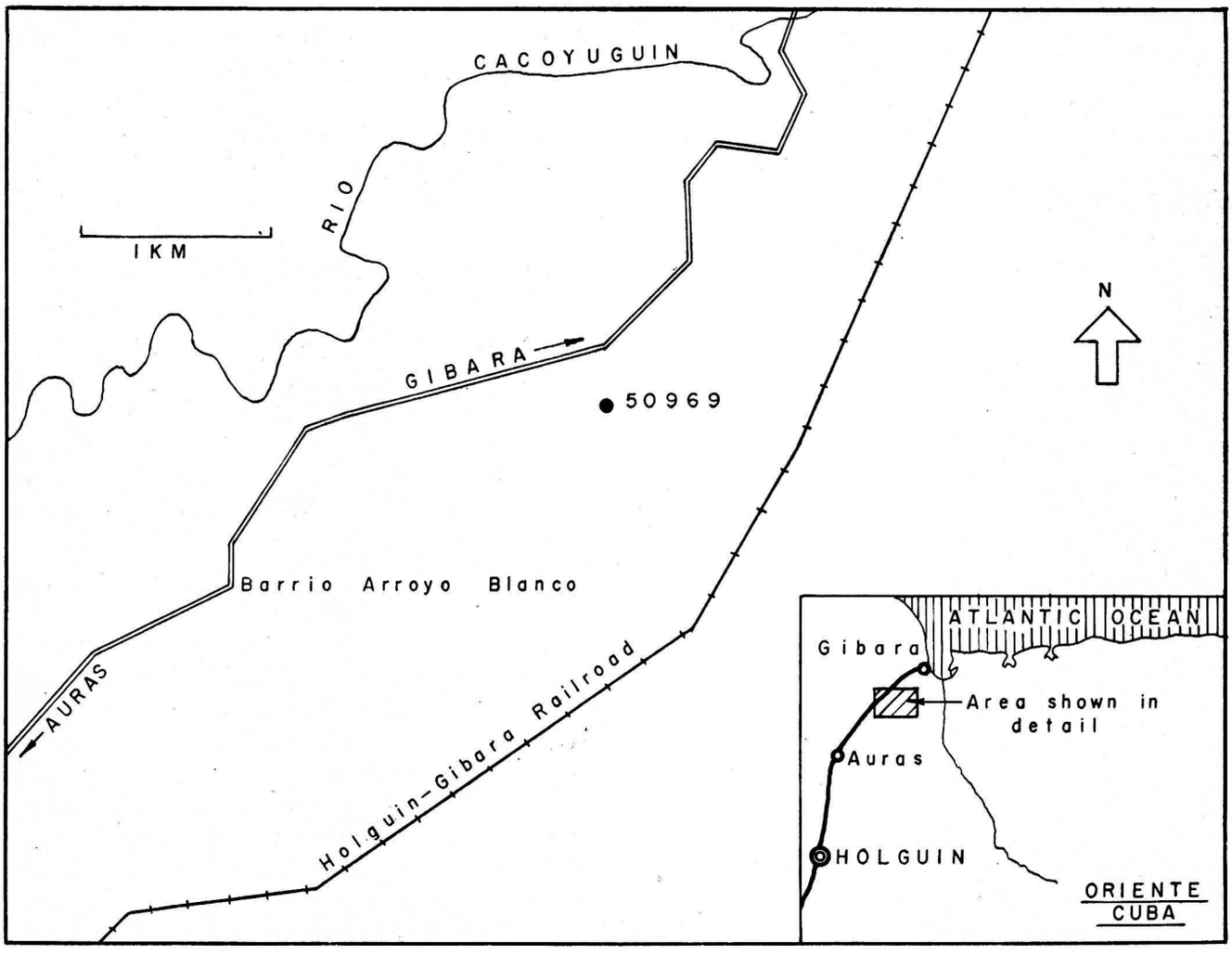
ABSTRACT

Historbitoides, a new monotypic Upper Cretaceous pseudorbitoid genus from Cuba is described in this note. The genotype is *H. kozaryi,* n. sp.

INTRODUCTION

The morphology of the weakly stellate equatorial layer of *Historbitoides,* n. gen., is more complicated than that of *Pseudorbitoides* H. Douvillé, with which it is related by equatorial structures obviously developed from the single system of vertical radial plates. The dimorphic test and the symmetric multiserial juvenarium suggest that *Historbitoides,* n. gen., may have evolved from a primitive representative of *Pseudorbitoides* with uniserial juvenarium and a single system of radial plates, such as *P. israelskyi* Vaughan and Cole. On the other hand, the complicated equatorial structures may indicate derivation from a *P. rutteni*-like ancestor with incipient irregularities in the peripheral portion of the radial plates. The new genus apparently represents a final step in the trend



TEXT FIGURE 1

Map of the type locality of *H. kozaryi,* n.sp. Kozary station 50969, Gibara area, Oriente Province, Cuba.

characterized by the palingenetically progressing complication of the structures of the pseudorbitoidal equatorial layer. In this respect it can be compared with *Rhabdorbitoides* Bronnimann, which likewise is an end-stage, but of a parallel lineage characterized by multiple layers of radial rods in the equatorial layer.

H. kozaryi, n. sp., occurs in a dense, white to buff limestone which crops out at Kozary station 50969, Gibara area, Oriente Province, Cuba. This limestone is a homogenous calcarenite without any igneous fragments. The texture in thin section is fragmental, with orbitoids, pseudorbitoids, sulcoperculinas, algae and mollusk remains embedded in a dense to finely fragmental, dark-grey recrystallized matrix. The larger Forminifera are in part coated by a thin layer of dark matrix. Pelagic Foraminifera are absent. M. Kozary, in his manuscript on the geology of the Gibara area, Oriente Province, Cuba, describes the type locality as follows (see text-fig. 1):

> "Station 50969 lies a few meters north of a well-preserved old Spanish watch tower, located along an east-west trending rise, about 380 meters of the Holguín-Gibara highway at km. 24, on the Argüelles farm, Barrio Arroyo Blanco, Municipio Gibara. The exposure is a 3 m wide, 17 m long, vertical dipping, west-striking tectonic sliver of limestone within a preponderantly ultramafic terrane".

Acknowledgments.—The author wishes to thank M. Kozary, Habana, for the pseudorbitoid material from Oriente Province, Cuba, and unpublished stratigraphic information. He is indebted to Gulf Oil Corporation for the use of the facilities of the Geological Laboratory in Habana and for the permission to publish this note. Holotype and figured thin sections will be deposited in the U. S. National Museum, Washington, D.C., U.S.A.

Description of new genus and species:

Superfamily **Orbitoidicae** Schubert, 1920[1]

Family **Pseudorbitoididae** Rutten, 1935

Genus **Historbitoides** Bronnimann, n.gen.

Genotype.—Historbitoides kozaryi Bronnimann, n.sp.

Definition.—The lenticular test consists of a single equatorial layer and two lateral layers. The juvenarium appears to be quadriserial and symmetric in vertical section. The equatorial layer with its interconnected irregular vertical radial plates is differentiated in radii and interradii. This stellate structure, however, is weak and masked by the overlying lateral layers, so that the exterior of the test is probably not stellate. In the radii, the vertical radial plates are arranged around and perpendicular to the axis of the radius. In the interradii, the plates cut across the equatorial layer and, as a rule, fuse in the middle between top and bottom of the equatorial layer. The fused portions form a true, but discontinuous intermediate floor. There are no annular walls, and the equatorial layer is not limited laterally by roof and floor. The primary lateral chambers rest directly on the equatorial structures, and are overlain by the secondary lateral chambers, which form the lenticular thickening of the test. The lateral chambers are in regular tiers; they communicate by basal stolons and by fine pores. Pillars are present.

Differential diagnosis.—Historbitoides, n.gen., differs from all other pseudorbitoid genera by the interconnected irregular vertical radial plates, and by the incipient stellate differentiation of the equatorial layer.

Occurrence.—Historbitoides, n. gen., has been found only in Oriente Province, Cuba.

Age.—Upper Cretaceous (Maestrichtian).

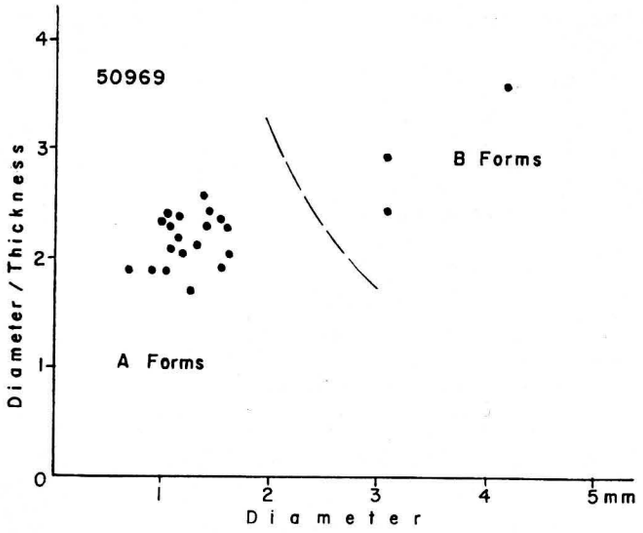
Historbitoides kozaryi Bronnimann, n.sp.

Plate 13, figures 1-11; text-figures 1-7

Holotype.—The holotype of *H. kozaryi,* n.sp., is the microspheric specimen illustrated by figure 3 of plate 13. It is represented by an excentric vertical section, which cuts across a radius. The holotype is from Kozary station 50969, thin section No. 4.

Exterior.—H. kozaryi is represented only by oblique cuts. The surface of the lenticular test is therefore not known. The outline of the test is probably circular, although the interior is weakly stellate. The species is dimorphic; the megalospheric specimens are more numerous than the microspheric ones. The small megalospheric specimens are strongly umbonate with a few larger pustules on the central thickening of the test. The diameter of megalospheric tests is from 0.7 mm to 1.6 mm, average about 1.2 mm, the thickness from 0.4 mm to 0.8 mm, average about 0.6 mm. The considerably larger microspheric specimens are disc-shaped and less umbonate than the megalospheric ones. The pillars are regularly distrib-

1. The termination *-icae* for superfamily names follows the usage of Stenzel, H. B. (1950, Proposed uniform endings for higher categories in zoological systematics: *Science,* Vol. 115, p. 9).



TEXT FIGURE 2
Dimension diagram of *H. kozaryi*, n.sp.

uted over the test. Three centered, practically vertically cut microspheric specimens have the following dimensions in mm.:

Diameter	3.02	4.2	3.03
Thickness	1.07	1.18	1.25

The dimension diagram (text-fig. 2) shows that *H. kozaryi* is similar in size and shape to *P. rutteni*, and also to *P. israelskyi* of which topotypes have been measured. The distinction between the three species must therefore be based on internal features, especially on the structure of the equatorial layer and also on the type of juvenarium.

Interior.—

1. *Juvenarium.*—

The megalospheric center appears to be quadriserial (pl. 13 fig. 1; text-fig. 6). Protoconch and deuteroconch are subspherical in section. The protoconch is equal to, or slightly larger, than the deuterconch. From each of the two unequal primary auxiliary chambers originate two unequal short spirals. In some vertical sections the longitudinal axis of the embryo forms an angle with the equatorial layer. Such an angle has not been noted in other pseudorbitoids, although it is known from many Tertiary orbitoids. Centered horizontal sections of microscospheric specimens are not available.

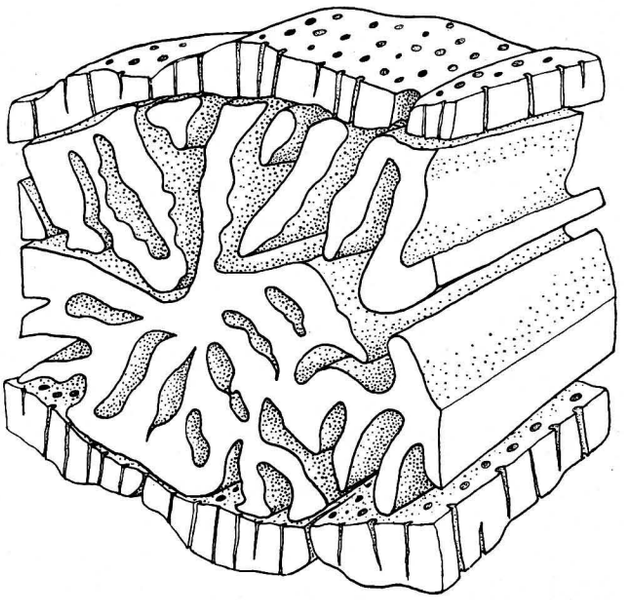
The following dimensions in microns have been measured in:

a) three almost centered horizontal sections

Maximum diameter of			
juvenarium	295	384	308
embryo	205	256	218
large primary auxiliary chamber	128	192	—

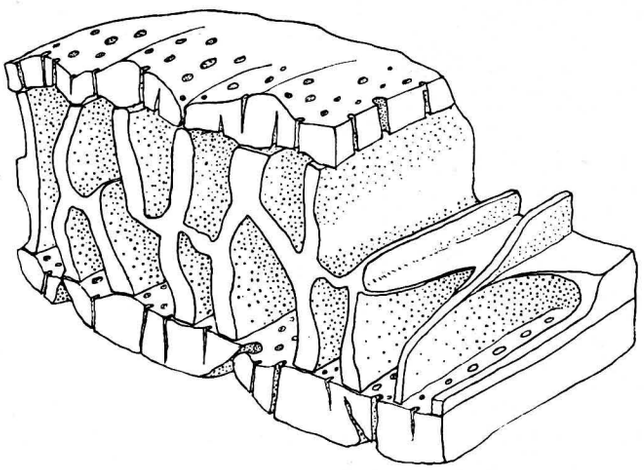
b) four centered vertical sections

Diameter of test	1020	1540	833	1250
Thickness of test	460	668	450	770
Number of lateral layers	—	11-12	5-6	—
Maximum diameter of embryo	268	244	200	256
Maximum thickness of embryo	218	192	194	—



TEXT FIGURE 3

Diagram of a model of the structure of a radius. The front of the model is directed toward the periphery. Only primary lateral chambers are shown. Not to scale.



TEXT FIGURE 4

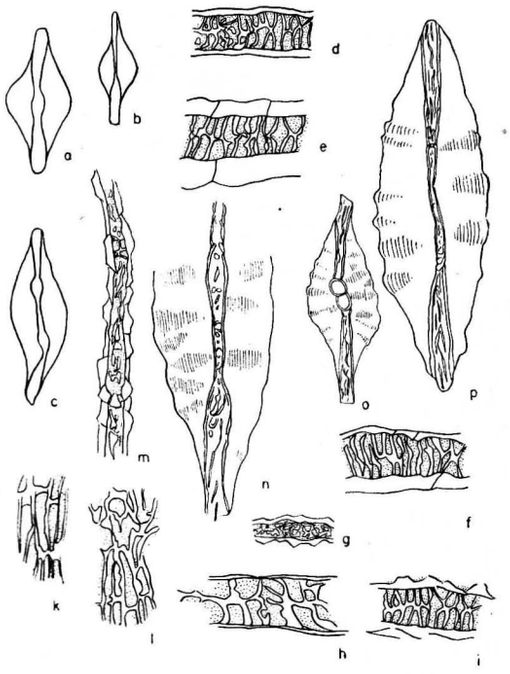
Diagram of a model of the structure of the interradius showing the interconnected radial plates. The front of the model is directed toward the periphery. Only primary lateral chambers are shown. Not to scale.

2. *Neanic stage.*—

The diagnostic features of *Historbitoides,* n.gen., are best shown in excentric vertical and oblique equatorial sections. In the undiagnostic centered vertical sections, the neanic stage of the equatorial layer does not exhibit distinct structures and such sections are difficult to recognize as pertaining to *H. kozaryi.* Thin lines and discontinuous irregular forms represent random cuts across the complicated system of plates, which is distinctly more delicate than in *Pseudorbitoides.* The plates start immediately outside the juvenarium, and in some individuals, they extend slightly outside the lateral layers forming a sort of narrow peripheral flange. In oblique vertical sections, the number of discontinuous thin lines is greater than in oriented sections and, as a rule, they are short and are more or less parallel to each other but are oblique to the boundaries of the equatorial layer. They may be interconnected. The diagnostic excentric vertical sections show the complicated organization of the equatorial layer in figs. 3, 4 and 6-8 of pl. 13. The vertical plates are irregularly interconnected and cut completely across the equatorial layer. On closer examination it can be seen that the dominant vertical character of the equatorial structures is maintained regardless of the many irregularities, which appear to be more pronounced in megalospheric than in microspheric specimens. The plates tend to fuse in the middle of the equatorial layer and to form transverse connections represented by H-, X-, and Y-like cuts in the excentric vertical sections. Free radial plates may occur intercalated between groups of linked plates. The transverse connections are best developed in microspheric specimens. They represent a true median floor, which is uneven and discontinuous and has nothing in common with the "floors" or divisions described by Vaughan and Cole (1943, p. 99) and by Rutten (1935, p. 543) in *Vaughanina cubensis* and in *Pseudorbitoides israelskyi* (= *P. rutteni* Bronnimann). In megalospheric specimens, the transverse connections are not so clearly restricted to the middle of the equatorial layer, thus the excentric vertical cut is even more irregular. In oblique equatorial sections (pl. 13, figs. 9, 10), the radial plates appear as more or less parallel lines, and the discontinuous floor is represented by irregularly outlined patches between two or more radial plates. These patches more or less occur in the middle of the sectioned equatorial layer between the lateral chambers. The oblique equatorial section of *Historbitoides* shows the following succession: lateral chambers—radial plates—patches of interconnected floor—radial plates—lateral chambers.

The following measurements in microns are from the equatorial layer of microspheric (a, b) and megalospheric (c) specimens.

	a	b	c
Height of equatorial layer	103	87	58
Thickness of radial plates	8–12	8–12	5–6
Thickness of walls of primary lateral chambers	30	30–45	15–20



TEXT FIGURE 5

H. kozaryi, n.sp. All from Kozary station 50969. a-c, n-p 39 x, d-1, m 105 x.

a-c Vertical sections of megalospheric specimens showing the stellate differentiation of the equatorial layer.

d-i Excentric vertical sections across the equatorial layer; g is from a megalospheric specimen.

K,1 Oblique sections across the equatorial layer.

m-p Vertical sections of megalospheric (centered) (o) and microspheric (almost centered) (m,n,p) individuals. The structures of the equatorial layer are irregular and undiagnostic.

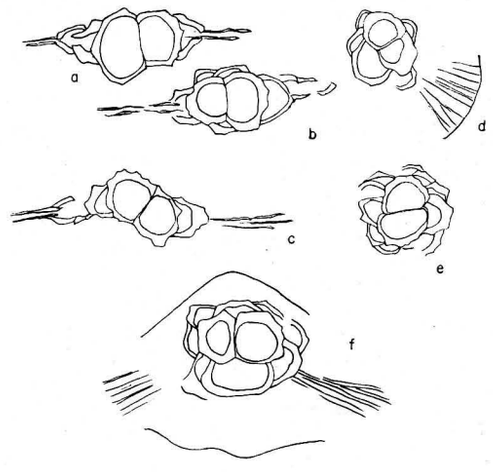
A remarkable new feature of the equatorial layer of *H. kozaryi,* n.sp., is the formation of a weak incipient stellate structure. It shows itself by thickenings and thinnings of the equatorial layer and fan-like widenings of the peripheral portion of the equatorial layer (text-fig. 5). Incipient radius and interradius are illustrated by fig. 8 of pl. 13 and by the diagrammatic drawings of models in text-figs. 3 and 4. Details of these structures are given in text-fig. 7. The radii are the most conspicuous part of the equatorial layer. Where well developed, as in the holotype, they are represented by narrow swellings of the equatorial layer to about twice the thickness of the interradial part. The radii exhibit in the excentric vertical section a more or less radiate arrangement of the vertical plates around the axis of the radius (pl. 13, fig. 3; text-fig. 7).

The stellate organization of *Historbitoides,* n.gen., is identical in principle to that of the Eocene *Asterocyclina,* i.e., it is formed by the differentiation of the equatorial layer and not by the lateral layers. In such forms, the stellate character of the equatorial layer may show itself in the stellate shape of the test, or, if weak, may be completely masked by the covering lateral chambers. As no cuts with clearly stellate outlines have been encountered, it appears that *H. kozaryi,* n.sp., belongs to this latter group. *Asterorbis macei* Palmer, from the Cuban Upper Cretaceous, on the other hand, is a good representative of the group of forms where the internal stellate arrangement is revealed by the stellate test. Circular forms with radii, which are built like the Eocene *Aktinocyclina* are not yet known in the Upper Cretaceous.

The lateral layers are as in *Pseudorbitoides.* The primary lateral chambers are low and thick walled; they rest directly on the radial structures of the equatorial layer. The secondary lateral chambers are in regular tiers. Pillars are present. Communications are by basal stolons and by fine pores.

The following measurements in microns are from three vertical sections. Dimensions of lumina are inner dimensions.

	Megalospheric specimen. Not centered, damaged at periphery.	Megalospheric specimen. Centered, but somewhat oblique.	Microspheric specimen. Not centered, cut vertically near periphery.
Diameter of test	1025	1800	3080
Thickness of test	410	640	515
Number of layers of lateral chambers	ca.7	13-15	5-6
Secondary lateral chambers			
length	± 40	± 65	± 130
height	± 10	± 10	10–25
wall	± 6	± 5	6–12
Diameter of pillars	25–50	25–40	25–65
Thickness of equatorial layer at periphery	65	115	155



TEXT FIGURE 6

H. kozaryi, n.sp. All from Kozary station 50969. 105 x. Vertical and equatorial sections of the juvenarium.

Age.—The thin sections from Kozary station 50969 contain the following assemblage:

Historbitoides kozaryi Bronnimann, n. sp. (common)

Vaughanina cubensis Palmer (common)

Orbitoides sp. (small representative) (common)

Sulcoperculina cf. *S. vermunti* (Thiadens)

Sulcoperculina angulata Brown and Bronnimann, MS. (common)

Sulcoperculina globosa de Cizancourt

Sulcoperculina sp.

prisms of *Inoceramus* and other mollusk fragments

remains of echinoderms and algae.

V. cubensis and *S. globosa* indicate a Maestrichtian age for this assemblage.

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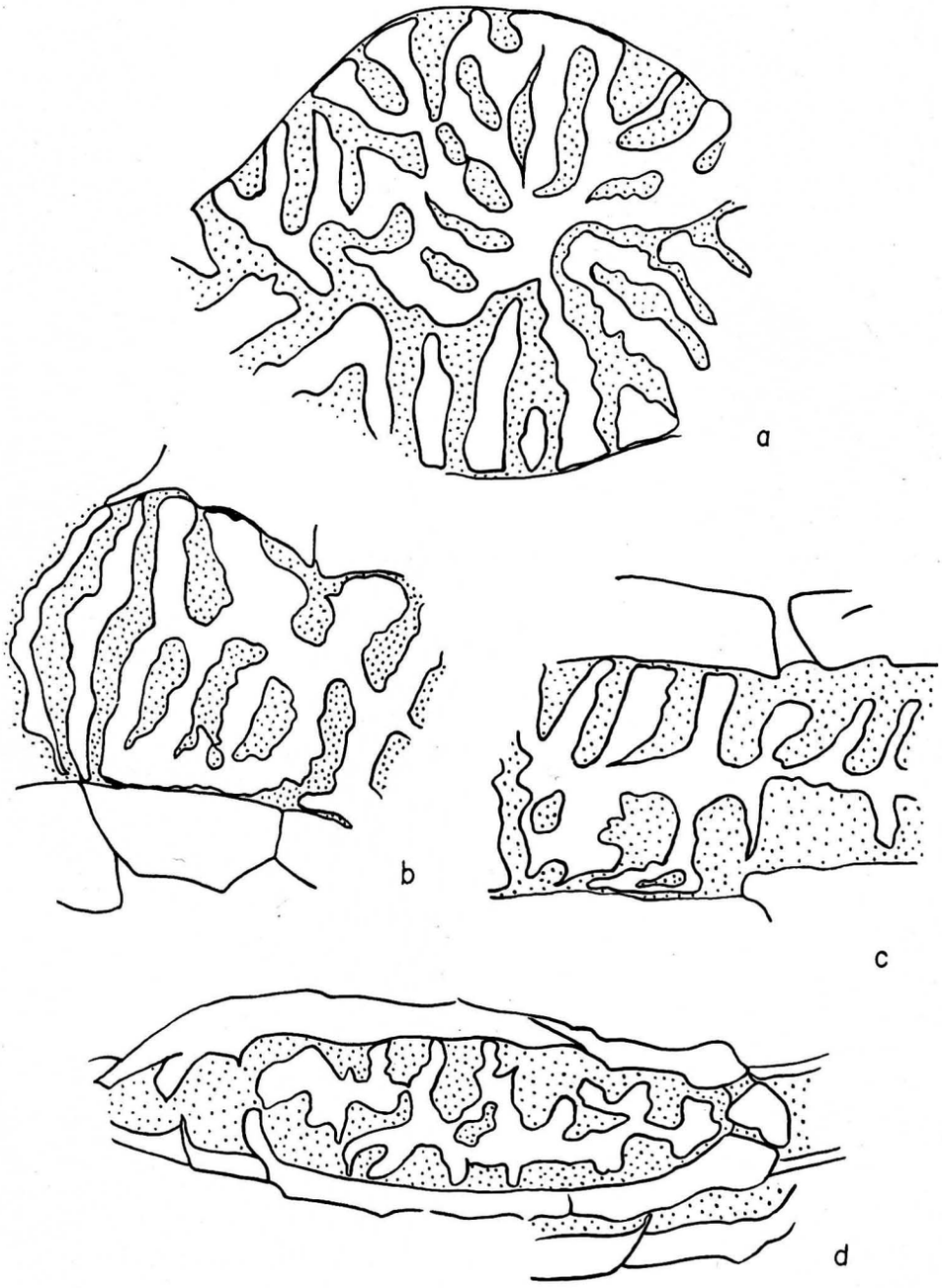
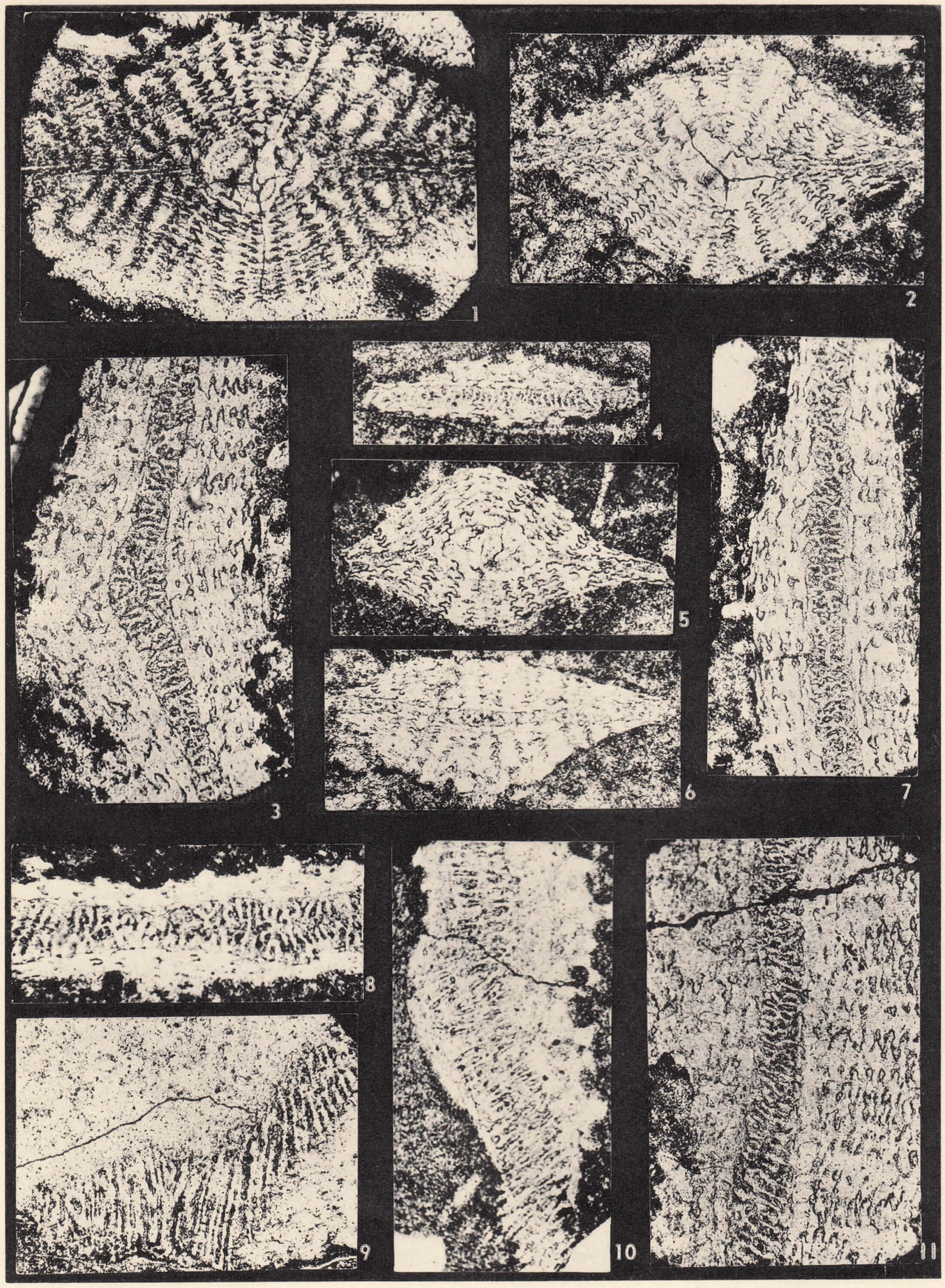


TEXT FIGURE 7

H. kozaryi, n.sp. All from Kozary station 50969. Appr. 325 x. Excentric vertical sections across well developed radius (a), weak radius (b), interradial portion (c), ?radius of a megalospheric specimen (d).

EXPLANATION OF PLATE 13

FIGS.	All approximately 52X.	PAGE
	Historbitoides kozaryi Bronnimann, n.gen., n.sp.	61
1, 2, 5	Centered vertical and oblique vertical sections. Equatorial structures are indistinct.	
3, 7, 8, 11	Excentric vertical sections across the equatorial layer of microspheric specimens. The section of the holotype, fig. 3, exhibits a distinct but weak radius.	
4, 6	Excentric vertical sections across megalospheric specimens. Fig. 4 is close to the periphery, fig. 6 near the juvenarium.	
9, 10	Oblique horizontal sections of microspheric specimens.	



Bronnimann: Upper Cretaceous Historbitoides from Cuba

CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH

VOLUME VII, PART 2, 1956

RECENT LITERATURE ON THE FORAMINIFERA

Below are given some of the more recent works on the Foraminifera that have come to hand.

ANSARY, S. E. Report on the foraminiferal fauna from the upper Eocene of Egypt.—Publ. Instit. Desert d'Egypte, No. 6, 1955, pp. 1-160, pls. 1-4, map, tables.—The fauna, based on 73 samples from 3 sections, includes 112 species and varieties (12 species and 3 varieties new). Correlation with Jackson Eocene of America is suggested.

AUROUZE, GERMAINE, and BIZON, JEAN-JACQUES. Sur la présence de Spirocyclines dans le Portlandien du Bassin de Paris.—Bull. Soc. Géol. France, 6(me) sér., tome 5, fasc. 1-3, Oct. 1955, pp. 51-54, pl. 1b.—**Spirocyclina infravalenginiensis.**

BARTENSTEIN, H. Taxionomische Revision der als **Eoflabellina** und **Flabellamminopsis** bezeichneten Foraminiferen.—Paläont. Zeitschrift, Band 29, Nr. ¾, Aug. 1955, pp. 170-176, pls. 20, 21.—**Eoflabellina** Payard 1947 a synonym of **Lenticulina. Flabellamminopsis** Malecki 1954 a synonym of **Triplasia.** Neotypes for **Lenticulina d'orbignyi** (Roemer 1839) and **Triplasia murchisoni** Reuss 1854 are erected.

BOSTWICK, DAVID A. Stratigraphy of the Wood River formation, south-central Idaho.—Journ. Pal., vol. 29, No. 6, Nov. 1955, pp. 941-951, pls. 96-98.—Numerous fusulinids, none new, mostly indeterminate as to species, are illustrated.

BOWEN, R. N. C. Quaternary Foraminifera from St. John's Fjord, West Spitsbergen.—Annals and Mag. Nat. Hist., ser. 12, vol. 7, Oct. 1954, pp. 737-752, text figs. 1, 2 (pls.).—Twenty-four species, none new, from a raised beach deposit, indicating conditions slightly less cold than at present.

The stratigraphical range of the foraminiferal genus **Orbulina** d'Orbigny 1839.—Geol. Mag., vol. 92, No. 2, March-April 1955, pp. 162-167.—Pre-Oligocene records of the genus are based on wrong identifications and Oligocene records are probably from strata belonging in Miocene.

Observations on the foraminiferal genus **Gaudryina** d'Orbigny, 1839.—Micropaleontology, vol. 1, No. 4, Oct. 1955, pp. 359-364, text figs. 1-6.—Emendation of the genus with **Heterostomella, Plectina, Dorothia, Marssonella, Karreriella, Bermudezina,** and **Migros** included as synonyms of **Gaudryina.**

BRADSHAW, JOHN S. Preliminary laboratory experiments on ecology of foraminiferal populations.—Micropaleontology, vol. 1, No. 4, Oct. 1955, pp. 351-358, text figs. 1-8.—Effect of food, temperature, and salinity on population growth of **Rotaliella heterocaryotica** Grell.

BRUNN, JAN. H., CHEVALIER, JEAN-PIERRE, and MARIE, PIERRE. Quelques formes nouvelle de Polypiers et de Foraminifères de l'Oligocène et du Miocène NW de la Grèce. (Foraminifères by P. MARIE, pp. 202-204)—Bull. Soc. Géol. France, 6(me) sèr., tome 5, fasc. 1-3, Oct. 1955, pp. 193-205, pls. 8-10, text fig. 1 (map and section), table 1.—**Austrotrillina brunni** n. sp. from upper Oligocene or basal Aquitanian.

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IVANOVA, E. A., and KHVOROVA, I. V. Stratigraphy of middle and upper Carboniferous of upper part of Moscow syncline (in Russian).—Akad. nauk SSSR, Pal. instit., Trudy, vol. 53, 1955, pp. 1-279, text figs. 1-46, tables 1-6.—Includes lists of Foraminifera.

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SKINNER, JOHN W., and WILDE, GARNER L. New fusulinids from the Permian of West Texas.—Journ. Pal., vol. 29, No. 6, Nov. 1955, pp. 927-940, pls. 89-95.—Four species, all new. **Paradoxiella** n. gen. (type species **P. pratti** n. sp.).

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WALTON, WILLIAM R. Ecology of living benthonic Foraminifera, Todos Santos Bay, Baja California.—Journ. Pal., vol. 29, No. 6, Nov. 1955, pp. 952-1018, pls. 99-104, text figs. 1-24.—Numerous samples were studied as to living-dead ratio, number of specimens per unit wet volume, and sediment size. Study of 8 seasonal traverses made at approximately 6-week intervals, extending from shore to about 600 fms., indicates greatest abundance between 20 and 50 fms. and maximum production in late spring and summer. Four geographic assemblages and 4 depth facies are recognized from distributions and abundances of the living benthonic Foraminifera. Results are recorded in tabular form and plotted graphically. "Relict" sediments are indicated by presence of species not known to be living in the area Over a hundred species, none new, not all specifically identified, were distinguished in the counting and are illustrated.

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RUTH TODD