CONTRIBUTIONS
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Contents

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130. UPPER CRETACEOUS ORBITOIDAL FORAMINIFERA FROM CUBA

PART III. *PSEUDORBITOIDES* H. DOUVILLÉ, 1922

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INTRODUCTION

The present paper is the continuation of two previous notes on Upper Cretaceous orbitoidal Foraminifera from Cuba (Bronnimann, 1954 a, b). It contains the descriptions of *Pseudorbitoides trechmanni* H. Douvillé, 1922, from Jamaica, B.W.I., and of the related *Pseudorbitoides rutteni* Bronnimann, n.sp., from Cuba. Remarks on age significance and phylogenetic relationship of these species are added. Furthermore, the definition of the family Pseudorbitoididae M. G. Rutten, 1935, and the emended definition of the type genus *Pseudorbitoides* H. Douvillé, 1922, are proposed.

The descriptions are based on the following material:

Pseudorbitoides trechmanni H. Douvillé

a) Topotypes from the Upper Cretaceous *Barrettia* bed at Green Island, Jamaica, B.W.I. Type locality map see text-fig. 1a. Abundant, mainly oblique cuts of *P. trechmanni* in thin sections of a hard, yellow-brown, fragmental limestone, which also contains rare *Sulcoperculina* cf. *S. vermunti* (Thiadens), rare small, benthonic Foraminifera, and abundant algal and rudist fragments.

b) Photographs of an equatorial and a vertical thin section, both not quite centered, of free topotypes collected by C. T. Trechmann (pl. 9, fig. 2; pl. 10, fig. 5). The two oriented thin sections have been studied and figured by Vaughan (1929), and by Vaughan and Cole (1943). They are deposited in the U. S. National Museum, Washington, D.C., U.S.A., and were not available for direct investigation.

Pseudorbitoides rutteni Bronnimann, n.sp.

a) Abundant, mostly oblique cuts of *P. rutteni* in rock thin sections. Type locality map see text-fig. 8a. As a rule, the rocks are heterogeneous fragmental limestones, composed of limestone and igneous fragments with a variable amount of matrix. *P. rutteni* has been found in different localities in central and southern Las Villas Province, Cuba, where it is associated with *Sulcoperculina* cf. *S. vermunti* (Thiadens), *Sulcoperculina* sp., *Oligostegina ovalis* Kaufmann, *Globotruncana stuarti* (de Lapparent), *Gümbelina* cf. *G. globulosa* (Ehrenberg), *Torreina torrei* Palmer, small rotaliform Foraminifera, and abundant algal and rudist fragments. In some localities, the pseudorbitoids are possibly redeposited.

b) Three rock thin sections (Nos. 14411-14413), and three oriented equatorial sections of free specimens (Nos. 14417-14419), one of which is centered, from the collection of the Min.-Geol. Institute of the University of Utrecht. The original material is a heterogeneous, fragmental Upper Cretaceous limestone reported by Rutten (1936) from the Habana formation of Las Villas Province, Cuba. The thin sections are from locality L 414; in addition to *P. rutteni,* n.sp., they contain *Sulcoperculina* cf. *S. vermunti* (Thiadens), and abundant algal and rudist fragments. In two more rock thin sections of the Utrecht collection, from locality L 415, (Nos. 14421 and 14423), a new Upper Cretaceous pseudorbitoid is associated with *Torreina torrei* Palmer. This form, possibly representative of a new genus, will be described in a later note. The geographic and geologic situation of the localities L 414 and L 415 is given in Rutten's geologic map of part of the road between Camajuaní and Falcon, Las Villas Province (Rutten, 1936, p. 45, fig. 12) and in a sketch map accompanying Rutten's paper on the larger Foraminifera of northern Santa Clara (Las Villas) Province, Cuba (1935, p. 529, fig. 1D).

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The holotype of *P. rutteni,* the neoholotype of *P. trechmanni,* and the figured specimens of these species, excepting those which are in thin sections from the collection of the Min.-Geol. Institute of the University of Utrecht, will be deposited in the U.S. National Museum, Washington, D.C.

Family PSEUDORBITOIDIDAE

M. G. Rutten, 1935

Type Genus.—Pseudorbitoides H. Douvillé, 1922.

Definition.—Test lenticular, divided into a single equatorial layer and two lateral layers. Juvenarium uniserial to quadriserial. Equatorial layer consists of juvenarium and vertical radial plates, arranged either in two alternating systems of plates separated by a median gap, or in a single system of plates, or in a combination of the two types. Plates may develop irregularities toward the periphery. In the microspheric form, arcuate equatorial chambers may be intercalated between the uniserial juvenarium and the radial plates. Annular walls, and roofs and floors of the equatorial layer may be developed. Lateral layers of chambers rest directly on the grid formed by the vertical radial plates. Communications by stolons and fine pores.

Age.—Upper Cretaceous (Campanian to Maestrichtian).

Occurrence.—Jamaica; Cuba; Guatemala; Haiti; Venezuela; Mexico; southern United States; possibly Bonaire, D.W.I.

Diagnosis.—The Pseudorbitoididae differ from the Orbitoididae in having vertical radial plates in the equatorial layer. In primitive representatives, such as *Sulcorbitoides,* the Pseudorbitoididae show distinct sulcoperculinoid features. They are derived from *Sulcoperculina* with *Sulcorbitoides* as the most primitive representative of this family.

The following genera are herein assigned to the Pseudorbitoididae: *Pseudorbitoides* H. Douvillé, 1922 (type genus), *Vaughanina* Palmer, 1934, and *Sulcorbitoides* Bronnimann, 1954.

Remarks.—The above definition differs little from M. G. Rutten's (1941, p. 38) definition of the subfamily Pseudorbitoidinae. Because the vertical radial plates furnish some of the diagnostic features, emphasis is given here to these plates and not to the thin canals or canal-like chambers, which are formed by them (M. G. Rutten, 1935 p. 543). The equatorial layer does not double or treble toward the periphery as mentioned by H. Douvillé (1922, p. 203; 1924, p. 369) and M. G. Rutten (1935, p. 543; 1941, p. 38). Furthermore, not only uniserial but also quadriserial juvenaria have been observed. Apart from the equatorial layer, the morphology of the type genus closely resembles that of orbitoid genera, and for this reason, the pseudorbitoids were regarded by M. G. Rutten (1935, p. 544) and by Vaughan and Cole (1948, p. 352) as belonging to the Orbitoididae Schubert, 1920. However, M. G. Rutten (1941, p. 34) was later inclined to remove the pseudorbitoids from the Orbitoididae, but for lack of information on the internal structure, he retained them as a subfamily. He regarded it as probable, "that, if more work on better preserved forms of this genus (*Pseudorbitoides*) were done, these forms should also be separated from the Orbitoididae."

According to Vaughan and Cole (1943, p. 100), M. G. Rutten did not have preparations of the equatorial layer of *P. trechmanni,* the type species of *Pseudorbitoides.* The definition of the subfamily Pseudorbitoidinae was based on Cuban orbitoids, then determined by M. G. Rutten (1935, p. 544) as *P. israelskyi* Vaughan and Cole and *P. trechmanni.* Study of topotypes of these two species shows M. G. Rutten's "*P. trechmanni*" to be close to, but in peripheral structure of the equatorial layer and embryonic apparatus different from *P. trechmanni* from Jamaica. His "*P. israelskyi*" is likewise different from the uniserial *P. israelskyi* from Louisiana. M. G. Rutten's "*P. israelskyi*" and "*P. trechmanni*" are herein interpreted as synonyms of *P. rutteni,* n.sp. This species is a true *Pseudorbitoides,* which differs only slightly from *P. trechmanni.* Hence M. G. Rutten correctly defined and named the Pseudorbitoidinae. Formerly, only *Pseudorbitoides* was assigned to the subfamily by M. G. Rutten (1941, p. 38). Later, Vaughan and Cole (1948, pp. 35, 35) added *Vaughanina* Palmer, 1934, and the writer, *Sulcorbitoides* Bronnimann, 1954.

Genus **Pseudorbitoides** H. Douvillé, 1922

Genotype.—Pseudorbitoides trechmanni H. Douvillé, 1922.

Definition.—The lenticular test is divided into a single equatorial layer and two lateral layers. The lateral layers cover the equatorial layer completely or they leave a marginal ring or flange of the equatorial layer free as in *Vaughanina.* The megalospheric juvenarium is uniserial to quadriserial; the microspheric juvenarium is uniserial. The neanic stage of the equatorial layer is represented by vertical radial plates, arranged in a single system; near the center, the radial plates may be disposed in two systems of alternating plates as described in *Sulcorbitoides.* Toward the periphery, the radial plates may develop irregularities and may be reduced. There are no annular walls. In the microspheric form, open arcuate equatorial chambers may be intercalated between juvenarium and the radial plates. The equatorial layer is not limited laterally by roof and floor, and it is not divided by "additional floors" into horizontal divisions. The lateral layers rest directly on the radial plates and on the chambers of the juvenarium. Those which rest on the radial plates are the primary lateral chambers, and those which form the lenticular thickening of the test are the secondary lateral chambers. The lateral chambers are arranged in regular tiers, and communicate by basal stolons and by fine pores. Pillars are present.

Diagnosis.—Pseudorbitoides differs from *Sulcorbitoides* by having the single system of vertical radial plates in all or in the later portion of the neanic stage, and by the multiserial juvenaria. It is distinguished from *Vaughanina* by the single system of radial plates, and by the absence of annular walls, and of roof and floor of the equatorial layers. Unlike *Sulcorbitoides,* and to some degree also unlike long-spiraled representatives of *Vaughanina,* the uniserial juvenarium of *Pseudorbitoides* shows little affinity with *Sulcoperculina.* But indications of two alternating systems of radial plates near the juvenarium suggest that *Pseudorbitoides* has evolved from *Sulcorbitoides.* The single system of plates is believed to have developed from the two systems by growing of the alternating plates across the equatorial layer. The diagnostic features are tabulated below:

	Juvenarium	*Neanic stage*
Sulcorbitoides	Sulcoperculinoid; distinct sulcus.	Two alternating systems of vertical radial plates. Annular walls absent. Lateral chambers rest directly on the radial plates of the equatorial layer. Lateral layers cover the equatorial layer completely.
Vaughanina	Sulcoperculinoid; but less pronounced sulcus.	Two alternating systems of vertical radial plates. Annular walls present. Lateral chambers and radial plates are separated by roof and floor of the equatorial layer. Lateral layers do not completely cover the equatorial layer.
Pseudorbitoides		
Megalospheric form	Uniserial to quadriserial; no accessory auxiliary chambers.	One system of vertical radial plates; close to the juvenarium occasionally indication of the two alternating systems as described in *Sulcorbitoides.* Annular walls absent. Lateral layers rest directly on the radial plates. The radial plates may develop irregularities or may be much reduced toward the periphery. Lateral layers do not always completely cover the equatorial layer.
Pseudorbitoides		
Microspheric form	Uniserial, composed of about 15 chambers, arranged in about 2 whorls.	Neanic stage as in the megalospheric form, with the difference that open arcuate equatorial chambers occur between juvenarium and radial plates.

Occurrence.—Jamaica; Cuba; Haiti; southern United States.

Reported occurrence.—*Pseudorbitoides* H. Douvillé has also been found outside the above listed areas. These occurrences, however, need to be verified. Glaessner (1952, p. 25) reported, without giving further information, the "unexpected" discovery of *Pseudorbitoides* in New Guinea, and recently Papp and Küpper (1954, pp. 8-10, pl. 2, fig. 3) described a new species, *Pseudorbitoides longispiralis* Papp and Küpper, 1954, from the Lower Maestrichtian of Silberegg, Guttaring-Klein St. Paul, Kärnten, Austria. Their description is not conclusive, although radial canals are mentioned, and the illustration of the slightly off-centered equatorial section is not adequate to confirm the generic assignment.

Pseudorbitoides trechmanni H. Douvillé, 1922.

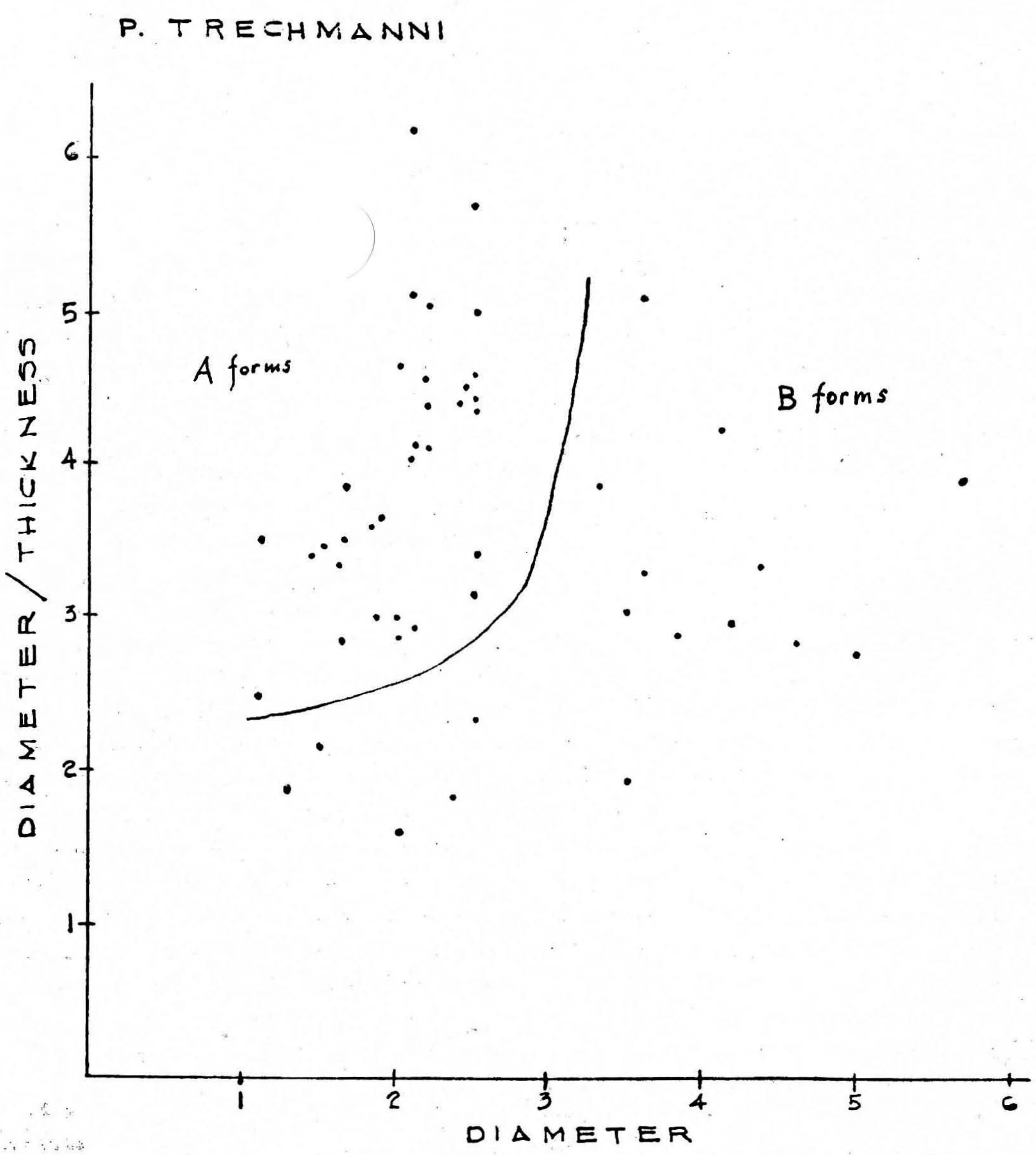
Plates 9, 10, Text-figures 1-7

Pseudorbitoides Trechmanni—H. Douvillé, 1922, C.R. Somm. Soc. Géol. France, vol. 22, p. 204, fig. 1; H. Douvillé, 1924, Bull. Soc. Géol. France, Vol. 23, (1923), pp. 369-370, figs. 1, 2.

Pseudorbitoides trechmanni—Vaughan, 1929, Journ. Pal., vol. 3, No. 2, pp. 168-169, pl. 21, figs. 4-6; Vaughan & Cole, 1943, idem, vol. 17, No. 1, pp. 97-100, pl. 17, figs. 5, 6.

Type locality.—Trechmann (1922, p. 505) described the type locality of *P. trechmanni* as follows:

The **Barrettia** limestone from which my collections were made occurs on the Haughton Hall estate, near Green Island Harbour, in Hanover Parish in Western Jamaica. The locality is apparently the same as that referred to by Whitfield as Orange Cove. The name Orange Bay is given by some to part of the coast which lies some two miles southwest of the ridge of **Barrettia** limestone at Haughton Hall.



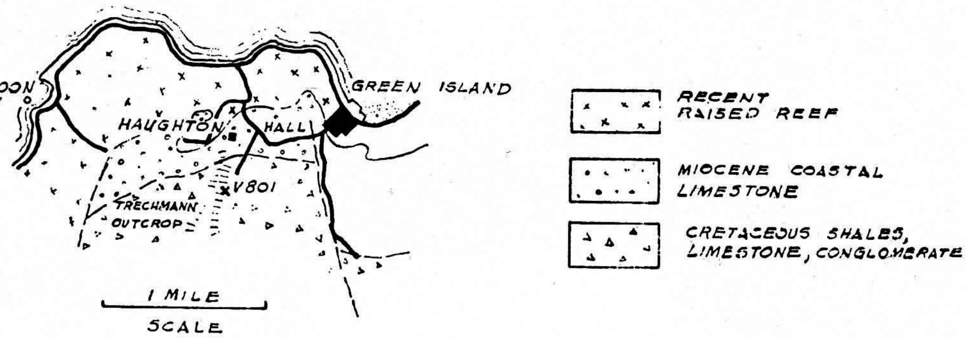
TEXT FIGURE 1

Dimension diagram of topotypes of *Pseudorbitoides trechmanni.*

The topotypes of *P. trechmanni,* recently collected by H. R. Versey, Geological Survey Jamaica, are from the same ridge of *Barrettia* limestone at Haughton Hall mentioned by Trechmann (see location map, text-fig. 1a). Mr. Versey, in his letter of September 20, 1954, states:

> The locality (V801) of the specimens sent to you is about 1/3 mile SSW of Haughton Hall, a little below the crest of the same ridge and on the eastern side. Trechmann it seems took his specimens from the west side of the ridge, but as on the eastern flank there is only the one limestone overlying shales dipping north and capped by conglomerate, there is no doubt that the two outcrops are of the same bed. Their distance apart cannot be more than 200 yds.

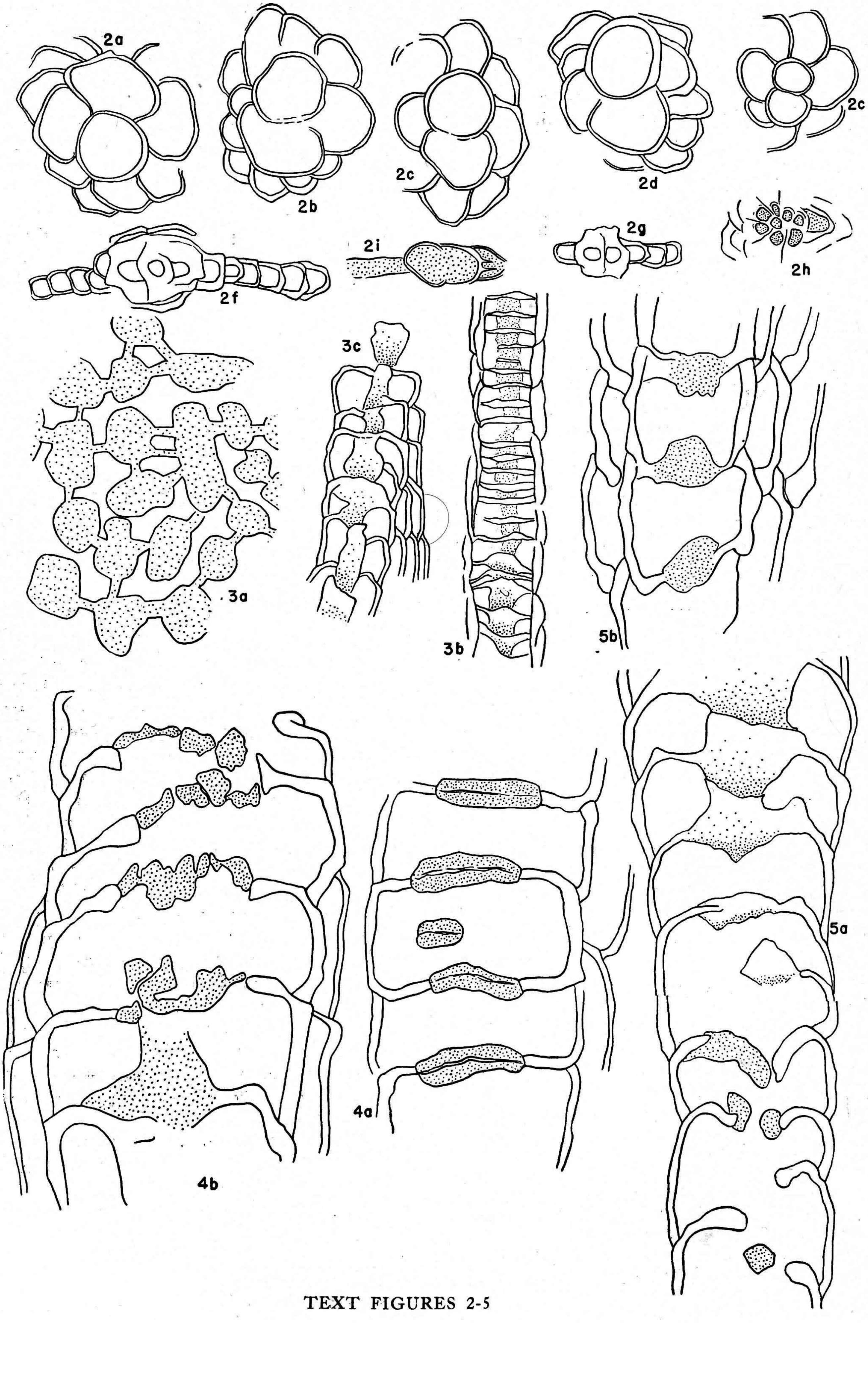
Exterior.—The sublenticular test of *P. trechmanni* was briefly described by Vaughan (1929, p. 168), who mentioned indistinct radial lines in places on the surface, and over the center a few papillae of about 100μ diameter. A microspheric specimen has a diameter of 3.5 to 4.0 mm, and a thickness of 1.2 mm; a smaller specimen, possibly megalospheric, has a diameter of about 2.0 mm and a thickness of about 0.75 mm. H. Douvillé (1924, p. 369) did not explicitly describe the exterior of *P. trechmanni,* and stated only that it has the general structure of orbitoids and that the diameter of his specimens is about 5.0 mm. Among the fossils Trechmann (1922, p. 508) lists from the *Barrettia* bed is a foraminifer. He states, "A lenticular form in shape like *Orbitoides,* measuring up to 6 mm. in diameter. Professor Douvillé assures me that the internal is not that of Orbitoides!" The recently collected topotypes from Green Island, Jamaica, are embedded in a hard rudist limestone and could not be isolated. Therefore, no additional information on the exterior of the test can be offered except that which can be deduced from thin sections. Vertical sections of the peripheral portion of the equatorial layer of complete specimens show for instance, that a peripheral flange is formed, similar in appearance to that of *Vaughanina* (pl. 9, figs. 3, 6, 7; pl. 10, figs. 1, 7; text-fig. 4b). The morphology of the flange is, however, different from that of *Vaughanina.* It will be discussed in the description of the vertical section. Microspheric specimens carry strong pillars of 30μ to 130μ thickness on the surface, whereas pillars are absent or weakly developed in the thinner megalospheric individuals (pl. 9, figs. 1, 3). The dimensions of more or less oblique, but centered vertical sections of megalospheric and microspheric specimens have been measured in rock thin sections and compiled in a dimension-diagram (text-fig. 1). Although such



TEXT FIGURE 1a

Map of the type locality of *Pseudorbitoides trechmanni.* After H. R. Versey.

Neoholotype.—H. Douvillé did not designate a holotype of *P. trechmanni,* and as his material appears to be lost (Bronnimann, 1954 b), a neoholotype should be introduced. The type specimen could have been chosen from the two oriented, but not quite centered thin sections, which are from microspheric topotypes collected by Trechmann and deposited in the U.S. National Museum. Both thin sections have been described and illustrated by Vaughan (1929, pl. 21, figs. 4-6), Vaughan and Cole (1943, pl. 17, figs. 5, 6) and in the present paper by pl. 9, fig. 2, and by pl. 10, fig. 5. However, it is preferable to choose the neoholotype from the rich topotype material of *P. trechmanni,* recently collected by Versey. It contains numerous microspheric and megalospheric specimens which serve as a good basis for morphologic investigations. The megalospheric specimen, illustrated by the vertical section figure 3 of plate 9, is herewith designated as the neoholotype of *P. trechmanni.* The section is centered and exhibits a) the "orbitoidal" embryo, b) the equatorial layer increasing rapidly in height toward the periphery, which is composed of vertical radial plates, and of high primary lateral chambers, c) the secondary lateral chambers, which are arranged in regular tiers and do not cover the equatorial layer at the periphery, and d) the absence of pillars.



TEXT FIGURES 2-5

measurements rarely give correct dimensions, they are adequate for the determination of the approximate range of diameter and thickness of the tests:

	Diameter mm.	Thickness mm.
Megalospheric form	1.1 - 2.5	0.35 - 0.8
Microspheric form	1.3 - 5.7	0.7 - 1.85

Two diameters of megalospheric and microspheric forms overlap. But microspheric specimens of small diameter are much thicker than the megalospheric specimens of the same diameter, and, therefore, the two forms can easily be separated. Large microspheric forms of *P. trechmanni* and of *P. rutteni*, n.sp., are relatively thin (text-figs. 8, 12).

Interior.—Only thin sections of microspheric specimens were studied by Douvillé (1922, 1924), Vaughan (1929), and Vaughan and Cole (1943). The present topotype material of *P. trechmanni,* on the other hand, consists of microspheric and megalospheric specimens. Both forms can now be described. As no free specimens were available, the morphologic analysis is based on many oblique and a few oriented sections. Exactly centered equatorial sections are rare, and none have been found of a microspheric specimen.

Megalospheric Form

1. *Equatorial section*

a) *Juvenarium Centers* of megalospheric specimens are illustrated by figs. 2, 3 and 4 of pl. 10, and by text-figs. 2 a-e. The embryo consists of a subspherical protoconch and a slightly larger subspherical to somewhat nephroid deuteroconch. The stolon between the two embryonic chambers, which appear to be separated by a plane wall, is excentrically situated (pl. 10, fig. 3); it measures in the figured juvenarium 14.5μ. Most juvenaria have two primary auxiliary chambers of different size. The smaller primary auxiliary chamber may be strongly reduced (pl. 10, figs. 2, 3).

Four different types of juvenaria have been observed in rock thin sections (text-figs. 2 a-e). The juvenaria are rarely cut in such a way that the nepionic spirals can be satisfactorily analyzed. The following types have been recognized:

1) Two primary auxiliary chambers of slightly different size, with four nepionic spirals composed of one to three, rarely more chambers. This type is illustrated by text-fig. 2a, by pl. 10, figs. 2, 3, and probably also by text-figs. 2d.

2) Two primary auxiliary chambers of greatly different size, with three nepionic spirals composed of one to three chambers. Only one spiral springs from the small primary auxiliary chamber. This type is illustrated by text-fig. 2b, and by pl. 10, fig. 4.

3) Two primary auxiliary chambers of slightly different size, with two nepionic spirals composed of two chambers each. No spiral starts from one of the primary auxiliary chambers. This type is illustrated by text-fig. 2c.

4) One primary auxiliary chamber, from which two nepionic spirals start, each composed of two to three chambers.

Number and dimensions of the primary auxiliary chambers, and number and duration of the nepionic spirals, measured in number of chambers per spiral, are variable. Juvenaria with two primary auxiliary chambers and four spirals are the rule. Only one specimen has been seen with a single primary auxiliary chamber. Uniserial juvenaria, as reported from *Sulcorbitoides pardoi* Bronnimann, *Pseudorbitoides israelskyi* Vaughan and Cole, *Vaughanina cubensis* Palmer and *Vaughanina barkeri* Bronnimann, appear to be absent in the topotype material of *P. trechmanni* (megalospheric form). More progressive juvenaria, in the sense used by Tan (1935), with accessory auxiliary chambers, are also absent.

Dimensions of the elements of the megalospheric juvenarium are (in microns):

EXPLANATION OF TEXT FIGURES 2-5

Text figure 2. *Pseudorbitoides trechmanni.* All topotypes, appr. 70 ×. a-e, i) megalospheric juvenaria. f-h) microspheric juvenaria.

Text figure 3. *Pseudorbitoides trechmanni.* All topotypes, appr. 70 ×. a) lateral chambers cut parallel to the equatorial layer. b) vertical section near the margin, perpendicular to a centered vertical section. c) marginal portion of a centered vertical section showing the high primary lateral chambers and the obliquely cut radial plates.

Text figure 4. *Pseudorbitoides trechmanni.* All topotypes, appr. 325 ×. a) vertical section as in text-fig. 3b, exhibiting the bi-lamellar structure of the radial plates. b) part of a centered vertical section close to the periphery.

Text figure 5. *Pseudorbitoides trechmanni.* All topotypes, appr. 325 ×. Centered vertical sections. a) at margin of the test. b) intermediate between juvenarium and periphery.

Maximum diameter of	
protoconch	**60 to 140**
deuteroconch	80 to 165
large primary auxiliary chamber	100 to 130
Thickness of wall of embryonic chambers	5 to 9
Diameter of the whole juvenarium	380 to 520

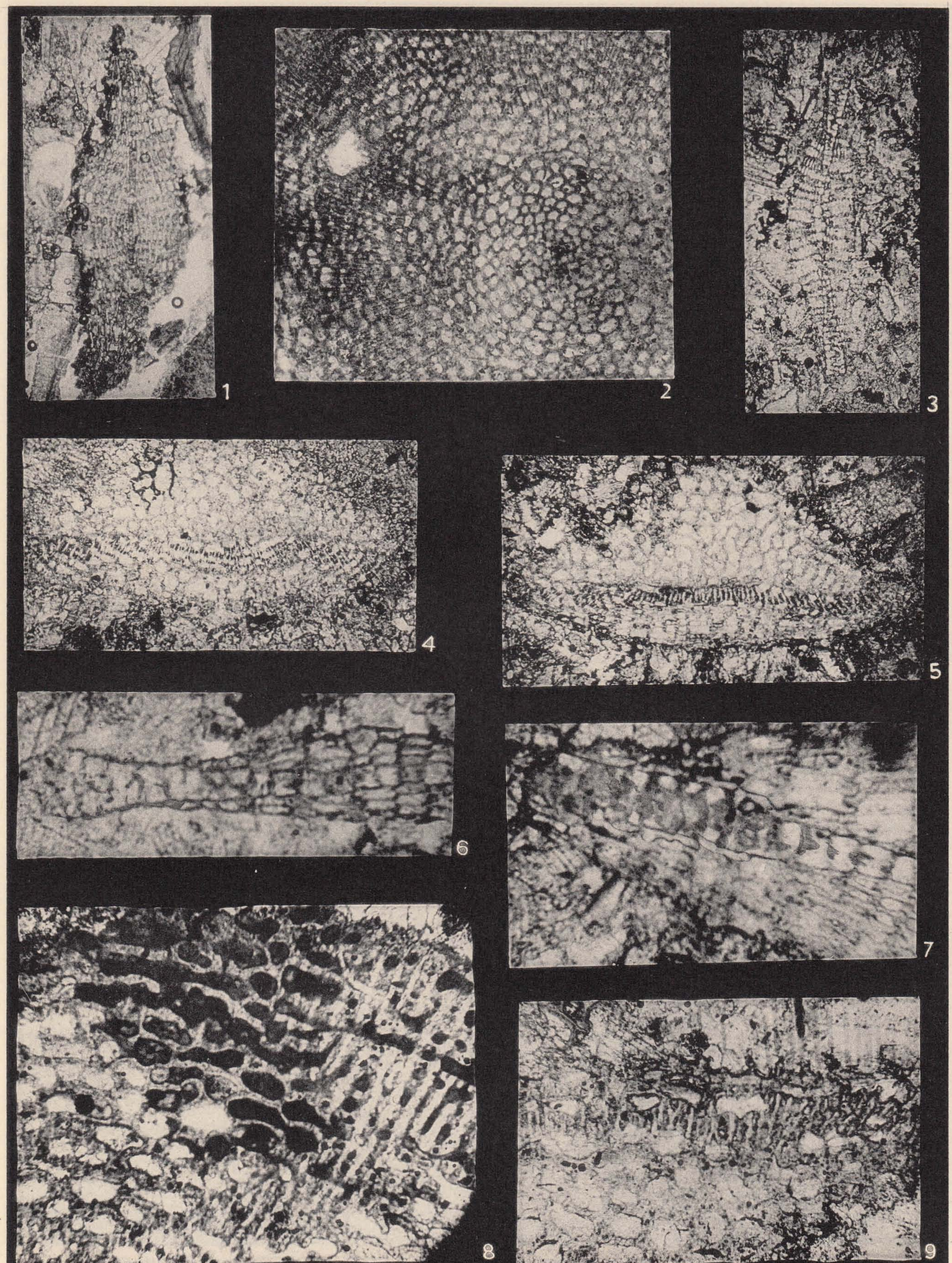
b) *Neanic stage*

The neanic stage is characterized by a single system of vertical radial plates, which appear in equatorial sections as straight, radial walls of about 10μ to 20μ thickness. They cut completely across the equatorial layer, and are above and below covered by lateral chambers. The radial plates start immediately outside the juvenarium and run only slightly diverging, to the periphery where they are about 20μ to 30μ apart. Toward the periphery, new plates are intercalated. A fine, dark, median line indicates that the plates are composed of two thin lamellae (text-fig. 7.) About sixty plates have been counted in one quadrant of an equatorial section. The corresponding figure is about 30 in *Sulcorbitoides pardoi,* which has two alternating systems of vertical radial plates, separated by a median gap. The plates of *Sulcorbitoides* are coarser than those of *P. trechmanni.* It appears that the single system of radial plates evolved from the two systems. In *Sulcorbitoides,* single plates appear near the periphery (Bronnimann, 1954 a, p. 56), suggesting the replacement of the two alternating systems by the single system of radial plate. However, it could not be ascertained whether plates from top and bottom of the equatorial layer fuse or whether the plates become gradually higher until they cut completely across the equatorial layer. The latter possibility is here favored because it is a) the simpler of the two alternatives, and b) the number of radial plates is much greater in forms with a single system than in those with two alternating systems of plates. *P. rutteni,* n.sp. has 52 or more plates per quadrant; *P. trechmanni* has about 60 plates per quadrant. Conversely, the increase in the number of plates in *P. trechmanni* and *P. rutteni,* n.sp. could not be explained if the plates from top and bottom would fuse. In rare cases, indications of the less advanced, sulcorbitoid type, with two alternating systems of plates, have been noted in vertical tangential sections near the juvenarium of *P. trechmanni* (text-fig. 2i).

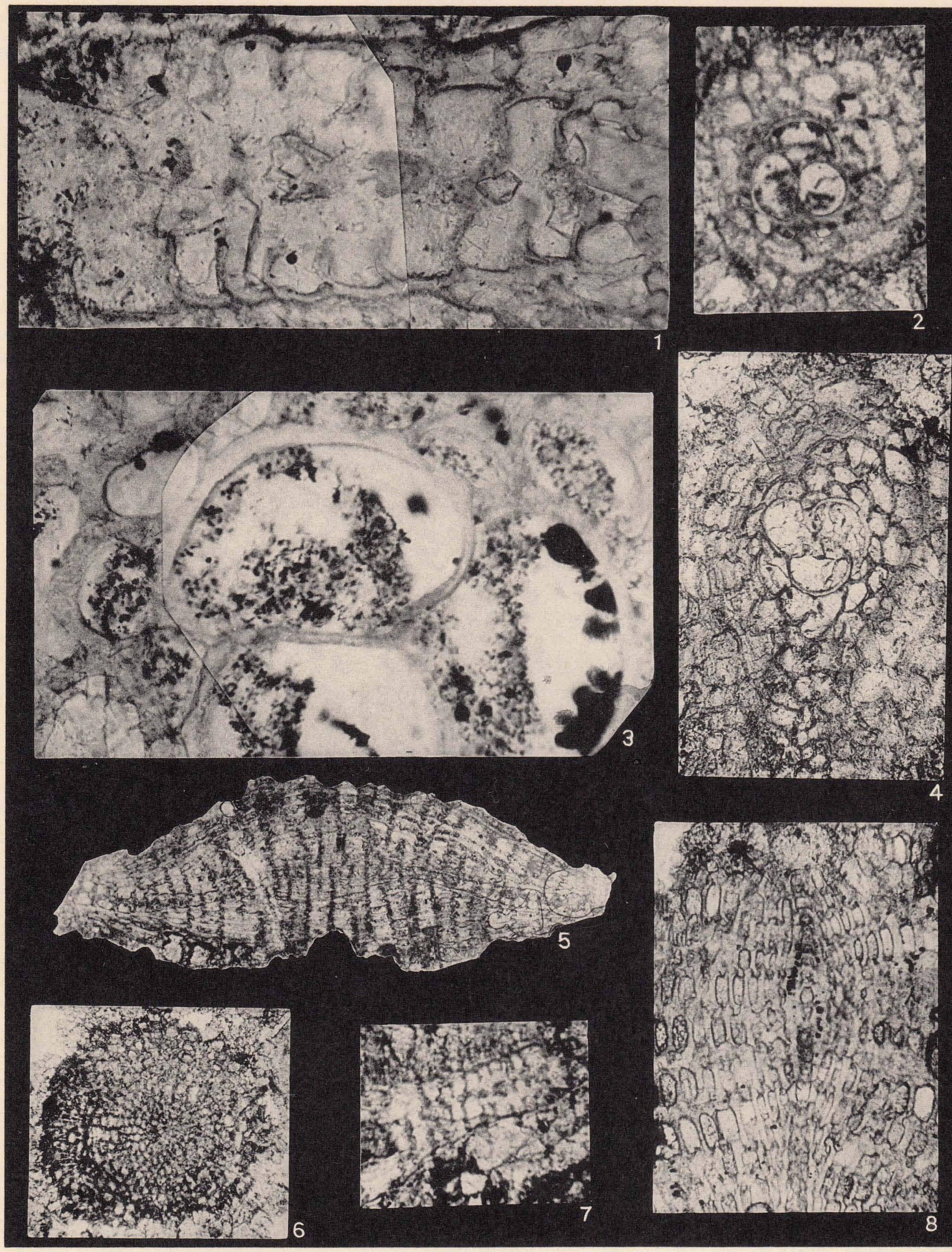
Vaughan (1929, p. 168) interpreted the vertical radial plates first as radiating lines above the equatorial chambers and later, Vaughan and Cole (1943, p. 97) described them as "radial plates, many of which cut across the equatorial chambers which however, are distinct from the center to the periphery." This description is based on the thick equatorial section of a microspheric specimen, which is herein refigured (pl. 9, fig. 2; text-fig. 6). Near the center of this specimen, but outside the embryonic spiral, open arcuate equatorial chambers occur of the same type as described for instance in primitive *Lepidocyclina.* Radial plates start only

EXPLANATION OF PLATE 9

FIGS.		PAGE
1-9.	*Pseudorbitoides trechmanni* H. Douvillé. Topotypes from the *Barrettia* bed of Green Island, Jamaica, B.W.I.	60-68
1.	Vertical section of a microspheric specimen. 32.5 ×. Thin section No. 16.	
2.	Central portion of the microspheric specimen described and figured by Vaughan (1929, pl. 21, figs. 5, 6) and by Vaughan and Cole (1943, pl. 17, fig. 5). This photograph clearly shows at the right the initial portion surrounded by open arcuate equatorial chambers; outside this initial portion are the radial plates. 300 ×.	
3.	Neoholotype of *P. trechmanni* H. Douvillé. Centered vertical section of a megalospheric specimen. The equatorial layer appears to be double near the periphery of the test. 27 ×. Thin section No. 11.	
4.	Oblique-equatorial section. The radial plates and the large primary lateral chambers are exposed. The primary lateral chambers are in radial rows and tend to form annuli. 32.5×. Thin section No. 4.	
5.	Oblique-vertical section. The radial plates in the central portion are overlain by large primary lateral chambers. Secondary lateral chambers below in regular tiers. 19 ×. Thin section No. 13.	
6, 7.	Peripheral portions of vertical sections showing the high primary lateral chambers, especially in fig. 7, and the radial plates. Fig. 6. Thin section No. 17. 117 ×. Fig. 7. Thin section No. 30. 102 ×.	
8.	Equatorial section cutting from the primary lateral chambers on the left to the overlying radial plates on the right side. Primary lateral chambers in annuli and radial rows. 94 ×. Thin section No. 31.	
9.	Excentric vertical section close to the margin of the test exposing the parallel radial plates covered on both sides by relatively high primary lateral chambers. 102 ×. Thin section No. 3.	



Bronnimann: Upper Cretaceous *Pseudorbitoides* from Cuba



Bronnimann: Upper Cretaceous *Pseudorbitoides* from Cuba outside this area, where lateral chambers easily can be mistaken for equatorial chambers (pl. 9, figs. 2, 8; text-figs. 6, 7). The structure of the equatorial layer was recognized by M. G. Rutten (1935, pp. 543, 544) who described it in his "*P. trechmanni*" and "*P. israelskyi*" as consisting "of long channel-like radial chambers, appearing as radial lines, and not thicker than 30μ." The radial plates are similar in *P. rutteni*, n.sp. and in *P. trechmanni*. However, as will be shown in the description of *P. rutteni*, n.sp., there are diagnostic differences in the peripheral development of the radial plates between this species and *P. trechmanni*. Figure 8 of plate 9 is a good photograph of the radial plates of *P. trechmanni*. The slightly oblique equatorial section extends from the lateral chambers on the left gradually into the region of the radial plates on the right. The apparent transverse connections between the radial plates are walls of the immediately underlying lateral chambers, which are arranged in radial rows (pl. 10, fig. 6; text-fig. 7). Toward the periphery, the lateral chambers tend to become aligned in annuli (pl. 9, fig. 8). A single lateral chamber covers three to five radial plates.

2. *Vertical section*

Centered and oblique vertical sections of megalospheric specimens are illustrated by pl. 9, figs. 3, 6, 9, pl. 10, figs. 1, 7, and by text-figs. 3-5. Vertical sections show better than equatorial ones the diagnostic features. The equatorial layer increases rapidly in height toward the periphery (pl. 9, fig. 3). Near the juvenarium, its height is about 50μ and near the periphery about 120μ to 150μ. The peripheral portion of the equatorial layer appears to be divided into two layers (pl. 9, fig. 3). H. Douvillé (1922, 1924), who figured a specimen with three such layers, apparently regarded this peripheral division as the diagnostic generic character of *Pseudorbitoides*. Vaughan (1929) and Vaughan and Cole (1943) described two divisions of the peripheral equatorial layer in a microspheric specimen (pl. 10, fig. 5). However, the closer investigation of very thin vertical sections results in a different interpretation of this apparent doubling or trebling of the equatorial layer. The oblique-excentric vertical sections of pl. 9, figs. 5 and 9, show the equatorial layer to be represented by lateral chambers and numerous parallel vertical plates, which near the center cut completely across the equatorial layer (pl. 9, fig. 5); near the periphery (pl. 9, fig. 9), they are restricted to the median portion of the equatorial layer, and are small relative to the total height of the equatorial layer. The radial plates, well developed in the major portion of the neanic stage, apparently become reduced toward the periphery of the test and in places only rudimentary plates can be detected (pl 9, fig. 6; pl. 10, figs. 1, 7; text-fig. 4b3. Horizontal sections (pl. 9, fig. 8), however, exhibit radial plates without any indication of reduction at the periphery of the test. The above observation may therefore be attributed to the obliquity of the vertical sections. The radial plates consist of two thin lamellae separated by a dark median line (text-fig. 4a). Their structure is identical with that of the radial plates described in *Vaughanina cubensis* Palmer (Bronnimann, 1954 b, p. 100, text-fig. 6, pl. 16, figs. 4, 7).

Above and below the radial plates are lateral chambers, here differentiated into two morphologic groups. Those which rest directly on the radial plates and form part of the equatorial layer are termed *primary lateral chambers*. All the other lateral chambers are termed *secondary lateral chambers*. Near the center, the primary lateral

EXPLANATION OF PLATE 10

FIGS. — PAGE

1-8. *Pseudorbitoides trechmanni* H. Douvilleé. Topotypes from the *Barrettia* bed at Green Island, Jamaica, B.W.I. 60-68

1. Peripheral portion of a centered vertical section, exposing the high, and radially short primary equatorial chambers, and the apparently rudimentary radial plates. The margin of the test is not covered by the secondary lateral chambers. 420 ×. Thin section No. 31.

2,4. Quadriserial nepionts with two unequal primary auxiliary chambers and 4 unequal spirals. Fig. 2. Thin section No. 31. 91 ×. Fig. 4. Thin section No. 4. 94 ×

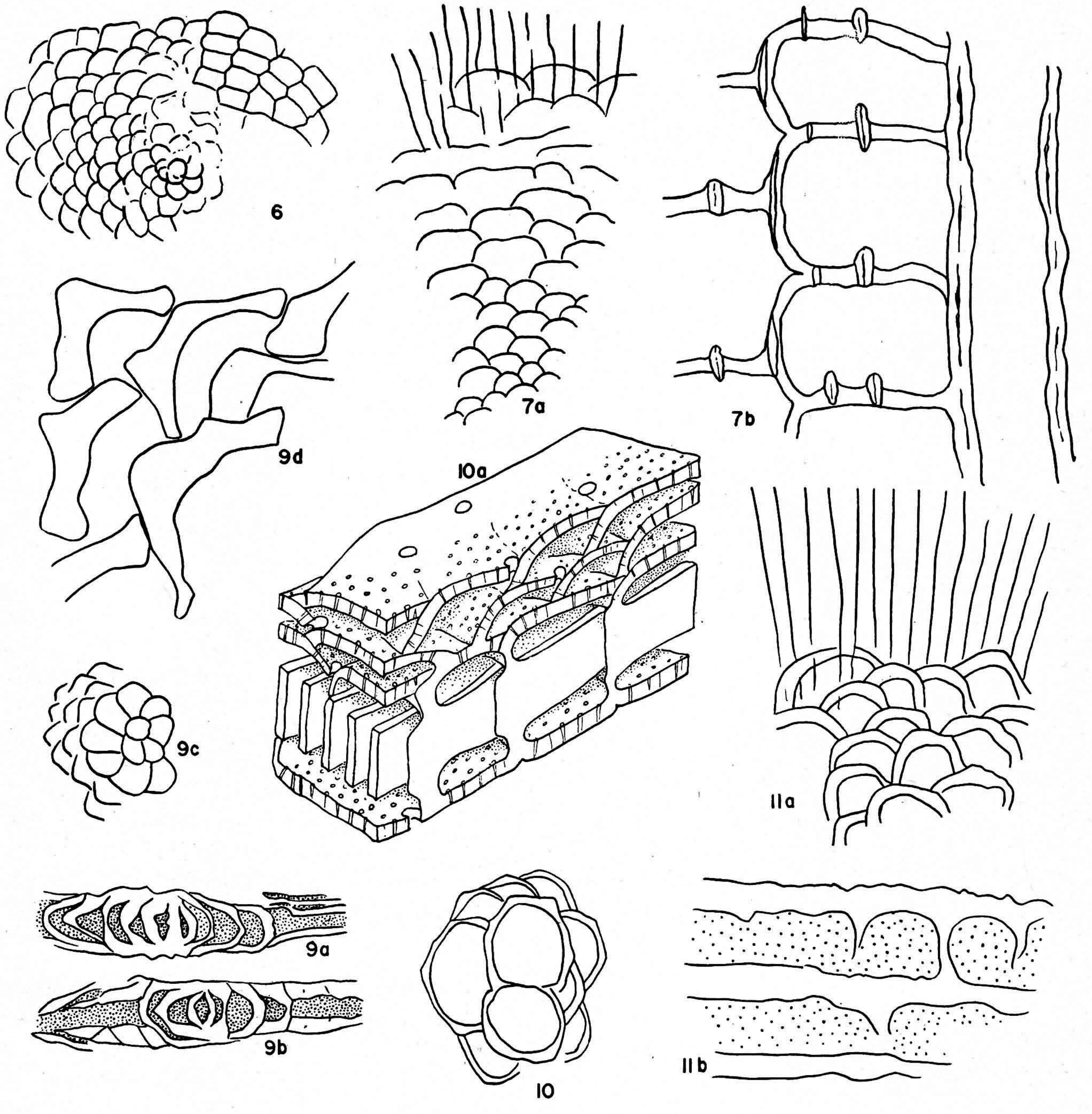
3. Same specimen as fig. 2, but more highly magnified. The stolon between proto- and deuteroconch is excentrically situated. 420 ×. Thin section No. 31.

5. Not quite centered vertical section of a microspheric specimen figured and described by Vaughan (1929, pl. 21, fig. 6) and by Vaughan and Cole (1943, pl. 17, fig. 6). 150 ×.

6. Not centered equatorial section of a microspheric specimen, exhibiting the radial plates on the left side, and adjoining primary lateral chambers in radial rows and over center and on the right side secondary lateral chambers. 32.5 ×. Thin section No. 4.

7. Same specimen as fig. 1. The peripheral flange is distinct. 117 ×. Thin section No. 20.

8. Same specimen as pl. 1, fig. 1. The initial spiral is covered on both sides by thick walls. 63 ×. Thin section No. 16.



TEXT FIGURES 6-11

Text figure 6. *Pseudorbitoides trechmanni.* Topotype collected by C. T. Trechmann and deposited in the U.S. National Museum. 150 ×.

Text figure 7. *Pseudorbitoides trechmanni.* All topotypes. a) part of a not quite centered equatorial section of a microspheric specimen with radial plates appearing toward the periphery. Appr. 70 ×. b) equatorial section of the boundary between primary lateral chambers and equatorial layer. The primary lateral chambers are aligned in radial rows. Appr. 325 ×.

Text figure 9. *Pseudorbitoides rutteni.* a, b) Vertical sections of microspheric juvenaria. Locality L 414, Cuba. Appr. 70 ×. c) Centered equatorial section of microspheric specimen. No. 14417 of the collection of the Geol.-Min. Institute of the University of Utrecht. Locality L 414, Cuba. Appr. 70 ×. d) Equatorial chambers outside the embryonic spiral of the same microspheric specimen as in text-fig. 9c. Appr. 325 ×.

Text figure 10. *Pseudorbitoides rutteni.* Megalospheric juvenarium. Locality L 414, Cuba. Appr. 70 ×.

Text figure 10a. *Pseudorbitoides rutteni.* Model of a portion of the equatorial layer overlain by some lateral chambers. The front is directed toward the periphery of the test.

Text figure 11. *Pseudorbitoides rutteni.* All from locality L 414, Cuba. Appr. 325 ×. a) part of the equatorial section of a microspheric specimen showing the radial plates outside the equatorial chambers. b) radial plates with transverse connections.

chambers are low, flat topped and relatively thick-walled (10μ to 15μ); near the periphery, they are high, radially short, and appear to be rather thin-walled (7μ to 10μ). This peripheral type of high and radially short primary lateral chamber is typical of *P. trechmanni* (pl. 9, figs. 3, 6, 9; pl. 10, fig. 7; text-figs. 3c, 4, 5). The primary lateral chambers are regularly arranged, at least in the late neanic stage (text-fig. 7b). They are aligned in radial rows, and chambers of adjoining rows alternate. The peripheral primary lateral chambers are uniformly subrectangular and shorter in radial than in tangential direction. Their sidewalls rest on the radial plates. In the figured equatorial section (text-fig. 7b), the following measurements were made: length ± 64μ, height ± 38μ. The equatorial layer is clearly defined throughout by the difference between primary and secondary lateral chambers.

The secondary lateral chambers are arranged in regular tiers and form the lenticular thickening of the test. They do not cover the equatorial layer completely (pl. 9, figs. 3, 6; pl. 10, fig. 7). Over the center, 5 to 7 layers of chambers have been counted. The chambers are 35μ to 65μ high, and large chambers have a diameter of 120μ to over 200μ (text-fig. 3a). The walls are 5μ to 10μ thick, and as a rule are slightly thinner than those of the primary lateral chambers. Communications are by basal stolons and by fine pores. Megalospheric specimens have no or only weakly developed pillars (pl. 9, fig. 3).

Microspheric Form

1. *Equatorial section*

The morphology of the equatorial layer of the microspheric form is not yet fully understood and therefore the terms juvenarium and neanic stage are not used.

H. Douvillé (1922, p. 204, text-fig. 1) figured the spiral of a microspheric embryo with 15 chambers arranged in about two volutions. The initial chamber is subspherical. The embryonic spiral is surrounded by open arcuate equatorial chambers of the same type as can be seen in Vaughan's (1929, pl. 21, figs. 4, 5) photographs of a microspheric specimen. H. Douvillé's figure shows outside the open arcuate equatorial chambers also a few subrectangular chambers, which he described as follows (1924, p. 369) 'les logettes . . . sont souvent un peu écartées, il en résulte qu'elles se disposent en files rayonnantes." These chambers are primary lateral chambers arranged in radial rows. Vaughan's equatorial section has obligingly been rephotographed at the U.S. National Museum (pl. 9, fig. 2), because the originals were not available. Text-fig. 6 is a camera lucida drawing after a detailed photograph of the center of the same specimen. It has a subspherical initial chamber and a spiral of 1½ to 2 volutions consisting of at least 9 chambers. The thin section is not quite centered and the final portion of the embryonic spiral is masked, so that the exact number of spiral chambers cannot be determined. The section extends from the open arcuate equatorial chambers on the left hand across the center, and then into primary lateral chambers, which are subrectangular and arranged in radial rows. The spiral chambers communicate by single basal stolons, and the equatorial chambers by four basal stolons. The equatorial layer of this specimen (pl. 9, fig. 2) can be subdivided in a central portion without radial plates and an outer portion with radial plates. The central portion consists of embryo, surrounding open arcuate equatorial chambers, and because of the obliquity of the section, a few primary lateral chambers. Only outside this central portion do the radial plates appear which occur in megalospheric specimens immediately outside the juvenarium. Although the center is not preserved, a microspheric specimen (text-fig. 7a) of the recently collected topotype material has, from center to periphery, first open arcuate equatorial chambers, then subrectangular primary lateral chambers arranged in radial rows. Only outside this central group appear the first radial plates underlain by large primary lateral chambers. This succession: embryonic spiral—equatorial chambers—radial plates, is characteristic of the microspheric form of *P. trechmanni* and of *P. rutteni*, n.sp.

The significance of the intercalated equatorial chambers is not clear, and it is not known whether they are part of the juvenarium or whether they belong to the neanic stage. The comparison with the megalospheric form, where the radial plates start immediately outside the juvenarium, suggests that the equatorial chambers form part of the juvenarium.

The equatorial chambers between embryonic spiral and radial plates can be interpreted in two ways. They are either a normal development of a microspheric *Sulcoperculina*, the ancestor of *Pseudorbitoides*, or they are a completely new feature, first developed in the center of the microspheric form of *P. trechmanni*. At present neither of these possibilities can be verified. Microspheric *Sulcoperculinas* are not known to the writer. The second possibility would completely change the present concept of phylogenetic significance of megalo- and microspheric forms, at least in the pseudorbitoids, according to which the microspheric form is morphologically more primitive than the megalospheric form. It would mean, that the microspheric form and not the megalospheric form is the more progressive and morphologically plastic type, which begets the new structural elements.

The radial plates are developed as in the megalospheric form.

2. *Vertical section*

Centered vertical sections of microspheric specimens are illustrated by pl. 9, figs. 1, 7; pl. 10, figs. 5, 7, and by text-figs. 2f, g. The initial chamber has a diameter of 10μ to 20μ; spiral chambers are 25μ to 40μ long and 10μ to 20μ high. Toward the lateral chambers, the embryo is enveloped by 50μ to 65μ thick walls. Including the walls, it is, on the average, about 100μ high. The equatorial layer increases gradually in height toward the periphery. Near the center it is about 50μ high, and at the periphery, it reaches 200μ to 250μ, *i.e.,* about twice the height of the equatorial layer of the megalospheric form. The equatorial layer is separated from the secondary lateral chambers by the thick walls of the equatorial chambers of the center and by the thick walls of the primary lateral chambers, which increase in height toward the periphery.

The secondary lateral chambers are in regular tiers, and 10 to 16 layers have been counted over the center. The microspheric specimens exhibit heavy pillars, which at the surface are 25μ to 150μ thick.

The arrangement of primary and secondary lateral chambers is identical in megalo- and microspheric forms. A slightly off-center equatorial section of a microspheric form (pl. 10, fig. 6) shows on the left side radial plates overlain by primary lateral chambers, arranged in radial rows. Communications are by basal stolons and by fine pores.

Age and occurrence.—*P. trechmanni* appears to be indigenous to Jamaica. To the writer's knowledge, it has been found only in the *Barrettia* limestones near Green Island, and were it not for the following phylogenetic-stratigraphic considerations, this pseudorbitoid would be of little value for the determination of the disputed age of the *Barrettia* limestones. *P. trechmanni* and *P. rutteni,* from Cuba, are structurally closely related and believed to represent practically the same evolutionary level. They are both more advanced than *Pseudorbitoides israelskyi* Vaughan and Cole, 1932, and, therefore, regarded as stratigraphically somewhat younger than this species, whose type specimens are according to M. C. Israelsky (letter of May 27, 1954) not from the Monroe Gas cap-rock of Louisiana, as stated by the writer (Bronnimann, 1954a, p. 61), but from beds correlated by Israelsky with Taylor (Campanian). Monroe and Jackson Gas cap-rock are both of Navarro age (Maestrichtian), and in "Mississippi *P. israelskyi* occurs under the Jackson Gas cap-rock, . . . in beds equivalent to Taylor on fossils other than the orbitoids."

N. K. Brown, Jr. recently collected samples of typical Anacacho limestone of Taylor age at the west end of the Anacacho Mts., left (east) bank of Elm Creek, 0.5 mile south of Southern Pacific Railroad crossing, Kinney County, Texas (Bureau of Economic Geology locality 136-T-1). They contain commonly *P. israelskyi* and rare doubtful *Sulcorbitoides pardoi* Bronnimann, 1954. This assemblage is different from the rich *S. pardoi* fauna reported from a sample of Anachaco limestone collected in White's Asphalt Quarry, 4.5 miles southwest of Blewett, Uvalde County, Texas (Bronnimann, 1954a, p. 61). Thus, *P. israelskyi* in the above localities is of Campanian age. This points to a Campanian or Maestrichtian age for *P. trechmanni* and *P. rutteni.* A high Upper Cretaceous age is in agreement with the opinions of Trechmann (1924), Spath (1925), MacGillavry (1937), Vermunt (1937), and others, who placed the *Barrettia* beds of the Greater Antilles and Central America in the Upper Campanian or Maestrichtian (Stephenson, 1941, p. 36; Imlay, 1944, pp. 1010, 1011). On the other hand, Muellerried (1936) assigned *Barrettia* faunas occurring in the state of Chiapas, Mexico, on the basis of ammonites, to the Upper Turonian and Coniacian, and echinid specialists (Hawkins, 1923, 1924; Lambert, 1928; Weisbord, 1934) regarded the rudistid beds of Jamaica and Cuba as Cenomanian to Coniacian. An early Senonian age is also favored by Chubb, who wrote in a recent report (in press): "Taking all factors into consideration, and in spite of some evidence for an earlier age, it seems probable that the *Barrettia Beds* should be regarded as Turonian." (H. R. Versey, letter of September 20, 1954.)

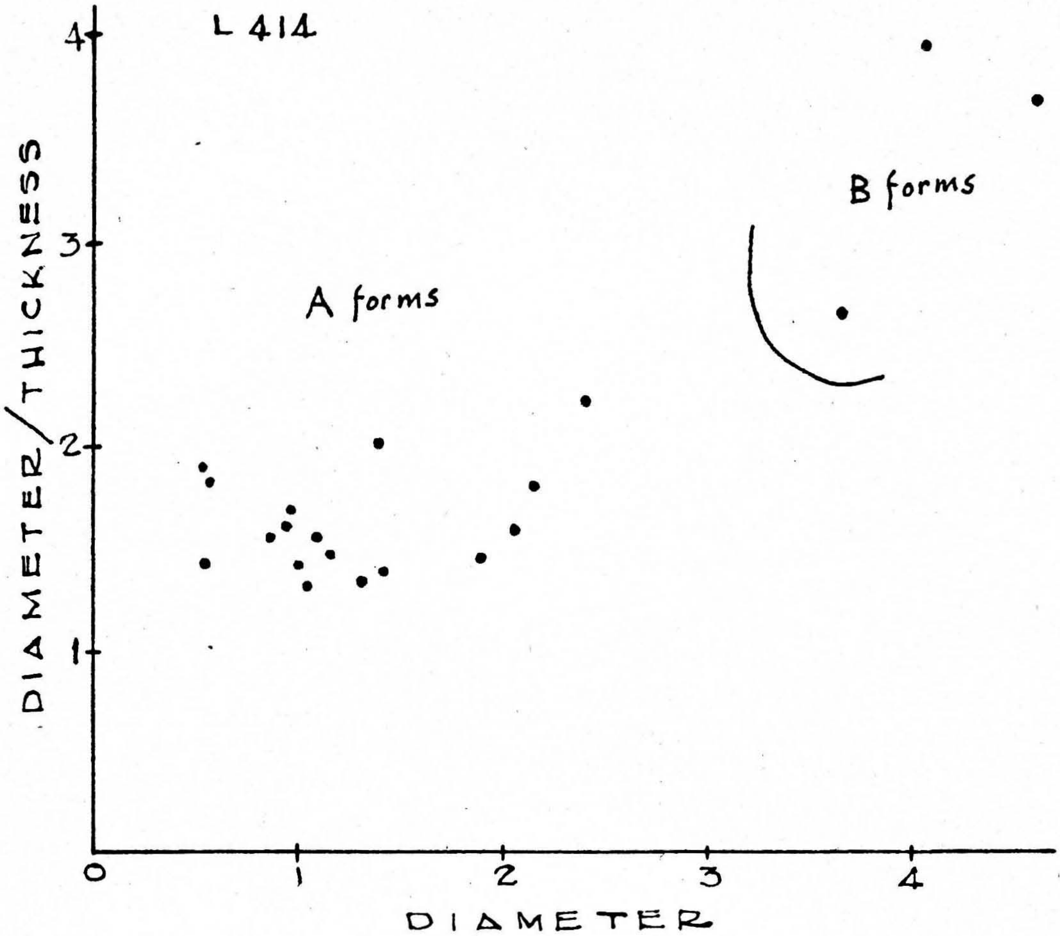
The foraminiferal fauna associated with *P. trechmanni* is poor and not diagnostic.

Pseudorbitoides rutteni Bronnimann, n.sp.

Plates 11,12; Text figures 8-17

Pseudorbitoides israelskii Rutten, 1935, Journ. Pal., vol. 9, p. 544, pl. 62, fig. 5; text-figs. 4 K, L, O. Q; Rutten, 1935, *ibid.,* vol. 9, p. 544. pl. 62, fig. 2; text-figs. 4 E-H, 8.

Type locality.—P. B. Truitt, who collected the original samples, CUGOC Ser. No. 21724, described the type locality of *P. rutteni* n.sp., T. 2481, as follows (see location map, text-fig. 8a): "On the road from Camajuaní to Santa Clarita, Las Villas Province, 4.5 kilometers south of Camajuaní meas-



TEXT FIGURE 8

Dimension diagram of *Pseudorbitoides rutteni* from locality L 414, Cuba.

ured from the Camajuaní slaughter house." This is apparently the same road as the one in Rutten's map showing the geographic position of locality L 415 (1935, p. 529, text-fig. 1D), between Camajuaní and the carretera central, east of Falcon.

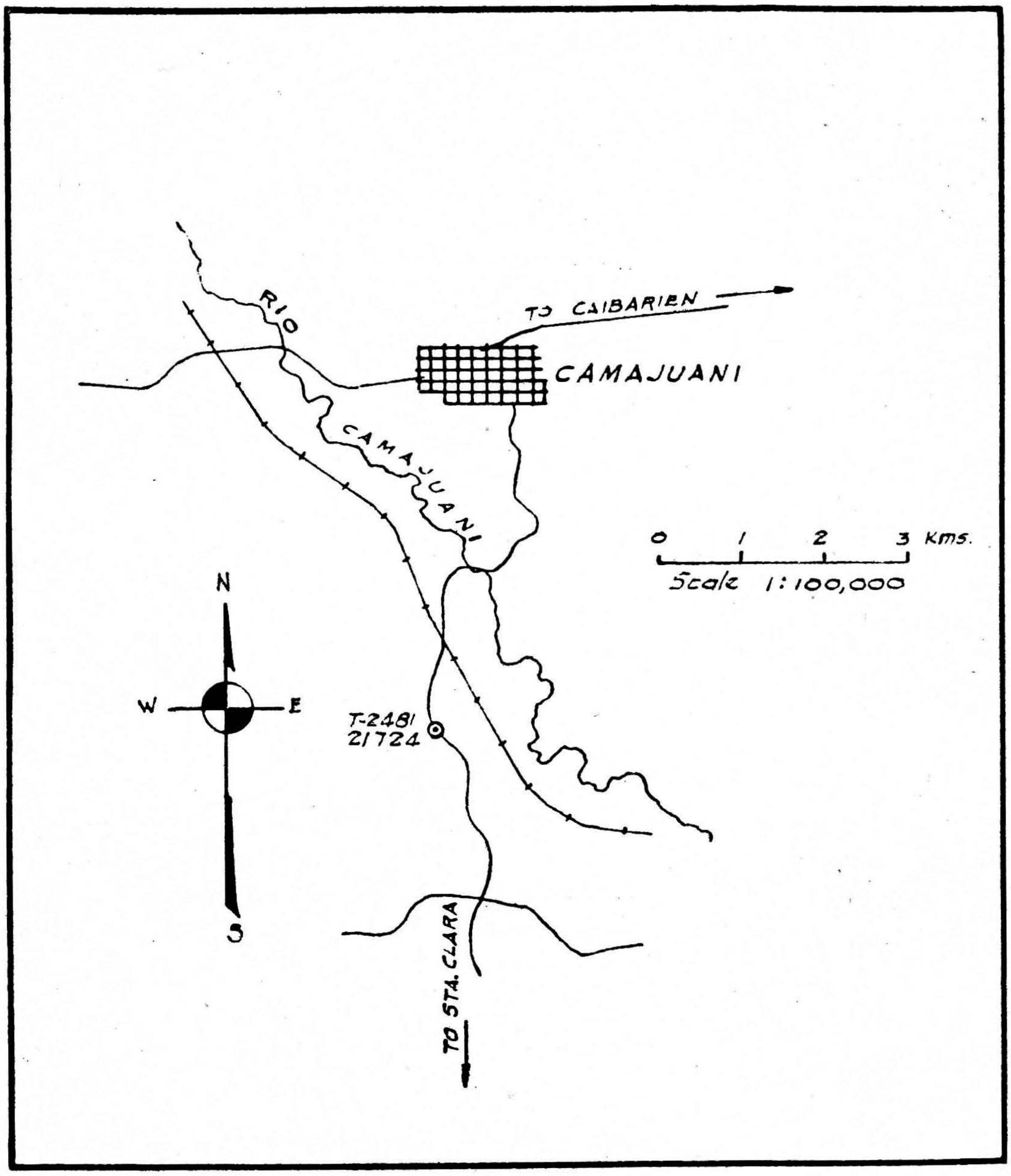
Holotype.—The equatorial section, figure 3 of plate 11, is the holotype of *P. rutteni*, n.sp. CUGOC Ser. No. 21724, thin section No. 5, Las Villas Province, Cuba. Upper Cretaceous (? Campanian, Maestrichtian). The species is named for M. G. Rutten. The holotype, enveloped by a thin coating of black matrix, is from a heterogeneous fragmental limestone; the specimen appears to be redeposited. The associated Upper Cretaceous microfauna is nondiagnostic and does not allow a more detailed age determination.

Taxonomy.—M. G. Rutten (1935, pp. 543, 544) distinguished in his *Pseudorbitoides* material from three localities (H 153, L 415, L 485) south of Camajuaní and east of Santa Clara, Las Villas Province, Cuba, *"P. israelskyi"* and *"P. trechmanni"* by the shape and the dimension of the tests. In both groups, he reported megalospheric individuals. As mentioned earlier, the two forms which Rutten identified as *P. israelskyi* and *P. trechmanni* differ from topotypes of these species. Inasmuch as his two forms are associated in the same samples and cannot be separated from each other on morphologic grounds, they are regarded as one species, which is herein named *P. rutteni*, n.sp.

Exterior.—No free specimens were available, and the surface of the lenticular test is not known. Measurements of diameter and thickness of more or less centered vertical sections (see remarks on dimension-diagram of *P. trechmanni*), have been compiled in dimension-diagrams of three populations (text-figs. 8, 12). The diagrams refer to M. G. Rutten's material from locality L 414 (Rutten, 1936, p. 45, fig. 12) and to two populations of *P. rutteni*, n.sp., CUGOC Ser. Nos. 21724 and 21727; they all show practically identical distributions. The tests are grouped by their dimensions into megalospheric and microspheric specimens; the latter are rare throughout. The range of diameter and thickness is for all three populations:

	Diameter mm.	Thickness mm.
Megalospheric form	0.5 - 2.7	0.25 - 1.67
Microspheric form	3.3 - 5.3	1.1 - 1.92
Total populations	0.5 - 5.3	0.25 - 1.92

Rutten's (1935, p. 544) measurements for both of



TEXT FIGURE 8a

Map of the type locality of *Pseudorbitoides rutteni.* After P. B. Truitt.

his forms are 0.84 mm. to 4.8 mm. for diameter, and 0.7 mm. to 1.4 mm. for thickness. These dimensions fall well within the range determined here for the total populations of *P. rutteni,* n.sp.

The megalospheric specimens are small, relatively thick and as a rule, strongly umbonate to subglobular; the microspheric specimens are large and relatively thin. The comparison of the diagrams of *P. trechmanni* (text-fig. 1) and *P. rutteni,* n. sp. (text-figs. 8, 12) immediately shows the megalospheric forms of *P. trechmanni* to be much thinner than those of *P. rutteni,* n.sp.; their diameters cover more or less the same range. The large and thin microspheric forms of *P. trechmanni* are similar in dimensions to the microspheric forms of *P. rutteni,* n.sp.

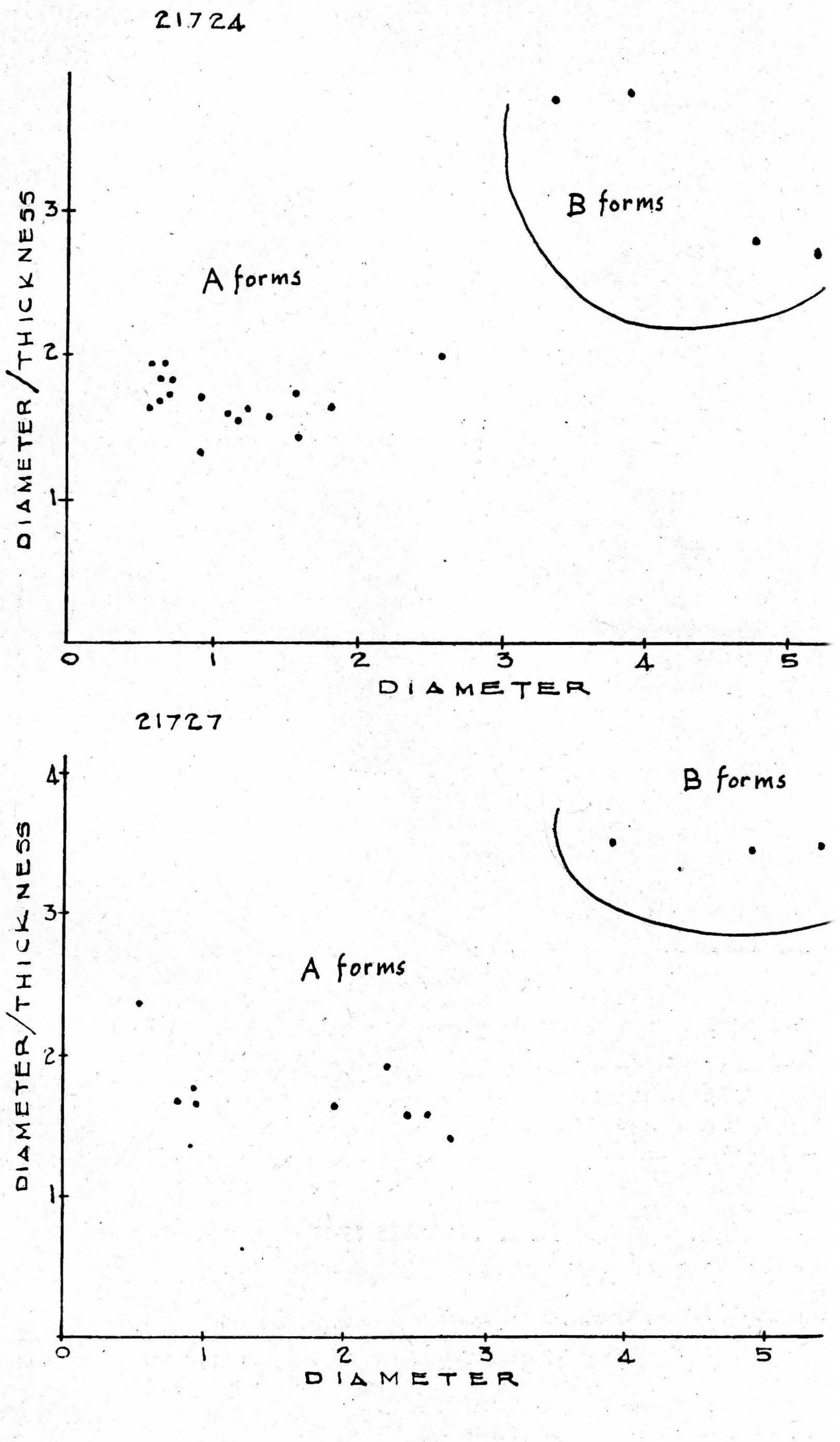
Micro- and megalospheric specimens carry pillars which are 40μ to 65μ thick at the surface. The lateral layers are well developed, and appear to cover completely the equatorial layers. In some specimens, suggestions of a peripheral flange have been observed.

Megalospheric Form

1. *Equatorial section*

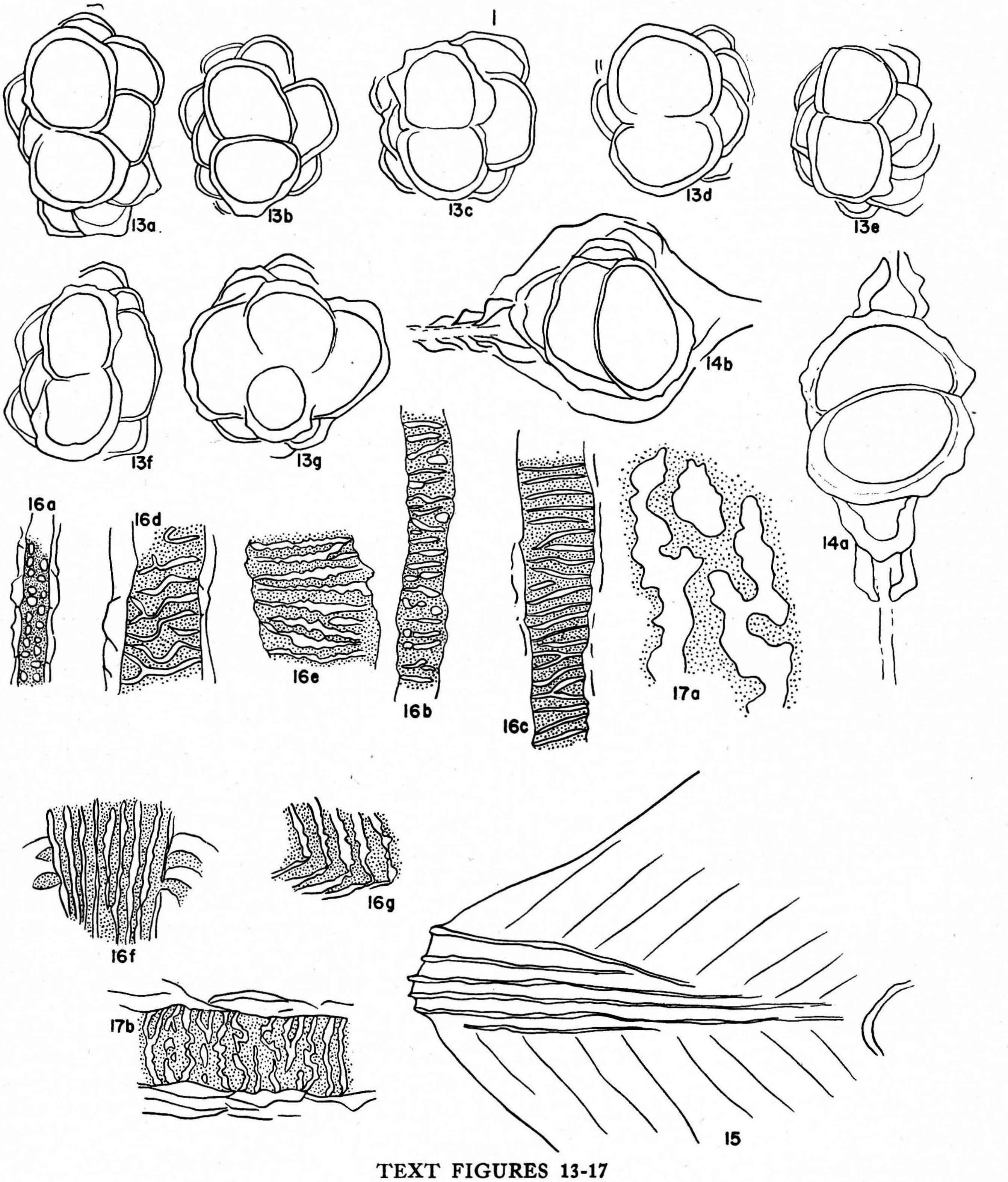
a) *Juvenarium*

The juvenarium consists of a bilocular embryo and a quadriserial nepiont. Protoconch and deuteroconch are almost equal in size, subspherical to somewhat elongate ellipsoid, which appears to be typical of *P. rutteni,* n.sp. (pl. 11, figs. 3, 6; text-figs. 10, 13). The juvenaria have two primary auxiliary chambers, as a rule of different size, from which four unequal spirals issue (text-figs. 10,



TEXT FIGURE 12

Dimension diagrams of *Pseudorbitoides rutteni.* a) Topotypes, CUGOC Ser. No. 21724. b) CUGOC Ser. No. 21727.



TEXT FIGURES 13-17

Text figure 13. *Pseudorbitoides rutteni.* Megalospheric juvenaria. CUGOC Ser. Nos. 21724 and 21727. All appr. 70 X.

Text figure 14. *Pseudorbitoides rutteni.* Megalospheric juvenaria. CUGOC Ser. Nos. 21724 and 21727. All appr. 70 X.

Text figure 15. *Pseudorbitoides rutteni.* Oblique section showing radial vertical plates. CUGOC Ser. No. 21727. Appr. 70 X.

Text figure 16. *Pseudorbitoides rutteni.* All CUGOC Ser. No. 21724. Appr. 70 X. a-e) Vertical sections across the equatorial layer. f) Oblique section across the radial plates and the primary lateral chambers. g) Oblique vertical section cutting the radial plates and the primary lateral chambers.

Text figure 17. *Pseudorbitoides rutteni.* Collection Kozary, Gibara area, Oriente Province, Cuba. CUGOC Ser. No. 50882. a) Part of section figured in b) showing irregular vertical radial plates at the periphery. Appr. 325 X. b) Irregular vertical plates at the periphery covered by lateral chambers. Appr. 70 X.

13). No accessory auxiliary chambers have been noted and the populations appear to be quadriserial throughout.

Dimensions of the megalospheric juvenarium measured in six centered equatorial sections are (in microns):

Maximum diameter of	
protoconch	105 to 140
deuteroconch	90 to 190
large primary auxiliary chamber	128 to 180
Thickness of wall of embryonic chambers	10 to 13
Diameter of whole juvenarium	260 to 450

b) *Neanic stage*

The neanic stage is characterized by radial vertical plates, which start immediately outside the juvenarium (pl. 11, fig. 5; pl. 12, fig. 10; text-fig. 15), and extend to the periphery of the test. As in *P. trechmanni,* the major portion of the neanic stage has the single system of plates. The arrangement of the radial plates in an intermediate position between juvenarium and periphery is shown in the drawing of a model of a part of the equatorial layer (text-fig. 10a). Near the juvenarium, the two alternating systems of radial plates have been noted (pl. 12, fig. 11; text-fig. 16a). This suggests, that *P. rutteni,* n.sp. evolved from an ancestor with two systems of radial plates, such as *Sulcorbitoides.* The existence of the two alternating systems in the early neanic stage is much clearer in *P. rutteni,* n.sp. than in *P. trechmanni.*

The radial plates are straight and almost parallel, extending to the periphery. Toward the margin, additional plates are intercalated (pl. 11, figs. 5, 7). The sides of the plates in equatorial section show minute irregularities, which may be due to the particular kind of preservation of the Cuban material. In some cases, distinct transverse connections between two adjoining radial plates have been noted (text-fig. 11b) (M. G. Rutten, 1935, p. 543).

Occasionally the radial plates appear to be constricted at equal radial distances (pl. 11, figs. 5, 7). These thinnings are probably in connection with the overlying primary lateral chambers, which occur as irregular dark lumina on the left side of the equatorial thin section illustrated by fig. 7 of pl. 11. A single primary lateral chamber covers about 3 to 5 radial plates (pl. 12, fig. 8; text-fig. 11a). Otherwise no irregularities can be detected in the structure of the radial plates. The radial plates are 6μ to 12μ thick and 10μ to 30μ apart. In one quadrant of the equatorial layer of a specimen 52 radial plates, in another specimen about 80 plates have been counted. The corresponding figure is about 60 plates in *P. trechmanni.* There are no annular walls.

2. *Vertical section*

a) *Juvenarium*

The juvenarium in vertical and oblique vertical section is illustrated by pl. 12, figs. 1, 2, 9, and by text-fig. 14. The vertical diameter of the protoconch in 4 specimens is:

a) 150μ b) 166μ c) 218μ d) 222μ

The juvenarium is shorter and thicker in *P. rutteni* than in *P. trechmanni.*

b) *Neanic stage*

Excentric vertical sections show the ontogenetic development of the vertical radial plates. Near the center are the primitive two alternating systems of radial plates, as described in *Sulcorbitoides pardoi* (pl. 12, fig. 11; text-fig. 16a). The two systems of radial plates can also be seen in centered vertical sections on both sides of the juvenarium (pl. 12, figs. 2, 9; text-fig. 14). Particularly in pl. 12, fig. 2, they appear as straight lines immediately below the thick-walled primary lateral chambers. The dark space corresponds to the narrow median gap between the two alternating systems of plates. In a very short distance from the juvenarium, this ancestral feature is superseded by the single system of radial plates (pl. 11, figs. 1, 2, 4; pl. 12, fig. 7; text-figs. 16, 17). The plates are at first regular, with straight walls, and run almost parallel (pl. 12, fig. 7; text-fig. 10a), but then they develop Y and S-shaped bends (pl. 11, fig. 4; text-fig. 16d), and closer to the periphery they are irregular, almost labyrinthic (pl. 11, fig. 1; text-fig. 17).

The equatorial layer is composed of radial plates and adjoining primary lateral chambers. But unlike *P. trechmanni,* the equatorial layer of *P. rutteni,* n.sp. does not have the high peripheral primary lateral chamber. They are low throughout the ontogeny, and the radial plates cut completely across the equatorial layer. The different behaviour of the primary lateral chambers enables one to distinguish between *P. trechmanni* and *P. rutteni,* n.sp. in vertical section. The primary lateral chambers are, at least toward the periphery, arranged in radial rows (pl. 12, fig. 8).

Because there is not much difference between primary and secondary lateral chambers, the equatorial layer is not as clearly defined as in *P. trechmanni.* The equatorial layer of a megalospheric form is at the periphery about 190μ thick, and of a microspheric form about 130μ.

The secondary lateral chambers are in regular tiers. Over the center, 5 to 20 layers have been counted; small megalospheric forms (pl. 12, fig. 9) have only few layers. As a rule, the secondary lateral chambers are low (10μ to 30μ, short (40μ to 90μ) and thick-walled (10μ to 15μ). The lateral chambers are connected by stolons and fine pores (pl. 12, fig. 5). Pillars are present, but never common; occasionally they are lacking.

Microspheric Form

1. *Equatorial section*

M. G. Rutten's material from locality L 414 contains an equatorial section of a free microspheric specimen of 3.6 mm. in diameter (No. 14417 of the collection of the Geol.-Min. Institute of Utrecht). Unfortunately it is too thick for photographing. A camera lucida drawing of the center of this specimen has been prepared (text-fig. 9c). It has an initial spiral composed of at least 11 chambers in 1½ volutions. The first chamber is subspherical.

The diameter of the initial spiral is 165μ. The maximum diameter of the equatorial chambers is 10μ to 30μ, and the walls are 5μ to 8μ thick.

Outside of the spiral are open arcuate equatorial chambers, some of which are illustrated in text-fig. 9d. The shape of the chambers reminds one somewhat of the chambers of *Orbitocyclina*. Only outside this area, appear radial plates.

As in the microspheric form of *P. trechmanni*, the succession of structural elements in the microspheric form of *P. rutteni*, n.sp. is: embryonic spiral —equatorial chambers—radial plates.

The vertical radial plates are developed as in the megalospheric generation. First appear the two alternating systems and then, over the major portion of the equatorial layer up to the periphery, the single system of radial plates.

2. *Vertical section*

Centered vertical sections of microspheric specimens are illustrated by pl. 12, figs. 3, 4, and by text-fig. 9a, b. The central portion is covered laterally by walls, which reach a thickness of about 40μ. The thickness of the initial portion, including the walls, is 90μ to 120μ. The morphology of the equatorial layer in vertical section confirms the succession of structural elements as established in the equatorial section.

Primary and secondary lateral chambers are as in megalospheric individuals. Pillars are present.

Diagnosis.—*P. rutteni*, n.sp. is in juvenarium and equatorial layer closer to *P. trechmanni* than to *P. israelskyi*. It differs from *P. trechmanni* in the following features: The juvenarium of the megalospheric form is throughout quadriserial; in vertical section, the megalospheric embryo is thick; the two systems of radial plates occur for a short distance in *P. rutteni*, n.sp., whereas they are absent or only suggested in *P. trechmanni;* the equatorial layer is not clearly defined; the primary lateral chambers remain low throughout the neanic stage.

Age and occurrence.—*P. rutteni*, n.sp. has been found in heterogeneous fragmental limestones of Upper Cretaceous age outcropping in Las Villas Province and in Oriente Province, Cuba. The life range of *P. rutteni*, n.sp. is difficult to establish because of the lack of associated diagnostic fossils and of redeposition. General phylogenetic-stratigraphic considerations, discussed in the paragraph on age and occurrence of *P. trechmanni* and under phylogenetic remarks, render a Campanian or Maestrichtian age of *P. rutteni*, n.sp. probable.

Phylogenetic remarks.—*Sulcorbitoides* and *Pseudorbitoides* both characterized by radial plates, evolved from a *Sulcoperculina*-like ancestor.

P. trechmanni, the genotype of *Pseudorbitoides*, and *P. rutteni*, n.sp. are closely related, and phylogenetically represent more or less the same evolutionary stage. On the basis of the juvenarium, which is quadriserial throughout in *P. rutteni*, n.sp., this species appears to be higher evolved than *P. trechmanni*, which has mainly quadriserial, but also rare biserial and triserial embryos. On the

EXPLANATION OF PLATE 11

FIGS.		PAGE
1-7.	*Pseudorbitoides rutteni*, n.sp., CUGOC Ser. No. 21724, Las Villas Province, Cuba, Upper Cretaceous	68-75
1, 2, 4.	Vertical sections showing the two principal types of radial plates of the single system. Figs. 2 and 4 with regular plates, only in places with Y- and S-shaped plates; in fig. 2, the intercalation of new plates can be seen.Fig. 1 shows the irregular, almost labyrinthic radial plates of the peripheral portion of large microspheric specimens. The plates extend, in all sections, completely across the equatorial layer, and the primary lateral chambers are low and thick walled. All 117 ×. Figs. 1, 4 CUGOC Ser. No. 21724 (1). Fig. 2. CUGOC Ser. No. 21724 (3).	
3.	Holotype of *P. rutteni* n.sp. Quadriserial nepiont. 117 ×. CUGOC Ser. No. 21724 (5).	
5, 7.	Portions of equatorial sections with radial plates exposing intermittent thinnings of the plates, intercalation of new plates toward the periphery and large primary lateral chambers. All 117 ×. Fig. 5. CUGOC Ser. No. 21724 (2). Fig. 7. CUGOC Ser. No. 21724 (3)	
6.	Quadriserial nepiont. 117 ×. CUGOC Ser. No. 21724 (1).	

other hand, the occurrence of the two alternating systems of radial plates in *P. rutteni,* n.sp. and only indications of this type of arrangement in *P. trechmanni,* suggest *P. rutteni,* n.sp. to be the less progressive form. As a rule this group of species can be characterized as having a quadriserial embryo and, in the major portion of the neanic stage, the single system of radial plates. The intermediate evolutionary stage between this group and *Sulcorbitoides,* is represented by *P. israelskyi,* which has a uniserial juvenarium throughout, and as *P. rutteni,* n.sp., the two alternating systems of radial plates in the early neanic, and the single system of radial plates in the final neanic stage.

This phylogenetic system means in stratigraphic terms that *Sulcorbitoides pardoi* is the older and *P. trechmanni-P. rutteni* are the younger species of this group of Pseudorbitoididae. *P. israelskyi* occupies stratigraphically an intermediate position, *i.e.,* is older than *P. trechmanni* and *P. rutteni,* n.sp. and younger than *S. pardoi.* Where redeposition can be excluded, *P. rutteni,* n.sp. was never found associated with *S. pardoi,* and *Vaughanina* was never found with *P. rutteni,* n.sp. *P. israelskyi* has not yet been recognized in Cuba, excepting some doubtful specimens, so that no information regarding the association of this species with other pseudorbitoids can be offered. However, Vaughan and Cole (1943, p. 98) mentioned, without giving details, that *P. israelskyi* appears to occur at a lower horizon than *P. trechmanni.* This statement agrees with the above deduction. It is not yet possible to correlate the occurrence of these pseudorbitoids with the *Globotruncana-Rugoglobigerina—Gümbelina* stratigraphy, excepting *Vaughanina,* which is known in Cuba from the Middle to Upper Maestrichtian *Globotruncana mayaroensis* zone (Bronnimann, 1954b).

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EXPLANATION OF PLATE 12

FIGS. PAGE

1-11. *Pseudorbitoides rutteni* n.sp. 68-75

1. Oblique-equatorial section of a megalospheric specimen, exposing part of a quadriserial nepiont. 110 ×. Coll. Min.-Geol. Inst. Univ. Utrecht, L 414, No. 14412.
2. Centered vertical section of a megalospheric specimen with two systems of radial plates on both sides of the juvenarium. 117 ×. Coll. Min.-Geol. Inst. Univ. Utrecht, L 414, No. 14413.

3,4. Centered vertical sections of microspheric specimens. All 117 ×. Coll. Min.-Geol. Inst. Univ. Utrecht, L 414, No. 14413.

5. Lateral chambers showing the thick walls, stolons and fine pores. 117 ×. Coll. Min.-Geol. Inst. Univ. Utrecht, L 414, No. 14419.
6. Slightly oblique vertical section of a megalospheric specimen. Radial plates are regular from center to periphery. 21 ×. CUGOC Ser. No. 21724 (1).
7. Excentric vertical section. Plates are regular. 117 ×. CUGOC Ser. No. 21724 (1).
8. Portion of a slightly oblique equatorial section going from the radial plates into the primary lateral chambers, which are arranged in radial rows. One primary lateral chamber covers 3 to 5 radial plates. 117 ×. Coll. Min.-Geol. Inst. Univ. Utrecht, L 414 No. 14419.
9. Centered vertical section of a small umbonate megalospheric specimen. Indications of the two systems of radial plates throughout the short equatorial layer. 117 ×. CUGOC Ser. No. 21724 (1).
10. Oblique section showing radial plates, megalospheric juvenarium and lateral chambers. 42 ×. CUGOC Ser. No. 21724 (1).
11. Excentric vertical section close to the center exposing the two alternating systems of radial plates. 130 ×. Coll. Min.-Geol. Inst. Univ. Utrecht, L 414, No. 14413.

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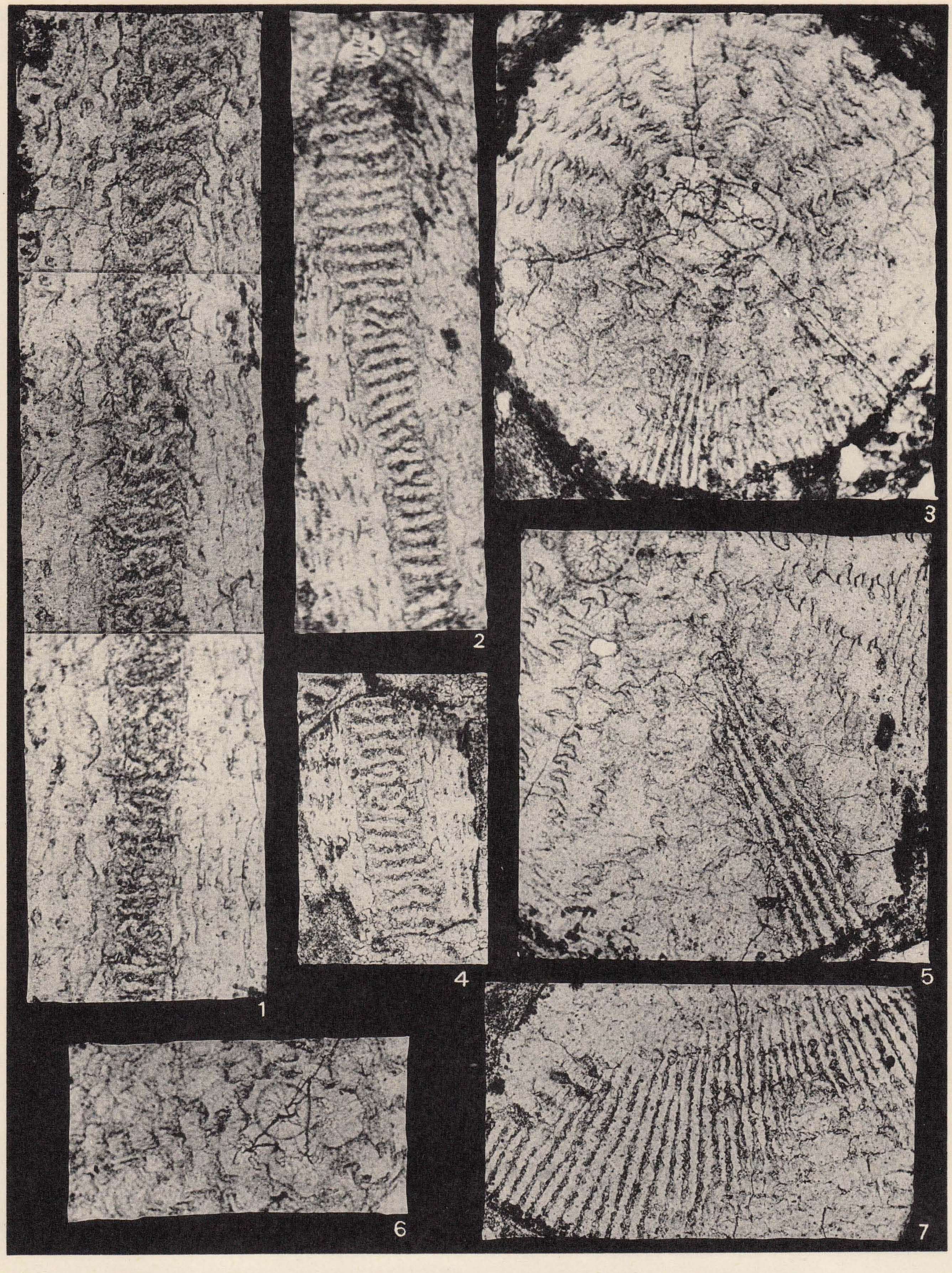
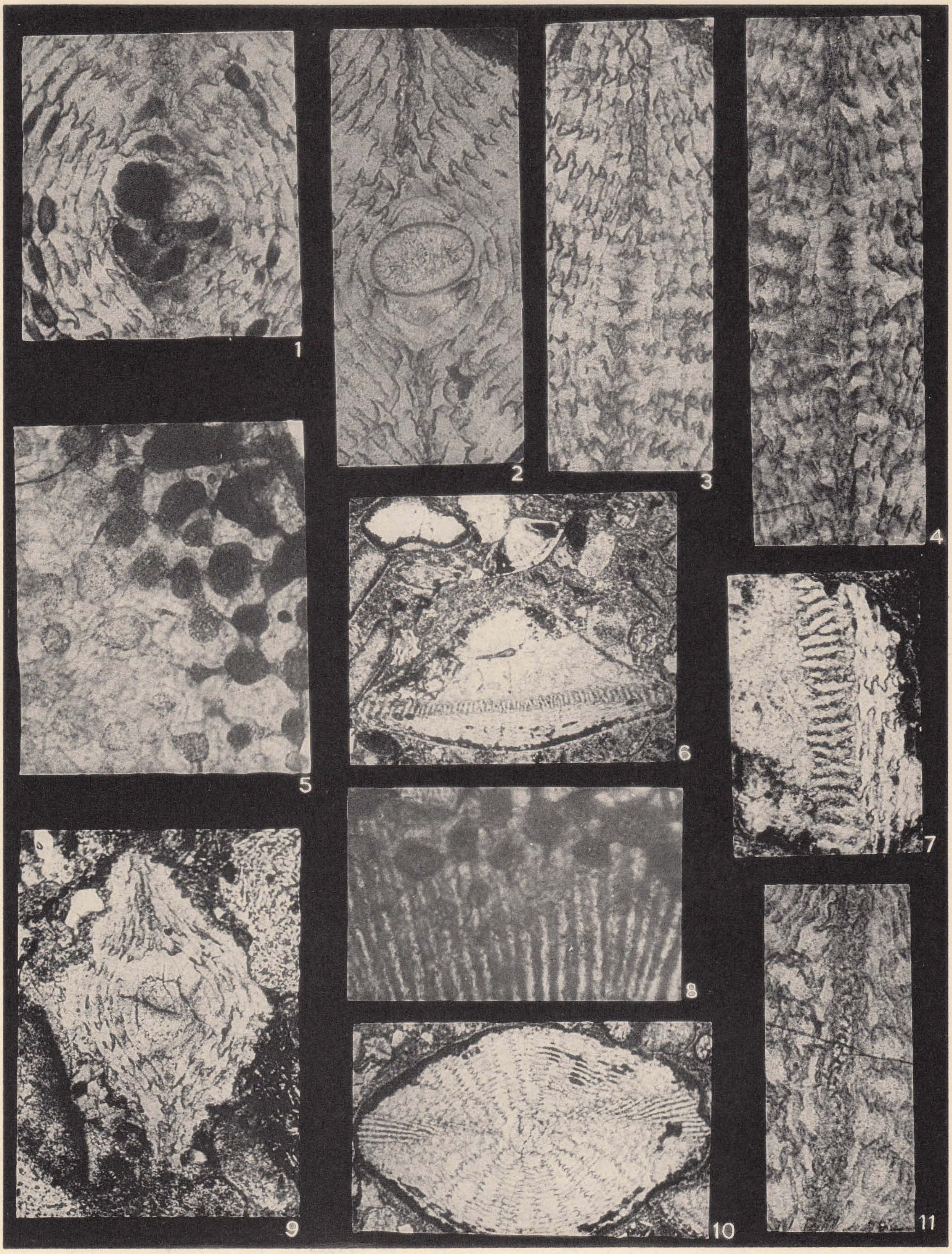


Bronnimann: Upper Cretaceous *Pseudorbitoides* from Cuba

For Explanation of Plate 11, see p. 74



Bronnimann: Upper Cretaceous *Pseudorbitoides* from Cuba

For Explanation of Plate 12, see p. 75

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131. EVIDENCE OF DISPLACED FORAMINIFERA IN THE PURISIMA FORMATION OF THE HALFMOON BAY AREA, CALIFORNIA*

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In a recent article, Goodwin and Thomson presented an excellent stratigraphic analysis of the foraminiferal faunas of the Purisima formation (Pliocene) of the Halfmoon Bay area, San Mateo County, California (1954). Analysis of the paleoecology warrants some additional considerations. Two faunas were collected from about 2900 feet of shales and mudstones in the exposed middle part of the Purisima formation. A lower *Elphidiella hannai* zone is stated to represent a water depth of about 125 feet at the time of deposition of the sediments. An upper *Uvigerina juncea* zone is considered by Goodwin and Thomson to represent similar depths with "a slight temperature change."

Bathymetric groups of the Purisima Foraminifera are given in Figure 1, together with their stratigraphic occurrence in two zones. Assignment of the lower *Elphidiella hannai* assemblage to a shallow water environment is consistent with observations of the present distribution patterns of this assemblage. However, the assignment of the *Uvigerina juncea* assemblage to a shallow water environment under cooler temperature conditions may be a possibility, but it represents only one of at least three possibilities and does not explain adequately the presence of bathyal species. A second possibility is that some of the deeper water species of the *Uvigerina juncea* zone (Figure 1) were reworked from Miocene assemblages; however, none of these is diagnostic of the Miocene. A third possibility is that bathyal conditions existed during the deposition of the sediments of the *Uvigerina juncea* zone, as evidenced by the presence there of considerable numbers of *Epistominella pacifica, Nonion pompilioides,* and others (Figure 1). The presence of *Nonion pompilioides* suggests that the depth of water was about 5000 feet deep or more (Natland, 1933, Bandy, 1953). *Epistominella pacifica* is the most abundant of the deep water species and occurs between depths of about 1000 and 3000 feet off southern California and much deeper than this off San Francisco (Bandy, 1953). It seems reasonable to assume that the associated shoal water species of the *Uvigerina juncea* zone were displaced into deeper water, a phenomenon observed often in Recent faunas (Phleger, 1951; Bandy, 1953).

BATHYMETRIC GROUPS	STRATIGRAPHIC OCCURRENCES	
	Elphidiella hannai zone	Uvigerina juncea zone
INNER SHELF ZONE		
Buliminella elegantissima	x	x
Cibicides fletcheri	x	x
Elphidiella hannai	x	x
Elphidium hughesi var. obesum	x	x
Eponides cf. E. ornata	x	x
Nonionella cushmani	x	x
Nonionella miocenica	x	x
Quinqueloculina akneriana var. bellatula		x
Trochammina sp.	x	x
OUTER SHELF ZONE		
Cassidulina californica		x
Cassidulina limbata		x
Lagena striata		x
Uvigerina juncea		x
BATHYAL ZONE		
Epistominella pacifica		x
Nonion pompilioides		x
Robulus sp.		x
Siphonodosaria sp.		x
Uvigerina cf. U. gesteri		x

Figure 1. Bathymetric groups and stratigraphic distribution in faunal zones of the Purisima formation. Stratigraphic data from Goodwin and Thomson, 1954.

* Contribution No. 148 of the Allan Hancock Foundation, University of Southern California, Los Angeles, California.

Figure 2 presents the depth-temperature range suggested by the faunas of both foraminiferal zones of the Purisima formation. Abrupt subsidence is indicated between the two faunal zones. If there had been progressive subsidence one would expect a sequence of inner shelf faunas, outer shelf faunas (*Cassidulina* spp.), and bathyal faunas. The rapid transition from inner shelf facies to bathyal facies is an anomaly which may be explained in one of the following ways; perhaps some of the section was faulted out at this point (Purisima Creek fault), the apparent abruptness of the faunal break may be due to the widely spaced collecting intervals, and possibly non-deposition resulted in the telescoping of outer shelf and bathyal faunas during a period of subsidence.

Elphidiella hannai assemblages are found in modern environments along the Pacific Coast where the temperatures range from above 13° to less than 8° C (Figure 2). Bathyal species of the *Uvigerina juncea* zone inhabit modern environments along the Pacific Coast where the temperature range is from about 8° to 2° C. It isn't likely that the temperature factor varied rapidly during the Pliocene and it seems more reasonable to ascribe an influx of bathyal species to the advent of deeper water conditions brought on by tectonic activity.

In summation, observational data from modern assemblages suggest considerable deepening of water during the deposition of the silty mudstones of the Purisima formation. Shoal faunas were displaced into deeper water producing mixed faunas during the deep water part of the cycle.

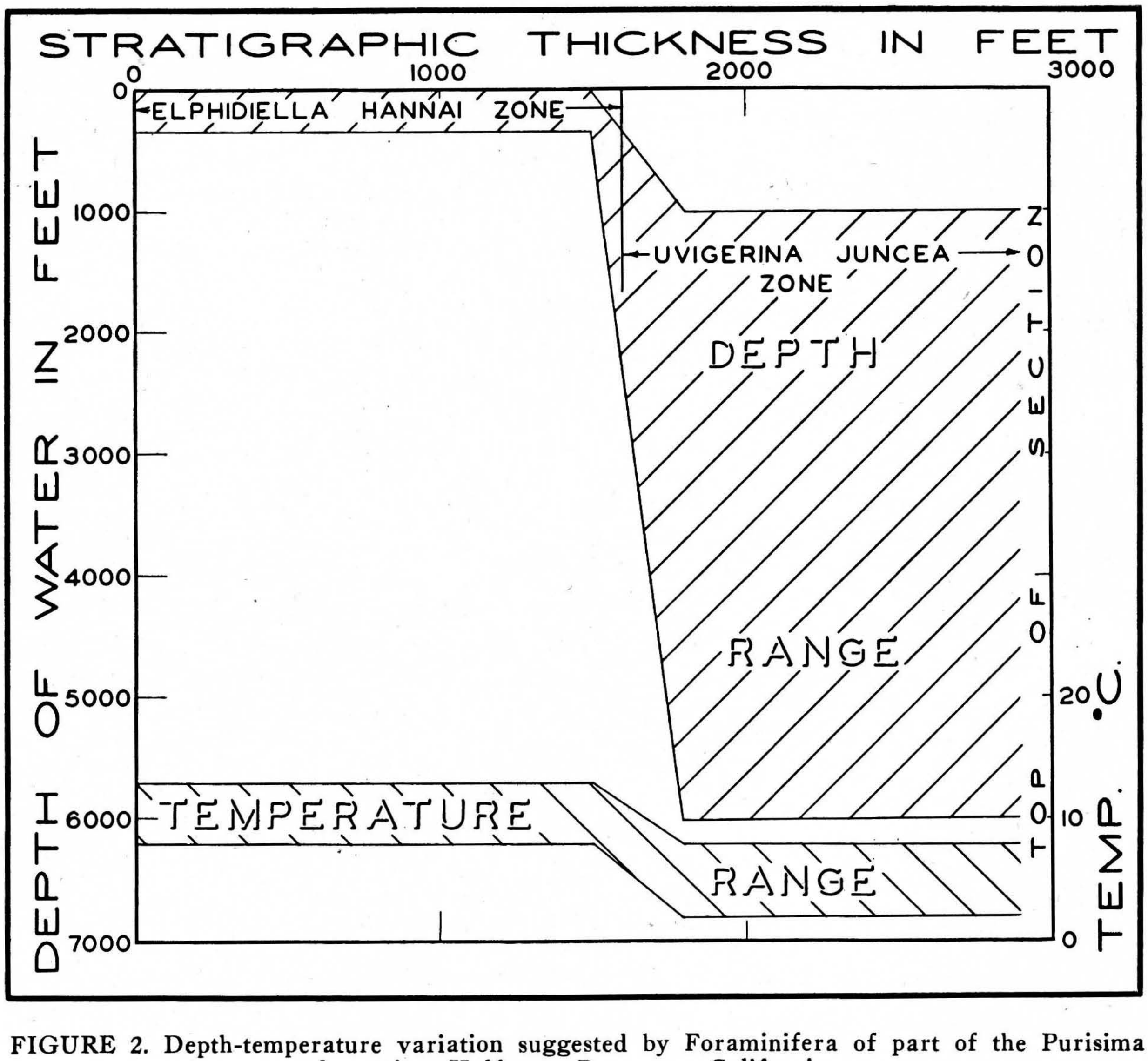

FIGURE 2. Depth-temperature variation suggested by Foraminifera of part of the Purisima formation, Halfmoon Bay area, California.

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132. NOTES ON *CERATOBULIMINA* AND *ALLOMORPHINA*

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In a recent article, Hofker (1954, a) has criticized this writer's interpretation of the structure of the internal partition and the origin of the foramina in *Ceratobulimina* (Troelsen, 1954, a), an interpretation which was essentially a confirmation and expansion of a statement by Glaessner (1948, pp. 154-155). According to Hofker (*op. cit.*), "the septal foramen at its distal border shows the attached part of the toothplate of the former chamber" and "the septal foramina . . . are undoubtedly homologous to [part of] the apertural foramen" (see also Hofker's Text Figure 1, g).

This writer, on the other hand, stated, *i.a.*, that "a line connecting the septal foramina would lie on the outside (distal side) ["peripheral" would have been a better term than "distal"] of the partitions" and that "the septal foramen can . . . not be homologous with any part of the aperture." This relationship is illustrated diagrammatically in Text Figure 1. Because the writer's original figures of dissected specimens of *C. contraria* came out rather badly in the reproduction (Troelsen, 1954, a, pl. X, Figs. 5 & 13), a new set of drawings has been made of a specimen which was dissected by the glue-and-acid method (Troelsen, 1954, b). Text Figures 2 and 3 show two different views of this specimen. It may be seen that while the foramina are visible in both views, the aperture is entirely hidden by the internal partition of the ultimate chamber (Text Fig. 2, extreme right). The relationship between the aperture and the foramina is so clear that it seems difficult to escape the conclusion that Glaessner and this writer must be right in assuming a secondary origin of the foramina.

In another article, Hofker (1954, b) describes the existence of toothplates in a species which he refers to *Allomorphina trigona* Reuss. The writer has, therefore, re-examined his specimens of *A. trigona,* which came from the same locality as Hofker's, *viz.,* Ziegelei Sooss (Badener Tegel of Miocene [Tortonian] age) in the Vienna Basin. These tests were examined by several methods, including thin sections, but no trace of an internal partition could be detected, although a slight thickening of the inside of the apertural lip was observed. In this respect, the writer's specimens agree with several other Cenozoic and Recent species which in the literature have been referred to the genera *Allomorphina* and *Chilostomella.* In their external characters, his specimens agree very well with Reuss's original figures. The possibility exists that Hofker and this writer have been examining two different species. Unless Reuss's type specimen can be re-examined, it may, however, be difficult to decide which one is the true *A. trigona.*

Although Hofker (1954, b, p. 150) now appears ready to abandon this subdivision, he has previously (1951, pp. 7-10) divided the species, which in the literature have been described as *Allomorphina,* into two groups, one with and one without toothplates. These would seem to correspond to *Quadrimorphina* and *Allomorphina,* respectively, as this writer interprets these genera. Since both belong to the group having a perforate granulate microstructure of the test wall, they may, however, be somewhat related.

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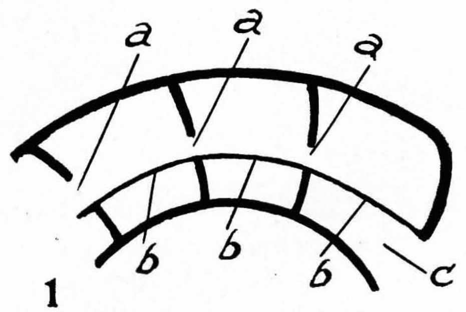

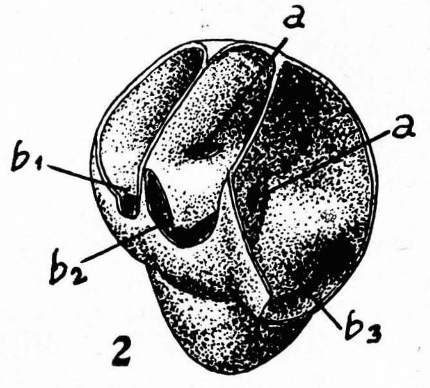

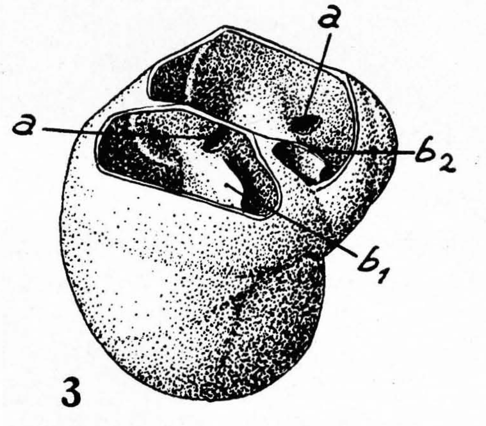

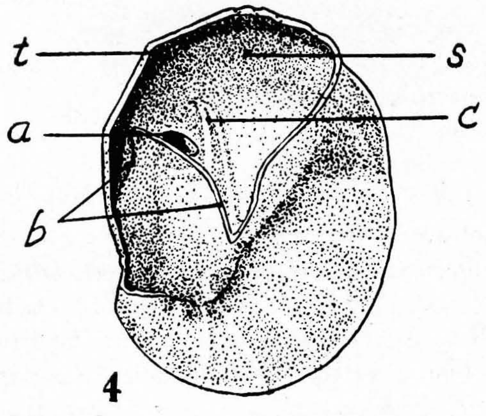

TEXT FIGURES 1-4

Figs.		Page
1.	Diagrammatical section through last chambers of *Ceratobulimina*. a: foramina; b: internal partitions; c: aperture	80
2-3.	*Ceratobulimina contraria* (Reuss), middle Oligocene, Faarup brickwork, Faarup St., Denmark (type coll., Mineralogisk-geologisk Museum, Copenhagen). Last three chambers opened. Fig. 2 shows distal sides of septa (dorsal side of test to the left; apertural face to the right). Fig. 3 shows proximal sides of septa. a: foramina; b_1, b_2, b_3: internal partitions (b_2 shows dorsal attachment of partition exposed by dissection process). × 100.	80
4.	*Ceratobulimina crepidula* (Finlay), Goodwood formation (360 feet above base), lower Miocene, Pleasant Point, New Zealand (presented by N. de B. Hornibrook. Type coll., Mineralogisk-geologisk Museum, Copenhagen). Ultimate chamber missing. a: foramen; b: attachment of internal partition of ultimate chamber; c: sealed aperture of penultimate chamber; s: septum; t: broken test wall. × 100. Note: foramen does not coincide with former aperture	80

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133. NEW NAMES FOR FORAMINIFERAL HOMONYMS III.

HANS E. THALMANN
Stanford University

The following new names for homonyms are herewith proposed with the authorization of Setembrino Petri (letter dated December 21, 1954) and C. R. Stelck (letter dated December 16, 1954):

Elphidium ? toddae Petri, nom. nov.

For: *Elphidium ? limbatum* Petri, 1954, Univ. São Paulo, Faculd. Filos. Cienc. e Letr., Boletim, No. 176, Geol. No. 11, p. 75, pl. 5, figs. 1, 2, Miocene, Brazil, [non *Elphidium macellum* (Fichtel and Moll) var. *limbatum* (Chapman 1907), Queckett Micr. Club, Jour., ser. 2, vol. 10, p. 142, pl. 10, fig. 9]. Renamed in honor of Ruth Todd, U.S. Geological Survey, Washington, D.C.

Streblus beccarii (Linnaeus) var. **mendesi** Petri, nom. nov.

For: *"Rotalia" beccarii* (Linnaeus) var. *angulata* Petri, 1954, loc. cit., p. 106, pl. 9, figs. 10-12, Miocene, Brazil, [non *Rotalia ketienziensis* (Ishizaki) var. *angulata* Kuwano, 1950, Geol. Soc. Japan, Jour., vol. 56, No. 657, p. 312, text figs. 1 and 2]. Renamed in honor of Josué Camargo Mendes, Professor of Paleontology, University of São Paulo.

Spiroloculina henbesti Petri, nom. nov.

For: *Spiroloculina concava* Petri, 1954, loc. cit., p. 53, pl. 2, figs. 3-6, Miocene, Brazil, [non *Spiroloculina acutimargo* Brady var. *concava* Wiesner, 1913, Zool. Anzeiger, vol. 41, p. 521 (teste: Heron-Allen and Earland, 1916, Linn. Soc. London, Trans., ser. 2, Zool., vol. 11, pt. 13, p. 208, pl. 39, figs. 1-3)]. Renamed in honor of Lloyd G. Henbest, U.S. Geological Survey, Washington, D.C.

Textularia leinzi Petri, nom. nov.

For: *Textularia curta* Petri, 1954, loc. cit., p. 46, pl. 1, figs. 1, 2, Miocene, Brazil, (non *Textularia flintii* Cushman var. *curta* Cushman, 1922, U.S. Nat. Mus., Bull. 104, p. 14, pl. 2, figs. 2, 3). Renamed in honor of Viktor Leinz, Professor of Geology, University of São Paulo.

Tritaxia spiritensis Stelck and Wall subsp. **prolongata** Stelck and Wall, nom. nov.

For: *Tritaxia spiritensis* Stelck and Wall subsp. *elongata* Stelck and Wall, 1954, Research Council Alberta, Rept. 68, p. 32, pl. 2, fig. 15, Upper Cretaceous, western Canada, [non *Tritaxia elongata* Halkyard, 1919, Mem. Proc. Manchester Lit. Phil. Soc., vol. 62 (1917), No. 6, Manchester 1919, p. 45, pl. 3, fig. 9].

CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
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RECENT LITERATURE ON THE FORAMINIFERA

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

AVNIMELECH, M., FARNESS, A., and REISS, Z. Mollusca and Foraminifera from the Lower Albian of the Negev (southern Israel).—Journ. Pal., vol. 28, No. 6, Nov. 1954 (Jan. 15, 1955), pp. 835-839, text figs. 1-9.—**Bullopora negevensis,** n.sp. and discussion of taxonomy and systematic position of the genus **Bullopora.** New family and subfamily, Nubeculariidae and Nubeculinellinae.

BISWAS, BUDDHADEB. On the occurrence of **Hantkenina alabamensis** from the Khasi Hills, Assam, India.—Journ. Pal., vol. 28, No. 6, Nov. 1954 (Jan. 15, 1955), pp. 791-795, pl. 94, text fig. 1 (map).

BOURDON, MARC, and LYS, MAURICE. Microfaune des marnes à **Ostrea longirostris** Lmk. (Stampien) de la carrière de la Souys-Floirac (Gironde).—C. R. S. Soc. Géol. France, Nov. 15, 1954, pp. 336-338, distribution table.

BURGL, HANS, and TOBON, YOLANDA DUMIT. El Cretaceo Superior en la region de Girardot.—Bol. Geol., Bogotá, vol. II, No. 1, 1954, pp. 23-48, pls. 1-8 (map, sections, distribution charts), text figs. 1-12 (out-crop photographs).—Foraminifera are used to supplement the age assignments based on ammonites.

CASTANARES, AGUSTIN AYALA. El genero **Globotruncana** Cushman, 1927, y su importancia en estratigrafia.—Bol. Asoc. Mex. Geol. Petr., vol. 6, No. 11-12, Nov.-Dec. 1954, pp. 353-471, pls. 1-16, map, range chart.—About 47 species, varieties, and subspecies in **Globotruncana, Rotalipora, Thalmanninella,** and **Ticinella,** are described and illustrated. Keys to genera and to species are included and stratigraphic ranges indicated.

CHANG, LI-SHO. Two new species of smaller Foraminifera from the Miocene of Taiwan: **Gaudryina Pseudogaudrina) kokuseiensis** and **Karreriella shangtaoensis.**—Bull. Geol. Survey Taiwan, No. 7, Nov. 1954, pp. 59-61, pl. 1.

COLE, W. STORRS. Larger Foraminifera and smaller diagnostic Foraminifera from Bikini drill holes, **in** Bikini and nearby Atolls, Part 4, Paleontology.—U. S. Geol. Survey Prof. Paper 260-0, Dec. 30, 1954, pp. 569-608, pls. 204-222, tables 1, 2.—The Miocene and older portion of the 2556 feet of section (**i.e.,** below 850 feet) is subdivided in accordance with the Indo-Pacific letter classification, and three zones recognized in Tertiary **e.** Thirty-nine species and varieties, 14 new, are described and illustrated.

CROUCH, ROBERT W. Paleontology and Paleoecology of the San Pedro shelf and vicinity.—Sedimentary Petrology, Sept. 1954, pp. 182-190, text figs. 1, 2 (map and check list).—Study of Recent and misplaced fossil Foraminifera. Discussion of criteria for redeposition vs. reworking of earlier sediments. Ecologic interpretation of Timms Point formation.

CUMMINGS, ROBERT H. New genera of Foraminifera from the British Lower Carboniferous.—Journ. Washington Acad. Sci., vol. 45, No. 1, Jan. 1955, pp. 1-8, text figs. 1-5.—**Endothyranopsis,** n.gen. (type species **Involutina crassa** Brady 1869) and **Loeblichia,** n.gen. (type species **Endothyra ammonoides** Brady 1873) in Endothyridae. **Fourstonella,** n.gen. (type species **Stacheia fusiformis** Brady 1876) in Trochamminidae.

CUSHMAN, JOSEPH A., TODD, RUTH, and POST, RITA J. Recent Foraminifera of the Marshall Islands, **in** Bikini and Nearby Atolls, Part 2, Oceanography (Biologic).—U. S. Geol. Survey Prof. Paper 260-H, Dec. 20, 1954, pp. 319-384, pls. 82-93, text figs. 116-118, tables 1-5.—Over 300 species and varieties, 19 new, from 195 bottom samples between beach and 835 fathoms. Distribution and abundance tables are included.

GANSS, O., and KNIPSCHEER, H. C. G. Das Alter der Nierentaler und Zwieselalmschichten des Beckens von Gosau.—Neues Jb. Geol. u. Paläont., Abh., Band 99, pt. 3, August 1954, pp. 361-378, pls. 23, 24, text fig. 1.—Foraminifera listed and a few illustrated.

GIANOTTI, AGOSTINO. Microfaune della serie Tortoniana del Rio Mazzapiedi-Castellania (Tortona-Alessandria).—Riv. Ital. Pal. Stratig., Mem. VI, 1953, pp. 167-301, pls. 10-19, text figs. 7-10, tables 4-6.—The Tortonian is divisible into 3 parts: the upper containing faunal indications of unfavorable living conditions; the middle with a deep water fauna with Recent affinities; the lower with a rich archaic fauna indicating favorable living conditions. About 400 species and varieties are recorded and many illustrated, 4 new.

IWASA, SABURO, and KIKUCHI, YOSHIKI. Foraminifera from the Sugota formation, Akita Prefecture, Japan.—Trans Proc. Palaeont. Soc. Japan, n. ser., No. 16, Dec. 15, 1954, pp. 183-194, text figs. 1-8, table 1.—A benthonic fauna of 149 species and subspecies, 8 new, is listed in a distribution table, and correlated with other formations of Vindobonian age. The new species are described and illustrated.

de KLASZ, I., and KNIPSCHEER, H. C. G. Die Foraminiferenart **Reussella szajnochae** (Grzybowski): ihre systematische Stellung und regional-stratigraphische Verbreitung.—Geol. Jb., Band 69, Oct. 1954, pp. 599-610, pl. 45, 1 table.—A lineage study to increase the stratigraphic usefulness of Upper Cretaceous Reussellas. One new subspecies.

LOEBLICH, ALFRED R. JR., and TAPPAN, HELEN. New names for two foraminiferal homonyms.—Journ. Washington Acad. Sci., vol. 44, No. 12, Dec. 1954, p. 384.—**Oolina borealis** for **costata** Williamson not Egger, and **Fissurina siciliensis** for **marginata** Seguenza not Montagu.

A revision of some glanduline Nodosariidae (Foraminifera).—Smithsonian Misc. Coll., vol. 126, No. 3, Febr. 3, 1955, pp. 1-9, pl. 1.—**Rectoglandulina** (type species **R. appressa,** n.sp.) for **Pseudoglandulina** suppressed. **Pandaglandulina** (type species **P. dinapolii,** n.sp.) with a curved axis. Four species, 3 new, are described and illustrated.

MALECKI, J. New genera of agglutinated Foraminifera from the Polish Miocene.—Ann. Soc. Geol. Pologne, vol. 22, fasc. 4, Ann. 1952, 1954, pp. 497-513, pls. 12, 13, text figs. 1-5.—Two new lituolids: **Pseudotriplasia** (genotype **P. elongata,** n.sp.) and **Phyllopsammia** (genotype **P. adanula,** n.sp.). Six species, all new.

MATSUNAGA, TAKASHI. **Oinomikadoina ogiensis,** n.gen., n.sp., from the Pliocene of Niigata, Japan.—Trans Proc. Palaeont. Soc. Japan, n.ser., No. 15, Oct. 15, 1954, pp. 163, 164, 3 text figs.—Differs from **Cibicides** in having supplementary apertures, one each on the peripheral edge of the last few chambers.

RUSCELLI, MARIA. Microfaune della serie Elveziana del Rio Mazzapiedi-Castellania (Tortona-Alessandria).—Riv. Ital. Pal. Stratig., Mem. VI, 1953, pp. 99-166, pls. 5-9, text figs. 3-6, table 3.—This Helvetian fauna includes 173 species and varieties, 2 new. The series is divided into a lower marly neritic part and an upper arenaceous sublittoral part.

SAID, RUSHDI. Foraminifera from some "Pliocene" rocks of Egypt.—Journ. Washington Acad. Sci., vol. 45, No. 1, Jan. 1955, pp. 8-13.—A fauna with Mediterranean affinities in the shadow Nile Valley gulf indicates a cold, wet climate of Calabrian (lower Pleistocene) age. Thirty-four species (one a new name) are discussed.

SAURIN, EDMOND. L'âge des calcaires de Sagada (Luçon, Philippines).—C. R. S. Soc. Géol. France, Nov. 8, 1954, pp. 290-292.—Larger Foraminifera mentioned.

SKINNER, JOHN W., and WILDE, GARNER L. New early Pennsylvanian fusulinids from Texas.—Journ. Pal., vol. 28, No. 6, Nov. 1954 (Jan. 15, 1955), pp. 796-803, pls. 95, 96, tables of measurements.—Four new species.

STELCK, C. R., and WALL, J. H. Kaskapau Foraminifera from Peace River Area of Western Canada.—Research Council of Alberta Rept. No. 68, 1954, pp. 1-38, pls. 1, 2, text figs. 1-5 (map, sections, outcrop photographs).—Five microfaunal zones are recognized in the Cenomanian-Turonian transition beds. Ecology and local and regional correlations are discussed. Twenty-six species and subspecies, 23 new, are described and illustrated.

THALMANN, HANS E. Bibliography and index to new genera, species, and varieties of Foraminifera for the year 1953.—Journ. Pal., vol. 28, No. 6, Nov. 1954 (Jan. 15, 1955), pp. 840-873.

TODD, RUTH, and POST, RITA. Smaller Foraminifera from Bikini drill holes, in Bikini and Nearby Atolls, Part 4, Paleontology.—U. S. Geol. Survey Prof. Paper 260-N, Dec. 30, 1954, pp. 547-568, pls. 198-203, text fig. 166, table 1.—Five holes were drilled on Bikini, the deepest to 2556 feet. Miocene was penetrated at about 850 feet and the bottom of the section is possibly in Eocene strata. About 55 fossil species, 18 new, are described and illustrated. Relatively shallow deposition throughout the section is indicated.

TORIYAMA, RYUZO. Geology of Akiyoshi. Part II. Stratigraphy of the Non-calcareous groups developed around the Akiyoshi Limestone Group.—Mem. Fac. Sci., Kyushu Univ., ser. D, Geol., vol. 5, No. 1, Aug. 30, 1954, pp. 1-46, text figs. 1-6, tables 1-5.

A gigantic fusulinid species from the Kitakami Massif, northeastern Japan.—Trans. Proc. Palaeont. Soc. Japan, n.ser., No. 15, Oct. 15, 1954, pp. 179-182, pl. 24, text figs. 1, 2.—**Lepidolina? gigantea** n.sp.

WEISS, LAWRENCE. Foraminifera from the Paleocene Pale Greda formation of Peru.—Journ. Pal., vol. 29, No. 1, Jan. 1955, pp. 1-21, pls. 1-6, text figs. 1, 2.—Seventy-four species, varieties, and subspecies, 14 new, with age restriction based mainly on Globorotalias.

RUTH TODD