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134. DICTYOCONUS WALNUTENSIS (CARSEY) IN THE MIDDLE ALBIAN GUACHARO LIMESTONE OF EASTERN VENEZULA

WOLF MAYNC
Venezuelan Atlantic Refining Company, Caracas

INTRODUCTION

The presence of *Dictyoconus walnutensis* (Carsey) in the Lower Cretaceous of Eastern Venezuela was recently recorded by the writer (Maync, 1953, p. 101; Rod and Maync, 1954, p. 274 etc.) This characteristic foraminifer, which seems to be restricted to the Middle Albian Guácharo limestone (Chimana formation), was hitherto not observed in Lower Cretaceous formations of Western Venezuela; neither does the writer know of any published data concerning the occurrence of *Dictyoconus walnutensis* in other parts of South America. Consequently, a brief note on its presence in Eastern Venezuela is believed to be warranted.

Some thin-sections of *Dictyoconus walnutensis* (Carsey) from the Guácharo limestone are reproduced in the present paper which also contains some remarks on allied genera and taxonomy.

R. Wright Barker, Houston (Texas), kindly put valuable topotype material of *Dictyoconus walnutensis* (Carsey) and *"Coskinolina" adkinsi* Barker from the classic section on Mt. Barker, near Austin, (Texas), at the writer's disposal which is gratefully acknowledged here.

F. G. Keyzer most obligingly gave first-hand information regarding *Coskinolinoides texanus* Keyzer, 1942, its occurrence and *Dictyoconus walnutensis* in the Lower Cretaceous of Cuba.

During a recent stay in Europe, the writer had the opportunity to examine material of a *Dictyoconus*-bearing limestone from the Lower Cretaceous of the Aquitaine, France. He feels greatly indebted to Professor J. Cuvillier, Paris, for the opportunity to examine these thin-sections and to discuss many taxonomic stratigraphic questions.

The figured specimens of *Dictyoconus walnutensis* (Carsey) from the Guácharo limestone of Venezuela (Pl. 14, figs. 1-7) are deposited in the U.S. National Museum, Cushman Collection, Washington 25, D.C.

Family ORBITOLINIDAE

Genus **Dictyoconus** Blanckenhorn, 1900

Dictyoconus walnutensis (Carsey), 1926

Plates 13, 14

Orbitolina walnutensis Carsey, 1926, The Texas Univ., Bull. No. 2612, p. 23, pl. 7, figs. 11 a-b; pl. 8, fig. 3.

Dictyoconus walnutensis Carsey sp., Pfender, 1938, Bull. Soc. Géol. France, 5, sér. vol. VIII, p. 234-236, pl. XIV, fig. 4.

Dictyoconus walnutensis (Carsey), Davies, 1939, Roy. Soc. Edinburgh, Trans., vol. 59, pt. 3, No. 29, p. 775-776, pl. 1, figs. 4, 6.

Dictyoconus walnutensis (Carsey), Cole, 1942, Florida Geol. Surv., Bull. No. 20, pl. 4, figs. 6-7.

Dictyoconus walnutensis (Carsey), Barker, 1944, Journ. of Pal., vol. 18, No. 2, March, p. 205, pl. 35, figs. 6-8.

Dictyoconus walnutensis (Carsey), Lozo, 1944, The Americ. Midl. Nat., vol. 31, No. 3, pl. 5, fig. 8.

No free specimens of *Dictyoconus walnutensis* (Carsey) are so far available from Venezuela but the thin-sections from the Guácharo limestone leave no doubt that the present species is referable to the Texas form. Median and axial sections are indistinguishable from the species described and figured from the Texas Lower Cretaceous of which ample topotype material could be thin-sectioned for comparison (see Pls. 13, 14).

The genus *Dictyoconus* is based on the Eocene species *D. egyptiensis* (Chapman), 1900. Several other Tertiary species of *Dictyoconus* have been erected in the course of time, such as *D. gunteri* Moberg, *D. codon* Woodring, *D. puilboreauensis* Woodring, *D. americanus* (Cushman). It has become evident, however, especially by the excellent studies of L. M. Davies and W. Storrs Cole, that none of these forms is actually a sharply delimited species but all of them appear to intergrade with respect to their morphological characteristics. Most of these "species" seem to have evolved from a common ancestor and may be referred to one single morphological unit, *viz., Dictyoconus americanus* (Cushman). Future studies possibly will show that some Eocene species recorded from the Old World, e.g., *D. egyptiensis-coralloides,* etc., might find their place also in the *americanus* group. One thin-sectioned specimen of *D. americanus,* from the middle Eocene of the Dominican

Republic, is given here for comparative purposes (Pl. 13, fig. 9).

There is still some debate as to the taxonomic position of the genus *Dictyoconus* which is often allocated to the Valvulinidae, subfamily Ataxophragmiinae (Cushman, 1937; Frizzell, 1949). The genera of this lineage (*Arenobulimina-Lituonella-Coskinolina-Dictyoconus*), of which *Dictyoconus* is thus considered to be the end member, reveal a progressively reduced initial spire. The author prefers, however, to place *Dictyoconus* and similar specialized genera in the family Orbitolinidae Martin, 1890.

In his memoir on Larger Foraminifera of the Middle East, F. R. S. Henson established several new genera in this complex morphological group of the conical Orbitolinidae but there obviously still remain many taxonomic problems to be solved.

Except for the Eocene species of *Dictyoconus,* which may be included in the group of *D. americanus,* the genus is known to be represented by a few Cretaceous species, *viz., D. walnutensis* (Carsey), *D. arabicus* Henson, and *D.* (?) *valentinus* Almela. A new *Coskinolina*-like, steeply conical species of *Dictyoconus* (showing a base of 1.2 mm. and a height of 2.1 mm.) moreover occurs in foraminiferal limestones of supposed Urgonian age in the Swiss ultrahelvetic Alps (see Pl. 13, fig. 8) where it is associated with *D. walnutensis* (Garsey), *Orbitolina concava* (Lamarck).

The figured thin-sections (Pl. 14, figs. 1-8) of some specimens of *Dictyoconus* from Eastern Venezuela reveal the identity with *D. walnutensis* from the Middle Albian of the Mt. Barker section, Texas (Cole, 1942, pl. 4, figs. 6-7; Barker, 1944, pl. 35, figs. 6-8; Lozo, 1944, pl. 5, figs. 7-11; present paper, Pl. 13, figs. 1-7).

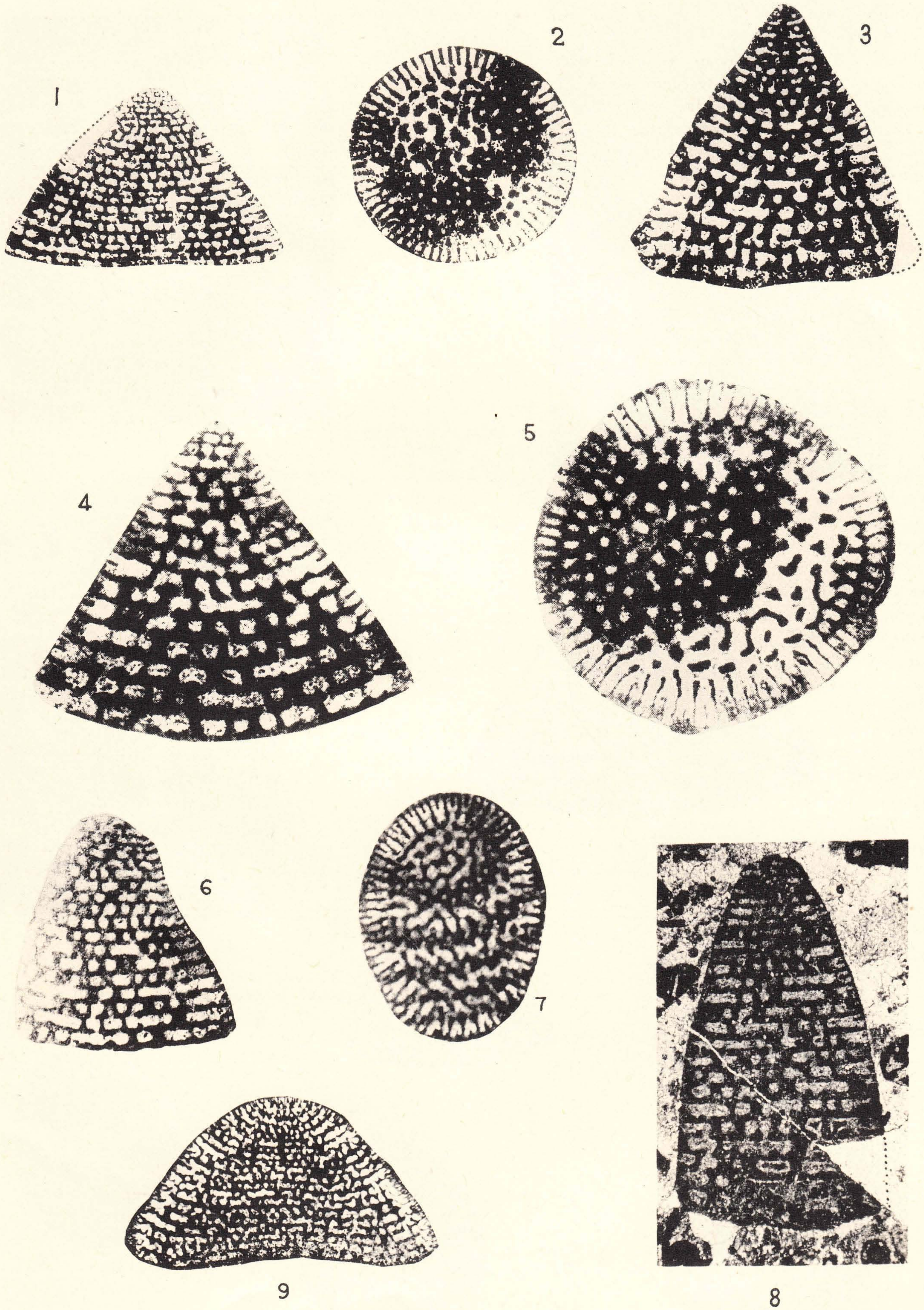
Free topotype specimens from Mt. Barker prove that *D. walnutensis* has a featureless even surface (thin epidermal layer); abraded or etched specimens show a regular network of rectangular chamberlets which subdivide the primary saucer-shaped uniserially arranged chambers. There is as yet no direct proof of dimorphism of *D. walnutensis,* except for a few slightly steeper-conical specimens showing a twisted bulb-like apex whereas the major part of the tests is composed of larger and broader specimens. The former might represent the megalospheric generation, the latter the microspheric form.

The test of the Venezuelan specimens is a low cone with a circular outlined, plano-convex base (basal diameter usually larger than the height of the cone). The axial sections show the diagnostic single plate projecting inward from the wall into the peripheral chambers (horizontal sub-epidermal plate).

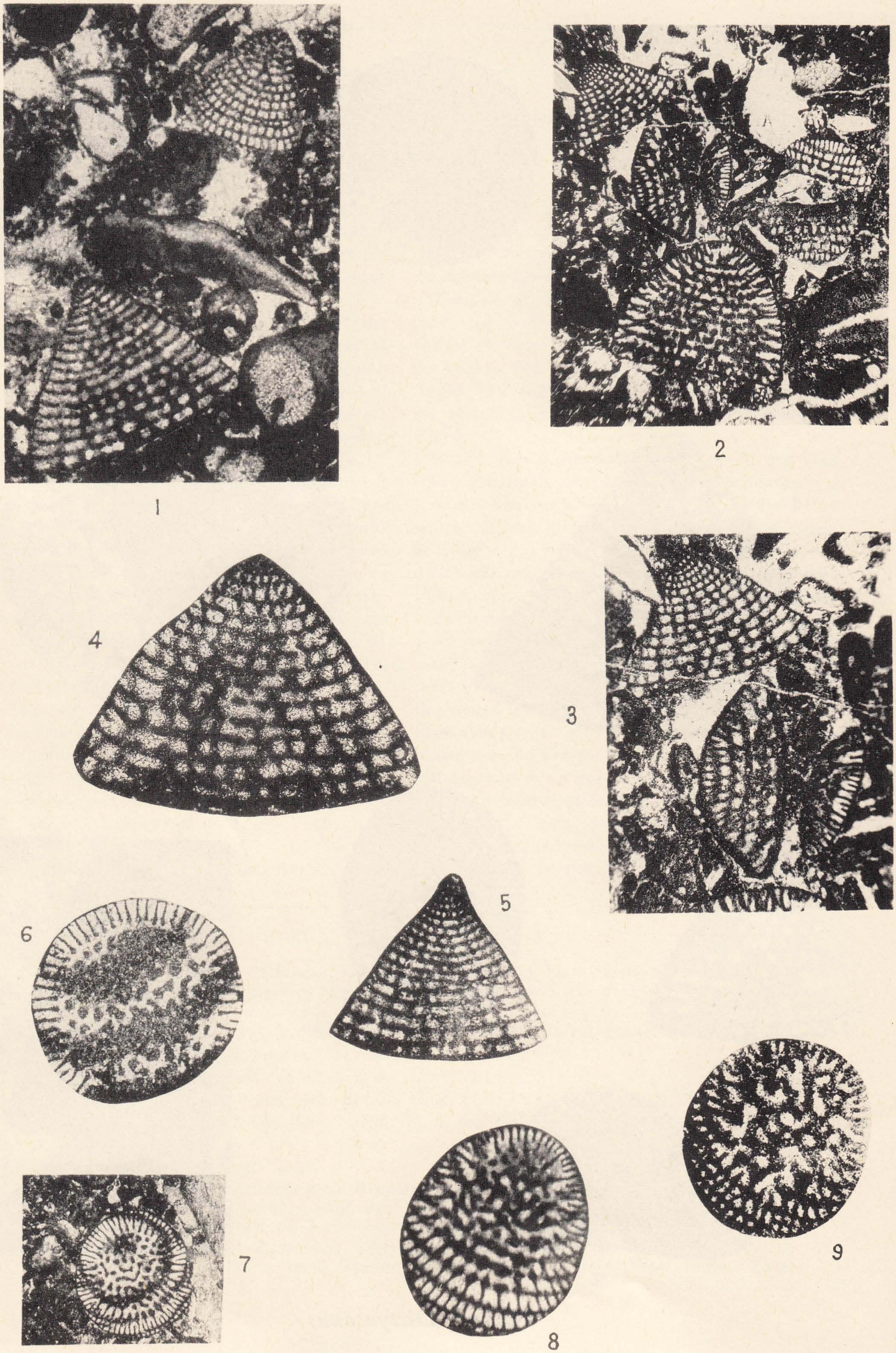
Except for *D. walnutensis* (Carsey) the Guácharo limestone (middle Chimana formation) of Eastern Venezuela carries a very similar form which can only be distinguished from said species of *Dictyoconus* by the fact that it lacks, as a rule, the horizontal marginal plate (axial sections). Consequently, it cannot be placed in *Dictyoconus* according to the present definition of that genus. Since a central pillar structure is developed (not visible in shallow sections which then resemble those of *Orbitolinopsis* or *Iraqia*), it is assigned by the writer to the genus *Coskinolina.* In a very few cases, however, a few rudimentary horizontal plates may be present and it is then impossible to differentiate this form of *Coskinolina* from a true, though primitive species of *Dictyoconus.* The development of such sporadic horizontal plates suggests a close relationship of this form with the more specialized genus *Dictyoconus.* This new, in

EXPLANATION OF PLATE 13

FIGS.		PAGE
1-7.	*Dictyoconus walnutensis* (Carsey); basal Comanche Peak formation (3 feet above the top of the Walnut clay). Surface sample from near the top of Mt. Barker, west of Austin, Texas (USA)	86
1.	Longitudinal section. × 17. (ex Barker, 1944, Journal of Pal., vol. 18, no. 2, Pl. 35, fig. 6)	
2.	Transverse section. × 16 approx. (ex Barker, *loc.cit.,* Pl. 35, fig. 7)	
3.	Axial section. × 32 approx. (ex Barker, *loc. cit.,* Pl. 35, fig. 8)	
4.	Axial section. × 42. (ex Cole, 1942, Florida Geol. Surv., Geol. Bull, No. 20, Pl. 4, fig. 6)	
5.	Horizontal section. × 42 (ex Cole, *loc.cit.,* Pl. 4, fig. 7)	
6.	Axial section. × 26	
7.	Oblique transverse section. × 26	
8.	*Dictyoconus,* n.sp. Urgonian limestone, Regenbolshorn (Abelboden), Canton of Bern, Switzerland. Surface sample No. 42047 coll. Prof. Leupold, Micropaleontological laboratory of the Swiss Federal Institute of Technology, Zürich. × 28	86
9.	*Dictyoconus americanus* (Cushman). Outcrop sample 200 meters east of kilometer post 91, highway Ciudad Trujillo to Azua, Dominican Republic, Hispaniola, West Indies. Axial section. × 10	85



Maync: *Dictyoconus*



Maync: *Dictyoconus*

some respects intermediate, form will be described in due course by the writer.[1]

Dictyoconus arabicus Henson was described from limestones of ? Barremian to Lower Aptian age of Arabia (Henson, 1948[2]), associated with *Choffatella decipiens* Schlumberger and *Orbitolina discoidea* var. *delicata* Henson. The species *D. arabicus* exhibits a radial arrangement of the apertural openings which are irregularly distributed in *D. walnutensis*. With respect to its interior structure (subdivision of the marginal chambers by one single horizontal plate) *D. arabicus* can hardly be distinguished from *D. walnutensis*, which is much smaller in size than the Arabian species (see Table). The large specimen figured from Texas (Barker, 1944, pl. 35, fig. 6; Lozo, 1944, pl. 5, figs. 10-11) might actually turn out to be closer to *D. arabicus*.

The only other described Cretaceous species of *Dictyoconus*, *viz.*, *D. valentinus* Almela, 1946, from the Cenomanian of Spain, shows similarities with *D. walnutensis* in outline and dimensions of the test (see Table). In his description, A. Almela points out that *D. valentinus* very often shows a concave base so that the central portion disappears in horizontal sections (Almela, 1946). *D. walnutensis* in turn is stated to show either a flattened or more often a convex base. Among the examined topotype material of *D. walnutensis*, however, there are quite a number of specimens with a concave base.

D. valentinus shows a greater number of apertural pores than *D. walnutensis* which are reported to be rather irregularly distributed and to have a polygonal form, whereas *D. walnutensis* exhibits circular openings. The statement that the marginal chambers are more regularly developed in *D. valentinus* than in the Texas species is, however, not borne out by the prepared thin-sections, and free worn or etched specimens (topotypes) of *D. walnutensis* consistently show the sub-epidermal rectangular meshwork of cellules that is held to be a rather typical feature of *D. valentinus* by A. Almela.

The two figures of axial sections of *D. valentinus* (Almela, 1946, figs. 10, 12) fail to show any horizontal partitions of the marginal chambers. If such plates should actually be lacking in the form under discussion, it cannot be attributed generically to *Dictyoconus*. Having no true pillars in its central part, it cannot be assigned to *Coskinolina* either. According to F. R. S. Henson, *D. valentinus* structurally belongs to the genus *Iraqia* (Henson, 1949) as its central portion is formed by the intergrowth of interseptal partitions. An objection to such an allocation is the fact that *Iraqia* is reported to be endowed with "a well-developed subepidermal zone with horizontal and vertical plates as well as main partitions" (Henson, 1948, p. 69), whereas *D. valentinus* appears to lack at least the horizontal elements (*Orbitolinopsis* type). A definite decision cannot be made without a restudy of either the original material or the examination of topotype specimens.

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1. A near-surface section of a very similar if not identical foraminifer has been figured by J. Pfender as **Dictyoconus** sp. (Pfender, 1938, Pl. XV, fig. 4). This specimen is derived from a limestone of supposed Cenomanian age, found at Xiliatl, north of Xilitla (San Luis Potosi), Mexico. Another closely related form from the Valanginian of southern France is also depicted (**ibid.**, Pl. XIV, fig. 6, top).

The genus (and species) represented in the Venezuelan Guácharo limestone also occurs widely in Lower Cretaceous (Trinity) rocks of southern Florida (so-called **"Coskinolina S"** from the Sunniland producing horizon). Ample material of this marker from different wells in Florida was recently put at the writer's disposal by Louise Jordan, Consultant, Tallahassee, Florida. In compliance with the request of Louise Jordan, this Florida material will be incorporated in the author's future publication on this undescribed form.

2. **Dictyoconus** cf. **arabicus** Henson is also reported to occur in Cenomanian beds of south-west Iran (Kent **et al.**, 1951).

EXPLANATION OF PLATE 14

FIGS.		PAGE
1-8.	*Dictyoconus walnutensis* (Carsey): basal Guácharo member (middle Chimana formation), Middle Albian. Surface sample Rod-1306, section on Río Carinicuao, south of Cariaco, State of Sucre, Eastern Venezuela (see Bull. A.A.P.G., vol. 38, 1954, no. 2, p. 225, section 18, at D)	86
1.	Axial section showing the diagnostic short horizontal plate in peripheral chambers. X 27 Right corner: *Coskinolina*, n.sp. (*"Coskinolina* S" auctorum of Florida, U.S.A.)	
2.	Random sections. × 17	
3.	Axial section (same specimen as shown in Fig. 2, left corner). × 27	
4.	Longitudinal section. × 44	
5.	Axial section. × 30	
6.	Section slightly oblique to the base. × 27	
7.	Section slightly oblique to the base. × 15	
8.	Oblique section. × 27	
9.	*Dictyoconus walnutensis* (Carsey); Valanginian, north of Toulon, southern France (ex Pfender, 1938, Bull. Soc. Géol. France, sér. 5, vol. VIII, Pl. XIV, fig. 1). Oblique section. × 40	85

DIMENSIONS OF THE CRETACEOUS SPECIES OF *DICTYOCONUS*

Species	Diameter of base	Height of cone	Ratio base/height
D. walnutensis (Carsey)			
Texas (USA)	mm.	mm.	
	1.42[1]	1.24[1]	1.14
	1.33[2]	1.33[2]	1.0
	1.33[3]	1.28[3]	1.0
	2.54[4]	2.00[4]	1.27
	1.16[5]	1.00[5]	1.16
	min. 0.9 [5]	min. 0.8 [5]	1.12
	max. 1.50[5]	max. 1.40[5]	1.07
Venezuela	1.37[6]	1.07[6]	1.28
	1.40[7]	1.0 [7]	1.4
	1.20[8]	0.8 [8]	1.5
	1.6 [9]	—	—
	1.3 [10]	1.1 [10]	1.18
France	1.15[11]	1.0 [11]	1.1
D. arabicus Henson			
Arabia	2.4-3.2[12]	1.7-2.0[12]	1.4-1.6
	1.6 [13]	1.17[13]	1.36
	2.59[14]	2.26[14]	1.14
D. valentinus Almela			
Spain	1.3-1.9[15]	1.0-1.7[15]	1.3-1.1

[1] Cole, 1942, Florida Geol. Surv., Bull. 20, Pl. 4, fig. 6 (Pl. 13, fig. 4 of present paper).
[2] Barker, 1944, Journ. Pal., vol. 18, no. 2, Pl. 35, fig. 5.
[3] Lozo, 1944, Amer. Midl. Nat., vol. 31, no. 3, Pl. 5, fig. 7 (same specimen figured by Barker, **loc.cit.**, Pl. 35, fig. 8); Pl. 13, fig. 3 of present paper.
[4] Ibidem, Pl. 5, figs. 10, 11 (same specimen figured by Barker, **loc.cit.**, Pl. 35, fig. 6); Pl. 13, fig. 1 of present paper.
[5] Average measurements made on 30 free topotype specimens from Mt. Barker, Texas (received by R. W. Barker).
[6] Pl. 14, fig. 1 of present paper.
[7] Pl. 14, fig. 5 of present paper.
[8] Pl. 14, fig. 3 of present paper.
[9] Pl. 14, fig. 2 of present paper.
[01] Pl. 14, fig. 4 of present paper.
[11] Pfender, 1938, Bull. Soc. Géol. France, vol. 8, Pl. XIV, fig. 4.
[12] Henson, 1948. Larger Imperf. For. etc., p. 36.
[13] Ibidem, Pl. XIV, fig. 3.
[14] Ibidem, Pl. XIV, fig. 1.
[15] Almela, 1946, Inst. Geol. Min. España, no. 16, p. 153.

REMARKS ON SOME RELATED GENERA OF CONICAL ORBITOLINIDAE

Externally, most genera of the orbitolinid group show similar features and can, therefore, not readily and reliably be discriminated from each other. By means of thin-sections, however, diagnostic features are revealed which allow a generic differentiation. Horizontal sections (parallel to the base of the cone) however, may often display an identical or at least a very similar internal structure (*e.g., Coskinolina, Coskinolinoides,* and *Dictyoconus*), but axial sections differ enough from each other for a generic identification. The principles of such a generic differentiation have been developed by L. M. Davies (1930, 1939); W. Storrs Cole (1941, 1942, 1944, 1945); F. R. S. Henson (1948); R. Ciry and P. Rat (1953) to whose fundamental papers the reader is referred.

F. R. S. Henson (1948, p. 22) subdivided the Orbitolinidae into a *group* (*I*) showing a conical test with a) interseptal buttresses or pillars (*Lituonella, Coskinolina, Dictyoconus*) or *b*) interseptal partitions (*Orbitolinopsis, Iraqia, Kilianina, Orbitolina, Coskinolinoides* and *Simplorbitolina*). The genera with a flabelliform or compressed-conical test (*Lituonelloides, Coskinolinopsis, Dictyoconella*) are included in *group* (*II*) which is allied to the *Lituonella-Coskinolina-Dictyoconus* lineage but shows irregularly labyrinthic interseptal structures.

The simplest representative of conical Orbitolinidae with a central pillar structure, *Lituonella* Schlumberger, 1905, shows a completely undivided marginal zone (outer ring) and reveals the presence of vertical buttresses from floor to roof of the chambers in the central area. *Lituonella* is an Eocene genus.

According to the broadened interpretation of the genus (Cole, 1941), *Coskinolina* Stache, 1875, exhibits a marginal trough with regular radial chambers each of which may or may not be subdivided by one single vertical plate (sections parallel to the base). Such vertical partitions are absent in *Lituonella*. *Coskinolina* completely lacks any further subdivision by additional vertical lamellae (like the Eocene forms of *Dictyoconus*), and horizontal (transverse) plates are altogether absent (axial sections). In horizontal sections, *Coskinolina* thus represents a simple primitive *Dictyoconus* with none or only one vertical plate per marginal chamber. Only axial sections are, therefore, of diagnostic value as they show either the presence or absence of one or more horizontal partitions of the peripheral zone that form cellular chamberlets (*Dictyoconus* or *Coskinolina*[3]).

The genera *Lituonella, Coskinolina,* and *Dictyoconus* show buttress-like pillars in the central shield.

3. A marginal case in this respect seems to be the new form mentioned which occurs in the Guácharo member of Venezuela as well as in the Trinity beds of Florida. This foraminifer generally lacks any horizontal plate on which account it is referable to **Coskinolina.** Occasionally, such a horizontal plate is however, indicated and the form is then a primitive **Dictyoconus** (like **D. walnutensis**).
The occasional lack of vertical and horizontal plates in **D. walnutensis** was stressed by L. M. Davies (Davies, 1939). The new undescribed form differs from **D. walnutensis** in having usually no horizontal partitions developed, in other words, the presence of such transverse plates is exceptional.

A *Coskinolina*-like test from the Lower Cretaceous of Texas has been described by F. G. Keyzer as a new genus *Coskinolinoides,* with *C. texanus* Keyzer, 1942, as geno-holotype (Keyzer, 1942). This genus differs from *Coskinolina* in lacking the central buttress-like pillars; the marginal chambers are usually subdivided by one radial vertical plate (as in *Coskinolina*) and by some intermediate vertical semi-septa. No horizontal partitions (*Dictyoconus* type) are developed (Keyzer, 1942, p. 1016). Since true pillars are lacking, the narrow central zone (*reticulum*), if present at all, must have formed by interfusion of interseptal elements.

Topotype specimens of *Coskinolinoides texanus* Keyzer from the uppermost Walnut Clay of the Mt. Barker section, north-west of Austin (Texas), were obtained through the courtesy of R. Wright Barker, Houston. Thin-sections distinctly show that *Coskininolinoides* and *Coskinolina* are different genera. In *Coskinolinoides,* the saucer-shaped, usually slightly deformed chambers generally extend more or less continuously across the test. In other words, there is no clearly outlined central portion with a distinct pillar structure (labyrinthic core) such as is typical of *Coskinolina.* Only a vague vertical zone ("chimney") may occasionally interrupt the adult uniserial chambers in the center but true pillars are lacking in all thin-sectioned specimens. *Coskinolina* thus consists of a relatively thin outer layer of regular chambers (marginal trough) which reach inwards from the periphery and envelop usually a well-delineated core of labyrinthic cellules (pillar structure). In *Coskinolinoides,* on the other hand, such a central mass of irregular elements is completely absent, the chambers extend from the sides of the cone across the center, being only subdivided by a few vertical, often irregular partitions.

In 1944, R. Wright Barker described *Coskinolina adkinsi* Barker, 1944, from the same locality and stratigraphic level (Barker, 1944). The sporadically present vertical plate subdividing the peripheral chambers is clearly recognizable on the horizontal section of *Coskinolina adkinsi* figured by R. W. Barker (*loc.cit.,* pl. 35, fig. 2) and by F. E. Lozo (1944, pl. 5, figs. 5,6); such short vertical partitions (semi-septa) are often lacking. The vertical pillars "are not well developed in any of the sections made, and in most can best be described as rudimentary to absent; they are, perhaps, better regarded as buttresses, kidney-shaped or semilunar in cross section near their base" as described by Davies (Barker, 1944, p. 207).

According to the given descriptions, *Coskinolinoides texanus* Keyzer and *Coskinolina adkinsi* Barker cannot be differentiated. That *Coskinolinoides texanus* Keyzer "looks very much like" *Coskinolina adkinsi* Barker had already been stressed by F. R. S. Henson (Henson, 1949, p. 175). Judging from the available figures, the writer became convinced of the obvious synonymy of *Coskinolinoides texanus* and *Coskinolina adkinsi* the more so as both forms were collected in outcrops of the Lower to Middle Albian Walnut formation, northwest and west of Austin, Texas (section Mt. Barker). In a letter dated January 19, 1954, to R. Wright Barker, the writer pointed out this identity and inquired whether or not this synonymy had been placed on record in some publication. R. Wright Barker, too, had realized that both species were synonyms (letter of January 25, 1954). The same conclusion had also been reached independently by Louise Jordan (letter dated May 11, 1954) and is fully endorsed by F. G. Keyzer. There is thus no doubt as to the synonymy between *Coskinolinoides texanus* Keyzer, 1942, and *Coskinolina adkinsi* Barker, 1944. According to the law of priority the name *Coskinolina adkinsi* should be dropped in favor of *Coskinolinoides texanus.* The same conclusion was drawn recently by Donald L. Frizzell (Frizzell, 1954, p. 76).

Since *Coskinolinoides texanus* Keyzer lacks the horizontal plates in the marginal chamberlets and shows very poorly developed central pillars if any, it can easily be differentiated from another Lower Cretaceous form, *Dictyoconus walnutensis* (Carsey). The conical test of *Coskinolinoides texanus* is, moreover, much smaller than that of *Dictyoconus walnutensis,* as it shows a base of only 0.325-0.45 mm. and a height of 0.30-0.45 mm. or an average value of 0.39 mm. for both basal diameter and height of cone (compare the dimensions of *Dictyoconus walnutensis,* table on p. 88).

The genus *Dictyoconus* has radial septa and primary vertical plates like *Coskinolina* but, unlike the latter, also may show several secondary subepidermal septula (major and minor vertical plates) which subdivide the peripheral chambers into chamberlets. In *Dictyoconus,* the marginal chambers are, moreover, subdivided by horizontal (transversal) partitions (pigeon-hole structure) which are not developed in *Coskinolina.* The apertural pores are irregularly distributed on the base. In both *Dictyoconus* and *Coskinolina,* vertical pillars connect the floors and roofs of the saucer-shaped chambers. Accordingly, the two genera are readily distinguished by means of thin-sections through or parallel to the axis of the conical tests. The presence of one (or more) horizontal short lamella which projects inward from the sub-epidermis (subdivision into two or more cellules) is, therefore, diagnostic of the genus *Dictyoconus.* This subdivision of the sub-epidermal layer by one or more horizontal plate also gives the clue for separating different species of the genus: While *Dictyoconus walnutensis* (Carsey), *D. arabicus* Henson, and *D. cookei* (Moberg) show but one single horizontal subdivisional plate in each marginal chamber, axial sections of the representatives of the group *D. americanus* (Cushman) disclose additional sub-epidermal plates, thus forming several cellules or pigeon-holes in each chamberlet.

D. cookei (Moberg) from the middle Eocene of Florida does not differ structurally from the Lower Cretaceous species *D. walnutensis* (Carsey); both forms are more primitive than those of the group of *D. americanus* in so far as they have only one single horizontal plate developed which subdivides the marginal chamberlets. *D. cookei* is, however, larger in size than *D. walnutensis* (Cole, 1941, p. 26), its base attaining an average diameter of 2.22 mm. and its cone showing an average height of 1.6 mm. (minimum values 1.6 and 1.3 mm., respectively).

The only hitherto known *Coskinolina*-like forms which lack the pillar structure of the central portion as well as the horizontal sub-epidermal plate are *Coskinolinoides* Keyzer, 1942, and *Orbitolinopsis* Silvestri, emend. Henson, 1948. *Coskinolinoides* differs from the inadequately known genus *Orbitolinopsis* in showing a rather coarse interior structure; its primary chambers are almost continuous so that the central portion with incipient pillars is very narrow (see Barker, 1944, pl. 35, figs. 1, 3). Occasionally, there is no trace of such a central portion (see Keyzer, 1942, p. 1017, text fig. d; see topotype specimens figured in the present paper). In *Orbitolinopsis,* the central zone is broad. In *Coskinolinoides,* the uniserial primary chambers are more or less horizontal, in *Orbitolinopsis* they are saucer-shaped. The very small test of *Coskinolinoides* has an acute cone, while that of the few known representatives of *Orbitolinopsis* is broad.

The genus *Orbitolinopsis* is still poorly known and a final diagnosis has not yet been given. In horizontal sections, it shows a peripheral ring of chambers which are divided by one single vertical plate like *Coskinolina.* Horizontal sub-epidermal plates are not developed, and vertical pillars in the center are absent. According to F. R. S. Henson, the central part (*reticulum*) in *Orbitolinopsis* is formed by an irregular interseptal network where the meshes are connected by stolons (Henson, 1948, p. 67). R. Ciry and P. Rat, on the other hand, maintain that the reticulum of *Orbitolinopsis* shows a radial structure due to the coalescence of the main septa in the central part (Ciry and Rat, 1953, p. 93).

The poorly known genus *Iraqia* Henson, 1948, with the genotype *I. simplex* Henson from the Lower-Middle Cretaceous of Iraq and Iran, appears to have features of both *Dictyoconus* and *Orbitolina.* By having primary radial partitions and usually one single horizontal plate in adult chambers, *Iraqia* evidently possesses the same structural features as *Dictyoconus walnutensis.* A morphological difference is, however, the character of the central shield: In *Iraqia,* the *reticulum* is formed by irregular interseptal partitions (as in *Orbitolinopsis*), in *Dictyoconus* by vertical pillars.

According to F. R. S. Henson, the genera *Iraqia* and *Orbitolinopsis* are closely related but *Iraqia* has horizontal sub-epidermal plates which are absent in the latter genus (Henson, 1948).

The recently erected genus *Simplorbitolina* Ciry and Rat, 1953, from the Aptian-Albian of the Pyrenees, shows radial vertical plates that subdivide the saucer-shaped uniserial chambers (marginal trough). In the inframarginal zone, these thin straight main partitions suddenly thicken inward, become irregularly undulate, and merge near the central shield (reticulum). Because of the coalescence of these radiate septa, the reticulum displays a distinctly stelliform structure similar to *Orbitolina.* Between the vertical plates which reach into the central portion, are discontinuous intermediate septula (semi-septa) which only form a partition in the peripheral zone (marginal chamberlets). Two or three septula subdivide the juvenile secondary chamberlets whereas only one semi-septum is generally present in the adult.

Simplorbitolina lacks the horizontal (transverse) septa or septula which are present in *Dictyoconus* and *Orbitolina.* It also lacks the central pillars between floor and ceiling of the chambers which are a characteristic feature in *Dictyoconus* and *Coskinolina.* The apertural perforations are located between the radial septa. *Simplorbitolina* is, in other words, an *Orbitolina* where the horizontal plates of the peripheral chamberlets are absent.

Transverse sections of the recently established genus *Fallotella* Mangin, 1954, with *F. alavensis* Mangin, 1954, from the Paleocene-Eocene of Spain as genotype, show radiate septa which usually alternate with short semi-septa (vertical plates of the marginal ring) (Mangin, 1954). In horizontal sections, *Fallotella* thus resembles *Coskinolina, Coskinolinoides,* or a primitive *Dictyoconus;* it differs from *Coskinolinoides,* however, in having a well-developed pillar structure of the central portion. Axial sections of *Fallotella* disclose a simple *Coskinolina* structure (lack of horizontal plates in the marginal chamberlets, presence of pillars in the center). Accordingly, the horizontal section of *Fallotella* is that of *Coskinolina* (or of a simple *Dictyoconus*) and the axial section also bears the true characters of *Coskinolina.* In the writer's opinion, the general status of *Fallotella* is, therefore, not justified, the more so as there also exists close agreement with regard to the size of the tests and the stratigraphic level of both *Coskinolina* and *Fallotella.* The argument that the apertural opening in *Fallotella* are arranged in a linear pattern (Mangin, 1954, pl. 3, fig. 1a) whereas the circular perforations in *Coskinolina* are distributed at random, is open for debate. It is by no means difficult to line up the openings near the center in *Coskinolina* in rows (compare, *e.g.*, Cole, 1941, pl. 4, fig. 7; Cole, 1942, pl. 5, fig. 4). Yet even in case such a different arrangement of the perforations in *Coskinolina* and *Fallotella* holds true, a generic differentiation is hardly warranted on this basis, rather an assignment to different species (compare *Dictyoconus walnutensis* and *D. arabicus*).

GEOGRAPHIC AND STRATIGRAPHIC DISTRIBUTION OF *DICTYOCONUS WALNUTENSIS* (Carsey)

Dictyoconus walnutensis (Carsey) has hitherto been recorded from the Lower Cretaceous of the Gulf Province (Texas, Mexico) and from the Tethys region of the Old World (France, Iran). It has probably been found at many other localities in these provinces but to the best of the writer's knowledge such occurrences have not been placed on record. The author was, for instance, informed by the late Donald W. Gravell and by F. G. Keyzer that *Dictyoconus walnutensis*-bearing limestones, as well as others carrying *Coskinolinoides texanus* Keyzer, crop out in central Jaronú and in the Cordillera Central, Cuba, stratigraphically above the levels with *Choffatella decipiens* Schlumberger and *Orbitolina concava-texana* (Roem.).

With regard to North America, *D. walnutensis* is generally believed to be restricted to the Comanche Peak and Edwards limestones (Middle Albian) of Texas (Barker, 1944; Lozo, 1944). It was recently recorded by L. F. Stead from the upper half of the Glen Rose formation of central Texas, with its acme at the very top of the formation, just below the Walnut clay. Externally, the two figured specimens (Stead, 1951, pl. II, figs. 26-27) certainly look very similar to *Dictyoconus* but since no sections are published, which alone would prove that these Glen Rose specimens actually belong to *D. walnutensis* (Carsey), the presence of this species in the Glen Rose marls should be accepted with reservation.

The specimens of *Dictyoconus walnutensis* (Carsey), reported from a Lower Cretaceous limestone drilled in the well Cory-1, Monroe County, Florida (Campbell, 1939; Applin and Applin, 1944) should actually be referred to *Coskinolinoides texanus* Keyzer (*teste* Louise Jordan, letter to the writer).

Up to this date, *D. walnutensis* (Carsey) has not been found by the writer in formations below or above the basal Guácharo limestone (Chimana formation) of Eastern Venezuela (*Dictyoconus* zone) to which a Middle Albian age is assigned (Rod and Maync, 1954). No specimens have as yet been observed in the corresponding beds of West Venezuela.

In France, *D. walnutensis* (Carsey) is recorded from Valanginian limestones where it is said to be associated with *Pseudocyclammina lituus* (Yok.) Yabe and Hanzawa and *Pfenderina neocomiensis* (Pfender, 1938, p. 232). It must be stressed, however, that the typical specimens of *Pseudocyclammina lituus* (Yok.) Yabe and Hanzawa, figured by J. Pfender on plate XIII, were not obtained from any of the localities that have yielded the specimens of *Dictyoconus walnutensis* shown on her plate XIV, figs. 1-4 (J. Pfender's figure 1 is reproduced in the present paper as fig. 9, Pl. 14). On the other hand, the same foraminiferal association was recently recorded from subsurface beds of supposed Valanginian age of the Aquitaine region, France(Cuvillier and Debourle, 1954, p. 76). From a well near Orthez, these authors describe a detrital limestone carrying "*Dictyoconus* aff. *walnutensis* Carsey, *Choffatella* sp., *Pseudocyclammina lituus* Yabe et Hanzawa, *Coscinoconus* sp., probablement avec des rares *Eorupertia* sp. et quelque Clypéines" (*loc.cit.*). This limestone is reported to overlie Upper Jurassic limestones (with *Pseudocyclammina* aff. *kelleri* Henson, *Choffatella* sp.) and is superseded by the *Orbitolina*-bearing "Ste. Suzanne marls" (*Orbitolina conoidea-discoidea, O. lenticularis*) which are referred to the ?Middle Aptian. The above-mentioned faunule with *Dictyoconus* aff. *walnutensis* etc. is, in our opinion, not of such a diagnostic value that it positively indicates Neocomian (Valanginian), but since it was found to occur 350-400 m. below the lowermost *Orbitolina* beds of the "Ste. Suzanne marls," a pre-Aptian age (Neocomian-Barremian) of this *Dictyoconus*-bearing limestone is likely. Thanks to J. Cuvillier, the writer had an opportunity to make a first-hand examination of thin-sections. There is hardly any doubt that the specimens of *Dictyoconus* belong to *D. walnutensis* (Carsey), and especially their association with *Clypeina* speaks in favor of a Neocomian age.

Dictyoconus walnutensis (Carsey) also occurs in Urgonian limestones of Switzerland.

D. walnutensis (non-diagnostic section) is also figured from Aptian-Albian beds of Sepaieh, Iran (Pfender, 1938, Pl. XV, fig. 7).

Specimens of *D. walnutensis* are illustrated from the rudistid-bearing limestone of Cerro Escamela, Mexico (Pfender, 1938, pl. XV, figs. 1-3). The Escamela limestone is supposed to represent Cenomanian and Turonian (Pfender, 1938; Imlay, 1944). Such an age assignment is, however, hardly final, as the assumed Cenomanian marker of rudistids, *viz., Coalcomana ramosa* (Boehm), was also found to be accompanied by true Albian faunas in other parts of Mexico. Furthermore, the Escamela limestone contains *Orbitolina*-bearing levels (Aptian-Albian). Based on the occurrence of *D. walnutensis* in Albian beds of Texas, Cuba, and Venezuela, it seems warranted to assume approximately the same age for the horizon with *D. walnutensis* within the Escamela limestone of Mexico.

The presence of *Dictyoconus* in the El Abra and Tamabra limestones of largely Albian age of Mexico was recently recorded by E. Lopez Ramos (Lopez Ramos, 1954).

The specimen referred to *Dictyoconus* (*walnutensis*) from Xiliatl, State of San Luis Potosí, Mexico, observed in a limestone of supposed Turonian-Cenomanian age (Pfender, 1938, Pl. XV, fig. 4) appears to represent a *Coskinolina* of the "*Coskinolina S*" type as found in Florida and Eastern Venezuela.

With regard to the Western Hemisphere, *Dictyoconus walnutensis* (Carsey) thus occurs in beds of Albian (Fredericksburg) age (Texas, Mexico(?), Cuba, Venezuela). In the Old World (Tethys province), the species seems to have appeared earlier since it is recorded from the Aptian-Albian (Iran) and from pre-Aptian (?Valanginian) limestones of France.

REFERENCES

Almela, A., 1946, Una nueva especie de "Dictyoconus" del Cenomaniense valenciano. Inst. Geol. Min., España, Notas y Comun., Madrid, no. 16, p. 151-156.

Applin, P. L. and Applin, E. R., 1944, Regional subsurface stratigraphy and structure of Florida and southern Georgia. Am. Assoc. Petr. Geol., Bull., vol. 28, no. 12, p. 1673-1753.

Barker, R. W., 1944a, Some Larger Foraminifera from the Lower Cretaceous of Texas. Journ. of Pal., vol. 18, no. 2 (March), p. 204-209.

Barker, R. W., 1944b, Some Larger Foraminifera from the Lower Cretaceous of Texas: Corrections. Journ. of Pal., vol. 18, no. 4 (July), p. 416.

Campbell, R. B., 1939, Outline of the Geological History of Peninsular Florida, Proc. Florida Acad. Sci., vol. 4.

Carsey, D. O., 1926, Foraminifera of the Cretaceous of central Texas. Texas Univ. Bull. No. 2612, p. 1-56.

Ciry, R. and Rat, P., 1953, Description d'un nouveau genre de Foraminifère, *Simplorbitolina manasi* nov. gen., nov. sp. Bull. Scientif. de Bourgogne, vol. 14, (1952-53), Dijon, p. 85-100.

Cole, W. Storrs, 1941, Stratigraphic and paleontologic studies of wells in Florida. State of Florida, Dept. Conserv., Geol. Survey, Geol. Bull. no. 19, Tallahassee.

Cole, W. Storrs, 1942, Stratigraphic and paleontologic studies on wells in Florida. No. 2. *Ibidem,* Geol. Bull. no. 20.

Cole, W. Storrs, 1944, Stratigraphic and paleontologic studies of wells in Florida. No. 3. *Ibidem,* Geol. Bull. no. 26.

Cole, W. Storrs, 1945, Stratigraphic and paleontologic studies of wells in Florida. No. 4. *Ibidem,* Geol. Bull. no. 28.

Cole, W. Storrs and Gravell, D. W., 1952, Middle Eocene Foraminifera from Peñon Seep, Matanzas Province, Cuba. Journ. of Pal., vol. 26, no. 5, p. 708-725.

Cushman, J. A., 1937, A Monograph of the foraminiferal Family Valvulinidae. Cushman Lab. for Foram. Res., Special Pub. No. 8.

Cushman, J. A., 1947, A supplement to the Monograph of the foraminiferal Family Valvulinidae. *Ibid.,* Special Publ. No. 8-A.

Cuvillier, J. and Debourle, R., 1954, Découverte du Jurassique terminal et du Néocomien en Aquitaine occidentale et méridionale. Soc. Géol. France, compte rend. somm., no. 4, p. 75-76.

Davies, L. M., 1930, The genus *Dictyoconus* and its allies: A review of the group, together with a description of three new species from the Lower Eocene beds of northern Baluchistan. Roy. Soc. Edinburgh, Trans., vol. 56, p. 485-505.

Davies, L. M., 1939, An earlier *Dictyoconus* and the genus *Orbitolina*: their contemporaneity, structural distinction, and respective natural allies. *Ibidem,* vol. 59, p. 773-790.

Frizzell, Don. L., 1949, Rotalid Foraminifera of the Chapmanininae: Their natural distinction and parallelism to the *Dictyoconus* lineage. Journ. of Pal., vol. 23, no. 5, p. 481-495.

Frizzell, Don L., 1954, Handbook of Cretaceous Foraminifera of Texas. Univ. of Texas, Bureau of Econ. Geol., Rep. of Investig., No. 22, June, 1954, p. 1-232.

Garfias, R. V. and Chapin, Th. C., 1949, Geología de Mexico. Editorial Jus, México.

Henson, F. R. S., 1948, Larger Imperforate Foraminifera of South-Western Asia. Brit. Mus. Nat. Hist., London.

Henson, F. R. S., 1949, Recent Publications on Larger Imperforate Foraminifera of the Middle East. Ann. and Mag. Nat. Hist., London, ser. 12, vol. ii, p. 173-177.

Imlay, R. W., 1944, Cretaceous formations of Central America and Mexico. A.A.P.G., Bull., vol. 28, no. 2, 1077-1195.

Kent, P. E., Slinger, F. C., and Thomas, A. N., 1951, Stratigraphical exploration surveys in southwest Persia. Proc. Third World Petr. Congr., sect. I (geol.), The Hague, p. 141-161.

Keyzer, F. G., 1942, On a new genus of arenaceous Foraminifera from the Cretaceous of Texas. K. Nederl. Akad. Wetensch., Proc., Amsterdam, vol. 45, no. 10, p. 1016-1017.

Lopez, Ramos, E., 1954, Distribución de la porosidad en las calizas del Cretácico Medio de la región de Tampico-Poza Rica, Veracruz. Congr. Géol. Internat., 19a sess., Compte rendus. Alger, 1952, sect. XII, fasc. xiii p. 293-312.

Lozo, F. E., 1944, Biostratigraphic relations of some North Texas Trinity and Fredericksburg (Comanchean) Foraminifera. The Americ. Midland Nat., vol. 31, no. 3, p. 513-582.

Mangin, J-Ph., 1954, Description d'un nouveau genre de Foraminifère: *Fallotella alavensis.* Bull. Scientifique de Bourgogne, vol. XIV, 1952-1953, pp. 209-219.

Maync, W., 1953, *Pseudocyclammina hedbergi* n.sp. from the Urgo-Aptian and Albian of Venezuela.. Contrib. Cushman Found. for Foram. Res., vol. IV, pt. 3, p. 101-103.

Pfender, J., 1938, Les Foraminifères du Valanginien Provençal. Géol. Soc. France, Bull., vol. 8, p. 231-242.

Rod, E. and Maync, W., 1954, Revision of Lower Cretaceous Stratigraphy of Venezuela. A.A.P.G., Bull., vol. 38, no. 2, p. 193-283.

Stead, L. F., 1951, Foraminifera of the Glen Rose formation (Lower Cretaceous) of Central Texas. The Texas Journ. of Sci., vol. III, no. 4, p. 577-605.

CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH

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135. AN UNUSUAL FEATURE OF MILIOLID REPRODUCTION[1]

ZACH M. ARNOLD
Museum of Paleontology, University of California at Berkeley

DISCUSSION

Students of the Foraminifera have long believed that with the apportionment of the parental protoplasm to the offspring during asexual reproduction the parent's existence as a living creature is terminated. Lister, in his classical studies on *Elphidium crispum* (*Polystomella crispa*) (1895) determined that the megalospheric young were produced by "multiple fission of the whole of the protoplasm of the parent." Swarczewsky (1909) concluded that asexual reproduction terminated the life of individual *Allogromia ovoidea,* an observation extended to *Allogromia laticollaris* by Arnold (1948); Føyn (1936) reached the same conclusion after a study of another primitive foraminifer *Myxotheca arenilega.* A similar fate for the parental organism following asexual reproduction is obvious from an examination of Myers' illustrations of *Patellina corrugata's* life cycle (1935) and, although not stated, can certainly be inferred from his account of the life cycle of *Spirillina vivipara* (1936). In a later paper (1940) the same author observed that although small "anucleate masses of cytoplasm remain" inside the parental test following multiple fission these masses are subsequently eaten by the developing young and are, therefore, of no further significance in the animal's life cycle. Le Calvez, in a text-book summary of his experiences in the study of foraminiferan biology, remarked that "L'abandon ou la dissolution du test maternel est une règle absolue" (1953, p. 182).

During an early stage in the writer's current investigation of the biology of a small and highly variable miliolid from La Jolla, California, individual parents were found to produce not one, but two—and possibly more—broods of young before their own existence ceased. The original samples, collected by Mr. Jack Bradshaw of the Scripps Institution of Oceanography at La Jolla, California, were taken from a depth of 20 fathoms during the month of January, 1953.

Laboratory populations derived from the La Jolla miliolids have been maintained for two years by the writer through the use of previously described methods (Arnold, 1954). In January, 1955, a series of isolation cultures was established in which a marine species of *Chlamydomonas* was used as the principal food source, according to the procedure mentioned recently by Grell (1954) in his studies on *Rotaliella heterocaryotica.* It is upon the study of these isolation cultures that the present observations are based.

Individual Foraminifera that were to be isolated were placed in specially designed isolation rings which were in turn mounted in 5-inch petri dishes flooded with sea water to reduce evaporation from the isolation rings. The rings themselves were prepared by cutting segments from 15 mm. glass vials and cementing the finished segments to the bottom of the petri dishes with araldite cement, a non-nutritive, waterproof cement that must be cured for one hour at or above 180°C. before satisfactory bonding occurs.

The first indication of any unusual parental potentialities during or associated with the reproductive period came with the observation that the protoplasmic contents of the tests of parents which had already reproduced remained orange-brown in color rather than turning grey or white as is usual in species possessing such post-reproductive residua. The first few such cases were dismissed as representing forms which merely had an excess of residual protoplasm, but as additional examples appeared a closer examination seemed desirable and showed that the tests were not only practically filled with protoplasm, but that the protoplasm itself was still perfectly normal in appearance and still quite capable of the intra-test cyclosis which is so characteristic of the species in its vegetative phase. The proloculus and inner chambers, as well as the outer chambers of most of the specimens so examined contained actively surging protoplasm. Such animals, when returned to isolation cultures and supplied with food, began feeding normally and appeared to resume all the usual activities of a vegetative form, no longer giving

[1] A contribution from the Museum of Paleontology of the University of California at Berkeley.

any evidence of their earlier reproductive activity.

These preliminary observations had barely been completed when isolation cultures developed in which two distinct size classes of young appeared in association with a single, much larger parent. In such cases a dozen or so young measuring 80 to 100 microns in length occurred in association with an approximately equivalent number of young measuring only 20 to 40 microns. The larger young represented an advanced stage in development and generally possessed four or more chambers, whereas the young of the second brood typically exhibited only two or three chambers. In an effort to explain the significance of this phenomenon, parents which had recently produced young in isolation were transferred to new isolation chambers, after a detailed microscopical examination failed to disclose additional embryonic young in association with the parental test or its contained protoplasm. Several parents so isolated have subsequently produced a second brood of young, and it now appears that the process is not an unusual occurrence at all but a characteristic feature of the species' asexual reproductive activities. The time interval between the appearance of succesive broods has already been observed to range between three days and four weeks, but an extension of this range seems highly probable as additional culture data accumulate. Reproductive maturity is, in many cases, reached when the individual is only 90 microns in length, and the ability to reproduce its kind apparently remains until death intervenes.

The young miliolids are produced not in the terminal parental chambers, as has been so often thought, but rather in a cyst-like algal mass which is gathered about the parent's mouth through the highly effective efforts of the animal's own pseudopodia. It is into this cyst-like agglomeration of algae and other debris that the surging parental protoplasm flows, and it is within this same incubation chamber that the parental protoplasmic mass breaks down into discrete protoplasmic bodies around which a test is later secreted. The production of young from the breakdown of a parental syncytium within an external incubation chamber has been described in such multiloculine species as *Spirillina vivipara* (Myers, 1936), *Patellina corrugata* (Myers, 1935) and *Tretomphalus bulloides* (Myers, 1943).

The introduction of more than one reproductive period into the vegetative life of a single individual is an interesting phenomenon in itself and an unusual occurrence within an Order in which reproduction normally terminates the individual's life. It may be of some evolutionary significance that an attribute not commonly encountered along the lower reaches of the phylogenetic scale is developed in this miliolid, and it seems likely that additional information to be gained from continuing experimental comparisons of individuals from successive broods may yield additional data of interest and value to students of the Foraminifera.

At the present time, however, the process is being exploited in the attempted solution of a perplexing taxonomic problem; that of determining whether this small and highly polymorphic miliolid can be assigned to a single existing genus, or whether, because of ontogenetic complications, it can be straight-jacketed into no existing generic pigeonhole and must await further investigation before it can finally come to rest in a suitable taxonomic niche. The need for a satisfactory taxonomic definition of this species arose with the appearance of large populations of a second miliolid in comparable isolation cultures. This latter miliolid, a warm-water species from the littoral waters of the Gulf of Mexico in the vicinity of Panama City, Florida, must, because of marked morphological similarities with the California species, be studied in similar detail before a reliable basis for distinguishing it from its cold-water counterpart can be demonstrated. Any reasonably accurate taxonomic designation for either species must await an explanation of the ontogenetic changes exhibited by each as well as a detailed description of morphogenetic variations in the animals' tests. The results of current studies of these and related problems will be published in the near future.

REFERENCES

Arnold, Z. M., 1948, A new foraminiferan belonging to the genus *Allogromia*. Trans. Amer. Micro. Soc. 67(3): pp. 231-235.

Arnold, Z. M., 1954, Culture methods in the study of living Foraminifera. Journ. of Pal., vol. 28, pp. 404-416.

Føyn, B., 1936, Ueber die Kernverhältnisse der Foraminifere *Myxotheca arenilega* Schaudinn. Arch. f. Protist., vol. 87, pp. 272-295.

Grell, K. G., 1954, Der Generationswechsel der polythalamen Foraminifere *Rotaliella heterocaryotica. Ibid,* vol. 100, pp. 268-298.

Le Calvez, J., 1953, Ordre des Foraminifèes. In Grassè, P. Traité de Zoologie, vol. 1, Fasc. 2, pp. 149-265.

Lister, J. J., 1895, Contributions to the life-history of the Foraminifera. Phil. Trans. Roy. Soc. London, B, vol. 186, pp. 401-453.

Myers, E. H., 1935, The life history of *Patellina corrugata*. Bull. Scripps Inst. Oceanography, Tech. Ser., vol. 3, pp. 355-392.

Myers, E. H., 1936, The life-cycle of *Spirillina vivipara* Ehrenberg, with notes on morphogenesis, systematics and distribution of the Foraminifera. Journ. Roy. Micro. Soc., vol. 56, pp. 120-146.

Myers, E. H., 1940, Observations on the origin and fate of flagellated gametes in multiple tests of *Discorbis* (Foraminifera). Journ. Mar. Biol. Assoc. United King., vol. 24, pp. 201-226.

Myers, E. H., 1943, Biology, Ecology and Morphogenesis of a Pelagic Foraminifer. Stanford. Univ. Publ. Biol. Sciences, vol. 9, pp. 3-30.

Swarczewsky, B., 1909, Zur Kenntniss der *Allogromia ovoidea* (Rhumbler). Arch. f. Protist., vol. 14, pp. 396-413.

CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
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136. UPPER CRETACEOUS ORBITOIDAL FORAMINIFFERA FROM CUBA

PART IV. RHABDORBITOIDES, N.GEN.

P. BRONNIMANN
Habana, Cuba

INTRODUCTION

A new pseudorbitoid, possibly representative of a new genus, was mentioned by the writer (Bronnimann, 1955, p. 57) in his paper on *Pseudorbitoides* H. Douvillé. This form was subsequently found in Upper Cretaceous limestones in Las Villas and Oriente provinces, Cuba. The morphologic analysis showed that it does, in fact, represent a new pseudorbitoid genus, for which the name *Rhabdorbitoides* n.gen. is proposed. *Rhabdorbitoides* n.gen. is monotypic; the genotype is *R. hedbergi,* n.sp.

Rhabdorbitoides, n.gen. is a morphologically advanced pseudorbitoid genus with a complex equatorial layer. Like *Vaughanina* Palmer it is a specialized and stratigraphically significant end-form. The orbitoidal test, the symmetric uniserial juvenarium and the early neanic two layers of alternating rods suggest that *Rhabdorbitoides,* n.gen. is not directly related to *Sulcoperculina* Thalmann, but to *Sulcorbitoides* Bronnimann or an ancestral form of *Pseudorbitoides, s.s.* On the other hand, *Sulcorbitoides* is regarded as derived from *Sulcoperculina,* which is a morphologically plastic group of Upper Cretaceous larger rotaliids. It evolved independently of its *Pseudorbitoides* off-shoots and arrived at similar complex structures in the development of the radial rods as *Rhabdorbitoides,* n.gen.

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The described material has been collected by M. Kozary, Habana, in the Gibara area, Oriente Province, and by P. Truitt and H. Wassall, geologists of Gulf Oil Corporation, Habana, in the course of field work in Las Villas Province. The original samples are in the collection of M. Kozary and of Cuban Gulf Oil Company, Habana. Holotype and figured thin sections will be deposited in the U.S. National Museum, Washington, D.C., U.S.A.

TERMINOLOGY

Equatorial layer, lateral layers.—Equatorial layer and lateral layers are herein used in their general meaning. They are applied to the three parts into which the orbitoidal test can be divided, without implying a specific type of internal structure.

Vertical radial plates, radial rods.—In the previous notes on pseudorbitoids (Bronnimann 1954a, b; 1955) the term "vertical radial plates," or "radial plate," denotes the fundamental structural element of the equatorial layer. It is rod-like and short in *Sulcoperculina* and *Sulcorbitoides,* plate-like with median bifurcations in *Vaughanina,* and plate-like with peripheral deformations in *Pseudorbitoides.*

The term "radial rod" will be applied henceforth to the structural element of the equatorial layer of *Sulcorbitoides* and *Rhabdorbitoides,* n.gen., and the term "radial plate" will be restriced to the real plate-like radial element of the equatorial layer of *Vaughanina* and of *Pseudorbitoides.* Morphologically, radial rod and radial plate are regarded as homologous.

Superfamily **Orbitoidicae** Schubert, 1920

Family **Pseudorbitoididae** M. G. Rutten, 1935

Genus **Rhabdorbitoides** Bronnimann, n.gen.

Genotype.—Rhabdorbitoides hedbergi Bronnimann, n.sp.

Definition.—The lenticular test is divided into a single equatorial layer and two lateral layers. The juvenarium appears to be uniserial. It is not asymmetric rotaloid as in *Sulcorbitoides.* The neanic stage of the equatorial layer consists of radial rods, arranged in irregular layers and rows, and primary lateral chambers. Near the center, the radial rods are in two systems or layers, separated by a narrow median gap. Toward the periphery, the number of layers or systems of radial rods increases to ten by irregular intercalation of new rods between the two early neanic layers. In the marginal area, regular annular and irregular vertical and diagonal connections exist between the rods, forming a lattice work. There are no annular walls. The equatorial layer is not limited laterally by roof and floor. The primary lateral chambers rest directly on the rods, and are overlain by the secondary lateral chambers which form the lenticular thickening of the test. The lateral chambers are in regular tiers and communicate by basal stolons and fine pores. Pillars are present.

Differential Diagnosis.—*Rhabdorbitoides,* n.gen. differs from *Pseudorbitoides* H. Douvillé and *Vaughanina* Palmer by the radial rods in the later part of the neanic stage of the equatorial layer. It differs from *Sulcorbitoides* Bronnimann, which has throughout the equatorial layer two systems or layers of alternating rods by the increase in the number of layers of rods toward the periphery. *Rhabdorbitoides,* n.gen. is distinguished from all pseudorbitoid genera by the delicate marginal lattice work of the equatorial layer.

Occurrence.—*Rhabdorbitoides,* n.gen. has been found in Las Villas and Oriente provinces, Cuba.

Age.—Upper Cretaceous.

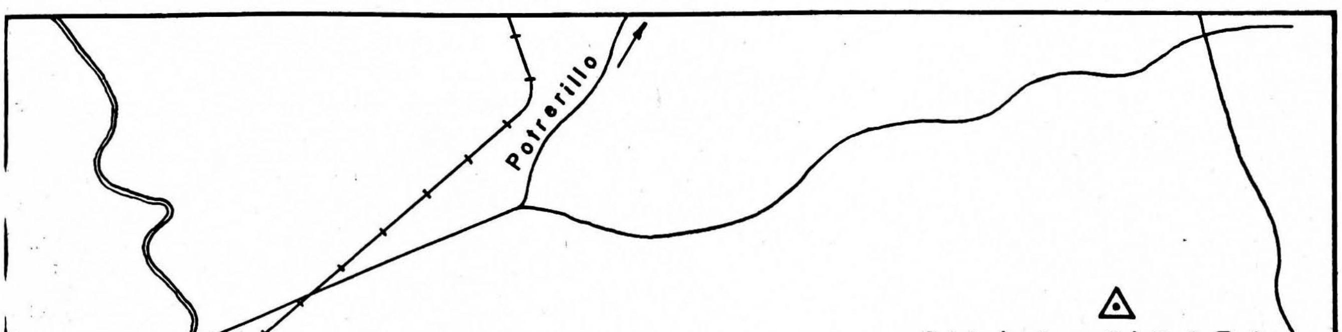
Rhabdorbitoides hedbergi Bronnimann, n.sp.

Plate 15, figures 1-14; text-figures 1-5

Description of material.—The morphologic description of *R. hedbergi,* n.sp. is based on thin sections of fragmental limestones from the following localities in Oriente and Las Villas provinces:

a) *Type locality*

M. Kozary, who collected the type material describes the type locality as follows (see text-fig. 1):



TEXT FIGURE 1

Map of the type locality of *R. hedbergi,* n.sp., Kozary station 50426.

"The type locality K 50426 lies at the Tinajita hill, 2600 m southeast of a small-gauge railroad bridge passing over the Gibara river. The Silla Gibara-Tinajita hills are about 8 km southeast of Gibara, Oriente Province, Cuba."

The Tinajita formation, proposed by Kozary in his manuscript on the geology of the Gibara area, is a "white to buff, well-indurated homogeneous calcarenite containing occasional sand-size igneous fragments, interbedded with calcarenites without igneous fragments." The fragmental limestone displays in thin sections a rich algal-orbitoidal assemblage embedded in a dark gray finely fragmental matrix; pelagic Foraminifera are rare. The assemblage seems to be homogeneous both from a lithologic and faunal point of view. It consists of:

Rhabdorbitoides hedbergi, n.sp.
Pseudorbitoides israelskyi Vaughan and Cole
Sulcoperculina cf. *S. vermunti* (Thiadens)
Sulcoperculina sp.
Globotruncana lapparenti tricarinata (Quereau)
Gümbelina cf. *G. globulosa* (Ehrenberg)
Globigerina ex gr. *cretacea* (Ehrenberg)
Globigerinella sp.
Oligostegina spp.
Algae, mollusk and echinoderm fragments.

b) *Other localities*

1. *Kozary stations* 50453 and 51476

The texture of the thin sections from two additional Kozary stations 50453 and 51476, Gibara area, Oriente Province, is more coarsely fragmental than that of the type sample. The pseudorbitoids and other fossil remains are usually coated with a thin layer of dark gray, dense material. A worn specimen of *Sulcorbitoides pardoi* Bronnimann and the coated organic fragments possibly suggest a heterogeneous composition of the faunas from these two localities.

2. *Locality* L 415

The geographic and geologic situation of locality L 415 is shown in M. G. Rutten's (1936, p. 45, fig. 12) geologic map of part of the road between Camajuaní and Falcon, Las Villas Province. Two thin sections from locality L 415, Nos. 14421 and 14423 of the collections of the Geol. Min. Institute of the University of Utrecht, show an algal-orbitoidal limestone with finely fragmental, in places recrystallized matrix, and rare igneous grains. Some of the orbitoidal Foraminifera have a thin coating of dark gray material, similar to that observed in Kozary stations 50453 and 51476. The assemblage is composed of:

Torreina torrei Palmer
Rhabdorbitoides hedbergi, n.sp.
Sulcoperculina cf. *S. vermunti* (Thiadens)
Sulcoperculina sp.
Orbitocyclina sp. or *Lepidorbitoides* sp.
Globotruncana lapparenti tricarinata (Quereau)
Globotruncana ex gr. *lapparenti* Brotzen
Globotruncana cf. *G. stuarti* (de Lapparent)
Oligostegina spp.

3. *CUGOC Ser. No.* 13958 (Cuban Gulf Oil Co. Collection)

Thin sections from CUGOC Ser. No. 13958, Malpaëz-Chinchilla traverse, Las Villas Province, are from an orbitoidal-algal limestone, with gray finely fragmental matrix. Some of the Foraminifera are enveloped by a thin layer of dark gray dense material. The assemblage consists of:

Torreina torrei Palmer
Rhabdorbitoides hedbergi, n.sp.
Pseudorbitoides israelskyi Vaughan and Cole
? *Vaughanina cubensis* Palmer
Orbitocyclina sp. or *Lepidorbitoides* sp.
Sulcoperculina cf. *S. vermunti* (Thiadens)
Sulcoperculina sp.
Globotruncana lapparenti tricarinata (Quereau)
Globotruncana ex gr. *lapparenti* Brotzen
Gümbelina cf. *G. globulosa* (Ehrenberg)
Globigerina ex gr. *cretacea* (Ehrenberg)
Oligostegina spp.
Ostracodes, algae, mollusk and echinoderm fragments.

4. *CUGOC Ser. No.* 23088

CUGOC Ser. No. 23088 is from a large bioherm, 2.5 kilometers northeast of La Rana, on the road from Zaza del Medio to Venega, Las Villas Province. Thin sections show an orbitoidal-algal limestone with finely fragmental matrix, similar to CUGOC Ser. No. 13958. The Foraminifera, however, are not coated. The assemblage contains:

Torreina torrei Palmer
Rhabdorbitoides hedbergi, n.sp.
Sulcoperculina cf. *S. vermunti* (Thiadens)
Sulcoperculina sp.
Pseudorbitoides sp.
Oligostegina spp.

Faunal association and texture of the thin sections listed in the five localities suggest the assemblages of L 415, CUGOC Ser. No. 13958, and possibly also of CUGOC Ser. No. 23088 to be heterogeneous.

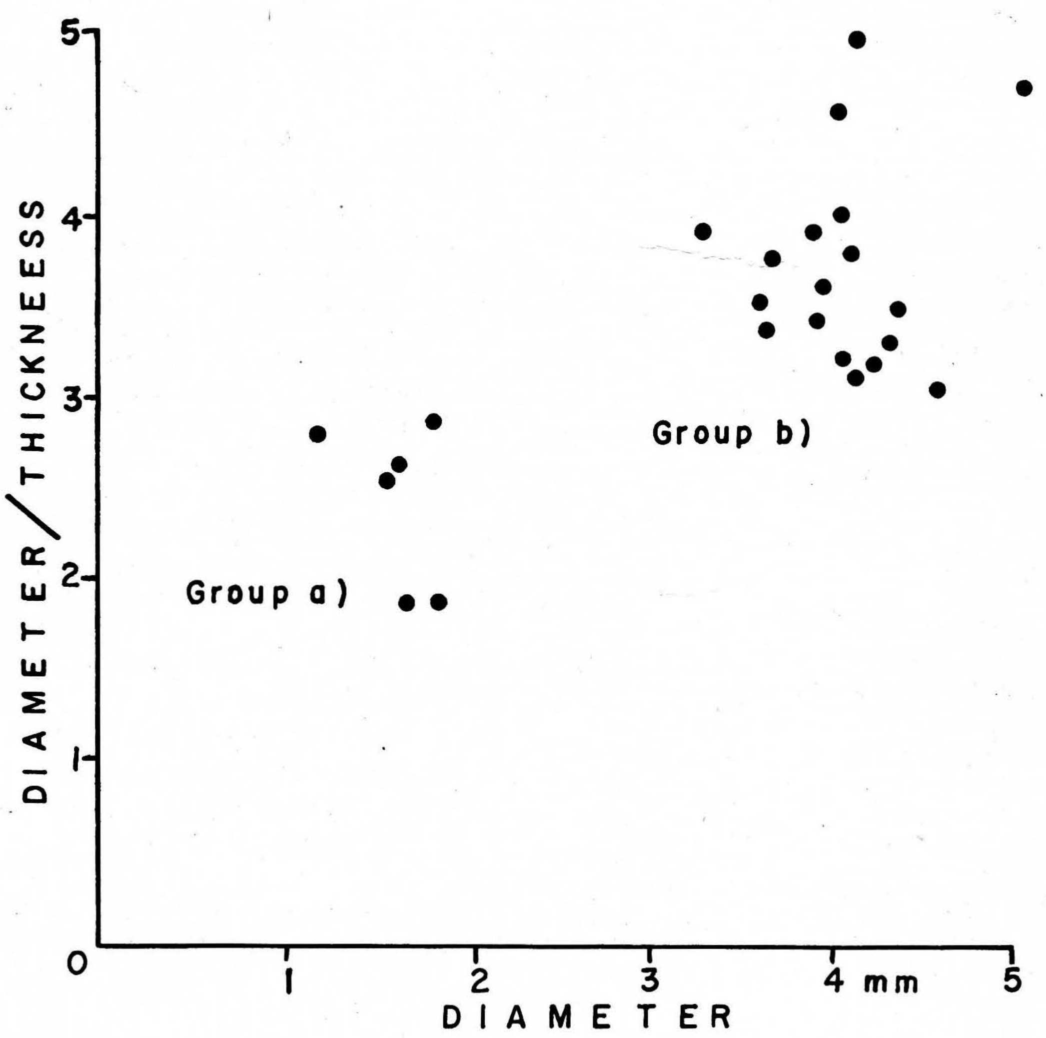
Holotype.—The holotype of *Rhabdorbitoides hedbergi,* n.sp. is the oblique equatorial section of the specimen illustrated by figure 1 of Plate 17, Kozary station 50426, thin section No. 1. The species is named for H. D. Hedberg.

Exterior.—The rock thin sections contain weakly umbonate to almost flat tests. The equatorial layer is thick at the periphery. In large specimens it protrudes as a distinct peripheral flange not covered by lateral chambers (pl. 17, figs. 4, 7). Prominent flanges of similar appearance, but of different internal structure, have also been observed in *Vaughanina cubensis* Palmer and in microspheric specimens of *Pseudorbitoides trechmanni* H. Douvillé (Bronnimann, 1954b; 1955). Pillars are irregularly distributed over the central portion of the test. Their diameters range from 25μ to 130μ, measured at the surface of the test. In the typical population, *R. hedbergi,* n.sp. is associated with *Pseudorbitoides israelskyi* Vaughan and Cole. The dimension diagram (text-fig. 2) distinctly shows two groups of forms. The smaller and relatively thicker individuals of group a) represent *P. israelskyi,* and the larger and relatively thinner individuals of group b) are *R. hedbergi,* n.sp. The diameter of *R. hedbergi,* n.sp. ranges from 2.7 mm. to 5.2 mm., average about 4.0 mm., and the thickness from 0.9 mm. to 1.54 mm., average about 1.2 mm. Its dimensions are similar to those of microspheric specimens of *P. trechmanni* H. Douvillé and *P. rutteni* Bronnimann. The associated specimens of *P. israelskyi* have a diameter of 1.3 mm. to 1.8 mm. and a thickness of 0.4 mm. to 1.1 mm.

Interior.—

1. *Equatorial section*

The equatorial sections of the juvenaria are oblique throughout and do not afford a clear view of embryonic and nepionic chambers. Equatorial sections of the center are illustrated by Pl. 15, figs.



TEXT FIGURE 2

Dimension diagram of *R. hedbergi,* n.sp. and *P. israelskyi* from the type locality Kozary station 50426.

1, 2, 6 and text-fig. 4 a-f. The juvenarium consists of a bilocular embryo and a small number of peri-embryonic chambers, apparently arranged in a single short spiral. Protoconch and deuteroconch are subspherical and differ only slightly in size (see Table I). The single primary auxiliary chamber is larger than the deuteroconch. A second primary auxiliary chamber was not observed. Inasmuch as the large primary auxiliary chamber apparently has a single basal stolon, the juvenarium is most probably uniserial. The stolon between the embryonic chambers could not be detected.

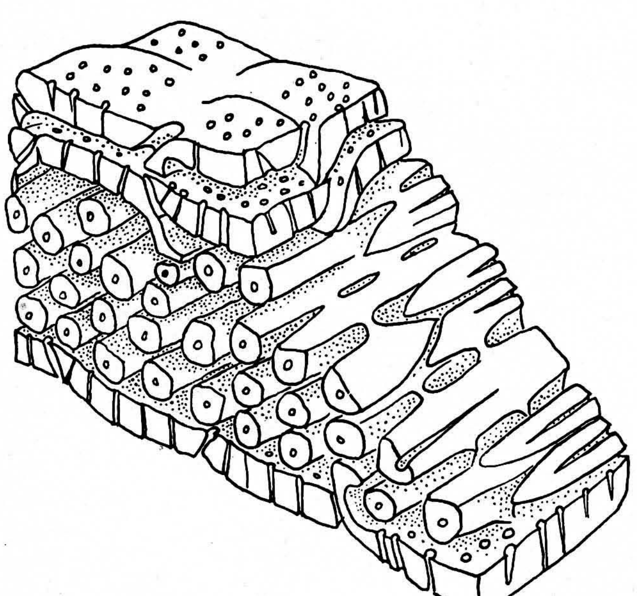
Dimensions of the chambers and chamber-walls of the juvenarium measured in five oblique equatorial sections of paratypes from Kozary station 50426 are listed in Table I. Dimensions of lumina are inner dimensions.

TABLE I

NUMBER OF SPECIMEN

(All measurements are in microns)

	1)	2)	3)	4)	5)
Maximum diameter of					
protoconch	128	130	140	125	115
deuteroconch	150	140	—	128	130
primary auxiliary chamber	180	192	155	180	182
Thickness of wall of embryonic chamber	10- 20				
Diameter of whole juvenarium	390-410				



TEXT FIGURE 3

R. hedbergi, n.sp. Model of a portion of the margin of the test. The front is directed toward the periphery. Secondary lateral chambers are shown only above the equatorial layer. Not to scale.

The dimensions of the embryonic chambers and of the whole juvenarium are greater than in *Vaughanina cubensis* Palmer and in *Pseudorbitoides israelskyi* Vaughan and Cole, both of which are uniserial species. On the other hand, they are close to those of the bi- to quadriserial juvenaria of *P. trechmanni* H. Douvillé and *P. rutteni* Bronnimann (Bronnimann 1954 b, p. 100, table I; 1955).

b) *Neanic stage*

The structure of the equatorial layer is illustrated by pl. 17, figs. 7, 9-11, 13, 14, text-figs. 4,5, and by the model of a part of the margin of the test (text-fig. 3). The model shows the arrangement in space of the radial rods, primary and secondary lateral chambers, annular connections between rods, and the communications. The thin vertical and diagonal connections are not illustrated.

Immediately outside the juvenarium, the equatorial layer consists of primary lateral chambers and of two systems or layers of alternating radial rods. This type of equatorial structure has been described, using a somewhat different terminology in *Sulcorbitoides* and in the early neanic stage of *Pseudorbitoides, s.s.* Sections through the early neanic stage of *R. hedbergi,* n.sp. are illustrated by pl. 15, figs. 3, 10 and by text-figs. 5 c-e.

Excentric vertical sections between the early neanic stage with two systems of radial rods and the periphery (pl. 15, fig. 5; text-figs. 5 b, h, i) display three to four irregular layers of rods. At the periphery of adult specimens, about eight to ten layers of rods fill the space between the primary lateral chambers (pl. 15, figs. 7, 9, 14; text-fig. 5a). The radial rods are in irregular layers and rows; in oblique sections through the equatorial layer they are represented by longer or shorter sections of rods disposed in radial lines (pl. 15, figs. 1, 2, 11; text-fig. 5 k). The radial rods have minute irregularities, similar to those noted on the radial plates of *P. rutteni* and *P. israelskyi.* Toward the periphery, these irregularities become stronger until they form minute knot-like protuberances. They are spaced in regular intervals, and centered equatorial sections show that they are arranged in annuli. Eventually the protuberances of adjoining rods may fuse to form annular connections, which apparently link only rods of the same layer (pl. 15, fig. 11).

Radial rods of a distinct layer and annular connections thus produce, in the final stage of the equatorial layer, a regular meshwork of tiny rectangles. In addition to these regular annular connections in the marginal area, there are connections in vertical and diagonal directions, which link irregularly the rods of the superimposed layers.

These vertical and diagonal connections can be seen only under high magnification in very thin oblique or excentric vertical sections (pl. 15, fig. 13; text-fig. 4 l, m). They are tenuous, thread-like protuberances of the radial rods, which in their peripheral portions are finely grooved, parallel to the axis of the rods. Cross-sections of the grooved portions are irregularly star-like, with minute furrows and ridges from which the tenuous connections arise. Oblique equatorial sections of the marginal area are dominated by the radial rods and the annular connections, the arrangement of which gives the impression of interlacing filaments of a textile fabric (pl. 15, fig. 11). The regular annular and the irregular vertical and diagonal connections seem to be associated only in the marginal area, where they form with the radial rods a kind of lattice work similar to the structure of the skeleton of certain hexactinellid sponges, but with irregular vertical components. A fine canal is in the center of each rod. It is regarded as the homologue of the fissural space between the lamellae of the radial plates of *Pseudorbitoides* and *Vaughanina* (Bronnimann 1954 b, 1955). The rods average 5μ to 10μ thick and are about 5μ to 13μ apart. In cross-sections of peripheral portions of radial rods about 10 ridges have been counted. The annular connections are about 5μ to 7μ thick. The diameter of the very fine thread-like diagonal and vertical connections are less than 1μ. In a quadrant of an equatorial section 90 to 120 rods have been counted at the periphery, and about 65 between center and periphery.

2. *Vertical section.*—

a) *Juvenarium*

Vertical sections of the juvenarium are illustrated by pl. 15, fig. 4 and text-fig. 4 g-k. The juvenarium is about 180μ to 250μ thick, and about 400μ long. It does not show any sign of rotaloid asymmetry. The spiral chambers have distinct sulcus-like indentations from which the radial rods of the two early neanic layers start.

b) *Neanic stage*

Excentric vertical sections of the neanic stage show better than other sections the diagnostic features of *R. hedbergi* (pl. 15, figs. 5, 7, 9, 10, 13, 14). Phylogenetically significant is the excentric vertical section (pl. 15, fig. 10) near the juvenarium. The two layers of alternating rods of the early neanic stage are as in *Pseudorbitoides israelskyi* and in *Sulcorbitoides pardoi* (Bronnimann 1954a, pl. 11, fig. 1; text-fig. 1).

The equatorial layer increases gradually in thickness from 25μ to 50μ near the center to 260μ to 320μ near the periphery. The flange is considerably thicker than in *Vaughanina cubensis* Palmer where it attains 200μ, rarely more, or in *Pseudorbitoides trechmanni* H. Douvillé where it is about 120μ to 150μ thick. There are no annular walls.

The primary lateral chambers are low and thick walled; they rest directly on the radial rods. Specimens with a diameter of 3 to 4 mm. have about 10 to 16 layers of secondary lateral chambers on each side of the equatorial layer. The secondary lateral chambers are in regular tiers. Pillars are irregularly distributed. Communications are by basal stolons and by fine pores.

The measurements listed in Table II are taken from three centered vertical sections of topotypes. Dimensions of lumina are inner dimensions.

TABLE II

	Number of specimen 1	2	3
Diameter of test	3.08 mm.	4.4 mm.	3.1 mm.
Thickness of test	0.96 mm.	1.3 mm.	0.8 mm.
No. of layers of secondary lateral chambers	14-16	15-16	±10
Secondary lateral chambers at periphery			
length	±160μ	40-160μ	40-130μ
height	20-25μ	10-25 μ	±25 μ
thickness of wall		5-10 μ	
Diameter of pillars measured at surface of test	25-80μ	25-130μ	25-80 μ
Thickness of rods	±10μ		
Horizontal distance between rods	10-40μ		

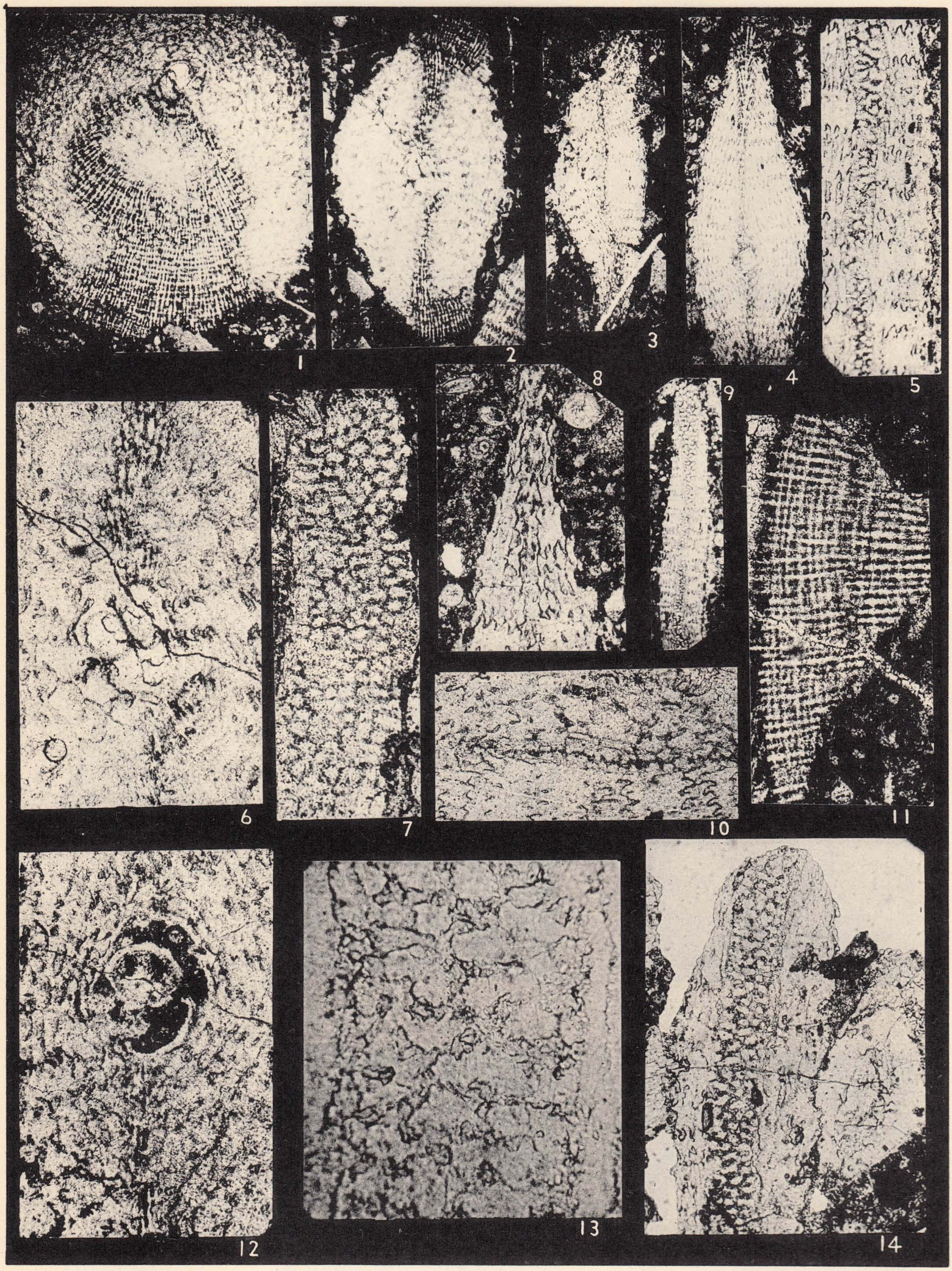
Age.—The assemblages with *R. hedbergi,* n.sp. are different in Oriente Province and in Las Villas Provinces.

a) *Oriente Province*

Only the type locality assemblage K 50426, appears to be autochthonous. It is characterized by *Globotruncana lapparenti tricarinata* (Quereau) (Turonian to Maestrichtian) and *Pseudorbitoides israelskyi* Vaughan and Cole. The other species listed in K 50426 do not allow a more accurate age determination. The age of *R. hedbergi,* n.sp., therefore, is linked with that of *P. israelskyi,* which is known from Taylor beds in Texas, Louisiana and Mississippi.

b) *Las Villas Province*

The assemblages described from Las Villas Province are regarded as allochthonous. *Torreina tor-*



Bronnimann: Upper Cretaceous *Rhabdorbitoides* from Cuba *rei* Palmer occurs in all of them, but is absent in the three localities reported from Oriente Province. This species is indigenous to Cuba, and its age significance is not yet known in terms of a biostratigraphic zonation based on orbitoidal or planktonic Foraminifera. In addition to *T. torrei,* the assemblages yield *Orbitocyclina* sp. or *Lepidorbitoides* sp., genera pertaining to the Maestrichtian. A questionable *Vaughanina* sp. has also been found. This points to a Maestrichtian age of the limestones with *R. hedbergi,* n.sp. in Las Villas Province, which in these localities appears to be redeposited from Campanian beds.

REFERENCES CITED

Bronnimann, P., 1954a, Upper Cretaceous Orbitoidal Foraminifera from Cuba. Part I. *Sulcorbitoides* n.gen. Contr. Cushman Found. For. Research, vol. 5, pp. 55-61.

Bronnimann, P., 1954b, Upper Cretaceous Orbitoidal Foraminifera from Cuba. Part II. *Vaughanina* Palmer. *Ibid.,* vol. 5, pp. 91-105.

Bronnimann, P., 1955, Upper Cretaceous Orbitoidal Foraminifera from Cuba. Part III. *Pseudorbitoides* H. Douvillé, 1922. *Ibid.,* vol. 6, pp. 57-76.

Rutten, M. G., 1935, Larger Foraminifera of Northern Santa Clara Province, Cuba. Jour. Pal., vol. 9, No. 6, pp. 59-62.

Rutten, M. G., 1936, Geology of the Northern Part of the Province Santa Clara, Cuba. Geogr. Geol. Medeel., Rijksuniversiteit Utrecht, No. 11.

Vaughan, T. W., and Cole, W. Storrs, 1943, A restudy of the foraminiferal genera *Pseudorbitoides* and *Vaughanina.* Jour. Pal., vol. 17, No. 1, pp. 97-100.

EXPLANATION OF TEXT FIGURE 4

R. hedbergi, n.sp. All from Kozary station 50426. 88 ×. a-f. Oblique equatorial sections of juvenaria. g-k. Vertical sections of juvenaria. l. Almost vertical excentric section across the radial rods of the marginal area. The rods are in cross section, irregularly star-like with protuberances connecting between the neighboring rods. m. Oblique vertical section with drawn out protuberances which indicate that the radial rod is longitudinally grooved.

EXPLANATION OF TEXT FIGURE 5

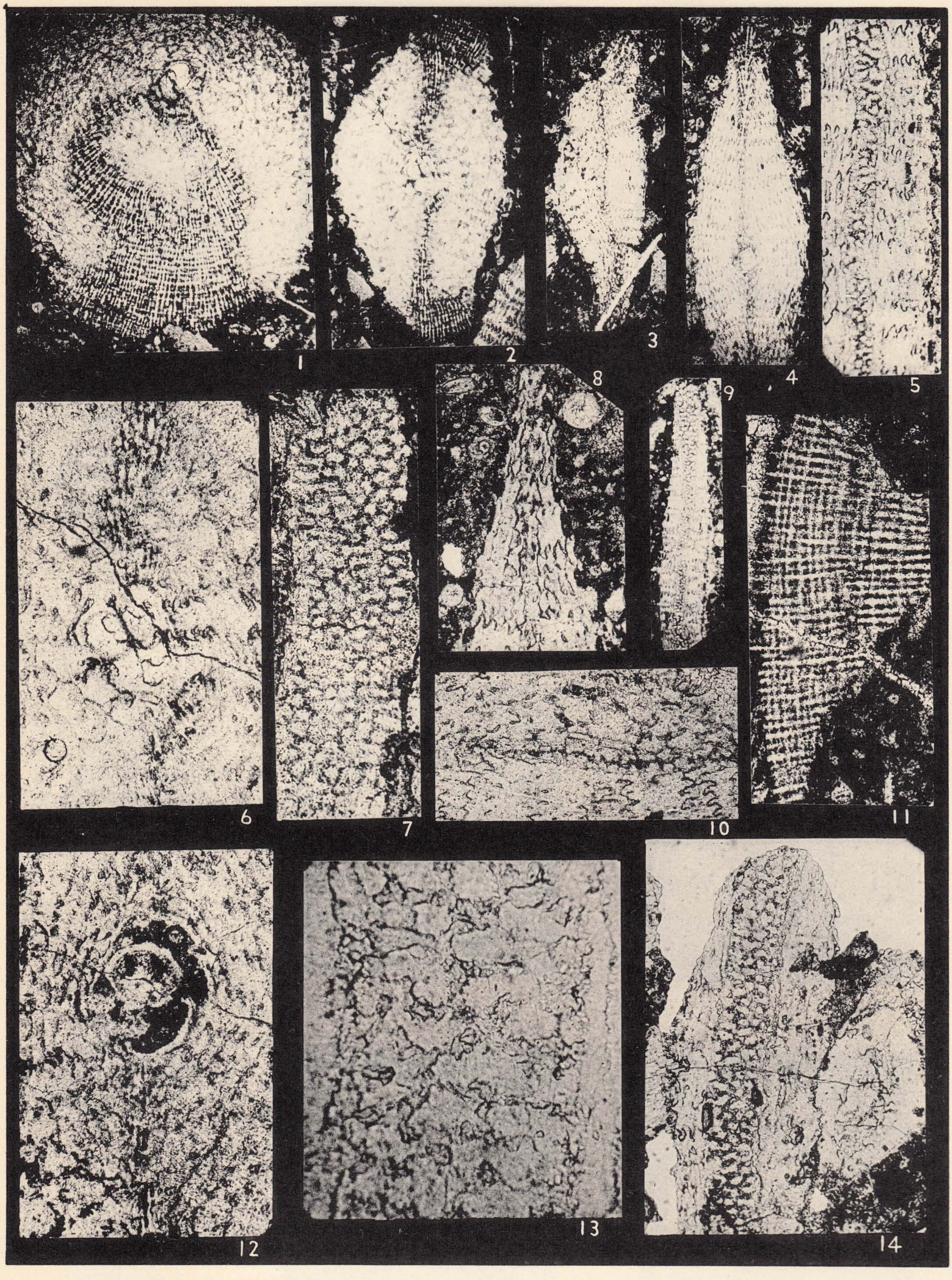
R. hedbergi, n.sp. a. Oblique cut across peripheral flange. b. Slightly oblique excentric vertical section of the same specimen. CUGOC Ser. No. 23088. 88 ×. c, e. Excentric vertical section near the juvenarium showing the two layers of alternating rods. c) Kozary station 51476. e) Kozary station 50426. 88 ×. d. Excentric vertical section across the sulcus-like portion of the juvenarium. Kozary station 50426. 140 ×. f, g. Oblique sections across the equatorial layer exposing some of the radial rods. Kozary station 50426. 88 ×. h, i. Excentric vertical sections across the layers of rods and primary and secondary lateral chambers. h. CUGOC Ser. No. 23088. i. Kozary station 50426. 88 ×. Oblique equatorial section across the equatorial layer exposing radial rods arranged in radial lines, and CUGOC Ser. No. 23088. 88 ×. l. Oblique equatorial section of the marginal portion of the equatorial layer showing radial rods and knot-like thickenings. Station L 415, thin section No. 14423, Coll. Geol.-Min. Institut of the University of Utrecht. 88 ×. m. Oblique section across the marginal flange. Same thin section as l. 88 ×

EXPLANATION TO PLATE 15

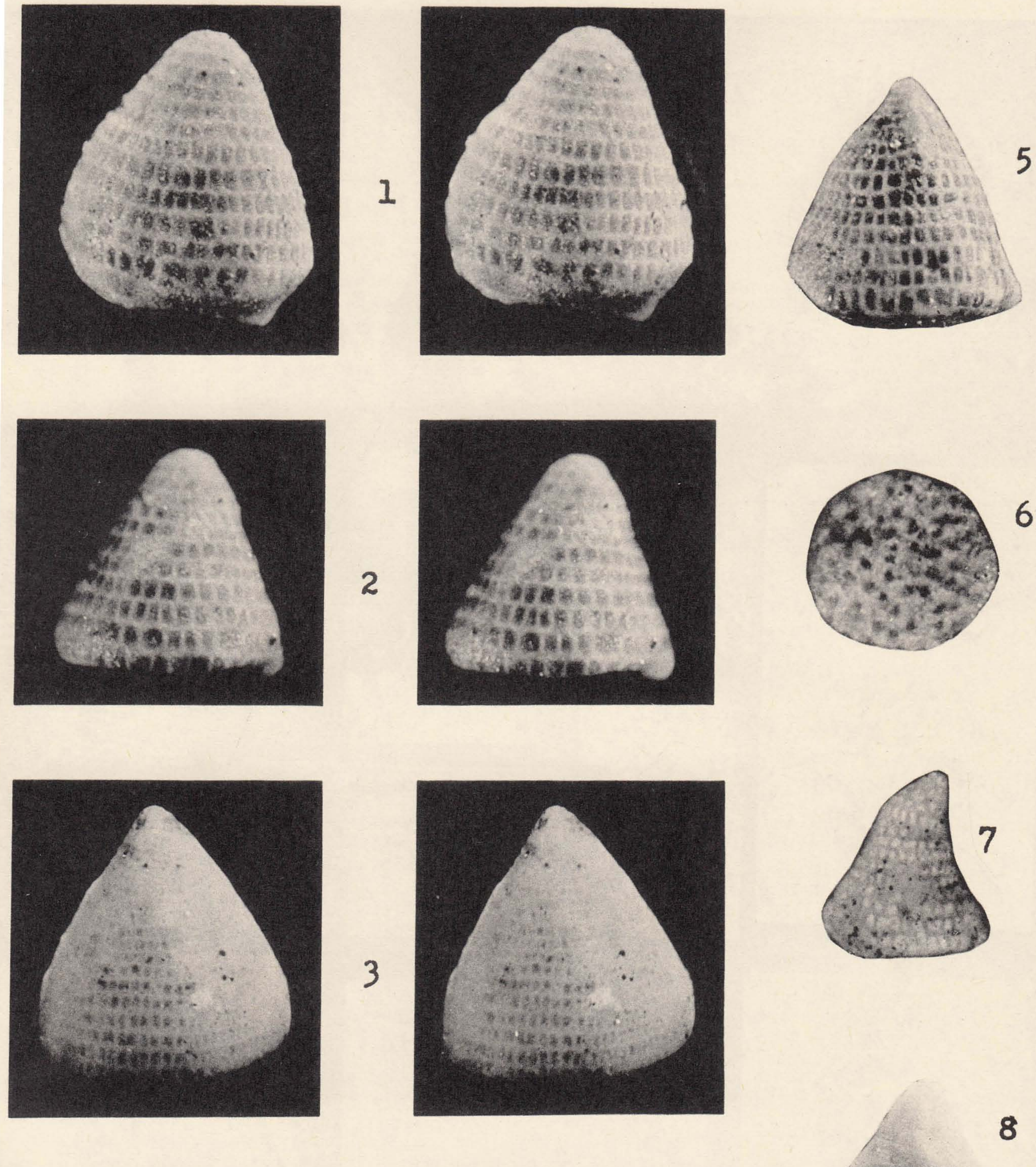
FIGS. PAGE

1-14. *Rhabdorbitoides hedbergi* Bronniman, n.gen., n.sp. 98

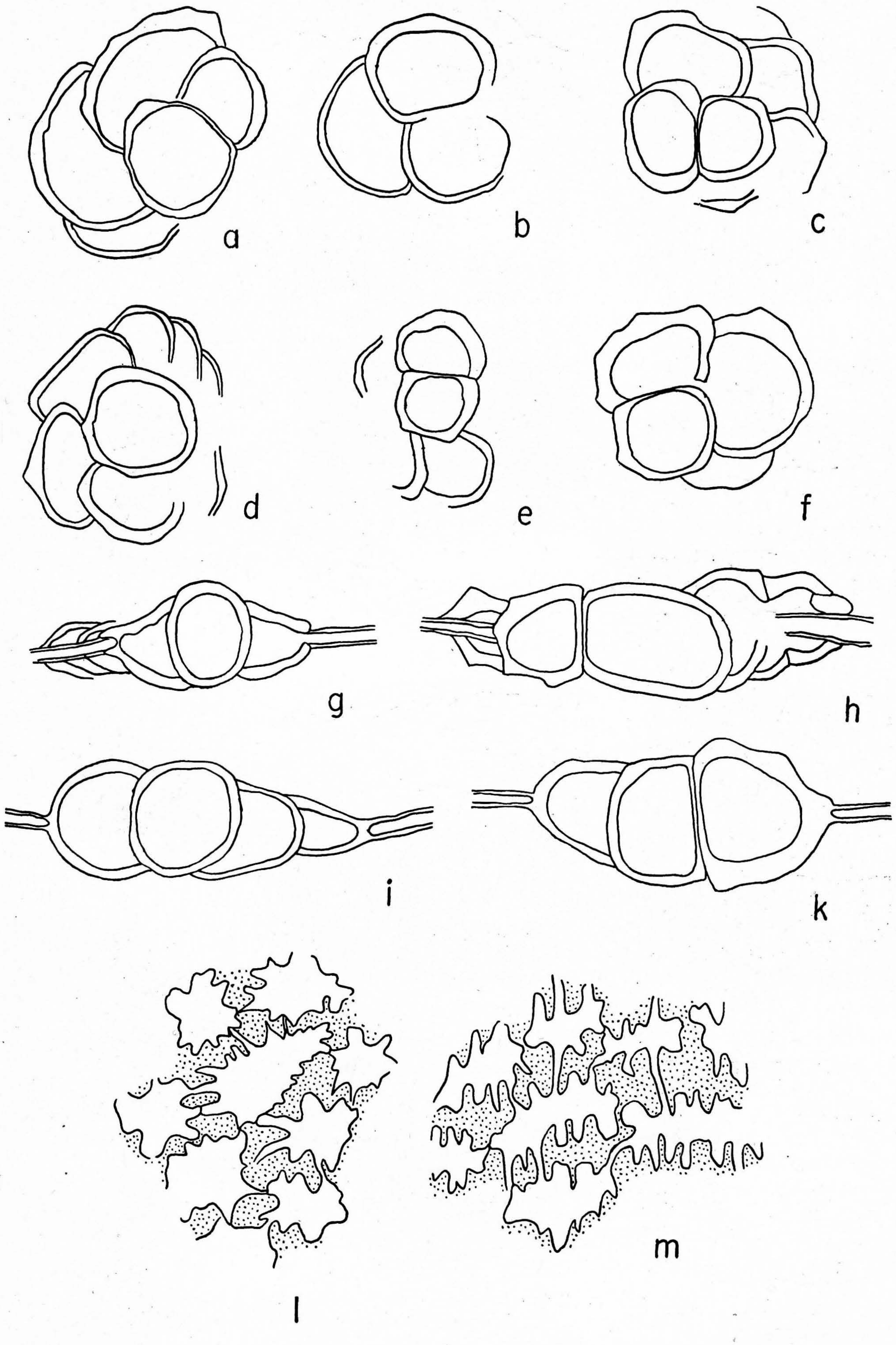
1. Holotype. Kozary station 50426, Gibara area, Oriente Province. 20 ×
2. Oblique equatorial section. Kozary station 50426, Gibara area, Oriente Province. 20 ×
3. Excentric vertical section just outside the juvenarium showing the primitive two layers of radial rods. Kozary station 51476, Gibara area, Oriente Province. 20 ×
4. Centered vertical section with the peripheral portion slightly obliquely cut. The radial rods protrude and form a peripheral flange. Kozary station 50426, Gibara area, Oriente Province. 20 ×
5. Excentric vertical section between juvenarium and periphery exposing three to four irregular layers of rods. CUGOC Ser. No. 13958, thin section No. 1, Las Villas Province. 56 ×
6. Center of the specimen illustrated in fig. 2, displaying the more or less equal embryonic chambers and the large primary auxiliary chamber. Kozary station 50426, Gibara area, Oriente Province. 56 ×
7. Excentric vertical section across the peripheral flange with about seven irregular layers of rods. Kozary station 50426, Gibara area, Oriente Province. 56 ×
8. Oblique section of the peripheral portion. *Oligostegina* spp. are in the matrix. CUGOC Ser. No. 13958, thin section No. 1, Las Villas Province. 56 ×
9. Excentric vertical section. CUGOC Ser. No. 13958, thin section No. 1, Las Villas Province. 20 ×
10. Same specimen as fig. 3, showing the early neanic stage in excentric vertical section. Kozary station 50426, Gibara area, Oriente Province. 64 ×
11. Latticework of the peripheral equatorial layer in oblique equatorial section. CUGOC Ser. No. 13958, thin section No. 1, Las Villas Province. 56 ×
12. Oblique section of the juvenarium exposing deuteroconch, primary auxiliary chamber and part of the nepionic spiral. Protoconch only slightly cut. Kozary station 50426, Gibara area, Oriente Province. 56 ×
13. Portion of the excentric vertical section of fig. 14 showing the irregular star-like cross-sections of the radial rods and some of the irregular connections. Thin section No. 14423, Coll. Geol.-Min. Institute, University of Utrecht. Station L 415, Las Villas Province. 280 ×
14. Same specimen as fig. 13 with a *Sulcoperculina* cf. *S. vermunti* (Thiadens) on the right. Thin section No. 14423, Coll. Geol.-Min Institute, University of Utrecht. Station L 415, Las Villas Province. 56 ×



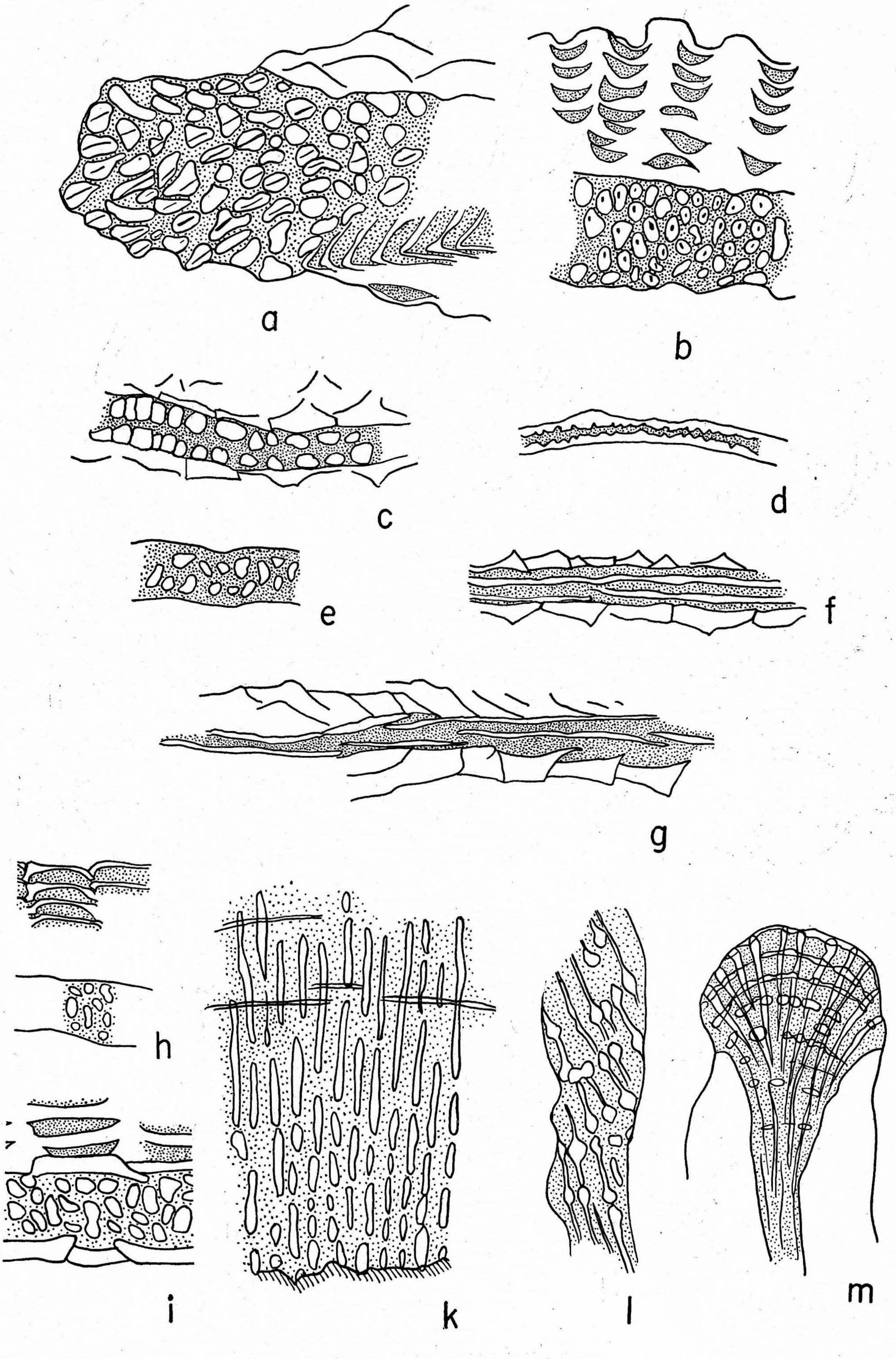
Bronnimann: Upper Cretaceous *Rhabdorbitoides* from Cuba



Maync: *On Coskinolina sunnilandensis*, n. sp.



Bronnimann: Text Figure 4



Bronnimann: Text Figure 5

CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH

VOLUME VI, PART 3, JULY, 1955

137. COSKINOLINA SUNNILANDENSIS, N.SP. A LOWER CRETACEOUS (URGO-ALBIAN) SPECIES

WOLF MAYNC

Venezuelan Atlantic Refining Company, Caracas,

ABSTRACT—A conical foraminifer occurring in Lower Cretaceous (Albian) limestones of Florida and Venezuela is described and figured as *Coskinolina sunnilandensis*, n.sp. This foraminifer, found in the Sunniland producing zone of southern Florida, was listed by American paleontologists as *"Coskinolina S"* or *"Dictyoconus S,"* without description. This form was first observed by the writer in 1952 in limestones of the Guácharo member of the Albian Chimana formation in Eastern Venezuela and was recently found in an Urgonian limestone of the ultrahelvetic Bonvin (Tothorn-Sex mort) decke, Canton of Bern, Switzerland. An identical or similar form also occurs in Cretaceous limestones of Mexico. These scattered occurrences suggest that this *Coskinolina* biofacies will occur in many other parts of the Lower Cretaceous Tethys domain.

INTRODUCTION

A detailed study of a great number of thin-sections of surface samples from the Lower Cretaceous sequence of Venezuela resulted in the discovery of some diagnostic Foraminifera which proved to be of biostratigraphic value. A few of these markers, *viz., Choffatella decipiens* Schlumberger, *Pseudocyclammina hedbergi* Maync, and *Dictyoconus walnutensis* (Carsey), have already been dealt with in some publications (Maync, 1950; 1953; 1955; Rod and Maync, 1954).

Quite common in the Guácharo middle member of the Chimana formation of Eastern Venezuela are *Dictyoconus walnutensis* (Carsey) and a very similar conical-orbitolinid foraminifer which was first believed to fall within the range of variation of the species of *Dictyoconus*. Systematic study, of additional thin-sections, however, afforded convincing evidence that the form associated with *Dictyoconus walnutensis* should be placed in the genus *Coskinolina* Stache, 1875, emend. Cole, 1941.

While working on a manuscript on this form, Louise Jordan, of Tallahassee, Florida, suggested that I also study and describe the so-called *"Coskinolina S,"* recognized in the Lower Cretaceous

EXPLANATION OF PLATE 16

Note: In order to get the three-dimensional effect, the specimens mounted in the figures 1-4 should be observed with a stereoscope.

FIGS. PAGE

1-2, 5-7. *Coskinolina sunnilandensis* n.sp. Lower Cretaceous (upper Trinity, Albian), Florida, U.S.A. 106

1. Holotype. External view; treated with very weak acid to show the sub-epidermal rectangular cellules. × 55. Humble Oil and Refining Company's No. 16 Gulf Coast Realties, core No. 23, 11633'-11636'.
2. Paratype, × 55. Same locality and occurrence as fig. 1.
3. *Dictyoconus walnutensis* (Carsey). Topotype specimen. External view revealing fine-meshed sub-epidermal structure. × 38. Near top of Mt. Barker, West of Austin, Texas, basal Comanche Peak formation (3 feet above Walnut clay) 107
4. *Dictyoconus americanus* (Cushman). Specimen treated with hydrochloric acid to show sub-epidermal pigeon-hole structure. × 15. Middle Eocene limestone, Peñon Seep, Province Matanzas, Cuba 107

5-7. *Coskinolina sunnilandensis,* n.sp. 107

5. External view, × 55. Humble Oil and Refining Company's No. 7 Gulf Coast Realties, core No. 28, 11778'-11782'.
6. View of base with apertural pores, × 55. Humble Oil and Refining Company's No. 16, Gulf Coast Realties, core No. 23, 11633'-11636'.
7. Side view of a specimen showing asymmetrical (excentric) apex, × 55. Commonwealth Oil Company's No. 1 Wiseheart, core No. 24, 11351'-11357'.

8-9. *Dictyoconus walnutensis* (Carsey). Topotype specimens (same locality and occurrence as specimen illustrated in figure 3). Side views, × 27. 107

Orbitolina-bearing subsurface beds (Trinity) of southern Florida, on the taxonomic position of which there had arisen some controversy (*Coskinolina* or *Dictyoconus?*). After her suggestion was agreed to, Louise Jordan sent the necessary material, mostly core samples from different wells in Collier County, Dade County, and Monroe County, Florida, and it soon became evident that "*Coskinolina S*" and the species of *Coskinolina* occurring in Venezuela are identical. For having entrusted me with the interesting material of "*Coskinolina S*" from Florida, the writer wishes to express his thanks to Louise Jordan.

This new species of *Coskinolina* was first observed early in 1952 when thin-sections of the *Dictyoconus*-bearing limestones of the Guácharo member of eastern Venezuela were studied. Surface samples had been collected by Emile Rod, Venezuelan Atlantic Refining Company (see Rod and Maync, 1954). However, since numerous well-preserved free specimens were subsequently obtained from well samples from Florida, the naming and description of the new form is preferably based on the North American material.

Special thanks are extended to the management of Humble Oil and Refining Company, Houston, Texas, for the permission to publish the data on *Coskinolina sunnilandensis* and its occurrence in the subsurface formations of southern Florida.

Esther R. Applin, Jackson, Mississippi, very kindly gave some additional information with regard to "*Coskinolina S*" or "*Dictyoconus S*" from the Sunniland horizon, Florida, and sent a number of prints of photomicrographs for comparison. For this assistance I feel greatly indebted to Mrs. Applin.

All the specimens of *Coskinolina sunnilandensis,* n.sp. figured in the present study were photographed by George Fournier, Mene Grande Oil Company, Caracas, to whom I tender cordial thanks.

The present study is based on the following material from southern Florida:

1) Humble Oil and Ref. Co. No. 3 Lee Tidewater Cypress, cutting samples 11780′-11800′;
2) Ditto, core sample No. 100, 11790′-11795′;

Collier County

3) Humble Oil and Ref. Co. No. 7 Gulf Coast Realties, core No. 25, 11761′-11764′;
4) Ditto, core No. 28, 11778′-11782′;
5) Humble Oil and Ref. Co. No. 16 Gulf Coast Realties, core No. 23, 11633′-11636′;
6) Ditto, core No. 45, 11745′-11755′ (bottom and top samples);
7) Humble Oil and Ref. Co. Lee Cypress No. 3, core No. 117, 11872′-11882′ (bottom).

Dade County

8) McCord Oil Inc. well No. 1 Damoco, core No. 21, 11659′-11660′;
9) Ditto, core No. 22, 11660′-11665′;
10) Commonwealth Oil Co. No. 1 Wiseheart (discovery well of Forty Mile Bend Field), core No. 24, 11351′-11357′;
11) Ditto (*Orbitolina limestone*), core No. 27, 11451′-11501′.

Monroe County

12) O. D. Robinson No. 1 State of Florida on Barnes Sound, core No. 40, 10227′-10230′.

This material, derived from boreholes in southern Florida, yielded washed residues with numerous free specimens of *Coskinolina sunnilandensis,* n.sp.; the harder rock samples were thin-sectioned for study.

In Eastern Venezuela, *Coskinolina sunnilandensis,* n.sp. occurs in limestones of the basal Guácharo member of the Chimana formation, Middle Albian, (see Rod and Maync, 1955). It is especially abundant in the surface samples Rod 1206 and 1306. Rod -1206 was collected in the section at Placeta, Caripe area, State of Monagas (see Rod and Maync, 1954, p. 223, section 10, at D), and sample Rod-1306 is derived from Río Carinicuao, south of Cariaco, State of Sucre (see Rod and Maync, 1954, p. 225, section 18, at D).

No free specimens of *Coskinolina sunnilandensis,* n.sp. were obtained from the Venezuelan surface samples.

Fossiliferous Urgonian limestone samples from Regenbolshorn, Canton of Bern (Switzerland), which also yielded *Coskinolina sunnilandensis,* n.sp., were collected by Wolf Leupold, Professor of Micropaleontology at the Swiss Federal Institute of Technology, Zürich (sample Leupold No. 42047). This limestone, of which numerous thin-sections were made, occurs as a Lower Cretaceous remnant beneath the Wang beds (Maestrichtian) which in this area usually transgress directly upon the Upper Jurassic Malm limestone.

Genus **COSKINOLINA** Stache, 1875, emend. Cole, 1941

Coskinolina sunnilandensis, n.sp.

Pl. 16, figs. 1-2, 5-7; Pl. 17, figs. 1-9, 12.

Dictyoconus sp. Pfender, 1938, Soc. Géol. France Bull., sér. 5, vol. VIII, pl. XV, fig. 4.

Coskinolina, n.sp. Maync, 1955, Contrib. Lab. Foram. Res., vol. VI, pt. 3, pl. 14, fig. 1 (top).

Holotype.—Coskinolina sunnilandensis, n.sp. (Pl. 16, fig. 1.) deposited in the U.S. National Museum, Cushman Collection, Washington 25, D.C.

Paratype.—Pl. 16, fig. 2, deposited in the U.S. National Museum, Cushman Collection, Washington 25, D.C.

Unfigured paratypes.—Deposited in the Florida Geological Survey, Tallahassee, Florida, and in the Micropaleontological Laboratory of the Swiss Federal Institute of Technology (ETH) Zürich, Switzerland.

Description. — Test calcareous-microgranular, forming an evenly sloping cone the base of which is circular in outline and usually slightly convex. On an average the height of the cone is somewhat greater than the basal diameter (see dimensions in the table below). The smoothly finished surface of the cone does not show any ornamental features (thin epidermal coating). Weathered or etched specimens, however, reveal regularly arranged sub-epidermal cellules which are formed by the subdivision of the peripheral chambers (horizontal concentric rings) by secondary radial, vertically set partitions (pl. 16, figs. 1-2, 5, 7). Such a sub-epidermal pigeon-hole structure, though of a definitely finer mesh, is also present in *Dictyoconus walnutensis* (Carsey) (see Pl. 16, figs. 3, 8-9).

The initial small spire is occasionally visible in a twisted asymmetrical knob at the apex but this early slightly excentric whorl only rarely stands out conspicuously.

The apertures are formed by rather regularly distributed openings on the base (central shield).

Interior structure.—Horizontal sections disclose that the regular outer ring of each adult chamber is consistently subdivided into peripheral chamberlets by a single vertical partition (Pl. 17, fig. 4). Such sections parallel to the base are thus of no diagnostic generic value as they do not differ from those of a primitive *Dictyoconus* (*D. walnutensis, D. cookei, D. arabicus*). Axial (longitudinal) sections show that the chambers of the marginal trough are not subdivided by one (or more) horizontal plate on which account an assignment to the genus *Coskinolina* is justified. True enough, a single minute horizontal plate may rarely be developed in one or another of the peripheral chambers (Pl. 17, fig. 3, 5) but such horizontal partitions are definitely lacking in nearly all of the thin-sectioned specimens. Forms where a sporadic horizontal plate is present in one or more of the chambers of the marginal trough can hardly be distinguished from *Dictyoconus walnutensis* (Carsey) or from *D. cookei* (Moberg) where horizontal subdividing plates may be missing in occasional chambers. In the lower Cretaceous species *Dictyoconus arabicus* Henson, too, "the secondary horizontal plates are rudimentary or absent" (Henson, 1948, p. 35). *Coskinolina sunnilandensis,* n.sp. could in this case be called a very primitive *Dictyoconus,* were it not for the fact that such a horizontal plate is lacking in at least 95% of the examined specimens. The absence of single horizontal plates is quite exceptional for primitive *Dictyoconus* (*D. walnutensis,* etc.) and so is their presence in *Coskinolina sunnilandensis,* n.sp.

The inner portion of the conical test (central shield) is formed by irregular vertical pillars. This broad labyrinthic core is distinct from the regular systematic structure of the peripheral chamberlets, and the boundary between the labyrinthic inner portion and the mantle of marginal chamberlets is sometimes clearly pronounced (Pl. 16, fig. 6). A similar conspicuous difference between the structure of the external chambers and the central core is also evident in *Coskinolina*-like tests from the Jurassic of France, figured in the "Album de microphotographies de roches sédimentaires" (Hovelacque and Kilian, 1900, Pl. IX, fig. 2). This Bathonian form, however, which was subsequently referred by Juliette Pfender to her new genus *Kilianina*[1] (Pfender, 1935), does not reveal a central pillar structure and is, therefore, close to the genus *Orbitolinopsis.*

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[1] There is some confusion as to the year of J. Pfender's publication on the new genus **Kilianina.** The reprint which Miss Pfender sent me long ago ("Sur un Foraminifère nouveau du Bathonien des Montagnes d'Escreins (H.-Alpes); **Kilianina Blancheti,** nov. gen., nov. sp.", Grenoble, Imprimerie Allier Père et Fils) bears the year date, 1935 (Pagination 243-252, Pls. I-II). The Catalogue of Foraminifera (Ellis and Messina), on the other hand, gives 1933 as the year of publication of the same paper and lists it as a contribution in the "Annales Science-Médicine de l'Université de Grenoble, n.s., vol. 10). In the bibliography of a subsequent paper (Les Foraminifères du Valanginien provençal, 1938 Géol. Soc. France, Bull., sér. 5, vol. VIII, p. 240), J. Pfender lists her paper on **Kilianina** under the same title but cites it as an article from the "Travaux du Laboratoire de Géologie de l'Université de Grenoble, vol. XVIII, 1934-1935 (paru en 1936), p. 125." J. Cuvillier and V. Sacal (1951) give the reference with a changed title, **viz.,** "Foraminifères du Bathonien des Montagnes d'Escreins **(K. blancheti),** Trav. du Lab. de Géol., Grenoble, p. 121-130, pl. I et II, 1936." It seems, therefore, that the same paper was published more than once in different periodicals.

Dimensions.—The measurements of 32 free specimens of *Coskinolina sunnilandensis,* n.sp. are given below:

	Diameter of base	Height of cone	Ratio base/height
	0.6 mm.	0.8 mm.	0.75
	0.5	0.7	0.85
	0.6	0.6	1.0
	0.6	0.85	0.7
	0.5	0.6	0.83
	0.7	0.8	0.88
	0.6	0.7	0.85
	0.5	0.6	0.83
	0.7	0.8	0.88
	0.8	0.8	1.0
	0.7	0.7	1.0
	0.7	0.9	0.78
	0.4	0.5	0.80
	0.8	0.8	1.0
	0.6	0.6	1.0
	0.5	0.6	0.83
	0.8	0.8	1.0
	0.7	0.7	1.0
	0.5	0.5	1.0
	0.6	0.7	0.85
	0.6	0.6	1.0
	0.8	0.8	1.0
	0.5	0.5	1.0
	0.6	0.6	1.0
	0.6	0.6	1.0
	0.7	0.7	1.0
	0.5	0.5	1.0
	0.6	0.6	1.0
	0.5	0.5	1.0
	0.5	0.5	1.0
	0.7	0.8	0.88
	0.45	0.5	0.9
Average	0.61 mm.	0.667 mm.	0.91
Maximum	0.8	0.9	0.88
Minimum	0.4	0.5	0.80

For other species of *Coskinolina* these measurements attain the following values:

Coskinolina floridana Cole
(Cole, 1941, p. 24):

Average	0.85 mm.	1.02 mm.	0.83
Maximum	1.06	1.19	0.89
Minimum	0.68	0.85	0.80

Coskinolina elongata Cole
(Cole, 1942, p. 20)

Average	1.22 mm.	1.57 mm.	0.75
Maximum	1.44	2.08	0.69
Minimum	1.0	1.15	0.87

Coskinolina alavensis (Mangin)
(Mangin, 1954, pl. 3, fig. 5):

	1.85 mm.	2.10 mm.	0.88

(Mangin, 1954, p. 213):

Average	1.35	1.55	0.87

Remarks.—The conical foraminifer from the Lower Cretaceous Trinity of southern Florida, which has been placed by some authors in *Coskinolina,* by others in *Dictyoconus,* is here identified, described, and figured as *Coskinolina sunnilandensis,* n.sp. To the best of our knowledge, this new species is the only described Cretaceous representative of the genus.[2]

The decision to assign this foraminifer to the genus *Coskinolina* Stache, 1875, emend. Cole, 1941, was reached after a study of numerous thin-sections most of which revealed the absence of a horizontal plate in the marginal chambers (axial sections). Because such horizontal lamellae are normally lacking and may only be observed occasionally and incipiently, assignment to *Dictyoconus* Blanckenhorn in our opinion is not justified.

The average size and shape of the conical test of *Coskinolina sunnilandensis,* n.sp. is in full agreement with other known species of the genus. As is evident in the table above, the average dimensions of the base and the height of the cone as found in *Coskinolina sunnilandensis,* n.sp. are 0.61 mm. and 0.67 mm., respectively, values which give a ratio base/height of 0.91. The few specimens of *Coskinolina sunnilandensis* observed in the Urgonian limestone of Regenbolshorn, Switzerland, are somewhat larger than the average tests from either Florida or Venezuela, as they show a base of 0.75-0.9 mm., a height of 0.9-1.1 mm. (ratio base/height of 0.81-0.84). In average specimens of *Coskinolina floridana* Cole these dimensions are 0.85 mm. and 1.02 mm. (ratio base/height of 0.83). In *Coskinolina elongata* Cole, the base and height values were 1.22 mm. and 1.57 mm. (ratio base/height of 0.75). *Coskinolina alavensis* (Mangin),[3] occurring in the Paleocene to Lower Eocene of Spain, shows an average base of 1.35 mm. and a height of 1.55 mm. (ratio base/height of 0.87).

Even if all these measurements, made on a number of species of *Coskinolina,* show certain differences, the proportional factor base/height of the cone is consistently 1.0 or less which means that the height of the average specimens of *Coskinolina* is greater than the basal diameter. In the known

[2] Some **Coskinolinae** from Lower Cretaceous (Aptian-Cenomanian) rocks of western France have been figured in "Corrélations Stratigraphiques par Microfacies en Aquitaine Occidentale" (Cuvillier and Sacal, 1951, pls. XV, XX, XXXI) but no description or specific determination is given. **Coskinolina adkinsi** Barker, 1944, from the Lower Cretaceous of Texas, does not belong to the genus **Coskinolina.** It is in synonymy with **Coskinolinoides texanus** Keijzer, 1942 (see Maync, 1955).

[3] This form was originally described as **Fallotella alavensis** Mangin (Mangin, 1954) but as it completely agrees with the concept of the genus **Coskinolina** Stache, emend. Cole, 1941, the erection of a new genus is not warranted (see Maync, 1954, The Micropaleontologist, vol. VIII, No. 4, October, 1954, p. 28).

Cretaceous species of the genus *Dictyoconus,* however, this ratio is consistently 1.0 or higher. In other words, the test of *Dictyoconus* is generally a lower, broader cone which has the diameter at the base equal to or even larger than the height of the cone.

Interior structure.—The interior structure of *Coskinolina sunnilandensis,* n.sp. is clearly shown in the photomicrographs. The overall character certainly is that of *Coskinolina* and only when horizontal peripheral partitions are present (which is very rare), the interior structure recalls a primitive *Dictyoconus* type.

There are great similarities between the new Lower Cretaceous species of Florida and the known Eocene forms of the same area, and it may be assumed that *Coskinolina sunnilandensis,* n.sp. is a direct forerunner of *Coskinolina floridana* Cole. One can even say that the Lower Cretaceous species *C. sunnilandensis* hardly underwent any evolutionary differentiation, as *Coskinolina floridana* from the Eocene still shows the same interior features. This morphological stability is also evident in the Eocene species *Dictyoconus cookei* (Moberg) which does not differ in its principal structure from the Lower Cretaceous *Dictyoconus walnutensis* (Carsey). The only differential criterion seems to be the fact that the Eocene representatives of both genera are of larger size than their ancestral forms.

With respect to the interior structure, *Coskinolina sunnilandensis,* n.sp. and *C. floridana* Cole show complete agreement whereas the more steeply-conical species *C. elongata* Cole as a rule shows a much coarser interior, both peripheral chambers and central shield structure (compare our figures with Cole, 1941, pls. 4-5; 1942, pls. 4-5; 1944, pls. 2, 12; Applin and Applin, 1944, pl. 2, fig. 8; pl. 4, fig. 5). *Coskinolina elongata* is, moreover, more primitive than *C. floridana* in showing only occasionally the vertical subdivisional plates in the chambers of the marginal trough (Cole, 1942).

In shallow sub-axial sections or in sections tangential to the cone surface the central portion with its typical pillar structure and irregular meshwork is not properly visible; the sections of *Coskinolina sunnilandensis* then greatly resemble those of the still deficiently known lineage *Orbitolinopsis-Iraqia* the *reticulum* of which is reported to lack a true pillar structure (Henson, 1948). The Cenomanian *Coskinolina* reproduced in Cuvillier and Sacal (1951, Pl. XXXII, fig. 1), with its inwardly inclined, undivided marginal chambers and its non-labyrinthic centre (absence of pillars), is similar to *Kilianina blancheti* Pfender from the Bathonian Jurassic of France (Pfender, 1935, Pl. I, fig. b; Pl. II, fig. 1).

A tangential thin-section of a conical foraminifer, which appears to be identical with *Coskinolina sunnilandensis,* n.sp., has been figured by Juliette Pfender (Pfender, 1938, Pl. XV, fig. 4) (Maync, 1955). This form, identified as *Dictyoconus* sp., occurs in a Cretaceous limestone from Xiliatl, near Xilitla (San Luis Potosí), Mexico. A near surface section of another, quite similar test ("jeune *Dictyoconus* ou *Coskinolina*"), derived from the Valanginian of the Provence, France, was figured in her Plate XIV, figure 6 (Pfender, *loc.cit.*).

In his paper on *Coskinolinoides*[4] F. G. Keijzer stressed the possibility that the above-mentioned specimens figured by J. Pfender might be referred to his new genus *Coskinolinoides* (Keijzer, 1942). After having studied topotype specimens of *Coskinolinoides texanus* Keijzer (*Coskinolina adkinsi* Barker, 1944), such an assignment cannot be supported by the writer. The figures of the Mexican and French specimens disclose the regular rectangular meshwork which is characteristic of superficial sections of *Coskinolina sunnilandensis,* n.sp. (and *Dictyoconus*) whereas such vertical elements are absent in axial sections of *Coskinolinoides* (see Keijzer, 1942, text figs. d, e; see also thin-sections figured on Plate 17 of the present paper). Besides, J. Pfender's figure 5 (pl. XV) depicts a cone with a base of about 0.72 mm. and a height of about 0.85 mm. (ration base/height of 0.84). These values agree very well with those found in different species of *Coskinolina,* yet are twice as high as those given for *Coskinolinoides* (average dimensions 0.30 mm. for basal diameter, 0.42 mm. for height of cone).

Stratigraphic distribution and occurrences.—In Humble Oil and Refining Company's well No. 2 Gulf Coast Realties, 30, 48 S., 30 E., Collier County, Florida, the biostratigraphic succession is as follows (communication by Louise Jordan):

Washita Cretaceous
8401′ Top of Lower Cretaceous
9900′ Faunizone with *Coskinolinoides texanus* Keijzer and *Lituola inflata* Lozo
(Fredericksburg)
11160′ Top occurrence of *Orbitolina texana*
11619′ Top of Sunniland producing horizon, with *Orbitolina texana* and *Coskinolina*

[4] **Coskinolinoides** differs from the representatives of the **Coskinolina-Dictyoconus** trend in lacking a central core with a distinct pillar structure; the apparent morphological similarities between **Coskinolinoides** and **Coskinolina,** indicated by the absence of horizontal plates in the marginal chamberlets of either genus, are thus merely superficial.

sunnilandensis, n.sp. within 200' interval

11872'-12525' Essentially anhydrite containing a few stringers of *Orbitolina* limestone

12525'-13512' Limestone section with some dolomite and anhydrite

13050' *Choffatella decipiens* and *Orbitolina texana*

13165' *Orbitolina texana*

13512' TD.

In the subsurface formations of Florida, *Coskinolina sunnilandensis,* therefore, characterizes the Sunniland limestone interval which attains a thickness of about 275' in the Sunniland Field. It occurs, in other words, above the horizon with *Choffatella decipiens* and below the faunizone with *Coskinolinoides texanus* and is of upper Trinity age (lower to basal middle Albian). *Dictyoconus walnutensis* (Carsey) is apparently not found in the Lower Cretaceous subsurface section of southern Florida but some specimens of *Pseudocyclammina hedbergi* Maync were observed in several of the prepared thin-sections.

In the lower 300' of the Glen Rose limestone of Comal County, Texas, *Orbitolina texana* (Roemer) occurs in association with an undescribed species of *Coskinolina* which is identical with the form of *Coskinolina* from the Sunniland section, southern Florida (Jordan and Applin, 1952). In the Texas sequence, *Coskinolinoides texanus* Keijzer and *Dictyoconus walnutensis* (Carsey) occur in formations of both Trinity and Fredericksburg age (Glen Rose; Walnut, Goodland, Edwards formations; see Frizzell, 1954).

In Eastern Venezuela, *Coskinolina sunnilandensis* was found to be associated *i.a.,* with *Dictyoconus walnutensis* (Carsey), *Orbitolina concava-texana* (Roemer), and *Pseudocyclammina hedbergi* Maync (Maync, 1953, 1955; Rod and Maync, 1954); one specimen of *Coskinolinoides* aff. *texanus* Keijzer was recently observed, also in the basal Guácharo member of the Chimana formation (middle Albian).

In the ultrahelvetic Urgonian limestone from Regenbolshorn, Canton of Bern (Switzerland), *Coskinolina sunnilandensis* is accompanied by *Dictyoconus walnutensis* (Carsey), *Trocholina alpina* (Leupold), *Coscinophragma cribrosa* (Reuss), by large specimens of *Lituola* (type *L. inflata* Lozo), and by representatives of the genera *Orbitolina, Pseudocyclammina, Choffatella, Pseudochrysalidina,* etc.

The conical foraminifer, figured by Juliette Pfender as *Dictyoconus* sp. (Pfender, 1938, Pl. XV, fig. 4), is tentatively identified with *Coskinolina sunnilandensis,* n.sp. This specimen was found at Xiliatl (San Luis Potosí), Mexico, in a limestone of supposed Cenomanian-Turonian age (Maync, 1955).

With the exception of this last-mentioned occurrence, on which no reliable data are as yet available to the writer, *Coskinolina sunnilandensis* is present in Lower Cretaceous (Urgo-Albian) beds. It is now known from Florida, Venezuela, and Switzerland and will probably be recorded from other regions of the Lower Cretaceous Tethys province.

LITERATURE CITED

Applin, P. L., and Applin, E. R., 1944, Regional subsurface stratigraphy and structure of Florida and southern Georgia, Am. Assoc. Petr. Geol., Bull., vol. 28, no. 12, p. 1673-1753.

Barker, R. W., 1944, Some Larger Foraminifera from the Lower Cretaceous of Texas. Journ. of Pal., vol. 18, no. 2 (March), p. 204-209.

Cole, W. Storrs, 1941, Stratigraphic and paleontologic studies of wells in Florida. State of Florida, Dept. Conserv., Geol. Survey, Geol. Bull. no. 19, Tallahassee.

Cole, W. Storrs, 1942, Stratigraphic and paleontologic studies of wells in Florida.—No. 2. *ibid.* Geol. Bull. no. 20.

Cole, W. Storrs, 1945, Stratigraphic and paleontologic studies of wells in Florida.—No. 3. *ibid.* Geol. Bull. no. 28.

Cushman, J. A., 1937, A Monograph of the foraminiferal Family Valvulinidae. Cushman Lab. for Foram. Research, Special Public. No. 8.

Cuvillier, J. and Sacal, V., 1951, Corrélations stratigraphiques par Microfaciès en Aquitaine Occidentale. E. J. Brill, Leiden, Holland.

Frizzell, Don L., 1954, Handbook of Cretaceous Foraminifera of Texas. Bureau of Econ. Geol., Univ. of Texas, Rep. of Invest. No. 22.

Henson, F. R. S., 1948, Larger Imperforate Foraminifera of South-Western Asia. Brit. Mus. Nat. Hist., London.

Hovelacque, M. and Kilian, W., 1900, Album de microphotographies de roches sédimentaires, d'après les échantillons recueillis et choisis par W. Kilian. Gauthier-Villars, Paris.

Jordan, L. and Applin, E. R., 1952, *Choffatella* in the Gulf Coastal Regions of the United States and description of *Anchispirocyclina* n.gen. Contrib. Cushman Found. for Foram. Research, vol. III, pt. 1 (March), 1952, p. 1-5.

Keijzer, F. G., 1942, On a new genus of arenaceous

Foraminifera from the Cretaceous of Texas. K. Nederl. Akad. Wetensch., Proc., Amsterdam, vol. 45, no. 10, p. 1016-1017.

Mangin, J.-Ph., 1954, Description d'un nouveau genre de Foraminifère: *Fallotella alavensis.* Trav. du Laboratoire de Géol., Fac. des Sciences de Dijon, Bull. Scientifique de Bourgogne, vol. XIV (1952-1953), p. 209-219.

Maync, W., 1953, *Pseudocyclammina hedbergi* n.sp. from the Urgo-Aptian and Albian of Venezuela. Contrib. Cushman Found. for Foram. Research, vol. IV, pt. 3, p. 101-103.

Maync, W., 1955, *Dictyoconus walnutensis* (Carsey) in the Middle Albian Guácharo limestone of Eastern Venezuela. *Ibid,* vol. VI, pt. 3, pp. 85-93.

Pfender, J., 1935, Sur un Foraminifère nouveau du Bathonien des Montagnes d'Escreins (H.-Alpes): *Kilianina blancheti* nov. gen., nov. sp. Grenoble, Imprimerie Allier Père et Fils, p. 243-252.

Pfender, J., 1938, Les Foraminifères du Valanginien Provençal. Géol. Soc. France, Bull., vol. 8, p. 231-242.

Rod, E., and Maync, W., 1954, Revision of Lower Cretaceous Stratigraphy of Venezuela. Am. Assoc. Petr. Geol., Bull. vol. 38, no. 2, p. 193-283.

EXPLANATION OF PLATE 17

(See Plate 17 following page 122)

FIGS. PAGE

1-6. *Coskinolina sunnilandensis,* n.sp. Lower Cretaceous (upper Trinity, Albian, Florida, U.S.A. 106

1. Axial section showing undivided peripheral chambers (compare with *Dictyoconus walnutensis* depicted in figure 11), × 44. Humble Oil and Refining Company's No. 16, Gulf Coast Realties, core no. 23, 11633'-11636'.
2. Axial section, × 40. Humble Oil and Refining Company's No. 7, Gulf Coast Realties, core No. 28, 11778'-11782'.
3. Axial section showing sporadic horizontal plates in marginal chamberlets, × 40. Humble Oil and Refining Company's No. 16, Gulf Coast Realties, core no. 45 (top), 11745'-11755'.
4. Parallel section revealing chamberlets of the marginal trough subdivided by one single vertical plate and multiple apertures in the centre. × 40. Humble Oil and Refining Company's No. 16, Gulf Coast Realties, core No. 23, 11633'-11636'.
5. Sub-axial section showing occasional short horizontal partitions in the peripheral chamberlets, × 40. Humble Oil and Refining Company's No. 16, Gulf Coast Realties, core No. 23, 11633'-11636'.
6. Transverse section displaying mantle of peripheral chamberlets and pillar structure of central core, × 40. Humble Oil and Refining Company's Lee Cypress No. 3, core No. 117, 11872'-11882'.

7-9. *Coskinolina sunnilandensis,* n.sp. Lower Cretaceous (Middle Albian) Guácharo member of Chimana formation, Eastern Venezuela 106

7-8. Surface sample Rod-1206, Placeta (Caripe area), State of Monagas.

7. Axial section showing undivided marginal chamberlets, × 27.
8. Superficial section, × 38.
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CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
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138. UPPER CRETACEOUS FORAMINIFERA FROM THE "FRANCISCAN SERIES" NEW ALMADEN DISTRICT, CALIFORNIA.

KLAUS KUPPER
Stanford University

INTRODUCTION

Cretaceous Foraminifera are now recorded from many localities in the "Franciscan Series" of the Coast Ranges of central California and western Oregon. Soon after Cyrus F. Tolman and his associates began studying the geology of an area in Santa Clara County, California, for the development of the cement industry at Permanente, paleontologists recognized that the Foraminifera in the Calera limestone should be placed in the cosmopolitan, pelagic genus *Globotruncana.* Material from the quarry and elsewhere was given by Hubert G. Schenck to Hans E. Thalmann, who (1942, 1943) was the first to publish on the significance of the specimens for interregional correlation.

Since 1943, many workers studied intensively *Globotruncana* and its allies. In California, Cushman and Todd (1948) described specimens from the New Almaden District; their paper was revised by Glaessner (1949). European and Russian workers have erected new genera and presented accurate stratigraphic information for many of these smaller Foraminifera.

This advance of knowledge led the author to reexamine the material from California and to collect additional samples. The best preserved specimens are from the Cushman and Todd (1948) locality near New Almaden, Santa Clara County, California. The new material contains specimens which are much better preserved than those available to previous micropaleontologists and consequently one can now determine many morphological details heretofore unknown. Thus with assurance the inference is drawn that the faunule is early or medial Cenomanian in age.

The writer is indebted to several colleagues at Stanford University. Hans E. Thalmann suggested this study, Siemon Wm. Muller translated the generic description of *Rotundina* from Russian into English. Hubert G. Schenck and George L. Harrington read and criticized the typescript. Edgar H. Bailey of the U. S. Geological Survey confirmed that the sample collected by the present writer is from the same locality as that of Cushman and Todd. Finally, thanks are due to the Shell Foundation for Fundamental Research in Geology at Stanford University for financial assistance.

LOCALITY

The exact description given by Cushman and Todd is quoted in full: "The fossil locality lies in a roadcut in a small streamvalley in the southwest of Sec. 24, T. 8, S., R. 1 W., Mt. Diablo Meridian. On the standard topographic sheet of the Los Gatos, California quadrangle (scale 1 : 62.500) it is a point 4.1 inches from the west edge of the map and 2.3 inches from the north edge. The locality is reached by a small secondary road which trends southwesterly from Shannon road at a point 0.7 miles west of Guadalupe creek. The fossils are found in a roadcut about 0.23 miles from the Shannon road junction." This locality has been assigned the Stanford University locality number LSJU Loc. M 609.

AGE

Cushmand and Todd (1948) inferred a lower Cretaceous age for the faunule. Glaessner (1949) preferred Aptian-Albian because of the similarity between the California species and some in the Mediterranean region. His decision was mainly based on his identification of some of the specimens from near New Almaden as *"Anomalina" roberti* Gandolfi and *Globotruncana ticinensis* Gandolfi. Since the present author's study of better specimens proves that these two species do not occur in the New Almaden locality, Glaessner's opinion is invalidated. Moreover none of the species recognized here is restricted to the "Aptian-Albian"; *Planomalina buxtorfi* (Gandolfi) and *Globotruncana* (*Rotundina*) *californica* (Cushman and Todd) range from the Albian into the lower Cenomanian. All of the other species of *Globotruncana,* with the exception of *Globotruncana* (*Rotalipora*) *apenninica apenninica* (Renz), range from lower to middle Cenomanian. The evidence thus favors correlating the limestones and shales of the "Franciscan Series" at the locality near New Almaden with strata classified as Cenomanian in Europe and Africa.

CLASSIFICATION

In the following a brief summary of the distinctive characters of the subgenera of *Globotruncana* is given. Only subgeneric rank is assigned to the different categories related to *Globotruncana* in the same way as Reichel (1949) proposed, although several authors as Bermudez (1952) and Sigal (1948) favor generic rank. The description of the subgenus *Rotundina* Subbotina is later given in full as the original paper is not readily available. The genus *Praeglobotruncana* Bermudez, 1952 (type species: *Globorotalia delrioensis* Plummer) is of uncertain position as the apertural characters which are of great importance have not been described either by Plummer or Bermudez. Should Bermudez' assumption be correct that *"Globotruncana" apenninica* Renz is congeneric, then *Praeglobotruncana* would become a junior synonym of *Rotalipora* Brotzen, 1942. This, however, cannot be decided definitely until the type species has been restudied. In the following synopsis no attempt is made to give a complete list of synonymies; only the original references of the subgenus and type species are given.

SYNOPSIS

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. The umbilicus is open, mostly covered with a flat or arched plate. Apertures ventral, interiomarginal aperture either inter- or extra-umbilical; accessory apertures are interumbilical, sutural or lacking.

Subgenus **Globotruncana** Cushman, 1927

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

Subgenotype.—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.—One or two keels, umbilicus covered with an arched plate, interiomarginal aperture tending to an extraumbilical position, no accessory apertures.

Subgenus **Rotalipora** Brotzen, 1942

Sver. Geol. Unders., ser. C, no. 451, p. 32

Subgenotype.—Rotalipora turonica Brotzen, 1942, Sver. geol. Unders. Ser. C, no. 451, p. 32-33, tf. 10; p. 34, tf. 11,4, tf. 10, (by original designation), Turonian, Germany.

Diagnosis.—One keel on the periphery; interiomarginal aperture is intra-umbilical, with sutural apertures.

Subgenus **Thalmanninella** Sigal, 1948

Rev. Inst. Franç. du Petrole etc., vol. III, no. 4, p. 101-102

Subgenotype. — Thalmanninella brotzeni Sigal, Rev. Inst. Franç. du Petrole etc., vol. III, no. 4, p. 102; pl. I, fig. 5 a-c, fig. 6 a-b, 7; (by original designation), Cenomanian, Algeria.

Diagnosis.—One keel on the periphery; interiomarginal aperture is intra-umbilical, with intra-umbilical accessory apertures.

Subgenus **Rotundina** Subbotina, 1953

Fossil Foraminifera U.S.S.R., Moscow, p. 164

Subgenotype.— Globotruncana stephani Gandolfi 1942, Riv. Ital. Pal. XLVIII, no. IV, p. 130-133, pl. III, figs. 4-5; pl. IV, fig. 36-37, 41-45, pl. VI, fig. 4, 6, pl. IX, fig. 5, 8, pl. XIII, fig. 5, pl. XIV, fig. 2; (by original designation), Cenomanian, Switzerland.

Diagnosis.—With or without one keel; interiomarginal aperture is inter-umbilical, no accessory apertures.

Subgenus **Ticinella** Reichel, 1949

Eclog. geol. Helv., vol. 42, no. 2, pp. 600-603

Subgenotype.—Anomalina roberti Gandolfi, 1942, Riv. Ital. Pal. XLVIII, no. IV, pp. 100-101, pl. II, fig. 2, pl. IV, fig. 4-7, 20, pl. V, fig. 1, pl. XIII, fig. 3-6, (by original designation), Aptian-Albian Switzerland.

Diagnosis.—Without keel; interiomarginal aperture is intra-umbilical, umbilical plate is pierced by inter-umbilical apertures.

SYSTEMATICS

Family **GLOBOROTALIIDAE**

Subfamily **GLOBOTRUNCANINAE**

Genus **Globotruncana** Cushman, 1927

Subgenus **Rotalipora** Brotzen, 1942

Globotruncana (Rotalipora) globotruncanoides Sigal, 1948

Plate 18, fig. 1 a-c

1948. *Rotalipora globotruncanoides* Sigal, Rev.

Inst. Franç. du Petrole etc., vol. III, no. 4, pp. 100-101, pl. I, fig. 4a-c, pl. II, fig. 3 a-b, 4 a-b, 5.

1948. *Globorotalia decorata* Cushman and Todd, Contrib. Cushman Lab. Foram. Res., vol. 24, pt. 4, no. 322, p. 97-98.

1952. *Rotalipora globotruncanoides* Sigal, Sigal, XIX Congr. geol. Internat. le Ser., No. 26, p. 26, fig. 24.

This species was described by Cushman and Todd (1948) as *Globorotalia decorata.* It possesses large sutural apertures in the last two chambers. It is identical with the form described previously by Sigal from Algeria and Morocco from Cenomanian beds. The identity of the two species is not obvious when comparing Cushman and Todd's figure of the dorsal side of their holotype with Sigal's sketch of three sides. However, in the topotype material from New Almaden only this form possesses such a distinct ornamentation on the dorsal side except for *Globotruncana* (*Rotalipora*) *evoluta* Sigal which was separated also by Cushman and Todd on the basis of the shape of the test as *Globorotalia almadenensis.* The morphological details of the New Almaden material are consistent with the range of variation as figured by Sigal for *Globotruncana* (*Rotalipora*) *globotruncanoides* (see Sigal, 1948, pl. II, fig. 3 a-b).

Reichel (1949, p. 606) pointed out that *Globotruncana* (*Rotalipora*) *globotruncanoides* Sigal is closely related to *Globotruncana* (*Rotalipora*) *apenninica* (Renz) and probably should be regarded as a subspecies of the latter. However, pending a revision of Gandolfi's provisional subspecies of *Globotruncana* (*Rotalipora*) *apenninica* (Renz), it is better to separate the two species, especially since their stratigraphic ranges are different. Mornod (1948) identified the two species incorrectly in part because his *Globotruncana* (*Rotalipora*) *apenninica* (Renz) differs both from Sigal's and Renz's species in the number of sutural apertures on every suture.

Glaessner (1949, p. 1616) compared *Globorotalia decorata* Cushman and Todd with *Globotruncana ticinensis* Gandolfi and pointed out the similarity with *Globorotalia delrioensis* Plummer. The first comparison is not correct, since according to Reichel (1949, p. 603-604) *Globotruncana ticinensis* Gandolfi possesses the apertural characteristics of a *Thalmanninella,* whereas *Globorotalia decorata* according to my observations is a *Rotalipora.* The second comparison of Glaessner's cannot be accepted because nothing is known of the apertural characteristics of Plummer's species.

Stratigraphic distribution.—Available information is summarized by Sigal (1948, 1952) and Dubourdieu and Sigal (1949). Sigal (1948, 1949) recorded this species from the middle and lower Cenomanian. Dubourdieu and Sigal (1949) made a much more precise statement; the sequence in Algeria is given in terms of ammonite zones and *Globotruncana* (*Rotalipora*) *globotruncanoides* Sigal is shown as ranging from the basal part of the middle Cenomanian (zone with *Acanthoceras mantelli*) into the lower part of the upper Cenomanian (zone with *Acanthoceras rotomagense*).

Depository.—Hypotype, Stanford Univ. Paleo. Type Coll. No. 8306.

Globotruncana (Rotalipora) apenninica apenninica (Renz), 1936

Plate 18, fig. 2 a-c

1936. *Globotruncana apenninica* Renz, Eclog. geol. Helv., vol. 29, no. 1, p. 14, pl. VI, fig. 1-11, pl. VIII, fig. 1

1942. *Globotruncana apenninica* Renz s.str., Gandolfi, Riv. Ital. Pal., XLVIII, no. IV, p. 116-123, figs. 42; 2-3, pl. II, fig. 5 a-d.

1948. *Globotruncana apenninica apenninica* Renz, Cita, Riv. Ital. Pal. LIV, no. III, p. 1-2, pl. III, fig. 1

1949. *Globotruncana* (*Rotalipora*) *apenninica* (O. Renz), Reichel, Eclog. geol. Helv., vol. 42, no. 2, pp. 604-607, pl. XVI, fig. 4, pl. XVII, fig. 4.

1952. *Globotruncana* (*Rotalipora*) *apenninica* Renz var. *typica* Gandolfi, Church, Contrib. Cushman Found. Foram. Res. vol. III, pt. 2, pp. 69-70, fig. 2.

This very characteristic species is represented in our material by one specimen only. This species was not found by Cushman and Todd, but it was mentioned by Church (1952) from the Calera limestone quarry at Rockaway Beach, San Mateo County, California. In using the subspecific name *Globotruncana* (*Rotalipora*) *apenninica apenninica* (Renz) the author follows the procedure of Cita (1948). The subspecies is often cited as *Globotruncana* (*Rotalipora*) *apenninica* var. *typica* Gandolfi, despite the fact that Gandolfi did not propose the varietal name *typica,* but used the word "tipica" (fig. 42) interchangeably with "*s.str.*" (pl. II).

The other nomenclatorially invalid varieties of Gandolfi which were designated *alpha, beta* and *gamma* have, with the exception of *alpha,* been identified as other species:

Globotruncana apenninica Renz var. *alpha* Gandolfi: related to *Thalmanninella* according to Reichel (1949, p. 605).

Globotruncana apenninica Renz var. *beta* Gandolfi: *Globotruncana (Rotundina) stephani* (Gandolfi) *turbinata* (Reichel).

Globotruncana apenninica Renz var. *gamma* Gandolfi: *Globotruncana (Rotalipora) reicheli* Mornod.

Stratigraphic distribution.—*Globotruncana (Rotalipora) apenninica* (Renz) is generally accepted as a marker for the Cenomanian. It has been recorded from the Cenomanian only and according to Sigal it does not pass into the Turonian. Dubourdieu and Sigal (1949) give a stratigraphic range for this species from basal Cenomanian (zone with *Mortoniceras rostratum*) to basal upper Cenomanian (zone with *Acanthoceras rotomagense*) in Algeria.

Depository.—Hypotype, Stanford Univ. Paleo. Type Coll. No. 8307.

Globotruncana (Rotalipora) evoluta

Sigal, 1948

Plate 18, fig. 3 a-c

1948. *Rotalipora cushmani* (Morrow) var. *evoluta* Sigal, Rev. Inst. Franç. du Pétrole etc., p. 100, pl. I, fig. 3 a-c, pl. II, fig. 2 a-b.

1948. *Globorotalia almadenensis* Cushman and Todd, Contrib. Cushman Lab. Foram. Res., vol. 24, pt. 4, no. 322, p. 98, pl. 16, fig. 24.

1949. *Rotalipora cushmani* (Morrow) var. *evoluta* Sigal, Glaessner, Bull. Amer. Assoc. Petrol. Geol., vol. 33, no. 9, p. 1616.

1949. *Globotruncana (Rotalipora) evoluta,* Reichel, Eclog. geol. Helv., vol. 42, no. 2, p. 605, footnote.

The identity of *Globorotalia almadenensis* Cushman and Todd with *Globotruncana (Rotalipora) evoluta* Sigal was indicated by *Glaessner* (1949). The shape of the test varies from long ellipsoidal and flat to short ellipsoidal and high. It was originally described as a variety of *"Globorotalia" cushmani* Morrow, which according to Reichel is closely related to *Rotalipora turonica* Brotzen, whereas the "variety" *evoluta* seems to be a more advanced form of *Globotruncana apenninica* Renz var. *alpha* Gandolfi.

Stratigraphic distribution.—This species so far has been recorded only by Sigal from "the very lowest Cenomanian" of Algeria.

Depository.—Hypotype, Stanford Univ. Paleo. Type Coll. No. 8308

Globotruncana (Thalmanninella) sp.

Plate 18, fig. 4 a-c

This species is represented by one specimen and is put on record because it seems to be the first representative of the subgenus *Thalmanninella* in the Western Hemisphere.

Test biconvex, with an ellipsoidal outline and a broad distinct keel. On the dorsal side 12 chambers are neatly preserved forming the larger part of 2½ whorls. The chambers are separated by distinct raised sutures. On the ventral side 8 chambers are visible in the last whorl. The umbilicus is wide and deep. The last formed chamber forms a plate over part of the umbilicus. The previous chambers have an intra-umbilical aperture and are covered by a small horizontal lip. The interiomarginal aperture at the base of the last-formed chamber is almost half-circular in outline.

Other species of this subgenus differ from our unnamed species in having depressed sutures and no lip-like coverings over the intra-umbilical apertures.

Depository.—Hypotype, Stanford Univ. Paleo. Type Coll. No. 8309.

Subgenus **Rotundina** Subbotina, 1953

In the following the translation of Siemon Wm. Muller of the original Russian text is repeated in full. Originally Subbotina proposed generic rank for *Rotundina;* however, as indicated earlier in this paper the present author favors subgeneric rank.

"Type species: *Globotruncana stephani* Gandolfi, 1942, Cenomanian.

Globotruncana (in part)

Globigerina (in part).

Description.—Test with more or less inflated, sometimes spherical chambers, distinctly separated from each other by incised sutures which on the ventral side are arranged radially. Chambers are always slightly elongate near the umbilicus where a characteristic inflation is often developed. Umbilicus open. Peripheral margin broad and evenly rounded without a keel or with one keel which may disappear on the last chambers or with two keels which in some specimens are only barely discernible.

Aperture is situated near the umbilical ends of the chambers, extending for some distance along the peripheral suture. In all the Rotundinas near the umbilicus a well exposed outgrowth of walls is present. Taken together these outgrowth produce a wide rim (border) surrounding the umbilicus. Wall coarsely spinose and the spines on the ventral side are coarser than the ones on the dorsal. The spines are either scattered uniformly over the entire surface or, in weakly keeled forms, are concentrated dominantly on sutural shoulders of the dorsal side. The Cretaceous genus *Rotundina* is very close to the Paleogene *Acarinina,* which is distinguished by a complete absence of any trace of a keeling and by the presence of a very narrow rim instead of a wide rim around the aperture.

Distribution: Cenomanian—Maastrichtian."

Globotruncana (Rotundina) aumalensis (Sigal), 1952

Plate 18, fig. 5 a-c

1952. *Globigerina aumalensis* Sigal, XIX Congr. géol. Int., 1. Ser., no. 26, p. 28, fig. 29.

This species was only very briefly characterized by Sigal as having a spiral convexity and an indication of a keel. The interiomarginal aperture, a narrow slit at the base of the last formed chamber, is partly situated within the umbilicus. The dorsal side is convex, the ventral side almost flat. In outline this species is almost round and does not have a keel; however, a keel is suggested by the acute angle between the dorsal and ventral side of the chambers of the last whorl.

Originally described as a *Globigerina,* it falls within the scope of the subgenus *Rotundina* Subbotina. This species is closely related to *Globotruncana* (*Rotundina*) *stephani* (Gandolfi) differing only in the absence of a distinct keel and the lack of beaded sutures on the earliest chambers of the spiral side.

At present it is difficult to propose an exact differentiation between these primitive forms and Tertiary Globorotalias (see also Reichel's statement, 1949, p. 609).

Stratigraphic distribution.—According to Sigal (1952) this species is restricted to the middle Cenomanian of Algeria, the only locality where it has been previously recorded.

Depository.—Hypotype, Stanford Univ. Paleo. Type Coll. No. 8310.

Globotruncana (Rotundina) stephani stephani (Gandolfi)

Plate 18, fig. 6 a-c

1936. *Globotruncana apenninica* Renz, Eclog. geol. Helv. vol. 29, p. 501, fig. d.

1942. *Globotruncana stephani* Gandolfi, Riv. Ital Pal. XLVIII, no. IV, p. 130-133, pl. III, fig. 4-5, pl. IV, fig. 36-37, 41-45, pl. VI, fig. 4,6, pl. IX, fig. 5,8, pl. XIII, fig. 5, pl. XIV, fig. 2.

1948. *Globigerina almadenensis* Cushman and Todd, Contrib. Cushman Lab. Foram. Res., vol. 24, pt. 4, no. 322, p. 95-96, pl. 16, fig. 18, 19.

1949. *"Anomalina" roberti* Gandolfi, Glaessner, Bull. Amer. Assoc. Petr. Geol. vol. 33, no. 9, p. 1616.

1949. *Globotruncana* (*Globotruncana*) *stephani* Gandolfi, Reichel, Eclog. geol. Helv., vol. 42, no. 2, p. 608-609, pl. XVI, fig. 6, pl. XVII, fig. 6.

1953. *Rotundina stephani* (Gandolfi), Subbotina, Fossil Foraminifera U.S.S.R., pp. 165-166, pl. II, fig. 5-7, pl. III, fig. 1,2.

Globigerina almadenensis Cushman and Todd was compared with *"Anomalina" roberti* Gandolfi by Glaessner, 1949. These two species differ in the possession of intra-umbilical apertures characteristic for *Ticinella* (see Reichel 1949). The specimen figured here corresponds in all details with the very detailed descriptions of Gandolfi (1942) and Reichel (1949).

Stratigraphic distribution.—Generally the range for this species is given as Cenomanian. In the upper Cenomanian, however, it is replaced by *Globotruncana* (*Rotundina*) *stephani* (Gandolfi) *turbinata* (Reichel). The association of the two subspecies has not yet been recorded, therefore the conclusion seems to be justified that the typical subspecies is restricted to the lower and middle Cenomanian whereas the subspecies *turbinata* is restricted to the upper Cenomanian.

Depository.—Hypotype, Stanford Univ. Paleo. Type Coll. No. 8311.

Globotruncana (Rotundina) californica (Cushman and Todd), 1948

Plate 18, fig. 7 a-c

1942. *Anomalina lorneiana* Orbigny, Gandolfi, Riv. Ital. Pal. XLVIII, no. IV, p. 98-99, pl. II, fig. 1, pl. IV, fig. 1-3,19, pl. VIII, fig. 2, pl. XIII, fig. 1,2,4,5.

1948. *Globorotalia californica* Cushman and Todd, Contrib. Cushman Lab. Foram. Res., vol. 24, pt. 4, no. 322, p. 97-98, pl. 16, fig. 22-23.

1949. *Globotruncana ticinensis* Gandolfi, Glaessner, Bull. Amer. Assoc. Petrol. Geol., vol. 33, no. 9, p. 1616.

This species has a wide range of variation. The holotype, as figured by Cushman and Todd, is almost round in outline and trochoid in the spiral part of the test. There is every intergradation in the New Almaden samples from this type to the more ellipsoidal and planispiral type figured on pl. 18, fig. 7 a-c. No intra-umbilical apertures are present, therefore Glaessner's comparison of *Globorotalia californica* with *Globotruncana* (*Thalmanninella*) *ticinensis* (Gandolfi) cannot be confirmed, although the similarity in every other respect is striking. *Globotruncana* (*Rotundina*) *californica* is not conspecific with the type of *Anomalina lorneiana* Orb. because of the difference in position of the interiomarginal aperture and the lack of an umbilical plate in Orbigny's specimen. However it seems to be conspecific with Gandolfi's material. It appears to be questionable whether the placing of this species in the subgenus *Rotundina* is an improvement over the various other places it occupied. The relationship with the most primitive representative of *Thalmanninella* [*G.*(*T.*) *roberti* (Gandolfi)] is evident, and for this reason it seems to be related to *Globotruncana, s.l.* The choice of placing this species within the recognized subgenera is restricted to *Rotundina* as the only subgenus without supplementary apertures or arched umbilical plate. A close relationship with the other species of *Rotundina* cannot yet be established.

Stratigraphic distribution.—Gandolfi (1942) reports this species from the base of the "Scaglia variegata," which according to the interpretation of Reichel (1947, fig. 11) corresponds to the Albian.

Depository.—Hypotype, Stanford Univ. Paleo. Type Coll. No. 8312.

Genus **Planomalina** Loeblich and Tappan, 1946

Planomalina buxtorfi (Gandolfi), 1942

Plate 18, fig. 8 a-b

1942. *Planulina buxtorfi* Gandolfi, Riv. Ital. Pal., XLVIII, no. IV, p. 103, fig. 35, pl. III, fig. 7, pl. V, fig. 4-5, pl. VI, fig. 1, pl. VIII, fig. 8, pl. IX, fig. 2, pl. XI, fig. 6, pl. XIII, fig. 13, 15.

1948. *Planulina buxtorfi* Gandolfi, Cita, Riv. Ital. Pal., LIV, no. 3, pp. 15-16, pl. II, fig. 13.

1948. *Planomalina ? almadenensis* Cushman and Todd, Contrib. Cushman Lab. Foram. Res. vol. 24, pt. 4, no. 322, p. 98, pl. 16, fig. 25.

1949. *"Planulina" buxtorfi* Gandolfi, Glaessner, Bull. Amer. Assoc. Petrol. Geol., vol. 33, no. 9, p. 1616.

1952. *Planulina buxtorfi* Gandolfi, Sigal, XIX Congr. géol. Intern. I. Ser., no. 26, p. 23, fig. 22.

No criteria are available for separation of *Planomalina buxtorfi* and *Planomalina almadenensis.* This species differs from *Planomalina apisdostroba* Loeblich and Tappan in being less evolute. Contrary to Cushman and Todd's statement, the sutures of *Planomalina buxtorfi* from New Almaden are distinctly raised in well-preserved specimens; in samples taken near the surface they are frequently weathered off.

Stratigraphic distribution.—Gandolfi (1942) recorded this species from the "Scaglia bianca" which according to Reichel (1947, fig. 11) comprises the top Albian and basal Cenomanian. An identical range was given by Cita (1948) and Sigal (1952) for their sections near Lake Gardia in northern Italy and Algeria respectively.

Depository.—Hypotype, Stanford Univ. Paleo. Tpe Coll. No. 8313.

Genus **Globigerina** Orbigny, 1826

Globigerina sp.

Plate 18, fig. 9 a-c

1948. *Globigerina* sp., Cushman and Todd, Contrib. Cushman Lab. Foram. Res., vol. 24, pt. 4, no. 322, p. 96, pl. 16, fig. 17.

This species was briefly mentioned by Cushman and Todd (1948) as being represented by only two specimens. Only one specimen has been found in our collections.

This unnamed species is extremely high spired for the genus *Globigerina,* all the chambers are about of equal height after the first whorl. The umbilicus is deep, however it is impossible to observe any chamber communications into the umbilicus. The assignment to the genus *Globigerina* is definitely tentative. No similar species are known to the author.

Depository.—Hypotype, Stanford Univ. Paleo. Type Coll. No. 8314.

REFERENCES

Bandy, O. L., 1951. Upper Cretaceous Foraminifera from the Carlsbad Area, San Diego County, California. Jour. Paleont. vol. 25, no. 4, pp. 488-513, pls. 72-75, 2 textfigs.

Bermudez, P. J., 1952, Estudio sistematico de los Foraminiferos rotaliformes. Bol. Geologia, Caracas, Venezuela, vol. II, no. 4, 230 pp., 35 plates.

Brotzen, F., 1936, Foraminiferen aus dem schwedischen untersten Senon von Eriksdal in Schonen. Sveriges geol. Unders. ser. C, No. 396, Arsbok 30, no. 3, 206 pp, 69 textfigs., 14 pl.

Brotzen, F., 1942, Die Foraminiferengattung *Gavelinella* nov. gen. und die Systematik der Rotaliformes. *Ibid.*, no. 451, Arsbok 36, no. 8, pp. 1-60, 1. pl., 18 textfigs.

Church, C. C., 1952, Cretaceous Foraminifera from the Franciscan Calera Limestone of California. Contrib. Cushman Found. Foram. Res., vol. III, pt. 2, pp. 68-71, 2 textfigs.

Cita, M. B., 1948. Ricerce stratigrafiche sul Cretacicoe sull'Eocene di Tignale (Lago di Gardia.) Riv. Ital. Pal. vol. 54, pp. 49-74, 117-133, 143-168, 2 figs. 2 pls.

Cushman, J. A., 1926, Some Foraminifera from the Mendez shale of Eastern Mexico. Contrib. Cushman Lab. Foram. Res., vol. 2, pt. 1, no. 26, pp. 16-24, pls. 2-3.

Cushman, J. A., 1927, An outline of a reclassificaion of the Foraminifera. *Ibid.*, vol. 3, pt. 1, no. 39, 104 pp. 21 pls.

Cushman, J. A., & Todd, R., 1948, A foraminiferal fauna from the New Almaden District, California. *Ibid.* vol. 24, pt. 4, no. 322, pp. 90-98, pl. 16, figs. 4-25.

Davis, E. F., 1918, The Franciscan Sandstone. Bull. Dept. Geol. Univ. Calif. Pub., vol. 11, no. 1, pp. 1-44.

Dubourdieu, G. & Sigal, J., 1949, Notes stratigraphiques et paléontologiques sur la région du Dj. Ouenza (Algérie), Aptien, Albien, Cenomanian Bull. Soc. géol. France, (5), tome XIX, pp. 205-221, 3 figs., 1 pl.

Fairbanks, H. W., 1895, The stratigraphy of the California Coast Ranges. Jour. Geol., vol. 3, pp. 415-433, 1 fig.

Glaessner, M. F., 1949, Foraminifera of Franciscan (California). Bull. Amer. Assoc. Petrol. Geol., vol. 33, no. 9, pp. 1615-1617.

Goudkoff, P. P., 1945, Stratigraphic relations of Upper Cretaceous in Great Valley, California. *Ibid.*, vol. 29, No. 7, pp. 956-1007, 17 figs.

Lawson, A. C., 1915, U.S. Geological Survey Atlas, San Francisco Folio, no. 193.

Loeblich, A. R. Jr., & Tappan, H., 1946, New Washita Foraminifera. Jour. Paleont., vol. 20, no. 3, pp. 238-258, 3 pls., 4 textfigs.

Mornod, L., 1949, Les Globorotalidés du Crétacé supérieur du Montsalvens (Préalpes fribourgeoises). Eclog. geol. Helv., vol. 42, no. 2, pp. 573-596, 14 textfigs, 1. pl.

Nomland, J. O., & Schenck, H. G., 1932, Cretaceous beds at Slate's Hot Springs, California. Univ. Calif. Publ. Bull. Dept. Geol. Sci., vol. 21, no. 4, pp. 27-49.

Reichel, M., 1047, Les Hantkeninidés de la Scaglia et des Couches Rouges (Crétacé supérieur). Eclog. geol. Helv., vol. 40, no. 2, pp. 391-409, 1 pl., 11 textfigs.

Reichel, M., 1949, Observations sur les Globotruncanas du Gisement de la Breggia (Tessin). *Ibid.*, vol. 42, no. 2, pp. 596-617, 2 plates, 7 textfigs.

Renz, O., 1936, Stratigraphische und mikropaläontologische Untersuchungen der Scaglia (Obere Kreide-Teriär) im zentralen Apennin, *Ibid.*, vol. 29, no. 1, pp. 1-149, 14 textfigs, 15 plates.

Renz, O., 1936, Über Globotruncanen im Cenomanien des Schweizerjura. *Ibid.* vol. 29, no. 2, pp. 500-503, 1 textfig.

Sigal, J., 1948, Notes sur les genres de foraminifères *Rotalipora* Brotzen 1942 et *Thalmanninella.* Rev. Inst. Franc. Pétrole et Ann. Combust. Liquides, vol. 3, no. 4, pp. 95-102, 2 plates.

Sigal, J., 1952, Aperçu stratigraphique sur la micropaléontologie du Crétacé. XIX Congr. Géol. Internat., 1. Ser., no. 26, pp. 3-45, 1 table, 46 textfigs.

Subbotina, N. N., 1953, Fossil Foraminifera from the U.S.S.R., Globigerinidae, Hantkeninidae and Globorotaliidae (In Russian). Trudy Vses. Neft. Naukno-Issledov. Geol.-Razved. Inst. n.s. 76, 296 pp., 41 pls.

Thalmann, H. E., 1942, *Globotruncana* in the Franciscan Limestone, Santa Clara County, California. Geol. Soc. Amer., Bull. vol. 53, no. 12, p. 1838.

Thalmann, H. E., 1943, Upper Cretaceous age of the "Franciscan" limestone near Laytonville, Mendocino County, California. *Ibid.* vol. 54, no. 12, p. 1827.

Walker, G. W., 1950, The Calera limestone in San Mateo and Santa Clara Counties, California. Calif. Div. Mines, Special Report 1-B, 8 pp., 1 map, 6 textfigs.

CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH

VOLUME VI, PART 3, JULY, 1955

139. LAMARCKINITA, NEW NAME, REPLACING RUTTENELLA KEYZER, 1953 (NON RUTTENELLA VAN DEN BOLD, 1946)

F. G. KEYZER
Venezuelan Atlantic Refining Company, Caracas, Venezuela

C. W. Drooger, F. C. Dilley, and Hans E. Thalman kindly informed me that the genus name *Ruttenella* which I proposed for a foraminiferal genus in 1953, is preoccupied by W. A. van den Bold, 1946, for a genus of the Ostracoda. The following new name is, therefore, substituted:

LAMARCKINITA, new name for *Ruttenella* Keyzer, 1953, Leidse Geologische Mededeel., vol. 17, p. 279, non *Ruttenella* van den Bold, 1946, Proefschrift (Thesis), Rijks-Universiteit Utrecht, p. 84. The type species is *Lamarckinita butonensis* (Keyzer, 1953), *loc.cit.*, p. 280, pl. 4, figs. 11-16, from the Mio-Pliocene of Buton, Indonesia.

My thanks are due to Miss Ruth Todd and Hans E. Thalmann for checking the availability of the new proposed name.

CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH

VOLUME VI, PART 3, JULY, 1955

140. A NEW NAME FOR AN EOCENE FORAMINIFER FROM THE UPPER LONDON CLAY OF THE ISLE OF WIGHT, ENGLAND

R. N. C. BOWEN
Department of Geology, University College, Exeter, England

I am indebted to Hans E. Thalmann for directing my attention to the possibility of confusion between *Nodosaria subcanaliculata* (Neugeboren) var. *spinescens* Bowen, 1954 and *Nodosaria spinescens* (Reuss) described in 1851 under the generic name of *Dentalina.*

The following new name is, therefore, proposed for the former: *Nodosaria subcanaliculata* (Neugeboren) var. *neospinescens* Bowen, new name; for: *Nodosaria subcanaliculata* (Neugeboren) var. *spinescens* Bowen, 1954, in Proc. Geologists' Assoc., vol. 65, pt. 2, p. 155, fig. B-9, from the upper Londay Clay of Whitecliff Bay, Isle of Wight, England.

CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH

VOLUME VI, PART 3, JULY, 1955

RECENT LITERATURE ON THE FORAMINIFERA

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

AKERS, W. H. Planktonic Foraminifera, suggested means of correlating Gulf coastal and West Indian Neogene sediments.—Trans. Gulf Coast Assoc. Geol. Soc., vol. 4, Nov. 1954, pp. 169-180, text figs. 1-3. —The ranges or lowest levels of five planktonic species seem to provide ties of contemporaneity between the Gulf Coast and the West Indies: **Globigerinatella insueta, Globorotalia mayeri, G. fohsi, G. menardii,** and **Orbulina.** Direction of coiling may provide a refinement of correlation within the limited ranges of the coiled species.

AUROUZE, GERMAINE, and de KLASZ, IVAN. Sur la présence de Schackoïnes dans le Cretace Supérieur de France, de Bovière et de Tunisie.—Bull. Soc. Geol. France, 6 ser., vol. 4, ann. 1954, pp. 97-103, pl. VIa, text fig. 1.

BOLTOVSKOY, ESTEBAN. Foraminiferos del Golfo San Jorge.—Rev. Instit. Nac. Invest. Ciencias Nat. y Mus. Argentino, Ciencias Geol., vol. 3, No. 3, 1954, pp. 85-228, pls. 1-19, map, photographs.—A cold water, depauperate fauna obtained from 9 short cores: 148 species and subspecies, 6 new and one new name.

Foraminiferos de la Bahia San Blas.—Rev. Instit. Nac. Invest. Ciencias Nat. y Mus. Argentino Ciencas Geol., vol. 3, No. 4, 1954, pp. 247-300, pls. 20-29, text fig. 1 (map).—A monotonous and impoverished fauna from 5 to 25 m., with **Eponides frigidus** comprising 40% of the fauna. Only 104 species and subspecies encountered, one new.

CHANG, LI-SHO. Microfossils from the cores of the exploratory bore hole No. 2 near Liuchangli, Taipei, and their stratigraphic significance.—Formosan Mining Industry, vol. 6, No. 4, Febr. 1955, pp. 18-24, pls. 1, 2, text figs. 1, 2, table 1.—Pliocene Foraminifera are listed and illustrated.

CHATTERJI, A. K. On an abnormal type of Tryblio-lepidine-nucleoconch from Australia.—Current Science, Dec. 1954, vol. 23, pp. 395-396, text fig. 1. —A double protoconch.

CITA, M. B. Osservazioni micropaleontologiche su alcuni campioni raccolti nei conglomerati terziari dela Bresciano.—Riv. Ital. Pal. Stratig., vol. 60, No. 4. 1954, pp. 213-219.

COLOM, G. Les Moronites du Détroit Nord-Betique (Espagne).—Congr. Geol. Internat. C.R. 19th Sess. Alger 1952, Sec. 13, fasc. 13, 1954, pp, 25-33 text figs. 1-3. (paleographic maps).

Sur la prèsence de gisements èocenes sous-marins en face du Cap Toriñana (Galicie).—Congr. Geol. Internat. C. R. 19th Sess. Alger 1952, Sec. 13, fasc. 13, 1954, pp. 289-292, 1 text fig.—Lutetian forams from submarine outcrop off NW Spain.

La sedimentacion pelagica de la isla de Maio (Archipelago de Cabo Verde) y sus equivalentes Mediterraneos (Malm-Neocomiense).—Bol. R. Soc. Española Hist. Nat., Tom. Hernández-Pacheco, 1954, pp. 179-192, pls. 8-12, text fig. 1 (map).

COLOM, GUILLERMO, CASTANY, GILBERT, and DURAND DELGA, MICHEL. Microfaunes pélagiques (Calpionelles, Fissurines) dans le NE de la Berbérie.—Bull. Soc. Geol. France, ser. 6, tome 3, 1953, pp. 517-534, text figs. 1-10.—The planktonic "Fissurines" (**Orbulinaria, Oligostegina**) have an uncertain systematic position, possibly in the Foraminifera.

COOKSON, ISABEL C., and SINGLETON, O. P. The preparation of translucent fossils by treatment with hydrofluoric acid.—Geol. Soc. Australia, News Bull., vol. 2, No. 1, March 1954, pp. 1, 2.

CURTIS, NEVILLE MACKAY, JR. Paleoecology of the Viesca member of the Weches formation at Smithville, Texas.—Journ. Pal., vol. 29, No. 2, March 1955, pp. 263-282, pls. 30, 31, text figs. 1-5.—Oscillation through four depth zones from 1 to 100 meters is recognized, principally on the inverse frequency relationship of **Quinqueloculina claiborniana** and **Siphonina claibornensis.** Twenty-one species, many illustrated, are discussed and their changing frequencies recorded.

DALEON, BENJAMIN A., and MANALAC-SOMANIEGO, REMEDIOS. Some small Foraminifera from the upper Miocene of Siquijor Island.—The Philippine Geologist, vol. 8, No. 4, Sept. 1954, pp. 99-121 (mimeographed). pl. 1, distribution table—Distribution and abundance in beds of Tertiary f and g age is indicated for 96 species, only 41 of which are identified or tentatively identified.

DROOGER, C. W. **Miogypsina** in northwestern Morocco.—Proc. Kon. Nederl. Akad. Wetenschappen, ser. B, vol. 57, No. 5, 1954, pp. 580-591, text figs. 1, 2.

The Oligocene-Miocene Boundary on both sides of the Atlantic.—Geol. Mag., vol. 91, No. 6, Nov.-Dec. 1954, pp. 514-518, text fig. 1.—Miogypsinid evidence on the question.

EAMES, F. E. The Miocene/Oligocene Boundary and the use of the term Aquitanian.—Geol. Mag., vol. 90, No. 6, Nov.-Dec. 1953, pp. 388-392.—Proposes to regard all **Orbulina-** and **Miogypsina**-bearing beds as post-Oligocene

The Caribbean "Oligocene".—Geol. Mag., vol. 91, No. 4, July-Aug. 1954, pp. 326, 327.

ERICSON, DAVID B., WOLLIN, GOESTA, and WOLLIN, JANET. Coiling direction of **Globorotalia truncatulinoides** in deep-sea cores.—Deep-Sea Research, vol. 2, 1954, pp. 152-158, pl. 1, text figs. 2-4.—The North Atlantic is divisible into provinces distinguished by dominance of right or left coiling. Changes in coiling ratio in cores mark zones useful for precise correlation.

FARIOLI, A. Ricerche micropaleontologiche sul Calabriano di S. Colombano al Lambro (Milano).—Riv. Ital. Pal. Stratig., vol. 60, No. 4, 1954, pp. 221-246, pls. 8-10, tables 1-4.—The Italian Calabrian records are compiled in a table. A few species are illustrated.

GLAESSNER, MARTIN F. Taxonomic, stratigraphic and ecologic studies of Foraminifera, and their interrelations.—Micropaleontology, vol. 1, No. 1, Jan. 1955, pp. 3-8.

GOTZINGER, G. Die Flyschzone, Gesteine und stratigraphische Stellung, in Erläuterungen zur geologischen Karte der Umgebung von Wien, by Götzinger et al.—Austria Geol. Bundes., 1954, pp. 43-64, pl. 7 (by R. NOTH).—Foraminifera are listed and illustrated.

GRILL, R. Die Flyschausläufer nördlich der Donau, in Erläuterungen zur geologischen Karte der Umgebung von Wien, by Götzinger et al.—Austria Geol. Bundes., 1954, pp. 93-97.—Foraminifera are listed.

Das Inneralpine Wiener Becken nördlich der Donau, in Erläuterungen zur geologischen Karte der Umgebung von Wien, by Götzinger et al.—Austria Geol. Bundes., 1954, pp. 132-138, pl. 13, table 4.—Tortonian and Sarmatian are zoned by Foraminifera and numerous species are illustrated.

HAGN, HERBERT. Zur Kenntnis alpiner Eozän-Foraminiferen III. **Eorupertia cristata** (Gümbel).—Pal. Zeitschrift, Band 29, Nr. 1/2, March 1955, pp. 46-73, pls. 4-6, text figs. 1, 2.—Study of canal system and other internal structures of this species and the evolutionary position of **Eorupertia.**

HOFKER, J. Uber die familie Epistomariidae (Foram.). —Palaeontographica, Band 105, Abt. A, 1954, pp. 166-206, text figs. 1-56. Four genera, 3 new, are discussed: **"Höglundina, Brotzenia,** n.gen. (genotype **Epistomina spinulifera** Reuss), **Hiltermannia,** n.gen. (genotype **Epistomina chapmani** ten Dam), and **Voorthuysenia,** n.gen. (genotype **Epistomina tenuicostata** Bartenstein). Twenty-four species, 8 new, are described and illustrated. Evolutionary relationships and stratigraphic ranges are indicated.

The forming of species of Foraminifera during the Upper Cretaceous.—Arch. Neerland. Zool., Tome 10, 4e livr., 1954, pp. 516-518.—Modes of alteration of species into new species.

Foraminifera of southern Limburg, Netherlands. I.—Natuur. Maandblad, 44e Jrg., No. 1-2, Feb. 25, 1955, pp. 4, 5, text figs. a-e.—**Cibicides roestae** Visser belongs in **Lockhartia.**

ISRAELSKY, M. C. Foraminifera of the Lodo formation, central California. Part 2. Calcareous Foraminifera (Miliolidae and Lagenidae, part).—U.S. Geol. Survey Prof. Paper 240-B, March 29, 1955, pp. 31-79, pls. 12-19, 1 distribution table, text fig. 3.—One miliolid and 169 species of three lagenid genera: **Cristellaria, Robulus,** and **Hemirobulina,** are described and illustrated and their stratigraphic distribution recorded. Only one of the species was found comparable with an already known species, 69 are new, and 100 are, because of their rarity, designated by letters.

KITAGAWA, YOJI, and NIINO, HIROSHI. On the submarine geology of an area from Yotsukura to Hitachi in the Joban Coal Field.—Bull. Geol. Survey Japan, vol. 5, No. 6, June 1954, pp. 27-34, text figs. 1, 2 (maps), photograph of foraminifer, distribution table. (In Japanese with English abstract).—A study of Recent bottom samples in which are listed 50 species, none new.

KUGLER, H. G. Jurassic to Recent sedimentary environments in Trinidad.—Bull. Assoc. Suisse Geol. et Ing. du Pétrole, vol. 20, No. 59, Dec. 31, 1953, pp. 27-60, table, map, section.

The Miocene/Oligocene Boundary in the Caribbean Region.—Geol. Mag., vol. 91, No. 5, Sept.-Oct. 1954, pp. 410-413.—Proposes to place the boundary at the base of the **Globorotalia fohsi** zone.

PAPP, A. Morphologisch-genetische Untersuchungen an Foraminiferen.—Pal. Zeitschrift, Band 29, Nr. 1/2, March 1955, pp. 74-78, text fig. 1.—Based on a **Pseudorbitoides-Lepidorbitoides** series in the upper Senonian. One new subspecies is illustrated.

PETTERS, V. Development of Upper Cretaceous foraminiferal faunas in Colombia.—Journ. Pal., vol. 29, No. 2, March 1955, pp. 212-225, text figs. 1-7 (maps, charts).—Seven faunas between Turonian and Maestrichtian, with interpretation of their paleoecology and correlation.

PROTO DECIMA, F., and FERASIN, F. Nuove specie di Foraminiferi nell' Eocene del Monte Ceva (Colli Euganei).—Riv. Ital. Pal. Stratig., vol. 60, No. 4, 1954, pp. 247-252, pl. 11, text fig. 1.—Five species and two varieties.

RENZ, H. H. Some Upper Cretaceous and Lower Tertiary Foraminifera from Aragua and Guárico, Venezuela.—Micropaleontology, vol. 1, No. 1, Jan. 1955, pp. 52-71, pls. 1-8, text fig. 1 (map).—Nineteen species, 7 indeterminate, of larger Foraminifera are described and illustrated in thin section.

RUSCELLI, M. Rettifica di nomenclatura di Foraminiferi per omonimia.—Riv. Ital. Pal. Stratig., vol. 60, No. 4, 1954, p. 257.—**Cibicides mexicanus** Nuttall var. **dertonensis** n. name for var. **miocenicus** Ruscelli 1953.

SCHWEIGHAUSER, JAKOB. — Mikropaläontologische und stratigraphische Untersuchungen im Paleocaen und Eocaen des Vicentin (Norditalien).—Schweiz. Pal. Abhandl., vol. 70, 1953-54, pp. 1-97, pls. 1-13, text figs. 1-59.—Twenty-five species and one variety in the genera **Discocyclina** and **Asterocyclina** are described and illustrated as free specimens and in section. In addition, random rock sections illustrate these and other larger Foraminifera.

SMOUT, ALAN HILDER. Lower Tertiary Foraminifera of the Qatar Peninsula.—British Museum (Natural History), Febr. 1954, pp. i-ix, 1-96, pls. 1-15, text figs. 1-44.—Test structure and family relationships are discussed, particularly for 10 genera in the amended super-family Rotaliidea. A new super-family Discorbidea is proposed. Fourteen genera, 3 new, and 36 species and varieties, 20 new, are described and illustrated, both as free specimens and in section. **Kathina** (type **K. delseota,** n.sp.), **Dictyokathina** (type **D. simplex,** n.sp.), and **Daviesina** (type **D. khatiyahi,** n.sp.) all in the Rotaliidae.

SPERRAZZA, J. Distribution of Foraminifera, in Reefs and sedimentary processes of Raroia, by Norman D. Newell.—Atoll Research Bull. No. 36, Nov. 30, 1954, pp. 27-32, table 1, text fig. 5.—Table showing occurrence and bathyal distribution of lagoon Foraminifera.

STAINFORTH, R. M. Comments on the Caribbean Oligocene.—Geol. Mag., vol. 91, No. 2, March-April 1954, p. 175.

TAI, Y. Miocene Foraminifera from the Syobara Basin, Hiroshima Prefecture.—Journ. Sci., Hiroshima Univ., ser. C. (Geol.), vol. 1, No. 3, Oct. 1953, pp. 1-9, text figs. 1-5, table 1.—The changing composition of the fauna (88 species) through ten horizons is graphically illustrated and interpreted ecologically.

THOMAS, G. A., and DICKINS, J. M. Correlation and age of the marine Permian formations of Western Australia.—Australian Journ. Sci., vol. 16, No. 6, June 1954, pp. 219-223, text figs. 1-3.

TROELSEN, J. C. **Globotruncana contusa** in the White Chalk of Denmark.—Micropaleontology, vol. 1, No. 1, Jan. 1955, pp. 76-82, text figs. 1, 2.—Supporting evidence of a warm-water phase in the Baltic area toward the end of Maestrichtian time.

VASICEK, MILOSLAV. Changes in the ratio of sinistral and dextral individuals of the foraminifer **Globorotalia scitula** (Brady) and their use in stratigraphy. —Sbornik Ustred. Ustavu Geol., Svasek XX, 1953, pp. 345-420, pl. 1, tables.—Application of the ratio-change method to zoning and correlation in the Tortonian of Moravia. Discussion of some of the possible factors that determine coiling direction and distort the measurement of it. Coiling ratio varies both in time and regionally. Chance coiling probably does not exist. Ratio changes are probably a result of environmental changes. Alteration of micro- and megalospheric generations as related to climatic seasons is suggested as a possible mechanism by which environment causes ratio changes.

VINOGRADOV, A. P. The elementary chemical composition of marine organisms.—Mem. No. 2, Sears Found. Marine Res., 1953, Sec. I of Chap. VI, Foraminifera, pp. 164-171.

VAN DER VLERK, I. M. Correlation of the Tertiary of the Far East and Europe.—Micropaleontology, vol. 1, No. 1, Jan. 1955, pp. 72-75, tables 1, 2.—Discussion of present limits of correlation.

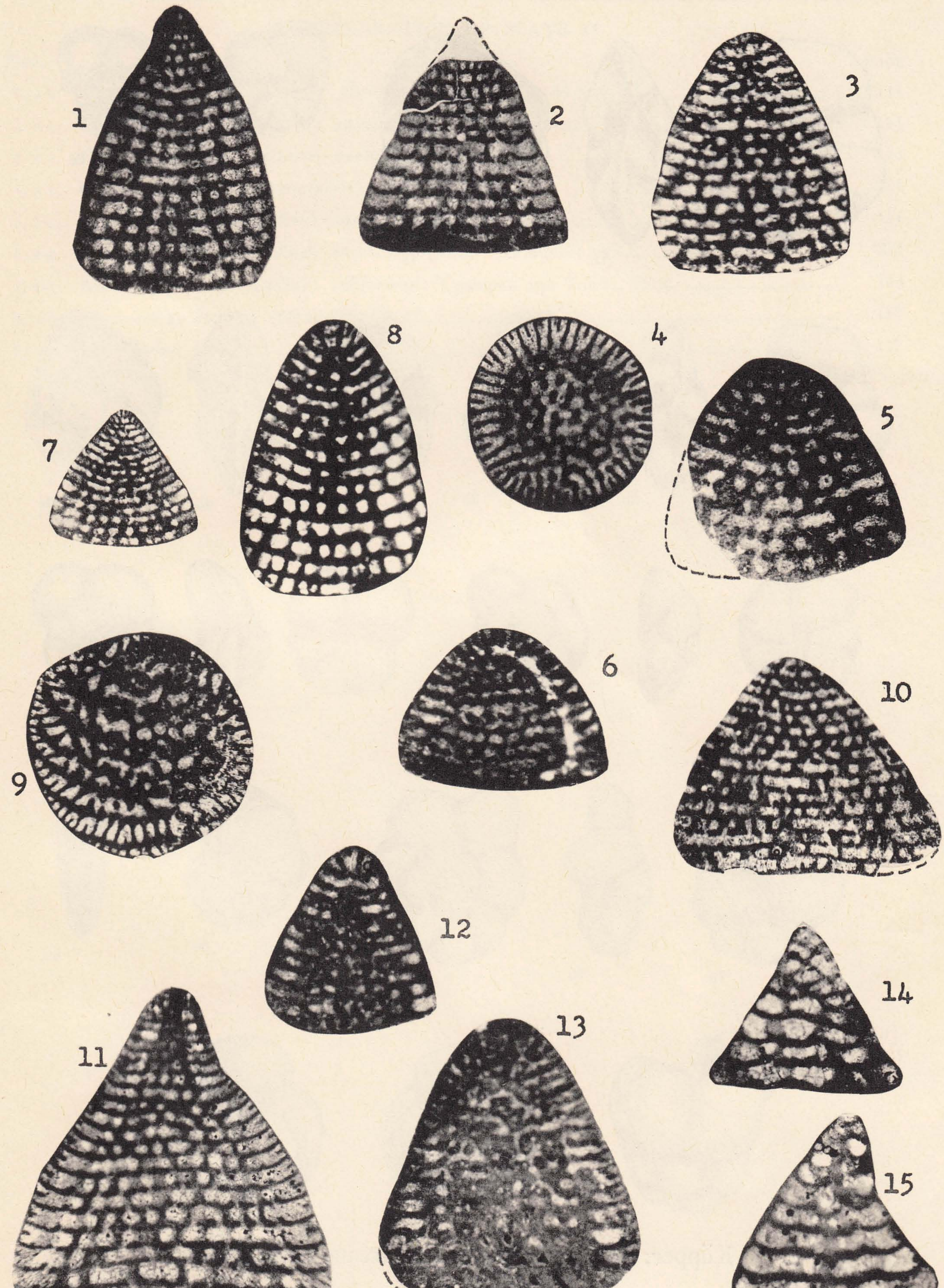
YOSHIDA, SABRO. Studies on the Foraminifera of brackish waters. III. The Foraminifera of Lake Saroma.—Geol. Min. Instit., Tokyo Univ. Educ., Kawada Mem. Vol., Aug. 31, 1954, pp. 149-158, 1 pl., text figs. 1-4 (maps), tables 1-7.—The fauna consists of 26 species; 8 occur abundantly. Distribution and abundance are recorded. Nine species are illustrated.

ZEI, MARIA MONCHARMONT. I foraminiferi della scogliera a **Cladocora caespitosa** della Punta delle Pietre Nere presso il lago di Lesina, in provincia di Foggia.—Rend. Accad. Sci. Soc. Naz. Napoli, ser. 4, vol. 21, 1954, pp. 1-26, pls. 1-3.—Ninety-three species, none new, most of them figured.

La microfauna delle argille pleistoceniche di Cutrofiano (Lecce).—Boll. Soc. Nat. Napoli, vol. 63, 1954, p. 1-28, 1 pl.—Sixty-three species, none new.

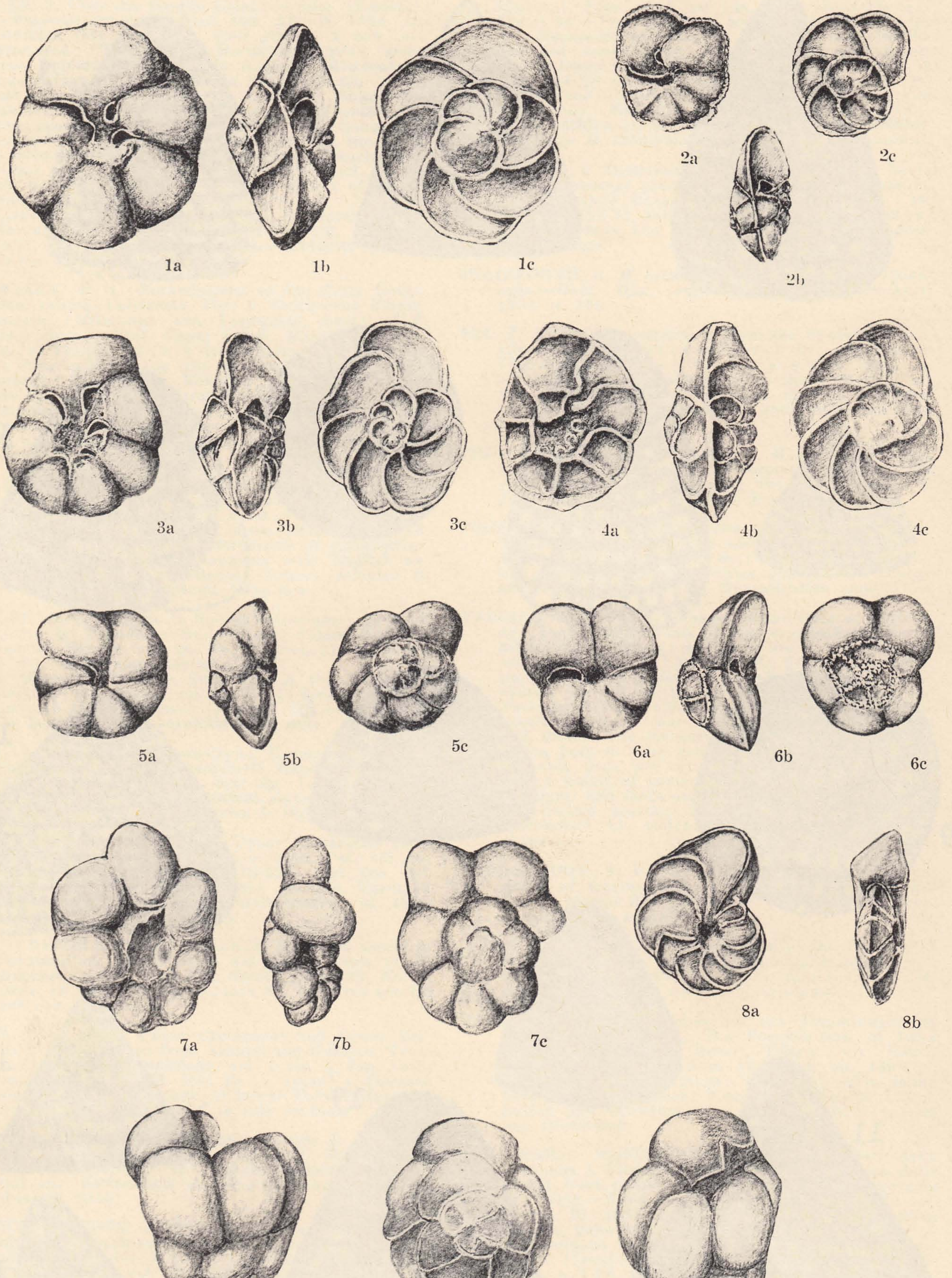
Sulla presenza del gen. **Globotruncana** Cush. in una serie calcareo-marnosa a liste di selce presso Rodi Garganico (Foggia).—Boll. Soc. Nat. Napoli, vol. 63, 1954, pp. 63, 64, 1 pl.

RUTH TODD



Maync: *On Coskinolina sunnilandensis*, n. sp.

Explanation of Plate 17 on page 111



Küpper: California Upper Cretaceous Foraminifera

EXPLANATION OF PLATE 18

FIGS.		PAGE
1, a-c.	*Globotruncana* (*Rotalipora*) *globotruncanoides* Sigal, 45 ×	114
2, a-c.	*Globotruncana* (*Rotalipora*) *apenninica apenninica* (Renz), 45 ×.	114
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8, a-b.	*Planomalina buxtorfi* (Gandolfi), 45 ×.	117
9, a-e.	*Globigerina* sp., 45 ×.	117