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IN MEMORIAM

José Royo y Gomez
(1895-1961)

Ralph A. Liddle
(1897-1963)

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ILLUSTRATIONS OF CONFLICTING INTERPRETATIONS OF THE BIOLOGY AND CLASSIFICATION OF CERTAIN LARGER FORAMINIFERA

By

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CONTENTS

ILLUSTRATIONS OF CONFLICTING INTERPRETATIONS OF THE BIOLOGY AND CLASSIFICATION OF CERTAIN LARGER FORAMINIFERA*

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ABSTRACT

Conflicting concepts concerning the development and significance of certain internal structures and of variability in selected species of larger Foraminifera are discussed. Multilocular embryonic chambers are the result of irregularities in the reproductive cycle, and it is emphasized that they can not be used in defining a genus or subgenus, or in stratigraphic determinations. *Pliolepidina* H. Douvillé, 1917, and *Triplalepidina* Vaughan and Cole, 1938, are considered to be synonyms of *Lepidocyclina s. s.* The significance of the variability in shape and size of bilocular embryonic chambers and of stolon systems in classification is illustrated and analyzed. Variation in individual specimens of species is demonstrated by an analysis of numerous specimens of *Lepidocyclina pustulosa* H. Douvillé, *L. radiata* (Martin), and *Helicostegina polygyralis* (Barker). Additional synonyms of *L. pustulosa* are given and defended.

INTRODUCTION

Three extensive publications (Eames, *et al.*, 1962*a*, *b;* Hanzawa, 1962) have appeared recently in which descriptions of the internal structure of many of the larger Foraminifera are given, and the significance of these structures in classification and nomenclature is analyzed. Eames, *et al.* (1962*a*, *b*) restricted their attention mainly to the camerinids and lepidocyclines in one publication (1962*a*) and to the lepidocyclines exclusively in the other (1962*b*). Hanzawa (1962) reviewed and revised the classification of many of the significant genera of Cretaceous and Tertiary larger Foraminifera. Perusal of these discourses will reveal that there is little, if any, consensus.

During the past few years Cole published several articles in the *Bulletins of American Paleontology*, *Contributions from the Cushman Foundation for Foraminiferal Research*, and *Micropaleontology* in which the variability in internal structures between individual specimens has been emphasized. Moreover, an attempt was made to relate the development of certain structures, such as

*The cost of the printed plates was supplied by the William F. E. Gurley Foundation for Paleontology of Cornell University. Richard Margerum, departmental laboratory technician, assisted me greatly by patiently preparing a vast number of specimens. I acknowledge my indebtedness to him for this service.

multilocular embryonic chambers, to ontogeny (Cole, 1960*a*, p. 134; 1962*a*, p. 39).

Therefore, there has been published in a short space of time three divergent revisions of the classification of many of the larger Foraminifera. As certain concepts which have been emphasized are completely at variance, this article has been prepared in an attempt, not only to clarify, but also to establish more firmly, certain basic biologic and taxonomic facts regarding certain larger Foraminifera. No effort is made in this discourse to refute every concept and identification with which Eames, *et al.* (1962*a, b*) and Hanzawa (1962) dealt. However, certain of their major conclusions, which seemingly are based upon misconceptions, will be examined in detail.

Cole (1962*a*, p. 29) wrote: "It is evident that many paleontologists tend to neglect the biology of species, depending upon form alone in developing classifications. Moreover, some of these paleontologists seemingly refuse to accept even a limited degree of plasticity or variation in individuals of a species. Such rigidity has led to the erection of many superfluous specific, subgeneric, and generic names."

In contradistinction Hanzawa (1962, p. 130) wrote: ". . . it is often difficult to locate a boundary between some distinguishable structural elements or within a similar structural element, because everything in nature is gradational. Recognition of the range of variability by paleontologists is at best inconsistent."

Hanzawa admitted that variability does occur but seemingly he denied that any use could be made of the recognition of variability in the development of a classification. Therefore, he (Hanzawa, 1962, p. 130) could argue that *Nephrolepidina* and *Eulepidina* should be retained as they had ". . . been distinguished as two distinct subgenera of the genus *Lepidocyclina* by various authors for half a century."

Hanzawa (1962, p. 138) not only retained the names *Nephrolepidina* and *Eulepidina* but also elevated them from subgeneric to generic rank. Cole (in Cole, *et al.*, 1960, p. 101) on the other hand stated that ". . . as embryonic chambers of the nephrolepidine and eulepidine shape intergrade and both shapes are found in specimens assigned to a single species, these two subgenera are combined."

Eames, *et al.* (1962*b*, p. 300, 301) placed all the lepidocycline species with multilocular embryonic chambers in the genus *Pliolepidina* H. Douvillé, 1917, stating that this genus is restricted to "Aquitanian to Burdigalian or (?) Vindobonian." Hanzawa (1962, p. 136, 137) recognized two genera, *Pliolepidina* H. Douvillé, 1917, and *Multilepidina* Hanzawa, 1932, in which multilocular embryonic chambers develop. He (Hanzawa, 1962, Chart 1) gave the stratigraphic range of *Pliolepidina* as upper Eocene and that of *Multilepidina* as Burdigalian.

Cole (1960*a*; 1961*a*; 1962*a*) had postulated that multilocular embryonic chambers could most reasonably be interpreted as the result of irregularity in the reproductive cycle. Thus, any species could contain individuals with multilocular embryonic chambers, whereas other individuals would have bilocular embryonic chambers. If this is correct, it is obvious that multilocular embryonic chambers can not be used to characterize a genus.

Moreover, and even more important from the stratigraphic viewpoint, is the necessity for a correct interpretation to be made concerning the development of multilocular embryonic chambers! If the concept presented by Cole (1960*a*; 1961*a*; 1962*a*) is accepted, specimens with multilocular embryonic chambers can occur in any geographic area and at any stratigraphic position within the entire geographic and stratigraphic range of a genus or a species.

However, if multilocular embryonic chambers characterize a species or group of species, this kind of chamber must be genetically controlled. Therefore, such species logically should be placed in a distinct subgenus or genus which would have a definite stratigraphic range and might be geographically restricted.

Paleontology should be more than an empirical study. As data accumulate from observation of abundant material, and as the life histories of species still living become known, it is imperative that the data from all these sources be correlated and interpreted. Direct proof by observation of living specimens of the lepidocyclines that individuals of a species in their reproductive cycle produce progeny with multilocular and bilocular embryonic chambers is impossible as the lepidocyclines are extinct.

However, if the data are sufficiently abundant, a less direct approach than actual observation of the reproductive cycle may be used. Thus, the association in a single specimen of multilocular and bilocular embryonic chambers is accepted here as proof that the bilocular embryonic chambers are the inheritable kind, whereas the multilocular kind are the result of some irregularity in the reproductive cycle. Although a detailed discussion of the association of bilocular and multilocular embryonic chambers and the interpretation of this kind of association has been published previously (Cole, 1962*a*), additional facts will be given in another section of this discourse.

Eames, *et al.* (1962*b,* p. 300, 302) placed considerable emphasis upon the total diameter of the embryonic chambers in defining certain genera and species. The use of this criterion in conjunction with minor variation of structure which occurs in individuals of every species caused them to recognize numerous species, all of which occur in association and have been grouped by other authors into single species. This is particularly shown by their division of *Lepidocyclina pustulosa* into several species, all of which are considered here to be synonyms. In a similar manner they rejected the synonymy of *L. radiata* given by Cole (1960*a,* p. 137) and maintained several species as valid ones.

Although many of the species which Hanzawa and Eames, *et al.* figured are not even mentioned in this discourse, omission of these does not imply that there is agreement concerning their identification or classification. One or two specific examples, however, are discussed briefly.

Eames, *et al* (1962*b,* pl. 8, figs. 4, 5) identified specimens from Trinidad as "*Lepidocyclina* (*Nephrolepidina*) *lehneri* van der Geyn and van der Vlerk," an inadequately described species from the Oligocene. Other specimens (Eames, *et al.* 1962*b,* pl. 8, figs. 6, 7) from this same sample are identified as *Lepidocyclina* (*Nephrolepidina*) *suwanneensis* Cole. A single poorly oriented equatorial section (pl. 8, fig. 8) is identified as *Lepidocyclina* (*Lepidocyclina*) *gubernacula* Cole, an Eocene species.

Two of the equatorial sections (Eames, *et al.,* 1962*b,* figs. 4, 7) are interpreted here as representing one species, *L.* (*Nephrolepidina*) *tempanii* Vaughan and Cole (= *L.* (*Eulepidina*) *tournoueri* Lemoine and R. Douvillé) (compare: Eames, *et al.,* 1962*b,* pl. 8, figs. 4, 7 with Vaughan and Cole, 1941, pl. 39, figs. 5, 8). One of the vertical sections (Eames, *et al.*, 1962*b*, pl. 8, fig. 5) should be compared with figures 1-22, plate 16 (Cole, 1952). It is a typical vertical section of *L.* (*L.*) *canellei* Lemoine and R. Douvillé. The equatorial section and the vertical section (Eames, *et al.*, 1962*b*, pl. 8, figs. 6, 8) are nondescript ones which most nearly resemble poor sections of *L.* (*L.*) *mantelli*.

This fauna is similar to ones reported by Cole from Panama (1952, p. 7) and from Carriacou (1958*a*, p. 221), and by Vaughan and Cole (1941) from the upper Oligocene of Trinidad.

One other set of illustrations (Eames, *et al.*, 1962*a*, pl. 1, figs. C, D) will be noted. These specimens are identified as *Palaeonummulites cumingi* (Carpenter). They are not that species but are excellent examples of *Camerina ammonoides* (Gronovius)—compare fig. C, pl. 1 (Eames, *et al.*, 1962*a*) with figs. 2-8, pl. 30 (Cole, 1959), and fig. D, pl. 1 (Eames, *et al.*, 1962*a*) with fig. 9, pl. 15 (Cole, 1961*b*).

Although this discourse is directed primarily to an analysis of certain genera and species, one of the major conclusions must be that lepidocyclines with multilocular embryonic chambers are not characteristic of any particular geologic stage. Therefore, beds in which supposed reworked Eocene genera and species occur ". . . in association with *Pliolepidina tobleri* which we regard as being of Miocene age" (Eames, *et al.*, 1962*a*) must be Eocene, not Aquitanian in age as Eames, *et al.*, postulated, as these faunas are indigenous ones without any Aquitanian genera or species.

In the Caribbean region above the Eocene the stratigraphic ranges of the genera and species of larger Foraminifera proposed by Cole in 1957 (p. 34) and subsequently refined (Cole, 1958*a*, p. 220; Cole and Applin, 1961, p. 131; Cole, 1961, p. 138) seemingly coincide with the stratigraphic ages assigned to the major subdivisions of the Oligocene and Miocene by Woodring (1960, p. 27, fig. 1), who used molluscan faunas to make these assignments.

SPECIES ILLUSTRATED

The species which are illustrated and discussed in detail in this article are given in the following list:

Helicostegina polygyralis (Barker)

Pl. 10, figs. 5-8; Pl. 11, figs. 1-9.
Lepidocyclina (*Polylepidina*) *antillea* Cushman
Pl. 1, fig. 3; Pl. 5, fig. 5; Pl. 6, fig. 1; Pl. 7, figs. 5, 6.
Lepidocyclina (*Lepidocyclina*) *ariana* Cole and Ponton
Pl. 1, fig. 4.
Lepidocyclina (*Eulepidina*) *chaperi* Lemoine and R. Douvillé
Pl. 8, fig. 3; Pl. 9, figs. 1-3; Pl. 10, fig. 13.
Lepidocyclina (*Eulepidina*) *ephippioides* Jones and Chapman
Pl. 8, figs. 4, 5; Pl. 9, figs. 4, 5.
Lepidocyclina (*Lepidocyclina*) *gubernacula* Cole
Pl. 13, fig. 4.
Lepidocyclina (*Lepidocyclina*) *mantelli* (Morton)
Pl. 1, figs. 1, 2; Pl. 12, fig. 5; Pl. 13, fig. 2.
Lepidocyclina (*Lepidocyclina*) *ocalana* Cushman
Pl. 5, fig. 6; Pl. 12, figs. 1, 2, 3; Pl. 13, figs. 1, 3, 6.
Lepidocyclina (*Lepidocyclina*) *proteiformis* Vaughan
Pl. 6, fig. 3.
Lepidocyclina (*Lepidocyclina*) *pustulosa* H. Douvillé
Pl. 1, fig. 5; Pl. 2; Pl. 3; Pl. 4; Pl. 5, figs. 1-4; Pl. 6, figs. 2, 4; Pl. 10, figs. 1-4, 9-12; Pl. 14, figs. 1-5.
Lepidocyclina (*Eulepidina*) *radiata* (Martin)
Pl. 14, fig. 6.
Lepidocyclina (*Eulepidina*) *undosa* Cushman
Pl. 8, figs. 1, 2; Pl. 12, fig. 4; Pl. 13, fig. 5.
Pseudophragmina (*Proporocyclina*) *zaragosensis* (Vaughan)
Pl. 7, figs. 1-4.

LOCALITIES OF THE FIGURED SPECIMENS

Trinidad and vicinity

Locs. 1, 2—Soldado Rock (upper Eocene); 1 (K2854), 2 (K903); H. G. Kugler, collector (for location see maps in Kugler, 1938 and Vaughan and Cole, 1941, pl. 2 (reference: Vaughan and Cole, 1941, p. 65).

Loc. 3—Vista Bella, San Fernando; upper Eocene; H. G. Kugler collector, May 1932 (references: Cole, 1960 *a*, p. 133; 1961*a*, p. 137; 1962, p. 30).

Loc. 4—(E. L. 1435) Vista Bella Estate, San Fernando (reference: Vaughan and Cole, 1941, p. 16).

Loc. 5—(U.S.G.S. loc. 9199), Farallón Rock, not certain (reference: Vaughan and Cole, 1941, p. 16).

Loc. 6—Point Bontour, San Fernando (reference: Hodson, 1926, p. 21).

Loc. 7—Mount Moriah formation of Test-well A at a depth of 525 feet (reference: Nuttall, 1928, pl. 8, fig. 6).

Loc. 7*a*—Steep bank on east (waiting rooms) side of San Fernando Railway Station (coordinates N: 237060 links; E: 356425 links); dark grey-brown calcareous silt; J. B. Saunders, collector (reference Cole, 1960*b*; 1961*a*).

Panama Canal Zone

Loc. 8—Transisthmian Highway, 4.1 miles in direct line northwest of Río Gatuncillo bridge; calcareous sandstone 0.25 to 0.5 inch thick, in silty mudstone; 22*a*; J. R. Schultz and W. P. Woodring, collectors, 1947 (references: Cole, 1952, p. 4; Woodring, 1957, p. 114).

Loc. 9—Transisthmian Highway, 3.6 miles in direct line northwest of Río Gatuncillo bridge; calcareous mudstone; J. R. Schultz and W. P. Woodring, collectors, 1949 (references: Cole, 1952, p. 4; Woodring, 1957, p. 114).

Jamaica

Loc. 10—Lilyfield, St. Ann, Jamaica; collected by H. R. Versey (reference: Cole, 1956, p. 214).

Mexico

Loc. 11—Guayabal formation (middle Eocene) type locality, 12 kilometers west of Potrero del Llano, Tampico Embayment area; W. S. Cole, collector (reference: Cole, 1927).

Loc. 12—0.5 kilometers southwest of Palma Sola, State of Vera Cruz (reference: Vaughan, 1924, p. 812); type locality for *Lepidocyclina proteiformis* Vaughan.

Loc. 12*a*—Arroyo Torrero, Palma Sola, State of Vera Cruz from bed 10 of the Tantoyuca formation (upper Eocene); D. R. Semmes, collector; gift of the late T. W. Vaughan; type locality for *Triplalepidina veracruziana* Vaughan and Cole.

Loc. 13—Between kilometer posts 17-18 on the Aguila Petroleum Company's narrow-gauge railroad between Potrero and Tanhuijo, State of Vera Cruz (sta. S. C. M-S 1); W. S. Cole, collector (references: Cole and Gillespie, 1930; Cole, 1961*c*, p. 377).

Florida

Loc. 14—Oakhurst quarry of the Florida Lime Company, one and one-half mile southeast of Ocala; W. S. Cole and G. M. Ponton, collectors; 16 July 1929.

Loc. 15—Cummer Lumber Company's Phosphate Pit No. 6 one mile south of Newberry, Alachua County; H. Naegeli, collector; 13 June 1947.

Loc. 16—Ocala limestone (upper Eocene) on the bank of the Chipola River near Marianna, Jackson County; H. Gunter and W. S. Cole, collectors.

Loc. 17—Quarry in the Marianna limestone (Oligocene) on the Chipola River, one-half mile east of Marianna; collected by W. S. Cole, July 1945 (references: Vaughan, 1927, p. 3; Cole, 1957, p. 38).

Loc. 18—Sinkhole near Duncan Church, Washington County; G. M. Ponton, collector, 1932 (reference: Cole, 1934, p. 21).

Loc. 19—Southern States Oil Corporation's well (W-19), located one and one-half mile north of Monticello, Jefferson County, at a depth of 1740 feet (references; Cole and Ponton, 1934, p. 142; Cole, 1945, p. 111).

Loc. 20—St. Mary's River Oil Corporation, Hilliard Turpentine Company No. 1 (W-336) well, about 4 miles northwest of Hilliard, Nassau County, at a depth of 1340-1350 feet (reference: Cole, 1944, p. 57).

Mississippi

Loc. 21—Weston Library well No. 2, Sun Oil Company, Hancock County, at a depth of 4510-4540 feet; specimens supplied through the courtesy of R. D. Wood of the Humble Oil and Refining Company (reference: Cole, 1960*a*, p. 133).

St. Bartholomew, French West Indies

Loc. 22—S. B. 12. Marly tuff, 0.2 m. thick with abundant larger Foraminifera forming a transition zone between the lower horizon of cross-bedded tuffs and the overlying limestones on the promontory separating Anse des Lézards and Anse des Cayes on the north coast of the island; A. Senn, collector, (reference: Cole, 1960*b,* p. 58).

Grenada, Windward Islands

Loc. 23—Loose block from stream side near Clozier Bridge at 1135 feet above sea level on the Belvidere Road, Gouyave side; P. Martin-Kaye, collector, locality 4961; upper Eocene (reference: Cole, 1960*a,* p. 133; Cole, 1962, p. 31).

Loc. 23*a*—Gouyare River (M K 6740); P. Martin-Kaye, collector.

Peru

Loc. 24—713 to 716 feet above the base of the exposed Verdun formation about 6 ½ miles N. 46° E. of Point of Parinas, 4 ½ miles N. 45° E. of Negritos, and 2 ½ miles S. 29° E. of the Port of Talara, Department of Piura; gift of the late T. W. Vaughan.

Saipan Island

Loc. 25—Laulau district, along old railroad grade on the north side of Laulau Bay in the third cut from the west and about 1 mile west of the intersection with the East Coast Highway north of Laulau village; S-25; J. Bridge, collector (reference: Cole and Bridge, 1953, p. 9).

Loc. 26—Conspicuous limestone quarry in the Dago Cliffs about 0.75 miles north of Isley Field and about 0.75 miles east of Isley Entrance Road; altitude about 210 feet; J. Bridge, collector (reference: Cole and Bridge, 1953, p. 10).

Fiji

Loc. 27—Entrance to cave at Kalambu, Viti Levu, from a large block in stream bed at the entrance to cave; W. Briggs, collector, 7 June 1962 (Ladd sta. 174-177, 316) (reference: Ladd, 1934, p. 81, 84).

MULTIPLE AND MULTILOCULAR EMBRYONIC CHAMBERS

The mechanism which results in the formation of multiple and multilocular embryonic chambers has been discussed recently (Cole, 1960*a*; 1961*a*, p. 140; 1962*a*, p. 33-41). As Eames, *et al.* (1962*b*, p. 294) do not accept the explanation, additional data are presented in an attempt to refute certain of their arguments which are based upon their misconception of reproduction in the Foraminifera.

It has been established that megalospheric gamonts develop from mononucleate amoebulae. Myers (1943, p. 16) noted in the asexual reproduction of *Tretomphalus* ". . . when the nuclei are equally spaced, multiple fission takes place, resulting in as many mononucleate amoebulae as there were nuclei present. The amoebulae become invested in a delicate chitinous membrane over which the ectoplasm deposits a layer of calcium carbonate. This unilocular test becomes the proloculus of the megalospheric gamont . . . The second chamber is added as an anucleated bud . . ."

Such observations as those made by Myers upon the development of megalospheric individuals in species of living Foraminifera suggest the method of formation of the embryonic chambers in extinct genera of Foraminifera. In genera, such as *Lepidocyclina, Discocyclina, Cycloclypeus* and others, the typical arrangement of the embryonic chambers is bilocular, consisting of an initial chamber from which in turn the second embryonic chamber is generated. These chambers are formed by a mononucleate amoebulae.

The wall around the initial chamber in larger Foraminifera has one stolon (fig. 5, Pl. 1) through which the ectoplasm is extruded to form the second chamber. However, in the wall of the second chamber one or more stolons are developed whose position and number govern the number and arrangement of the periembryonic chambers (Cole, 1962*b*, p. 148). The equatorial chambers are formed from ectoplasm which is extruded through stolons which pierce the walls of the periembryonic chambers.

Certain megalospheric individuals are found which have multilocular embryonic chambers. Eames, *et al.* (1962*b*, p. 294) considered that such multilocular embryonic masses represent a single set of embryonic chambers, therefore, the inference must be drawn that these were formed by a single mononucleate amoebulae rather than by several nuclei within a mass of cytoplasm (Cole, 1962*a*, p. 39).

However, Eames, *et al.* (1962*b*, p. 294) agreed that rare individuals of *Lepidocyclina,* as well as individuals of other genera, may have two or more sets of perfectly formed bilocular embryonic chambers (fig. 6, Pl. 4) beyond which the development of the test is identical with that of individuals which have only one set of bilocular embryonic chambers.

Individuals with multiple sets of bilocular embryonic chambers are formed by the association of two or more mononucleate amoebulae. However, regardless of the number of amoebulae which are involved in the production of the embryonic mass the subsequent development of the test is identical with that of individuals which develop from a single amoebula.

This kind of development is shown clearly in the specimens of *Pseudophragmina* (*Proporocyclina*) *zaragosensis* (Vaughan) illustrated as figures 1-4, Plate 7. Other specimens from this locality (loc. 21) were illustrated from thin sections as figures 4, 5, plate 4 (Cole, 1960*a*). Vaughan (1945, pl. 44, fig. 1) and Cole (1942, pl. 13, fig. 4; pl. 14, fig. 3) illustrated specimens of this species with a single set of bilocular embryonic chambers.

The specimens of *Pseudophragmina zaragosensis* (figs. 1-4, Pl. 7) in which multiple sets of embryonic chambers occur have the individual sets of bilocular embryonic chambers arranged in a row (fig. 1, Pl. 7) or more commonly in a rudely circular mass (figs. 2, 3, Pl. 7; fig. 4, pl. 4, Cole, 1960*a*). In most of the specimens with the more or less circular arrangement the initial chambers of the individual sets are in a peripheral position with the second embryonic chambers of each set in contact in the interior of the embryonic mass. Occasional specimens (fig. 4, Pl. 7) have several sets of embryonic chambers forming a mass with one or more sets marginal to the central mass (observe the single set to the left side, fig. 4, Pl. 7).

The arrangement of the multiple sets of bilocular embryonic chambers surrounded by normally developed equatorial chambers in *Pseudophragmina* is duplicated almost exactly in *Lepidocyclina*. However, in *Lepidocyclina* the walls of the initial embryonic chambers of the individual sets are not developed as they are in *Pseudophragmina*.

The peripheral chambers of the multilocular embryonic masses of *Lepidocyclina* correspond to the second embryonic chamber of bilocular sets. This fact is demonstrated by the arrangement of the stolons through the outer wall of the embryonic mass and the number and arrangement of the periembryonic chambers (Cole, 1962*a*, p. 41).

However, it still might be argued that the formation of the multilocular embryonic chambers in *Lepidocyclina* is different from the development of multiple sets of embryonic chambers in *Pseudophragmina*. If this position could be substantiated, *Lepidocyclina* with multilocular embryonic chambers would not be the result of irregularity in the reproductive cycle of species with single sets of bilocular embryonic chambers.

Two American species in which specimens with multilocular embryonic chambers have been described adequately are known. These are *Lepidocyclina pustulosa* H. Douvillé (= *Pliolepidina tobleri* H. Douvillé of Eames, *et al.*, 1962*b*, p. 312) as recognized by Cole (1960*a*, p. 136; 1962*a*, p. 33) and *Lepidocyclina vaughani* Cushman (Cole, 1961*a*, p. 140).

Lepidocyclina pustulosa with multilocular embryonic chambers is always associated with specimens which have a single set of bilocular embryonic chambers of the lepidocycline *s. s.* kind, whereas *L. vaughani* with multilocular embryonic chambers is associated with specimens with eulepidine kind of embryonic chambers. It is impossible to separate individuals with multilocular embryonic chambers from associated individuals with bilocular embryonic chambers except on the kind of embryonic chambers (multilocular or bilocular) which are present.

If multilocular chambers are sufficiently important to delimit species, they might be important enough to define a genus. Thus, Eames, *et al.* (1962*b*, p. 300) define *Pliolepidina* as "The megalospheric nucleoconch is subdivided into three or more chambers by thin partitions within the thick nucleoconch wall. In other characters, this genus does not differ significantly from *Lepidocyclina*."

However, Cole has illustrated five specimens of *Lepidocyclina pustulosa* (1960*a*, pl. 2, fig. 5; 1962*a*, pl. 7, figs. 1, 5; pl. 8, figs. 1, 8) in which there is not only a multilocular embryonic mass, but also either incorporated in the periphery or in juxtaposition to the multilocular mass there are one or more sets of bilocular embryonic chambers of the lepidocycline *s. s.* kind. These bilocular embryonic chambers are entirely comparable to those occurring in associated specimens with a single set of bilocular embryonic chambers.

This association of a multilocular embryonic mass and bilocular embryonic chambers in specimens which are otherwise similar in other internal structures to specimens with single bilocular sets of embryonic chambers is suggestive that only one species is involved. But, this relationship might be fortuitous.

However, it has been demonstrated that in *Lepidocyclina vaughani* rare specimens (Cole, 1961*a*, pl. 12, fig. 5) occur in which a multilocular embryonic mass is found in association with a set of eulepidine embryonic chambers which is similar to those in specimens with single sets of embryonic chambers.

These specimens with multilocular embryonic chambers in association with bilocular embryonic chambers are similar to specimens in which two or more sets of bilocular embryonic chambers occur (fig. 6, Pl. 4). Specimens with two sets of bilocular embryonic chambers are formed by two, mononucleate amoebulae. Moreover, the configuration of the embryonic chambers in such specimens conforms to the pattern which would result if only one set of bilocular embryonic chambers were formed.

However, if several nuclei are associated in a mass of cytoplasm on the border of which are one or more small masses of cytoplasm each of which contained a single nucleus, a multilocular embryonic mass will result on the periphery of which would be one or more sets of bilocular embryonic chambers.

Inasmuch as the pattern of the bilocular embryonic chambers is genetically controlled, it follows that multilocular embryonic masses are the result of irregularity in asexual reproduction. Therefore, this kind of embryonic mass cannot be used to define a genus or subgenus.

Thus, *Pliolepidina tobleri* H. Douvillé as recognized by Eames, *et al.* (1962*b*, p. 312) is a species based upon abnormal specimens and must be a synonym of *Lepidocyclina pustulosa* H. Douvillé, a conclusion which Vaughan and Cole (1941, p. 66) reached many years ago.

As additional specimens of species of *Lepidocyclina* in which multilocular chambers have not been reported are sectioned, some specimens are found which have such chambers. Figure 2 of Plate 12 illustrates a specimen of *Lepidocyclina ocalana* which has three large embryonic chambers. A specimen (fig. 1, Pl. 12) of this same species with bilocular embryonic chambers is illustrated for comparison.

Previously, a specimen (Cole, 1944, pl. 16, fig. 10) of *L. ocalana* (identified as *L. mortoni*) which had trilocular embryonic chambers had been illustrated. At that time the significance of this kind of embryonic chamber was not fully appreciated.

There is every indication that multiple embryonic chambers will be found in many other species. Sachs (personal communication) already observed multilocular chambers in another species not known to have such chambers, and he eventually will publish on his observations.

PLIOLEPIDINA H. DOUVILLE, 1917, A SYNONYM OF *LEPIDOCYCLINA* S. S. GÜMBEL, 1870

H. Douvillé (1915, p. 727, text fig. 34) proposed the subgeneric name *Pliolepidina,* which he based upon an unnamed species of *Lepidocyclina* with multilocular embryonic chambers. In 1917 he (H. Douvillé, p. 843, text figs. 5, 6) gave the specific name *P. tobleri* to the specimens with multilocular embryonic chambers, thus validating *Pliolepidina.*

Later, Vaughan and Cole (1941, p. 64) decided that "The subgenus *Pliolepidina* was initially based on the peculiar embryonic chambers of the megalospheric form of *L. tobleri,* but as the peculiarity of those chambers is teratologic, that feature is invalid as the basis of a subgenus."

Vaughan and Cole (1941, p. 66) concluded that specimens with bilocular embryonic chambers which they identified as *Lepidocyclina pustulosa* H. Douvillé and which always occur in association with the specimens with multilocular embryonic chambers was the normal form. For this series composed of individuals with multilocular embryonic chambers and others with bilocular embryonic chambers Vaughan and Cole retained the specific name *Lepidocyclina* (*Pliolepidina*) *pustulosa* H. Douvillé.

At the same time Vaughan and Cole (1941, p. 64) redefined the subgenus *Pliolepidina* to include specimens with bilocular and multilocular embryonic chambers. In addition they (1941, p. 65) transferred certain species, previously classified as *Lepidocyclina s. s.* to the redefined subgenus *Pliolepidina*.

Pliolepidina was assumed to differ from *Lepidocyclina s. s.* in the development of the stolon system. *Pliolepidina* at that time was believed to have a four-stolon system, and *Lepidocyclina s. s.* a six-stolon system.

Various attempts have been made to use stolon systems as a basis of classification, one of the most penetrating of which was the one by Grimsdale (1959). Although the importance of such studies should not be minimized, the difficulty of obtaining satisfactory preparations which expose the stolon system must be recognized. Theoretically stolon systems might be ideal structures upon which to base a classification, but practically it is impossible at the present time to use these systems.

One is forced to relie on structures which may be observed readily, yet these structures must be sufficiently distinct and stable to characterize each genus and subgenus. Equatorial sections of *Pliolepidina* and *Lepidocyclina* resemble each other, but Cole (1961*a*, p. 142; 1962*a*, p. 49) attempted to show that there were sufficient differences in the development of the embryonic, periembryonic and equatorial chambers to maintain these two subgenera.

On Plate 1 there are two illustrations (figs. 1, 2) of parts of the equatorial sections of *Lepidocyclina mantelli* (Morton), the type species of *Lepidocyclina s. s.* These specimens were collected from the Marianna limestone of lower Oligocene age. Figure 5 of Plate 1 illustrates at the same magnification part of an equatorial section of *Lepidocyclina pustulosa* H. Douvillé, the type species of

Pliolepidina as redefined by Vaughan and Cole (1941, p. 64). This specimen came from the upper Eocene of Trinidad.

In addition, part of the equatorial section of *Lepidocyclina ariana* Cole and Ponton (fig. 4, Pl. 1) from the middle Eocene of Florida is illustrated for comparison. This species has been considered by Cole (1944, p. 61) to be a representative species in the subgenus *Pliolepidina*.

Figure 3 of Plate 1 is *Lepidocyclina antillea* Cushman, the type of *Polylepidina,* from the middle Eocene of Jamaica. *L. antillea* is the first known species which may be placed in the genus *Lepidocyclina*. The subgenus *Polylepidina* is characterized by the partial coil of periembryonic chambers which surrounds the embryonic chambers except for a short distance across the top of the second embryonic chamber.

The arrangement of the periembryonic chambers in *Polylepidina* is distinct and constant so that these chambers can be used satisfactorily to distinguish this subgenus from the other subgenera of *Lepidocyclina*. Moreover, in every suite of specimens referred to *Polylepidina* there are always rare specimens in which an amphistegine kind of aperture is developed (figs. 5, 6, Pl. 7). This has been observed in specimens from Florida, Mexico, St. Bartholomew, and Jamaica.

Eames, *et al.* (1962*b,* p. 300) elevated *Pliolepidina* to generic rank, basing this genus on a species which does "not differ significantly from *Lepidocyclina*" except by the development of multilocular embryonic masses. If the thesis of Vaughan and Cole (1941, p. 64) that all lepidocyclines with multilocular embryonic masses are abnormal is accepted, the name *Pliolepidina* will become invalid if the normal form of the type species of *Pliolepidina* belongs to another previously described genus or subgenus.

Although Eames, *et al.* (1962*b,* p. 294) did not accept the proof advanced originally by Vaughan and Cole (1941, p. 64) and enlarged by Cole (1960*a*) that specimens with multilocular embryonic chambers are abnormal, there seems to be sufficient evidence (Cole, 1961*a*, p. 140; 1962*a,* p. 33) available to substantiate the conclusion of Vaughan and Cole. The evidence previously available is more completely reinforced by the additional facts presented in this article.

The decision, therefore, on the validity of *Pliolepidina* must be decided on the characteristics of *Lepidocyclina pustulosa*. This is without question the normal specimens with bilocular embryonic chambers which by reproductive irregularities produced specimens with multilocular embryonic masses.

Although Cole as recently as 1962(*a*, p. 49) was convinced that *Pliolepidina*, based upon *Lepidocyclina pustulosa* (= *L. tobleri*, an abnormal form), could be differentiated from *Lepidocyclina s. s.* this position cannot be maintained. Comparison of the illustrations of *L. mantelli* (figs. 1, 2, Pl. 1) with those of *L. pustulosa* (fig. 5, Pl. 1) and *L. ariana* (fig. 4, Pl. 1) demonstrate that the embryonic apparati (embryonic and periembryonic chambers) are the same. Thus, *Pliolepidina* is a synonym of *Lepidocyclina s. s.*

Cole (1962*a*, p. 50) postulated that *Lepidocyclina s. s.* was restricted to the Americas with a stratigraphic range from lower Oligocene into the lower Miocene, whereas *Pliolepidina* was assumed to range from the American middle Eocene to the top of the upper Eocene. However, he (1962*a*, p. 50) noted that specimens from the upper Eocene of Morocco (Bourcart and David, 1933, p. 48; Brönnimann, 1940) should be assigned to *Pliolepidina*.

If the proof that *Pliolepidina* is a synonym of *Lepidocyclina s. s.* is accepted, the stratigraphic range of *Lepidocyclina s. s.* in the Americas is from upper middle Eocene into the lower Miocene. Elsewhere, *Lepidocyclina s. s.* is known to-date only from the upper Eocene of Morocco.

VARIATION IN AND SYNONYMS OF *LEPIDOCYCLINA PUSTULOSA* H. DOUVILLÉ

Lepidocyclina (Lepidocyclina) pustulosa H. Douvillé Pl. 1, fig. 5; Pls. 2-4; Pl. 5, figs. 1-4; Pl. 10, figs. 1-4

1917. *Isolepidina pustulosa* H. Douvillé, Paris Acad. Sci., C. R., v. 164, p. 844, text figs. 1, 2, 3, 4.
1924. *Lepidocyclina trinitatis* H. Douvillé, Géol. Soc. France, Mém, n. ser., v. 1, No. 2, p. 34, 35, pl. 1, fig. 1; text figs. 7-12.
1926. *Lepidocyclina (Lepidocyclina) bontourana* Hodson, Bull. Amer. Paleont., v. 12, No. 47, p. 21, pl. 5, figs. 2, 4, 5.
1928. *Lepidocyclina subglobosa* Nuttall, Geol. Soc. London, Quart. Jour., v. 84, Pt. 1, p. 104, pl. 8, figs. 3, 5, 6, 7.

Vaughan and Cole (1941, p. 65) listed a number of species which they considered to be synonyms of *L. pustulosa* among which they included *L. trinitatis* H. Douvillé and *L. bontourana* Hodson. Although Vaughan and Cole excluded *L. subglobosa* Nuttall from the list and maintained this species as a separate one, Cole (1952, p. 17) became convinced "from the study of many thin sections that *L. subglobosa* Nuttall represents small specimens of *L. pustulosa.*"

In the discussion of *L. pustulosa* Vaughan and Cole (1941, p. 65) wrote: "Numerous names have been applied to different forms, all of which are considered to represent different types of form and shape of *L. pustulosa* . . . The definition of the original name *pustulosa* must be enlarged to cover this almost bewildering variation in form."

Grimsdale (1959, p. 29), in a competent and stimulating review of the American Lepidocyclinidae, "accepted for the most part" the synonymy of *L. pustulosa* presented by Vaughan and Cole (1941, p. 65). However, he (Grimsdale, 1959, p. 30) did object to the suggestion made by Cole (1952, p. 17) that *L. subglobosa* Nuttall was another synonym of *L. pustulosa.*

Although Grimsdale (1959, p. 16) plotted similar stratigraphic ranges for *L. subglobosa* and *L. pustulosa* in the upper Eocene, he postulated that *L. subglobosa* was derived from *L. pustulosa,* and that *L. subglobosa* in turn generated the Oligocene to lower Miocene species *L. yurnagunensis* Cushman. He (Grimsdale, 1959, p. 30) remarked that in his studies in Trinidad he had "no difficulty" in distinguishing *L. subglobosa* from *L. pustulosa,* but that he had "considerable trouble in separating *L. subglobosa* from *L. yurnagunensis.*"

Later, Cole (1960*a,* p. 136) re-emphasized that specimens assigned to *L. subglobosa* could not be distinguished from other specimens which had been referred without question to *L. pustulosa.* In addition, he attempted to demonstrate that *L. yurnagunensis* could be distinguished from *L. pustulosa* by observation of the shape of the equatorial and embryonic chambers, and he (Cole, 1961*a,* pl. 9, figs. 2, 5; pl. 10, figs. 3, 4, 6; pl. 15, figs. 5, 6; pl. 16, figs. 2-6) illustrated a number of specimens of *L. yurnagunensis* for comparison with specimens of *L. pustulosa.*

Recently, Eames, *et al.* (1962*b,* p. 301-303, 310, 311, 314) expressed the opinion that there were at least three valid specific names among those which Vaughan and Cole (1941, p. 65) and Cole (1960*a*, p. 135) included in the synonymy of *L. pustulosa* H. Douvillé (1917). These species are: *L. tobleri* H. Douvillé (1917), *L. trinitatis* H. Douvillé (1924) and *L. bontourana* Hodson (1926). Eames, *et al.*, however, placed *L. subglobosa* Nuttall (1928) in the synonymy of *L. pustulosa* as Cole (1952, p. 17) had already suggested should be done.

Specimens with multilocular embryonic chambers which Eames, *et al.* (1962*b*, p. 312) classified as *Pliolepidina tobleri* (H. Douvillé) are discussed in another section of this article and attention here will be focused upon those which have bilocular embryonic chambers.

In their synonymy Eames, *et al.* (1962*b*, p. 314) assigned specimens originally referred to *L. pustulosa* by Vaughan and Cole (1941, p. 65) to *L. trinitatis* with the comment (p. 312) in their synonymy of *L. pustulosa* "It is unlikely that any of the figures represent this species; the diagnostic ones are *L. trinitatis* and *P. tobleri*."

As many of the specimens assigned by Vaughan and Cole (1941, pl. 25, figs. 6, 7, 9; pl. 26, figs. 1-6; pl. 27; pl. 28, figs. 1-7, 9; pl. 29; pl. 30, fig. 3) to *L. pustulosa* were from Kugler's locality K2854 (loc. 1 of this article), 12 additional equatorial sections were made from a part of the original collection which is still in my possession.

The measurements of the embryonic chambers obtained from these thin sections were plotted on the scatter diagram (fig. 1), and the measurements of the specimens which are illustrated (Pl. 1, fig. 5; Pl. 2, figs. 1-6) are given in Table 1. Specimens from this same locality of which illustrations have been published previously were measured (Table 2) and these measurements were plotted on figure 1. Thus, a total of 17 measurements was obtained from specimens from this locality.

Table 1.—Measurements of specimens of *Lepidocyclina pustulosa* plotted on figure 1 which are illustrated on the Plates 1-4.

Locality	*Plate*	*Figure*	*Distance across embryonic chambers (μ)*	*Distance across initial chamber (μ)*	*Diameter of section (mm.)*
1 (K2854)	2	1	310	160	2.2
1 (K2854)	2	2	340	180	2.8

1 (K2854)	2	3	360	200	1.8
1 (K2854)	2	4	440	250	1.75
1 (K2854)	2	6	480	260	3.5
1 (K2854)	1	5	490	250	2.45
1 (K2854)	2	5	520	290	2.8
2 (K903)	3	1	640	400	2.9
3 (Vista Bella)	3	2	710	390	2.95
2 (K903)	3	6	770	400	2.15
2 (K903)	3	5	880	540	3.5
3 (Vista Bella)	4	5	890	510	4.0

Table 2.—Reference to previously published illustrations of specimens of *Lepidocyclina pustulosa* plotted on figure 1.

Reference	*Plate*	*Figure*	*Distance across embryonic chambers (µ)*	*Distance across initial chamber (µ)*	*Diameter of section (mm.)*
Cole (1952)	15	14	240	130	1.36
	14	2	260	180	1.47
Vaughan and Cole (1941)	31	8	260	160	1.54
*Nuttall (1928)	8	6	280 (est.)	160 (est.)	1.45 (est.)
Vaughan and Cole (1941)	25	5	390	210	1.91
Cole (1952)	20	15	390	220	1.22
Cole (1960*a*)	2	9	400	250	2.7
	2	3	410	200	2.5
Cole (1949)	55	8	420	260	3.75
Cole (1952)	14	1	470	280	1.12
Cole (1960*a*)	2	4	520	300	2.7
	2	1	550	340	3.2
**Hodson (1926)	5	5	630	320	2.2
Cole (1962*a*)	6	4	670	360	1.9
Cole (1960*a*)	2	6	1020	610	4.0

*Type of *L. subglobosa* (est. = computed from illustration)
**Type of *L. bontourana*

The measurements to obtain the data for the scatter diagram (fig. 1) were made across the embryonic chambers at right angles to the dividing wall between the chambers. The distance across both chambers includes the thickness of the wall of the embryonic chambers on both ends of the measurement. The distance across the initial chamber includes the thickness of the wall of this embryonic chamber and the thickness of the partition between the two embryonic chambers.

New equatorial sections of specimens from localities 2 and 3

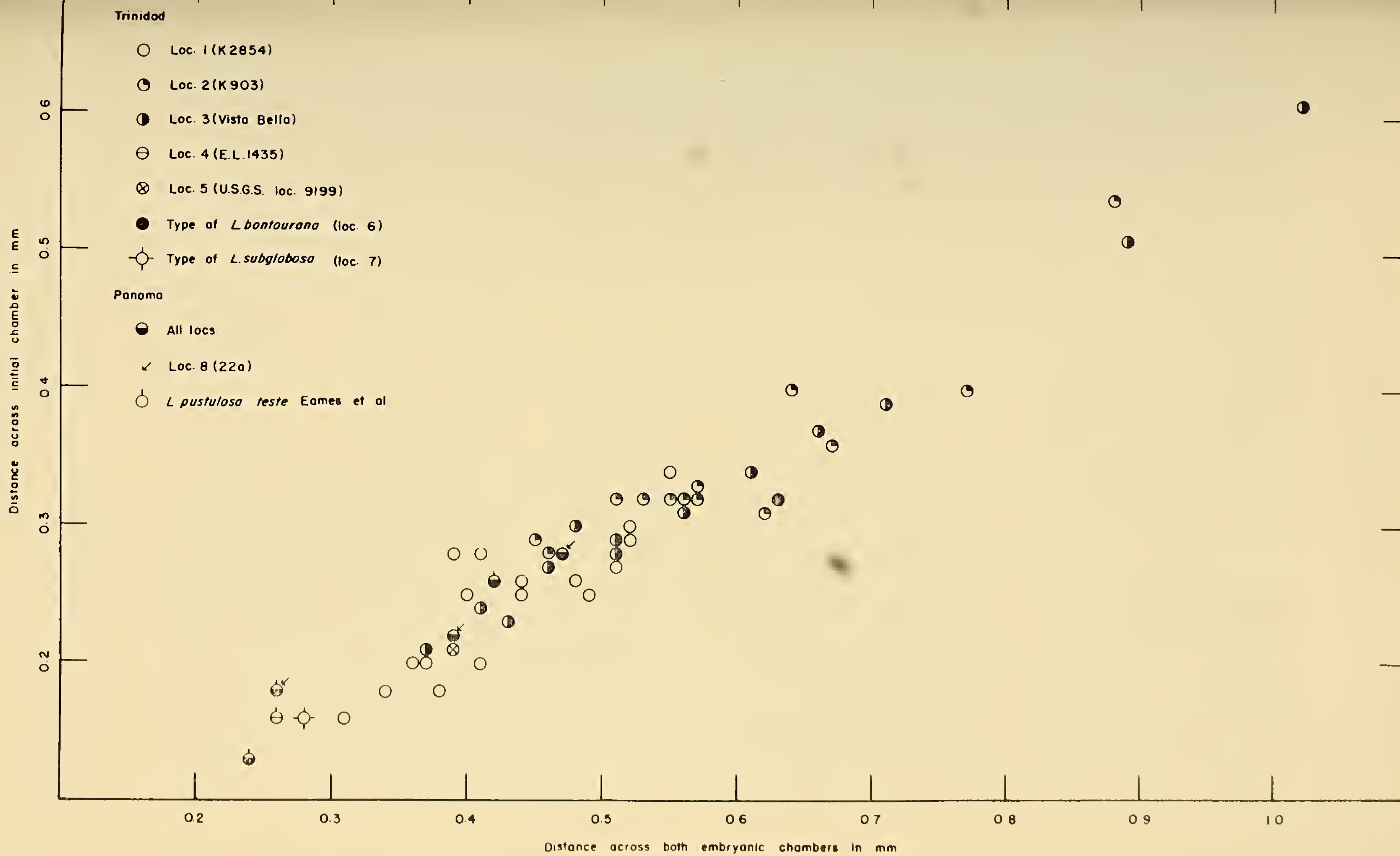

Figure 1.—Scatter diagram to demonstrate variability in the size of the embryonic chambers in *L. pustulosa.*

were prepared and measured. These measurements were plotted on figure 1, and certain of these specimens whose measurements are given in Table 1 are illustrated (Pl. 3, figs. 1, 2, 5, 6; Pl. 4, fig. 5).

Finally, measurements were made of specimens from additional localities in Trinidad and vicinity and the Panama Canal Zone, all of which have been illustrated previously. These measurements were plotted on figure 1. Through the kindness of Dr. Katherine Palmer, Director of the Paleontological Research Institution, I was able to examine and measure the type of *L. bontourana* Hodson (1926). The measurements given for the type of *L. subglobosa* Nuttall (1928), however, had to be estimated from the type illustration.

A total of 52 measurements was obtained of which 15 were of previously published equatorial sections and 12 of which are from sections illustrated in this article. Although not all of the sections which were measured have been published, there is seemingly a sufficient number of illustrations available so that conclusions may be made independent of the measurements.

Eames, *et al.* (1962*b*, p. 302) gave in a table the differences by which they believed *L. pustulosa* and *L. trinitatis* can be separated. Moreover, they emphasized that "*Lepidocyclina* (*L.*) *bontourana* Hodson, 1926, can be distinguished from both *L. trinitatis* and *L. pustulosa* by its larger megalospheric nucleoconch, the greater diameter of which is 0.70-0.86 mm., whereas that of *L. trinitatis* rarely exceeds 0.55 mm., and that of *L. pustulosa* is usually less than 0.35 mm."

The "maximum overall diameter of the megalospheric nucleoconch" of *L. trinitatis* is stated by Eames, *et al.* (1962*b*, p. 302) as "0.40-0.65 mm. (rarely over 0.55 mm.)." Thirty-two of the 52 specimens (fig. 1) analyzed have embryonic chambers with a distance across both chambers from 400 to 650 μ (roughly 61%). Ten of these 32 specimens have embryonic chambers with a distance across both chambers from 550 to 650 μ.

Thirteen of the 52 specimens (roughly 25%) have embryonic chambers with a distance across both chambers below 400 μ, and 7 specimens (roughly 13 percent) have embryonic chambers with a distance across both chambers greater than 650 μ.

The scatter diagram (fig. 1) shows that the greatest number of specimens have embryonic chambers with a distance across both chambers between 360 and 630 μ, a spread of 270 μ. Between these arbitary limits there are 38 specimens (roughly 73%). Eames, *et al.* (1962*b*, p. 302) allowed for *L. trinitatis* a spread of 250 μ (from 0.40 to 0.65 mm.).

If measurements such as these alone are used, the major part of the specimens should be assigned to *L. trinitatis*. Thus, the remaining 27 percent of the specimens at either end of the plot could be other species.

However, this would be an entirely arbitary decision because the scatter diagram shows complete continuity. Moreover, it demonstrates clearly that within limits the size of the embryonic chambers reflects the locality from which the specimens were obtained.

From locality 1 (K2854) there are 17 specimens with the diameter of the embryonic chambers between 310 to 550 μ, a spread of 240 μ; from locality 2 (K903) there are 13 specimens with embryonic chambers with diameters between 450 and 880 μ, a spread of 430 μ; and from locality 3 (Vista Bella) the diameters of 13 specimens are from 380 to 1020 μ, a spread of 640 μ.

It should be noted that the specimens from locality 1 (K2854) with diameters of 310 to 550 μ overlap those from locality 2 (K903) with diameters from 450 to 880 μ, whereas those from locality 3 (Vista Bella) overlap, include, and extend beyond those of both the other localities.

From the foregoing analysis the conclusion has been reached that the size of the embryonic chambers cannot be used to delimit species.

Table 3 gives similar measurements of the embryonic chambers of *Lepidocyclina yurnagunensis*. These specimens would fall between the limits given for *L. pustulosa* and *L. trinitatis* by Eames, *et al.* (1962*b*, p. 302).

Table 3.—Measurements of certain published specimens of *Lepidocyclina yurnagunensis*

Reference	*Plate*	*Figure*	*Distance across embryonic chambers (μ)*	*Distance across initial chamber (μ)*	*Diameter of section (mm.)*
Cole (1961*a*)	16	6	240	130	2.3
(1960*a*)	3	8	260	150	2.6
(1961*a*)	16	5	280	150	3.4
	16	3	300	160	2.1
	16	2	320	190	2.2
Cole and Applin (1961)	7	13	330	190	2.1
Cole (1960*a*)	16	4	360	210	2.5
	10	3	390	210	2.3
*Not figured	—	—	400	230	2.8
Cole (1961*a*)	10	4	470	270	2.3

*Cole (1960*a*) p. 137, loc. 4.

Although the scatter diagram (fig. 1) demonstrates a gradational series with regard to the size of the embryonic chambers, there may be other structures suggested by Eames, *et al.* (1962*b*, p. 302) by which the species which they recognized can be identified.

For example, they (p. 302) stated that the average size of the ephebic equatorial chambers both in *L. pustulosa* and *L. trinitatis* was the same (0.04-0.09 mm.), but the chambers of *L. pustulosa* are "thick-walled with relatively small lumen," whereas those of *L. trinitatis* are "thin-walled with relatively large lumen."

If reference is made to the specimen illustrated as figure 2, Plate 2, it will be noted that the equatorial chambers on the lower edge are thin-walled with a large opening, whereas those shown elsewhere in this section are thicker walled with a smaller opening. The details of these equatorial chambers are shown by figures 1-4, Plate 5. The equatorial chambers of other specimens for comparison are illustrated at the same magnification by figures 3, 4, Plate 4.

As an example of another misconception, the arrangement of the periembryonic chambers may be cited. Eames, *et al.* (1962*b*, p. 302) wrote: "The auxiliary chambers of *L. bontourana* are usually long and low, forming an obvious ring around the nucleoconch, whereas those of the other two species usually show two inflated primary auxiliary chambers." However, all the specimens, regardless of the size of the embryonic chambers, have the embryonic chambers surrounded by a more or less complete ring of long, narrow periembryonic chambers.

If figure 6, Plate 3 of a specimen whose embryonic chambers have a maximum diameter of 770 μ is compared with the type illustration of *L. bontourana* Hodson (1926, pl. 5, fig. 5), the embryonic chambers of which have a maximum diameter of 830 μ, it will be observed that the periembryonic chambers are similar in both specimens. The specimen illustrated as figure 3, Plate 2 whose embryonic chambers have a maximum diameter of 360 μ has periembryonic chambers which are entirely comparable to those of the specimens with the larger embryonic chambers.

The specimens illustrated by figure 4, Plate 2 (with a maximum diameter of embryonic chambers of 440 μ) and figure 5, Plate 2 (with a maximum diameter of embryonic chambers of 520 μ) have periembryonic chambers comparable in arrangement to those of *L. bontourana*. However, on the size of the embryonic chambers these specimens would have to be referred to *L. trinitatis* if the criterion of Eames, *et al.* (1962*b*, p. 302) of size of embryonic chambers alone were used.

Many equatorial sections which have been illustrated are not exactly centered, therefore, the full development of the periembryonic chambers does not show. In such illustrations the two periembryonic chambers, one on each end opposite the dividing wall of the embryonic chambers, become unusually prominent as they are the ones first exposed in sectioning. Nuttall's illustration (1928, pl. 8, fig. 6) was made obviously from such a section.

A specimen identified by Cole (1960*a*, pl. 2, fig. 6) as *L. pustulosa* was discussed by Eames, *et al.* (1962*b*, p. 294) as follows: "The isolepidine nucleoconch is far too large for either *L. pustulosa* or *L. trinitatis,* and too little of the specimen is illustrated to permit specific identification." The original illustration (Cole, 1960*a*, pl. 2, fig. 6) was to show the embryonic, periembryonic and some of the equatorial chambers, X 40. This specimen is illustrated by figure 1, Plate 4, X 40, to show more of the equatorial chambers, and by figure 2, Plate 4, X 20, which includes all of the structures from the embryonic chambers to the edge of the test. This specimen whose embryonic chambers have a diameter of 1020 μ in all other respects is comparable to specimens with smaller embryonic chambers.

Specimens with embryonic chambers with diameters greater than 700 μ are rare as only 5 (roughly 9 percent) of the 52 plotted in figure 1 has this size of embryonic chamber. Two of these were obtained from locality 2 and three came from locality 3, a locality which has specimens with the greatest spread in size of embryonic chambers.

Additional vertical sections (figs. 1-4, Pl. 10) of four specimens of *L. pustulosa* from locality 1 (K2854) are illustrated. Vaughan and Cole (1941, pl. 26, figs. 1-6) figured six specimens from this locality. These 10 vertical sections should demonstrate the variation of this species in vertical section.

Specimens formerly assigned to *Triplalepidina veracruziana* Vaughan and Cole which are considered to be synonymous with *L. pustulosa* are discussed separately in another section of this discourse.

STRATIGRAPHIC RANGE OF *LEPIDOCYCLINA PUSTULOSA* H. DOUVILLÉ

Eames, *et al.* (1962*b*, p. 302) wrote "It was suggested by Eames, *et al.* (1962) that occurrences of *L. pustulosa* and *L. trinitatis* in beds which they considered to be of Aquitanian age consisted of material reworked from the Eocene. Although these two species, and also *L. bontourana* do seem to occur in beds that are unequivocally Eocene, no specimens that could be referred to *P. tobleri,* nor indeed to any species of *Pliolepidina,* occur below the levels that we could consider to be Aquitanian. *P. tobleri* itself has been recorded from levels as high as the Burdigalian Culebra formation."

Eames, *et al.* thereby admit that *L. pustulosa* and species here considered to be synonymous with *L. pustulosa* have been recorded correctly as occurring in the Eocene, except their "*Pliolepidina tobleri.*"

The only reference of which I am aware of the occurrence of "*L. tobleri*" in the Culebra formation is the one by Cushman (1918) in which he recorded on page 90 that *L. panamensis* (accepted by Eames, *et al.,* 1962*b*, p. 312 as a synonym of "*L. tobleri*") occurred "at 6012*a* and 6012*e* in Gaillard Cut, in the Culebra formation."

However, on page 95 Cushman wrote under occurrence of *L. panamensis* ". . . 6012*a* and 6012*c*, south of Empire Bridge, in the Culebra formation, specimens of small orbitoids occur, but they are not sufficiently well preserved for positive identification. Although those from the latter station seem somewhat like *L. panamensis* in their thin borders and raised center with papillae, they cannot be specifically identified with certainty."

At the best this would seem a dubious record of occurrence upon which to place any reliance whatsoever. In 1961 (Cole, 1961*a*, p. 139) in an article which I assume was published during the interval that Eames, *et al.* manuscript was in the editor's hands I reported on an examination of additional material collected at the same time that the samples studied by Cushman were obtained. The specimens in these samples which are similar to the brief description given by Cushman (1918) are *Lepidocyclina yurnagunensis,* and lepidocyclines with multilocular embryonic chambers were not found.

Eames, *et al.* (1962*a*, p. 81) were aware from information sent by letter written by J. B. Saunders and from a list of species published by Cole (1960*b*, p. 57) that lepidocyclines with multilocular embryonic chambers occurred in association with *Globorotalia cerroazulensis* (Cole) in Trinidad.

Bolli (1957, p. 160) and Cole (1960*b*, p. 57) recorded from samples collected at the same locality smaller and larger Foraminifera, all of which had been recorded only from the Eocene, among which were lepidocyclines with multilocular embryonic chambers.

Even if the samples from which this fauna was obtained were collected from a slip mass in a geological younger formation, the fauna of such a slip mass would be an indigenous one which could be used to obtain the geological age of the slip mass. The only paleontological evidence which would invalidate such a dating would be a mixed fauna of species diagnostic of two different stratigraphic ages. As the smaller and larger Foraminifera are all characteristic of the Eocene, the conclusion must be that this fauna does not indicate any evidence of reworking, and that lepidocyclines with multilocular embryonic chambers are indigenous ones in an Eocene association.

Eames, *et al.* (1962*b*, p. 302) continued to insist that lepidocyclines with multilocular embryonic chambers which they identified as *Pliolepidina tobleri* developed in and characterized the Miocene. Therefore, they reasoned all associated species must be reworked. Cole (1961*a*, p. 137) commented on this peculiar faunal relationship as follows: ". . . the species with irregular, multilocular embryonic chambers would be the only indigenous species present at the localities from which it is known in the vast Caribbean area."

One other record of the occurrence of *L. pustulosa* as *L.* (*Pliolepidina*) *tobleri* in the Oligocene requires clarification. Stainforth (1948, p. 134) reported lepidocyclines with multilocular embryonic chambers occurred in Ecuador in association with *Lepidocyclina yurnagunensis* Cushman and *L. undosa* Cushman.

I have examined specimens from this locality. The supposed "*L. yurnagunensis*" is *L. pustulosa* with bilocular embryonic chambers, and "*L. undosa*" is *L.* (*Eulepidina*) *chaperi*. This is a typical upper Eocene association of lepidocyclines.

The proof given here and elsewhere that lepidocyclines with multilocular embryonic chambers result from irregularities of the reproductive cycle may not be accepted. However, this concept appears to be more logical in view of the data available than the concept that these specimens are positive indicators of the Miocene and that associated specimens of undoubted Eocene age are reworked.

All the evidence clearly indicates that *Lepidocyclina pustulosa* with bilocular or multilocular embryonic chambers does not range above the top of the Eocene.

THE STATUS OF THE GENERIC NAME *TRIPLALEPIDINA* VAUGHAN AND COLE, 1938.

Grimsdale (1959, p. 19) recognized that *Triplalepidina* Vaughan and Cole (1938, p. 167), type species *T. veracruziana,* based upon specimens from a locality near Palma Sola, Vera Cruz, Mexico, was a synonym of *Lepidocyclina*. He (Grimsdale, 1959, p. 19) postulated "From *L. peruviana* sprang *L. veracruziana* in which the thickening of the walls of the equatorial chambers is heavily augmented to form an almost solid mass of shell material, infilling the central parts of the equatorial chambers, and dividing the equatorial layer into three zones."

On Plate 6, figure 2 is an illustration of an equatorial section of a specimen from Peru which has been identified as *L. peruviana,* and two vertical sections (figs. 9, 12) on Plate 10 illustrate other details of this species. Topotypes of *L. veracruziana* are illustrated by figure 4, Plate 6 and figure 11, Plate 10. Additional specimens (fig. 10, Pl. 10; figs. 1-5, Pl. 14) of *L. veracruziana* from another locality are illustrated to supplement the topotypes.

If these illustrations are compared, it is impossible to discover any criteria by which two species could be recognized as the internal structures including the division of the peripheral equatorial chambers into chamberlets is the same. Therefore, *L. veracruziana* is a synonym of *L. peruviana.*

Vaughan (1924, p. 797) in one of his preliminary studies of species of *Lepidocyclina* decided that *L. peruviana* Cushman was a synonym of *L. r. douvillei* Lisson. Later, he (Vaughan, in Sheppard, 1937, p. 165) reversed this conclusion stating that there were two related but recognizable species.

Cole (1944, p. 70) identified in samples from a well in Florida *L. peruviana* and *L. r. douvillei,* but emphasized that "The embryonic and equatorial chambers (of *L. r. douvillei*) are similar to those of *L. peruviana.*"

Recently, Sachs (unpublished thesis) concluded that *L. peruviana* and *L. cedarkeysensis* Cole (1942, p. 43) were synonyms of *L. r. douvillei.* Restudy of these species has convinced me that Sachs was correct.

The topotype specimens of *L. r. douvillei* figured by Vaughan (in Sheppard, 1937, fig. 118-9, 10, 11) from Organos Chicos, Peru, are from limestone. These specimens are similar in vertical section to *L. cedarkeysensis* which also was embedded in limestone. These specimens from Peru and from Florida have thicker roofs and floors of the lateral chambers than do specimens commonly assigned to *L. peruviana* which do not occur in limestone.

However, there are in any suite of specimens individuals which have roofs and floors of the lateral chambers of the thick kind, others with the thinner kind, and still others of an intermediate kind. Although one kind tends to predominate at any particular locality, authors have usually recognized both *L. peruviana* and *L. r. douvillei* as components of the same faunas.

However, specimens identified as *L. peruviana* commonly show a peripheral wedge of shell material dividing the equatorial layer, whereas those identified as *L. r. douvillei* lack this wedge of shell material. As this wedge of shell material varies from individual to individual and by its position at the periphery of the test is obviously a gerontic development of the test, its presence or absence is not considered to be significant for specific determination.

Finally, if the illustrations given here and by others of *L. pustulosa* are compared with those of *L. r. douvillei,* it will be discovered that the internal structures are so similar that it is impossible to separate these specimens into two distinct species. Moreover, some typical specimens of *L. pustulosa* have the equatorial layer separated into three zones (see: Vaughan and Cole, 1941, pl. 26, figs. 1, 6, lower part). Thus, *L. r. douvillei* (= *L. peruviana, L. veracruziana, L. cedarkeysensis*) is considered to be a synonym of *L. pustulosa* H. Douvillé.

L. veracruziana at its type locality was assigned by Vaughan and Cole (1938, p. 169) to the Tantoyuca formation (upper Eocene). Later, Cole (1956, p. 221) found *L. veracruziana* in the same rock fragments from which the type specimens of *Lepidocyclina proteiformis* Vaughan (1924, p. 810) had been obtained.

Barker (1936, p. 455) gave the range of *L. proteiformis* as middle Eocene (Guayabal formation, Cole, 1927), but Muir (1936, p. 117), following Adkins, recorded *L. proteiformis* in the basal Tantoyuca formation.

The specimen (fig. 3, Pl. 6), identified as *L. proteiformis,* is from the type locality of the Guayabal formation thus giving additional confirmation that *L. proteiformis* does occur in beds in Mexico which are equivalent to the Cook Mountain of Texas.

Grimsdale (1959, p. 19) maintained *L. veracruziana* (= *L. pustulosa*) as a distinct species of the upper Eocene and accounted for the association of this species with *L. proteiformis* by reworking. He stated "There is also local large scale reworking of Middle Eocene material in the base of the Upper Eocene Tantoyuca formation and its equivalents in eastern Mexico."

Although there is abundant evidence that certain species, such as *Lepidocyclina* (*Polylepidina*) *antillea* Cushman, are restricted to the middle Eocene, there are data available to suggest that other species may range from the upper middle Eocene into the upper Eocene (Cole, 1958*c,* p. 423).

L. pustulosa as a distinct species (accompanied by specimens previously identified as *L. r. douvillei* and *L. cedarkeysensis*) is known to occur in Florida (Cole, 1942, p. 45; 1944, p. 34) in the middle Eocene. Raadshoven (1951, p. 482) reported *Lepidocyclina* resembling *L. peruviana—L. r. douvillei* from middle Eocene strata of Venezuela. In Mexico *L. veracruziana* was reported from the upper Eocene. In Peru (Stainforth, 1955, p. 2074) and Ecuador (Vaughan, in Sheppard, 1937, p. 153) *L. peruviana* and *L. r. douvillei* are placed in the upper Eocene.

Therefore, seemingly the stratigraphic range of *L. pustulosa* is upper middle Eocene into the upper Eocene. Cole (1958*b,* p. 264; 1958*c,* p. 416; 1962*b,* p. 145) suggested that other larger Foraminifera, previously thought to be restricted either to the upper middle or upper Eocene, range from middle into upper Eocene.

Although too few specimens have been sectioned to be certain, data available suggest that *L. proteiformis* is a synonym of *L. ocalana.* If this suggestion is correct, the association of *L. proteiformis* and *L. veracruziana* (= *L. pustulosa*) at the type locality of *L. proteiformis* would not be the result of reworking, but the association of species whose ranges extend from middle into upper Eocene.

COMMENTS ON SOME OF THE INTERNAL STRUCTURES OF *LEPIDOCYCLINA* AND THEIR USE IN DEFINING SUBGENERA

Traditionally, the genus *Lepidocyclina* has been subdivided into six and sometimes more subgenera by authors. These subgenera are: *Polylepidina, Pliolepidina, Lepidocyclina s. s., Nephrolepidina, Eulepidina,* and *Multilepidina.* Recently, reduction of the number of subgenera has been proposed. Cole suggested in 1960*a* (p. 138) that *Nephrolepidina* was a synonym of *Eulepidina* and that *Multilepidina* could not be maintained as it was based upon an abnormal form.

If *Pliolepidina* is accepted as a synonym of *Lepidocyclina s. s.* there will be three subgenera, *Polylepidina, Lepidocyclina s. s.* and *Eulepidina* in the genus *Lepidocyclina.*

Some authors have stated that certain or all of these subgenera are sufficiently distinct to be elevated to generic rank. Hanzawa (1962, p. 137, 138, 145) considered that each of the subgenera should be so treated. Eames, *et al.* (1962*b,* p. 300) maintained *Lepidocyclina s. s.* and *Nephrolepidina* as subgenera of *Lepidocyclina* but advanced *Pliolepidina* and *Eulepidina* to generic status.

Galloway (1928, p. 299) was one of the first to suggest that *Polylepidina,* described by Vaughan (1924, p. 807) as a subgenus of *Lepidocyclina,* should be elevated to generic rank. Vaughan (1929, p. 288) vigorously objected to this suggestion of Galloway because of the similarity in the construction of the tests of *Polylepidina* and *Lepidocyclina.*

The structures of the tests of all the known lepidocyclines are so similar, differing only in minor detail, that the phylogeny of the lepidocyclines is best expressed by the use of subgeneric names which minimize distinctiveness and emphasize the homogeneity of the species. Moreover, there will be less confusion if subgeneric names later are suppressed as the generic name will remain constant. Finally, agreement has not been reached upon the interpretation and evaluation of structures which are used to define a genus. Distinctive structures which have been assumed to characterize a certain genus have been found later to be equally developed in species assigned to another genus.

Hanzawa (1962, p. 145) not only elevated *Polylepidina* to generic rank but also transferred this genus to the family Helicolepidinidae. In part, he justified this by a comparison of the structure of the walls of the equatorial chambers of *Helicolepidina* and *Polylepidina.* He (p. 146) wrote: "The illustrations of the median sections . . . strongly suggest the existence of the intermural canals . . ."

In the explanation of an illustration of the equatorial chambers (Hanzawa, 1962, pl. 4, fig. 2) of *Polylepidina gardnerae* Cole (= *L.* (*P.*) *antillea* Cushman) he stated: "Microspheric specimen; septa are rather thick and consist of three layers, the outer two thin, while the middle one is rather wide and seems to show a void space and to represent interseptal canal . . ."

Figure 5 of Plate 5 illustrates the structure of the wall of the equatorial chambers of a megalospheric specimen of *Polylepidina* which is entirely similar to the illustration given by Hanzawa (1962, pl. 4, fig. 2). Figure 6 of Plate 5 illustrates the equatorial chambers of *Lepidocyclina ocalana*. The similarity in the structure of the walls of the equatorial chambers of these two species is easily observed.

Vaughan (1929, p. 289) many years ago accurately described the structure of the walls of *Polylepidina* and concluded that these walls were entirely comparable to those found in other species of *Lepidocyclina*.

Eames, *et al.* (1962*b*, p. 295) claimed that "*Eulepidina* is also clearly distinguishable from *Lepidocyclina* (*s. s.*), *Nephrolepidina*, and *Pliolepidina* by the form of the equatorial chambers when seen in axial section. The multiplicity of the intercameral foramina and their associated ridges and grooves produces a characteristic appearance in axial sections, even in primitive species . . .; the septa between the chambers are often seen to be sinuous (oppositely corrugated on both sides), and the ridges are extensive. Advanced species . . . show great multiplication of the foramina and grooves, and they are then clearly distinct from even large microspheric *Nephrolepidina* (*e. g.*, of the Burdigalian or Vindobonian, such as *L.* (*N.*) *ngampelensis, L.* (*N.*) *papulifera, L.* (*N.*) *gigantea*), in which the thickness of the equatorial layer in the outer limits of the flange may at least equal that of *Eulepidina*."

On Plate 13, figures 1-5 are parts of five vertical sections which show ridges and grooves, hereafter called pectinations, of the kind which Eames, *et al.* (1962*b*, p. 295) claimed are characteristic of *Eulepidina*. On Plate 12, figure 3 is an enlargement of part of figure 1, Plate 13; figure 4 is an enlargement of figure 5, Plate 13, and figure 5 is an enlargement of figure 2, Plate 13. Figure 4 of Plate 13 shows in vertical section the occurrence of multiple stolons. These specimens are arranged according to their stratigraphic distribution in Table 4.

Study of the illustrations will demonstrate conclusively that pectinations on the wall of the equatorial chambers do not characterize *Eulepidina* as claimed by Eames, *et al.* (1962*b*, 295), nor can such pectinations and multiplicity of stolons "be most characteristic of advanced *Eulepidina*" (Eames, *et al.* 1962*b*, p. 297).

TABLE 4

Stratigraphic distribution and identification of the specimens on Plate 13.

Specimen	*Identification*	*Generation*	*Formation*	*Age*
Pl. 13, figs. 1, 3, 6	*L.* (*L.*) *ocalana* Cushman	Microspheric	Ocala ls.	Late Eocene
Pl. 13, fig. 6	*L.* (*L.*) *gubernacula* Cole	Megalospheric	Gatuncillo fm.	Late Eocene
Pl. 13, fig. 2	*L.* (*L.*) *mantelli* (Morton)	Megalospheric	Suwannee ls.	Oligocene
Pl. 13, fig. 5	*L.* (*E.*) *undosa* Cushman	Megalospheric	Suwannee ls.	Oligocene

The contention of Eames, *et al.* concerning the value of stolons and pectinations in defining a genus or subgenus is as incorrect as Chatterji (1961, p. 423) was when he assumed that multiplicity of the equatorial chambers in the peripheral zone was characteristic of *Nephrolepidina* (see figs. 3, 4, Pl. 13, both of which are *Lepidocyclina s. s.*).

Eames, *et al.* (1962*b*, p. 300) retained *Nephrolepidina* as a subgenus of *Lepidocyclina* and elevated *Eulepidina* to generic rank. As I interpret their definitions, the specimen illustrated as figure 2, Plate 8 would conform to their definition of *Eulepidina,* whereas the other specimens (figs. 3-5, Pl. 8; figs. 1-5, Pl. 9) would be classified as *Nephrolepidina.*

Figure 1 of Plate 2 is a specimen which on the shape of the embryonic chambers might be classified as *Nephrolepidina.* This specimen was prepared on purpose to illustrate how a specimen of the kind of figure 2, Plate 8 can be made to appear as if the second chamber does not embrace completely the initial chamber.

The specimens (fig. 3, Pl. 8; figs. 1, 2, 3, Pl. 9), identified as *L.* (*Eulepidina*) *chaperi* Lemoine and R. Douvillé, are from the same sample. A vertical section (fig. 13, Pl. 10) of this species from this locality is introduced for completeness. The embryonic chambers of this species show variation in shape from nephrolepidine (fig. 3, Pl. 8; fig. 2, Pl. 9) through figure 1, Plate 9 to eulepidine (fig. 3, Pl. 9).

Specimens (figs. 4, 5, Pl. 8; figs. 4, 5, Pl. 9) from Saipan Island are introduced for comparison. These specimens show that the contact of the initial chamber with the outer wall of the embryonic chambers is variable. Moreover, the shape of the embryonic chambers in figure 4, Plate 8 and figure 5, Plate 9 is similar to that of figure 3, Plate 9.

The arrangement of the embryonic chambers of figure 4, Plate 9 and figures 4, 5, Plate 8 is entirely similar to that of figure 2, Plate 8. Thus, *Eulepidina* as defined by Eames, *et al.* (1962*b*, p. 300) must be based solely upon the size of the embryonic chambers.

In another section of this discourse evidence is advanced that in *L. pustulosa* the size of embryonic chambers in a species has great latitude. Therefore, it seems to be illogical to use size as a distinctive criterion in defining a genus.

Moreover, Vaughan (1926, pl. 24, fig. 1) illustrated the embryonic chambers of *L. undosa* which are distinct nephrolepidine in shape, yet are of sufficient size to be included in Eames, *et al.* definition of *Eulepidina*.

Gravell (1933, p. 31) wrote concerning *L. undosa* "A large number of sections of this species show the embryonic apparatus varying from the nephrolepidine to eulepidine type, making the assignment of this species to either subgenus virtually optional."

This same situation has been found in other species. For example, the specimen illustrated by Cole (1960*a*, pl. 1, fig. 6) on size and arrangement of the embryonic chambers should be classified as *Eulepidina* if the definition of Eames, *et al.* (1962*b*, p. 300) is followed, yet it was associated with specimens otherwise similar except for the shape and size of the embryonic chambers (Cole, 1960*a*, pl. 1, figs. 1-3, 7, 8, 10). Eames, *et al.* (1962*b*, p. 316) considered all of these specimens to be representatives of *Lepidocyclina* (*Nephrolepidina*) with the exception of figure 1, plate 1 (Cole, 1960*a*) which they assigned to *Pliolepidina* as recognized by them.

These citations demonstrate that the classification proposed by Eames, *et al.* is not logical. They included in their *Nephrolepidina* a specimen which conforms to their own definition of *Eulepidina*. But, they excluded and placed in their *Pliolepidina* a specimen from the same locality which is similar in all other structures to those which they placed in their *Nephrolepidina*.

COMMENTS ON *LEPIDOCYCLINA RADIATA* (Martin)

Van der Vlerk (1961) published an excellent description and illustrations of the equatorial section of the type of *L. radiata*. A specimen (Cole, 1962*a*, pl. 4, fig. 2) from Oneata, Lau, Fiji, has an equatorial section which is identical with that of the type of *L. radiata*. A number of specimens from Oneata were studied by Cole (1960*a*, p. 136; 1962*a*, p. 35-39, 42-46), and the conclusion was reached that all of these specimens should be assigned to *L. radiata*. The series included specimens with bilocular, trilocular, and multilocular embryonic chambers.

Recently, additional material from near the type locality of *Lepidocyclina* (*Cyclolepidina*) *suvaensis* Whipple on Viti Levu, Fiji, was sent me through the courtesy of Harry S. Ladd. A part of an equatorial section (fig. 6, Pl. 14) of one of the specimens from this collection is illustrated and most certainly is *L. radiata*.

Although Cole (1960*a*, p. 137) placed *L.* (*C.*) *suvaensis* in the synonymy of *L. radiata*, Eames, *et al.* (1962*b*, p. 316) assigned some of the specimens figured by Whipple (in Ladd, 1934, pl. 20) to *Pliolepidina irregularis* (Hanzawa) (Whipple's figs. 5-8) and others (Whipple's figs. 1-4) to *Pliolepidina luxurians* (Tobler).

At the Oneata locality Cole (1960*a*, p. 136) recognized only *L. radiata*, but Eames, *et al.* (1962*b*) identified from the illustrations given by Cole (1960*a*, pl. 1) two species each of which was assigned to a different genus.

All of these specimens have identical internal structures with the exception of the embryonic chambers which may be bilocular, trilocular, or multilocular. Although Eames, *et al.* (1962, p. 303) discussed how these species may be recognized, seemingly the major emphasis was placed upon the kind of embryonic chambers present. If this were not the case, how could they determine that figure 1 of plate 1 (Cole, 1960*a*) represented *P. irregularis*, whereas figure 2 of this plate was assigned to *L. oneataensis* as the equatorial chambers of the two specimens have the same shape?

It is even a little more difficult to decide how Eames, *et al.* (1962*b*, p. 316) could separate the specimens illustrated by Whipple (in Ladd, 1934, pl. 20) into two species.

Finally, it would appear to be inconsistent to separate specimens with bilocular embryonic chambers into one genus and others with multilocular embryonic chambers in another genus, yet include specimens with trilocular embryonic chambers (Cole, 1960*a*, pl. 1, fig. 10; Pl. 10, fig. 6) with those with bilocular embryonic chambers. Should not these specimens with trilocular embryonic chambers be segregated into still another genus?

Although Eames, *et al.* (1962*b*, p. 293) stated that one of the sections with trilocular embryonic chambers (Cole, 1960*a*, pl. 1, fig. 10) was "a skew section of the 'trybliolepidine' type of nucleoconch," they were mistaken. This section and others (see: Cole, 1962*a*, pl. 4, figs. 1, 2, 4, 5; Pl. 14, fig. 6) were made by me and observed throughout their preparation. These specimens had embryonic chambers with a threefold division which could be seen clearly during the entire preparation of the section. Moreover, the distribution of the equatorial chambers and the periembryonic chambers demonstrates that these are centered, not oblique, sections.

A specimen of *L. radiata* with two, separate sets of trilocular embryonic chambers (Cole, 1962*a*, pl. 4, fig. 1) has been illustrated. Recently, from the same locality (L 466, Oneata, Lau, Fiji) another specimen was found which has two separate sets of embryonic chambers. One of the sets is trilocular, but the other set is multilocular consisting of a large central chamber on the periphery of which there are four smaller chambers. This multilocular set resembles the one illustrated as figure 3, plate 5 (Cole, 1962*a*).

It has been demonstrated that sets of bilocular and multilocular embryonic chambers occur as "twins," and the specimen described above proves that trilocular and multilocular embryonic chambers develop within a single specimen. These associations are considered to prove without question that multilocular embryonic chambers result from irregularity in the reproductive cycle of *Lepidocyclina*. Therefore, this kind of embryonic chamber cannot be used to characterize a genus or subgenus.

VARIATION IN *HELICOSTEGINA POLYGYRALIS* (Barker)

Helicostegina polygyralis (Barker) Pl. 10, figs. 5-8; Pl. 11

1932. *Helicolepidina polygyralis* Barker, Geol. Mag., v. 69, p. 309, 310, pl. 22, fig. 5; text fig. 4.

This species and its synonyms have been considered in detail recently (Cole, 1960*b*, p. 59). Several megalospheric specimens from locality 7*a* were illustrated in the previous discussion. Since that time several microspheric specimens (figs. 1-4, Pl. 11) were found at this locality and are illustrated to complete the series of illustrations.

Several additional megalospheric specimens (figs. 5-8, Pl. 11) from locality 7*a* and from locality 23*a* are illustrated to demonstrate that the length of the whorl of spiral chambers is somewhat variable. However, the prominence of this whorl as viewed in median section is controlled mainly by the position of the section.

One specimen (fig. 5, Pl. 11) illustrates a short whorl of the kind which was assumed to characterize *Helicostegina paucispira* (Barker and Grimsdale), whereas another specimen (fig. 8, Pl. 11) has a long whorl of the kind described for *Helicostegina soldadensis* Grimsdale. Another specimen (fig. 6, Pl. 11) illustrates one in which the whorl is intermediate between the other two.

The specimen (fig. 7, Pl. 11) with the extremely prominent whorl and a small number of equatorial chamberlets was ground slightly beyond the median plane on purpose. At one stage in the preparation of this thin section its appearance was similar to that of the specimen illustrated in figure 8, Plate 11.

Sections of a sufficient number of specimens from several localities have been prepared to demonstrate that the length of the whorl of spiral chambers cannot be used in specific determinations.

Microspheric specimens have been found at the type localities from which megalospheric specimens of *H. polygyralis* and *H. paucispira* were obtained. These microspheric specimens are entirely comparable to those found in Trinidad (figs. 1-4, Pl. 11) and in Florida (Cole, 1960*b*, pl. 10, figs. 8-10; pl. 11, figs. 1, 9, 10).

Helicostegina polygyralis at its type locality in Ecuador was associated with *Asterocyclina asterisca* (Guppy), *Camerina flori-*

densis (Heilprin) (= *Operculina ocalana* Cushman) and *Polylepidina* sp. (Barker, 1932, p. 305). Vaughan (in Sheppard, 1937, p. 155) stated that the specimen identified by Barker as *Polylepidina* (1932, pl. 22, fig. 3) may be *Helicolepidina.* Vaughan seemingly was correct, and this specimen may be *Helicolepidina spiralis* Tobler. Vaughan and Barker placed this fauna in the upper Eocene.

Later, Barker and Grimsdale (1936, p. 244) assigned *H. polygyralis* (Barker) to the lower middle Eocene, and on the same chart showed *Helicolepidina paucispira* Barker and Grimsdale [= *Helicostegina polygyralis* (Barker)] in the upper Eocene. *Helicostegina soldadensis* Grimsdale [= *Helicostegina polygyralis* (Barker)] was described from the upper Eocene of Trinidad.

Cole (1945, p. 47) and Cole and Applin (1961, p. 132) reported *Helicostegina polygyralis* from wells in Florida and Georgia in association with Foraminifera diagnostic of the Ocala limestone (upper Eocene).

Barker (1932, p. 305) was correct in his original assignment of *Helicostegina polygyralis* to the upper Eocene, and Barker and Grimsdale (1936, p. 244) were not correct when they described Mexican specimens as *Helicolepidina paucispira* and assigned *Helicolepidina* (= *Helicostegina*) *polygyralis* to the lower middle Eocene.

Hanzawa (1962, p. 143, 144) retained *Helicostegina soldadensis* Grimsdale, *Helicolepidina polygyralis* Barker, and *Helicolepidina paucispira* Barker and Grimsdale as valid species in the genera to which they were assigned originally. He failed to recognize that the internal structure in these supposed species is the same, therefore, they must be representatives of a single species.

Moreover, he (Hanzawa, 1962, p. 144) stated that "*Helicolepidina paucispira* is barely distinguishable from *Eulinderina guayabalensis* . . ." Cole (1960*b*, p. 60) demonstrated conclusively that *Eulinderina* was a synonym of *Lepidocyclina* (*Polylepidina*). Even the most uncritical inspection of preparations of *Lepidocyclina* (*Polylepidina*) and *Helicostegina* will convince one that the internal structures are entirely different (compare fig. 1, Pl. 6, *Lepidocyclina* (*Polylepidina*) with figs. 5-8, Pl. 11, *Helicostegina*), especially if the construction of the entire test is evaluated. *Helicostegina poly-*

gyralis has a test which is constructed so that it is entirely similar to *Helicostegina dimorphora* Barker and Grimsdale, the type of *Helicostegina.*

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PLATES

Explanation of Plate 1

Figure Page

All the illustrations are the central part of equatorial sections of megalospheric individuals to show the embryonic, periembryonic, and equatorial chambers; X 40.

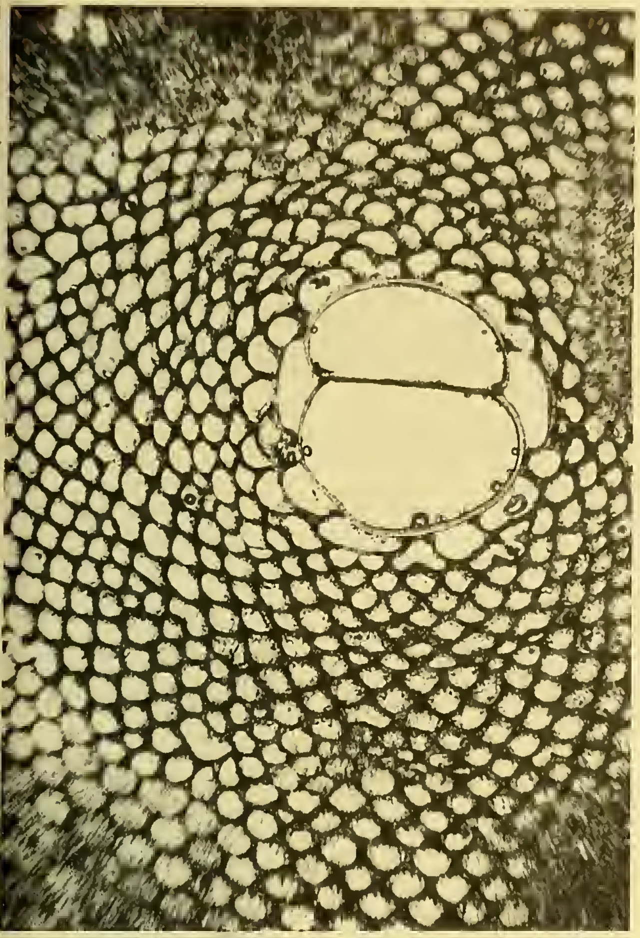
1, 2. **Lepidocyclina (Lepidocyclina) mantelli** (Morton) 19, 38

3. **Lepidocyclina (Polylepidina) antillea** Cushman 20, 36

4. **Lepidocyclina (Lepidocyclina) ariana** Cole and Ponton .. 20
This specimen was illustrated previously as figure 6 of plate 17, Fla. Geol. Survey Bull. 28, 1945.

5. **Lepidocyclina (Lepidocyclina) pustulosa** H. Douvillé 14, 21
Note the stolon between the initial and second embryonic chambers, and between the second embryonic chamber and the principal periembryonic chamber on the right side.

1, 2. Loc. 17 (Oligocene)—
see text for locality descriptions.
3. Loc. 10 (middle Eocene).
4. Loc. 19 (middle Eocene).
5. Loc. 1 (K2854) (upper Eocene).



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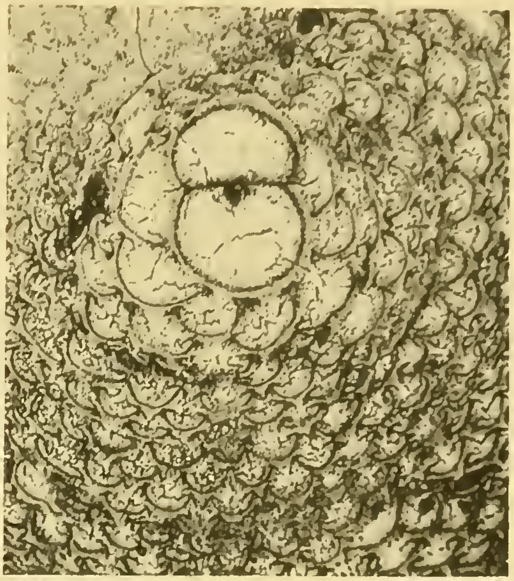

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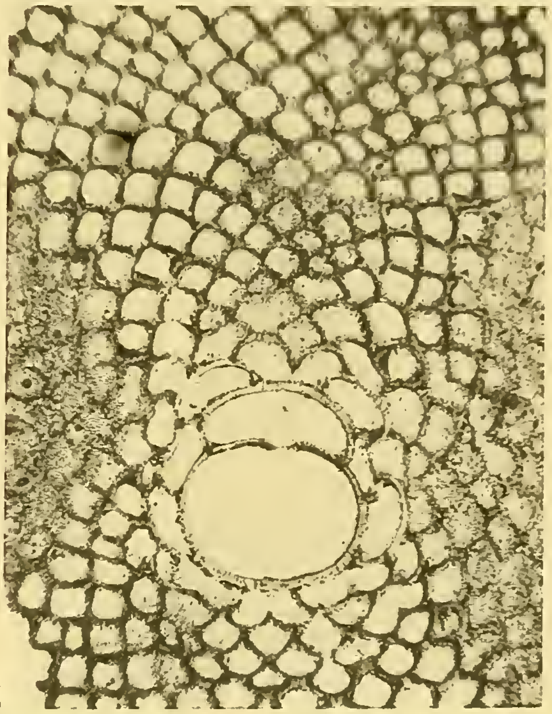

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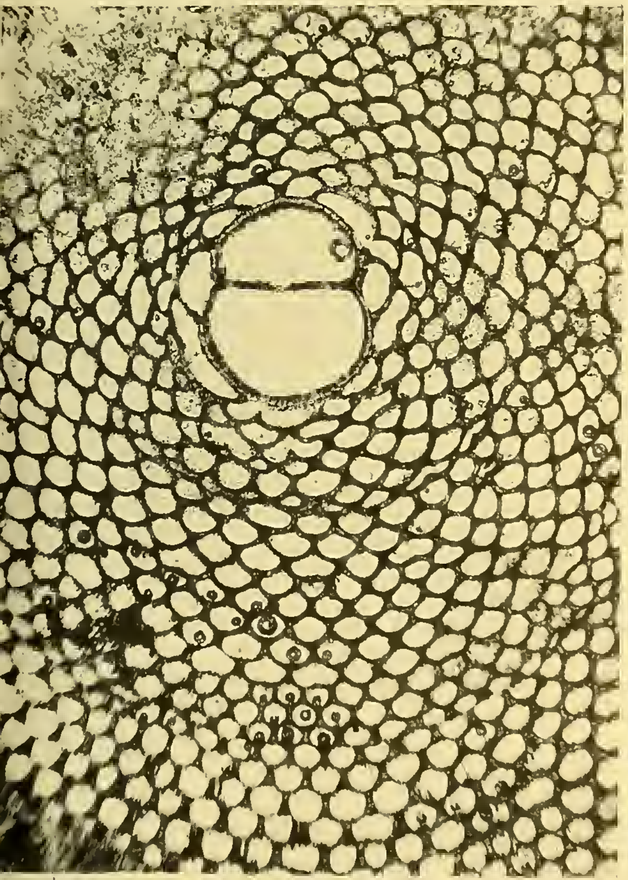

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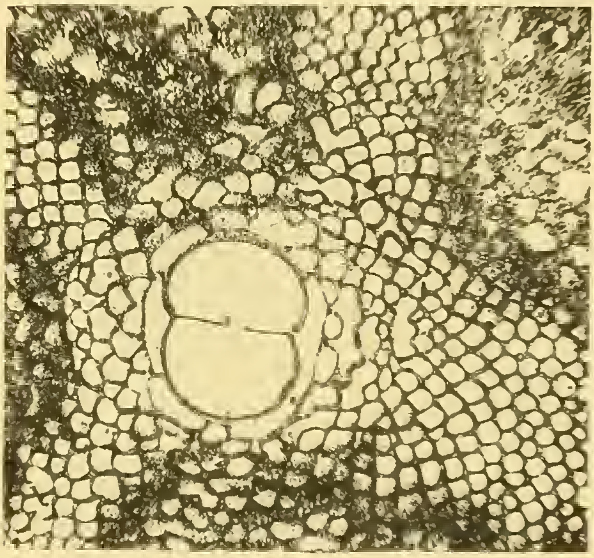

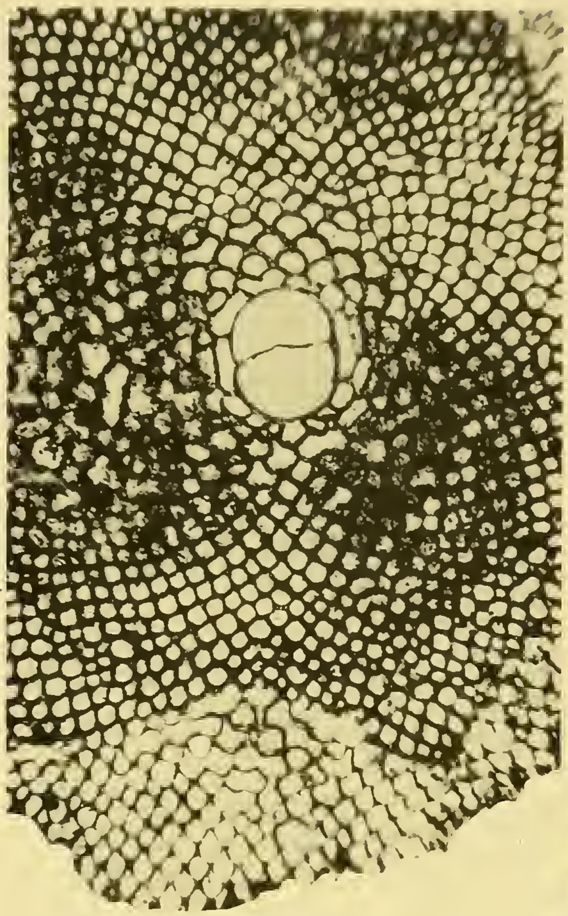

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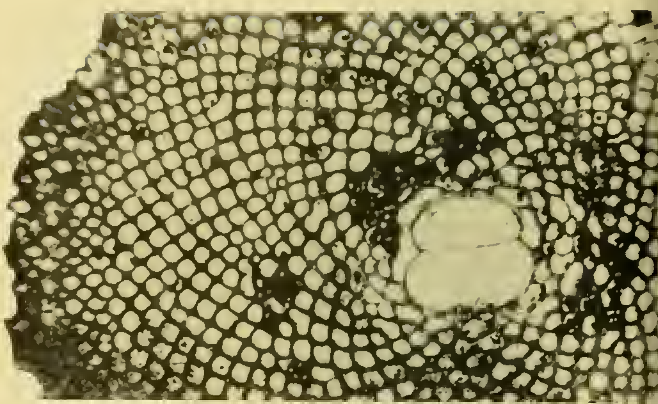

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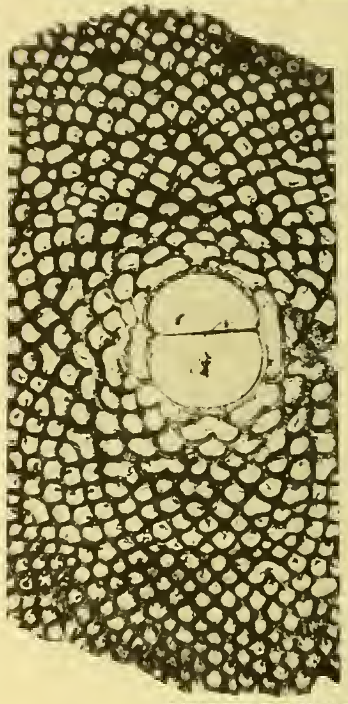

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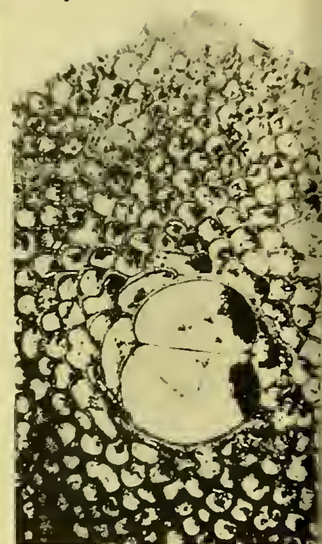

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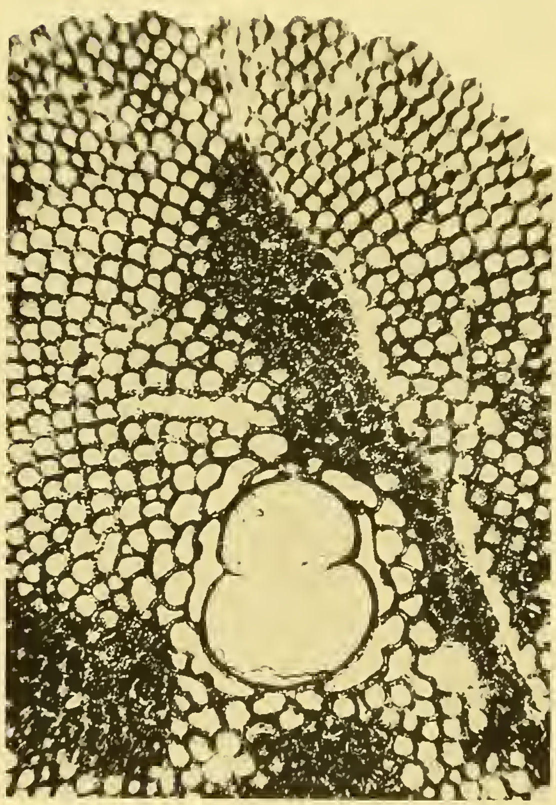

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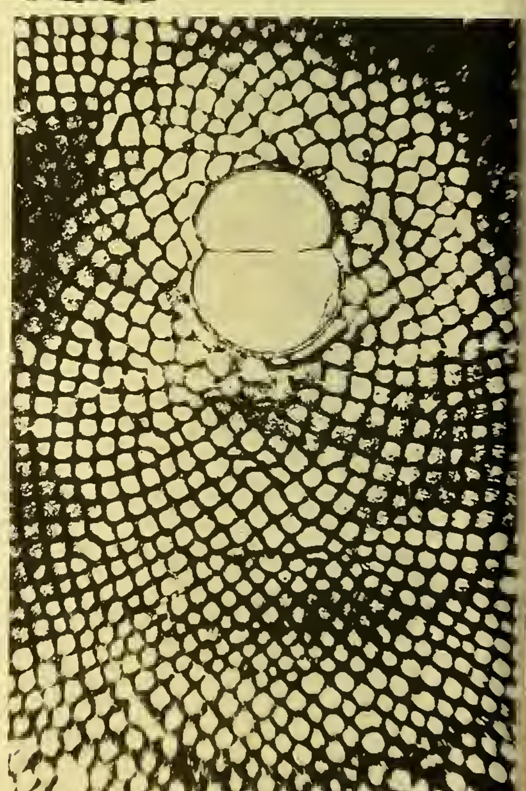

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Explanation of Plate 2

Figure Page

All the illustrations are the central part of equatorial sections of megalospheric individuals to show the embryonic, periembryonic, and equatorial chambers; X 40.

1-6. **Lepidocyclina (Lepidocyclina) pustulosa** H. Douvillé 21
These sections illustrate the increase in size of the embryonic chambers; the series continues on Plate 3; 2. Note the thin-walled equatorial chambers in the lower part of this specimen in contrast to those nearer the embryonic chambers; 1. This specimen is illustrated, X 20, as figure 3, Plate 3.
1-6. Loc. 1 (K2854) (upper Eocene)—
see text for locality descriptions.

Explanation of Plate 3

Figure | Page

1-6. **Lepidocyclina (Lepidocyclina) pustulosa** H. Douvillé 21

1, 2, 5, 6. Parts of equatorial sections, X 40, of megalospheric specimens to show the embryonic, periembryonic, and equatorial chambers; 6. This specimen should be compared with the type illustration of *L. bontourana* Hodson, 1926, fig. 5, pl. 5.

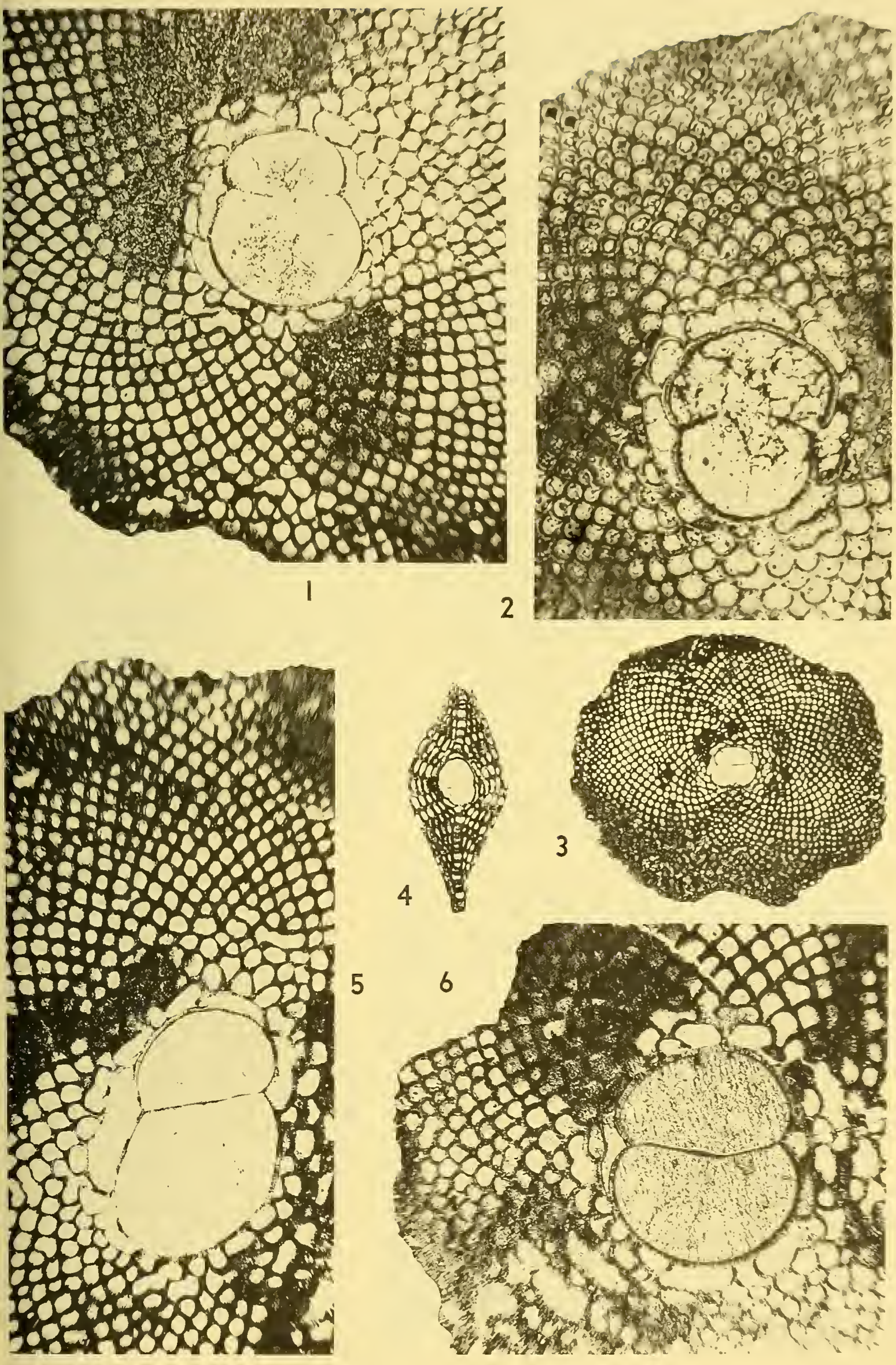
3. Equatorial section, X 20; compare with *L. subglobosa* Nuttall, 1928, fig. 6, pl. 8 (see figure 1, Plate 2, for enlargement).

4. Vertical section, X 20; compare with *L. subglobosa* Nuttall, 1928, fig. 5, pl. 8.

1, 5, 6. Loc. 2 (K903) (upper Eocene)— see text for locality descriptions.

2. Loc. 3 (Vista Bella) (upper Eocene).

3, 4. Loc. 1 (K2854) (upper Eocene).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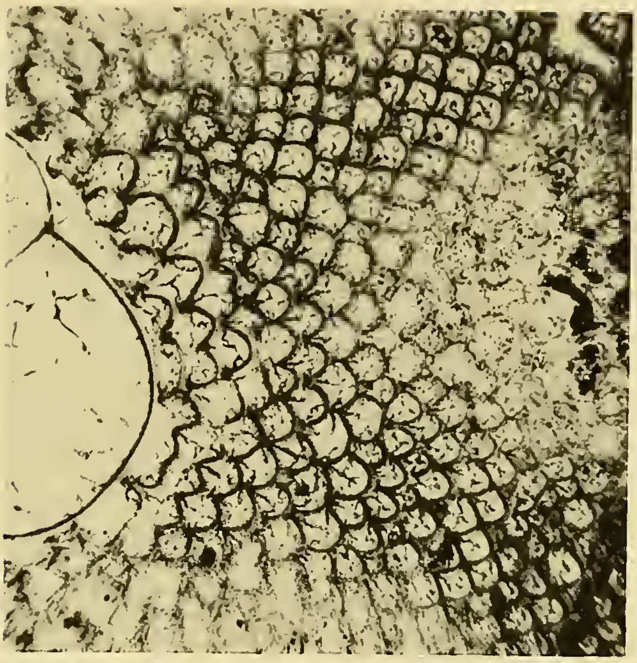

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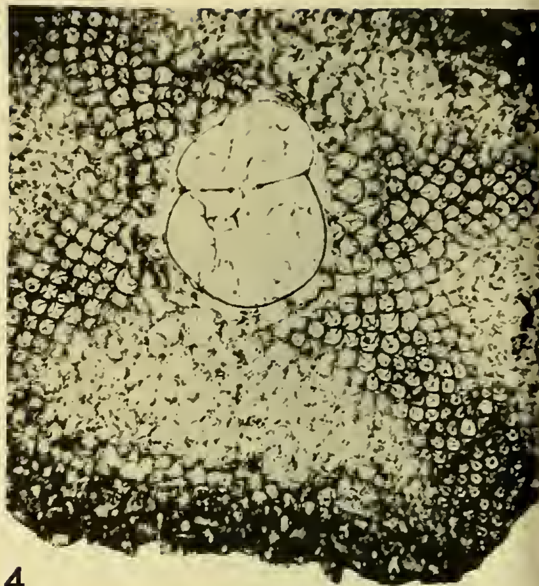

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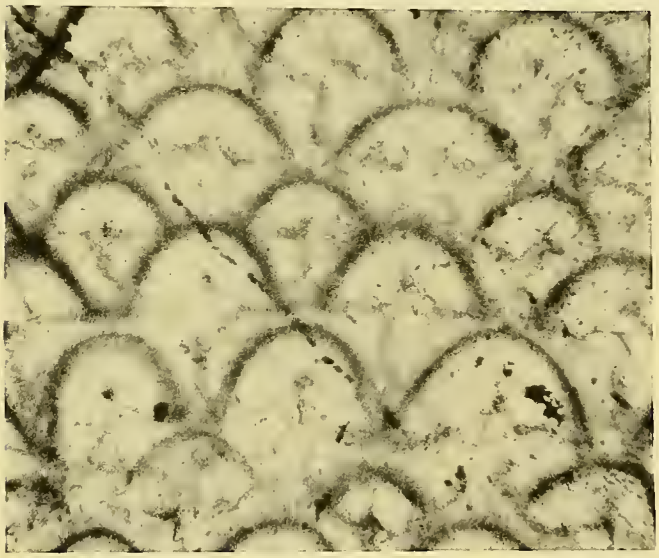

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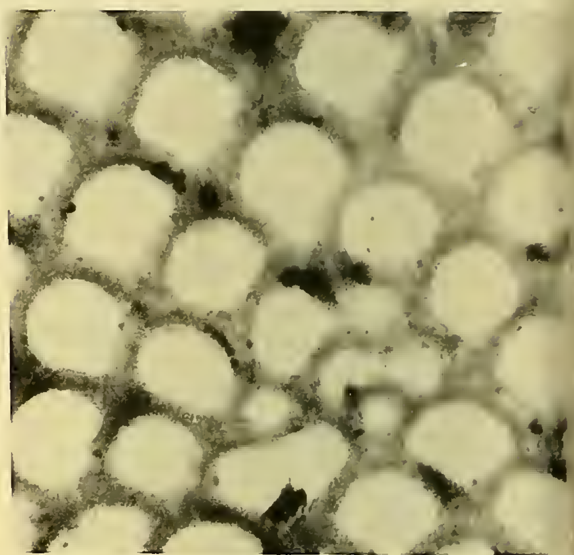

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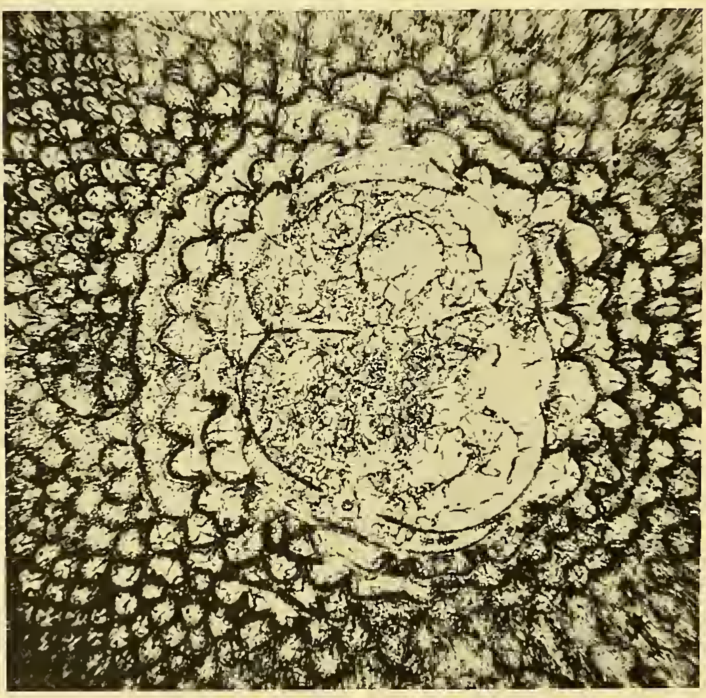

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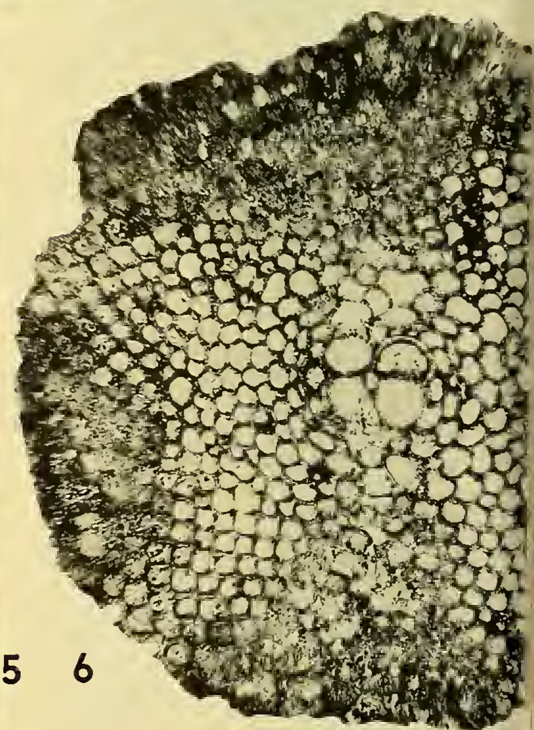

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Explanation of Plate 4

Figure | Page

1-6. **Lepidocyclina (Lepidocyclina) pustulosa** H. Douvillé 15, 21

1, 2. Parts of the same equatorial section, 1, X 40; 2. X 20, to illustrate unusually large embryonic chambers; this specimen was figured as fig. 6, pl. 2, Cole, 1960*a*.

3. Part of the equatorial section, figures 1, 2, this plate, X 210, to show the shape and arrangement of the equatorial chambers; these chambers are filled with calcite.

4. Part of the equatorial section, figure 1, Plate 2 and figure 3, Plate 3, X 210, to show the shape and arrangement of equatorial chambers, these chambers are not filled.

5. Part of an equatorial section, X 40, of a comparison specimen with unusually large embryonic chambers.

6. Part of an equatorial section, X 40, of specimen with a double set of perfect bilocular embryonic chambers, each of which is small.

1-3,5. Loc. 3 (Vista Bella) (upper Eocene)—
see text for locality descriptions.

4. Loc. 1 (K2854) (upper Eocene).

6. Loc. 7*a* (upper Eocene).

Explanation of Plate 5

Figure Page

All the illustrations are parts of equatorial sections to illustrate the shape of the equatorial chambers; 1-5, X 210; 6, X 40.

1-4. **Lepidocyclina (Lepidocyclina) pustulosa** H. Douvillé 21
1-4. Equatorial chambers of the specimen illustrated as figure 2, Plate 2; 1, 4, near the embryonic chambers; 2. Toward periphery, but inside of the thin-walled equatorial chambers; 3. Near periphery in the zone of thin-walled chambers.

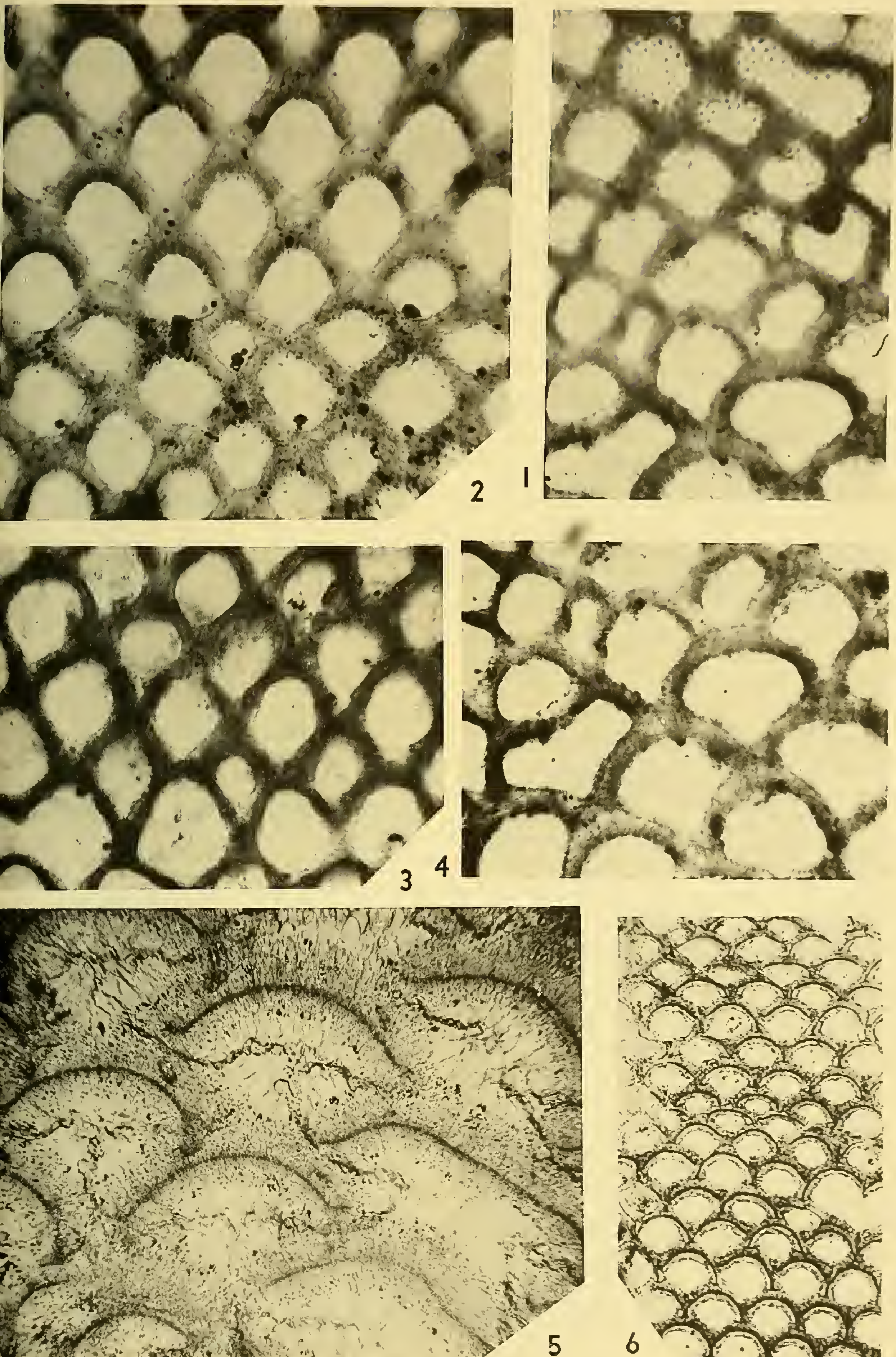
5. **Lepidocyclina (Polylepidina) antillea** Cushman 36
Equatorial chambers of the specimen illustrated as figure 1, Plate 6 to show the three-fold division of the chamber wall.

6. **Lepidocyclina (Lepidocyclina) ocalana** Cushman 37
Equatorial chambers which have the same threefold division of the chamber walls as *L.* (*P.*) *antillea.*

1-4. Loc. 1 (K2854) (upper Eocene)—
see text for locality descriptions.

5. Loc. 20 (upper middle Eocene).

6. Loc. 16 (upper Eocene, Ocala limestone).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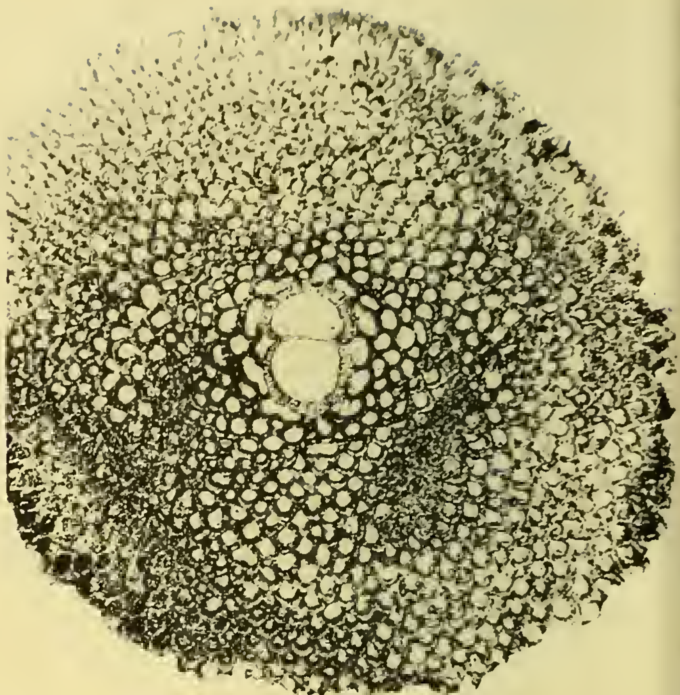

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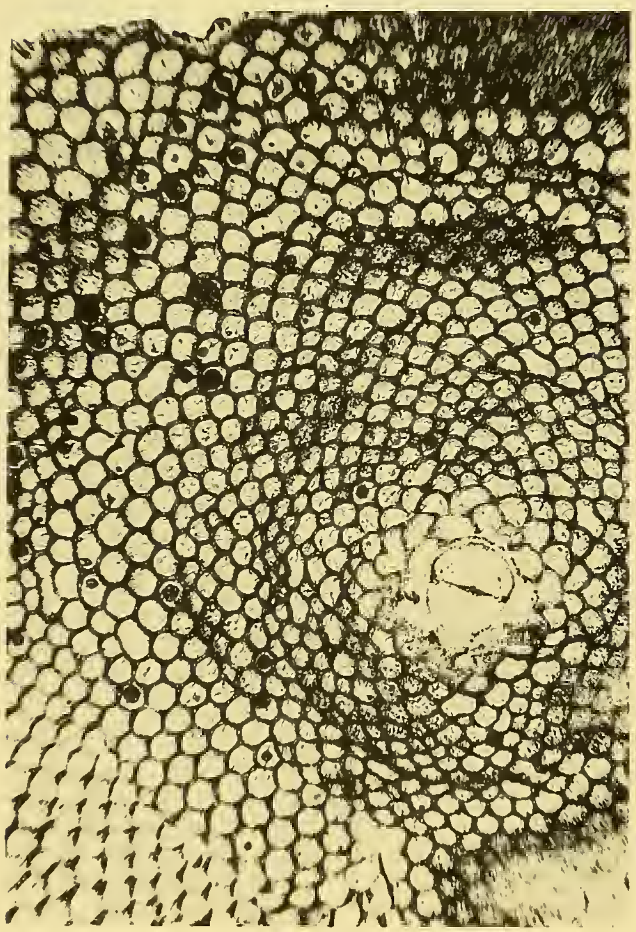

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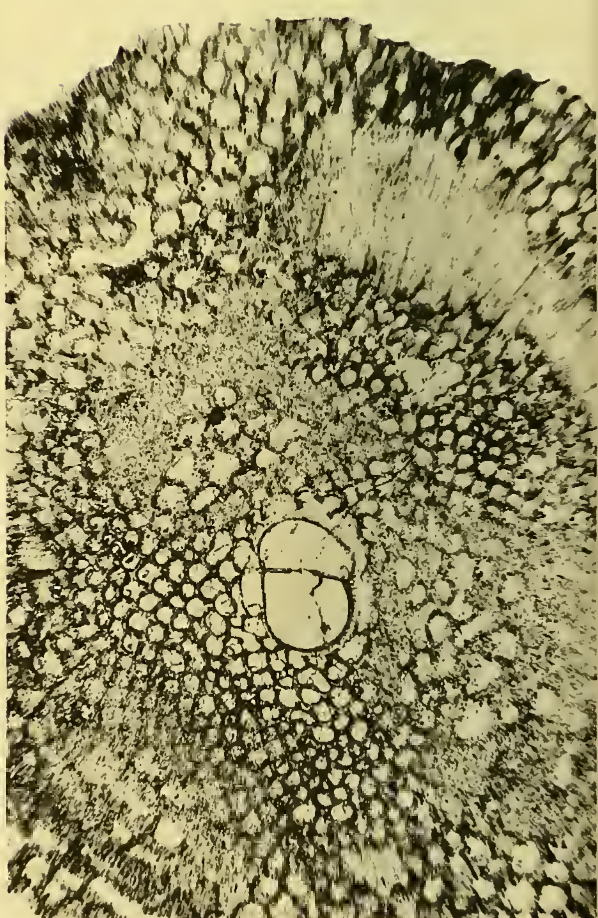


Explanation of Plate 6

Figure		Page
1.	**Lepidocyclina (Polylepidina) antillea** Cushman .... Equatorial section, X 40.	36
2, 4.	**Lepidocyclina (Lepidocyclina) pustulosa** H. Douvillé ...... Equatorial sections, X 40; 2. Specimen of the kind previously identified as *L. peruviana* Cushman; 4. Specimen of the kind previously identified as *Triplalepidina veracruziana* Vaughan and Cole; a topotype.	32
3.	**Lepidocyclina (Lepidocyclina) proteiformis** Vaughan .... Equatorial section, X 40.	10, 34

1. Loc. 20 (upper middle Eocene)—
   see text for locality descriptions.
2. Loc. 24 (upper Eocene).
3. Loc. 11 (upper middle Eocene; Guayabal formation).
4. Loc. 12*a* (upper Eocene).

Explanation of Plate 7

Figure	Page

1-4. **Pseudophragmina (Proporocyclina) zaragosensis** (Vaughan) 15

Four specimens with multiple sets of embryonic chambers, X 40, photographed by reflected light; 1. Three sets in a line; 2, 3, several sets grouped roughly in a circle; note the tendency of the initial chamber of each set to occur in a peripheral position; 4. Several sets grouped together with one set on the left excluded from the group.

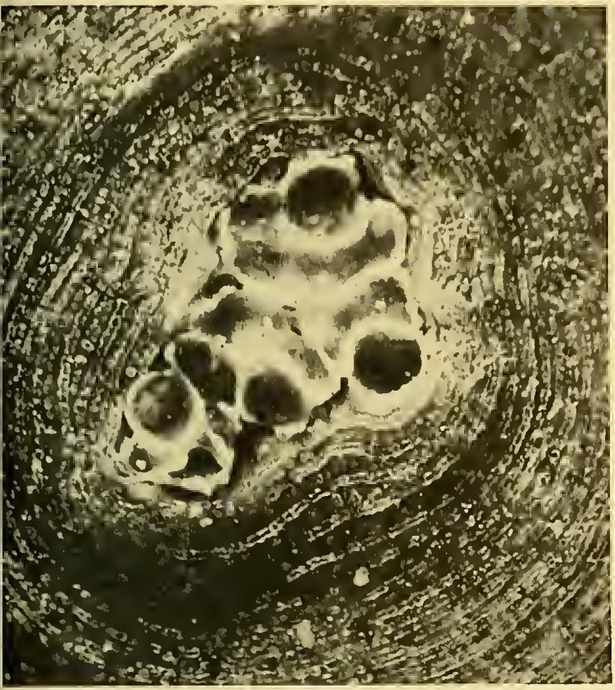
5, 6. **Lepidocyclina (Polylepidina) antillea** Cushman 20, 36

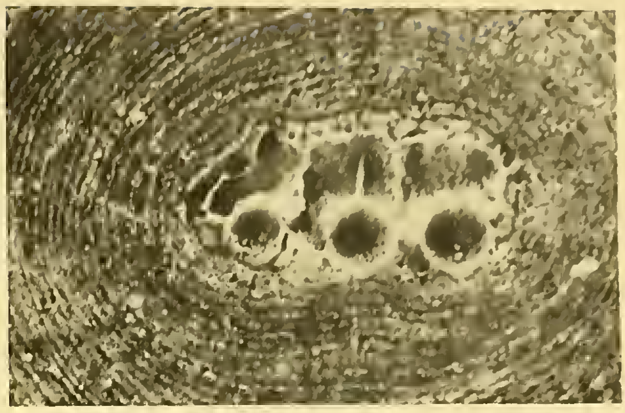
Enlargements, X 210, of periembryonic chambers to show the apertures with anteriorly directed inner lips; 5. From the specimen illustrated as figure 9, plate 27, Cole, 1956; 6. From the specimen illustrated as figure 5, plate 13, Cole, 1960*b*.

1-4. Loc. 21—see text for locality descriptions.

5. Loc. 22

6. Loc. 10





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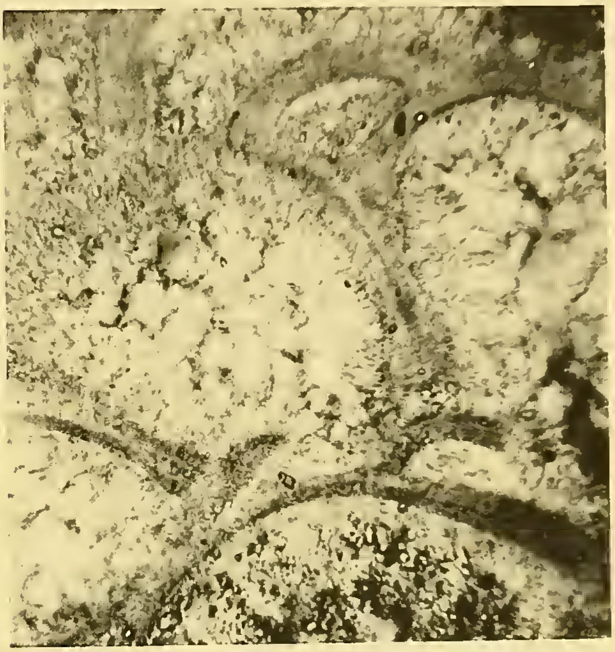

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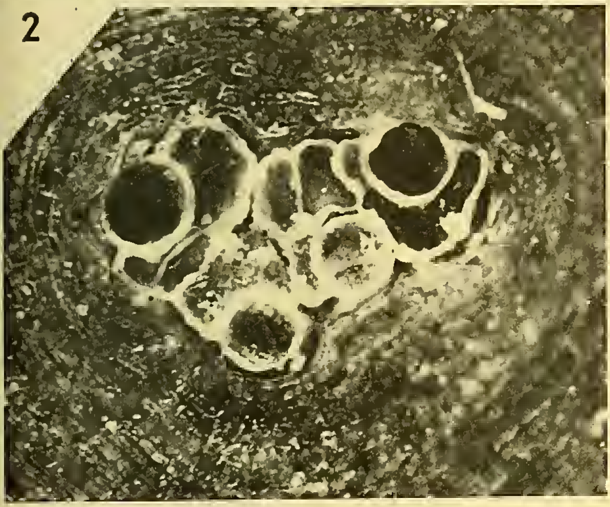

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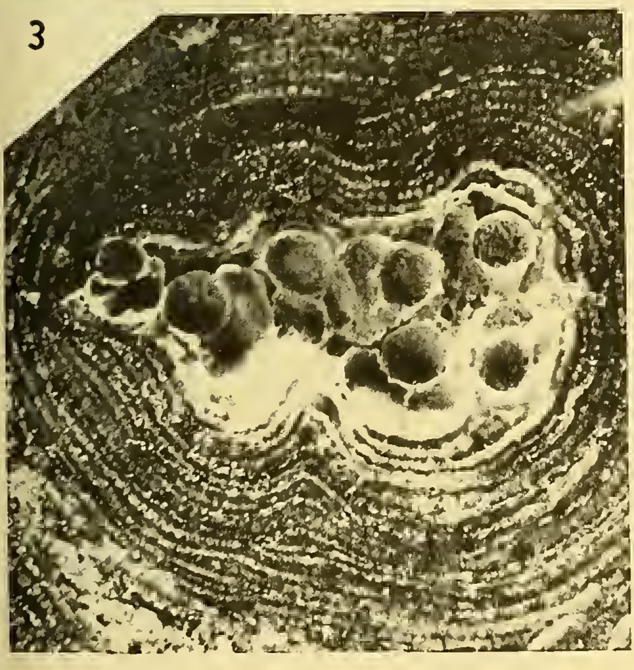

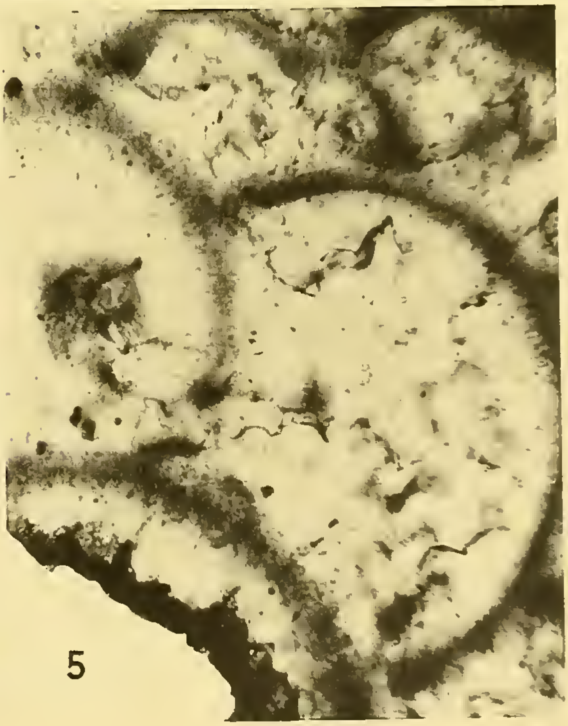

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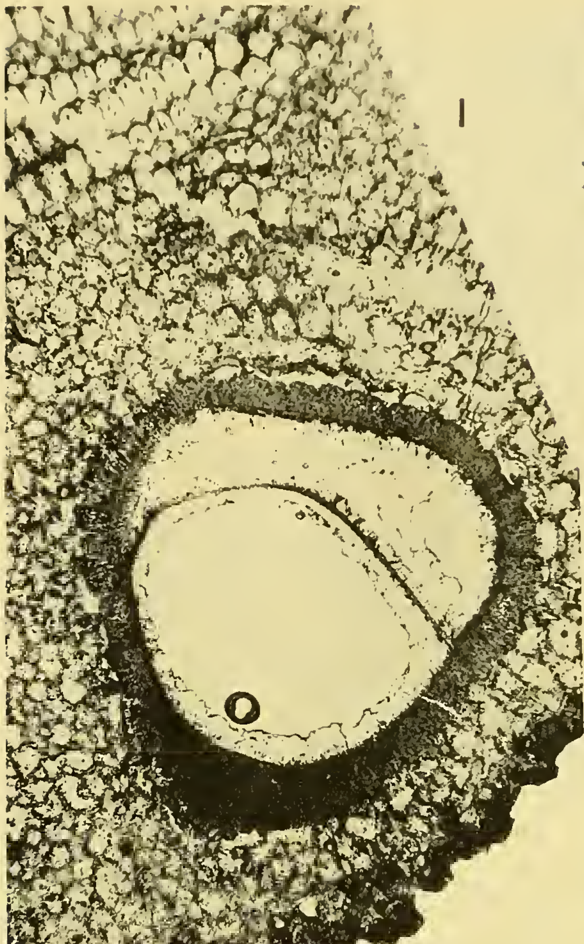

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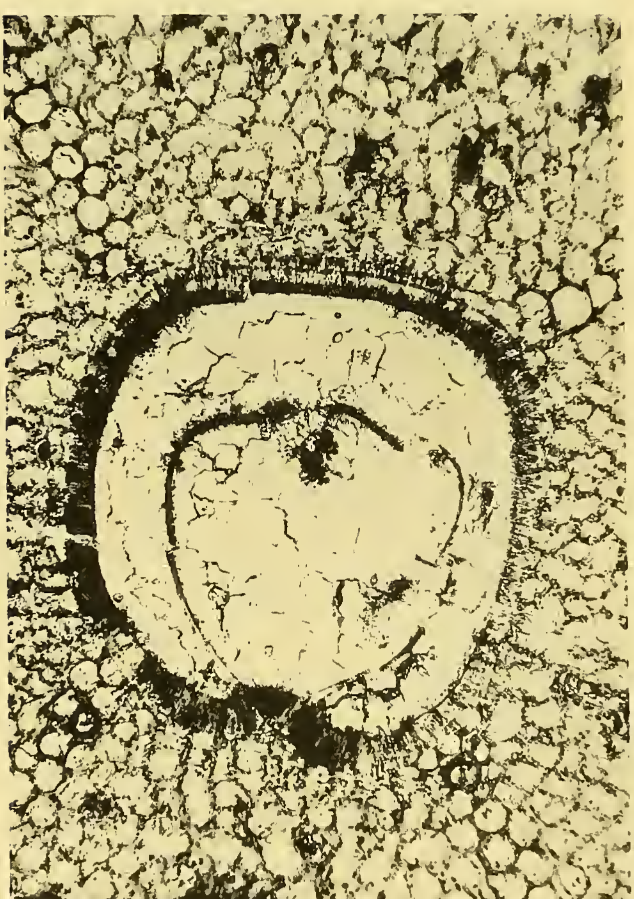

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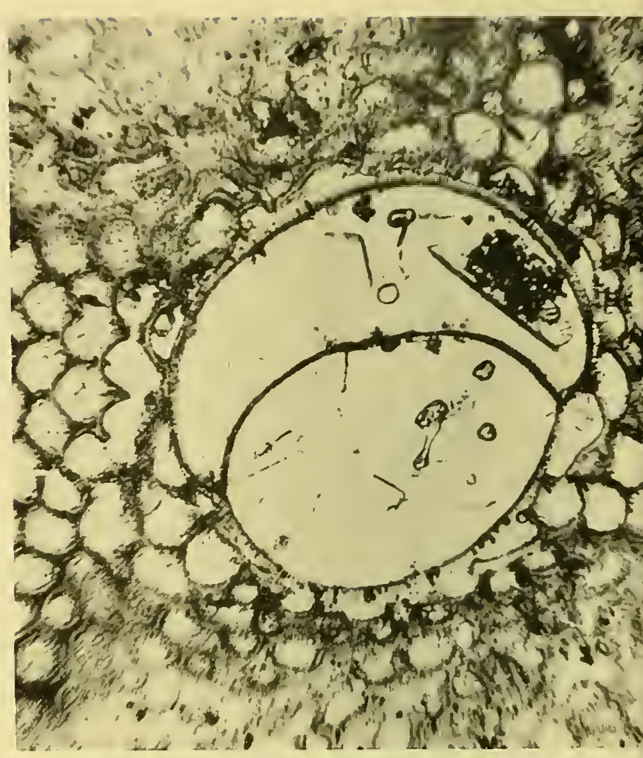

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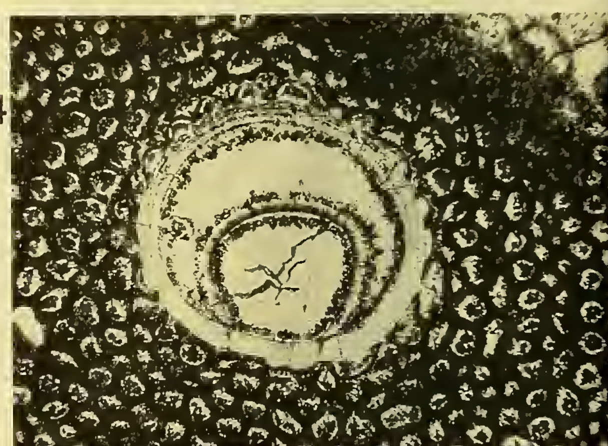

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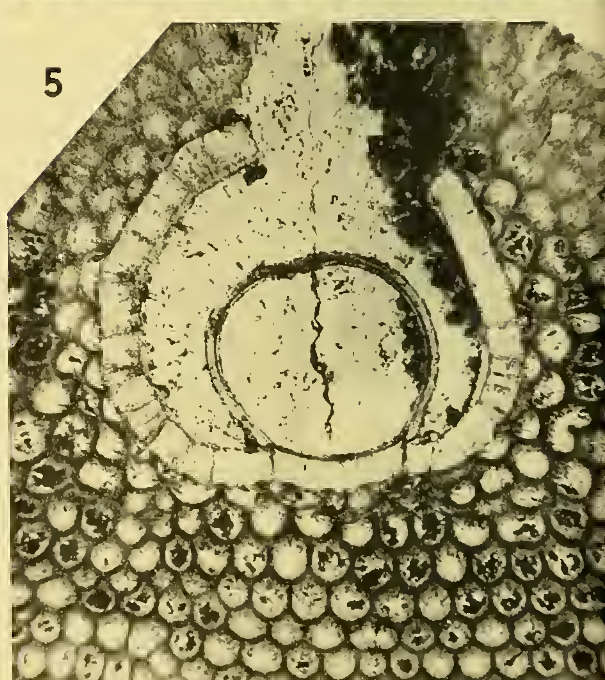


Explanation of Plate 8

Figure		Page
	All the illustrations are the central part of equatorial sections of megalospheric individuals to show the embryonic chambers; 1, 2, X 20; 3-5, X 40.	
1, 2.	**Lepidocyclina (Eulepidina) undosa** Cushman	39
	1. Section so oriented that the embryonic chambers appear to be "nephrolepidine" with the second chamber only partially embracing the initial chamber; at one stage in the preparation of this section the embryonic chambers had the same relationship as those of figure 2 of this plate.	
	2. Section so oriented that the initial chamber is surrounded completely by the second chamber except at the common boundary of the two chambers.	
3.	**Lepidocyclina (Eulepidina) chaperi** Lemoine and R. Douvillé	38
	Specimen with large, thin-walled "nephrolepidine" embryonic chambers; compare with figure 8, plate 10, Cole, 1952.	
4, 5.	**Lepidocyclina (Eulepidina) ephippioides** Jones and Chapman	38
	Two specimens whose embryonic chambers should be compared with those of figure 2, this plate.	

1, 2. Loc. 13 (Oligocene; Meson formation)—see text for locality descriptions.

3. Loc. 23 (upper Eocene).

4. Loc. 25 (Tertiary *e*; lower Miocene).

5. Loc. 26 (Tertiary *e*; lower Miocene).

Explanation of Plate 9

Figure | Page

All the illustrations are the central part of equatorial sections of megalospheric individuals to show the arrangement of the embryonic chambers; X 40.

1-3. **Lepidocyclina (Eulepidina) chaperi** Lemoine and R. Douvillé 38

The embryonic chambers vary from the specimen with the initial chamber slightly embraced by the second chamber (fig. 2 = nephrolepidine) to the one (fig. 3) in which the initial chamber is completely embraced by the second chamber except at the common boundary through figure 1 which shows an intermediate pattern.

4, 5. **Lepidocyclina (Eulepidina) ephippioides** Jones and Chapman 38

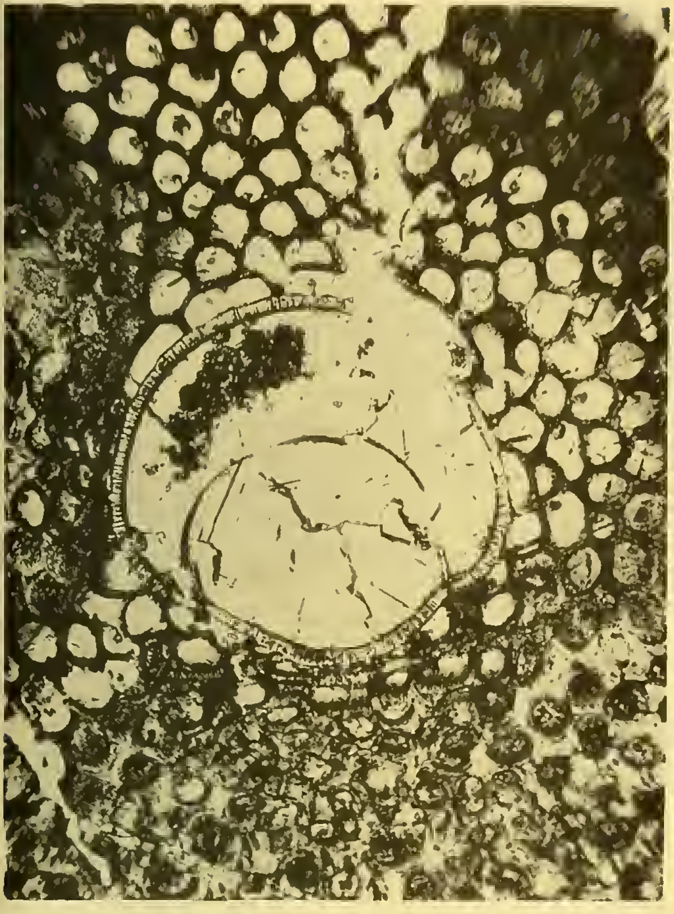
4. A specimen in which the common boundary between the initial and second chamber is short.

5. A specimen with embryonic chambers similar to those in figure 3, this plate.

1-3. Loc. 23 (upper Eocene)—
see text for locality descriptions.

4. Loc. 26 (Tertiary *e*, lower Miocene).

5. Loc. 25 (Tertiary *e*, lower Miocene).



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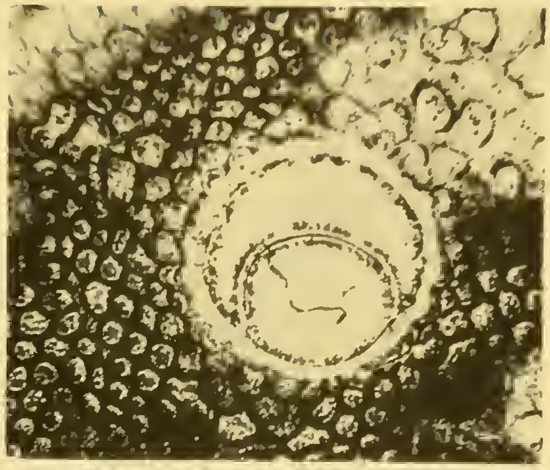

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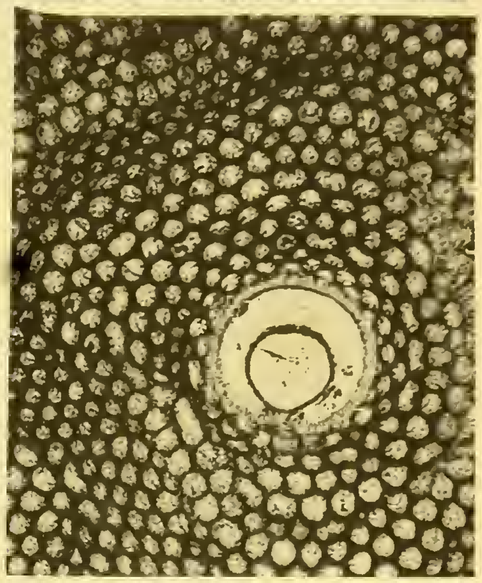

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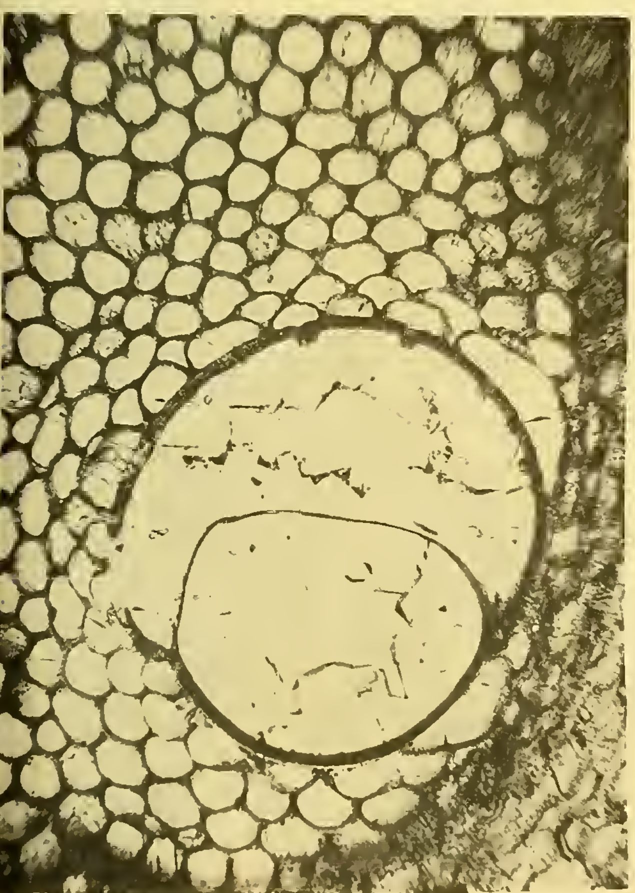

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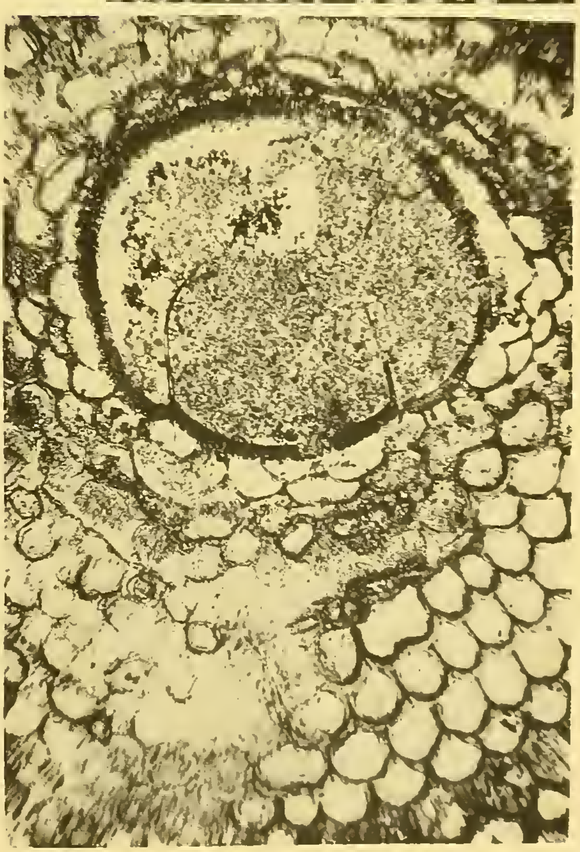

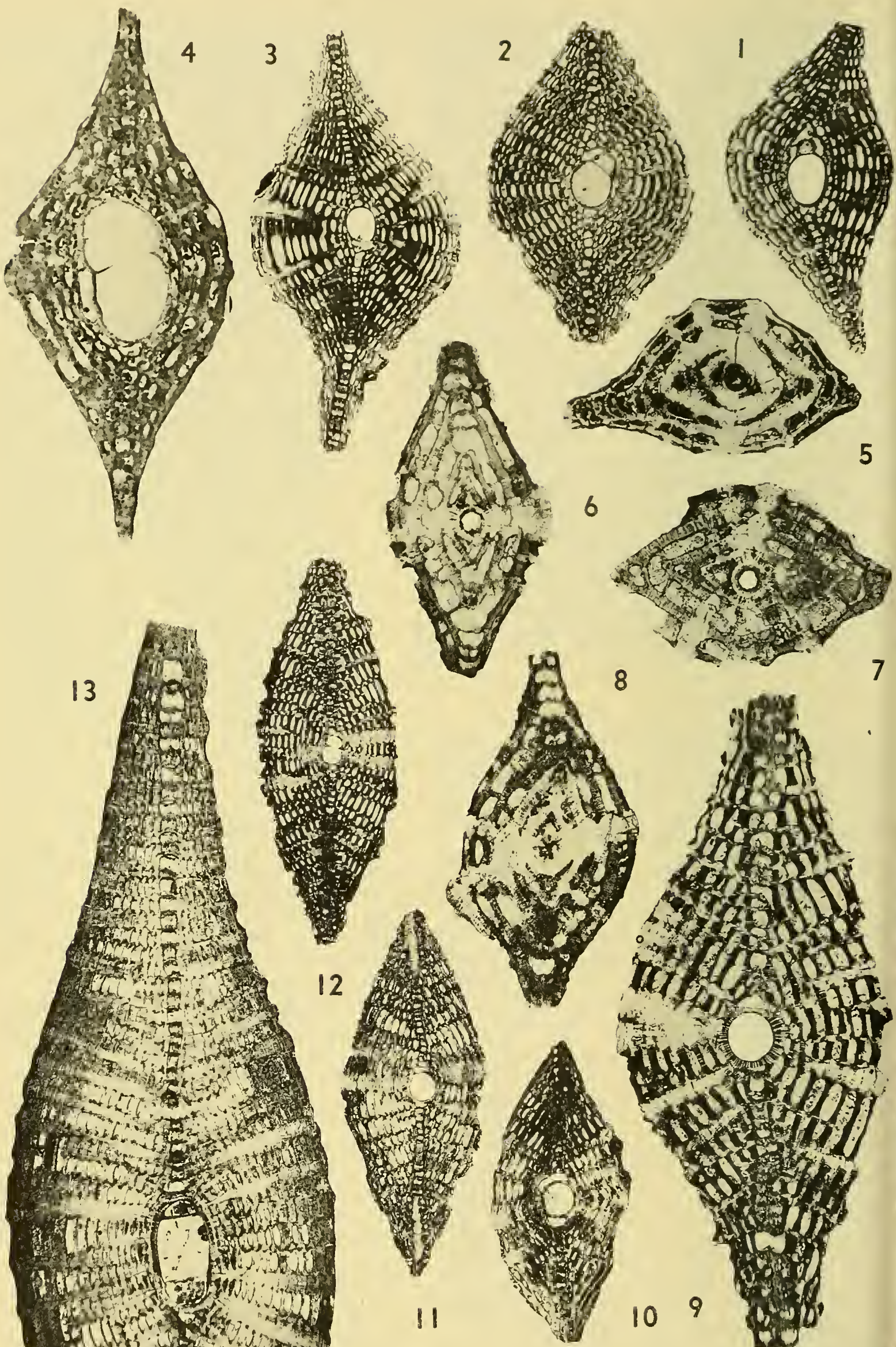
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Explanation of Plate 10

Figure | Page

All sections are vertical sections.

1-4, 9-12. **Lepidocyclina (Lepidocyclina) pustulosa** H. Douvillé . 21, 32

1-4. To illustrate the arrangement of lateral chambers and cross-section shape of the test. 1-3, X 20; 4, X 40; additional vertical sections from this locality are illustrated as figures 1-6, plate 26, Vaughan and Cole, 1941.

9, 12. To show the equatorial layer separated into two parts by a median layer of shell material in the peripheral zone; 9, X 40; 12, X 20; in specimens previously identified as *L. peruviana*.

10, 11. Specimens previously identified as *Triplalepidina veracruziana* Vaughan and Cole, X 20; 11, a topotype.

5-8. **Helicostegina polygyralis** (Barker) 42

To illustrate the initial trochoid spire, the pillars and the thickness of the wall of the chambers, X 40.

13. **Lepidocyclina (Eulepidina) chaperi** Lemoine and R. Douvillé 38

To show embryonic and lateral chambers, X 20.

1-4. Loc. 1 (K2854) (upper Eocene)—see text for locality descriptions.

5. Loc. 23*a* (upper Eocene).

6-8. Loc. 7*a* (upper Eocene).

9, 12. Loc. 24 (upper Eocene).

10. Loc. 12 (upper Eocene).

11. Loc. 12*a* (upper Eocene).

13. Loc. 23 (upper Eocene).

Explanation of Plate 11

Figure		Page
1-9.	**Helicostegina polygyralis** (Barker)	42

1, 2. Vertical sections, 1, X 40; 2, X 20, of microspheric individuals.

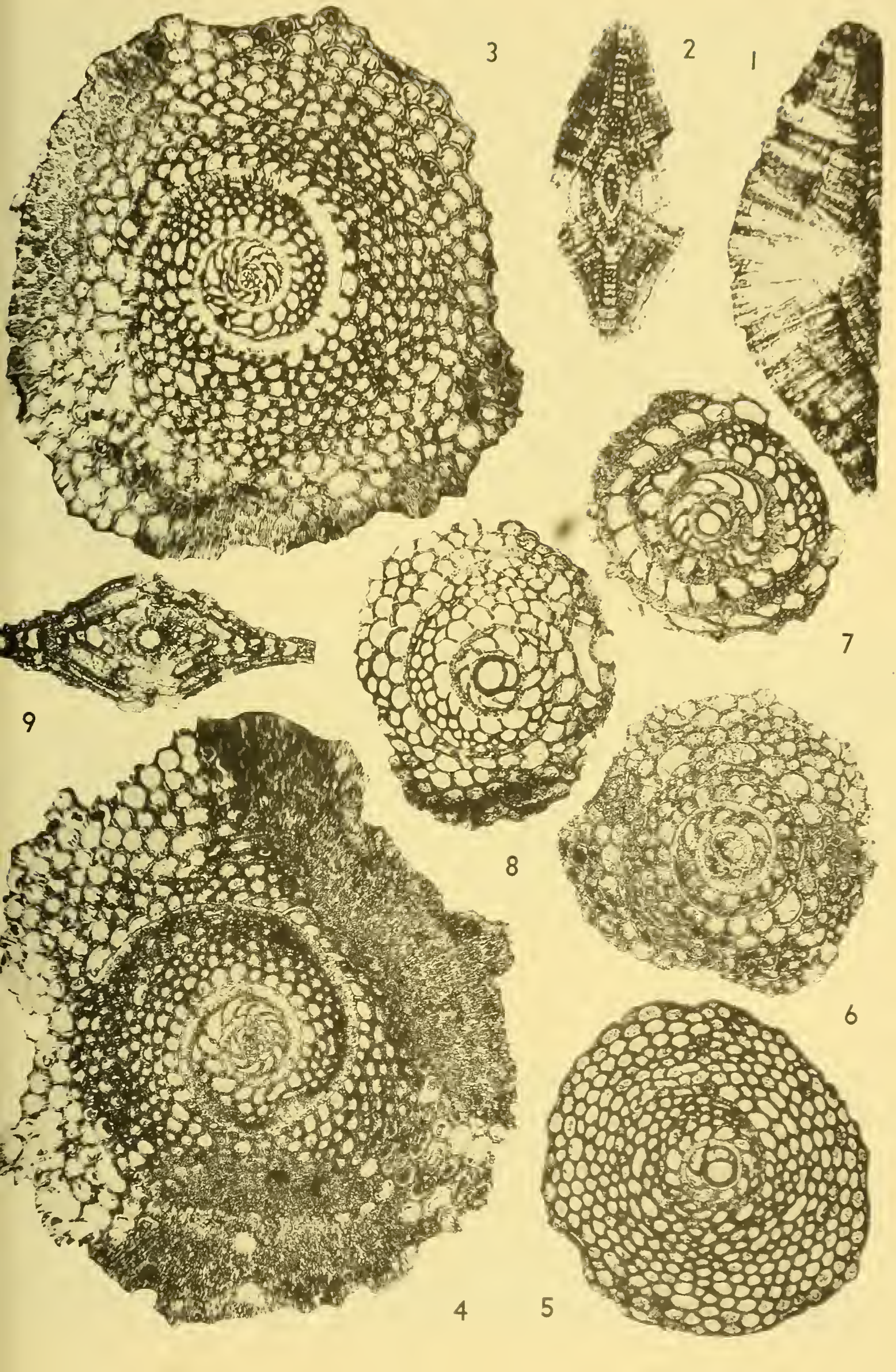
3, 4. Equatorial sections, X 40, of microspheric individuals.

5-8. Equatorial sections, X 40, of megalospheric individuals to show the varying lengths of the spiral coil which in part is controlled by the position of the section.

9. Vertical section, X 40.

1-4, 6-9. Loc. 7*a* (upper Eocene)— see text for locality descriptions.

5. Loc. 23*a* (upper Eocene).



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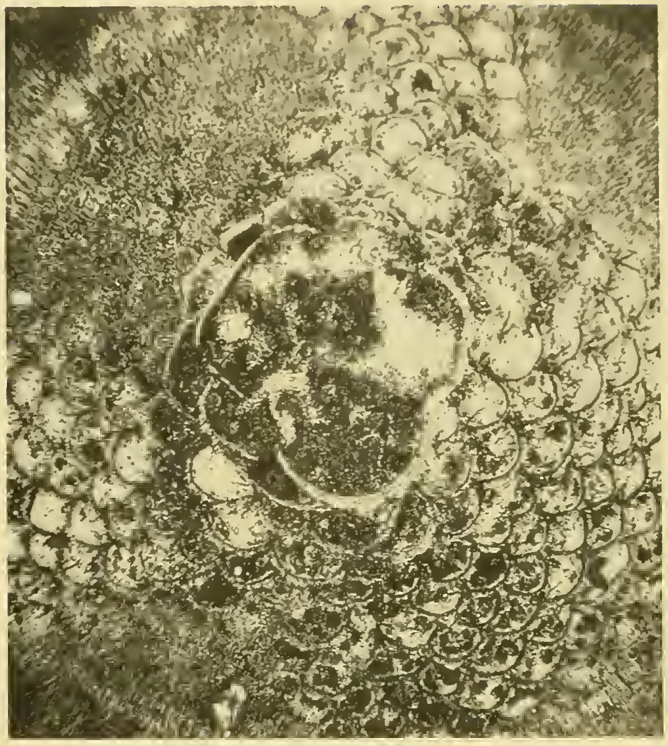

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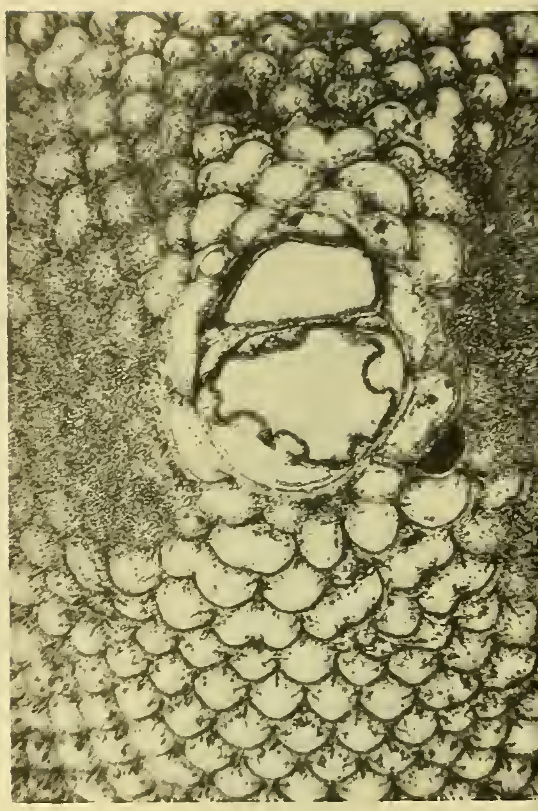

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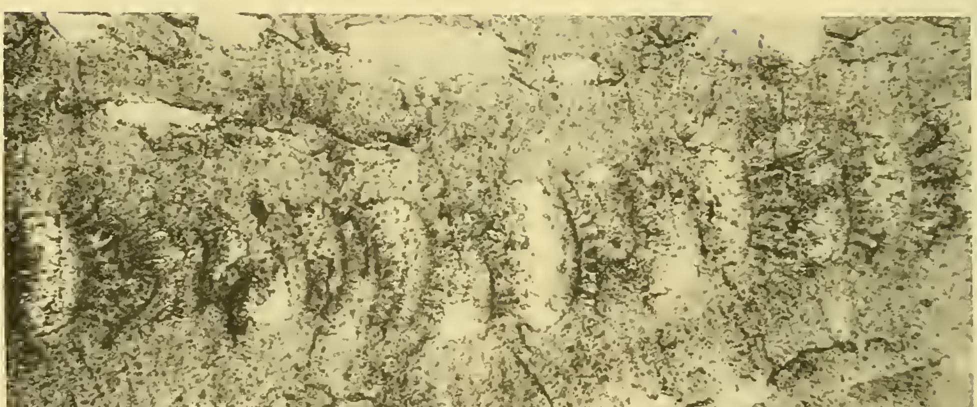

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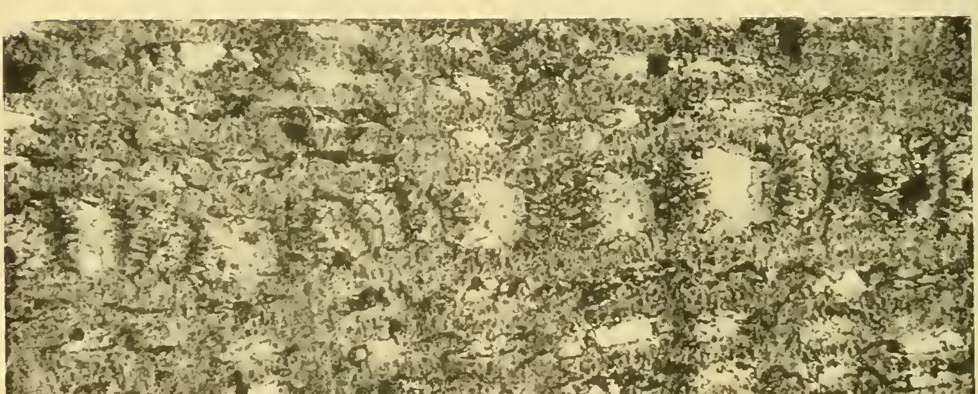

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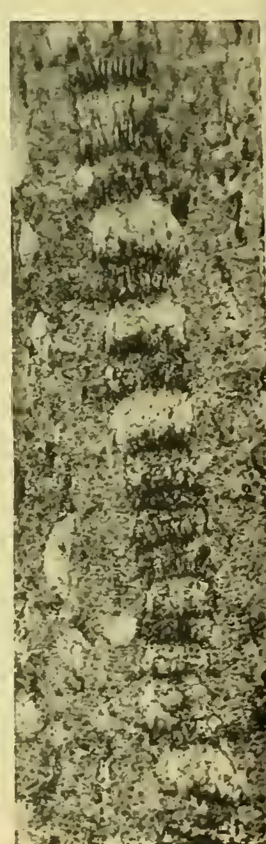

Explanation of Plate 12

Figure		Plate
1, 2, 3.	**Lepidocyclina (Lepidocyclina) ocalana** Cushman	18, 37

1. Part of an equatorial section, X 40, of a megalospheric individual with bilocular embryonic chambers.
2. Part of an equatorial section, X 40, of a megalospheric individual with multilocular embryonic chambers.
3. Part of the equatorial layer, X 80, to show the pectinations which develop on the distal side of the wall of the equatorial chambers; see also figure 1, Plate 13.

4.	**Lepidocyclina (Eulepidina) undosa** Cushman	38

Part of the equatorial layer, X 80, to show the pectinations which develop on the distal side of the wall of the equatorial chambers; see also figure 5, Plate 13.

5.	**Lepidocyclina (Lepidocyclina) mantelli** (Morton)	38

Part of the equatorial layer, X 80, to show pectinations which are similar to those of *L.* (*E.*) *undosa;* see also figure 2, Plate 13.

1, 2. Loc. 15 (upper Eocene; Ocala limestone)—see text for locality descriptions.

3. Loc. 14 (upper Eocene; Ocala limestone)

4, 5. Loc. 18 (Oligocene; Suwannee limestone)

Explanation of Plate 13

Figure		Page
1, 3, 6.	**Lepidocyclina (Lepidocyclina) ocalana** Cushman	37, 38

Parts of vertical sections, X 40, of microspheric specimens to show the pectinations which develop on the distal side of the walls of the equatorial chambers and complexity of the equatorial chambers at the periphery of the test; for enlargement of part of figure 1, see figure 3, Plate 12.

2\. **Lepidocyclina (Lepidocyclina) mantelli** (Morton) 38

Part of a vertical section, X 40, of a megalospheric individual to show the pectinations on the distal side of the walls of the equatorial chambers; for enlargement, see figure 5, Plate 12.

4\. **Lepidocyclina (Lepidocyclina) gubernacula** Cole 10, 38

Part of a vertical section, X 40, of a megalospheric individual to show stolons and the complexity of the peripheral equatorial chambers.

5\. **Lepidocyclina (Eulepidina) undosa** Cushman 38, 39

Part of a vertical section, X 40, of a megalospheric individual to show pectinations which are similar to those found in *L. mantelli;* for enlargement, see figure 4, Plate 12.

1, 3, 6. Loc. 14 (upper Eocene; Ocala limestone)—see text for locality descriptions.

4\. Loc. 9 (upper Eocene).

2, 5. Loc. 18 (Oligocene; Suwannee limestone)

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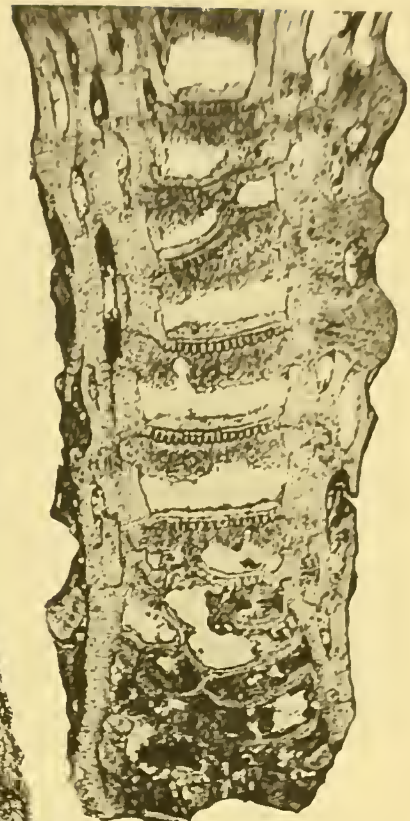

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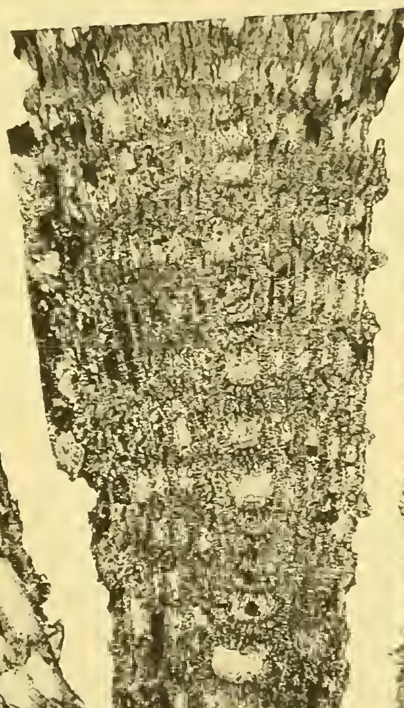

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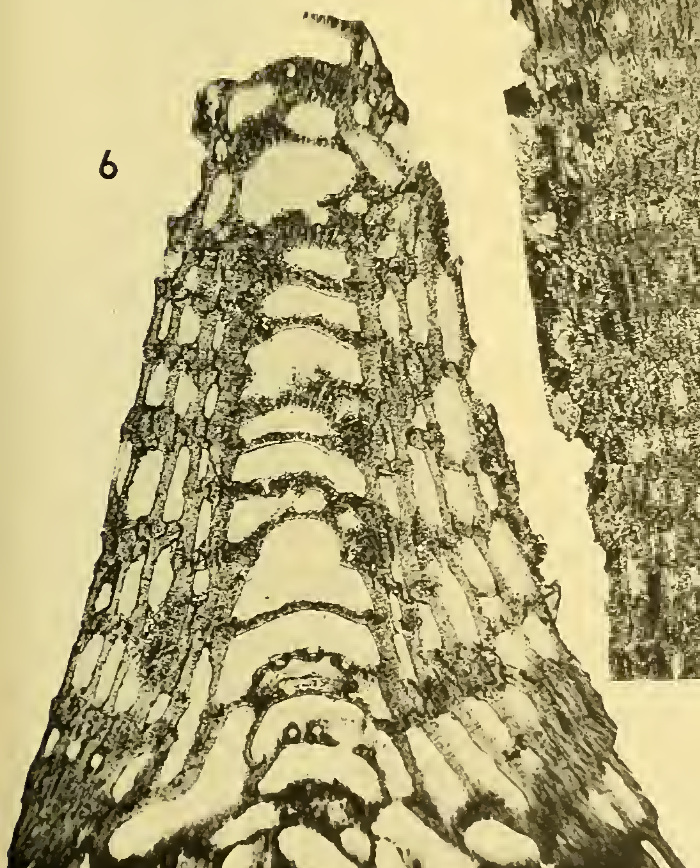

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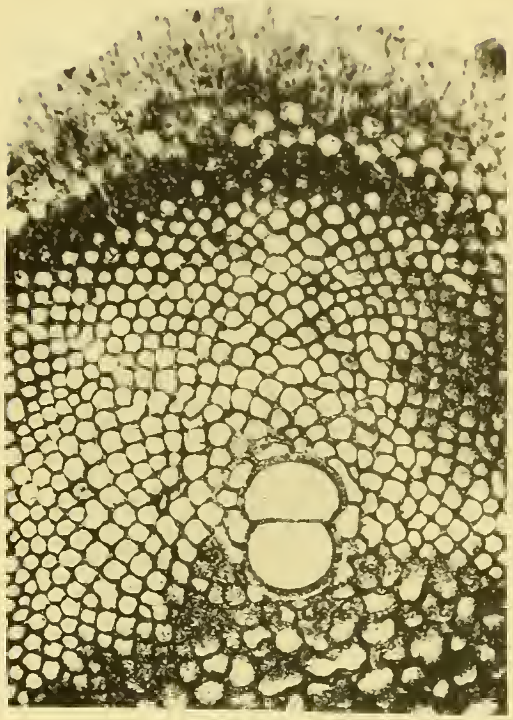
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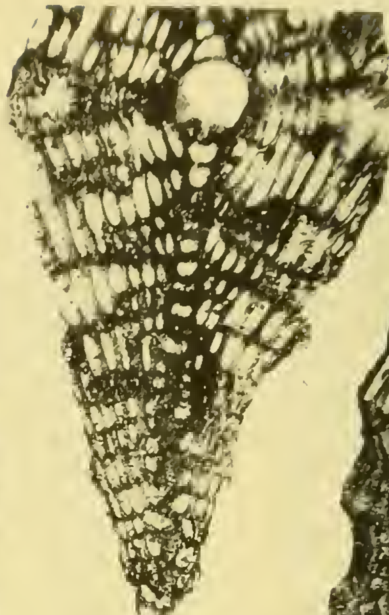
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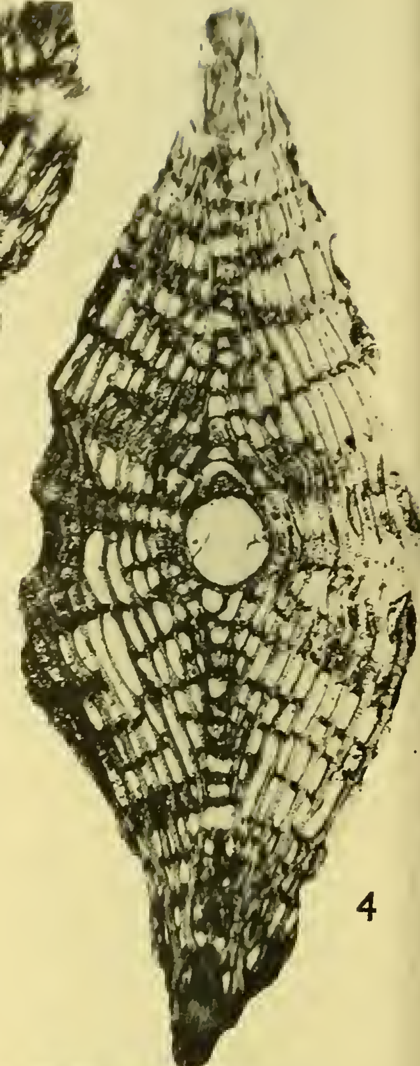
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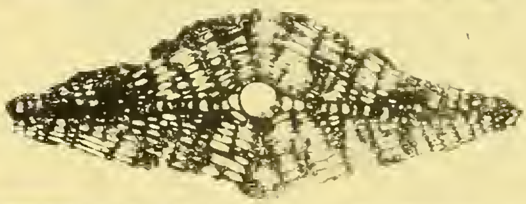
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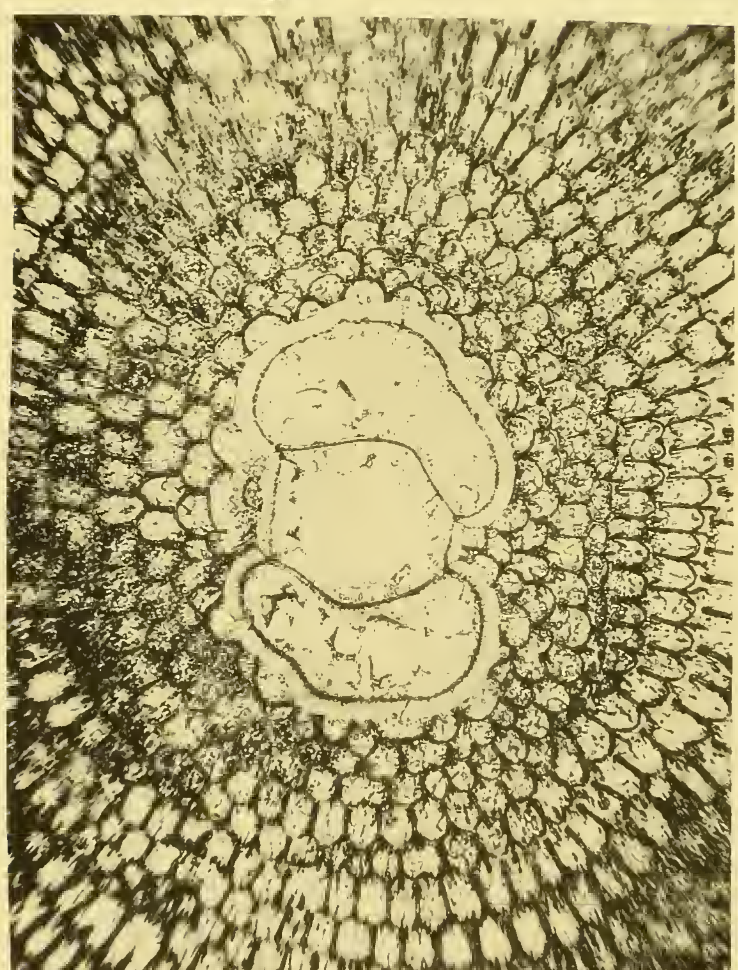
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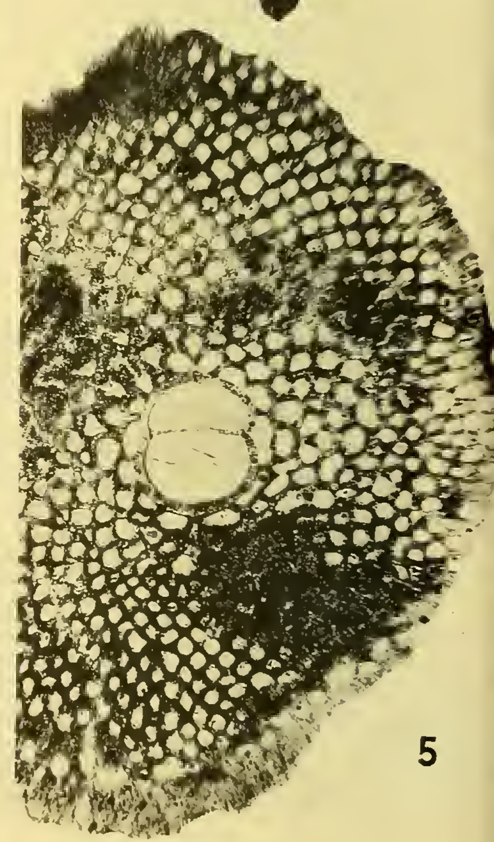
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Explanation of Plate 14

Figure | Page

1-5. **Lepidocyclina (Lepidocyclina) pustulosa** H. Douvillé .. 32

1, 5. Parts of equatorial sections, X 40, of specimens previously identified as *Triplalepidina veracruziana* Vaughan and Cole.

2-4. Vertical sections; 2, X 20; 3, 4, X 40; of specimens previously identified as *Triplalepidina veracruziana* Vaughan and Cole; 3, enlargement of the right side of the specimen illustrated as figure 2; note the threefold division of the equatorial layer in the peripheral zone of each of these specimens.

6. **Lepidocyclina (Eulepidina) radiata** (Martin) 41

Part of an equatorial section, X 40, to show trilocular embryonic chambers and the elongate hexagonal equatorial chambers.

1-5. Loc. 12 (upper Eocene)—
see text for locality descriptions.

6. Loc. 27 (Miocene).

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NEW LINUPARID CRUSTACEANS FROM THE UPPER CRETACEOUS OF TEXAS

By

EDWARD DAVIDSON
Cornell University

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CONTENTS

NEW LINUPARID CRUSTACEANS FROM THE UPPER CRETACEOUS OF TEXAS

Edward Davidson
Cornell University, Ithaca, New York

ABSTRACT

Two species of the crustacean genus *Linuparus,* one of which is a new species, are described from the Upper Cretaceous of Texas.

INTRODUCTION

In his description of macrurous decopods Stenzel (1952) records unidentified palinurid fragments from Woodbine formation. Decapods have been found by the author at two localities near Arlington, Tarrant County, Texas. More than 30 specimens representing a new species were collected from the Tarrant formation (variously assigned to the upper-most Woodbine by Stephenson, 1952; and to the basalmost Eagleford by Moreman, 1942) in a road cut on Highway 360 two miles south of the intersection of Highway 360 with Highway 183 in Tarrant County, Texas. A like number of specimens representing another species were collected from the Dexter member of the Woodbine formation (Stephenson, 1952) at a locality on Rush Creek five miles southwest of Arlington, Texas.

ACKNOWLEDGMENTS

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SYSTEMATIC DISCUSSION

Family **PALINURIDAE**

Genus **LINUPARUS** Gray, in White, 1847

The name *Linuparus* was used by Gray in manuscript for De Hann's *Palinurus trigonus,* a Recent form from Japan, and was first published by White (1847) in a list of the Crustacea at the British Museum (Natural History). Fossil forms were assigned to other genera: *Podocratus* Geinitz, 1850, Becks *in* Schluter, 1862; *Thenops* Bell, 1857. In 1897 A. E. Ortmann recognized the relation of these fossil forms to *Linuparus.* Between 1898 and 1935 both *Linuparus* and *Podocratus* were applied to fossils of this genus. Beginning with Rathbun's (1935) acceptance of

Linuparus, and following Mertin's (1941) monographic treatment of the genus, *Linuparus* has been accepted as the proper name.

The genus *Linuparus* is characterized by a tricarinate carapace bearing numerous spines and tubercles. The rostrum is absent in *Linuparus* and in its place are two large supraorbital spines which are typically flattened and triangular in shape. The carapace is divided into an anterior cephalic portion and a posterior thoracic portion by a deep transverse cervical groove. The antennae are greatly extended and carry long flagellae which have longitudinal furrows on both the top and the bottom. The tricarinate appearance of the carapace is carried on into the abdomen, where there are three carinae on each segment.

Mertin (1941) recognized four subgenera, but because the species described in this paper have characters common to more than one of the subgenera, they are of doubtful value.

Linuparus tarrantensis, n. sp. Pl. 15, figs. 1-4

Description.—The carapace is rectangular, tricarinate, flattened dorsally, slightly granular with a few small spines, transversely divided by a broadly U-shaped cervical groove. This deep groove divides the carapace into equal cephalic and thoracic portions. The cephalic portion bears three carinae and several large spines. On the anterior margin are two large, centrally located, semitriangular, orbital spines, slightly rounded dorsally and projecting anteriorly beyond the anterior margin and partially covering the eyes. There are a few small granules on the dorsal surface of these orbital spines. The rostrum is lacking, as is characteristic of the genus, and the margin between the orbital spines is concave and gently rounded. The area between the orbital spines is nongranular and depressed. Directly behind and slightly lateral to the orbital spines are two long, recumbent, granular, postorbital spines directed anteriorly. Behind each postorbital spine is a smooth, irregular circular, nongranular, depressed area bordered by two carinae. Along the mid-line is the median carina, extending from the cervical groove to the depression between the orbital spines. Anteriorly the median carina passes into a line of granules which grade posteriorly into an elongate cluster of pitted granules. Posterior to the cluster of granules and separated from them by a slight saddle, the median carina bifurcates and forms two arcuate, granular ridges which enclose an oval, depressed area. The two arcuate ridges nearly rejoin on the median line at the cervical groove. The depressed area posterior to each of the postorbital spines is bounded laterally by a lateral carina. The lateral carinae begin at the cervical groove and curve slightly inward to terminate directly behind the eyes. The posterior halves of the carinae consist of a high, longitudinally arched, granule-covered ridge. Anteriorly the lateral carinae taper off to three or four, large, pitted granules and a slight ridge which extends almost to the eye. Lateral and parallel to the lateral carinae is a long, nongranular furrow. Outside of this furrow, the lateral margin of the cephalic portion carries granule-covered carinae which begin posteriorly at the end of the cervical groove and curve outward to form bulges on the carapace and then back inward to terminate in large antero-lateral spines. The spines are rounded, sharply pointed terminally, extending anteriorly beyond the margin about the same distance as the orbital spines. Between the orbital and antero-lateral spines is a long, concave, flattened area that lies directly above the base of the antennae. With the exception of the nongranular areas mentioned earlier, the space between the carinae on the cephalic portion is relatively smooth with only a few, widely spaced, small granules.

The thoracic portion of the carapace is much more distinctly tricarinate than the cephalic portion. It bears a large median carina which is covered with numerous granules and in most specimens terminates anteriorly at the cervical groove in a large tubercle. Between this median carina and the lateral carinae the carapace is relatively flat and bears numerous small granules. The lateral carinae are higher and sharper than median carina. At their anterior end they curve slightly inward and bear a cluster of granules. They terminate at the cervical groove directly behind the lateral carinae of the cephalic portion. Lateral to the thoracic lateral carinae the carapace drops almost vertically, and on the antero-lateral area of the thoracic portion of the carapace is a large, oval, granule covered protuberance extending for a short distance anteriorly beneath the lateral margin of the cephalic half of the carapace. The most posterior area of the thoracic portion bears a deep arcuate groove which ends directly behind the posterior limit of the lateral carinae. It curves inward and cuts off a portion of the granular median carina.

The sternum is elongate and triangular. Only the second through the fifth segments are present. The segments are divided by grooves, extending on either side from the margin toward the center. The lateral edges of each segment are turned upward and are tuberculate. The second segment is V-shaped with the sides rising sharply from the center. The upward-turned lateral margins bear a cluster of small tubercles. The third segment is broadly U-shaped with a wide flattened area in the center. The margins of this segment also carry a cluster of small tubercles. The fourth segment bears a rounded knob on each side of the center and a small depression in the center. The margins of the fourth segment are tuberculate, and a posterior projection of the margin consists of several small rearward projecting spines. The fifth segment is narrow, and the margins fit in beneath the projection from the posterior margin of the fourth segment. The margins of the fifth segment are turned upward and are slightly pointed and carry two small spines. The center of the fifth segment carries two, large, round, pointed knobs, each of which has two small spines projecting from the top. To the naked eye the entire sternum appears smooth, but it has many small pits scattered over it.

The abdomen bears three prominent carinae, one median and two lateral. The carinae are directly posterior to the carinae of the carapace. The segments of the abdomen are arched transversely and slope away from the median carinae like a roof. On the first segment both the lateral and median carinae are high, sharp ridges bearing a single row of granules. There is a distinct cross furrow directly anterior to the posterior margin. Another furrow extends from the posterior end of each lateral carina obliquely inward and forward to the anterior margin. The lapets join directly at the edge of the lateral carinae. They are rectangular and the posterior margins bear a row of small granules. With the exception of the furrow areas, the segment is covered with numerous small pits. The second segment is similar to the first except that the median carina is slightly lower, the cross furrow is only faintly visible, and the lapets are much less rectangular. The third segment differs from the second only in further reduction of the median carina, absence of the cross furrow and reduction of the oblique furrow. The lapets are slightly smaller than those on the second segment. The fourth segment bears a row of small granules for the median carina, and the lateral carinae are much reduced. The lapets are small, and the oblique furrow is only faintly visible. The median carina of the fifth segment consists of two rows of three or four small granules. The lateral carinae are only faint ridges, and the oblique furrow is only faintly visible. The lapets remain small as in the fourth segment. The telson and uropods are obscured or broken away on all specimens, and the ventral surface of the abdomen is not exposed on any specimen.

Discussion.—*Linuparus tarrantensis* is singular in its lack of spinosity and the characteristic shape of its median carina in the gastral region.

Other species of *Linuparus* have a ridge or a line of spines along each side of the gastral region. A bifurcate, granular ridge in the gastral area is found in only one other species, *L. kleinfelderi* Rathbun, 1931, an Upper Cretaceous species from New York State. However, *L. kleinfelderi* differs from *L. tarrantensis* in that the ratio of the length of the cephalic and thoracic portions of the carapace is 1:1.3 in *L. kleinfelderi* while in *L. tarrantensis* the ratio is 1:1. The lateral thoracic carinae of *L. kleinfelderi* bear a stout spine at their termination at the cervical groove, a spine not present on *L. tarrantensis,* which bears at most one larger tubercle. The remainder of the carinae on *L. kleinfelderi* tend to be more spinose than those on *L. tarrantensis.* The lateral carinae of the abdomen remain strong in *L. kleinfelderi,* while in *L. tarrantensis* the lateral carinae of the posterior part of the abdomen are reduced and become only faint ridges. The first abdominal segment of *L. kleinfelderi* bears a single large spine, while in *L. tarrantensis* the first abdominal segment bears a row of granules. At the anterior end of the gastral region *L. kleinfelderi* bears a spine somewhat larger than the others around it; no such spine is present on *L. tarrantensis.*

Dimensions.—On the specimens studied the carapace length ranged from 1 to 7 cm. The ratio of the length of the cephalic portion of the carapace to the thoracic portion is constant at 1:1. This ratio is based using the anterior end of the orbital spines as the anterior end of the cephalic portion.

Material.—Holotype and paratype, U. S. Nat. Mus. Cat., Nos. 132020, 132021.

Horizon of occurrence.—In a road cut located on Highway 360 two miles south of its junction with Highway 183, Tarrant Co., Texas, Tarrant formation, Gulf series, Upper Cretaceous.

Linuparus, n. sp.

Cf. L. kleinfelderi Rathbun, 1931, pp. 161, 162.

About 30 specimens of another species of *Linuparus* were collected by the author at a locality five miles southwest of Arlington, Texas. These specimens represent a large species in which the carapace ranges from 10 cm. to about 15 cm. in length. It is similar to both *L. tarrantensis* and *L. kleinfelderi.* It differs from *L. tarrantensis* in that it is more spinose with a different arrangement of spines on the abdominal segments. It is similar to *L. kleinfelderi,* but the poor state of preservation and the fragmentary nature of the specimens does not allow assignation at this time.

Material.—About 30 specimens in the paleontologic collection at Arlington State College, Arlington, Texas.

Horizon of occurrence.—Along the banks of Rush Creek about five miles southwest of Arlington, Tarrant Co., Texas, Dexter member, Woodbine formation, Gulf series, Upper Cretaceous.

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PLATE

EXPLANATION OF PLATE 15

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1-4. **Linuparus tarrantensis** Davidson, n. sp.	70

1. Holotype, ventral view of the sternum, X 2, USNM, Cat. No. 132020.

2. Dorsal view of a partially coiled abdomen, X 2, from the collection of Mrs. Geraldine Kienzlen, Dallas, Texas.

3. Holotype, dorsal view of the carapace, X 1, USNM, Cat No. 132020.

4. Drawing of holotype carapace, X 1.
   All illustrated specimens are from the Tarrant formation, Tarrant Co., Texas.

Cost of plate defrayed by the William F. E. Gurley Fundation for Paleontology of Cornell University.

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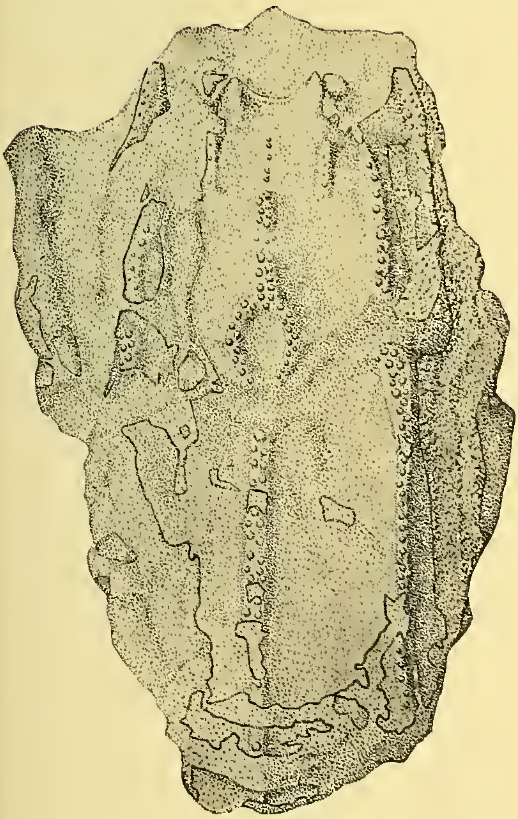

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RELATIONSHIPS OF A NEW LOWER DEVONIAN TEREBRATULOID (BRACHIOPODA) FROM ANTARCTICA

By

A. J. Boucot, K. E. Caster, David Ives, and
John A. Talent

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RELATIONSHIPS OF A NEW LOWER DEVONIAN TEREBRATULOID (BRACHIOPODA) FROM ANTARCTICA

A. J. Boucot,[1] K. E. Caster,[2] David Ives,[3] and
John A. Talent.[4]

ABSTRACT

Brachiopods from strata resting nonconformably upon basement complex of the Horlick Mountains, Antarctica, belong to the new genus *Pleurothyrella* which also includes terebratuloids from South Africa, Bolivia, and New Zealand. *Pleurothyrella* is closely related to *Cloudella,* a genus known from strata of Late Gedinnian and Siegenian age in the Appalachians. *Pleurothyrella* occurs outside Antarctica with spiriferids in strata correlated with the Lower Emsian. Related to *Pleurothyrella* are *Mutationella* (occurring world-wide in strata of Early Gedinnian to Emsian age) and *Mendathyris* (from Upper Gedinnian strata in the Appalachians). *Mutationella* is ancestral to *Mendathyris, Cloudella, Pleurothyrella, Derbyina, Paranaia,* and *Scaphiocoelia.* The relationship of *Mendathyris* to *Mutationella* is demonstrated by its ontogeny; early stages are identical to *Mutationella,* and middle stages are transitional. Middle stages of *Cloudella* and *Pleurothyrella* are transitional to *Mutationella.* Small specimens of "*Mutationella*" occur in South Africa, Bolivia, and New Zealand.

Mutationella falklandica (Clarke) occurs in the Falkland Islands as large specimens, showing that *Mutationella* coexisted with *Pleurothyrella* in the Southern Hemisphere, although the small specimens of "*Mutationella*" might be early growth stages of *Pleurothyrella.* In the Northern Hemisphere after Early Gedinnian time *Mutationella* occurs in the Old World, and *Mutationella, Mendathyris,* and *Cloudella* in the Appalachians. *Pleurothyrella* may be characteristic of the Malvinokaffric facies. The Antarctic species of *Pleurothyrella* most closely resembles the South African species *P. relicta,* less closely the South African species *P. africana,* more distantly the Bolivian *P. knodi,* and still more remotely the New Zealand species *P. venusta.*

Restudy of the enigmatic Malvinokaffric genus *Scaphiocoelia* leads to the conclusion, based partly on new material, that it is closely related to *Mendathyris.* Analysis of available collections of South African rensselaeroids suggests that a few are globithyrinids, one form not a terebratuloid, and the majority not generically identifiable.

An ontogenetic study of the genus *Reeftonella* reveals its relationships to the cryptonellids rather than the centronellids.

INTRODUCTION

In 1959 Mr. William E. Long made the initial discovery of marine Lower Devonian fossils in Antarctica (Figure 1), near the South Pole in the Horlick Mountains (Long, 1959). The fossils, which consist chiefly of terebratuloid brachiopods, together with a few pelecypods and a single inarticulate brachiopod, occur in the Horlick formation, made up of sandstone and shale, which rests nonconformably (Long, 1962) upon basement complex. The basal marine Lower Devonian beds are overlain by a Carboniferous (?) unit, the Buckeye tillite, which also rests elsewhere upon the same

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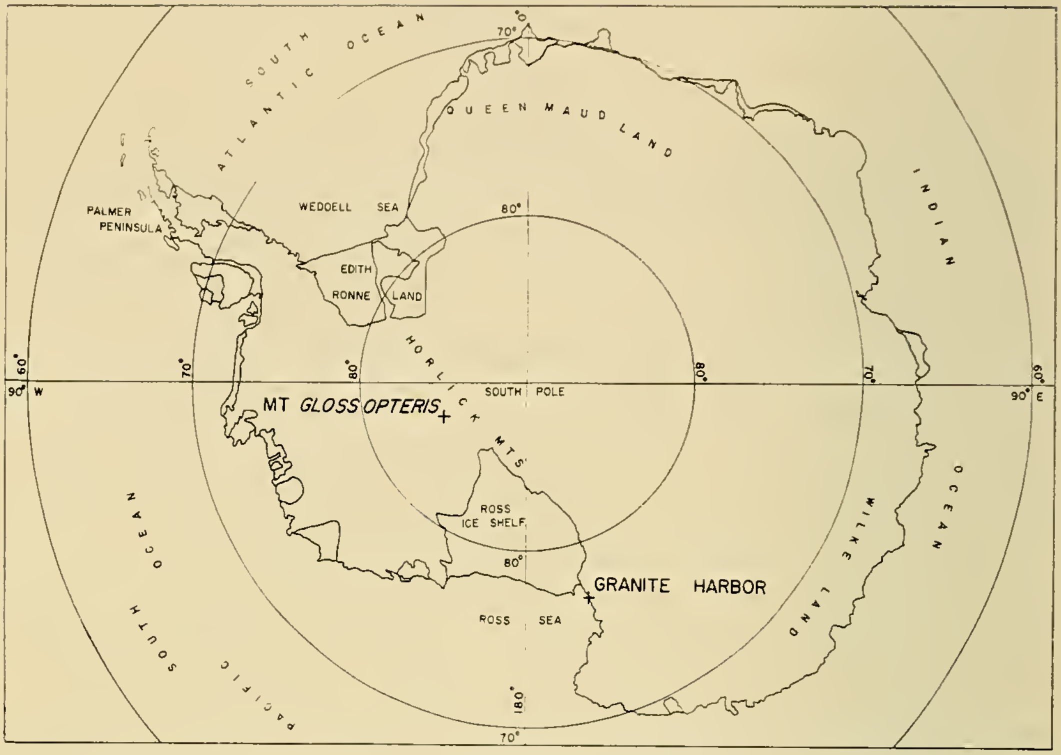

Fig. 1—Index map of Antarctica showing known Devonian fossil localities.

pre-Devonian basement complex. Fish scales of Late Devonian age are reported from the lower part of the Beacon sandstone (Woodward, 1921) of Granite Harbor, Antarctica, these being the only other fossils assigned to the Devonian of the continent.

The Paleozoic in the Horlick Mountains, which rests on basement complex and with Lower Devonian fossils at its base, is reminiscent of the similar stratigraphy in South Africa and the Falkland Islands. As the basal marine Lower Devonian faunas in both South Africa and the Falklands belong to the Malvinokaffric Province of the Lower Devonian it was with great interest that the Antarctic fossils were examined to determine their zoogeographic affinities.

A number of rensselaeroid brachiopods (terebratuloids bearing radial costellae) have been described previously from the Southern Hemisphere, chiefly from the Malvinokaffric Province, but the monographic work on the Devonian terebratuloids (Cloud, 1942) reveals that the southern shells are all too poorly described to be assigned generically with any degree of assurance. Thus it was found necessary to re-examine as many of the southern rensselaeroids as possible in order to get a better understanding of the specimens from the Horlick Mountains. Caster had providentially made an excellent collection of rensselaeroids from the Bokkeveld beds of South Africa which were available for this study. Caster also had made rubber replicas of the rensselaeroids previously described by Reed and Schwarz from South Africa. Dr. Brian Mason, American Museum of Natural History, New York, presented Boucot with quartzite boulders from the Reefton beds in New Zealand which contained a new rensselaeroid, and Dr. C. A. Fleming, Senior Paleontologist, New Zealand Geological Survey, loaned additional specimens. Professor Pierre Pruvost of the Sorbonne had loaned Boucot the type specimens of *"Rensselaeria" knodi* from Bolivia, and Dr. Winifred Goldring, formerly of the New York State Museum, had made available to Boucot for study the types of *"Rensselaeria" falklandica,* which are deposited in the New York State Museum, as well as providing photographs. The types of Schwarz's species *"Rensselaeria" relicta* were unfortunately not seen but inspection of the illustrations suggests that the specimens collected by Caster belong to Schwarz's species. Some of the rensselaeroids figured by Reed from South Africa were studied by Boucot during a visit to the Sedgwick Museum, Cambridge, but proved to be too poorly preserved to add anything of value to the problem. In addition, a series of rensselaeroids belonging to the same subfamily as the southern specimens was available from collections made by Boucot and his students in the northern Appalachians. Rensselaeroids related to the southern forms are unknown in the Northern Hemisphere except in the Appalachians. It should be of some interest to the reader to learn that Boucot and Talent independently arrived at the conclusion that the undescribed rensselaeroids from Reefton belonged to a new genus and species. Boucot was working with casts and molds from quartzite collected by Mason and Fleming, whereas Talent was working with calcareous siltstone in which the shell is preserved, collected by Ives.

The authors wish to express their gratitude to Dr. Fleming for informing Boucot and Talent that they were independently working on the same problems, thus giving them an opportunity to collaborate.

We acknowledge with pleasure our indebtedness to Professor R. S. Allan, University of Canterbury, Christchurch, New Zealand, for the encouragement and critical reading of the part of the paper dealing with *P. venusta.*

Finally, we are grateful to Dr. J. Wyatt Durham, Museum of Paleontology, University of California, for the loan of young specimens of *P. antarctica* from the Horlick Mountains.

The cost of the collotype plates has been met by grants from the California Institute of Technology, the Institute of Polar Studies, and the Graduate School of the University of Cincinnati. Much of the research done by Boucot for inclusion in this paper was supported by NSF Grant No. G-21983.

This report is also noted as Contribution No. 26 of the Institute of Polar Studies, The Ohio State University, Columbus, Ohio, U.S.A.

ZOOGEOGRAPHIC IMPLICATIONS OF THE HORLICK MOUNTAINS BRACHIOPODS

The terebratuloids from the Horlick Mountains belong to a previously undescribed genus, here named *Pleurothyrella* which bears close relationship to the Appalachian genus *Cloudella. Pleurothyrella* is known from two other widely separated areas within the Malvinokaffric Province, as well as from New Zealand. The species from New Zealand is distinct from the other three, which form a relatively compact group, yet is similar enough to be included within the new genus.

Of the strongly costellate genera belonging to the Mutationellinae, to which subfamily *Pleurothyrella* belongs, the ancestral genus *Mutationella* alone appears in the Northern Hemisphere, except for the northern Appalachians where *Cloudella* and *Mendathyris* occur. *Mutationella* in the Northern Hemisphere has a stratigraphic range of Lower Gedinnian (Boucot, 1960, p. 319) to Emsian (*Mutationella guerangeri*) in the Old World and Siegenian in the New World (*Mutationella parlinensis* and *M.? circularis*). In the Southern Hemisphere *Mutationella* is known with certainty only from the Falkland Islands (*M. falklandica*) and from the Baton River beds of New Zealand (*M.* sp. = *Trigeria* sp. of Shirley, 1938, p. 475). The strata in the Falkland Islands are probably of Early Emsian age, as indicated by the presence of *Acrospirifer antarcticus* which indicates the zone of *Acrospirifer hercyniae*. The age of the Baton River beds has been concluded by Shirley (*op. cit.*, p. 489) to be "probably Upper Siegenian or Lower Coblenzian," but recent studies by Boucot suggest that an Upper Gedinnian assignment is more likely. Thanks to the cooperation of Professor A. R. Lillie, Auckland, a large collection of material was obtained by Boucot which yielded the following brachiopods in addition to *Mutationella*: *Kozlowskiellina* sp., *Gypidula* sp., *Atrypa "reticularis,"* aff. *Machaeraria* sp., *"Camarotoechia"* sp., *Eospirifer* sp., *Howellella* sp., *Meristella?* sp., *Elytha?* sp., *"Chonetes"* sp., *Cyrtina* sp., *Nucleospira* sp., *Cymostrophia?* sp., *Leptaenisca* sp., aff. *Stropheodonta s. s.*, *Mesodouvillina?* sp., *Fascicostella* sp., *Isorthis* sp., and *Schizophoria* sp. The absence of acrospiriferids in the Baton River fauna, as well as the abundance of *Howellella* and a number of Devonian-type genera such as *Cyrtina*, *Fascicostella*, and *Mutationella*, suggests that although the fauna is undoubtedly of Early Devonian age, as earlier concluded by Shirley, an Upper Gedinnian assignment is most likely.

DEPOSITIONAL ENVIRONMENT OF THE HORLICK MOUNTAINS BRACHIOPODS

The stratigraphic occurrence of the Horlick Mountains terebratuloids at the base of the Horlick formation makes their depositional environment of great interest regionally. The occurrence elsewhere in the lower part of the Beacon sandstone (Woodward, *op. cit.*) of Old Red sandstone facies suggests that a nonmarine environment is indicated for the strata lying well above the brachiopod occurrence, but there can be no doubt that the basal beds are of marine origin. Articulate brachiopods have never been recorded to live in anything but marine waters. There is little likelihood that the Horlick Mountains brachiopods have been reworked into nonmarine beds from previously existing marine beds because of the state of their preservation. *Pleurothyrella* belongs to a group of shells that are easily disarticulated by transporting agencies. As the Horlick Mountains shells are all present in an articulated condition (although it should be noted that some are filled with coarse, clastic particles of gravel size), extensive transportation is clearly ruled out. Their occurrence in the few feet of the Horlick formation immediately above a great nonconformity suggests that they lived in a shallow-water environment, which was raised above sea-level shortly after the deposition of the basal beds.

As for the temperature of the sea in which the basal beds were deposited, little can be said except to infer that it was similar to that prevailing in other parts of the Malvinokaffric environment. Knowledge of Lower Devonian animal geography (Boucot, 1960b) is still too rudimentary to know if the geographic poles occupied their present position. The limited information available from the known distribution of Lower Devonian brachiopods, however, certainly does not rule out the possibility that the geographic poles were in the same position as today. If such were indeed the case, one would infer that the Malvinokaffric Province, which reaches northward to the vicinity of the equator, might have been relatively temperate.[5] Reefs, and for that matter, corals, are not present in the Malvinokaffric Province, whereas reefs occur to the north in North Africa, and in Venezuela and Colombia solitary corals are abundant. If the presence of corals and reefs (chiefly stromatoporiodal in composition) can be taken to indicate warm water, then the Malvinokaffric sea may have been relatively cool.

EVOLUTION OF THE MUTATIONELLINAE

The subfamily Mutationellinae contains the following genera: *Mutationella, Podolella, Derbyina, Paranaia, Cloudella, Scaphiocoelia, Mendathyris,* and *Pleurothyrella.* The present study reinforces the essential unity and close relationship of this group of shells as originally pointed out by Cloud (1942). Since Cloud's paper was published additional information has become available on the European occurrences of *Mutationella* (Boucot, 1960) which indicates that the genus is widespread in strata of Early Gedinnian age (previous citations of the genus from the Silurian are now known to be actually of Early Gedinnian age) in eastern and western Europe, as well as in strata of Siegenian and Emsian age in the Rhenish facies. All of the genera other than *Mutationella* make their first appearance in Upper Gedinnian (New Scotland limestone equiva-

[5]Tillites are reported from the Lower Devonian of South Africa, Piauí and Paraná (Brazil), Malvinokaffric realm. K.E.C.

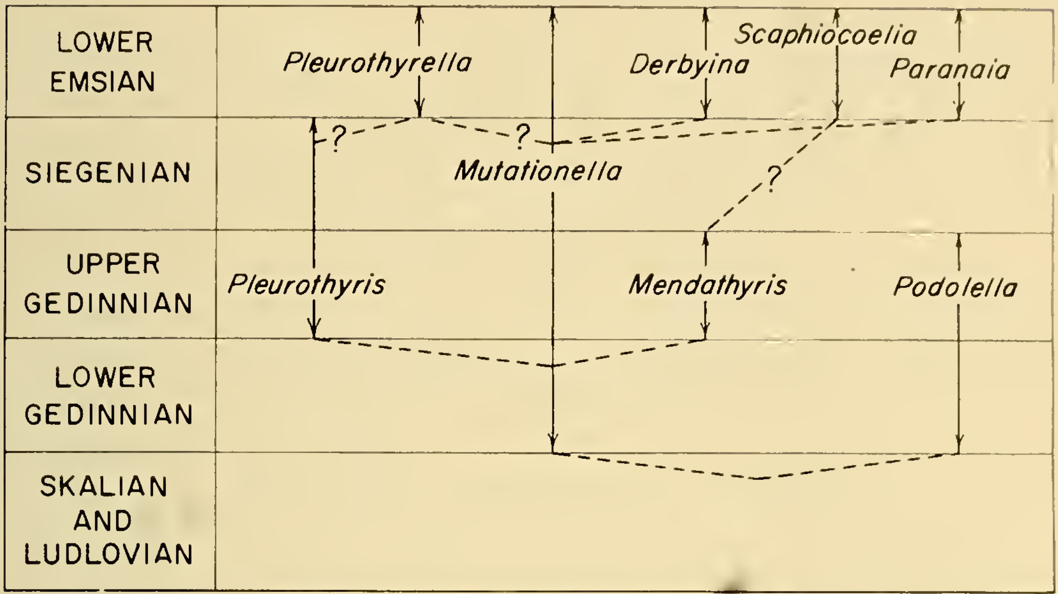

Fig. 2—Inferred phylogenetic relationships of the Mutationellinae. Revise *Pleurothyris* to read *Cloudella*, nom. nov. (see Appendix)

lents) or younger Lower Devonian beds, where they may occur associated with *Mutationella*. The ontogenetic series described here for *Mendathyris*, which is known only from beds of Late Gedinnian age in the northern Appalachians, demonstrates its derivation directly from *Mutationella*. The similarity of *Cloudella* to *Mutationella* was emphasized by Cloud (*op. cit.*, p. 123) who pointed out that the two genera are externally almost identical except for the more strongly incurved beak of the pedicle valve in *Cloudella*, a more deeply impressed muscle field, and partially obsolescent dental lamellae. Study of small specimens of *Cloudella* reinforces Cloud's conclusion. *Podolella* can be viewed as essentially a *Mutationella* with radial ornamentation only in the peripheral regions; it differs in this respect from all the other genera in the subfamily, which are invariably strongly ornamented radially. Although the complete ontogeny of *Cloudella* is unknown, it is clear that only the deposition of secondary material in the umbonal cavities and the development of a more deeply impressed muscle field and incurved beak in the pedicle valve are necessary to convert a small mutationelliform specimen of the type figured in this paper (Pl. 35, fig. 11) into *Cloudella*. *Cloudella* is known only from strata of Late Gedinnian (New Scotland) and Siegenian (Becraft-Oriskany) age in the northern Appalachians. *Pleurothyrella* is essentially a giant *Cloudella* possessing swollen cardinalia and a small cardinal process (in well-preserved specimens) in the brachial valve, together with an exceptionally well-impressed muscle field in the pedicle valve. *Pleurothyrella* is definitely known only from strata of Early Emsian age in the Southern Hemisphere. Stratigraphically it would be reasonable to derive *Pleurothyrella* from either *Cloudella* or *Mutationella*. The known geographic distributions of *Cloudella* and *Pleurothyrella* are so disjunct that it is tempting to think of their both having been derived independently from *Mutationella*. The latter genus is world-wide in strata of Early Gedinnian to Early Emsian age, but knowledge of the geographic distribution of the Lower Devonian fauna is still too incomplete for any well-documented conclusion to be made. The partially known ontogeny of *Pleurothyrella* from both South Africa and Antarctica supports the derivation from *Mutationella*.

Both *Derbyina* and *Paranaia* are known with certainty only from the Amazon Basin in Brazil, where they occur in strata that are probably of Lower Emsian age. The available descriptions of both genera are fragmentary and the illustrations poor, but it is clear that both could easily have been derived from *Mutationella*. *Derbyina*, as pointed out by Cloud (*op. cit.*, p. 121), differs from *Mutationella* only in having a prominent raised median plication on the brachial valve, corresponding groove on the pedicle valve, and smooth umbones. *Paranaia* is similar to *Derbyina*, as pointed out by Cloud (*op. cit.*, p. 122), and might in fact be a synonym if adequate material of both were available for study. *Scaphiocoelia* is concluded to be a terebratuloid closely related to *Mendathyris* and differing chiefly in the shape of the valves.

SYSTEMATIC DESCRIPTIONS

Superfamily **TEREBRATULACEA** Waagen, 1883

Family **DIELASMATIDAE** Schuchert, 1929

Subfamily **MUTATIONELLINAE** Cloud, 1942

Genus **PLEUROTHYRELLA**, gen. nov.

Pl. 16, figs. 1-21; Pl. 17, figs. 1-16; Pl. 18, figs. 1-19; Pl. 19, figs. 2-16; Pl. 20, figs. 1-11; Pl. 21, figs. 1, 4-17; Pl. 22, figs. 1-14; Pl. 23, figs. 1-17; Pl. 24, figs. 1-5, 11-15; Pl. 25, figs. 1-7; Pl. 26, figs. 1-11; Pl. 27, figs. 1-10; Pl. 28, figs. 1-13; Pl. 29, figs. 1-11; Pl. 31, figs. 1-2.

Type species.—*Scaphiocoelia? africana* Reed, 1906, Geol. Mag., vol. 3, Decade V, Pl. XVII, figs. 1-3.

Diagnosis.—*Pleurothyrella* is characterized by the presence in large specimens of a bulbous, imperforate cardinal plate which may or may not be surmounted by a posteriorly situated cardinal process.

Comparison.—*Pleurothyrella* can be distinguished from the closely related genus *Cloudella* by the absence in large specimens of a perforate cardinal plate and the occasional presence of a posteriorly situated cardinal process. The cardinal plate of *Cloudella,* in addition to being perforate, is never swollen. Some species of both genera have anteriorly bifurcating costellae.

Pleurothyrella has more deeply impressed musculature in the pedicle valve than *Mutationella,* as well as a bulbous, imperforate cardinal plate. *Mendathyris* is distinguished from *Pleurothyrella* by the presence of a much more laterally elongate interarea in the pedicle valve, of a perforate cardinal plate in the brachial valve, and of well-marked transverse ridges in the adductor field of the brachial valve.

Exterior—Adult specimens are of large size for the family as are *Cloudella, Mendathyris,* and the Siegenian and Emsian species of *Mutationella.* The valves are unequally biconvex, with the pedicle valve always having a greater degree of convexity than the brachial valve. The pedicle valve may be from one-half to three times as deep as the brachial valve. The position of maximum width is situated in the vicinity of the midlength. The anterior commissure is rectimarginate and crenulate. The anterior and lateral margins are evenly rounded. The cardinal margin is submegathyrid to subterebratulid. The beak of the pedicle valve is slightly to strongly incurved. The palintrope may be from one-half to two-thirds the maximum width of the shell. The palintrope may be relatively short or of moderate length. The palintrope of the brachial valve is short, barely distinguishable except in well-preserved specimens. The beak of the brachial valve is slightly incurved into the delthyrium. The delthyrium includes an angle of about 60 to 120 degrees. A gently concave deltidium fills the delthyrium. The deltidium appears to be composed of medially conjunct plates apically perforated by a small foramen, but the preservation of the available specimens precludes certainty on these points. The foramen is probably hypothyrid to submesothyrid in position. The ornamentation consists of radiating costellae that increase in size anteriorly and may, in some species, bifurcate. The umbonal regions of both valves may be relatively smooth, possibly due to abrasion, or distinctly costellate. The outlines of the shell may be subcircular or longitudinally elongate. The shell substance is punctate.

Interior of brachial valve.—The cardinalia in the adult consists of an imperforate, relatively thick to bulbous cardinal plate. Posteriorly the cardinal plate may bear a small, scoop-shaped cardinal process. In medium-sized specimens the cardinal plate is perforate and does not bear a cardinal process. The dental sockets are laterally directed and flare laterally. The cardinal plate may be either free anteriorly or sessile. The adductor impressions are deeply excavated posteriorly and weakly impressed anteriorly. The adductor impressions are longitudinally elongate and extend anteriorly from one-fifth to one-third the length of the valve. The adductor impressions are medially separated by a well-defined myophragm which may be either broad or narrow. The adductor impressions may consist of two pairs of scars separated by a pair of short myophragms. The crura are short, rodlike, and anteriorly directed. The nature of the loop is not known, but it is seen in cross-section in one specimen at about the midlength to be relatively close to the lateral margins of the shell. The umbonal region of the valve is smooth due to the deposition of secondary material, but the peripheral regions are strongly crenulated by the impress of the external ornamentation.

Interior of pedicle valve.—The dental lamellae are relatively short and are either completely obsolete or obsolescent. The shell is greatly thickened in the umbonal region of large specimens, less so in medium-sized specimens. The hinge teeth are stubby and situated above the anterior portions of the dental lamellae bordering the hinge line. The muscle field is deeply impressed. It consists of a hemispherical, posterior umbonal chamber anterior to which is a short myophragm that bisects the small, linear adductor impressions, which are flanked laterally by the large, elongate diductor impressions. The muscle field extends anteriorly from one-third to one-half the length of the valve. The muscle field becomes progressively less well impressed anteriorly until it merges into the crenulated impression of the external costellae.

Geographic distribution.—Horlick Mountains, Antarctica; South Africa; Totora, Bolivia; Lankey and Stoney Creeks, New Zealand.

Stratigraphic distribution.—Basal Lower Devonian beds of the Horlick Mountains, Antarctica; top of the Table Mountain sandstone and Bokkeveld beds of South Africa; Icla shale of Bolivia; Reefton beds and possibly Reefton limestone of New Zealand. With the exception of the Antarctic occurrence all of the material is associated with an invertebrate fauna which can best be dated as Lower Emsian. The Antarctica collection has not yielded any material other than *Pleurothyrella* that is of use for dating purposes.

SPECIES ASSIGNED

Scaphiocoelia? africana Reed, 1906, *op. cit.*

Rensselaeria relicta Schwarz, 1906, Rec. Albany Mus., v. I, pt. VI, p. 364, pl. VII, fig. 7.

Rensselaeria knodi Clarke, 1913, Serv. Geol. Miner. Brasil, Mon., v. 1, p. 77, 82, 268.

Pleurothyrella antarctica, sp. nov.

Pleurothyrella venusta, sp. nov.

SPECIES REJECTED

Scaphiocoelia? africana var. *elizabethae* Reed, 1908, Ann. S. African Museum, vol. 4, p. 404-405, Pl. XLVIII, figs. 10-14 (=true *Scaphiocoelia*).

Discussion.—*Pleurothyrella* is founded on relatively large and medium-sized specimens. Because of the information gained from study of the growth series of the closely related genus *Mendathyris*, which has an early growth stage identical to the ancestral form *Mutationella*, it is predicted that early growth stages of *Pleurothyrella* will also be similar if not identical to *Mutationella*, as are the medium-sized specimens. This complicates the generic identification of small and medum-sized specimens of *Mutationella* found in strata of post-Early Gedinnian age; they may in fact be early growth stages of any of the genera concluded to have been derived from *Mutationella*. In the absence of growth series of either *Mutationella* or one of the derived genera together with small specimens of *Mutationella* it is probably best to continue to call these small specimens *Mutationella*, with the reservation that they may be early growth stages of another genus. This problem is well illustrated by material from the Malvinokaffric Province in Bolivia and South Africa which consists of small specimens whose morphology, both internal and external, is identical to that of *Mutationella* but which could be early growth stages of either *Mutationella*, which occurs in the Falkland Islands [*Mutationella falklandica* (Clarke, 1913)], or of one of the species of *Pleurothyrella*.

Cloud (1942, p. 143) suggested the possibility that *P. relicta* (Schwarz, 1906) might belong to *Scaphiocoelia*, but study of Caster's plastotypes from the top of the Table Mountain sandstone-Bokkeveld rules out this possibility. However, study of Reed's collection of *Scaphiocoelia africana* at the Sedgwick Museum and of plastotypes made by Caster of *S. africana elizabethae* leaves no doubt that *Scaphiocoelia* does occur in South Africa.

Diagnostic characters of the species of *Pleurothyrella**

Character	*P. relicta*	*P. antarctica*	*P. knodi*	*P. venusta*	*P. africana*
Costellae	coarse	coarse	medium-sized	originate by bifurcation	medium-sized
Outline	subcircular to elongate	subcircular	elongate	subcircular	subcircular to elongate
Cardinal Plate	bulbous	very bulbous	relatively flat	relatively flat	bulbous
Pedicle Muscle Field	large	large	relatively small	large	large
Brachial Valve	relatively flat	very convex	convex	convex	relatively flat

*The terms "coarse," "medium-sized," "bulbous," "very bulbous," "relatively flat," "large," "relatively small," "very convex," and "convex," are only used in a relative sense. In order to understand their significance the reader should inspect the figures accompanying this paper to note the relative size and convexities involved. In the case of convexities measurements are not too meaningful, as linear measurements vary indirectly with the actual changes in curvature.

Pleurothyrella africana (Reed, 1906) Pl. 16, figs. 1-21; Pl. 17, figs. 1-16; Pl. 18, figs. 1-19; Pl. 19, figs. 2-16; Pl. 20, figs. 1-11; Pl. 21, fig. 1

Scaphiocoelia africana Reed, 1906, *op. cit.*
Rensselaeria cf. *confluentina* Reed *non* Fuchs, 1906, *op. cit.*, p. 308, pl. XVI, fig. 6.
Rensselaeria montaguensis Reed, 1908 *pars,* Ann. S. African Mus., v. 4, p. 401-402, pl. XI, fig. 5, not figs. 6-7.

Exterior.—Adult specimens are of large size for the family. The valves are unequally biconvex, with the pedicle valve from two to three times the depth of the brachial valve. The position of maximum width is situated near or slightly anterior to the midlength. The anterior and lateral margins are evenly rounded. The cardinal margin is submegathyrid. The beak of the pedicle valve is slightly incurved. The palintrope, of moderate length, is from one-half to two-thirds the maximum width of the shell. The palintrope of the brachial valve is short, barely distinguishable except in well-preserved specimens. The beak of the brachial valve is slightly incurved into the delthyrium. The delthyrium includes an angle of about 60 degrees. A gently concave deltidium fills the delthyrium. The construction of the deltidium was not apparent from study of the available specimens. The pedicle foramen is probably hypothyrid in position. The ornamentation consists of radiating costellae that increase in size anteriorly. The umbonal regions of both valves are usually smooth, possibly due to abrasion. The shell substance is punctate. The shells are subcircular to longitudinally elongate in outline.

Interior of brachial valve.—The cardinalia in the adult consist of an imperforate, relatively bulbous cardinal plate. Posteriorly the cardinal plate bears a small, scoop-shaped cardinal process. In medium-sized specimens the cardinal plate is perforate, does not bear a cardinal process, and is swollen but not bulbous. The dental sockets are laterally directed and flare laterally. The cardinal plate is sessile anteriorly in large specimens but free in medium-sized specimens. The adductor impressions are longitudinally elongate and extend anteriorly from one-third to one-half the distance to the mid-length. The posterior portion of the adductor field is deeply impressed, even in medium-sized specimens, but the anterior portion is weakly impressed. The adductor field is medially bisected by a broad myophragm which is particularly strong posteriorly but never reaches the proportions of a true septum. The umbonal region is smooth due to the deposition of secondary material but the peripheral regions are strongly crenulated by the impress of the external ornamentation. The crura are short, rodlike, and anteriorly directed from the median portion of each half of the cardinal plate.

Interior of pedicle valve.—The dental lamellae are relatively short, almost completely obsolescent in adult specimens and less so in medium-sized specimens. The hinge teeth are stubby and basally supported by the free anterior margins of the dental lamellae. The lateral face of each dental lamella, except for its anterior edge, is cemented to the wall of the valve. The shell is greatly thickened by the deposition of secondary material in the umbonal region; this tendency is less pronounced in medium-sized than in the large specimens. The muscle field is deeply impressed posteriorly and less so anteriorly. The umbonal chamber is slightly expanded laterally and anteriorly bordered by the deeply impressed muscle field. The posterior portion of the muscle field is medially divided by a short, pronounced myophragm. The muscle field is not noticeably subdivided but is longitudinally elongate in form. The muscle field extends anteriorly about one-half the distance to the midlength and becomes progressively less well impressed anteriorly until it merges into the crenulated impression of the external costellae.

Ontogeny of *Pleurothyrella africana* (Reed, 1906)

Interior of brachial valve.—

Early stage: The early stage is not represented definitely in the collections known to the writers. However, mutationelliform small brachiopods that could represent the early stage are known from the Bokkeveld sandstone.

Middle stage: The middle stage is here defined to include medium-sized specimens in which a relatively flat cardinal plate is present, perforated posteriorly by a foramen. The muscle field is well impressed and consists of one pair of longitudinally elongate lateral adductor impressions whose posterior terminations are well anterior of the foramen perforating the cardinal plate. Medially separating the lateral adductors is a broad, raised area which is the site of a pair of medial adductors divided by a low myophragm. The valve is relatively flat. Traces of a cardinal process have not been observed.

Late stage: The late stage is characterized by the sealing off of the foramen in the cardinal plate and by the development of the cardinal plate into a relatively swollen, bulbous structure. A posterior cardinal process is present on top of the swollen cardinal plate. The valve is relatively more convex. The lateral adductors are deeply impressed into the secondary material filling the umbonal region. The posterior portion of the muscle field curves down into the umbonal region, whereas in the middle stage the muscle field was relatively planar.

Interior of pedicle valve.—

Early stage: See early stage of brachial valve.

Middle stage: The middle stage is here defined to include medium-sized specimens in which the muscle field becomes increasingly well impressed and is divisible into a set of diductor and a set of adductor impressions. In addition, there is deposition of secondary material in the umbonal cavities so as to make the dental lamellae slightly to moderately obsolescent.

Late stage: The late stage is defined to include large specimens in which the dental lamellae are almost completely obsolescent and the muscle field is deeply impressed posteriorly.

Holotype.—The holotype is South African Museum No. 607 (Reed, 1906, pl. XVII, fig. 1); plastotype, UCM28875.

Occurrence.—"Warm Bokkeveld, Ceres," Cape Province, Union of South Africa. Bokkeveld beds.

Pleurothyrella antarctica, sp. nov. Pl. 21, figs. 4-17; Pl. 22, figs. 1-14; Pl. 23, figs. 1-17

Exterior.—Adult specimens are large for the family. The valves are unequally biconvex with the pedicle valve about one and one-half times as deep as the brachial valve. The position of maximum width is situated near the midlength. The anterior commissure is rectimarginate and crenulate. The anterior and lateral margins are evenly rounded. The cardinal margin is subterebratulid. The beak of the pedicle valve is slightly incurved. The palintrope is about two-thirds the maximum width of the shell. The palintrope of the brachial valve is short. The beak of the brachial valve is slightly incurved into the delthyrium. The delthyrium includes an angle of about 60 degrees. A gently concave deltidium fills the delthyrium. The deltidium appears to be composed of medially conjunct plates apically perforated by a small foramen, but the preservation of the specimens precludes certainty regarding these points. The foramen appears to be hypothyrid in position. The ornamentation consists of relatively coarse, radial costellae which increase in size anteriorly and do not bifurcate. The umbonal regions of both valves are strongly costellate. The outline of the shell is subcircular.

Interior of brachial valve.—The cardinalia consist of an extremely bulbous, almost hemispherical, swollen cardinal plate. The presence of a posterior cardinal process could not be ascertained on the available material. The cardinal plate is completely sessile both anteriorly and posteriorly. The crura are short, bladelike, or rodlike, and anteriorly directed from the median portion of each half of the cardinal plate. The adductor impressions are deeply excavated posteriorly into the secondary material which lines the umbonal region, and faintly impressed anteriorly. A myophragm bisects the adductor field. The myophragm is posteriorly relatively broad and strong but becomes low and weakly impressed anteriorly. The muscle field extends anteriorly forward of the midlength. A loop is present as seen on a cross-section made at about midlength. The loop at the midlength is relatively broad. The peripheral portions of the valve are strongly crenulated by the impress of the external ornamentation.

Interior of pedicle valve.—The dental lamellae are relatively short and obsolescent. The lateral face of each lamella is cemented to the wall of the valve except for the anterior edge which is free. The stubby hinge teeth are situated on top of the anterior edge of the dental lamellae. The muscle field is deeply impressed posteriorly into the thick deposit of secondary material which fills the umbonal region of the valve. The muscle field is longitudinally elongate and consists of a narrow, longitudinally elongate pair of adductors enclosed by a large pair of longitudinally elongate diductor impressions. The adductors are slightly raised above the level of the diductors. The muscle field extends more than half the distance to the anterior margin. A short myophragm bisects the anterior part of the diductor field, anterior of the adductor field. A hemispherical umbonal chamber is situated posterior of the diductor impressions.

Ontogeny of *Pleurothyrella antarctica*, sp. nov.

Interior of brachial valve.—

Early stage: The early stage is unknown but is presumed to be mutationelliform.

Middle stage: The middle stage is here defined to include medium-sized specimens in which either discrete hinge plates or a flat cardinal plate perforated posteriorly by a foramen is present. The muscle field is only moderately well impressed and consists of a pair of longitudinally elongate lateral adductor impressions separated medially by a long, linear medial pair of adductors divided by a narrow myophragm. The adductors terminate posteriorly well anterior to the cardinalia. Secondary material is laid down in the umbonal region but is relatively thin.

Late stage: The late stage is characterized by the sealing off of the foramen in the cardinal plate and by the development of an excessively swollen cardinal plate. The valve becomes relatively far more convex than in the middle stage. The muscle field is more deeply impressed, and secondary material is relatively thick in the umbonal region.

Interior of pedicle valve.—

Early stage: The early stage is unknown but is presumed to be mutationelliform.

Middle stage: The middle stage is here defined to include medium-sized specimens in which the muscle field is moderately well impressed but not easily divisible into adductor and diductor impressions. In addition there is deposition of secondary material in the umbonal cavities so as to make the dental lamellae slightly to moderately obsolescent.

Late stage: The late stage is defined to include large specimens in which the dental lamellae are almost completely obsolescent and the muscle field is deeply impressed posteriorly.

Holotype.—USNM, No. 137746.

Occurrence.—*Pleurothyrella antarctica* is known only from the locality in the Horlick Mountains, Antarctica, described by Long (1959).

Discussion.—Cooper (*in* Long, 1959, p. 10) suggested that *P. antarctica* was similar to *Mutationella falklandica* (Clarke, 1913), but the latter lacks the bulbous cardinalia of *P. antarctica* and has discrete hinge plates rather than a cardinal plate. In addition the musculature of both valves in *M. falklandica* is too weakly impressed for such a large specimen to be considered to belong to *Pleurothyrella*.

Pleurothyrella knodi (Clarke, 1913) Pl. 24, figs. 1-5, 11-15; Pl. 25, figs. 1-7; Pl. 26, figs. 1-2

Rensselaeria ovoides non Eaton, Knod, 1908, Neues Jahrb. f. Min., Geol. u. Pal., XXV Beil.-Band, p. 557-558, pl. XXVIII, figs. 6-7.
Rensselaeria knodi Clarke, 1913, Serv. Geol. Miner. Brasil, Mon., vol. 1, p. 77, 82, 268.

Exterior.—Only a few fragments of the external impression are available, but the general form of the species can be learned from inspecting the steinkerns, as the shell material, except in the umbonal regions, is relatively thin.

The adults (no small specimens are known) are relatively large for the family. The valves are unequally biconvex with the pedicle valve having one and one-half the depth of the brachial valve. The position of maximum width is situated at about the midlength. The beak of the pedicle valve is gently incurved. The anterior commissure is rectimarginate and crenulate. The anterior and lateral margins are evenly rounded. The palintrope is slightly less than one-half as wide as the maximum width of the shell. The ornamentation consists of radiating costellae which increase in size anteriorly. Increase in number of costellae by bifurcation could not be noted on the steinkerns. The shells are longitudinally elongate.

The delthyrium includes an angle of about 120 degrees. The palintrope is short.

Interior of brachial valve.—The cardinalia consist of an imperforate cardinal plate posteriorly surmounted by a scoop-shaped cardinal process. The cardinal process is elliptical in plan, laterally elongate, and resembles a low scoop. This process is completely different in its construction from the cardinal processes of other Devonian terebratuloids. The crura are short, pointed, and anteriorly directed, coming off the median portion of each half of the cardinal plate. The dental sockets are laterally directed and flare laterally. The cardinal plate is posteriorly sessile. There are two pairs of adductor impressions. The lateral pair is relatively short, elongate, antero-laterally directed, and medially separated from the medial pair of adductors by a pair of short myophragms. The junction of the two pairs of adductors posteriorly gives rise to a shallow notch which could be mistaken for a pair of short crural plates. The median pair of adductor impressions is elongate, reaching anteriorly about one-third the distance to the anterior margin, and is medially separated by a low, narrow myophragm which is especially pronounced posteriorly. The umbonal region of the valve is smooth due to the deposition of secondary material, but the peripheral regions are strongly crenulated by the impress of the external ornamentation.

Interior of pedicle valve.—The dental lamellae are short, obsolescent, and cemented laterally to the walls of the valve except for the anterior edges which are free. The upper portion of each dental lamella bears a stubby hinge tooth. The shell is greatly thickened by the deposition of secondary material in the umbonal region but is relatively thin elsewhere. The muscle field is moderately well impressed for the genus. It consists of a concave, posterior umbonal chamber anterior to which is a short myophragm that bisects the small, linear, longitudinally elongate adductor impressions which are flanked laterally by the larger, longitudinally elongate diductor impressions. The muscle field is deeply impressed posteriorly but weakly impressed anteriorly and extends anteriorly less than one-third the length of the valve. The peripheral portions are deeply crenulated by the impress of the external ornamentation.

Lectotype.—The specimen figured by Knod (1908, pl. XX-

VIII, figs. 6, 6a, 6b) is here selected as the lectotype (Dereims Collection, Collection de Géologie de la Sorbonne, No. 58.005).

Occurrence.—The material of this species in the Dereims Collection is cited by Knod (*op. cit.*) as "found in a reddish brown sandstone together with *Leptocoelia flabellites* [*Australocoelia tourteloti*] and *Spirifer antarcticus* near Totora. The sandstone belongs to the lower part of the Icla beds" from Bolivia.

Discussion.—Cloud (1942, p. 84) suggested that *P. knodi* might belong to the genus *Globithyris,* which elsewhere has never been demonstrated to occur in the Southern Hemisphere, but the absence of a true median septum in the brachial valve taken together with the peculiarities of the muscle field in the pedicle valve of both genera precludes this assignment. The steinkern of *Mutationella* figured from Bolivia might, as previously mentioned, be an early growth stage of *P. knodi,* but no material suggestive of *Pleurothyrella* was found in the boulders from which the steinkern was broken.

Pleurothyrella venusta, sp. nov. Pl. 26, figs. 3-11; Pl. 27, figs. 1-10; Pl. 28, figs. 1-13; Pl. 29, figs. 1-11; Figure 3.

Exterior.—Adult specimens of the species are large for the family. The valves are unequally biconvex with the pedicle valve being about one and one-half times as deep as the brachial valve. The position of maximum width is situated near the midlength. The anterior commissure is rectimarginate to feebly sulcate and crenulate. The cardinal margin is subterebratulid to submegathyrid. The beak of the pedicle valve is strongly incurved. The palintrope is over one-half the maximum width of the shell. The palintrope is relatively short in the pedicle valve and barely distinguishable in the brachial valve. The beak of the brachial valve is slightly incurved into the delthyrium. The delthyrium includes an angle of about 60 degrees. A concave pair of medio-basally conjunct deltidial plates fills the delthyrium. The foramen is submesothyrid in position. The ornamentation consists of radiating costellae which increase in size anteriorly and increase in number by bifurcation. A large specimen bears about 79 or 80 costae. The umbonal region of each valve is costellate. The outlines of the shell are subcircular to elongate-ovate.

Interior of brachial valve.—The cardinalia consist of a thick, flat cardinal plate. A small, posteriorly situated cardinal process is probably absent, although this could not be determined because of poor preservation in the quartzite specimens. The cardinal plate is sessile both anteriorly and posteriorly. The crura are short, pointed, and anteriorly directed from a position about median in each half of the cardinal plate. The dental sockets are laterally directed and flare laterally. The cardinal plate is imperforate, but the anterior portion of the foramen is still present in large specimens, and it is continous in smaller to medium-sized specimens. Crural plates are absent, there being neither anterior projections from the base of the cardinal plate nor evidence of structural crural plates buried within the cardinal plate. The muscle field is deeply impressed posteriorly and consists of two pairs of adductor impressions. The muscle field extends anteriorly about one-third of the distance to the anterior margin. The lateral pair of adductor impressions are relatively narrow, longitudinally elongate, and anterolaterally directed. The lateral pair of adductor impressions extends farther to the posterior than the median pair. The median pair of adductor impressions are longitudinally elongate and medially separated by a threadlike myophragm. The myophragm extends anteriorly about one-third the distance to the anterior margin. The lateral adductors bear transverse rugosities, whereas the medial scars are smooth. The umbonal portions of the valve are smooth due to the deposition of secondary material, but the peripheral portions are strongly crenulated by the impress of the external ornamentation.

Interior of pedicle valve.—The dental lamellae are relatively short and obsolescent. The lateral sides of the dental lamellae are cemented to the walls of the valve except for the anterior margins which are free. A stubby hinge tooth surmounts the anterior edge of each dental lamella. The shell is greatly thickened by the deposition of secondary material in the umbonal region of large specimens. The muscle field is elongate, about one-quarter of the width of the valve, and extends for two-fifths of the length of the valve; it consists of a hemispherical posterior umbonal chamber anterior to which are two pairs of longitudinally elongate impressions. The lateral pair is about one-half the length of the medial pair. The muscle field is deeply impressed posteriorly but becomes progressively less well impressed anteriorly, until it merges into the crenulated impression of the external ornamentation.

Holotype.—Canterbury Museum (Christchurch, New Zealand) No. B. 301.

Dimensions.—Six substantially complete specimens were available for measurement; their dimensions to the nearest half millimeter are listed below.

	1	2	3	4	5	6
Length	45.5	54.0	43.5	43.0	45.0	45.0
Width	42.5	43.0	46.0	42.5	43.5	42.0
Thickness	30.0	30.0	29.5	27.5	27.5	25.5
Approx. number of costae at margin	80	80	75	70	80	75

1-5, paratypes; 6, holotype prior to etching

Occurrence.—All the casts and molds from quartzite boulders, including material collected by Dr. Brian Mason, American Museum of Natural History, New York, and Dr. C. A. Fleming, New Zealand Geological Survey, were collected from Lankey Creek or its tributary, Stoney Creek. Caster, Fleming, and Allan jointly made collections from the same area, and additional material is in the Allan collection at the University of Canterbury, Christchurch, New Zealand. Dr. Fleming (oral communication, 1959) suggested that these boulders were probably derived from the lower quartzite of the Reefton beds. Associated with the specimens of *P. venusta* in the quartzite are a small acrospiriferid of Lower Devonian aspect and a smooth dialasmatid which could belong to either *Cryptonella* or *Cranaena* in the absence of any information regarding its loop. The age of this association is certainly Devonian and as it apparently occurs under the Reefton mudstones which contain a Lower Emsian fauna, there seems little doubt that the quartzite faunule is of about the same age.

The Devonian faunas of the Reefton group were described by R. S. Allan in 1935. Since then the stratigraphy and structure of the Reefton district have been revised by R. P. Suggate (1957), and there has been further work on the brachiopods (Allan, 1947; Boucot, 1959), corals (Hill, 1956), and mollusks (Fleming, 1957)

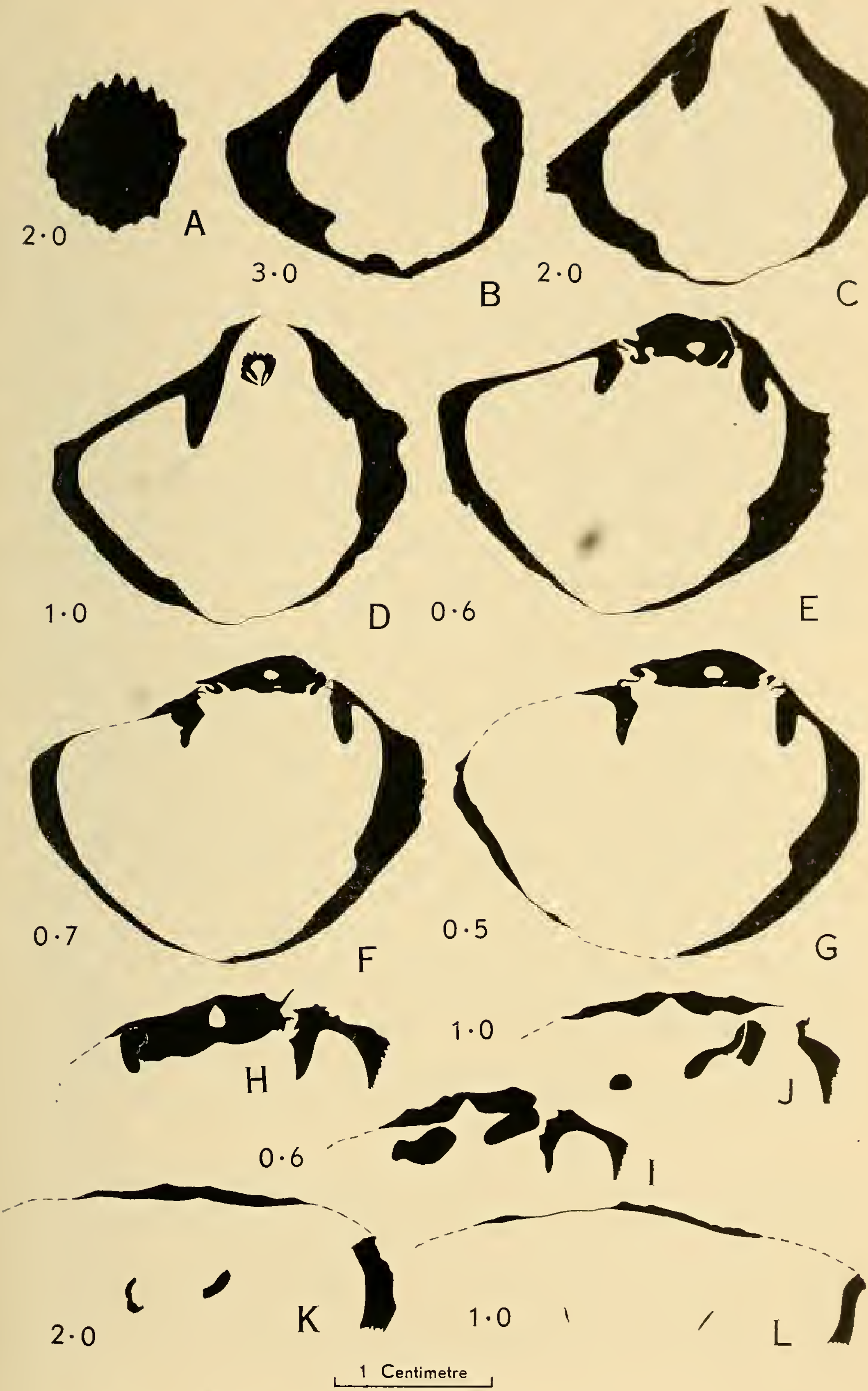

Figure 3.—Serial sections of *Pleurothyrella venusta*, sp. nov., from loose boulders in Lankey Creek, 100 yards upstream from Stoney Creek junction, Reefton, New Zealand. Canterbury Mus. No. 8 306.

of these faunas. The only terebratuloid brachiopod previously described from these beds is *Meganteris neozelanica* Allan, the type species of *Reeftonella* Boucot. It is one of the most abundant species in the Lower Reefton quartzite and the Reefton mudstone, which underlie the Reefton limestone, and has also been recorded doubtfully from felspathic sandstones in the Reefton limestone in Stoney Creek (Allan, 1935).

The articulated specimens of *Pleurothyrella venusta* described in this paper were collected by Ives from a poorly rounded boulder about a foot in diameter in the bed of Lankey Creek, about 100 yards upstream from its junction with Stoney Creek (see Suggate, 1957, for locality). They occur in association with an undescribed species of *Actinopteria,* an unidentified spiriferid brachiopod, and fragments of brachiopods, crinoids, undescribed species of bryozoan, and a favositid coral. The matrix contains detrital carbonate grains and quartz grains up to 0.1 mm. in diameter; the combined carbonates total 83%.

Calcareous sandstones and calcareous mudstones have been recorded from the Lower Reefton quartzite. Only the highest bed of this formation, a calcareous silty sandstone, has been recorded as fossiliferous; the fossils are in the form of moulds. A calcareous mudstone near the base of the succeeding Reefton mudstone contains *Hexagonaria* (R. S. Allan, personal communication). The overlying Reefton limestone is the only highly calcareous formation in the Lankey Creek-Stoney Creek watershed known to yield fossils with shell material preserved; these include corals and bryozoans (Allan, 1935; Hill, 1956), crinoid remains, and undetermined brachiopods, including a species of "*Spirifer.*" Two analyses of the purer limestones from this formation showed 84.8 and 87.5% $CaCO_3$ (Morgan, 1919). The composition and fauna of the boulder yielding the terebratuloids suggests derivation from the limestones of the Reefton limestone.

The Reefton mudstone has been regarded by Allan (1947) as Siegenian in age, although Boucot would now consider it to be Lower Emsian because of its large spiriferid which is similar to *Acrospirifer hercyniae,* as well as the occurrence of *Pleurothyrella* in beds of probable Early Emsian age in Bolivia and South Africa. This being so, the overlying, and apparently conformable, Reefton limestone would be most probably Emsian or Couvinian in age. Dorothy Hill (1956, 1957) on the basis of a small coral fauna advocated a Couvinian [= Eifelian] age for the Reefton limestone, a conclusion accepted by C. A. Fleming (1957a). The problem is not readily resolved, as the Couvinian age attached to the Reefton limestone depends principally on the identification of *Tipheophyllum bartrumi* (Allan) in the Sulcor limestone at Attunga and the Bluff limestone at Taemas, New South Wales, and the correlation of these formations. The Sulcor limestone is definitely of Couvinian age, but the Bluff limestone appears to be of Emsian, perhaps late Emsian age (Talent, 1963). The range of *Tipheophyllum* was recently extended by the discovery of a new species of this genus in the Siegenian or possibly older Coopers Creek formation at the base of the Walhalla group in Victoria. The resolution of these differing determinations of age for the Reefton limestone and the Reefton mudstone must await the discovery elsewhere of their distinctive faunal elements, or of the discovery at Reefton of additional species already known elsewhere to have restricted ranges.

Ontogeny of *Pleurothyrella venusta*, sp. nov.

Since submitting the paper for publication Ives has obtained several specimens from quartzite outcrops just downstream from the main limestone in Lankey's Creek, Reefton area, New Zealand. These quartzites yielded small to medium-sized specimens of *Pleurothyrella* which demonstrate the presence of an early mutationellid stage in the brachial valve characterized by discrete hinge plates, a scarcely discernible muscle field, no myophragm in the brachial valve, short dental lamellae in the pedicle valve, and a scarcely impressed muscle field. The smallest specimens observed with these characters are about 7 mm. in maximum width. They occur together with medium- and large-sized specimens of *Pleurothyrella venusta* and fully demonstrate the mutationellinid ancestry of the genus.

Pleurothyrella relicta (Schwarz, 1906) Pl. 31, figs. 1-2

Rensselaeria relicta Schwarz, 1906, Rec. Albany Mus. (South Africa), vol. I, pt. VI, p. 364, pl. VII, fig. 7.
Rensselaeria montaguensis Reed, 1908 *pars*, Ann. S. African Mus., vol. 6, pt. 8, No. 14, p. 401, pl. 48, fig. 7.

Exterior.—No specimens of the exterior are available for study, but its form may partly be deduced from impressions of the interior. The adults are relatively large for the family. The valves are unequally biconvex; the brachial valve is gently convex, and the pedicle valve deeply convex. The position of maximum width is situated near the midlength. The anterior commissure is rectimarginate and crenulate. The anterior and lateral margins are evenly rounded. The palintrope is about half the maximum width. The ornamentation consists of coarse, radial costellae that do not bifurcate anteriorly. The outline is subcircular to longitudinally elongate in the two specimens studied.

Interior of brachial valve.—In the medium-sized specimens studied the cardinalia consist of a perforate cardinal plate formed from medially conjunct hinge plates. The crura are short and anteriorly directed, coming off the median portion of the hinge plates. The dental sockets are laterally directed and flare laterally. The cardinal plate is posteriorly sessile. The two pairs of adductor impressions are deeply excavated posteriorly but fade anteriorly. They are longitudinally elongate and separated medially by a well-developed myophragm. The umbonal region is smooth due to the deposition of secondary material, but the peripheral region is strongly crenulated by the impress of the external ornamentation.

Interior of pedicle valve.—The dental lamellae are short and almost completely obsolescent due to the deposition of secondary material in the umbonal cavities. The upper portion of each dental lamella bears a stubby hinge tooth. The shell is greatly thickened in the umbonal regions by the deposition of secondary material. The muscle field is moderately well impressed for the genus; it consists of a hemispherical umbonal chamber anterior to which is a myophragm that bisects the linear, longitudinally elongate adductor impressions, which are flanked laterally by longitudinally elongate diductor impressions. The muscle field is weakly impressed anteriorly. The peripheral regions are deeply impressed by the external ornamentation.

Lectotype.—The brachial valve figured by Schwarz (*op. cit.*) is selected as the lectotype (Albany Museum, No. 93).

Occurrence.—This species is known only from the Bokkeveld beds of South Africa.

Discussion.—Cloud (1942, p. 143) suggested that *P. relicta* might belong to *Scaphiocoelia* ("The illustrations of this species resemble the Bokkeveld shells referred to *Scaphiocoelia* by Reed"). However, this study shows that Reed's South African *Scaphiocoelia* belongs to both *Scaphiocoelia* (*S.? africana elizabethae*) and *Pleurothyrella* (*S.? africana*), and it is the latter that *P. relicta* resembles in all respects except radial ornamentation.

Genus **MENDATHYRIS** Cloud, 1942

Pl. 31, figs. 3-9; Pl. 32, figs. 1-12; Pl. 33, figs. 1-15

Discussion.—*Mendathyris* was founded by Cloud (1942, p. 125-126) upon large specimens and a few medium-sized individuals. Subsequent collecting at the type locality from the Chapman sandstone at Grindstone, Presque Isle Stream, Aroostook County, Maine, by Boucot in 1953 and Mr. Raymond Fletcher, Brown University, in 1959 uncovered collections rich in small as well as large and medium-sized specimens. Thus two complete sets of specimens ranging in size from about two millimeters in width to about two centimeters in width are now available. Both of these collections demonstrate the correctness of Cloud's deduction (*op. cit.*) that *Mendathyris* is closely allied to both *Cloudella* and *Mutationella*. The ontogeny of *Mendathyris* demonstrates the presence of an early "*Mutationella* stage" and a middle and late stage clearly assignable to *Mendathyris*. The transitions between the early, middle, and late stages are completely gradational.

Ontogeny of *Mendathyris mainensis* (Williams, 1900)

Interior of brachial valve.—

Early stage: The early or "*Mutationella* stage" is here defined to include small forms having discrete hinge plates rather than a cardinal plate *or* a cardinal plate formed from discrete hinge plates which are joined *only* by a narrow median suture; a prominent myophragm medially dividing the muscle field which is so poorly impressed as to be either barely discernible or not discernible; the umbonal regions weakly costellate except in the notothyrial cavity due to the almost complete absence of thick deposits of secondary material.

Middle stage: The middle stage is here defined to include medium-sized specimens in which a relatively flat cardinal plate is present, perforated by a foramen posteriorly. The muscle field is well impressed and consists of two pairs of adductor impressions—a postero-lateral pair which projects slightly posterior into the notothyrial cavity so as to give the impression that a pair of crural plates might be present (although such is not the case) and a median pair. The median adductors are bisected by a myophragm which extends posteriorly almost to the point where the foramen emerges onto the upper surface of the cardinal plate, whereas in the early stage the myophragm extends posteriorly only to the antero-basal margins of the hinge plates or the cardinal plate and never to the rear of the notothyrial cavity. Deposition of secondary material is prominent in the umbonal region and completely obscures the impress of the external ornamentation. The development of transverse rugosities on the lateral adductor impressions first appears in the middle stage and continues on into the late stage.

Late stage: The late stage is characterized by the sealing off of the foramen in the cardinal plate and by the development of the cardinal plate into a relatively swollen, bulbous structure. The myophragm bisecting the median adductors extends posteriorly just to the base of the sealed-off foramen and begins to extend downward almost at right angles to the anterior portion, whereas in both the early and middle stages the myophragm is gently curved but never sharply bent posteriorly.

Interior of pedicle valve.—

Early stage: The early or "*Mutationella* stage" is here defined to include small forms having short dental lamellae that show no tendency towards obsolescence; there is no deposition of secondary material in the umbonal cavity so as to obscure the impress of the external ornamentation; the muscle field is merely a smooth area included between the dental lamellae; and subdivisions into diductor and adductor impressions are not visible. The presence of an umbonal chamber is not evident.

Middle stage: The middle stage is here defined to include medium-sized specimens in which the muscle field becomes increasingly well impressed and is divisible into a set of diductor and a set of adductor impressions. In addition there is deposition of secondary material in the umbonal cavities so as to make the dental lamellae slightly to moderately obsolescent. An umbonal chamber is well defined. The umbonal region is free from crenulation owing to the extensive deposition of secondary material. A narrow interarea is present.

Late stage: The late stage is defined to include large specimens in which the dental lamellae are almost completely obsolescent, the muscle field deeply impressed posteriorly, and the umbonal chamber no longer visibly constricted anteriorly from the posterior part of the muscle field. A prominent, short myophragm bisects the posterior portion of the muscle field, whereas in the middle stage the myophragm, when present, is relatively threadlike. A well-developed interarea is present.

Genus **MUTATIONELLA** Kozłowski, 1929

Mutationella falklandica (Clarke, 1913) Pl. 36, figs. 11-13

Rensselaeria falklandica Clarke, 1913, Serv. Geol. Miner. Brasil, Mon., vol. 1, p. 267-268, Pl. 17, figs. 29-31.
Mutationella falklandica (Clarke, 1913), Boucot, 1960, Mém. Inst. Géol. Univ. Louvain, tome XXI, p. 319.

Discussion.—Cloud (1942, p. 84) suggested the possibility that *M. falklandica* might belong to *Globithyris*, but the presence in the former of a myophragm rather than a median septum coupled with the absence of crural plates precludes this possibility.

Interior of brachial valve.—The cardinalia consist of hinge plates, which might be barely conjunct antero-medially to form a cardinal plate, medially separated by a relatively wide trough. The muscle field is feebly impressed and consists of a pair of adductor impressions medially bisected by a low myophragm. The dental sockets are laterally directed and flare laterally. The umbonal region is crenulated by the impress of the external ornamentation.

Occurrence.—Strata of Early Devonian, probably Early Emsian, age at Port Howard, East Falkland.

"Mutationella" sp. Pl. 34, figs. 1-5

Discussion.—In the material from which Boucot and Gill (1956) described *Australocoelia tourteloti*, from a boulder of possible

Early Emsian age in Bolivia, was included a single specimen of a terebratuloid with the morphology of *Mutationella.* At the time the specimen was assigned to *Mutationella* (Boucot and Gill, *op. cit.*), but now that we are in a position to predict that *Pleurothyrella knodi* should have an early "*Mutationella* stage" in its ontogeny, the generic assignment of this specimen is difficult. If the specimen had been found in association with a growth series of specimens belonging to *P. knodi* we would have no qualms about assigning the specimen to *Pleurothyrella* in much the same manner as we have assigned the early "*Mutationella* stage" specimens of *Mendathyris* from Maine to the latter genus. Or, if *Mutationella sensu stricto* were unknown in the Malvinokaffric Province, we would not be reluctant to assign this specimen to *Pleurothyrella.* With the knowledge that large specimens of *Mutationella* (*i.e., M. falklandica*) do occur in the Province, it appears fruitless to try to assign such small specimens generically at this time. Possibly when further knowledge is available about Early Devonian terebratuloids, including more information about their loops, it will be possible to identify small individuals with certainty.

Mutationella parlinensis, sp. nov. Pl. 34, figs. 6-16; Pl. 35, figs. 1-2

Exterior.—The shell is unequally biconvex, with the brachial valve gently convex, and the pedicle valve more inflated. The outline of the shell is subcircular to longitudinally elliptical. The greatest width and thickness are usually located near the midlength. The anterior commissure is rectimarginate and crenulate. The anterior and lateral margins are rounded. The cardinal margins are submegathyrid. The pedicle foramen is submesothyrid in position. Large shells possess short planareas. The deltidial plates are discrete. The beak of the pedicle valve is erect to suberect in large specimens and tends to become slightly incurved over the brachial valve. The shell is punctate. The surface is ornamented by costellae which increase in width peripherally. The costellae have broad, rounded cross-sections and are separated by narrow, V-shaped interspaces. Forty to sixty costellae are usually present on each valve.

Pedicle interior.—The shell is thin in the umbonal region with no thickening except in the delthyrial cavity of large specimens. The dental lamellae are short and thin. The muscle field is indistinct, elongate in form, and extends about one-third the distance to the anterior margin. It consists of a narrow, median diductor laterally bounded by elongate lateral diductor impressions. The posterior portion of the delthyrial cavity is occupied by the pedicle callist. The pedicle foramen is much narrower than the chamber occupied by the pedicle callist. The hinge teeth are stubby and basally supported by the dental lamellae. The interior is crenulated by the impress of the external ornamentation except in the umbonal region, which tends to be smooth.

Brachial interior.—The cardinalia consist of discrete hinge plates. A few specimens possess a narrow band joining the anterior portions of the hinge plates. In the majority of specimens this narrow band is not present, either because it broke during burial or because it was never formed. The dental sockets are elongate and laterally directed. They are closed over posteromedially by the outer socket ridges but widen laterally and are free. The muscle field is weakly impressed in most specimens, ellipsoidal in outline, and one-fifth as wide and one-third as long as the valve. The large, ovate, lateral adductors enclose a pair of narrow, median adductors. The median adductors widen rapidly at the anterior end of the muscle field. The muscle field is bisected by a myophragm.

Comparison.—*M. parlinensis* is closely allied morphologically to the type species in all regards except that the former attains dimensions of about three times those known in the latter. In addition, large specimens of *M. parlinensis* have a more carinate pedicle valve than do large specimens of *M. podolica,* but this may be a function of difference in size. The curvature of the beak is similar to that found in *M. podolica* and is not strongly incurved as in *Cloudella stewarti.* This species possesses short dental lamellae as does the type species. The cardinalia are in all respects similar to those of the type species, even in the evanescent character of the band connecting the hinge plates. The weakly impressed musculature is similar to that of the type species, as is the thin shell in the umbonal region of the pedicle valve.

M. parlinensis closely resembles "*Trigeria*" *gaudryi* Hall and Clarke, 1893 (*non* Oehlert, 1877) from the Ridgely sandstone near Cumberland, Maryland. Unfortunately no specimens of "*T.*" *gaudryi*

Hall and Clarke (*non* Oehlert) were available for study, but plaster casts of their figured specimens were studied. *M. barroisi* has fewer costellae than *M. parlinensis.*

M. parlinensis is similar internally and externally to *Mutationella falklandica* (Clarke, 1913) with the exception that the latter has relatively coarser costae.

The species *"Rensselaeria" circularis* Schuchert, 1913 may well be identical (as suggested by Cloud, 1942, p. 83) with *"Trigeria" gaudryi* Hall and Clarke (*non* Oehlert) but lack of well-preserved material does not permit solution of the problem. *"R." circularis* was assigned by Cloud (1942, p. 83) to *Globithyris,* but this assignment is untenable owing to the absence of crural plates or a median septum in the brachial valve of the former. A myophragm is present in the brachial valve of *"R." circularis,* as in *Mutationella,* and the hinge plates appear to be discrete. It is suggested that *"R." circularis* be assigned questionably to *Mutationella* pending the discovery of more adequate specimens.

Occurrence.—Localities SD-2718, 2691, 2719, 2717, 2721, 2731, 2735, 2720, 2765, 2749, 2777, 2795, 2793, 2776, 2767, 2722, 2861, 2727, 2732, 2831, 2890, 2875, 2824, 2865, 2823, 2783, 2821, 2834, 2847, 2862, 3088, 3090, 3225, 2832, and cf. 2819, 2825, 2747, Somerset County, Maine, in the Tarratine formation (Lower Devonian) and questionably the Kineo member of the Tomhegan formation (Lower Devonian). Locality numbers are those of the Silurian-Devonian locality catalog of the U. S. Geological Survey.

Distribution.—Somerset County, Maine, and possibly Cumberland, Maryland, if *"Rensselaeria" circularis* and *"Trigeria" gaudryi* belong to this genus and species. A single, poorly preserved specimen from the Percé limestone at Percé, Quebec, in the collections of the Museum of Comparative Zoology, Cambridge, resembles this species. Strata of similar age in Piscataquis and Penobscot Counties, Maine, have not, as yet, produced specimens of *Mutationella,* but *Cloudella* (a closely related genus) occurs in the area of Matagamon Dam, Penobscot County, and *Mendathyris* (another closely related genus) occurs in the Presque Isle area, Aroostook County, Maine.

Holotype.—USNM 126178.

Figured specimens.—USNM 126168, 126185, 126166, 126173, 126171.

Measured specimens.—USNM 126671 A-V.
Unmeasured specimens.—USNM 126638, 126674.

Genus **CLOUDELLA,** Boucot and Johnson, nom. nov.

See Appendix, present study.

Cloudella matagamoni, sp. nov. Pl. 35, figs. 3-16

Exterior.—The shell is unequally biconvex, with the pedicle valve having an inflated, convex form, and the brachial valve is gently convex. The outline of the shell is subcircular to longitudinally elliptical. The beak of the pedicle valve is incurved. Discrete deltidial plates parallel the sides of the delthyrium. The ornamentation consists of costellae which are relatively coarse and partly originate by bifurcation. The costellae have an angular cross-section and are separated by narrow interspaces. The anterior and lateral margins are rounded. The anterior commissure is rectimarginate and crenulate. The cardinal margins are submegathyrid. The pedicle foramen is submesothyrid in position. The maximum width is located near the midlength.

Pedicle interior.—The dental lamellae are short and almost obsolete due to the deposition of secondary material in the umbonal cavities and in the delthyrial cavity. The diductor impressions are marked posteriorly, weaken rapidly in the anterior direction, and are bisected by a myophragm. An expanded chamber for the pedicle callist is located at the rear of the delthyrial cavity but is only moderately developed in some specimens. The interior is strongly crenulated by the impress of the external ornamentation. The hinge teeth are short and stubby.

Brachial interior.—The cardinalia consist of discrete hinge plates. A prominent myophragm extends anteriorly to about the midlength and terminates posteriorly just short of the notothyrial cavity. The paired adductor impressions are narrow and lie on either side of the myophragm. The dental sockets are narrow, laterally directed, and roofed over medially.

Comparison.—*C. matagamoni* has fewer costellae than *C. stewarti.* In addition, in *C. matagamoni* the hinge plates are discrete whereas they are medially conjunct in *C. stewarti,* but this difference may reflect the fact that the available specimens of the former are smaller than those of the latter. The area of the pedicle callist is far more expanded in *C. stewarti* than in *C. matagamoni*, but again this may be more a reflection of size than anything else.

Ontogeny of *Cloudella matagamoni*

Although a complete growth series of this species is not known, some conclusions can be made about the ontogeny of this genus based on the new collections from Maine. The small specimens of both valves lack well-impressed muscle fields (Pl. 35, figs 9-11) and possess either short dental lamellae or a well-defined myophragm in the pedicle and brachial valves respectively so as to give rise to a "mutationelliform" stage similar to that of *Mendathyris*. The large specimens of this species are characterized by deeply impressed muscle fields in both valves. It is evident that a complete growth series would reveal an ontogeny with an early "mutationelliform" stage succeeded by later stages characteristic of *Cloudella*, as was the case with the related genus *Mendathyris*.

Remarks.—The occurrence in Maine extends the stratigraphic range of the genus from rocks of New Scotland to those of Oriskany age.

Occurrence.—Locality SD-3608, Matagamon Quadrangle, Penobscot County, Maine, in the Matagamon sandstone which is of Becraft-Oriskany age.

Holotype.—USNM 126172.

Figured specimens.—USNM 126179, 126211, 126169, 126170, 126175, 126174, 126176.

Unfigured specimens.—USNM 126675.

Genus **SCAPHIOCOELIA** Whitfield, 1891

Pl. 39, figs. 12-16; Pl. 40, figs. 5-14; Pl. 41, figs. 1-12

Discussion.—Cloud (1942, p. 142-143) ably summarized previous knowledge of the enigmatic Malvinokaffric genus *Scaphiocoelia*. However, after studying *Pleurothyrella* (including *P. africana* Reed which was erroneously assigned to *Scaphiocoelia?*) and *Scaphiocoelia elizabethae* Reed [which was erroneously assigned by Reed, 1908, p. 404-405, to the same species as *P. africana* (Reed)], reconsideration of the *Scaphiocoelia* problem is in order. Specimens of *Scaphiocoelia* from both South Africa and Bolivia make it clear that previous descriptions of the genus have overemphasized the problem of its possible lack of punctation and underemphasized its internal morphology. Cloud (*op. cit.*) quoted Whitfield's statement that the "shell structure (is) strongly fibrous, without any punctae under a hand magnifier," as well as a statement by Kozłowski that is to the same effect. This apparent lack of punctae appears, at first, to be a formidable objection to including *Scaphiocoelia* in the terebratuloids. However, hand lens examination of *P. africana, P. antarctica,* and *P. venusta* failed to reveal any punctae, and thin section examination showed punctae only in some specimens, which makes the punctation argument less convincing. Lack of punctae in these forms may have resulted from alteration and an original low punctation density.

Internally the morphology in both valves of *Scaphiocoelia* is remarkably similar to that of *Pleurothyrella* and *Mendathyris,* the only significant difference being that some specimens of *Scaphiocoelia* have a posteriorly situated boss on the swollen cardinal plate. The well-developed interareas in both valves mirror those in *Mendathyris.* Fundamentally, the real distinction between *Scaphiocoelia* and the other genera of the Mutationellinae is its concavo-convex form, but this type of profile has been independently developed in other groups of terebratuloids.

Diagnosis.—Mutationellinid brachiopods having a gently concave brachial valve and a deeply convex, naviculate pedicle valve. Interareas are well developed in both valves. The bosslike cardinal plate has a posterior bosslike protuberance.

Comparison.—All the other mutationellinid genera are biconvex rather than concavo-convex. *Mendathyris* is the only other mutationellinid possessing a well-developed interarea. The posterior bosslike protuberance of the cardinal plate is unlike structures present on the relatively unmodified cardinal plates of the other mutationellinid genera.

Exterior.—The brachial valve is gently concave; the pedicle valve is strongly convex and naviculate. The pedicle valve is somewhat larger than the brachial valve. The outlines of both valves are longitudinally elongate. The hinge line is straight and equal to about half the maximum width, which is situated near the midlength. The brachial valve bears a broad sulcus and the pedicle valve a corresponding fold. The postero-lateral, lateral, and anterior margins are evenly rounded. The commissure is weakly uniplicate and strongly crenulate. The interarea of the pedicle valve is moderately long, concave, and apsacline; that of the brachial valve is relatively short and anacline. The interareas of both valves are strongly striated by lines parallel to the hinge line. The delthyrium includes an angle of about 90 degrees and is apparently unmodified. The foramen is mesothyrid. The cardinal margin is megathyrid. The costellae do not bifurcate anteriorly.

Interior of brachial valve.—The cardinalia consist of a bulbous cardinal plate formed from medially conjunct hinge plates. The structure of the cardinal plate is evidenced by a groove that extends medially from posterior to anterior. The cardinal plate is either foramenate or possessed of a filled foramen. In individuals with swollen cardinal plates the median groove may not be visible. A cardinal process may or may not be present. In *S. boliviensis* there is a posterior, swollen area on the cardinal plate which has the form of a cardinal process, as illustrated by Kozłowski (1923, p. 92, fig. 6). In *S. elizabethae,* instead of the posterior swelling, there may be a linear cardinal process as in Reed's figure 10 (1908, pl. XLVIII) or none at all as in his figure 13 (*op. cit.*). The muscle field is similar to that of *Pleurothyrella* and consists of two pairs of adductors. The outer, larger pair is antero-laterally directed, elongate, and extends almost one-half the distance to the anterior margin. The inner, smaller pair is also longitudinally elongate.

Interior of pedicle valve.—The muscle field is deeply impressed, particularly posteriorly, and consists of a large, longitudinally elongate diductor field which encloses the narrow adductor field. The dental lamellae are short and obsolescent. The hinge teeth are stout and situated at the top of the remnants of the dental lamellae.

Occurrence.—Early Emsian age beds in Bolivia (Icla and Sicasica formations), Paraguay (chocolate-brown ironstone), and South Africa (Bokkeveld sandstone).

Derivation.—*Scaphiocoelia* is relatively similar in everything but the convexity of the brachial valve to both *Pleurothyrella* and *Mendathyris*. *Pleurothyrella* makes a poor ancestor because it is known only in strata of the same age as those which have yielded *Scaphiocoelia*, and it lacks well-developed interareas. *Mendathyris* occurs in Late Gedinnian age beds in the northern Appalachians and has well-developed interareas, making it a more eligible ancestor, or at least much closer to an ancestral type than any of the other mutationellinids. It is predicted that early growth stages of *Scaphiocoelia* will be mutationellinid in form.

Family **CRYPTONELLINAE** Thomson, 1926, emend. Cloud, 1942

Genus **CRYPTONELLA** Hall, 1861

Cryptonella? sp. Pl. 24, figs. 6-10; Pl. 30, figs. 8-18

Remarks.—In both the Bolivian material borrowed from the Dereims Collection of the Sorbonne and in the New Zealand collection from the lower quartzite of the Reefton beds there are a few smooth dielasmatids. In the absence of information regarding the loops (*i.e.*, whether or not they are cryptonelliform or cranaeniform) or the characters of the beak region in the pedicle valve, it is difficult to assign them generically. Because the muscle fields and general form of the specimens from Bolivia and New Zealand are somewhat reminiscent of specimens of "*Cryptonella*" *rhenana*, whose generic assignment is also in doubt, they have been questionably assigned to *Cryptonella*.

A foramenate, concave cardinal plate is present in the material from both localities. The brachial muscle field is not preserved in the Bolivian specimens, but in the New Zealand material it consists of two pairs of longitudinally elongate adductor impressions separated by a prominent myophragm. Short dental lamellae are prominent in the pedicle valve.

Genus **REEFTONELLA** Boucot, 1959

Ontogeny of **Reeftonella neozelanica** (Allan, 1935)

Pl. 36, figs 1-6; Pl. 37, figs. 1-15; Pl. 38, figs. 1-8; Pl. 39, figs. 1-11; Pl. 40, figs. 1-2.

In a previous paper (Boucot, 1959, p. 768) it was mentioned that *R. neozelanica* does not possess crural plates in the brachial valve, a point that distinguishes it from any of the Centronellidae.

We are now able to illustrate an ontogenetic series that makes clear the internal morphology of the genus.

Interior of brachial valve.—

Early growth stage: The early growth stage is characterized by the presence of a relatively small, foramenate cardinal plate and two pairs of linear adductor impressions in the brachial valve. The lateral pair of adductor impressions projects slightly posteriorad of the median pair in a manner suggestive of the presence of crural plates. This same tendency for a pair of lateral adductor impressions to project slightly posteriorad can be observed, at some growth stage or other or in certain variants, in many of the dialasmatid genera and is a good source of possible confusion with the genera of the centronellids.

Middle growth stage: The middle growth stage is characterized by the presence of a relatively large, foramenate cardinal plate, and by the anterior migration of the adductor field to a position where the lateral pair no longer projects posteriorly to give the impression that crural plates might be present. This anterior migration of the adductor field is largely a function of the deepening of the umbonal region in a manner which lifts the cardinal plate well above the muscle field.

Late growth stage: The late growth stage is characterized by the development of a more bulbous, sessile cardinal plate in which the foramen has finally become sealed off. The lateral pair of adductor impressions in this stage bears transverse grooves reminiscent of the condition in *Meganterella, Mendathyris,* and *Meganteris.*

Interior of pedicle valve.—

Early growth stage: The early growth stage is characterized by the presence of short dental lamellae which laterally enclose the unimpressed muscle field. At this stage the shell displays none of the generically distinctive characters of larger specimens and could easily be confused with any one of a number of other genera.

Middle growth stage: The middle growth stage is characterized by the presence of obsolescent dental lamellae which postero-laterally enclose a deeply impressed muscle field. The relative length of the muscle field increases with increasing length of the valve.

Late growth stage: In the late growth stage the dental lamellae are either completely obsolete, so as to expose the stubby hinge teeth, or are almost completely obsolete.

Family **RHIPIDOTHYRIDAE**

Subfamily **GLOBITHYRINAE**

Genus **GLOBITHYRIS** Cloud, 1942

Globithyris? sp. Pl. 30, figs. 1-7

Rensselaeria sp. *alpha* Reed, 1903, Ann S. African Museum, Vol. IV, pt. III, p. 176-177, pl. XXI, fig. 8.
Rensselaeria montaguensis Reed, 1908 *pars*, Ann. S. African Museum, vol. IV, p. 401-402, pl. XLVIII, fig. 6, not figs. 5, 7.

Exterior.—From the available plaster casts and published illustrations of Reed's material not much can be said about the exterior except what can be gleaned from the impressions of the interior of the brachial valves. The two valves are subequally biconvex and subcircular in outline. The posterolateral, lateral, and anterior margins are evenly rounded, and the anterior commissure is strongly crenulate. The valves are ornamented by radiating costellae that do not bifurcate anteriorly.

Interior of brachial valve.—The cardinalia consist of a cardinal plate formed from medially conjunct hinge plates; the whole structure has the form of a cruralium supported basally by a median septum. The median septum is posteriorly relatively thick, diminishes in height anteriorly, and extends about one-third of the distance to the anterior margin. The dental sockets are laterally directed. The impress of the external ornamentation extends into the umbonal region.

Interior of pedicle valve.—Almost no information is available about the interior of the pedicle valve except that short dental lamellae are present and the muscle field is not well impressed.

Remarks.—Reed (1908, p. 402) remarked that his *R.* sp. *alpha* is probably identical with *R. montaguensis* and then went on to say that Schwarz thought *R.* sp. *alpha* probably identical with *R. relicta* (= *Pleurothyrella relicta*). This is one of those happy situations where everybody is partly correct, as *R. montaguensis* as figured and described by Reed (*op. cit.*) includes *Pleurothyrella* *relicta* (Reed's fig. 7), *Pleurothyrella africana* (Reed's fig. 5), and *Globithyris?* sp. (Reed's fig. 6, which is identical with his *R.* sp. *alpha*).

Occurrence.—All of these forms occur in the Bokkeveld sandstone.

MISCELLANEOUS RENSSELAEROIDS FROM SOUTH AFRICA

Schwarz (1906) and Reed (1906, 1908, 1903) described a variety of radially plicate shells from the Bokkeveld sandstone which they have assigned to various species of *Rensselaeria* and *Derbyina.* The bulk of the large forms assigned to *Rensselaeria* we find to belong to *Pleurothyrella,* but the preponderance of the small forms appears to be unassignable. Reed's *Rensselaeria* cf. *cayuga* (1908, p. 402-403, pl. XLVIII, fig. 8; herein, Pl. 40, figs. 3-4) is an unidentifiable fragment of an orthotetacid brachiopod, possibly *Schuchertella,* as evidenced by the flattish, anteriorly bifurcating costellae and the planar nature of the shell fragment. Reed's *Rensselaeria* sp.? (1903, p. 178, pl. XXI, fig. 10; herein, Pl. 36, figs. 9-10) is a partially exfoliated rensselaeroid, probably a brachial valve as it is relatively flat, in which the umbonal region has been partially stripped in such a manner as to give the impression of an extra set of costellae, the specimen being generically unidentifiable. Schwarz's *Rensselaeria hottentot* (1906, p. 365, pl. VII, fig. 8; herein, Pl. 36, figs. 18-19) reassigned by Reed (1925, p. 62-63) to *Derbyina,* is a small, radially costate shell in which the median costellae are more prominent than is common in rensselaeroids except for *Derbyina,* but more information on the internal structures might show the specimen to be rhynchospiroid rather than a terebratuloid. Cloud (1942, p. 47) assigned "*R.*" *hottentot* questionably to *Nanothyris* as Schwarz's figure suggests that crural plates are present, but the plastotype shows conclusively that the figure is misleading; no internal structures are visible, and the prominent median costellae are unlike those known hitherto in any species of *Nanothyris.* Reed's *Rhynchospira?* cf. *silveti* (1903, p. 188, pl. XXIII, figs. 8-9; herein, Pl. 29, figs. 14-15), which he later (1925, p. 41) reassigned to *Derbyina,* is a generically unassignable, small, radially costate, flat shell. Reed's *Ptychospira* *variegata* (1906, p. 309, pl. XVI, fig. 7; herein, Pl. 29, fig. 13) is a small radially costate, flattish, generically unidentifiable valve in which the suggestion of strong punctation appears from the plastotype to have been exaggerated by the artist. Schwarz's *Trigeria simplex* (1906, p. 366, pl. VII, fig. 9; herein, Pl. 19, fig. 1) may be an early growth stage of *Pleurothyrella africana*. Schwarz's *Trigeria silveti* Ulrich (1906, p. 367, pl. VII, fig. 10) may be an early growth stage of *Scaphiocoelia* as suggested by its sulcate brachial valve, which if true would tend to link *Scaphiocoelia* more closely with the mutationellinids as the presence of short dental lamellae and a poorly impressed muscle field (*op. cit.*, fig. 10a) would indicate. Reed's *Rensselaeria* sp. *beta* (1903, p. 177, pl. XXI, fig. 9) appears to be an intermediate growth stage of *Pleurothyrella relicta,* as evidenced by both the cardinalia and the interior of the pedicle valve. Reed's *Trigeria* aff. *gaudryi* (1903, p. 178-179, pl. XXI, figs. 11-12) is generically unidentifiable but may be the brachial interior of *Pleurothyrella africana*. Schwarz's *Rensselaeria* sp. *beta* (1906, p. 365; herein, Pl. 29, fig. 12), assigned questionably by Reed (1925, p. 61) to *Trigeria gydoensis,* is an unidentifiable rensselaeroid which is much finer ribbed than Reed's other forms of "*R.*" sp. *beta*. Reed's *Retzia* cf. *adrieni* (1903, pl. XXIII, fig. 6; herein, Pl. 36, figs. 7-8), which was later assigned to *Derbyina hottentot?* (Reed, 1925, p. 206), is generically unassignable.

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APPENDIX

Cloudella, nom. nov. for *Pleurothyris* Cloud (Terebratuloidea)

A. J. BOUCOT AND J. G. JOHNSON

Pleurothyris Cloud, 1942, p. 123, proposed for a Lower Devonian terebratuloid genus from New Brunswick, is a homonym of *Pleurothyris* Schrammen, 1912, p. 249 (sponge) and also of *Pleurothyris* Lowe, 1843 (not seen) *fide* De Laubenfels, 1955, p. E86.

We propose *Cloudella* Boucot & Johnson, *nom. nov.* to replace *Pleurothyris* Cloud *non* Schrammen; *non* Lowe. The type species of *Cloudella* is *Rensselaeria stewarti* Clarke, 1907, New York State Mus. Bull., No. 107, p. 239, 240, 7 figs. on p. 240.

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PLATES

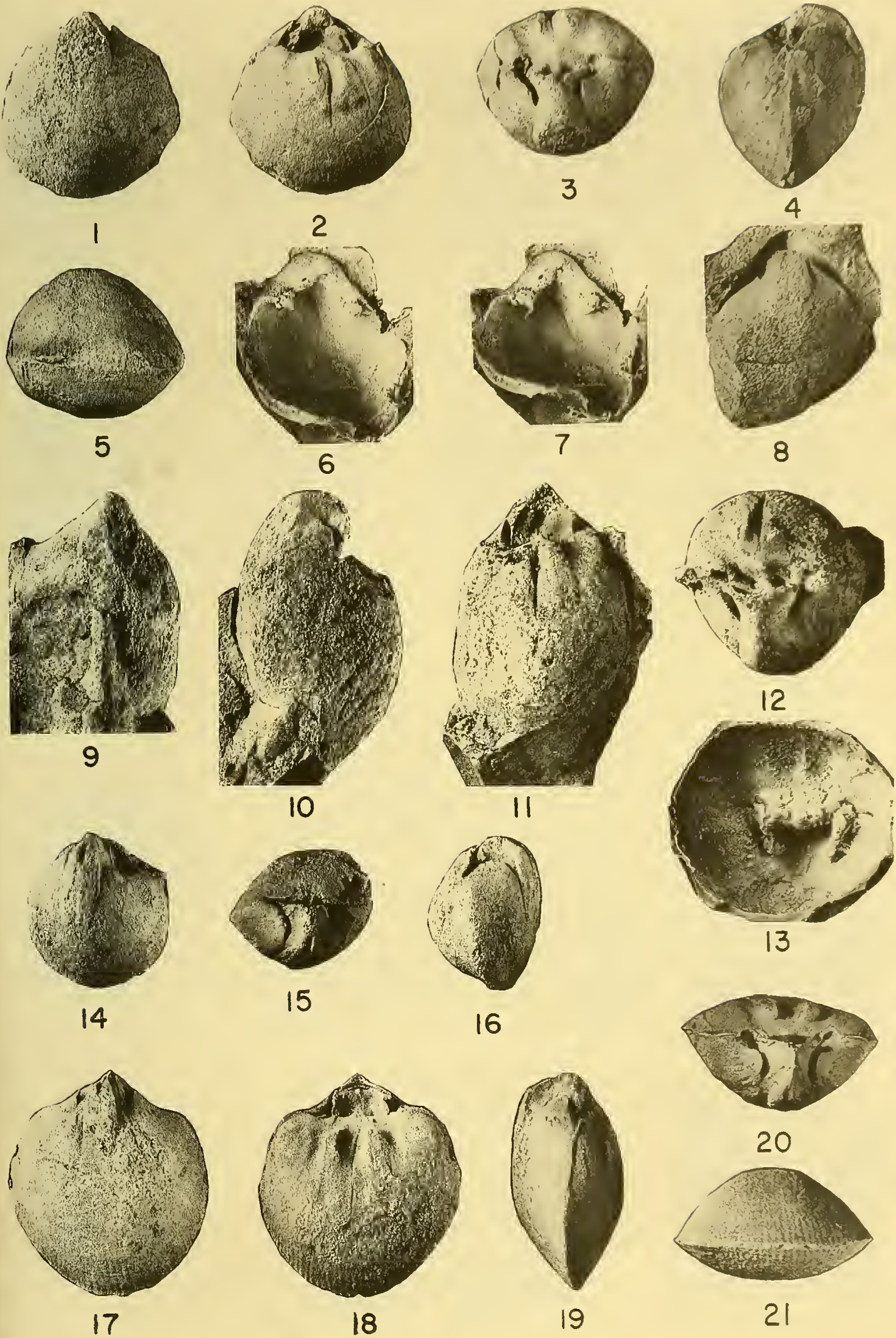
Explanation of Plate 16

Figure Page

All figures are impressions except figures 6, 7, 13; all figures × 1. UCM=Univ. of Cincinnati Museum. Engraving of figures reduced about 1/10 of measurement cited.

1-21. **Pleurothyrella africana** (Reed, 1906) 93

Bokkeveld beds, Weltvreden, Vredenhof, near Prince Albert, Cape Province, South Africa. 1. Interior, pedicle view; shows subcircular outline and obsolescent dental lamellae; UCM, No. 35651. 2. Interior, brachial view; shows impression of bulbous cardinal plate, and myophragm bisecting the adductor field which reaches the mid-length; only the peripheral region is crenulated by the impress of the external ornamentation; UCM, No. 35651. 3. Interior, posterior view shows stubby hinge teeth, obsolescent dental lamellae, and triangular cross-section of the medial pair of adductor impressions; UCM, No. 35651. 4. Interior, side view shows apparent subequal convexity of the valves due to canting of the specimen to the right; UCM, No. 35651. 5. Interior, anterior view; shows greater depth of pedicle valve (above) and rectimarginate anterior margin; UCM, No. 35651. 6. Rubber replica of pedicle valve; shows gently incurved beak; UCM, No. 35652. 7. Rubber replica of pedicle valve shows stubby hinge teeth and obsolescent dental lamellae; UCM, No. 35652. 8. Interior of pedicle valve shows obsolescent dental lamellae; UCM, No. 35652. 9. Interior, posterior view shows obsolescent dental lamellae and anteriorly directed crura; UCM, No. 35653. 10. Interior, pedicle view shows obsolescent dental lamellae; UCM, No. 35653. 11. Interior, side view shows greater depth of pedicle valve; UCM, No. 35653. 12. Interior, brachial view shows longitudinally elongate outline and myophragm bisecting adductor field which reaches about one-third the distance to anterior margin; UCM, No. 35653. 13. Rubber replica of posterior portion of interior shows obsolescent dental lamellae and stubby hinge teeth; UCM, No. 35653. 14. Interior, pedicle view shows postero-median myophragm which bisects diductor field; UCM, No. 35654. 15. Interior, posterior view shows obsolescent dental lamellae; UCM, No. 35654. 16. Interior, side view shows greater depth of pedicle valve; UCM, No. 35654. 17. Interior, pedicle view shows peripheral crenulation and obsolescent dental lamellae; UCM, No. 35655. 18. Interior, brachial view shows sealed-off foramen in the cardinal plate and long myophragm bisecting the adductor field; UCM, No. 35655. 19. Interior, side view shows the greater depth of pedicle valve; UCM, No. 35655. 20. Interior, posterior view shows obsolescent dental lamellae, stubby hinge teeth, and narrow median adductor impressions medially bisected by a low myophragm; UCM No. 35655. 21. Interior, anterior view; shows rectimarginate, crenulate anterior margin (pedicle valve above); UCM, No. 35655.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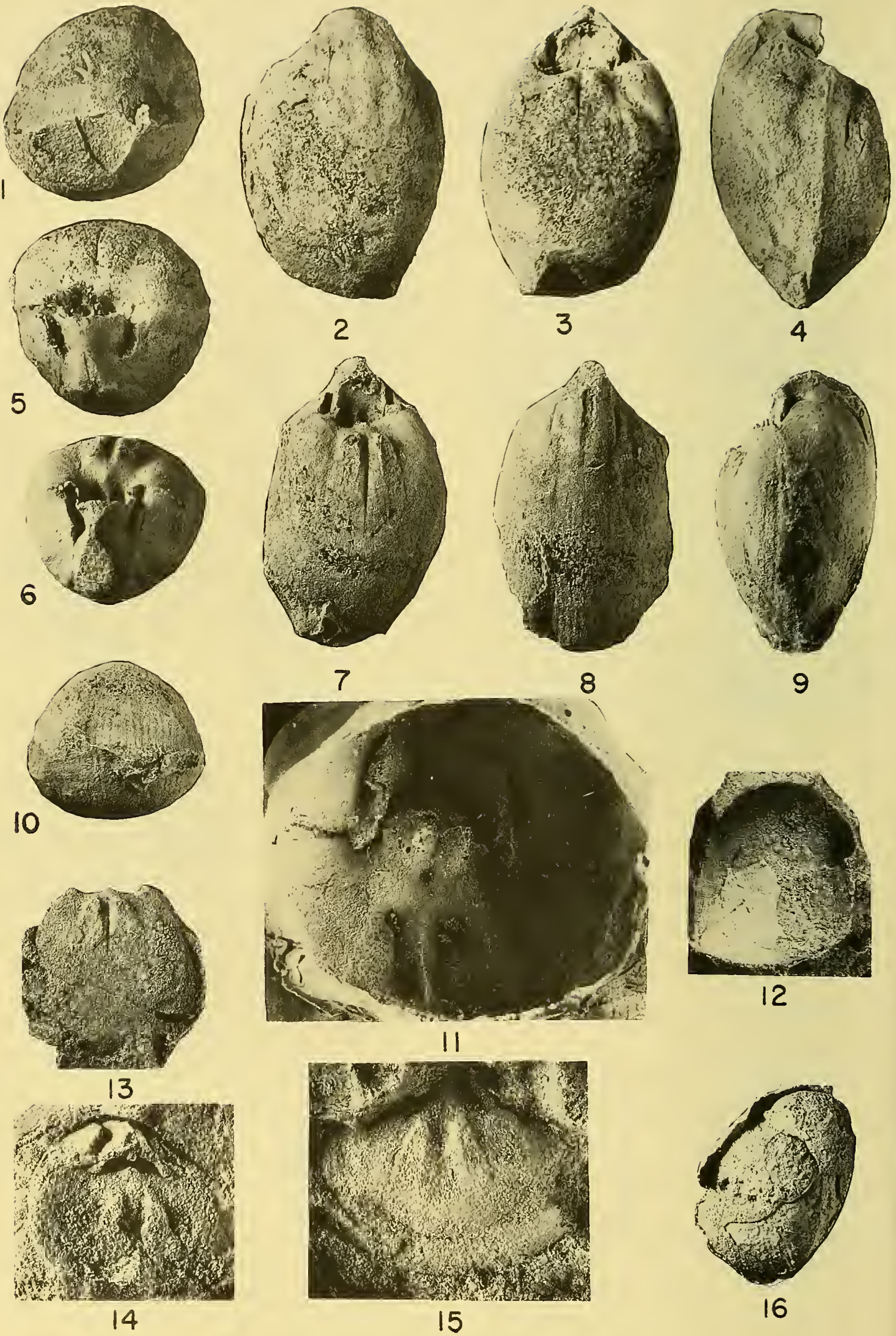
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Explanation of Plate 17

Figure Page

All figures are impressions except figures 11, 16; all are × 1 except figure 11, 14, 15. Engraving of figures reduced about 1/10 of measurement cited.

1-16. **Pleurothyrella africana** (Reed, 1906) 93

Bokkeveld beds, Weltvreden, Vredenhof, near Prince Albert, Cape Province, South Africa. 1. Interior, anterior view shows greater depth of pedicle valve (above); UCM, No. 35657. 2. Interior, pedicle view shows almost obsolete dental lamellae; UCM, No. 35657. 3. Interior, brachial view shows impression of bulbous cardinal plate and posterior slit for cardinal process; UCM, No. 35657. 4. Interior, side view shows greater depth of pedicle valve; UCM, No. 35657. 5. Interior, posterior view shows relatively weakly impressed adductor field in brachial valve; UCM, No. 35657. 6. Interior, posterior view shows obsolescent dental lamellae and stubby hinge teeth; UCM, No. 35656. 7. Interior, brachial view shows impression of bulbous cardinal plate, and myophragm bisecting the adductor field, which extends to about the midlength; UCM, No. 35656. 8. Interior, pedicle view shows peripheral crenulation due to impress of external ornamentation; UCM, No. 35656. 9. Interior, side view shows greater depth of pedicle valve and profile posteriorly of brachial adductor field; UCM, No. 35656. 10. Interior, anterior view shows greater depth of pedicle valve (above); UCM, No. 35656. 11. Rubber replica of posterior portion of interior, × 2; shows obsolescent dental lamellae, sealed-off foramen below the sessile cardinal plate, and triangular cross-section of medial adductor impressions; UCM, No. 35656. 12. Posterior portion of exterior, shows how umbonal region of brachial valve is directed under that of pedicle valve; UCM, No. 35665. 13. Interior, brachial view shows two pairs of longitudinally elongate adductor impressions medially bisected by a myophragm; UCM, No. 35666. 14. Interior, brachial view, × 2; shows foramen filling and absence of crural plates; UCM, No. 35667. 15. Interior, brachial view, × 2; shows foramen in cardinal plate; UCM, No. 35668. 16. Rubber replica of posterior portion of exterior, shows incurved beak of pedicle valve; UCM, No. 35665.

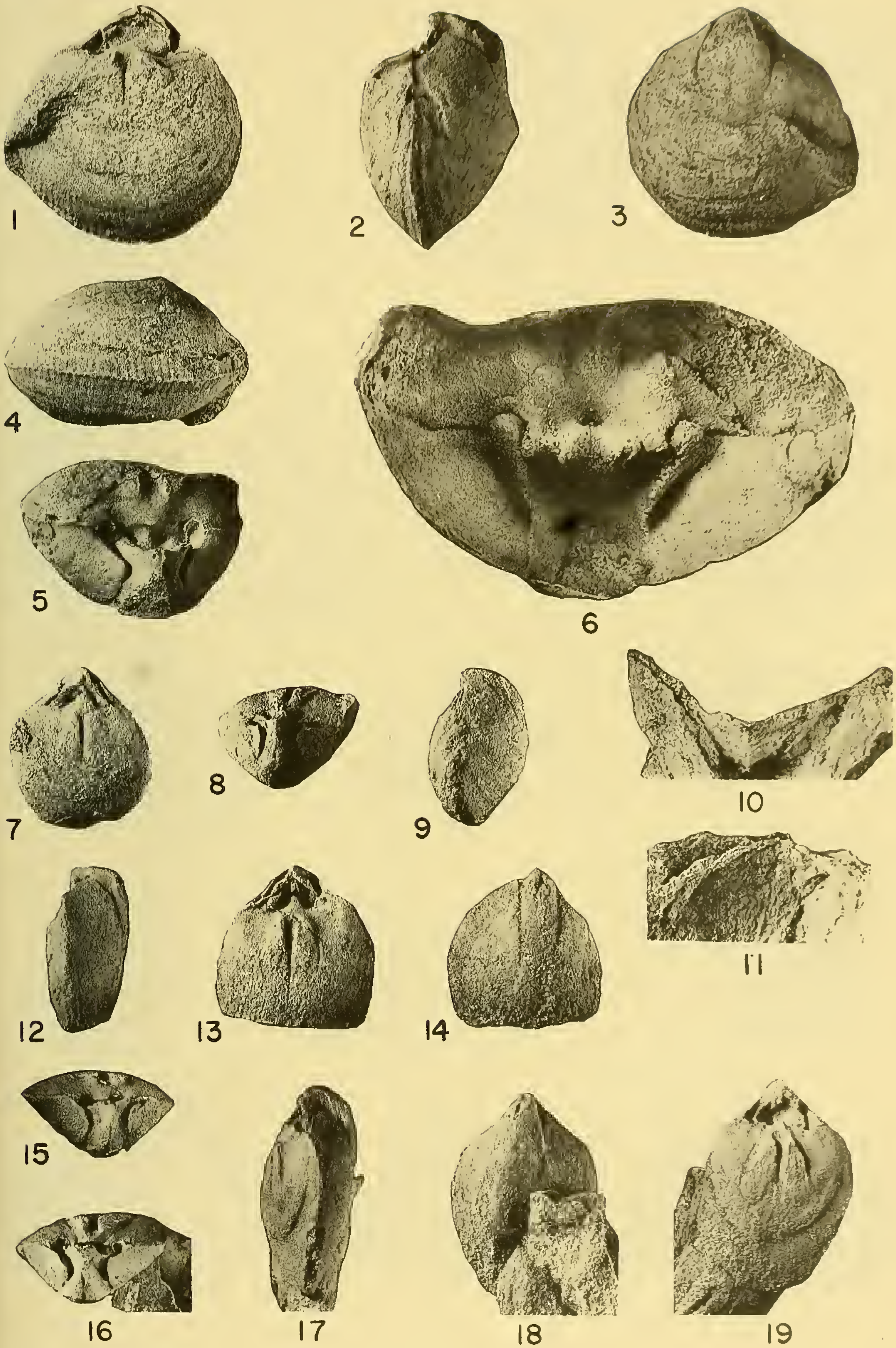
Explanation of Plate 18

Figure | Page

All figures are impressions; all are × 1 except figure 6. Engraving of figures reduced about 1/10 of measurement cited.

1-19. **Pleurothyrella africana** (Reed, 1906) 93

Bokkeveld beds, Weltvreden, Vredenhof, near Prince Albert, Cape Province, South Africa. 1. Interior brachial view shows impression of bulbous cardinal plate, relatively short myophragm bisecting adductor field. 2. Interior side view shows greater depth of pedicle valve. 3. Interior pedicle view shows subcircular outline, obsolescent dental lamellae. 4. Interior anterior view shows rectimarginate, crenulate anterior margin. 5. Interior posterior view shows stubby hinge teeth, anteriorly directed crura. 6. Interior posterior view (rubber replica), × 2, shows obsolescent dental lamellae, stubby hinge teeth. Figs. 1-6, UCM, No. 35659. 7. Interior brachial view shows foramen in cardinal plate. 8. Interior posterior view shows obsolescent dental lamellae. 9. Interior side view shows greater depth of pedicle valve. Figs. 7-9, UCM, No. 35660. 10. Exterior beak region shows strongly incurved pedicle beak. 11. Exterior beak region (rubber replica) shows narrow brachial palintrope. Figs. 10-11, UCM, No. 35658. 12. Interior side view shows greater depth of pedicle valve. 13. Interior brachial view shows foramen in cardinal plate. 14. Interior pedicle view shows obsolescent dental lamellae. 15. Interior posterior view shows obsolescent dental lamellae. Figs. 12-15, UCM, No. 35661. 16. Interior posterior view shows obsolescent dental lamellae, stubby hinge teeth. 17. Interior side view shows obsolescent dental lamellae, secondary deposits in umbonal cavities. 18. Interior pedicle view shows obsolescent dental lamellae. 19. Interior brachial view shows peripheral crenulations, longitudinally elongate outline. Figs. 16-19, UCM, No. 35662.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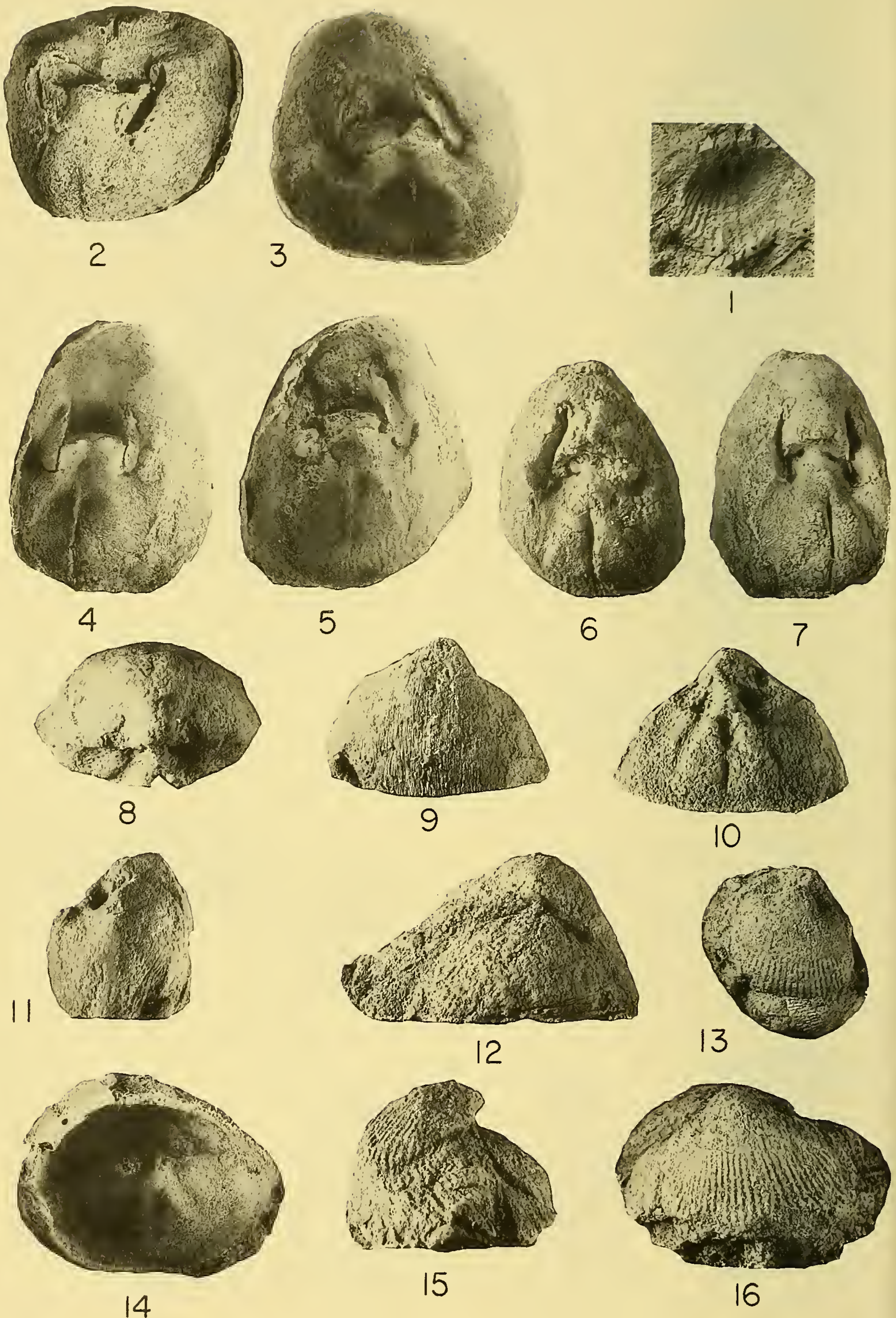


Explanation of Plate 19

Figure Page

All specimens from Bokkeveld beds. Engraving of figures reduced about 1/10 of measurement cited.

1. **Pleurothyrella?, simplex** (Schwarz, 1906) 121

Gydo Pass, Ceres, South Africa. 1. Interior brachial view (rubber replica), × 2, showing plication density, well-impressed adductor field; Albany Mus., No. 2589 (pl. 7, fig. 9, Schwarz, 1906).

2-16. **Pleurothyrella africana** (Reed, 1906) 93

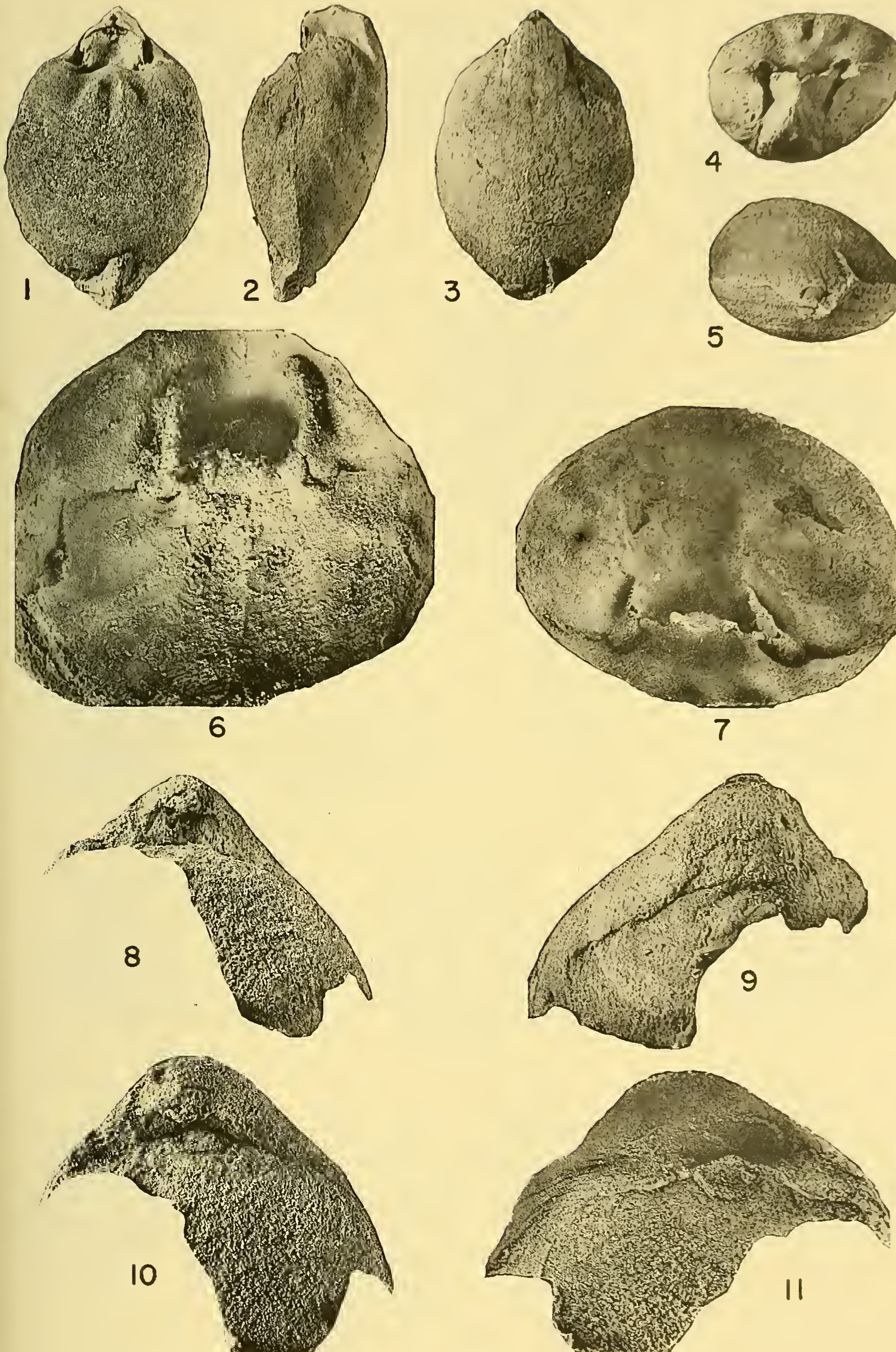
2. Internal posterior impression (plaster replica), × 1, shows obsolescent dental lamellae, stout hinge teeth; S. African Mus., No. 607 (unfigured specimen from Reed, 1906, p. 306-308); Gouritz River, N. of the Langebergen, South Africa. 3. Interior posterior view (rubber replica), × 1, shows prominent myophragm bisecting brachial muscle field, relatively bulbous cardinal plate; same specimen as fig. 2. 4. Interior posterior view (rubber replica), × 1, shows prominent myophragm bisecting brachial muscle field, pit at base of cardinal plate marking position of foramen, bulbous cardinal plate, short crural bases, stout dental lamellae supporting stubby hinge teeth, relative shortness of dental lamellae; S. African Mus., No. 607 (unfigured specimen from Reed, 1906, p. 306-308); foothills N. of the Langebergen, South Africa. 5. Interior posterior view (rubber replica), × 1, shows prominent myophragm bisecting brachial muscle field, short dental lamellae supporting stout hinge tooth; same locality and catalog number as specimen in fig. 4. 6. Internal posterior impression (plaster replica), × 1, shows form of brachial adductor field, pronounced myophragm; same specimen as fig. 5. 7. Internal posterior impression (plaster cast), × 1, shows prominent brachial myophragm, obsolescent dental lamellae in pedicle valve; same specimen as fig. 4. 8. Internal posterior impression (plaster cast), × 2, shows obsolescent dental lamellae, relative valve depths. 9. Internal pedicle impression (plaster cast), × 2, shows deeply impressed muscle field. 10 Internal brachial impression (plaster cast), × 2, shows discrete hinge plates separated by well-defined trough, large myophragm. 11. Internal side impression (plaster cast), × 2, shows depth of brachial adductor impressions. Figures 8-11, 14, S. African Mus., No. 606 (Reed's *Rensselaeria montaguensis pars,* 1925, p. 59, which is a medium-sized specimen of *Pleurothyrella africana*); Uniondale, South Africa. 12. Exterior brachial view (plaster cast), × 2, shows form of palintrope. 13. Interior pedicle view (plaster cast), × 1, shows size of costellae; S. African Mus., No. 605 (Reed's *Rensselaeria* cf. *confluentina* Fuchs, 1906, Pl. 16, figs. 6, 6a, which is a medium-sized specimen of *Pleurothyrella africana*); Gouritz River, South Africa. 14. Interior posterior view (rubber replica), × 2, shows discrete hinge plates, median trough, well-developed myophragm. 15. Exterior side view (plaster cast), × 2, shows incurved pedicle beak. 16. Exterior pedicle view (plaster cast), × 2, shows form and size of costellae. Figs. 12, 15-16, S. African Mus., No. 1610 (Reed's *Rensselaeria montaguensis pars,* 1908, pl. 21, figs. 5, 5a, which is a medium-sized specimen of *Pleurothyrella africana*); Montagu, South Africa.

Explanation of Plate 20

Engraving of figures reduced about 1/10 of measurement cited.

Figure		Page
1-11.	**Pleurothyrella africana** (Reed, 1906)	93

Bokkeveld beds, Weltvreden, Vredenhof, near Prince Albert, Cape Province, South Africa. 1. Interior brachial view, shows longitudinally elongate outline, slit on posterior portion of cardinal plate for cardinal process. 2. Impression of interior, side view, shows greater pedicle depth, deeply impressed pedicle muscle field emphasized by secondary deposits in umbonal cavities. 3. Impression of interior, pedicle view, shows obsolescent dental lamellae, postero-medially divided diductor field. 4. Impression of interior, posterior view, shows stubby hinge teeth, obsolescent dental lamellae. 5. Impression of interior, anterior view, pedicle valve above, shows rectimarginate, crenulate anterior margin. 6. Posterior portion of interior (rubber replica), shows cardinal process at back of notothyrial cavity. 7. Posterior portion of interior (rubber replica), shows obsolescent dental lamellae, stubby hinge teeth. 8. Exterior brachial view (rubber replica) shows relatively large deltidial plates and large foramen between them. 9. Exterior pedicle view (rubber replica). 10. Exterior brachial view (rubber replica). 11. Impression of beak region. Figs. 1-5, $\times$ 1; figs. 6-11, $\times$ 2, Figs. 1-7, UCM, No. 35663; figs. 8-11, UCM, No. 35664.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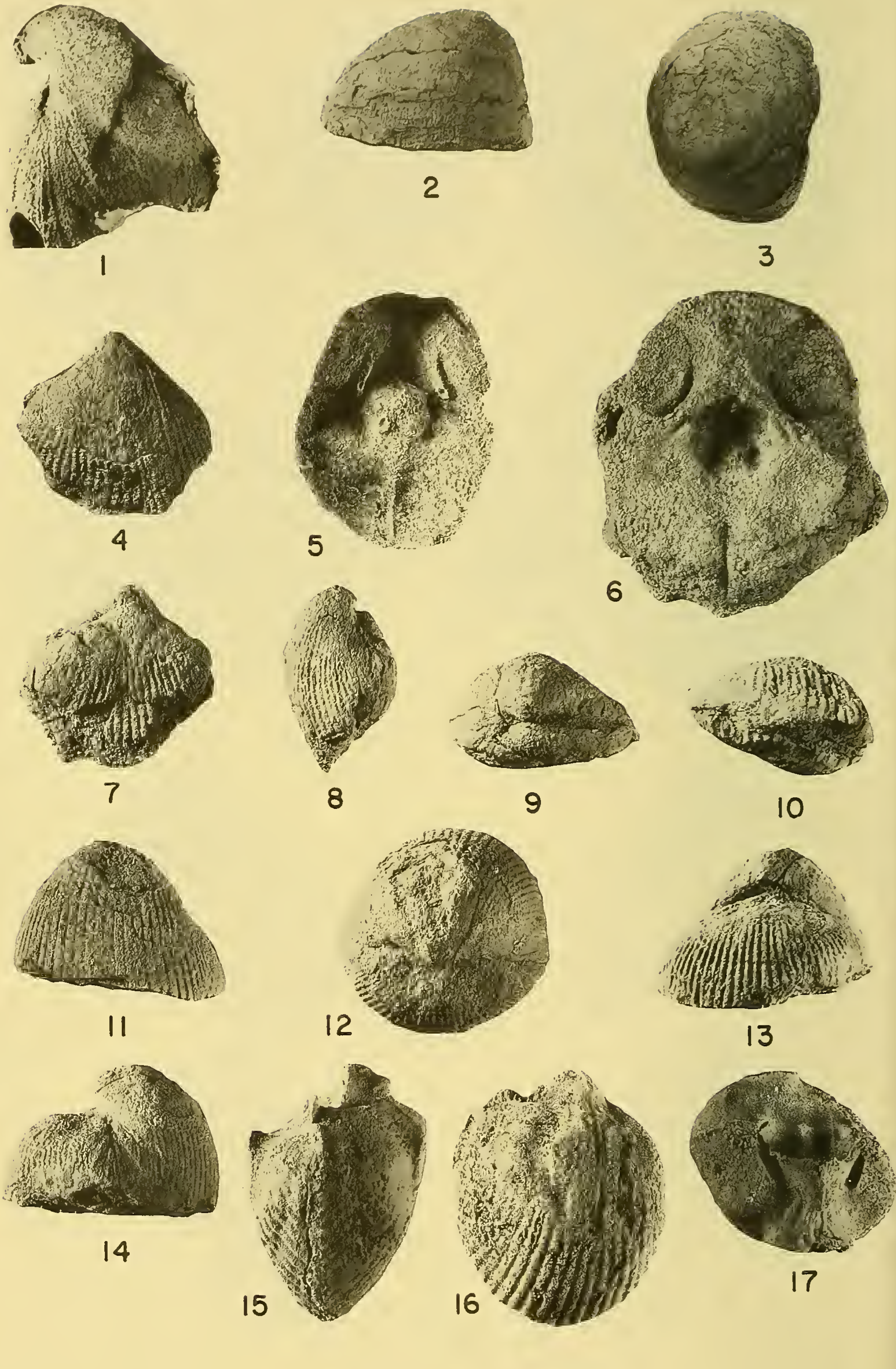
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Explanation of Plate 21

Engraving of figures reduced about 1/10 of measurement cited.

Figure Page

USNM = U. S. National Museum

1. **Pleurothyrella africana** (Reed, 1906) 93

Bokkeveld beds, Weltvreden, Vredenhof, near Prince Albert, Cape Province, South Africa. 1. Exterior side view (rubber replica), × 2, shows incurved pedicle beak; UCM, No. 35664.

2-3. Inarticulate brachiopod 81

Horlick formation, Horlick Mountains, Antarctica. 2. Side view of exfoliated exterior, × 1. 3. Top view of exfoliated exterior, × 1, Both USNM, No. 137741.

4-17. **Pleurothyrella antarctica,** sp. nov. 95

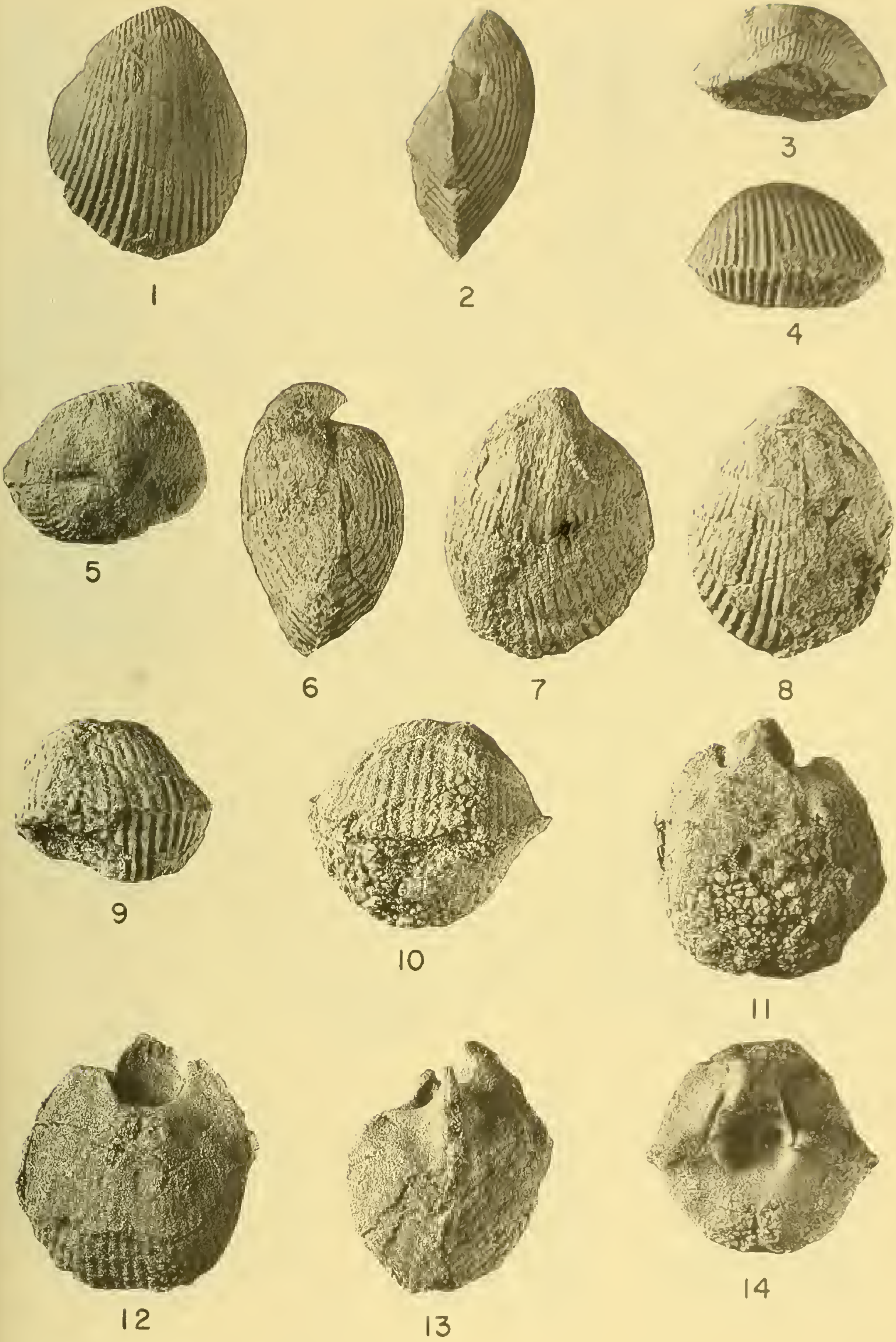
Horlick formation, Horlick Mountains, Antarctica. 4. Partially exfoliated pedicle exterior shows subcircular outline, coarse costellae. 5. Posterior portion of interior (rubber replica) shows bulbous, sessile cardinal plate, anteriorly directed crura, obsolescent dental lamellae. 6. Interior impression, posterior view, shows impression of bulbous cardinal process, anteriorly directed crura, myophragm bisecting brachial adductor field, obsolescent dental lamellae. 7. Partially exfoliated brachial exterior shows gently incurved pedicle beak, subcircular outline. 8. Partially exfoliated exterior, side view, shows greater depth of pedicle valve (to the left), presence of costellae on umbo. 9. Partially exfoliated exterior, posterior view, shows greater depth of pedicle valve (pedicle valve above). 10. Partially exfoliated exterior, side view, shows rectimarginate anterior margin (specimen slightly crushed). 11. Partially exfoliated pedicle exterior shows costellae on umbo. 12. Partially exfoliated exterior, posterior view, shows greater depth of pedicle valve (pedicle valve above). 13. Partially exfoliated brachial exterior shows costellate umbo. 14. Partially exfoliated exterior, side view, shows gently incurved pedicle beak. 15. Interior impression, side view, shows greater depth of pedicle valve, deeply impressed posterior portions of muscle field in both valves. 16. Interior impression, pedicle view, shows longitudinally elongate outline, coarse costellae, posteriorly deeply impressed muscle field. 17. Interior impression, posterior view, shows greater depth of pedicle valve (above), obsolescent dental lamellae. Figs. 4-17 all × 1. Figs. 4, 7-10, USNM, No. 137740b; figs. 5-6, USNM, No. 137740a; figs. 11-14, USNM, No. 137742; figs. 15-17, USNM, No. 137743.

Explanation of Plate 22

Engraving of figures reduced about 1/10 of measurement cited.

Figure		Page
1-14.	**Pleurothyrella antarctica,** sp. nov.	95

Horlick formation, Horlick Mountains, Antarctica. 1. Impression of pedicle interior shows relatively strong, unbranched costellae. 2. Interior impression, side view, shows greater depth of pedicle valve (to the right). 3. Interior impression, posterior view, shows costellate umbo. 4. Interior impression, anterior view, shows rectimarginate, crenulate anterior margin. 5. Partially exfoliated exterior, posterior view, shows incurved pedicle beak. 6. Partially exfoliated exterior, side view, shows gently incurved pedicle umbo. 7. Partially exfoliated pedicle exterior, shows relatively coarse costellae. 8. Partially exfoliated brachial exterior shows costellate umbo. 9. Interior impression, anterior view, shows greater depth of pedicle valve (above), rectimarginate crenulate anterior margin. 10. Interior impression, anterior view, shows relatively coarse costellae. 11. Interior impression, pedicle view, shows subcircular shell outline. 12. Interior impression, brachial view, shows impression of bulbous cardinal plate. 13. Interior impression, side view, shows subequal depth of two valves. 14. Interior impression, posterior view, shows anteriorly directed crura, obsolescent dental lamellae. All Figs. × 1. Figs. 1-4, USNM, No. 137744; figs. 5-9, USNM, No. 137745; figs. 10-14, USNM, No. 137746 (holotype).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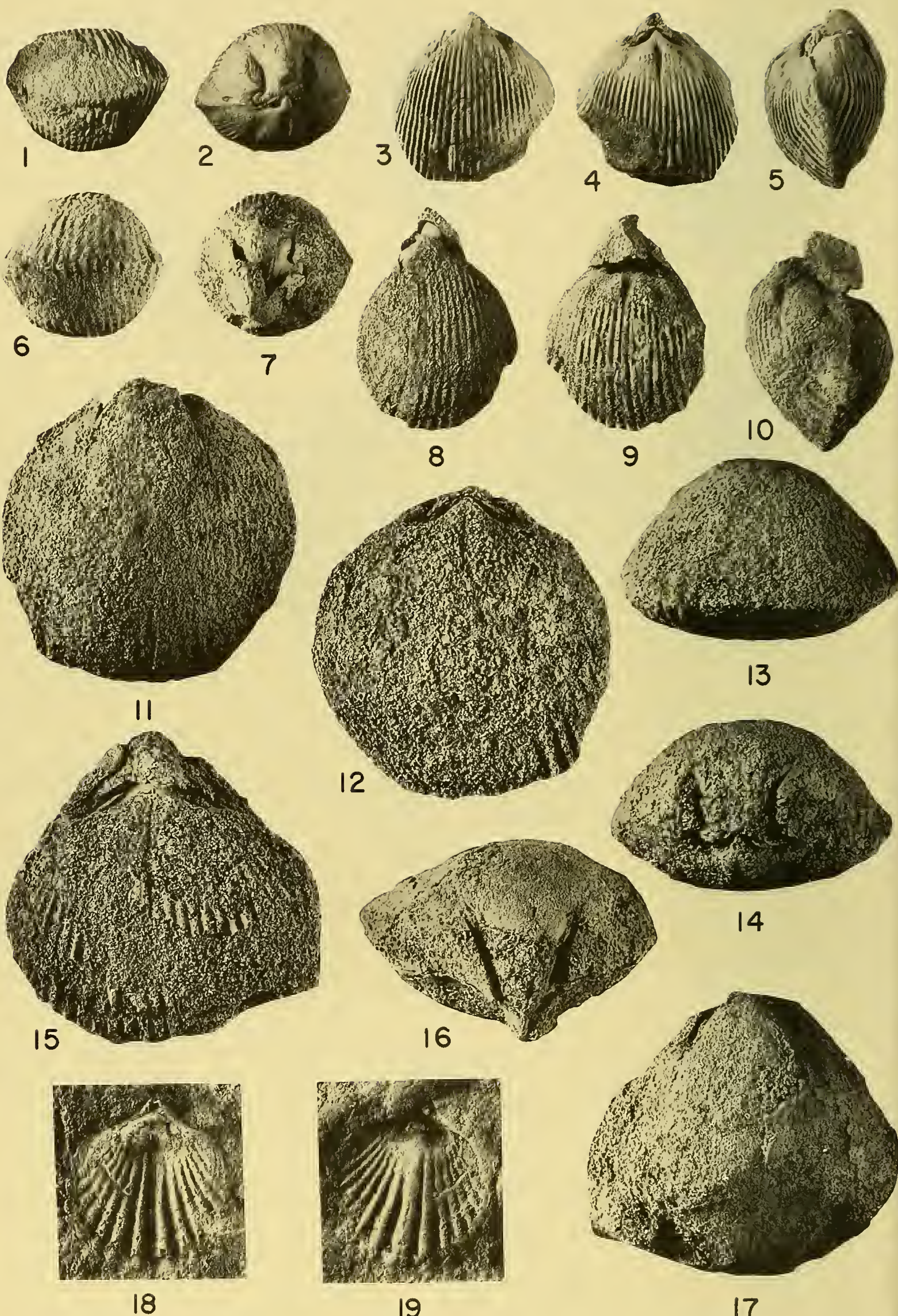
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Explanation of Plate 23

Figure | Page

UCMP = Univ. of California Museum of Paleontology

Engraving of figures reduced about 1/10 of measurement cited.

1-17. **Pleurothyrella antarctica,** sp. nov. 95

Horlick formation, Horlick Mountains, Antarctica. 1. Interior impression, anterior view, × 2; apparent curvature of commissure is due to breakage of anteriormost portion of steinkern. 2. Posterior view, interior impression, × 1, shows filling of trough between hinge plates and short dental lamellae. 3. Impression of pedicle interior, × 1, shows short dental lamellae, relatively coarse costellae, poorly impressed muscle field. 4. Impression of brachial interior, × 1, shows prominent myophragm dividing adductor field. 5. Interior impression, side view, × 1, shows greater depth of pedicle valve. 6. Interior impression, anterior view, × 1, shows rectimarginate commissure. 7. Interior impression, posterior view, × 1, shows relatively short dental lamellae. 8. Impression of pedicle interior, × 1, shows relatively coarse costellae. 9. Impression of brachial interior, × 1, shows myophragm dividing weakly impressed adductor field. 10. Interior impression, side view, × 1, shows relative depth of valves. 11. Impression of pedicle interior, × 2, shows relatively short dental lamellae, weakly impressed muscle field. 12. Impression of brachial interior, × 2, shows weakly impressed myophragm, subcircular outline. 13. Interior impression, anterior view, × 2, shows greater depth of pedicle valve, rectimarginate commissure. 14. Interior impression, posterior view, × 2, shows short dental lamellae, discrete hinge plates. 15. Impression of brachial interior, × 2, shows relatively coarse costellae, weakly impressed myophragm. 16. Interior impression, posterior view, × 2, shows relatively short dental lamellae. 17. Impression of pedicle interior, × 2, shows weakly impressed muscle field. Figs. 1-5, UCMP, No. 30743; figs. 6-10, UCMP, No. 30745; figs. 11-14, UCMP, No. 30748; figs. 15-17, UCMP, No. 30744.

18-19. Unidentified terebratuloid or rhynchospirid 120

Bokkeveld beds, Hottentot's Kloof, Ceres, South Africa. 18. Brachial exterior (rubber replica), × 3, shows prominent medial costellae. 19. Brachial exterior (plaster cast) × 3, shows prominent median interspace. Both Albany Mus., No. 2578 (Schwarz's *"Rensselaeria" hottentot,* 1906, pl. VII, fig. 8).

Explanation of Plate 24

Figure Page

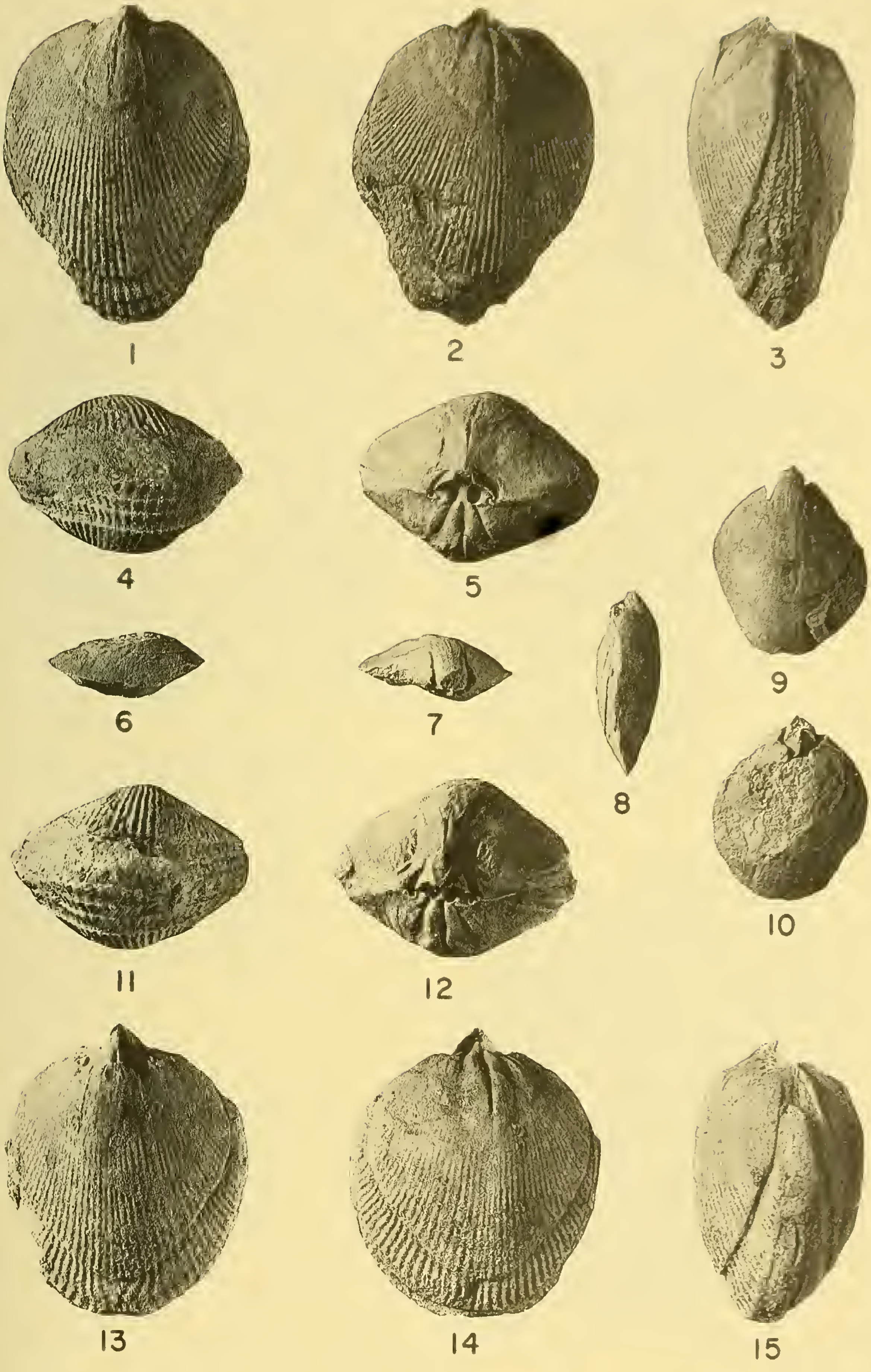
All figures × 1. Engraving of figures reduced to about 1/10 of measurement cited.

1-5, 11-15. **Pleurothyrella knodi** (Clarke, 1913) 98

Lower part of Icla beds, Totora, Bolivia. 1. Impression of pedicle interior, shows impress of radial ornamentation peripherally, strong growth lines, elongate valve outline, smooth umbonal region, longitudinally elongate diductor field posteriorly bisected by short myophragm. 2. Impression of brachial interior, shows smooth umbonal region, relatively long median myophragm, short lateral myophragm. 3. Interior impression, side view, shows deeply impressed pedicle muscle field, greater depth of pedicle valve. 4. Interior impression, anterior view, shows rectimarginate, crenulate anterior margin. 5. Interior impression, posterior view, shows short crural bases, slit for cardinal process, relatively strong median myophragm, lateral myophragms which laterally bound and medially bisect brachial adductor field, almost obsolescent dental lamellae and short myophragm of pedicle valve. Figs. 1-5, Coll. Geol. Sorbonne, 58.007. 11. Interior impression, anterior view, shows rectimarginate crenulate anterior margin. 12. Interior impression, posterior view, shows greater depth of pedicle valve (above), obsolescent dental lamellae. 13. Impression of pedicle interior shows longitudinally elongate outline. 14. Impression of brachial interior shows medium-sized costellae, myophragm extending only about one-third distance to anterior margin. 15. Interior impression shows strong concentric growth lines, posteriorly weakly impressed muscle field of pedicle valve (to left). Figs. 11-15, Coll. Geol. Sorbonne, 58.005; lectotype.

6-10. **Cryptonella?** sp. 117

Lower part of Icla beds, Totora, Bolivia. 6. Interior impression, anterior view, shows rectimarginate anterior margin (brachial valve above, valve slightly canted downward). 7. Interior impression, posterior view, shows short dental lamellae. 8. Interior impression, side view, shows greater depth of pedicle valve (to right). 9. Impression of pedicle interior shows impress of concentric growth lines. 10. Impression of brachial interior shows concave cardinal plate. Figs. 6-10, Coll. Geol. Sorbonne, 58.010.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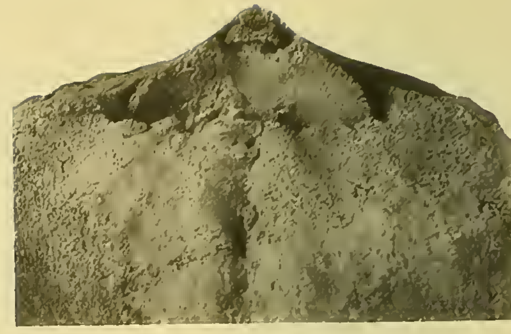
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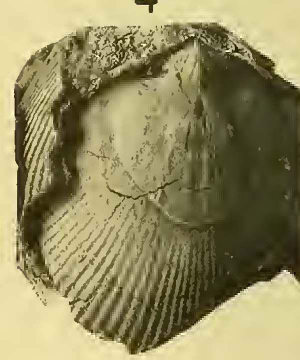
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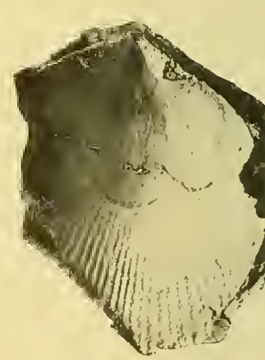
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Explanation of Plate 25

Figure — Page

1-7. **Pleurothyrella knodi** (Clarke, 1913) 98

Lower part of Icla beds, Totora, Bolivia. 1. Impression of pedicle interior, × 1, shows strong peripheral impress of external ornamentation, short, posteriorly situated myophragm, longitudinally elongate diductor field. 2. Impression of brachial interior, × 3, shows elliptical slit occupied by cardinal process. 3. Impression of brachial interior, × 2, shows elliptical slit occupied by cardinal process, relatively flat cardinal plate. 4. Interior posterior view (rubber replica), × 3, shows posteriorly situated, scoop-shaped cardinal process on broad cardinal plate, almost obsolescent dental lamellae, myophragm bisecting adductor field medially. 5. Interior impression, posterior view, × 3, shows elliptical slit left by solution of cardinal process, short myophragm bisecting brachial adductor field (above), similar structure bisecting pedicle diductor field. 6. Impression of pedicle interior, × 1, shows nearly obsolescent dental lamellae, elongate, paired diductor impressions posteriorly separated by short myophragm, elongate adjustor pit, open delthyrium. 7. Pedicle interior (rubber replica), × 1, shows obsolescent dental lamellae, smooth umbonal region, open delthyrium, short, posteriorly situated myophragm. Figs. 1-5, Coll. Geol. Sorbonne, 58.009; figs. 6-7, Coll. Geol. Sorbonne, 58.006.

Explanation of Plate 26

Engraving of figures reduced about 1/10 of measurement cited.

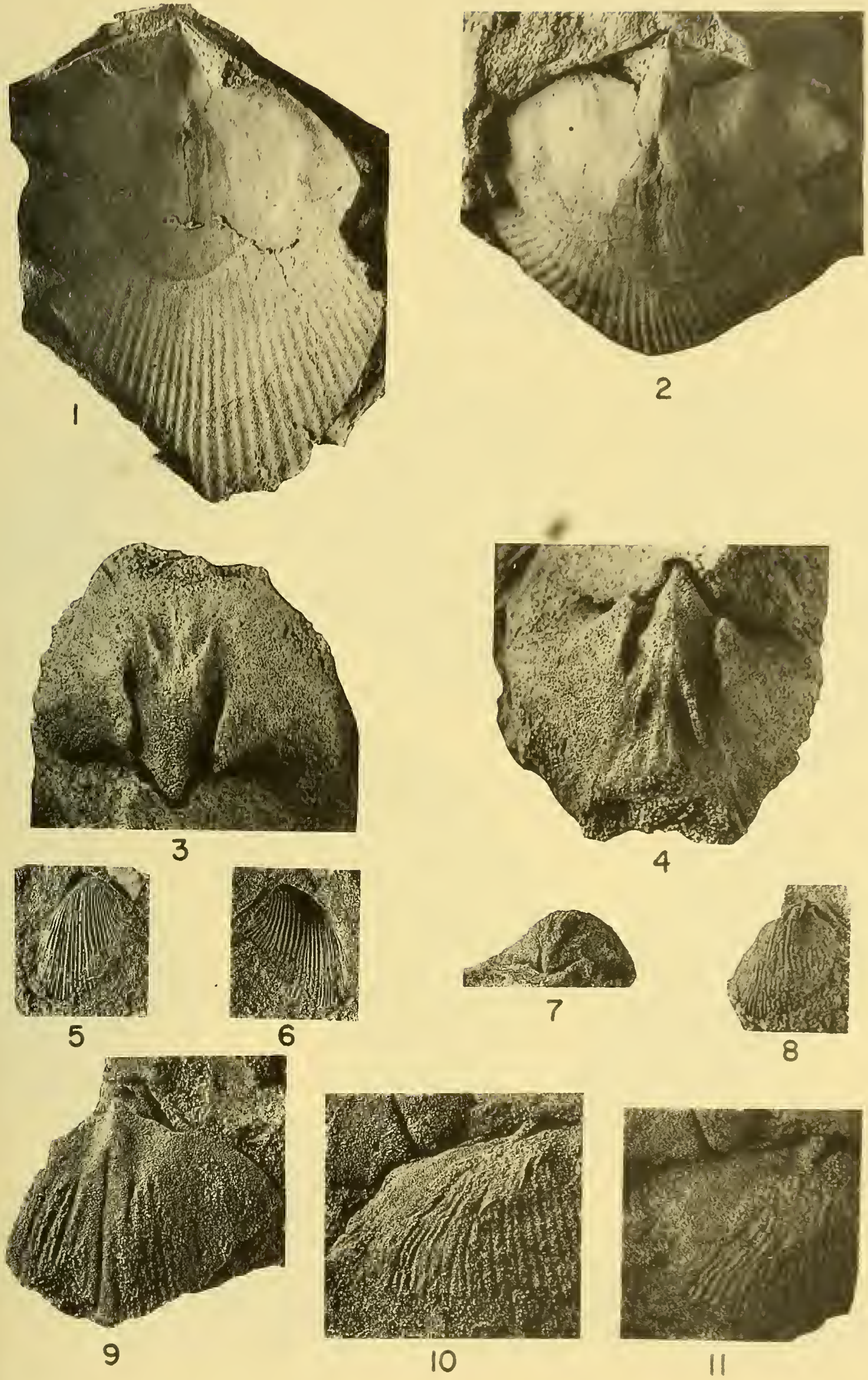
Figure — Page

1-2. **Pleurothyrella knodi** (Clarke, 1913) 98

Lower part of Icla beds, Totora, Bolivia. 1. Pedicle interior (rubber replica), × 2, shows obsolescent dental lamellae, smooth umbonal region, open delthyrium, short, posteriorly situated myophragm. 2. Pedicle interior, × 2, shows almost completely obsolescent dental lamellae, elongate paired diductor impressions posteriorly separated by short myophragm, elongate adductor pit, open delthyrium. Both Coll. Geol. Sorbonne, 58.006.

3-11. **Pleurothyrella venusta,** sp. nov. 100

Lower quartzite of Reefton beds, loose boulders in Lankey Creek, Reefton, New Zealand. 3. Impression of pedicle interior, posterior view, × 3, shows obsolescent dental lamellae; USNM, No. 137751. 4. Impression of pedicle interior, posterior view, × 3, shows obsolescent dental lamellae; USNM, No. 137751. 5. Pedicle exterior (rubber replica), × 1, shows bifurcating costellae, costellate umbonal region; USNM, No. 137752. 6. Impression of pedicle exterior, × 1, shows bifurcating costellae; USNM, No. 137752A. 7. Impression of pedicle interior, posterior view. × 1, shows strongly impressed muscle field; USNM, No. 137752B. 8. Impression of pedicle interior, × 1, shows obsolescent dental lamellae; USNM, No. 137752B. 9. Impression of brachial interior, × 2, shows foramen filling, myophragm subdividing muscle field; USNM, No. 137749. 10. Impression of brachial interior, × 2, shows foramen filling, weakly impressed muscle field; USNM, No. 137753. 11. Impression of brachial interior, × 2, shows foramen filling; USNM, No. 137753.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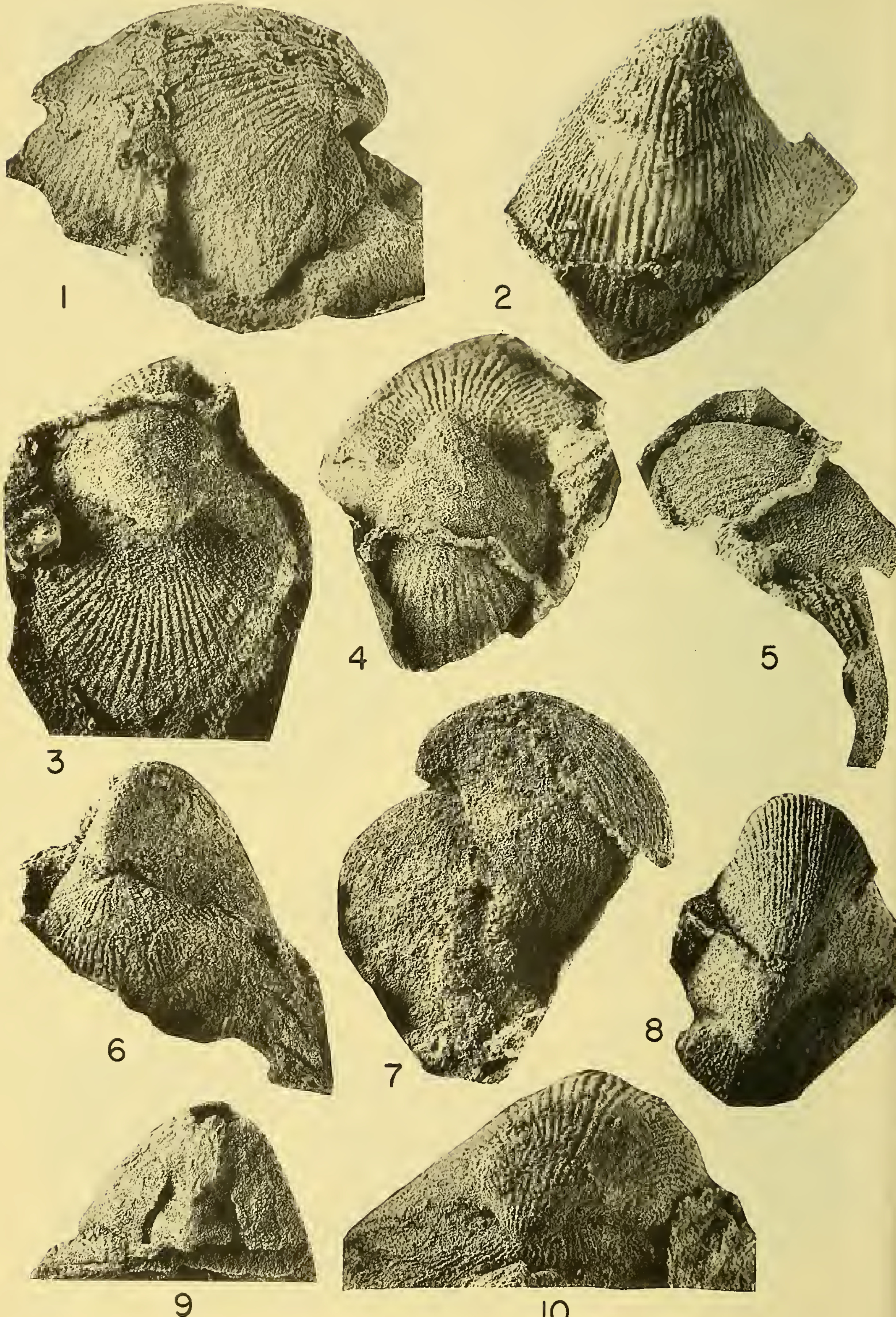
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Explanation of Plate 27

Figure		Page
	All figures are × 2. Engraving of figures reduced about 1/10 of measurement cited.	
	NZGS = New Zealand Geological Survey	
1-8, 10.	**Pleurothyrella venusta,** sp. nov.	100
	Stoney Creek, Reefton, New Zealand; boulders from quartzite below mudstone (collected by C. A. Fleming, Aug. 1956). Sheet District, S38, Grid. Ref. 363252, Sheet Fossil Loc. No. S38/619, Coll. No. GS 6737. 1. Exterior, side view (rubber replica) ; NZGS, No. BR1123. 2. Pedicle exterior (rubber replica), NZGS, No. BR1123, shows bifurcating plications. 3. Brachial exterior (rubber replica) ; NZGS, No. BR1125. 4. Exterior (rubber replica), posterior view; NZGS, No. BR1125. 5. Exterior (rubber replica), side view, NZGS, No. BR1125, shows incurved beak of pedicle valve. 6. Brachial exterior (rubber replica), NZGS, No. BR1124, shows bifurcating plications. 7. Exterior (rubber replica), side view, NZGS, No. BR1124, shows incurved beak of pedicle valve. 8. Exterior (rubber replica), posterior view; NZGS, No. BR1124. 10. Exterior (rubber replica), posterior view; NZGS, No. BR1123.	
9.	**Pleurothyrella venusta,** sp. nov.	100
	Reefton beds, loose boulders, Lankey Creek, Reefton, New Zealand. 9. Impression of pedicle interior, posterior view, shows obsolescent dental lamellae; USNM, No. 137750.	

Explanation of Plate 28

Figure | Page

CB = Canterbury Museum

Engraving of figures reduced about 1/10 of measurement cited.

1. **Pleurothyrella venusta,** sp. nov. 100

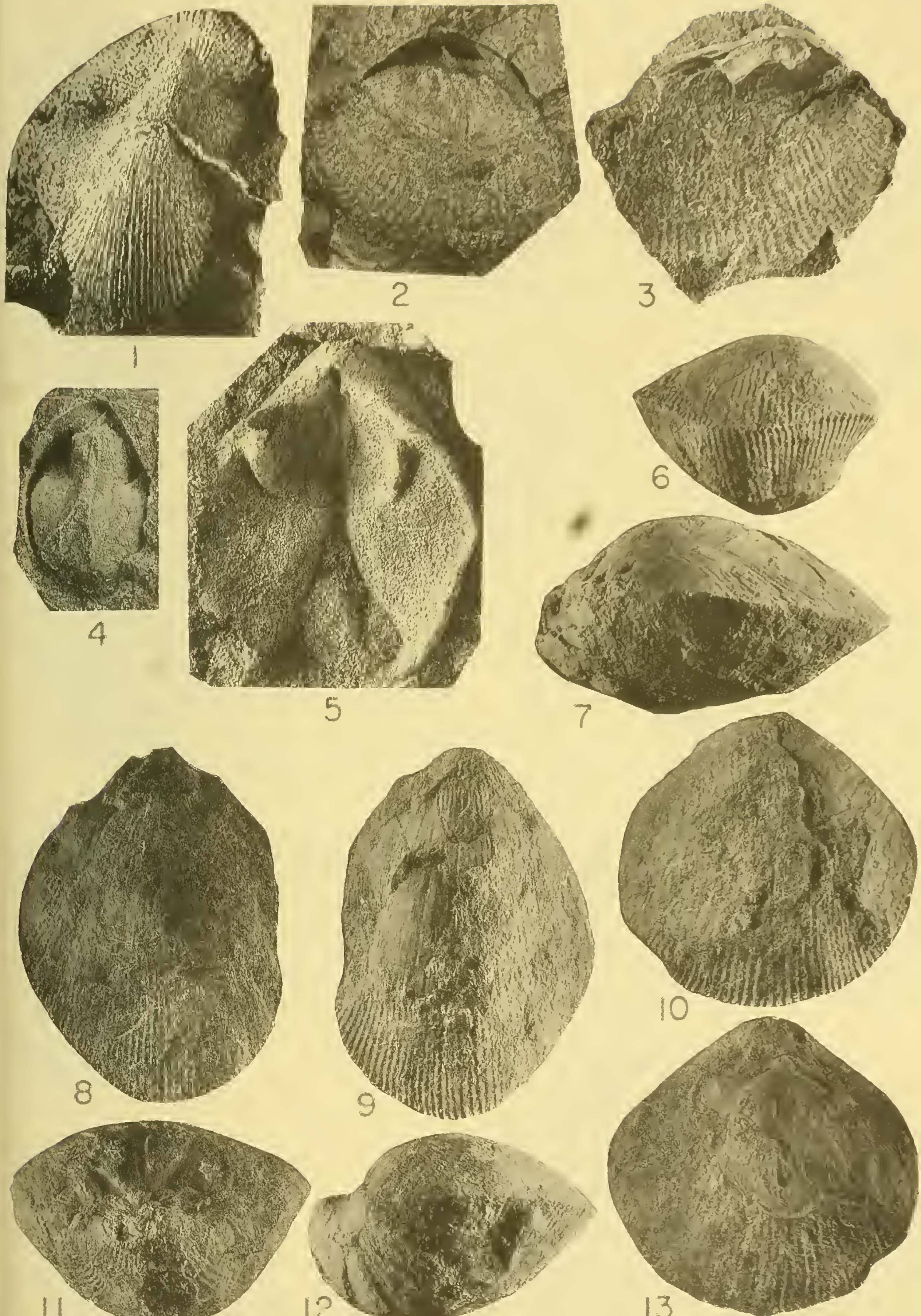
Stoney Creek, Reefton, New Zealand; boulders from quartzite below mudstone; collected by C. A. Fleming, Aug. 1956. Sheet District, S38; Grid. Ref. 363252; Sheet Fossil Loc. No. S38/619; Coll. No. GS 6737. 1. Exterior posterior view (rubber replica), × 2, NZGS, No. BR1124.

2-5. **Pleurothyrella venusta,** sp. nov. 100

Lower quartzite of Reefton beds, loose boulders in Lankey Creek, Reefton, New Zealand. 2. Impression of brachial interior, × 1, shows sealed-off foramen filling, myophragm bisecting muscle field which reaches to midlength; USNM, No. 137748. 3. Brachial interior (rubber replica), × 1, shows relatively flat cardinal plate, narrow palintrope; USNM, No. 137748. 4. Impression of pedicle interior, × 1, shows umbonal chamber; USNM, No. 137747. 5. Pedicle interior (rubber replica), × 2, shows gently incurved beak, stubby hinge teeth, obsolescent dental lamellae; USNM, No. 137747.

6-13. **Pleurothyrella venusta,** sp. nov. 100

Loose boulders in Lankey Creek, 100 yards upstream from Stoney Creek junction, Reefton, New Zealand. 6. Anterior view. 7. Lateral view. 8. Brachial view. 9. Pedicle view. 10. Pedicle view. 11. Posterior view. 12. Lateral view. 13. Brachial view. Figs. 6-13, paratypes; figs. 6-9, CB, B. 303; figs. 10-13, CB, B. 304.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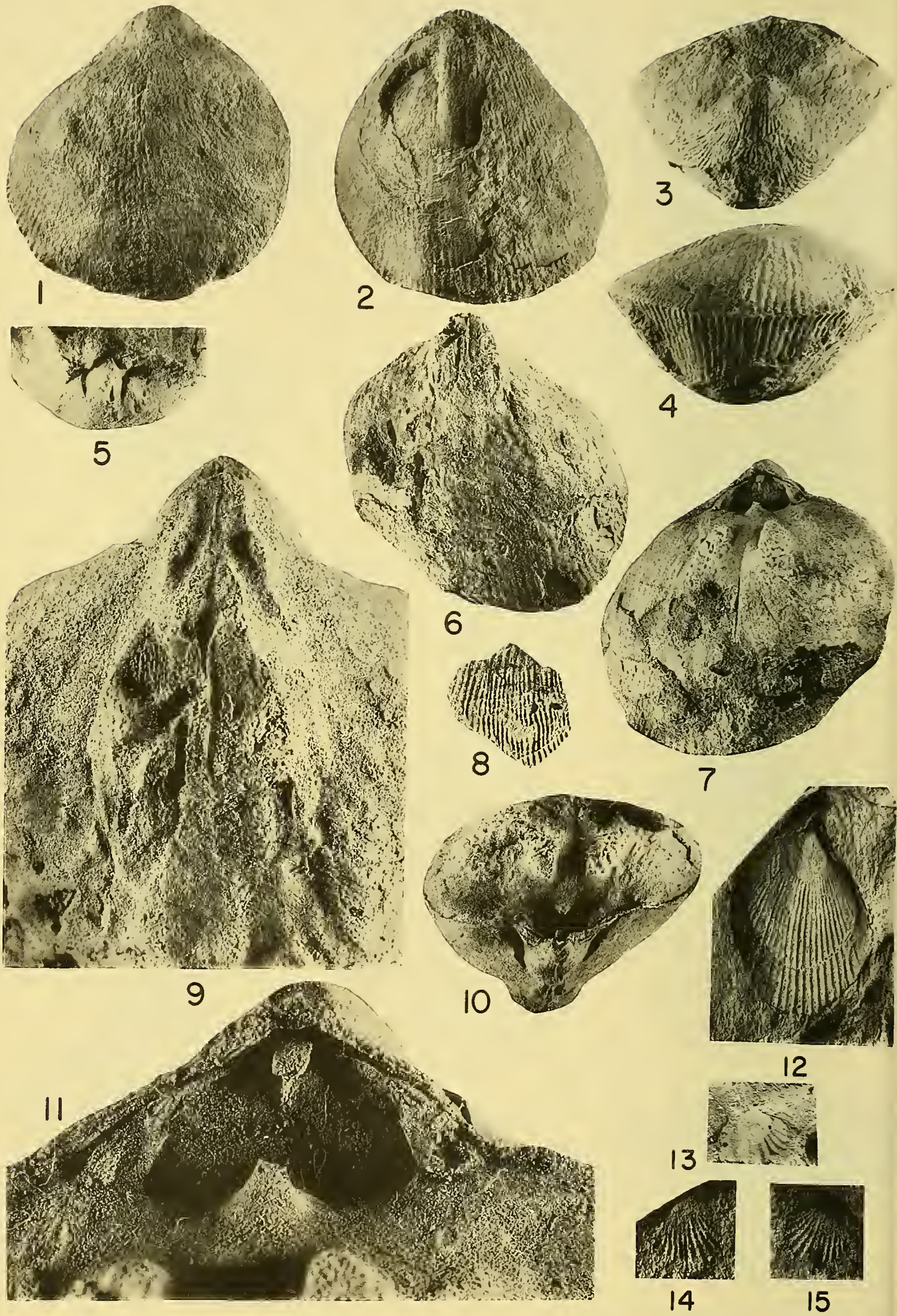
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Explanation of Plate 29

Engraving of figures reduced about 1/10 of measurement cited.

Explanation of Plate 30

Engraving of figures reduced about 1/10 of measurement cited.

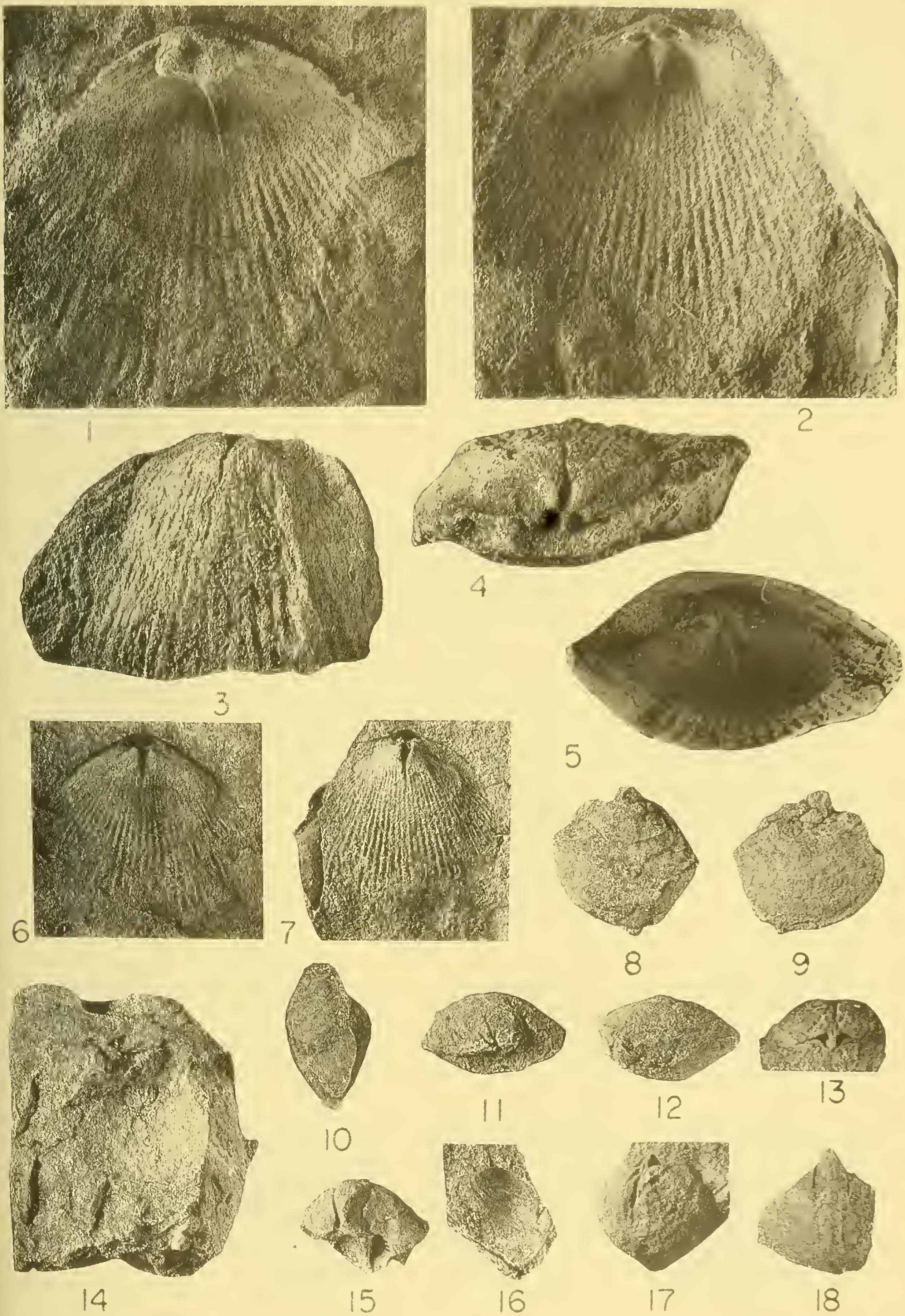
Figure Page

1-7. **Globithyris?** sp. 119

Bokkeveld beds. 1. Brachial interior (rubber replica), × 2, shows prominent median septum supporting cardinal plate formed from medially fused hinge plates. This is Reed's *Rensselaeria* sp. *alpha* (1903, pl. XXI, fig. 8), which is a globithyrinid as shown by its prominent median septum rather than a myophragm. S. African Mus., No. 149; Assegai Bosch, Roode Berg, Ladismith, South Africa. 2. Brachial interior (rubber replica), × 2, shows prominent median septum (replica imperfect in area of cardinal plate, where bubbles broke giving impression of concave extremities); unfigured specimen on same slab as that in fig. 1. 3. Brachial interior (plaster cast), × 2, shows prominent median septum; S. African Mus., No. 1611; Montagu, South Africa. This is Reed's *Rensselaeria montaguensis pars* (1908, pl. 48, fig. 6), which is a globithyrinid as shown by its prominent median septum. 4. Interior, posterior view (plaster cast), × 2, shows prominent median septum, anteriorly directed crural processes; same specimen as fig. 3. 5. Interior, posterior view (rubber replica), × 2, shows form of median septum; same specimen as fig. 3. 6. Brachial interior (plaster cast), × 1, shows prominent median septum; same specimen as fig. 1. 7. Brachial interior (plaster cast), × 1, shows prominent median septum; same specimen as fig. 2.

8-18. **Cryptonella?** sp. 117

Lower quartzite of Reefton beds, loose boulders in Lankey Creek, Reefton, New Zealand. 8. Impression of pedicle interior shows short dental lamellae. 9. Impression of brachial interior shows convex impression of concave cardinal plate just anterior of filling of delthyrium. 10. Interior impression, side view, shows greater depth of pedicle valve (to right). 11. Interior impression, posterior view, shows greater depth of pedicle valve (above), short dental lamellae. 12. Interior impression, anterior view, shows rectimarginate anterior margin. 13. Impression of brachial interior, posterior view, shows foramen filling, absence of crural plates. 14. Impression of brachial exterior shows smooth exterior. 15. Impression of pedicle interior, posterior view, shows dental lamellae, stubby hinge teeth. 16. Impression of brachial exterior shows concentric growth lines. 17. Impression of brachial interior shows two pairs of adductor impressions medially bisected by myophragm. 18. Impression of pedicle interior shows short dental lamellae. Figs. 8-18, × 1. Figs. 8-12, 14, USNM, No. 137756; figs. 13, 16, 17, USNM, No. 137754; figs. 15-18, USNM, No. 137755.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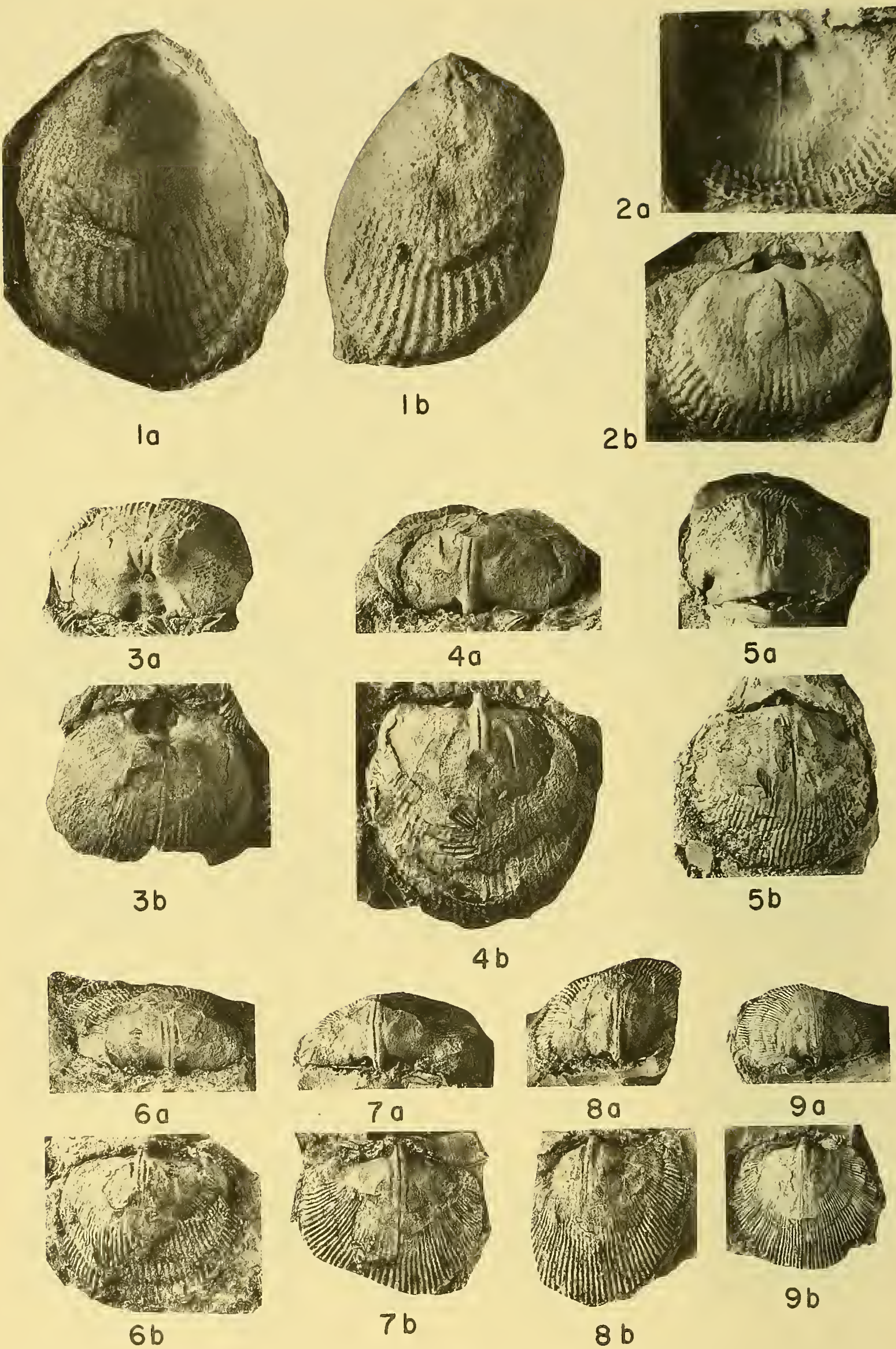
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Explanation of Plate 31

Figure Page

All figures × 1. Engraving of figures reduced about 1/10 of measurement cited.

1-2. **Pleurothyrella relicta** (Schwarz, 1906) 105

Bokkeveld beds. 1a. Pedicle interior (rubber replica) shows stubby hinge teeth; S. African Mus., No. 1612 (Reed's *Rensselaeria montaguensis pars,* 1908, pl. 48, fig. 7, which belongs to *P. relicta* as evidenced by its coarse plications). 1b. Pedicle interior (plaster cast) shows coarse costellae, obsolescent dental lamellae; same specimen as 1a. 2a. Brachial interior (rubber replica) shows foramenate cardinal plate, well-developed myophragm, anteriorly directed crural processes; Albany Mus., No. 93 (Schwarz's holotype). 2b. Brachial interior (plaster cast) shows well-impressed muscle field, coarse costellae; Albany Mus., No. 93.

3-9. **Mendathyris mainensis** (Williams, 1900) 107

Chapman sandstone, Grindstone, Presque Isle Stream, Presque Isle Quadrangle, Maine. 3a-b. Late stage; impression of brachial interior shows relatively bulbous cardinal plate, transverse markings on lateral adductor impressions, myophragm anterior of cardinal plate; USNM, No. 137757. 4a-b. Middle stage; impression of brachial interior shows foramen filling, posteriorly directed myophragm reaching into notothyrial cavity, transverse markings on lateral adductor impressions; USNM, No. 137758. 5a-b. Middle stage; impression of brachial interior shows anterior extent of myophragm (foramen filling broken in this specimen), absence of crenulations in umbonal region; USNM No. 137759. 6a-b. Middle stage; impression of brachial interior shows foramen filling, extent of myophragm, transverse markings on lateral adductor impressions; USNM, No. 137760. 7a-b. Middle stage; impression of brachial interior shows foramen filling, extent of myophragm, absence of crenulations in umbonal region; USNM, No. 137761. 8a-b. Middle stage; impression of brachial interior showing foramen filling, absence of crenulations in umbonal region; USNM, No. 137762. 9a-b. Middle stage; impression of brachial interior shows foramen filling, extent of myophragm; USNM, No. 137763.

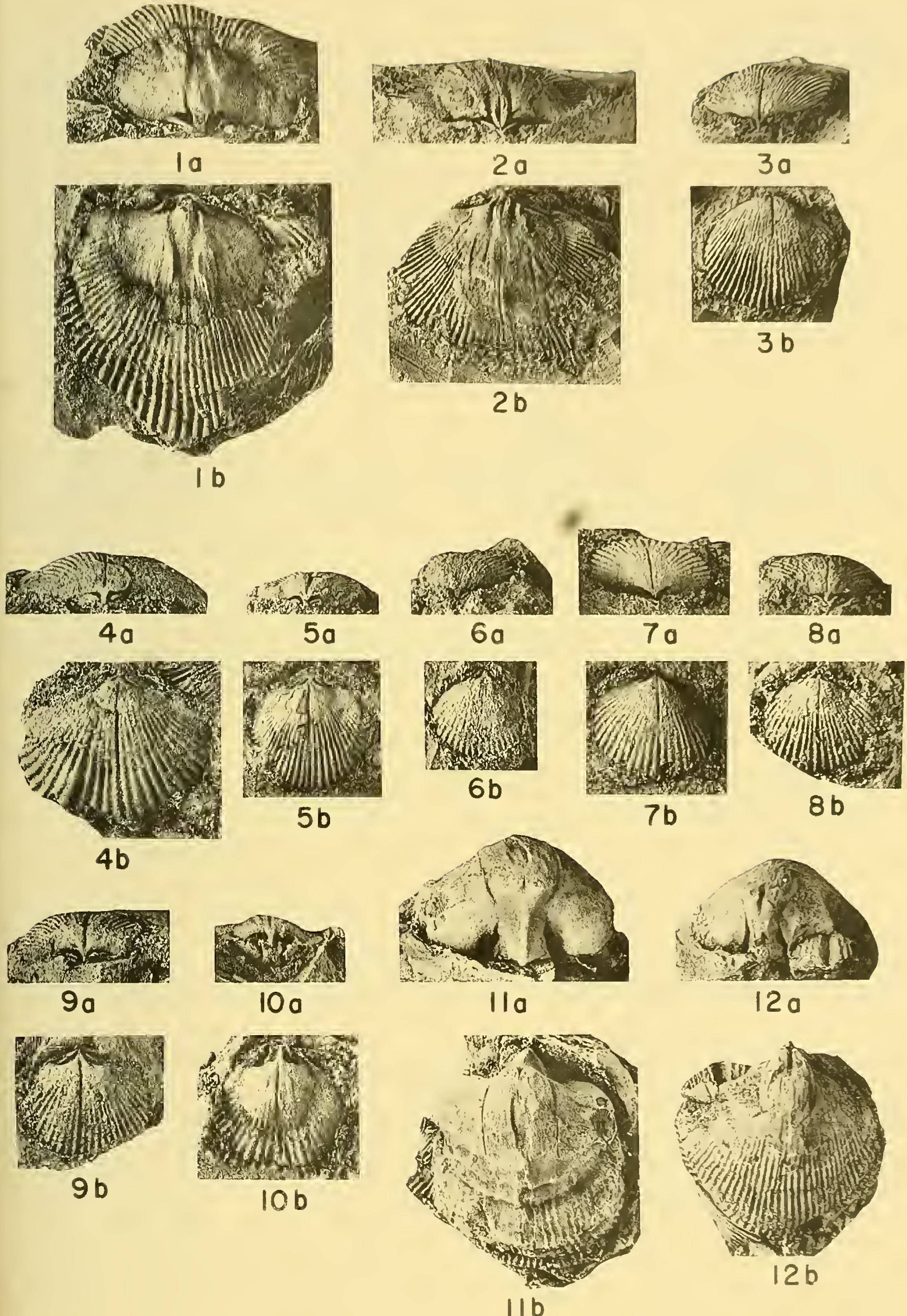
Explanation of Plate 32

Engraving of figures reduced about 1/10 of measurement cited.

Figure Page

1-12. **Mendathyris mainensis** (Williams, 1900) 107

Chapman sandstone, Grindstone, Presque Isle Stream, Presque Isle Quadrangle, Maine. 1a-b. Middle stage; impression of brachial interior, × 2, shows posteriorly projecting impressions of lateral adductors which give rise to notch simulating crural plate; USNM, No. 137764. 2a-b. Middle stage; impression of brachial interior, × 2, shows well-impressed muscle field, notches which simulate crural plates; USNM, No. 137765. 3a-b. Early stage; impression of brachial interior, × 2, shows absence of well-impressed muscle scars, presence of costellae in umbonal cavity; USNM, No. 137766. 4a-b. Early stage; impression of brachial interior, × 3, shows well-defined myophragm, absence of well-impressed muscle scars; USNM, No. 137767. 5a-b. Early stage; impression of brachial interior, × 3, shows prominent myophragm, costellae in umbonal region, absence of well-impressed muscle scars; USNM, No. 137768. 6a-b. Early stage; impression of brachial interior, × 3, shows prominent myophragm, costellae in umbonal region, absence of well-impressed muscle scars; USNM, No. 137769. 7a-b. Early stage; impression of brachial interior, × 3, shows prominent myophragm, costellae in umbonal region, absence of well-impressed muscle scars; USNM, No. 137770. 8a-b. Early stage; impression of brachial interior, × 3, shows prominent myophragm, costellae in umbonal region, absence of well-impressed muscle scars; USNM, No. 137771. 9a-b. Early stage; impression of brachial interior, × 3, shows prominent myophragm, costellae in umbonal region, absence of well-impressed muscle scars; USNM, No. 137772. 10a-b. Early stage; impression of brachial interior, × 3, shows prominent myophragm, costellae in umbonal region, absence of well-impressed muscle scars; USNM, No. 137773. 11a-b. Late stage; impression of pedicle interior, ×1, shows obsolescent dental lamellae, short myophragm at posterior end of muscle field, continuity of umbonal chamber and muscle field; USNM, No. 137774. 12a-b. Late stage; impression of pedicle interior, × 1, shows obsolescent dental lamellae, short myophragm at posterior end of muscle field, continuity of umbonal chamber and muscle field; USNM, No. 137776.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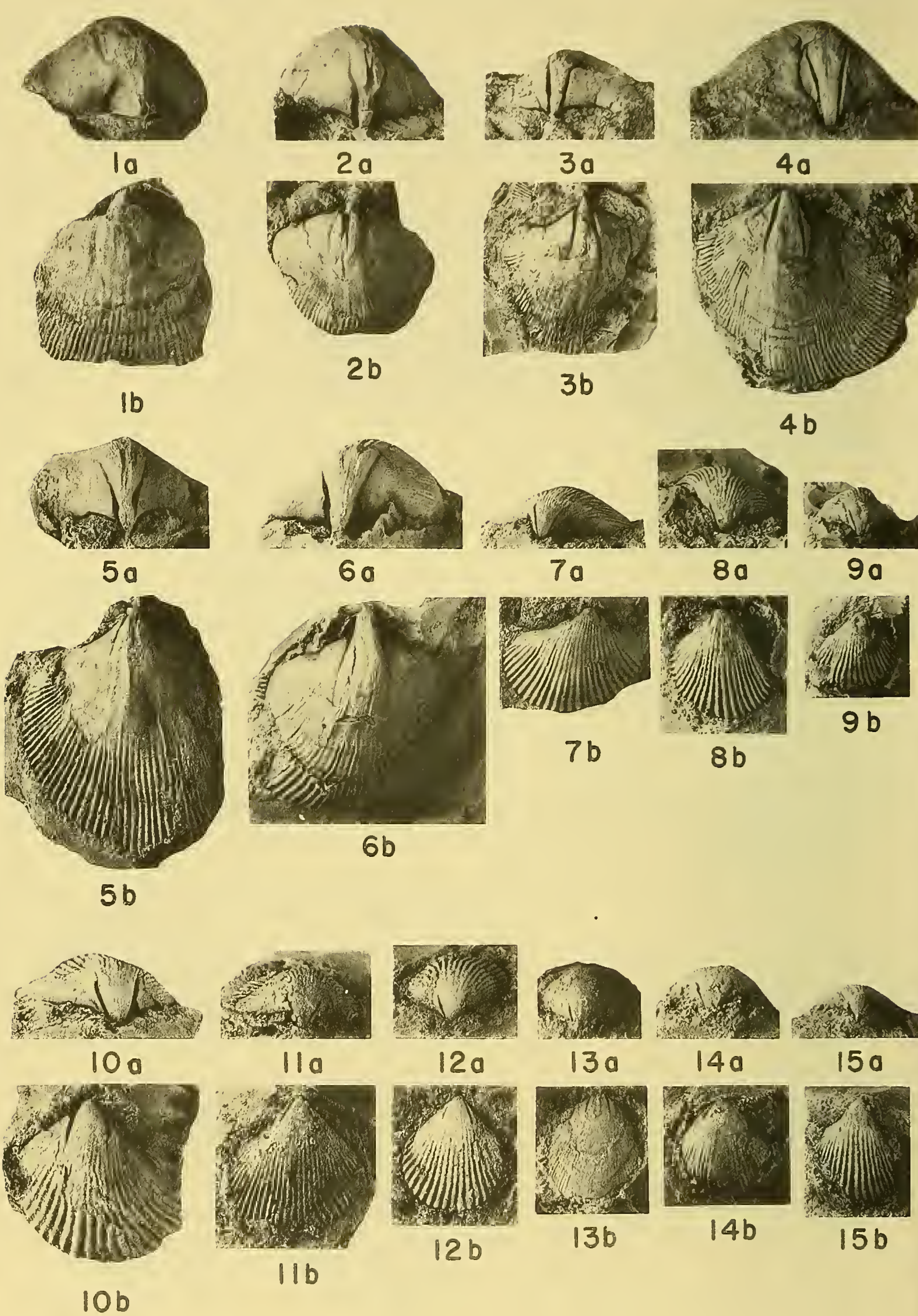
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Explanation of Plate 33

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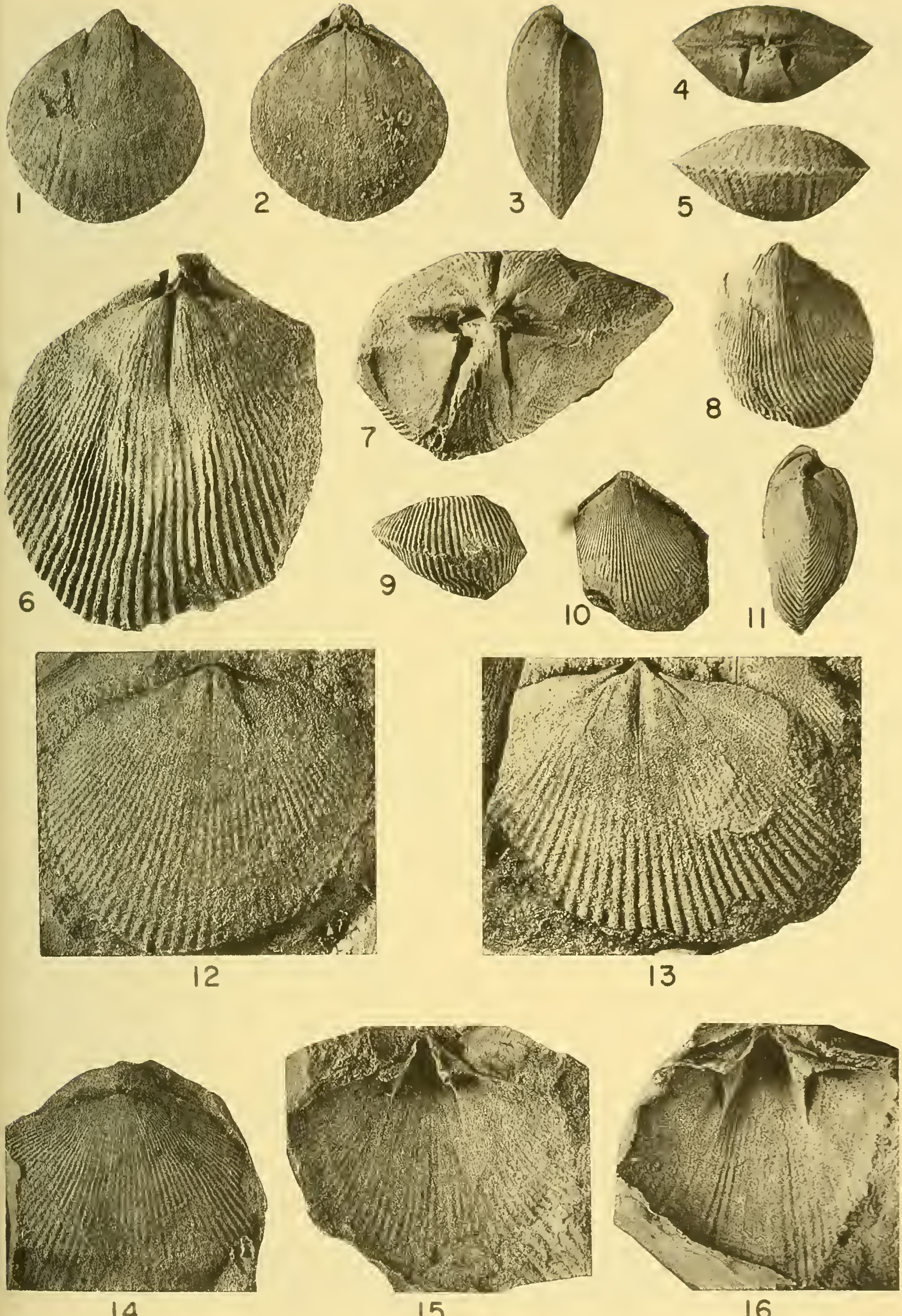
Figures 1-3 × 1; 4-9 × 2; 10-15 × 3. Engraving of figures reduced about 1/10 of measurement cited.

1-15. **Mendathyris mainensis** (Williams, 1900) 107
Chapman sandstone, Grindstone, Presque Isle Stream, Presque Isle Quadrangle, Maine. 1a-b. Late stage; impression of pedicle interior, shows obsolescent dental lamellae, short myophragm at posterior end of muscle field, continuity of umbonal chamber and muscle field; USNM, No. 137775. 2a-b. Middle stage; impression of pedicle interior, shows constriction between umbonal chamber and posterior portion of muscle field, short dental lamellae; USNM, No. 137777. 3a-b. Middle stage; impression of pedicle interior, shows constriction between umbonal chamber and posterior portion of muscle field, absence of prominent myophragm at posterior of muscle field, short dental lamellae; USNM, No. 137778. 4a-b. Middle stage; impression of pedicle interior, shows constriction between umbonal chamber and posterior portion of muscle field, absence of prominent myophragm at posterior of muscle field, short dental lamellae; USNM, No. 140092. 5a-b. Middle stage; impression of pedicle interior, shows constriction between umbonal chamber and posterior portion of muscle field, absence of prominent myophragm at posterior of muscle field, absence of short dental lamellae; USNM, No. 140092a. 6a-b. Middle stage; impression of pedicle interior, shows constriction between umbonal chamber and posterior portion of muscle field, absence of prominent myophragm at posterior of muscle field, absence of short dental lamellae; USNM, No. 140088. 7a-b. Early stage; impression of pedicle interior, shows short dental lamellae, absence of differentiation between umbonal chamber and muscle field, absence of deeply impressed muscle field, costellae on umbonal region; USNM, No. 140089. 8a-b. Early stage; impression of pedicle interior, shows short dental lamellae, absence of differentiation between umbonal chamber and muscle field, absence of deeply impressed muscle field, costellae on umbonal region; USNM, No. 140090. 9a-b. Early stage; impression of pedicle interior, shows short dental lamellae, absence of differentiation between umbonal chamber and muscle field, absence of deeply impressed muscle field, costellae in umbonal region; USNM, No. 140091. 10a-b. Early stage; impression of pedicle interior, shows short dental lamellae, absence of differentiation between umbonal chamber and muscle field, absence of deeply impressed muscle field, costellae on umbonal region; USNM, No. 140091a. 11a-b. Early stage; impression of pedicle interior, shows short dental lamellae, absence of differentiation between umbonal chamber and muscle field, absence of deeply impressed muscle field, costellae on umbonal region; USNM, No. 140093. 12a-b. Early stage; impression of pedicle interior, shows short dental lamellae, absence of differentiation between umbonal chamber and muscle field, absence of deeply impressed muscle field, costellae on umbonal region; USNM, No. 140093a. 13a-b. Early stage; impression of pedicle interior, shows short dental lamellae, absence of differentiation between umbonal chamber and muscle field, absence of deeply impressed muscle field, costellae on umbonal region; USNM, No. 140093b. 14a-b. Early stage; impression of pedicle interior, shows short dental lamellae, absence of differentiation between umbonal chamber and muscle field, absence of deeply impressed muscle field, costellae on umbonal region, USNM, No. 140093c. 15a-b. Early stage; impression of pedicle interior, shows short dental lamellae, absence of differentiation between umbonal chamber and muscle field, absence of deeply impressed muscle field, costellae on umbonal region; USNM, No. 140093d.

Explanation of Plate 34

Sandstone of Lower Devonian age (see Boucot and Gill, 1956, p. 1176), Comorapo-Tunal region, Dept. Santa Cruz, Bolivia. USNM, No. 126164E. 1. Impression of pedicle interior. 2. Impression of brachial interior. 3. Interior impression, side view. 4. Interior impression, posterior view. 5. Interior impression, anterior view. All × 3.

Lower sandstone of Tarratine formation, Locality SD-2718, Long Pond quadrangle, Somerset County, Maine. 6. Impression of brachial interior, × 2; USNM, No. 126178A; holotype. 7. Interior impression, posterior view, × 2; USNM, No. 126178A; holotype. 8. Impression of pedicle interior, × 1; USNM, No. 126178A; holotype. 9. Interior impression, anterior view, × 1; USNM, No. 126178A; holotype. 10. Pedicle exterior (rubber replica), × 1; USNM, No. 126173B. 11. Interior impression, side view, × 1; USNM, No. 126178A; holotype. 12. Impression of brachial interior, × 2; USNM, No. 126168A; 13. Impression of brachial interior, × 2; USNM, No. 126185A. 14. Brachial exterior (rubber replica), × 2; USNM, No. 126186. 15. Pedicle interior (rubber replica), × 2; USNM, No. 126166B. 16. Pedicle interior (rubber replica) × 2; USNM, No. 126171.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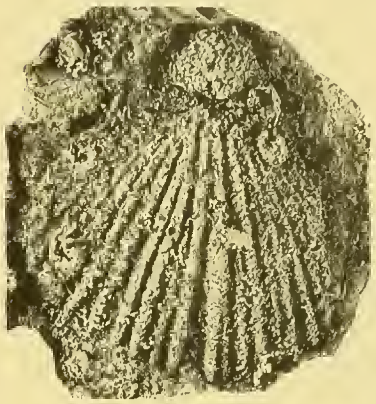
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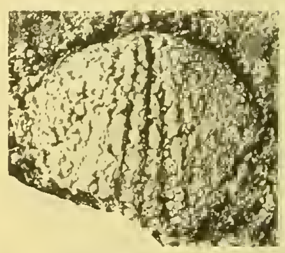
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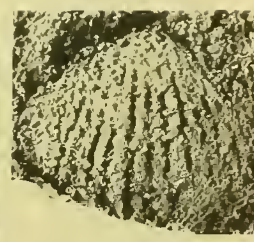
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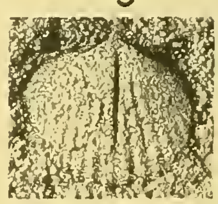
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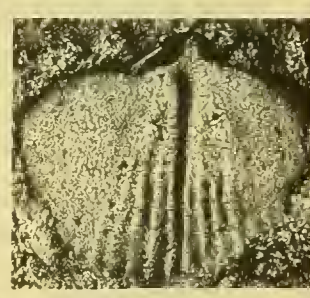
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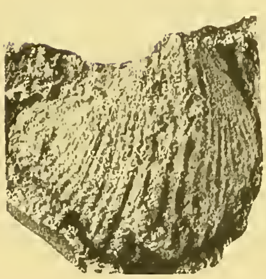
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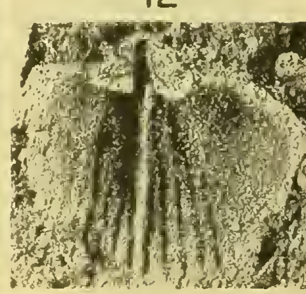
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Explanation of Plate 35

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Engraving of figures reduced about 1/10 of measurement cited.

1-2. **Mutationella parlinensis,** sp. nov. 110

Lower sandstone of Tarratine formation, Locality SD-2718, Long Pond quadrangle, Somerset County, Maine. 1. Impression of pedicle interior, × 2; USNM, No. 126171. 2. Impression of pedicle interior, × 2; USNM, No. 126166B.

3-16. **Cloudella matagamoni,** sp. nov. 113

Matagamon sandstone, Locality SD-3608, Traveler Mountain quadrangle, Penobscot County, Maine. 3. Impression of pedicle interior, × 3; USNM, No. 126179A. 4. Brachial exterior (rubber replica), ×3; holotype; USNM, No. 126172. 5. Impression of brachial exterior, × 3; holotype; USNM, No. 126172. 6. Impression of brachial interior, × 3; holotype; USNM, No. 126172. 7. Impression of brachial interior, × 3; USNM, No. 126174B. 8. Brachial interior (rubber replica), × 3; USNM, No. 126174B. 9. Impression of brachial interior, × 4; USNM, No. 126176A. 10. Brachial exterior (rubber replica), × 4; USNM, No. 126176B. 11. Impression of brachial interior, × 3; USNM, No. 126211B. 12. Impression of brachial interior, × 3; USNM, No. 126175B. 13. Pedicle exterior (rubber replica), × 3; USNM, No. 126170. 14. Impression of pedicle interior, × 4; USNM, No. 126169A. 15. Impression of brachial interior, × 3; USNM, No. 126211A. 16. Brachial interior (rubber replica), × 3; USNM, No. 126175B.

Explanation of Plate 36

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Engraving of figures reduced about 1/10 of measurement cited.

1-6. **Reeftonella neozelanica** (Allan, 1935) 117

Reefton beds, loose boulders, Lankey Creek, Reefton, New Zealand. 1. Middle stage; impression of brachial interior shows foramen (middle part broken out), anterior position of lateral adductor impressions; USNM, No. 139903. 2. Middle stage; impression of brachial interior shows foramen, anterior position of lateral adductor impressions; USNM, 139904. 3. Middle stage; impression of brachial interior shows foramen, anterior position of lateral adductor impressions; USNM, No. 139906. 4. Middle stage; impression of brachial interior shows foramen, anterior position of lateral adductor impressions; USNM, No. 139905. 5. Middle stage; impression of brachial interior shows foramen, anterior position of lateral adductor impressions; USNM, No. 139907. 6. Middle stage; impression of brachial interior shows foramen, anterior position of lateral adductor impressions; USNM, No. 139908. Figures 1—6, × 2.

7-8. Unidentified terebratuloid? 121

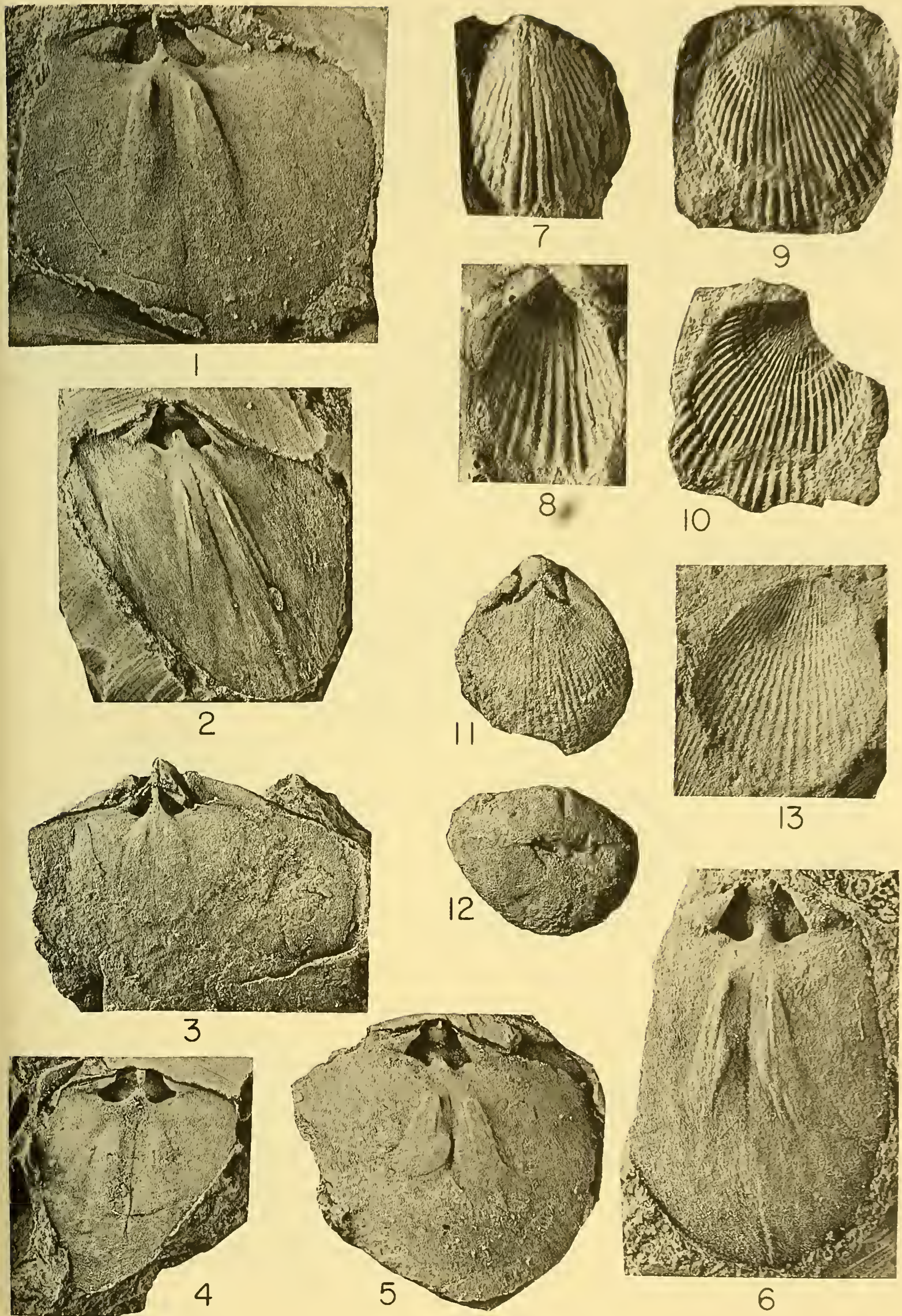
Bokkeveld beds, Gydo Pass, Ceres, South Africa. 7. Pedicle interior (plaster cast) (Reed's *Retzia* cf. *adrieni,* 1903, pl. XXIII, fig. 6, which is generically unidentifiable). 8. Pedicle interior (rubber replica). Both, × 2; S. African Mus., No. 153.

9-10. Unidentified rensselaeroid 120

Bokkeveld beds, locality unknown, South Africa. 9. Brachial exterior (rubber replica) shows coarse costellae, flat form of valve. In umbonal region partially stripped costellae give impression of greater number of costellae. Reed's *Rensselaeria* sp.? (1903, pl. XXI, fig. 10), which resembles *Pleurothyrella relicta* in coarse ornament but which cannot be assigned without information about interior. 10. Brachial exterior (plaster cast). Both, × 1; S. African Mus., No. 805/152.

11-13. **Mutationella falklandica** (Clarke, 1913) 109

Strata of Lower Devonian age, Port Howard, East Falkland. 11. Impression of brachial interior, × 1; New York State Mus., No. 8479. 12. Impression of interior, posterior view, × 1; New York State Mus. No. 8478. 13. Impression of brachial exterior, × 1; New York State Mus. No. 8477.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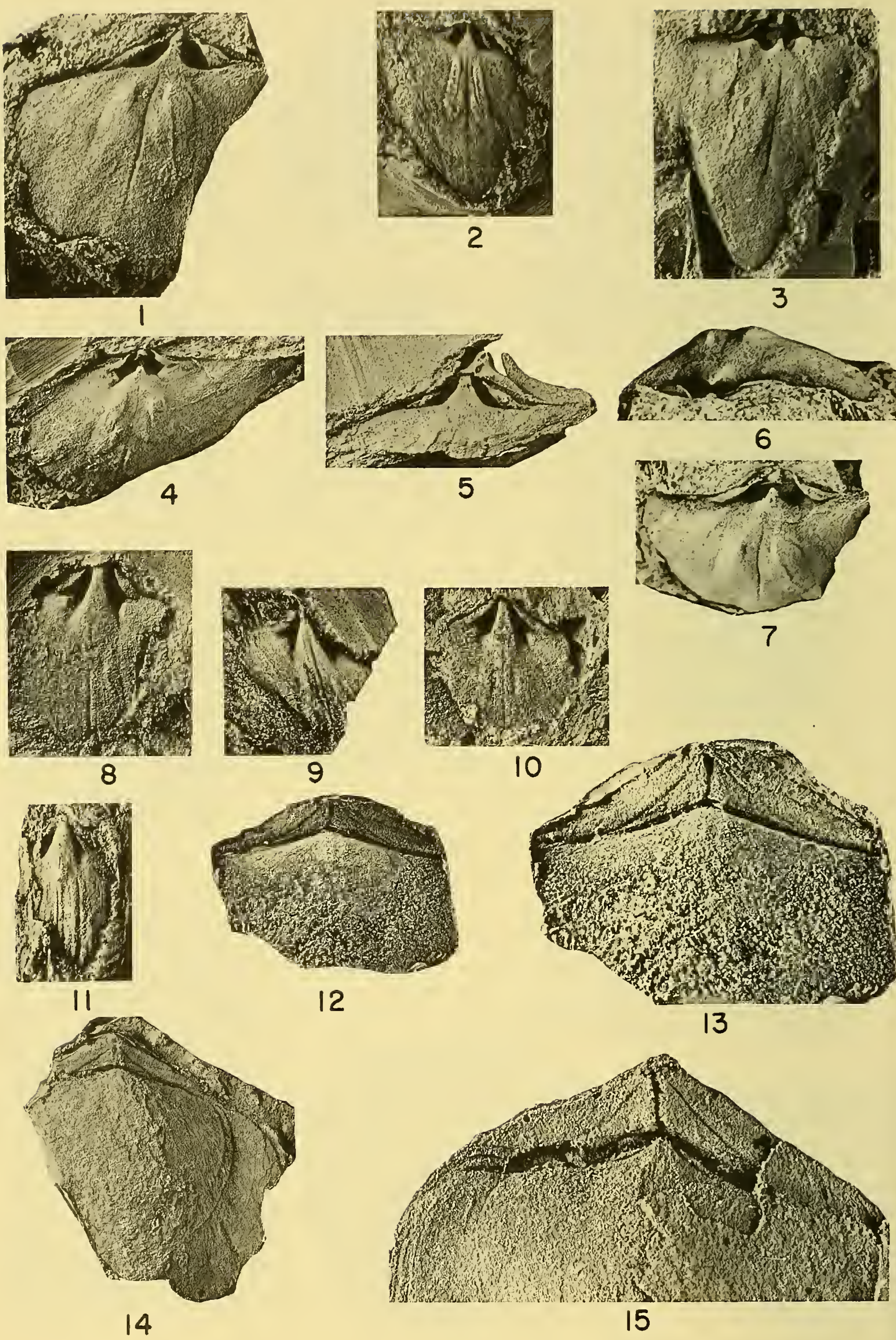
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Explanation of Plate 37

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Engraving of figures reduced about 1/10 of measurement cited.

1-15. **Reeftonella neozelanica** (Allan, 1935) 117

Reefton beds, loose boulders, Lankey Creek, Reefton, New Zealand. 1. Middle stage; impression of brachial interior, × 2, showing foramen, anterior position of lateral adductor impressions; USNM, No. 139909. 2. Middle stage; impression of brachial interior, × 2, shows foramen, anterior position of lateral adductor impressions; USNM, No. 139910. 3. Middle stage; impression of brachial interior, × 2, shows foramen, anterior position of lateral adductor impressions; USNM, No. 139911. 4. Middle stage; impression of brachial interior, × 2, shows foramen, anterior position of lateral adductor impressions; USNM, No. 139912. 5. Middle stage; impression of brachial interior, × 2, shows foramen, anterior position of lateral adductor impressions; USNM, No. 139913. 6-7. Middle stage; impression of brachial interior, × 2, shows foramen, anterior position of lateral adductor impressions; USNM, No. 139915. 8. Early stage; impression of brachial interior, × 3, shows slots (result of posteriorly projecting impressions of lateral adductors) lateral to foramen filling, weakly impressed muscle field; USNM, No. 139914. 9. Early stage; impression of brachial interior, × 3, shows slots (result of posteriorly projecting impressions of lateral adductors) lateral to foramen filling, weakly impressed muscle field; USNM, No. 139916. 10. Early stage; impression of brachial interior, × 3, shows slots (result of posteriorly projecting impressions of lateral adductors) lateral to foramen filling, weakly impressed muscle field; USNM, No. 139917. 11. Early stage; impression of brachial interior, × 4, shows slots (result of posteriorly projecting impressions of lateral adductors) lateral to foramen filling, weakly impressed muscle field; USNM, No. 139918a. 12-13. Brachial exterior (rubber replica), × 2, × 3, shows medially conjunct deltidial plates, apical position of pedicle foramen at junction of deltidium and beak; USNM, No. 139919. 14. Brachial exterior (rubber replica), × 2, shows medially conjunct deltidial plates, apical position of pedicle foramen at junction of deltidium and beak; USNM, No. 139920. 15. Brachial exterior (rubber replica), × 3, shows medially conjunct deltidial plates, apical position of pedicle foramen at junction of deltidium and beak; USNM, No. 139921.

Explanation of Plate 38

Reefton beds, loose boulders, Lankey Creek, Reefton, New Zealand. 1. Brachial exterior (rubber replica), × 1, shows medially conjunct deltidial plates, apical position of pedicle foramen at junction of deltidium and beak; USNM, No. 139921. 2-3. Middle stage; impression of brachial interior, × 2, × 3, shows foramen (middle portion broken out)in cardinal plate; USNM, No. 139927. 4. Middle stage; impression of brachial interior, × 3, shows foramen (middle portion broken out) in cardinal plate; USNM, No. 139927. 5-6. Late stage; impression of brachial interior, × 2, × 1, shows absence of foramen in cardinal plate; USNM, No. 139924. 7-8. Late stage; impression of pedicle interior, × 2, shows obsolete or obsolescent dental lamellae; USNM, Nos. 139928-139929.

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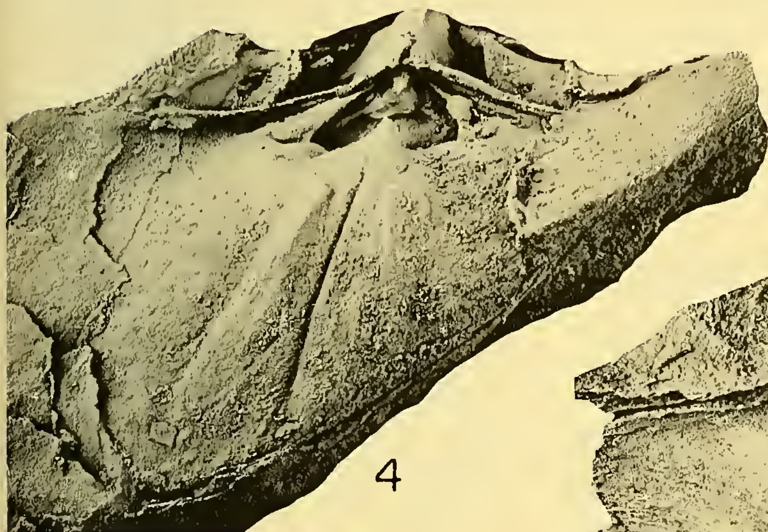

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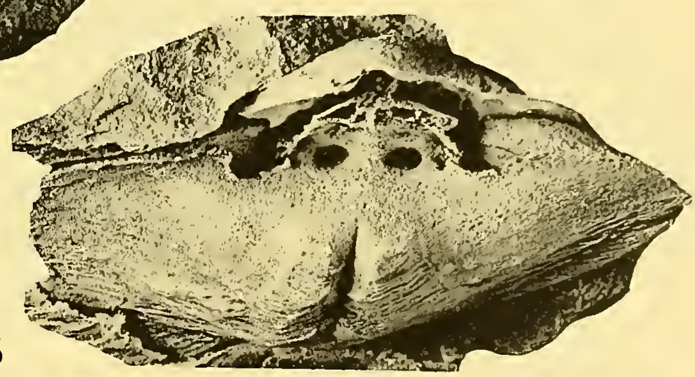

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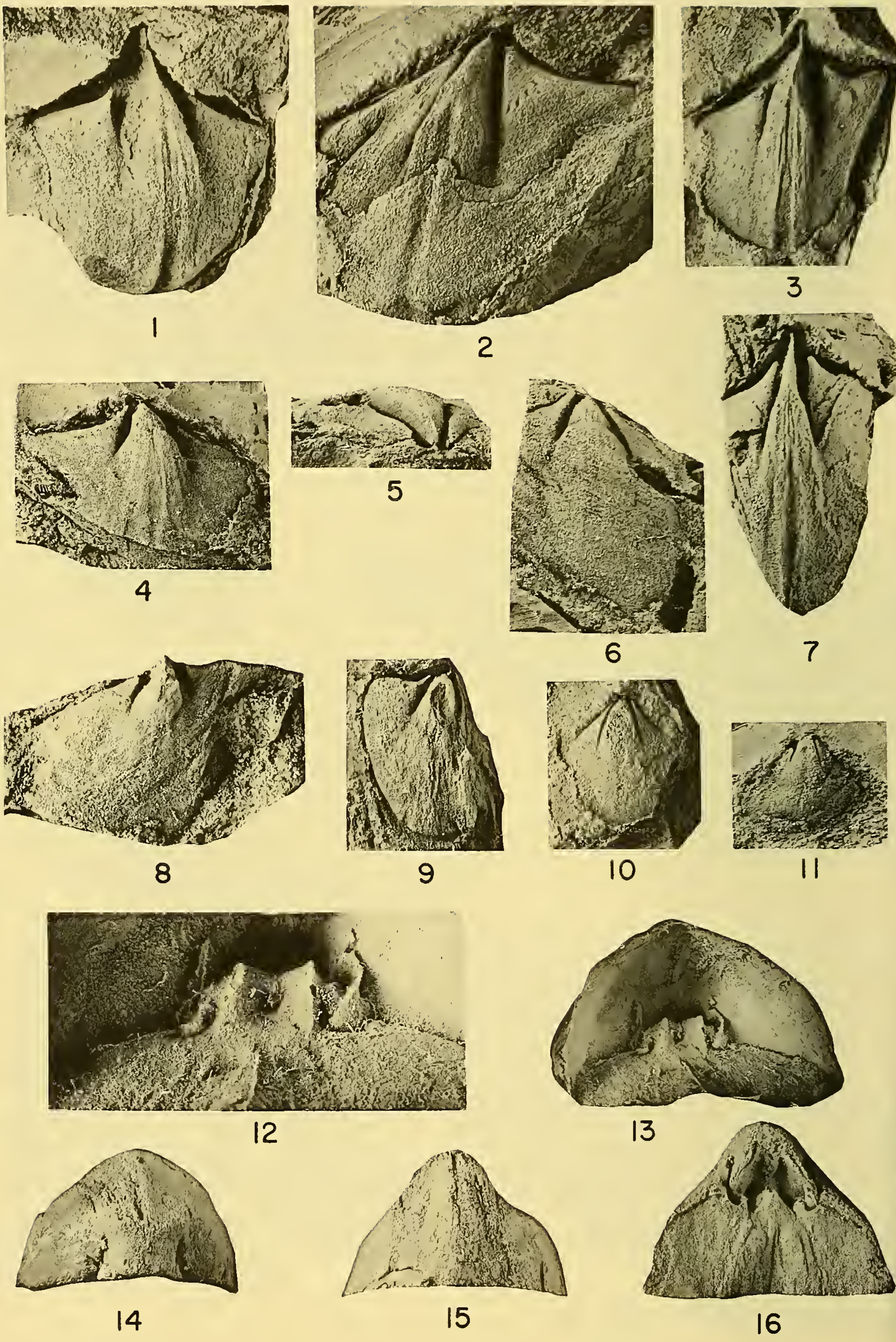
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Explanation of Plate 39

Figure Page

Engraving of figures reduced about 1/10 of measurement cited.

1-11. **Reeftonella neozelanica** (Allan, 1935) 117

Reefton beds, loose boulders, Lankey Creek, Reefton, New Zealand. 1. Middle stage; impression of pedicle interior, × 3, shows short dental lamellae, well-impressed muscle field; USNM, No. 139931. 2. Middle stage; impression of pedicle interior, × 2, shows short dental lamellae, well-impressed muscle field; USNM, No. 139932. 3. Middle stage; impression of pedicle interior, × 2, shows short dental lamellae, well-impressed muscle field; USNM, No. 139933. 4. Middle stage; impression of pedicle interior, × 2, shows short dental lamellae, well-impressed muscle field; USNM, No. 139932. 5-6. Middle stage; impression of pedicle interior, × 2, × 2, shows short dental lamellae, well-impressed muscle field; USNM, No. 139935. 7. Middle stage; impression of pedicle interior, × 3, shows short dental lamellae, well-impressed muscle field; USNM, No. 139936. 8. Middle stage; impression of pedicle interior, × 3, shows short dental lamellae, well-impressed muscle field; USNM, No. 139937. 9-11. Early stage; impression of pedicle interior, × 3, × 3, × 4, shows short dental lamellae, absence of well-impressed muscle field; USNM, Nos. 139938, 139939, 139940a.

12-16. **Scaphiocoelia elizabethae** Reed, 1908 114

Bokkeveld beds, Montagu, South Africa. 12. Interior (rubber replica), posterior view, × 2, shows foramenate cardinal plate, obsolescent dental lamellae, stout hinge teeth (Reed's *Scaphiocoelia? africana,* 1908, pl. 48, fig. 9). 13. Interior (rubber replica), posterior view, × 1, shows strongly convex pedicle valve, flat brachial valve. 14. Interior (plaster cast), posterior view, × 1, shows short, obsolescent dental lamellae. 15. Pedicle interior (plaster cast), × 1, shows cordate form of muscle field. 16. Brachial interior (plaster cast), × 1, shows form of muscle field, bulbous, medially depressed cardinal plate. Figs. 12-16, S. African Mus., No. 1173.

Explanation of Plate 40

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Engraving of figures reduced about 1/10 of measurement cited.

1-2. **Reeftonella neozelanica** (Allan, 1935) 117

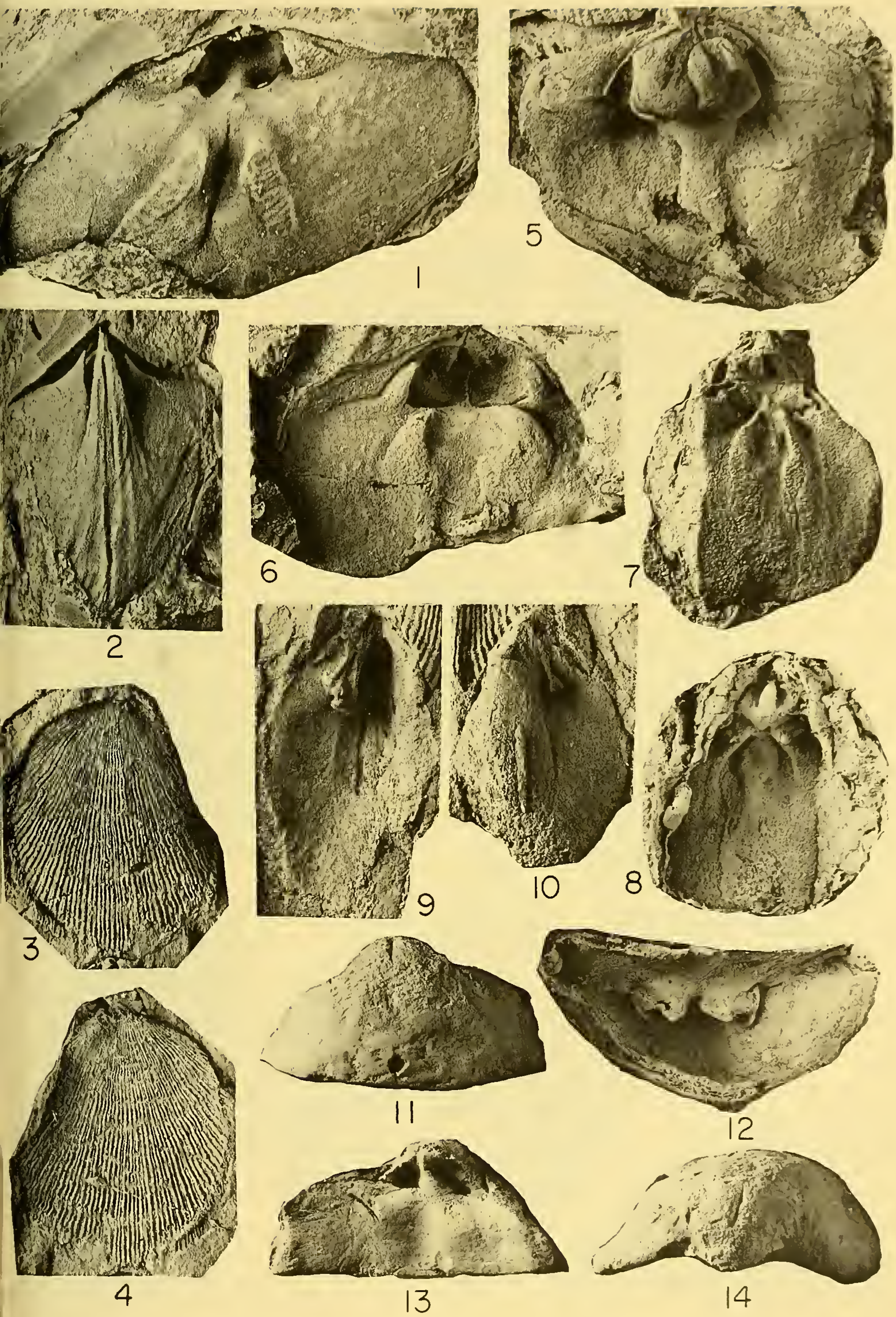
Reefton beds, loose boulders, Lankey Creek, Reefton, New Zealand. 1. Late stage; impression of brachial interior shows absence of foramen in cardinal plate, transverse markings on lateral adductor impressions; USNM, No. 139925. 2. Middle stage; impression of pedicle interior shows short dental lamellae, well-impressed muscle field; USNM, No. 139930.

3-4. Unidentified orthotetacid 120

Bokkeveld beds, Uitenhage, South Africa. 3. Portion of exterior (plaster cast) shows relatively flattish, anteriorly bifurcating costellae. 4. Portion of exterior (rubber replica). Both, S. African Mus. No. 602 (Reed's *Rensselaeria* cf. *cayuga*, 1908, pl. 48, fig. 8, which has ornament characteristic of an orthotetacid fragment).

5-14. **Scaphiocoelia elizabethae** Reed, 1908 114

Bokkeveld beds, Riet Kuil, South Africa. 5. Brachial interior (rubber replica) shows well-developed, relatively broad interarea, wide dental sockets, broad, low myophragm subdividing quadripartite adductor field, sessile cardinal plate formed from medial fusion of bulbous hinge plates, structure suggests linear cardinal process (possibly medial portion of right hinge plate oddly compressed secondarily) ; S. African Mus. No. 1177 (Reed's *Scaphiocoelia? africana* var. *elizabethae,* 1908, pl. 48, fig. 14). 6. Brachial interior (plaster cast) shows relatively flat valve form, relatively short median pair of adductors flanked laterally by larger, longer pair; same specimen as fig. 5. 7. Brachial interior (plaster cast) shows platelike cardinal plate medially surmounted by linear cardinal process, short medial pair of adductor impressions laterally bounded by longer linear pair; S. African Mus., No. 1173a (Reed's *Scaphiocoelia? africana* var. *elizabethae,* 1908, pl. 48, fig. 10). 8. Brachial interior (plaster cast) shows posteriorly expanding, broad myophragm dividing muscle field; same specimen as fig. 7. 9. Pedicle interior (rubber replica) shows convex form, stout hinge teeth, filling of umbonal cavities making dental lamellae obsolescent; S. African Mus., No. 1175 (Reed's *Scaphiocoelia? africana* var. *elizabethae,* 1908, pl. 48, fig. 12). 10. Pedicle interior (plaster cast) shows cordate form of muscle field; same specimen as fig. 9. 11. Pedicle interior (plaster cast) shows myophragm bisecting muscle field; S. African Mus. 12. Interior (rubber replica), posterior view, shows flat brachial valve, deeply convex pedicle valve; same specimen as fig. 11. 13. Brachial interior (plaster cast) shows median trough separating bulbous hinge plates; same specimen as fig. 11. 14. Interior (plaster cast), posterior view, shows form of muscle field, obsolescent dental lamellae; same specimen as fig. 11. Figs. 1-2, × 2; figures 3-14, × 1.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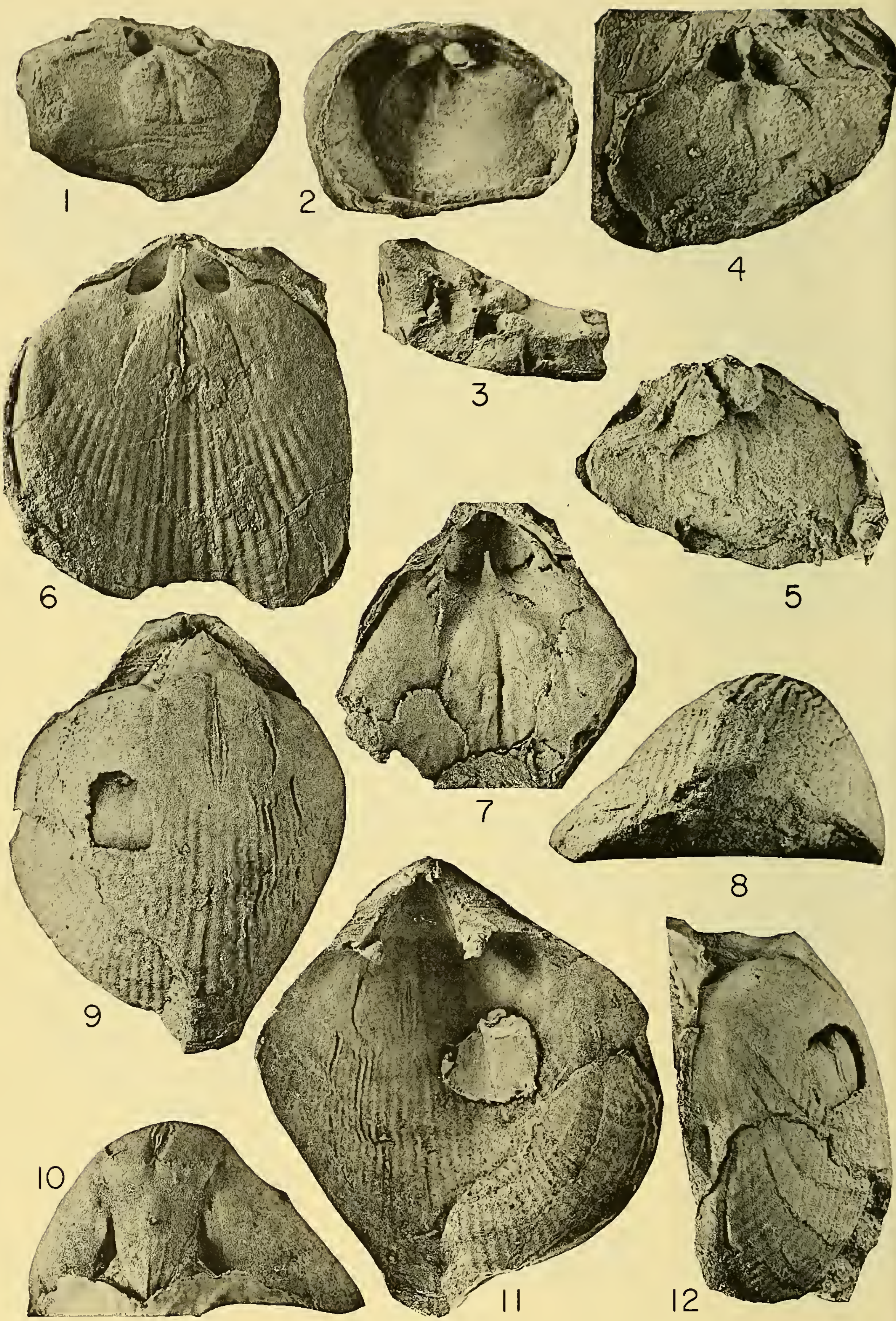
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Explanation of Plate 41

Figure	Page

Engraving of figures reduced about 1/10 of measurement cited.

1-5. **Scaphiocoelia elizabethae** Reed, 1908 114

Bokkeveld beds, Riet Kuil, South Africa. 1. Brachial interior (plaster cast) shows quadripartite form of adductor field (medial pair smaller), flat to gently concave form of valve; S. African Mus., No. 1164 (Reed's *Scaphiocoelia? africana* var. *elizabethae*). 2. Brachial interior (rubber replica) shows bulbous hinge plates joining medially to form cardinal plate, posteriorly expanding, broad, low myophragm; same specimen as fig. 1. 3. Brachial valve (plaster cast), posterior view, shows cross-section shape of myophragm, form of cardinal plate. 4. Brachial interior (plaster cast) shows flat to gently concave valve, quadripartite form of muscle field (Reed's *Scaphiocoelia? africana* var. *elizabethae*, 1908, pl. 48, fig. 13); S. African Mus., No. 1176. 5. Brachial interior (rubber replica) shows trough between stout hinge plates, form of posteriorly expanding myophragm; same specimen as fig. 4.

6-12. **Scaphiocoelia boliviensis** Whitfield 114

Icla beds, Icla, Bolivia; Steinmann Collection, Bonn University. 6. Impression of brachial interior shows remnants of interarea, foramen filling of bulbous cardinal plate, flattish sulcate form, quadripartite adductor field; Bonn Univ., Boucot No. 1. 7. Impression of brachial interior shows foramen filling of bulbous cardinal plate, myophragm bisecting quadripartite muscle field, remnants of interarea; Bonn Univ., Boucot No. 2. 8. Impression of pedicle interior (anterior view) shows highly convex cross-section; Bonn Univ., Boucot No. 3. 9. Impression of pedicle interior shows obsolescent dental lamellae, form of muscle field; same specimen as fig. 8. 10. Impression of pedicle interior (posterior view) shows obsolescent dental lamellae, stout hinge teeth; same specimen as fig. 8. 11. Pedicle interior (rubber replica) shows short interarea, stout hinge teeth; same specimen as fig. 8. 12. Impression of pedicle interior (side view) shows convexity of valve; same specimen as fig. 8. All figures × 1.

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ANALYSIS OF LEPIDOCYCLINA RADIATA (Martin)

By

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Cornell University

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ANALYSIS OF *LEPIDOCYCLINA RADIATA* (Martin)*

W. Storrs Cole
Cornell University

ABSTRACT

Variation in specimens of a species of *Lepidocyclina* from the Tertiary *f* (Miocene) of the Fiji Islands is analyzed, and the conclusion is reached that these specimens should be assigned to *Lepidocyclina radiata* (Martin). Certain Indo-Pacific species which are considered to be synonyms of *L. radiata* are discussed. The paleoecology of the localities from which the specimens from the Fiji Islands were obtained is evaluated. The faunal list of larger Foraminifera from the Futuna limestone (Tertiary *f*, Miocene) of Lau, Fiji, is revised, and the "series concept" (Cole, 1960, p. 138) for the identification of species with variable shape and internal structures is applied to the revision of the species from the Futuna limestone. The reduction of the number of specific names made possible by the use of the "series concept" for specific identification strengthens stratigraphic correlations.

INTRODUCTION

This discourse is an attempt to demonstrate that the external form and the embryonic chambers in a single species of *Lepidocyclina* vary in shape and size from specimen to specimen. However, by the study of numerous specimens from a single locality it is possible to interpret these shapes and structures so that they become integral parts of one continuous series.

Once a series is completely resolved so that the extremes of variation in a species are understood, it is possible to incorporate less well-known, but previously assumed valid species, into an analyzed series. Thus, the number of specific names are reduced, but at the same time geographic and stratigraphic ranges may be assigned with greater assurance and precision to a smaller number of readily recognized species.

Cole (1960) analyzed *Lepidocyclina pustulosa* H. Douvillé (p. 135) and *L. radiata* (Martin) (p. 136) by the series method. Although Eames, *et al.*, (1962*b*, p. 299) admit intergradation in external shape, and in the embryonic chambers (p. 292) of certain species, as in *Lepidocyclina rutteni*, they (Eames, *et al.*, 1962*b*, p. 293, 301) objected to the series which Cole (1960) developed for *L. pustulosa* and *L. radiata*.

Cole (1963) resisted this challenge by presenting vastly expanded data on *Lepidocyclina pustulosa* and by adding a few addi-

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tional comments on *L. radiata.* As more data have become available on *L. radiata* through the preparation of additional thin sections, the concentration in this discourse will be on that species.

The series method of analysis is not only vital to the interpretation of species, but also it is the easiest to use. There is an increasing tendency to attempt to analyze species through complex, statistical methods which by their intricacies cause more confusion than enlightenment concerning variation. If a sufficient number of specimens are not analyzed, or if certain variable structures are given undue weight in the development of a formula, the end result is the erection of numerous specific names which are based on misconceptions. Thus, an artificial classification based on "form" species results in which stages of the life history of species are ignored. Moreover, such artificial classifications do not attempt any evaluation of ecological conditions which may impose certain superficial modifications on the structure of the test similar to those postulated for species of *Camerina* (Cole, 1958, p. 191).

Parker (1962, p. 219) wrote "The artificial splitting of species produces complications that are endless, as each worker emphasized different criteria. The result is that one is presented with an enormous array of taxa having identical ranges . . . Planktonic foraminifera are extremely variable and large suites of specimens are needed to understand the variation within a species. It also is desirable to have suites of specimens from various localities."

Cole (1962, p. 30) wrote "The description of new species and new genera is meaningless, and, in fact, detrimental, unless the proper background has been obtained, not only through the examination of the literature, but also by actual observation on many specimens from as many localities as possible."

As an example of the confusion which has existed in the interpretation of species the taxonomic history of the supposedly well-known American species *L. undosa* may be used. This species has been regarded as being a valid one which could be separated from other supposedly valid species, such as *L. favosa.*

Vaughan (1933, p. 37) many years ago demonstrated that *Lepidocyclina crassata* Cushman and *L. chattahoochensis* Cushman were synonyms of *L. favosa* Cushman, remarking that "This is an amazingly variable species." By 1953 (Cole, p. 30) stated concerning *L. favosa* and *L. undosa*: "At most localities these two species occur together. It is extremely probable that only one highly variable species is represented, and that *L. gigas* Cushman is the microspheric form of the combined species."

However, by 1945 (Cole, *b*, p. 41-44) there were sufficient data available to demonstrate that *L. undosa* could be interconnected with *L. favosa* through specimens which Vaughan (1926, p. 395) had named *L. undosa tumida*. Yet, such was the grip of tradition that it was not until 1961 (Cole and Applin, p. 133) that *L. favosa* was cited definitely as a synonym of *L. undosa*.

Meantime, Van der Vlerk (1959, p. 673) published a chart to illustrate the evolution of the eulepidine kind of embryonic chamber. As representatives of the American species with eulepidine embryonic chambers he arranged *L. senni* Gorter and Van der Vlerk (1932, p. 109) at the base ("Vicksburgien") above which he placed *L. favosa* ("Chichasawhayien"), and at the top he introduced *L. undosa* ("Chattien") as the most advanced species.

Such an arrangement is not only illogical, but also it is misleading, particularly as it suggested stratigraphic separation of distinct species with restricted ranges.

Gravell (1933, p. 31) and Cole (1934, p. 26, 27) demonstrated that the equatorial sections of specimens referred to *L. undosa* and *L. favosa* were similar and possessed embryonic chambers which varied from specimen to specimen from nephrolepidine to eulepidine. Moreover, specimens referrable to these two species have been reported in association from numerous localities (Gravell and Hanna, 1938, p. 996; Cole, 1934, p. 26, 27). Finally, *L. senni* as shown by the type illustrations (Gorter and Van der Vlerk, 1932, pl. 14, figs. 3, 4) is unquestionably a synonym of *L. undosa*.

Although these data were available to Van der Vlerk and Cole among others, many "form" species (for example, *L. favosa* and *L. undosa*) were treated as valid ones. Such misconceptions inhibit the development of a natural classification. Moreover, the tendency is to assign different stratigraphic ranges to the supposedly valid species and to use minor structural variations as proof of evolutionary change with time.

If, however, even a limited number of species are analyzed by the series concept, a more stable classification should result with more complete understanding of the reproduction and variation in the species of even such extinct genera as *Lepidocyclina.*

The specimens which are illustrated are deposited temporarily in the Cole collection at Cornell University but eventually will be transferred to the U. S. National Museum.

Localities of figured specimens

Lau, Fiji

Loc. 1—Basal foraminiferal limestone, near western end of western lake, Oneata; altitude about 15 feet; H. S. Ladd, collector; Tertiary *f,* Miocene, Futuna limestone (references: Ladd and Hoffmeister, 1945, p. 189, locality L 466; Cole, in Ladd and Hoffmeister, 1945, p. 274; Cole, 1960, p. 134; 1961, p. 138; 1962, p. 31).

2—Limestone, cave on northern coast about 0.33 mile west of Futuna, Vanua Mbalavu; Tertiary *f,* Miocene, Futuna limestone (Ladd and Hoffmeister, 1945, p. 176, locality 62; Cole, in Ladd and Hoffmeister, 1945, p. 274).

Viti Levu, Fiji

3—Tuffaceous marl from a large block in stream bed at entrance to cave at Kalambu; W. Briggs, collector, 1962; Tertiary *f,* Miocene, Suva formation; sample supplied through the courtesy of Harry S. Ladd (reference: Ladd, 1934, p. 81, 84; localities 174-177 and 316; Whipple, in Ladd, 1934, p. 150).

4—Abandoned quarry 6.25 miles from Suva on Princes Road to Nausori; W. Briggs, collector, 1962; Tertiary *f,* Miocene, Suva formation; sample supplied through the courtesy of Harry S. Ladd (reference: Ladd, 1934, p. 80, locality 158; Whipple, in Ladd, 1934, p. 150).

Borneo

5—Djaing Langif, Tabalong District, southeast Borneo; gift to the late T. W. Vaughan by A. Tobler (reference: Douvillé, 1925, p. 109, text fig. 83; Cole, 1961, p. 140).

6—Kahajan (report no. 105-Kah. I, no. 239, 231.4-232.4 m.); specimen is a gift from I. M. van der Vlerk (reference: Cole, 1961, p. 138).

VARIATIONS BETWEEN SPECIMENS OF *LEPIDOCYCLINA RADIATA* (Martin)

In 1945 Cole (*a,* p. 292) described *Lepidocyclina oneataensis* as a new species, the type of which was obtained from locality 1. Specimens from this locality were restudied later (Cole, 1960, p. 136), and the conclusion was reached that *L. oneataensis* was a synonym of *L. radiata* (Martin). In addition, seven formerly recognized Indo-Pacific species of *Lepidocyclina* were placed in the synonymy of *L. radiata.*

Van der Vlerk (1961) restudied the type of *L. radiata* (Martin). The description and illustrations which he published supplied essential details of the internal structure of *L. radiata* which had not been known. However, Van der Vlerk (1961, p. 622) decided that he would have to complete additional studies before expressing an opinion on the synonymy of *L. radiata* which had been suggested by Cole (1960).

In 1962 Eames, *et al.,* (*b,* p. 303) concluded that all the species which Cole (1960, p. 137) had placed in the synonymy of *Lepidocyclina radiata* were valid and could be recognized readily. Moreover, they (Eames, *et al.,* 1962*b,* p. 293) considered that these species "had different stratigraphic ranges."

Three important questions are apparent because of the conclusions of Van der Vlerk and Eames, *et al.* Is there only one species at locality 1? If so, is this species *L. radiata* (Martin)? Is the synonymy proposed by Cole logical?

Variability between specimens of species can best be demonstrated by an analysis of individuals from a single population, particularly one in which only a single species occurs. Locality 1 is ideal as specimens are abundant and well preserved. From locality 1 illustrations of 41 specimens are available as follows:

Source	*Illustration*	*Kind of illustration*
Cole (1945)	pl. 26, figs. A-D	Equatorial sections
	pl. 26, figs. E-H	Vertical sections

	pl. 26, figs. I, J	External views
Cole (1960)	pl. 1, figs. 1-3, 6-8, 10; pl. 3, fig. 7	Equatorial sections
	pl. 1, figs. 4, 5	Vertical sections
Cole (1961)	pl. 11, fig. 1	Equatorial section
Cole (1962)	pl. 4, figs. 1, 2	Equatorial sections
This article	Pl. 42, figs. 1-4; Pl. 43, figs. 1-3; Pl. 44, fig. 1; Pl. 47, fig. 5	Equatorial sections
	Pl. 43, fig. 4; Pl. 44, figs. 4-6	Vertical sections
	Pl. 45, figs. 2, 4, 6	External views

In a previous study (Cole, 1962, p. 35, 36) data were given, based on 28 specimens from locality 1, on the kind of embryonic chambers which these specimens had. These same data are given for 56 specimens in Tables 1 and 2.

It should be emphasized that the specimens from locality 1 have similar internal structures and could not be separated except by the shape of the embryonic chambers. Specimens without a rim (Pl. 45, fig. 6), with a rim without rays (Pl. 45, fig. 2), and with a rim with rays (Pl. 45, fig. 4) were sectioned. In every case the equatorial and lateral chambers were similar. Therefore, if more than one species were present at locality 1, the only distinguishing structure would be the shape and arrangement of the embryonic chambers.

Table 1 shows that about 73 percent of the specimens from locality 1 had bilocular embryonic chambers which varied from nephrolepidine (Pl. 42, figs. 1, 3, 4) through eulepidine (Cole, 1945*a*, pl. 26, fig. A; 1960, pl. 1, fig. 2) to trybliolepidine (Pl. 42, fig. 2). The remaining 27 percent have embryonic chambers of irregular kind of which about 18 percent were trilocular.

The specimens with irregular embryonic chambers interconnect as a series with those with bilocular embryonic chambers through the specimen illustrated as figure 3, Plate 43. This specimen originated from a mass of cytoplasm in which there were two nuclei, both of which were responsible for the formation of the nearly normal,

Table 1.—Number and percent of regular and irregular embryonic chambers in *L. radiata* from locality 1

Kind of embryonic chamber	*Number of specimens*	*Percent*
Bilocular	41	73.2
Trilocular	10	17.8
Otherwise irregular	5	8.9
Totals	56	99.9

Table 2.—Number and percent of specimens of *L. radiata* from locality 1 arranged according to kind of embryonic chambers

Kind of embryonic chamber	*Number of specimens*	*Percent*
Nephrolepidine	13	23.2
Eulepidine	17	30.3
Trybliolepidine	11	19.6
Trilocular	10	17.8
"Twinned" trilocular	1	1.7
"Twinned" trilocular and multilocular	1	1.7
"Twinned" multilocular	1	1.7
Multilocular	2	3.6
Totals	56	99.6

large, initial embryonic chamber. After its development one nucleus produced as a second embryonic chamber the aborted small chamber on the right side of the initial chamber, whereas the other nucleus, which became the dominant one, caused the formation of the normal, large, second embryonic chamber.

In specimens, such as the ones illustrated by figure 2, Plate 43; figure 5, Plate 46; and figure 5, Plate 47, a mass of cytoplasm with two nuclei caused the formation of trilocular embryonic chambers. The central chamber of such an embryonic set corresponds to the initial chamber of a bilocular set. A mass of cytoplasm in which there are more than two nuclei resulted in the formation of multilocular embryonic chambers (Pl. 43, fig. 1).

It has been demonstrated in *Lepidocyclina pustulosa* H. Douvillé (Cole, 1960, pl. 2, fig. 5; 1962, pl. 7, figs. 1, 5) and in *Lepidocyclina vaughani* Cushman (Cole, 1961, pl. 12, fig. 4) that rare specimens occur in which there is a set of normal bilocular embryonic chambers adjacent to which there is a multilocular set of embryonic chambers. Such specimens interconnect specimens with bilocular embryonic chambers with those which have multilocular embryonic chambers.

In the suite of specimens from locality 1 one specimen (Pl. 44, fig. 1) was found in which there was a trilocular set of embryonic chambers adjacent to which there was a multilocular set. Thus, specimens with multilocular embryonic chambers may be correlated with those with trilocular embryonic chambers which in turn interconnect with specimens with normal bilocular embryonic chambers.

As a result of the study made in 1960 Cole (p. 138) wrote: "The evidence presented demonstrates that within one species of *Lepidocyclina* there is extreme variability in the shape of the embryonic chambers. Some specimens referred to *L. radiata* have nephrolepidine embryonic chambers, others have eulepidine chambers, still others have trybliolepidine chambers, and finally, others have multilepidine chambers. This variability in the shape of the embryonic chambers constitutes one series."

The major emphasis has been placed so far in this analysis upon the variable shape of the embryonic chambers as these chambers are the only element which is variable. Numerous vertical sections (Cole, 1945*a*, pl. 26, figs. E-H; 1960, pl. 1, figs. 4, 5; Pl. 43, fig. 4; Pl. 44, figs. 4-6; Pl. 46, fig 3) have been prepared. These sections are so similar that they must represent only one species.

Moreover, specimens were cut to the equatorial plane so that the embryonic and equatorial chambers could be observed. After this a half vertical section was prepared. The specimen (Pl. 46, fig. 3), for example, had trilocular embryonic chambers, yet the lateral chambers are similar to specimens with bilocular embryonic chambers.

The evidence presented in 1960 (Cole) upon which the concept of using a series of specimens of a single species to demonstrate that long used subgeneric names such as *Nephrolepidina* or *Multilepidina,* are invalid was thought to be conclusive. Yet, Drooger (1962, p. 39) argued in part ". . . it is certainly not advisable to give too much weight to these subgenera. Nevertheless, they have been used for a long time, especially because of their stratigraphic value, and there has been general agreement about the way these subgenera are to be used."

Eames, *et al.,* (1962*b,* p. 290) also challenged the "series concept" of Cole as shown by the following quotation: "later work has established the existence of so many species with pliolepidine nucleoconchs . . . that it is no longer possible to regard this type of nucleoconch as teratoid, as Cole (1960) persisted in doing."

Such statements which are unsupported by detailed analysis of the kind presented in this discourse not only confuse the issue but also are not based upon generally accepted biological principles.

Names, either specific, subgeneric, or generic, cannot be maintained because they ". . . have been used for a long time . . ." (Drooger, 1962, p. 39). Nor is it possible to evade the acceptance of the fact that multilocular embryonic chambers do occur in specimens of a series in which normal bilocular embryonic chambers occur. Eames, *et al.,* (1962*b,* p. 299) in spite of the data available insisted that they ". . . strongly reaffirm the maintenance of the supraspecific classification of the lepidocycines based primarily on the characters of the megalospheric nucleoconch."

As I consider arguments of the kind advanced by Drooger (1962), Hanzawa (1962), and Eames, *et. al.,* (1962*b*) for *status quo* sterile and defeatist, this restudy of the specimens from locality 1 was undertaken. I hope that the illustrations of the specimens from locality 1 given here and elsewhere demonstrate that only one species with variable embryonic chambers is present at this locality.

If a more logical explanation can be given concerning the variable shape of embryonic chambers than the one advanced in 1960 by me, it would be welcomed and accepted. However, one cannot accept as valid proof generalized statements, such as, "Even extreme examples of normal variation in *P. tobleri* . . . are still clearly (especially in view of the nature and arrangement of the post-nepionic equatorial chambers) examples of complex, but single embryonts . . ." (Eames, *et al.*, 1962*b*, p. 294). This concept is absurd in view of the data available by 1960 and subsequently demonstrated in the most positive manner by abundant illustrative material.

LEPIDOCYCLINA RADIATA (MARTIN) IN THE FIJI ISLANDS

Although the question of variability in a single species has been proven, the name to be applied to this species might be questioned in view of the retention of the specific name *L. oneataensis* Cole by Eames, *et al.*, (1962*b*, p. 303), and their rejection of *L. radiata* for the specimens from locality 1 as proposed by Cole (1960, p. 136).

If the illustrations of the type of *Lepidocyclina radiata* given by Van der Vlerk (1961, pl. 1, fig. 1; pl. 2, figs. 1-4) are compared with those of the specimens from locality 1 originally named *L. oneataensis* Cole (1945, p. 292), it will be observed that there are no significant differences in the shape and arrangement of internal structures.

Figure 5, Plate 46 is an enlargement of the embryonic chambers of the specimen illustrated as figure 2, plate 4 (Cole, 1962). This should be compared with the illustration of the type (Van der Vlerk, 1961, pl. 2, fig. 1) of *L. radiata*. The embryonic chambers of the type of *L. radiata* are approximately one-half the size of those of the specimen (fig. 5, Pl. 46) from locality 1, but otherwise identical.

Such a difference in size might indicate that these are different species if the shape and arrangement of the elements of the test were not identical. However, size alone has been demonstrated to be extremely variable, not only between specimens of a given species from a given locality, but also between specimens of a given species from different localities. This has been demonstrated in *Lepidocyclina pustulosa* (Cole, 1963, fig. 1, p. 25).

Unfortunately, only the details of the type of *L. radiata* are known, therefore the total range in size of the internal structures of specimens associated with the type is not known. However, this lack of data is not absolutely critical. The internal structures of the specimens from locality 1 are not only identical, except for size, with those of the type of *L. radiata,* but also certain specimens (fig. 4, Pl. 45) from locality 1 have the same external appearance as does the type of *L. radiata* (see: Van der Vlerk, 1961, pl. 1, fig. 1).

Therefore, *Lepidocyclina oneataensis* Cole, 1945 (*a*, p. 292) is considered to be a synonym of *L. radiata* (Martin), 1880, as I stated on less complete, but still interpretable, data previously (Cole, 1960, p. 136).

Through the courtesy of Harry S. Ladd I have been able to examine the specimens from Viti Levu, Fiji, which Whipple (in Ladd, 1934, pl. 19, figs. 2-6) identified as *Lepidocyclina radiata* (Martin). In addition, I received from Ladd large samples collected by W. Briggs from Viti Levu (localities 3, 4).

One of these samples (loc. 3) contained abundant specimens of the species Whipple named *Cyclolepidina suvaensis* and the other (loc. 4) had rare specimens of this species. These specimens have been studied in detail, and several of these specimens are illustrated (Pl. 44, figs. 2, 3; Pl. 45, figs. 1, 5, 7, 8; Pl. 46, fig. 2; also Cole, 1963, fig. 6, pl. 14).

From locality 3 with numerous specimens of "*Cyclolepidina suvaensis*" over 100 equatorial sections were prepared. Specimens with bilocular embryonic chambers were not found. Fifty specimens from this lot were selected at random and the number of chambers in each embryonic set was counted. Three (6 percent) specimens had trilocular embryonic chambers (see: Cole, 1963, pl. 14, fig. 6). The number and percent of specimens with more than three chambers in the embryonic mass follow: four chambers, 16 (32 percent) specimens (Pl. 44, fig. 2); 5 chambers, 17 (34 percent) specimens (Pl. 45, fig. 8); 6 chambers, 12 (24 percent) specimens; and 7 chambers, 2 (4 percent) specimens (Pl. 47, fig. 6).

Specimens of "*Cyclolepidina suvaensis*" were rare at locality 4. Seven specimens were recovered of which one (Pl. 45, figs. 1, 5) is illustrated. All seven specimens from this locality had abnormal (multilocular) embryonic chambers. However, Whipple (in Ladd, 1934, pl. 19, figs. 4, 5) in a sample from locality 4 found two specimens with bilocular embryonic chambers. These are the ones that Whipple identified correctly as *L. radiata*.

The specimens from localities 3 and 4, originally identified as *Cyclolepidina suvaensis* Whipple, have vertical sections (Pl. 45, fig. 7) and equatorial chambers (Cole, 1960, pl. 4, fig. 3) which are identical with those of the specimens assigned to *L. radiata* from locality 1. Specimens from locality 3 (Cole, 1963, pl. 14, fig. 6) with trilocular embryonic chambers interconnect the series from locality 3 with the series from locality 1 (Pl. 46, fig. 5) in regard to embryonic chambers.

SYNONYMS OF *LEPIDOCYCLINA RADIATA* (Martin)

The species, grouped geographically, which are considered to be synonyms of *L. radiata* follow:

East Indies

Borneo

Lepidocyclina borneensis Provale, 1909
(*Pliolepidina*) *amoentai* Zuffardi-Comerci, 1929

Java

Lepidocyclina gerthi Caudri, 1939
(*Eulepidina*) *limbata* H. Douvillé, 1916
L. papulifera H. Douvillé, 1916 (microspheric)

Sumatra

Lepidocyclina (*Pliolepidina?*) *luxurians* Tobler, 1925

Formosa

Lepidocyclina (*Multilepidina*) *irregularis* Hanzawa, 1932

Fiji Islands

Lepidocyclina (*Cyclolepidina*) *suvaensis* Whipple, 1934
(*Multilepidina*) *fijiensis* Cole, 1945
(*Eulepidina*) *oneataensis* Cole, 1945
(*Nephrolepidina*) *plummerae* Cole, 1945

Urukthapel, Palau Islands

Lepidocyclina (*Nephrolepidina*) *palauensis* Cole, 1950

Specimens from Viti Levu identified by Whipple (in Ladd, 1934, pl. 20, figs. 1-8) as *Cyclolepidina suvaensis* have been reclassified by Eames, *et al.*, (1962*b*) as follows: *Pliolepidina luxurians* (p. 316, for Whipple's figures 1-4) and *Pliolepidina irregularis* (p. 316, for Whipple's figures 5-8). Although Whipple's identification (*in* Ladd, 1934, pl. 20, figs. 3-6) of other specimens from Viti Levu as *L. radiata* is accepted by Eames, *et al.*, (1962*b*, p. 316), other specimens from Oneata (Cole, 1945*a*, pl. 23, figs. C-E) which are identical with Whipple's specimens are assigned by Eames, *et al.*, (1962*b*, p. 316) to *L. oneataensis*.

Eames, *et al.*, (1962*b*, pl. 6, fig. 4) identify a specimen from central Papua as *Lepidocyclina* (*Nephrolepidina*) *martini* (Schlumberger). This equatorial section is obviously not that species (see: Cole, 1945*a*, pl. 25; Pl. 46, fig. 1, for sections of *L. martini*), but is similar to Whipple's illustration (in Ladd, 1934, pl. 19, fig. 5) and the one given by Cole (1945*a*, pl. 23, fig. E) of *L. radiata*.

For specimens which are considered here to represent one species, Eames, *et al.*, (1962*b*) have used five specific names as follows: *Pliolepidina irregularis* (Hanzawa), *Pliolepidina luxurians* Tobler, *Lepidocyclina* (*Nephrolepidina*) *oneataensis* Cole, *Lepidocyclina* (*Nephrolepidina*) *radiata* (Martin) and *Lepidocyclina* (*Nephrolepidina*) *martini* (Schlumberger).

Even more amazing is their assignment (Eames, *et al.*, 1962*b*, p. 316) of the microspheric specimens (Cole, 1945*a*, pl. 21, figs. A, D-G), identified originally by Cole as *L.* (*Multilepidina*) *irregularis* Hanzawa, to *L. omphalus* Tan. *L. omphalus* is obviously the microspheric form of *L. martini* (Schlumberger), as it is the microspheric form of *L. elegans* Tan, a synonym of *L. martini*.

The publication of Eames, *et al.*, (1962*b*) has so many misconceptions that it is impractical to verify all of them. In addition to the examples given one or two other instances are cited.

Although they admit (Eames, *et al.*, 1962*b*, p. 303) that *L. transiens* Umbgrove, 1929, resembles *L. oneataensis* (= *L. radiata*) they distinguished it by having a flange which is ". . . poorly delimited and narrow, and the pseudopillars poorly developed. The equatorial chambers are much less elongate. The megalospheric nucleoconch has a thinner boundary wall and is perhaps slightly larger."

If Umbgrove's illustrations (1929, unnumbered plate) of *L. transiens* are compared with those of *L. radiata*, the only significant difference that can be found is in the degree of elongation of the equatorial chambers in most specimens of *L. radiata* from locality 1.

However, specimens of *L. radiata* from locality 1 have great variation in the degree of elongation of the equatorial chambers. The specimen (Cole, 1960, pl. 1, fig. 2) which best illustrates this has chambers with radial diameters from 80 to 320 μ.

Caudri (1939, p. 228) in her competent review of *Lepidocyclina* from Java placed *L. transiens* in the synonymy of *L. borneensis*. She also included *L. amoentai* Zuffardi-Comerci as another synonym of *L. borneensis*. Although she (1939, p. 247) maintained *L. borneensis* as a distinct species, she placed it in the "Subgroup of *L. luxurians*," characterizing this group in the following terms: "very large hexagonal median (equatorial) chambers, in circles, rectangular lateral chambers." This brief characterization is applicable to *L. radiata*.

If species are to be defined by the fact that on the average specimens from one locality have more elongate equatorial chambers than do specimens from another locality, the number of species would become astronomical.

As all the structures of *L. transiens* are identical with those of *L. radiata*, except in the degree of elongation of the equatorial chambers, it is not logical to maintain two species. *L. transiens* is a synonym of *L. radiata*.

Although an extensive discussion (Cole, 1962, p. 44) concerning the reasons for considering *L. borneensis* to be a synonym of *L. radiata* has been published recently, additional details follow, particularly to summarize certain aspects of the vertical sections.

Cole (1961) published illustrations of specimens from locality 5 which had been identified by H. Douvillé as *L. borneensis* (see: Cole, 1961, pl. 11, figs. 3, 5) which had irregular embryonic chambers. A vertical section of a specimen from this locality is illustrated as figure 3, Plate 45. At the same time he (Cole, 1961, pl. 11, figs. 2, 6) gave illustrations of the equatorial layer of a specimen from locality 6 which had been identified by Van der Vlerk as *L. borneensis*. A vertical section of a specimen from this locality is illustrated as figure 4, Plate. 46.

Although the specimen of "*L. borneensis*" (Pl. 46, fig. 4) is only about half the size of the specimen of "*L. oneataensis*" (Pl. 46, fig. 3), these vertical sections are otherwise identical. If the equatorial chambers of "*L. borneensis*" (Cole, 1961, pl. 11, fig. 6) are compared with those of "*L. oneataensis*" (Pl. 42, fig. 4), it will be observed that they have the same shape, and, often the same size although certain of the chambers of "*L. oneataensis*" are more elongate radially.

Eames, *et al.*, (1962*b*, pl. 5, fig. 2) illustrated under the name *Pliolepidina* sp. b a specimen from east-central Papua which they characterized as having ". . . spatulate-ogival chambers similar to those of *Pliolepidina tobleri*." Seemingly, they did not recognize that such shaped chambers occur also in *Lepidocyclina radiata*.

Their illustration should be compared with figure 6, Plate 47. This specimen has several annuli of arcuate equatorial chambers similar to those of the Papuan specimen before elongate hexagonal chambers develop. The specimen (fig. 2, Pl. 46) has arcuate equatorial chambers and elongate hexagonal equatorial chambers in the same annuli. This same intermingling of two kinds of equatorial chambers is illustrated by another specimen from Lau, Fiji (Cole, 1945*a*, fig. B, pl. 23). The analysis of these specimens is possible mainly by the application of the series concept.

Each species which has been listed as a synonym has been compared to the series from locality 1, and all have found to exhibit the same structures. There are admittedly size differences between specimens, but otherwise all of these specimens fit exactly in the series analyzed from locality 1 even to the development in most cases of specimens with abnormal embryonic chambers.

The method of study has been stated and specific examples of the application of the series concept have been cited. Therefore, it does not seem necessary to analyze each specific name placed in synonymy in detail.

ECOLOGY

The faunas of larger Foraminifera at localities 1, 3, 4 are strikingly different. There are abundant *Lepidocyclina radiata* at localities 1 and 3, and few specimens of this species at locality 4. At locality 1 the common associated species is *Camerina complanata* which is represented by numerous large specimens (see: Cole, 1945*a*, pl. 13, fig. I).

Cycloclypeus indopacificus Tan (Pl. 45, fig. 9; Pl. 47, figs. 1-4) occurs in abundance at localities 3, 4. The only other species observed at localities 3 and 4 was rare, small specimens of *Camerina complanata* at locality 4. One other difference should be noted. There are numerous, large microspheric specimens of *Lepidocyclina* at locality 3 and few of these at locality 4. No microspheric specimens were found at locality 1, but a few might be recovered from a larger sample.

If data concerning depth of occurrence of genera of larger Foraminifera in the existing seas (Cole, 1957, p. 750) can be accepted as an indicator of past conditions, locality 1 with abundant *Camerina* would represent the shallowest depth, probably around 40 fathoms.

Abundant *Cycloclypeus* at localities 3 and 4 suggest depths of about 180 fathoms. However, it may be postulated that because of the comparative abundance of *Lepidocyclina* at locality 3 this locality reflects slightly shallower conditions than does locality 4 at which *Lepidocyclina* are rare.

Ecological conditions may be one of the causes of abnormal reproduction in the larger Foraminifera. Cole (1962, p. 43) expressed the opinion that ". . . populations in which the number of specimens with multilocular embryonic chambers are high were living under marginal conditions. In such populations reproduction was upset which resulted in the formation of multilocular embryonic chambers in many individuals."

The specimens of *Cycloclypeus* (Pl. 47, figs. 1-4) at locality 3 have the first nepionic chamber subdivided into numerous chamberlets. This condition is not usual in the specimens from other localities which I have examined. Tan (1932, p. 18) also observed "As a rule the first nepionic chamber is not subdivided into chamberlets."

As all the specimens of *Lepidocyclina* which were associated with these specimens of *Cycloclypeus* had abnormal embryonic chambers, there may be some factor in the ecological situation which caused specimens of two distinct genera to produce abnormal structures. However, there are not sufficient data to make a definite correlation although this association is suggestive that ecological conditions do have influence.

STRATIGRAPHIC CONCLUSIONS

Van der Vlerk (1961, p. 624) wrote that the *Cycloclypeus* associated with the type of *L. radiata* have ". . . three, or at the most, four nepionic chambers. From these facts it can be concluded that the *Cycloclypeus* of Sindangbaran must be assigned to the Sectio *carpenteri,* Subsectio *carpenteri.* This too is an indication that a Tertiary-f age is probable."

Whipple (in Ladd, 1934, p. 142) found specimens of *Cycloclypeus* (*Katacycloclypeus*) *annulatus* Martin in association with "*Cyclolepidina suvaensis*" (= *L. radiata*) at several stations on Viti Levu, Fiji. Tan (1932, table 5) gave the range of *C.* (*K.*) *annulatus* in Indonesia as Burdigalian through the Vindobonian.

At localities 3 and 4 *L. radiata* is associated with specimens which are identified as *Cycloclypeus indopacificus* Tan, a species which Cole (Cole, *et al.,* 1960, p. 97) considered to extend from upper Tertiary *e* into probably Tertiary *g*. However, this species is best developed and most abundant in Tertiary *f*.

Although cycloclypei were not found at locality 1, Cole (1945*a,* Table 18) recovered specimens of cycloclypei at other stations at which *Lepidocyclina oneataensis* (= *L. radiata*) occurred. At that time he identified these cycloclypei as *C. indopacificus terhaari* Tan, *C. inornatus inornata* Tan, and *C. reticulatus* Caudri. These are all *C. indopacificus* Tan.

All the data indicate that the localities on Oneata from the Futuna limestone at which *L. radiata* was found are Tertiary *f* in age, and correlate with the stations on Viti Levu (Suva formation) at which *L. radiata* occurred. This correlation had been made previously (Cole, 1945*a,* p. 272) but is strengthened by this study.

As individual species, such as *L. radiata,* often have relatively long stratigraphic ranges, the presence of such species does not necessarily exactly date the strata in which they occur, except to limit these sediments within the known total stratigraphic range of the particular species.

L. radiata ranges from Tertiary *e* into Tertiary *f*. The better known species which are considered to be synonyms of *L. radiata* as the result of this study as well as previous ones have been reported by competent authorities to have a range from Tertiary *e* into Tertiary *f*.

For example, Van der Vlerk (1928, p. 192) gave the range of *L. borneensis* as "Tertiary *e;* lower part Tertiary *f,*" an opinion substantiated by Caudri (1939, p. 149, 150). *L. luxurians* was reported by Van der Vlerk (1928, p. 192) as occurring only in Tertiary *e*, but Mohler (1949, fig. 3, p. 526) extended the range of this species into Tertiary *f*.

Eames, *et al.*, (1952*b*, p. 293) not only maintained seven of the species which are considered to be synonyms of *L. radiata*, but also they stated each of these species has a definite stratigraphic range. Two of these species (*L. borneensis* and *"P." luxurians*) are stated to range from Tertiary *e* into Tertiary f_2; one (*"P." irregularis*) is given as T. f_{1-2}; another (*L. radiata*) is confined to T. f_2; still another (*L. oneataensis*) is restricted to T. f_{2-3}; and two others (*L. gerthi* and *L. transiens*) are assigned to T. *f*.

Even if one were to accept that these seven species are distinct and recognizable ones, it is doubtful if their stratigraphic ranges could be stated with the precision which Eames, *et al.*, imply. If the possibility is accepted that variation may occur in a species, such stratigraphic restrictions become an absurdity.

It is only when a species has become so completely known throughout its geographic and stratigraphic range that there is no question concerning its identification that such a species may be used with the precision implied by Eames, *et al.*, (1962*a*, *b*).

Thus, stratigraphic correlation must depend upon specific associations, *i.e.*, the entire fauna, not only at a single locality, but at as many localities as may be available. Even then one may not be absolutely certain of the stratigraphic relationship of two related, but somewhat different, faunas. Such faunas may be stratigraphically equivalent, or there may be some stratigraphic separation.

Table 3 gives the fauna of larger Foraminifera found in the Futuna limestone (Ladd and Hoffmeister, 1945, p. 26) of Lau, Fiji. Cole (1945*a*, p. 274) originally identified 27 species and varieties which were obtained from this limestone. Modernization of these specific and varietal names reduces the number to 12.

Although the age determination of the Futuna limestone is not affected by this reorganization, the original correlation between the individual localities within this formation is improved by demonstrating that the same species occur at numerous stations. For example, from one locality only *Lepidocyclina transiens* Umbgrove was identified. This lepidocycline was associated with camerinids and cycloclypei which occurred with *L. oneataensis* Cole at numerous other localities in the Futuna limestone (Cole 1945*a*, p. 274).

The recognition that *L. transiens* and *L. oneataensis* are synonyms of *L. radiata* not only simplifies the problem of identification of the species but also permits a more exact correlation to be made.

Table 3.—Comparison of specific names for specimens from the Futuna limestone used formerly and at present.

Generic and specific names used in: 1945*a* (Cole, p. 274)	1963
Operculinella cumingii (Carpenter)	*Camerina venosa* (Fichtel and Moll)
Operculina bartschi Cushman *O. complanata japonica* Hanzawa	*Camerina complanata* (Defrance)
O. mbalavuensis Cole	*Camerina mbalavuensis* (Cole)
Cycloclypeus (*Cycloclypeus*) *eidae* Tan *C.* (*C.*) *posteidae pentekaideka-septus* Tan	*Cycloclypeus* (*C.*) *eidae* Tan
C. (*C.*) *indopacificus douvillei* Tan *terhaari* Tan *inornatus inornatus* Tan *posteidae hexaseptus* Tan *reticulatus* Caudri	*Cycloclypeus* (*C.*) *indopacificus* Tan
C. (*Katacycloclypeus*) *annulatus* Martin	*Cycloclypeus* (*K.*) *annulatus* Martin
C. (*K.*) *martini* van der Vlerk	*Cycloclypeus* (*K.*) *martini* van der Vlerk
Lepidocyclina (*Multilepidina*) *irregularis* Hanzawa (*M.*) *fijiensis* Cole (*Nephrolepidina*) *plummerae* Cole (*Eulepidina*) *oneataensis* Cole *transiens* Umbgrove *radiata* (Martin) *L. papulifera* H. Douvillé	*Lepidocyclina* (*Eulepidina*) *radiata* (Martin)
L. (*Nephrolepidina*) *japonica* Yabe *angulosa* Provale	*Lepidocyclina* (*E.*) *japonica* Yabe
L. (*N.*) *martini* Schlumberger *L. stratifera* Tan	*Lepidocyclina* (*E.*) *martini* Schlumberger
L. (*Nephrolepidina*) *rutteni* van der Vlerk *rutteni lauensis* Cole	*Lepidocyclina* (*E.*) *rutteni* van der Vlerk
L. (*N.*) *sumatrensis inornata* Rutten	*Lepidocyclina* (*E.*) *sumatrensis* (Brady)

Regional correlation is improved by the proper recognition of species. For example, Cole (1950) identified from a limestone in the Palau Islands *Camerina bartschi* Cushman, *C. ammonoides* (Gronovius), *Lepidocyclina rutteni lauensis* Cole and *L. palauensis* Cole. He correctly placed this limestone in Tertiary *f*. However, this age assignment is strengthened, and the correlation of this limestone with the Futuna limestone of Lau, Fiji, is enhanced by recognizing that *L. palauensis* is a synonym of *L. radiata*.

It should be emphasized that if Eames, *et al.*, (1962*b*, p. 301) had employed the series concept enunciated by Cole (1960, p. 138), they would have recognized that lepidocyclines with trilocular and multilocular embryonic chambers are abnormal specimens within specific series of which many of the specimens have normal bilocular embryonic chambers. Thereby, they would not have placed every specimen with multilocular embryonic chambers in a separate genus (*their "Pliolepidina"*) which they concluded was stratigraphically restricted to "Aquitanian to Burdigalian or (?) Vindobonian."

Analyses of such species as *L. pustulosa* (Cole, 1963) and *L. radiata* clearly demonstrate that lepidocyclines with abnormal embryonic chambers cannot be used for stratigraphic correlation. Therefore, the argument of Eames, *et al.*, (1962*a*) that all the American sediments which contain lepidocyclines with multilocular embryonic chambers (*their "Pliolepidina tobleri"*) are *ipso facto* Miocene, thus transferring most of the American Oligocene section, and, in addition, some of the American upper Eocene into the Miocene, is incorrect. Insofar as larger Foraminifera are involved, it would appear that their conclusions concerning the stratigraphic position of parts of the American upper Eocene and Oligocene are invalid.

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PLATES

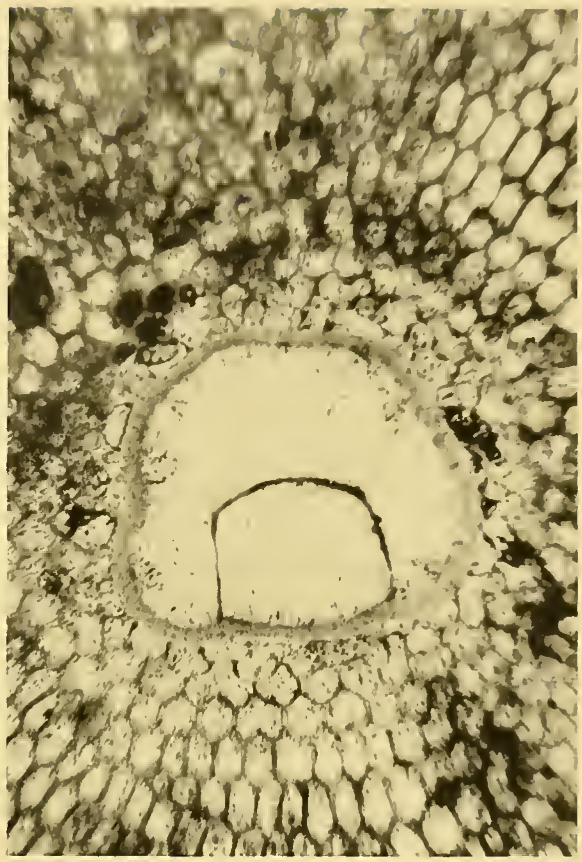
Explanation of Plate 42

Figure		Page
1-4.	**Lepidocyclina (Eulepidina) radiata** (Martin)	162, 171

1,3,4. Central part of equatorial sections, X 40, of megalospheric specimens with "nephrolepidine" kind of embryonic chambers to illustrate variable shape of these chambers.

2. Central part of an equatorial section, X 40, of a megalospheric specimen with embryonic chambers of the "trybliolepidine" kind.

1-4. Loc. 1—see text for locality descriptions.



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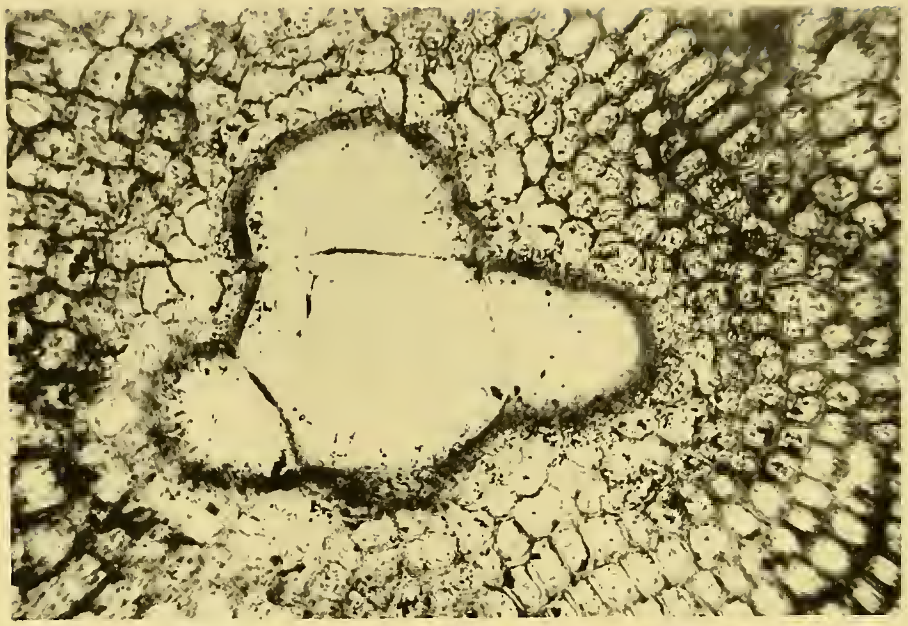

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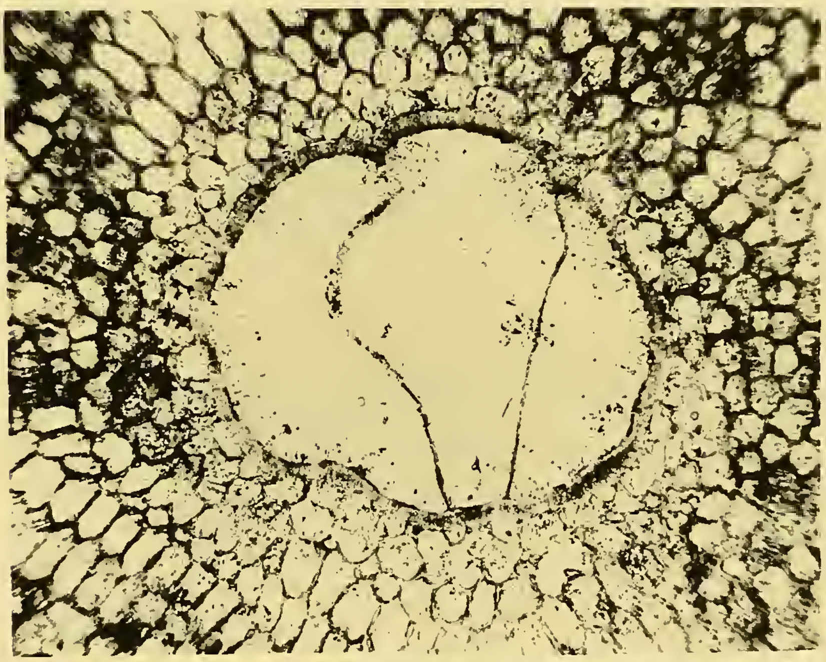

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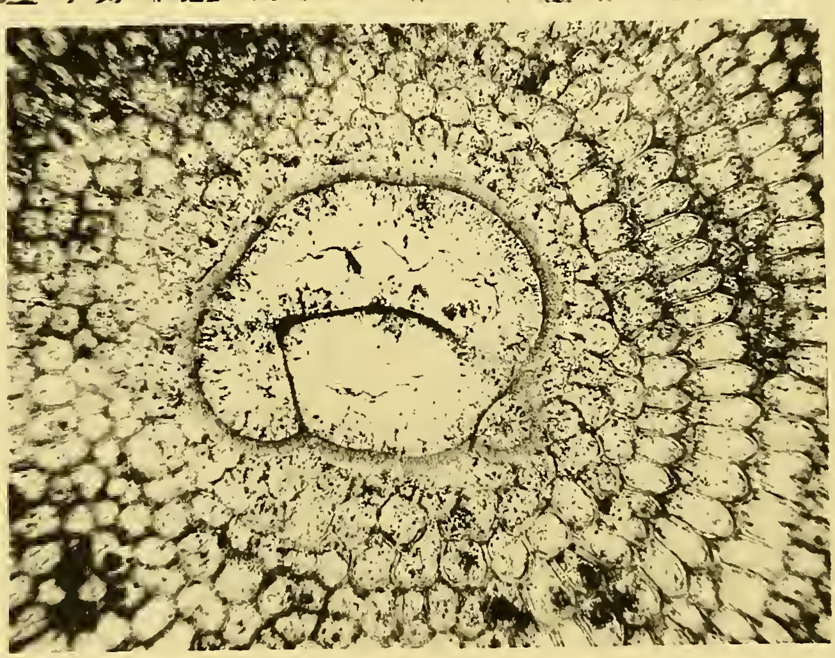

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4

Explanation of Plate 43

Figure | Page

1-4. **Lepidocyclina (Eulepidina) radiata** (Martin) 162, 163, 164

1. Central part of an equatorial section, X 40, of a megalospheric specimen with multilocular embryonic chambers.
2. Central part of an equatorial section, X 40, of a megalospheric specimen with trilocular embryonic chambers.
3. Central part of an equatorial section, X 40, of a megalospheric specimen with slightly deformed, eulepidine embryonic chambers; note particularly the small, aborted chamber on the right side of the initial chamber.
4. Vertical sections, X 20, of two megalospheric specimens.

1-4. Loc. 1—see text for locality descriptions.

Explanation of Plate 44

Figure Page

1-6. **Lepidocyclina (Eulepidina) radiata** (Martin) 164, 167

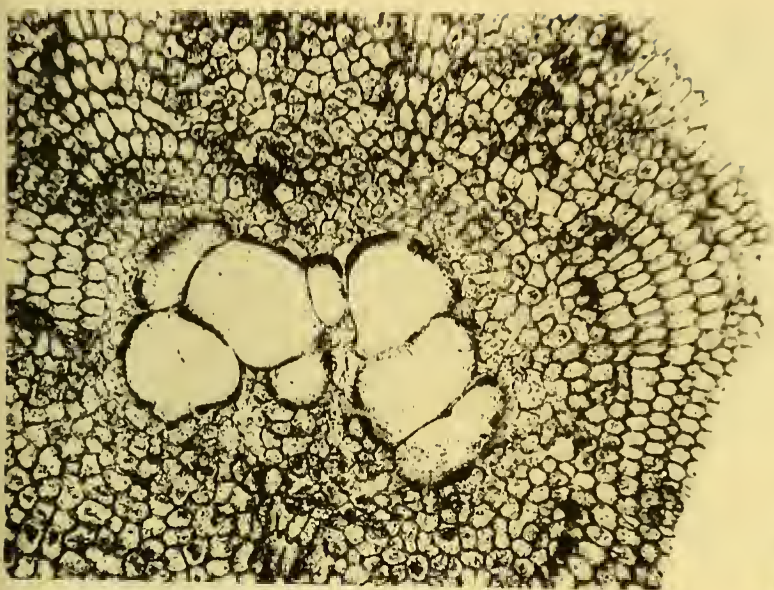
1. Central part of an equatorial section, X 20, of a megalospheric individual in which two sets of embryonic chambers are developed; those to the right are trilocular and the one on the left is multilocular.

2,3. Central part of equatorial sections, X 40, to illustrate the variable shape of multilocular embryonic chambers.

4-6. Vertical sections, X 20, of megalospheric specimens; 4, seemingly a specimen with multilocular embryonic chambers.

1,4-6. Loc. 1—see text for locality descriptions.

2,3. Loc. 3.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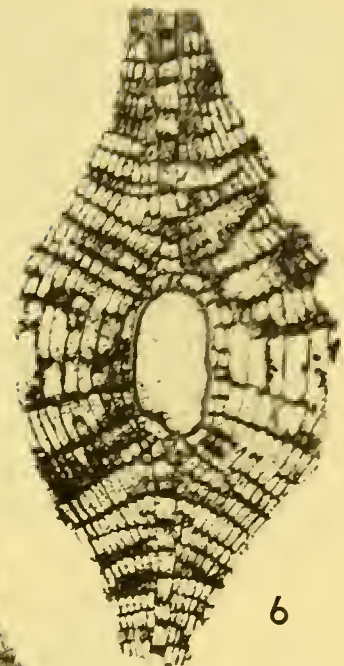
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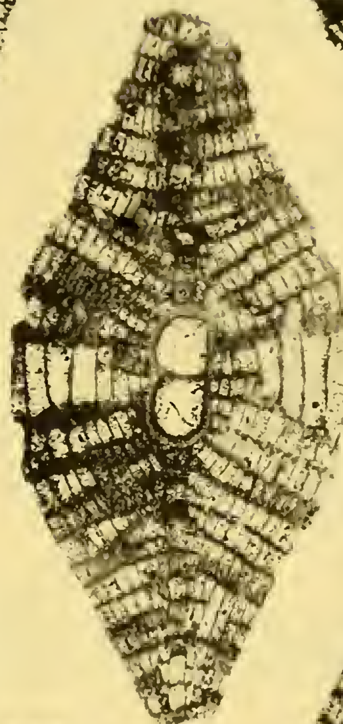
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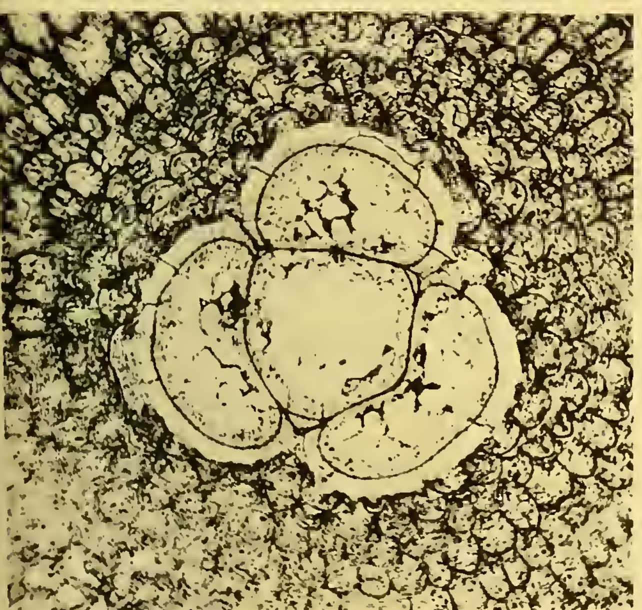
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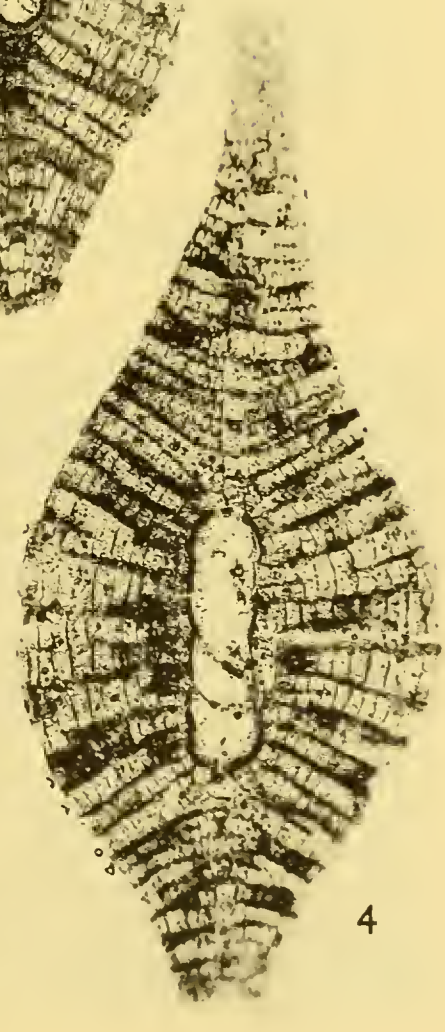
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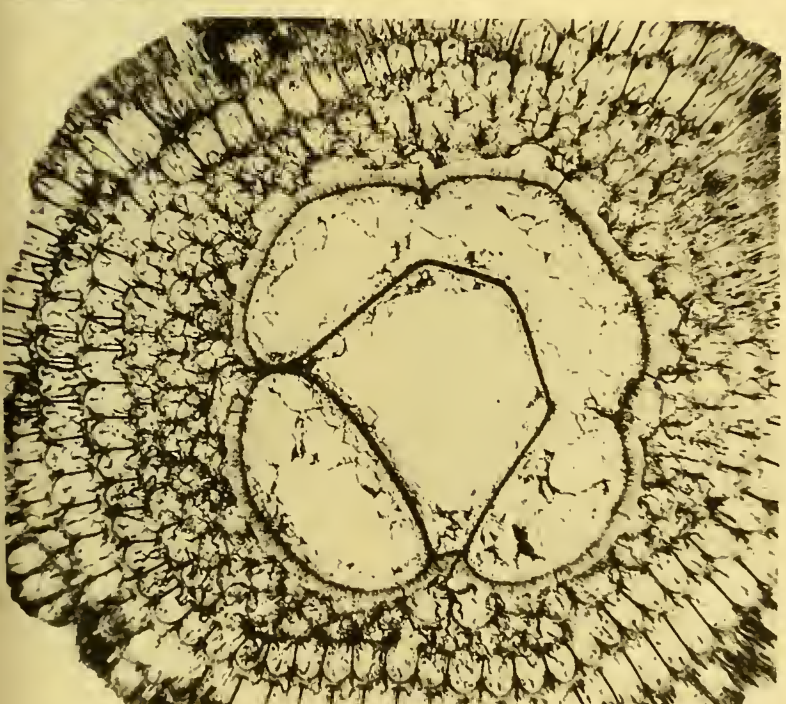
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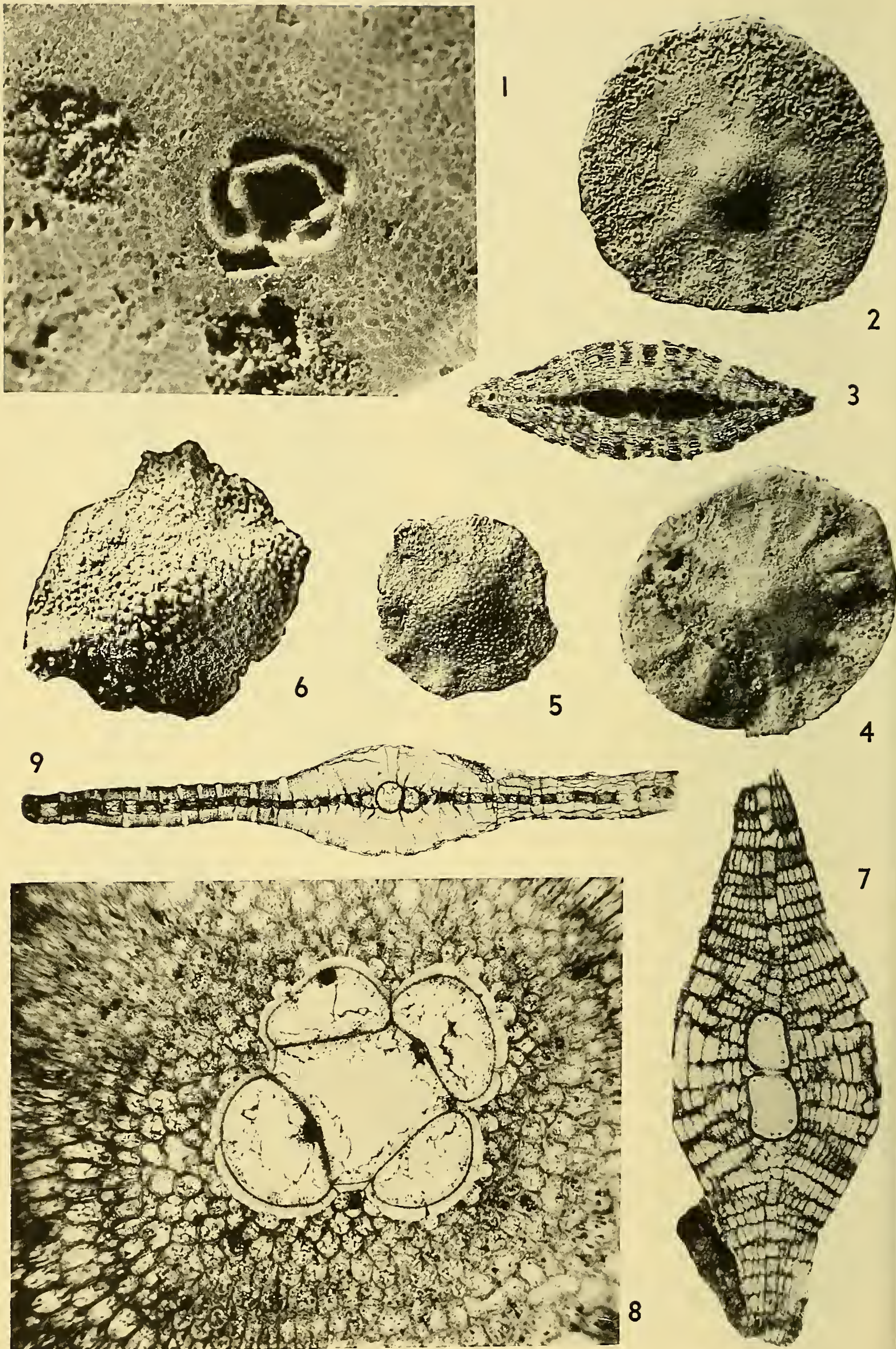
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Explanation of Plate 45

Figure Page

1-8. **Lepidocyclina (Eulepidina) radiata** (Martin) 162, 167, 168, 170

1. Central part, X 20, by reflected light of the megalospheric specimen illustrated as figure 5, this plate.

2. External view, X 4, of a megalospheric specimen with a small, sharply defined, elevated umbo which is surrounded by a broad, thin, flat rim.

3. Vertical sections, X 20, of a specimen previously identified as *L. borneensis* Provale; for equatorial sections of specimens from this locality see: Cole, 1961, pl. 11, figs. 3, 5.

4. External view, X 4, of a megalospheric specimen with a broad, low umbo which is surrounded by a broad, thin, flat rim across which are numerous, narrow, distinctly elevated rays.

5. External view, X 4, of a megalospheric specimen with a broad, low umbo and a relatively narrow rim with numerous, broad, low undulations.

6. External view, X 10, of the umbonal part of a megalospheric specimen whose rim has been destroyed.

7. Vertical section, X 20, of a megalospheric specimen whose rim has been destroyed.

8. Central part, X 40, of a megalospheric specimen with multilocular embryonic chambers.

9. **Cycloclypeus (Cycloclypeus) indopacificus** Tan 173

Vertical section, X 20; note pillars in the rim on the left side.

1,5,7. Loc. 4—see text for locality descriptions.

2,4,6. Loc. 1.

3. Loc. 5.

8,9. Loc. 3.

Explanation of Plate 46

Equatorial section, X 40, of a megalospheric specimen to illustrate the embryonic, periembryonic and equatorial chambers and the rayed character of the test; introduced for comparison with *L. radiata* (Martin).

2. Part of an equatorial section, X 40, of a microspheric specimen to illustrate the variable shape of the equatorial chambers which result from the section encountering the equatorial plane at different levels.

3. Vertical section, X 20, of a megalospheric specimen which was ground on one side to the equatorial layer; the embryonic chambers of this specimen were trilocular, similar to those of the specimen illustrated as figure 5, this plate.

4. Vertical section, X 40, of a megalospheric specimen identified by I. M. van der Vlerk as *L. borneensis* Provale; for an equatorial section of a specimen from this same locality see: Cole, 1961, pl. 11, figs. 2, 6.

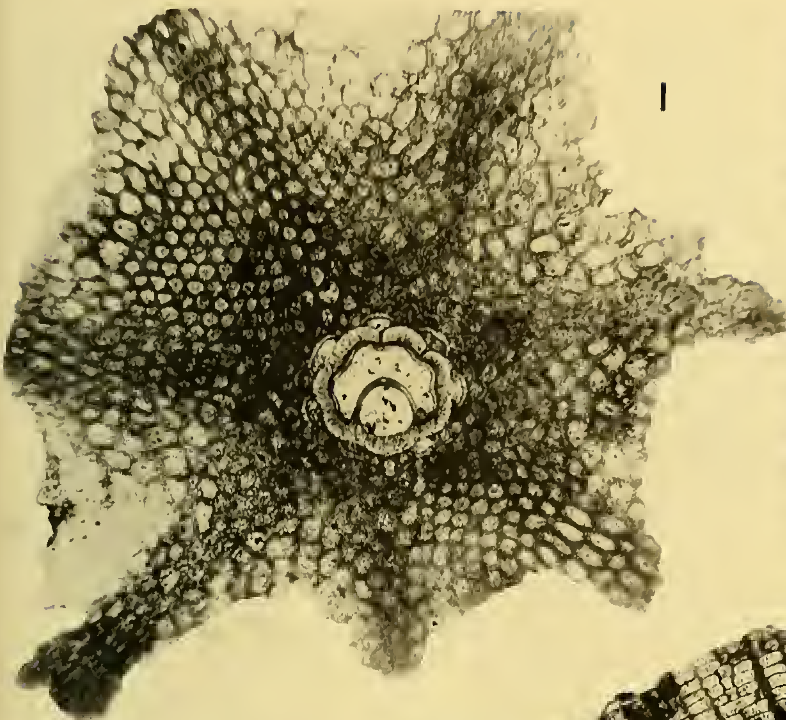
5. Central part, X 90, of the megalospheric specimen illustrated as figure 2, plate 4 (Cole, 1962) ; this illustration should be compared with the sketch and photograph given by Van der Vlerk (1961, fig. 1) of the type of *L. radiata* (Martin).

1. Loc. 2—see text for locality descriptions.

2. Loc. 3.

3,5. Loc. 1.

4. Loc. 6.



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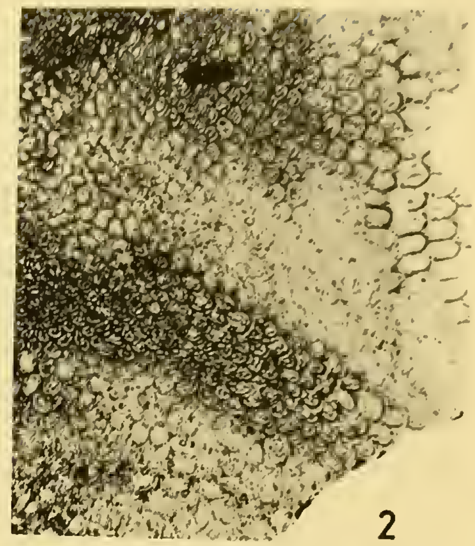

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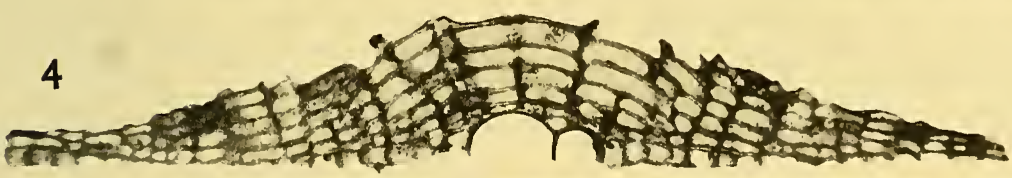

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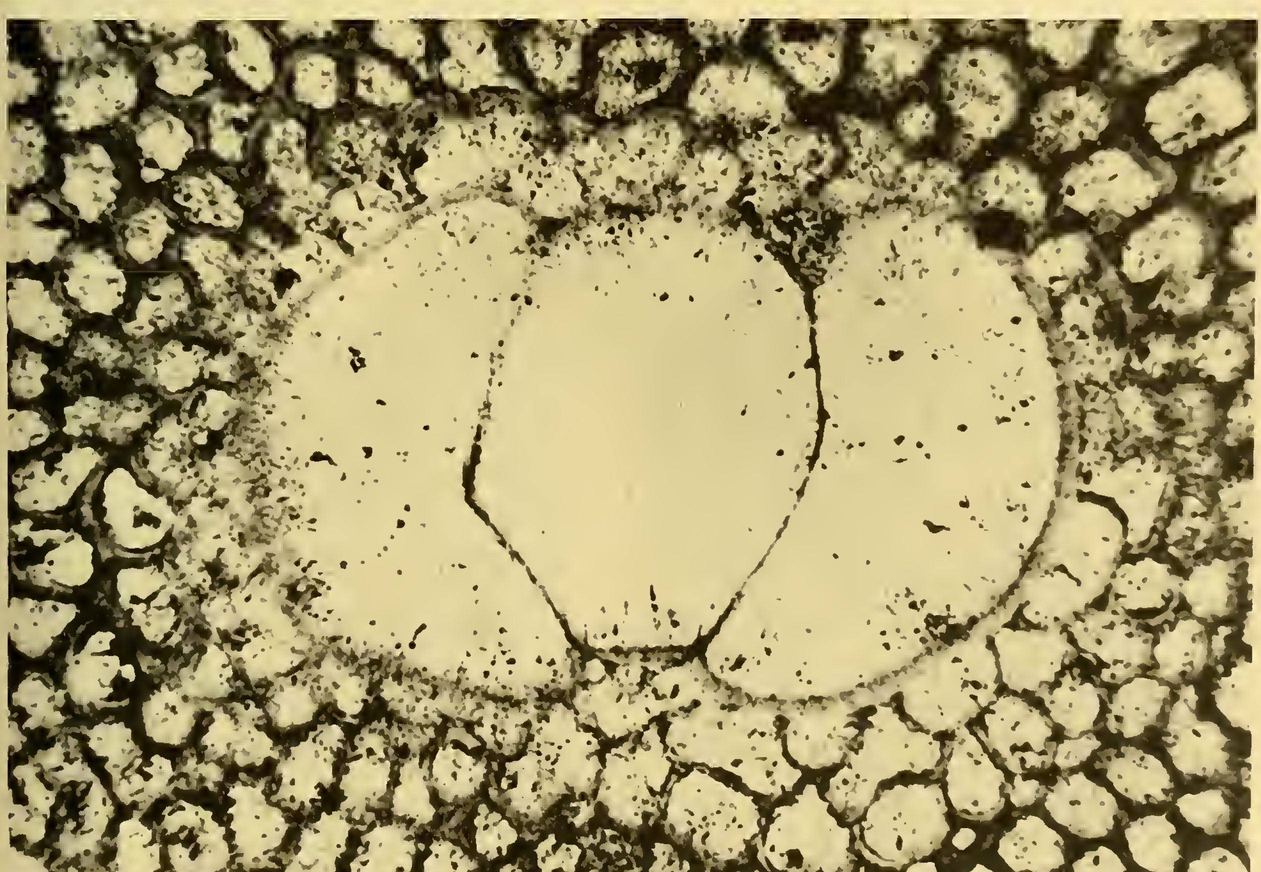

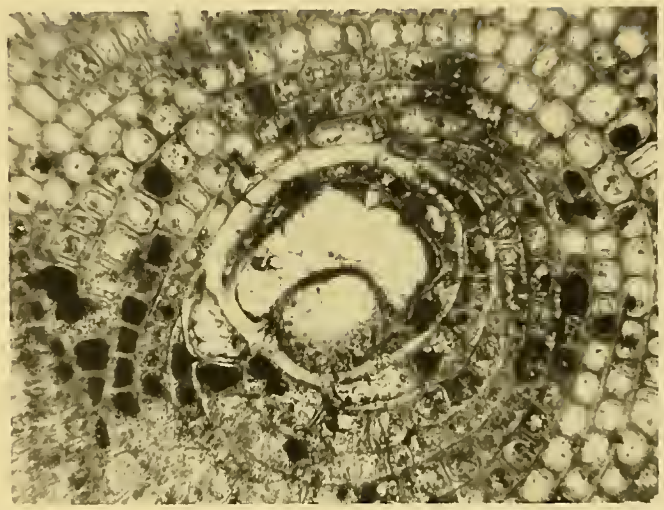

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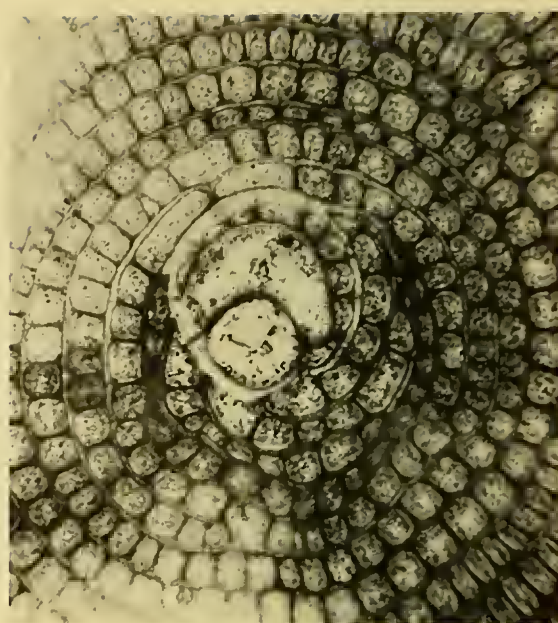

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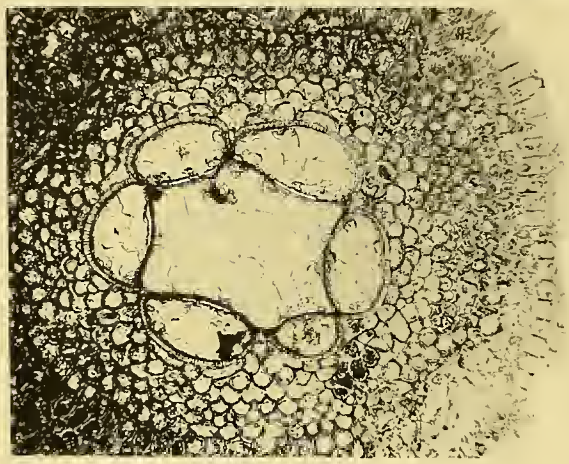

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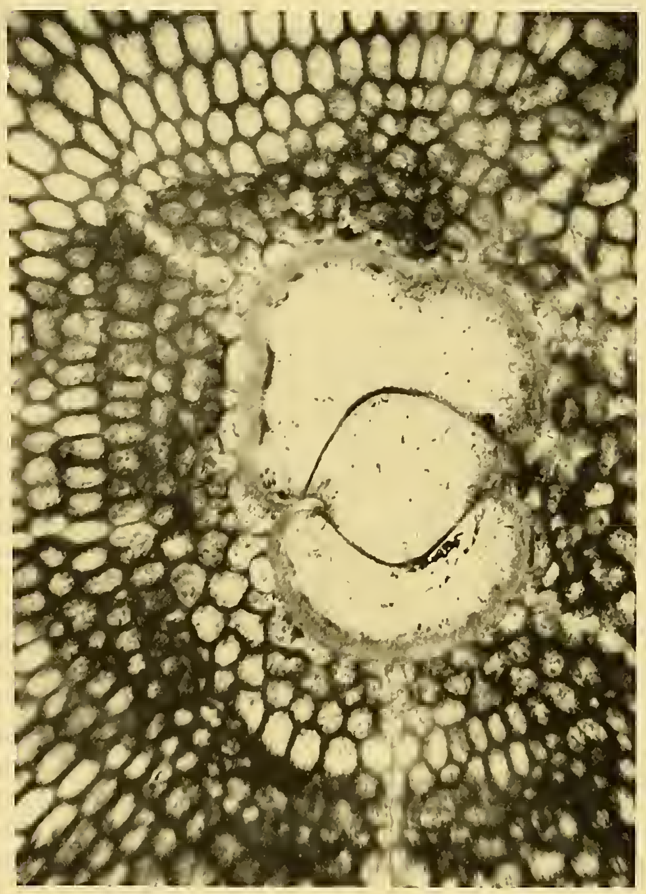

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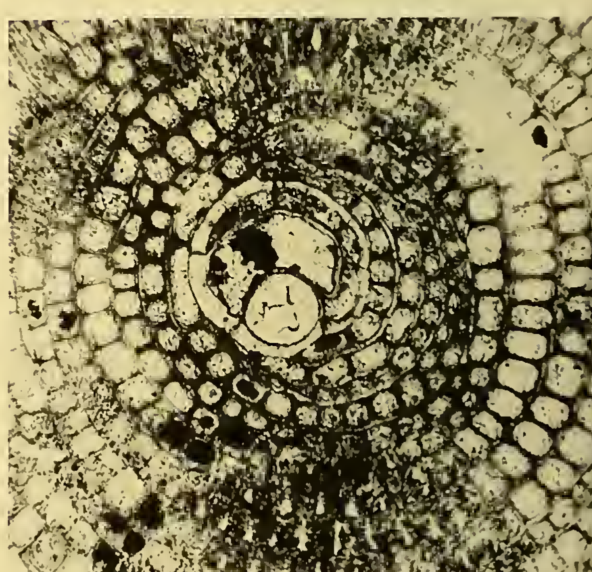

4

Explanation of Plate 47

Figure		Page
1-4.	**Cycloclypeus (Cycloclypeus) indopacificus** Tan	171

Parts of equatorial sections, X 40, to illustrate the embryonic and nepionic chambers; note in each specimen the first nepionic chamber is subdivided into several chamberlets.

5, 6.	**Lepidocyclina (Eulepidina) radiata** (Martin)	163, 167, 171

5. Central part of an equatorial section, X 40, of a specimen with trilocular embryonic chambers.

6. Central part of an equatorial section, X 20, of a specimen with multilocular embryonic chambers; note the change in shape of the equatorial chambers from the center to the periphery.

1-4,6. Loc. 3—see text for locality descriptions.

5. Loc. 1.

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ARENACEOUS FORAMINIFERA FROM THE OSGOOD FORMATION AT OSGOOD, INDIANA

By

Ruth G. Browne

and

Virginia J. Schott

July 15, 1963

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CONTENTS

ILLUSTRATIONS

ARENACEOUS FORAMINIFERA FROM THE OSGOOD FORMATION AT OSGOOD, INDIANA

Ruth G. Browne
and
Virginia J. Schott

ABSTRACT

A large and diverse fauna of arenaceous Foraminifera has been collected from the upper five feet of the Osgood formation (Niagaran) as exposed in the Southeastern Materials Corporation quarry in the SW 1/4, SW 1/4, sec. 22, T. 8 N., R. 11 E. at Osgood in Ripley County, Indiana. The fauna consists of 24 genera and 63 species. The genus *Metamorphina,* new genus and 12 new species are described. Represented are the following families: Astrorhizidae Brady, Saccamminidae Brady, Ammodiscidae Rhumbler, Hyperamminidae Eimer and Fickert, and Trochamminidae Parker and Jones.

INTRODUCTION

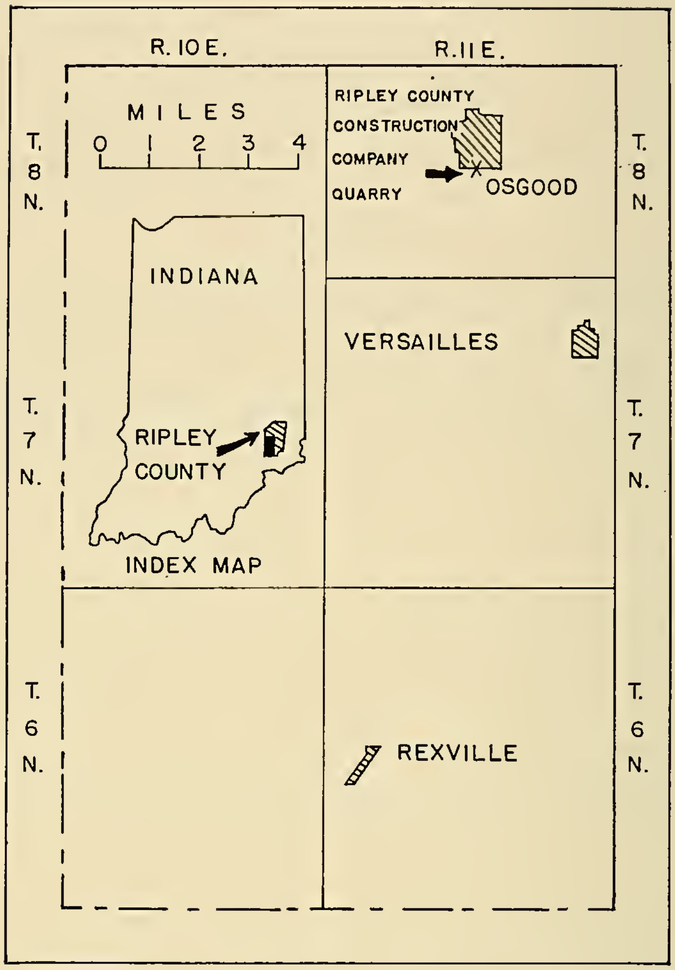
The authors visited the Ripley County Construction Company quarry located on the south edge of the town of Osgood, Ripley County, Indiana, (Text fig. 1) in October 1960. Material was collected from the gray calcareous shale bed which together with interbedded gray, coarse-grained, fossiliferous limestone forms the upper five feet of the Osgood formation as exposed in the base of the quarry. The Foraminifera which form the basis of this study were derived from this material.

Although Raymond (1955) initially did some work on this fauna, the authors decided to pursue the study further when they noted the great abundance and variety of species of Foraminifera present in this microfauna. It is their opinion that as complete and exhaustive a study as possible should be devoted to these Foraminifera from the type locality of the Osgood.

The purpose of this paper is twofold: 1. To determine the genera and species of the arenaceous Foraminifera present and their relative abundance. 2. To advance the knowledge of mid-Paleozoic Foraminifera in the hope that the study of this fauna may prove of potential value in stratigraphic correlation.

ACKNOWLEDGMENT

The authors are grateful to various individuals who aided in the preparation of this manuscript: Dr. Thomas G. Perry, Professor of Geology of Indiana University, for his help and the loan of the Osgood types which Raymond (1955) studied for his Master's thesis; Mr. Charles Stone, photographer of Louisville, Kentucky, for the illustrations; Dr.



TEXT-FIG. 1 — MAP SHOWING LOCATION OF THE RIPLEY COUNTY CONSTRUCTION COMPANY QUARRY, OSGOOD, INDIANA (AFTER RAYMOND, 1955).

Arland Hotchkiss of the University of Louisville for use of photomicroscopy equipment; Mrs. Howard Byers, U. S. Geological Survey, Louisville Kentucky, for typing the manuscript. Special thanks are due Mr. Michael Mound, paleontologist on the staff of Indiana University, who checked the identification of the species, reviewed the preliminary draft of this paper, and contributed helpful suggestions.

The type specimens are located in the Indiana University collections at Bloomington, Indiana.

PREVIOUS STUDIES OF SILURIAN FORAMINIFERA

Although scattered records of pre-Mississippian Foraminifera occur in the literature, the first authenticated account is a study made by Moreman (1930). Moreman described forms from the Arbucle and Viola limestones (Ordovician) and from the Chimneyhill limestone (Silurian) of Oklahoma. Later works than Moreman's original paper include another by Moreman (1933), Ireland (1939), Stewart and Priddy (1941), Dunn (1942), Cumings (1952), Eisenack (1954), Raymond (1955), Miller (1956), and Mound (1961).

All Paleozoic "smaller" Foraminifera described to date are arenaceous. Moreman attributed the absence of arenaceous forms in pre-Ordovician rocks to the fragility of the tests. He believed they had not attained sufficient development to permit their extraction by currently known laboratory procedures. He attributed the apparent absence of calcareous genera as substantiating Cushman's belief concerning the primitive character of arenaceous forms.

COLLECTION AND PREPARATION OF MATERIAL

Approximately 18 pounds of Osgood shale were collected from the top five feet of the formation in the lower part of the Ripley County Construction Company's quarry at Osgood, Indiana.

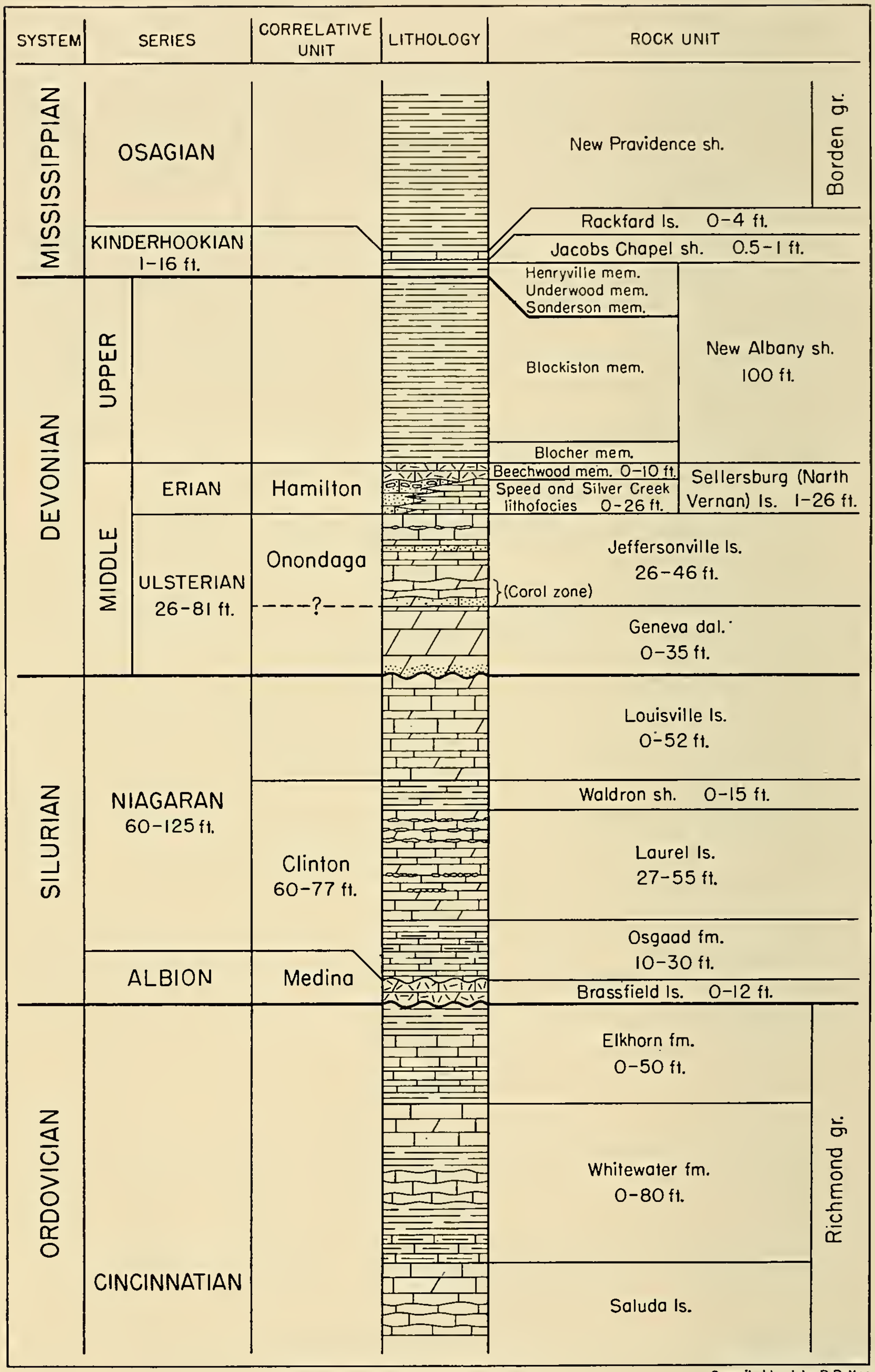
The coarse material was removed, and the remainder soaked to disintegrate the shale. The shale was then thoroughly washed and run through a series of sieves which retained everything not small enough to pass through the 200 mesh sieve. The residue was then dried and approximately half the washed material was set aside for examination for microfossils. The remainder of the dried residue was then soaked in a 10-normal solution of hydrochloric acid until the calcareous material was digested. The resultant undissolved material was then washed and dried. The Foraminifera for this study were derived from both the washed samples and the insoluble residues.

STRATIGRAPHY

NAME AND DEFINITION

The term Osgood was originally applied by Foerste (1896) to strata exposed in the vicinity of the town of Osgood, Ripley County, Indiana. No type section was designated. At this time Foerste termed these beds "the Osgood phase of the Laurel formation." A year later Foerste (1897) redefined these strata, separating them from the Laurel formation and assigning them equal rank with the Laurel, Waldron, and Louisville—all members of the Niagaran series.

PLATE I



COMPOSITE STRATIGRAPHIC COLUMN OF SILURIAN, DEVONIAN, AND ADJACENT ROCKS IN SOUTHEASTERN INDIANA

Compiled by John B. Patton and Haydn H. Murray, 1955

DISTRIBUTION AND LITHOLOGY

In Indiana the Osgood formation crops out in a belt that trends slightly east of north and extends from Clark County northeast to Wayne County. Over this area the formation maintains a thickness averaging 3 to 23 feet.

Swartz, *et al.* (1942, pl. 1) recognized the Osgood as a stratigraphic unit in Indiana, Kentucky, and Tennessee. Stewart and Priddy (1941) stated, "As a result of the earlier study by the Junior author it has been shown . . . . ; the Osgood shale of Ohio is equivalent to the upper shale (Zone E) of the Osgood formation of Indiana." Perry and Hattin (1960) referred to a personal communication "(Bowman 1955)" to the effect that the Ohio Geological Survey currently recognized the Osgood in Preble, Clark, and Greene Counties, Ohio.

Foerste (1897, p. 210) described three lithologic units of the Osgood formation in Indiana as follows:

> The general characteristics of the Osgood beds as seen near Osgood consist of a series of clayey rocks, averaging about ten feet in thickness; overlying the clayey rocks is found a shaley soft clay varying from 1 to 2 feet in thickness; above the clay or so-called soapstone layer are several layers of limestone, carrying the characteristic Osgood fauna.

Cummings (1922) recognized four lithologic subdivisions of the Osgood which are in ascending order:

(1) the lower Osgood limestone which is usually 8 to 15 inches thick but is absent locally

(2) the lower Osgood shale or clay which is 11 to 16 feet thick

(3) the upper Osgood limestone which is 3 to 5 feet thick and may be crinoidal

(4) the upper Osgood shale or clay that is 3 to 5 feet thick.

The division of the Osgood formation as currently accepted by the Indiana Geological Survey is the same as that of Esarey, *et. al.* (1947, p. 15) who described the formation as follows:

> *Osgood shale* Rochester (basal Niagaran of Indiana). Type section at Osgood, Indiana. Averages 22 feet in thickness. Lower or basal limestone gray to tan, 1 to 6 feet thick. Lower shale soft, blue, 1 to 2 feet thick. Upper limestone gray to tan, crinoidal, fossiliferous, 6 feet thick. Upper shale gray, calcareous, fossiliferous, 11 feet thick.

The upper five feet of the Osgood as exposed in the bottom of the Southeastern Materials Corporation quarry at Osgood, Indiana, consists of gray calcareous shale which contains thin layers of gray coarse-grained limestone. The fauna of this report came from the shale beds.

CORRELATION

Bassler (1906) correlated the Osgood shale with the Rochester shale of the standard New York section (Niagaran) on the basis of a study of the bryozoan faunas.

He stated that comparison of the bryozoan elements of the faunas from the Rochester shale and the Osgood of Indiana "seem to show beyond question that the Osgood is chiefly, if not exactly comparable with the Rochester shale." Swartz, *et. al.* (1942, pl. 1) presented a correlation chart which equated the Osgood as follows:

Western New York—equivalent to the Rochester shale and the underlying Irondequoit limestone
Arkansas and Oklahoma—St. Clair limestone (upper part)
Northeastern and northwestern Illinois—Rockdale dolomite
Western Ohio and east-central Kentucky—Bisher formation (east side of Cincinnati Arch)
Western Kentucky—Osgood formation (west side of Cincinnati Arch)

Boyce (1956) on the basis of a study of the macrofauna of the Osgood concluded:

" . . . . the Osgood formation is correlated, at least in part, with the Rochester shale."

Because no study has been made of the Foraminifera of the Rochester shale no correlation on this basis is possible at the present time.

Of the Paleozoic foraminiferal studies made to date, the Chimneyhill limestone (Lower Silurian) of Oklahoma has the most species in common with this fauna. The Brassfield limestone of Indiana (Lower Silurian) is next. Future faunal studies from other localities will undoubtedly assist in closer correlation.

FAUNAL ASSOCIATIONS

The Foraminifera of this report are associated with an abundant and varied macrofauna which, with the exception of the bryozoans, has been described by (Boyce, 1956). This is noteworthy because most Osgood exposures in Indiana contain few fossils of any kind. The same paucity of fossils in the Osgood beds has been noted in Tennessee, Wilson (1949), Ohio, Foerste (1935) and McFarlan (1943).

Boyce listed species representing each major phyla except Porifera. The phylum with the greatest representation in number of specimens is the Brachiopoda. Next in order is the Coelenterata. Representatives of other phyla are not numerous in the fauna. The fossils are in an excellent state of preservation and weather readily from the soft enclosing shale.

TABLE 1

Stratigraphic and geographic distribution of the Foraminifera from the Osgood shale at Osgood, Ind.

	Viola (Ordovician); Okla.	Albion: Brassfield; Ind.	Albion: Brassfield; Mo., Ill.	Chimneyhill; Okla.	Niagaran: Osgood; Ind.	Niagaran: Osgood; Ky.-Ohio	Niagaran: Osgood; Mo., Ill., Tenn.	Niagaran: Dayton; Ohio	Niagaran: Laurel, Waldron, Massie; Ind., Ohio	Niagaran: Niagaran; Ill.	Niagaran: Joliet; Ill.	Niagaran: Banbridge; Mo.	Niagaran: Henryhouse; Okla.	Silurian	Devonian	Mississippian	Pennsylvanian	Permian	Jurassic	Cretaceous	Recent
ASTRORHIZIDAE																					
Thuramminoides sphaeroidalis Plummer *emend.*	–	–	–	–	×	–	–	–	–	–	–	–	–	–	×	×	–	–	–	–	–
Pseudastrorhiza delicata Gutschick & Treckman	–	–	–	–	×	–	–	–	–	–	–	–	–	–	–	×	–	–	–	–	–
Rhabdammina bifurcata, n. sp.	–	–	–	–	×	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
AMMODISCIDAE																					
Ammodiscus exsertus (Cushman)	–	×	–	×	×	×	×	×	–	–	×	×	–	–	–	×	–	–	–	–	×
Ammodiscus incertus (d'Orbigny)	–	×	–	×	×	×	×	×	×	–	×	×	–	–	–	–	×	–	–	–	×
Ammodiscus biconvexus, n. sp.	–	–	–	–	×	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ammodiscus compressus, n. sp.	–	–	–	–	×	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ammodiscus moundi, n. sp.	–	–	–	–	×	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Psammonyx campbelli, n. sp.	–	–	–	–	×	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bifurcammina parallela Ireland	–	–	–	×	×	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lituotuba exserta Moreman	–	×	–	×	×	×	–	×	×	–	–	×	–	–	–	–	–	–	–	–	–
Lituotuba inflata Ireland	–	×	–	×	×	–	–	×	–	–	–	–	–	–	–	–	–	–	–	–	–
Lituotuba gallowayi, n. sp.	–	–	–	–	×	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lituotuba laticervis, n. sp.	–	–	–	–	×	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Glomospira siluriana Ireland	–	–	–	×	×	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Glomospira articulosa Plummer	–	–	–	–	×	–	–	–	–	–	–	–	–	–	–	×	×	–	–	–	–
SACCAMMINIDAE																					
Psammosphaera cava Moreman	–	×	×	×	×	–	×	–	–	–	–	×	×	–	–	×	–	–	–	–	–
Psammosphaera laevigata White	–	×	–	–	×	–	×	–	–	–	–	–	–	–	–	–	–	×	–	×	–
Stegnammina cylindrica Moreman	–	×	×	×	×	–	–	–	–	–	–	–	–	–	×	–	–	–	–	–	–
Thekammina quadrangularis Dunn	–	×	×	–	×	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ceratammina cornucopia Ireland	–	–	–	×	×	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Sorosphaera bicella Dunn	–	×	×	–	×	–	–	–	–	–	–	×	–	–	×	–	–	–	–	–	×
Sorosphaera tricella Moreman	–	×	–	×	×	–	–	–	–	×	–	×	–	–	–	–	–	–	–	–	–
Raibosammina sp.	–	–	–	–	×	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shiderella bicuspidata Dunn	–	–	–	–	×	–	×	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shiderella elongata Dunn	–	–	–	×	×	–	–	–	–	–	–	×	–	–	–	–	–	–	–	–	–
Lagenammina stilla Moreman	–	×	–	×	×	–	–	–	–	–	–	×	×	–	–	–	–	–	–	–	–
Lagenammina bulbosa Dunn	–	–	×	–	×	–	×	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lagenammina sphaerica Moreman	–	–	–	×	×	–	–	–	–	–	×	×	–	–	–	×	–	–	–	–	–
Amphicervicis elliptica Mound	–	×	–	–	×	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Proteonina acuta Dunn	–	–	–	–	×	–	×	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Proteonina cumberlandiae Conkin	–	–	–	–	–	–	×	–	–	–	–	–	–	–	–	×	–	–	–	–	–
Proteonina perryi, n. sp.	–	–	–	–	×	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Proteonina cf. *P. jolietensis* Dunn	–	–	×	–	×	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Proteonina cervicifera Cushman & Waters	–	–	–	–	×	–	–	–	–	–	–	–	–	–	–	–	×	–	–	–	–
Proteonina cf. *P. wallingfordensis* Conkin	–	–	–	–	×	–	–	–	–	–	–	–	–	–	–	×	–	–	–	–	–
Thurammina arcuata Moreman	–	–	–	×	×	–	–	–	–	–	×	–	–	–	–	–	–	–	–	–	–
Thurammina coronata Dunn	–	–	–	–	×	–	–	–	–	–	–	×	–	–	–	–	–	–	–	–	–
Thurammina elliptica Moreman	–	×	×	×	×	×	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Thurammina foerstei Dunn	–	×	×	–	×	×	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Thurammina cf. *T. hexactinellida* Dunn	–	–	×	–	×	–	×	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Thurammina irregularis Moreman	–	×	–	×	×	–	×	–	–	–	×	–	–	–	–	–	–	–	–	–	–
Thurammina papillata var. *monticulifera* Ireland	–	–	–	–	×	–	×	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Thurammina cf. *seminaformis* Dunn	–	–	×	–	×	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Thurammina slocomi Dunn	–	–	×	–	×	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Croneisella typa Dunn	–	–	×	–	×	–	×	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tholosina convexa Moreman	–	–	–	×	×	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tholosina acinaciforma, n. sp.	–	–	–	–	×	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tholosina acuta, n. sp.	–	–	–	–	×	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tholosina corniculata, n. sp.	–	–	–	–	×	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tholosina rostrata, n. sp.	–	–	–	–	×	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Metamorphina gibbosa (Ireland)	–	–	–	×	×	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Metamorphina tholsus (Moreman)	×	–	–	–	×	–	–	–	–	–	–	–	–	×	–	×	–	–	–	–	–
HYPERAMMINIDAE																					
Hyperammina curva Moreman	–	×	–	×	×	–	×	–	–	–	–	×	–	–	×	×	–	–	–	–	–
Hyperammina compressa Paalzow	–	–	–	–	×	–	–	–	–	–	–	–	–	–	–	–	–	×	–	–	–
Hyperammina conica Gutschick, Weiner, & Young	–	–	–	–	×	–	–	–	–	–	–	–	–	–	–	×	–	–	–	–	–
Hyperammina harrisi Ireland	–	–	–	×	×	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hyperammina deminutionis (Moreman)	–	–	–	×	×	–	–	–	×	×	–	–	–	–	–	–	–	–	–	–	–
Hyperammina (?) *rudis* Parr	–	–	–	–	×	–	–	–	–	–	–	–	–	–	–	–	–	×	–	–	–
Hyperammina sp.	–	–	–	–	×	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bathysiphon exiguus Moreman	×	×	×	×	×	×	×	–	×	–	–	–	×	–	–	–	–	–	–	–	–
Bathysiphon rugosus Ireland	–	×	–	×	×	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
TROCHAMMINIDAE																					
Trochammina prima Stewart & Priddy	–	–	–	–	×	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Under the heading "Systematic Paleontology" of this report, the individual descriptions of the above species are given. Their occurrence is noted. The following table is the interpretation, devised by the authors, for the relative occurrence of species:

rare - 1 or 2 specimens
uncommon - 3 to 5 specimens
common - 6 to 20 specimens
abundant - more than 20 specimens

SYSTEMATIC PALEONTOLOGY

Order **FORAMINIFERA** d'Orbigny, 1826

Family **ASTRORHIZIDAE** Brady, 1881

Genus **THURAMMINOIDES** Plummer, 1945

Thuramminoides sphaeroidalis Plummer emend. Pl. 48, fig. 1, 2

Thuramminoides sphaeroidalis Plummer, 1945, Univ. Texas, Pub. 4401, pp. 218, 219, pl. 15, figs. 4-10 Middle Pennsylvanian; Crespin, 1958 Bur. Min. Res., Geol. and Geophys. Bull. 48, pp. 40, 41, pl. 3, figs. 9-11; pl. 31, figs. 1, 2 Australia, Permian; Conkin and Conkin, 1960, Geol. Soc. Amer. S.E. Sect., Abstracts, p. 8 Silurian and Devonian; Conkin, Bull. Amer. Paleont., vol. 43, pp. 240-247, pl. 17, figs. 1-10, pl. 18, figs. 1-4, pl. 26, figs. 1-3, fig. 1 Mississippian.

Thuramminoides teicherti (Parr), Crespin, 1958, Bur. Mineral Res., Geol. and Geophys. Bull. 48, pp. 41, 42, pl. 3, figs. 12-13, Australia, Permian.

Test free, unilocular, compressed and disk-shaped to spherical; wall moderately thick, composed of fine to medium-sized sand grains embedded in much cement; test wall which surrounds a hollow interior consisting of many tubes which radiate outwards towards surface of the test; most tubes extending from test center do not pierce surface of test; outer part of test wall occupied by additional smaller tubes most of which pierce the surface; some small protuberances on surface of test which are not apertures; apertures multiple, provided apparently by the functioning of the two sets of tubes.

	Max. diam.	Min. diam.
Pl. 48, fig. 1	.537 mm.	.503 mm.
Pl. 48, fig. 2	.436 mm.	.386 mm.

Test diameter for nine specimens ranges from .402 mm. to .537 mm.

Occurrence.—Common.

Remarks.—Conkin, in studying the species found sufficient spherical, noncompressed forms so that he was able to section specimens and know the true character of the species. Spherical tests are present in the Osgood fauna, but the majority are compressed. The flattened, disk-shaped specimens with small protuberances are characteristic of the species in this fauna.

Genus **PSEUDASTRORHIZA** Eisenack, 1932

Pseudastrorhiza delicata Gutschick and Treckman Pl. 48, fig. 3

Pseudastrorhiza delicata Gutschick and Treckman, 1959, Jour. Paleont., vol. 33, p. 231, pl. 33, figs. 1-5 Rockford Is., Ind.; Gutschick, Weiner and Young, 1961, p. 1204, pl. 147, fig. 8, text, fig. 4-2 Lower Mississippian—Okla., Texas, and Mont.

Test free, consisting of a subspherical center chamber from which numerous delicate, finger-like projections radiate in all directions; wall thin, smooth, composed of silt-sized sand grains; apertures not apparent.

	Max. diam. including projections	Min. diam.
Pl. 48, fig. 3	.185 mm.	.143 mm.

Occurrence.—Rare, one specimen.

Remarks.—The single specimen recovered has eight projections. It conforms to Gutschick's and Treckman's type although the dimensions are somewhat smaller.

Genus **RHABDAMMINA** M. Sars, 1869

Rhabdammina bifurcata, n. sp. Pl. 48, figs. 4, 5

Test free, small, consisting of three nearly straight, branching arms which unite to form a Y-shaped test, the longest arm is over double the length of the two shorter which are of about equal length; arms in one plane; wall of fine to medium-sized sand grains with much cement; apertures circular at the open ends of the tubes.

	Length of test	Diam.	Length of short arms	Length of long arm
Pl. 48, fig. 4, holotype	.294 mm.	.075 mm.	.067 mm.	.176 mm.
Pl. 48, fig. 5, paratype	.252 mm.	.084 mm.	.05 mm.	.168 mm.

Occurrence.—Rare, two specimens.

Remarks.—This species is distinguished by its Y-shaped form, its nearly straight sides, and its small size. The etymology of the species name *bifurcata* refers to the shape of the test: *bi,* L., two and *furca,* L., fork.

Family **AMMODISCIDAE** Rhumbler, 1895

Subfamily **AMMODISCINAE** Cushman, 1913

Genus **AMMODISCUS** Reuss, 1861

Status of *Ammodiscus* Reuss and *Involutina* Terquem

Considerable confusion has lately arisen over the distinction between the two foraminiferal genera *Ammodiscus* Reuss and *Involutina* Terquem, both described in 1862. From the time Reuss first defined *Ammodiscus* up to the first emendation of the genus by Loeblich and Tappan (1954) most authors assigned the planispirally coiled arenaceous Foraminifera to the genus *Ammodiscus.*

Loeblich and Tappan noted that Reuss failed to name any species as type for the genus *Ammodiscus*. They believed that the first species cited in connection with the genus *Ammodiscus* was *Ammodiscus infimus* (Strickland), Bornemann, 1874 (=*Orbis infimus* Stickland, 1846) which would make this species the type by monotypy. Ellis and Messina (1957) in a discussion of Loeblich and Tappan's emendation stated that Bornemann referred two species to *Ammodiscus*—*Orbis infimus* Strickland, 1846 and *Involutina aspera* Terquem, 1864. Thus, the designation of *Orbis infimus* Strickland as a type species has validity only on the basis of Loeblich and Tappan's selection and not by monotypy.

Loeblich and Tappan further stated, in consideration of *Orbis infimus* Strickland as the type species, that the genus *Ammodiscus* Reuss should be suppressed. Barnard (1952), who examined Strickland's type specimens, found *Orbis infimus* to be a calcareous species and a junior synonym of *Spirillina* Ehrenberg, 1843. This was at variance with Reuss' concept of the genus. Believing the genus *Involutina,* with *I. silicea* Terquem as type species, capable of embracing the agglutinated, nonseptate forms they recommended their removal to this genus.

Many workers disapproved of this solution for the genera *Ammodiscus* and *Involutina* because they were not willing to consider *Ammodiscus* a calcareous genus. Bornemann (1874) in an early emendation of the genus *Involutina* restricted *Involutina* to the calcareous species when he reallocated seven of the eight species named by Terquem to other genera, leaving only *Involutina jonesi* Terquem and Piette, 1862 to represent the genus. Thus, Cushman's 1928 designation of *Involutina silicea* Terquem as type species, although adopted by many authors, was in error.

Bornemann in emending the genus *Involutina* actually provided the first revision of the genus *Ammodiscus*. He described the species *Ammodiscus infimus* Stickland (including *Involutina silicea* Terquem as a synonym) and *Ammodiscus aspera* Terquem.

The principal difficulty which has occurred since Bornemann's revision is due to the fact that Bornemann erroneously assumed that *I. silicea* Terquem was synonymous with *Orbis infimus* Strickland and included it in synonymy with *Ammodiscus infimus* (Strickland). Bornemann's descriptions were apparently based on Terquem's species because the descriptions fit Terquem's species and he claimed to have obtained some of Terquem's original material. Moreover, the fact he mentioned he was referring his specimens to Terquem's species even though Strickland had not mentioned their siliceous character should remove any doubts.

Loeblich and Tappan (1961) in their emended emendation of the genus *Ammodiscus* noted all these points and clarified the status of *Ammodiscus* and *Involutina*. The type species of *Ammodiscus* is *Ammodiscus infimus* Bornemann, 1874 (not *Orbis infimus* Strickland, 1846) = *Involutina silicea* Terquem, 1862; fixed by subsequent designation by Loeblich and Tappan (1954) emended 1961.

Ammodiscus exsertus Cushman Pl. 48, fig. 16

Ammodiscus exsertus Cushman, 1910, U. S. Nat. Mus., Bull. 71, pt. 1, p. 75, figs. 97a, b Recent, Japan; Moreman, 1930, Jour. Paleont., vol. 4, p. 58, pl. 7, figs. 4, 8 Chimneyhill ls., Okla.; Stewart and Priddy, 1941, Jour. Paleont., vol. 15, p. 373, pl. 54, fig. 18 Dayton ls., Ohio; Osgood fm., Ind.; Dunn, 1942, Jour. Paleont., vol. 16, p. 338, pl. 44, fig. 23 Osgood ls., Mo.; Raymond, 1955, A. M. thesis, Indiana Univ., p. 20-21, pl. 4, fig. 2 Osgood fm., Ind.

Ammodiscus brevitubus Dunn, 1942, Jour. Paleont., vol. 16, p. 339, pl. 44, fig. 4 Osgood ls., Ill.

Involutina exserta Gutschick and Treckman, 1959, Jour. Paleont., vol. 33, p. 241, pl. 35, figs. 8, 9 Rockford ls., Ind.; Mound, 1961, Indiana Dept. Conserv. Geol. Surv., Bull. No. 23, p. 20, pl. 1, figs. 3-5 Brassfield ls., Ind.

Test free, planispiral, consisting of an ovoid proloculus and a tubular second chamber which makes several revolutions about the proloculus with the final portion gradually uncoiling at a 90° angle to the coiled portion; wall smooth, finely arenaceous, with much cement, aperture circular, at the open end of the uncoiled portion.

	Length of test	Diam.	Length of neck	Diam. of neck
Pl. 48, fig. 16	.386 mm.	.269 mm.	.118 mm.	.050 mm.

Test length for 15 specimens ranges from .352 mm. to .386; diameter ranges from .251 mm. to .302 mm.; length of neck ranges from .15 to .32 mm.

Occurrence.—Abundant.

Remarks.—The authors agree with Raymond that *Ammodiscus brevitubus* is not a valid species. The differences which Dunn stated for establishing it as a new species, distinct from *Involutina exserta* (Cushman), are a lesser number of whorls and an inflated condition of the test. Comparison of Dunn's figured specimen with the figured type does not show these differences.

Ammodiscus incertus (d'Orbigny) Pl. 49, figs. 3, 4

Operculina incerta d'Orbigny, 1839, *in* Sagra, Historia physique politique naturelle Cuba, "Foraminiferes", p. 49, pl. 6, figs. 16, 17 Recent, Cuba.

Ammodiscus incertus Brady, 1884, Rept. Voyage Challenger, Zoology, vol. 9, p. 330, pl. 38, figs. 1-3 Recent, North and South Atlantic and South Pacific; Moreman, 1930, Jour. Paleont., vol. 4, p. 58, pl. 7, fig. 7 Chimneyhill ls., Okla.; Stewart and Priddy, 1941, Jour. Paleont., vol. 15, p. 374, pl. 54, fig. 19 Dayton ls., Ohio; Laurel ls., Ind. and Ohio; Osgood fm., Ind.; Dunn, 1942, Jour. Paleont., vol. 16, p. 338, pl. 44, fig. 23 Osgood ls., Mo.; Raymond, 1955, A. M. thesis, Ind. Univ., p. 21-22, pl. 4, fig. 3 Osgood fm., Ind.

Ammodiscus minutus Dunn, 1942, Jour. Paleont., vol. 16, p. 339, pl. 44, fig. 44 Osgood ls., Mo.

Ammodiscus annularis Ireland, 1956, Jour. Paleont., vol. 30, p. 846, pl. 4, figs. 4-6 Upper Pennsylvanian, Kansas.

Involutina incerta Mound, 1961, Indiana Dept. Conserv. Geol. Surv., Bull. No. 23, p. 19, pl. 1, figs. 1, 2 Brassfield ls., Ind.

Test free, planispiral, consisting of an ovoid proloculus and a gradually enlarging tubular second chamber which makes four to five revolutions about the proloculus; wall smooth, finely arenaceous, with much cement; aperture circular at the open end of the tube.

	Max. diam.	Min. diam.
Pl. 49, fig. 3	.302 mm.	.302 mm.
Pl. 49, fig. 4	.151 mm.	.151 mm.

Test diameter for 15 specimens ranges from .201 mm. to .335 mm.

Occurrence.—Abundant.

Remarks.—This species is represented by the largest number of individuals in the fauna and characterizes the assemblage.

Ammodiscus biconvexus, n. sp. Pl. 48, figs. 10-12

Test free, about equally biconvex, slightly ellipsoidal in outline with the shorter axis averaging (for six specimens) 4/5 of the length of the longer axis; test consisting of a nearly spherical proloculus and a tubular second chamber which coils about the proloculus for 1-3/4 revolutions; dorsal surface, with all coils visible, shows the second chamber winding from the summit of the proloculus in a low descending spiral to the periphery; only the final revolution visible on the ventral surface; wall thick, siliceous with fine to moderately large quartz grains and much cement; aperture oblique at the open end of the tubular chamber.

	Max. diam.	Min. diam.	Thickness
Pl. 48, figs. 10, 12, holotype	.521 mm.	.411 mm.	.168 mm.
Pl. 48, fig. 11, paratype	.586 mm.	.403 mm.	.185 mm.

Range Chart for Six Specimens in mm.

Max. diam. (D_1)	Min. diam. (D_2)	Thickness (T)	T_2/D_1+D_2
.521	.411	.168	.360
.586	.403	.185	.374
.294	.252	.185	.677
.285	.226	.168	.658
.352	.226	.151	.519
.235	.168	.151	.751

Occurrence.—Common.

Remarks.—The nature of the coiling on the dorsal surface and the biconvex test distinguishes the species. The shape of test approaches tests of the genus *Trochammina* but unlike forms of that genus the test is undivided.

Ammodiscus compressus, n. sp. Pl. 48, figs. 20-23

Test free, thin in peripheral view; periphery subacute; test consisting of a spherical proloculus and a second chamber increasing rapidly in diameter; second chamber coiling planispirally about the proloculus for 1-3/4 revolutions; all coils visible from the dorsal surface, only the final volution visible on the ventral surface; sutures on the dorsal side distinct, depressed; wall composed of medium-sized sand grains with much cement; aperture narrowly elliptical formed by the open end of the tubular second chamber.

	Max. diam.	Min. diam.	Thickness
Pl. 48, figs. 20-22, holotype	.604 mm.	.470 mm.	.118 mm.
Pl. 48, fig. 23, paratype	.310 mm.	.252 mm.	.084 mm.

Range Chart for Ten Specimens in mm.

Max. diam. (D_1)	Min. diam. (D_2)	Thickness (T)	$2T/D_1+D_2$
.478	.420	.118	.240
.604	.470	.118	.217
.420	.302	.101	.279
.310	.252	.084	.298
.302	.269	.101	.354
.352	.269	.118	.380
.352	.269	.084	.270
.285	.235	.101	.396
.335	.302	.084	.264
.285	.269	.075	.274

Occurrence.—Common.

Remarks.—The thin compressed test and the subacute periphery distinguishes this species from other species of *Ammodiscus* in the fauna. The etymology of the species name *compressus* refers to the thin test: *compressus,* L., compressed.

Ammodiscus moundi, n. sp. Pl. 48, figs. 6-9

Test free, plano-convex, consisting of a proloculus and a tubular, regularly enlarging second chamber which coils about the proloculus for 1-3/4 revolutions; obliquely flattened in section with all coils visible on the flat surface and final revolution overlapping earlier coils on the convex surface; suture on flat side depressed; wall moderately thick, finely siliceous, well cemented and smoothly finished; aperture oblique at the open end of the tubular chamber.

	Max. diam.	Min. diam.	Thickness
Pl. 48, fig. 6, holotype	.369 mm.	.328 mm.	.218 mm.
Pl. 48, fig. 8, paratype	.143 mm.	.134 mm.	.101 mm.
Pl. 48, fig. 7, paratype	.369 mm.	.319 mm.	.168 mm.
Pl. 48, fig. 9, paratype	.226 mm.	.201 mm.	.101 mm.

Range Chart for Ten Specimens in mm.

Max. diam. (D_1)	Min. diam. (D_2)	Thickness (T)	$2T/D_1+D_2$
.521	.403	.277	.599
.369	.328	.218	.626
.369	.319	.168	.488
.285	.252	.151	.563
.201	.151	.134	.761
.210	.168	.118	.624
.143	.134	.101	.731
.176	.151	.084	.515
.252	.218	.118	.414
.226	.201	.101	.441

Occurrence.—Common.

Remarks.—This species has close affinities with *Ammodiscus planoconvexa* Paalzou. No range chart is given for *A. planoconvexa.* The dimensions given for the type, however, show it to be considerably larger with 2 to 2-1/2 revolutions instead of 1-1/2. Moreover, it is about half the thickness for its size of *Ammodiscus moundi.*

This species is named after Mr. Michael Mound, paleontologist on the staff of Indiana University.

Genus **PSAMMONYX** Doderlein, 1892

Psammonyx campbelli, n. sp. Pl. 49, fig. 6

Test free, thin, much compressed; periphery acute; consisting of a spherical proloculus and a rapidly enlarging tubular second chamber coiled loosely and planispirally about the proloculus for 1-3/4 revolutions; wall finely siliceous, well cemented; aperture an elongate slit at the open end of the test.

	Max. diam.	Min. diam.	Thick-ness
Pl. 49, fig. 6, holotype	.428 mm.	.328 mm.	.109 mm.

Occurence.—Rare, one specimen.

Remarks.—Although *Psammonyx* is a genus with most known representatives in the Recent, the authors are placing this species in this genus because of the loosely coiled, highly compressed test. The rapidly expanding second chamber and nature of the aperture likewise seem to fit the qualifications of the genus *Psammonyx.*

This species is named in honor of Dr. Guy Campbell, formerly of Hanover College, Hanover, Indiana.

Genus **BIFURCAMMINA** Ireland, 1939

Bifurcammina parellela Ireland Pl. 48, figs. 24, 25

Bifurcammina parallela Ireland, 1939, Jour. Paleont., vol. 13, p. 202, pl. B. fig. 37 Chimneyhill ls., Okla.; Raymond, 1955, A. M. thesis, Indiana Univ., p. 23, pl. 4, fig. 1 Osgood, Ind.

Test free, consisting of an ovoid proloculus and a tubular second chamber; second chamber closely and usually planispirally coiled for three to five revolutions about the proloculus; final whorl somewhat inflated and uncoiling at a 90° angle to the coiled portion, forming a neck; neck with two tubes made by the bifurcation of the final whorl; wall smooth, finely arenaceous with much cement; apertures at the open ends of the tubes; color white.

	Length of test	Diam. of test	Diam. of neck
Pl. 48, fig. 24	.420 mm.	.352 mm.	.101 mm.
Pl. 48, fig. 25	.470 mm.	.386 mm.	.118 mm.

Test length for four specimens ranges from .403 mm. to .420 mm.;

diameter ranges from .319 mm. to .352 mm.; diameter of neck ranges from .101 mm. to .118 mm.

Occurrence.—Common.

Remarks.—Although all the Osgood specimens are flattened, occasional specimens show an early portion which is glomerately coiled. Apparently none of Ireland's specimens exhibited this feature.

Genus **LITUOTUBA** Rhumbler, 1895

Lituotuba exserta Moreman — Pl. 48, figs. 18, 19

Lituotuba exserta Moreman, 1930, Jour. Paleont., vol. 4, p. 59, pl. 7, figs. 5, 6 Chimneyhill ls., Okla.; Ireland, 1939, Jour. Paleont., vol. 13, p. 193, Table 1 Silurian, Okla.; Stewart and Priddy, 1941, Jour. Paleont., vol. 15, p. 374, pl. 54, figs. 20, 21 Dayton ls., Ohio, Laurel ls., Osgood fm., Ind.; Dunn, 1942, Jour. Paleont., vol. 16, p. 339, pl. 44, figs. 33, 37 Bainbridge ls., Mo.; Raymond, 1955, A. M. thesis, Indiana Univ. p. 25, 26, pl. 4, fig. 7 Osgood fm., Ind.; Mound, 1961, Indiana Dept. Conserv. Geol. Surv., Bull. No. 23, p. 21, pl. 1, figs. 6-8 Brassfield ls., Ind.

Test free, with an ovoid proloculus and a gradually enlarging, tubular second chamber; test glomerately coiled in early portion, becoming planispiral and unwinding in final volution to form a neck at a right angle to the direction of coiling; wall smooth, finely arenaceous with much cement; aperture circular, simple at open end of the tube.

	Length of test	Diam.	Length of neck	Diam of neck
Pl. 48, fig. 18	.369 mm.	.252 mm.	.101 mm.	.075 mm.
Pl. 48, fig. 19	.335 mm.	.134 mm.	.134 mm.	.084 mm.

Length of test for 17 specimens ranges from .302 mm. to .369 mm.; diameter ranges from .134 mm. to .268 mm.; length of neck ranges from .067 mm. to .109 mm. width of neck ranges from .067 mm. to .084 mm.

Occurrence.—Abundant.

Remarks.—Stewart and Priddy (1941) noted the variation in the shape of the test from circular to elliptical with the longer axis in the latter being parallel to the direction of elongation of the straight portion. Mound (1961) stated "In elliptically shaped tests the direction of elongation may be either parallel to the direction of the extension of the straight portion of the outer coil, or perpendicular to this direction, though remaining in the same plane." Both circular and elliptical forms are present in this fauna. The elliptical forms show considerable variation in the angle of the axis of the neck (extension of the straight portion of the outer coil) to the circumference of the test. The same forms show variation in the location of the neck on the circumference of the test. These observations suggest deformation.

Lituotuba inflata Ireland — Pl. 48, fig. 17

Lituotuba inflata Ireland, 1939, Jour. Paleont., vol. 13, p. 201, pl. B, figs. 34, 35 Chimneyhill ls., Okla.; Stewart and Priddy, 1941, Jour. Paleont., vol. 15, p. 375, pl. 54, fig. 22 Dayton ls., Ohio; Raymond, 1955, A. M. thesis, Indiana Univ. p. 26, pl. 4, fig. 8 Osgood fm., Ind.; Mound, 1961, Indiana Dept. Conserv. Geol. Surv. Bull. No. 23, p. 21, figs. 9-11.

Test free, with an ovoid proloculus and a tubular second chamber, glomerately coiled in early portion, becoming planispiral and unwinding in final volution to form a short neck at right angles to the test; final coil and neck noticeably inflated; wall smooth, finely arenaceous; aperture circular at open end of tube.

	Length of test	Diam.	Length of neck	Diam of neck
Pl. 48, fig. 17	.369 mm.	.285 mm.	.134 mm.	.084 mm.

Occurrence.—Rare.

Remarks.—This species is distinguished from *L. exserta* by the noticeable inflation of the final whorl and its uncoiled portion. Ireland described the neck as "equal in length to about two-thirds the width of the test." The Osgood specimens have shorter necks.

Lituotuba gallowayi, n. sp. — Pl. 48, figs. 13-15

Test free, consisting of a spherical proloculus and a tubular loosely coiled, rapidly enlarging, second chamber; second chamber coils from the proloculus and slightly away from the planispiral for about 1-½ revolutions, then unwinds to form a short neck; unwound portion lies in a direction tangential to the direction of coiling; neck measures from a third to half the length of test (three specimens) ; wall finely siliceous and smooth; aperture circular and somewhat constricted at the open end of the uncoiled portion of test.

	Length of test	Diam.	Max. diam. of neck	Min. diam. of neck	Length of neck
Pl. 48, fig. 15, holotype	.360 mm.	.285 mm.	.151 mm.	.084 mm.	.134 mm.
Pl. 48, fig. 13, paratype	.285 mm.	.201 mm.	.134 mm.	.075 mm.	.118 mm.
Pl. 48, fig. 14, paratype	.320 mm.	.194 mm.	.118 mm.	—	—

Length of test for three specimens ranges from .285 mm. to .360 mm.; maximum diameter ranges from .194 mm. to .285 mm.; maximum diameter of neck ranges from .118 to .151 mm.; minimum diameter of neck ranges from .075 mm. to .084 mm.; length of neck ranges from .118 mm. to .134 mm.

Occurrence.—Uncommon.

Remarks.—The rather rapidly enlarging tubular second chamber, the loose coiling and manner of coiling distinguish this species.

This species is named in honor of Dr. J. J. Galloway, late Emeritus professor of paleontology of Indiana University.

Lituotuba laticervis, n. sp. Pl. 49, fig. 5

Test free, consisting of an assumed proloculus which is not distinguishable from a tubular second chamber of one revolution which unwinds to become rectilinear with the rectilinear portion lying on approximately the same plane and at right angles to the coiled portion; the uncoiled portion or neck is approximately half the length of the test; wall thick, siliceous with much cement; aperture circular and somewhat constricted at the open end of the test.

	Length of test	Diam. across coiled portion	Length of neck	Diam. of neck
Pl. 49, fig. 5, holotype	.53 mm.	.285 mm.	.201 mm.	.168 mm.

Occurrence.—Rare, one specimen.

Remarks.—The wide stout neck of this species is its distinguishing feature. The most closely related species is *Lituotuba salinensis* Dunn (1942). This single specimen of *L. laticervis* is over twice the size of Dunn's species. The diameter of the neck is over half the diameter of the coiled portion while Dunn's illustration shows the neck of his species about a third of the diameter of the coiled portion. The etymology of the species derives from *latus,* L., wide and *cervicis* L., little neck.

Genus GLOMOSPIRA Rzehak, 1888

Glomospira siluriana Ireland Pl. 49, fig. 2

Glomospira siluriana Ireland, 1939, Jour. Paleont., vol. 13, p. 201, pl. B, figs. 27, 28 Chimneyhill ls., Okla.; *G. cf. siluriana* Raymond, 1955, A. M. thesis, Indiana University p. 24, pl. 4, fig. 5 Osgood fm., Ind.

Test free, consisting of a proloculus and a tubular, gradually enlarging second chamber which is coiled in varying planes around the proloculus for 3-½ to 5 revolutions; wall smooth, finely arenaceous with much cement; aperture at the open end of the tube.

	Max. diam.	Min. diam.
Pl. 49, fig. 2	.403 mm.	.352 mm.

Occurrence.—Rare.

Remarks.—Raymond, 1955, reported this species from the Osgood of Indiana. He remarked that the few specimens recovered were smaller than Ireland's type specimens. The two specimens recovered in this fauna parallel Ireland's types in size.

Glomospira articulosa Plummer Pl. 49, fig. 1

Glomospira articulosa Plummer, 1945, Bur. Econ. Geol., Pub., No. 4401 p. 233, pl. 16, figs. 21-25 Marble Falls, Smithwick and lower Strawn—Texas; Ireland, 1956, Jour. Paleont., vol. 30, no. 4, p. 847, text—fig. 4, figs. 7-10 Upper Pennsylvanian—Kan.; Gutschick and Treckman, 1959, Jour. Paleont., vol. 33, no. 2, p. 242, 243, pl. 35, figs. 17-19 Rockford ls., Ind.; Conkin, 1961, Bull. Amer. Paleont., vol. 43, no. 196, p. 295, 296, pl. 22 fig. 10, pl. 27 figs. 1, 17 Mississippian, Ky., northern Tenn., southern Ind., and south central Ohio.

Test compact, composed of a proloculus and a tubular, slowly enlarging coiled portion; convolutions without definite arrangement; wall siliceous, finely arenaceous with much cement; apertures two, formed by the hollow ends of the tube.

	Length of test	Diam. of test
Pl. 49, fig. 1	.640 mm.	.640 mm.

Occurrence.—Rare, one specimen.

Remarks.—The compact test, the size and lack of definite arrangement of the convolutions conform to Mrs. Plummer's type species. The single specimen recovered appears to have suffered distortion so that it is roughly triangular in cross section. The appearance of this species in the Osgood strata extends considerably the range of the species since the type species was recorded from strata of Mississippian and Pennsylvanian age.

Family **SACCAMMINIDAE** Brady, 1884

Subfamily **PSAMMOSPHAERINAE** Cushman, 1927

Genus **PSAMMOSPHAERA** Schulze, 1875

Psammosphaera cava Moreman Pl. 49, figs. 7-10

Psammosphaera arcuata Dunn, 1942, Jour. Paleont., vol. 16, p. 323, pl. 42, figs. 14, 24 Brassfield ls., Ill.

Psammosphaera conjunctiva Dunn, 1942, Jour. Paleont., vol. 16, p. 323, pl. 42, fig. 28 Osgood ls., Mo.

Psammosphaera excerpta Dunn, 1942, Jour. Paleont., vol. 16, p. 323, pl. 42, figs. 7, 8 Osgood ls., Ill.

Psammosphaera gigantea Dunn, 1942, Jour. Paleont., vol. 16, p. 323, pl. 42, fig. 9 Osgood ls., Tenn.

Psammosphaera minuta Dunn, 1942, Jour. Paleont., vol. 16, p. 323, pl. 42, figs. 10-12 Bainbridge ls., Mo.

Psammosphaera cava Moreman, 1930, Jour. Paleont., vol. 4, p. 48, pl. 6, fig. 12 Chimneyhill ls., Okla.; Ireland, 1939, Jour. Paleont., vol. 13, p. 192, 193, table 1 Silurian, Okla.; Stewart and Priddy, 1941, Jour. Paleont., vol. 15, p. 371, pl. 54, figs. 8, 9 Osgood fm., Ind.; Dunn, 1942, Jour. Paleont., vol. 16, p. 322, pl. 42, fig. 6 Osgood ls., Mo.; Raymond, 1955, A. M. thesis, Indiana Univ. p. 11, 12, pl. 3, fig. 4 Osgood fm., Ind.; Gutschick and Treckman, 1959, Jour. Paleont., vol. 33, p. 232, pl. 33, figs. 6, 7 Rockford ls., Ind.; Mound, 1961, Indiana Dept. Conserv. Geol. Sur., Bull. No. 23, p. 26, 27, pl. 2, figs. 2-6 Brassfield ls., Ind.

Test free, spherical; wall thin to thick composed of medium-sized to coarse sand grains; aperture not apparent.

	Max. diam.	Min. diam.
Pl. 49, fig. 8	.118 mm.	.118 mm.
Pl. 49, fig. 9	.420 mm.	.244 mm.
Pl. 49, fig. 10	.420 mm.	.420 mm.
Pl. 49, fig. 7	.840 mm.	.622 mm.

Diameter for 30 specimens ranges from .118 mm. to .822 mm.

Occurrence.—Abundant

Remarks.—The above synonomy lists species of differing form. Gutschick and Treckman (1951) found from a study of the genus that the test is subject to deformation, resulting in frequently recurring forms. The Osgood specimens placed in this species likewise show recurring forms, variation in size of test, thickness of wall and grain size. With gradational forms present size of test and wall thickness do not seem valid criteria for specific designation. The authors agree with Mound that grain-size variations can result from material available to the organism.

Psammosphaera laevigata White Pl. 49, fig. 19

Psammosphaera pusilla Parr, 1942, Royal Soc. Western Australia, Jour., vol. 27, p. 106, pl. 1, figs. 6, 7 *Lingula* beds—Western Australia.

Psammosphaera laevigata White, 1928, Jour. Paleont., vol. 2, p. 183, pl. 27, figs. la, b Velasco fm., Mexico; Mound 1961, Ind. Dept. Conserv. Geol. Sur., Bull. No. 23, p. 27, pl. 2, figs. 7, 8 Brassfield ls., Ind.

Test free, spheroidal; wall thin to thick, smooth and silky in appearance, finely arenaceous and well cemented; aperture not apparent.

	Max. diam.	Min. diam.
Pl. 49, fig. 19	.420 mm.	.403 mm.

Diameter for eight specimens ranges from .26 mm. to .436 mm.

Occurrence.—Common.

Remarks.—The spheroidal shape and the finely arenaceous, smooth texture distinguish these forms. Some specimens are flattened as in White's figure.

Genus **STEGNAMMINA** Moreman, 1930

Stegnammina cylindrica Moreman Pl. 49, figs. 11, 12

Stegnammina trangularis Moreman, 1930, Jour. Paleont., vol. 4, p. 49, pl. 7, fig. 11 Chimneyhill ls., Okla.
Stegnammina elongata Ireland, 1939, Jour. Paleont., vol. 13, p. 194, pl. A, fig. 17 Haragan sh., Okla.
Stegnammina cylindrica biens Dunn, 1942, Jour. Paleont., vol. 16, p. 325, pl. 42, fig. 25 Brassfield ls., Mo.
Stegnammina cylindrica Moreman, 1930, Jour. Paleont., vol. 4, p. 49, pl. 7, fig. 12 Chimneyhill ls., Okla.; Mound, 1961, Indiana Dept. Conserv. Geol. Sur., Bull. No. 23, p. 25, pl. 1, figs. 26, 27 Brassfield ls., Ind.

Test free, cylindrical to subcylindrical with ends somewhat flattened; wall thin, composed of fine to medium-sized sand grains well cemented; aperture not apparent.

	Length of test	Diam.
Pl. 49, fig. 12	.335 mm.	.168 mm.
Pl. 49, fig. 11	.420 mm.	.185 mm.

The length of seven specimens ranges from .310 mm. to .470 mm; diameter ranges from .168 mm. to .252 mm.

Occurrence.—Common.

Remarks.—*Stegnammina cylindrica* seems to vary considerably. The authors agree with Mound that the variations in length and test shape do not warrant separation into species.

Genus **THEKAMMINA** Dunn, 1942

Thekammina quadrangularis Dunn Pl. 49, figs. 13, 14

Thekammina quadrangularis Dunn, 1942, Jour. Paleont., vol. 16, p. 326, pl. 42 Brassfield ls., Ill.; Mound, 1961, Indiana Dept. Conserv. Geol. Surv., Bull. No. 23, p. 25, pl. 1, fig. 28.

Test free, box-shaped with depressed faces; wall thin to thick, composed of medium-sized sand grains; aperture not apparent.

	Length of test	Diam.
Pl. 49, fig. 13	.470 mm.	.201 mm.
Pl. 49, fig. 14	.252 mm.	.118 mm.

Test length for six specimens ranges from .235 mm. to .470 mm.; diameter ranges from .118 mm. to .235 mm.

Occurrence.—Common.

Remarks.—The box-shaped test distinguishes the species. Unlike Dunn and Mound's specimens *T. quadrangularis* of this fauna is not coarsely arenaceous.

Genus **CERATAMMINA** Ireland, 1939

Ceratammina cornucopia Ireland Pl. 49, figs. 17, 18

Ceratammina cornucopia Ireland, 1939, Jour. Paleont. vol. 13, No. 2, p. 196, figs. A-31, 32 Devonian, Okla.

Test free, horn-shaped; wall thin, smooth, finely arenaceous, well cemented; aperture not apparent.

	Length of test
Pl. 49, fig. 17	.285 mm.
Pl. 49, fig. 18	.310 mm.

Test length for seven specimens ranges from .201 mm. to .352 mm.

Occurrence.—Common.

Remarks.—The Osgood specimens are somewhat smaller than Ireland's figured type. The initial end of the majority of the specimens is somewhat rounder and less blunt.

Genus **SOROSPHAERA** Brady, 1879

Sorosphaera bicella Dunn Pl. 49, fig. 16

Sorosphaera bicelloidea Stewart and Lampe, 1947, Jour. Paleont., vol. 21, p. 533, 534, pl. 78, figs. 5a, b, c, Delaware ls., Ohio; Summerson, 1958, Jour. Paleont., vol. 32, p. 551, pl. 81, fig. 14 Columbus ls., Ohio.

Sorosphaera bicella Dunn, 1942, Jour. Paleont., vol. 16, p. 325, pl. 42, figs. 17, 18 Bainbridge ls., Mo., Brassfield ls., Ill.; Summerson, 1958, Jour. Paleont., vol. 32, p. 551, pl. 81, fig. 13 Columbus ls., Ohio; Mound, 1961, Indiana Dept. Conserv. Geol. Sur., Bull. No. 23, p. 33, 34, pl. 3, figs. 4-6 Brassfield ls., Ind.

Test free, composed of two spherical chambers; wall thin, smooth, composed of fine to medium-sized sand grains; apertures not apparent.

	Diameters of individual chambers
Pl. 49, fig. 16	0.134 mm.

Diameters of individual chambers of five specimens range from .101 mm. to .134 mm.

Occurrence.—Uncommon

Remarks.—*Sorosphaera bicella* Dunn resembles *Webbinella gibbosa* Ireland. The former has a free test and inflated chambers, while the latter species is attached and plano-convex.

Sorosphaera tricella Moreman Pl. 49, fig. 15

Sorosphaera irregularis Grubbs, 1939, Jour. Paleont., vol. 13, p. 544, pl. 61, fig. 4 Niagaran series, Ill.

Sorosphaera tricella Moreman, 1930, Jour. Paleont., vol. 4, p. 49, pl. 5. figs. 12, 14 Chimneyhill ls., Okla.; Dunn, 1942, Jour. Paleont., vol. 16, p. 325, pl. 42, fig. 15 Bainbridge ls., Mo.; Raymond, 1955, A. M. thesis, Ind. Univ., p. 14, pl. 3, fig. 5 Osgood fm., Ind.; Mound, 1961, Indiana Dept. Conserv. Geol. Surv. Bull. No. 23, p. 34, pl. 3, figs. 7-10 Brassfield fm., Ind.

Test free, composed of three lobate chambers, closely joined in one plane; wall thin, finely arenaceous, surface smooth, apertures not apparent.

	Diameters of individual chambers
Pl. 49, fig. 15	.151 mm to .252 mm.

Occurrence.—Rare.

Remarks.—The Osgood specimens appear identical with Moreman's type specimens. *Sorosphaera osgoodensis* Stewart and Priddy which has four or more chambers in one plane could conceivably break up into a smaller number of chambers and so resemble *S. tricella* or *S. bicella* depending on the number of chambers remaining after breakage. Professor D. E. Hattin of Indiana University is currently engaged in a study of related sphaerical forms from the Waldron shale of Indiana. He showed the authors a series of photographs of an ontogenetic sequence he had assembled. It is probable that one species of *Sorosphaera* may result from this study and the forms with a lesser number of chambers prove to be stages.

Genus **RAIBOSAMMINA** Moreman, 1930

Raibosammina sp. Pl. 49, fig. 22

Test free, subcylindrical, chamber crooked but not branched; wall of unequal thickness; surface rough; aperture not apparent.

	Length of test	Max. diam.	Min. diam.
Pl. 49, fig. 22	.84 mm.	.226 mm.	.134 mm.

Occurrence.—Rare, one specimen.

Remarks.—Dunn, 1942, in describing *Raibosammina aspera* Moreman, remarked that numerous specimens of irregular sizes and shapes were found in the Silurian of the Mississippi basin that may belong to this genus and this species.

Genus **SHIDELERELLA** Dunn, 1942

Shidelerella bicuspidata Dunn Pl. 49, fig. 21

Shidelerella bicuspidata Dunn, 1942, Jour. Paleont., vol. 16, p. 329, pl. 43, fig. 1 Osgood ls., Ill.

Test, elongate fusiform, with tapering neck and two small, short projections at opposite end of test, wall thick, composed of medium-sized sand grains, well cemented; aperture simple at end of neck, none apparent at ends of the small projections.

	Length of test	Diam.
Pl. 49, fig. 21	.570 mm.	.328 mm.

Occurrence.—Rare, one specimen.

Remarks.—The test of the Osgood specimen is about half the size of Dunn's type, though the proportions closely approximate the type. The wall is thick instead of thin.

Shidelerella elongata Dunn Pl. 49, fig. 23

Shidelerella elongata Dunn, 1942, Jour. Paleont., vol. 16, p. 329, pl. 42, figs. 32, 33 Bainbridge ls., Mo.

Test free, elongate, cylindrical, with a tapering neck at either extremity of the test; wall thin, composed of medium-sized sand grains with much cement; aperture a circular opening at the end of the longer neck, not determinable at end of the shorter neck.

	Length of test with necks	Diam.	Length of Longer neck	Length of shorter neck
Pl. 49, fig. 23	.16 mm.	.26 mm.	.075 mm.	.042 mm.

Occurrence.—Rare, one specimen.

Remarks.—Dunn gave no measurements on the length of the tubes but his type figure seems to conform to the Osgood specimen.

Genus **LAGENNAMMINA** M. Sars, 1869

Lagennamina stilla Moreman Pl. 49, fig. 20

Lagennamina stilla Moreman, 1930, Jour. Paleont., vol. 4, p. 51, pl. 6, fig. 9 Chimneyhill ls., Okla.; Ireland, 1939, Jour. Paleont., vol. 13, p. 193, table 1, pl. A., fig. 22 Silurian, Okla.; Dunn, 1942, Jour. Paleont., vol. 16, p. 327, pl. 42, figs. 30, 31 Joliet ls., Ill.; Raymond, 1955, A. M. thesis, Indiana Univ., p. 10, 11, pl. 3, fig. 2 Osgood fm., Ind.; Mound, 1961, Indiana Dept. Conserv. Geol. Sur., Bull. No. 23, p. 26, pl. 2, fig. 1 Brassfield ls., Ind.

Test free, flask-shaped; wall arenaceous, thin, smooth, aperture circular at the end of the neck.

	Length of test	Diam.
Pl. 49, fig. 20	.277 mm.	.201 mm.

Length of test for two specimens is .18 mm. and .277 mm.; diameter is .14 mm. and .201 mm.

Occurence.—Rare.

Remarks.—Size of test compares to Raymond's and Mound's specimens rather than Moreman's type specimen.

Lagennamina bulbosa Dunn Pl. 50, fig. 1

Lagennamina bulbosa Dunn, 1942, Jour. Paleont., vol. 16, p. 327, pl. 42, figs. 21, 26 Osgood ls., Ill.: Brassfield ls., Ill.

Test free, spherical with short neck; wall thin, composed of medium-sized to coarse sand grains with much cement; surface rough; aperture circular at the end of neck.

The diameter of test for three specimens ranges from .45 mm. to .503 mm.; diameter of neck ranges from .084 mm. to .134 mm.; length of neck ranges from .101 mm. to .120 mm.

Occurrence.—Uncommon.

Remarks.—The Osgood specimens compare in size and form to Dunn's type. However, the wall is thin, while he described the type as having a thick wall.

Lagennamina sphaerica Moreman Pl. 50, fig. 2

Lagennamina sphaerica Moreman 1930, Jour. Paleont., vol. 4, no. 1, p. 51, pl. 5, fig. 15 Chimneyhill ls., Okla.; Dunn 1942, Jour. Paleont., vol. 16, No. 3, p. 327, pl. 42, fig. 29; Gutschick and Treckman, 1959, Jour. Paleont., vol. 33, p. 233, pl. 33, fig. 14; Gutschick, Weiner and Young, 1961, Jour. Paleont., vol. 35, No. 6, p. 1207, 1208, pl. 147, figs. 15, 17, 18; text—figs. 3-8, 4-8 Lower Mississippian—Okla. and Texas.

Test small, spherical in shape with elongated neck; wall thin, smooth, composed of silt-sized quartz grains well cemented.

	Length of test	Diam.	Length of neck	Diam. of neck
Pl. 50, fig. 2	.310 mm.	.173 mm.	.067 mm.	.042 mm.

Occurrence.—Rare, one specimen.

Remarks.—The single specimen recovered from the fauna is somewhat distorted. The size and shape of test agrees with Moreman's type, but the wall is composed of finer sized sand grains.

Genus **AMPHICERVICIS** Mound, 1961

Amphicervicis elliptica Mound Pl. 50, fig. 7

Amphicervicis elliptica Mound 1961, Indiana Dept. Conserv. Geol. Sur., Bull. No. 23, p. 29, pl. 2., figs. 14-20; text fig. 4 Brassfield ls., Indiana.

	Length of test including projections	Diam.
Pl. 50, fig. 7	.403 mm.	.285 mm.

Test attached, externally unilocular, plano-convex in outline; wall finely arenaceous, smooth, well cemented; apertures at the end of two short projections located at either extremity of the test.

Occurrence.—Rare, one specimen.

Remarks.—No attempt was made at sectioning the single specimen recovered. Consequently, the internal chambers were not observed. The attached test, the ratio of the length of test to the diameter and general description conforms to Mound's type specimens.

Genus **PROTEONINA** Williamson, 1858

Proteonina acuta Dunn — Pl. 50, fig. 4

Proteonina acuta Dunn, 1942, Jour. Paleont., vol. 16, No. 3, p. 326, pl. 43, fig. 2 Osgood Is., Ill.

Test free, flask-shaped, chamber narrowing gradually upward leaving no line of demarcation to form a neck; wall thin, composed of fine sand grains with much cement, surface rough; aperture at terminus of tapered portion of test.

	Length of test	Max. diam.
Pl. 50, fig. 4	.335 mm.	.210 mm.

The length of test for three specimens is .335 mm. Diameter ranges from .168 mm. to .210 mm.

Occurrence.—Uncommon.

Remarks.—The Osgood specimens are somewhat more blunt at the apex than Dunn's figured specimen, but they are less so than the figured type of *Proteonina jolietensis* Dunn, 1942. The dimensions conform to those given by Dunn for *P. acuta.*

Proteonina cumberlandiae Conkin — Pl. 50, figs. 11, 12

Proteonina cumberlandiae Conkin, 1961, Bull. Amer. Paleont., vol. 43, No. 194, p. 248, pl. 19, figs. 1-3; pl. 26, figs. 4, 5 Mississippian—Ky., southern Ind., northern Tenn., southcentral Ohio.

Test free, unilocular with a tapered neck; chamber teardrop-shaped, 1.3 to 1.6 longer than width of test for two specimens; wall of finely siliceous grains in siliceous cement; aperture at tapered end of test.

	Length of test	Length of chamber	Diam. of chamber	Diam. base of neck	Diam. end of neck
Pl. 50, fig. 12	.294 mm.	.235 mm.	.168 mm.	.059 mm.	.05 mm.
Pl. 50, fig. 11	.218 mm.	.218 mm.	.134 mm.	—	—

Occurrence.—Rare, two specimens.

Remarks.—Both Osgood specimens have the test compressed and in one the neck appears broken off. The shape of the test and the measurements conform to this species. The authors, however, have some reservations concerning this species. It is difficult to delineate a point at which the neck begins because the tapering is gradual. The distinction between this species and *P. acuta* Dunn (1942) does not appear clear cut enough to eliminate the possibility of gradational forms between the two species.

Proteonina perryi, n. sp. Pl. 50, fig. 8

Test free, single chambered; shape resembling somewhat a violin with an ovoid test slightly constricted in the middle portion and having one end rounded and the other with a blunt, tapered neck; wall of fine to medium-sized grains in siliceous cement; aperture circular at the end of the neck.

	Length of test	Diam. of test	Length of neck
Pl. 50, fig. 8, holotype	.554 mm.	.310 mm.	.05 mm.

Occurrence.—Rare, one specimen.

Remarks.—The authors consider this single specimen sufficiently well preserved and the distinguishing characteristics pronounced enough to establish a new species. This species is named in honor of Dr. Thomas G. Perry, professor of Geology at Indiana University.

Proteonina cf. **P. jolietensis** Dunn Pl. 50, fig. 3

Proteonina jolietensis Dunn, 1942, Jour. Paleont., vol. 16, p. 326, pl. 43, fig. 2 Brassfield ls., Ill.

Test free, flask-shaped, somewhat constricted, at the apertural end but without a neck; base of test broadly rounded; wall thick, finely siliceous, well cemented; aperture opening at the apex of the test.

	Length of test	Max. diam. of test	Min. diam. of test across apertural end
Pl. 50, fig. 3	.470 mm.	.352 mm.	.084 mm.

The single specimen recovered from the fauna has suffered distortion. Although the specimen has dimensions nearly double those which Dunn gave for *P. jolietensis* the general form and shape of the test conform to this species.

Proteonina cervicifera Cushman and Waters Pl. 50, figs. 9, 10

Proteonina cervicifera Cushman and Waters, 1928, Contri. Cush. Lab. Foram. Res., vol. 4, pt. 2, No. 59, p. 33 Strawn, Pennsylvanian.

Test free, somewhat compressed consisting of a single spherical-shaped chamber and a short, stout neck; neck measuring a third of the length of the chamber (two specimens) ; wall of coarse sand grains with siliceous cement; aperture an opening at the end of the neck.

	Length of neck	Diam. of test	Diam. of neck at base	Diam. of neck at apex
Pl. 50, fig. 9	.420 mm.	.302 mm.	.201 mm.	.168 mm.

Length of test for two specimens is .403 mm. and .420 mm.; diameter is .302 for both; length of neck is .084 mm. and .101 mm.; diameter of neck at base is .176 mm. and .201 mm.; diameter of neck at apex is .151 mm. and .168 mm.

Remarks.—This is the first record of this species in the Silurian. It is distinguished by its spherical test and short stout neck.

Proteonina cf. **P. wallingfordensis** Conkin Pl. 50, figs. 5, 6

Two specimens of *Proteonina* were recovered which are golf-club-shaped with short, blunt, slightly tapering necks, located off center and to one margin of the test. These may be highly distorted specimens of *P. wallingfordensis* to which they otherwise appear to conform. The possibility, however, exists that the shape of the test is original and these are a different species. The insufficient number of recovered forms leaves the question open.

	Length of chamber	Diam. of chamber	Length of neck	Diam. base of neck	Diam. end of neck
Pl. 50, fig. 5	.285 mm.	.420 mm.	.067 mm.	.151 mm.	.101 mm.
Pl. 50, fig. 6	.250 mm.	.369 mm.	.05 mm.	.101 mm.	.075 mm.

Occurrence.—Rare.

Remarks.—Conkin distinguished *P. wallingfordensis* from *P. cervicifiera* by its slender more tapering neck.

Genus **THURAMMINA** H. B. Brady, 1879

Thurammina arcuata Moreman Pl. 50, figs. 21, 22

Thurammina arcuata Moreman, 1930, Jour. Paleont., vol. 4, p. 54, pl. 6, figs. 2-3 Chimneyhill ls., Okla.; Ireland, 1939, Jour. Paleont., vol. 13, p. 193, pl. B, fig. 8 Silurian, Okla.; Stewart and Priddy, 1941, Jour. Paleont., vol. 15, p. 372, pl. 54, fig. 14; Dunn, 1942, Jour. Paleont., vol. 16, p. 329, pl. 43, fig. 35; Raymond, 1955, A. M. thesis, Indiana Univ., p. 14, pl. 3, fig. 6 Osgood fm., Ind.

Test free, small, inflated, subspherical to arcuate; wall thin, smooth, finely arenaceous, well cemented; apertures at the ends of two or three projections located along the margin of the test.

	Length of test	Diam.
Pl. 50, fig. 22	.201 mm.	.168 mm.
Pl. 50, fig. 21	.218 mm.	.201 mm.

The length of test for three specimens ranges from .201 mm. to .218; diameter ranges from .14 mm. to .201 mm.

Occurrence.—Uncommon, three specimens.

Remarks.—The Osgood specimens are smaller than Moreman's type and bear a greater resemblance to Ireland's figured specimens. The probability exists that with a sufficient number of specimens a complete ontogenetic sequence could be found showing successive stages in the number of projections.

Thurammina coronata Dunn Pl. 50, fig. 20

Thurammina coronata Dunn, 1942, Jour. Paleont., vol. 15, p. 331, pl. 43, fig. 18.

Test free, crown-shaped, with two tubular projections at either end of test and one or more prominent projections extending upward; wall thin, composed of medium-to large-sized sand grains, much cement; surface rough; apertures at end of tubes.

	Length of test including projections	Diam.	Length of one projection	Width of one projection
Pl. 50, fig. 20	.325 mm.	.252 mm.	.067 mm.	.084 mm.

Occurrence.—Rare, one specimen.

Remarks.—The shape of the test and the placement of the projections distinguish the species.

Thurammina elliptica Moreman Pl. 50, fig. 23

Thurammina elliptica Moreman, 1930, Jour. Paleont., vol. 4, p. 54, pl. 5, figs. 2, 4 Chimneyhill ls., Okla.; Ireland, 1939, Jour. Paleont., vol. 13, p. 193, pl. B, fig. 7, Table 1 Silurian, Okla.; Stewart and Priddy, 1941, Jour. Paleont., vol. 15, p. 373, pl. 54, fig. 16 Osgood fm., Ind.; Dunn, 1942, Jour. Paleont., vol. 16, p. 329, pl. 43, fig. 33 Brassfield ls., Mo.

Test free, elliptical in outline; wall thin, finely arenaceous, well cemented; apertures two at the end of short tubelike protuberances, located centrally at opposite extremities of the test.

	Length of test including protuberances	Diam.
Pl. 50, fig. 23	.269 mm.	.193 mm.

Occurrence.—Rare.

Remarks.—*Thurammina elliptica* may be distinguished from its congeners by its elliptical form. Some specimens may show the apertures located eccentrically.

Thurammina foerstei Dunn Pl. 50, fig. 13

Thurammina foerstei Dunn, 1942, Jour. Paleont., vol. 16, p. 331, pl. 43, fig. 27 Osgood ls., Ill. Mo.; Raymond, 1955, A. M. thesis, Indiana Univ. p. 16, pl. 3, fig. 10 Osgood fm., Ind.; Mound, 1961, Indiana Dept. Conserv. Geol. Sur., Bull. No. 23, p. 25, pl. 1, figs. 24, 25 Brassfield ls., Ind.

Test free, sphaeroidal; wall smooth, finely arenaceous, well cemented; apertures two at the end of short tubelike protuberance located at opposite extremities of the test.

	Length of test	Diam.
Pl. 50, fig. 13	.218 mm.	.218 mm.

Occurrence.—Rare.

Remarks.—*Thurammina foerstei* differs from its congener *T. elliptica* Moreman by its sphaeroidal shape and its short rounded projections.

Thurammina cf. T.? hexactinellida Dunn Pl. 50, fig. 14

Thurammina? hexactinellida Dunn, 1942, Jour. Paleont., vol. 16, p. 332, pl. 43, figs. 19, 36 Osgood ls., Ill.; Brassfield ls., Ill.

Test free, depressed spherical; wall thick of medium-sized sand grains, surface rough; apertures at the ends of spinelike protuberances with four equally spaced protuberances present in one plane, a fifth present in a plane at right angles to the former, and a sixth probably originally present but broken in the same plane, on the opposite side of the test.

	Max. diam.	Min. diam.	Length of protuberance	Width of protuberance
Pl. 50, fig. 14	.470 mm.	.436 mm.	.084 mm.	.101 mm.

Occurrence.—Rare, one specimen.

Remarks.—The form and dimensions of the Osgood specimen parallels Dunn's type.

Thurammina irregularis Moreman Pl. 50, figs. 18, 19

Thurammina irregularis Moreman, 1930, Jour. Paleont., vol. 4, p. 521, pl. 6, figs. 1, 5 Chimneyhill ls., Okla.; Dunn, 1942, Jour. Paleont., vol. 16, p. 330, pl. 43, figs. 13, 14 Osgood ls. and Joliet ls., Ill.

Test free, subspherical; wall thick, composed of fine to medium-sized sand grains, well cemented; apertures located at the ends of a variable number of nipple-like protuberances which given an irregular outline to the test.

	Max. diam.	Min. diam.
Pl. 50, fig. 19	.302 mm.	.294 mm.
Pl. 50, fig. 18	.403 mm.	.319 mm.

Occurrence.—Uncommon.

Remarks.—No attached linear series of chambers, as described by Moreman, was found, but this may be because of the lack of a sufficient number of specimens. Although Moreman described the species as having a thin wall the few specimens of this fauna have a thick wall.

Thurammina papillata monticulifera Ireland Pl. 50, fig. 15

Thurammina papillata var. *monticulifera* Ireland, 1939, Jour. Paleont., vol. 13, p. 197, fig. A-35 Silurian, Okla.; Dunn, 1942, Jour. Paleont., vol. 16, p. 330, pl. 43, figs. 15, 24.

Test free, irregular in outline; wall thin with rough surface due to irregularly spaced monticules of medium-to large-sized sand grains; apertures at the end of the protuberances.

	Max. diam. including projections	Min. diam.	Length of projection	Diam. of projection
Pl. 50, fig. 15	.797 mm.	.512 mm.	.118 mm.	.126 mm.

Occurrence.—Rare, one specimen.

Remarks.—This specimen resembles those of Dunn more than those of Ireland in the irregular outline of test and irregular spacing of monticules.

Thurammina? cf. T. seminaformis Dunn Pl. 50, fig. 17

Thurammina? seminaformis Dunn, 1942, Jour. Paleont., vol. 16, p. 333, pl. 44, figs. 2-5 Brassfield ls., Ill.

Test free, seed-shaped; wall finely arenaceous, well cemented; surface smooth; two short projections located in medium plane of test at the elongated extremities.

	Length of test	Diam.
Pl. 50, fig. 17	.319 mm.	.168 mm.

Occurrence.—Rare, one specimen.

Remarks.—Dunn has described this species as a good index fossil of the Brassfield formation. The single specimen recovered seems to conform to his description and figured types.

Thurammina slocomi Dunn Pl. 50, fig. 16

Thurammina slocomi Dunn, 1942, Jour. Paleont. vol. 16, p. 333, pl. 43, figs. 8, 12 Osgood Is., Ill.

Test free, quadrate in outline, rounded above the upper part of test and somewhat flatter below; four nipple-like protuberances marking the corners of the test, the two uppermost extending directly outward and the two lower projecting downward; wall siliceous composed of moderate-sized sand grains with much cement; apertures at the ends of the projections.

	Length of test including projections	Diam.	Distance between lower projections
Pl. 50, fig. 16	.386 mm.	.252 mm.	.235 mm.

Occurrence.—Rare, one specimen.

Remarks.—The measurements of this specimen approximate those of Dunn's figured types.

Genus **CRONEISELLA** Dunn, 1942

Croneisella typa Dunn Pl. 50, fig. 24

Croneisella typa Dunn, 1942, Jour. Paleont., vol. 16, 335, pl. 44, figs. 10, 11.

Test free, cylindrical, slightly constricted in central part; wall thin, finely arenaceous with much cement; apertures at the ends of two short sloping necks located at either end of test.

	Length of test including necks	Diam.
Pl. 50, fig. 24	.570 mm.	.252 mm.

Occurrence.—Rare.

Remarks.—The single specimen recovered conforms to Dunn's type with the exception that the central part of the test shows less constriction.

Subfamily **WEBBINELLINAE** Cushman, 1929

Genus **THOLOSINA** Rhumbler, 1895

Tholosina convexa Moreman Pl. 51, fig. 14

Tholosina convexa Moreman, 1930, Jour. Paleont., vol. 4, p. 55, pl. 5, fig. 17.

Test attached, free part convex in shape and attached part assuming shape of object to which it grew; wall thin, finely arenaceous; aperture at the end of a single projection extending from the attached surface.

	Length of test including projection	Diam.	Length of projection
Pl. 51 fig. 14	.319 mm.	.185 mm.	.033 mm.

Occurrence.—Rare, one specimen.

Remarks.—The single specimen recovered parallels Moreman's type figure.

Tholosina acinaciforma, n. sp. Pl. 51, fig. 12

Test attached, scimitar-shaped; upper surface convex and lower surface assuming concave form resulting from attachment; wall thin, finely arenaceous; aperture an opening at the pointed end of the test.

	Length of test	Max. diam.	Min. diam.
Pl. 51, fig. 12, holotype	.369 mm.	.151 mm.	.084 mm.

Occurrence.—Rare, one specimen.

Remarks.—This species is distinguished by the scimitar-shaped outline of the test. The etymology refers to the shape of the test; *acinaces,* L., scimitar and *forma,* L., form.

Tholosina acuta, n. sp. Pl. 51, fig. 11

Test probably attached, elongate; one end of test bluntly rounded and the other sharply pointed; wall siliceous with fine to medium-sized sand grain; aperture an opening at the end of the pointed projection.

	Length of test	Diam.	Length of projection
Pl. 51, fig. 11, holotype	.436 mm.	.218	.067

Occurrence.—Rare, one specimen.

Remarks.—There is little doubt this specimen belongs to the genus *Tholosina* although no surface of attachment is observable. In outline it resembles somewhat *Tholosina elongata* Moreman. Its sharp pointed projection with a single aperture distinguishes the species. The etymology of the species refers to the projection; *acutus,* L., sharp at the end or ending in sharp point.

Tholosina corniculata, n. sp. Pl. 51, fig. 10

Test roughly horn-shaped, one surface more convex than the other; appears to have been attached by the flatter surface; test slightly oblique in side view; wall moderately thick, finely siliceous, aperture an opening in the narrow projecting end of the test.

	Length of test	Max. diam.	Diam. across projection
Pl. 51, fig. 10, holotype	.386	.235	.059

Occurrence.—Rare, one specimen.

Remarks.—The shape of the test and single projection distinguishes the species. The etymology of the species refers to the hornlike shape of the test: *corniculatus,* L., from *corniculum* L., horn.

Tholosina rostrata, n. sp. Pl. 51, fig. 13

Test attached, roughly hemispherical in outline with one margin curved and the other nearly straight; one end of test with a short, stubby beak-shaped projection, the other end forming a straight line with the margins; attached surface concave and the free surface convex; wall finely siliceous and smoothly finished; aperture an opening at the end of the projection.

	Length of test	Max. diam.	Min. diam.
Pl. 51, fig. 13, holotype	.285 mm.	.176 mm.	.08 mm.

Occurrence.—Rare, one specimen.

Remarks.—The short beak-shaped projection distinguishes the species. The etymology of the species refers to the shape of the projection; *rostratus,* L., from *rostratum,* L., beak.

Genus **METAMORPHINA** Browne, n. gen.

Type species,—*Webbinella tholsus* (Moreman), 1933, Jour. Paleont., vol. 7, No. 4, p. 395, pl. 47, figs. 8, 10.

Generic diagnosis.—Test attached, plano-convex, varying in outline from circular to oval to linear; often surrounded by a marginal flange; single chambered to multichambered; wall of fine sand grains, smooth to roughly finished with the basal wall thin and frequently missing; aperture not apparent.

Discussion.—The present genus is described to fill a vacancy for forms left without assignment when Loeblich and Tappan (1957) revised the description of the genus *Webbinella.* Their examination of the holotype of *Webbina hemispherica* Parker, Jones, and Brady [type species *Webbinella* (Rhumbler)] showed it to be an attached polymorphinid form belonging to the calcareous genera. As a consequence *Webbinella* was placed in the family Lituolidae. For the arenaceous forms previously assigned to *Webbinella,* Loeblich and Tappan proposed a twofold solution. They erected a new genus, *Hemisphaerammina,* for the single chambered forms and allocated the multilocular forms to the genus *Webbinelloidea.*

The only distinction drawn between *Hemisphaerammina* and *Webbinelloidea* by Loeblich and Tappan is the number of chambers. This separation seemed warranted to them by their observations concerning the various species of *Webbinelloidea* as well as by Stewart and Lampe's selection of a two-chambered form as type species of *Webbinelloidea.*

The authors do not concur with Loeblich and Tappan's views for disposal of the arenaceous forms originally assigned to *Webbinella.* By assigning all multilocular forms to *Webbinelloidea* they are in opposition to two generic concepts. Rhumbler, in defining the genus *Webbinella,* specifically notes the marginal flange as being taxonomically characteristic of the genus. Stewart and Lampe, accepting Rhumbler's definition for *Webbinella,* erected the genus *Webbinelloidea* for forms not possessing a marginal flange. In so doing they likewise observed that *Webbinelloidea* differs from *Webbinella* solely by the absence of a flange.

Loeblich and Tappan made no mention of the presence or absence of a marginal flange. Forms, both with and without a flange but otherwise identical, are present in the Osgood fauna. Consideration was given to emending the descriptions of the genera *Hemisphaerammina* and *Webbinelloidea* to include these forms. The authors are of the opinion, however, that basic differences other than the presence or absence of a flange require the restriction of these non-Webbinelloideas. Forms encompassed under *Metamorphina,* n. genus, differ from *Webbinelloidea* in the structure of the basal or attaching wall. While *Webbinelloidea* nearly always has a thick floor, the basal wall is frequently absent in *Metamorphina,* n. genus or, if present, is thin. In the latter instance, close contact was apparently maintained between the protoplasm and the attaching surface eliminating the necessity for a thick floor.

The etymology of the generic name *Metamorphina* refers to the various changes encompassed in the genus—changes in form of outline as well as the presence or absence of a marginal flange: *meta,* Gr., between, among, often used in compounds to imply change, and *morphe,* Gr., form.

Metamorphina gibbosa (Ireland)

Webbinella gibbosa Ireland, 1939, Jour. Paleont., vol. 13, p. 198, pl. B, figs. 23, 24 Chimneyhill ls., Okla.

Test attached, plano-convex, surrounded by a narrow marginal flange; bilocular with chambers somewhat broader than long, separated by a partition; wall siliceous, well cemented; aperture not apparent.

	Length of test	Diameter
*Specimen A	.403 mm.	.269 mm.
*Specimen B	.470 mm.	.319 mm.

Occurrence.—Rare, two specimens.

Remarks.—This species differs from two-chambered forms of *M. tholsus* of similar outline by the higher convexity of its chambers and a less depressed and pronounced suture between the chambers. The exterior narrow flange seems to be characteristic of the species. The surface is not so smoothly finished as that of two-chambered specimens of *M. tholsus,* but this may be due solely to the particular specimens retrieved and the lack of numbers.

Metamorphina tholsus (Moreman) Pl. 51, figs. 1-9

Sorosphaera geometrica Eisenack, 1954, Senckenbergiana Lethaea, vol. 35, No. 1-2, p. 61, pl. 4, figs. 19, 20, pl. 5, figs. 2-6; text-fig. 1 Silurian—Gotland; Gutshick, Weiner and Young 1961, Jour. Paleont. vol. 35, No. 6, p. 1205, pl. 147, 11-14, 16 Lodgepole ls., Mont.

Webbinella quadripartita Moreman, 1933, Jour. Paleont., vol. 7, No. 4, p. 396, pl. 47, figs. 4, 7 Haragan fm., Okla.; Raymond, 1955, A. M. thesis Indiana Univ. p. 18, pl. 3, fig. 12 Osgood fm., Ind.

Webbinella gibbosa Raymond, 1955, A. M. thesis, Indiana Univ., p. 17, pl. 3, fig. 11 Osgood fm., Ind.

Webbinella sp. A. Raymond, 1955, A. M. thesis, Indiana Univ. p. 19, pl. 3, fig. 13 Osgood fm., Ind.

Webbinella sp. B. Raymond, 1955, A. M. thesis, Indiana Univ. p. 19, pl. 3, fig. 14 Osgood fm., Ind.

Webbinella tholsus Moreman, 1933, Jour. Paleont., vol. 7, No. 4, p. 395, pl. 47, figs. 8, 10 Viola fm., Okla.

Test attached, plano-convex with low domed convexity, normally widening in the plane of attachment, marginal flange often present; number of chambers variable, one- to seven-chambered forms recovered and a single form with 13 chambers; chambers arranged sometimes in linear fashion, more often in oblong or circular arrangement, closely appressed making rectilinear boundaries with adjoining chambers; sutures distinct, depressed; wall finely arenaceous, well cemented and smoothly finished; aperture not apparent even though the basal wall is frequently missing.

	Length of test	Diameter
Pl. 51, fig. 1	.235 mm.	.235 mm.
Pl. 51, fig. 2	.436 mm.	.285 mm.
Pl. 51, fig. 3	.570 mm.	.252 mm.
Pl. 51, fig. 4	.521 mm.	.403 mn

* Through oversight this species was not illustrated. Specimens duplicate almost exactly Ireland's figures, I. U hypotype No. 7072.

Pl. 51, fig. 5	.604 mm.	.554 mm
Pl. 51, fig. 6	.570 mm.	.537 mm
Pl. 51, fig. 7	.727 mm.	.453 mm
Pl. 51, fig. 8	.675 mm.	.675 mm
Pl. 51, fig. 9	1.172 mm.	.640 mm.

Diameter of test for three specimens of single-chambered forms ranges from .235 mm. to .319 mm. Length of test for five specimens of two-chambered forms ranges from .403 mm. to .570 mm. Diameter ranges from .235 mm. to .319 mm. Length of test for four specimens of three-chambered forms ranges from .470 mm. to .503 mm. Diameter ranges from .369 mm. to .521 mm. Length of test for five specimens of four-chambered forms ranges from .487 mm. to .675 mm. Diameter ranges from .310 mm. to .537 mm. Length of test for three specimens of five-chambered forms range from .470 mm. to .570 mm. Diameter ranges from .403 mm. to .537 mm. Length of test of two specimens of six-chambered forms is .604 mm. and .727 mm. Diameter is .436 mm. and .453 mm.

Occurrence.—Abundant.

Remarks.—It appears that confusion has resulted between the two genera *Sorosphaera* Brady and *Webbinella* Rhumbler. Rhumbler's generic description of *Webbinella* requires an attached, plano-convex test while Brady's definition of *Sorosphaera* described the test as composed of a group of independent inflated chambers. Moreover, *Webbinella* has no general aperture while *Sorosphaera* has minute interstitial apertures. These requirements for *Webbinella* as defined by Rhumbler are equally applicable to *Metamorphina,* n. genus, replacing *Webbinella.*

This species seems to be the same species identified by Eisenack as *Sorosphaera geometrica.* His illustrations and descriptions conform to the Osgood specimens. Eisenack pointed out that the species *Sorosphaera geometrica* is differentiated from species of *Sorosphaera* named from the American Silurian (*viz. S. tricella, S. bicella, S. multicella*) "by the fundamental surface design of the chamber and the outjutting edge of the flat surface of contact."

All complete tests of this species in the Osgood fauna show a flattened surface where they have been attached either loosely or firmly to some object. This is so despite the fact that individual chambers may be nearly globular and complete. While a majority of the specimens show a distinct marginal flange some do not.

The authors are employing the generic name *Metamorphina* to this species instead of *Sorosphaera* because the test is attached, possesses no detectable aperture, and usually displays a marginal flange.

Eisenack included in this one species the same forms as the Osgood with a varied number of chambers. As in Eisenack's fauna, several one-celled stages, not single cases broken off occur. Although *Webbinella tholsus* Moreman is described as a single chambered form the authors believe it represents the first stage of development in this multilocular species.

Some specimens show tiny pores in the surface of the chambers which are too consistent and possess too much regularity to be due to injury.

Gutschick, *et. al.* (1961) recorded specimens from the Lower Mississippian which they identified as *S. geometrica.* They, like the authors, believed these varied forms represent a single species.

Consideration was given to making separate species of the forms included here under *M. tholsus.* With circular, oval, and linear arranged forms all present, specimens with a like number of chambers are of different aspect. The similarities between them, however, seem more apparent than the differences. On the basis of the present fauna no specific designation seems possible.

Family **HYPERAMMINIDAE** Eimer and Fickert, 1899

Subfamily **HYPERAMMINAE** Cushman, 1910

Genus **HYPERAMMINA** Brady, 1878 emend. Conkin, 1961

Conkin (1954) discussed the relationship of *Hyperammina* and *Hyperamminoides.* He (1961) proposed the following emendation of the description of genus *Hyperammina* to include all species of *Hyperammina* and *Hyperamminoides*:

(1) the second chamber may be nontapering, may taper towards the proloculus, or in a few species taper toward both the aperture and the proloculus ('hourglass tapering'); (2) aperture may be moderately or strongly constricted; and (3) exterior may be marked by transverse constrictions of varying strength.

The authors are following Conkin for the above generic description of species of *Hyperammina.*

Hyperammina curva (Moreman) Pl. 52, figs. 14-16

Bathysiphon curvus Moreman, 1930, Jour. Paleont., vol. 4, p. 45, pl. 5, figs. 9, 10 Chimneyhill ls., Okla.; Ireland, 1939, Jour. Paleont., vol. 13, pl. A., fig. 7

Chimneyhill ls., Okla.; Stewart and Priddy, 1941, Jour. Paleont., vol. 15, p. 370, pl. 54, fig. 5 Laurel ls., Ind.; Osgood fm., Ind.; Dunn, 1942, Jour. Paleont., vol. 16, p. 322, pl. 42, fig. 5 Osgood ls., Ill.

Hyperammina sublaevigata Dunn, 1942, Jour. Paleont., vol. 16, p. 337, pl. 44, fig. 6 Bainbridge ls., Mo.

Hyperammina compacta Gutschick and Treckman, 1959, Jour. Paleont., vol. 33, p. 235, pl. 34, figs. 12-16.

Hyperammina curva Mound, 1961, Ind. Dept. Conserv. Geol. Sur., Bull. No. 23, p. 35, pl. 3, figs. 13-16 Brassfield ls., Ind.

Test free, curved, consisting of an ovoid proloculus and a gradually enlarging second chamber; wall thin to thick, smooth to rough, finely to coarsely arenaceous; aperture at open end of test.

	Length of test	Max. diam.	Min. diam.	Proloculus
Pl. 52, fig. 14	.604 mm.	.185 mm.	.151 mm.	.143 mm x .235 mm.
Pl. 52, fig. 16	.940 mm.	.168 mm.	.109 mm.	
Pl. 52, fig. 15	.369 mm.	.092 mm.	.067 mm.	

Length of test for 24 specimens ranges from .352 mm. to .940 mm.; maximum diameter ranges from .084 mm. to .185 mm.; minimum diameter ranges from .05 mm. to .15 mm.

Occurrence. —Abundant

Remarks.—Some specimens show slight constrictions of the tapering second chamber. The curvature of the test and the lack of distinct separation between the proloculus and second chamber distinguish the species.

Hyperammina compressa Paalzow Pl. 52, figs. 9, 10

Hyperammina compressa Paalzow, 1935, Die Foraminiferen in Zechstein des ostlichen Thurigen., Preuss. Geol. Landesanst., Jahrb., 1935, Bd. 56, Heft 1, p. 28 Permian.

Test free, consisting of a proloculus and a gradually tapering test, typically compressed; wall thin, finely siliceous, smoothly finished; aperture at the open end of the test.

	Length of test	Max. diam.	Min. diam.
Pl. 52, fig. 9	.503 mm.	.126 mm.	.067 mm.
Pl. 52, fig. 10	.503 mm.	.118 mm.	.050 mm.

Test length for seven specimens ranges from .319 mm. to .545 mm. Maximum diameter ranges from .101 mm. to .193 mm. Minimum diameter ranges from .050 mm. to .118 mm.

Occurrence.—Common.

Remarks.—The species is easily distinguished by the compressed test. Previously recorded from the Permian, its occurrence in the fauna extends considerably the range of the species.

Hyperammina conica Gutschick, Weiner, and Young Pl. 52, figs. 2-5

Hyperammina conica Gutschick, Weiner, and Young, 1961, Jour. Paleont., vol. 35, p. 1212, pl. 149, figs. 8-10, 15-16; text figs. 3-9-12; 4-12-14, 20, 21 Lower Mississippian, Okla., and Texas.

Hyperammina casteri Conkin, 1961, Bull. Amer. Paleont., vol. 43, No. 196, p. 260, pl. 20, figs. 1-2, 4, 6, 8, 10-11, 13, 16; pl. 26, fig. 8 microspheric form only Mississippian, Ky, southern Ind., northern Tenn., and southcentral Ohio.

Megalospheric form—test free, consisting of a spherical proloculus and a uniformly expanding second chamber giving a cone-shaped appearance to the test; wall of moderate thickness, translucent to opaque, usually smooth and well cemented but may be granular; aperture circular and constricted.

	Test length	Max. diam.	Min. diam.	Proloculus
Pl. 52, fig. 3	.860 mm.	.182 mm.	.067 mm.	.067 mm. x .067 mm.
Pl. 52, fig. 2	.974 mm.	.235 mm.	.075 mm.	broken

Microspheric form—test free, consisting of a delicate, pointed proloculus and a gradually expanding second chamber which assumes the same cone shape of the megalospheric form; wall of moderate thickness, smooth, opaque to finely granular and translucent, well cemented; aperture circular and constricted.

	Test length	Max. diam.	Min. diam.	Proloculus
Pl. 52, fig. 4	.503 mm.	.185 mm.	.042 mm.	.033 mm. x .05 mm.
Pl. 52, fig. 5	.403 mm.	.101 mm.	.033 mm.	—

Test length for 10 specimens of the megalospheric form ranges from .521 mm. to 1.108 mm. Maximum diameter ranges from .134 mm. to .352 mm. Minimum diameter ranges from .067 mm. to .101 mm.

Test length for 10 specimens of the microspheric form ranges from .302 mm. to .436 mm. Maximum diameter ranges from .101 mm. to .134 mm. Minimum diameter ranges from .033 mm. to .067 mm.

Occurrence.—Abundant.

Remarks.—The forms of this species appear to conform exactly (both megalospheric and microspheric tests) to those described by Gutschick, *et. al.* as *Hyperammina conica.* It is the authors' opinion that the microspheric form of Conkin's species *Hyperammina casteri* includes both microspheric and megalospheric forms of Gutschick's species. The specimens which Conkin described as the megalospheric form of *H. casteri* is not present in this fauna. Since Gutschick described no similar forms it is presumed they were, likewise, absent from that faunal assemblage. This leads the authors to conclude that forms described as megalospheric tests of *H.*

casteri are probably another species. Megalospheric tests of *H. conica* are readily distinguishable from the microspheric tests. The proloculus of the former is spherical in shape and the separation of the proloculus from the second chamber begins close to the maximum diameter of the proloculus, leaving no distinct demarcation. The delicate, tiny, and somewhat pointed proloculus of the microspheric tests is usually broken off but, when present, it is well separated from the second chamber. The range chart given by Conkin for the microspheric forms of *H. casteri* covers the ranges for both megalospheric and microspheric forms of *H. conica.*

The ratio of microspheric to megalospheric forms in the present fauna is one to one.

Hyperammina conica resembles several species. If differs from *H. johnsvalleyensis* Harlton, 1933, in its smaller size and the fact the second chamber is not compressed in *H. conica. Hyperammina nitida* Gutschick and Treckman, 1959, and *Reophax buccina* Gutschick and Treckman, 1959, both possess similarities to *H. conica.* The second chamber of *H. nitida* expands at a lesser rate, giving the test a smaller conical angle than *H. conica. Reophax buccina* has a larger proloculus than *H. conica* and an internally chambered test.

Hyperammina harrisi Ireland Pl. 52, figs. 12, 13

Hyperammina harrisi Ireland, 1939, Jour. Paleont., vol. 13, p. 200, fig. A-26 Chimneyhill ls., Okla.; Raymond, 1955, A. M. thesis, Indiana Univ., p. 10, pl. 3, fig. 1 Osgood fm., Ind.

Test free, slender, somewhat compressed, gently curved, consisting of an ovoid proloculus and slowly enlarging tubular second chamber separated from the proloculus with only slight constriction; wall smooth, finely arenaceous, well cemented; aperture at open end of tube.

	Length of test	Max. diam.	Min. diam.	Proloculus
Pl. 52, fig. 13	.403 mm.	.084 mm.	.067 mm.	.067 mm x .084 mm.
Pl. 52, fig. 12	.570 mm.	.118 mm.	.075 mm.	.067 mm x .101 mm.

Test length for four specimens ranges from .403 mm. to .570 mm.; maximum diameter ranges from .101 mm. to .118 mm.; minimum diameter ranges from .059 mm. to .075 mm.; smallest proloculus .059 mm. x .067 mm.; largest proloculus is .067 mm. x .101 mm.

Occurrence.—Uncommon.

Remarks.—The Osgood specimens seem identical with the Chimneyhill specimens.

Hyperammina deminutionis (Moreman) Pl. 51, figs. 15, 16

Bathysiphon deminutionis Moreman, 1930, Jour. Paleont., vol. 4, No. 1, p. 46, pl. 5, fig. 6 Chimneyhill ls., Okla.; Stewart and Priddy, Jour. Paleont., vol. 15, No. 4, p. 370, pl. 54, fig. 6 Laurel ls. and Osgood fm., Ind.

Test free, slightly curved, gently tapering, showing exterior constrictions; wall thin, smooth, finely arenaceous, well cemented; aperture at open end of tube.

	Length of test	Max. diam.	Min. diam.
Pl. 51, fig. 15	.386 mm.	.084 mm.	.042 mm.
Pl. 51, fig. 16	.319 mm.	.075 mm.	.042 mm.

Test length for three specimens ranges from .319 mm. to .386 mm.; maximum diameter ranges from .075 mm. to .092 mm.; minimum diameter ranges from .042 mm. to .050 mm.

Occurrence.—Uncommon.

Remarks.—The Osgood specimens have the size and general form of the Chimneyhill specimens. The tests do not, however, diminish in diameter at both ends. The authors have placed this species under the genus *Hyperammina* instead of *Bathysiphon* because of the tapering test and an aperture at the broad end of the tube. The delicate size and the few specimens recovered could explain the open end of the test at the narrower extremity if the proloculus were broken. The probability also arises that Moreman's specimens may have been broken at a constriction which would make the test appear to have an aperture of less diameter than the remainder of test.

Hyperammina (?) rudis Parr Pl. 52, fig. 1

Hyperammina(?) rudis Parr, 1942, Roy. Soc. Western Australia, Jour., 1942, vol. 27 (1940-1941), No. 8, p. 105.

Test free, straight, circular in cross section; wall thick, rough, siliceous composed of angular quartz grains in a ferruginous cement; aperture at open end of tube.

	Length of test	Diam.
Pl. 52, fig. 1	1.140 mm.	.370 mm.

Occurrence.—Rare, one specimen.

Remarks.—The one specimen recovered fits Parr's description of the species in all respects. The authors concur with Parr as to the dubious placement of the species in the genus *Hyperammina.* There is no apparent constriction at the closed extremity which would suggest a proloculus. Sectioning was not attempted with a single specimen.

Hyperammina sp. Pl. 52, fig. 6

Test free, elongate, gently tapering, marked by closely spaced constrictions; narrow, thin ridges, caused by constriction spacing encircle the test and lend a corrugated appearance; wall thick, finely arenaceous with much cement; surface rough; aperture a circular opening in the constricted terminal portion of the test.

	Length of test	Max. diam.	Min. diam.
Pl. 52, fig. 6	.562 mm.	.134 mm.	.101 mm.

Occurrence.—Rare, one specimen.

Genus **BATHYSIPHON** Sars, 1872

Bathysiphon exiguus Moreman Pl. 52, figs. 7, 8

Bathysiphon parallelus Dunn, 1942, Jour. Paleont., vol. 16, p. 322, pl. 42, fig. 1 Osgood ls., Mo.

Bathysiphon exiguus Moreman, 1930, Jour. Paleont., vol. 4, p. 46, pl. 6, fig. 8 Viola ls., Okla.; Stewart and Priddy, 1941, Jour. Paleont., vol. 15, p. 370, pl. 54, fig. 7 Laurel ls., Ind.; Osgood fm., Ind.; Dunn, 1942, Jour. Paleont., vol. 16, p. 322, pl. 42, fig. 27 Brassfield ls. Niagaran ser., Ill.; Mound, 1961, Ind. Dept. Conserv. Geol. Sur., Bull. No. 23, p. 36, pl. 3, figs. 17-20 Brassfield ls., Ind.

Test free, straight, tapering slightly; wall thin, finely arenaceous; surface smooth; apertures at either end of tube.

	Length of test	Diam.
Pl. 52, fig. 8	.420 mm.	.101 mm.
Pl. 52, fig. 7	.586 mm.	.118 mm.

The length of test for 12 specimens ranges from .420 mm. to .586 mm.; diameter ranges from .075 mm. to .118 mm.

Occurrence.—Common.

Remarks.—Some of the specimens which are broken may possibly be *Hyperammina curva* which is often indistinguishable from *B. exiguus* if the initial portion is missing.

Bathysiphon rugosus Ireland Pl. 52, fig. 11

Bathsiphon rugosus Ireland, 1939, Jour. Paleont. vol. 13, No. 2, p. 192 Hunton fm. and Henryhouse sh, Okla.

Test free, cylindrical in shape with sides somewhat constricted; wall thin, composed of medium-sized sand grains; surface rough; apertures at the opposite ends of the test.

	Length of test	Diam.
Pl. 52, fig. 11	.537 mm.	.168 mm.

Occurrence.—Rare, one specimen.

Remarks.—The distinguishing feature of this species is the size of the sand grains which compose the test. The specimen conforms to Ireland's type. The species may belong in synonomy with *B. exiguus* Moreman where Mound (1961) has placed at. The authors are tentatively retaining Irelend's identification on the basis of a single specimen recovered.

Family **TROCHAMMINIDAE** Schwager, 1877

Subfamily **TROCHAMMININAE** Brady, 1884

Genus **TROCHAMMINA** Parker and Jones, 1859

Trochammina prima Stewart and Priddy, Pl. 51, figs. 17, 18

Trochammina prima Stewart and Priddy, 1941, Jour. Paleont., vol. 15, No. 4, p. 375, pl. 54, figs. 23-25 Osgood, Ind.

Test free, trochoid, biconvex; dorsal side with an initial chamber and five additional ones in a volution; ventral side with five chambers visible; sutures not depressed, limbate on dorsal side; wall thin and smooth, finely arenaceous with much cement; aperture a narrow slit on the ventral side of the last chamber.

	Max. diam.	Min. diam.
Pl. 51, fig. 17	.252 mm.	.235 mm.
Pl. 51, fig. 18	.269 mm.	.252 mm.

The maximum diameter for three specimens ranges from .235 mm. to .269 mm.; minimum diameter ranges from .201 mm. to .252 mm.

Occurrence.—Uncommon.

Remarks.—Stewart and Priddy based this species on one specimen. They placed the specimen in the genus *Trochammina* provisionally as they were unable to determine an aperture. Since the apertures are readily apparent on the Osgood forms, the generic position of the species is no longer in doubt.

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PLATES

ERRATA

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Lagennammina read *Lagenammina*

Lagennammina read **Lagenammina**

Lagennamina read *Lagenammina*

Lagennamina read **Lagenammina**

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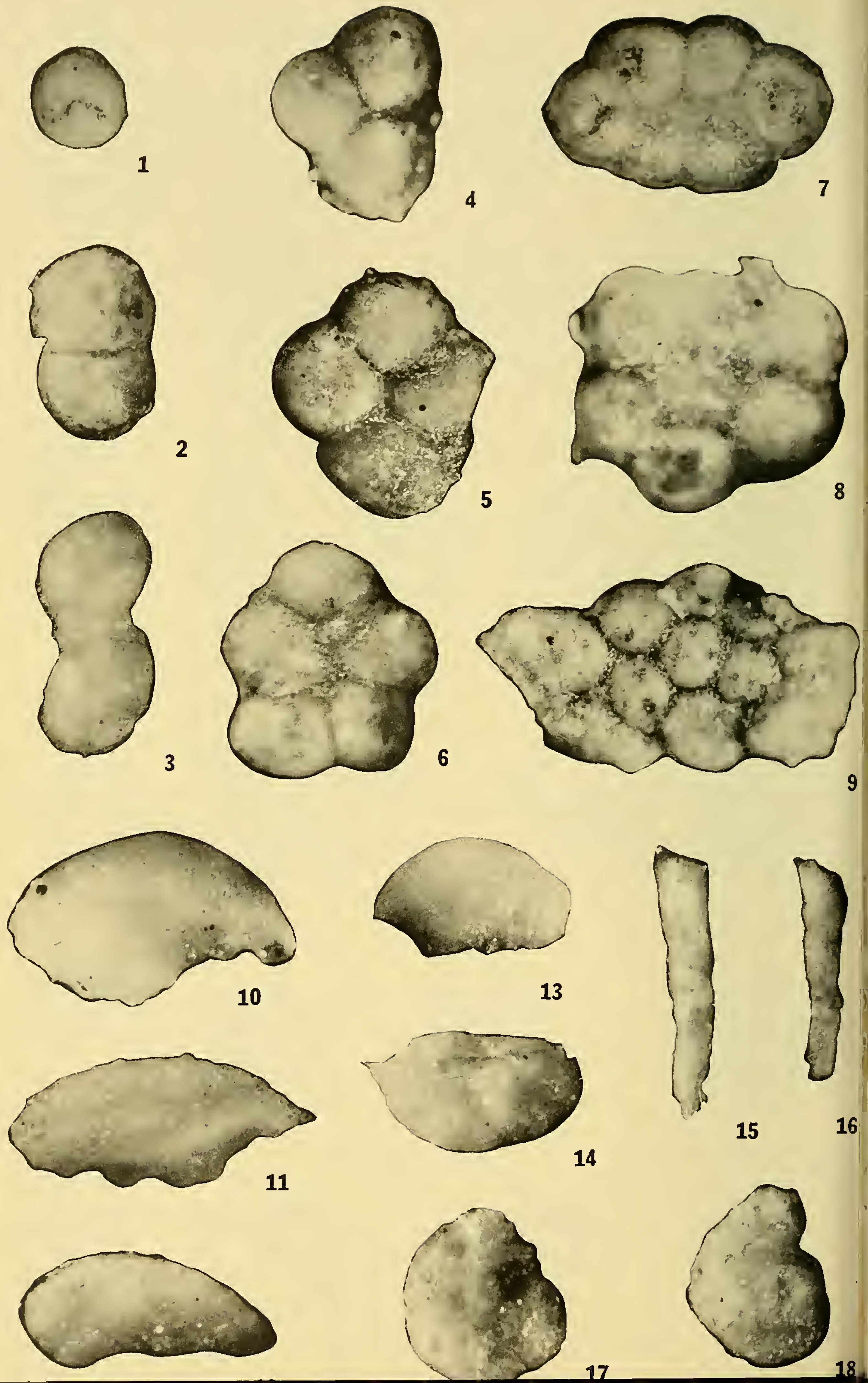
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By

Ruth G. Browne and Stephen M. Herrick

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RUTH G. BROWNE[2] and STEPHEN M. HERRICK[3]

ABSTRACT

Recent studies of Paleocene strata from Reidland, Kentucky, have revealed a significant foraminiferal assemblage in the Clayton(?) formation. The fauna is interesting, first because of its occurrence in a 6-inch zone occupying the extreme top of the Clayton(?) formation and, secondly, because the fauna contains certain species, such as *Textularia plummerae, Bulimina quadrata, Pseudoparrella exigua, Alabamina wilcoxensis, Asterigerina primaria,* and others, that characterize the upper part of the Midway in Texas and Alabama. In this regard Newton and others (1961, p. 64-66) reported *Bulimina quadrata* and *Alabamina wilcoxensis* as occurring in possible Clayton as well as in a transitional zone between the Clayton and Porters Creek formations and in the lower 50 feet of the Porters Creek in Alabama.

In Kentucky these species may have transgressed time lines and now characterize the Clayton(?) formation rather than the upper part of the Paleocene as in the southern parts of the Mississippi Embayment area. Thus, the Clayton(?) formation in Kentucky may have been deposited in a transgressive sea. On this basis, the Clayton(?) would be progressively geologically younger northward and constitute the stratigraphic equivalent of the Clayton in the southern part of the Embayment.

Other interesting facts about this foraminiferal fauna are the chemical composition of the tests and richness in numbers of individuals and diversity of species. The species belong to the so-called "smaller" Foraminifera. All tests, even those of normally calcareous species, are noncalcareous; none react to dilute hydrochloric acid. The assemblage includes 17 families, 36 genera, and 63 species.

INTRODUCTION

In March 1960, L. M. MacCary, geologist, U. S. Geological Survey, Paducah, Kentucky and Nat Dortch, geologist, Paducah Junior College, Paducah, Kentucky, supplied the senior author with the initial samples of foraminiferal material for this report from a site at Reidland, Kentucky. The site, 8.2 miles southeast of the Paducah Courthouse, was found and measured by T. W. Lambert, geologist, U. S. Geological Survey, Paducah, McCracken Co., Kentucky. The site is located in the bank of a stream which is a tributary of the Clark River. The Foraminifera were recovered principally from the top six inches of a 3-foot zone of dark gray glauconitic sand and clay which underlies the Porters Creek clay and is considered by Lambert to be the local representative of the Clayton(?) formation.

The senior author collected additional samples from the Reidland site in October 1960. In December 1960 the junior author and I. G. Sohn, U. S. Geological Survey, also collected from the Reidland locality. After observing the Reidland fauna, Sohn became interested in the fact that the Foraminifera were replaced and composed of material other than the calcite of normally unreplaced calcareous fossils. He decided to include this

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phenomenon as a part of the Director's Annual Report 1961. To this end he invited the junior author and T. W. Lambert to collaborate, with the junior author supplying a preliminary faunal list of Foraminifera and Lambert supplying the stratigraphic data (Sohn, Herrick, and Lambert, 1961).

ACKNOWLEDGMENTS

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DISCUSSION OF STRATIGRAPHY

McFarlan (1943) stated that insofar as is known "marine conditions in Kentucky during the Tertiary Period existed only in Porters Creek (Midway) time."

Cooper (1944) in a discussion of the northern limit of the Mississippian Embayment with respect to Illinois mentioned the probability that the earliest Cenozoic formations extended farther than the then known outcrops in southern Illinois. The Owl Creek formation and the Coon Creek Tongue of the Ripley formation of Late Cretaceous age, overlie and underlie, respectively, the McNairy sand member of the Ripley formation to the south in Tennessee. Their apparent absence from the Illinois section could be due to lack of recognition. Shoreline conditions represented by sandy, glauconitic, nonfossiliferous deposits might take on the character of the McNairy sand member.

The same probability for the presence of some of these units belonging to the Ripley formation and the Midway group that maintains in Illinois is true of these formations in Kentucky. The presence of marine fossils in the glauconitic sandy clay beneath the Porters Creek and the lithologic similarity to the Clayton formation of Illinois are reasons for assuming the presence of the Clayton(?) formation in Kentucky. Lithology and the tracing southward of the next underlying formation indicate that it is the McNairy sand member of the Ripley formation.

The formation considered to be the Clayton(?) formation derives its name from an exposure at Clayton, Barbour County, Alabama, where it has a thickness of 10 feet. This formation together with the Porters Creek comprise the Midway group of the central and northern embayment area. The accompanying map (Cooper, 1944, fig. 1) shows the outcrop

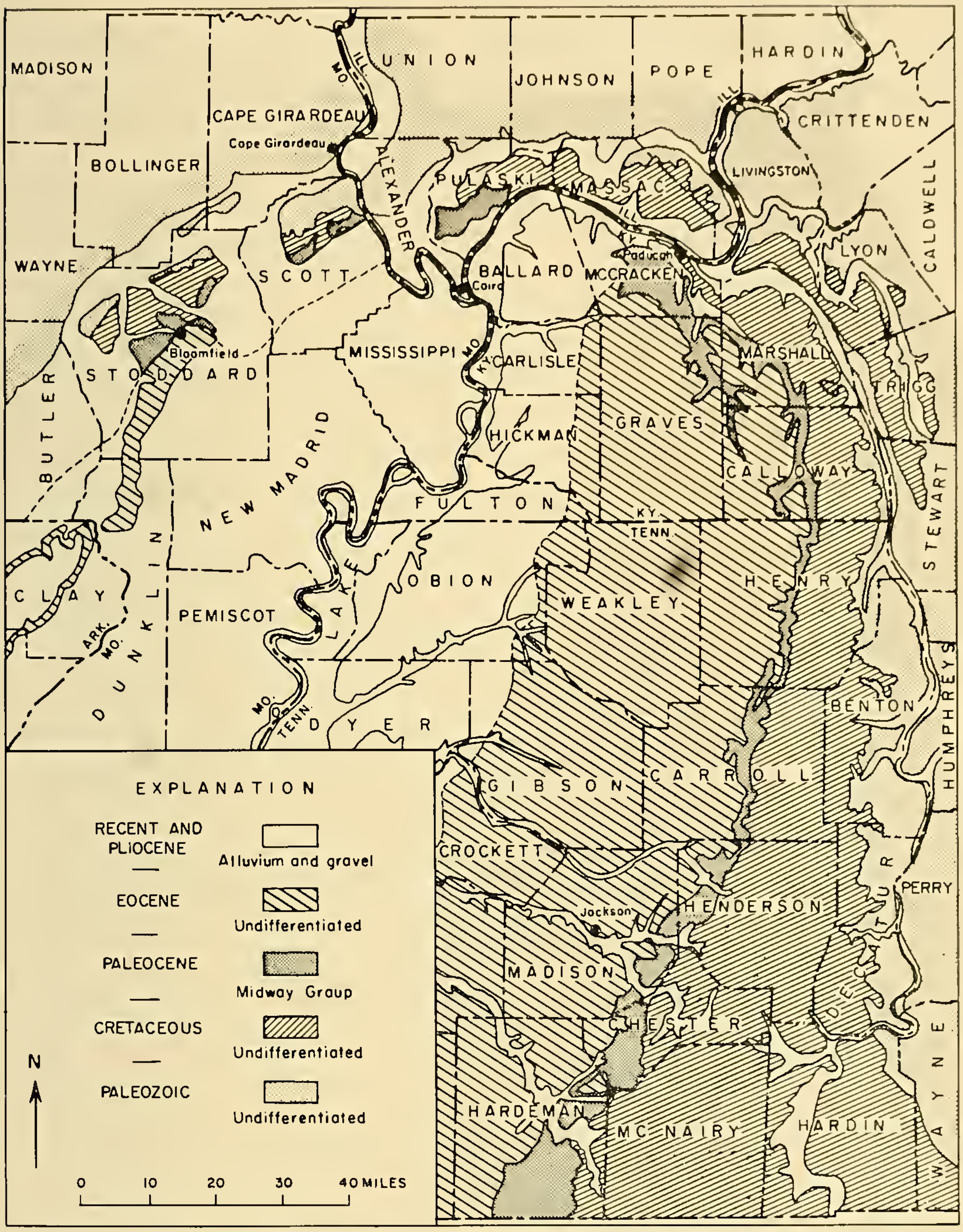

Figure 1.—Map of the upper part of the Mississippi Embayment showing the outcrops of Eocene and Paleocene (modified from Cooper, 1944).

pattern of Tertiary and Cretaceous formations in the upper part of the Mississippi Embayment. The accompanying chart (Pryor and Glass, 1961, fig. 2) indicates the correlation of these formations in the same area.

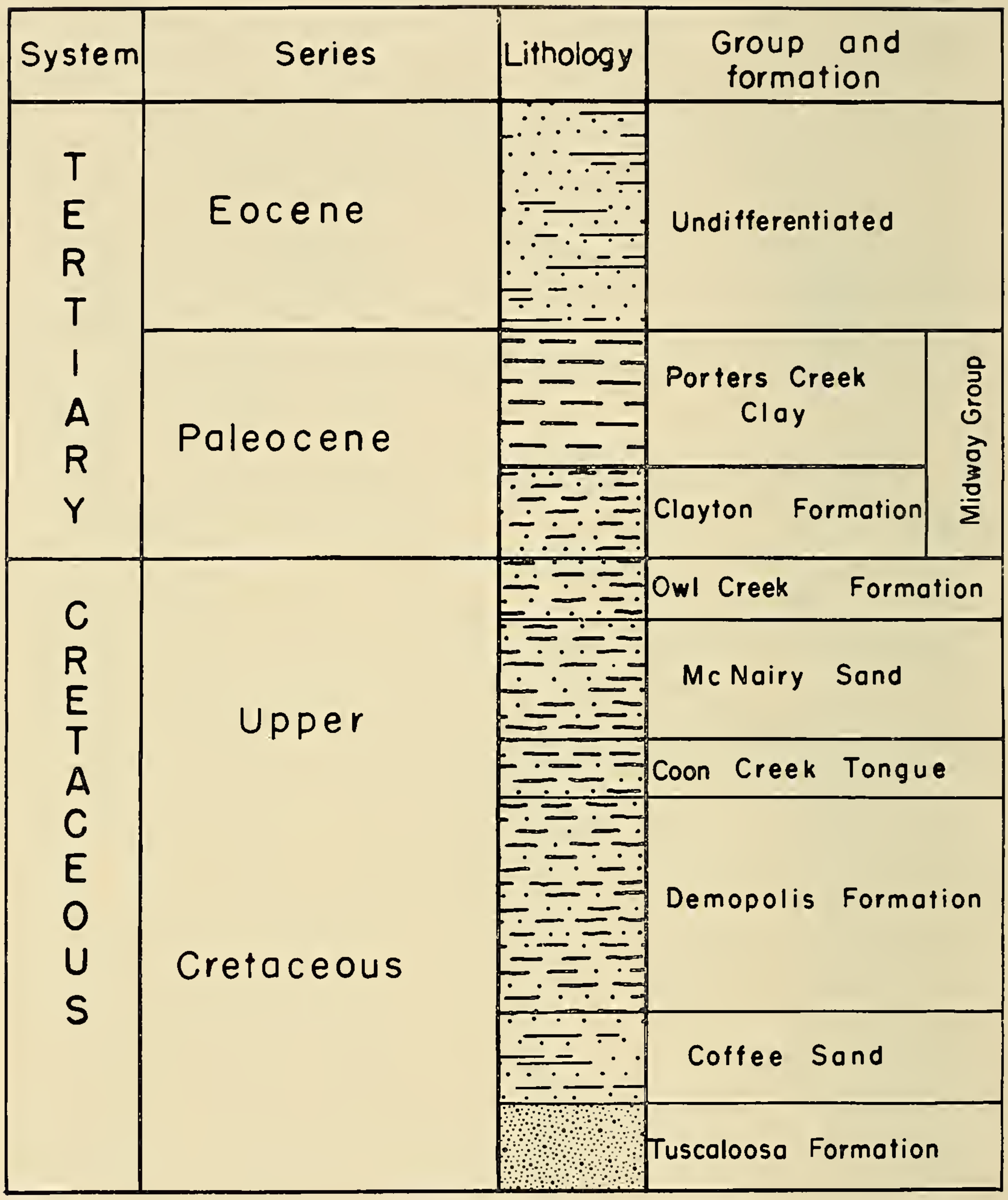

Figure 2.—Generalized stratigraphic column for upper part of Mississippi Embayment (modified from Pryor and Glass, 1961).

The section which follows is Lambert's (1961, p. B-227) measured section for these formations.

Geologic Section at Reidland, McCracken County, Kentucky
Kentucky south coordinate grid
1186.4-258.2

	Thickness (feet)
PALEOCENE:	
MIDWAY GROUP:	
PORTERS CREEK CLAY:	
Black claystone	10
CLAYTON(?) FORMATION:	
Glauconitic claystone, sandy; Foraminifera and barite(?) crystals	2 to 3
UPPER CRETACEOUS:	
McNAIRY SAND:	
Black claystone	6
Black glauconitic claystone	5 (?)
Interlaminated lignitic clay and fine-grained micaceous sandstone	15+

DISCUSSION OF FAUNA

The foraminiferal fauna of the Clayton(?) formation is composed of 17 families, 36 genera, and 63 species. The family Lagenidae includes one-fourth of the species present and another quarter is divided about equally between representatives of the families Rotaliidae and Anomalinidae. The remaining half of the fauna is composed of species belonging to genera distributed among the various other families present. Four of these families comprise the arenaceous forms. Few species, however, are included.

Three species are relatively abundant in the fauna—*Bulimina quadrata, Anomalina midwayensis,* and *Clavulinoides midwayensis.* With the exception of the latter species the arenaceous species present are of rare occurrence. Of the globigerine forms *G. pseudobulloides* and *G. triloculinoides* are common. *Alabamina wilcoxensis* and *Pulsiphonina prima* are common species. Broken chambers of the larger specimens—*Stilostomella* cf. *S. paleocenica, S. midwayensis,* and *Nodosaria latejugata*—are frequently encountered. The rare forms belonging to the calcareous genera include *Robulus pseudomamilligerus, Cibicides alleni, Cibicides newmanae, Chilostomelloides eocenica, Polymorphina* cf. *P. frondea,* and *Cibicidina missis-*

sippiensis. Of the arenaceous forms *Reophax?* sp., *Ammobaculites midwayensis, A. expansus,* and *Textularia midwayana* are rare.

This Midway assemblage, considered as a whole, has the components and complexion of the upper part of the Midway faunal zone (Porters Creek) as known in the southern embayment area. In the region of Texas and Alabama forms restricted to this zone include *Textularia plummerae, Bulimina quadrata, Globigerina compressa, Pseudoparrella exigua, Alabamina wilcoxensis, Asterigerina primaria,* and *Chilostomelloides eocenica.* The relative abundance or scarcity of particular species is also similar to that of the upper part of the Midway. *Clavulinoides midwayensis* is abundant in the fauna whereas *Robulus midwayensis* was not recovered from the fauna. If Lambert's designation of Clayton(?) is correct, the above-named species must have transgressed time horizons and the Clayton(?) is geologically younger in the northern part of the embayment area than it is in the southern part.

The fact that the Reidland Foraminifera are replaced, as noted above, is unusual. Species normally belonging in calcareous genera were selected from various samples of the rocks and were treated with dilute hydochloric acid. None reacted to the acid, affirming Sohn's findings that these species from this locality are not calcareous.

The general lack of fossil remains and calcareous material from the Cretaceous and Tertiary sediments of the northern part of the embayment region in Illinois, Mississippi, and Kentucky, was mentioned by Lamar and Sutton (1930). This seems to account for the fact, as well as providing additional evidence, that the present fauna and one described by Cooper (1944) from a cutting in a water well at Cache, Alexander County, Illinois, are the only known records of Tertiary Foraminifera in the northern embayment area. In the latter instance the depth, 115 to 135 feet, probably prevented leaching and consequent loss of the fossils.

Identification of the various species has been extremely difficult because of the replaced condition of the tests, such replacement having destroyed some of the specific characteristics.

DISCUSSION OF SPECIES

Family **REOPHACIDAE**

Genus **REOPHAX** Montfort, 1808

Reophax? sp. Pl. 53, fig. 1

An arenaceous species with test of angular quartz grains may belong to this genus. The wall is single. Chambers are not discernible.

Length of hypotype, 1.24 mm.; maximum diameter, 0.50 mm.; minimum diameter, 0.30 mm.

Family LITUOLIDAE
Genus AMMOBACULITES Cushman, 1910

Ammobaculites midwayensis Plummer Pl. 53, fig. 2

Ammobaculites midwayensis Plummer, 1932, Univ. Texas, Bull. 3201, p. 63, pl. 5, figs. 7-11 (upper part of the Midway—Texas); Cushman, 1951, U.S. Geol. Sur., Prof. Paper 232, p. 4, pl. 1, figs. 8-12, (upper part of the Midway—Texas).

Test well enough preserved to assign to this species. Initial portion of test apparently coiled with succeeding chambers rectilinear, elongate. Finish of test coarsely arenaceous, composed of angular quartz grains; aperture terminal.

Cushman stated (1951) that this species is a good index fossil for the upper 50 to 75 feet of the Midway group in Texas.

Length of hypotype, 0.33 mm.; diameter, 0.13 mm.

Ammobaculites expansus Plummer Pl. 53, fig. 3

Ammobaculites expansus Plummer, 1932, Univ. Texas, Bull. 3201, p. 65, pl. 5, figs. 4-6 (upper part of the Midway—Texas); Cushman, 1951 U. S. Geol. Sur., Prof. Paper 232, p. 4, pl. 1, figs. 5-7.

Sutures obscure but test well enough preserved to show broad initial coiling followed by the suggestion of an elongate portion composed of rectilinear chambers. Surface of test coarsely arenaceous, composed of quartz grains bound by white cement; aperture (not shown in figured specimen) an elongate opening at end of final chamber.

This is a characteristic species of the uppermost Midway of Texas. A single specimen was recovered.

Length of hypotype, 0.52 mm.; diameter, 0.42 mm.; thickness, 0.14 mm.

Family TEXTULARIIDAE
Genus TEXTULARIA Defrance, 1824

Textularia midwayana Lalicker Pl. 53, figs. 6-10

Textularia midwayana Lalicker, 1935, Cushman Lab. Foram. Research, Contr., v. 11, p. 49, pl. 6, figs. 7-9 (Midway, Arkansas-Texas); Cushman, 1951, U. S. Geol. Sur., Prof. Paper 232, p. pl. 1 figs. 28-30 (Midway, Arkansas-Texas).

Test elongate, tapering, compressed to slightly inflated; chambers distinct, numerous; sutures depressed; wall coarsely arenaceous; aperture a low arched slit at the base of the final chamber.

The authors are unable to distinguish between the species *Textularia midwayana* and *Textularia plummerae,* hence all specimens of these species were placed under *T. midwayana.* The compressed forms are probably *T. plummerae* and the thicker forms *T. midwayana.*

This species is rare in the fauna; only three specimens were recovered. In the Gulf Coastal region it is diagnostic of the silty layers of the upper part of the Midway. The form ranges through the Tertiary formations.

Length of hypotype (broken specimen), 0.43 mm.; greatest diameter 0.26 mm.; thickness, 0.18 mm.

Length of hypotype (another specimen), 0.40 mm.; greatest diameter, 0.25 mm.; thickness, 0.12 mm.

Family **VERNEUILINIDAE**

Genus **CLAVULINOIDES** Cushman, 1936

Clavulinoides midwayensis Cushman — Pl. 53, figs. 4,5

Clavulinoides angularis Plummer 1926, (not d'Orbigny), Univ. Texas, Bull. 2644, p. 70, pl. 3, figs. 4, 5 (Midway—Texas).

Clavulinoides midwayensis Cushman, 1936, Cushman Lab. Foram. Research., Special Pub. 6, p. 21, pl. 3, figs. 9, 15; Cushman, 1951, U. S. Geol. Sur., Prof. Paper 232, p. 8, pl. 2, figs. 10-16 (Midway, Alabama-Arkansas-Texas-Mississippi).

Test triangular, in the microspheric form expanding rather rapidly through the triserial portion, in the megalospheric form expanding gradually in the uniserial portion; chambers distinct; sutures distinct, less depressed in the microspheric form than in the megalospheric form; wall coarsely arenaceous; aperture round in the megalospheric form and triangular in the microspheric form.

This is one of the more abundant forms of the fauna. It is typical and compares exactly with Cushman's description and figures.

Length of hypotype (microspheric form), 1.10 mm.; diameter, 1.68 mm.

Length of hypotype (megalospheric form), 1.17 mm.; diameter, 0.30 mm.

Family **LAGENIDAE**

Genus **ROBULUS** Montfort, 1808

Robulus sp. A — Pl. 54, fig. 5

Two broken specimens with three chambers each of a large species of *Robulus* were recovered.

This large form has a protruding neck and a long robuline slit.

Length of hypotype (broken specimen), 1.1 mm.; diameter (broken specimen), 0.67 mm.; thickness (broken specimen), 0.45 mm.

Robulus sp. B Pl. 54, fig. 4

A single broken specimen of *Robulus* with three chambers is not identifiable. The sutures are deep and decidedly curved.

Length of hypotype (broken specimen), 0.70 mm.; diameter (broken specimen), 0.77 mm.; thickness (broken specimen), 0.33 mm.

Robulus insulsus Cushman Pl. 54, fig. 3

Cristellaria orbicularis Plummer, 1926, (not d'Orbigny), Univ. Texas, Bull. 2644, p. 92, pl. 7, fig. 1 (Midway-Texas).

Robulus insulsus Cushman, 1951, U. S. Geol. Sur., Prof. Paper 232, p. 16, pl. 5, figs. 1-3 (Midway-Alabama and Texas).

Test small, thick, close coiled with a narrow peripheral keel; chambers six to seven; sutures curved, flush with the surface, radiating outward from the umbo; aperture not determinable.

Typically the specimens of this species show a transparent wall and a clear umbonal region not observed in the Reidland specimens, owing to the replaced condition of the wall.

Diameter of hypotype (larger specimen), 0.40 mm. x 0.50 mm.; thickness (larger specimen), 0.29 mm.

Diameter of hypotype (smaller specimen), 0.27 mm. x 0.33 mm.; thickness (smaller specimen), 0.17 mm.

Robulus turbinatus (Plummer) Pl. 54, figs. 12, 13

Cristellaria turbinata Plummer, 1926, Univ. Texas, Bull. 2644, p. 93, pl. 7, fig. 4.

Robulus turbinatus Cushman, 1940, Cushman Lab. Foram, Research. Contr., v. 16, p. 55, pl. 9, fig. 17; Cushman, 1951, U. S. Geol. Sur., Prof. Paper 232, p. 14, pl. 4, figs. 6-9 (Midway, Alabama-Arkansas-Mississippi-Texas).

Test circular, compressed; peripheral margin with a ragged white flange; chambers eight in final whorl, narrow; sutures raised and of about equal width from umbo to peripheral margin; aperture at apex of septal face.

The distinguishing feature of this species is its narrow, ragged flange. *R. orbicularis* (d'Orbigny) also has a flange, but the flange of this species is better developed and not ragged.

This species occurs rarely in Cretaceous strata.

Diameter of hypotype, 0.41 mm.; thickness, 0.21 mm.

Robulus cf. R. rosettus (Gümbel) Pl. 54, figs. 10, 11

Robulina rosetta Gümbel, 1870, K. bayer. Akad. Wiss., Math-phys. Abt., Abh., Kl. 2, v. 10, p. 642, pl. 1, fig. 73.

Robulus rosetta Cushman, 1940, Cushman Lab. Foram. Research Contr., vol. 16, p. 55, pl. 9, fig. 24.

Robulus cf. *R. rosettus* Cushman, 1951, U. S. Geol. Sur., Prof. Paper 232, p. 16, pl. 4, figs. 20, 21 (Midway, Arkansas-Mississippi-Texas).

A few specimens of *Robulus* with five chambers, a distinct keel, and a slight neck are referred to this species.

Diameter of hypotype, 0.42 mm. x 0.37 mm.

Robulus cf. R. piluliferus Cushman Pl. 54, figs. 8, 9

Robulus piluliferus Cushman, 1947, Cushman Lab. Foram. Research Contr., v. 23, p. 83, pl. 18, fig. 4; Cushman, 1951, U. S. Geol. Sur., Prof. Paper 232, p. 16, pl. 5, fig. 4 (Midway, Arkansas-Texas).

The classification of this species of *Robulus* seems quite certain for the beaded, broken sutures are distinct.

Cushman (1951) stated, "This species differs from *R. midwayensis* (Plummer) in the generally smaller size and the broken sutures."

Diameter of hypotype (larger specimen), 1.14 mm.; thickness, 0.26 mm.

Thickness of hypotype (smaller, broken specimen), 1.17 mm. x 0.70 mm.

Robulus degolyeri (Plummer) Pl. 54, figs. 6, 7

Cristellaria degolyeri Plummer, 1926, Univ. Texas, Bull. 2644, p. 97, pl. 7, fig. 7.

Robulus degolyeri Bandy, 1944, Jour. Paleont., vol. 18, p. 368, pl. 60, fig. 5; Cushman, 1951, U. S. Geol. Sur., Prof. Paper 232, p. 14, pl. 3, figs. 21, 22 (Midway, Texas-Mississippi-Arkansas; Eocene-Oregon).

Test longer than broad, slightly compressed; periphery acute, bounded by a ragged flange; chambers seven to nine; sutures of clear shell material, raised, and originating in a raised umbonal area; aperture a small slit at apex of septal face.

The Reidland forms of this species differ from the type in that the sutures maintain approximately the same width from the periphery to the umbonal boss. In the type species the sutures taper slightly from the umbonal area to the periphery.

This species is quite distinct from *Robulus pseudomamilligerus* which has more chambers, is larger, and more strongly compressed. The form is of little stratigraphic value because it has been found in Cretaceous clays.

Length of hypotype (larger specimen), 0.90 mm.; diameter, 0.60 mm.; thickness, 0.40 mm.

Length of hypotype (smaller specimen), 0.81 mm.; diameter, 0.52 mm.; thickness, 0.29 mm.

Robulus pseudomamilligerus (Plummer) Pl. 54, fig. 2

Cristellaria pseudo-mamilligera Plummer, 1926, Univ. Texas, Bull. 2644, p. 98, pl. 7, fig. 11.

Robulus pseudo-mamilligerus Cushman, 1940, Cushman Lab. Foram. Research Contr., v. 16, p. 55, pl. 9, fig. 16; Cushman, 1951, U. S. Geol. Sur., Prof. Paper 232, p. 13, pl. 4, figs. 1-5 (Midway, Texas-Arkansas-Alabama).

Test elongate, quite compressed; peripheral margin bounded by a sharp keel; chambers 11 in final whorl; sutures raised, distinctly curved, extending outward from a group of protuberances; aperture protruding at top of septal face.

This form is rare in the fauna. Its large size and compressed test separate it from other species.

Length of hypotype, 1.10 mm.; diameter, 0.79 mm.; thickness, 0.40 mm.

Genus **MARGINULINA** d'Orbigny, 1826

Marginulina sp. Pl. 54, fig. 1

Two specimens, both broken, are too rare to permit specific identification. They seem to resemble a specimen from the Midway of Arkansas figured by Cushman (1951, p. 18, pl. 5, fig. 33) and referred to as *Marginulina* sp. B.

Length of hypotype, 0.35 mm.; diameter, 0.31 mm.

Genus **DENTALINA** d'Orbigny, 1826

Dentalina eocenica Cushman Pl. 53, figs. 11-13

Dentalina cf. *D. cooperensis* Cooper, 1944, Jour. Paleont., vol. 18, p. 347, pl. 54, fig. 21. Not *D. cooperensis* Cushman, 1933, p. 8.

Dentalina eocenica Cushman, 1944, Cushman Lab. Foram. Research, Contr., vol. 20, p. 36, pl. 6, fig. 1; U. S. Geol. Sur., Prof. Paper 232, p. 22, pl. 6, figs. 30-33 (Midway, Texas-Arkansas-Mississippi-Alabama).

Test small, slender, slightly curved; chambers increasing in size as added; sutures distinct but little depressed, oblique only in initial end of test; aperture radiate and terminal.

This species, as far as the authors are able to determine, is the same as the species which Cooper (1944, p. 347, pl. 54, fig. 21) described as "*Dentalina* cf. *D. cooperensis* Cushman," from the Paleocene of Illinois.

Length of hypotype (broken specimen), 0.42 mm.; diameter (widest part), 0.13 mm.

Length of hypotype (complete specimen), 0.72 mm.; diameter, 0.15 mm.

Dentalina cf. D. obliqua (Linné) Pl. 53, fig. 15

Nautilus obliquus Linné, 1758, Syst, Nat. ed. 10, p. 711; Gmelin, 1791, ed. 13, p. 3372.

Dentalina obliqua Plummer, 1931, Univ. Texas, Bull. 3101, p. 153, pl. 11, fig. 6 (Upper Cretaceous, Texas); Toulmin, 1941, Jour. Paleont., vol. 15, p. 586, pal. 79, fig. 17 (Paleocene. Salt Mountain limestone, Alabama).

The single final chamber of a specimen with oblique sutures and wall ornamented with numerous low costae running obliquely across the chamber appears to belong to this species.

Length of hypotype, 0.36 mm.

Dentalina cf. D. communis (d'Orbigny) Pl. 53, fig. 14

Nodosaria (*Dentalina*) *communis* d'Orbigny, 1826, Soc. nat. sci., Ann., v. 7, p. 254, no. 35.

Dentalina communis Howe and Wallace, 1932, Louisiana Dept. Cons., Geol. Bull. 2, p. 24, pl. 6, fig. 8 (upper Eocene, Louisiana); Toulmin, 1941, Jour. Paleont., v. 15, p. 584, pl. 79, fig. 15 (Paleocene. Salt Mountain limestone, Alabama); Cooper, 1944, ibid., vol. 18, p. 347, pl. 55, fig. 10 (Midway, Illinois).

A single broken specimen with three chambers is doubtfully referred to this species. The almost straight sides with chambers somewhat broader than high and the oblique sutures resemble Cooper's figured specimen.

Length of hypotype (broken specimen), 0.33 mm.; diameter, 0.13 mm.

Genus NODOSARIA Lamarck, 1812

Nodosaria spinescens (Reuss) Pl. 53, figs. 19, 20

Dentalina spinescens Reuss, 1851, Zeit. deutsch. geol. Gesell., vol. 3, p. 62, pl. 3, fig. 10.

Nodosaria spinescens Plummer, 1926, Univ. Texas, Bull. 2644, p. 84, pl. 4, fig. 12 (upper part of Midway, Texas).

Test slender; chambers ellipsoidal, about twice as long as broad with a few short spines around the base close to the sutural constrictions; aperture terminal and round.

Owing to the replaced condition of the species few specimens have the spines preserved. However, the relatively smooth ellipsoidal chambers distinguish it from any other species in the fauna.

Length of hypotype (broken specimen), 0.60 mm.; diameter, 0.17 mm.

Length of hypotype (single chamber), 0.60 mm.; diameter, 0.33 mm.

Nodosaria latejugata Gümbel Pl. 53, figs. 21, 22

Nodosaria latejugata Gümbel, 1870, K. bayer. Akad. Wiss., Math.-phys. Abt., Abh., Kl. 2, vol. 10, p. 619, pl. 1, fig. 32.
Nodosaria affinis Plummer, 1926, Univ. Texas, Bull. 2644, p. 89, pl. 14, figs. 2 a-d (Midway-Texas).
Nodosaria latejugata Toulmin, 1941, Jour. Paleont., vol. 15, p. 588, pl. 79, figs. 26, 27 (Paleocene. Salt Mountain limestone, Alabama); Cooper, 1944, Jour. Paleont., vol. 18, p. 348, pl. 55, figs. 24, 25 (Midway-Illinois); Cushman, 1944, Cushman Lab. Foram. Research. Contr., vol. 20, p. 37, pl. 6, figs. 6-8; Cushman, 1951, U. S. Geol. Sur., Prof. Paper 232, p. 23, pl. 7, figs. 1, 2 (Midway, Alabama-Mississippi-Texas-Arkansas).

Test elongate; chambers inflated and globular with 10 to 12 strong longitudinal costae which have sharp edges; sutures transverse and depressed; aperture round and protruding.

This readily recognized species is common in the fauna. Its size affords identification in the field by means of a hand lens.

Length of hypotype (single chamber), 0.97 mm.; diameter, 0.77 mm.

Length of hypotype (single chamber, end view), 0.75 mm.; diameter, 0.60 mm.

Genus **CHRYSALOGONIUM** Schubert, 1907

Chrysalogonium granti (Plummer) Pl. 53, figs. 16, 17

Nodosaria granti Plummer, 1926, Univ. Texas, Bull. 2644, p. 83, pl. 5, figs. 9, a-d, 1926 (Midway, Texas).
Nodosaria filiformis Carsey, 1926, Univ. Texas, Bull. 2612, p. 33, pl. 7, fig. 8 (Upper Cretaceous, Texas).
Chrysalogonium granti (Plummer), Toulmin, 1941, Jour. Paleont., vol. 15, p. 589, pl. 79, figs. 34, 35 (Paleocene. Salt Mountain limestone, Alabama); Cooper, 1944, Jour. Paleont., v. 18, p. 346, pl. 54, figs. 26, 27 (Midway, Illinois); Cushman, 1951, U. S. Geol. Sur., Prof. Paper 232, p. 24, pl. 13, fig. 11 (Midway, Texas-Arkansas-Mississippi-Alabama).

Test elongate, slender; chambers cylindrical; wall opaque, smooth; sutures not distinct.

The only specimens of this species which were recovered are broken. All seem to be the early portions of the tests, for the chambers show no inflation.

Length of hypotype (longer specimen), 0.43 mm.; diameter, 0.08 mm.

Length of hypotype (shorter specimen), 0.25 mm.; diameter, 0.08 mm.

Chrysalogonium eocenicum Cushman and Todd Pl. 53, fig. 18

Chrysalogonium eocenicum Cushman and Todd, 1946, Cushman Lab. Foram. Research, Contr., vol. 22, p. 53, pl. 9, figs. 3-5; Cushman, 1951, U. S. Geol. Sur. Prof. Paper 232, p. 25, pl. 7, figs. 13-15 (Midway, Texas-Arkansas-Alabama).

Test elongate, distinctly curved and tapering from the apertural end to the acute initial end; chambers distinct, somewhat inflated; sutures distinct, depressed; aperture cribrate, terminal.

Length of hypotype (broken specimen; initial portion), 0.42 mm.; diameter, 0.11 mm.

Length of hypotype (broken specimen; apertural portion), 0.37 mm.; diameter, 0.11 mm.

Family POLYMORPHINIDAE

Genus GLOBULINA d'Orbigny, 1839

Globulina gibba d'Orbigny Pl. 54, figs. 19, 20

Globulina gibba d'Orbigny, 1826, Annales sci. nat., vol. 7, p. 266, No. 10, Modeles, No. 63.
Polymorphina gibba Plummer, 1926, Texas Univ., Bull. 2644, p. 122, pl. 6, figs. 8 a-b (Midway, Texas).
Globulina gibba Toulmin, 1941, Jour. Paleont., vol. 15, p. 594, pl. 80, fig. 9, (Paleocene, Salt Mountain limestone, Alabama); Cushman, 1951, U. S. Geol. Sur. Prof. Paper 232, p. 33, pl. 9, figs. 26-28 (Midway, Texas-Arkansas-Mississippi-Alabama).

Test oval in side view; chambers few, distinct but not inflated; sutures marked by dark lines; aperture radiate.

The only form with which this species might be confused is *Globulina lactea* (Walker and Jacob) which is smaller, with faintly inflated chambers. *G. gibba* has no stratigraphic value.

Length of hypotype (large specimen), 0.31 mm.; diameter, 0.27 mm.

Length of hypotype (smaller specimen), 0.23 mm.; diameter, 0.21 mm.

Genus POLYMORPHINA d'Orbigny, 1826

Polymorphina cf. **P. frondea** (Cushman) Pl. 54, fig. 14

Bolivina frondea Cushman, 1922, U. S. Geol. Sur., Prof. Paper 129-F, p. 126, pl. 29, fig. 3; Cushman, 1923, Prof. Paper 133, p. 20.
Polymorphina frondea Cushman, 1929, Cushman Lab. Foram. Research, Contr., vol. 5, p. 41; Cushman, 1951, U. S. Geol. Sur., Prof. Paper 232, p. 35, pl. 10, fig. 13 (Midway, Mississippi-Alabama).

This species appears to be the same as the one figured by Cushman (1951, p. 35, pl. 10, fig. 13) with the exception that the initial end instead of being acute is blunt and rounded.

Length of hypotype, 0.69 mm.; diameter, 0.58 mm.

Genus **RAMULINA** Rupert Jones, 1875

Ramulina cf. **R. globulifera** H. B. Brady Pl. 54, fig. 15

Ramulina globulifera H. B. Brady, 1879, Mic. Soc. Quart. Jour., vol. 19, p. 272, pl. 8, figs. 32, 33; Plummer, 1931, Texas Univ., Bull. 3101, p. 174, pl. 11, fig. 15 (Upper Cretaceous, Texas); Toulmin, 1941, Jour. Paleont., vol. 15, p. 596, pl. 80, fig. 21 (Paleocene. Salt Mountain limestone, Alabama).

Ramulina cf. *R. aculeata* Cushman, 1940, Cushman Lab. Foram. Reseach, Contr., vol. 16, p. 64, pl. 11, figs. 13, 14 (Midway, Alabama); Cushman, 1951, U. S. Geol. Sur., Prof. Paper 232, p. 36, pl. 10, figs. 24-26 (Midway, Texas-Arkansas-Mississippi-Alabama).

Several specimens with hispid globular test and stolon tubes are referred to this species.

Diameter of hypotype (includes broken stolon tubes), 0.58 mm.

Family **NONIONIDAE**

Genus **NONIONELLA** Cushman, 1926

Nonionella sp. Pl. 54, figs. 16-18

Nonionina turgida Plummer, 1926, (not Williamson) (part), Univ. Texas, Bull. 2644, p. 159, pl. 12, fig. 6; Cushman, 1951, U. S. Geol. Sur., Prof. Paper 232, p. 37, pl. 11, figs. 5, 6 (Midway, Alabama).

A single specimen of *Nonionella* resembles Mrs. Plummer's figured specimen.

Length of hypotype, 0.15 mm.; diameter, 0.13 mm.; thickness, 0.06 mm.

Family **HETEROHELICIDAE**

Genus **BOLIVINOPSIS** Yakovlev, 1891

Bolivinopsis cf. **B. rosula** (Ehrenberg) Pl. 55, fig. 2

Spiroplecta rosula Ehrenberg, 1854, Microgeologie, pl. 32, pt. 2, fig. 26.

Spiroplectoides rosula (Ehrenberg), Cushman, 1927, Cushman Lab. Foram. Research, Contr., vol. 3, p. 62, pl. 13, figs. 9 a-b; p. 114, pl. 23, figs. 6, 7; Cushman, 1931, Tennessee Div. Geology, Bull. 41, p. 44, pl. 7, fig. 9.

Bolivinopsis rosula Macfadyen, 1933, Royal Micro. Soc., Jour., vol. 53, p. 141, Jennings, 1936, Bull. Amer., Paleont., vol. 23, No. 78, p. 26; Cushman, 1946, U. S. Geol. Sur., Prof. Paper 206, p. 101, pl. 44, figs. 4-8.

Cushman (1951) assigned two small young specimens from the Naheola formation of Alabama to this genus but does not refer them to any particular species. Although only two single broken specimens belonging to this genus were recovered they are sufficiently well preserved for purposes of identification, hence they are tentatively referred to this species.

Length of hypotype, 0.14 mm.; diameter, 0.06 mm.

Genus **CHILOGUEMBELINA** Loeblick and Tappan, 1956

Chiloguembelina morsei (Kline) Pl. 55, fig. 1

Gümbelina morsei Kline, 1943, Mississippi Geol. Sur., Bull. 53, p. 44, pl. 7, fig. 12 (upper part of Midway-Mississippi); Cushman, 1951, U. S. Geol. Sur., Prof. Paper 232, p. 38, pl. 11, fig. 10 (upper part of Midway, Mississippi.
Chiloguembelina morsei Loeblich and Tappan, 1957, U. S. Nat. Mus., Bull. 215, p. 179, pl. 40, figs. 2 a, b, 4; pl. 42, figs. 1 a, b; pl. 43, figs. 2, 6a, b.

Test small, slightly compressed, tapering, with the greatest width above the middle; chambers distinct, inflated, somewhat broader than high; sutures distinct, depressed; aperture high.

Kline stated that this species is common in the Porters Creek but unknown from the Clayton.

Length of hypotype, 0.12 mm.; diameter, 0.06 mm.; thickness, 0.05 mm.

Genus **SIPHOGENERINOIDES** Cushman, 1927

Siphogenerinoides eleganta (Plummer) Pl. 55, fig. 3

Siphogenerina eleganta Plummer, 1926, Univ. Texas, Bull. 2644, p. 126, pl. 8, fig. 1.
Siphogenerinoides eleganta Cushman, 1940, Cushman Lab. Foram. Research, Contr., v. 16, p. 66, pl. 11, fig. 17; Cooper, 1944, Jour. Paleont., vol. 18, p. 351, pl. 54, fig. 14 (Midway, Illinois); Cushman, 1951, U. S. Geol. Sur., Prof. Paper 232, p. 39, pl. 11, figs. 16-19 (Midway, Alabama-Arkansas-Mississippi-Texas).

Test small, straight, early portion biserial, later chambers alternating; sutures distinct and sharply depressed, sloping downward in alternating directions in later part of test; aperture terminal.

Length of hypotype, 0.31 mm.; diameter, 0.10 mm.

Family **BULIMINIDAE**

Genus **BULIMINA** d'Orbigny, 1826

Bulimina cacumenata Cushman and Parker Pl. 55, fig. 7

Bulimina cacumenata Cushman and Parker, 1936, Cushman Lab. Foram. Research Contr., v. 12, p. 40, pl. 7, fig. 3; Kline, 1943, Mississippi Geol. Sur., Bull. 53, p. 47, pl. 7, fig. 8; Cushman, 1951, U. S. Geol. Sur., Prof. Paper 232, p. 40, pl. 11, figs. 22, 23 (Midway, Alabama-Arkansas-Texas).

Test small, fusiform, greatest width above middle of test, initial end with a sharp point; chambers distinct in latter part of test and slightly inflated; sutures clear in latter part of test, little depressed; aperture loop-shaped.

This is the smallest *Bulimina* of the fauna. Its small size and sharply pointed initial end are distinguishing characteristics.

Length of hypotype, 0.22 mm.; thickness, 0.16 mm.

Bulimina cf. B. arkadelphiana midwayensis Cushman and Parker
Pl. 55, fig. 6

Bulimina arkadelphiana Cushman and Parker var. *midwayensis* Cushman and Parker, 1936, Cushman Lab. Foram. Research, Contr., vol. 12, p. 42, pl. 7, figs. 9, 10; Cushman, 1951, U. S. Geol. Sur., Prof. Paper 232, p. 40, pl. 11, figs. 25, 26 (Midway, Arkansas-Texas).

Bulimina aculeata Plummer, 1926, (not d'Orbigny), Univ. Texas, Bull. 2644, p. 73, pl. 4, fig. 3 (upper part of Midway, Texas).

A single weathered specimen recovered from the fauna may belong to this subspecies. The general outline and the sharp fine spines protruding from the base of the chambers resemble those of this species.

Length of hypotype, 0.31 mm.; diameter, 0.16 mm.

Subgenus **DESINOBULIMINA** Cushman and Parker, 1940

Bulimina (Desinobulimina) quadrata Plummer Pl. 55, figs. 13, 14

Bulimina (*Ellipsobulimina*) *quadrata* Plummer, 1926, Univ. Texas, Bull. 2644, p. 72, pl. 4, figs. 4, 5.

Bulimina quadrata Jennings, 1936, Bull. Amer. Paleont., vol. 23, no. 78, p. 30, pl. 3, fig. 19.

Bulimina (*Desinobulimina*) *quadrata* Cushman, 1940, Cushman Lab, Foram. Research, Contr., v. 16, pl. 11, fig. 21; Cushman, 1951, U. S. Geol. Sur., Prof. Paper 232, p. 41, pl. 11, figs. 27-30 (upper part of Midway, Arkansas; Midway group, Texas).

Test in megalospheric form almost cylindrical, increasing only slightly in diameter from the blunt initial end to the broadly rounded oral end; microspheric form pointed at initial end, increasing gradually in diameter to the broadly rounded apertural end; chambers broad, little inflated; sutures appear as sharp lines in early part of test, becoming slightly depressed above; aperture a vertical slit on inner side of the final chamber.

This species is abundant in the fauna and follows the type. In Texas this is a frequent form in the upper part of the Midway to which horizon it is restricted.

Length of hypotype (megalospheric form), 0.57 mm.; diameter, 0.28 mm.

Length of hypotype (microspheric form), 0.75 mm.; diameter, 0.33 mm.

Genus **BOLIVINA** d'Orbigny, 1839

Bolivina midwayensis Cushman Pl. 55, fig. 12

Bolivina midwayensis Cushman, 1936, Cushman Lab. Foram. Research, Special Pub. 6, p. 50, pl. 7, fig. 12; Kline, 1943, Mississippi Geol. Sur., Bull. 53, p. 49, pl. 4, fig. 14; Cushman, 1951, U. S. Geol. Sur., Prof. Paper 232, p. 43, pl. 12, figs. 11, 12 (Midway, Mississippi-Alabama-Arkansas-Texas).

Test elongate, slightly tapering, compressed, biserial throughout; chambers distinct, little inflated and of similar shape; sutures distinct, somewhat depressed and oblique, forming an approximate 45° angle with the horizontal; wall smooth; aperture an oval opening close to the inner margin of the last formed chamber.

The shiny perforate wall in the type of *B. midwayensis* is not apparent in the Reidland specimens owing to their replaced condition.

Length of hypotype, 0.50 mm.; diameter, 0.16 mm.

Genus **LOXOSTOMA** Ehrenberg, 1854

Loxostoma cf. **L. deadericki** Cushman Pl. 55, fig. 4

Loxostoma deadericki Cushman, 1947, Cushman Lab. Foram. Research, Contr., v. 23, p. 85, pl. 18, figs. 8-10; 1951, Cushman, U. S. Geol. Sur., Prof. Paper 232, p. 44, pl. 12, figs. 21-23, (Midway, Arkansas).

Because only one broken specimen was recovered there is doubt about the identification of this fossil.

Length of hypotype (broken specimen), 0.36 mm.; diameter, 0.20 mm.

Loxostoma deadericki exilis Cushman Pl. 55, fig. 5

Loxostoma deadericki Cushman var. exilis Cushman, 1947, Cushman Lab. Foram. Research, Contr., vol. 23, p. 85, pl. 18, figs. 11-13; Cushman, 1951, U. S. Geol. Sur., Prof. Paper 232, p. 44, pl. 12, figs. 24-26 (Midway, Alabama).

Test elongate, little compressed, early portion biserial, with final chambers becoming uniserial; chambers inflated; sutures distinct, depressed.

The subspecies differs from the type form in its smaller size, more slender form, more inflated chambers, and its more deeply depressed sutures.

Length of hypotype, 0.27 mm.; diameter, 0.10 mm.

Family **ELLIPSOIDINIDAE**

Genus **STILOSTOMELLA** Guppy, 1894

Stilostomella cf. **S. paleocenica** (Cushman and Todd) Pl. 55, figs. 10, 11

Ellipsonodosaria paleocenica Cushman and Todd, 1946, Cushman Lab. Foram. Research, Contr., vol. 22, p. 61, pl. 10, fig. 26; Cushman, 1951, U. S. Geol. Sur., Prof. Paper 232, p. 46, pl. 13, figs. 3-5 (Midway, Mississippi-Alabama-Arkansas-Texas).

Although no complete tests were recovered numerous chambers of varying sizes—some smooth and some covered by tiny projecting spines—seem reasonably certain of belonging to this species. The chambers are almost globular in appearance, and the final chamber has a short neck.

Length of hypotype (broken specimen; larger chamber), 0.97 mm.; diameter, 0.74 mm.

Length of hypotype (broken specimen; smaller chamber), 0.60 mm.; width, 0.53 mm.

Stilostomella cf. S. midwayensis (Cushman and Todd) Pl. 55, figs. 8, 9

Nodosaria spinulosa Plummer, 1926, (not *Nautilus spinulosus* Montagu), Univ. Texas, Bull. 2644, p. 84, pl. 4, fig. 19.

Ellipsonodosaria alexanderi Cushman, 1936, Cushman Lab. Foram. Research, Contr., v. 12, p. 52, pl. 9, figs. 6-9; Kline, 1943, Mississippi Geol. Sur., Bull. 53, p. 51, pl. 5, fig. 1 (not fig. 2).

Ellipsonodosaria spinulosa (Plummer), Cooper, 1944, Jour. Paleont., vol. 18, p. 352, pl. 54, fig. 20 (Paleocene, Illinois).

Ellipsonodosaria midwayensis Cushman and Todd, 1946, Cushman Lab. Foram. Research, Contr., vol. 22, p. 61, pl. 10, fig. 25; Cushman, 1951, U. S. Geol. Sur., Prof. Paper 232, p. 47, pl. 13, figs. 6-10 (Midway, Alabama-Arkansas-Texas).

No complete tests of this species were recovered. The ornamentation of the chambers with platelike longitudinal costae with spinose projections near the base of the chambers and with the costae continuous over several chambers seems to place specimens of this fauna in this species.

Length of hypotype (broken specimen; two chambers), 0.97 mm.; diameter, 0.42 mm.

Length of hypotype (single chamber), 0.58 mm.; width 0.38 mm.

Family **ROTALIIDAE**

Genus **VALVULINERIA** Cushman, 1926

Valvulineria wilcoxensis Cushman and Ponton Pl. 55, fig. 22, 23

Valvulineria wilcoxensis Cushman and Ponton, 1932, Cushman Lab. Foram. Research, Contr., vol. 8, p. 70, pl. 9, fig. 6; Cushman, 1944, *idem.*, vol. 20, p. 26, pl. 4, fig. 26; Cushman, 1951, U. S. Geol. Sur., Prof. Paper 232, p. 50, pl. 14, figs. 10-13 (Midway, Tennessee-Arkansas-Texas).

Test almost circular, somewhat lobate, approaching bilateral symmetry, with ventral side slightly more convex; umbilical region somewhat depressed on the ventral side; chambers distinct with last formed chamber inflated; sutures distinct and curved; wall perforate; aperture a long narrow slit at the base of the last formed chamber, extending from the periphery along the ventral side beneath the lip of the ventral margin of the final chamber.

Length of hypotype, 0.25 mm.; width, 0.16 mm.; thickness, 0.12 mm.

Genus **GYROIDINA** d'Orbigny, 1826

Gyroidina aequilateralis (Plummer) Pl. 55, figs. 17, 18

Rotalia aequilateralis Plummer, 1926, Univ. Texas, Bull. 2644, p. 155, pl. 12, fig. 3 (Midway, Texas).

Gyroidina aequilateralis Cushman, 1944, Cushman Lab. Foram. Research, Contr., vol. 20, p. 45, pl. 7, fig. 24.

Gyroidina subangulata Cushman and Todd, 1942, (not Plummer), *idem.,* vol. 18, p. 40, pl. 7, figs. 11, 12.

Gyroidina aequilateralis (Plummer), Cushman, 1951, U. S. Geol. Sur., Prof. Paper 232, p. 51, pl. 14, figs. 16, 17 (Midway, Alabama-Texas-Arkansas).

Test small, biconvex; chambers 10 in final whorl; dorsal sutures distinctly curved and flush with the surface; ventral sutures almost straight and raised around the umbilicus; aperture a narrow slit at the base of the final chamber.

This species occurs rarely in the fauna and is not considered stratigraphically diagnostic.

Diameter of hypotype, 0.16 mm.; thickness, 0.10 mm.

Gyroidina subangulata (Plummer) Pl. 55, figs. 15, 16

Rotalia soldanii (d'Orbigny) var. *subangulata* Plummer, 1926, Univ. Texas, Bull. 2644, p. 154, pl. 12, fig. 1 (Midway, Texas).

Gyroidina subangulata Cushman, 1940, Cushman Lab. Foram. Research, Contr., vol. 16, p. 71, pl. 12, fig. 7; Kline, 1943, Mississippi Geol. Sur., Bull. 53, p. 53, pl. 5, figs. 13-15; Cushman, 1951, U. S. Geol. Sur. Prof. Paper 232, p. 51, pl. 14, figs. 14, 15 (Midway, Alabama-Arkansas-Texas).

Test almost circular, plano-convex, dorsal side flat, ventral side strongly convex, composed of two convolutions; eight to nine chambers in final whorl; sutures distinct and flush with the surface except for the final two or three chambers, oblique on dorsal surface and almost straight on ventral surface; wall smooth and punctate; aperture a long narrow slit extending the length of the base of the septal face of the final chamber.

Gyroidina subangulata is easily distinguished from *Gyroidina aequilateralis.* The former species has a plano-convex test of eight to nine chambers whereas the latter has a biconvex test and has 10 chambers in the final whorl.

This is a common species over the world, ranging from the Cretaceous to the Recent.

Diameter of hypotype, 0.29 mm.; thickness, 0.16 mm.

Genus **OSANGULARIA** Brotzen, 1940

Osangularia expansa (Toulmin) Pl. 55, figs. 20, 21

Truncatulina culter Plummer, 1926, (not Parker and Jones), Univ. Texas, Bull. 2644, p. 147, pl. 10, fig. 1; pl. 15, fig. 2.

Pulvinulinella culter (Parker and Jones) var. *midwayana* Cushman and Todd, 1946, *idem.*, v. 22, p. 63, pl. 11, fig. 12.

Parrella expansa Toulmin, 1941, Jour. Paleont., v. 15, p. 604, text figs. 3, 4F, 4G, (Paleocene. Salt Mountain limestone, Alabama); Cushman, 1951, U. S. Geol. Sur., Prof. Paper 232, p. 53, pl. 16, figs. 11, 12 (Midway, Mississippi-Arkansas-Texas).

Test trochoid, ventral side convex, dorsal side less so, periphery with a distinct flange; all chambers visible on dorsal surface, only eight of final whorl visible ventrally; sutures oblique dorsally and flush with the surface, very slightly curved ventrally; aperture consisting of two parts—a curved elongate opening extending from the periphery at the base of the last formed chamber diagonally across the septal face and a smaller slit extending from the periphery at the base of the septal face to the umbilical area.

The specimens are somewhat less flat than the Texas forms and the ventral sutures less curved at the periphery. The species is distinguished by its flaring peripheral flange and apertural character.

Diameter of hypotype, 0.38 mm.

Genus **COLEITES** Plummer, 1934

Coleites cf. C. reticulosus (Plummer) Pl. 55, fig. 19

Pulvinulina reticulosa Plummer, 1926, Univ. Texas, Bull. 2644, p. 152, pl. 12, fig. 5 (upper part of Midway, Texas).

Coleites reticulosus Plummer, 1934, Amer. Midland Naturalist, vol. 15, p. 606, pl. 24, figs. 5-9; Cushman and Garrett, 1939, Cushman Lab. Foram. Research Contr., vol. 15, p. 87, pl. 15, figs. 14-20; Cushman, 1940, *idem.*, v. 16, p. 71, pl. 12, fig. 20; Cushman, 1951, U. S. Geol. Sur., Prof. Paper 232, p. 54, pl. 15, figs. 1-5 (upper part of Midway, Arkansas-Alabama).

A single specimen with a broadly elongate, compressed test, and a sharp periphery bounded by a ragged flange was recovered. The rough surface, resulting from the replaced condition of the test, appears to have obliterated the original reticulate surface as well as prevented recognition of the chambers.

This species, rare in the present sample, has apparently been recorded only from the upper part of the Midway.

Length of hypotype, 0.71 mm.; diameter, 0.51 mm.; thickness, 0.21 mm.

Genus **PULSIPHONINA** Brotzen, 1948

Pulsiphonina prima (Plummer) Pl. 56, figs. 1, 2

Siphonina prima Plummer, 1926, Univ. Texas, Bull. 2644, p. 148, pl. 12, fig. 4; Cushman, 1927, U. S. Nat. Mus., Proc., vol. 72, art. 20, p. 2, pl. 2, fig. 4; Jennings, 1936, Bull. Amer. Paleont., vol. 23, No. 78, p. 33, pl. 4. fig. 3; Kline, 1943, Mississippi Geol. Sur., Bull. 53, p. 55, pl. 5, figs. 21, 22; Cooper, 1944, Jour. Paleont., vol. 18, p. 353, pl. 55, figs. 7-9; Cushman, 1946, U. S. Geol. Sur., Prof. Paper 206, p. 143, pl. 59, figs. 3-5; Cushman, 1951, *idem.*, Prof. Paper 232, p. 55, pl. 15, figs. 7-9 (Midway, Mississippi-Alabama-Arkansas-Texas).

Pulsiphonina prima Olsson, 1960, Jour. Paleont., vol. 34, No. 1, p. 39, pl. 7, figs. 1-3.

Test small, biconvex, much compressed; peripheral angle sharp and serrate; all chambers visible dorsally, five chambers of final convolution visible ventrally; dorsal sutures obliquely curved and marked by the serrate edges of the preceding chambers, ventral sutures somewhat depressed and slightly curved; aperture a small elliptical opening on the ventral side along the peripheral margin with its long axis in the direction of coiling.

The minute size, compressed test, and serrate edges make this species distinctive in the fauna.

Diameter of hypotype, 0.17 mm.; thickness, 0.07 mm.

Genus **SIPHONINA** Reuss, 1850

Siphonina wilcoxensis Cushman Pl. 56, fig. 3, 4

Siphonina wilcoxensis Cushman, 1927, U. S. Nat. Mus., Proc., vol. 72, art. 20, p. 3, pl. 2, figs. 1-3; Cushman and Ponton, 1932, Cushman Lab. Foram. Research Contr., vol. 8, p. 70, pl. 9, fig. 7; Toulmin, 1941, Jour. Paleont. vol. 15, p. 605, pl. 81, figs. 15, 16 (Paleocene. Salt Mountain limestone, Alabama); Cushman, 1944, Cushman Lab. Foram. Research Contr., vol. 20, p. 27, 46, pl. 7, fig. 27; U. S. Geol. Sur., Prof. Paper 232, p. 56, pl. 15, fig. 10 (Midway, Alabama-Arkansas).

Test small, biconvex with the ventral side more convex than the dorsal; periphery acute and serrate, somewhat lobate; five chambers in the final whorl; dorsal sutures oblique and flush with the surface, ventral sutures slightly depressed and radial; wall punctate; aperture a narrow opening on the ventral side parallel to the periphery, with a lip.

This species differs from *Pulsiphonina prima,* with which it can be easily confused, by the presence of a lip on the aperture.

Diameter of hypotype, 0.25 mm.; thickness, 0.10 mm.

Family AMPHISTEGINIDAE

Genus ASTERIGERINA d'Orbigny, 1839

Asterigerina primaria Plummer Pl. 56, figs. 7, 8

Asterigerina primaria Plummer, 1926, Univ. Texas, Bull. 2644, p. 157, pl. 12, fig. 8 (Midway, Texas); Toulmin, 1941, Jour. Paleont., v. 15, p. 606, pl. 81, fig. 22 (Paleocene. Salt Mountain limestone, Alabama); Cushman, 1944, Cushman Lab. Foram. Research Contr., v. 20, p. 46, pl. 7, fig. 28; Cushman, 1951, U. S. Geol. Sur., Prof. Paper 232, p. 56, pl. 15, fig. 15 (Midway, Alabama-Texas).

Test small, trochoid, with the dorsal side convex and the ventral nearly flat; margin bounded by a sharp keel; five chambers in final convolution; dorsal sutures slightly curved and flush, or raised with respect to surface, ventral sutures depressed and curved; aperture an arched opening in ventral face of last chamber, directed towards a pustulate umbilicus.

The minute size of this species and its pustulate umbilicate region distinguish it in the fauna. This species with five chambers resembles Plummer's figured specimens more than Toulmin's.

Diameter of hypotype, 0.20 mm.

Family CASSIDULINIDAE

Genus CERATOBULIMINA Toula, 1915

Ceratobulimina perplexa (Plummer) Pl. 56, figs. 15, 16

Rotalia perplexa Plummer, 1926, Univ. Texas, Bull. 2644, p. 156, pl. 12, fig. 2 (Midway, Texas).

Ceratobulimina perplexa Cushman and Harris, 1927, Cushman Lab. Foram. Research, Contr., vol. 3, p. 173, pl. 29, fig. 2; Glaessner, 1937, Moscow Univ. Studies in Micropaleontology, vol. 1, p. 20, 23, pl. 1, figs. 2, 3; pl. 2, fig. 25; Cushman, 1946, Cushman Lab. Foram. Research, Contr., vol. 22, p. 108, pl. 17, figs. 3-5; Cushman, 1951, U. S. Geol. Sur., Prof. Paper 232, p. 56, pl. 16, figs. 1-5 (Midway, Alabama-Texas).

Test small, about equally biconvex; peripheral margin broadly rounded; chambers six in final whorl; dorsal sutures marked by curved, tapering thickened bands; ventral sutures depressed, radiating from a sunken umbilicus; aperture a round opening at the base of the septal face.

The specimens included in this fauna are smaller than the type.

Length of hypotype, 0.16 mm.; width, 0.11 mm.; thickness, 0.08 mm.

Genus **ALABAMINA** Toulmin, 1941

Alabamina wilcoxensis Toulmin — Pl. 56, figs. 17, 18

Pulvinulina exigua H. B. Brady var. *obtusa* Plummer, 1926, (not Burrows and Holland, 1897, p. 49), Univ. Texas, Bull. 2644, p. 151, pl. 11, fig. 2.
Pulvinulinella exigua (H. B. Brady) var. *obtusa* Cushman and Ponton, 1932, (not Burrows and Holland), Cushman Lab. Foram. Research, Contr., vol. 8, p. 71, pl. 9, fig. 9.
Pulvinulinella obtusa (Burrows and Holland), Cushman and Garrett, 1939, *idem.,* v. 15, p. 87, pl. 15, figs. 12, 13; Cushman and Todd, 1945, *idem.,* vol. 21, p. 101, pl. 16, figs. 7, 8; vol. 22, p. 63, pl. 11, figs. 9, 10.
Alabamina wilcoxensis Toulmin, 1941, Jour. Paleont. vol. 15, p. 603, pl. 81, figs. 10-14, text fig. 4a-c (Paleocene. Salt Mountain limestone, Alabama); Cushman, 1951, U. S. Geol. Sur., Prof. Paper 232, p. 57, pl. 16, figs. 6, 7 (Midway, Mississippi-Alabama-Arkansas-Texas; Wilcox, Alabama).

Test subcircular, biconvex, slightly more convex on the ventral side; periphery somewhat acute; chambers six in final convolution; sutures distinct, straight and oblique to the periphery on the dorsal surface and radial on the ventral face; aperture a long narrow opening at the base of the septal face on the final chamber and what appears as a supplementary opening is an identation extending peripherally from the wall and formed by a fold on the wall of the test.

The specimens appear to resemble Toulmin's type except that the sutures of the final two or three chambers are slightly depressed on the dorsal surface. The species is common in the fauna.

Diameter of hypotype (ventral view), 0.30 mm.; thickness, 0.16 mm.

Diameter of hypotype (dorsal view), 0.30 mm.; thickness, 0.14 mm.

Genus **PSEUDOPARRELLA** Cushman and Ten Dam, 1948

Pseudoparrella cf. P. exigua (H. B. Brady) — Pl. 56, figs. 13, 14

Pulvinulina exigua H. B. Brady, Plummer, 1926, Univ. Texas, Bull. 2644, p. 150, pl. 11, fig. 3 (upper part of Midway, Texas).

Test small, circular in outline, almost equally biconvex, periphery subacute; six chambers in final whorl; sutures slightly curved and radiate on the ventral side, dorsal sutures oblique and flush with the surface, showing as dark lines; aperture a long narrow slit at the base of the final chamber.

This species differs in certain aspects from *Alabamina wilcoxensis* which it closely resembles. It is more circular, more equally biconvex, and the apertural character differs.

Diameter of hypotype, 0.23 mm.; thickness, 0.15 mm.

Family CHILOSTOMELLIDAE

Genus ALLOMORPHINA Reuss, 1850

Allomorphina paleocenica Cushman — Pl. 56, figs. 5, 6

Allomorphina trigona Plummer, 1926, (not Reuss), Univ. Texas, Bull. 2644, p. 129, pl. 8, fig. 5; Kline, 1943, Mississippi Geol. Sur., Bull. 53, p. 56, pl. 6, figs. 1, 2; Cushman and Todd, 1946, Cushman Lab. Foram. Research, Contr., vol. 22, p. 63, pl. 11, figs. 11, 15.
Allomorphina paleocenica Cushman, 1948, *idem.*, vol. 24, p. 45, pl. 8, fig. 10; Cushman, 1951, U. S. Geol. Sur., Prof. Paper 232, p. 58, p. 16, figs. 19-22, (Midway, Alabama-Arkansas-Texas).

Test trochoid, one side of test nearly straight and the other bluntly rounded; chambers embracing, three in a whorl; aperture an elongate slit with overhanging lip at the base of the last formed chamber on the ventral side.

This species is a living species.

Length of hypotype (ventral view), 0.52 mm.; diameter, 0.36 mm. thickness, 0.29 mm.

Length of hypotype (dorsal view), 0.42 mm.; width, 0.35 mm.; thickness, 0.28 mm.

Allomorphina subtriangularis (Kline) — Pl. 56, fig. 9

Chilostomella subtriangularis Kline, 1943, Mississippi Geol. Sur., Bull. 53, p. 56, pl. 6, fig. 3.
Allomorphina subtriangularis Cushman, 1951, U. S. Geol. Sur., Prof. Paper 232, p. 59, pl. 17, figs. 1, 2 (Midway, Arkansas-Texas).

Test subtriangular, somewhat longer than broad with the greatest width above the middle; aperture a nearly straight slit at the base of the last formed chamber.

Length of hypotype, 0.62 mm.; width, 0.25 mm.; thickness, 0.35 mm.

Genus CHILOSTOMELLOIDES Cushman, 1926

Chilostomelloides eocenica Cushman — Pl. 56, fig. 10

Chilostomelloides eocenica Cushman, 1926, Cushman Lab. Foram. Research, Contr., vol. 1, pt. 4, p. 78, pl. 11, fig. 20; Plummer, 1926, Univ. Texas, Bull. 2644, p. 129, pl. 8, fig. 8; Kline, 1943, Mississippi Geol. Sur., Bull. 53, p. 57, pl. 6, fig. 8; Cushman, 1951, U. S. Geol. Sur., Prof. Paper 232, p. 59, pl. 17, figs. 4, 5 (Midway, Arkansas-Alabama).

Test elongate, sides gently convex, end bluntly rounded; aperture an arched opening with lip on the final chamber, set at an angle from the wall of the test.

Length of hypotype, 0.31 mm.; diameter, 0.16 mm.

Genus **PULLENIA** Parker and Jones, 1862

Pullenia quinqueloba (Reuss) Pl. 56, figs. 11, 12

Nonionina quinqueloba Reuss, 1851, Zeit. deutsch. geol. Gesell., vol. 3, p. 71, pl. 5, fig. 31 (Oligocene, Germany).
Pullenia quinqueloba Cushman, 1924, U. S. Nat. Mus., Bull. 104, pt. 5, pl. 8, figs. 5-9, 11 (Recent. Atlantic Ocean); Plummer, 1926, Univ. Texas, Bull. 2644, p. 136, pl. 8, fig. 12 (upper part of Midway, Texas); Cushman, 1940, Lab. Foram. Research, Contr., vol. 16, p. 72, pl. 12, figs. 13, 14 (Midway, Alabama); Toulmin, 1941, Jour. Paleont., v. 15, p. 607, pl. 81, fig. 24 (Paleocene. Salt Mountain limestone, Alabama).

Test small, closely coiled in one plane with only the final chambers showing; peripheral margin rounded; five chambers; sutures slightly depressed; aperture a long narrow slit extending along the base of the septal face.

In Texas this form is persistent along the outcrop of the beds of the upper part of the Midway. It ranges to the Recent.

Length of hypotype, 0.35 mm.; diameter, 0.28 mm.; thickness, 0.18 mm.

Family **GLOBIGERINIDAE**

Genus **GLOBIGERINA** d'Orbigny, 1826

Globigerina compressa Plummer Pl. 56, figs. 19,21

Globigerina compressa Plummer, 1926, Univ. Texas, Bull. 2644, p. 135, pl. 8, fig. 11; Jennings, 1936, Bull. Amer. Paleont., vol. 23, No. 78, p. 193, pl. 31, fig. 8; Toulmin, 1941, Jour. Paleont., vol. 15, p. 607, pl. 82, figs. 1, 2 (Paleocene. Salt Mountain limestone, Alabama); Kline, 1943, Mississippi Geol. Sur., Bull. 53, p. 58, pl. 6, figs. 5, 6; Cooper, 1944, Jour. Paleont., vol. 18, p. 353, pl. 54, figs. 8, 9 (Midway, Illinois); Cushman, 1951, U. S. Geol. Sur., Prof. Paper 232, p. 60, pl. 17, fig. 9 (Midway, Alabama-Arkansas-Texas).

Test small, much compressed, closely coiled, margin lobate; chambers increasing gradually in size with five in the final convolution; sutures depressed; aperture a single slightly arched slit.

This form though rare in this fauna is distinctive, being much more compressed than other species of *Globigerina*. In Texas it is confined to upper part of the Midway.

Diameter of hypotype, 0.26 mm. x 0.19 mm.; thickness, 0.11 mm.

Globigerina triloculinoides Plummer Pl. 56, figs. 24, 25

Globigerina triloculinoides Plummer, 1926, Univ. Texas, Bull. 2644, p. 134, pl. 8, fig. 10; Jennings, 1936, Bull. Amer. Paleont., vol. 23, No. 78, p. 193, pl. 31, fig. 10; Toulmin, 1941, Jour. Paleont., vol. 15, p. 607, pl. 82, fig. 3 (Paleocene. Salt Mountain limestone, Alabama); Kline, 1943, Mississippi Geol. Survey Bull. 53, p. 59, pl. 6, figs. 12, 13; Cooper, 1944, Jour. Paleont., vol. 18, p. 353, pl. 54, figs. 12, 13 (Midway, Illinois); Cushman, 1951, U. S. Geol. Sur., Prof. Paper 232, p. 60, pl. 17, figs. 10, 11 (Midway, Alabama-Arkansas-Mississippi-Texas).

Test small, trochoid, with two convolutions; chambers globose, rapidly increasing in size, with three to three and a half visible in final convolution; aperture a narrow slit on the final chamber.

This is a common species of the upper part of the Midway of Texas and Alabama.

Diameter of hypotype (ventral view), 0.22 mm. x 0.25 mm.; thickness, 0.17 mm.

Diameter of hypotype (dorsal view), 0.16 mm x 0.18 mm.; thickness, 0.15 mm.

Globigerina pseudobulloides Plummer Pl. 56, figs. 22, 23

Globigerina pseudo-bulloides Plummer, 1926, Univ. Texas, Bull. 2644, p. 133, pl. 8, fig. 9; Glaessner, 1937, Moscow Univ. Problems of Paleontology, vol. 2-3, p. 382, pl. 4, fig. 31; Kline, 1943, Mississippi Geol. Sur., Bull. 53, p. 58, pl. 6, figs. 9-11; Applin and Jordan, 1945, Jour. Paleont., vol. 19, p. 131 (list); Cushman and Todd, 1946, Cushman Lab. Foram. Research, Contr., vol. 22, p. 64; Cushman, 1951, U. S. Geol. Sur., Prof. Paper 232, p 60, pl. 17, figs. 7, 8 (Midway, Tennessee-Alabama-Arkansas-Texas).

Test small, rotaliform, trochoid, composed of two to two and a half whorls; margin lobate; five chambers in final whorl, globose; umbilical depression present; aperture a single opening on the final chamber, extending from margin to umbilicus beneath a narrow lip.

This species is readily distinguished from *G. triloculinoides* which has three and a half chambers in the final whorl instead of five.

Diameter of hypotype (ventral view), 0.21 x 0.22 mm.; thickness, 0.10 mm.

Diameter of hypotype (dorsal view), 0.19 x 0.20 mm.; thickness, 0.10 mm.

Family **ANOMALINIDAE**

Genus **ANOMALINA** d'Orbigny, 1826

Anomalina midwayensis (Plummer) Pl. 57, figs. 1, 2

Truncatulina midwayensis Plummer, 1926, Univ. Texas, Bull. 2644, p. 141, pl. 9, fig. 7; pl. 15, fig. 3 (Midway, Texas).

Anomalina midwayensis Cushman, 1940, Cushman Lab. Foram. Research, Contr., vol. 16, p. 73, pl. 12, fig. 18; Kline, 1943, Mississippi Geol. Sur., Bull. 53, p. 60, pl. 6, figs. 17, 18; Cooper, 1944, Jour. Paleont., vol. 18, p. 354, pl. 54, figs. 15-17 (Paleocene. Illinois); Cushman, 1951, U. S. Geol. Sur., Prof. Paper 232, p. 62, pl. 17, figs. 17-19 (Midway, Texas-Arkansas-Mississippi-Alabama).

Test biconvex, showing about two convolutions from the dorsal side. periphery rounded; chambers six to eight in final whorl; sutures distinct, curved on both dorsal and ventral surfaces; aperture a slit at the base of the septal face, under a lip extending to the umbilicus.

Whereas Plummer's description of this species stated that there are usually nine chambers in the final whorl, none of the specimens of this fauna has nine chambers. Some of the specimens show a trochoid coiling of the dorsal surface suggesting the subspecies *trochoides* but the merging of the forms is so gradual that no attempt at separation was made.

The abundance of this species in the Midway makes it a good index fossil.

Diameter of hypotype (ventral view), 0.40 mm. x 0.48 mm.; thickness, 0.19 mm.

Diameter of hypotype (dorsal view), 0.39 mm. x 0.47 mm.; thickness, 0.16 mm.

Anomalina acuta Plummer Pl. 57, figs. 11, 12

Anomalina ammonoides (Reuss) var. *acuta* Plummer, 1926, Univ. Texas, Bull. 2644, p. 149, pl. 10, fig. 2.
Anomolina acuta Glaessner, 1937, Moscow Univ. Problems of Paleontology, vol. 2-3, p. 386, pl. fig. 40; Toulmin, 1941, Jour. Paleont., v. 15, p. 608, pl. 82, figs. 9, 10 (Paleocene. Salt Mountain limestone, Alabama); Kline, 1943, Mississippi Geol. Sur., Bull. 53, p. 59, pl. 5, figs. 3, 4; Cooper, 1944, Jour. Paleont., vol. 18, p. 353, pl. 54, figs. 3-5 (Midway, Illinois); Cushman, 1951, U. S. Geol. Sur., Prof. Paper 232, p. 62, pl. 18, figs. 3-6 (Midway, Texas-Arkansas-Mississippi-Alabama).

Test small, biconvex, compressed; peripheral margin acute; chambers numerous, 13 to 15 on the final whorl; dorsal sutures limbate to depressed, merging into a prominent boss; ventral sutures thickened around the inner edges of the whorl, merging into an irregular filling of clear material; aperture arched over the peripheral margin.

This species is distinguished by its lateral compression and numerous chambers.

Diameter of hypotype (dorsal view), 0.55 mm. x 0.32 mm.; thickness, 0.11 mm.

Diameter of hypotype (ventral view), 0.32 mm. x 0.30 mm.; thickness, 0.11 mm.

Anomalina welleri (Plummer) Pl. 57, figs. 7, 8

Truncatulina welleri Plummer, 1926, Univ. Texas, Bull. 2644, p. 143, pl. 9, fig. 6.
Anomalina welleri Plummer, 1932, *idem.*, Bull. 3201, p. 54, 62 (lists).
Nonionella welleri Kline, 1943, Mississippi Geol. Sur., Bull. 53, p. 44, pl. 4, fig. 21.

Anomalina welleri Cushman, 1951, U. S. Geol. Sur., Prof. Paper 232, p. 63, pl. 18, fig. 12 (Midway, Texas).

Test small, biconvex, compressed; chambers 11 in final whorl, narrow, curved; sutures distinct—those on ventral side joining in a low ridge around the umbilical depression; aperture a low arch close to the periphery.

This species is differentiated from *Anomalina acuta* by its smaller size, fewer chambers, and absence of a central boss on the dorsal face. The species occurs in the upper part of the Midway of Texas.

Diameter of hypotype (ventral view), 0.26 mm.; thickness, 0.11 mm.

Diameter of hypotype (dorsal view), 0.25 mm.; thickness, 0.10 mm.

Anomalina clementiana (d'Orbigny) Pl. 57, figs. 3, 4

Rosalina clementiana d'Orbigny, 1840, Soc. geol. France, Mem., 1st ser., vol. 4, p. 37, pl. 3, figs. 23-25.

Anomalina clementiana Franke, 1925, Greifswald Univ., Geol.-palaeont. Inst., Abh., vol. 6, p. 85, pl. 7, figs. 12a-c; Franke, 1928, Preuss, geol. Landesanstalt Abh., new ser., v. 111, p. 179, pl. 16, figs. 9a-c; Cushman, 1931, Tennessee Div. Geology, Bull. 41, p. 61, pl. 13, figs. 1a-c; Cushman, 1931, Cushman Lab. Foram. Research, Contr., vol. 7, p. 46, pl. 6, figs. 10a-c; Jennings, 1936, Bull. Amer. Paleont., vol. 23, No. 78, p. 28, pl. 5, figs. 2a-b; Cushman, 1946, U. S. Geol. Sur., Prof. Paper 206, p. 155, pl. 63, figs. 12, 13; Cushman, 1951, *Idem.,* Prof. Paper 232, p. 63, pl. 18, figs. 8-11 (Midway, Texas-Arkansas-Mississippi).

Test subcircular, planispiral, periphery rounded; chambers seven to nine in final whorl; dorsal sutures curved and raised; ventral sutures radial and depressed; aperture peripheral.

Diameter of hypotype (dorsal view) 0.16 mm.; thickness, 0.08 mm.

Diameter of hypotype (ventral view) 0.18 mm.; thickness, 0.09 mm.

Genus **CIBICIDINA** Bandy, 1949

Cibicidina mississippiensis (Cushman) Pl. 57, figs. 5, 6

Anomalina mississippiensis Cushman, 1922, U. S. Geol. Sur., Prof. Paper 129-E, p. 98, pl. 21, figs. 6-8 (middle Oligocene, Mississippi); Cole and Ponton, 1930, Florida Geol. Sur., Bull. 5, p. 46, pl. 9, figs. 2, 3 (lower Oligocene, Florida).

Cibicides mississippiensis Ellisor, 1933, Bull. Amer. Assoc. Petr. Geol., vol. 17, No. 11, pl. 5, fig. 6 (not fig. 7) (upper Eocené. Texas); Cushman, 1935, U. S. Geol. Sur., Prof. Paper 181, p. 54, pl. 22, fig. 3; Cushman, 1946, Cushman Lab. Foram. Research, Spec. Publ. 16, p. 39, pl. 8, figs. 5, 6 (upper Eocene. Georgia-North and South Carolinas, Florida-Alabama-Mississippi; lower Oligocene. Florida-Alabama-Texas).

Cibicidina mississippiensis Bandy, 1949, Bull. Amer. Paleont., vol. 32, p. 93, pl. 15, figs. 7a-c (upper Eocene. Alabama).

Test small, peripheral margin bluntly rounded; chambers inflated, six in final whorl, increasing regularly in size, last two or three chambers on inner margin of the dorsal side raised slightly above the surface; dorsal sutures marked by thickened bands of clear shell material; ventral sutures depressed; aperture a curved opening at the base of the septal face extending on to the dorsal surface.

This species was originally described from the Oligocene of the Gulf Coast and subsequently reported from the upper Eocene of the Atlantic and Gulf Coastal Plains. If this identification is correct this is the first reported occurrence of this species in the earliest Tertiary, or Paleocene.

Diameter of hypotype, 0.31 x 0.35 mm.; thickness, 0.20 mm.

Genus **CIBICIDES** Montfort, 1808

Cibicides newmanae (Plummer) Pl. 57, figs. 13-15

Discorbis newmanae Plummer, 1926, Univ. Texas, Bull. 2644, p. 138, pl. 9, fig. 4 (Midway, Texas).
Cibicides newmanae (Plummer), Cushman and Todd, 1942, Cushman Lab. Foram. Research Contr., v. 18, p. 46, pl. 8, fig. 16; Cushman, 1951, U. S. Geol. Sur., Prof. Paper 232, p. 66, pl. 19, figs. 12-14 (Midway, Texas-Arkansas-Alabama).

Test oval, dorsal side convex, ventral side flat; peripheral margin sharp; chambers eight, enlarging in size as added; sutures curved on both sides of test and appearing as dark lines; aperture peripheral, at the base of the final chamber and extending ventrally into the umbilical area.

This species is rare in the Reidland fauna. The concavity of the ventral face and the great amount of lateral compression distinguish the species. The specimens recovered are somewhat smaller than the type.

Length of hypotype, 0.20 mm.; diameter, 0.16 mm.; thickness, 0.05 mm.

Cibicides alleni (Plummer) Pl. 57, figs. 9, 10

Truncatulina alleni Plummer, 1926, Univ. Texas, Bull. 2644, p. 144, pl. 10, fig. 4.
Cibicides alleni Plummer, 1932, *idem.,* Bull. 3201, p. 54, 61 (lists); Cushman, 1940, Cushman Lab. Foram. Research, Contr., vol. 16, p. 73, fig. 19; Kline, 1943, Mississippi Geol. Sur., Bull. 53, p. 61, pl. 6, figs. 21, 22; Cooper, 1944, Jour. Paleont., vol. 18, p. 354, pl. 54, figs. 24, 25 (Midway, Illinois); Cushman 1951, U. S. Geol. Sur., Prof. Paper 232, p. 66, pl. 18, figs. 16, 17 (Midway, Texas-Arkansas-Mississippi-Alababma).

Test biconvex with dorsal side more rounded; peripheral margin sharp, somewhat lobate; chambers 11 in final whorl; both periphery and sutures outlined by shell material, curved dorsally and ventrally; aperture a slit extending over the periphery onto the ventral side.

Only one somewhat imperfect specimen was recovered from the fauna. It is small in size for the species.

Diameter of hypotype, 0.26 mm. x 0.19 mm.; thickness, 0.16 mm. x 0.12 mm.

Cibicides praecursorius (Schwager) Pl. 57, figs. 16-18

Discorbina praecursoria Schwager, 1883, Paleontographica, vol. 30, Pal. Theil, p. 125, pl. 24 (4), fig. 12; pl. 29 (6), fig. 16.

Cibicides praecursorius Cushman and Ponton, 1932, Cushman Lab. Foram. Research Contr., vol. 8, p. 72, pl. 9, fig. 14; Toulmin, 1941, Jour. Paleont., vol. 15, p. 610, pl. 82, figs. 19-21 (Paleocene. Salt Mountain limestone, Alabama); Kline, 1943, Mississippi Geol. Sur., Bull. 53, p. 62, pl. 5, figs. 5, 6; Cushman and Todd, 1946, Cushman Lab. Foram. Research, Contr., vol. 22, p. 65, pl. 11, figs. 20, 21; Cushman, 1951, U. S. Geol. Sur., Prof. Paper 232, p. 65, pl. 19, figs. 1-6 (Midway, Texas-Arkansas-Tennessee-Alabama).

Test plano-convex, dorsal side flat, ventral side convex; margin acute; chambers distinct, somewhat inflated; sutures curved and limbate; aperture a slit extending from the base of the final chamber over to the dorsal surface.

This species differs from *Cibicides burlingtonensis* in that the chambers increase gradually in size and the final chamber is not so expanded.

Length of hypotype, 0.36 mm.; diameter, 0.31 mm.

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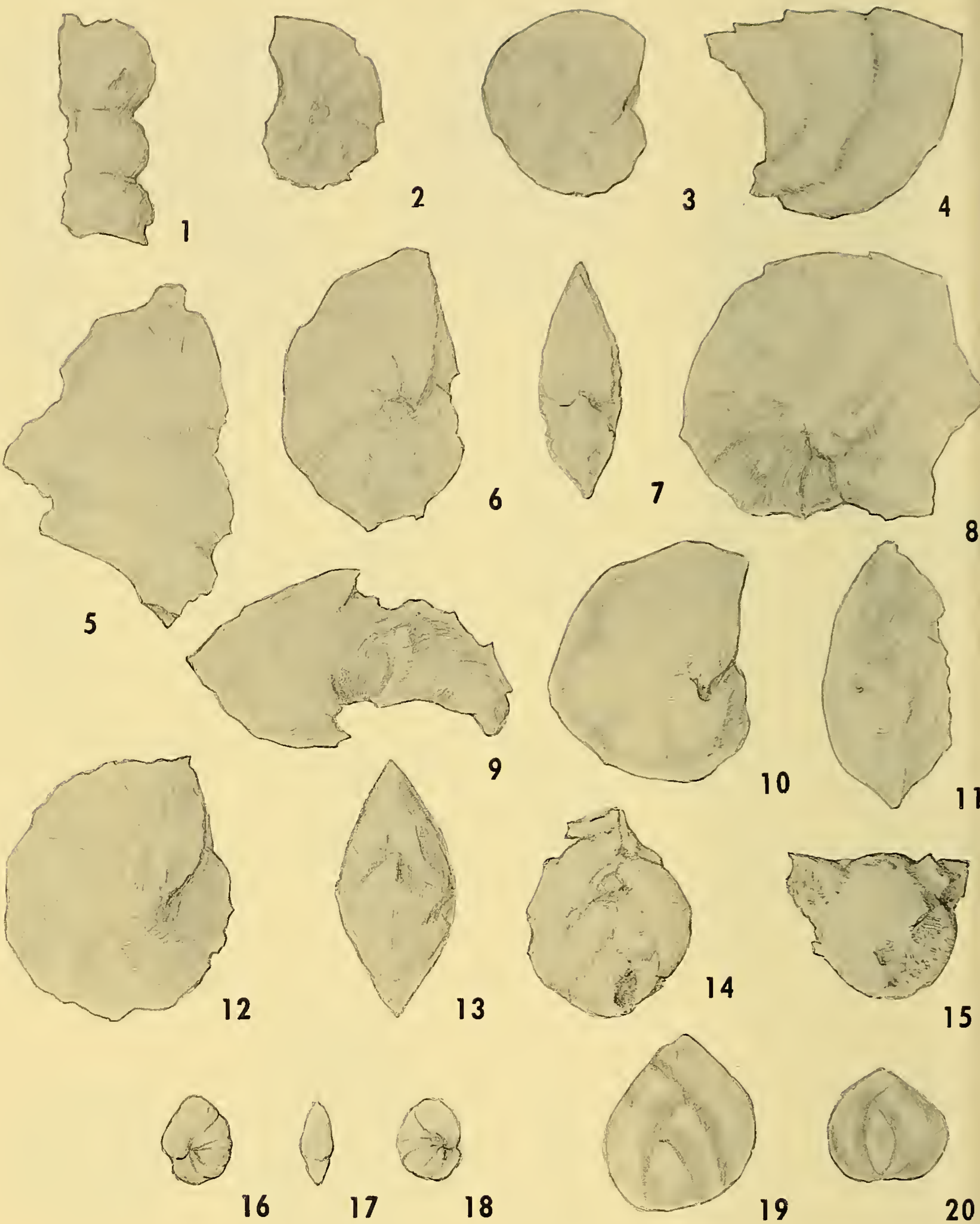
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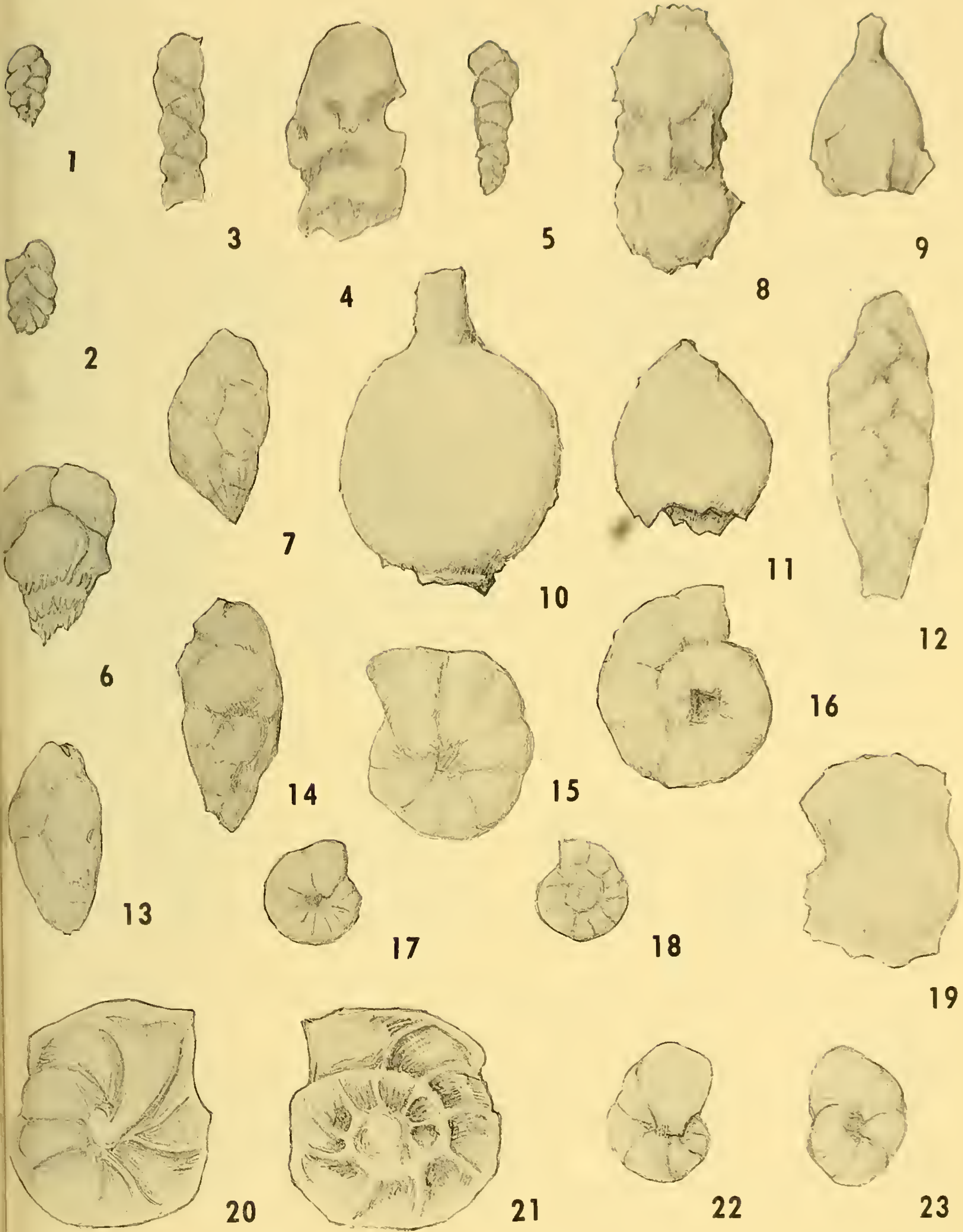
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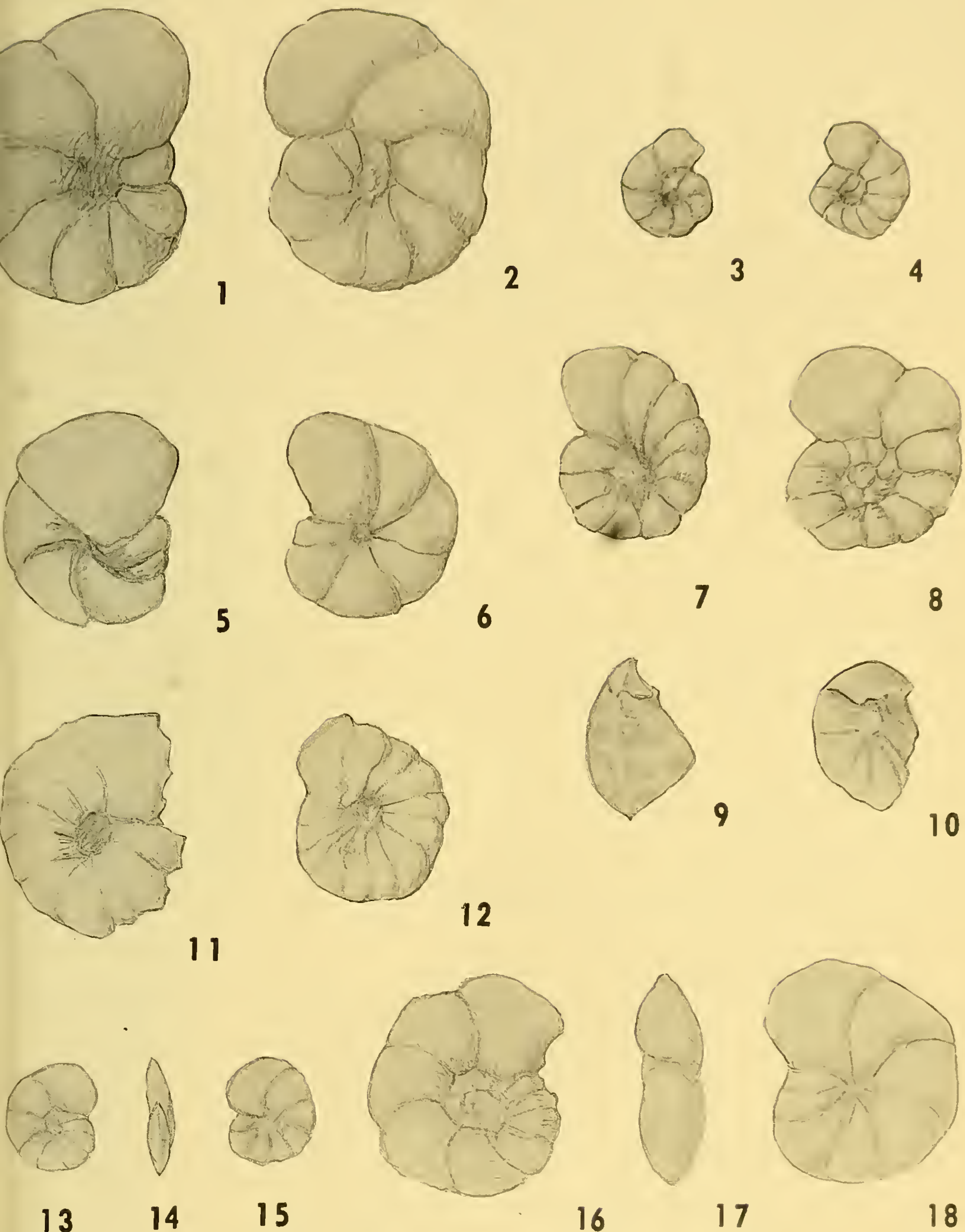
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297—Line 7 from bottom read planata for planta

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313—Line 10 from top read .95 for 95

318—Line 19 from bottom read Colln. for Collin.

339—Line 7 transpose

342—Line 8 from bottom, heading, read
purus for **parcipictus;** Pl. 66, figs. 4, 4a for Pl. 65, figs. 4, 5

346—Line 19 from top read 262 for 252

348—Line 1 read Tryon for Tyron

380—Lines 9, 14 from top, delete. Move line 10 to line 14

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TYPE SPECIMENS OF MARINE MOLLUSCA DESCRIBED BY P. P. CARPENTER FROM THE WEST COAST OF MEXICO AND PANAMA

By

Katherine V. W. Palmer
Paleontological Research Institution

October 22, 1963

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CONTENTS

TYPE SPECIMENS OF MARINE MOLLUSCA DESCRIBED BY P. P. CARPENTER FROM THE WEST COAST OF MEXICO AND PANAMA

Katherine V. W. Palmer
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ABSTRACT

Philip P. Carpenter described over 126 species of mollusks from the western Mexican, Lower Californian, and western Panamic regions. This number excludes those species described from Mazatlan by Carpenter in his catalogue (1855-1857) of the Reigen Collection of mollusks from Mazatlan, State of Sinoloa, Mexico. Eighty-four Carpenter types of this report have been located, 53 are in the United States National Museum, 25 are in the British Museum (Natural History), and 16 are in the Redpath Museum at McGill University. The types of 27 of the species have not been found. They are apparently lost. Some of the specific names given by Carpenter have been found to be synonymous with those for previously described species. Specific names attributed erroneously to Carpenter and specific names never described (*nomina nuda*) are enumerated. Illustrations of types of the species discussed are given. These are mostly of types which are figured for the first time. The original description of each species is included so that those notes will be accessible to students who otherwise would not have them available.

INTRODUCTION

In 1958 the major portion of the project to locate and illustrate the types of the marine molluscan species described by Phillip P. Carpenter from the West Coast of North America was completed. This dealt with the types of the species described by Carpenter from San Diego to British Columbia. The work was published as Memoir 76 by the Geological Society of America in 1958. The second group of species described by Carpenter is composed of those chiefly from the upper Panamic province of western America, Cape San Lucas (Cape St. Lucas), tip of Baja California del Sur of Lower California, Panama, Acapulco, State of Guerrero, Mexico, and a few stated only to have come from the Gulf of California. A third group concerns itself with the plan of the illustration of the species described by Carpenter in the text of the "Catalogue of the Reigen Collection of Mazatlan Mollusca in the British Museum" published by Carpenter in 1855-1857.

The second part of the project described above is the material discussed and figured in this report. The book on the Carpenter types from San Diego to British Columbia by the author included relevant details of Carpenter's life, his work in connection with shell collections in America and England, the collections he studied, and the museums involved. Readers are referred to the 1958 memoir

(Palmer) for such information and background. It will not be repeated herein. Facts pertinent to the southern area are given in this report. The bibliography includes only those references which are abbreviated in this text except the complete titles of Carpenter's writings on the West Coast mollusks. A bibliography of 37 pages with documentary details was included in the first work by Palmer in 1958 and can be consulted for additional help.

An examination of the illustrations of species on the 35 plates published in Palmer (1958) and on the present 13 plates, which are a large portion of types or pertinent to type material of species described by Carpenter, may dispel the too-long held surmise that the types of Carpenter species were lost, unmarked, or too poor to be identifiable. The remarkable fact is that the vicissitudes of time have eliminated only a small percentage of this original material. Over 100 years has elapsed and during that period reorganization, alteration of facilities, and changes in personnel have occurred. These all inevitably present hazards to continuity of the preservation of original material. The three major museums concerned with the care of the collections of this report are to be congratulated that the losses in proportion to the total number of specimens involved have been minor.

A wealth of information and sagacious suggestions are obtainable in the two reports which Carpenter made to the British Association for Advancement of Science in 1856 and 1863. Unfortunately those publications are out-of-print as is also the reprint (1872) by the Smithsonian Institution of the 1863 (1864) report. Because the books are unavailable to workers, interested persons are deprived of a resumé of early voyages and publications of molluscan data of which they may never become aware or may discover after difficult searching. It is more important to make available basic literature and material than it is to add further names which may or may not be processed against an already cluttered nomenclature. For this reason the original descriptions of the Carpenter species for the area stipulated are included herein as well as the illustration of the types. Where it is fairly certain that the type or types of a species have been lost, the original description should be studied to determine key points in the description. The publications from which the original descriptions have been taken are available only to those who have access to the larger libraries.

If one doubts the labor, ability, and logic which Carpenter utilized in the examination of molluscan shells, the following is a sample [footnote, p. 173, Rept. British Assoc. Adv. Sci. for 1856, 1857 (1857b)] of his technique. It is the basis of a series of synonymies compiled by Carpenter for species described by Eschscholtz, 1829 (Zoologischer Atlas, enthaltend Abbildungen und Beschreibungen neuer Thierarten, Berlin, continued by Ratke to 1833):

*The above extensive citation of synonyms is the result of (1) the study of Eschscholtz's diagnoses:—(2) The judgment of them by Philippi, after seeing the types, as recorded in *Zeit. f. Mal.* 1846, p. 106-8:—(3) The fully recorded judgment of Middendorff in the *Mal. Ross.* and *Sib. Reise, in locis:*—(4) The careful and repeated examination of Mr. Nuttall's shells, (*a*) in his own collection, aided by his recollection, and with the full concurrence of his judgment; (*b*) in Dr. Jay's catalogue; (*c*) in Mr. Cuming's collection, as received from Nuttall, through Jay, and figured by Reeve:—(5) The comparison with these of Dr. Gould's specimens, collected on the same coast by the officers of the United States' Exploring Expedition and of the Mexican war:—(6) The examination of the types of Mr. Reeve's species in the Cumingian collection:—(7) The interpretation of all the above by the experience derived from the repeated and most careful examination of many thousand (at least 15,000) Limpets in the Mazatlan collection. It is offered as an approximation to the truth. It is a subject of great regret that Mr. Reeve, in describing the Limpets of the West N. American coast, did not avail himself of the previous labours of Eschscholtz, Middendorff and Menke in the same direction. If an author professes that he cannot understand the labours of his predecessors, he is not bound to add to them; but if he builds on their foundation, without making that foundation his own, he cannot expect the stability of his edifice.

It has been asserted that Carpenter did not use type in a modern sense or that he did not designate specimens as such. As I pointed out in 1958 (p. 4) both ideas are erroneous assumptions. I have examined all of the major collections except those in the British Museum (Natural History) which involved Carpenter material and have found the designation of type by Carpenter a common factor. To quote from Carpenter (1857b, p. 165)—"Those identifications therefore are by far the most satisfactory which are made by a comparison of types. But even here the student must exercise caution." He goes on to explain how specimens in collections get mixed, lost, lose their labels, or mislabelled. Time has not overcome these hazards as collections in present day institutions are beset with the same ills. Carpenter made three suggestions (1857b, p. 165) in regard to making systematic literature and registry of the location of types available to naturalists and libraries. The essence of his suggestions have been promulgated by different persons since Carpenter's day and various catalogues of types in certain museums have been published. But Carpenter with all his appreciation, study, and method of type designation did not consider these factors alone. He continued (1857b, p. 165), "But the foundation-point of all our inquiries must be the discrimination of species themselves as they exist in nature . . . Every description therefore which is founded on single or extremely few specimens must be regarded as only provisional, till their circumstances of variation are known . . ." The further reading of Carpenter's philosophy, from which the brief lines are quoted, will reveal the broad and modern concept, displayed by him.

In his dissertation on the Acmaeidae of the West Coast (1866, p. 338 footnote) where an analysis of Gould's species of troublesome Acmaeas are given, Carpenter explained:

> All the remarks on Dr. Gould's species are written after very careful study of the figured types in the Smithsonian Institution; those on Nuttall's species of the types in his own collection (since presented to the British Museum); those on Reeve's species of the types in Mus. Cuming, now removed to the British Museum; and those on D'Orbigny's species, of the types in his own collection in the British Museum.

The types which are involved in the present study may now be found in the U. S. National Museum, British Museum (Natural History), or the Redpath Museum at McGill University. Some have been lost. Lists are compiled and included as to the present location of the types. I have examined the types in the U. S. National Museum and in the Redpath Museum and made notes regarding the shells. I have not been fortunate enough to be able to study those in the Department of Mollusca, British Museum (Natural History). I am indebted to Norman Tebble for the examination of the shells and for the data concerning those specimens.

The distribution as indicated in the text is not meant to be complete. For extended range see Hertlein and Strong (1940-1951), Keen (1958), and Olsson (1961).

ACKNOWLEDGMENTS

Continued cooperation in regard to Carpenter material has been received from members of the staff of the Department of Mollusca, of the United States National Museum, Redpath Museum at McGill University, and the British Museum (Natural History). The United States National Museum and the British Museum (Natural History) generously provided the illustrations of the types in the respective institution. Special thanks are due Harald Rehder, J. P. E. Morrison of the U. S. National Museum, Mrs. Alice Turnham and Vincent Condé of the Redpath Museum, and J. W. Pollack, McGill University, and Peter Dance and Norman Tebble of the British Museum (Natural History). Special appreciation is extended to Norman Tebble who checked the long list of species, the types of which were probably in the British Museum (Natural History), and who provided notes with information regarding the specimens which are now present in that museum.

John F. Ogle-Skan of Manchester, England, checked certain references and obtained a copy of a needed publication. Dr. Venia Phillips, Manuscript Librarian at the Academy of Natural Sciences in Philadelphia, kindly provided information from rare publications. Vincent Condé of the Redpath Museum verified the list of type material in that Musenm.

The author wishes to thank G. B. Stratton, Librarian and Clerk of Publications of the Zoological Society of London, for furnishing the list of the exact dates of parts 23 and 24 of the Proceedings of the Zoological Society of London. Because the bound volumes of those numbers in libraries bear only date of one year on the title page, the actual dates of the various pages and sheets are troublesome. As a help to writers the notes compiled by Mr. Stratton are printed in the bibliography of this paper under heading of Zoological Society of London.

LOCALITIES AND COLLECTIONS OF WEST COAST (MEXICAN AND PANAMANIAN) SPECIES DESCRIBED BY CARPENTER

The following species were described by Carpenter (1856a) from the west Mexican coast exclusive of Mazatlan:

? *Scrobicularia producta*. Gulf of California. Holotype, Reg. No. 19621113 BM(NH)

**Donax semistriatus*. Gulf of California.

Galerus ? sinensis var. *fuscus*. Gulf of California [?]. Carpenter suggested that the specimen had been imported.

Galerus subreflexus. Gulf of California. Possible paratype, Reg. No. 19621122 BM(NH).
Scalaria reflexa. San Blas, Gulf of California. Holotype, Reg. No. 19621116 BM(NH).

The type of those species with an asterisk has not been found.

The following species were collected by Thomas Bridges in Panama and described by Carpenter in 1856, pages 159-166 (1856c). Dall (1866, p. 236) wrote a brief description of Bridges' life and travels. Bridges was an important collector of natural history material from western South America and North America. The specimens were in the Hugh Cuming collection which was transferred to the British Museum (Nat. Hist.) All came from the Bay of Panama. The type of those species with an asterisk has not been found.

* 1. *Stigilla disjuncta*
* 2. *Tellina Deshayesii*
3. ? *Scrobicularia virido-tincta.* Holotype, No. 19621115 BM(NH)
4. *Semele planata.* Holotype, Reg. No. 196311 BM(NH)
5. *Mactra (Mactrella) lacinata.* Holotype, Reg. No. 19621117 BM(NH)
6. *Cyclina producta.* Holotype, Reg. No. 19621112 BM(NH)
7. *Melampus Bridgesii.* Holotype, Reg. No. 196312 BM(NH)
8. *Umbrella ovalis.* Syntypes, Reg. No. 196313 BM(NH)
* 9. *Pyrgula quadricostata*
*10. *Erata ? Maugeriae* var. *Panamensis*
11. ? *Cithara sinuata.* Holotype, Reg. No. 196314 BM (NH)
*12. *Mangelia acuticostata*
13. *Mangelia ? rigida* var. *fuscoligata.* Holotype, Reg. No. 196315 BM(NH)
14. *Defrancia intercalaris.* Holotype, Reg. No. 196316 BM(NH)
15. *Defrancia serrata.* Holotype, Reg. 196317 BM(NH)
16. *Drillia punctatostriata.* Holotype, Reg. No. 196318 BM(NH)
17. ? *Pleurotoma gracillima.* Holotype, Reg. No. 196319 BM(NH)
18. *Scalaria regularis.* Holotype, Reg. No. 1950.4.18.13/16 BM(NH)
19. *Scalaria tiara.* Holotype, Reg. No. 196320 BM(NH)
*20. *Scalaria subnodosa*
21. *Scalaria Cumingii.* Holotype, Reg. No. 1950.3.31.1 BM(NH)
22. *Scalaria Hindsii.* Holotype, Reg. No. 196321 BM(NH)
23. *Natica excavata.* Holotype, Reg. No. 196322 BM(NH)
24. ? *Triton crebristriatus.* Holotype, Reg. No. 19621120 BM(NH)
*25. *Phos biplicatus*
26. *Latyrus tumens.* Holotype, No. 19621119

The following species were described by Carpenter from material collected by A. A. Gould from the western coast of Mexico, Panama, and California (Gould and Carpenter, 1857, pp. 198-208). Those whose type locality is in the area of this report are included.

**Corbula polychroma.* Gulf of California; Sta. Barbara
**Tapes tenerrima.* Panama
**Lucina Artemidis.* ? Acapulco
Crucibulum corrugatum. Mazatlan
**Fasciolaria bistriata.* Panama
Columbella Santa-Barbarensis

The type of those species with an asterisk has not been found.

Carpenter described (1864a) the following molluscan species, the shells of which had been collected by Mr. John Xantus, U. S. Coast Survey, from Cape St. Lucas (called also Cape San Lucas), southern tip of Baja California. The types of the species described were presented to the Smithsonian Institution. Carpenter stated that duplicates would be found in the British Museum or in the collection of H. Cuming. The type of those species with an asterisk has not been found. (For Xantus see Carpenter, 1864b, p. 617, Reprint, 1872, p. 103.)

1. *Asthenothaerus villosior.* Holotype, No. 16292 USNM
* 2. *Solemya valvulus*
3. *Tellina (Peronaeoderma) ochracea.* Holotype, No. 12584 USNM
4. *Psammobia (? Amphichaena) regularis.* Holotype, No. 10407 USNM
5. *Callista pollicaris.* Holotype, No. 12721 USNM
* 6. *Callista (? pannosa* var.) *puella*
7. *Levicardium apicinum.* Original material USNM and Redpath Mus.
8. *Lucina lingualis.* Syntypes, No. 15898 USNM; No. 114 Redpath Mus.
* 9. ? *Crenella inflata*
10. *Bryophila setosa.* Holotype, No. 16187 USNM
11. ? *Atys casta.* Lectotype and paratype, No. 4014 USNM
12. *Ischnochiton parallelus.* Syntypes, No. 4017 USNM; No. 46 Redpath Mus.
13. *Ischnochiton* (? var.) *prasinatus.* Holotype, No. 15892 USNM
14. *Ischnochiton serratus.* Syntypes, No. 16204 USNM lost; No. 98 Redpath Mus.
15. *Nacella peltoides.* Lectotype, No. 4023 USNM; paratype, No. 1156 Redpath Mus.
16. *Acmaea* (? var.) *atrata.* Holotype, No. 4019 USNM
17. *Acmaea strigatella.* Syntypes, No. 12594 USNM
18. *Glyphis saturnalis.* Syntypes, No. 15853 USNM
19. *Eucosmia variegata.* Syntypes, No. 11836 USNM
20. *Eucosmia (? variegata,* var.) *substriata.* Holotype, No. 11829 USNM
21. *Eucosmia punctata.* Possible paratype, No. 19621123 BM(NH)
22. *Eucosmia cyclostoma.* Holotype, No. 11831 USNM
23. *Haplocochlias cyclophoreus.* Syntypes, No. 18112 USNM
24. *Narica aperta.* Holotype, No. 15897 USNM
25. *Fossarus parcipictus.* Holotype, No. 4060 USNM
26. *Fossarus purus.* Holotype, No. 16210 USNM
27. *Litorina* [*sic*] *pullata.* Syntype, No. 12661 USNM
28. *Litorina* [*sic*] *(Philippii,* var.*) penicillata.* Syntypes, No. 4058 USNM
29. *Rissoa albolirata.* Holotype, No. 16216 USNM
30. *Fenella crystallina.* Holotype, No. 15888 USNM
31. ? *Hydrobia compacta.* Holotype, No. 16209 USNM
*32. *Hyala rotundata*

33. ? *Diala electrina.* Holotype, No. 16217 USNM
*34. *Acirsa Menesthoides*
35. *Cythnia asteriaphila.* Holotype, No. 13746 USNM
36. *Bittium nitens.* Holotype, No. 4068 USNM
37. *Mangelia subdiaphana.* Holotype, 16219 USNM
38. *Drillia appressa.* Holotype, No. 4087 USNM
39. *Cithara fusconotata.* Holotype, No. 4081 USNM
*40. *Obeliscus variegatus*
41. *Odostomia (Evalea) aequisculpta.* Holotype, No. 16221 USNM
42. *Odostomia (Evalea) delicatula.* Holotype, No. 4102 USNM
43. *Chrysallida angusta.* Holotype, No. 16212 USNM
44. *Eulima fuscostrigata.* Holotype, No. 4105 USNM
45. *Opalia crenatoides.* Holotype, No. 15874 USNM
46. *Truncaria eurytoides.* Holotype, No. 4148 USNM
*47. *Sistrum (? ochrostoma,* var.*) rufonotatum*
*48. ? *Nitidella millepunctata*
49. ? *Nitidella densilineata.* Lectotype, No. 4146 USNM
*50. ? *Anachis tincta*
51. ? *Anachis fuscostrigata.* Holotype, No. 16223 USNM
52. *Pisania elata. ?* Holotype, No. 87 Redpath Mus.

Carpenter (1865c) described the following species which were collected in Panama by C. B. Adams:

Lepidopleurus adamsii. Syntypes, No. 42 Redpath Mus.
Lepidopleurus tenuisculptus. Holotype, No. 126 Redpath Mus.
Ischnochiton elenensis = *Chiton elenensis* Sowerby
Ischnochiton (? var.) *expressus.* Holotype, No. 38 Redpath Mus.
"Callochiton" pulchellus. Specimens, No. 47, Redpath Mus. USNM
Acmaea (? floccata, var.*) filosa.* Holotype, No. 15923 USNM
Acmaea (? floccata, var.*) subrotundata.* Holotype, No. 15922 USNM
Acmaea (? var.) *vernicosa.* Holotype, No. 15924 USNM

The following species were described by Carpenter (1865d) mainly from specimens collected by Rev. J. Rowell of San Francisco. They were deposited in the Smithsonian Institution. The type of those species with an asterisk has not been found.

(Tellina) Angulus decumbens. Panama, Rowell, Pease. Syntypes, No. 16101 USNM; No. 2374 Redpath Mus.
Lucina undata. Gulf of California, Rowell. Syntypes, No. 122 Redpath Mus.
Calliostoma (*? lima* var.) *aequisculpta.* Acapulco, Newberry. Holotype, No. 16013 USNM
**Narica insculpta.* Acapulco, Rowell
Drillia eburnea. Near Gulf of California, Rowell. Holotype, No. 22817 USNM
Mangilia albolaqueata. Panama, Rowell. Holotype, No. 55393 USNM
Eulima falcata. Acapulco, Rowell. Holotype, No. R123 USNM
Cerithiopsis intercalaris. Guacomayo. Holotype, No. 15342 USNM
Columbella humerosa. Acapulco, Rowell. Holotype, No. 610334 USNM
**Muricidea dubia,* var. *squamulata.* Cape St. Lucas, Xantus

The following species were described by Carpenter (1865g) from the Gulf of California and included with a greater number of species from upper California. All were from the collection of the Smithsonian Institution.

Angulus Gouldii. San Diego, Cassidy; Cerros Is., Ayres = *Tellina meropsis* Dall, 1900. See Palmer, 1958, p. 105.
**Barleeia subtenuis*. San Diego, Cassidy; Cape St. Lucas, Xantus; Mazatlan, Reigen. See Palmer, 1958, p. 165.
Barleeia haliotiphila. Rowell. Holotype, No. 15558 USNM
Drillia penicillata. Cerros Is., Veatch. Holotype, No. 6320 USNM
**Odostomia straminea*. Gulf of California, Rowell; Cape St. Lucas, Xantus.
Ocinebra Poulsoni. San Diego, Nuttall; Cerros Is., Veatch; Santa Barbara, Jewett. Type BM 61.5.18.22 BM (NH).

The type of those species with an asterisk has not been found.

Besides one species from Mazatlan, Carpenter (1865i) described the following from Panama collected by Col. E. Jewett:

Rissoina expansa. Mazatlan
Mangelia hamata. No. 95 Redpath Mus.
Mangelia cerea. No. 91 Redpath Mus.
Chemnitzia caelata. Probably Panama, No. 3136 Redpath Mus.

DEPOSITORIES OF TYPES

The following is a list of the location of types of the marine molluscan species described by Carpenter from the west coast of Mexico, Baja California, and Panama, exclusive of Mazatlan.

BRITISH MUSEUM (NATURAL HISTORY)

Pelecypoda
- Cyclinella producta (as *Cyclina*), Reg. No. 19621112
- Mactra lacinata, Reg. No. 19621117
- ? Scrobicularia producta [see *A. dombei* (Hanley)], Reg. No. 19621113
- Scrobiculina viridotincta (as ? *Scrobicularia*), Reg. No. 19621115
- Semele planta, Reg. No. 196311
- Tagelus violascens (as *Solecurtus*), Reg. No. 1857.6.4.2531
- Pandora (Clidiophora) cristata, Reg. No. 1963441

Gastropoda
- Serpulorbis squamigerus (as *Aletes*), Reg. No. 55.3.14.57
- Epitonium cumingii (as *Scalaria*), Reg. No. 1950, 3.31.1
- Epitonium hindsii (as *Scalaria*), Reg. No. 196321

Epitonium reflexum (as *Scalaria*), Reg. No. 19621116
Epitonium regulare (as *Scalaria*), Reg. No. 1950.4.18. 13/16
Epitonium tiara (as *Scalaria*), Reg. No. 196320
Natica excavata Reg. No. 196322
Tritonalia poulsoni (as *Buccinum*), BM 61.5.18.22
Caducifer crebristriatus (as *Triton*), Reg. No. 19621120
Latirus tumens, Reg. No. 19621119
"Pleurotoma" gracillima, Reg. No. 196319
Drillia punctatostriata, Reg. No. 196318
Daphnella sinuata (as *Cithara*), Reg. No. 196314
Clathurella rigida fuscoligata (as *Mangelia*), Reg. No. 196315
Clathurella intercalaris (as *Defrancia*), Reg. No. 196316
Clathurella serrata (as *Defrancia*), Reg. No. 196317
Umbraculum ovale (as *Umbrella*), Reg. No. 196313
Melampus bridgesii, Reg. No. 196312

REDPATH MUSEUM, McGILL UNIVERSITY

Pelecypoda
Pecten paucicostatus [see *A. tumbezensis* (d'Orbigny)], No. 121 syntypes
Lucina lingualis, No. 114 syntypes
Lucina undatoides Hertlein and Strong (*L. undata* Carpenter), No. 122 syntypes
Elpidollina decumbens (as *Tellina*), No. 2374 syntype

Gastropoda
Mitrella santabarbarensis (as *Columbella*), No. 74
Tritonidea elata (as *Pisania*), No. 87
Mangelia cerea, No. 91
Mangelia hamata, No. 95
Chemnitzia caelata, No. 3136
Williamia peltoides (as *Nacella*), No. 1156 paratype

Amphineura
Ischnochiton adamsii (as *Lepidopleurus*), No. 42
Chaetopleura parallela (as *Ischnochiton*), No. 46 syntype
Ischnochiton tenuisculptus (as *Lepidopleurus*), No. 126
Callistochiton expressus (as *Ischnochiton*), No. 38

"Callistochiton pulchrior" MS. (see *C. pulchellus* Gray), No. 47

Ischnochiton serratus, No. 98 paratype

The names of the following types of Upper California which are in the Redpath Museum were omitted from the list in Palmer, 1958 (p. 21) and should be added to that record. They are given in the text (1958) under each species.

Ischnochiton corrugatus. No. 37

Mopalia muscosa fissa Carpenter ms. *in* Pilsbry = *M. acuta* (Carpenter). No. 9

U. S. NATIONAL MUSEUM

Pelecypoda

Philobrya setosa (as *Bryophila*), No. 16187

Pecten paucicostatus [see *A. tumbezensis* (d'Orbigny)], No. 15643b syntypes

Lucina lingualis, No. 15898 syntypes

Pseudochama inermis (Dall), No. 24108

Pitar pollicaris (as *Callista*), No. 12721

Elpidollina decumbens (as *Tellina*), No. 16101 syntype

Scrobiculina ochracea (as *Tellina*), No. 12584

Gari regularis (as *Psammobia*), No. 10407

Asthenothaerus villosior, No. 16292

Gastropoda

Acmaea atrata, No. 4019

Acmaea filosa, No. 15923

Acmaea strigatella, No. 12594

Acmaea subrotundata, No. 15922

Acmaea vernicosa, No. 15924

Diodora saturnalis, No. 15853

Calliostoma aequisculptum, No. 16013

Haplocochlias cyclophoreus, No. 18112

Eulima falcata, No. R 123

Eulima fuscostrigata, No. 4105

Cythnia asteriaphila, No. 13746

Tricolia cyclostoma (as *Eucosmia*), No. 11831

Tricolia substriata (as *Eucosmia*), No. 11829
Tricolia variegata (as *Eucosmia*), No. 11836
Littorina penicillata, No. 4058
Littorina pullata, No. 12661 (4059)
Alvania albolirata (as *Rissoa*), No. 16216
Alvania electrina (as *Diala*), No. 16217
Barleeia haliotiphila, No. 15558
Assiminea compacta (as ? *Hydrobia*), No. 16209
Bittium nitens, No. 4068
Eumeta intercalaris (as *Cerithiopsis*), No. 15342
Fenella crystallina, No. 15888
Opalia crenatoides, No. 15874
Fossarus parcipictus, No. 4060
Fossarus purus, No. 16210
Vanikoro aperta (as *Narica*), No. 15897
Aesopus eurytoides (as *Truncaria),* No. 4148
? Aesopus fuscostrigata (as ? *Anachis*), No. 16223
? Anachis humerosa (as *Columbella*), No. 610334
Mitrella densilineata (as *Nitidella),* No. 4146, lectotype
Pseudomelatoma penicillata (as *Drillia),* No. 6320
Crassispira appressa (as *Drillia*), No. 4087
Clavus albolaqueatus (as Drillia), No. 55393
Laevitectum eburneum (as Drillia), No. 22817
Mangelia subdiaphana, No. 16219
Atys casta, No. 4014, lectotype and paratype
Odostomia aequisculpta, No. 16221
Turbinella angusta (as *Chrysallida*), No. 16212
Odostomia delicatula, No. 4102
Williamia peltoides (as *Nacella*), No. 4023, lectotype

Amphineura
Chaetopleura parallela (as *Ischnochiton*), No. 4017 syntype
Chaetopleura prasinatus (as *Ischnochiton*), No. 15892
Ischnochiton serratus, No. 16204 holotype

TYPES NOT FOUND

Pelecypoda
Solemya valvulus

Crenella inflata
Lucina artemidis
Laevicardium apicinum
Protothaca tenerrima (as *Tapes*)
Transennella puella (as *Callista*)
Tellina deshayesii
Strigilla disjuncta
Donax semistriatus
Thracia squamosa

Gastropoda

Tricolia carpenteri Dall for *Phasianella punctata*
Pyrgula quadricosta
Hyala rotundata
Barleeia subtenuis
Epitonium subnodosum (as *Scalaria*)
Acirsa menesthoides
Vanikoro insculpta (as *Narica*)
Calyptraea subreflexa (as *Galerus)* possible paratype BM (NH)
Erato ? maugeriae var. panamensis
Sistrum (? ochrostoma, var.) rufonotatum
Muricopsis squamulata (as *Muricidea*)
Anachis tincta
Mitrella millepunctata (as ? *Nitidella*)
Phos biplicatus
Fasciolaria bistriata
Mangelia acuticostata
Odostomia straminea

SYSTEMATIC DESCRIPTIONS

PELECYPODA

Solemya valvulus Carpenter

Solemya (Petrasma) valvulus Carpenter, 1864a, p. 311; Reprint, 1872, p. 210; Keen, 1958, pp. 236, 547, fig. 606 not holotype as stated; Palmer, 1958. p. 60 see for synonymy prior to 1958.

Original description.—
S. testa minore, tenuissima, diaphana, vix testacea, cornea, pallidiora, lineis tenuibus, distantibus, fuscis, radiatim ornata; postice tenulter radiatim striata; tumente, satis elongata, marginibus antice et postico regulariter excurvatis; umbonibus vix conspicuis; lineis anticis divaricantibus, extus parentibus, intus lacunam cartilagineam definienti-

bus; cardine edentulo; ligamento postice elongato, antice curto, latiore, bifurcato; cicatricibus adductorum subrotundatis. Long. ·85, lat. ·25, alt. ·14 poll.

See Palmer, 1958, for discussion.

Holotype.—Not found. The type is not in the USNM as reported by Oldroyd.

Distribution.—Cape St. Lucas, Lower California (Xantus) (type); San Pedro, California, to Punta Penasco, Sonora, Mexico (Hertlein and Strong).

Crenella inflata Carpenter

? *Crenella inflata* Carpenter, 1864a, p. 313, Reprint, 1872, p. 211; 1864b, pp. 553, 618, Reprint, 1872, pp. 39, 104.
Crenella divaricata (d'Orbigny), Soot-Ryen, 1955, p. 80.
Crenella divaricata (Orbigny, 1853), Keen, 1958, p. 50 *C. inflata* Carpenter in synonymy.

Original description.—
? *C.* testa valde inflata, minuta, albida, subrhomboideo-orbiculari; diagonaliter parum producta; marginibus subquadrangulatim rotundatis; umbonibus prominentibus, valde antice intortis; tota superficie ut in *C. decussata* sculpta, costulis crebris radiantibus æquidistantibus, hic et illic aliis intercalatis; lirulis concentricis decussantibus : intus margine dorsali brevissimo, arcuato, dentato; ligamento curtissimo, in fossa omnino interna, celata, lamina definiente, sito; lamina cardinali sub umbonibus intus porrecta, dentibus validis instructa; marginibus internis omnino crenatis; cicatr. adduct. subæqualibus, ventraliter sitis. Long. ·1, lat. ·12, alt. ·09 poll.
Located provisionally in *Crenella* from its likeness to *C. decussata,* but with peculiarities of hinge and adductors which approach *Nuculina* on one side and *Cardilia* on another.
Valves; very rare. (An aberrant form.) Also Panama, *C. B. Ad.*—(Carpenter, 1864b, p. 518).

The Cape San Lucas species has been included as the same as the Cuban *C. divaricata* (d'Orbigny, 1853). The type of *C. inflata* has not been found nor has it been illustrated.

Type.—Unknown.

Distribution.—Cape St. Lucas (Xantus) (type).

"Modiola" nitens Carpenter

"Modiola" nitens Carpenter, 1857 *in* Gould and Carpenter, p. 202; Carpenter 1857c, pp. 227, 309, 349; 1860d, p. 2; 1864b, pp. 535, 564, 616, Reprint, 1872, pp. 21, 50, 102; Pilsbry and Lowe, 1932, p. 138; Palmer, 1958, pp. 73, 74 see for discussion.

On page 535 (Carpenter, 1864b) Carpenter stated "27. *Modiola nitens* [= *M. subpurpureus* Mus. Cum., and is not from Cal.]". (See Palmer, 1958, p. 74.)

Philobrya setosa (Carpenter)

Bryophila setosa Carpenter, 1864a, p. 314, Reprint, 1872, p. 212; 1864b, pp. 538, 612, 618, 645, Reprint, 1872, pp. 24, 98, 104, 131; Stoliczka, 1871, p. 383.
Philobrya setosa Carpenter, Cooper, 1867, Geog. Cat. Moll. Geol. Sur. California, p. 12; Carpenter, Reprint, 1872, index, p. 21; for complete synonymy see Palmer, 1958, p. 65, pl. 1, figs. 11-16; Olsson, 1961, p. 148, pl. 3, figs, 12, 12a.

Original description.—
B. testa parva, regulari; cinerea, salmoneo seu chocolateo, intus subnacreo, exquisite tincta: t. juniore planata, semirotundata, dorsaliter recta, æquilaterali, conspicue punctata : t. adolescente subdiaphana : t. adulta solidiore; umbonibus rectis, terminalibus, intus alte excavatis; marg. dorsali berviore, recto; antico recto; ventrali et postico late rotundatis : extus epidermide subspongiosa vestita, radiis setarum subdistantibus, marginibus eleganter pectinatis : intus ligamento solido dorsaliter producto; limbo pallii æqualiter prope marginem decurrente; cicatr. adduct. submediana inconspicua; postice hiante; antice propter byssum tenuem sinuata. Long. ·13, lat. ·2, alt. ·1 poll.
Like a minute *Pinna,* or a transverse *Margaritiphora* without ears, or an *Isognomon* without pits. Differs from the other Aviculids in being viviparous, like some other minute bivalves.

For discussion including original notes and dimensions of syntypes see Palmer, 1958, pages 65, 66, and illustration of syntypes, plate 1, figures 11-16.

Syntypes.—No. 16187, USNM.

Distribution.—Cape St. Lucas, (Xantus) (type), Lower California, Santa Barbara, "20 fm Cp." (Carpenter); Forrester Island, Alaska, to Gulf of California (Dall).

Aequipecten (Leptopecten) tumbezensis (d'Orbigny) Pl. 58, figs. 1-6

Pecten tumbezensis d'Orbigny, Hertlein, 1936, p. 55.
Pecten paucicostatus Carpenter, 1864b, pp. 536, 614, 645, Reprint, 1872, pp. 22, 100, 131; Carpenter, 1865h, p. 179, Reprint, 1872, p. 281; Pilsbry and Lowe, 1932, p. 139; Palmer, 1945, p. 99.
Pecten (Plagioctenium) paucicostatus Carpenter, Arnold, 1906, p. 137, pl. XXXIX, figs. 3, 3a (type), 4 "cotype"; Dall, 1921, p. 19; Oldroyd, 1924, p. 56, pl. 41, figs. 4, 5 as *Chlamys.*
Aequipecten (Leptopecten) tumbezensis (Orbigny), Keen, 1958, p. 70 *P. paucicostatus* Carpenter in synonymy.
Chlamys (*Leptopecten*) *tumbezensis* (d'Orbigny), Grau, 1959, p. 118, pl. 40
Aequipecten (Pacipecten) tumbezensis d'Orbigny, Olsson, 1961, p. 164, pl. 21, figs. 2-2c see for synonymy.

Somewhat resembling very young *caurinus;* but ribs fewer, stronger. (Carpenter, 1864, p. 645).
Original description.—Carpenter, 1865h, p. 179.
P. testa subconvexa, vix æquilaterali; castaneo seu rubido seu electrino picta; costis xi.-xv., validis, angustis, rotundatis; interstitiis multo latioribus, subplanatis; tota superficie minutissime concentrice striata; auriculis latis, haud æqualibus, lirulis circ. vi. ornatis; sinu paucidentato; intus pallidiore, linea cardinis costata, ad suturas

auricularum tuberculosa; fossa ligamentali curta, transversim lata. Long., 1.7; lat., 1.84; alt., .56. (Carpenter.)
Hab. Sta. Barbara (*Jewett*); Sta. Barbara Island (*Cooper*).

There are two specimens in the U. S. National Museum, labelled "types Sta Barbara Jewett and Cooper Cataline Id." These labels correspond to one of the original localities listed. This locality seems to be in error. One specimen was figured by Arnold, 1906. This specimen bears 14 radiating ribs and measures 38 mm., width, 34 mm., height, and 6 mm., semidiameter. The other specimen, 15643b, designated "type" (Plate 58, figures 2, 3) is an opposite valve. It has 12 wide radiating ribs with wide interspaces. It measures 35 mm., width, 32.5 mm., height. One ear was broken in life and partially repaired by the animal.

There are also two specimens (right and left valves) in the Redpath Museum No. 121, which were labelled type by Carpenter. These are figured herein (Plate 58, figures 1, 4, 5, 6). They were labelled by Carpenter "type" "Sta. Barbara Jewett (? Nicaragua)."

Syntypes.—No. 15643b, USNM; No. 121, Redpath Museum (*P. paucicostatus* Carpenter)

Distribution.—Gulf of California to Peru. Type locality?

"Lucina artemidis Carpenter" *in* **Gould and Carpenter**

Lucina Artemidis Carpenter *in* Gould and Carpenter, 1857, p. 201; 1857c, pp. 227, 308; 1860d, p. 4 small a; 1864a, p. 642, Reprint, 1872, p. 128 = *Lucina californica* Conrad, Dall, 1901a, p. 813 young of *L. californica.*

Original description.—Carpenter *in* Gould and Carpenter, 1856e, p. 201.
L. t. alba, solidiore, subrotundata, subplanata; marginibus ventrali antice producto, postico subplanato, dorsali subangulato; umbonibus appressis, haud prominentibus; superficie sulcis concentricis crebris ornata; lunula parva, vix excavata, in valva altera omnino sita, altera margine incurvata; intus, dent. card. ii.—ii. *divergentibus, lat. ant.* i.—ii. *prominentibus, distantibus, post.* i.—ii. *valde distantibus, parvis; cicatr. musc. ant. elongatis, serratis, post. parvis; linea pallii a margine haud distante.*
Long. ·75, lat. ·84, alt. ·37.
Hab. ? Acapulco, teste Gould; Mus. suo, sp. un.
Found in company with *Tellina vicina,* C. B. Ad. Has the characteristic shape and interior of *Lucina,* with the sculpture of *Dosinia.*

Holotype.—Unknown.

Distribution.—? Acapulco, State of Guerrero, west Mexico.

Lucina (Callucina) lingualis Carpenter Pl. 59, figs. 1-5

Lucina lingualis Carpenter, 1864a, p. 313; Reprint, 1872, p. 211; Palmer, 1945, p. 99.

Phacoides (Cavilucina) lingualis (Carpenter), Dall, 1901a, pp. 811, 827, pl. XXXIX, fig. 7; Lamy, 1920, p. 207.
Lucina (Myrtea) lingualis Carpenter, Grant and Gale, 1931, p. 286.
Lucina (Callucina) lingualis Carpenter, Chavan, 1937, p. 254 *ligualis* [*sic*]; Keen, 1958, p. 94, fig. 186 after Dall.
Lucina (Cardiolucina) lingualis Carpenter, Durham, 1950, p. 76, pl. 18, figs. 3, 10.
Lucina (Cavilinga) lingualis Carpenter, Hertlein and Strong, 1946, p. 113; Olsson, 1961, p. 211, pl. 31, fig. 11.

Original description.—Carpenter, 1864a, p. 313.
L. testa solida, linguiformi, valde prolongata; plerumque aurantiaco-carnea, intus intensiore; lirulis concentricis obtusis crebre ornata; marginibus undique excurvatis; lunula minima, altissime excavata; parte postica obscure biangulata, seu subrotundata; umbonibus anticis, incurvatis; ligamento subinterno, lamina valida; dent. card. et lat. normalibus, validis; cicatr. adduct. posticis subovalibus, anticis satis elongatis; linea pallii lata, rugosa; margine interno crenulato. Long. ·88, lat. ·92, alt. ·4 poll.
Variat t. minus prolongata. Variat quoque t. pallide viridi, seu pallide carnea, seu alba.

The type material consists of six specimens in the USNM and three in the Redpath Museum. The syntypes in the Redpath and one in the USNM are figured herein. The shells have an orange color on the inside which shows slightly through to the exterior. The interior ventral margin is finely crenulated.

Measurements.—Syntypes, USNM:

Width	height	thickness (1 valve)
11 mm.	12 mm.	3 mm.
11.5	12	3.5
11.5	12	3.5
10	11	3
10	10	3
8	9	2

Syntypes (6). — No. 15898, USNM; (3) No. 114, Redpath Museum.

Distribution.—Cape St. Lucas (Xantus) (type). Magdalena Bay, Gulf of California, to Acapulco, Mexico (Keen), Pliocene to Recent (Durham).

Lucina (Cavilinga) prolongata Carpenter Pl. 61, figs. 11, 12

Lucina prolongata Carpenter, 1855, p. 100, No. 145 Mazatlan; 1857c, pp. 248, 308; 1860d, p. 4.
Phacoides (Cavilucina) prolongatus (Carpenter), Dall, 1901a, p. 811 Cape San Lucas; Lamy, 1920, p. 207.
Linga (Cavilinga) prolongata (Carpenter), Chavan, 1937, p. 201.

Lucina (Cavilinga) prolongata Carpenter, Keen, 1958, p. 94, fig. 187; Olsson, 1960, p. 210, pl. 31, figs. 8, 8a, 10, 10b type copy Carpenter's original drawing.

A specimen No. 3988, USNM from Cape St. Lucas is recorded as the "cotype". This shell cannot be the type because the species was described by Carpenter from Mazatlan. The type should be, therefore, in the British Museum (Nat. History). Olsson illustrated copies of the drawings of the types.

Type.—British Museum (Natural History).

Distribution.—Mazatlan, State of Sinoloa, west Mexico (type) Mazatlan, to Punta Blanca, Ecuador (Olsson).

Lucina (Pleurolucina) undatoides Hertlein and Strong Pl. 59, figs. 6-8

Lucina undata Carpenter, 1865d, p. 279, Reprint, 1872, p. 272, not *Lucina undata* Lamarck, 1818, p. 543.
Phacoides (Pleurolucina) undatus (Carpenter), Dall. 1901a, pp. 811, 826, pl. 39, fig. 14; Lamy, 1920, p. 205.
Lucina (Phacoides) undata Carpenter, Lamy, 1909, p. 239.
Lucina undatoides Hertlein and Strong, 1945, p. 105 new name for *Lucina undata* Carpenter, 1865 not Lamarck, 1818.
Myrtaea undata (Carpenter), Palmer, 1945, p. 99.
Phacoides undata (Carpenter), Pilsbry and Lowe, 1932, p. 136 La Paz.
Parvilucina (Pleurolucina) undata (Carpenter), Chavan, 1937, p. 214, fig. 5.
Lucina (Pleurolucina) undatoides Hertlein and Strong, Keen, 1958, p. 96, fig. 195 after Dall; Olsson, 1961, p. 209, pl. 31, fig. 13.
Original description.—Carpenter, 1865d, p. 279.

L. *t. convexa, tenuiore, albida; tota superficie lirulis concentricis creberrimis, compressis, haud acutis ornata, interstitiis minimis; parte ventrali costis radiantibus* iii., *obtusis, latis, validissimis, interstitiis parvis; lunula maxima, a sulco bene definita, sub umbonibus incurvatis fossa alta minuta indentata; parte postica alata; margine a costis valde undato minute crenulato; ligamento quasi interno: intus dent. card. parvis, a fossa lunulari intortis; lat. curtis, obtusis; cicatr. adduct. antica irregulari, postica subovali; linea palliari prope marginem sita, undata.*

Long. ·45, lat. ·44, alt. ·3.

Hab. Gulf of California (teste *Rowell*).

The outline somewhat resembles *Cryptodon;* but the aspect is more that of *Verticordia,* while the minute subumbonal pit is suggestive of *Opis.* The shell is sexpartite; the portion between the anterior rib and the lunule resembles a fourth rib, while the projecting lunule and the posterior wing are quite distinct from the body of the shell. The specimen sent by Mr. Rowell to the Smithsonian Institution was completely smashed. The diagnosis is written from a perfect shell sent by Dr. Newcomb to Mr. Cuming.

Syntypes.—No. 122, Redpath Museum, McGill University.

Distribution.—Gulf of California (type).

Because the name *L. undatoides* Hertlein and Strong is a substitute name for the preoccupied *L. undata* Carpenter, 1865 (not *L. undata* Lamarck, 1818) it should take the same type as of *L. undata* Carpenter and not that as selected by Hertlein and Strong 1945. The Carpenter types are available and figured herein.

"Sphaerella tumida"

Sphaerella tumida Conrad MS. *in* Carpenter, 1864b, pp. 544, 643, Reprint, 1872, pp. 30, 129 = *Lucina* [*Diplodonta*] *orbella* Gould, Boston Soc. Nat. History, 1851, vol. IV, p. 87; Otia Conchologica, 1862, p. 212. Not Carpenter, Proc. Zool. Soc. London, 1856, p. 215 *fide* Dall, 1901a, p. 795.

Sphaerella tumida, which was a manuscript name of Conrad *in* Carpenter, is as Carpenter and Dall determined, *Diplodonta orbella* (Gould).

Pseudochama inermis (Dall) Pl. 61, figs. 8-10

Chama inermis Carpenter MS. with type *Chama inermis* Dall, 1871, p. 148.
Pseudochama inermis (Dall), Pilsbry and Lowe, 1934, p. 83, pl. 8, figs. 1-3; Keen, 1958, p. 112, fig. 246 copy Pilsbry and Lowe.

The manuscript name of Carpenter was utilized by Dall in 1871 with a description.

Pilsbry and Lowe gave a description also of the species including the notes with the holotype which Carpenter wrote regarding the shell.

The type (illustrated herein for the first time) is white. Figure 9 has a stripe of purple along the margin. Figure 10 has a narrow brown line just above the margin.

Dimensions.—Greatest width, attached valve, 82 mm.; thickness, 40 mm. (holotype).

Holotype.—No. 24108, USNM.

Distribution.—Panama (type) ? (Dall). Tres Marias Islands (Lowe)—coast Oaxaco, Mexico (Keen, Stanford Univ. Coll.).

Laevicardium apicinum Carpenter Pl. 69, figs. 5, 6

Levicardium apicinum Carpenter, 1864a, p. 313, Reprint, 1872, p. 211.
Liocardium apicinum Carpenter, 1864b, pp. 537, 618, Reprint, 1872, pp. 23, 104; 1865b, p. 274, Reprint, 1872, p. 261.
Cardium apicinum (Carpenter), Dall, 1901, p. 391 = *C. (Laevicardium) elenense* (Sowerby), 1841, p. 109 as *Cardium.*
Laevicardium apicinum Carpenter, Grant and Gale, 1931, p. 305.
Cardium (*Laevicardium*) *apicinum* Carpenter, Lamy, 1909, p. 235 under *C. elenense;* Pilsbry, and Lowe, 1932, p. 135.
Laevicardium elenense apicinum (Carpenter), Hertlein and Strong, 1947, p. 146; Keen, 1958, p. 120; Olsson, 1961, p. 256.

Original description.—Carpenter, 1864a, p. 313.
L. testa subtrigona, parva, tenuissima, nitidissima, subcompressa, epidermide tenui induto; radiis seu striis radiantibus nullis; striis concentricis satis regularibus, subobsoletis, t. jun. magis extanibus; umbonibus angustis, parum incurvatis; margine ventrali satis ex-

curvato, antico parum producto, postico subtruncato, dorsalibus obtuse angulatis: colore valde variante; plerumque pallide viridi-cinereo, rufo-fusco seu angulatim tæniato seu maculato seu punctato; regione umbonali plerumque pallida, interdum rufo-fusca seu aurantiaca; parte postica haud intensiore: intus plerumque citrina, hepatico varie penicillata: dent. card. et lat. acutis, tenuibus; margine minutissime subobsoletim crenulato. Long. ·55, lat. ·5, alt. ·3 poll.
Variat t. latiore. Variat quoque colore fere omnino hepatico, seu carneo, seu pallide aurantiaco, seu pallide cinereo, seu albido: rarissime ut in *Tapete fuscolineata* ornata.

Liocardium apicinum. Extremely abundant. Living. Also La Paz; Acapulco, Jewett. (Carpenter, 1864b, p. 618.)

At the U. S. National Museum, there are in the type collection, two bottles with many specimens labelled "Cardium elense 'apicinum Cpr type' USNM 3986 Cape St. Lucas Xantus." The specimens are not segregated.

In the Redpath Museum in the Carpenter Collection there are 38 doubles and 6 single specimens labelled "C S L Xantus Acapulco Newberry La Paz Pedersen". The largest of the specimens is figured herein.

Specimen figured.—No. 128, Redpath Museum.

Distribution.—Cape St. Lucas (type).

Cyclinella producta (Carpenter) Pl. 64, figs. 10-13

Cyclina producta Carpenter, 1856c, p. 161; 1857c, pp. 284, 305; 1860d, p. 3, Hertlein and Strong, 1948, p. 180.
Cyclinella producta (Carpenter), Keen, 1958, p. 138 Addenda, p. 621 examined type BM "variation of *C. subquadrata.*"

Original description.—Carpenter, 1856c, p. 161.
6. Cyclina producta, n.s. *C. testa tenui, ventricosiore, alba, ventraliter producta; concentrice tenuissime striata; marginibus subregulariter arcuatis; umbonibus eleganter incurvatis; lunula nulla, linea cordiformi vix monstrante; area ligamenti elongata; dent. card. valva altera postico bifido, anticis* ii., *contiguis; altera posticis* ii. *acutis, elongatis, antico acuto; sinu pallii subangulato, umbones versus fere dimidium ascendente.*
Long. 1·62, lat. 1·58, alt. 1·05 poll.
Hab. In Sinu Panamensi; legit *T. Bridges.* Sp. un. in Mus. Cuming.
In shape something like *Cyrena maritima,* C. B. Ad., but in habit resembling *Cyclina subquadrata,* Hanl. (=*Artemis saccata,* Gould).

The holotype is in the British Museum (Nat. Hist.) with label, "Loc. Panama Bay H. Cuming Coll. ex Bridges."

Holotype.—Reg. No. 19621112 BM (NH).

Distribution.—Panama (type).

Pitar (Hyphantosoma) pollicaris (Carpenter) Pl. 59, figs. 9-11

Dione prora Conrad, Reeve, 1863 *fide* Carpenter, 1864a, p. 312.
Callista pollicaris Carpenter, 1864a, p. 312, Reprint, 1872, p. 210; 1864b, pp. 572, 618, Reprint, 1872, pp. 58, 104.

Cytherea (*Callista*) *pollicaris* Carpenter, Stearns, 1894, p. 153.
Pitaria pollicaris (Carpenter), Dall, 1902, p. 387.
Pitar pollicaris (Carpenter), Pilsbry and Lowe, 1932, p. 134; M. Smith, 1944, p. 60.
Pitar (Hyphantosoma) pollicaris Carpenter, Hertlein and Strong, 1948, p. 173; Olsson, 1961, p. 277, pl. 49, figs. 7, 7a.
Hyphantosoma pollicaris (Carpenter), Keen, 1958, p. 130, fig. 291 after Reeve, 1863, *Dione*, vol. 14, pl. X, fig. 45 as *D. prora* Conrad.

C. testa magna, ventricosa, solidiore; epidermide tenuissima induta; sordide albida, umbonibus rufo-fuscis; (t. adolescente) punctulis crebris rufo-fuscis, et tæniis paucis circa nymphas ornata; lævi, striis incrementi exceptis; postice, et paululum antice, quasi pollice impresso notata; latiore, antice producta, sed haud angulata; postice unda depressa, supra nymphas radiante, inter costas duas obsoletas sinuante, margine subtruncato; marginibus ventrali regulariter excurvato, dorsali rectiore; lunula elongata, linea impressa definita, medio tumente, postice flaccida: intus candida; dent. card. normalibus; dente laterali valvæ dextræ postico, valvæ sinistræ antico, usque ad extremitatem lunaloe porrecto; cicatr. adduct. subrotundatis; sinu palli magno, rotundato, usque ad medium interstitii porrecto. Long. 2·58, lat. 2·25, alt. 1·43 poll.

Figured by Mr. Reeve (Conch. f. 45) as "*Dione prora*, var." The above diagnosis proves it to be a distinct and (considering the general similarity of the thin, colourless, inflated group) a well-marked species.

The type material of this species consists of one shell labelled "Cape St. Lucas Xantus." The specimen is well preserved. The color is white with the area of the escutcheon and of the lunule reddish brown. The posterior end is obliquely truncated with a dorsal posterior concave area. There are a few cross lines in the sunken area showing incipient *Hyphantosoma* sculpture. The lunule is large and elongate with a secondary indentation or incised line. The lunule is about 20 mm. in length. The pallial sinus is broadly rounded.

Dimensions.—Length, 68 mm.; height, 57 mm.; greatest thickness, 35 mm. (holotype).

Holotype.—No. 12721, USNM.

Distribution.—Cape St. Lucas, Lower California (Xantus) (type) to Callao, Peru (Dall).

Transennella ? puella (Carpenter)

Callista (? *Pannosa*, var.) *puella* Carpenter, 1864a, p. 313, Reprint, 1872, p. 211; 1864b, pp. 537, 572, 618, 684, Reprint, 1872, pp. 23, 58, 104, 170.
Callista puella Carpenter, Reeve, 1863, pl. XII, sp. 62 under *Dione pannosa* Sowerby.
Macrocallista (Chionella) puella (Carpenter), Dall, 1902, p. 387.

Transennella puella (Carpenter), Hertlein and Strong, 1939, pp. 377, 378, pl. 32, figs. 14-16; Hertlein and Strong, 1948, p. 169; Keen, 1958, p. 126, fig. 280.

Original description.—Carpenter, 1864a, p. 313.
C. testa "*C. pannosæ*" simili, sed multo minore, tenuiore, plerumque latiore; sinu pallii majore, eleganter incurvato; dent. card multo tenuioribus, lat. ant. magis elongato; lamina cardinali umbones versus sinuata: colore maxime variante; nonnunquam ut in *C. pannosa* triangulariter maculata; plerumque ut in *Tapete virginea* notata; interdum albida, seu aurantia, seu fusca, haud maculata; rarius ut in *Tapete fuscolineata* penicillata; rarissime paucistrigata, seu maculis paucissimis. Long. ·66, lat. ·5, alt. ·32 poll.
Variat t. transversa. Variat quoque t. subtrigona, et formis intermediis.
Quoted by Mr. Reeve, under *Dione pannosa,* as "*D. puella,* Cpr."; but the name was only given in MS. in accordance with M. Cuming's assertion that it was distinct. The colourless subtrigonel shells were regarded by Mr. Reeve as a separate species; but he did not allude to them in his monograph.

There are 17 specimens (11 doubles, 6 singles), in the type collection in the U. S. National Museum, No. 3977 from Cape St. Lucas, collected by Xantus. They are not labelled types nor do they have original labels. They are labelled "Paradione puella Cpr.," hence they are probably the shells which Dall examined when he so labelled the species.

The shells are small with purple umbones with zigzag coloration. The lunule is large and elongate. The ventral margin is grooved but not typical of *Transenella.* The pallial sinus is pitaroid and not squarish as in *Callista* where Dall indicated when he placed the species in *Paradione.*

Dimensions.—Length, 17 mm.; height, 13 mm.; thickness (double), 7 mm.

Holotype.—Lost.

Distribution.—Cape St. Lucas (type). See Hertlein and Strong, 1948, p. 169.

Protothaca (Callithaca) tenerrima (Carpenter)

Tapes tenerrima Carpenter *in* Gould and Carpenter, 1857, p. 200; 1860d, p. 3; Palmer, 1958, pp. 97, 98 see for synonymy, copy of original description, notes, correction of type locality, and distribution.

Type.—Not found. Broken originally and probably lost.

Distribution.—Type locality, not Panama as originally given but corrected by Carpenter in 1864b, page 531. California (type). See Palmer, 1958, page 98.

"Circe" margarita Carpenter Pl. 61, figs. 13, 14

Circe margarita Carpenter, 1855, p. 81; 1857c, pp. 247, 306; Dall, 1902, p. 408; Keen, 1944, pp. 17, 18 cf. young *Amiantis callosa;* Haas, 1945, pp. 4, 5.

There are in the U. S. National Museum five specimens, No. 3982, labelled "Cotypes PPC Cape S. Lucas Xantus." These specimens are probably what Dall examined for his notes on the shells written in 1902 in his synopsis of the Veneridae. They are not types because *Circe margarita* was described by Carpenter in the Mazatlan Catalogue. The types would, therefore, be in the first Mazatlan Collection and are in the British Museum (Natural History). Because the type has not as yet been illustrated the Cape St. Lucas shells are figured herein. The teeth are not well shown.

The shell is small (3 mm. length), transparent, the undulating concentric ribs or folds are *Raeta*-like. They show through to the interior and are coarse for the size of the shell. Small pallial sinus. The teeth are large in comparison to shell size with three cardinals in the right valve and a socket for an anterior lateral and probably one for a posterior lateral. There are two cardinals in the left valve with anterior lateral and posterior lateral. The form has been considered a juvenile. Additional material may be collected in the future to determine its generic status.

Dimensions.—Length, 3 mm.; height, 3 mm. (No. 3982 USNM)

Holotype.—BM (NH).

Distribution.—Mazatlan, State of Sinoloa, west Mexico (type).

Mactra lacinata Carpenter Pl. 63, figs. 12-15

Mactra lacinata Carpenter, 1856b, p. 161; 1857b, pp. 284, 304; 1860d, p. 3 *laciniata.*
? *Mulinia lacinata* (Carpenter), Dall, 1894b, p. 42 probably *Mulinia.*

Original description.—Carpenter, 1856b, p. 161.

5. MACTRA (MACTRELLA) LACINATA, n.s. *M. testa parva, tenuissima, cinerea, ventricosa; postice angulata, carina modica, fimbriata; læviori, concentrice vix undulata, rugulis epidermidis tenuis subdistantibus ornata; subæquilaterali, umbonibus prominentibus; dent. card. parvis, lat. acutis, haud distantibus; sinu pallii parvo, subangulato.*
Long. ·56, lat. ·69, alt. ·4 poll.
Hab. In Sinu Panamensi; legit *T. Bridges.* Mus. Cuming, sp. tria.
Has a general similarity to *M. angulata* and kindred species. Remarkable for the epidermal fringe on the keel and regular concentric wrinkles.

Holotype.—Reg. No., 19621117, BM (NH).

Distribution.—Panama (type).

Donax culminatus Carpenter = *D. carinatus* Hanley *fide* Carpenter and Hanley

Donax culminatus Carpenter, 1855, pp. 43, 548 corrections; 1863, p. 366, Reprint, 1872, p. 202; 1864b, p. 552, Reprint, 1872, p. 38.
"*Donax carinatus* (*versus teste* Hanl.) = *culminatus* Maz. Cat. (type) Acapulco Newberry," Palmer, 1945, p. 99 specimen (1½) No. 103 Redpath Mus.

The specific name *Donax culminatus* described from Mazatlan was confused with *Donax carinatus* Hanley, 1843, as Carpenter explained in the various references and label with the shells in the collection at the Redpath Museum. The shell in the Redpath Museum is ambiguously labelled "type" which it cannot be. The type is with the Mazatlan Collection. The synonymy is not complete.

Donax "? punctostriatus var." **caelatus** Carpenter

Donax ? punctatostriatus, var. *caelatus* Carpenter 1855, p. 46 Mazatlan; 1857c, p. 246; Palmer, 1945, p. 99

Carpenter described this form in the Mazatlan Catalogue from Mazatlan. Therefore the type should be from that locale and be in the collection in the British Museum (Nat. Hist.). In the Carpenter Collection in the Redpath Museum there are nine specimens labelled originally "type Acapulco Newberry" (reported, Palmer, 1945, p. 99). These specimens are not types.

Donax semistriatus Carpenter

Donax semistriatus Carpenter, 1856a, p. 230; 1857c, p. 287.

Original description.—Carpenter, 1856a, p. 230.
D. t. parva, valde transversa, trumidiore; parte superficiei antica lævi, nitida; reliqua concentrice sulcata, sulcis impressis, interdum bifurcatis; striisque radiantibus evanescentibus, sulcos punctantibus; sulcis in parte postica valde cælatis; aureo-fuscus, ad umbones rubro-fuscus radiatus; margine simpliciter crenulato.
Long. ·4, lat. ·8, alt. ·2 poll.
Hab. in Sinu Californiensi. Mus. Cuming.
Somewhat resembles *D. pulchellus,* Hanl., but differs in the markings, the anterior third of the surface being quite smooth, while the remainder is furrowed with rather distant concentric lines, ending suddenly, and slightly indented by evanescent striulæ.

Holotype.—Unknown.

Distribution.—Gulf of California (type).

Tagelus violascens Carpenter Pl. 64, fig. 1

Solecurtus violascens Carpenter, 1855, p. 27 footnote; 1857c, pp. 282, 301; 1860d, p. 2; 1864b, p. 665, Reprint, 1872, p. 151.

Tagelus violasceus (Carpenter), M. Smith, 1944, p. 64; ? Durham, 1950, p. 91, pl. 24, figs. 8, 11.
Tagelus (Tagelus) violascens (Carpenter), Keen, 1958, p. 192, fig. 472.

Original description.—Carpenter, 1855, p. 27.
* Lower down the coast was found a large specimen which appears a distinct species, and I therefore append a description, and deposit the shell in the B. M. Col.
Solecurtus violascens, St. "affini simili, sed majore, solida, violascente, rugis epidermidis tenuioribus; nymphis elongatis, sinu pallii versus umbones minus arcuato. Long. 95, lat. 3.33, alt. .56.—*Hab.* S. W. Mexico, *P. P. C.*

Carpenter in the description of *Solecurtus politus,* n.s. (1855, Mazatlan Cat., p. 27) pointed up the differences between his new species *S. violascens* and *S. affinis* C. B. Adams and *S. politus.*

Holotype.—Reg. No. 1857.6.4.2531 BM (NH).

Distribution.—S. W. Mexico (type). Margarita Bay, Lower California (Carpenter, 1864b). Gulf of California to Port Culebra, Costa Rica (Keen).

Gari (Gobraeus) regularis Carpenter

Psammobia (? Amphichaena) regularis Carpenter, 1864a, p. 312, Reprint, 1872, p. 210; 1860d, p. 2; 1864b, p. 618, Reprint, 1872, p. 104.
Psammobia regularis Carpenter, Stearns, 1894, p. 155; Oldroyd, 1924, p. 184; Lamy, 1909, p. 250.
Psammobia (Gobraeus) regularis (Carpenter), Dall, 1898, p. 57.
Gari (Psammocola) regularis Carpenter, Hertlein and Strong, 1950, p. 218, pl. II, fig. 10; Keen, p. 190, fig. 466.
Gari (Gobraeus) regularis (Carpenter), Palmer, 1958, p. 113, pl. 15, figs. 1-6 holotype; Olsson, 1960, p. 357 suggested synonym of *G. fucata* (Hinds), 1845 p. 67 as *Tellina.*

See Palmer, 1958, page 113 for synonymy, illustration of type, and notes on the type. For discussion of *Psammocola* Blainville, 1824, see Palmer, 1958, pages 111, 112.

Original description.—
P. testa minore, regulariter ovali, subæquilaterali; violacea, plus minusve radiata seu maculata; lævi, striolis incrementi ornata; epidermide tenui, flavido-olivacea induta, postice rugulosa; marginibus undique regulariter excurvatis; umbonibus vix projectis; ligamento conspicuo: intus dent. card. ii.-i., haud bifidis; cicatr. adduct. postica rotundata, antica ovali; sinu pallii elongato, haud incurvato, per duos trientes interstitii porrecto. Long. 1·05, lat. ·5, alt. ·26 poll.

Holotype.—No. 10407, USNM.

Distribution.—Cape St. Lucas (Xantus) (type); San Diego, California, to Cape St. Lucas, Lower California (Dall). Gorda Banks, 60 fm., Point Arena, Port Guatulco, 7 fm. (Hertlein and Strong).

Semele planata Carpenter Pl. 64, figs. 6-9

Semele planata Carpenter, 1856c, p. 160; 1857c, pp. 284, 303; Tryon, 1869, p. 121; Dall, 1915, p. 25; Keen, 1958, p. 198.

Original description.—Carpenter, 1856c, p. 160.
4. SEMELE PLANATA, n.s. *S. testa subtriangulari, margine ventrali valde excurvato; cinereo-albida, circa lunulam minimam et arcam ligamenti roseo eleganter penicillata, intus favido tincta; rugis concentricis subdistantibus, irregularibus, parum elevatis; striulis creberrimis radiantibus, valde irregularibus, rugulosis sculpta; postice maxime sinuata; valva una magis quam altera planata; fossa ligamenti recta, angusta; sinu pallii modico, lato.*
Long. 1·4, lat. 1·56, alt. ·47 poll.
Hab. In Sinu Panamensi; legit *T. Bridges,* Sp. un. in Mus. Cuming.
Differs from *S. punctata,* Sow., in the absence of punctures, in the triangular dorsal margins, unequal flattening of the valves, straight narrow hinge-pit, and the much smaller size of the pallial sinus.

Fortunately the type of this little known species is available. Through the courtesy of the British Museum (Nat. Hist.) illustrations of the form are included herein.

Holoype.—Reg. No. 196311 BM (NH).

Distribution.—Bay of Panama (type).

Cumingia adamsi Carpenter

Cumingia sp. indet. C. B. Adams, 1852, p. 512.
Cumingia Adamsi Carpenter, 1863, p. 367, Reprint, 1872, p. 203; 1864b, p. 552 Reprint, 1872, p. 38; Tryon, 1869, p. 123; Hertlein and Strong, 1949, p. 250; Keen, 1958, p. 202 under *C. lamellosa* Sowerby, 1833, p. 34; Olsson, 1861, p. 372, pl. 67, figs. 6, 6a holotype.

Carpenter named the specimen from Panama indicated by Adams as indeterminate. The holotype was figured by Olsson (1961) for the first time. It is No. 203763 MCZ. Olsson gave a full description of the holotype and distribution of the species.

Tellina deshayesii Carpenter

Not *Tellina deshayesii* Carpenter, Hanley, 1844, p. 148 Red Sea?
Tellina Deshayesii Carpenter, 1856c, p. 160; 1857c, pp. 284, 303; Hertlein and Strong, 1947, p. 71.

Original description.—Carpenter, 1856c, p. 160.
2. TELLINA DESHAYESII, n. s. *T. testa* "T. exili" *simili, sed multo magis inæquilaterali; ligamento solido; postice vix rostrata.*
Long. ·56, lat. ·9, alt. ·26 poll.
Hab. In Sinu Panamensi; legit *T. Bridges.* Sp. un. in Mus. Cuming.

Carpenters' name is preoccupied but until the species is identified definitely it is not feasable to rename the Panama species.

Holotype.—Unknown. Not in BM (NH).

Distribution.—Panama.

Strigilla disjuncta Carpenter

Strigilla disjuncta Carpenter, 1856c, p. 160; 1857c, pp. 284, 303; 1864b, p. 554, Reprint, 1872, p. 40 "appears to the author identical with *S. sincera,* Hanl." ["Quite distinct," H. Cuming.]; Tryon, 1869, p. 98; Hertlein and Strong, 1949, p. 96, pl. 1, fig. 20; Keen, 1958, p. 182, fig. 440; Olsson, 1961, pp. 386, 387, pl. 73, figs. 1-1c.

Strigilla sincera Hanley, M. Smith, 1944, p. 65, fig. 845. Not *S. sincera* (Hanley), 1844, p. 68 as *Tellina.*

Original description.—Carpenter, 1856c, p. 160.

1. STRIGILLA DISJUNCTA, n.s. *S. testa satis magna, alba, tenui, planata; inæquilaterali, postice producta; marginibus dorsalibus subrectis, ad angulam* 120°, *aliis bene arcuatis; lineis incrementi vix monstrantibus; lineis undulatis exillimis, antice concentricis, umbones versus ascendentibus, sinu angustiore; dein ad marginem ventralem rapide descendentibus; dein subito, angulo acuto, circiter* 20° *postice rursus ascendentibus; lineis angularum in valva utraque haud convenientibus; margine postico sinuato, sculptura postea fortiore; margine antico quoque sinuato; lunula distincta, sinuata; ligamento subelongato; dent. card. valva altera uno parvo et uno magno bifido; altera uno parvo bifido; dent. lat. acutioribus, haud distantibus.*

Long. 1·35, lat. 1·54, alt. ·54 poll.

Hab. In Sinu Panamensi; legit *T. Bridges.* (Mus. Cuming. sp. duo.)

Allied to *S. sincera,* Hanl.; remarkable for its large size and very fine markings, and named from the lines of markings in the two valves not agreeing at the edges.

Carpenter (1864b) thought the species he named was the same that had been named *S. sincera* previously by Hanley. Later authors have also identified the shells as identical. The consensus is that each name represents a distinct form as thought by H. Cuming. (See above.)

Unfortunately the type is not to be found.

Distribution.—Bay of Panama (type).

For range see Olsson, 1961.

Elpidollina decumbens (Carpenter) Pl. 60, figs. 3-9

(Tellina) Angulus decumbens Carpenter, 1865d, p. 278, Reprint, 1872, p. 271; Tryon, 1869, p. 92

Tellina (Moerella) decumbens Carpenter, Keen, 1958, p. 170, fig. 395 holotype.

Elpidollina decumbens (Carpenter), Olsson, 1961, p. 407, pl. 68, figs. 14, 15 type species of *Elpidollina* Olsson, 1961

Original description.—

A. t. tenui, subplanata, alba seu rosacea; lævi, striolis incrementi insculpta; epidermide pallide straminea induta; antice et ventraliter valde producta; postice truncata, angulata; umbonibus acutioribus, vix prominentibus; marginibus dorsalibus postico recto, antico ad angulum parum excurvato, antico et ventrali valde et regulariter excurvatis; parte postica v. dextr. subito angulata, v. sinistr. parum sinuata; nymphis angustis, elongatis, cartilagine omnino externo: dent. card.

mi nimis; dent. lat. v. dextr. antico satis conspicuo, postico obsoleto; v. sinistr. nullis; cicatr. adduct. posticis subrhomboideis, anticis valde elongatis, angustis; sinu pallii maximo, subtriangulari, usque ad cicatricem alteram utraque valva porrecta.

Long. 1·7, lat. 1·2, alt. ·68 poll.

Hab. Panama (teste *Rowell, Pease*).

This shell was affiliated by Mr. Hanley to the W. African *T. nymphalis,* but differs in the internal scars. Externally it resembles *T. dombeyi,* Lam. (= *Scrobicularia producta,* Cpr. P.Z.S. 1855, p. 230), but is easily recognized by the strictly Tellinoid ligament and anterior lateral tooth, by the posterior portion being pinched instead of waved, and by the junction of the pallial sinus with the opposite scar. By the same characters it is distinguished from *T. tersa,* Gld., which closely resembles *S. dombeyi,* var., in Mus. Cum. Like many other Tellens, it has a white and a pink variety. The name was printed by an oversight in Brit. Assoc. Rep. 1863, p. 669, as *A. amplectans;* but as it was unaccompanied by a diagnosis, and does not describe the shell, no confusion will arise from reverting to the name first given.

Reeve (1868) figured a "*Tellina peasii* Carpenter". Dr. Keen placed Reeve's figure and reference in synonymy with *E. decumbens. Tellina peasii* Carpenter is a *nomen nudum* and by a mixture of authors. *Macoma peasei* "Carpenter", Tryon, 1869, p. 103 [not Carpenter] is *Tellina Peasii* Sowerby *in* Reeve, 1868, pl. 49, fig. 288. [Not Carpenter.]

Original material of *Tellina decumbens* Carpenter consists of two double specimens at the U. S. National Museum and two valves at the Redpath Museum. One of the valves in the USNM has written on the interior "drawn by G. V. Angas for S 1", (Pl. 58, fig. 5). The umbos are a bright pink which shows through to the interior of the shell.

Dimensions.—Length, 43 mm.; height, 32 mm.; thickness (double), 18 mm. (syntype USNM).

Syntypes.—No. 16101, USNM; No. 2374, Redpath Museum.

Distribution.—Panama (type).

Scrobiculina ochracea (Carpenter) Pl. 60, figs. 1, 2, 10

Tellina (Peronaeoderma) ochracea Carpenter, 1864a, p. 311, Reprint, 1872, p. 210; 1864b, p. 618, Reprint, 1872, p. 104; Tryon, 1869, p. 86 under *T. viridotincta* Carpenter

Tellina ochracea Carpenter, Pilsbry and Lowe, 1932, p. 132.

Tellina (Scrobiculina) ochracea Carpenter, Dall, 1900, p. 302; Hertlein and Strong, 1949, p. 66; Durham, 1950, p. 89, pl. 23, figs. 9, 18; Keen, 1958, p. 176, fig. 414.

Scrobiculina ochracea Carpenter, Olsson, 1961, p. 409.

Original description.—

T. testa majore, parum inæquilaterali, tenui, satis planata; carneo-ochracea, intus intensiore; lævi, nitida, marginem versus striis incrementi; postice vix radiatim striatula; ventraliter antice valde excurvata, postice vix angulata; marginibus dorsalibus obtuse angulatis, umbonibus conspicuis; ligamento tenui et cartilagine subinternis; nymphis intortis: dent. card. utriusque valvæ ii., quarum i. bifidus; dent. lat. valvæ dextræ ii.; sinu pallii irregulariter ovali, per duos trientes interstitii porrecto; cicatr. adduct. subovatis, nitidissimis. Long. 1.9, lat. 1·4, alt. ·44 poll.

The original material consists of two valves labelled "C. St. Lucas type." Outside of the shell is whitish orange in the umbonal area. Inside the color is a yellowish orange.

Holotype.—No. 12584, USNM.

Distribution.—Cape St. Lucas (type). Gulf of California. Arena Bank, Gulf of California, 45 fm. (Hertlein and Strong).

Scrobiculina viridotincta Carpenter Pl. 62, figs. 7-10

? *Scrobicularia virido-tincta* Carpenter, 1856c, p. 160; 1857c, pp. 284, 303; Lamy, 1913, p. 251
Tellina (*Scrobicularia*) *viridotincta* Carpenter, Tryon, 1869, p. 86
Macoma viriditincta [*sic*] (Carpenter), Stearns, 1894, p. 156
Tellina (*Scrobiculina*) *viridotincta* (Carpenter), Dall, 1900, p. 302; Hertlein and Strong, 1949, p. 66; *ibid.*, vol. 35, pt. 4, pl. 1, fig. 14; not Keen, 1958, p. 176, fig. 415; Addenda, see p. 623 and cf. type figures herein.
Tellina viridotincta (Carpenter), Pilsbry and Lowe, 1932, p. 133
Scrobiculina viridotincta (Carpenter), Olsson, 1961, p. 408

Original description.—Carpenter, 1856c, p. 160.
3. ? SCROBICULARIA VIRIDO-TINCTA, n.s. ? *S. testa* "? S. productæ" *simili; sed latiore, ovali, tenuiore, magis planata, antice haud producta, alba; umbonibus viridi tinctis.*
Long. 1·42, lat. 2·05, alt. ·65 poll.
Hab. In Sinu Panamensi, una cum? *S. producta;* legit *T. Bridges.*
Sp. un. in Mus. Cuming.
Another of the species intermediate between *Tellina* and *Scrobicularia* proper, and apparently nearer to the former genus.

Dall (1900) made this species the type species of his *Scrobiculina.*

The holotype is in the British Museum (Nat. Hist.) and through the courtesy of Norman Tebble and the museum, photographs of the holotype, as well as those of the other types of the Carpenter species, are included in this report.

The holotype bears the label, "Loc. Panama Bay, H. Cuming Coll. ex. Bridges."

Holotype.—Reg. No. 19621115 BM (NH)

Distribution.—Panama (type)

Psammotreta dombei (Hanley) Pl. 62, figs. 3-6

? *Scrobicularia producta* Carpenter, 1856a, p. 230; 1857c, pp. 284, 287, 303;

1864b, p. 554, Reprint, 1872, p. 40 = "*Lutraria Dombeyi* Lam."; 1865d, p. 279, Reprint, 1872, p. 272 = "*Tellina dombeyi* Lam."; Lamy, 1913, p. 250; Keen, 1958, p. 182 under *Macoma (Psammotreta) aurora* Hanley, 1844.

Metis Dombei (Hanley), Tryon, 1869, p. 105 *S. producta* Carpenter = *Apolymetis dombei* (Hanley, 1844), Keen, 1958, Addenda, p. 621 = *S. producta* Carpenter.

Psammotreta dombei (Hanley), Olsson, 1961, p. 412, pl. 74, fig. 2; pl. 85, figs. 1-1b

Original description.—Carpenter, 1856a, p. 230.

? *S. t. candida, tenui, sublævi, striis incrementi exillimis, confertis, antice et ventraliter maxime producta; margine anteriore bene excurvato, postico valde undato, ventrali subincurvato; umbonibus prominentibus, appressis; lunula indistincte impressa; ligamentis, externo magno, interno minimo, alteri adjacente; dentibus cardinalibus duobus, quarum alter bifidus, alter minimus; cicatricibus muscularibus, antica elongata, angusta, marginem ventralem appropinquante; postica subquadrata, intus undulata; sinu pallii maximo; pagina interna cardinem versus undulata.*

Long. 1·45, lat. 1·88, alt. ·7 poll.

Hab. Sinu Californiensi: legit C. Shipley, Esq. Mus. Cuming.

Resembles *S. angulata*, Chemn., but differs in the great production of the anterior ventral portion, in the development of the wave, and in the length of the external ligament. This and the following species form connecting links between *Scrobicularia* and *Tellina*.

Carpenter (1864b, p. 554; 1865d, p. 279) persisted in the opinion that the shell he described as ? *Scrobicularia producta* was "*Tellina dombeyi* Lam." [Hanley, 1844, p. 144].

The holotype of *S. producta* Carpenter bears the label "Loc. Gulf of California, H. Cuming Colln. ex C. Shipley."

Holotype.—Reg. No. 19621113 BM (NH).

Distribution.—Gulf of California (type).

Juliacorbula biradiata (Sowerby)

Corbula biradiata (Sowerby), 1833, p. 33.

Corbula polychroma Carpenter, 1857c, pp. 226, 228, 300; Gould and Carpenter, 1857, p. 198; Carpenter, 1864b, p. 534, Reprint, 1872, p. 20 "= *C. biradiata*, var." [Sowerby], p. 553, Reprint, 1872, p. 39 "*Corbula rubra* = *C. biradiata* jun., No. 503, M. 31. No. 509 are dead valves of the same, = *C. polychroma*, Cpr."; Carpenter, 1863, p. 31, Reprint, 1872, p. 205; Hertlein and Strong, 1950, p. 239 under *Aloides (Caryocorbula) biradiata* (Sowerby).

Corbula (Caryocorbula) biradiata Sowerby (*C. polychroma* Gould and Carpenter, 1857), Keen, 1958, p. 208, fig. 524.

Juliacorbula biradiata (Sowerby), Olsson, 1958, p. 437, pl. 75, figs. 4-4b see for synonymy and notes on *J. biradiata*.

Carpenter indicated that the specimens named *Corbula polychroma* by him and Gould were the same as *C. biradiata* named earlier by Sowerby which also included the *C. ruba* of C. B. Adams.

Pandora (Clidiophora) cornuta C. B. Adams

Pandora cornuta C. B. Adams, 1852, pp. 295, 323; Turner, 1956, p. 43, pl. 17, figs. 15, 16 type.
Clidiophora acutedentata Carpenter, 1864c, p. 598, Reprint, 1872, p. 227 substitute name for *P. cornuta* Adams; Carpenter, 1869, p. 69.

Carpenter's name was a substitute for *P. cornuta* C. B. Adams because Carpenter thought that *cornuta* was inappropriate for the character of the species. This was not a valid reason for renaming so Carpenter's specific name may be disregarded.

Pandora (Clidiophora) cristata Carpenter Pl. 69, figs. 1-4

Clidiophora cristata Carpenter, 1864c, p. 597, Reprint, 1872, p. 226; 1869, p. 69.
Pandora cristata (Carpenter), Sowerby *in* Reeve, 1874, *Pandora,* pl. 1. fig. 1.
Pandora (Clidiophora) cristata Carpenter, Keen, 1958, p. 225, fig. 571; Olsson, 1961, p. 456 under *Pandora (Clidiophora) arcuata* Sowerby, 1835, p. 93.

Original description.—
C. *t. securiformi, minus transversa, tenui, subplanata; umbonibus ad 2/5 longitudinis sitis; ventraliter maxime excurvata; marginibus dorsalibus, post. maxime incurvato, ant. hic et illic alulis triangularibus cristato: intus marginibus posticis utraque in valva erectis: v. dextr. dente postico satis longo, cicatrice adductoris tenus haud porrecto; dente centrali extante; dente antico a margine separato, usque ad cic. anticam porrecto, haud extante: v. sinistr. dente post. bifido, haud extante, alterum recipiente, fossa cartilaginea contigua; d. centr. nullo; d. ant. satis extante, usque ad cicatr. anticam porrecto; linea palliari a margine valde remota, regulariter in puncta divisa; radiis ab umbonibus usque ad puncta conspicuis, aequalibus; ossiculo tenui, elongato.* Long. 1·0, lat. ·6, alt. ·1 poll.
Hab. in sinu Californiensi; legit Conway Shipley diligentissimus; sp. un. in Museo Cumingiano.
This species is known from *C. claviculata* by the much greater posterior curvature of the beaks, and anteriorly by the beautiful triangular wing-like serrations of the margin, in which it resembles *Tellidora burneti.* The inside has elegant rays from the umbo to the dotted pallial line.

Olsson believed the *Clidiophora cristata* Carpenter and C. *claviculata* (Carpenter), 1856a (p. 228) were the same as the species earlier described by Sowerby (1835) as *Pandora arcuata.* The illustrations herein of the holotype of *C. cristata* reveals that the Carpenter species is distinct from that of Sowerby which was so thoroughly figured by Olsson (1961, pl. 81, figs. 1a-1g). The beautiful photographs of the holotype furnished by the British Museum (Nat. Hist.) reveal the conspicuous rays described by Carpenter in the last line of his description.

C. claviculata is the type species of *Clidiophora* Carpenter, 1856a. It was described from Mazatlan.

Holotype.—Reg. No. 1963441 BM (NH).

Distribution.—Gulf of California (type).

Thracia squamosa Carpenter Pl. 63, figs. 16, 17

Thracia squamosa Carpenter, 1856a, p. 229; 1857c, pp. 287, 300, 366; 1860d, p. 2; 1864b, p. 619, Reprint, 1872, p. 105 "1 broken pair."

Original description.—Carpenter, 1856a, p. 229.
T.t. "T. villosiuculae" simili, sed magis transversa; superficie granulis distinctioribus instructa; ligamento extus curtiori, intus fulcro majore, minus declivi; sinu palli angustiore, magis producto.
Long. ·72, lat. 1·14, alt. ·38 poll.
Hab. Mazatlan: legit C. Shipley, Esq. Mus. Cuming.
Remarkably like the British species, from which it differs,—in the shape, which is rather more transverse, lengthening the pallial sinus; in the external granules, which are somewhat coarser; and in the ligamental pit, which is rather larger, and therefore at a greater angle from the margin.

The specimen (USNM 15885) is a broken pair as Carpenter stated in 1864. A small part of each hinge remains intact. They are figured herein. The shell is thin, almost transparent, white and brittle. The outer surface is microscopically punctate with a scabrous appearance on the under surface of the outer layer.

The specimens labelled type in the U. S. National Museum from Cape St. Lucas cannot be the type. The species was described from Mazatlan. They may be the specimens which Carpenter mentioned as collected at Cape St. Lucas.

Specimen figured.—No. 15885, USNM, "C. St. Lucas Xantus". Not type as labelled in the collection.

Distribution.—Mazatlan, state of Sinoloa, west Mexico (type), Cape St. Lucas. Magdalena Bay, Lower California, through Gulf (Keen).

Asthenothaerus villosior Carpenter

Asthenothaerus villosior Carpenter 1864a, p. 311; Reprint, 1872, p. 209; 1864b, p. 618, Reprint, 1872, p. 104; Keen, 1958, p. 231, fig. 591 (type).

See Palmer, 1958, p. 75, pl. 4, figs. 5-9 for synonymy, illustration of type, and discussion.

Original description.—
A. testa inæquivalvi, inæquilaterali, umbonibus ad trientem longitudinis sitis; tenuissima, alba, (sub lente) omnino minutissime et creberrime pustulosa; rugis incrementi obtusissimis, irregularibus, maxime t. juniore, ornata; epidermide tenui, pallide olivacea induta; parte pos-

tica truncata, parum hiante; antica valde rotundata; marginibus dorsalibus et ventrali parum excurvatis; umbonibus angustissimis; regionibus lunulari et nymphali subcarinatis: intus, margine cardinali utriusque valvæ acuto; ligamento inconspicuo; cartilagine subspongiosa, satis elongata, postice deflecta; fovea haud indentata; cicatricibus adductorum parvis, subrotundatis; sinu pallii majore, ovali, ad dimidium interspatii porrecto. Long. ·38, lat. ·26, alt. ·14 poll.†

† The measures of length are taken from the anterior to the posterior margins. The "detailed notes" are still in MSS.

Holotype.—No. 16292, USNM.

Distribution.—Cape St. Lucas (Xantus) (type); San Pedro, California, to Cape San Lucas (Dall, 1921).

GASTROPODA

Acmaea atrata Carpenter Pl. 65, figs. 27-29

Acmaea (? var.) *atrata* Carpenter, 1864a, p. 474, Reprint, 1872, p. 213; 1864b, pp. 541, 618, 666, Reprint, 1872, pp. 27, 104, 152; Pilsbry, 1891, p. 29, pl. 7, figs. 61-65 types; Stearns, 1894, p. 197; Burch, 1946, p. 34; Burch, 1946a, No. 57, p. 15.

Collisella atrata (Carpenter), Dall, 1871a, p. 255, pl. 14, figs. 15, 15a dentition.

Acmaea atrata Carpenter, Pilsbry and Lowe, 1932, p. 129; Keen, 1958, p. 243, fig. 2 copy Pilsbry, type; Palmer, 1958, p. 122 which see.

Original description.—Carpenter, 1864a, p. 474.

A. testa solida, rugosa, conica, apice paulum antrorsum sito; extus costis crebris rotundatis irregularibus, hic et illic majoribus sculpta, haud apicem versus discordanter corrugatis; interstitiis minimis; intus alba, castaneo et nigro varie maculata; margine latiore, nigro tessellato. Long. 1·3, lat. 1·0, alt. ·5 poll.

Variat margine nigro-punctato, punctis plerumque bifidis. Variat quoque costis parvis, creberrimis; margine nigro.

Intermediate between *"P discors,"* Phil., and *"P. floccata,"* Reeve.

Three specimens in the U.S. National Museum represent the original material, two of the shells are in a bottle labelled "type fig'd". These are probably the types illustrated by Pilsbry. The largest of the three specimens has the apex about one-third the distance from the margin. The shell is coarsely sculptured with about 26 primary, large, radiating ribs. The shell is badly worn yet finer ribs between the coarse radiating ribs are revealed. The ribs appear black through the callus on the interior margin. This condition produces a black and white effect. The callus on the inside is irregularly thickened. The muscle scar is narrow, lines with brownish coloration. The sculpture of the three specimens is the same and indicates that they represent the same species. The medium-sized shell is the best preserved with all of the radiating ribs coarse. Those on the shorter portion of shell are the coarsest with two secondary and a tertiary rib between.

Dimensions.—Syntypes, greatest diameter, 32 mm., width, 25 mm., height, 16 mm.; 19 mm., 14 mm., 6 mm.; 12 mm., 9 mm., 5 mm. respectively.

Syntypes.—No. 4019, three specimens, USNM.

Distribution.—Cape St. Lucas, Lower California (Xantus) (type). Magdalena Bay, Lower California, to Acapulco, State of Guerrero, west Mexico (Keen, 1958).

Acmaea filosa Carpenter Pl. 65, figs. 24-26

Acmaea (? *floccata,* var.) *filosa* Carpenter, 1865c, p. 276, Reprint, 1872, p. 267.

Acmaea filosa Carpenter, Pilsbry, 1891, p. 27, pl. 7, figs. 80-82 type; Pilsbry and Lowe, 1932, p. 129; Keen, 1958, p. 244, fig. 5 copy Pilsbry type.

Original description.—

A. *t.* "A. mesoleucæ" *forma et indole simili; sed sculptura multo tenuiore; t. jun. lævi; dein lirulis delicatulis, acutis, haud granulosis, valde distantibus, interdum obsoletis, filosa; interstitiis latis, lævibus; tenui, planata, ovali, subdiaphana; nigrofusco, corneo radiatim strigata, seu varie maculata: intus livida seu albida, coloribus externis transeuntibus; limbo lato, acuto.*

Long. ·7, lat. ·56, alt. ·12.

=*Lottia* ? *patina,* C. B. Ad. Pan. Shells, no. 367.

Hab. Panama *(C. B. Adams).*

There is no described west-tropical species to which these shells can be affiliated, unless they prove to be a very delicate variety of *A. floccata,* Rve. Unfortunately the Panama limpets have never been collected in sufficient numbers to make out their specific limits satisfactorily. The names here given may stand as species or varieties, according to future elucidation. In shape and texture, but not in colour or sculpture, these shells resemble *A. fascicularis;* in the latter respects, *A. strigatella.* They were named *"tenera,* Ad." by Dr. Dohrn, but are sufficiently distinct from that West-Indian species.

The type material consists of the holotype. The specimen is flat, dark brown, with irregular, light, wide, radiating lines which are not continuous from tip to margin. The apex has light brown spots or blotches. The interior is bluish white with a brown spot in the apical area. The margin is brownish with light, wide lines showing through.

Dimensions.—Greatest diameter, 18 mm.; width, 14 mm.; height, 3 mm.; width from apex to margin, 5 ± mm.

Holotype.—No. 15923, USNM.

Distribution.—Panama (type). El Salvador to Panama and Galapagos Islands (Keen, 1958).

Acmaea strigatella Carpenter Pl. 65, figs. 11-14

Acmaea strigatella Carpenter, 1864a, p. 475, Reprint, 1872, p. 214; Pilsbry, 1891, p. 27, pl. 7, figs. 83-85 types; Keen, 1958, p. 246; Palmer, 1958, p. 125 see for full synonymy and notes.

Original description.—

A. testa *A. mesoleucæ* simili, sed minore, haud viridi; striolis minimis, confertissimis, plerumque erosis tenuissime sculpta; albida, strigis olivaceo-fuscis, plerumque radiantibus, interdum confluentibus picta; apice sæpius nigro; intus albida, margine satis lato, strigis tessellato. Long. ·9, lat. ·74, alt. ·3 poll.

Variat colore hic et illic aurantiaco tincto: strigis omnino tessellatis.

According to Darwin, this might be regarded as a cross between the northern forms *A. pelta* and *A. patina,* about to change into the Gulf species, *A. mesoleuca.* The dark variety resembles *A. cantharus,* but the very delicate crowded striæ well distinguish it when not abraded.

The syntypes in the U.S. National Museum consist of six specimens. Three of the shells are immature which show the irregular blotched apical area over the whole upper surface as on the apical whorls of *A. filosa* Carpenter. The larger mature specimens have the apex eroded with the radiating dark lines revealed. The interior may be whitish, bluish, or greenish white with a dark margin and alternating dark and light lines.

Palmer (1958) gave a discussion of the confusion of the names *strigatella* and *strigillata* and the status of each.

Dimensions.—Syntypes.

Apex from margin mm.	Greatest diameter mm.	width mm.	height mm.
6	21	18	8
5	17	14	7
4±	15	12	6+
5—	15	11	4
4±	14	11	4
3±	10	8	3

Syntypes.—No. 12594, USNM.

Distribution.—Cape St. Lucas (Xantus) (type). Magdalena Bay, Lower California, to Mazatlan, Mexico.

Acmaea subrotundata Carpenter Pl. 65, figs. 21-23

Acmaea (? *floccata,* var.) *subrotundata* Carpenter, 1865c, p. 277, Reprint, 1872, p. 268.

Acmaea subrotundata Carpenter, Pilsbry, 1891, p. 28, pl. 33, figs. 1-3 type *A. subrotunda* [*sic*]; Pilsbry and Lowe, 1932, p. 129; Burch, 1946, p. 35; Keen, 1958, p. 246, fig. 13.

Original description.—
A. *t.* "A. *var.* filosæ" *simili, sed subtrotundata, magis elevata, vertice subcentrali; colore intensiore, lineis corneis crebrioribus, angustis; t. jun. sæpe pallidiore, radiis duobus postice triangulata: intus callo livido, tenuiore.*
Long. ·53, lat. ·45, alt. ·15.
= *Lottia,* sp. ind. *a,* C. B. Ad. Pan. Shells no. 368.
Hab. Panama *(C. B. Adams).*

The type material consists of the holotype labelled "A (var. ?) subrotundata = Lottia C. B.Ad. Cpr." "fig'd." The apex of the specimen is pointed and subcentral. It is dark brown with worn, fine radiating lines with wide interspaces. The interior is light with a brownish or pinkish central area; the margin is dark with brown lines, and the radiating ribs show through from the exterior.

Dimensions.—Greatest diameter, 14 mm.; width, 12 mm.; height, 4 mm.; apex from margin, 5 + mm. (holotype).

Holotype.—No. 15922, USNM.

Distribution.—Panama (type). Nicaragua to Panama (Keen, 1958).

Acmaea vernicosa Carpenter Pl. 65, figs. 15-17

Acmaea (? var.) *vernicosa* Carpenter, 1865c, p. 277, Reprint, 1872, p. 268; Pilsbry, 1891, p. 28, pl. 33, fig. 99 type.
Acmaea vernicosa Carpenter, Burch, 1946, p. 35; Keen, 1958, p. 246, fig. 15 copy Pilsbry.

Original description.—
A. *t. parva, subrotundata, depresso-conica, apice ad duas quintas partes sito; albido-viridi, strigis paucis rufo-fuscis hic et illic ornata, sæpius radiis duobus candidis, postice triangulata; extus lineis acutis radiantibus, valde distantibus, sæpe obsoletis vix sculpta: intus livida, callosa, sæpius spathula candida ornata; basi subplanata, limbo angusto.*
Long. ·3, lat. ·24, alt. ·1.
Hab. Panama *(Jewett, C. B. Adams).*
=*Lottia,* sp. ind. *b,* C. B. Ad. Pan. Shells, no. 369.
Had this form been brought from the China Seas, it might have been taken for the young of *A. biradiata,* Rve. From its solidity, however, its rough exterior, and its callous interior, it appears to be adult. It is barely possible that it may develope into *A. vespertina.* It differs from the young of *A. subrotundata* in being much thicker and less spotted with the green tint.

The holotype has a label "Acmaea (var.) vernicosa Cpr." "Panama, C.B.Ads." "type fig'd". An old label reads, "A. (Collisella)? vespertina var. vernicosa" "Panama C.B. Adams". A note is included, "probably = young A. discors" "teste A.R. Grant".

The shell is small, and as Carpenter stated, would be taken for a young specimen. There are fine radiating lines on the exterior. The color is white with a brownish creamy cast. The inside is white with a central callus. The margin has a light brown hue with four, dark brown patches on the margin.

Dimensions.—Greatest diameter, 7 mm.; width, 6 mm.; height, 2 ± mm.; apex from margin, 3 ± mm. (holotype).

Holotype.—No. 15924, USNM.

Distribution.—Panama (type).

Diodora saturnalis (Carpenter) Pl. 65, figs. 18-20

Glyphis saturnalis Carpenter, 1864a, p. 475, Reprint, 1872, p. 214; 1864b, p. 618, Reprint, 1872, p. 104.
Fissuridea saturnalis (Carpenter), Pilsbry and Johnson, 1891, p. 105 stated was known as "*Glyphis densiclathrata* Reeve" (1850, Conch. Icon., VI).
Diodora saturnalis (Carpenter), Keen, 1958, p. 252, fig. 34.

Original description.—

G. testa *G. inæquali* simili, sed minore, latiore, altiore, tenuissime cancellata; striis radiantibus plus minusve propinquis, plus minusve nodulosis; fissura prope trientem longitudinis sita, minima, lineari, medio lobata; intus callositate albida, truncata. Long. ·38, lat. ·24, alt. ·18 poll.

The minute hole resembles the telescopic appearance of Satura when the rings are reduced to a line.

The type material consists of six syntypes, including two adults, two intermediate individuals, and two young shells. The label reads "Type ? = Mus Rve". The specimens have all fresh sculpture and are the same species. The fine, nodose, radiating lines alternate in size. The surface has alternating white and brown strips.

Dimensions.—Syntypes.

Greatest diameter mm.	width mm.	height mm.	apex from margin mm.
11	7	—	3
10	7	4	3
8	5	4	2±
7	5	4	3—
5	3½	1½	2±
5	4	2+	2+

Syntypes.—No. 15853, USNM.

Distribution.—Cape St. Lucas (Xantus) (type). San Ignacia Lagoon, Lower California, to Ecuador (Keen, 1958).

Calliostoma aequisculptum Carpenter Pl. 65, figs. 9, 10

Calliostoma (? *lima,* var.) *aequisculpta* Carpenter, 1865d, p. 279, Reprint, 1872, p. 272; Pilsbry, 1889, p. 365 young of *C. lima* Philippi, 1849, Zeitschr. f. Mal., p. 159.
Calliostoma lima (Philippi), Keen, 1958, p. 255 ? *C. aequisculpta* Carpenter.

Original description.—
C. *t.* "C. limæ" *simili; sed anfr. planatis, suturis haud distinctis; sculptura regulari; jun. monilibus spiralibus inter se æqualibus; t. adulta majore et minore alternantibus; colore rufescente, granulis interdum rufo-fusco maculatis.*
Hab. Acapulco (*Newberry*).
Dr. Newberry's specimens agree in most essential respects with "*Trochus lima,* Phil.," in C. B. Ad. Pan. Shells, no. 276, which appears identical with the shells marked "*Ziziphinus antonii,* Koch, N. Zealand," in Mus. Cuming. The Acapulcan shells are quite flat, while those from Panama are for the most part shouldered as in *C. eximium,* Rve. (= *C. versicolor,* Mke. Maz. Cat. no. 289). However, there is no little variation among the Professor's specimens of *C. lima,* and some are so slightly shouldered that the Acapulcan form may be a local variety.

The holotype is of a light pinkish color which is dotted with pink small sharp spots. The apex is worn. The whorls are not shouldered. The surface of the shell has five, primary, nodose, revolving, beaded ribs. All primaries over the whorls, including the margin of the base, have alternating finer beaded ribs. There are primaries only on the base of the body whorl. The umbilical area is sunken but not open. The basal margin is somewhat sharp.

Dimensions.—Length, 16 mm.; greatest diameter, 20 mm. (holotype).

Holotype.—No. 16013, USNM.

Distribution.—Acapulco, State of Guerrero, west Mexico (type).

Haplocochlias cyclophoreus Carpenter Pl. 65, figs. 1, 2

Haplocochlias cyclophoreus Carpenter, 1864a, p. 476, Reprint, 1872, p. 215; Pilsbry, 1888, pp. 16, 107; Keen, 1958, p. 260; Palmer, 1958, p. 56.

Type species of *Haplocochlias* Carpenter, 1864.

Original description.—
H. testa compacta, parva, solidiore; albida, seu pallide aurantiaca; anfr. v., rapide augentibus, suturis impressis; tota superficie minutissime spiraliter striolata, nitida; apertura rotundata; peritremate continuo, incrassato, extus varicoso; labio distincto; axi t. jun. umbilicata,

adultæ lacunata. Long. ·19, long. spir. ·06, lat. ·2 poll., div. 100°.
When laid on its base, this shell resembles *Helicina;* but the mouth is more like *Cyclophorus.* The young shell is semitransparent; and resembles a *Vitrinella* with thickened lip.

The type material consists of five shells, two large, two tiny, and one intermediate in size. The body whorl is enlarged. The whorls are rounded. The apical whorls are worn or absent. Shell consists of five whorls. The surface is covered with microscopic spiral lines with finer interspaces. The color is white, the spire has an orange tinge. The body whorl is greatly enlarged. The aperture is rotund, the peritreme is continuous, enlarged, and rolled in appearance. The young is umbilicate, the adult shell is lacunate.

Dimensions.—Length, 6 mm.; greatest diameter, 5 mm.; largest syntype; length 1.75 mm., greatest diameter 1.5 mm. smallest syntype.

Syntypes.—No. 18112, USNM.

Distribution.—Cape St. Lucas (Xantus) (type).

Tricolia carpenteri Dall Pl. 63, figs. 9, 10

Phasianella (Eucosmia) punctata Carpenter, 1864a, pp. 475, 476, Reprint, 1872, p. 215; 1864b, p. 618, Reprint, 1872, p. 104. Not *Tricolia punctata* Risso, 1826, p. 123.
Not *Phasianella compta* var. *punctata* Carpenter, Pilsbry, 1888, p. 173 section *Tricolia.* San Diego.
Phasianella (Eucosmia) punctata Carpenter, Pilsbry, 1888, p. 177.
Phasianella (Tricolia) carpenteri Dall, 1908, p. 255 new name for *E. punctata* (Carpenter) not *E. punctata* (Risso)
Phasianella (Tricola [sic]) pulloides Carpenter, Strong, 1928, p. 192 in part.
"*Phasianella (Tricolia) carpenteri*" Dall, Palmer, 1958, p. 151.

Original description.—
E. testa *E. variegatæ* simili, sed multo majore, multo magis elongata, angustiore, Phasianelloidea; plerumque fusco creberrime punctata; umbilico parvo. Long. ·22, long. spir. ·11, lat. ·15 poll., div. 50°.

The holotype has not been found. There is a possible paratype in the British Museum (Natural History) which Mr. Tebble located. He wrote that "the damaged, juvenile specimen was collected by Mr. Xantus at Cape San Lucas, the type locality." If it were not damaged the shell could be selected as a lectotype.

Holotype.—Not found. Possible paratype, Reg. No. 19621123, BM (NH).

Distribution.—Cape St. Lucas (Xantus) (type).

Tricolia cyclostoma (Carpenter) Pl. 66, fig. 6

Eucosmia cyclostoma Carpenter, 1864a, p. 476, Reprint, 1872, p. 215; 1854b, p. 618, Reprint, 1872, p. 104.
Phasianella (Eucosmia) cyclostoma Carpenter, Pilsbry, 1888, p. 177.

Original description.—
E. testa parva, valde obtusa, lata, regulari, valvatoidea; marginibus spiræ vix excurvatis; pallide cinerea, fusco-olivaceo dense punctata seu maculata; anfr. nucleosis pallidis, mamillatis; normalibus iii, valde tumentibus, suturis valde impressis; apertura vix a pariete indentata; umbilico magno, subspirali. Long. ·05, long. spir. ·025, lat. ·05 poll., div. 90°

Curiously like a small depressed *Valvata obtusa,* but with the texture of *Phasianella.*

The tiny holotype consists of three whorls; the nucleus is broken. The whorls are rounded, slightly shouldered, and flecked with microscopic bits like parts of an epidermis. Aperture and umbilicus are large. The shell is a dark brownish color.

Dimensions.—Length, 2 mm.; greatest diameter, 2 ± mm. (holotype).

Holotype.—No. 11831, USNM. The holotype is on the original Carpenter glass mount with label "Type Eucosmia cyclostoma Cp. CSL."

Distribution.—Cape St. Lucas (Xantus) (type).

Tricolia substriata (Carpenter)

[*Phasianella*] *(Eucosmia)* (? *variegata,* var.) *substriata* Carpenter, 1864a, p. 475, Reprint, 1872, p. 215; 1864b, p. 618, Reprint, 1872, p. 104; Pilsbry, 1888, p. 177; Palmer, 1958, p. 150, pl. 19, figs. 20, 21 holotype, see for full synonymy and illustration of type.
Tricolia substriata (Carpenter), M. Smith, 1944, p. 6.

Original description.—
E. testa *E. variegatæ* simillima, sed anfr. circa basin et supra spiram (nisi in anfr. nucl. lævibus), interdum tota superficie tenuiter et crebre striatis; striis anfr. penult. circ. x.

Holotype.—USMN, No. 11829 (original label, "type C.S.I.").

Distribution.—Cape St. Lucas (Xantus) (type). Monterey, California, to Panama (Burch).

Tricolia variegata (Carpenter) Pl. 66, fig. 5

[*Phasianella*] *Eucosmia variegata* Carpenter, 1864a, p. 475, Reprint, 1872, p. 214; Pilsbry, 1888, p. 177; Not *Phasianella variegata* Lamarck, 1822, p. 52
Phasianella (Eulithidium) typica Dall, 1908, p. 255 new name for *Phasianella variegata* Carpenter; Palmer, 1958, p. 151 see for synonymy and notes.
Tricolia variegata (Carpenter), Robertson, 1958, p. 248, pl. 138, fig. 6; p. 279, pl. 148, fig. 1. *Eulithidium* Pilsbry, 1898 considered synonymous with *Tricolia* Risso, 1826, p. 122.

Original description.—
E. testa parva, lævi, turbinoidea, nitente, marginibus spiræ valde excurvatis; rosaceo et rufo-fusco varie maculata; anfr. nucleosis regularibus, vertice mamillato; normalibus iv., valde tumentibus, rapide augentibus, suturis impressis; anfr. ultimo antice producto; oasi rotunda; umbilico carinato; apertura vix a pariete indentata; peritremate pene continuo, acuto. Long. ·1, long. spir. ·05, lat. ·07 poll., div. 70°.
Variat interdum rugulis incrementi ornata.

The original types consists of four specimens, three of which are available. The shell consists of four smooth whorls. The nucleus is large. The suture is distinct. The enlarged body whorl is umbilicate. The specimen, intermediate in size, has microscopic spiral lines. The color is reddish brown or pinkish mottled with spots.

T. variegata (Carpenter) is the type species of *Eulithidium* Pilsbry, 1898 (p. 60). When the species is placed in the genus *Tricolia* the new name given by Dall is not necessary. The species was not originally classified in the genus *Phasianella.*

Dimensions.—Length, 3 mm. (large), greatest diameter, 2.5 mm.; length, 2 mm. (intermediate); greatest diameter, 1 mm. (smallest) (syntypes).

Syntypes.—No. 11836, USNM. The types are on the original Carpenter glass mount with label, "Type Eucosmia variegata Cpr. CSL."

Distribution.—Cape St. Lucas (Xantus) (type). Xantus Coll.

Eulima falcata Carpenter Pl. 66, fig. 7

Eulima falcata Carpenter, 1865d, p. 280, Reprint, 1872, p. 273; Bartsch, 1917, p. 303, pl. 42, fig. 6.
Melanella falcata (Carpenter), Pilsbry and Lowe, 1932, p. 120.
Melanella (Balcis) falcata (Carpenter), M. Smith, 1944, p. 8, fig. 75.

Original description.—
E. *t. valde tereti, valde curvata, alba, politissima, solidiore, marginibus spiræ meniscoideis; anfr. nucl. ? . . . [detritis]; norm. circ. x., planatis, lente augentibus; axi hamata, suturis indistinctis; basi elongata, haud tereti; apertura pyriforme, antice latiore; labro acuto; labio tenui, appresso.*
Long. ·31, long. spir. ·21, lat. ·09; div. 12°.
Hab. Acapulco, on *Ostrea iridescens,* Rowell.
The spire-outlines are scythe-shaped. It is much larger and more solid than *L. distorta* and (? var.) *yod.*

The original material consists of the holotype of 7½ whorls. They are white, smooth, curved, with the nuclear whorls broken.

The suture is fine and distinct. The body whorl is broken back of the aperture.

Dimensions.—Length, 8 mm.; greatest diameter, 2 mm. (holotype).

Holotype.—No. R 123, USNM. The label reads, "Eulima falcata R 123 USNM Acapulco Rowell off oysters."

Distribution.—Acapulco, state of Guerrero, west Mexico (type).

Eulima fuscostrigata Carpenter Pl. 65, fig. 8

Eulima fuscostrigata Carpenter, 1864a, p. 619, Reprint, 1872, p. 105; 1864b, p. 47, Reprint, 1872, p. 219.
Strombiformis fuscostrigata (Carpenter), Bartsch, 1917, p. 343, pl. 46, fig. 1.

Original description.—
E. testa minore, gracillima, albida, striga latiore rufo-fusca supra peripheriam ornata; basi quoque rufo-fusca, valde prolongata, regulariter excurvata; anfr. nucl. ii., tumidioribus; norm, viii., planatis, suturis haud conspicuis; varicibus nullis; apertura valde elongata; labro vix sinuato; labio vix calloso. Long. ·17, long. spir. ·12, lat. ·05 poll., div. 20°.

The original glass plate with the Carpenter label "type Leiostraca fuscostrigata Cpr. C.S.L." is with the holotype. The hole in the surface of the shell is the area where the shell was glued to the original glass. The surface is worn with distinct sutures. A light brownish band occurs just above the suture. Outer lip is fairly sharp.

Dimensions. — Length, 5 mm.; greatest diameter, 1.5 mm. (holotype).

Holotype.—No. 4105, USNM.

Distribution.—Cape St. Lucas (Xantus) (type).

Cythnia asteriaphila Carpenter

Cythnia asteriaphila Carpenter, 1864a, p. 478, Reprint, 1872, p. 218; 1864b, p. 618, Reprint, 1872, p. 104 as *Cythna.*
Stylifer (Cythnia) asteriaphila Carpenter, Tryon, 1886, p. 293; Palmer, 1958, p. 197, pl. 19, figs. 5, 5a holotype.

Original description.—
C. testa *C. tumenti* simillima, sed umbilico minore, haud carinato, tenuissima, diaphana; anfr. iv., tumidis; vert. nucl. normali, haud stylineo, apice mamillato: operculo tenuissimo, elementis concentricis, nucleo submediano sinistrorsum sito. Long. ·03, long. spir. ·015, lat. ·025 poll., div. 60°.
A solitary specimen was found by Dr. Stimpson, imbedded in a starfish, like *Stylina;* from which genus the vertex and operculum distinguish it.

The type material consists of the holotype which is on the original Carpenter mount with the label "Type Cythnia asteriaphila Cpr. C.S.L." A printed label in addition reads, "J. Xantus."

The holotype was figured by Palmer, 1958 and is not repeated here. The species is the type species of *Cythnia* Carpenter, 1864a.

Dimensions. — Length, 1 mm.; greatest diameter, .75 mm. (holotype).

Holotype.—No. 13746 USNM.

Distribution.—Cape St. Lucas (Xantus) (type).

Epitonium cumingii (Carpenter) Pl. 67, fig. 9

Scalaria Cumingii Carpenter, 1856c, p. 165; 1857c, pp. 284, 336; Carpenter, 1860d, p. 10; 1864b, p. 613, Reprint, 1872, p. 99 ? *Cumingii* S. Diego, p. 660, Reprint, 1872, p. 146 ? *Cumingii* between San Diego and San Pedro.
Epitonium cumingii (Carpenter), M. Smith, 1944, p. 7.
Epitonium (*s.l.*) *cumingii* (Carpenter), Keen, 1958, p. 276.

Original description.—Carpenter, 1856c, p. 165.
21. SCALARIA CUMINGII, n.s. *S. testa* "S. mitræformi" simili, *sed paullum graciliore; anfr.* x. *quarum* iii. *primi læves; costis paucioribus,* viii.-ix., *minus coronatis, haud acutissimis, haud reflexis, striulis incrementi minutissime sculptis; anfr. valde separatis.*
Long. ·35, long. spir. ·25, lat. ·14, div. 30°.
Hab. In Sinu Panamensi; legit *T. Bridges.* Sp. un. in Mus. Cuming.
The lines of growth on the varices show that the coronations were never so sharp and elevated as in *S. mitræformis.*

Holotype.—Reg. No. 1950.3.31.1 BM (NH).

Distribution.—Panama (type).

Epitonium (Nitidiscala) hindsii (Carpenter) Pl. 67, figs. 3-6

Scalaria Hindsii Carpenter, 1856c, p. 165; 1857c, pp. 284, 336; Carpenter, 1860d, p. 10; 1864b, p. 538, Reprint, 1872, p. 24; Tyron, 1887, p. 84.
Epitonium (*Nitidiscala*) *hindsii* (Carpenter), Keen, 1958, p. 274.

Original description.—Carpenter, 1856c, p. 165.
22. SCALARIA HINDSII, n.s. *S. testa "S. Cumingii" simili, sed magis elongata, majore, anfr.* x. *haud profunde separatis; varicibus acutis* viii., *acutius coronatis, lineis regularibus, ad marginem alteram spiræ parallelis, ascendentibus.*
Long. 1·04, long. spir. ·79, lat. ·4, div. 25°.
Hab. In Sinu Panamensi; legit *T. Bridges.* Sp. un. in Mus. Cuming*.
* The above species are published with doubt, as *Scalariæ* are seldom seen in sufficient numbers to ascertain the limits of specific variation. Species described from one or two specimens must always be regarded simply as "provisionally registered."

Syntypes.—Reg. No. 196321 BM (NH).

Distribution.—Panama (type).

Epitonium (Foveoscala) reflexum (Carpenter) Pl. 63, figs. 5, 6

Scalaria reflexa Carpenter, 1856a, p. 235; Carpenter, 1857c, pp. 288, 336; Carpenter, 1860d, p. 10.
Epitonium (Hirtoscala) reflexum (Carpenter), Keen, 1958, p. 272.

Foveoscala reflexa (Carpenter), de Boury, 1909, p. 257 type species of *Foveoscala*.

Original description.—Carpenter, 1865a, p. 235.
S. t. turrita, anfractibus x. *valde disjunctis, lævibus; varicibus in anfractu utroque* v. *magnis, valde prominentibus, ad marginem reflexis, supra in spira brevi semitubulari productis; lineis varicum subspiralibus; vertice lævi; apertura circulari, ad basin haud umbilicata.*
Long. ·6, lat. *(spinas includens)* ·21, long. spir. ·45, poll.; div. 40°.
Hab. San Blas, prope Sinum Californiensem; unicum legit—Donnell, R.N. Mus. Cuming.
Most nearly allied to *S. mitræformis*, Sow., and remarkable for the large size of the varices, which are reflexed, and produced at the shoulder into a semitubular spout. The varical lines make about one revolution from the apex to the base. In the very young shell the varices are not shouldered, and are more numerous.

Through the courtesy of Norman Tebble, Mollusca Section, British Museum (Natural History) the information and photographs of the type of this species have been obtained.

Dimensions.—Length, 16 mm. (holotype).

Holotype.—Reg. No. 19621116, BM (NH).

Distribution.—San Blas, Gulf of California (type).

Epitonium regulare (Carpenter) Pl. 67, figs. 10, 11

Scalaria regularis Carpenter, 1856c, p. 164; 1857c, pp. 284, 336; Carpenter, 1860d, p. 10; 1865, p. 31, Reprint, 1872, p. 244 compared to *Scalaria. . . . tincta* Cerros Is.
Epitonium (*Nitidoscala*) *regulare* (Carpenter), Pilsbry and Lowe, 1932, p. 120 Acapulco; Keen, 1958, p. 274.

Original description.—Carpenter, 1856c, p. 164.
18. SCALARIA REGULARIS, n.s. *S. testa parva, turrita, alba; anfr.* ix. *parum attingentibus; costis* x.-xii. *validioribus, extantibus, lineis subspiralibus apicem versus continuis; striulis spiralibus subobsoletis; umbilico nullo.*
Long. ·27, long. spir. ·19, lat. ·13, div. 32°.
Hab. In Sinu Panamensi; legit *T. Bridges*. Sp. tria in Mus. Cuming.
The ribs are stronger, more projecting, and the spiral sculpture fainter than in *S. Mindorensis*.

Holotype.—Reg. No. 1950. 4.18. 13/16 BM (NH).

Distribution.—Panama (type).

Epitonium tiara (Carpenter) Pl. 67, figs. 7, 8

Scalaria tiara Carpenter, 1856c, p. 164; 1857c, pp. 284, 336; 1860d, p. 10; 1864b, p. 624, Reprint, 1872, p. 110.
Epitonium (Nitidoscala) tiara (Carpenter), Keen, 1958, p. 274; Palmer, 1958, p. 188.

Original description.—Carpenter, 1856c, p. 164.
19. SCALARIA TIARA, n.s. *S. testa obesa, lævi, albida; anfr.* vii. *parum attingentibus, rapide augentibus; costis* xii. *acutis, valde extantibus, infra suturam parum alatis, attingentibus, lineis rectis ad apicem continuis; umbilico nullo.*

Long. ·27, long. spir. ·16, lat. ·16, div. 48°.
Hab. In Sinu Panamensi; legit *T. Bridges.* Sp. un. in Mus. Cuming.
Distinguished from *S. obesa,* Sow., by the small size of the corresponding whorls, slightly winged shoulders, and want of umbilicus.

The synonymy, discussion, distribution, and type were given by Palmer in 1958.

In 1963 the holotype of the species has been found by Norman Tebble, and a photograph of the shell has been furnished by the British Museum (Natural History).

Holotype.—Reg. No. 196320 BM (NH).

Distribution.—Panama (type).

Epitonium subnodosum (Carpenter)

Scalaria subnodosa Carpenter, 1856c, p. 165; 1857c, pp. 284, 336; Carpenter, 1860d, p. 10.
Epitonium (*s.l.*) *subnodosum* (Carpenter), Keen, 1958, pp. 276.

Original description.—
20. Scalaria subnodosa, n.s. *S. testa turrita, alba, gracili, lævi, anfr.* xii. *haud separatis; costis* xiv.-xvi. *plerumque acutis, huc et illuc latis, subdeclivibus, superne vix alatis; umbilico nullo.*
Long. 1·4, long. spir. 1·06, lat. ·5, div. 23°.
Hab. In Sinu Panamensi; legit *T. Bridges.* Sp. un. in Mus. Cuming.

Holotype.—Not found. Not BM (NH).

Distribution.—Panama (type).

Opalia (Dentiscala) crenatoides Carpenter Pl. 66, figs. 2, 3

Opalia crenatoides Carpenter, 1864a, p. 47, Reprint, 1872, p. 220; 1864b, p. 619, Reprint, 1872, p. 105; 1866b, p. 277 (not 1866h as in Palmer, 1958, p. 191); Keen, 1958, p. 278, fig. 156 after Baker, Hanna, and Strong; Palmer, 1958, p. 191.
Epitonium (*Dentiscala*) *crenatoides* (Carpenter), Baker, Hanna, and Strong, 1930b, p. 47, pl. 2, fig. 5; Pilsbry and Lowe, 1932, p. 120.

Original description.—Carpenter, 1864a, p. 47.
O. testa turrita, alba, marginibus spiræ rectis; anfr. nucl. ? . . . . ; norm. vi., compactis, attingentibus; costis radiantibus circ. x., in spira plerumque obsoletis, ultimo anfractu validioribus, latis, haud exstantibus, attingentibus, spiram lineis fere rectis ascendentibus; suturis inter costas altissime indentatis; carina obtusa basali, suturæ continua; inter costas radiantes undique, ut in suturis, indentata; costis interdum, propter lirulas spirales subobsoletas, subnodosis; columella haud umbilicata; basi antice lævi. Long. ·54, long. spir. ·38, lat. ·23 poll., div. 30°.
Additional specimens may connect this with the Portuguese *O. crenata.*
. . . 1 perfect and a few rubbed specimens. This, and the Santa Barbara fossil, *O.* ? var. *insculpta,* are so close to the Portuguese *O. crenata,* that additional specimens may connect them.—[Carpenter, 1864b, p. 619]

The original material consists of the holotype which is badly worn with the apex eroded. The shell consists of seven whorls with nine longitudinal ribs on the body whorl. There is a strong basal cord and a thickened continuous lip. There are faint remnants of strong spiral ribs on the body whorl which are completely eroded on the whorls of the spire. The ribs are deep pitted into the suture.

Dimensions. — Length, 13.5 mm.; greatest diameter, 6 mm. (holotype).

Holotype.—No. 15874, USNM. Original label reads, "Cape St. Lucas, J. Xantus."

Distribution.—Cape St. Lucas (Xantus) (type). Xantus Coll. Southern California to Nicaragua (Keen).

Acirsa menesthoides Carpenter Pl. 63, figs. 7, 8

Acirsa Menesthoides Carpenter, 1864a, p. 478, Reprint, 1872, p. 217; 1864b, p. 618, Reprint, 1872, p. 104; Keen, 1958, p. 276 with ?

Original description.—

A. testa nitida, turrita, majore, solidiore pallide fusca; anfr. nucl. lævibus; norm. vi., subplanatis, suturis distinctis; lineis crebris spiralibus insculpta, quarum circ. viii. in spira monstrantur; testa adolescente lirulis radiantibus obsoletis decussata; apertura subovali; columella solida, imperforata. Long. ·42, long. spir. ·3, lat. ·16 poll., div. 25°.

There is a specimen in the British Museum (Natural History), Reg. No.: 19621121, which Norman Tebble reports as a "possible paratype." It is "attached to a blue card on which is printed 'named from the type specimen in the Smithsonian Institute, Washington, D.C." In MS is added *"Acirsa menesthoides* Carpr . . . C. S. Lucas . . . J. Xantus."

If the holotype is never found the specimen named above could be selected as the neotype. The printed label with the specimen which states that it was named from the type is one of hundreds which were distributed by the Smithsonian Institution from Carpenter's identification. It is not so meaningful as it appears.

Holotype.—Unknown.

Distribution.—Cape St. Lucas (Xantus) (type).

Littorina dubiosa penicillata Carpenter Pl. 61, fig. 7

Litorina [*sic*] (*Philippii,* var.) *penicillata* Carpenter, 1864a, p. 477, Reprint, 1872, p. 216; 1864b, pp. 618, 623, Reprint, 1872, pp. 104, 109.
Littorina aspera Phil. var. *penicillata* Carpenter, Tryon, 1887, p. 250, pl. 44, fig. 85.
Littorina philippi penicillata Carpenter, von Martens, 1901, p. 584, pl. 43, fig. 14.

Littorina penicillata Carpenter, Pilsbry and Lowe, 1932, p. 124.
Littorina dubiosa penicillata (Carpenter), Keen, 1958, p. 282, fig. 175a from Von Martens, 1901.

Original description.—
L. Ph. testa parva, lineis radiantibus, variantibus, delicatulis, rarius ziczacformibus, et cingulis duobus spiralibus, quorum unum in spira monstratur, elegantissime penicillata. Long. ·33, long. spir. ·14, lat. ·2 poll., div. 50°.
Closely resembling the West-Indian *L. ziczac*, var. *lineata*, D'Orb. Intermediate specimens, however, clearly connect it with the common Mazatlan form.

The original material consists of three specimens in the U. S. National Museum. The apical whorls are worn and dark brown. There are microscopic widely spaced spiral lines over the remainder of the whorls except on the base of the body whorl. There is a dark blue band at the suture or just above. There are brownish or bluish longitudinal curved stripes over the whorls and on the base. The callus and inside of the aperture are brown. Margin of the columella is concave and ridged at the back. The brown or bluish band at the midline of the body whorl is prominent.

Dimensions.—Syntypes, length, 10 mm.; greatest diameter, 5.25 mm. (largest, Plate 61, figure 7).

Syntypes.—No. 4058, USNM.

Distribution.—Cape St. Lucas (Xantus) (type). Magdalena Bay, Lower California into Gulf of California (Keen).

Littorina pullata Carpenter Pl. 61, fig. 6

Litorina [*sic*] *pullata* Carpenter, 1864a, p. 477, Reprint, 1872, p. 216; 1864b, pp. 546, 618, Reprint, 1872, pp. 32, 104; Keen, 1958, p. 282, fig. 177.
Littorina (*Melarhaphe*) *scutulata pullata* Carpenter, Palmer, 1958, p. 159 see for synonymy.

Original description.—
L. testa parva, solidiore, luctuosa; spira satis exserta; nigrescente, seu livido-fusco tincta, lineis spiralibus exilissimis pallidioribus ornata; interdum obscure tessellata; anfr. v., subplanatis, suturis parum impressis; sublævi, striolis spiralibus tenuiter insculpta; columella intus incrassata; pariete haud excavato. Long. ·4, long. spir. ·18, lat. ·29 poll., div. 60°.
= *Litorina,* sp. ind., Maz. Cat. no. 399, p. 350.

The original material consists of three specimens in the U.S. National Museum labelled "type 4059 C.S.L.". The specimens were fresh with the apical whorls worn. The suture is distinct. The shell is dark and light brown. There are fine spiral lines which under the lens appear as grooved lines. There are darker spiral bands and lines with more prominent light ones on the middle of the body whorl. The outer lip is moderately sharp.

Dimensions.—Syntypes, length, 12 mm.; greatest diameter, 8 mm.; 12 mm., 8 mm.; 12 mm, 8.5 mm., respectively.

Syntypes.—No. 12661 (4059), USNM.

Distribution.—Cape St. Lucas (Xantus) (type). S. Lower California to Panama (Keen).

Pyrgula quadricostata Carpenter

Pyrgula quadricostata Carpenter, 1856c, p. 162; 1857b, pp. 284, 326; Carpenter, 1860d, p. 7.

Original description.—Carpenter, 1856c, p. 162.
9. PYRGULA QUADRICOSTATA, n. s. *P. testa ovali, alba, spira haud acuminata, marginibus excurvatis; carinis* iv. *acutis cincta, quarum* ii. *in spira extant, tertia vix supra suturam impressam apparet, quarta circa basin; aperturam versus, costulis incrementi decussata; apertura lata; labro tenui a plica quarta parietali interrupta.*
Long. ·28, long. spir. ·16, lat. ·15, div. 40°.
Hab. In? flumina Sinus Panamensis; legit *T. Bridges.* Sp. un. in Mus. Cuming.
This pretty little shell is the Pacific analogue of the Swiss species for which the genus was constituted; differing, however, in form and number of keels. The specimen has been tenanted by a hermit crab, and has Bryozoa near the mouth.

Holotype.—Not found. Not BM (NH).

Distribution.—Panama (type).

Hyala rotundata Carpenter

Hyala rotundata Carpenter, 1864a, p. 478, Reprint, 1872, p. 217; 1864b, p. 618, Reprint, 1872, p. 104.

Original description.—
H. testa (quoad genus) magna, tenui, alba, diaphana; anfr. nucl. normalibus, apice mamillato; norm. iv., globosis, rapide augentibus, suturis valde impressis; basi rotundata; apertura subrotundata, ad suturam subangulata; peritremate continuo; labio a pariete separato, rimulam umbilicalem formante; columella valde arcuata. Long. ·18, long. spir. ·09, lat. ·1 poll., div. 40°
A unique shell, resembling a marine *Bithinia.*

Holotype.—Unknown.

Distribution.—Cape St. Lucas (Xantus) (type).

Alvania albolirata (Carpenter) Pl. 61, fig. 3

Rissoa albolirata Carpenter, 1864a, p. 477, Reprint, 1872, p. 216; 1864b, p. 618, Reprint, 1872, p. 104; Tryon, 1887, p. 350.
Alvania albolirata (Carpenter), Bartsch, 1911d, pp. 333, 334, 338, pl. 29, fig. 6; Baker, Hanna, and Strong, 1930a, p. 28.

Original description.—

R. testa parva, alba, crystallina, normali; marginibus spiræ undatis; anfr. nucl. iii., lævibus, mamillatis; norm. iv., medio subconvexis, postice supra suturas planatis; basi subplanata, effusa, haud umblicata; lirulis spiralibus crebris, obtusis, quarum circ. x. in spira monstrantur; apertura subovata, peritremate continuo; labro arcuato, vix antice et postice sinuato calloso; labio valido. Long, ·1, long. spir. ·08, lat, ·04 poll., div. 250.

The original material consists of one specimen in the U.S. National Museum with the original Carpenter glass mount labelled "Type Rissoa albolirata Cpr. 16, 216 C.S.L."

The shell is white and almost transparent. There are six whorls, the apical ones are mammillate and smooth. The sutures are distinct. The surface of the whorls has microscopic, regular, spiral ribs with fine interspaces. The labrum is thickened. The callus is narrow.

Dimensions.—Holotype, length, 3 mm.; greatest diameter, 1 mm.

Holotype.—No. 16216, USNM.

Distribution.—Cape St. Lucas (Xantus) (type).

Alvania electrina (Carpenter) Pl. 61, fig. 5

? *Diala electrina* Carpenter, 1864a, p. 478, Reprint, 1872, p. 217; 1864b, p. 618, Reprint, 1872, p. 104.

Alvania electrina (Carpenter), Bartsch, 1911d, pp. 333, 335, 346, pl. 30, fig. 4 type; Baker, Hanna, and Strong, 1930a, p. 29.

Original description.—

?*D.* testa subdiaphana, rufo-cornea, nitida; marginibus spiræ parum excurvatis; vertice nucleoso, helicoideo; anfr. iii., tumidis, suturis haud impressis, apice magno mamillato; anfr. norm. iii., subplanatis, suturis distinctis; sculptura haud expressa; tota superficie costulis obscuris, latis, spiralibus, quarum vi.—viii. in spira monstrantur, et iii.—v. circa basim rotundatam, interdum obsoletis, cincta; costulis radiantibus circ. xviii., subobsoletis; apertura regulariter ovata, ad suturam angulata, peritremate continuo; basi haud umbilicata; columella regulariter arcuata. Long. ·09, long. spir. ·07, lat. ·03 poll., div. 30°.

The original material consists of one specimen in the U.S. National Museum with original Carpenter glass mount labelled "Type Diala electrina Cpr. C S L".

The holotype is glassy transparent of a light brown color. The first three whorls are smooth and mammillate. The remainder of the whorls have wide spiral ribs with fine interspaces. On the penultimate whorl the spirals are crossed by microscopic longitudinal ribs which give a slight undulate appearance.

Dimensions.—Length, 2.5 mm.; greatest diameter, 1 mm. (holotype).

Holotype.—No. 16217, USNM. (Bartsch, 1911f, page 347 gave the number as 12,217).

Distribution.—Cape St. Lucas (Xantus) (type).

Barleeia haliotiphila Carpenter

Barleeia haliotiphila Carpenter, 1864b, p. 656, Reprint, 1872, p. 142; 1865g, p. 144, Reprint, 1872, p. 312; Bartsch, 1920, p. 172, pl. 13, fig. 1 type; Palmer, 1958, p. 164 see for synonymy, original description, and notes.

Holotype.—No. 15558, USNM.

Distribution.—Recent, Lower California on *Haliotis* (type). Mendocino County, California, to Lower California (Dall). Pleistocene (Woodring, Bramlette, and Kew, 1946).

Barleeia subtenuis Carpenter — Pl. 66, fig. 9

Hydrobia ulvae Carpenter, 1857, p. 361.
Barleeia subtenuis Carpenter, 1864b, pp. 546, 623, 656, 669, Reprint, 1872, pp. 32, 109, 142, 155; 1865, p. 143, Reprint, 1872, p. 311; Palmer, 1958, p. 165, pl. 20, fig. 1-3 see for synonymy, original description, and discussion.

In addition to the notes in Palmer, 1958 (p. 165) the specimen figured herein, examined in 1961, has a label "San Diego in the catalogue 15564b is marked type then reentered as 15570" [JPEM]. A pencilled label reads, "San Diego not San Pedro." This specimen has five whorls, apical whorls worn. The shell is smooth. The sutures are distinct. The interior of the aperture is a light orange.

This specimen could be added to the three (USNM, No. 32363) specimens previously figured (1958) from which a neotype would be properly selected. The type locality would be San Diego. Apparently the Cape St. Lucas specimen, which Carpenter mentioned, is lost.

Dimensions.—Length, 2.75 mm.; greatest diameter, 1.25 ± mm.

Specimen figured.—No. 15564b (15570), USNM.

Distribution.—San Diego, California (type locality if neotype is so selected).

Assiminea compacta (Carpenter) — Pl. 65, fig. 3

? *Hydrobia compacta* Carpenter, 1864a, p. 618; Reprint, 1872, p. 104; 1864b, p. 478, Reprint, 1872, p. 217.
Syncera compacta (Carpenter), Bartsch, 1920, p. 166, pl. 12, fig. 4 type.

Original description.—

?*H.* testa lævi, curta, compacta, latiore; marginibus spiræ vix excurvatis; anfr. nucl. normalibus, apice mamillato; norm. iv., tumidis, suturis distinctis; spira curtiore; basi rotundata; apertura subovata; peritremate continuo; labio definito. Long. ·04, long. spir. ·02, lat. ·03 pol., div. 70°.

This unique shell may be a *Barleeia*.

The original Carpenter glass mount is with the holotype. It is marked "Type ? Hydrobia compacta Cpr CSL".

The shell is worn with about four whorls, smooth; sutures distinct; callus thick.

Holotype.—No. 16209, USNM.

Distribution.—Cape St. Lucas (Xantus) (type).

Serpulorbis (Serpulorbis) squamigerus (Carpenter)

Aletes squamigerus Carpenter, 1856f, p. 226; 1857c, pp. 200, 233, 324, 349; 1857, pp. 303, 304; 1860, p. 4; M. Smith, 1944, p. 13, figs. 143, 146, 147; Palmer, 1958, p. 173; Keen, 1961, p. 188.
Thylacodes squamigera (Carpenter), 1864b, p. 577, Reprint, 1872, p. 43.
Serpulorbis squamigera (Carpenter), 1864b, pp. 557, 654, Reprint, 1872, pp. 43, 140; Tomlin, 1927, p. 168.
Serpulorbis (*Serpulorbis*) *squamigerus* (Carpenter), Keen, 1961, p. 203, pl. 55, fig. 5.

See Palmer, 1958, for synonymy and notes. By a printer's error the heading *Aletes* in Palmer, 1958, was misplaced. It obviously belongs on page 173 preceding *Aletes squamigerus*. Also on page 172, lines 9-14 beginning "The holotype . . ." belong to *Pelatoconchus compactus* (Carpenter) and should follow the discussion on page 173.

In 1950 the late Guy L. Wilkins in searching in the British Museum (Natural History) for the type of *A. squamigerus* Carpenter reported that it was not found. Since that time during the researches on the Vermetidae by Dr. Keen, the type material has been recovered (see Keen, 1961, p. 203), and an illustration is included in Keen.

Syntypes.—BM (NH) Reg. No. 55.3.14.57 (Nuttall Coll.) [teste S. P. Dance, 1959]—Keen, 1961.

Distribution.—Santa Barbara, California (type). See Palmer, 1958, p. 173; Keen, 1961, p. 188.

Litiopa divisa Carpenter

Litiopa divisa Carpenter, 1856a, p. 234; 1857c, pp. 288, 350.

Original description.—

L. t. parva, anfractibus ix., *quarum* vi. *primi subturriti, liris trans-*

versis striisque spiralibus decussati, ultimique tres sublæves sunt, tumidiores, striulis plus minusve appressis, spiralibus, maxime ad basin, tenuissime ornata; nonnunquam linea suturam impressam subeunte; subdiaphana, fusca; labro acuto; labio vix monstrante; columella truncata, infra maxime undata.
Long. ·13, lat. ·06, long. spir. ·07, poll.; div. 30°.
Hab. Cape San Francisco: legit clar. Hinds. Mus. Cuming.
This is the only species hitherto recorded from the west coast of N. America; the ? *L. saxicola* of C. B. Ad. not belonging to the genus. Exactly the same species was taken in abundance "among small drifted canes, Straits of Sunda," Mus. Archer. It is remarkable for the different character of the first six and the last three whorls; the decussated portion suddenly becoming smooth, the joining whorl being often irregular in growth.

There is some doubt concerning the locality of this form. Originally indicated as from "Cape San Francisco" and thought to be from California. But later Carpenter (1857c) doubted the authenticity of the distribution and qualified the location to, "Probably in Ecuador; not in Upper California, as supposed when described" (p. 288) and "For the *Litiopa divisa,* an East Indian pelagic shell said to have been found on "Cape San Francisco," a locality of the same occurs near the Bay of Guayaquil" (p. 350).

Bittium nitens Carpenter Pl. 65, fig. 6

Bittium nitens Carpenter, 1864a, p. 479, Reprint, 1872, p. 218; 1864b, p. 618 Reprint, 1872, p. 104; Bartsch, 1911c, pp. 383, 384, 400, pl. 57, fig. 2 *Semibittium.*

Original description.—
B. testa regulari, rufo-fusca, hic et illic pallida, maxime nitente; anfr. nucl. iii., lævibus, tumidis, apice submamillato, subdeclivi; norm. vi., tumidis suturis impressis; costis radiantibus circ. xiv., haud contiguis, angustis, interstitiis undatis; costulis rotundatis, spiralibus, in spira iv., quarum postica multo minor, supercurrentibus, ad intersectiones subnodosis; costulis circa basim subrotundatam iv., haud decussatis; apertura subquadrata; columella haud truncata, obtuse angulata; labro acuto, a costulis indentato; labio inconspicuo. Long. ·21, long. spir. ·16, lat. ·06 poll., div. 20°.

The holotype consists of eight whorls with the nuclear whorls missing. Early whorls are worn. There are no spiral ribs on the upper whorls but on the middle whorls spirals and longitudinal ribs cross forming a nodose condition. There are about 14 longitudinal ribs over the shell, but there are revolving ribs only on the base. The aperture is quadrate. The labrum is thin, costate. The labium is short with the callus turned backward.

Dimensions.—Length, 5.75 mm.; greatest diameter, 2 mm. (holotype).

Holotype.—No. 4068, USNM. Original Carpenter glass mount is with the holotype with label, "Type Bittium nitens, *Cpr.* C.S.L."

Distribution.—Cape St. Lucas (Xantus) (type).

Eumeta intercalaris (Carpenter)

Cerithiopsis intercalaris Carpenter, 1865d, p. 281, Reprint, 1872, p. 274.
Eumeta intercalaris (Carpenter), Bartsch, 1911a, p. 565, fig. 1 type; Bartsch, 1911b, p. 327.

Original description.—

C. t valde elongata, rufo-fusca, marginibus spiræ rectis, suturi, impressis; anfr. nucl. iii. +? . . . (*decollatis*), *radiatim distanter liratis; norm.* x., *planatis; costis radiantibus primum* xii., *dein circ.* xxii., *angustis, haud extantibus, ad peripherian continuis, interstitiis quadratis; carinis spiralibus primum* ii. *nodulosis, dein alteris* ii. *minoribus inter eas intercalantibus; carina postica suturali haud nodulosa, secunda valde nodulosa, tertia intercalante æquante sed haud nodosa, quarta antica valde nodosa, quinta circa peripheriam, primæ et tertiæ simili, haud nodosa, alteraque contigua, minima, inter quas sutura gyrat; basi concava, lævi; columella valde contorta; canali brevi, aperto; labro? . . .**

Hab. Guacomayo.

This beautiful species comes nearest to *C. bimarginata,* C. B. Ad., of which, indeed, the type does not agree with the diagnosis so well as does this specimen. It differs in having other spiral ribs intercalating between the two principal ones, and in the radiating sculpture being continued to the periphery. One specimen only was found in the shell-washings, not perfect at the mouth.

Bartsch's figure is probably of the holotype. My measurements of the type are slightly less than those given by Bartsch. Bartsch did not state in the text (1911a, p. 566) that the drawing is of the type. The specimen 15342 USNM has note "fig'd."

The original material consists of one specimen, the holotype, in the USNM, labelled "Type Guacomayo Mexico." The specimen consists of nine whorls with the apex eroded. Each whorl has two nodose spiral ribs with wide interspaces. The suture is deep. The aperture is quadrate with a slight callus and one stout plication.

Dimensions.—Holotype, length, 5 mm.; greatest diameter, 1.5 mm.

Holotype.—No. 15342, USNM.

Distribution.—Guacomayo, western Guatemala (type).

Fenella crystallina Carpenter — Pl. 65, fig. 7

Fenella crystallina Carpenter, 1864a, p. 477, Reprint, 1872, p. 217; 1864b, p. 618, Reprint, 1872, p. 104.

Original description.—

F. testa alba, subdiaphana, turrita, rudiore; marginibus spiræ rectis, parum divergentibus; anfr. nucl. ?. . . (decollatis); norm. v., valde rotundatis, suturis impressis; costis radiantibus circ. xvi., valde rotundatis, haud extantibus, interstitiis latis; striis spiralibus regularibus, in anfr. penult. xvi.; apertura rotundata; basi rotundata; peritremate continuo; labro extus varicoso; labio calloso. Long. ·14, long. spir. ·11, lat. ·05 poll., div. 20°.

The holotype consists of five whorls. The nuclear whorls are missing. The shell is white and worn. There is an intimation of longitudinal lines. These are noted by the remnants, such as the pitted spots at the sutures, where the ribs had met. These present a frilled line at the suture. Microscopic spiral lines are apparent. The whorls are rounded; they could have been angular.

Dimensions.—Length, 4 mm.; greatest diameter, 2 mm. (holotype).

Holotype.—No. 15888, USNM. Label "Type Cape St. Lucas Xantus."

Distribution.—Cape St. Lucas (Xantus) (type).

Fossarus parcipictus Carpenter Pl. 65, figs. 4, 5

Fossarus parcipictus Carpenter, 1864a, p. 476, Reprint, 1872, p. 216; 1864b, p. 618, Reprint, 1872, p. 104.

Original description.—
F. testa parva, solidiore, spira plus minusve elevata; albida, rufofusco varie maculata; carinulis spiralibus acutioribus, quarum circ. vi. majores, striolisque crebris cincta; anfr. ultimo tumidiore; labro acuto, haud intus incrassato; umbilico satis magno, ad marginem carinato; operculo normali. Long. ·24, long. spir. ·06, lat. ·2 poll., div. 90°.
The few specimens found are very variable in outline.

The type material in the U. S. National Museum consists of two specimens. The smaller of the two is the better preserved specimen and is figured herein. It is selected as the lectotype.

Dimensions.—Lectotype (herein designated), Length, 4+ mm., greatest diameter, 4—mm.

Lectotype and paratype.—No. 4060, USNM.

Distribution.—Cape St. Lucas (Xantus) (type).

Fossarus parcipictus Carpenter Pl. 65, figs. 4, 5

Fossarus purus Carpenter, 1864a, p. 477, Reprint, 1872, p. 216; 1864b, p. 618, Reprint, 1872, p. 104.

Original description.—
F. testa *F. angulato* simili, sed alba, subdiaphana; anfr. nucl. ii., fuscis, ut in *F. tuberoso* cancellatis; norm. ii. et dimidio, altis, valde tumentibus, carinatis; carinis iv., validissimis, acutissimis, quarum ii. in spira monstrantur; carinulis aliis antice et postice plus minusve

expressis; tota superficie minute spiraliter striata; carinularum basalium interstitiis subobsolete decussatis; apertura late semilunata; labro a carinis valde indentato; labio recto, angusto; umbilico magno, carinato; operculo fusco, valde paucispirali, minutissime ruguloso, nucleo antico. Lon. ·08, long. spir. ·03, lat. ·08 poll., div. 90°.

The holotype has two, brown, tiny, apical whorls. The remainder of the shell is white. There are two, strong, revolving ribs on the nucleus and penultimate whorl. The body whorl is enlarged with four, strong, widely spaced, revolving ribs with microscopic cross lines between the ribs. The umbilicus is wide. Anatomy is dried within the shell.

Dimensions.—Length, 1.2 + mm.; greatest diameter, 1.5 ± (holotype).

Holotype.—No. 16210, USNM. Holotype is on the original Carpenter glass mount with label "Type Fossarus purus Cpr. C.S.L."

Distribution.—Cape St. Lucas (Xantus) (type).

Vanikoro aperta (Carpenter) Pl. 66, fig. 1

Narica aperta Carpenter, 1864a, p. 476, Reprint, 1872, p. 215; 1864b, p. 618, Reprint, 1872, p. 104.
Vanikoro aperta (Carpenter), Burch, 1946, p. 34; Hertlein and Strong, 1951, p. 110 footnote; Keen, 1958, p. 310, fig. 230.

Original description.—
N. testa parva, inflata, tenui, alba; anfr. nucl. ? . . .; norm. rapide augentibus, lirulis crebris spiralibus, in spira hic et illic majoribus, a striolis creberrimis radiantibus minutissime decussatis; suturis valde impressis; apertura subcirculari; umbilico maximo, carinato, anfractus intus monstrante. Long. ·28, long. spir. ·08, lat. ·3 poll., div. 110°.

The original material consists of the holotype. The specimen is white. The nucleus is worn. The large body whorl has the surface covered with coarse spiral ribs. The longitudinal ribs are crossed by the spirals on the whorls of the spire which are worn thus giving a punctate appearance particularly just above the spire. The aperture is large with an elongate carinate umbilicus.

Holotype.—No. 15897, USNM.

Distribution.—Cape St. Lucas (Xantus) (type).

Cf. **Vanikoro insculpta** (Carpenter)

Narica insculpta Carpenter, 1865d, p. 280, Reprint, 1872, p. 273.
Vanikoro insculpta (Carpenter), Burch, 1946, p. 34.

Original description.—
N. t. "N. apertæ *simili, sed magis compacta; paullum angustiore, umbilico tamen majore; lineis spiralibus circ.* xxvi. *distantibus insculptis*

cincta, quarum x. *in anfr. penult. monstrantur; postice lineis incrementi vix conspicuis.*
Long. ·3, long. spir. ·08, lat. ·28; div. 100°.
Hab. Acapulco, on *Ostrea iridescens,* Rowell.
The Cape St. Lucas species (*vide* Ann. Nat. Hist. 1864, xiii. p. 476) has the sculpture in irregularly raised lirulæ, while this has minute grooves chiselled out of a smooth surface. It appears that the San Franciscans import the huge tropical oysters in large quantities, their own species having the coppery flavour which Americans dislike in the British species. From the outside of the valves, Mr. Rowell obtained this and many other interesting species.

Carpenter distinguished this species from his *Narica aperta* described from Cape St. Lucas. The type of the Acapulco form has not been found. Carpenter's statement in the introduction to the article in which the species was described indicated that the type was originally in the Smithsonian Institution (USNM).

Type.—Not found.

Distribution.—Acapulco, State of Guerrero, west Mexico (type).

Calyptraea subreflexa (Carpenter) Pl. 63, figs. 1, 2

Galerus subreflesus Carpenter, 1856a, p. 233; 1857b, pp. 288, 323; Carpenter, 1860d, p. 10; 1864b, p. 566, Reprint, 1872, p. 52.
Trochita subreflexa Carpenter MS., Reeve, 1859, pl. II, fig. 7.
Calyptraea subreflexa (Carpenter), Tryon, 1886, p. 120, pl. 34, figs. 58, 59 copy Reeve; Keen, 1958, p. 311, fig. 234.

Original description.—Carpenter, 1856a, p. 233.
G. t. irregulari, conica, rufo-fusca, radiatim tenui-striata; striis aculeatis; sutura impressa; vertice involuto, apice depresso; lamina interna apicem versus ad duas trientes reflexa, umbilicum magnum monstrante, margine dilatata, haud angulata.
Lat. ·75, alt. ·4, poll.
Hab. In Sinu Californiensi. Mus. Cuming.
Differs from *G. striatus,* Brod. (which must not be confounded with *Dispotæa striata,* Say), in its much more delicate, irregular, finely spinous striæ; and in the form of the internal laminæ, which in this species is reflected back over two-thirds, in *G. striata* over the whole, forming a much larger umbilical region. The vertex of this shell is rather prominent, and is formed like a tumid *Planorbis,* with a sunken apex.

The following notes in regard to the specimen in the British Museum (Natural History) were furnished by Norman Tebble of the Mollusca Section:

The specimen photographed may be a paratype of this species.
It was removed from a Mus. Cuming tablet bearing the original label saying "Subreflexus Carpr.", and "Gulf of California", the type locality. Its dimensions do not correspond with those of the holotype as given by Carpenter (*P.Z.S. 23*:233), nor is it the specimen figured by Reeve, 1859 (*Conch. Icon,* 11, *Trochita,* species 7, Pl. 2, figs. 7a, b). Two other specimens found in the same box, and possibly formerly

attached to the same tablet (which originally bore 3 specimens), similarly do not correspond with Carpenter's measurements nor Reeve's figure, and appear to belong to another species.

Dimensions.—Holotype, see original description.

Possible paratype.—Reg. No.: 19621122, BM (NH).

Distribution.—Gulf of California (type).

Natica excavata Carpenter Pl. 67, figs. 12, 13

=*Natica* (*Stigmaulax*) *elenae* Recluz, 1844

Natica excavata Carpenter, 1856c, p. 165; 1857c, pp. 282, 336; Carpenter, 1860d, p. 11; 1864b, p. 554, Reprint, 1872, p. 40 variety of *N. Elenae* Recluz; Stearns, 1894, p. 195; Keen, 1958, p. 321, fig. 264 synonym of *Natica* (*Stigmaulax*) *elenae* Recluz, 1844, p. 205.

Original description.—Carpenter, 1856c, p. 165.

23. NATICA EXCAVATA, n. s. *N. testa* "N. Broderipianæ" *simili; sed callositate parietali maxime elongata; regione spirali umbilicari valde excavata; albida, rufo-castanea lineis irregularibus radiantibus penicillata; striulis radiantibus crebrioribus.*

Long. 1·45, long. spir. ·3, lat. 1·5, div. 130°.

Hab. In Sinu Panamensi; legit *T. Bridges.* 2 sp. in Mus. Cuming.—S. W. Mexico, P.P.C.

This shell resembles *N. lineata* (Philippines) in colouring; but that shell is smooth, while the Panama shell has distinct, though not deep, radiating furrows, ending in a circum-umbilical line.

Holotype.—Reg. No. 196322 BM (NH).

Distribution.—Panama (type). S. W. Mexico.

Erato ? maugeriae panamensis Carpenter

Erato ? Maugeriae var. *Panamensis* Carpenter, 1856c, p. 162; 1857c, p. 284.

Erato panamensis Carpenter, Keen, 1958, p. 331 maybe synonym of *Erato* (*Hespererata*) *marginata* Mörch, 1861, p. 85.

Original description.—Carpenter, 1856c, p. 162.

10. ERATO ? MAUGERIAE, var. PANAMENSIS. *E. testa* "E. Maugeriæ" *simillima, sed majore, vix graciliore, apice minore, spira plerumque extantiore.*

Long. ·28, long. spir. ·03, lat. ·18, div. 130°.

Hab. In Sinu Panamensi; legit *T. Bridges.* Sp. tria in Mus. Cuming.

The differences are so very trifling between the specimens examined from the Pacific and West Indies as not to justify (without further knowledge) a specific separation. They do not appear constant in either type. The first whorl in the Pacific shells is somewhat smaller, while the shell is larger.

Holotype.—Not found. Not in BM (NH).

Distribution.—Panama (type).

Muricopsis squamulata (Carpenter)

Muricidea dubia var. *squamulata* Carpenter, 1865d, p. 281, Reprint, 1872, p. 274; Hertlein and Strong, 1951, p. 86 footnote.

Muricopsis squamulata (Carpenter), Pilsbry and Lowe, 1932, p. 119; Durham, 1950, p. 111.

Muricidea dubius squamulata Carpenter, M. Smith, 1939, p. 11.
Muricidea squamulata Carpenter, Keen, 1958, p. 362 under *Muricopsis armatus* (A. Adams, 1854) as *Murex armatus* A. Adams, 1854, p. 71.

Original description.—
Variat *t. omnino albida; sculptura tenuiore; spira elevata; tota superficie minute squamulata, squamulis imbricatis.*
Hab. Cape St. Lucas (*Xantus*).
The opercula in the beautiful specimens sent by Mr. Pease are typically Muricoid. The essential features are those of *M. dubia;* the pale colour and delicate sculpture and imbrication may arise from a deep-water station, as is seen in similar European shells. Mr. Cuming, however, regards it as distinct.

Holotype.—Unknown.

Distribution.—Cape St. Lucas (Xantus) (type).

Coralliophila (Coralliophila) muricatus (Hinds)

Trophon muricatus Hinds, 1844, p. 14; M. Smith, 1944, p. 26, fig. 293 as *Coralliophila.*
Trophon Hindsii Carpenter, 1857b, pp. 205, 343, new name for *T. muricatus* Hinds, 1844, p. 14, not *Murex muricatus* Montagu, 1803, p. 252.
Latiaxis Hindsii (Carpenter), Tomlin, 1935, p. 182.
Coralliophila (*Coralliophila*) *hindsii* (Carpenter), Keen, 1958, p. 368, fig. 388 copy Hinds, 1844-45.

Carpenter renamed Hinds' *Trophon muricatus* because he thought the name was preoccupied by *Murex muricatus* Montagu, 1803 (page 262) which Carpenter put in *Trophon*. Because Montagu did not use *Trophon muricatus* the name of Montagu and Hinds are not homonyms. Hinds' name may stand in the new combination of *Coralliophila.* Both names, that of Hinds and of Montagu, are used in literature. The species occurs in the Gulf of California and Panama.

Genus **Tritonialia** Fleming, 1928

Tritonalia Fleming, 1828, pp. 346, 356
Corrigenda Ocenebra Leach *in* Gray, 1847, p. 269. Type species by subsequent designation, *Murex erinaceous* Linn., Gray, 1847, p. 133. Recent. Europe.

In 1958 I used *Ocenebra* Leach *in* Gray, following Winckworth (1934, p. 14) reasoning that Fleming's substitute name (1828) of *Tritonalia* was for *Triton* Montfort, 1810. On careful examination of Fleming one finds that Fleming did not indicate the author of *Triton* nor include *M. tritonis* (type of *Triton* Montfort, 1810) in his list of species of *Tritonalia.* He used the substitute name *Tritonalia* because *Triton* was used on his page 157 for a batrachian. Fleming used *T. erinaceus* (Linn.) and included as secondary eight fossil species. None of which belongs to

Triton Montfort. *M. erinaceous* Linn. was selected by Gray, 1847 as type species. The genus belongs in the Muricidae and not Cymatiidae (*Triton* = *Charonia*).

Tritonalia poulsoni (Carpenter)

Buccinum Poulsoni "Nutt. M.S." Carpenter, 1857, p. 227.
Ocinebra [*sic*] *Poulsoni* Nuttall, Carpenter, 1864b, pp. 537, 663, 665 Cerros Island, Dr. Ayres and Veitsch [*sic*], Reprint, 1872, pp. 23, 149, 151; 1865g, p. 148, Reprint, 1872, p. 316.
Ocenebra poulsoni Carpenter, Palmer, 1958, p. 205, pl. 26, fig. 8 see for synonymy, original notes, illustration, and notes.

Original description.—Carpenter, 1865g, p. 148.
O. t. turrita, solida, luteo-albida, rufo-sanguineo spiraliter lineata; vertice nucleoso parvo, lævi, parum tumente: t. juniore rhomboidea, haud varicosa, spira planata, peripheria subangulata, canali recta, longiore, labro intus dentato, labio distincto, subcalloso: t. adulta, anfr. 7, primis planatis, posticis tumidis; suturis planatis, sed area postica concava; costis subvaricosis crebris, tumentibus, irregularibus, anfractu ultimo 7, circiter quinquies subnodosis; tota superficie spiraliter crebre insculpta; sulcis punctatis, rufo-sanguineis; apertura ovali; labro acutiore, dorsaliter tumido, varicoso, intus dentibus validis circiter 6 munito; labio solido, sub suturam dente valido parietali munito, super columellam calloso; canali breviore, aperto.—Long. 1·85, *long. spir.* ·96, *lat.* ·93, *poll.: div.* 38°.
Hab. San Diego, *Nuttall.*—Cerros Is., *Veatch.*—Santa Barbara, *Jewett*
Je n'ai vu que trois individus de cette belle espèce: l'un d'eux, qui est typique, porte le nom de "*Buccinum Poulsoni*" dans la collection Nuttall qui fait partie du Musée britannique: un second, très-jeune, et d'un aspect fort particulier, bien qu'il appartienne évidemment à la même espèce a été recueilli par le colonel Jewett, probablement á Santa Barbara (mais, d'après son étiquette, à Panama): enfin celui du docteur Veatch provient de la basse Californie, et il est en très-mauvais état. Le premier a été dessiné sur bois pour l'institution Smithsonienne par M. Sowerby. Comme cette espèce intéressante est presque inconnue en France, j'ai cru devoir en donner une description suffisamment précise. P. P. C.

The type locality of this species is San Diego, California. Carpenter reported the species from Cerros Is. though in a bad state of preservation. Whether the range of the species does extend in the southern area remains to be confirmed.

Type.—British Museum (Natural History), BM 61.5.18.22.

Distribution.—Recent. San Diego, California (type); Santa Barbara, California, to Magadalena Bay, Lower California, (Dall). Pleistocene. California (see Grant and Gale, 1931, p. 712); Mexico (Hertlein, 1934).

Sistrum (? **ochrostoma,** var.) **rufonotatum** Carpenter

Sistrum (? *ochrostoma* var.) *rufonotatum* Carpenter, 1864a, p. 48, Reprint, 1872, p. 220; 1864b, p. 619, Reprint, 1872, p. 105; Pease, 1868, p. 116

under *Sistrum ochrostoma* Blainville; Tyron, 1883, p. 191 under *Engina pulchra* (*Reeve*) [1864], note by Pease, 1868, p. 116 repeated.
? *Sistrum rufonotatum* Carpenter, Keen, 1958, p. 376 synonym of *Morula ferruginosa* (Reeve, 1864).

Original description.—
S. testa *S. ochrostomati* simili, sed minore, augustiore, vix tabulata; alba, linea punctorum rufo-fuscorum subperipheriali, interdum lineis spiralibus, interdum ejusdem coloris maculis, ornata; vert. nucl. mamillato, anfr. iii., lævibus, vix tumidis; norm. v., plus minusve elongatis, in medio nodoso-angulatis, postice planatis, suturis ad angulum valde obtusum conspicuis; seriebus nodulorum spiralibus iii., quarum postica major, secundum costas radiantes obsoletas circ. vi.-viii. ordinatis; seriebus anticis inconspicuis ii.; interdum costulis spiralibus intercalatis; canali brevi, rectiore, aperto, angusto; apertura subovali, vix subquadrata, intus pallide aurantiaca; labro acutiore, dorsaliter subvaricoso, postice sæpe sinuato, intus obscure vi.-dentato; labio conspicuo, interdum exstante. Long. ·5, long. spir. ·23, lat. ·32 poll., div. 60°.
Variat testa obesa, nodulis validis. Variat quoque testa acuminata, nodulis subobsoletis. Long. ·52, long. spir. ·23, lat. ·25 poll., div. 42°.

Holotype.—Unknown.

Distribution.—Cape St. Lucas (Xantus) (type).

Aesopus eurytoides (Carpenter)

Truncaria eurytoides Carpenter, 1864a, pp. 47, 48, Reprint, 1872, p. 220; 1864b, p. 619, Reprint, 1872, p. 105; Palmer, 1958, p. 213, pl. 23, figs. 14-17 see for synonymy, illustration of types, and discussion; Not *Aesopus eurytoides* (Carpenter), Baker, Hanna, and Strong, 1938a, p. 252, pl. 24, fig. 10; not Keen, 1958, p. 379, fig. 415.

Original description.—Carpenter, 1864a, pp. 47, 48.
T. testa parva, turrita, gracili; albida, sæpius fascia circa peripheriam maculis fusco-aurantiacis picta; anfr. nucl. mamillatis, lævibus; norm. v., effusis, subplanatis, ultimo paulum constricto; costulis radiantibus circ. xx., aperturam versus evanidis; apertura subquadrata; labro haud incrassato, interdum intus subtiliter striato, haud dentato; labio appresso; columella abrupte truncata. Long. ·3, long. spir. ·2, lat. ·11 poll., div. 23°.
Variat basi fusco tincta, seu tota superficie ut in *Nitidella cribraria* picta.

Syntypes.—No. 4148, USNM.

Distribution.—Cape St. Lucas (Xantus) (type); San Diego, California, to Panama (Dall, 1921).

Cf. **Aesopus fuscostrigata** (Carpenter) Pl. 66, fig. 8

? *Anachis fuscostrigata* Carpenter, 1864a, p. 49, Reprint, 1872, p. 221; 1864b, p. 619, Reprint, 1872, p. 105.

Original description.—
?*A.* testa parva, turrita, livida, nitida; zonis rufo-fuscis, subspiralibus, in spira circ. iii., interdum, maxime ad basim, confluentibus, conspicue cincta; lirulis radiantibus subobsoletis, circ. x., prope suturam se monstrantibus; apertura subquadrata. Long. ·13, long. spir. ·095, lat. ·045 poll., div. 20°.

The original material consists of one specimen which is still in the original bottle fastened to the original Carpenter glass mount which bears the label "type Anachis fuscostrigata Cpr. C.S.L."

The holotype has the apex eroded. The shell consists of 4 ½ smooth whorls.

The revolving of the shell is irregular. About four (Carpenter may have considered three) spiral, irregular bands on the penultimate whorl and upper body whorl. The shell is thick. The canal short and blunt. There are no plications.

Carpenter questioned his generic determination of *Anachis*. A suggested placement in *Aesopus* Gould is given herein.

Dimensions.—Length, 3.5 mm.; greatest diameter, 1.25—mm. (holotype).

Holotype.—No. 16223, USNM.

Distribution.—Cape St. Lucas (Xantus) (type).

? **Anachis humerosa** (Carpenter) Pl. 66, fig. 11

Columbella humerosa Carpenter, 1864b, p. 669, Reprint, 1872, p. 155; 1865d, p. 281, Reprint, 1872, p. 274.
? *Anachis humerosa* (Carpenter), Keen, 1958, p. 382, fig. 438 holotype.

Original description.—Carpenter, 1865d, p. 281.
C. t. parva, turrita, alba, linea seu maculorum serie fusea interdum spiram ascendente; marginibus spiræ parum excurvatis; anfr. nucl.? . . . [*detritis*]; *norm.* vi., *convexis, postice tumentibus, suturis valde impressis; costis radiantibus vii.-viii., distantibus, validissimis, rotundatis; interstitis late undatis; lirulis validis spiralibus extantibus, interstitiis eas æquantibus, costae et harum interstitia transeuntibus; basi angusta; labro vix varicoso, postice emarginato, intus solidiore, dentibus circ.* iv. *munitis; apertura late undata, compacta.*
Long. ·26, long. spir. ·15, lat. ·13; div. 38°.
Hab. Acapulco, on *Ostrea iridescens,* Rowell.
The sculpture resembles that of *Rhizocheilus,* and the tall spire that of *Anachis;* yet it appears to belong to the restricted typical genus.

The original material consists of one specimen which has the label "Anachis humerosa Cpr. 1865." Type "on oyster" "Acapulco Rev. J. Rowell."

The holotype consists of six rounded whorls. The apex is worn with the nucleus missing. There are six, spiral, coarse ribs with about eight, large, longitudinal rounded ribs. The color is white with a few scattered brown spots. There is a conspicuous posterior notch, a thick outer lip with a sharp margin, thin inner callus, and a wide short canal.

Dimensions.—Length, 7 mm.; greatest diameter, 3 + mm. (holotype).

Holotype.—No. 610334, USNM.

Distribution.—Acapulco, State of Guerrero, west Mexico (type). Point Abrejos, Lower California, to Acapulco (Keen).

Anachis serrata Carpenter Pl. 70, figs. 7-9

Anachis serrata Carpenter, 1857, p. 509, Mazatlan; Carpenter, 1865b, p. 273, Reprint, 1872, p. 260 genus ?; Palmer, 1945, p. 100; Keen, 1958, p. 384.

This species was described from Mazatlan. The type would be in that collection. Carpenter (1865b) made additions to the description of the species from Cape St. Lucas, Xantus collection. Four specimens (Palmer, 1945) from C. S. Lucas in the Redpath Museum are labelled "type" but those specimens can not be of the original lot. They probably are the shells which Carpenter had in (1865b) making supplementary notes.

Specimens figured.—No. 75, Redpath Museum.

Distribution.—Cape St. Lucas (Xantus). Mazatlan (type).

Anachis tincta Carpenter

? *Anachis tincta* Carpenter, 1864a, p. 48, Reprint, 1872, p. 221; 1864b, p. 619, Reprint, 1872, p. 105.

Columbella tincta (Carpenter), Tryon, 1883, p. 178 section *Seminella.*

Anachis tincta Carpenter, Baker, Hanna, and Strong, 1938a, p. 250, pl. 24, fig. 8; Keen, 1958, p. 386.

Original description.—

?*A.* testa parva, turrita, albida, rufo-aurantiaco supra costas tincta; anfr. nucl. lævibus; norm. iv.-v., subplanatis, suturis valde impressis; costulis x. radiantibus, et liris spiralibus transeuntibus, in spira iii. supra costas conspicuis, unaque in sutura, dense insculpta; interstitiis alte cælatis; apertura subquadrata; labro in medio incrassato. Long. ·19, long. spir. ·12, lat. ·08 poll., div. 30°.

Holotype.—Unknown.

Distribution.—Cape St. Lucas (Xantus) (type).

Mitrella densilineata (Carpenter)

?*Nitidella densilineata* Carpenter, 1864a, p. 48, Reprint, 1872, p. 221; 1864b, p. 619, Reprint, 1872, p. 105.

Columbella densilineata Carpenter, Tryon, 1883, p. 115 section *Nitidella.*

Mitrella densilineata (Carpenter), Keen, 1958, p. 388, fig. 477a type; x 5.

Original description.—

?*N.* testa ?*N. millepunctatam* forma et indole simulante, sed omnino nitida, anfractibus planatis, suturis indistinctis, striolis circa basim minimis; livida, lineolis aurantiaco-fuscis divaricatis, sæpe ziczac-formibus, densissime signata. Long. ·25, long. spir. ·15, lat. ·1 poll., div. 35°.

The opercula of these two species being unknown, their generic position remains doubtful. The same is true of the two following.

Dimensions.—Length, 6 mm.; diameter, 2.4 mm. (Keen).

Lectotype.—No. 4146, USNM herein designated. Specimen figured by Keen, 1958, fig. 477a. "One of Carpenter's type specimens."

Distribution.—Cape St. Lucas (Xantus) (type).

Mitrella millepunctata (Carpenter)

? *Nitidella millepunctata* Carpenter, 1864a, p. 48, Reprint, 1872, p. 220; Carpenter, 1864b, pp. 619, 669, Reprint, 1872, pp. 105, 155.
Columbella millepunctata Carpenter, Tryon, 1883, p. 115 section *Nitidella,* p. 198, pl. 63, fig. 68.
Mitrella millepunctata (Carpenter), Baker, Hanna, and Strong, 1938a, p. 248, pl. 24, fig. 9; M. Smith, 1944, p. 27; Keen, 1958, p. 389, fig. 483 copy Baker, Hanna, and Strong, 1938 not 1930.

Original description.—
?*N.* testa parva, nitida, livida; spira exstante, anfractibus subplanatis, suturis distinctis; anfr. nucl. lævibus, adolescentibus obsolete radiatim lirulatis, adultis lævibus; zona alba postica, suturam attingente, aurantiaco maculata; tota præter zonam superficie aurantiaco puncticulata, punctis minimis, creberrimis, in quincunces dispositis; apertura subquadrata; labro incrassato, intus vi.-dentato; labio exstante, a lirulis circa basim spiralibus indentato. Long. ·3, long. spir. ·17, lat. ·15 poll., div. 40°.
Differs from *Columbella albuginosa,* Rve., in its peculiar and constant painting.

Holotype.—Unknown.

Distribution.—Cape St. Lucas (Xantus) (type).

Mitrella santabarbarensis (Carpenter) Pl. 66, figs. 12-15

Columbella Santa-Barbarensis Carpenter, *in* Gould and Carpenter, 1856e [1857], p. 208; Carpenter, 1857c, pp. 228, 231, 341, 349 [error in distribution, see below]; Reeve, 1858, Conch. Icon., vol. XI, *Columbella,* pl. XXI, fig. 122.
Columbella Sta.-Barbarensis Carpenter, 1864b, pp. 535, 567, 625, Reprint, 1872, pp. 21, 53, 111 = *C. Reevei;* Pace, 1902, p. 132.
Columbella Reevei Carpenter, 1864b, pp. 535, 567, 625, Reprint, 1872, pp. 21, 53, 111; Tryon, 1883, p. 118, pl. 47, fig. 50 copy Reeve, 1858, pl. XXI, fig. 122 section *Mitrella;* Pace, 1902, p. 129; Palmer, 1945, p. 100.
Mitrella santabarbarensis (Carpenter), Pilsbry and Lowe, 1932, p. 116.
Mitrella santa-barbarensis (Gould and Carpenter), Keen, 1958, p. 390, fig. 486 copy Reeve.
"*Columbella*" *santa-barbarensis* Carpenter, Palmer, 1945, p. 100; Palmer, 1958, p. 212.

Original description.—Carpenter *in* Gould and Carpenter, 1856e, p. 208.
C. t. elongata, subconica, fusco-aurantia, albido varie picta; epidermide tenui, transversim striata, munita; anfr. vii. *subplanatis, suturis distinctis, spiraliter striatis, striis distantibus; apertura subquadrata, intus violascente; labro acutiore, vix sinuato, vix denticulato; labio parvo,*

plica unica canali contigua; anfr. primis sæpe decussatis.
Long. ·36, long. spir. ·18, lat. ·15, div. 40°.
Hab. Sta. Barbara (*Jewett*). Mus. Gould.
This elegant species is known by its faintly striated surface, violet-tinted, open mouth, and the extremely minute labral denticles. The discovery of this and other species of the genus in the Upper Californian province, corrects the error as to its northern limit in Forbes' Zoological Map. The markings of the two specimens sent vary, as in the next species.

Columbella Sta.-Barbarensis [so named to correct the statement that California was above the limit of the genus, proves to be a Mexican shell, and was probably obtained at Acapulco. Having been redescribed by Reeve from perfect specimens, it may stand as *C. Reevei*].—[Carpenter, 1864b, p. 535, Reprint, 1872, p. 21. Columbella Sta. Barbarbarensis, Cpr. Sta. Barbara. Not merely fainted striated, teste Cpr., but unusually grooved. [Modified from Reeve, 1858, pl. 21, fig. 122.] [Described from a worn specimen in Jewett's Col., and named to mark a more northern limit to the genus than had been assigned by Forbes. The label was probably incorrect, as the shell lives in the tropical fauna. C. S. Lucas, *Xantus*: Acapulco, *Newberry;* Guacomayo, Mus. Smiths. The name (as expressing error) should therefore be altered to *C. Reevei,* Cpr.] —[Carpenter, 1864b, p. 567, Reprint, 1872 p. 53.]

Because the specific name denoted an error in distribution, which he corrected, Carpenter renamed the species. Because the original name was not preoccupied such a precedure is not valid, and the original name must stand regardless of the species distribution.

The type material is at the Redpath Museum, McGill University. It consists of five specimens, mounted on an original Carpenter glass mount with his label, "type C. S. Lucas."

There is a specimen in the Gould Collection, New York State Mus. Gould Coll. A 4634 which Wm. Marshall, in segregating the shells, suggested that it might be the type of the species. Carpenter stated that the species "had been named from a worn specimen in Jewett Coll." and there are five specimens in the Carpenter Collection at McGill. The only suggestion that the Gould specimen might be the type is the label "Types A 4634" n.s.

Dimensions.—Length, 11 mm.; greatest diameter, 5 mm. (holotypes figured).

Syntypes.—No. 74, Redpath Museum, McGill University.

Distribution.—Cape St. Lucas (type).

Caducifer crebristriatus (Carpenter) Pl. 63, figs. 3, 4

Triton crebristriatus Carpenter, 1856c, p. 165; 1857c, pp. 284, 337; Carpenter, 1860d, p. 11.
Caducifer crebristriatus (Carpenter), Tomlin, 1927, p. 163; Keen, 1958, p. 398.

Original description.—Carpenter, 1856c, p. 165.
24. ? TRITON CREBRISTRIATUS, n.s. ? *T. testa* "T. picto" *plerumque simulante; sed striis crebris spiralibus cincta; albida rufo-castaneo dense maculata; apertura vix varicosa, intus simplici.*
Long. ·58, long. spir. ·34, lat. ·24, div. 30°.
Hab. In Sinu Panamensi; legit *T. Bridges.* Sp. un. in Mus. Cuming.
Is destitute of the expressed spiral ribs of *T. pictus* (s.g. *Epidromus,* H. & A. Ad. Gen. i. 103). The only specimen seen has no teeth in the aperture. It may be only on the verge of maturity, or it may belong to a Buccinoid genus.

Faint plications can be seen on the interior of the outer lip.

Dimensions.—"The height of the specimen is 0.68 'not 0.58' as in original description. The measurements of breadth and angle of divergence of the spire agree." (N. Tebble, per. com., Nov. 27, 1962.)

Holotype.—Reg. No. 19621120, BM (NH).

Distribution.—Panama (type); Coiba Is. west of Bay of Panama and Gorgona Is., Colombia (Tomlin).

Phos biplicatus Carpenter

Phos biplicatus Carpenter, 1856c, p. 166; 1857b, pp. 284, 343; Carpenter, 1860d, p. 12; Tryon, 1881, p. 220; Strong and Lowe, 1936, p. 314 under *P. veraguensis* Hinds, 1844, (p. 37).
Nassa (*Phos*) *biplicata* Carpenter, Mörch, 1861, p. 92.

Original description.—Carpenter, 1856c, p. 166.
25. PHOS BIPLICATUS, n. s. *Ph. testa subelevata, anfr.* viii. *parum rotundatis; costis radiantibus circiter* xi. *rotundatis, interstitiis concavis; liris spiralibus extantibus acutis, supra costas castaneo tinctis, quarum* vi. *in anfr. penult. videntur; apertura contracta; labro intus dense lirato, labio interdum rugoso; columella plica acuta, canalem definiente, altera obtusa, vix bifida, superante; canali acuto, recurvato, ad dorsum nodoso et infra carina acuta ornato; colore albido, purpureo-fusco tincto.*
Long. 1·05, long. spir. ·6, lat. ·64, div. 50°.
Hab. In Sinu Panamensi; legit *T. Bridges.* Sp. un. in Mus. Cuming.

Holotype.—Unknown. Not BM (NH).

Distribution.—Panama (type).

Latirus tumens Carpenter Pl. 67, figs. 1, 2

Latyrus tumens Carpenter, 1856c, p. 166.
Lathirus tumens Carpenter, 1857c, pp. 284, 338; Carpenter, 1860d, p. 11; 1872, Reprint, Index, p. 61.
Latirus tumens Carpenter, Melvill, 1891, . . . Mem. Proc. Manchester Lit. Philos. Soc., ser. 4, vol. 4, pp. 391, 405, 411, pl. 2, fig. 14; Tomlin, 1927, p. 159; Hertlein and Strong, 1951, p. 80 footnote; Keen, 1958, p. 416.

Original description.—Carpenter, 1856c, p. 166.
26. LATYRUS TUMENS, n. s. *L. testa* "L. gracili" *simillima, sed costis maxime tumentibus, attingentibus, sulcis spiralibus crebris ornata; plicis columellaribus* iii. *quarta obsoleta.*

Long. 2·78, long. spir. 1·57, lat. 1·44, div. 50°.
Hab. In Sinu Panamensi; legit *T. Bridges.* Sp. un. in Mus. Cuming.
In *L. gracilis* the spiral lines are few and raised; in this species numerous and impressed.

The holotype in the British Museum (Nat. Hist.) has the label, Loc. Panama Bay 1+ Cuming Coll. ex. Bridges.

Holotype.—Reg. No. 19621119 BM (NH).

Distribution.—Panama (type).

Tritonidea elata (Carpenter) Pl. 66, figs. 16, 17

Pisania elata Carpenter, 1864a, p. 49, Reprint, 1872, p. 221; 1864b, p. 619, Reprint, 1872, p. 105; Keen, 1958, p. 400 cf. *Cantharus.*
Tritonidea elata (Carpenter), Palmer, 1945, p. 100 Carpenter label.

Original description.—
P. testa minore, valde turrita, Latiroidea; alba, rufo-fusco antice et postice varie maculata seu strigata; anfr. nucl.? . . .; norm. vi., convexis, suturis impressis; costis radiantibus vi.-viii., obtusis, interstitiis undatis; lirulis spiralibus distantibus, in spira plerumque iii., aliis minoribus intercalantibus; canali angusto, subrecurvato; apertura subovata; pariete postice dentata; columella parum contorta. Long. ·68, long. spir. ·37, lat. ·29 poll., div. 38°.

Specimen in the Carpenter collection at McGill University is labelled "type Gulf of California Pederson." The specimen (Pl. 66, figs. 16, 17) is a shell covered with a calcareous incrustation. The general characters correspond to Carpenter's description, but it is strange that if the specimen which Carpenter had did have a calcareous covering that Carpenter did not mention it. Also the name of Pederson on the glass mount intimates that the shell is not the original. The original specimens were collected by Xantus from Cape San Lucas. There is doubt that the specimen figured is the type. The measurements do not equal those of Carpenter.

Dimensions.—Specimen figured, length, 32 mm.; 13 mm., greatest diameter.

? Holotype.—No. 87, Redpath Museum.

Distribution.—Cape St. Lucas (Xantus) (type).

Fasciolaria bistriata Carpenter *in* Gould and Carpenter

Fasciolaria bistriata Carpenter *in* Gould and Carpenter, 1857, p. 207; 1857c, pp. 228, 231, 338; Keen, 1958, p. 414 Gould and Carpenter.
Turbinella (*Fasciolaria*) *bistriata* Carpenter, Tryon, 1881, p. 97. "Possibly Latirus."

Original description.—Carpenter *in* Gould and Carpenter, 1856e, p. 207.
F. t. regulari, tenui, aurantio-fusca, epidermide tenui induta; anfr. ix.

quorum duo nucleosi læves, apice mamillato, subdeclivi; normalibus convexis sutura distincta; costis transversis (*in anfr. penult.* xvi.) *tumentibus sed planatis, attingentibus, interstitiis, parvis, ad basin evanidis; lirulis acutis spiralibus* (*in anfr. penult.* vi.) *et inter eas striulis crebris, costis transeuntibus, eleganter ornata; apertura ovali, albida; labro acuto, secundum lirulas intus sulcato; pariete secundum lirulas plicato; labio ad basin parvo, vix plicato canali elongato, subrecto.*
Long. 1·07, long. spir. ·42, lat. ·48, div. 50°.
Hab. Panama, teste Gould; sp. unic. in Mus. suo.
The columellar folds in this very elegant and delicate shell are indistinct, but are compensated by the continuations of the spiral lirulæ over the body whirl.

Holotype.—Unknown.
Distribution.—Panama (type).

Daphnella sinuata (Carpenter) Pl. 68, figs. 15, 16

Cithara sinuata Carpenter, 1856c, p. 162; 1857c, pp. 284, 332; Carpenter, 1860d, p. 9.
Mangilia [*sic*] *sinuata* (Carpenter), Tryon, 1884, p. 271.
Daphnella sinuata (Carpenter), Keen, p. 446.

Original description.—Carpenter, 1856c, p. 162.
11. ? Cithara sinuata, n. s. *C. testa trapezoidea, spira subelevata, marginibus excurvatis; albida, rufo-fusco varie tincta; anfr.* ix., *subrotundatis, sutura parum impressa, quarum* iii. *nucleosi, diaphani, læves, dein liris spiralibus et radiantibus fortiter cancellatis; normaliter lirulis radiantibus et striulis spiralibus tenue sculptis, in anfr. ult. subobsoletis; apertura lineata, canali anteriore haud profundo, curtissimo; labro acuto, ad dorsum calloso, sinu antico parvo, postico angusto, profundo, intus haud denticulato; labio parietali haud calloso.*
Long. ·43, long. spir. ·18, lat. ·17, div. 43°.
Hab. In Sinu Panamensi; legit *T. Bridges.* Sp. tria in Mus. Cuming.
Closely related to *Pleurotoma concinna,* C. B. Adams, Pan. Shells, No. 167, from the description of which it differs in the whorls not being angular, and the sculpture on the spire being coarser, instead of finer, than the rest.

Holotype.—Reg. No. 196314 BM (NH).
Distribution.—Panama (type).

Clathurella intercalaris (Carpenter) Pl. 68, figs. 17, 18

Defrancia intercalaris Carpenter, 1856c, p. 163.
Clathurella intercalaris (Carpenter), Carpenter, 1857c, pp. 284, 332; 1860d, p. 9; Tryon, 1884, p. 299.
Clathurella (*Clathurella*) *intercalaris* (Carpenter), Keen, 1958, p. 470.

Original description.—Carpenter, 1856c, p. 163.
14. Defrancia intercalaris, n. s. *D. testa graciliore, pallide castanea, fascia circa peripheriam pallidiore, spira elevata, marginibus rectis; anfr.* x. *rotundatis, suturis parum impressis; costis radiantibus supra circiter* xi. *rotundatis, interstitiis latis; infra aliis intercalantibus; lirulis spiralibus, subdistantibus, in spira plerumque* iii., *ad basin crebrioribus; rugulis radiantibus minutissimis tota superficie sub lente confertissime ornata; apertura ovali, canali brevi; labro margine acuto, vix serrato,*

intus denticulato, ad dorsum varice prominente, lateraliter compresso; sinu postico rotundato, aperto, sutura vix attingente, callositate parietali parva.
Long. ·64, long. spir. ·35, lat. ·24, div. 25°.
Hab. In Sinu Panamensi; legit *T. Bridges.* Sp. un. in Mus. Cuming.
With some of the characters of *Drillia,* and a loose resemblance to *Pleurotoma gracillima,* this shell seems to have most affinity with *Defrancia rava,* Hinds.

Holotype.—Reg. No. 196316 BM (NH).
Distribution.—Panama (type).

Clathurella rigida fuscoligata (Carpenter) Pl. 68, figs. 9-14

Mangelia ? rigida var. *fuscoligata* Carpenter, 1856c, p. 163; 1857c, p. 284.
Mangilia [*sic*] *rigida fuscoligata* Carpenter, Tryon, 1884, p. 269.
Clathurella (? *Clathurella*) *rigida fuscoligata* (Carpenter), Keen, 1958, p. 471.

Original description.—Carpenter, 1856c, p. 163.
13. MANGELIA ? RIGIDA, var. FUSCOLIGATA. *M. testa* "M. rigidæ" *simili; sed graciliore, costis acutioribus, lineis spiralibus minus expressis, fascia rufo-fusca super suturam plus minusve conspicua.*
Long. ·27, long. spir. ·15, lat. ·08, div. 28°.
Variat t. plus minusve elevata, seu latiore.
Hab. In Sinu Panamensi; legit *T. Bridges.* Mus. Cuming.
As far as can be judged from a comparison of nine specimens brought by Mr. Bridges with two of *M. rigida,* Hinds, this is a very variable species, differing in colour, strength of sculpture, solidity, or spiral elevation. *M. neglecta,* C. B. Ad., four specimens of which were found to vary, may also prove a brown variety of the same species.

Syntypes.—Reg. No. 196315 BM (NH).
Distribution.—Panama (type).

Clathurella serrata (Carpenter) Pl. 68, figs. 19, 20

Defrancia serrata Carpenter, 1856c, p. 163.
Clathurella serrata (Carpenter), Carpenter, 1857c, pp. 284, 332; 1860d, p. 9; Tryon, 1884, p. 299.
Clathurella (*Clathurella*) *serrata* Carpenter, Keen, 1958, p. 471.

Original description.—Carpenter, 1856c, p. 163.
15. DEFRANCIA SERRATA, n. s. *D. testa parva, turrita, marginibus spiræ excurvatis; albida, rufo-fusco fasciata; fascia aream sinus implente, dein circa basin continua; anfr.* viii. *convexis, costis rotundatis* xii., *circa basin obsoletis, et lirulis spiralibus costarum apices serrantibus,* iii. *in spiram monstrantibus, eleganter instructis; apertura subquadrata; labro ad marginem serrato, intus tuberculis* v., *ad dorsum varice valde prominente, ornato; sinu rotundato, lato; labio subrugoso.*
Long. ·3, long. spir. ·18, lat. ·12, div. 28°.
Hab. In Sinu Panamensi; legit *T. Bridges.* Sp. un. in Mus. Cuming.
Has the general aspect of *Mangelia rigida,* var. *fuscoligata;* and also resembles *D. rava,* Hinds.

Holotype.—Reg. No. 196317 BM (NH).
Distribution.—Panama (type).

Clavus (Elaeocyma) albolaqueatus (Carpenter)

Drillia albolaqueata Carpenter, 1864b, p. 669, Reprint, 1872, p. 155.
Mangelia albolaqueata Carpenter, 1865d, p. 280, Reprint, 1872, p. 273.
Mangilia [*sic*] *albolaqueata* Carpenter, Tryon, 1884, p. 251.
Clavus (*Elaeocyma*) *albolaqueatus* (Carpenter), Keen, 1958, p. 450, fig. 748a type.

Original description.—Carpenter, 1865d, p. 280.
M. *t. solida, turrita, alba, rudi, marginibus spiræ rectis; anfr. nucl.? . . .* [*decollatis*]; *norm. circ.* ix. *subrotundatis, costis circ.* xi-xv., *declivibus, satis angustis, postice obsoletis, lineis subregularibus spiram ascendentibus; lirulis spiralibus anticis crebris, postice obsoletis; basi elongata; labro? . . . ; labio calloso; sinu postico majore, suturam attingente.*
Long. ·88, long. spir. ·55, lat. ·34; div. 30°.
Hab. Panama (teste *Rowell*).
Described from an imperfect and worn specimen, but easily recognized by its ivory-white colour, and ribs in slanting rows, as though the creature were roofed with white tiles. It was erroneously quoted in the Brit. Assoc. Rep. 1863, p. 669, as a *Drillia*.

Keen figured and described the holotype, a worn shell.

Dimensions.—Holotype, 22 mm., length; diameter, 9 mm. (Keen).

Holotype.—No. 55393, USNM (Keen).

Distribution.—Panama (type).

Crassispira appressa (Carpenter) Pl. 61, fig. 4

Drillia appressa Carpenter, 1864a, p. 46, Reprint, 1872, p. 218; 1864b, p. 618, Reprint, p. 104; Tryon, 1884, p. 213.
Crassispira appressa (Carpenter), Dall, 1919, p. 22, pl. 7, fig. 2 type; Keen, 1958, p. 457, fig. 785 copy Dall.

Original description.—
D. testa parva, compacta; rufo-fusca, interdum supra costas pallidiore; marginibus spiræ excurvatis; anfr. norm. vi., planatis, suturis indistinctis; costis tuberculosis radiantibus circ. xiv., antice et postice obsoletis; striolis spiralibus creberrimis; costa spirali irregulari postica, tuberculosa, super suturas appressa; area sinus parvi vix definita; basi satis prolongata; apertura subquadrata; labio distincto. Long. ·3, long. spir. ·17, lat. ·12 poll., div. 40°.

The original material consists of one specimen, the type, in the USNM labelled "Type Cape St. Lucas J. Xantus." The holotype is worn with the nucleus missing. The longitudinal ribs were strong but now eroded. Fine spiral lines are preserved in the interspaces but worn on the longitudinal ribs. The shell is light brown. The suture is appressed, irregular; outer lip thick; canal short and wide.

Dimensions.—Length, 8 mm.; greatest diameter, 3.5 mm. (holotype).

Holotype.—No. 4087, USNM.

Distribution.—Cape St. Lucas (Xantus) (type).

Mangelia acuticostata Carpenter

Mangelia acuticostata Carpenter, 1856c, p. 162; 1856, p. 401; 1857c, pp. 284, 332; 1860d, p. 9; 1864b, p.550; 1863, p. 348, Reprint, 1872, pp. 36, 184 *M. neglecta* C. B. Adama, 1852.
Mangilia [*sic*] *acuticostata* Carpenter, Tryon, 1884, p. 321 = *M. neglecta* C. B. Adams, 1852.
Mangelia (? *Mangelia*) *acuticostata* Carpenter, Keen, 1958, p. 468.

Original description.—Carpenter, 1856c, p. 162.
1. MANGELIA ACUTICOSTATA, n. s. *M. testa parva, turrita, albida, rufo-fusco tincta; marginibus spiræ excurvatis; anfr.* vii. *subtumentibus, superne obtuse angulatis, sutura impressa; costis radiantibus acutis, angustis, circiter* ix. *subobliquis; interstitiis latis, confertissime et minutissime spiraliter striulatis; apertura subelongata; labro acuto, simplici, sinu rotundato, aperto; ad dorsum varice acuto, extante; labro tenui.* Long.·32, long. spir. ·16, lat. ·12, div. 30°.
Hab. In Sinu Panamensi; legit *T. Bridges.* Sp. un. in Mus. Cuming.
Intermediate between *M. rigida,* Hinds, and *M. striosa,* C. B. Adams.

Holotype.—Not found. Not BM (NH).

Discription.—Panama (type).

Mangelia cerea Carpenter Pl. 66, fig. 18

Mangelia cerea Carpenter, 1864b, p. 538, Reprint, 1872, p. 24; 1865i, p. 400, Reprint, 1872, p. 294; Palmer, 1945, p. 99.
Mangilia [*sic*] *cerea* Carpenter, Tryon, 1884, p. 251.
Mangelia (*Mangelia*) *cerea* Carpenter, Keen, 1958, p. 467.

Original description.—
M. testa *M. hamatæ* simili, sed textura cerea, aurantiaca, graciliore, anfractibus tumidioribus, haud angulatis; anfr. nucl. lævibus; normalibus v., costis radiantibus haud acutis, interstitia æquantibus; liris spiralibus validioribus, haud filosis, supra costas nodulosis, in interstitiis subobsoletis; apertura, testa adulta,? . . . Long. ·25, long. spir. ·14, lat. ·1, div. 28°.
Variat testa rufo-fusca.
Hab. Panama (teste *Jewett*).
Col. Jewett's unique specimen is not mature. It is distinguished from *M. hamata* by the smooth nucleus, waxen texture, rounder whorls, more equal distribution of the contour between ribs and interstices, and especially by the spiral sculpture, which is faint in the hollows, but nodulose on the ribs. Mr. Cuming has a specimen with the same texture, but of a rich brown colour.

The original collection consists of the holotype in the Carpenter collection at the Redpath Museum, McGill University. The label reads, "Mangelia cerea Cpr. Type Panama Jewett (comp. gemmulosa, C.B.A. 173)".

Holotype.—No. 91, Redpath Museum.

Distribution.—Panama (type).

Mangelia hamata Carpenter Pl. 66, fig. 10

Mangelia hamata Carpenter, 1864b, p. 538, Reprint, 1872, p. 24; 1851i, p. 399, Reprint, 1872, p. 293; Palmer, 1945, p. 99; Burch, 1946, #62, p. 27; Keen, 1958, p. 467.
Mangilia [*sic*] *hamata* Carpenter, Tryon, 1884, p. 251; Dall, 1919, p. 71.

Original description.—
M. testa carneo-aurantiaca, satis turrita, marginibus spiræ excurvatis; anfr. nucl. ii. globosis, tenuissime cancellatis, apice mamillato; norm. vi., subelongatis, in spira tumentibus, subangulatis, suturis impressis; costis radiantibus x.-xii., acutioribus, validis, circa basim prolongatam continuis; interstitiis concavis; lirulis spiralibus filosis, distantibus, supra costas transeuntibus, in spira iii.-iv.; apertura subelongata, quasi hamata, intus lævi, intense colorata; labro acuto, dorsaliter varicoso, postice valde sinuato. Long. ·24, long. spir. ·13, lat. ·1, div. 25°.
Hab. Panama (teste *Jewett*).
This very beautiful species is easily recognized by the varicose lip, sloping off to a sharp edge; by the deeply cut posterior notch, giving the smooth mouth a hooked appearance; by the sharp ridges, traversed by distant spiral threads; and by the flesh-tinted orange colour.

The original material consists of one specimen in the Carpenter Collection at the Redpath Museum labelled, "Mangelia hamata Cpr. type Panama Jewett".

Holotype.—No. 95, Redpath Museum.

Distribution.—Panama (type).

Mangelia subdiaphana Carpenter

Mangelia subdiaphana Carpenter, 1864a, p. 45, Reprint, 1872, p. 218; 1864b, p. 538, Reprint, 1872, p. 24; Hertlein and Strong, 1951, p. 79.
Mangilia [*sic*] *subdiaphana* (Carpenter), Tryon, 1884, p. 271.
Cytharella subdiaphana (Carpenter), Dall, 1919, p. 75, pl. 24, fig. 4, type.
Mangelia (*Agathotoma*) *subdiaphana* Carpenter, Keen, p. 468, fig. 866 copy Dall.

Original description.—
M. testa parva, subdiaphana, albida, interdum rufo-fusco pallide tincta; satis turrita, marginibus spiræ parum excurvatis; anfr. nucleosis iii., lævibus, diaphanis, apice mamillato; norm. iv., satis excurvatis, haud angulatis, suturis impressis; fascia super spiram pallide fusca, alteraque candida contigua; costulis radiantibus xvi.-xviii., acutis, subrectis distantibus, interstitiis undatis; tota superficie minute et creberrime spiraliter striata; basi producta, striis magis expressis; apertura subelongata; labro ad dorsum incrassato, postice distincte emarginato, intus haud dentato; labio tenuissimo; columella recta, antice late canaliculata. Long. ·19, long. spir. ·1, lat. ·06 poll., div. 30°.

Dimensions.—Holotype, alt. 5 mm. (*fide* Dall, 1919).

The type was figured by Dall in 1919 and copied by Keen, 1958.

Type.—Holotype, No. 16219 USNM (No. 274104, Dall, 1919).

Distribution.—Cape St. Lucas (type).

Pseudomelatoma penicillata (Carpenter) Pl. 61, figs. 1, 2

Drillia penicillata Carpenter, 1864b, p. 658, Reprint, 1872, p. 144; 1865g, p. 146, Reprint, 1872, p. 314; Cooper, 1867, p. 32; not Keep, 1887, p. 56, fig. 38; Tryon, 1884, p. 182, in part under *D. inermis* Hinds, 1843, p. 37.

Not *Pleurotoma* (? *Clionella*) *penicillata* (Carpenter), Weinkauff, 1887, p. 125, pl. 28, figs. 1, 4 copied by Tryon, 1884, pl. 12, fig. 40.

Pseudomelatoma penicillata (Carpenter), Dall, 1918, p. 317; Dall, 1919, p. 21, pl. 22, fig. 3; Grant and Gale, 1931, p. 560, pl. 26, figs. 5a, 5b, 18; Keen, 1958, p. 477, fig. 914 copy Dall; Palmer 1958, p. 232.

Drillia penicillata, n.s. Like *inermis*, with delicate brownish pencillings—[Carpenter, 1864b, p. 658, Reprint, p. 144].

Original description.—Carpenter, 1865g, p. 146.

D. t. D. inermi forma et indole simili; sed conerea, rufo-fusco dense penicillata; lineolis creberrimis, interdum diagonalibus, seu zic-zac-formibus, seu varie interruptis; anfractibus planatis, plicato-costatis, costulis circiter 14, *regione sinus minimi, lati, expansi interruptis, postice nodosis; canali effusa.—Long.* 1·35, *long. spir.* ·75, *lat.* ·42, *poll.: div.* 25°.

Hab. Cerros Is., basse Californie, *Veatch*.

Tous les individus que j'ai vus de cette espèce étaient excessivement roulés, mais on peut la reconnaître trèsfacilement à sa coloration élégante.

The original material consists of one specimen which is badly eroded. The outer lip is broken. The longitudinal ribs though worn smooth are conspicuously prominent and nodose just below the suture. The apical whorls are missing. The color is dark brown, lighter on the nodes and the longitudinal ribs, darker between. Under the lens the zigzag brown lines show distinctly and reveal the retral sinus on the body whorl. The zigzag lines show in the photograph herein (fig. 2).

Dimensions.—Length, 31 + mm.; greatest diameter, 11 mm. (apex broken) (holotype).

Holotype.—No. 6320, USNM.

Distribution.—Cerros Is., Lower California (type).

Laevitectum eburneum (Carpenter)

Drillia eburnea Carpenter, 1864b, p. 668, Reprint, 1872, p. 154; 1865d, p. 280, Reprint, 1872, p. 273; Tryon, 1884, p. 183.

? *Clathrodrillia* (*Laevitectum*) *eburnea* (Carpenter), Dall, 1919, p. 19, pl. 13, fig. 5 type. Type species *Lævitectum*.

Pseudomelatoma (*Laevitectum*) *eburnea* (Carpenter), Grant and Gale, 1931, p. 564; Keen, 1958, p. 478, fig. 914a copy Dall type.

Laevitectum eburnea Carpenter, Palmer, 1958, p. 56 type species.

Original description.—

D. t. turrita, carneo-albida, tenuiore, lævi, maxime nitente; margini-

bus spiræ rectis; anfr. nucl.? . . . [*decollatis*]; *norm. circ.* ix., *postice planatis, supra suturas appressis, medio satis excurvatis; hic et illic rugis radiantibus, obsoletis, irregularibus exsculpta; basi prolongata, canali conspicuo, aperto; sinu postico minore, in sulco lato, haud definito, spiram asendente sito; labro acuto; labio indistincto; columella planata.*
Long. 1·3, long. spir. ·8, lat. ·45; div. 30°.
Hab. Near Gulf of California (teste *Rowell*).
Easily recognized by its smooth glossy aspect and French-white colour; the notch lying along a broad spiral channel, which throws the junction of the whorl as it were up the suture.

The species was described from the Gulf of California.

Dall figured the holotype in 1919 which was copied by Keen (1958). Therefore, the illustration is not repeated herein.

Dimensions.—Alt., 30 mm. *fide* Dall, 1919.

Holotype.—No. 22817, USNM.

Distribution.—Gulf of California (type).

"Pleurotoma" gracillima Carpenter Pl. 68, figs. 7, 8

? *Pleurotoma gracillima* Carpenter, 1856c, p. 164; 1857c, pp. 284, 330; Carpenter, 1860d, p. 9; Tryon, 1884, p. 174 not Weinkauff, 1887, Conch. Cab., Bd. 1, p. 26, t. 5, f. 4, 5.

Original description.—Carpenter, 1856c, p. 164.
17. ? Pleurotoma gracillima, n. s. ? *P. testa gracillima, pallide castanea, spira acuta, elevata, marginibus rectis; anfr.* xii. *rotundatis, sutura impressa; costibus radiantibus subdeclivibus* xviii., *ad jugum acutis, interstitiis parvis; lirulis spiralibus acutis, quarum* iii. *sive* iv. *in spiram monstrantur, ad intersectiones nodulosis; carina infrasuturali haud extante; area sinus latiore, sublævi; tota superficie minutissime spiraliter striulata, in spira radiatim corrugulata; apertura ovali, canali subelongato; labro margine acuto, vix serrato, ad dorsum valde calloso; sinu antico parvo, postico rotundato, aperto, suturæ contiguo, haud attingente; callositate parietali vix monstrante.*
Long. ·83, long. spir. ·49, lat. ·24, div. 20°.
Hab. In Sinu Panamensi; legit *T. Bridges.* Sp. unicum in Mus. Cuming.
Has many of the characters of *Drillia* and *Defrancia;* but the canal appears long enough to give it a place among the true *Pleurotomæ.*

Holotype.—Holotype, Reg. No. 196319 BM (NH).

Distribution.—Panama (type).

Drillia punctatostriata Carpenter Pl. 68, figs. 5, 6

Drillia punctatostriata Carpenter, 1856c, p. 164; 1857c, pp. 284, 331; Carpenter, 1860d, p. 9; Tryon, 1884, p. 213.

Original description.—Carpenter, 1856c, p. 164.
16. Drilla punctatostriata, n.s. *D. testa intense purpureo-fusca, gracili, spira acuminata, marginibus excurvatis; anfr.* x. *satis rotundatis, suturis haud impressis; lirulis spiralibus acutis, distantibus, quarum* iii.-v. *in spira monstrantur, supra costis radiantibus inconspicuis circiter* xx. *obliquis, nodosis; juxta suturam carina haud extante; area sinus lineis*

incrementi costis convenientibus vix decussata; apertura elongata, intus haud denticulata, canali minimo; labro margine acuto, haud serrato, ad dorsum tumente; sinu antico minore, postico rotundato, profundo, faucibus coarctatis; labio haud calloso; tota superficie sub lente minutissime et confertim punctato-striata.
Long. ·75, long. spir. ·4, lat. ·26, div. 27°.
Hab. In Sinu Panamensi; legit *T. Bridges.* Sp. un. in Mus. Cuming.

Holotype.—Reg. No. 196318 BM (NH).

Distribution.—Panama (type).

Cytharella (Agathotoma) fusconotata (Carpenter)

Cithara fusconotata Carpenter, 1864a, p. 46, Reprint, 1872, p. 218: Carpenter, 1864b, p. 618, Reprint, 1872, p. 104; Palmer, 1958, p. 227.

See Palmer, 1958, page 227 for synonymy and Oldroyd, 1927, page 148 for copy of original description.

Holotype.—No. 4081, USNM. Photo not furnished.

Distribution.—Cape St. Lucas (Xantus) (type); Laguna Beach, California, to Gulf of California (Dall).

Atys (Aliculastrum) casta (Carpenter)

? *Atys casta* Carpenter, 1864a, p. 314, Reprint, 1872, p. 212; 1864b, p. 618, Reprint, 1872, p. 104; *Atys castra* [*sic*] typ. error in Palmer, 1958, p. 239; Keen, 1958, p. 496, fig. 987 of lectotype. See Palmer, 1958, p. 239 for synonymy, illustration of types, and discussion.

Original description.—
?*A.* testa elongata, tenui, subdiaphana, albida; antrorsum paulum tumidiore; spira celata, lacunata, (t. adultæ) haud umbilicata; columella paulum intorta, effusa; umbilico antico minimo; labro postice producto, obtuse angulato; tota superficie subtiliter spiraliter striatula. Long. 4·, lat. ·18 poll.
On the confines of the genus, related to *Cylichna.*

Lectotype (*Palmer, 1958*) *and paratype.*—No. 4014, USNM.

Distribution.—Recent, Cape St. Lucas (Xantus) (type); Catalina Island, California, to Gulf of California (Dall, 1921). Pleistocene. California (Willett, 1937).

Longchaeus adamsii (Carpenter)

Obeliscus ? conicus jun. C. B. Ad., Carpenter, 1857, pp. 409, 410 *fide* Dall and Bartsch, 1909, p. 21.
Obeliscus Adamsii Carpenter, 1864b, pp. 547, 551, Reprint, 1872, pp. 33, 37. New name for species 486 Mazatlan, Cat. 1856, p. 409.
Obeliscus variegatus Carpenter, 1864a, p. 46, Reprint, 1872, p. 219; 1864b, pp. 613, 618, 658, Reprint, 1872, pp. 99, 104, 144.
Pyramidella (*Longchaeus*) *adamsi* (Carpenter), Dall and Bartsch, 1909, p. 21, pl. 1, figs. 6, 6a.
Longchaeus adamsi (Carpenter), Palmer, 1958, p. 243. See for extended synonymy and discussion.

Obeliscus adamsii Carpenter was a new name for *O. conicus* which was described from Mazatlan and hence the type is with the Mazatlan Collection in the British Museum (Nat. Hist.). Type of *O. variegatus* is unknown.

Original description.—O. variegatus, Carpenter, 1864a, p. 46,
O. testa *O. hastato* simili; nitidissima, striolis incrementi exilissimis; livido et castaneo varie nebulosa; prope suturam cancaliculatam lineis albidis picta; hic et illic callositate alba interna; peripheria circa basin insculpta, unicolore; columella truncata, triplicata; plica superiore acuta, exstante, circa basim continua; plicis anticis parvis, spiralibus. Long. ·44, long. spir. ·3, lat. ·15 poll., div. 23°.
Obeliscus ? variegatus. S. Diego. (Also La Paz, Cape St. Lucas.).—[Carpenter, 1864b, p. 613].
Obeliscus variegatus. 2 worn sp. Described from a fresh Guaymas shell. Mus. Cal. Ac.—[Carpenter, 1864b, p. 618].
Obeliscus ? variegatus n.s. From Gulf fauna. Periphery with spiral groove. Colour-pattern clouded.—[Carpenter, 1864b, p. 658].

See Dall and Bartsch (1909) and Palmer (1958) for description and discussion.

Types.—Holotype, *O. adamsii* (*O. conicus*) BM(NH); *O. variegatus* unknown.

Distribution.—O. adamsii (*O. conicus*) Mazatlan, Sinoloa, west Mexico (type). *O. variegatus,* Cape St. Lucas (Xantus) (type).

Odostomia (Menestho) aequisculpta (Carpenter)

Odostomia (*Evalea*) *aequisculpta* Carpenter, 1864a, pp. 46, 47, Reprint, 1872, p. 219.
Odostomia (*Oscilla*) *aequisculpta* (Carpenter), Dall and Bartsch *in* Arnold, 1903, p. 284, pl. 1, figs. 3, 3a type.
Odostomia (*Menestho*) *aequisculpta* Carpenter, Dall and Bartsch, 1909, p. 191, pl. 20, figs. 3, 3a type same as 1903; Palmer, 1958, p. 248 see for synonymy and discussion.

Original description.—
O. testa parva, ovoidea, alba, subdiaphana; marginibus spiræ subrectis; vert. nucl. ? . . ., normaliter truncato; anfr. norm. iv., parum arcuatis, suturis impressis; tota superficie costulis spiralibus circ. xiv., quarum vi. in spira monstrantur, latis, planatis, æquidistantibus; interstitiis parvis; basi rotundata; apertura ovata; peritremate haud continuo; labro acuto; labio subobsoleto; plica juxta parietem conspicua, acuta, transversa; columella arcuata, rimulam umbilicalem formante. Long. ·07, long. spir. ·04, lat. ·03 poll., div. 40°.

The original material consists of one specimen in bottle on the original Carpenter glass mount labelled "Type Odostomia aequisculpta Cpr CSL".

The specimen has a mammillate nucleus. The shell is wide. It has spiral ribs with narrow interspaces over the surface. The aperture is entire. The callus small.

Dimensions.—Holotype, Length, 2 mm.; greatest diameter, 1 mm.

Holotype.—No. 16221, USNM.

Distribution.—Cape St. Lucas (Xantus) (type).

Odostomia (Iolaea) delicatula (Carpenter)

Odostomia (*Evalea*) *delicatula* Carpenter, 1864a, p. 47, Reprint, 1872, p. 219.
Odostomia (*Iolaea*) *delicatula* Carpenter, Dall and Bartsch, 1909, pp. 5, 181, 183, pl. 20, figs. 5, 5a type; Baker, Hanna, and Strong, 1928, p. 237, pl. 12, fig. 15.

Original description.—
O. testa tenuissima, alba, diaphana, nitente, elongata; marginibus spiræ eleganter excurvatis; vert. nucl. lævi, globoso, decliviter immerso; anfr. norm. iii., subplanatis, suturis impressis; liris subacutis, spiralibus, quarum v. in spira monstrantur; interstitiis latis, undatis, creberrime decussatis; basi elongata; apertura oblonga, peritremate haud continuo; labro tenui; labio vix conspicuo; plica juxta parietem exstante, declivi. Long. ·075, long. spir. ·04, lat. ·03 poll., div. 30°.

The original material consists of one specimen with the original Carpenter glass mount labelled, "Type Parthenia delicatula Cpr CSL".

The type was figured by Dall and Bartsch, 1909.

The type is white, the nuclear whorls are mammillate and moderately high. There are microscopic spiral ribs, three on the penultimate whorl. The wide interspaces have microscopic longitudinal striae. A plication is high on the columella and a sharp rib on the columellar area appears like a slight umbilicus.

Dimensions.—Holotype, length, 2 mm.; greatest diameter, 1 mm. My measurements do not coincide with those of Dall and Bartsch.

Holotype.—No. 4102, USNM.

Distribution.—Cape St. Lucas (Xantus) (type).

Odostomia straminea Carpenter

Odostomia ? *straminea* Carpenter, 1864b, pp. 624, 659, Reprint, 1872, pp. 110, 145.
Odostomia straminea Carpenter, 1865g, p. 146, Reprint, 1872, p. 314; Dall and Bartsch, 1909, pp. 4, 5; Palmer, 1958, p. 247.
Odostomia (*Evalea*) *straminea* Dall and Bartsch, 1907, p. 527; Dall and Bartsch, 1909, p. 206 under *O. tenuisculpta* Carpenter.
Like tall var. of *inflata,* with straw-coloured epidermis, not striulate.—[Carpenter, 1864b, p. 145.]

Original description.—Carpenter, 1865g, p. 146.

21. Odostomia straminea.
O. t. "O. inflatæ, var. elatiori" simili, sed multo elatiore; haud inflata, epidermide straminea, haud striulata.—Long. ·18, *long. spir.* ·08, *lat.* ·1, *poll.: div.* 40°.
Hab. basse Californie (sur la partie dorsale d'une *Haliotide, Rowell.*— Cap St.-Lucas, *Xantus.*
On peut facilement distinguer cette espèce de celles du Nord par sa spire allongée et son épiderme d'un jaune de paille.

Type.—Not found.

Distribution.—Cape St. Lucas (Xantus) (type).

Turbinella (Pyrgiscus) angusta (Carpenter)

Chrysallida angusta Carpenter, 1864a, p. 47, Reprint, 1872, p. 219; 1864b, pp. 618, Reprint 1872, p. 104; Hertlein and Strong, 1951, p. 95 includes footnote.
Turbinella (*Pyrgiscus*) *angusta* (Carpenter), Dall and Bartsch, 1909, p. 91, pl. 8, fig. 6 type.

Original description.—
C. testa parva, satis elongata, nitida, alba, sculptura minus expressa; marginibus spiræ parum excurvatis; vert. nucl. parvo, subito immerso, dimidium truncationis tegente; anfr. norm. v., planatis, elongatis, suturis minus impressis; costis radiantibus circ. xiii., plerumque lineis continuis marginibus utrinque parallelis, circa basim productam obsoletis; lirulis spiralibus angustis, in spira circ. v., interstitiis decussantibus, supra costas haud nodulosis; apertura ovali; peritremate parum continuo; labro tenui, translucido; labio tenui; plica juxta parietem parva, obtusa. Long. ·095, long. spir. ·065, lat. ·028 poll., div. 20°.

Dimensions.—Length, 2.3 mm.; diameter, 0.8 mm. (Dall and Bartsch).

Holotype.—No. 16212, USNM.

Distribution.—Cape St. Lucas (Xantus) (type).

Chemnitzia caelata Carpenter Pl. 63, fig. 11

Chemnitzia caelata Carpenter, 1864b, p. 538, Reprint, 1872, p. 24; 1865h, p. 400, Reprint, 1872, p. 294.
Chemnitzia hypocurta Dall and Bartsch, 1906, p. 347 new name for *C. caelata* Carpenter, 1865h not *Turbinella caelata* Gould, 1861, Boston Soc. Nat. Hist., Proc., Vol. VII, p. 406.
Turbinella (*Pyrgiscus*) *favilla* Dall and Bartsch, 1909, p. 78.
Turbinella (*Pyrgiscus*) *hypocurta* (Dall), Hertlein and Strong, 1951, p. 94.

Original description.—Carpenter, 1865h, p. 400.
C. testa satis magna, cinerea, elongata; anfr. nucl. ? . . .; norm. xiii., planatis, suturis vix impressis; costis radiantibus xx.-xxviii., rectis, haud semper convenientibus, subacutis, ad peripheriam subito truncatis; sulcis spiralibus in spira iv.-v., valde impressis, interstitia et costarum latera transeuntibus, juga haud superantibus; basi subito angustata, angulata, lirulis spiralibus circ. vi. ornata; apertura subquadrata; columella satis torta. Long. ·35, long. spir. ·3, lat. ·09, div. 13°.
Hab. West coast of North America (*Jewett*).
This beautiful and unique shell was probably from Panama; but there was no locality-mark. It is remarkable for its deep furrows and

the suddenly shortened and spirally sculptured base. It is much larger and broader than the northern *C. Virgo,* and differs in details of sculpture.

Dall and Bartsch renamed in 1906 Carpenter's *Chemnitzia caelata* because they thought it would be preoccupied by *Turbinella caelata* Gould. In 1909 they again renamed Carpenter's species for the same reason. Until the species is better known generically it seems best to retain the original name. The first name of Dall and Bartsch would be the one to use if necessary. Certainly not both names.

The type is in the Redpath Museum. It was on a Carpenter glass mount labelled "unique type Jewett."

Holotype.—No. 3136, Redpath Museum, McGill University.

Distribution.—Panama (?).

Umbraculum ovale (Carpenter) Pl. 64, figs. 2-5

Umbrella ovalis Carpenter, 1856c, p. 161; 1857c, pp. 284, 313; 1860d, p. 5; 1864b, p. 566, Reprint, 1872, p. 52; Reeve, 1858, Conch. Icon., *Umbrella,* vol. XI, pl. 1, fig. 3.

Umbraculum ovale (Carpenter), Pilsbry, 1895, p. 177, pl. 70, fig. 61 copy Reeve; Pilsbry and Lowe, 1932, p. 108; M. Smith, 1944, p. 44, fig. 588; Keen, 1958, p. 504, fig. 1012.

Original description.—Carpenter, 1956c, p. 161.

8. UMBRELLA OVALIS, n. s. *U. testa* "U. Indicæ" *simili; sed margine haud undulato, regulariter ovali; apice spirali, subprominente, minus inæquilaterali; epidermide tenui, haud nitente; adulta intus aurantia.* Test. jun. long. 1·93, lat. 1·58 poll.

Hab. Ad ostia fluminis Chiriqui, in Sinu Panamensi; legit *T. Bridges.* Sp. duo in Mus. Cuming.

Concerning this remarkable shell, hitherto only found in the old world, and, in spite of the bulk of its animal, not observed by either Mr. Cuming, Prof. Adams, or Mr. Hinds, Mr. Cuming writes that it was not only brought by Mr. Bridges, but also by a gentleman in Paris, who collected it exactly in the same place. Two specimens are in Mr. Cuming's collection, of which one, very much thickened, appears to have formed part of a much larger shell.

Syntypes.—Reg. No. 196313 BM (NH).

Distribution.—Mouth of Chirique R., Panama (type).

Melampus bridgesii Carpenter Pl. 67, figs. 14, 15

Melampus Bridgesii Carpenter, 1856c, p. 161; 1857c, pp. 284, 315; 1860d, p. 5; M. Smith, 1944, p. 45; Keen, 1958, p. 507 *M. bridgesii* synonym of *M. tabogensis* (C. B. Adams, 1852).

Original description.—Carpenter, 1856c, p. 161.

7. MELAMPUS BRIDGESII, n. s. *M. testa parva, ovali, nigro-fusca, nitida; anfr.* viii., *sutura haud impressa, in spiram tenue spiraliter striulata; marginibus spiræ regulariter excurvatis; apertura pyriformi, labro acuto, nec calloso nec dentato; columella triplicata; plicis, antica spirali,*

obliqua; media acuta, transversa, subparietali; postica parietali, parva. Long. ·28, long. spir. ·08, lat. ·12 poll., div. utraque parte variante. *Hab.* Ad ora Sinus Panamensis; legit *T. Bridges.* Sp. tria in Mus. Cuming.

Has the general appearance of *M. Adamsianus,* Pfr., from N. Ireland, but is much more slender, with a simple labrum.

Holotype.—Reg. No. 196312 BM (NH).

Distribution.—Panama (type).

Williamia peltoides (Carpenter)

Nacella peltoides Carpenter, 1864a, p. 474, Reprint, 1872, p. 213; 1864b, pp. 545, 618, Reprint, 1878, pp. 31, 104.

Williamia peltoides (Carpenter), Keen, 1958, p. 510, fig. 1033 copy Dall; Palmer, 1958, p. 259, pl. 25, figs. 15, 16 lectotype and paratype. See for synonymy, illustration, and discussion of types.

Described from Cape St. Lucas specimens.—(Carpenter, 1864b)

Original description.—

N. testa parva, lævi, cornea, subdiaphana, ancyliformi, apice elevato, valde inæquilaterali, strigis pallide castaneis radiata; intus nitidissima, subaurantia. Long. ·14, lat. ·11, alt. ·05 poll.

= *Nacella,* sp. ind., Maz. Cat. no. 262, p. 202.

Lectotype and paratype.—Lectotype, No. 4023 USNM; paratype, No. 1156, Redpath Museum.

Distribution.—Cape St. Lucas (Xantus) (type). Monterey, California, through Gulf of California (Grant and Gale; Woodring, Bramlette, and Kew, 1946).

AMPHINEURA

Acanthochiton arragonites (Carpenter) Pl. 68, fig. 1

Acanthochiton arragonites Carpenter, 1856, p. 198; 1857c, pp. 252, 318; 1860d, p. 6; 1864b, p. 622, Reprint, 1872, p. 108 *Acanthochites;* Palmer, 1945, p. 102 not type; Keen, 1958, p. 518.

Acanthochites arragonites (Carpenter), Pilsbry, 1893, p. 25.

This species was described from Mazatlan by Carpenter and, therefore, the type should be in that collection in the British Museum (Natural History). There is in the Redpath Museum a specimen (No. 31) labelled by Carpenter "*Acanthochiton arragonites* Cpr type C. S. Lucas Xantus".

This specimen cannot be a type. An illustration of that specimen is included. The figuring of the holotype belongs with that of the Mazatlan Collection.

Holotype.—British Museum (Nat Hist.).

Distribution.—Mazatlan, State of Sinoloa, west Mexico (type).

Ischnochiton adamsii (Carpenter) Pl. 68, figs. 2-4

Lepidopleurus Adamsii Carpenter, 1864b, p. 551, Reprint, 1872, p. 37; 1865c, p. 274, Reprint, 1872, p. 265.

Lepidopleurus C. B. Adamsii Carpenter, Palmer, 1945, p. 100.
Ischnochiton (*Ishnochiton*) *adamsii* (Carpenter), Pilsbry, 1892, p. 111, pl. 18, figs. 51-55; Keen, 1958, p. 520, fig. 11 copy Pilsbry.
Ischnochiton adamsii (Carpenter, 1863) Leloup, 1961, p. 1, pl. I, fig. 1; pl. II, fig. 1; text figs. 1, 2.

Original copy.—Carpenter, 1865c, p. 274.
L. *t.* "L. dispari" *simili; pallide rufo-fusca, colore intensiore irregulariter strigata seu maculata; sæpius maculis albidis regione diagonali ornata; jugo vix acuto; arcis centralibus et valvis terminalibus conspicue granulosis; areis lateralibus irregulariter verrucosis, verrucis plerumque lobatis; mucrone antico, vix conspicuo: intus, valvis centralibus uni-, terminalibus* viii.-x.*-fissis; subgrundis parvis, dentibus acutis; suturis medianis postice rectis, antice laminas haud attingentibus, sinu planato, latissimo: limbo pallii imbricatim squamoso.*
Long. ·6, lat. ·3 poll.; div. 110°.
Variat *verrucis minus expressis, simplicioribus.*
= *Chiton dispar,* C. B. Ad. no. 373, par.
= *Lophyrus adamsii*, P. Z. S., 1863, p. 24.

Unfortunately for those who do not like to remove the non-testaceous portion from their Chitons, as they do from their other shells, the mantle-margin by no means affords a safe clue to the structure of the valves. Among the species of the genus *Ischnochiton,* Gray, (= *Lepidopleurus,* Add.,) known by the sharp incisor-teeth lying within a projecting lip, there are three types of mantle-margin, which may be conveniently separated as subgenera, to aid in the difficult task of describing and identifying species. The typical forms, for which the name *Ischnochiton* should be retained, have the scales somewhat chaffy, and very finely striated. *I. magdalensis* and *I. sanguineus* well represent the group. But another series have the mantle-scales imbricate and strong, as in *Chiton,* Gray, (= *Lophyrus,* Add.,) from which they cannot be distinguished without dissection. For this Messrs. Adams's name *Lepidopleurus* may be retained in a restricted sense. It is uncertain what Risso's original genus was meant to include: his diagnosis applies to all Chitons with distinct side-areas and scaly margins.

A third group, separated by Dr. Gray in his 'Guide,' p. 182, as having the "mantle-scales minute, granular," has been named *Trachydermon*: it abounds in the Californian region.

The specimens of *L. adamsii* were found among the duplicates named *Chiton dispar* by the Professor; one was attached to *Discina cumingii.*

Seven specimens were on the original Carpenter glass tile in the Redpath Museum, labelled "Lepidopleurus C. B. Adamsii Cpr. type on Discina Cumingii Panama. C. B. Adams 372." Three specimens are figure herein.

Dimensions.—Length, 13.6 mm.; width, 10±mm.

Syntypes.—No. 42, Redpath Museum.

Distribution.—Panama (type). Nicaragua to Panama (Keen).

Ischnochiton conspicuus "(Dall)", Pilsbry

"Maugerella conspicua Carpenter" *nomen nudum; in* Dall, 1879, p. 296, pl. II, fig. 11; Palmer, 1945, p. 101. [Dall, 1879, U.S. Nat. Mus., Proc., Vol. 1]

Ishnochiton (*Stenoplax*) *conspicuus* Pilsbry, 1892, p. 63; Palmer, 1958, p. 270, pl. 35, figs. 1, 2. See for synonymy and discussion.

The nomenclature of this species is involved, but Carpenter is not the author of this species. Specimens used by Dall which may be types are in the Redpath Museum and were illustrated by Palmer, 1958 (pl. 35, figs. 1, 2).

"*Ischnochiton cooperi* var. *acutior* Carpenter" *nomen nudum;* Palmer, 1945, p. 101.

For discussion of this name and specimens in the Redpath Museum from Todos Santos Bay, Baja California, see Palmer, 1958 (p. 274). The Redpath specimens were illustrated by Palmer (1958, pl. 34, figs. 1-6). If the species is given status it must be ascribed to Dall, 1919.

Ischnochiton (Lepidozona) serratus Carpenter

Ischnochiton serratus Carpenter, 1864a, p. 315, Reprint, 1872, p. 213; 1864b, p. 618, Reprint, 1872, p. 104.
Lepidozona serrata (Carpenter), Keen, 1958, p. 526.
Ischnochiton (*Lepidozona*) *serratus* (Carpenter), Palmer, 1958, p. 275, pl. 32, fig. 5 see for synonymy, discussion, and figure of paratype.

Original description.—Carpenter, 1864a, p. 315.
I. testa parva, cinerea, olivaceo hic et illic, præcipue ad suturas, punctata, interdum sanguineo maculata; ovali, subdepressa, suturis indistinctis; tota superficie minutissime granulata; ar. diag. valde distinctis, costis latissimis obtusis ii.-v. munitis, interstitiis nullis; marginibus posticis eleganter serratis; ar. centr. costis acutis, parallelis, utroque latere circ. xii.; jugo obtuso, haud umbonato; costis transversis, subradiantibus, fenestrantibus, interstitiis impressis: mucrone mediano, obtuso; valv. term. costis obtusis ut in ar. diag., circ. xx.; intus valvarum mediarum lobis bifissis, terminalium circ. ix.-fissis; lobis suturalibus magnis: limbo pallii squamis majoribus, imbricatis, vix striatulis. Long. ·34, lat. ·2 poll., div. 115°.
Differs from *Elenensis* in the sculpture of the terminal valves.

Dimensions.—Paratype, length, 8 mm.; width, 7 mm.

Holotype.—No. 16204, USNM (lost); paratype, No. 98, Redpath Museum.

Distribution.—Cape St. Lucas (type); San Diego, California, to Gulf of California (Dall).

Ischnochiton tenuisculptus (Carpenter) Pl. 70, figs. 1-3

Lepidopleurus tenuisculptus Carpenter, 1864b, pp. 551, 553, Reprint, 1872, pp. 37, 39; 1865c, p. 275, Reprint, 1872, p. 266.
Ischnochiton tenuisculptus (Carpenter), Pilsbry, 1892, p. 112; Keen, 1958, p. 521.

Original description.—Carpenter, 1865c, p. 275.
L. *t.* "L. adamsii" *simili; olivacea, colore pallido seu intensiore minute*

variegata; tota superficie minute granulosa; areis lateralibus vix definitis; suturis plerumque albido maculatis; mucrone antico, satis conspicuo parte postica concava: intus, ut in "L. adamsii" formata
Variat: *t. pallidore, ad jugum rufo-tincta.*
=*Chiton dispar,* C. B. Ad. no. 373, pars.
The outside of this shell much resembles the young of *Chiton* (*Lophyrus*) *stokesii,* that specimens may have been distributed under that name. Very few individuals were found.

There are two specimens in the Redpath Museum on Carpenter glass mounts with the label, "Lepidopleurus tenuisculptus Cpr. (type) C. B. Adams ms pars 373 ? = C. B. Adams, var."

Holotype.—No. 126, Redpath Museum.

Distribution.—Panama (type).

Callistochiton elenensis (Sowerby)

Chiton elenensis Sowerby, 1832, Proc. Zool. Soc. London, p. 27 *fide* Pilsbry, 1892.
Ischnochiton Elenensis Carpenter, 1864b, pp. 552, 553, 618, Reprint, 1872, pp. 38, 39, 104; 1865c, p. 275, Reprint, 1872, p. 266.
Callistochiton elenensis (Sowerby), Pilsbry, 1892, p. 268, pl. 59, figs. 27, 28; Keen, 1958, p. 522, fig. 24 copy Pilsbry.

Pilsbry surmised that the Carpenter species based on a Panama specimen from the C. B. Adams collection was the *Chiton elenensis* Sowerby.

Callistochiton expressus (Carpenter) Pl. 69, figs. 7, 8

Ischnochiton (? var.) *expressus* Carpenter, 1864b, p. 552, Reprint, 1872, p. 38; 1865c, p. 275, Reprint, 1872, p. 266; Palmer, 1945, p. 101.
Callistochiton expressus (Carpenter), Pilsbry, 1892, p. 268; Keen, 1958, p. 522.

Original description.—Carpenter, 1865c, p. 275.
I. *t.* "I. elenensi" *simili, sed carnea; areis centr. clathris* x., *distantibus, crebre decussatis, jugo acuto; ar. lat. costis* ii., *validissimis, angustis, tuberculis angustis: intus marginibus suturalibus posticis planatis, haud tuberculosis, haud sinuatis; lam. insert. ut antea, sinu angusto, ad jugum angulato. Valva antica costis* x., *validis, angustis: intus ut antea, sed fissuris* viii. *Valva postica mucrone postico, planato; parte postica expansa, haud concava, costis circ.* vii. *validissimis: intus lamina circ.* vii.-fissa, *subgrunda planata.*
With a strong general resemblance to *I. elenensis,* the differences in detail in the only two specimens examined, as above stated, appear of specific importance. If only varietal, it is equally important to notice how much change is tolerated by the habits of the animal. It may be the shell called *Chiton clathratus* by Prof. Adams, of which there were no duplicates to compare. It offers a still more marked transition to *Callochiton,* the margin of the posterior valve being somewhat pectinated by the great projection of the ribs.

One specimen in the Carpenter Collection, Redpath Museum (No. 38) is labelled "type Panama C. B. Adams No. 395 rare

Comp. Chaetopleura jun." The specimen is figured herein. The specimen is not complete, consisting of only six separate mounted plates and part of the girdle.

Holotype.—No. 38, Redpath Museum.

Distribution.—Panama (type).

Callistochiton pulchellus (Gray) Pl. 62, figs. 1, 2

Chiton pulchellus Gray, 1828, Spicilegia Zoologica, pt. 1, p. 6, t. 3, fig. 9.
"Callochiton" pulchellus: diagn. auct. Carpenter, 1857c, p. 317; 1860d, p. 5; 1863, p. 362, Reprint, 1872, p. 198; 1865c, p. 276, Reprint, 1872, p. 267.
Callistochiton pulchrior Carpenter MS. [*nomen nudem*], Pilsbry, 1898, p. 272, pl. 59, figs. 21-26 = C. *pulchellus* Gray, 1828; Palmer, 1945, p. 101.

Original description.—Carpenter, 1865c, p. 276.

"CALLOCHITON" PULCHELLUS: diagn. auct.

Extus areis centr. lineis interdum parallelis, interdum radiantibus, rugose scrobiculatis; ar. lat. costis ii., *validissimis, imbricato-nodosis: valva antica costis similibus circ.* ix.*: v. post. area centrali lata; mucrone subpostico, planato; parte postica costis* vii. *similibus, medianis curtissimis, excurvatis: pallio squamulis minutis imbricatis. Intus v. ant. subgrunda (ut in* Ischnochitone) *munita, sed a costis pectinata; dentibus acutis, intus linea undulata secundum costas instructa, extus concavis, parte convexa costarum incisis: v. medianis similiter pectinatis, laminis secundum costas diag. uniscissis: laminis suturalibus medio continuis, late sinuatis; suturis posticis a sculptura externa granulatis: v. post.* vii.*-lobata, marginibus planatis, laminis dense compressis incrassatis; dentibus obtusissimis, appressis, haud extantibus subobsoletis, extrorsum planatis, ut in v. ant. fissis; interdum fissuris quoque in partibus concavis.*

As I have seen no published diagnosis of the very peculiar type of insertion-plates observed in this species, which has hitherto been too rare to allow working naturalists an opportunity of dissection, I have given a minute description. The plates of insertion, as well as the exterior eaves, are scalloped by the strong ribs, and alternate with them. In the posterior valve the eaves are flattened outwards, in closely appressed layers, the blunt, ill-developed insertion-teeth lying flat upon them. The valves easily separate from the mantle, when immersed in water. Outside, the species is easily recognized by the two strong ribs of the diagonal areas, the central pitted in somewhat branching rows, and the ribs on the curiously flattened posterior valve resembling a clenched fist.

There are six specimens in Redpath Museum (No. 47) which are labelled "*C. pulchior* Cpr. type No. 375 Panama C. B. Adams = *pulchellus* C. B. Adams non Gray (on *C. neara* var. *Lessonii* C. B. Adams 348)". One small specimen is marked.*

Apparently Carpenter did not use the specimen in the Adams collection which he had indicated in 1863 but chose specimens in his own collection for the description of the species. The syntypes illustrate the features which Carpenter pointed out.

Pilsbry (1898) made no reservations about including Carpenter's *pulchellus* and *pulchrior* under *Callistochiton pulchellus* (Gray). Included herein is a photograph of one of the "syntypes" of "C. pulchrior Cpr. MS" which appears to confirm Pilsbry's judgment. This discussion is not to describe *C. pulchellus* (Gray) but only to include the data concerning the Carpenter material.

Dimensions.—Length, 8 mm.; width, 4.5 mm. (largest specimen, Redpath Mus. No. 47).

Specimens.—No. 47, Redpath Museum (*C. pulchrior* Cpr. MS.).

Distribution.—Panama (*C. pulchrior* Cpr. MS).

Chaetopleura parallela (Carpenter) Pl. 70, figs. 5, 6

Ischnochiton parallelus Carpenter, 1864a, p. 314, Reprint, 1872, p. 212; 1864b, p. 618, Reprint, 1872, p. 104; Keen, 1958, p. 524 in synonymy of *Chaetopleura lurida* Sowerby.

Chaetopleura parallela (Carpenter), Oldroyd, 1927, vol. II, pt. III, p. 287; Palmer, 1945, p. 100; Palmer, 1958, p. 267.

See Palmer for synonymy and description of types. The illustrations of the types are included herein.

Original description.—Carpenter, 1864a, p. 314.

I. testa ovata, subelevata (ad angulum 120°); rufo-fusca, olivaceo tincta; valvis latis, marginibus parum rotundatis, interstitiis parvis; valvis intermediis valde insculptis; areis lateralibus seriebus granulorum a jugo radiantibus circiter vi.; interdum irregularibus, granis rotundatis, separatis, extantibus; areis centralibus clathris creberrimis, jugo parallelis, horridis, extantibus, interdum granulosis, ornatis; valvis terminalibus seriebus granulorum, circ. xx., interdum bifurcantibus, ut in areis lateralibus, ornatis; mucrone vix conspicuo; limbo pallii angusto, pilulis furvicaceis creberrimis minutis conferto; lobis valvarum bifidis, terminalibus fissuris circ. xi. a parte externa simplici disjunctis. Long. ·7, lat. ·48, alt. ·16 poll.

Belongs to the group with minute setose scales.

The original material consists of one specimen in the U.S. National Museum and one specimen in the Redpath Museum.

The USNM type has a label, "Chaetopleura lurida Sby var. parallelus Cpr cotype". Another label by Dall was included with the specimen "Chaetopleura scabriculus Sby (Probably = columbiensis Sby) = parallela Cpr (type)". The specimen is encrusted with Bryozoa which cover the sculpture. In the exposed middle portion the ridges are parallel. The sides are crossed by beaded ridges. The sculpture is more clearly seen on the syntype in the Redpath Museum. The Redpath specimen is on an original Carpenter glass mount labelled "type C.S. Lucas Xantus = ? *Columbiensis*".

Dimensions.—Length, 21 mm.; width, 13 mm., USNM syntype.

Syntypes.—No. 4017, USNM; No. 46, Redpath Museum.

Distribution.—Cape St. Lucas (type). San Diego, California, to Cape San Lucas, Lower California (Dall). West Colombia (Burch).

Chaetopleura prasinatus (Carpenter) Pl. 70, fig. 4

Ischnochiton (? var.) *prasinatus* Carpenter, 1864a, p. 314, Reprint, 1872, p. 213; 1864b, p. 618, Reprint, 1872, p. 104.
Chaetopleura lurida Sowerby var. *prasinata* (Carpenter), Pilsbry, 1892, p. 34.
Chaetopleura prasinata (Carpenter), Dall, 1921, p. 193; Oldroyd, 1927, vol. II, pt. III, p. 287; Burch, 1947, No. 68, p. 4 cf.; Keen, 1958, p. 524 copy Pilsbry; Palmer, 1958, p. 267 which see.

Original copy.—Carpenter, 1864a, p. 314.
I. testa *I. parallelo* forma et indole simili, sed vivide viridi; ar. diag. seriebus bullularum irregulariter ornatis; ar. centr. clathris valde extantibus, acutis, jugo obtuso parallelis, utroque latere circ. xvi.; valv. term. seriebus bullularum circ. xviii.; mucrone submediano, inconspicuo; umbonibus haud prominentibus; tota superficie minutissime granulosa: intus valvarum lobis mediarum i.-term. circiter x.-fissis; sinu lato, planato; suturis planatis; limbo pallii angusto, minutissime squamulis furvicaceis creberrime instructo; interdum pilulis intercalatis. Long. ·8, lat. ·4 poll., div. 125°.

The original matter in the USNM consists of eight separate plates and three fragments. The included photograph is of the assembled plates. It shows radiating rows of rounded pimples with alternating dark and light bands. The vertically raised ribs on the middle plates are crossed by oblique partially and irregularly nodose rays.

Dimensions.—Widest plates, width, 10 mm.; height, 4 mm.

Holotype.—No. 15892, USNM.

Distribution.—Cape St. Lucas (type). San Diego, California, to Cape St. Lucas, Lower California (Dall).

Pallochiton lanuginosus Dall or Pilsbry

Hemphillia langinosus Carpenter MS. *nomen nudum,* Palmer, 1945, p. 101.

For synonymy, illustration, and discussion of the nomenclature of this species see Palmer, 1958 (p. 268). A "syntype" of one of the specimens probably used by Dall in the study of Carpenter's manuscript notes was illustrated by Palmer (1958, pl. 27, fig. 7 Redpath Museum).

The type locality is Lower California, the subarea of which will be settled by the decision of authorship of the specific name.

"Lepidopleurus pectinulatus" Carpenter and *"Lepidopleurus pectinatus"* Carpenter

For discussion of these names see Palmer, 1958 (p. 272, pl. 31, figs. 5, 6). A specimen in the Redpath Museum No. 70 is labelled "type La Paz Pease". As pointed out in 1958 the label must be an error or mixed.

SPECIFIC NAMES MISAPPLIED TO CARPENTER

Cytharella aculea Dall

The name *C. aculea* given by Dall (1919, p. 74, Cat. No. 73994 USNM) for a turrid species was suggested by a manuscript name of Carpenter. Dall pointed this out, "The name was suggested by Doctor Carpenter". Labels in collections attributed to Carpenter should be credited to Dall as Carpenter never described the species.

Crassispira melchersi ("Cpr.") in M. Smith, 1944, page 39 should be Menke, 1851, Zeit. Mal., p. 20 not Carpenter.

Dentalium semipolitum "Carpenter" *in* Stearns, 1894, p. 158 not Carpenter = Broderip and Sowerby, 1829 (p. 369).

Ocinebra (*Muricidea*) *squamulifer* "Carpenter", Stearns, 1894, p. 185; *"Muricidea squamulifera* Pfeiffer", M. Smith, 1939, p. 11. Not Carpenter. Carpenter's specific name was *squamulata*. See *Muricopsis squamulata* herein.

NOMINA NUDA

"Modiola planata" Carpenter is a *nomen nudum* (Palmer, 1958, p. 73). The name was never described or mentioned in literature by Carpenter. It was used by Tomlin (1928, Jour. Conch., vol. 18, No. 7, p. 192) in a list but the species was not described by Tomlin hence it remains a *nomen nudum* as of Tomlin also. Tomlin stated that he had taken the name from the British Museum (Natural History) collection. Three specimens (double valves) labelled by Carpenter "MS. type Beach at Panama Bradley", are in the Redpath Museum No. 108. The labels of the specimens in the two museums ought to have the name deleted. Manuscript names creep

into literature, as in the case of Tomlin, and cause unnecessary search by workers.

"Lucina capax" nomen nudum.

Lucina capax Carpenter, 1864a, p. 553, Reprint, 1872, p. 39 not "69" as in Dall; *Lucina* (*Diplodonta* ?) *capax* Carpenter, Dall, 1901a, pp. 796, 802 Panama.

This name is a *nomen nudum.* It appeared only in one of Carpenter's lists and was never described.

Chione undatostriata Carpenter is a *nomen nudum* (Palmer, 1945, p. 99).

There is a specimen in the Carpenter Collection, Redpath Museum, No. 113 labelled *"Chione undatostriata* Cpr. type Todos Santos Bay Hemphill". The species was never described by Carpenter.

Tellina amplectans Carpenter, 1864b, is a *nomen nudum.*

Tellina (*Angulus*) *amplectens* Carpenter, 1864b, p. 669, Reprint 1872, p. 155; 1865d, p. 279, Reprint, 1872, p. 272.

Carpenter in 1865d, page 279 corrected the name (*Tellina decumbens* which see herein) by stating, "The name was printed by an oversight in Brit. Assoc. Rept. 1863, p. 669, as *A. amplectens;* but as it was unaccompanied by a diagnosis, and does not describe the shell, no confusion will arise from reverting to the name first given".

Phasianella rubrilineata Strong

Phasianella rubrilineata Carpenter is a *nomen nudum.* The name was validated by Strong, (1928, p. 197). See Palmer, 1958, page 150.

"Cerithium rissoinoides Cpr." is a *nomen nudum.* There is a specimen in the USNM, No. 56023 which is labelled "Cerithium rissoinoides Cpr. type Gulf of Cal. Stearns". The writing is Carpenter's, and one label states "unique type". Apparently a description of the shell did not mature.

Rhizocheilus distans Carpenter is a *nomen nudum.*

Rhizocheilus distans Carpenter, 1857b, Cat. Mazatlan Shells, p. 484 footnote variety of "R. niveus, A. Ad."; 1863, p. 344, Reprint, 1872, p. 180; 1864b, pp. 548, 549, Reprint, 1872, pp. 34, 35.
Coralliophila distans (Carpenter), Tomlin, 1927, p. 164 *nomen nudum.*

The name *Rhizocheilus distans* was first mentioned by Carpenter in a footnote in the Mazatlan Catalogue and thereafter in his writings, but Carpenter never published a description to go with the name. The name, therefore, remains a *nomen nudum.*

"Mazatlania limans Carpenter" *in* Pilsbry and Lowe, 1932, p. 118 Acapulco is a *nomen nudum.* Carpenter did not describe or name such a species. It probably is supposed to be the same as *"Euryta limans* Cpr." which is apparently a manuscript name attached to a shell in the USNM, No. 56306. This name is also a *nomen nudum.* The specimen has a label "Euryta [filosa marked out] limans Gulf Stearns type". Pilsbry may have seen this specimen and used the name thinking Carpenter had described the form. *Mazatlania* was a name Dall (1900) composed to replace *Euryta* Adams, 1853 which was preoccupied by that of Gistl, 1848.

Polinices (var.) *fusca* Carpenter is a *nomen nudum.* It was indicated by Carpenter in 1864b (pp. 523, 625 Reprint, 1872, pp. 9, 110) as *"Natica otis* [var. = *fusca,* Cpr.]" page 523 and *"Polinices otis* et var *fusca.* Rare; dead." from Panama, Acapulco, Mazatlan, and Galapagos, page 625. Tryon, 1886, page 44 (pl. 12, fig. 2) placed it as a synonym of *Natica otis* Broderip and Sowerby, 1829, as did Stearns, 1894 (p. 196).

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Starting on page 209, sheet 134, published on 26th Jan. 1857
Starting on page 313, sheet 320, published on 10th Mar. 1857
(Part 24)

PLATES

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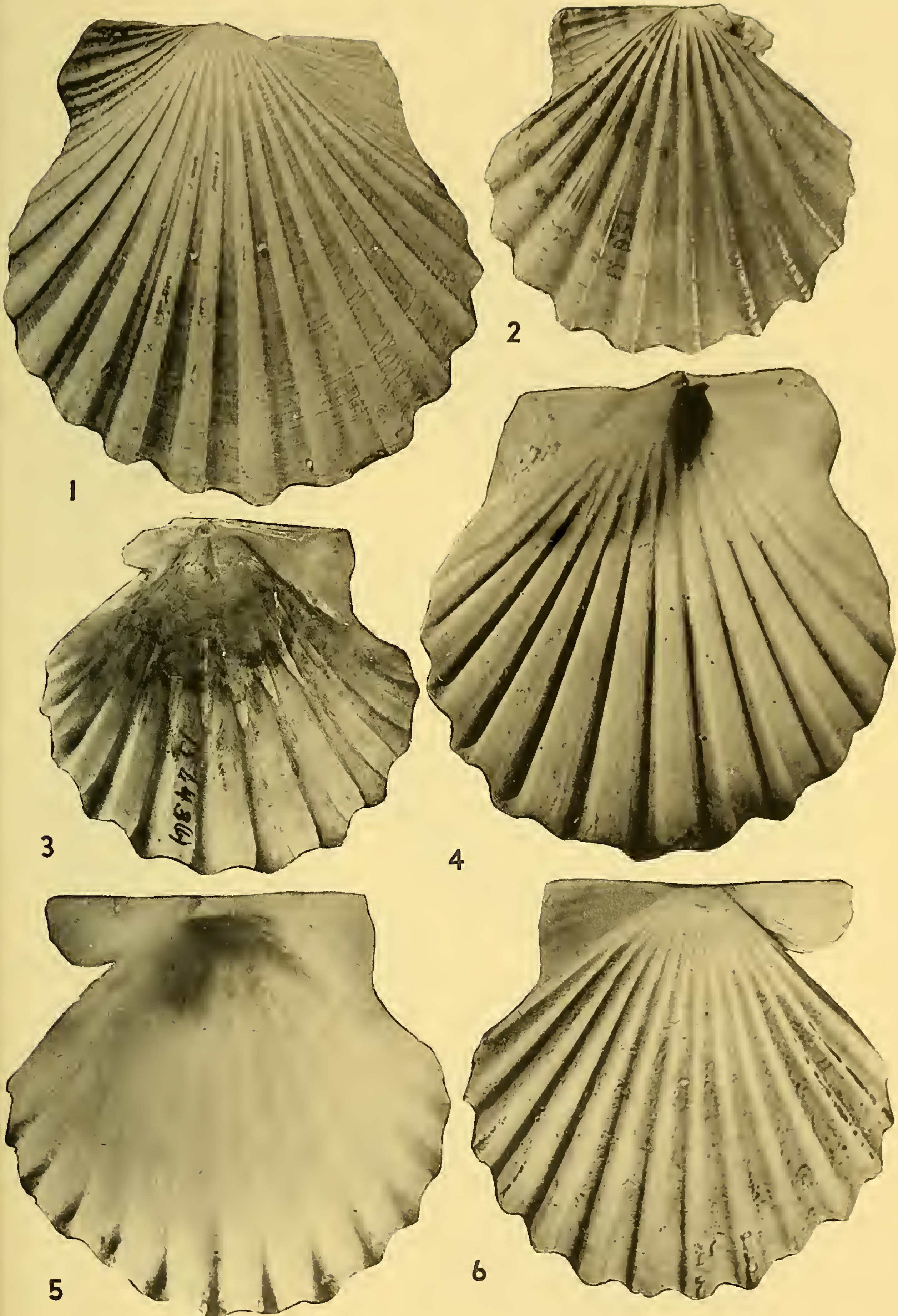
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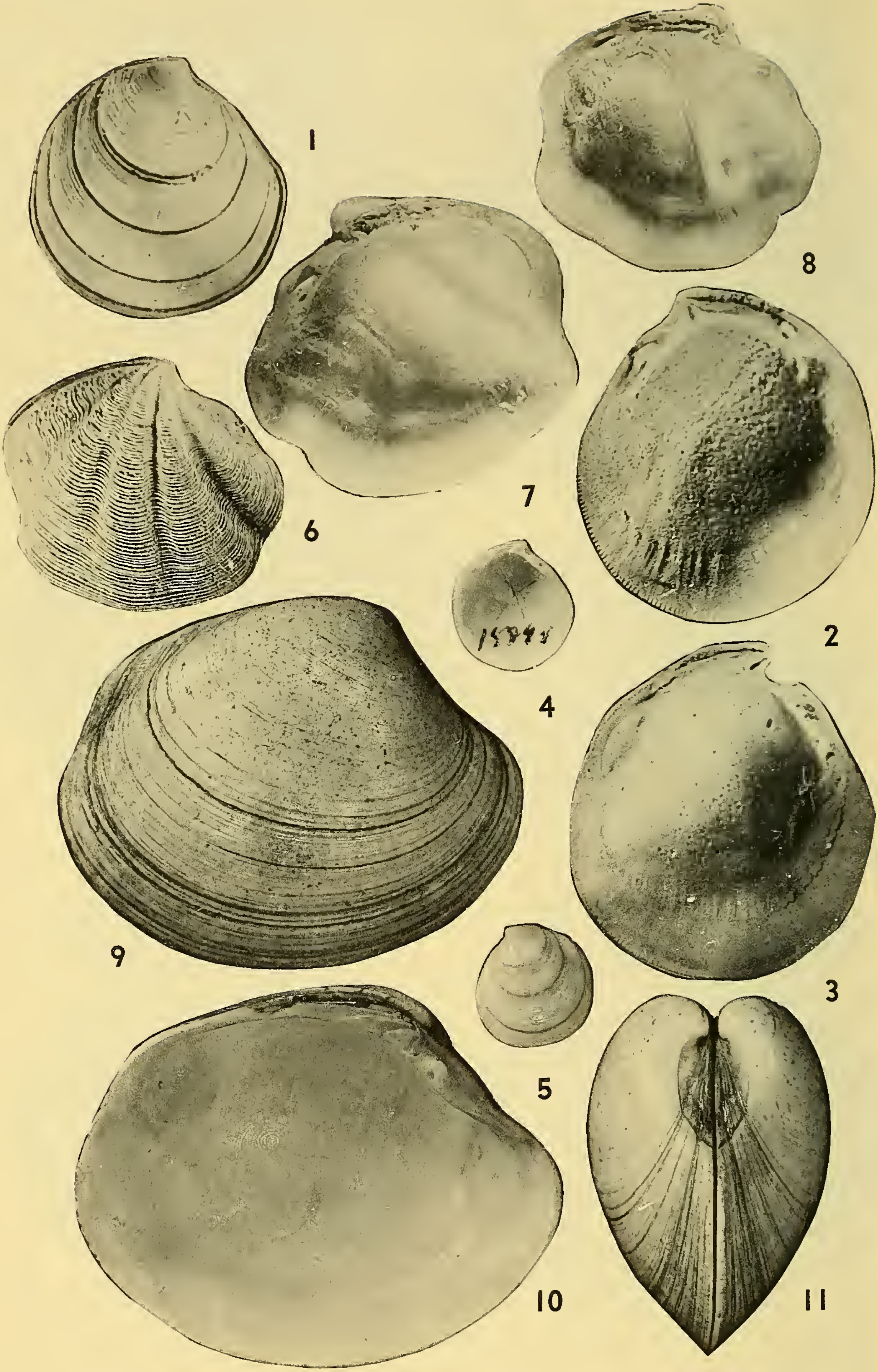
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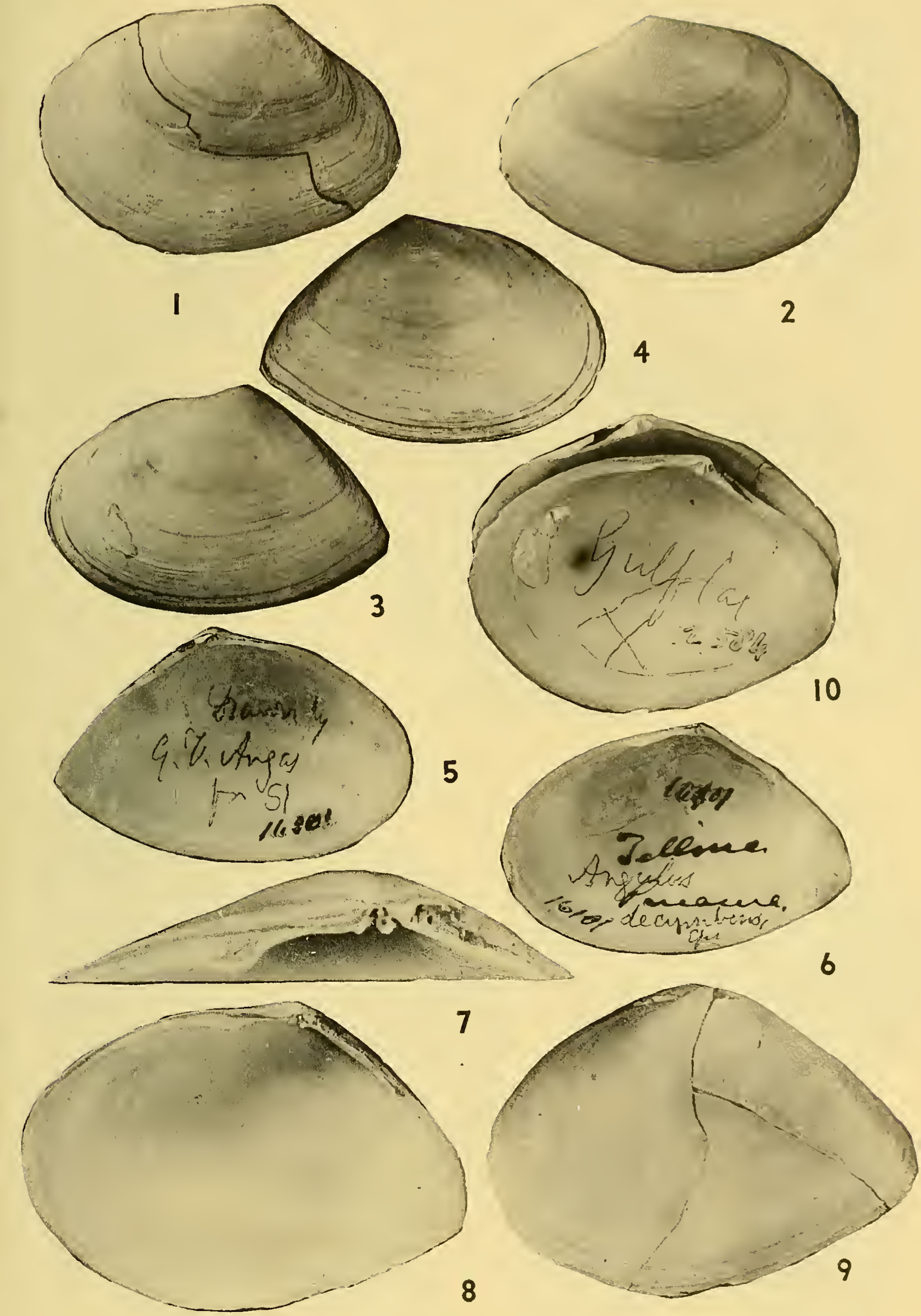
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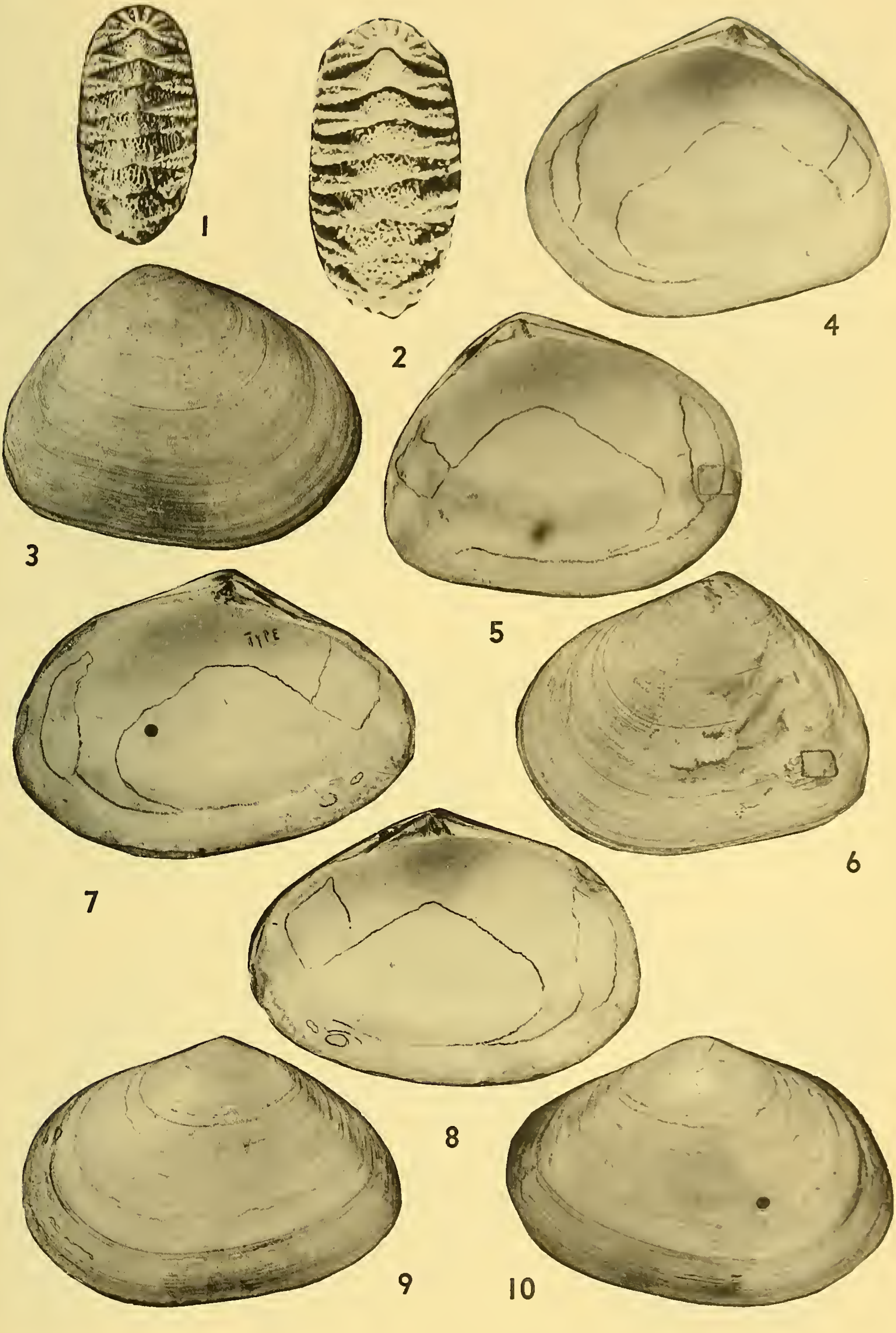
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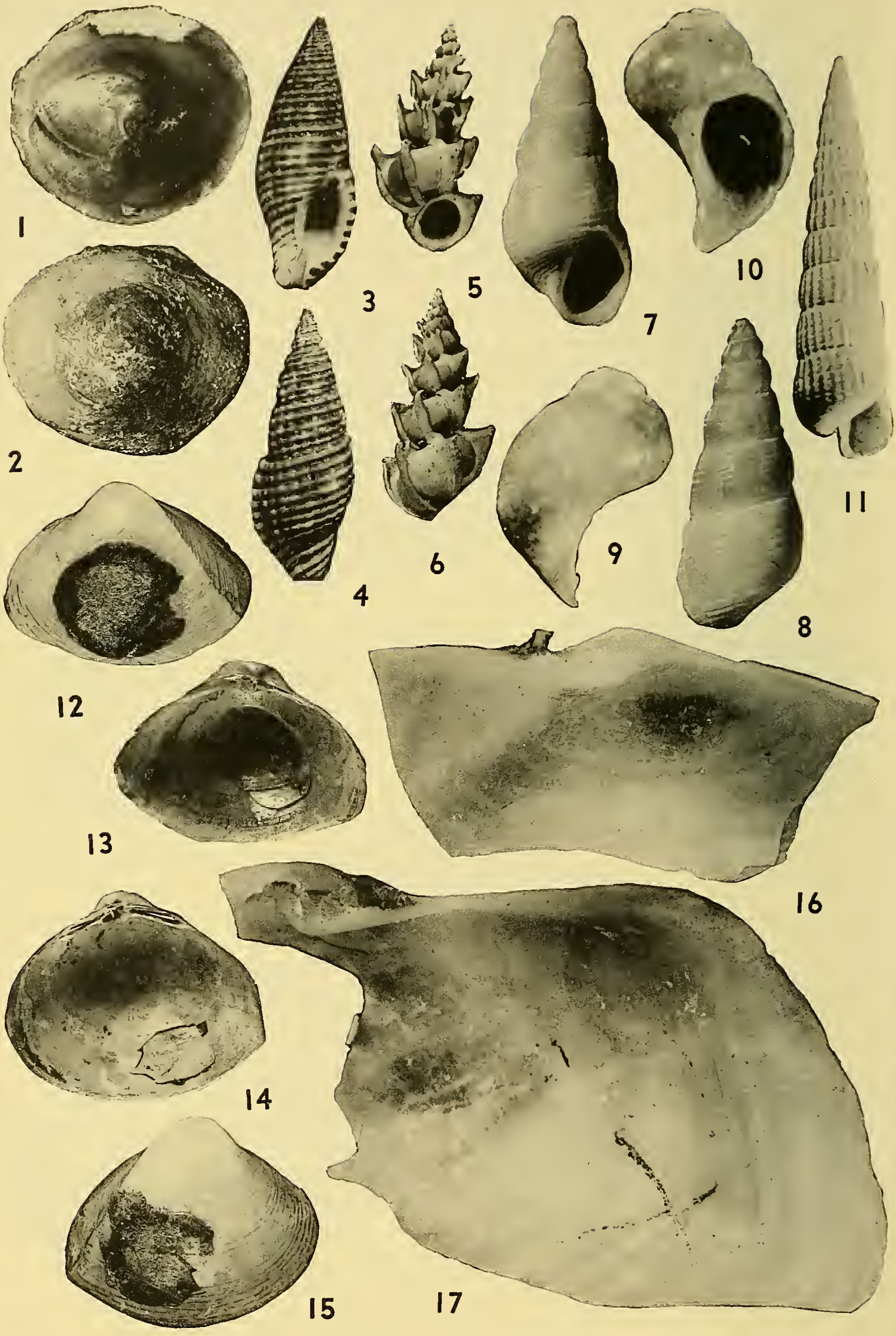

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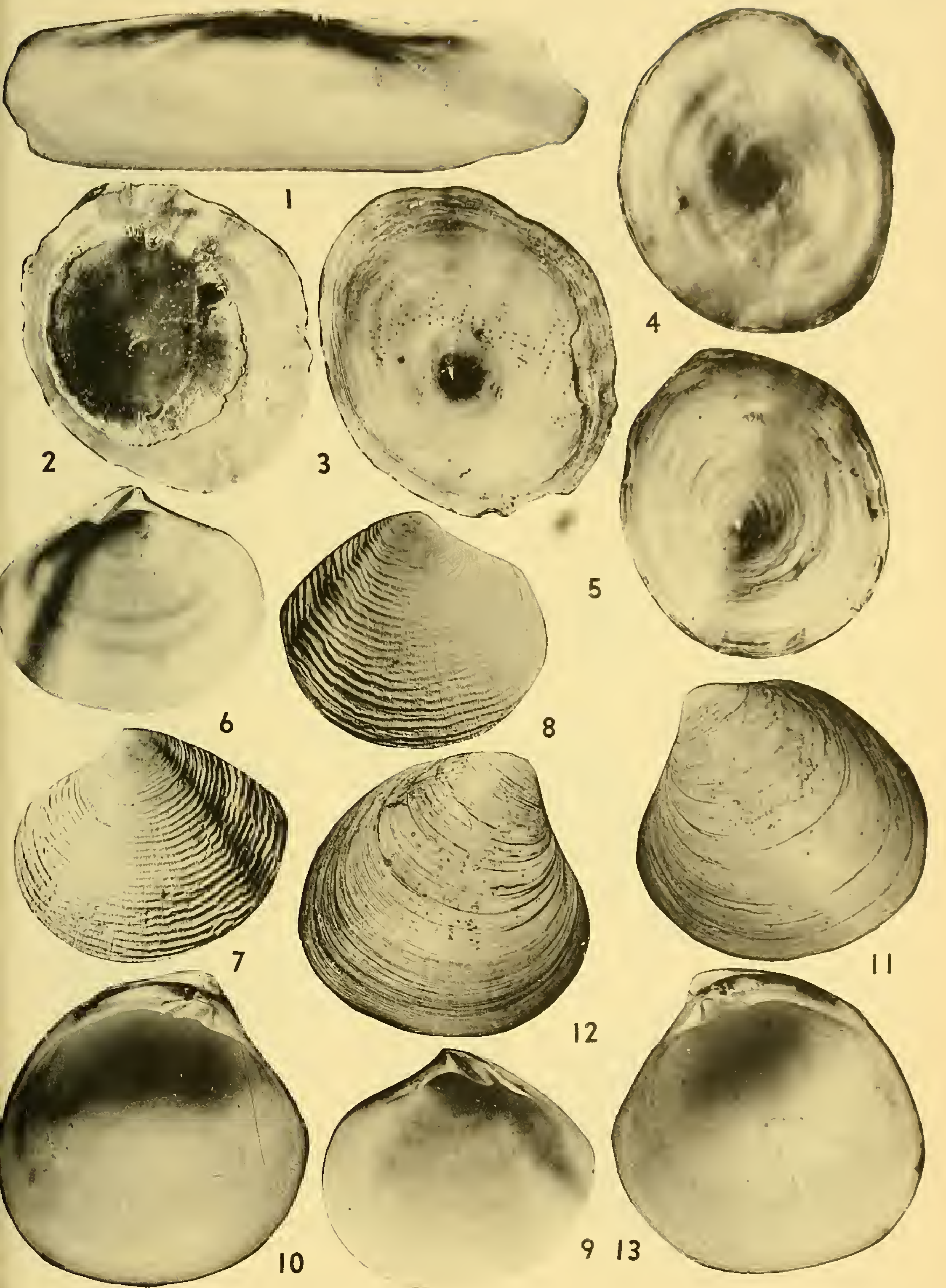
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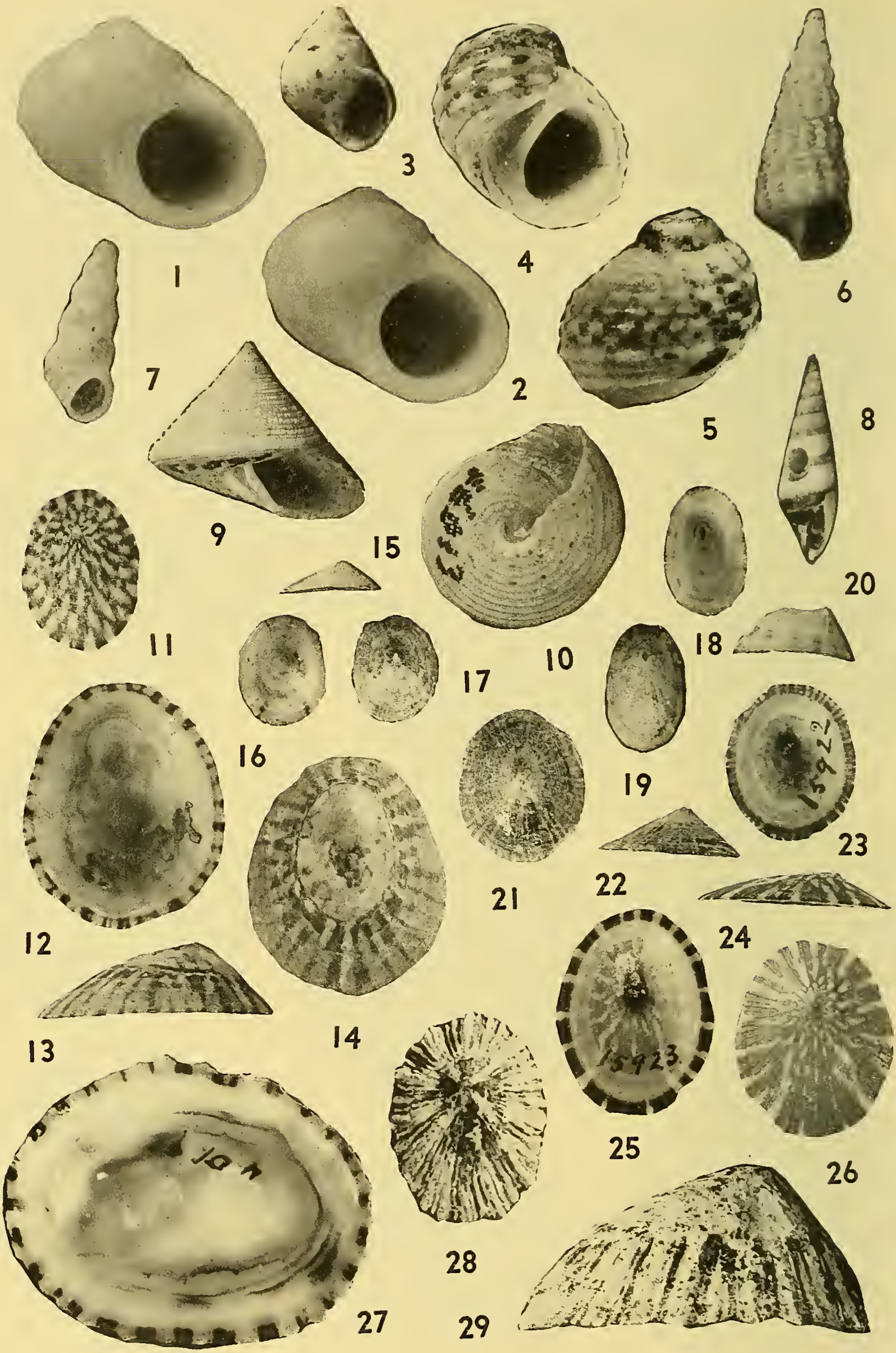
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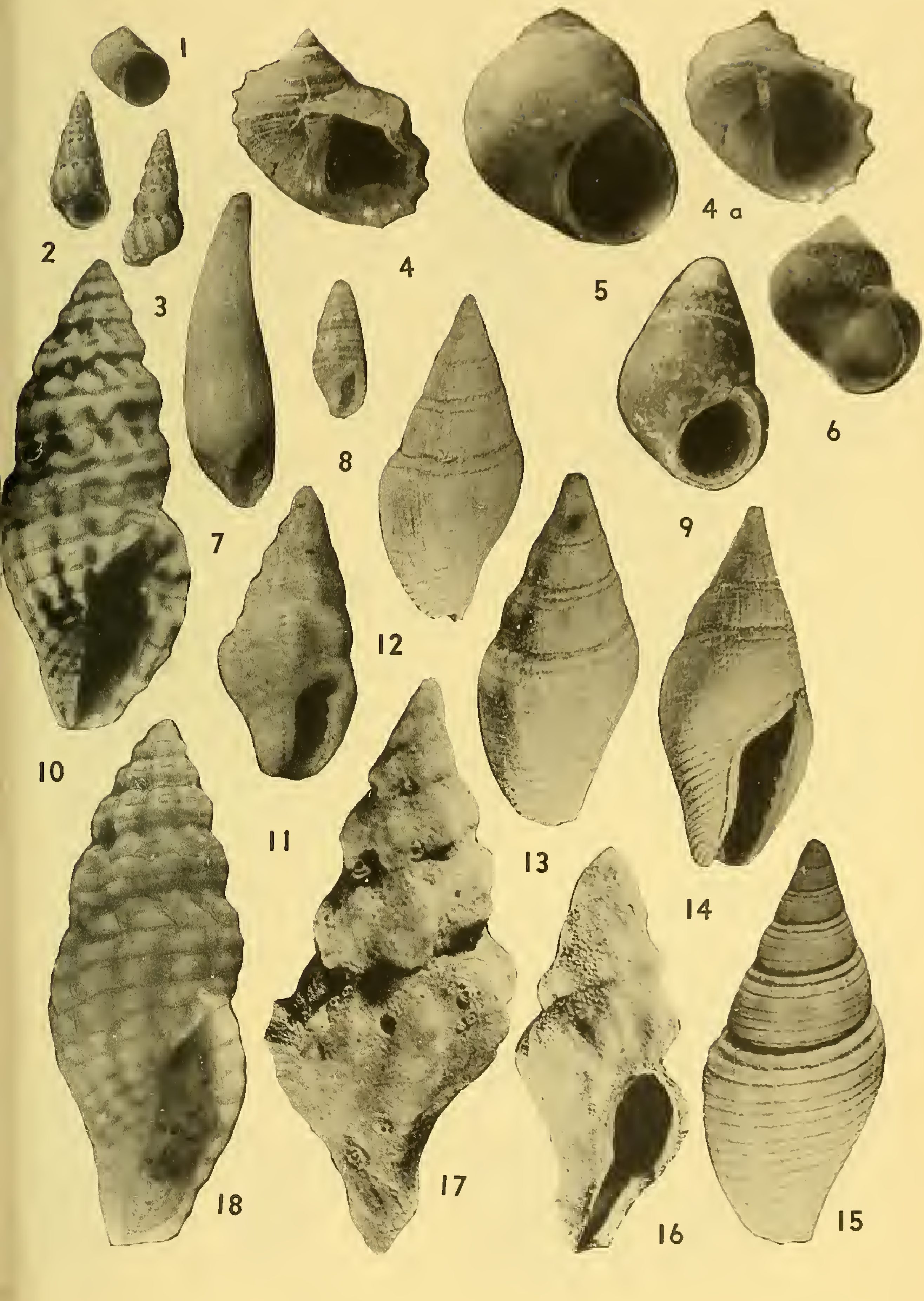
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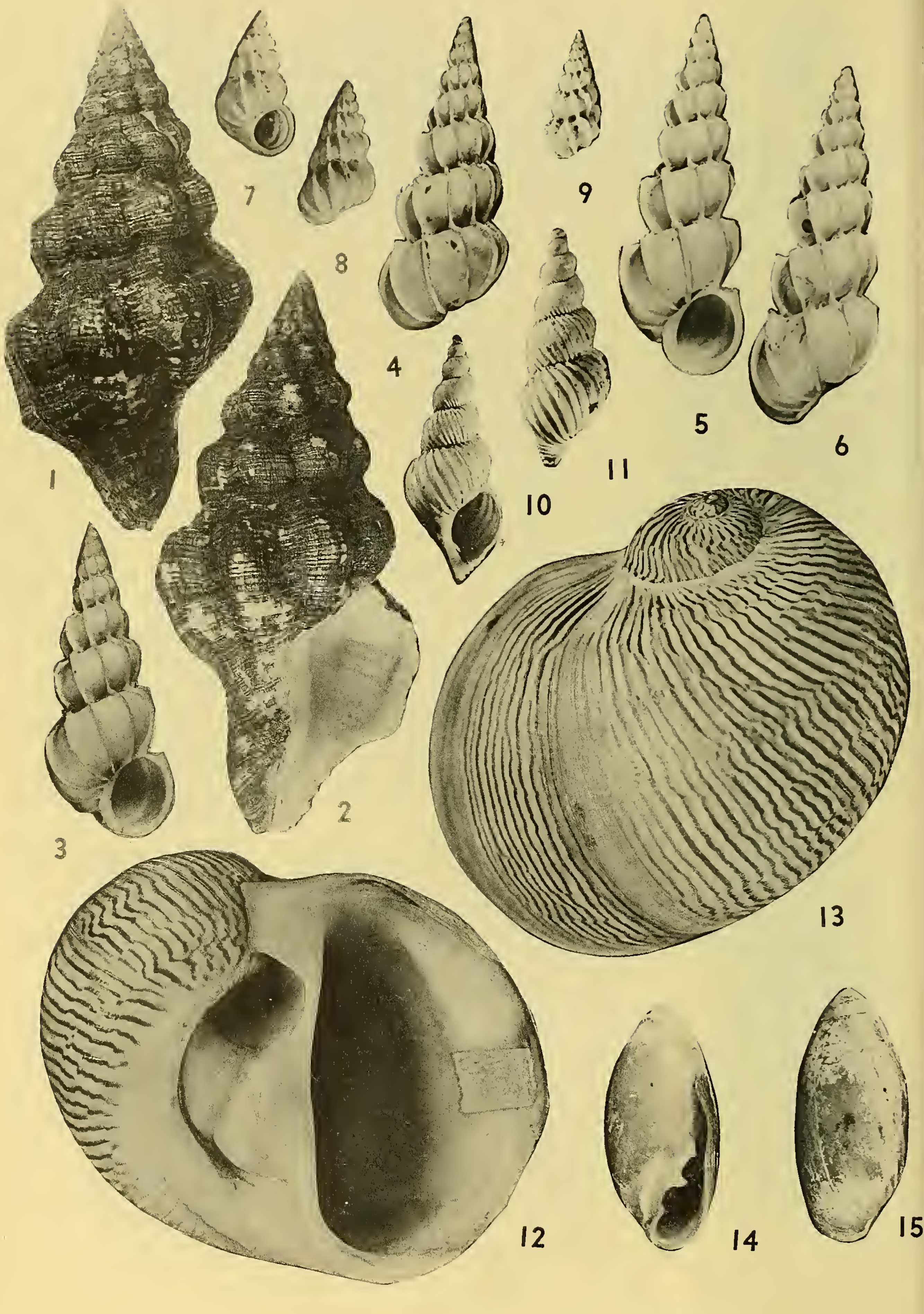

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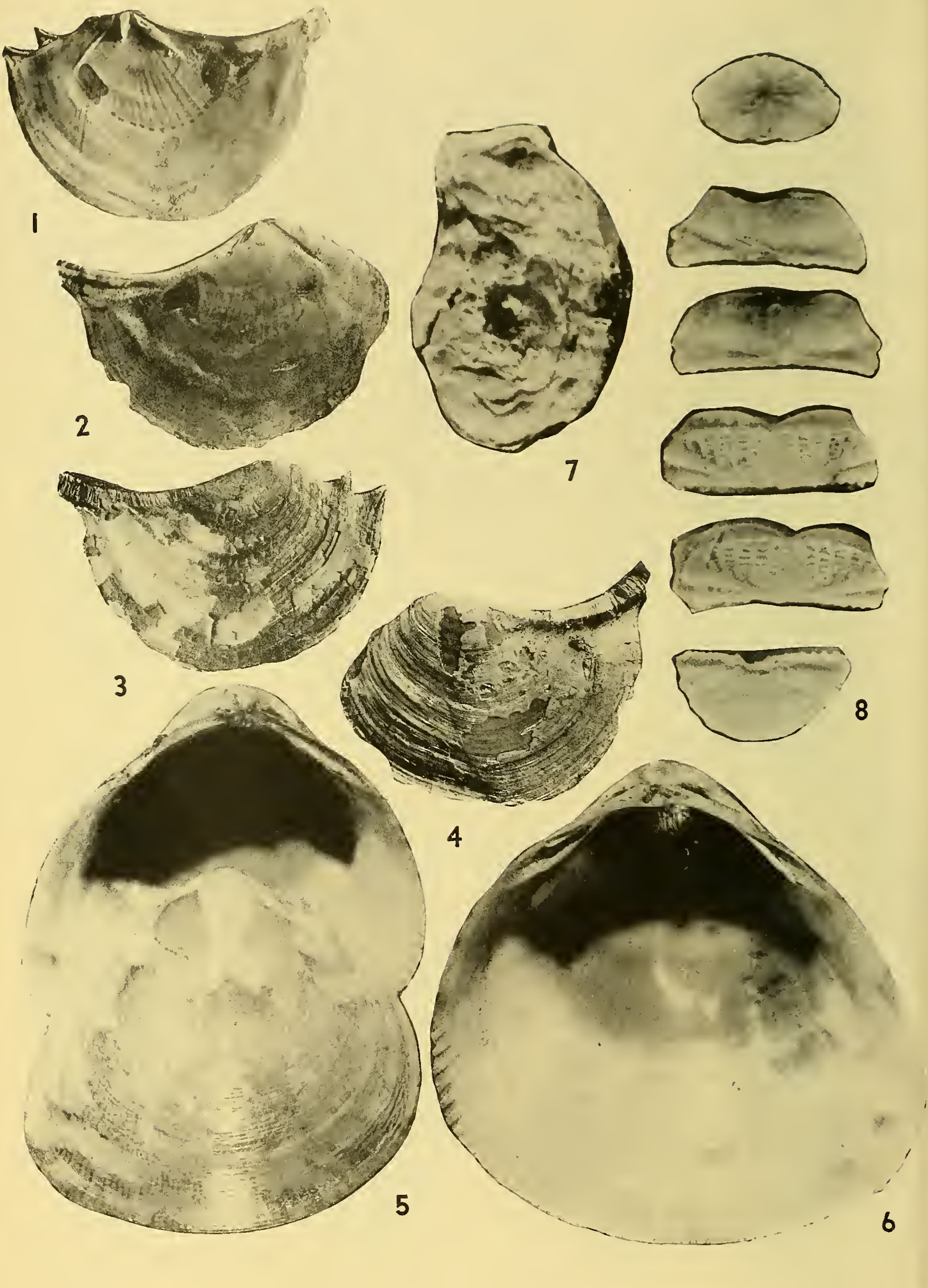
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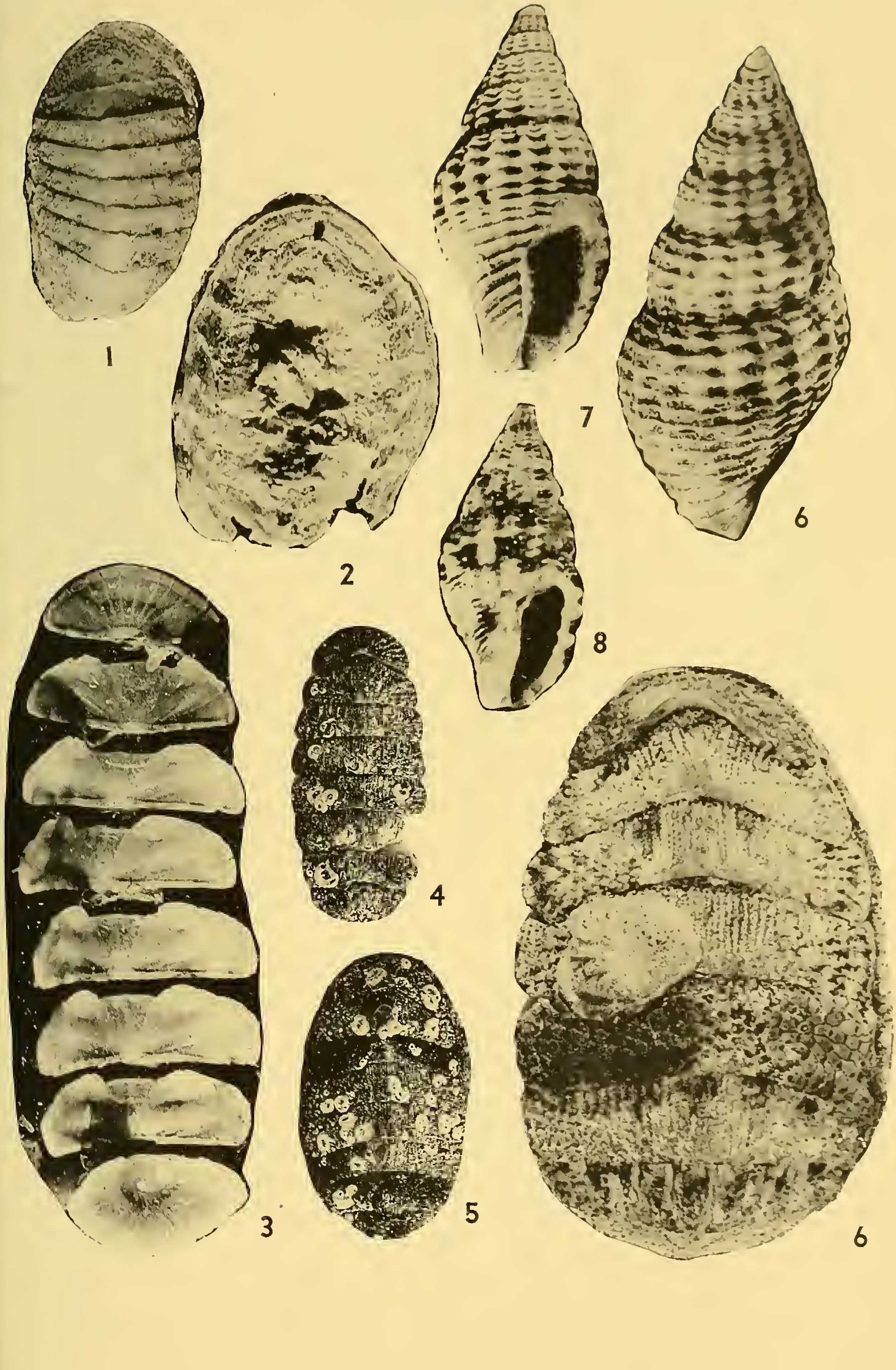
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