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Revision of some Caribbean Archaiasinae, new genera, species and subspecies

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ABSTRACT

Three new genera of the subfamily Archaiasinae are described on the basis of pillar and internal partitions: *Miosorites*, *Cycloputeolina* and *Parasorites*. The type species of *Miosorites* is *Orbitolites americanus* CUSHMAN. *Cycloputeolina bocki* sp.nov. is designated type species of *Cycloputeolina*. *Praesorites orbitolitoides* is designated types species of the new genus *Parasorites*. *P. orbitolitoides monensis* subsp.nov. is differentiated from *P. orbitolitoides orbitolitoides* on the basis of morphologic characteristics in the juvenile stages. The genus *Puteolina* is considered to be the ancestor of the genera *Archaias*, *Cyclorbiculina*, *Cycloputeolina*, *Miosorites* and *Parasorites*.

ZUSAMMENFASSUNG

Drei neue Gattungen der Unterfamilie Archaiasinae werden aufgrund der Pfeiler und der internen Unterteilungen der Kammern beschrieben: *Miosorites*, *Cycloputeolina* und *Parasorites*. Die Typusart von *Miosorites* ist *Orbitolites americanus* CUSHMAN. *Cycloputeolina bocki* n.sp. wird als Typusart von *Cycloputeolina* bezeichnet. *Praesorites orbitolitoides* wird als Typusart der neuen Gattung *Parasorites* designiert. *P. orbitolitoides monensis* n.subsp. wird von *P. orbitolitoides orbitolitoides* aufgrund der morphologischen Charakteristika der juvenilen Stadien unterschieden. Die Gattung *Puteolina* wird als Vorfahre der Gattungen *Archaias*, *Cyclorbiculina*, *Cycloputeolina*, *Miosorites* und *Parasorites* betrachtet.

Introduction

A long controversy has taken place regarding the taxonomic position of living and fossil Soritidae, mainly caused by the poor original descriptions of many of the genera and species. The genera of the subfamilies Archaiasinae and Soritinae are the most affected by the controversy. The genera *Archaias*, *Sorites*, *Amphisorus* and *Cyclorbiculina* and the species *Orbitolites americanus*, *Amphisorus matleyi*, *Archaias floridanus* and *Sorites marginalis* are common in the Caribbean since the Oligocene or Miocene. The purpose of this paper is to solve some of the taxonomic problems related to the Archaiasinae.

HENSON (SMOUT & EAMES 1958) used the term subepidermal partitions for inner structures of chambers in *Cyclorbiculina*. However, we prefer to use another name because two different types of partitions occur in the genera of Archaiasinae and the term subepidermal for one of the types may be confusing. The new terms used in this paper for some inner structures of Soritidae are defined below.

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Intradermal plates: transverse partitions of the chambers originated by inner infoldings of the lateral walls (Fig. 3b).

Pilintradermal plates (latin: pila, column; intra, in; Greek: dermos, skin): Transverse partitions of the chambers, arranged approximately in pairs and separated by one to five rows of orifices. They originate by the fusion of an inner infolding of the lateral walls and a pillar (Fig. 4a, c).

Succulus (socle): low, pedestal-like elevation, in the proximal side of the chambers arranged along the circumference of the chamber with sulci among them or arranged in nets. They constitute the basement of the pillars.

Punctuations: short perforations or "pits" which do not reach the inner side of the wall as the pores do.

Pillars of Soritinae are always interseptal pillars, but we refer to them for brevity just as pillars.

List of localities

Fossil localities

Sta. S-60-A. Quarry No. 2, Puerto Rican Cement Co., northwest of Ponce City. Southwestern Puerto Rico. Ponce Limestone, middle to late Miocene.

Sta. S-236-A. Cut on small highway, at 1.3 km from the crossing with Highway 446 (km 6.5) Northwestern Puerto Rico. Marls with "nodes" of hard limestone, Cibao Formation, early to middle Miocene.

Sta. S-237. Cut on Highway 446, km 7.8. Northwestern Puerto Rico. Limestone of Cibao Formation, early to middle Miocene.

Sta. S-511. Cut on Highway 110, km 5.55. Northwestern Puerto Rico. Pink Miosorites limestone, "Los Puertos limestone", middle Miocene.

Sta. S-553. Cut on Highway 110, km 18.85, west side of the highway north of Moca. Northwestern Puerto Rico. Cycloputeolina limestone, Aymamón Limestone, middle to late Miocene.

Sta. S-555. Cut on Highway 110, km 19.0, north of Moca. Northeastern Puerto Rico. Hard orange limestone, Aymamón Limestone. Middle to late Miocene.

Sta. S-806. Quarry approximately 2.5 km west of Aguadilla, northwestern Puerto Rico. Middle to late Miocene.

Type locality of Cercado Formation; west side of the Río Mao just above Paso del Perro, about 5 km south of Cercado de Mao. Northern Dominican Republic. Middle to late Miocene.

B-151. Arroyo La Palma 8.2 km southeast of bridge of the Río Zaza, on the highway from Arroyo La Palma to Sancti Spiritus, Las Villas Province, Cuba. Miocene.

B-173. Cut 2.3 to 2.7 km north of central highway, on the highway to San Diego de los Baños, Pinar del Río Province, Cuba. Paso Real Formation, Miocene.

Recent localities

Sta. Jo-3. Jobos Bay, 2 km east of Central Aguirre, at 4 m of depth, southern Puerto Rico. Recent.

Mz-6. Mayaguez Bay, western Puerto Rico, locality given by Seiglie (1974).

Sta. MI-1. Back-reef lagoon, 200 m south of Piedra Carabinero, approximately 5 m of depth, south of Mona Island, approximately 67 km west of Puerto Rico. Recent.

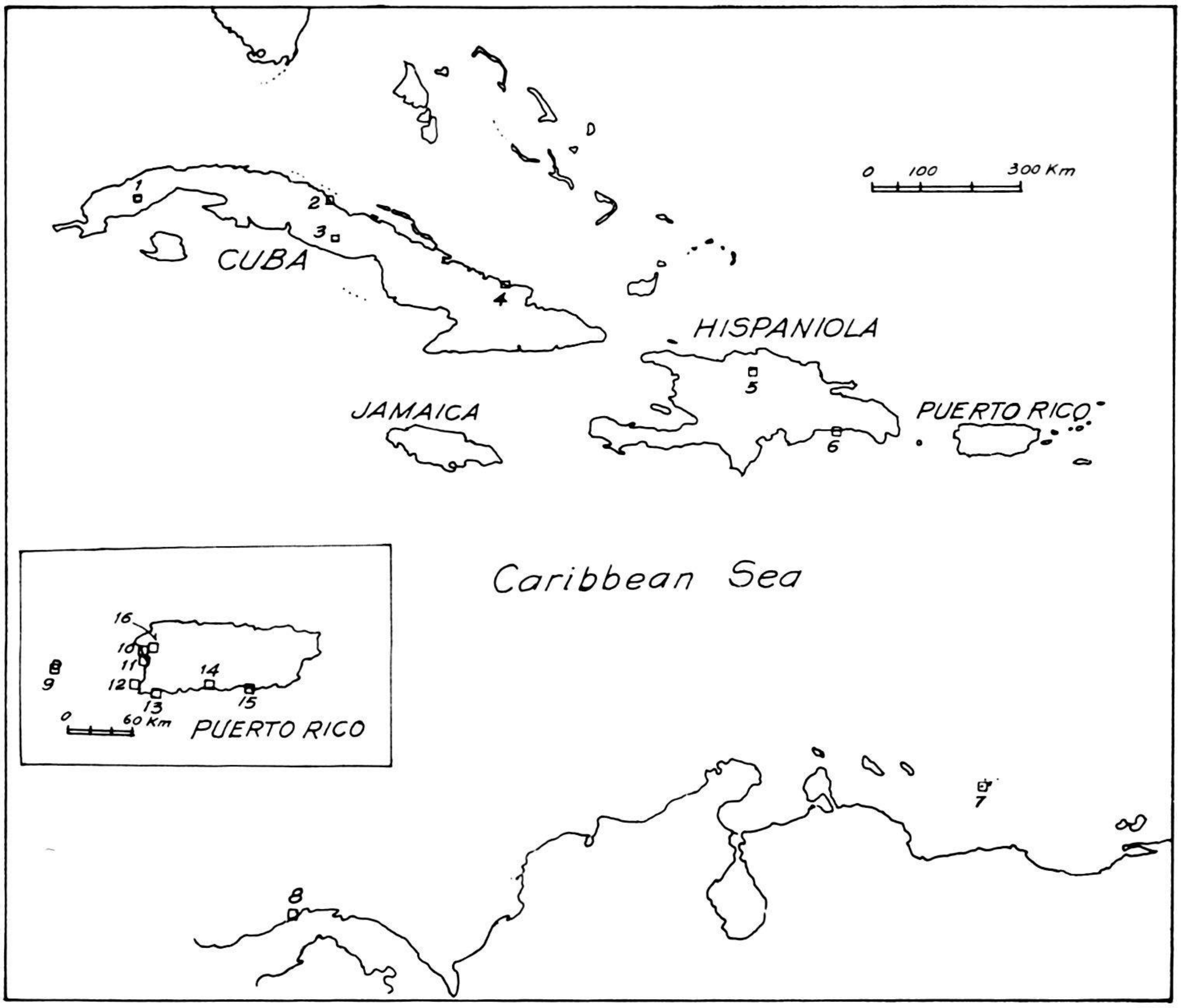

Fig. 1. Localities of the samples used in this paper: 1 = San Diego de los Baños, Pinar del Río Province, Cuba; 2 = Playa in Caibarien, Las Villas Province, Cuba; 3 = Arroyo La Palma, Las Villas Province, Cuba; 4 = Playas in Gibara, Oriente Province, Cuba; 5 = Cercado, Dominican Republic; 6 = Playa Juan Dolio, Dominican Republic; 7 = Los Roques Archipelago, Venezuela; 8 = Panama Canal Zone; 9 = Isla Mona, between Puerto Rico and Dominican Republic; 10 = Añasco Bay, western Puerto Rico; 11 = Mayaguez Bay, western Puerto Rico; 12 = Cabo Rojo shelf, off southwestern Puerto Rico; 13 = La Parguera shelf, off southwestern Puerto Rico; 14 = Ponce, southwestern Puerto Rico; 15 = Jobos Bay, southern Puerto Rico; 16 = Aguadilla and Moca areas, northwestern Puerto Rico. Recent localities: 2, 4, 6, 7, 8, 9, 10, 11, 12, 13, 15. Fossil localities: 1, 3, 5, 14, 16.

Ecology and paleoecology

The living and fossil genera and species of the subfamilies Archaiasinae and Soritinae mostly occur in back-reef environments. *Archaias angulatus* occurs in the Puerto Rican Oligocene in back-reef environments of the San Sebastián Formation and the Lares Limestone. *Archaias* sp. of the Puerto Rican Miocene occurs in limestones which represent sand patches close to reefs or in gastropod limestone of the Aymamón Limestone, northern Puerto Rico. It is also abundantly associated with *Miosorites americanus* in limestones which represent back-reef environments of the Cibao Limestone, northern Puerto Rico. It is abundant in thin stratified limestones which represent beaches and sand bars. It occurs also in limestone representing back-reef environments where the dominant foraminifers are *Cycloputeolina* sp., *Miosorites americanus* and miliolids (in lower Aymamón Limestone and Los Puertos Limestone).

Cyclorbiculina compressa occurs in sediments similar to those containing *Archaias angulatus*. *Cycloputeolina* sp. always occurs in limestones representing back-reef environments (back reef lagoons) and is associated with miliolids, *Miosorites americanus* or both. *Parasorites orbitolitoides* s. str. has been found in four back-reef areas off Puerto Rico (Mayaguez Bay, Jobos Bay, La Parguera shelf and Cabo Rojo shelf), and although dead their fragile tests are so well preserved and so abundant that they should be in their native habitat or close to it. *P. orbitolitoides monensis* subsp. nov. occurs in only one locality off Mona Island, in a backreef environment.

The fringing reef off the southern coast of Mona Island is separated from the shore by a back-reef lagoon. The living foraminiferal fauna associated with the coralline algae (genera *Jania* and *Corallina*) in this lagoon at a water depth of 5 m provides a model for interpretation of the fossil faunas of the Antilles. It consists of miliolids and the Soritidae species: *Archaias angulatus*, *Cycloputeolina bocki* sp. nov., *Cyclorbiculina compressa*, *Dendritina elegans*, *Parasorites orbitolitoides monensis*, subsp. nov. and *Puteolina proteus*. This fauna is comparable with the fossil back-reef fauna of the Cycloputeolina limestone, lower part of Aymamón Limestone. The fossil localities, 2.5 km east of Aguadilla, northwestern Puerto Rico, consist of a coral reef and back-reef with coralline algae associated to miliolids, *Archaias* sp., *Cycloputeolina* sp., *Miosorites americanus* and *Puteolina* sp. Another locality of the Miocene of south central Cuba which consists of a marl, contained mainly *Miosorites americanus*, *Archaias* sp., *Puteolina* sp. and *Dendritina preelegans*.

Evolution

The degree of evolutionary parallelism is remarkable in discoidal Soritidae. This parallelism also includes a discoidal genus, *Discospirina*, belonging to another closely related family. The similarity in construction in the genera of Archaiasinae and Soritinae is such that the tendency of some authors has been to reduce the number of genera (HOFKER 1971; SMOUT 1963). This parallelism is the consequence of the close phylogenetic relationships and of adaptation to similar environments.

The most important characteristic of Soritinae and Archaiasinae is the subdivision of the chambers. The genus *Puteolina* is the most probable ancestor of the genera within the Archaiasinae, and therefore, it is important to discuss why we consider *Puteolina* a valid genus.

HOFKER (1950) described the genus *Puteolus*, changed later to *Puteolina* (type species *Peneroplis proteus* D'ORBIGNY) on the basis of superficial puncti (pits). This is a characteristic common to many Soritidae and is even found in genera of the family Miliolidae, like *Quinqueloculina* and *Miliolinella*. Although puncti are undoubtly a significant characteristic in *Puteolina*, it does not follow that all Soritidae with puncti should be included in the same genus as indicated by HOFKER (1964, 1971), particularly as some species of *Puteolina* and also of *Archaias* do not have punctuations. LE CALVEZ (1970) described several genera of *Peneroplis* and *Dendritina* in the Eocene of the Paris basin. Two stems arise from this group of foraminifers. The genus *Dendritina* included all species with dendritic or complicated aperture most of them with surface furrows and one of them with smooth surface, and at least *D. pertusa* (FORKSAL) and *D. preelegans* GALLOWAY & HEMINWAY have *Spirolina*-like forms. Probably many of the species described in the genus *Spirolina* are species forms of *Dendritina*. The genus *Puteolina* does not develop *Spirolina*-like forms, but fan-shaped tests which in several cases have evolved to discoidal forms. The most evolved species of the *Dendritina* stem is *Peneroplis planatus* (FICHTEL & MOLL) which has developed arcuate chambers and a fan shaped form. These differences in evolutionary trends between *Dendritina*, *Peneroplis* and *Puteolina* represent different genetic stocks. The function of the longitudinal striae is not known, but there is an inherent difficulty for the striated genera to evolve to discoidal genera. The striae require additional material and also the additional material required to make the partitions of the discoidal genera (to increase the resistance of the test) demands an expense of energy which is probably excessive for the striated genera. A controversial point for the *Dendritina–Peneroplis* stem is to determine when an aperture is complicated enough for the form to be included in the genus *Dendritina*. We consider that all these characteristics are sufficient to separate the genera *Puteolina* and *Peneroplis*.

We consider that the ancestor of the Archaiasinae is *Puteolina proteus* (D'ORBIGNY) or a species close to it. Some individuals of this species present infoldings in the lateral walls of several chambers which constitute incipient subdivisions of the chambers. The partitions of *Cycloputeolina* gen. nov. and probably also of *Parasorites* gen. nov. originated by similar infoldings of the lateral walls. The subdivisions in the other stem of Archaiasinae originated by the fusion of an infolding of the lateral walls with a pillar. The most primitive *Archaias* should have pillars distributed at random, in a later stage of evolution *Archaias* has pillars arranged in rows on socculi approximately parallel to the periphery. This characteristic is present in a form of *A. angulatus*. Forms with the pillars arranged in rows and infoldings of the lateral walls were probably the ancestors of the genus *Cyclorbiculina*. *Miosorites* evolves from *Cyclorbiculina* by the disappearance of pillars and involute stage. The genus *Cyclorbiculinoides* ROBINSON of the Jamaican Eocene, has radial partitions continuous through the annular chambers and additional small apertures in the periphery, which locate them in a lateral branch of the Soritidae stem, and not as an ancestor of *Cyclorbiculina*.

The significance of the evolute or involute early stage in the evolution of Soritidae becomes clear in the forms of *Parasorites orbitolitoides* s. str. The microspheric form of this species is involute or semi-involute, and the megalospheric A1 and A2 are evolute. Therefore, the ancestor of this species is involute, because the microspheric form represents the most primitive form. *P. orbitolitoides monensis* is less evolved than *P. orbitolitoides orbitolitoides* because its three forms are involute. However, *P. orbitolitoides monensis* is probably more evolved regarding the puncti because its puncti are less numerous than in *P. orbitolitoides*.

Figure 2 shows the evolution of the genera of Archaiasinae.

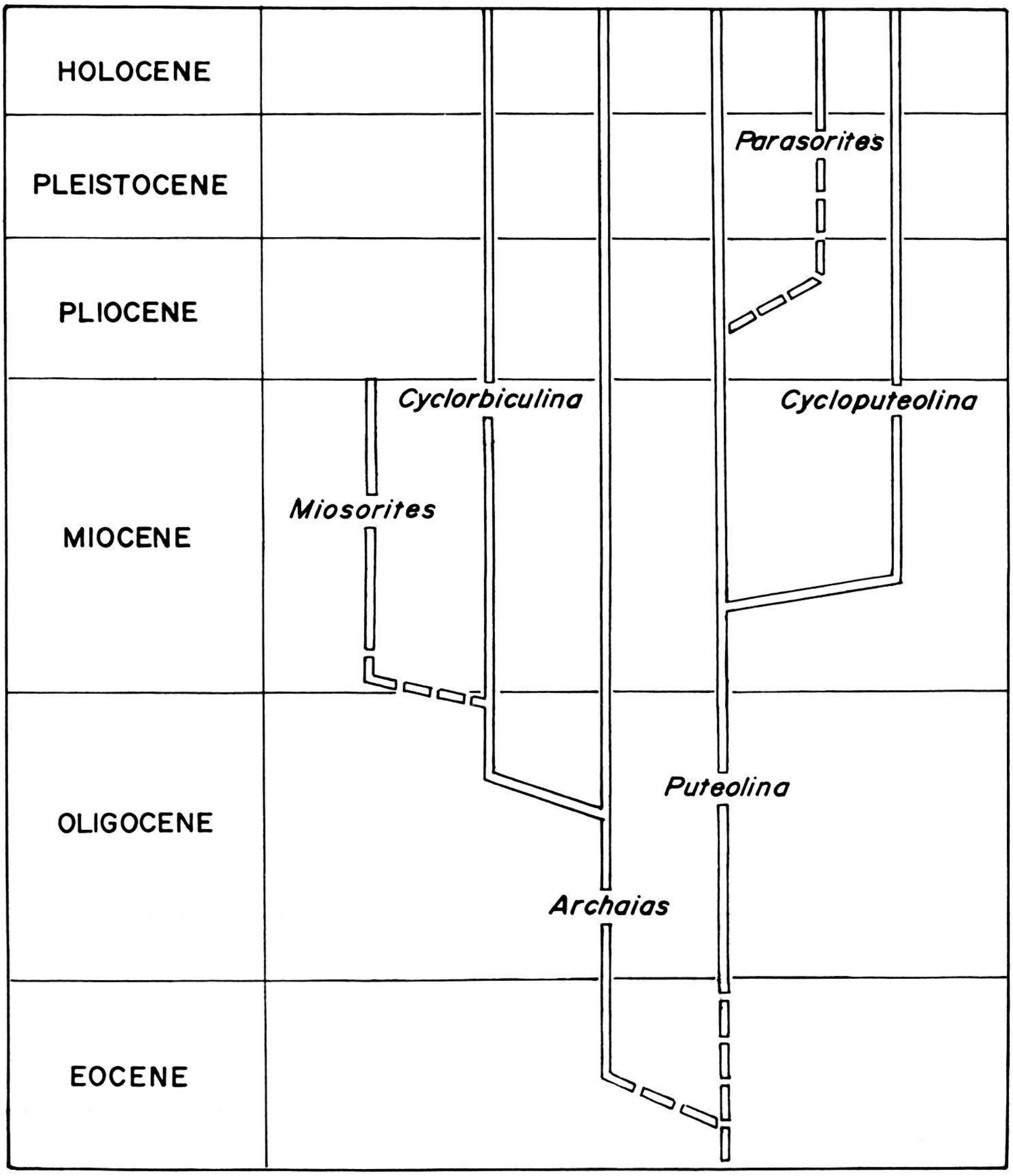

Fig. 2. Phylogenesis of the genera of the subfamily Archaiasinae.

Systematics

Subfamily *Archaiasinae* CUSHMAN 1927

Test discoidal, flaring or fusiform; chambers subdivided by pilintradermal or intradermal plates or with pillars; aperture consist of rows of orifices on a peripheral sulcus or irregularly arranged in the peripheral surface.

Range. - Middle Eocene to Holocene.

Remarks. - This subfamily includes the genus *Fusarchaias* REICHEL and *Cyclorbiculinoides* ROBINSON (1974) in addition to those described below. The chamber structure of the genera of this subfamily is shown in Figures 3 and 4.

Genus *Archaias* MONTFORT 1808

Type species. - *Nautilus angulatus* FICHTEL & MOLL 1798, Testacea microscopica, p. 113.

Remarks. - The characteristics which differentiate this genus from its closest relative, *Cyclorbiculina* is the presence of pillars more or less irregularly arranged with absence of pilintradermal plates and the distribution of the apertural orifices in all the peripheral surfaces (Fig. 4d). The pillars occur on succuli and the orifices in sulci or depressions (Fig. 3c and 3d).

The surface of the Holocene species of this genus is punctate, but, at least, some of the fossil species have smooth surface.

Locality. - 200 m south of Piedra Carabinero, off the southern coast of Mona Island, at 5 m of water depth.

Archaias angulatus (FICHTEL & MOLL)

1798 *Nautilus angulatus* FICHTEL & MOLL, Testacea microscopica, p. 113.

Remarks. - Two forms of this species occur in the Antilles. The socculi of one of the forms are arranged in a net with the pillars located at random on the socculi and the orifices and pillars approximately disposed in rows. The form with pillars arranged in rows occurs at Mona Island (between Puerto Rico and Hispaniola) and Playa de Boca Chica (Dominican Republic). The form with succuli arranged in nets occurs at Mona Island, Gibara (northeastern Cuba), La Parguera (Puerto Rico), Cabo Rojo shelf (Puerto Rico) and Los Roques Archipelago (Venezuela). We consider that both are ecological forms of the same species, but this is an interpretation. They may be different subspecies or even different species.

GALLOWAY & HEMINWAY (1941) reported *Archaias angulatus* (FICHTEL & MOLL) in the Oligocene San Sebastián Formation of northern Puerto Rico. However, this species does not occur in the San Sebastián Formation where a species which has not been yet described occurs. Another species also different to *A. angulatus* occurs in the Cibao Formation.

Archaias floridanus (CONRAD)

1846 *Nummulites floridanus* CONRAD, Amer. Sci. (2), *2*, p. 399, Text-fig.

1927 *Archaias floridanus* (CONRAD) VAUGHAN, Proc. Acad. nat. Sci. Philadelphia *79*, p. 299-303, Pl. 23, Fig. 3 a-c.

1941 *Archaias compressus* GALLOWAY & HEMINWAY (not D'ORBIGNY 1839), Sci. Surv. Porto Rico Virgin Is. *3/4*, p. 318, Pl. 5, Fig. 10a, b.

1958 *Archaias floridanus* (CONRAD), SMOUT & EAMES, Paleontology *1*, p. 207-225, Pl. 42, Fig. 1, 2.

1965 *Archaias floridanus* (CONRAD), COLE, Bull. amer. Paleont. *49*/219, p. 17, Pl. 5, Fig. 1, 4, 6; Pl. 4, Fig. 1, 2, 3 (No. Pl. 4, Fig. 4, 5, 8; No. Pl. 5, Fig. 2, 6).

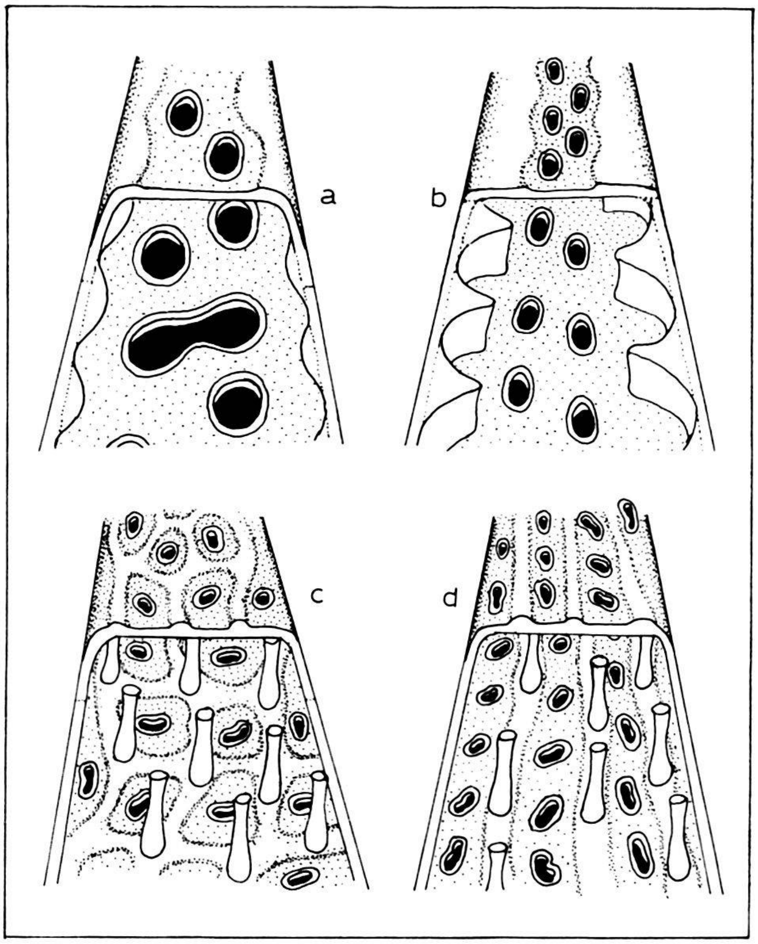

Fig. 3. Structure of annular chambers; a = reproductive chambers of *Cycloputeolina* gen. nov.; b = chamber with alternating intradermal plates of *Cycloputeolina* gen. nov.; c = chambers with pillars on reticulated socculi in *Archaias angulatus;* d = chamber with socculi along the periphery.

Remarks. - VAUGHAN (1929) redescribed *Nummulites floridanus* (of the lower Miocene Tampa Formation of Florida) and included it in the genus *Archaias,* illustrating specimens which show characteristics of the genus. VAUGHAN (1927) indicated that *A. floridanus* occurs in the Tampa Formation with *Sorites (= Miosorites)* which was the species that COLE (1965) described as *A. floridanus.* SMOUT & EAMES (1958) restudied *A. floridanus* from the Tampa type locality and they found that the type specimens has pilars but not pilintradermal plates. They illustrated a specimen (Pl. 42, Fig. 2) with apertural orifices scattered in all the peripheral surface, indicating the absence of pilintradermal plates. COLE (1965) included *Oribitolites americanus* in the synonymy of *Archaias floridanus.* He indicated that it has pillars, but most of the specimens that he illustrated undoubtedly have subepidermal plates (Pl. 4, Fig. 4, 5) are *Miosorites americanus.*

Specimens which doubtfully may be included in this species occur in the San Sebastián Formation.

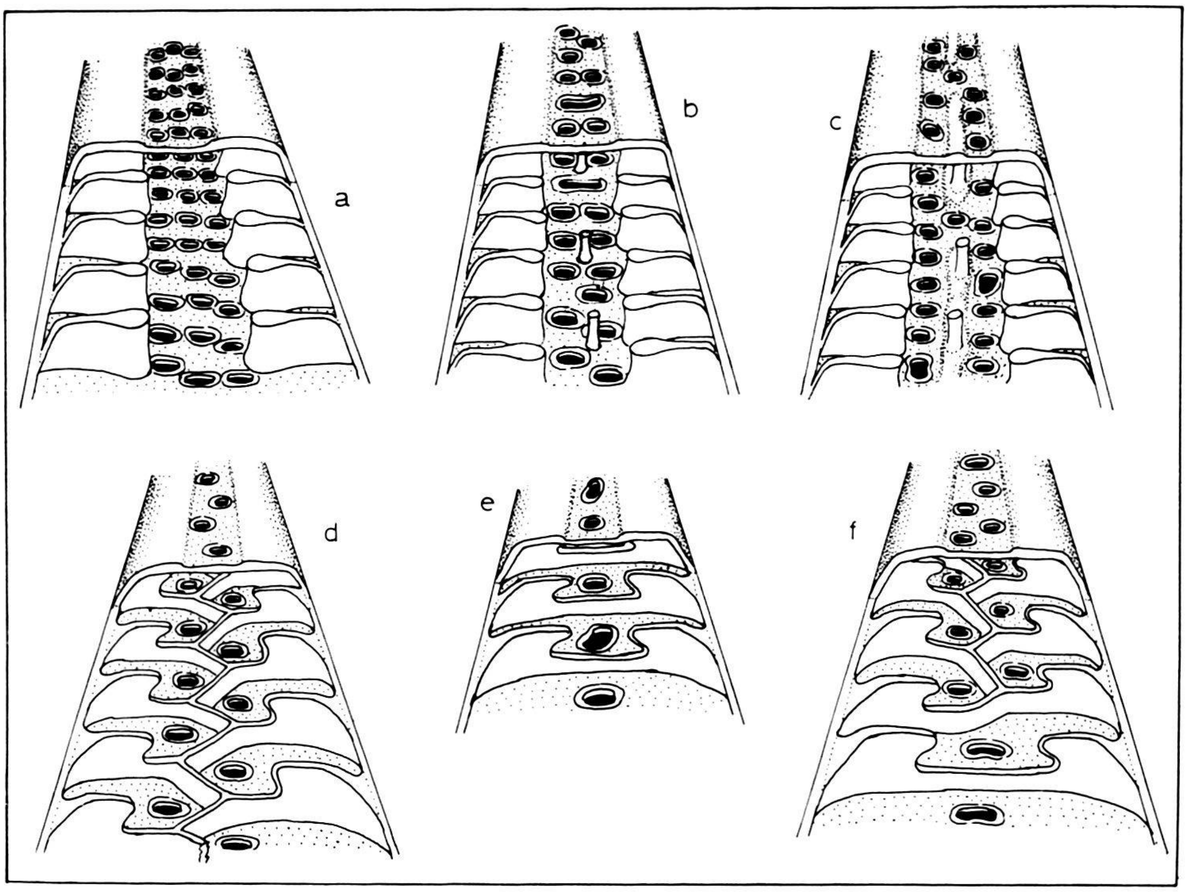

Fig. 4. Structure of annular chambers; a = pilintradermal plates in *Miosorites*, gen. nov.; b = pilintradermal plates in *Cyclorbiculina*, with two rows of orifices; c = pilintradermal plates with pillars in *Cyclorbiculina;* d, e, f = *Parasorites orbitolitoides;* d = chamber with two alternating rows of chamberlets; e = chamber with a single row of chamberlets; f = chamber with both single and double chamberlets.

Genus *Cyclorbiculina* SILVESTRI 1937

Type species: Orbiculina compressa D'ORBIGNY 1839. In: de la Sagra, Hist. Phyp. Pol. Natur. Cuba, p. 66.

Description. - Test large, discoidal, with the central portion swollen; proloculus followed by a flexostyle and then by an involute planispiral stage consisting of several whorls; then followed by flaring, reniform and annular chambers; chambers subdivided by two sets of pilintradermal plates, each plate of a set approximately opposite to a plate of the other set, pillars are present; surface punctate or smooth; aperture consists of one to three rows of orifices surrounded by a lip in a peripheral central sulcus, adult forms with two to three rows of orifices.

Range. - Oligocene to Holocene.

Cyclorbiculina compressa (D'ORBIGNY)

Description. - Test large, discoidal or discoidal with a notch from the border to the early planispiral stage which corresponds to the swollen center of the test;

proloculus followed by a flexostyle and then by an involute planispiral stage; proloculus of the microspheric form from 68 to 90 µm and 1½ to 2 whorls in the juvenile spiral stage, proloculus of the megalospheric form 100 to 125 µm and 1¼ to 2 whorls in the juvenile spiral stage; then followed by flaring, reniform and annular chambers; chambers subdivided by two sets of pilintradermal plates, each plate of a set approximately opposed to a plate of the other set; adult specimens have two or three rows of orifices, the specimens with three rows of peripheral orifices have pillars frequently arranged in rows on succuli; aperture in juvenile specimens consists of one row of orifices, adult specimens with two or three rows of orifices.

Range. - Miocene to Holocene.

Remarks. - Two forms of this species occur in the waters of Puerto Rico. Living specimens of a discoidal form is dominant from close to the shore to about 25 m of depth. A form with a notch is frequent from about 25 to 50 m of water depth in the surroundings of Puerto Rico. However, the specimens of the last form has not been observed alive and the specimens of the deepest samples may be transported. The form reported as *C. compressa* by GALLOWAY & HEMINWAY (1941) from the San Sebastián Formation is actually *Cyclorbiculina* sp.

Genus *Cycloputeolina* SEIGLIE & GROVE, gen. nov.

Type species. - *Peneroplis pertusus* (FORSKAL 1775) var. *discoideus* FLINT 1899, Rep. U.S. natl. Mus. (1897) pt. 1, p. 304, Pl. 49, Fig. 1.

Description. - Test large, discoidal, with the swollen central portion corresponding to the involute early stage; proloculus followed by a flexostyle generally shorter than half the circumference of the proloculus and then by an involute planispiral stage consisting from one to two and a half whorls; then reniform and annular chambers; the last planispiral chambers and all the reniform and annular chambers subdivided by two sets of alternating intradermal plates; aperture consists of one or two rows of orifices surrounded by a lip in a central peripheral sulcus.

Range. - Miocene to Holocene.

Remarks. - This genus differs from *Puteolina* because of the presence of intradermal plates and of reniform and annular chambers. It differs from *Cyclorbiculina* because it has alternating intradermal instead of opposite pilintradermal plates and it does not have pillars.

The type species of the genus *Puteolina* is *Puteolina proteus* (D'ORBIGNY) which does not have subdivisions in the chambers. The specimens illustrated by HAMOUI & BRUN (1974) as *Puteolina proteus* (Pl. 13, Fig. 2, 3) are actually of the genus *Cycloputeolina.*

Cycloputeolina bocki SEIGLIE & GROVE sp. nov.

Fig. 5, 6A, 6B

1964 *Puteolina (Sorites ?) discoidea* HOFKER (not FLINT 1897), Stud. Fauna Curaçao other Caribbean Is. *21,* p. 49, Fig. 87-99.

1971 *Puteolina discoidea* (FLINT) forma *pseudodiscoidea,* HOFKER Publ. nat. hist. Genoot. Limburg (21), *1-3,* p. 48; Pl. 82, Fig. 1, Pl. 83.

1974 *Puteolina proteus* HAMAOUI & BRUN, Bull. Cent. Rech. Pau-SNPA *8/1*, Pl. 12, Fig. 1; Pl. 13, Fig. 1-6; Pl. 14, Fig. 1, 2.

Description. - Test large, discoidal or ellipsoidal with a swollen central portion corresponding to the involute early stage; proloculus followed by a flexostyle less than half the circumference of the proloculus, diameter of the proloculus from about 40 to 42 μm in the microspheric form and from about 55 to 92 μm in the megalospheric form; the involute planispiral stage consist of one to two and a half whorls; the planispiral stage is followed by reniform and then by annular chambers; generally from 4 to 9 annular chambers; most of the spiral chambers and all the reniform and annular chambers subdivided by two sets of alternating intradermal plates; surface punctate; aperture consists of one or two rows of orifices surrounded by a lip in a peripheral sulcus. Dimensions 1 to 2.5 mm.

Types. - The holotype is illustrated by the Figure 6A, its maximum diameter is 1.95 mm, it has five annular chambers; it is deposited at the U.S. National Museum (U.S.N.M., No. 241157) paratypes 1 and 10 were deposited at the U.S. National Museum with the Nos. respectively 241158 and 241159.

Type locality. - Station MI-1, off southern Mona Island. Living specimens were taken at the type locality.

Range. - Holocene.

Remarks. - COLE (1965) included *Puteolina discoidea* (= *Peneroplis pertusus* var. *discoideus* FLINT 1899) in the synonymy of *Puteolina proteus* (= *Peneroplis proteus* D'ORBIGNY 1839). All the specimens of *Puteolina proteus* that COLE (1965) illustrated has internal partitions (intradermal plates) and most of them are adult specimens with annular chambers. All of them must be considered as *Cycloputeolina bocki* sp. nov. He also indicated that "the internal structure (of *Puteolina proteus*) which had simple, open chambers conformed exactly to the type species of the genus *Peneroplis planatus*". However, we have examined hundreds of samples from Panama, Venezuela, Lesser Antilles, Puerto Rico, Hispaniola and Cuba and no one fits the description of *P. planatus*, but all fit that of *Puteolina proteus* which has punctate surface and without internal partitions of any kind or annular chambers, and is not in disagreement with D'ORBIGNY'S (1839) description. We have examined specimens of *P. discoidea* (FLINT), that Wayne D. Bock sent us, of the type locality at Florida. They do not have internal partitions and are identical to those illustrated by FLINT (1899). This species has been only reported from Florida and it is not a senior synonym of *Cycloputeolina bocki* sp. nov.

No one species has been described that may be included in *Cycloputeolina*. It is distinguished from *Cycloputeolina* sp. described above, because of the lower number of annular chambers and because of the presence of surface punctuations.

The name is given in honor of Wayne D. Bock, School of Marine and Atmospheric Science, University of Miami, Florida.

Cycloputeolina sp. 1

Pl. 1, Fig. 1-4

Description. - Test large, discoidal with the central portion which corresponds to the involute early stage, swollen; proloculus followed by a flexostyle less than half

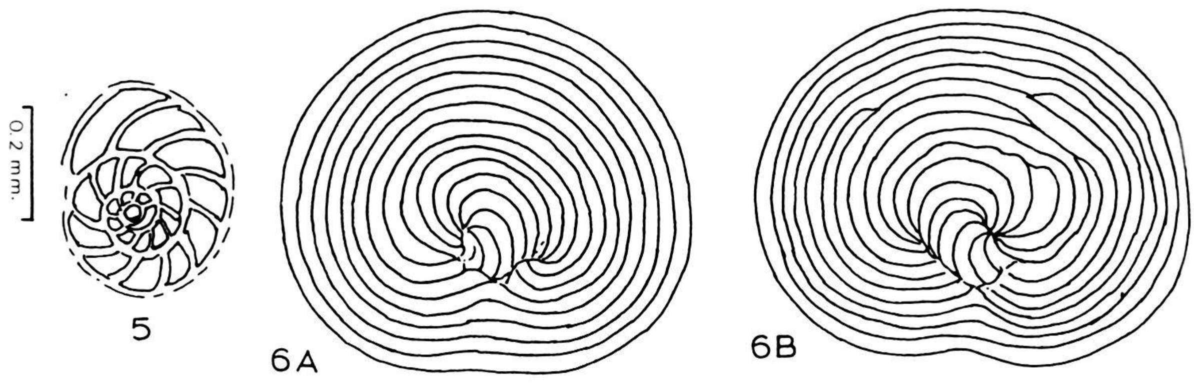

Fig. 5-6. *Cycloputeolina bocki* gen. nov. sp. nov. Sta. MI-1, off Mona Island; 5 = paratype 14 (Department of Geology, University of Puerto Rico), section of juvenile stage; 6A = holotype, max. diam. 1.95 mm, U.S.N.M., No. 241157; 6B = paratype 3 (Department of Geology, University of Puerto Rico), max. diam. 2.05 mm.

the circumference of the proloculus in length, then by an involute planispiral stage consisting of one and a half whorls; then followed by reniform and annular chambers or only by annular chambers; the planispiral stage is followed in adult individuals by fifteen to twenty one chambers; the last planispiral chambers and all the reniform and annular chambers are subdivided by two sets of intradermal plates; surface smooth; the aperture consists of one or two rows of orifices in a peripheral sulcus. Dimensions: 1.50 to 2.50 mm.

Types. - The most typical specimen is illustrated in Plate 1, Figure 4, U.S.N.M., No. 241160.

Range. - Middle to late Miocene.

Remarks. - No complete specimens which show all fundamental specific characteristics were found. Adult specimens have from ten to twenty two annular chambers. This number of chambers is rarely attained by *Cycloputeolina bocki* sp. nov.

Genus *Miosorites* Seiglie & Grove, gen. nov.

Type species. - *Orbitolites americana* Cushman 1918, Bull. U.S. natl. Mus. *103*, Pl. 43; Fig. 12-14; Pl. 44; Fig. 1, 2, Pl. 50.

Description. - Test large, discoidal biconcave. Microspheric form, proloculus followed by an evolute or short involute peneropline stage; not clear because of the relatively small size of the proloculus. Megalospheric A1 form: globular proloculus followed by a flexostyle and then by an evolute peneropline stage with chambers subdivided into chamberlets by pilintradermal plates, then followed by annular chambers also subdivided. Megalospheric A2 form: two embryoic chambers consisting of a rounded laterally compressed proloculus and a deuteroconch followed by subdivided arcuate, then reniform and then annular chambers. Arcuate, reniform and annular chambers are subdivided by pairs of pilintradermal plates, one on each side of the rows of orifices; the surface is smooth; the aperture contains one to five rows of rounded to elongate orifices.

Range. - Miocene and possible Pliocene.

Remarks. - This subgenus is differentiated from *Sorites* EHRENBERG, because the megalospheric A2 is formed by two embryoic chambers lepidocycline-like, and because the chamberlets of *Sorites* have an orbicular pattern that HOFKER (1971) called clockwise - counter - clockwise arrangement. This characteristic pattern is a consequence of the location of stolon and because chamberlets are displaced half the length of the chamberlets in successive annular chambers. It is distinguished from *Puteolina* HOFKER because of the large embryonic chambers of the megalospheric A2 form and because of the smooth surface, as compared to the punctate surface of *Puteolina.* It is differentiated from *Orbitolites* because of the shape of embryonic chambers and because the chamberlets of *Orbitolites* have an orbicular pattern and the chamberlets of the same chamber are not connected by orifices.

Miosorites gen. nov. is distinguished from *Cyclorbiculina,* the closest genus, because it does not have pillars and its megalospheric forms are evolute. It differs from the genus *Cycloputeolina* gen. nov. because it has pilintradermal plates, while *Cycloputeolina* has intradermal plates. The genus *Cyclorbiculinoides* ROBINSON (1974) is distinguished from *Miosorites* because the partitions are radial and more or less in alignment in successive annular chambers and between the two rows of peripheral apertures are smaller, irregularly scattered apertures. The origin and structure of inner partitions of *Cyclorbiculinoides* are not well known.

Miosorites americanus (CUSHMAN)

Pl. 1, Fig. 5, 6; Pl. 2, Fig. 1-6; Pl. 3, Fig. 1, 2; Pl. 4, Fig. 1, 2; Text-fig. 7

1918 *Orbitolites americana* CUSHMAN, Bull. U.S. natl. Mus. *103,* p. 99, Pl. 43, Fig. 12-14, Pl. 44, Fig. 1, 2; Pl. 50.

1932 *Sorites* ? sp. CUSHMAN & PONDON, Bull. Florida Statte Geol. Surv. *9,* p. 72, Pl. 17, Fig. 1-8.

1965 *Archaias floridanus* COLE (part) (not *Nummulites floridanus* CONRAD 1846), Bull. amer. Paleont. *49*/219, Pl. 4, Fig. 4, 5.

1974 *Sorites marginalis* FROST & LANGENHEIM (not LAMARCK 1816), Cenozoic Reef Biofacies, p. 61 to 63, Pl. 7, Fig. 1-5.

Description. - Test large, discoidal, bioconcave. Microspheric form: proloculus rounded, diameter from 24 to 27 µm, thirteen to fifteen chambers of an early evolute or involute peneropline stage, which consists of 1¼ whorls such that only the proloculus and the first two or three chambers are involved; presence of a flexostyle not clear because of relatively small size of proloculus and early chambers. Megalospheric A1 form: rounded, laterally compressed proloculus, 65 to 180 µm, followed by a flexostyle about one half coil in length, then followed by a peneropline - like stage consisting of 8 to 14 chambers subdivided by pilintradermal plates with the exception of the first ones, then followed by subdivided annular chambers. Megalospheric A2 form: two embryonic chambers, consisting of rounded, laterally compressed proloculus, from 130 to 410 µm diameter, in horizontal section and from 80 to 280 µm in vertical section, followed by a deuteroconch, from 255 to 620 µm in horizontal section and from 170 to 350 µm in vertical section; the deuteroconch enveloping about two thirds of the proloculus; embryonic chambers followed by one to three arcuate chambers subdivided in chamberlets by pilintradermal plates, then by reniform and annular chambers, also subdivided into chamberlets by plates; height of the pilintradermal plates from 15 to 90 µm and width from 25 to 390 µm, more closely spaced in later than in earlier chambers; its size is very variable depending on the environment; surface is smooth, aperture consisting of one to five rows of rounded to ellipsoidal orifices located in a central peripheral sulcus, with raised borders on both sides of the peripheral sulcus corresponding to the two sets of pilintradermal plates. Diameter of adult specimen 7.7 to about 30 mm, thickness at the margin from 0.15 to 1.3 mm.

Types. - The holotype of *Orbitolites americanus* deposited in the U.S. National Museum is lost. A lectotype (Pl. 2, Fig. 1) is designated herein from the paratypes, as a substitute for the lost holotype. The maximum dimension of the lectotype is 3.89 mm, the diameter, had the specimen not been broken should be about 4.1 mm, the diameter of the proloculus is 370 µm and the diameter of the deuteroconch is 560 µm; the U.S.N.M. for the lectotype is No. 241161. The paratype 1 is illustrated in Plate 2, Figure 4; U.S.N.M., No. 241162.

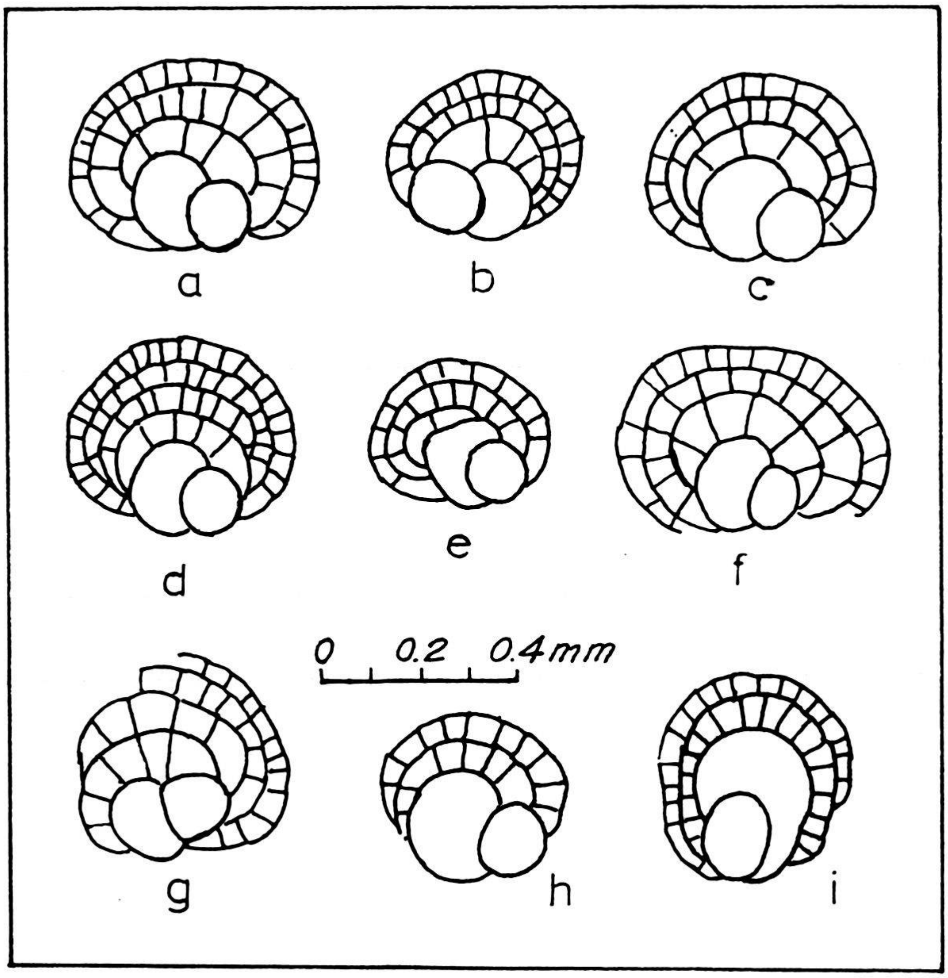

Fig. 7. Early chambers of the megalospheric A2 form of *Miosorites americanus* which shows a weak spiral; Specimens: a = No. 24, b = No. 38, c = No. 16, d = No. 26, e = No. 12, f = No. 24, g = No. 8a, h = No. 8b, i = No. 3b. All specimens from Arroyo La Palma, Las Villas Province, Cuba.

Range. - Early Miocene to latest Miocene; possibly Pliocene.

Occurrences. - This species has been reported only in the Caribbean region, but under so many different names that it is necessary to enumerate the localities where it has been reported. CUSHMAN (1918) reported it in Culebra Formation (early Miocene of Panama Canal Zone); VAUGHAN (1929) reported it in the Miocene of Jamaica as *Amphisorus matleyi;* CUSHMAN & PONTON (1932) reported its megalospheric A1 form in the Chipola Formation, Miocene of Florida, as *Sorites*? sp. It has been reported in the Miocene of Puerto Rico as *Marginopora vertebralis* by MONROE 1973 and as *M. matleyi* (VAUGHAN) by MOUSSA & SEIGLIE (1975). COLE (1965) reported it from the Miocene of Santo Domingo as *Archaias floridanus;* FROST & LANGENHEIM (1974) reported it in the Quinta Formation, early Miocene of Chiapas, Mexico; in Cuba it was reported by SEIGLIE (1965) as *Sorites marginalis* and by ITURRALDE-VINENT (1969) as *Marginopora* sp. It is reported in this paper from the type locality of the Cercado Formation, late Miocene of Santo Domingo; in northern Puerto Rico in the Cibao Formation, early Miocene, the Los Puertos Limestone, middle Miocene, the Aymamón Limestone, middle late Miocene and in the lowest part of the Quebradillas Limestone, earliest Pliocene; in the Ponce Limestone, middle to late Miocene of southern Puerto Rico; and in the Miocene of Las Villas (Sta. B-151) and Pinar del Río (B-173) Provinces, Cuba.

Ecology. - This species occurs in Puerto Rico in back-reefs or in sand patches among reefs, with the exception of the lower Quebradillas Limestone where it occurs with shallow water sediments transported to deep waters. The western part of the Cibao Formation represents back-reefs, coastal lagoons and other near shore environments. The near shore coastal lagoons are represented by deposits of terrigenous sands and clays. The back-reef environments are represented by fine grained limestone with only small amounts of terrigenous materials. Most of the specimens of *Miosorites americanus* taken in these environments were small and of the megalospheric A2 form. Some of the specimens in the most clayey environments of the Cibao Formation, northern Puerto Rico, have deformed embryonic chambers and some an ellipsoidal instead of a discoidal test. The specimens of the Ponce Limestone of southern Puerto Rico occur in a matrix of calcareous sand. This bed, of nearly pure calcium carbonate, represents a sand patch among reefs. Most of the specimens in this limestone were preserved in their living environment because their tests are complete and do not show signs of transportation. Their size, up to 30 mm, is the largest observed in Puerto Rico. The specimens of Los Puertos Limestone occur in a micrite which represents a back-reef environment and size of the specimens is somewhat smaller than those of the Ponce Limestone. Most of the specimens in these two formations have the central part recrystallized or it has disappeared, with the exception of a few individuals of the megalospheric A2 form. The specimens which have lost the central part are probably microspheric or megalospheric A1 forms which have the thinnest juvenile part. The megalospheric A2 form is therefore more abundant in back-reef environments affected by terrigenous sediments which correspond to the most unstable environment. See Plate 2, Figures 5 and 6.

Remarks. - FROST & LANGENHEIM (1974) considered *Orbitolites americanus* a junior synonym of *Sorites marginalis* indicating that the large embryonic chambers reported by some authors were the consequence of recrystallization. However, the specimens examined of the Cercado Formation, Hispaniola, and of the Miocene of Las Villas are prefectly preserved and we do not have any doubt about the large embryonic chambers of these specimens and those of Panama and Puerto Rico. This characteristic alone is enough to differentiate *Miosorites americanus* from all the *Sorites marginalis* in all the different interpretations given by the authors, CUSHMAN (1930), LOEBLICH & TAPPAN (1964), SMOUTH (1963), COLE (1965), LEHMANN (1961) and HOFKER (1964).

The senior author examined at the U.S. National Museum paratypes of *Amphisorus matleyi* VAUGHAN and the structure is like *Miosorites americanus.*

Genus *Parasorites* SEIGLIE & RIVERA, gen. nov.

Type species. - *Praesorites orbitolitoides* HOFKER 1930.

Description. - Test large, discoidal, trimorphic; proloculus followed by a flexostyle and then an involute or semi-involute planispiral stage in the microspheric form or by an evolute or semi-involute peneropline stage in the megalospheric forms and then by reniform and annular chambers; chambers are subdivided by intradermal plates which are thicker close to the lateral walls of the chambers and fused in pairs at the proximal side of the chambers; the orifices which connect the chambers are located between the intradermal plates; walls punctuate; aperture consists of one of two alternating rows of orifices in a depression along the periphery.

Range. - Holocene.

Remarks. - This genus is distinguished from *Sorites (= Amphisorus)* because it has a punctuate surface, the chambers have no orbicular pattern, the intradermal plates are different to the partitions in the chambers of *Sorites* (Fig. 8) and the apertural orifices are in a central longitudinal depression of the periphery instead of in transverse furrows. It is differentiated from *Cyclorbiculina* and *Miosorites* gen. nov. because the partitions of chambers are intradermal plates; because the pairs of intradermal plates are fused in their lower part; orifices are located between successive pairs of fused intradermal plates; because its three forms have a peneropline like stage, and because its surface is punctuated. It is distinguished from *Cycloputeolina,* by the shape of the intradermal plates and by the semi-involute or evolute stage of *Parasorites.*

Parasorites orbitolitoides orbitolitoides (HOFKER 1930)

Pl. 3, Fig. 5; Pl. 4, Fig. 3, 5; Text-fig. 9-11

1930 *Praesorites orbitolitoides* HOFKER, Siboga Exped., Monogr. IVa, pt. 2, p. 149, Pl. 55, Fig. 8, 10, 11; Pl. 57, Fig. 4, 6; Pl. 58, Fig. 1-5; Pl. 61, Fig. 3, 4.

Remarks. - HOFKER (1930) described three forms of this species, the megalospheric A2 form with a proloculus of 50 μm and a microspheric form with a proloculus of 15 μm. A histogram (Fig. 12) was made for the proloculus diameters of

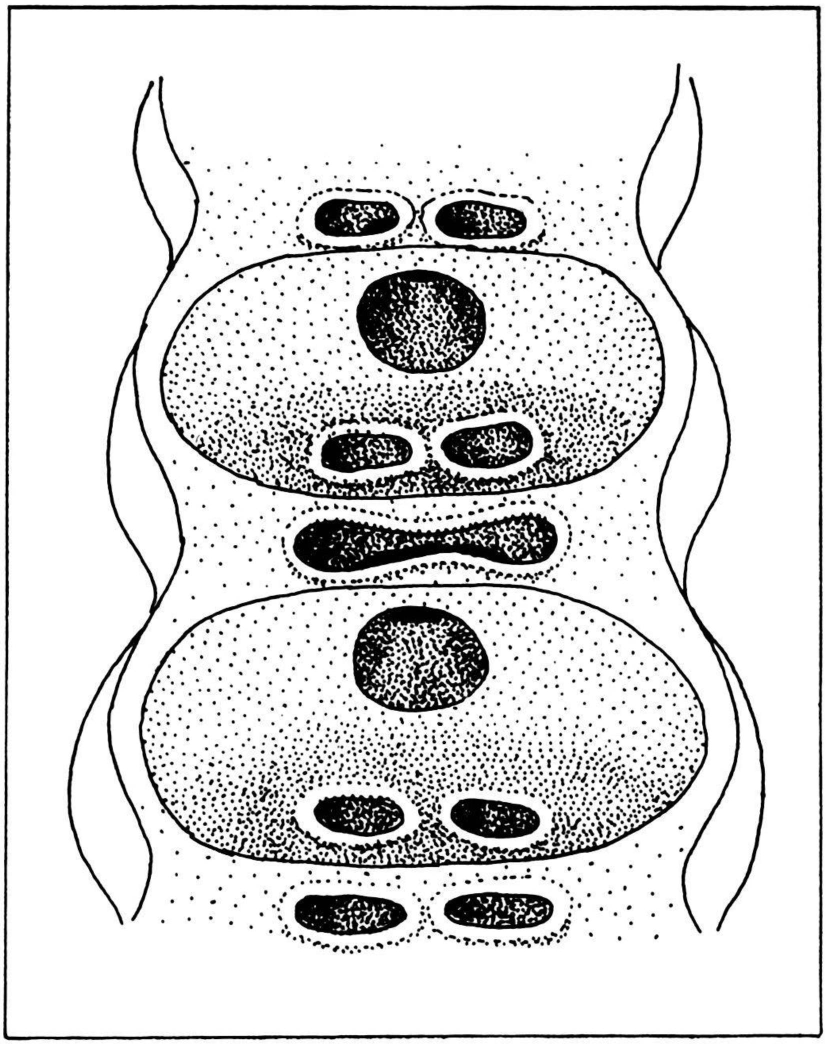

Fig. 8. Structure of annular chamber and chamberlets of the genus *Sorites*. Drawn from specimens of Playa Juan Dolio, Dominican Republic.

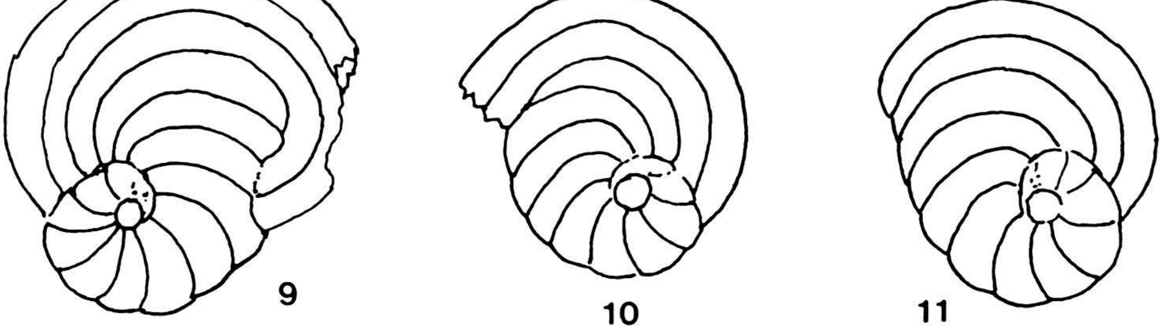

Fig. 9-11. Juvenile individuals of *Parasorites orbitolitoides orbitolitoides* s.str., Sta. Jo-3, Jobos Bay, southern Puerto Rico; 9 = type 3, max. dimension 0.45 mm; 10 = type 2, max. dimension 0.35 mm; 11 = U.S.N.M., No. 241168, max. dimension 0.37 mm.

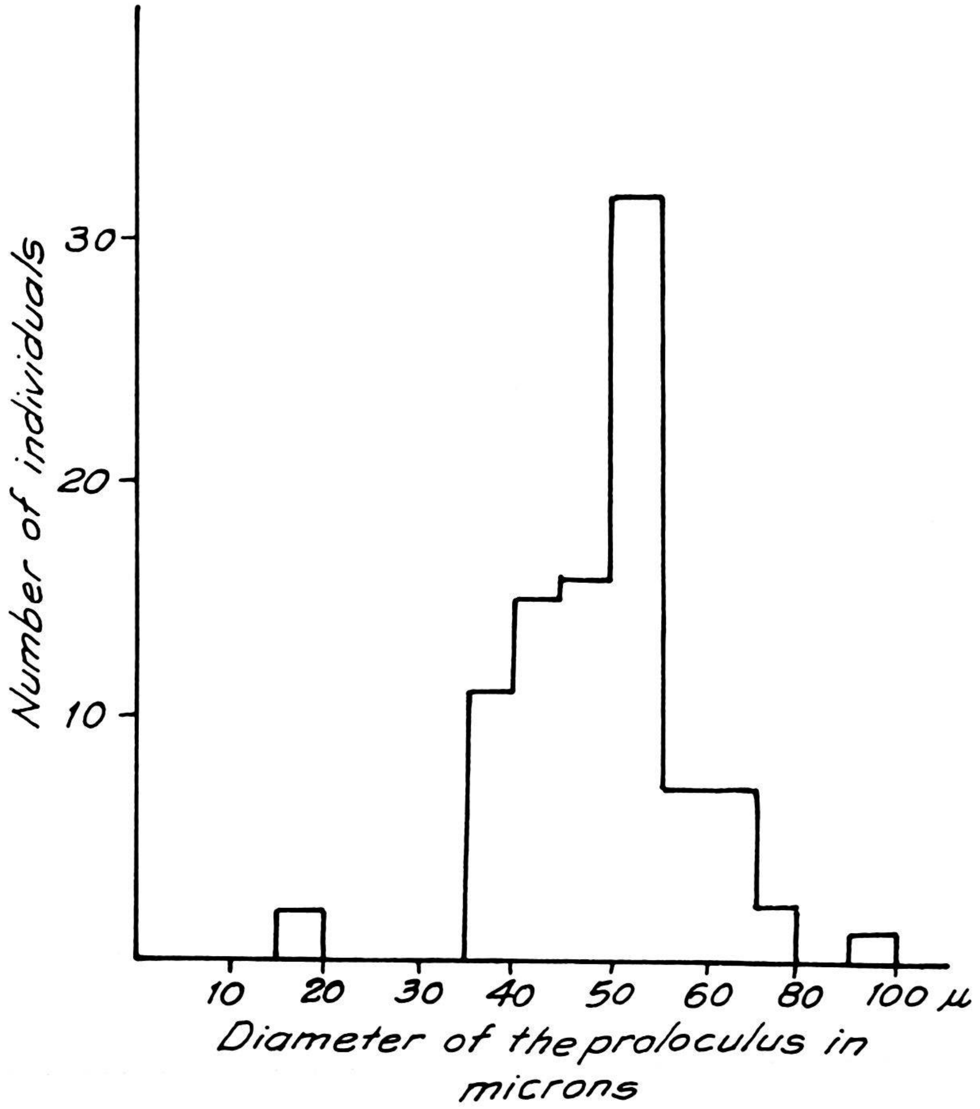

Fig. 12. Histogram of the relationship between the number of individuals and the size of the proloculus of *Parasorites orbitolitoides orbitolitoides*.

specimens of La Parguera shelf and Jobos Bay. The histogram indicates a very low number of microspheric individuals and the asymmetrical curve suggest the presence of megalospheric A1 and A2 forms. The microspheric is involute to semi-involute and the megalospheric forms are evolute. Annular chambers (Fig. 4d, e, f) of large specimens from Mayaguez have two sets of alternating chamberlets (Fig. 4d, f). Young individuals have sutures depressed or weakly projected. Punctuations on the surface are uniformly distributed and the diameter is between 2 to 4 mm.

Specimens of this species occur in samples of Añasco, Mayaguez and Jobos Bay, and of Cabo Rojo and La Parguera shelves (Fig. 1). No living specimen has been found in fourteen localities where tests occur.

Parasorites orbitolitoides monensis SEIGLIE & RIVERA, subsp. nov.

Pl. 3, Fig. 3, 4, 6; Pl. 4, Fig. 4, 6; Text-fig. 13-15

Description. - Test large, discoidal. Proloculus followed by an involute planispiral early stage which consists of whorls in the microspheric form; proloculus of microspheric form 25 μm, proloculus of the megalospheric A1 form, from 40 to 52 μm, proloculus of the megalospheric A2 form about 25 μm; sutures of juvenile form strongly limbate which gives a saw-like appearance to the periphery; planispiral chambers are followed by reniform and then by annular chambers; chambers are subdivided with the exception of the earliest in the planispiral stage; subdivisions consist of intradermal plates fused at the proximal side of the chambers; orifices which connect chambers occur singly between adjacent intradermal plates; surface with punctuations limited to the distal side of the sutures; punctuations limited to the distal side of the sutures; aperture consists of a row of orifices in a central peripheral sulcus. Diameter from 1.55 to 2.90 mm, mean diameter 2.11 mm.

Holotype and paratypes. - The holotype is represented by Plate 3, Figure 6. Its diameter is 1.57 mm. The holotype was deposited in the U.S. National Museum (U.S.N.M., No. 241163). Paratypes 1, 5, 3 and 15 were also deposited in the U.S. National Museum with Nos. 241164, 241165, 241166, 241167 and 241168. The remaining 40 paratypes were deposited in the collection of the Department of Geology, University of Puerto Rico at Mayaguez.

Type locality. - 200 m south of Piedra Carabinero, off the southern coast of Mona Island, at 5 m of water depth.

Range. - Recent, four of the specimens found in the sample at the type locality were alive.

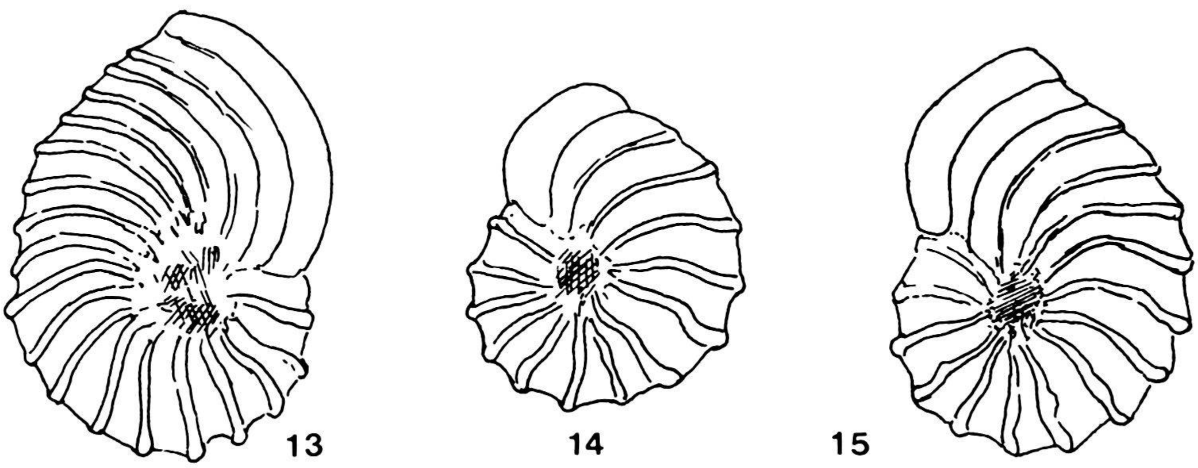

Fig. 13-15. Juvenile specimens of *Parasorites orbitolitoides monensis* subsp. nov., Sta. MI-1, off Mona Island; 13 = paratype 29, max. diam. 0.54 mm; 14 = paratype 30, max. diam. 0.41 mm; 15 = paratype 22, max. diam. 0.49 mm., U.S.N.M., No. 241169.

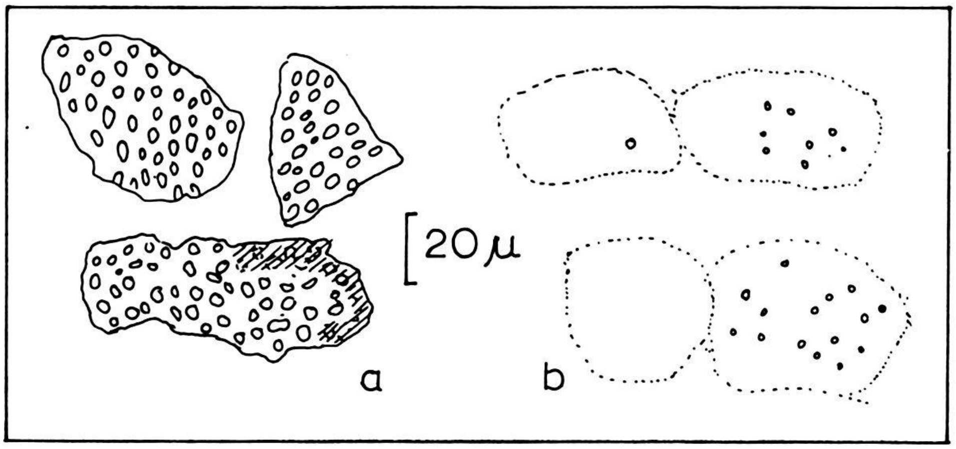

Fig. 16. Punctuations drawn from photographs on the surface of: a = *Parasorites orbitolitoides orbitolitoides*, b = *P. orbitolitoides monensis* gen. nov., subsp. nov., juvenile stage.

Remarks. - This subspecies is differentiated from *Parasorites orbitolitoides* s. str. because its early stage is always involute in the megalospheric forms, because the strongly limbate sutures of the juvenile form give a saw-like pattern to the periphery and because the punctuations in adult specimens are limited to a band close to the sutures (see Pl. 4, Fig. 5). The specimens of Mona Island of *P. orbitolitoides monensis* have the punctuations smaller than *P. orbitolitoides orbitolitoides* off Puerto Rico, but this may be not a characteristic of taxonomic importance (see Fig. 6). It is differentiated from all other species of the family by its generic characteristics.

This species occurs in Mona Island (between Puerto Rico and Hispaniola) and it has not been found in any of the 850 samples taken in more than 700 stations around Puerto Rico. However, we have specimens from a beach in Caribarién, northern Cuba, the Gulf of Batabanó and off Florida coasts.

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Plate 1

Cycloputeolina sp.

Fig. 1 Megalospheric A2 form, dwarf specimen. Sta. S-553, Aymamón Limestone, middle to late Miocene, ×22.

Fig. 2 Megalospheric A1 form. Sta. S-552A, Aymamón Limestone, middle to late Miocene, ×22.

Fig. 3 Vertical section. Sta. S-555, Aymamón Limestone, middle to late Miocene, ×22.

Fig. 4 Sta. S-553, Aymamón Limestone, middle to late Miocene, diameter 3.58 m.

Miosorites americanus (VAUGHAN)

Fig. 5 Test deformed. Sta. S-189A, Cibao Formation, late early Miocene, maximum diameter 2.14 mm.

Fig. 6 Two vertical sections of *M. americanus* and a vertical section of *Archaias* sp. Sta. S-237, Los Puertos Limestone, middle Miocene, ×22.

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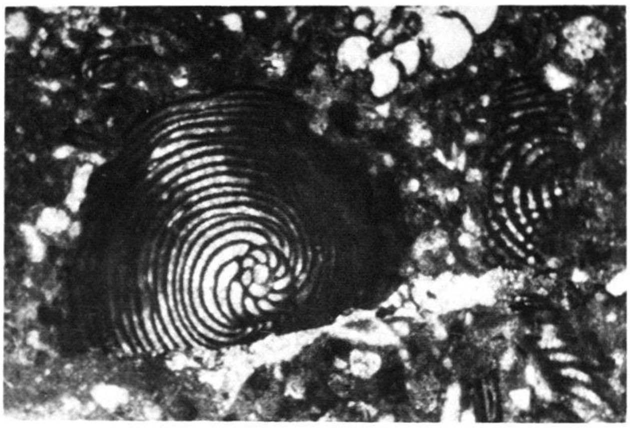

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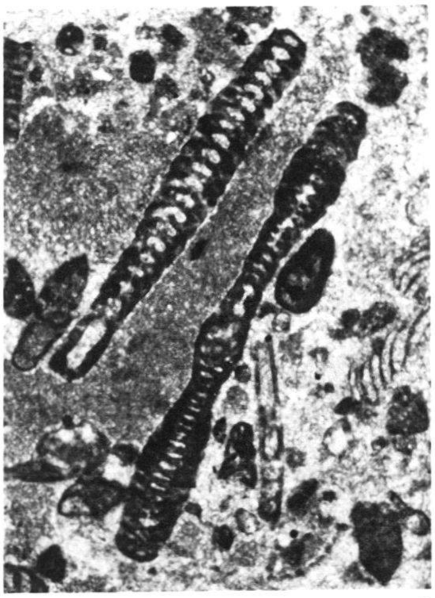

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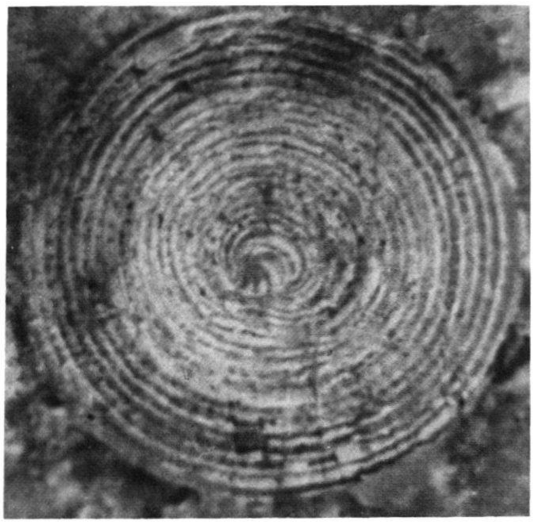

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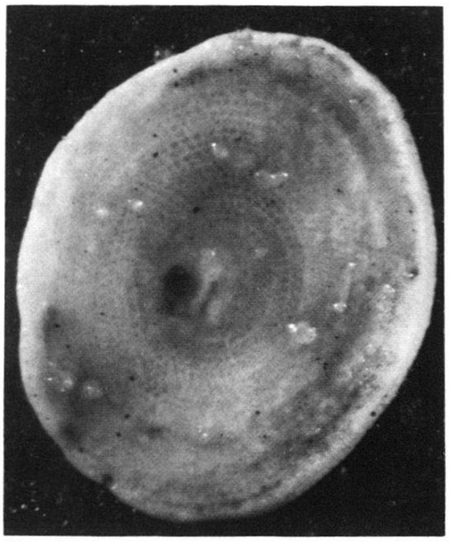

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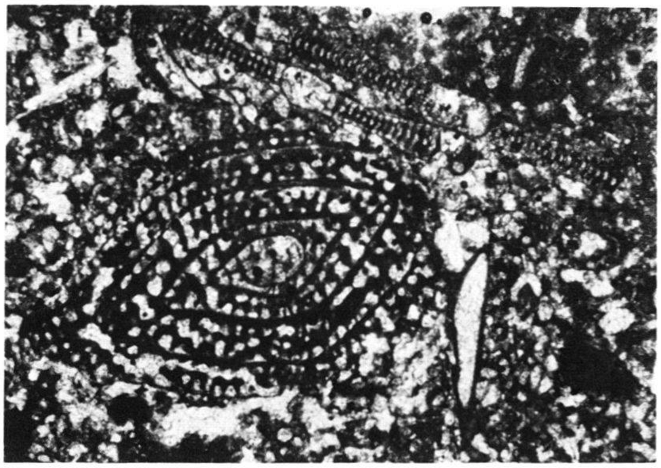

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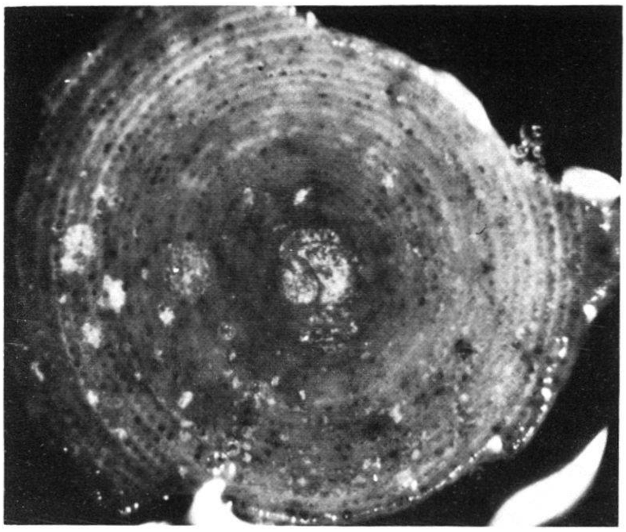
Plate 2

Miosorites americanus (VAUGHAN)

Megalospheric A2 form

Fig. 1	Lectotype. Culebra Formation, Panama Canal Zone, early Miocene, diameter 4.16 mm, maximum dimension in photo 3.89 mm.
Fig. 2-3	Type 1 from the type locality of Cercado Formation, Dominican Republic, maximum dimensions of the embryonic chambers 378 μ.
Fig. 4	Paratype 1. Culebra Formation, Panama Canal Zone, early Miocene, diameter of the proloculus 510 μ.
Fig. 5	Vertical section. Sta. 236A, Cibao Formation, late to early Miocene, $\times 20$.
Fig. 6	Embryonic chambers, deformed. Sta. S-511, Los Puertos Limestone, middle Miocene, $\times 77$.



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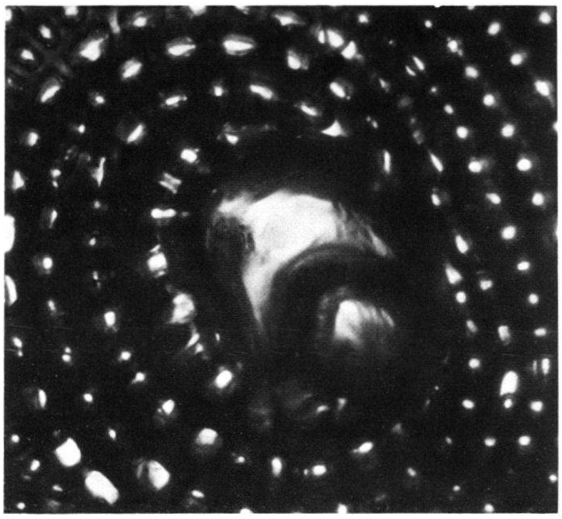

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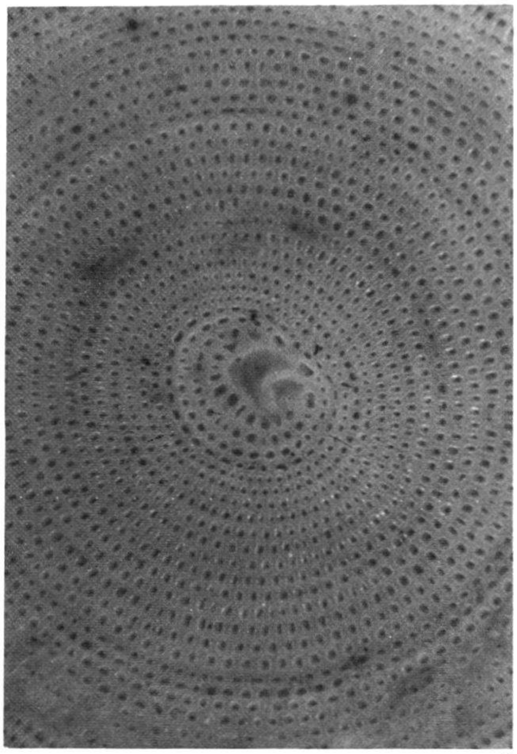

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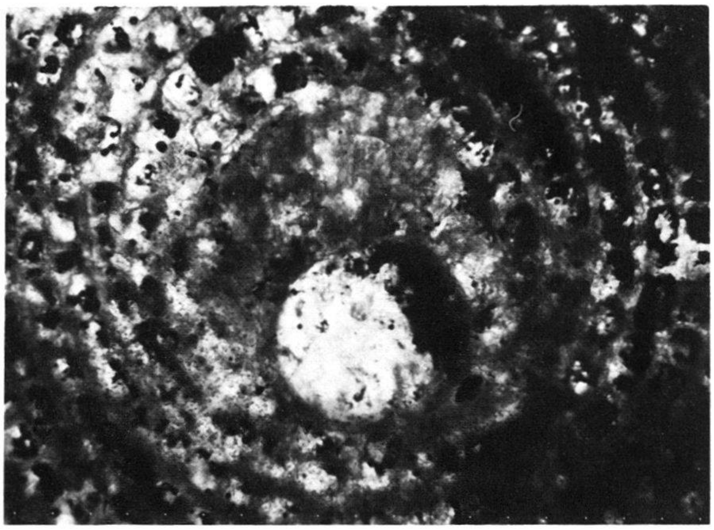

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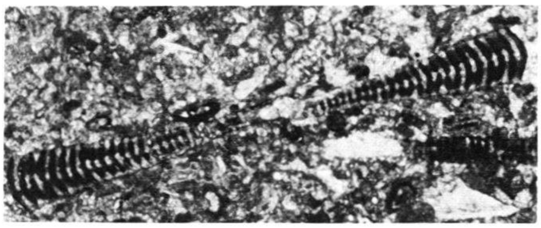

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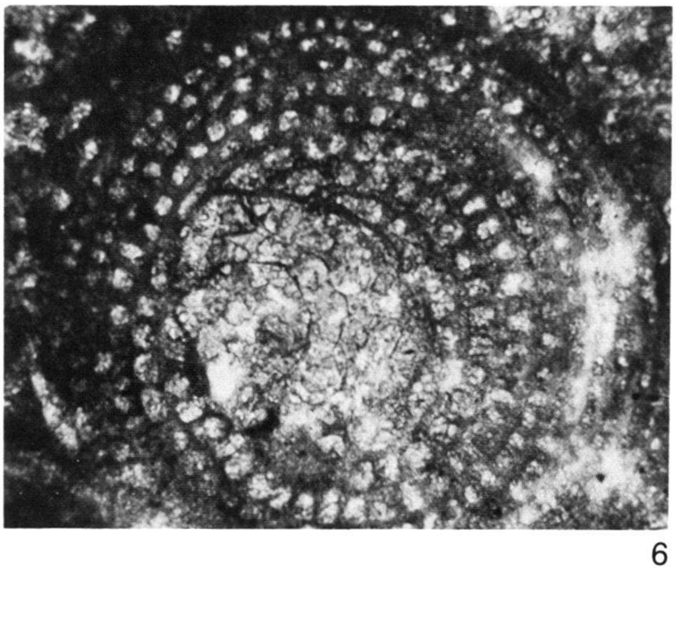


6

Plate 3

Fig. 1 *Miosorites americanus* (VAUGHAN), megalospheric A1 form. Sta. S-632, Aymamón Limestone, middle to late Miocene, ×21.

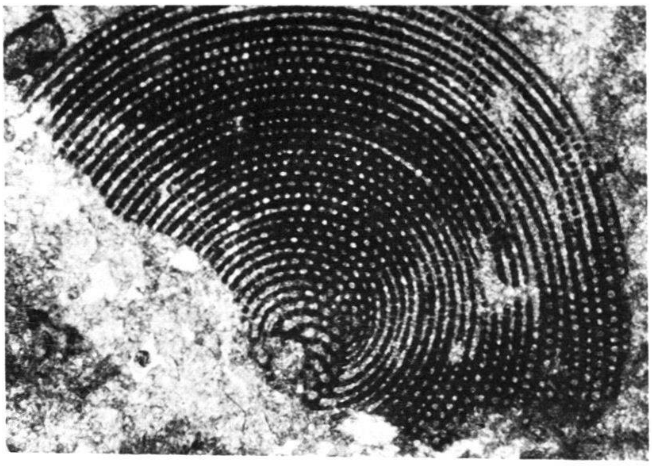
Fig. 2 *M. americanus* (VAUGHAN), megalospheric A2 form. Sta. S-60-A, Ponce Limestone, middle to late Miocene, ×40.

Fig. 3 *Parasorites orbitolitoides monensis* SEIGLIE & RIVERA subsp. nov., juvenile specimen. Paratype 1, Sta. MI-1 off Mona Island, maximum dimension 0.53 mm.

Fig. 4 *P. orbitolitoides monensis* SEIGLIE & RIVERA, subsp. nov. Paratype 3, Sta. MI-1, off Mona Island, Holocene, diameter 1.63 mm.

Fig. 5 *P. orbitolitoides* (HOFKER) s. str. Type 1, Sta. Mz-6, Mayaguez Bay, Holocene, diameter 1.85 mm.

Fig. 6 *P. orbitolitoides monensis* SEIGLIE & RIVERA subsp. nov., holotype Sta. MI-1, off Mona Island, Holocene, diameter 1.57 mm.



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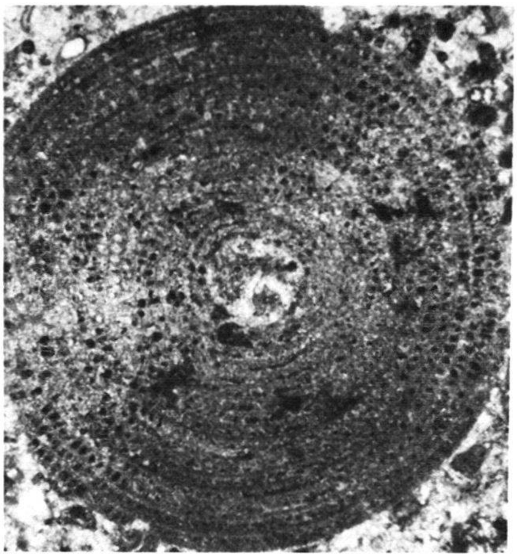

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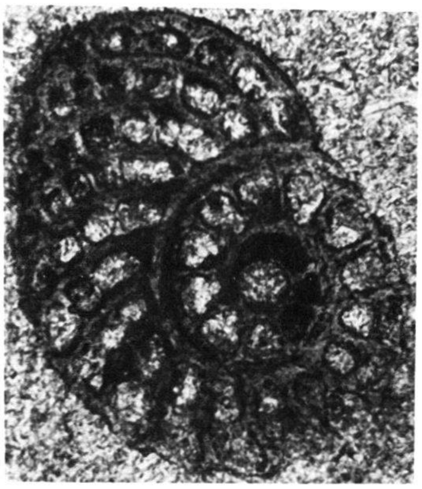

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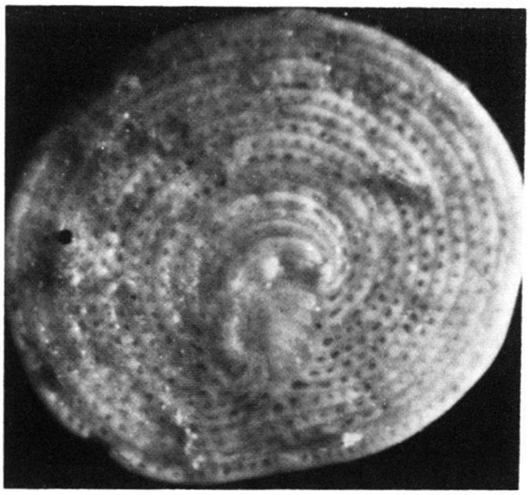

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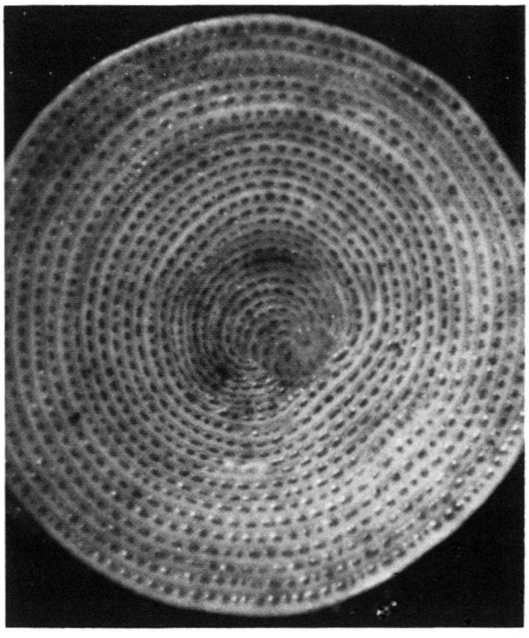

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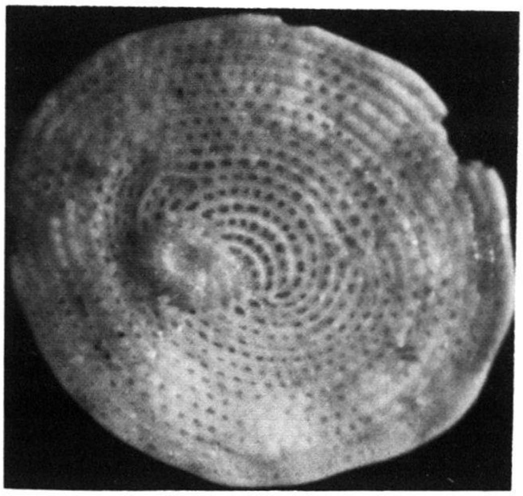

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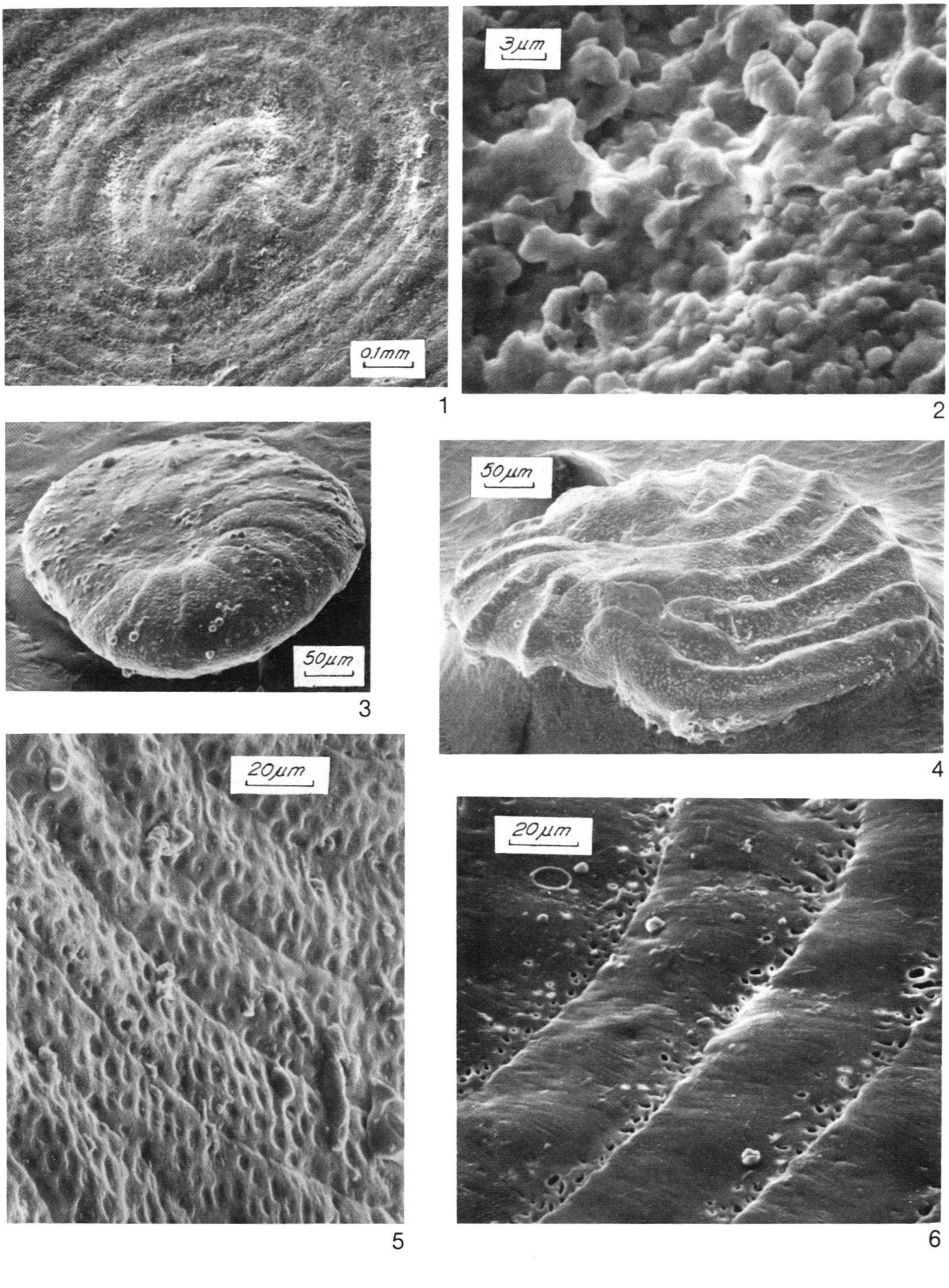
Plate 4

Fig. 1-2	*Miosorites americanus* (VAUGHAN), Sta. B-151 Miocene, Cuba; Figure 1: central part of the test; Figure 2: inner structure of the test wall, surface worn by weathering.
Fig. 3	*Parasorites orbitolitoides orbitolitoides* (HOFKER), juvenile specimen. Sta. Jo-3, Jobos Bay, Puerto Rico.
Fig. 4	*P. orbitolitoides monensis* SEIGLIE & RIVERA, subsp. nov., juvenile specimen. Off Mona Island, Puerto Rico.
Fig. 5	*P. orbitolitoides orbitolitoides* (HOFKER) to show punctuation all over the surface Sta. Jo-3, Jobos Bay, Puerto Rico.
Fig. 6	*P. orbitolitoides monensis* SEIGLIE & RIVERA, subsp. nov., surface to show punctations only close to suture. Off Mona Island.


0.1mm
1
3µm
2
50µm
3
50µm
4
20µm
5
20µm
6