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TERTIARY MOLLUSCA FROM PORTO RICO AND THEIR ZONAL RELATIONS

By Carlotta Joaquina Maury

INTRODUCTION

The collection of Porto Rican fossil mollusca upon which the results embodied in this paper are based, was made by Dr. Chester A. Reeds of The American Museum of Natural History, during the summer of 1915, under the auspices of the New York Academy of Sciences and the Porto Rican Government, The American Museum coöperating.

Unlike the beautifully preserved fossils in the northern part of the neighboring island of Santo Domingo, where the shells in the Miocene blue clays of the Yaqui Valley are as perfect as those on the recent beaches, the fossils from Porto Rico are nearly all in the form of external or internal molds. The majority have been preserved in a creamy or light buff limestone from which all the substance of the shells has been removed by leaching, leaving merely either the imprint of the exterior impressed upon the stone, or else the hardened mud which filled the internal spaces of the shell. Add to this the fragmentary state of the material, and the difficulty of correct determination can be imagined. By making artificial casts of the external molds and comparing them very carefully with actual shells from Santo Domingo, Jamaica and elsewhere, I could confront myself with undoubtedly true identities.

The internal molds were very unsatisfactory and the majority were simply left untouched. But in a few cases where these molds showed the exact form and peculiarities of muscle scars, or columella plications in reverse, or other internal features, one could feel reasonably sure they were the internal casts of certain shells. Sometimes the situation was saved by finding among a great many internal molds a single imprint of the exterior which clinched the identification.

I beg to offer my sincerest thanks to Dr. W. H. Dall, Honorary Curator of the Department of Molluscs, United States National Museum, and to Professor G. D. Harris, Department of Paleontology, Cornell University, for their valuable suggestions as to the stratigraphic age of the faunas from the Collazo shales and the

Campanile Zone. I am also indebted to Dr. Dall for his help on certain very puzzling identifications of some unfigured species by comparisons with types at the National Museum.

CHARACTERISTICS OF THE FAUNAS

Disappearance of Genera, and Pacific Affinities

As in other Antillean Tertiary collections one notes in this from Porto Rico two striking peculiarities: first, the presence of certain genera which have now entirely vanished from the whole Caribbean region, and second, the singular fact that in some cases the recent species most like the fossil form is not now living in the surrounding seas but is in the distant waters of the Pacific. This is due to migration through the Isthmus; the establishment of West Coast and Pacific colonies; and the extinction of the ancestral Antillean stock. The cause of this extinction is a complete mystery, for the larger portion of analogous recent species are Atlantic and West Indian, and are evidently descendants of Oligocene and Miocene forms which have continued on unchanged in the Antillean seas. This fact prevents our calling upon any violent or profound changes to explain the annihilation of the genera and species concerned, and the question remains open.

Range of Species

In brief, the vertical range of mulluscan species through the generalized Porto Rican section is short and limited. Only three percent of those I studied are common to the green shales and the limestone. Of these the omnipresent form is *Teredo incrassata* (Gabb) which ranges throughout the section and is extremely abundant. From the distribution of this species in the type region, Santo Domingo, I had thought of it as a Miocene form only; but Dr. T. W. Vaughan now lists it from the Upper Oligocene of the Emperador limestone, in the Panama Canal Zone. So it is not surprising to find these *Teredo* tubes also in the Porto Rican Oligocene horizons.

Arca umbonata Lamarck occurs in the Collazo green shales and in the Quebradillas and Ponce limestones. This is in harmony with the wide range of this species from the Upper Oligocene of the Tampa formation to the recent fauna, although I have carried it down lower by placing the shales tentatively in the Middle

Oligocene. *Ostrea collazica*, new species, is the third case common to the green shales and the limestone. This finely fluted oyster is highly characteristic of and abundant in the green shales, but at one locality Dr. Reeds found it extending up into the limestone.

Doubtless more complete collections would give a few other species in common between the shales and limestones, but in any case I am sure they will be found to be exceptional.

SIGNIFICANCE OF THE FAUNAL CHANGE

The striking change in the molluscan life at the close of the deposition of the Collazo shales clearly marks an important interval of time and change. If the Collazo shales are correctly referred to the Middle Oligocene, this interval would mark the transition from Middle to Upper Oligocene time.

CORRELATION OF THE FAUNAL ZONES

As a brief review of the conclusions of recent authors on Porto Rican paleontology and stratigraphy has already been given in an earlier paper[1] the matter need now only be summarized by saying that the Collazo green shales were generally referred to the Eocene and the Arecibo limestone to the Oligocene period. In 1917 I suggested, reasoning merely from analogies between Berkey's description of the Porto Rican beds[2] and my Santo Domingan sections[3] that the Collazo (Lares) shales might go with the *Orthaulax* zone, or with the probably older Monte Cristi range limestone, and be included in the Oligocene, while the limestones about the shales might correspond to my Dominican *Aphera* and *Sconsia* formations and be of Miocene age.

The present detailed study corroborates this hypothesis, and indicates furthermore the presence of a number of distinct faunal zones to be interpolated between the Collazo shales and the highest beds of the Arecibo limestone. In determining these zones a hundred and one species and varieties have been worked out, of which fifty-two are known and forty-nine are new. These are discussed in the systematic part of this paper.

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[1] C. J. Maury—On the Correlation of Porto Rican Tertiary Formations with Other Antillean and Mainland Horizons. Amer. Jour. Sci., XLVIII, pp. 209-215, September, 1919.

[2] C. P. Berkey—Ann. New York Acad. Sci., XXVI, pp. 1-70, Pls. I-III, 1915.

[3] C. J. Maury—Bull. Amer. Paleontology, No. 30, pp. 1-43, Pls. I-III, and Correlation Table, 1917.

A description of the faunal zones was also published in my earlier paper. On the north side of Porto Rico they consist of the following groups placed in descending geological order: (1) Quebradillas limestone with many Bowden and Dominican Miocene forms; (2) Aguadilla limestone with *Orthaulax aguadillensis;* (3) Lares limestone with *Campanile* (*Portoricia*) *laricum;* (4) Collazo shales with *Clementia rabelli.* On the south side are (a) the Ponce limestone with *Ostrea cahobasensis* Pilsbry and Brown; (b) Guanica limestone with *Ostrea antiguensis* and (c) Juana Diaz shales. The true time relation between the beds on the north and south sides of the island is very difficult to determine and is only tentatively expressed. The correlation also of the Collazo shales with the Lower Culebra formation is suggested but awaits further knowledge for proof.

In my report, On the Correlation of Porto Rican Tertiary Formations with Other Antillean and Mainland Horizons (Maury, 1919), I followed Dr. Dall in correlating the Flint River beds near Bainbridge with the Tampa formation of Florida. The molluscan evidence would seem to justify this relationship of these horizons especially since they both contain the striking forms, *Orthaulax inornatus* and *O. pugnax.*

Vaughan, however, believes that the Flint River beds are older than the Tampa formation and that they are stratigraphically equivalent to the Antigua formation. His conclusion is based on field sections and on evidence derived from the corals and foraminifera. In the letter dated October 7, 1919, Dr. Vaughan writes: "My stratigraphic placing of the Flint River coraliferous chert is based on several different kinds of evidence. One is the comparison of numbers of sections made along Flint River from Bainbridge down stream to below River Junction, Florida, and stratigraphic studies across Florida eastward from Apalachicola River. With regard to the coral fauna in the Flint River chert, there is very little in common with the coral fauna of Tampa—*Orthaulax inornatus* and *Orthaulax pugnax* are both species of considerable stratigraphic range and neither one of them can be used as a basis for close geologic correlation."

Now, if we lower the Flint River beds to the Antiguan, should we also drop the Lares limestone with *Campanile laricum* down to the same level? This would in turn suggest dropping the Collazo shales into Lower instead of Middle Oligocene. Beds of Lower

TENTATIVE CORRELATION OF THE PORTO RICAN TERTIARY FORMATIONS

			Porto Rico: North Side	Porto Rico: South Side	Santo Domingo	Haiti	Jamaica	Anguilla	Antigua	Panama	Florida	Georgia	Cuba
MIOCENE	Middle	Subdivisions of the Arecibo Formation	Quebradillas limestone with bowden Fauna and *Metia trinitaria*		Upper or *Sconsia* formation	Maissade beds	?			Gatun beds with *Sconsia*			La Cruz marl
MIOCENE	Lower	Subdivisions of the Arecibo Formation			Lower or *Aphera* formation		Bowden marl			?Lower Gatun horizon	Oak Grove sands Chipola marls		Marl at Baracoa
OLIGOCENE	Upper	Subdivisions of the Arecibo Formation	Aguadilla limestone with *Orthaulax aguadillensis*	Ponce chalky beds with *Ostrea cahobasensis*	*Orthaulax inornatus* zone	Las Cahobes beds and Thomonde beds with *Ostrea cahobasensis*		Anguilla formation		Emperador limestone Upper part of Culebra formation	Tampa formation with *Orthaulax inornatus* and *O. pugnax*		Various localities of Cuba
OLIGOCENE	Upper	Subdivisions of the Arecibo Formation	Lares limestone with *Campanile (Portoricia) laricum*										
OLIGOCENE	Middle	San Sebastian Lares, or Collazo shales	Rio Collazo Shales with *Clementia rabelli*	Guanica shaly limestone with *Ostrea antiguensis*	?Monte Cristi range limestone				Antigua formation with *Orthaulax pugnax* and *Ostrea antiguensis*	Lower part of Culebra formation		Flint River chert below Bainbridge with *Orthaulax inornatus* and *O. pugnax*	Coral reef at Guantanamo (Vaughan)

Oligocene age are represented by Hill's Montpelier white limestone and synchronous formations which are thought to be present in Cuba and Haiti.

There is a structural argument for postulating a Lower Oligocene age for the Collazo shales in that they show evidence of disturbance which has greatly deformed the fossils they contain. This might well have taken place during the period of Antillean diastrophism between the deposition of the Upper Eocene and the Middle Oliogocene.

On the other hand, the paleontological evidence suggests a younger age since the most abundant fossil is a *Clementia* like *C. dariena* from Gatun. According to the field observations, however, of Berkey and of Reeds, the shales must be much older than the Gatun Formation, which is about equivalent to the Quebradillas limestone, for they underlie the limestone series. The genus *Clementia* is generally thought to have originated in the Oligocene, but Professor Harris[4], has lately referred a St. Maurice Eocene shell, *Dosinia mercenaroidea* Aldrich, to *Clementia.* This, however, was a primitive form just differentiating from its relatives, while the shell from the Collazo shales is a typical, well defined *Clementia,* certainly of the same group as *Clementia dariena* and possibly identical, though more likely ancestral. Two of the Areas in the shales are forms which might run back even into Early Oligocene time; but one species is a later type resembling a Culebra shell. In view of these faunal relations, I do not think that the Collazo shales will prove older than Middle Oligocene.

The purely paleontological results given herein must be weighed by other investigators and harmonized with the actual succession showed by the field sections. It will very likely then be found that certain of the faunal zones in my correlation table should be somewhat raised or lowered.

Vaughan's recent geological survey of the island of Santo Domingo will doubtless reveal the presence there of new faunal horizons some of which may bring out more clearly the interrelation of the Porto Rican horizons. Meantime the following correlation table is suggested as an approximation towards the true sequences and relationships of the Tertiary molluscan zones of Porto Rico.

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[4]Bull Amer. Paleontology, No. 31, p. 151. 1919.

SYSTEMATIC DESCRIPTION OF SPECIES

CLASS PELECYPODA

Order Prionodesmacea

Genus **Arca** Linnæus

We are much indebted to Dr. Pearl Sheldon of Cornell University for critically examining and sending us valuable notes upon the Arcas. In a letter, dated June 27th, 1919, Dr. Sheldon writes:

> There are at least fourteen different species, many of them new, in the Porto Rican collection, but only a few of them can be described (owing to their very imperfect state), and only one certainly identified as an old species, *A. umbonata*. The single valve of *Arca* cf. *cumanensis* is the best preserved specimen in the collection, but one of the hardest to identify, because the two valves would be discrepant, and it might be *A. cumanensis* which is unfigured and only briefly described.
>
> The collection seems to be very different from the Santo Domingan Arcas. . . . . There are no species in common that can be identified except *A. umbonata*, and *Barbatia reticulata*. . . . The comparisons are chiefly from Panama or other distant localities.

Concerning this striking difference between the Porto Rican and Dominican Arcas, as observed by Dr. Sheldon, it is important to note that the specimens were sent to her with station numbers only, and that very few happened to be from the horizon I had identified, unknown to her, as equivalent to the Dominican and Bowden Miocene. Of these latter she refers one to *A. umbonata* and the other to a new species nearest a Dominican shell that I described as *A. cibaoica*. Dr. Sheldon's results from the Arcas thus strengthen the evidence I have gathered from the other molluscan genera, namely that in the Porto Rican collection we have to do with several distinct faunas, only one of which is like that of Bowden.

Arca umbonata Lamarck

Arca umbonata Lamarck, 1819, Anim. s. Vert., VI, p. 37.
Arca umbonata Philippi, 1847, Abbild. u. Beschr., III, p. 13, Pl. XVII, *b*, figs. 3 a-c.
Arca imbricata (Bruguière) Gabb (in part) 1873, Trans. Amer. Phil. Soc., XV, p. 254.
Arca umbonata Arango, 1879, Fauna Malacologica Cubana, p. 261.
Arca umbonata Dall, 1898, Trans. Wagner Inst. Sci., III, pt. 4, pp. 620. 659; 1900, *Idem* pt. 5, Pl. XXXVIII, figs. 4, 4 a.
Arca umbonata Sheldon, 1916, Paleontographica Americana I, p. 8, Pl. I, figs. 12-17.
Arca umbonata Maury, 1917, Bull. Amer. Paleont., No. 29, p. 164, Pl. XXX, fig. 11.
Arca umbonata Vaughan, 1919, Bull. 103 U. S. Nat. Mus., p. 564.

Lamarck described the type of this species from a recent shell from Jamaica. Yet, curiously, it has not turned up in the Miocene (Bowden) beds of that island, although I collected it from synchronous deposits in Santo Domingo on the Rio Cana, and now it appears in Reeds's collection from Porto Rico.

Arca umbonata has a wide geological and geographical range. It is found in the upper Oliogocene of the Tampa formation; the lower Miocene of the Chipola marls, Pleistocene of the Florida Keys and the Antilles, and is living from Cape Hatteras to Santa Caterina, Brazil, and also in the Antilles. The Porto Rican molds of this ark-shell are readily distinguished from the other Arcas by the sharp umbonal ridge characteristic of this species. Because of its nestling habit the form of the shell varies considerably. This species is one of the best represented Arcas in Porto Rico, and the localities show its presence in both the green shales and the limestones, and on the northern and southern sides of the Island. Apparently the shell was comparatively common as contrasted with its presence in the Dominican blue clays in which we found but a single valve, although other Arcas were wonderfully abundant and varied.

*Localities**.—Rio Collazo, near San Sebastian, Stations 35, 60; near Quebradillas, Station 134; near Ponce, Station 292.

Also a mold from Station 111 of which Dr. Sheldon notes "I am sure this is the young of *A. umbonata* but cannot entirely prove it." The others were all identified as unquestionably this species. Of the specimen from Station 35 Dr. Sheldon writes "Besides the general form this specimen has the coarse ribs on the posterior slope and the conspicuously finer, cancellated ribs anterior to the ridge which characterize *A. umbonata* and its Pacific allies."

Subgenus **Barbatia** Gray

Barbatia (Acar) reticulata Gmelin

Arca reticulata Gmelin, 1792, Syst. Nat. VI, p. 3311.

Arca reticulata Chemnitz, Conch. Cab., VII, p. 193, Pl. LIV, fig. 540.

Barbatia (*Acar*) *reticulata* Dall, 1898, Trans. Wagner Inst. Sci., III, pt. 4, p. 629.

Arca (*Barbatia*) *reticulata* Dall and Simpson, Bull. U. S. Fish Comm. XX, pt. 1, p. 460.

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*The locality numbers mentioned in this paper are those assigned in the field by Dr. Reeds. Their exact position will be recorded by him in a forthcoming report. The American Museum accession number, 440, is understood to precede all the Station numbers.

Arca (*Barbatia*) *reticulata* Sheldon, 1916, Paleontographica Americana, I, p. 20, Pl. IV, figs. 8-12.

Barbatia (*Acar*) *reticulata* Maury, 1917, Bull. Amer. Paleont., No. 29, p. 166, Pl. XXX, fig. 16.

There is a fragmentary imprint in a limestone block apparently made by a valve of *Barbatia reticulata,* since a cast from it agrees well with shells of this species.

This richly and deeply sculptured ark-shell was first developed in the Jacksonian Eocene of Mississippi. It continued on in the Oligocene of Tampa, Miocene of Bowden, of Matura, Trinidad, and of the Chipola River, Florida; Pliocene of Florida; Pleistocene of the Antilles; Recent from Cape Hatteras to the Gulf of Campeche. It is one of the very few fossil species still living on the Porto Rican shores and is reported by Dall and Simpson from the reefs at Ponce, from Mayaguez, Guanica, San Juan Harbor and Hucares. In 1917 I found a single valve in the Miocene bluffs of Cercado de Mao, Santo Domingo. The single external mold in the present series shows that the species was also present in Porto Rico, but seems then to have been a rare shell.

Locality.—Near Ponce, Station 288.

Arca (Scapharca) guajatica Sheldon and Maury, new species

Plate I, Figure 3

Shell very small, oblong, much inflated, marked by a shallow sulcus ending at about the middle of the ventral margin. The sculpture consists of twenty-seven or twenty-eight narrow, rounded ribs, widely spaced over the anterior and posterior parts of the valve, but finer and closer in the sulcus. Cardinal area partly concealed by the limestone matrix, but probably narrow. Margin of valve crenulate. Length of shell 7 mm., height 4 mm., semi-diameter 3 mm.

Five examples of this little form show that it is not the young of any other Ark in the collection, and it appears to be a new species. Its most conspicuous feature is the convexity in the umbonal region. This species recalls *Scapharca cibaoica* Maury from the Yaqui Valley, Santo Domingo, but it has a broadly inflated umbo instead of the small pointed beaks of that shell; the beaks are less anterior (at about two-fifths the length of the shell), the direction of the sinus is less oblique, so too is the general aspect of the shell, and finally the number of ribs is greater in the Porto Rican species. From Bowden also a small species, though larger than either of our Dominican or Porto Rican little Arcas, has been described by Dall as *A. bowdeniana,* but its general appearance is not like this Porto Rican shell.

Localities.—Four specimens from near Quebradillas, Station 130, and a mold, probably this species, from Station 128, same region.

Arca (Scapharca) aguadica Sheldon and Maury, new species

Plate I, Figure 2

Shell small, flattened, umbo not much inflated; beaks at the anterior third; cardinal area long and narrow; ribs about twenty-seven or twenty-eight, those on the posterior third appearing as low, narrow, rounded ridges on the mold, anterior ribs probably more closely spaced, ornamentation unknown. The outline of the shell is oblong, the base being nearly parallel to the hinge which is almost as long as the shell. The posterior margin of the best preserved specimen is straight, nearly at right angles to the hinge and basal margin, and curved only at the corners. More worn specimens have an elliptical posterior margin, yet the outline remains almost bilaterally symmetrical, instead of the usual produced and pointed *Arca* form. Length 17 mm., height 9.5 mm., diameter 7 mm.

This species may be distinguished from the young of the group to which *Arca secticostata* Reeve and *A. henekeni* Maury belong, and from the *Arca transversa* group, by its smaller and less inflated umbo, and especially by its flat, high, oblong and symmetrical posterior end. The collection affords five internal molds, showing both valves in place. Although the exterior has been dissolved away, the form of the mold is so characteristic as to be recognizable, because the species does not closely resemble any described from the Antillean region.

Locality.—Near Aguada in the northwestern part of the island, Station 124.

Arca (Scapharca) collazica Sheldon and Maury, new species

Plate I, Figure 4

Shell oblong, closely-ribbed, the ribs numbering thirty-two to thirty-six, simple, as wide as, or wider than the interspaces, and of almost the same size and spacing over the entire shell; anterior ribs beaded; cardinal area long and narrow, beaks at the anterior two-sevenths. Length of shell 28 mm., height 15 mm., semi-diameter 4 mm.

The green shales of Rio Collazo yielded several valves of a small *Scapharca* of common form, but with distinctive ribbing, unlike that of related species. Like other specimens from these shales they have suffered distortion from pressure. Because of the distortion of the valves it is uncertain whether the posterior end is more like that of *Arca oronlensis* Gabb (Journ, Acad. Nat. Sci. Phila., (2), VIII, p. 346, Pl. XLIV, fig. 21) from the Miocene of Panama and Costa Rica, and like *Arca dariensis* Brown and Pilsbry (Proc. Acad. Nat. Sci. Phila., LXIII, p. 362, Pl. XXII, fig. 10, 1911) from the Miocene of Panama, or like that of *A. gatunensis* Toula (Jahrb. der k. k. Geol. Reichsanstalt, Wien, LXI, p. 493, Pl. XXX, fig. 4, 1911), also from the Gatun Miocene. Of Antillean species it resembles *Arca inæquilateralis* Guppy (Quart. Jour. Geol. Soc. London, XXII, p. 293, Pl. XVIII, figs. 2a, 2b, 1866) from the Miocene of Bowden, which more nearly agrees in size, and *Arca losquemadica* Maury (Bull. Amer. Paleont., No. 29, p. 172, Pl. XXX, fig. 1, April, 1917) from the Dominican Miocene.

All these Isthmian and Antillean species, however, except *Arca oronlensis,* have ribs which are narrower on the central part of the shell and wider and divided by a groove on the anterior and posterior areas of the valve, while in the Porto Rican species the ribs are entire and nearly the same size over the entire shell. From *Arca oronlensis* the fossil differs in its smaller size, more numerous, and probably less beaded ribs.

Localities.—Rio Collazo near San Sebastian, Stations, 53, 54, 60.

Arca (Scapharca) sansebastiana Sheldon and Maury, new species

Plate I, Figure 5

Shell small, oblong, rather inflated, with the umbonal ridge very sharply defined; beak full, incurved; hinge-line rather short, its characters concealed by the matrix. The entire surface of the valve is sculptured with about twenty-five, apparently uniform ribs. No beading is shown on the ribs, but this may be due to the imperfect preservation of the shell. Length of right valve 18 mm., height 12 mm., semi-diameter 5 mm.

This species is most nearly akin to *Arca balboai* Sheldon (Palaeontographica Americana I, p. 69, 1917=*Arca dalli* Brown and Pilsbry, Proc. Acad. Nat. Sci. Phila., LXIV, p. 510, Pl. XXIV, fig. 4, January, 1913, name preoccupied), from the Isthmus of Panama. But the Porto Rican shell is smaller, longer in proportion to its height, much less inflated, and with the umbonal ridge much more sharply angled. The ribs also are fewer, numbering twenty against twenty-eight. Clearly, however, the affinities of this Porto Rican species are with the Isthmian shell, which was obtained from a lignitic clay at the bottom of the Culebra Cut, Las Cascades.

The new species is founded upon a single specimen of entirely different aspect from *Scapharca collazica,* with which it was associated.

Locality.—Rio Collazo near San Sebastian, Station 53.

Arca (Scapharca) cf. actinophora Dall

Arca (Scapharca) actinophora Dall, Trans. Wagner Inst. Sci., III, pt. 4, p. 647, Pl. XXXIII, fig. 26, 1898.

There are in the collection two specimens, probably belonging to the same species, one being the internal mold of both valves with broken posterior margin, the other the worn exterior of the umbonal region. The latter recalls *Arca auriculata* Lamarck, but the ribs are wider and the form of the mold is different. The ribs are wider than the interspaces, varying but little over the shell and entire as far as the fragment indicates.

This species is most like *Scapharca actinophora* Dall from Panama, but is smaller and is less attenuated posteriorly. It bears some resemblance also to *A. gatunensis* Toula, but is larger, the beaks higher, and more anterior, and the ribbing seemingly was different. This is probably a new species, but too poorly preserved to warrant specific description.

Localities.—Near Aguada, in the northwest part of the island, Station 117 (internal mold); near Ponce, in the south central part of the island, Station 293 (exterior, probably the same).

Arca (Cunearca) cf. cumanensis Dall

Arca (Cunearca) cumanensis Dall, Trans. Wagner Inst. Sci., III, pt. 4, pp. 633, 634, 1898.

There is a single right valve of a small *Cunearca* intermediate between the recent *A. incongrua* Say and *A. chemnitzi* Philippi, but nearer the former species. This Porto Rican shell answers the description of *Arca cumanensis* from the Miocene of Cumana, Venezuela, excepting that the posterior ribs near the hinge are nodulose. It is allied also to *Arca chemnitzoides* Maury from Trinidad (Jour. Acad. Nat. Sci. Phila., (2), XV, p. 44, Pl. VII, figs. 13, 14, 15, Pl. VIII, fig. 1, 1912), which is nearer *A. chem-*

nitzi. Probably this species is identical with *A. cumanensis* which has never been figured.

Locality.—Near Aguada, Station 123.

Genus **Glycymeris** Da Costa

Glycymeris acuticostata Sowerby

Pectunculus acuticostatus Sowerby, 1850; Quart. Jour. Geol. Soc. London, VI, p. 53, Pl. X, fig. 13.

Pectunculus acuticostatus Guppy, 1866, Quart. Jour. Geol. Soc., London, XXII, p. 293; 1867, Proc. Sci. Assoc. Trinidad, p. 164.

Axinea acuticostata Gabb, 1873, Trans. Amer. Phil. Soc., XV, p. 255.

Pectunculus acuticostatus Guppy, 1874, Geol. Mag. London, p. 443; 1876, Quart. Jour. Geol. Soc. London, XXXII, p. 532.

Glycymeris acuticostata Dall, 1898, Trans. Wagner Inst. Sci., III, pt. 4, p. 608.

Glycymeris acuticostata Brown and Pilsbry, 1911, Proc. Acad. Nat. Sci. Phila., p. 364.

Glycymeris acuticostata Maury, 1917, Bull. Amer. Paleont., No. 29, p. 180. Pl. XXVI, fig. 12; *Idem*, No. 30, pp. 10, 11, 20, 23.

Glycymeris acuticostata Vaughan, 1919, Bull. 103 U. S. Nat. Mus., p. 561.

In the collection is a single internal mold probably of *Glycymeris acuticostata*, because artificial casts made from the interior of a valve of similar size of this species from Santo Domingo show the same angle of slope of the hinge teeth and bear the same general aspect.

This species was originally described from the Yaqui Valley, Santo Domingo, where Colonel Heneken first collected it. The Maury expedition, 1916, found it quite common in the *Sconsia lævigata* formation of the Mao and Gurabo rivers, Santo Domingo, but did not obtain any specimen from the *Aphera* formation. The species is also known from Cumana, Bowden and Gatun, but is now for the first time found in Porto Rico.

Locality.—Near Quebradillas, Station 130.

Glycymeris cf. **jamaicensis** Dall

Pectunculus pennaceus Guppy, 1866, Quart. Jour. Geol. Soc. London, XXII, p. 293. Not of Lamarck.

Axinea pennacea Gabb, 1873, Trans. Amer. Phil. Soc., XV, p. 255.

Pectunculus decussatus Guppy, 1876, Quart. Jour. Geol. Soc. London, XXXII, p. 532. Not of Hanley.

Glycymeris jamaicensis Dall, 1898, Trans. Wagner Inst. Sci., III, pt. 4, p. 608; 1903, *Idem*, III, pt. 6, p. 1586.

Glycymeris jamaicensis Maury, 1917, Bull. Amer. Paleont., No. 29, p. 181, Pl. XXVI, fig. 13; *Idem*, No. 30, pp. 24, 27.

Partly imbedded in the limestone matrix is a *Glycymeris* which is sculptured with fine, impressed, radiating lines, giving under the lens the effect of obsolete ribs. This sculpture is characteristic of *Glycymeris jamaicensis* Dall from Bowden, which we also found in the Dominican Miocene, *Aphera* formation. It is quite probable that the Porto Rican shell is a young specimen of *G. jamaicensis* but it is too imperfect to identify decisively. The recent analogue of this species is *Glycymeris pennacea* Lamarck, while the corresponding Gatun species is *G. carbasina* Brown and Pilsbry.

Locality.—Near Aguada, Station 117.

Genus **Pteria** Scopoli

Pteria inornata (Gabb)

Avicula inornata Gabb, 1873, Trans. Amer. Phil. Soc., XV, p. 253.
Pteria inornata Dall, 1898, Trans. Wagner Inst. Sci., III, pt. 4, p. 669.
Pteria inornata Maury, 1917, Bull. Amer. Paleont., No. 29, p. 181, Pl. XXVI, fig. 14; *Idem*, No. 30, pp. 11, 13.

Two internal molds of a *Pteria* match very well with shells of *P. inornata* Gabb obtained by the writer on Santo Domingo. This attractive little shell is somewhat variable in form, just as these two molds are not quite alike, but Dominican specimens can be chosen that conform very exactly to each. Well preserved shells are marked with concentric wavy lines of chestnut brown, otherwise the surface is quite smooth. Usually one finds them without the outer layer and then they justify Gabb's name *inornata*. The substance of the shell has been entirely dissolved away from the Porto Rican specimens. This is the first time that this species has been reported from outside of the Dominican Republic.

The recent Porto Rican shell, *Pteria radiata* Leach, is larger and is ornamented with radiating rows of scales; but d'Orbigny's *Pteria candeana* is of much the same general aspect as the fossil.

Locality.—Señor Rabell's Ranch on Rio Guajataca, Station 110.

Genus **Ostrea** (Linnæus) Lamarck

Ostrea collazica, new species

Plate I, Figure 7; Plate II, Figure 1

Shell irregularly oval, valves very dissimilar in form and sculpture. The lower valve is very convex and irregularly ridged and deformed because of the large area of attachment usually in front of and below the beak. Some specimens show internal marginal crenulations anterior and posterior to the ligamental area. The beak is recurved The convex valve is sculptured with close, somewhat regular, wrinkled flutings, in younger shells about five to a space of ten millimeters, in old valves about three to the same distance. On young valves this radial sculpture is very noticeable, in old valves it becomes more or less obscured but traces can be seen on some areas. Some convex valves are greatly thickened, one measuring 65 mm. along the ligament area. The close, radial, wrinkled flutings, convex, irregularly ridged form, and large, deforming attachment area at once distinguish these valves from those of any other species in Porto Rico. The flat valve is marked only with exceedingly close, fine, wrinkled, concentric growth lamellæ. Beak very curving, often with a strong spiral twist as in *Exogyra.* Marginal crenulations are usually in front of and behind the beak. A medium-sized shell with both valves in place measures 70 mm. in height, 55 mm. in width and 40 mm. in thickness. Estimated length of an old valve 160 mm., width 105 mm.

Although extremely characteristic of and common in the green Collazo shales, this species was found also at one locality (Station 56), in the Arecibo limestone.

Localities.—Rio Collazo near San Sebastian, Stations 22, 24, 25, 26, 27, 28, 36, 38, 45, 46, 47, 48, 49, 50, 51, 52, 53, 55, 62, 63, 95, 107; near Lares, Station 56. Near Arecibo, Station 452, Dr. Reeds collected an enormously heavy *Ostrea,* possibly this species.

Ostrea berkeyi, new species

Plate I, Figure 6

Shell radially sculptured with smooth, well defined divaricating, radial ribs, divided into two unequal series by a main primary rib.

The shell differs from *Ostrea collazica* in being smaller and in having no wrinkled and irregular flutings. In its size and type of sculpture this *Ostrea* recalls the Clairbornian Eocene species, *Ostrea divaricata* Lea. Height of shell 40 mm., greatest width 25 mm., greatest thickness of convex valve 15 mm. This species is named in honor of Professor C. P. Berkey of Columbia University, in recognition of his valuable contributions to the geology of Porto Rico.

Locality.—Rio Collazo near San Sebastian, Station 107.

Ostrea sansebastiana, new species

Plate I, Figure 1

Shell nearly circular in outline, concave. Beak incurved. Exterior marked by fine, irregularly wrinkled lamellæ not unlike those of a flat valve of *Ostrea collazica.* Practically entire internal margin conspicuously crenulate Height of valve 65 mm., breadth 65 mm., semi-diameter 15 mm.

I should consider this shell to be a specimen of *Ostrea collazica* that had through some accident of growth assumed a rounded and concave form, were it not for the strong marginal crenulations which lead me to differentiate it under a special name.

Locality.—Rio Collazo near San Sebastian, Station 23.

Ostrea cahobasensis Pilsbry and Brown

Ostrea cahobasensis Pilsbry and Brown, 1917, Proc. Acad. Nat. Sci. Phila., LXIX, p. 40, Pl. VI, fig. 8.

Many specimens of a very heavy, thick oyster, of crude aspect, and in nearly every case badly broken, were collected on the south side of the island. The shells were much like the description and figure of *Ostrea cahobasensis* Pilsbry and Brown, the type of which is from Haiti, in the mountains north of Lake Assuei, on the trail to Las Cahobas, and the species is also found south of Thomonde. In both these Haitian localities the valves of this *Ostrea* form extensive beds.

Because of its very evident importance in correlation, Dr. H. A. Pilsbry by request compared one of the Porto Rican shells with the Haitian type, which is at the Philadelphia Academy, and stated that the Porto Rican shell, "shows no characters differentiating it from *Ostrea cahobasensis* Pilsbry and Brown. I am disposed to identify it provisionally with that Haitian species; yet the condition of your specimen does not admit of positive identification." There are, however, among the number some valves precisely like the figure of the type. Dr. Dall also remarked of our shell: "We have fragments of this from the mountains between Haiti and San Domingo." In Porto Rico this oyster is very abundant in and characteristic of the Ponce chalky beds.

The affinities of *Ostrea cahobasensis* seem to be with *O. vaughani* Dall, from the Tampa silex beds or the limestone immediately above them.

Localities.—Near Ponce, Stations 292, 293, 295.

Ostrea antiguensis Brown

Ostrea antiguensis Brown, 1913, Proc. Acad. Nat. Sci. Phila., LXV, pp. 603, 614, 615, Pl. XIX, fig. 7, Pl. XX, figs. 1, 5, 6.

On the island of Antigua Dr. A. P. Brown found in the hard limestone along the sea shore at Hodge's Bay, High Point and

Wetherill's Bay, many isolated oyster shells which he first referred to *Ostrea gatunensis* Brown and Pilsbry, but on further examination decided were new and named *Ostrea antiguensis*. On the south side of Porto Rico, east shore of Guanica Harbor, Dr. Reeds collected a quantity of beautifully preserved oyster shells from a shaly foraminiferal limestone. I was at first disposed to refer these specimens provisionally to *Ostrea gatunensis,* as a few valves bear considerable resemblance to the figure of the Gatun oyster, but the majority are broader and of a different aspect, so that I have concluded that the two species are distinct.

Dr. Brown's figures of the type of *Ostrea antiguensis* are of specimens so worn as to be hardly recognizable. Hence a specimen of the Guanica shell was sent to Dr. Pilsbry, who compared it with the type which is at the Philadelphia Academy. In a letter dated July 7th, 1919, Dr. Pilsbry writes:

> Your oyster is in my opinion, *Ostrea antiguensis* A. P. Brown. The original specimens are poorly preserved, being in hard rock. In the type there are indications of some ribs additional to the 7 mentioned by Brown. The wide depression, mentioned as characteristic of *antiguensis* (convex valve), is well marked in your shell, which is far better preserved than the type. I have no doubt of the identity.

The relationships of this oyster are with *Ostrea haitensis* Sowerby from the Miocene of Santo Domingo, *O. gatunensis* Brown and Pilsbry from Panama and *O. veatchi* Gabb from California. In addition to the strong, radiating, radial ribs of *O. haitensis* and *O. veatchi* there are upon the ribs of the Guanica oyster spinose flutings, formed by the raised concentric lamellæ. The sculpture of the flat valve is similar to that of the convex but is less bold.

Localities.—Guanica Harbor, Stations, 368, 369, 370, 371, 373, 374, 375, 376, 381.

Genus **Pecten** Müller

Pecten thetidis Sowerby

Pecten thetidis Sowerby, 1850, Quart. Jour. Geol. Soc. London, VI, p. 52.
Pecten thetidis Gabb, 1873, Trans. Amer. Phil. Soc., XV, p. 256.
Pecten thetidis Guppy, 1876, Quart. Jour. Geol. Soc. London, XXXII, p. 532.
Pecten (Aequipecten) thetidis Dall, 1898, Trans. Wagner Inst. Sci., III, pt. 4, p. 714; 1903, *Idem*, pt. 6, p. 1586.
Pecten (Aequipecten) thetidis Maury, 1917, Bull. Amer. Paleont., No. 29, p. 185, Pl. XXXIV, fig. 6; *Idem*, No. 30, p. 27.

In the Porto Rican collection are several Pectens which correspond to specimens of *Pecten thetidis* Sowerby that my party collected from the type region in the Yaqui Valley, Santo Domingo. Dr. Dall compared our Dominican shells with his Bowden shells, which in turn had been compared with Sowerby's type in the British Museum. This species bears very small spiny scales, visible only under a lens. These decorate the ribs and the radiating threads on the ears. The interspaces also are squamose in older shells.

Pecten thetidis has been recorded from Curaçao and Jamaica as well as Santo Domingo. Its range is now extended into northern Porto Rico.

Locality.—Near Aguada, Station 122.

Pecten inæqualis Sowerby

Pecten inæqualis Sowerby, 1850, Quart. Jour. Geol. Soc. London, VI, p. 52.

Pecten inæqualis Guppy, 1866, Quart. Jour. Geol. Soc. London, XXII, p. 294, Pl. XVIII, fig. 6; 1867, Proc. Sci. Assoc. Trinidad, p. 164.

Pecten inæqualis Gabb, 1873, Trans. Amer. Phil. Soc., XV, p. 256.

Pecten inæqualis Guppy, 1874, Geol. Mag. London, p. 443; 1876, Quart. Jour. Geol. Soc. London, XXXII, p. 532.

Pecten inæqualis Dall, 1898, Trans. Wagner Inst. Sci., III, pt. 4, p. 714; 1903, *Idem*, pt. 6, p. 1586.

Dr. Dall has identified one of the specimens in this collection as probably *Pecten inæqualis* Sowerby. The shell is incomplete but agrees well with Sowerby's description of the type, which was collected by Heneken in the Yaqui Valley, seventy years ago. Guppy later identified the species in Jamaica and figured a shell from that island. Gabb remarked that *Pecten inæqualis* was common in the Cibao (south of the Yaqui River in the northern part of Santo Domingo) and had been found by Bonaczy, one of his assistants, at Loma Cristina on the south side of the island, near San Cristobal. Dall notes that *Pecten inæqualis* is the most common and widely distributed of the Antillean Miocene Pectens. It is recorded, in addition to the Dominican type locality, from Jamaica by Guppy and Bland, from Curaçao by the United States Fish Commission, and from the Isthmus of Panama by R. T. Hill.

The mollusca associated with this specimen in Porto Rico so strengthen Dall's probable identification as to leave very little doubt that we can now extend the range eastward to Porto Rico.

Locality.—Near Aguada, Station 124.

Pecten guanicus, new species

Plate IV, Figure 4

Shell rather small, obliquely fan-shaped; right valve with about nineteen ribs. On the upper part of the valve towards the beaks, the ribs are carinated by a single radial thread and the narrow interspaces are smooth. Somewhat further down the single radial thread on each rib becomes accompanied by a second, this by a third and a fourth. About the same time that the tertiary radials appear on the ribs one or two radials develop on the interspaces. Hence on the ventral margin of the shell each rib is ornamented with four radial threads and each interspace with two. Anteriorly the ribs tend to become flatter than on the posterior part of the valve. Approximate altitude 24 mm., breadth 26 mm. The single specimen is partly concealed by the matrix but the characteristics of sculpture are well preserved.

In general form and in the sudden development of more ornate sculpture this species resembles *Pecten hatoviejonis* Maury from the trail between Hato Viejo and Potrero, Santo Domingo, but that shell is decidedly squamose whereas this is entirely without scales. Brown's[5] figure 6 of *Pecten anguillensis* Guppy bears a slight resemblance to the Porto Rican shell, but his figures 4, 7, 8 of *P. anguillensis* are quite unlike our specimen. The Antigua shell like ours has secondary ribbing but the ribs are far broader and much less numerous. The Porto Rican shell is decidedly more like the Dominican species.

Dr. Dall has examined this Pecten and he notes that the National Museum has it from Santo Domingo but not named.

Locality.—East shore Guánica Harbor, Station 369.

Pecten meseticus, new species

Plate III, Figure 2

Operculate valve perfectly flat and nearly circular in outline. The ribs number about twenty-five and the perfect ear shows six sharply defined radiating threads. In the umbonal region and upper part of the shell, the ribs are almost linear and very sharply carinated by a radial thread. Less than half way to the ventral margin two more radial threads develop, one on either side of the carinating thread, so that the rib becomes ornamented on top with the three radials. The interspaces are deep set with perpendicular margins and have no radial threads. They are, however, ornamented with sharp, very delicate raised growth lines hardly visible without a lens and as fine as spider webs. These also pass over the ribs but are most apparent in the interspaces. Altitude of shell 35 mm., breadth the same.

[5] Proc. Acad. Nat. Sci. Phil., 1913, Pl. XVIII.

We are much indebted to Dr. Dall for comparing this shell with *Pecten soror* Gabb. The latter species has never been figured, but Dall places this Porto Rican shell close to *P. soror* as identified by Guppy. According to Gabb's description the left valve of his type was concave, but our operculate valve is perfectly flat. The ribs of *P. soror* are fewer, nor does Gabb mention any radiating threads upon them. Doubtless, however, though not identical, the affinities of this Porto Rican Pecten are with the Dominican *P. soror*.

This is the most exquisite of the Porto Rican Pectens.

Locality.—East shore of Guanica Harbor, Station 375.

Pecten camuycencis, new species

Plate IV, Figure 5

Shell rather small, subcircular with nearly equal ears. The ribs, omitting the very small anterior and posterior ones, number twenty. Towards the umbonal region the ribs are entire and rather rounded, then about half way towards the ventral margin those on the central part of the valve become medially grooved while those near the anterior and posterior margins remain entire. An exceedingly delicate radial thread develops in the interspaces. It is visible only with a lens and then chiefly because it is accentuated by fine, sharp, V-shaped growth lines, the apices pointing forwards. These growth lines also swing over the ribs and form in the medial grooves U-shaped arches directed slightly backwards. The ears are marked by radial threads, roughened by the fine growth lines which cross over them. Altitude of shell 25 mm., width 26 mm.

Dr. Dall has compared this shell with the Pectens in the National Museum and says that it is not represented in the collection there. In its sculpture *Pecten camuycensis* is of the same general type as *Pecten gabbi* Dall (= *paranensis* Gabb, 1881, not of d'Orbigny, 1849) from Santo Domingo and Antigua, but that shell is larger and of a much less symmetrical and elegant form than the Porto Rican shell.

Locality.—Near Arecibo, Station 511.

Pecten sansebastianus, new species

Plate III, Figure 1

Shell of medium size, oblique, ovate, somewhat inflated. The sculpture consists of about twenty-four ribs which do not extend quite to the anterior and posterior margins. Over the anterior region of the valve each rib bears on either side of its keel a radial thread, but posteriorly the ribs may have four of these radii. Interspaces each with one radial thread. Ears of about the same size. The anterior rather coarsely radially striated, the posterior more finely so. Greatest height of shell, measured obliquely, 35 mm., width 32 mm.

Dr. Dall on comparing this Pecten with the collection in the National Museum says it is not represented there. In sculpture it resembles our Porto Rican species *P. guanicus* but otherwise is quite different. The type showed no scales or nodules upon the ribs but other specimens show microscopic spines, and it may be that these have been abraded from the type. The species is common and variable.

Localities.—Rio Collazo, near San Sebastian, Stations 49, 63. Specimens, probably this species, were also found at nearby Stations 27, 38, 47, 107 and a doubtful shell from 105.

Pecten sansebastianus laresianus, new variety

Plate IV, Figure 3

Shell with sculpture of the same general plan as that of *Pecten sansebastianus*, but the central keel of the ribs bears minute tear-like nodules. On either side is a radial thread and one also occupies every interspace. The ear is handsomely ornamented with well-defined nodose radii. Altitude 31 mm.

This appears to be a variety of *Pecten sansebastianus,* but more material may prove it distinct.

Locality.—Near Lares, Station 59.

Pecten guajatacus, new species

Plate IV, Figures 1, 2

Shell rather large, suborbicular, very inæquivalve; ribs thirteen to sixteen, tending to become obsolete near the anterior and posterior margins of the shell. The convex valve is moderately inflated but not extremely convex. The opposite valve is operculate in form. Altitude of largest specimen 55 mm., width approximately 53 mm.

Dr. Dall after examination notes that these shells are identical with specimens named *Pecten heermanni* Conrad in the National Museum collection. He did not mention where the latter specimens had been collected, but I presume from the Antillean region. If so, the label would seem to have been a provisional one, for a comparison of our specimens with Conrad's description of the type indicates that the Antillean and Californian fossils are of the same *P. eboreus* group, but specifically distinct. The true, western *P. heermanni* has twenty-one square ribs, and, judging from the description, is more compressed than the Porto Rican shell. For these reasons I would suggest that the latter should be differentiated by the name *P. guajatacus*.

Locality.—Señor Rabell's Ranch on Rio Guajataca, Station 113.

Genus **Amusium** Bolten

Amusium papyraceum (Gabb)

Pleuronectia papyracea Gabb, 1873, Trans. Amer. Phil. Soc., XV, p. 257; 1881, Jour. Acad. Nat. Sci. Phil., (2) VIII, p. 347.

Amusium papyraceum Dall, 1898, Trans. Wagner Inst. Sci., III, pt. 4, p. 718; 1903, *Idem*, pt. 6, p. 1586.

Amusium papyraceum Maury, 1917, Bull. Amer. Paleont., No. 29, p. 190, Pl. XXVI, fig. 22; *Idem*. No. 30, pp. 23, 28.

A single fragment of an *Amusium* evidently when complete about the size of *A. papyraceum* is in the Porto Rican collection. The substance of the shell is preserved and the internal surface, showing the characteristically paired ribs of *Amusium papyraceum,* lies upward in the matrix so that the ribs are clearly seen. They are spaced so as to allow two pairs to ten millimeters. Each pair occupies about four and each interspace about three millimeters. Gabb's type of this species measured about two inches. The probabilities are very strongly in favor of the fragment being identical with Gabb's shell, since the other Miocene form, *Amusium lyoni* Gabb has the internal ribs solitary, not paired.

Amusium papyraceum was first described by Gabb from Santo Domingo. It also occurs at Bowden. The shell is very closely related to, and perhaps identical with, *Amusium mortoni* Ravenel, living in the Antillean and Gulf waters.

Locality.—Near Arecibo, Station 475.

Section **Propeamusium** De Gregorio

Propeamusium hollicki, new species

Plate III, Figures 3, 4

Shell rather small, suborbicular, thin and semi-transparent, valves dissimilar, the lower gently convex, the upper flat and operculate, ears nearly equal. Outer surface of both valves smooth, but prettily diversified by the shining through of the delicate, internal, radiating riblets. These riblets occur in pairs which near the basal margin of the valve measure about one millimeter across, and are separated by interspaces about two and a half millimeters wide. Towards the beak the riblets converge. Each valve has usually eight pairs of riblets which are distributed over the central part of the shell, the anterior and posterior areas being smooth. The most perfect flat valve measures 16 mm. in altitude and 17 mm. in width. A small convex valve is 12 x 12.5 mm., and the largest 20 x 21 mm. This seems to be the maximum size attained, as we have a number of specimens from various localities.

No species resembling this has ever been recorded from the Antillean Miocene. It has somewhat the general aspect of *Propeamusium pourtalasianum marmoratum* Dall[6], a living form but differs among other respects in the lower valve being smooth, not concentrically sculptured, and the riblets being paired, not club-shaped. The Porto Rican shell is referred tentatively to the section *Propeamusium*. It appears most closely allied to this group, yet all of the characters are not revealed. According to Dall, the living members of this section are in deep waters in temperate and tropic seas, from 805 to 13 fathoms and at bottom temperatures of 39° F. to 82° F. which is a very unusual range. This, the most fragile and exquisite member of the genus *Amusium* yet discovered in the Antillean Miocene, is named in honor of Dr. Arthur Hollick.

Localities.—Rio Collazo near San Sebastian, Stations, 27, 36, 53, 54, 60, 63, 107.

Genus **Spondylus** Linnæus

Spondylus bostrychites Guppy

Spondylus bifrons Sowerby, 1850, Quart. Jour. Geol. Soc. London, VI, p. 53. Not of Goldfuss, 1835

Spondylus bostrychites Guppy, 1867, Proc. Sci. Assoc. Trinidad, p. 176.

Spondylus bostrychites Gabb, 1873, Trans. Amer. Phil. Soc., XV, p. 257.

Spondylus bostrychites Dall, 1898, Trans. Wagner Inst. Sci., III, pt. 4, p. 758; 1903, *Idem*, pt. 6, p. 1586; 1916, Proc. U. S. Nat. Mus., LI, 1917, p. 493.

Spondylus bostrychites Maury, 1917, Bull. Amer. Paleont., No. 29, p. 190, Pl. XXXII, fig. 4; *Idem*, No. 30, pp. 10, 20, 23.

Professor Gabb remarked of this shell: "A beautiful convex, almost equivalve Pecteniform species with remarkably narrow areas and a thin shell." This is a welcome addition to Sowerby's laconic, Latin, three-line description of the type, *Spondylus bifrons*, re-

[6] Bull. 37, U. S. Nat. Mus., Pl. IV, Fig. 3.

named, because preoccupied, by Guppy. Dall also adds a short description of this Antillean Miocene species in describing his variety *chipolanus* from Florida. Later he referred this to the typical species.

In 1874, Guppy listed *Spondylus bostrychites* from Jamaica, Anguilla and Haiti. By Haiti he really meant the Yaqui Valley, Santo Domingo, where Heneken obtained the type. The Porto Rican specimens are nearly all poorly preserved molds but several seem undoubtedly identical with shells my party collected in Santo Domingo and figured as this species.

Localities.—Señor Rabell's Ranch, Station 113; near Aguada, Station 117; near Arecibo, Station 499; near Ciales, Station 500.

Spondylus gumanomocon Brown and Pilsbry

Spondylus americanus Gabb, 1873, Trans. Amer. Phil. Soc., XV, p. 257. Not *S. americanus* Lamarck.

Spondylus gumanomocon Brown and Pilsbry, 1912, Proc. Acad. Nat. Sci. Phila., p. 514 (Footnote).

Spondylus gumanomocon Maury, 1917, Bull. Amer. Paleont., No. 29, p 191; *Idem*, No. 30, p. 22.

This Dominican Miocene species has never been figured, but when adult is easily known by its very large and heavy valves. A specimen collected by Gabb weighed over thirty-two ounces. Unfortunately, one does not always find these ponderous examples and one is perplexed by variations of form and growth stages. We have from Porto Rico some internal molds showing that the cavities of the two valves were nearly equal, while others show the typically flatter and the more convex valve, and finally, some of the specimens have the convex valve somewhat twisted. Similar variations of form appear in a series of recent *Spondylus americanus* in the American Museum and suggest that the same took place in the Miocene member of this group, *Spondylus gumanomocon.*

Localities.—Near Arecibo, Stations 463, 471; near Ciales, Stations 492, 493, 495, 496, 501, 502, 505.

Spondylus lucasi, new species

Plate V, Figure 1

Shell oval, oblique, small for the genus. The cardinal area is defective and broken, but shows traces of the isodont hinge of *Spondylus*. The sculpture consists of stronger, low, primary, radiating, rounded threads bearing spines at intervals, and between every two of these primaries are eight to ten or twelve much more delicate radiating lines. The central one of these is slightly stronger than the rest. It does not stand out sharply but the eye can discern that it is a shade thicker. The fine radii between the primaries nearly always alternate in strength, the finest lines of all being visible only with a lens. All of the fine radii are ornamented with minute scales, giving them a beaded appearance, especially on the anterior part of the valve. Approximate altitude of shell 33 mm., estimated breadth 28 mm.

Among the specimens of *Spondylus* were some fragmentary external molds remarkable for the extreme fineness and delicacy of their sculpture which was imprinted in reverse upon the limestone. A single shell shows the same delicate sculpture in the positive; the actual substance of the valves being retained.

The exquisite sculpture distinguishes this species from the specimens that my party collected in Santo Domingo. Our young shells of *Spondylus bostrychites* have very much coarser and less numerous radial ribs between the spinose primaries. The large shell, *Spondylus gumanomocon* has the primaries but little differentiated and frequently the spines are no longer than the coarse, imbricating scales which cover all the ribs alike. Dall has lately described *Spondylus filiaris* from the Flint River, Georgia, Oligocene. His figure of the young shell (Proc. U. S. Nat. Mus. LI, Pl. LXXXIII, fig. 5) bears at first glance quite a resemblance to the Porto Rican fossil, but the Georgian species has no spinose processes, the radii are quite smooth, and the sculpture not so delicate.

There is, however, a very beautiful *Spondylus* in the Calcaire grossier of Grignon, France. It is Lamarck's *S. radula*. In form it is quite unlike *Spondylus lucasi*, but its sculpture is so strikingly like as to be almost exactly parallel. The European Eocene shell is more sharply spinose and more prickly. This shell is named in honor of Dr. Frederic A. Lucas.

Localities.—Señor Rabell's Ranch, Rio Guajataca, Station 110; East Shore of Guanica Harbor, Station 370; near Arecibo, Station 509.

Genus **Lithophaga** Bolten

Lithophaga nigra (d'Orbigny)

Lithodomus niger d'Orbigny, 1845, In De la Sagra's Hist. Pol. y. Nat. Isla de Cuba, V. pt. 2, p. 351; 1855, *Idem*, Atlas, VIII, Pl. XXVIII, figs. 10, 11.

Modiola caribæa Philippi, 1847, Abbild. u. Beschr., III, p. 20, Pl. II, fig. 5.

Lithophaga nigra Dall, 1898, Trans. Wagner Inst. Sci., III, pt. 4, p. 799; 1915, Bull. 90 U. S. Nat. Mus., p. 129.
Lithophaga nigra Maury, 1917, Bull. Amer. Paleont., No. 29, p. 194; *Idem*, No. 30, p. 26.

A single specimen of this shell is present in this series. It is fragmentary but unquestionably this species, since it shows the entire anterior part of the two valves, which have remained in place, and the characteristic cross striations ending abruptly along an oblique line. In size it corresponds almost perfectly to d'Orbigny's figure of the type which was a recent specimen.

The earliest recorded appearance of this species is in the Upper Oligocene, Dall having identified it in the Tampa formation. My party found it in the Lower Miocene of the Yaqui Valley, Santo Domingo and it is now living from Florida to St. Thomas, West Indies. The fossil shells in all respects except color are like the recent specimens.

Locality.—Near Lares, Station 56.

Order Anomalodesmacea

Genus **Thracia** Blainville

Subgenus **Cyathodonta** Conrad

Cyathodonta reedsi, new species

Plate V, Figure 2

Shell rather elongate, beaks subcentral, right valve gently convex, with its anterior end somewhat produced and rounded, posterior end broad, abruptly truncated; posterior dorsal area flattened, nearly smooth and marked off by a rounded carina passing from the beak to the base of the truncation; dorsal line in front of the beak very sloping, but behind nearly straight; beak low, acute, curving over the hinge and evidently in life very close to, or touching, the opposite beak, its apex appears perforated but this may be due to an accident and not to contact with the opposite beak. Surface of valve anterior to the carina ornamented with close-set, nearly uniform, slightly wavy, concentric ripples, about four to every five millimeters. These ripples near the center of the disc are often broken off and then continued as though unskillfully spliced, and sometimes they anastomose with adjacent ripples. Nevertheless, their appearance is rather regular and elegant. In front of the carina is a shallow broad, inconspicuous sulcation. Hinge entirely concealed by the limestone matrix. Length of shell 32 mm., altitude 20 mm., thickness of one valve 7.5 mm.

The genus *Thracia* has never before been recorded from the Miocene of the Greater Antilles. Heneken, Guppy, Gabb and the writer all failed to find a Thracia in Santo Domingo or Jamaica, nor does Dall list this genus in the Henderson-Simpson collection from the Bowden beds of Jamaica. Dr. J. W. Spencer, however, collected two species from the Lesser Antilles, both on the Island of Guadeloupe. These were described by Dall as *Cyathodonta guadalupensis* and *C. spenceri,* and were referred to an Oligocene horizon.

Singularly enough, the Porto Rican *Thracia* is not like either of the Guadeloupe species, but resembles far more the older shell, *Cyathodonta vicksburgiana* Dall, from the Oligocene of Vicksburg, Mississippi. In general aspect it corresponds strikingly with *C. vicksburgiana*, but is proportionally higher, more convex, with beaks subcentral, instead of at the posterior third, and the ripples are less crowded, there being four instead of five to every five millimeters. To a less extent our fossil recalls Toula's Isthmian *Cyathodonta gatunensis*, which among other respects differs in its broader anterior end, less elongate form, and its crude aspect. This rare and more delicate shell is dedicated to Dr. Chester A. Reeds, by whom it was discovered.

Localities.—Near Quebradillas, Stations 126, 129, 131; near Ponce, Station 293.

Genus **Cuspidaria** Nardo

Cuspidaria islahispaniolæ Maury

Plate V, Figure 3

Neæra alternata Gabb, 1873, Trans. Amer. Phil. Soc., XV., p. 248. Not *Sphena alternata* d'Orbigny, 1845.

Neæra ornatissima Guppy, 1876, (in part), Quart. Jour. Geol. Soc. London, XXXII, p. 530. Not *Sphena ornatissima* d'Orbigny, 1845.

Cuspidaria islahispaniolæ Maury, April 29, 1917, Bull. Amer. Paleont., No. 29, p. 196, Pl. XXVI, fig. 20; *Idem*, No. 30, p. 13.

Cuspidaria gabbi Johnson and Pilsbry, May 5, 1917, Proc. Acad. Nat. Sci. Phil., LXIX, p. 195.

A specimen in the collection matches so perfectly with shells of my Dominican *Cuspidaria islahispaniolæ* from Bluff 3, Cercado de Maò, that there seems to be no doubt of their complete identity. Gabb and Guppy both referred the Miocene *Cuspidarias* from Santo Domingo to the recent species *C. alternata* and *C. ornatissima* of d'Orbigny. These they considered identical with each other and with the fossils.

Johnson and Pilsbry's revision of the Gabb collection in the Philadelphia Academy differentiated two species of *Cuspidaria* as *C. ornatior* (like *ornatissima*) and *C. gabbi* (like *alternata*). This harmonizes with Gabb's remark in 1873 that he had specimens grading into the two species. Johnson and Pilsbry unfortunately gave no figures, but judging from their description, *C. gabbi* is synonymous with *C. islahispaniolæ*. We have no representatives of *C. ornatior*.

Locality.—Near Juana Diaz, Station 178.

Cuspidaria juanadiaza, new species

Plate V, Figure 4

Shell small, plump, with full beaks and a long rostrum. Surface marked by rather coarse concentric growth lines as in some small Ledas. Exfoliated over central part of valve and under layers cracked and veined, but along the base and at the anterior and posterior ends the outer layer is preserved and shows no radial ribbing whatever. There is only a weak radial thread defining the rostrum. Hinge characters concealed. Length of shell 10 mm., height 6 mm.

This species is about the same size as *Cuspidaria islahispaniolæ*, but is at once differentiated by the absence of all radial ribbing. This feature also separates it from Dall's two Bowden species *C. craspedonia* and *C. distira* and also from *C. costellata* Deshayes. It is evidently a shell of the same type as the recent *Cuspidaria lamellosa* Sars, which lives in fifty to five hundred and fifty-two fathoms off the Norwegian and Rhode Island coasts. This is the first Cuspidarian of this group ever found in the Antillean Miocene.

Locality.—Near Jauna Diaz, Station 176.

Order Teleodesmacea

Genus **Crassatellites** Krüger

Crassatellites juanadiazus, new species

Plate IV, Figures 6, 7

Shell elongated, anterior end rounded, posterior end produced and bluntly pointed. The substance of the shell was thin and this has been increased by exfoliation. The original form has been altered by pressure which apparently has greatly increased the inequality of the valves giving the shell a *Corbula*-like form, with one valve very gibbous and incurving at its base, and the other valve flattened and seeming to fit into the larger. This appears to be due to distortion. On the convex valve a pronounced carina passes from the beak to the posterior angle; beak anterior to the center; nepionic shell, as far as can be seen, with very close, sharp, concentric ridges. With age these become progressively rounder and somewhat more distant and ornament the entire shell. Hinge concealed by the matrix. Length of shell 28 mm., height 16 mm., thickness of convex valve 7 mm.

Gabb's *Crassatellites reevei* from the Miocene of Santo Domingo is a very much larger shell, fifty-six millimeters in length, and more coarsely sculptured. I do not think this Porto Rican shell could be the young of that species as it has a very much more delicate and different aspect and appears adult. The Bowden species, *Crassatellites jamaicensis* Dall, is wholly unlike this fossil in both form and sculpture. The convex valve of the Porto Rican shell is, however, strikingly like *Crassatellites flexurus* (Conrad) from the Jacksonian Eocene of Jackson, Mississippi, but the latter shows no noticeable inequality of its valves, while the Porto Rican shell even before distortion would seem to have had discrepant valves.

A single specimen only was found.

Locality.—Near Juana Diaz, Station 182.

Genus **Venericardia** Lamarck

Venericardia collazica, new species

Plate VI, Figure 6

Shell elongate, very inequilateral, much inflated in the umbonal region, beaks very near the anterior end, very high, acute, curving over the hinge line. Ribs thirteen or fourteen showing traces on the mold of crenulations. The ribs are simple without secondary threads nor are there interstitial riblets in the interspaces. The interspaces are about as wide as or a little narrower than the ribs which are broadest and more distant on the central portion of the valves and become suddenly finer and closer on the posterior dorsal areas. Length of shell approximately 34 mm., height 20 mm., diameter 21 mm.

In general form this species resembles *Venericardia nasuta* Dall from the Eocene of Alabama (Trans. Wagner Inst. Sci., III, pt. 6, p. 1425, Pl. LIII, fig. 9, 1903), but that shell has lateral threads accompanying the anterior and medial ribs, and the ribs number twenty-five against fourteen in the Porto Rican shell. The species is founded on a single internal mold from the Collazo shales, still retaining in places a coating of the shell substance, which shows both valves together of a shell resembling *Carditamera* in its elongated form, but with the prominent, prosogyrate beaks characteristic of *Venericardia.*

Locality.—Rio Collazo near San Sebastian, Station 53.

Venericardia rabelli, new species

Plate VI, Figure 7

Shell rather small, sub-circular with low, acute beaks, strongly prosogyrate. Surface ornamented with many close-set ribs, numbering about twenty-one, and separated by narrower interspaces. The ribs of the anterior and central portion of the valve develop on either side of their central keels, fine threadlike secondary riblets which are just visible without a lens. On the posterior part of the valve these secondary threads become weaker and finally disappear. Traces yet remain of nodules on the anterior ribs. The characters of the hinge are concealed by the matrix. Length of shell 20 mm., height 17 mm., semi-diameter 10.5 mm.

This pretty little *Venericardia* recalls in some respects *V. cerrogordensis* Maury, from Santo Domingo. That shell is of similar form and size, and its anterior and central ribs also have two accompanying lateral, threadlike riblets, but there are only seventeen ribs in the Dominican species and they are far more distantly spaced. This *Venericardia* is dedicated to Señor Narcisso Rabell of San Sebastian.

Locality.—Weathered green shale, which has become reddish, in a roadside cut, Rio Collazo near San Sebastian, Station 62. Also a fragment, probably this same species from the nearby Station 54.

Venericardia juncalensis, new species

Plate VI, Figure 5

Shell when complete ovate-cordate in form moderately convex, compressed by pressure to which the Collazo shales were subjected. Substance rather thin; beaks low, acute; ribs fourteen when perfect strongly nodular. All the ribs except those of the posterior area are accompanied on either side by a radiating thread; at the base of the shell a medial rib with its two radiating threads measures about three millimeters across. Length of shell approximately 30 mm., height 29 mm., diameter of crushed shell 11 mm.

Although this species has the same general type of sculpture as the preceding shell and as *V. cerrogordensis* Maury, yet its aspect is unlike those two species.

Locality.—Rio Collazo near San Sebastian, region of Juncal, Station 94.

Genus **Echinochama** Fischer

Echinochama antiquata Dall

Chama arcinella Moore, 1853, Quart. Jour. Geol. Soc. London, IX, p. 130. Not *C. arcinella* Linnæus, 1767.

Chama arcinella Guppy, 1866, Quart. Jour. Geol. Soc. London, XXII, p. 294; 1867, Proc. Sci. Assoc. Trinidad, p. 163.

Chama arcinella Gabb, 1873, Trans. Amer. Phil. Soc. XV, p. 251.

Chama arcinella Guppy, 1874, Geol. Mag. London, p. 442; 1876, Quart. Jour. Geol. Soc. London, XXXII, p. 531.

Echinochama antiquata Dall, 1903, Trans. Wagner Inst. Sci., III, pt. 6, pp. 1404, 1586, Pl. LIV, fig. 9.

Echinochama antiquata Maury, 1917, Bull. Amer. Paleont., No. 29, p. 201, Pl. XXXIII, fig. 10; *Idem*, No. 30, p. 10.

Echinochama antiquata Jones, 1918, Jour. Geol., XXVI, p. 738.

This Miocene species was recorded from the Yaqui Valley, Santo Domingo and the Bowden beds of Jamaica by Guppy and Gabb as the recent shell *Chama arcinella* which has much more prominent and spiny ribs. Dall first discriminated the fossil and referred it to Fischer's genus *Echinochama*. The closest recent ally of *Echinochama antiquata* is a Pacific shell and not *Echinochama arcinella* which Dall and Simpson record from Mayaguez Harbor, Porto Rico and is abundant elsewhere in the Antilles.

The type of *Echinochama antiquata* is a Bowden shell. My party collected fine specimens from Cercado de Mao, Santo Domingo, and Jones has now found it in the Las Cahobas beds, south of Thomonde, Haiti.

From Porto Rico Reeds collected a single internal mold which fits very perfectly into a fine shell of *Echinochama antiquata* in this Museum collected by F. C. Nicholas from Bowden. The only other *Echinochama* which it might be is *E. yaquensis* Maury, but that tends to be smaller. It is almost certainly the internal mold of *Echinochama antiquata*.

Locality.—Near Arecibo, Station 445.

Genus **Lucina** Bruguière

Lucina chrysostoma (Meuschen) Philippi

Tellina crysostoma Meuschen, 1787, Mus. Gevers., p. 482. (Typographical error).

Lucina chrysostoma Philippi, 1847, Abbh. und Beschr. Conchy., II, p. 206, Pl. I, fig. 3.

Venus edentula Chemnitz, 1784, Conch. Cab., VII, Pl. XL, figs. 427-429. Not of Linnæus, 1758.
Lucina edentula Reeve, 1850, Conch. Icon., *Lucina*, Pl. II, fig. 9.
Lucina edentula Heilprin, 1886, Trans. Wagner Inst. Sci., I, pp. 102-103.
Lucina chrysostoma Dall, 1903, Trans. Wagner Inst. Sci., III, pt. 6, p. 1354.
Lucina chrysostoma Maury, 1917, Bull. Amer. Paleont., No. 29, p. 202, Pl. XXXV, fig. 2; *Idem*, No. 30, pp. 13, 26.
Lucina chrysostoma Jones, 1918, Jour. Geol. XXVI, pp. 740, 742.

This is one of the most abundant species in the Porto Rican collection. Among a great number of internal molds which show the plump form, elongated adductor scar and variable radial lines characteristic of the interior of shells of *Lucina chrysostoma*, are several very perfect impressions of the exterior of the shell, showing also the edentulous hinge. Artificial casts of these when compared with recent and Pleistocene specimens of *Lucina chrysostoma* showed no points of difference. This is the apricot shell of collectors,—so named because the interior of living shells has a fine apricot blush. Dall does not record this species from beds earlier than Pliocene; but it seems that it extended into the Miocene since both these Porto Rican specimens and mine from the Yaqui Valley, Santo Domingo, appear in all respects like the recent. Jones also reports it from the Maissade beds of Haiti.

Localities.—Near Juana Diaz, Station 174; near Ponce, Stations 285, 287, 288, 289, 290, 291, 292, 293, 297, 298, 299, 301; near Guayanilla, Station 320.

Genus **Phacoides** Blainville

There are several varied forms of this genus in the collection, but nearly all are internal molds, upon which no specific determinations can be based.

Subgenus **Here** Gabb

Phacoides (Here) quebradillicus, new species

Plate VI, Figure 8

Shell moderate in size, convex, with the posterior and anterior dorsal areas very sharply marked off by narrow, deep sulci. The beak is full, acute and strongly turned forwards. The entire surface of the valve is sculptured with very close-set, nearly uniform and equidistant concentric ridges, so fine as to be hardly visible without a lens. Characters of the hinge unknown. Length of shell 24 mm., approximate altitude 21 mm., semi-diameter 7 mm.

This species is much less convex than the subglobular Bowden shell, *Phacoides podagrinus* Dall, which is also a member of the Pliocene to recent, *P. pennsylvanicus* group. *Phacoides domingensis* Dall is flatter with less fine and regular, concentric sculpture, and is of the *Phacoides pectinatus* stock.

The Porto Rican shell, which is represented by a single, nearly perfect external mold of the left valve, is so finely sculptured that the cast of its imprint appears almost smooth to the eye. The delicate, nearly regular, concentric ridges stand out only with a lens. In its general aspect this species resembles *Phacoides (Here) wacissanus* Dall, from the Tampa silex beds more than any with which I am acquainted.

Locality.—Near Quebradillas, Station 126.

Subgenus **Lucinisca** Dall

Lucinisca hoveyi, new species

Plate VII, Figure 2

Shell small, rather plump, suborbicular, with an acute, strongly prosogyrate beak. Valve very beautifully latticed by the intersection of fine, sharp, close-set concentric ridges, with the somewhat stronger radial ribs. Ribs thread-like, nearly equidistant and about uniform in strength with no secondary riblets intervening. Anterior dorsal area marked by a change in sculpture as the ribs are obsolete and only the concentric ridges are present. Posterior dorsal area defined by a slight umbonal ridge beyond which the area is a little compressed. Hinge characters unknown, but the shell is referred tentatively to the subgenus *Lucinisca* because of its form and sculpture. Length of most perfect external mold 11 mm., height 10.5 mm., semi-diameter 4.5 mm.

This species is at once differentiated from the Santo Domingan Miocene shells, *Lucinisca hispaniolana* Maury and *L. cercadica* Maury, by its lack of secondary riblets. It is closer to Dall's Floridian *Lucinisca calhounensis* from the Tampa and Chipola horizons, for that has all the ribs subequal; but the Porto Rican shell is less compressed and differs in form, being plumper and more cordate. The external molds retain every detail of sculpture in reverse in the limestone rock, and show that this shell was one of the most exquisite on the Miocene beaches of Porto Rico. It is dedicated to Dr. E. O. Hovey.

Localities.—Near Quebradillas, Stations 126, 129, 131, 133, 136; near Ponce, Station 292.

Subgenus **Miltha** H. and A. Adams

Miltha cf. **smithwoodwardi** Maury

Phacoides (*Miltha*) *smithwoodwardi* Maury, April, 1917, Bull. Amer. Paleont., No. 29, p. 204, Pl. XXXV, fig. 6.

As in the Dominican Miocene waters, so in the Porto Rican, two species of *Miltha* were represented. Unfortunately, the collection affords only internal molds of the Porto Rican shells.

One of these molds has the very striking subquadrilateral and flattened form of *Miltha smithwoodwardi* Maury, from Bluff 2, Cercado de Mao, Santo Domingo. The mold is somewhat larger, measuring 53 mm. in length, 60 mm. in height and 18 mm. in diameter, while the corresponding measurements of the type were 45 x 50 x 12 mm. Nevertheless it was clearly either identical with or very closely akin to *Miltha smithwoodwardi,* for the striking posterior truncation, and the angles of the ventral margin are exactly parallel to the outlines of the Dominican shell. The beak also was markedly prosogyrate. The main difference in form is that the anterior dorsal margin of the mold is sloping and not angulated as in the Dominican shell. This species is represented in the living fauna by *Miltha childreni* Gray, in the Gulf of California. The only other living Miltha is found off Mozambique. The subgenus was at its maximum during the Eocene and has since declined. Dall calls attention to the interesting fact that in most horizons down to the Pliocene, species representing three groups occur—namely the group of *M. hillsboroënsis* Heilprin, that of *M. childreni* Gray, and that of *M. pandatus* Conrad. The first two groups are represented in the Porto Rican Miocene.

Localities.—Near Quebradillas, Station 137. A smaller, broken internal mold, probably the same species, from Señor Rabell's Ranch, Station 112.

Miltha cf. **hillsboroënsis** (Heilprin)

Lucina hillsboroënsis Heilprin, 1887, Trans. Wagner Inst. Sci., I, pp. 117, 120, Pl. XVI, fig. 62.

The other internal mold of *Miltha* under consideration has the general form of the Floridian species *M. hillsboroënsis* Heilprin from the Oligocene and Miocene, and of the related Pliocene shell, *M. disciformis* Heilprin. It also resembles the Santo Domingan member of this group, *Miltha riocanensis* Maury. Of all these, the mold corresponds in size best with *M. disciformis,* but that is a much later species. As the surface characters of the Porto Rican shell are quite unknown no specific identification is possible. We know, however, that a member of the *M. hillsboroënsis* group was living in the Miocene of Porto Rico.

Localities.—Near Ponce, Station 289. Also a larger, fragmentary mold 60 mm. in width, probably the same species, from Station 292.

Genus **Divaricella** von Martens

Divaricella prevaricata Guppy

Divaricella prevaricata Guppy, 1896, Proc. U. S. Nat. Mus., XIX (1897), No. 1110, p. 327, Pl. XXX, fig. 6.

Divaricella prevaricata Dall, 1903, Trans. Wagner Inst. Sci., III, pt. 6, pp. 1389, 1587.

Divaricella prevaricata Maury, 1917, Bull. Amer. Paleont., No. 29, p. 207, Pl. XXXV, fig. 10; *Idem*, No. 30, pp. 13, 24, 28.

The type of this Miocene species was described by Guppy from Bowden, Jamaica. My party collected shells corresponding to Guppy's description and figure in the Miocene of Santo Domingo, in the *Aphera islacolonis* formation in the bluffs of the Rios Mao, Gurabo and Cana. In the present collection there is a single, but very perfect, imprint of this shell in the limestone so that the species has now been found on three of the Greater Antilles. *Divaricella prevaricata* is smaller and more delicately sculptured than the recent representative, *Divaricella quadrisulcata* d'Orbigny, recorded by Dall and Simpson from Hucares, Porto Rico.

Locality.—Near Quebradillas, Station 125.

Genus **Cardium** (Linnæus) Bruguière

This genus is represented in the collection by a considerable number of specimens, but nearly all in the form of poorly preserved molds. Probably several correspond to Jamaican and Santo Domingan Miocene species.

Section **Trigoniocardia** Dall

Cardium (Trigoniocardia) sancti-sebastiani, new species

Plate VI, Figure 4

Shell sub-trigonal, exceedingly oblique, anterior end very short, posterior end produced and roundly pointed; beak very anteriorly placed, high, acute, curving forwards; posterior slope from the umbonal region to the posterior basal margin not carinated, but gently and evenly rounded, so that the posterior area is not well defined. On the body are ten radial ribs which show traces of having been crenulated, on the posterior area are five ribs closer, and finer than those on the body of the shell. Length 12 mm., altitude from beak to anterior basal angle 6 mm., semi-diameter 5 mm.

The Antillean Tertiary has yielded the following Cardiums of the section *Trigoniocardia*: *C. castum* Guppy (Quart. Jour. Geol. Soc. Lond, XXII, pl. XXVI, fig. 4, 1866) from the older Tertiary of Manzanilla, Trinidad, a small subovate shell with twenty-two ribs and beak nearly central; *C. haitense* Sowerby, from the Miocene of Santo Domingo and Bowden and its more oblique, more strongly carinated variety, *C. cercadica* Maury, both have fourteen ribs on the body and ten on the truncation; *C. aminense* Dall from Rio Amina, Santo Domingo, is a strongly carinate, very convex shell, with ten ribs on the body and ten also on the truncation, and *C. maturense* Dall from the later Tertiary of Matura, Trinidad, is not carinate, but is only slightly oblique and has twelve body and eight posterior ribs. The Porto Rican shell is clearly specifically distinct from any of these forms.

Locality.—Rio Collazo near San Sebastian, Station 53.

Cardium (Trigoniocardia) haitense Sowerby

Cardium haitense Sowerby, 1850, Quart. Jour. Geol. Soc. London, VI, p. 52, Pl. 10, fig. 11.

Cardium haitense Guppy, 1866, Quart. Jour. Geol. Soc. London, XXII, p. 293; 1867, Proc. Sci. Assoc. Trinidad, p. 163.

Cardium (Fragum) haitense Gabb, 1873, Trans. Amer. Phil. Soc., XV, p. 251.

Cardium haitense Guppy, 1874, Geol. Mag. London, p. 442; 1876, Quart. Jour. Geol. Soc. London, XXXII, p. 531.

Cardium (Trigoniocardia) haitense Dall, 1900, Trans. Wagner Inst., Sci., III, pt. 5, pp. 1103, 1105.

Cardium (Trigoniocardia) haitense Maury, 1917, Bull. Amer. Paleont., No. 29, p. 211, Pl. XXXVI, figs. 5, 5a.

In 1917 I noted that Sowerby's figures of the type of *Cardium haitense* included two forms; the upper representing a subquadrate shell with roundly angulated umbonal slope, the lower a trigonal shell, posteriorly produced with a sharp umbonal ridge. As the description fitted the first figure I suggested restricting the name *haitense* to that form and differentiating the second by the varietal name *cercadicum*. An external mold in this collection shows the same form and number of ribs as American Museum specimens of

C. haitense from Bowden, Jamaica, and mine from the Yaqui Valley, Santo Domingo. As long ago as 1867, Guppy recorded this shell from Jamaica and Cumana, Venezuela, as well as from the type locality which was the Yaqui Valley. To this distribution we may now add Porto Rico.

Localities.—Near Quebradillas, Station 133; near Arecibo, Station 476. Specimen from Station 476 poor and identification uncertain.

Cardium (Trigoniocardia) haitense cercadicum Maury

Cardium (Trigoniocardia) haitense variety *cercadicum* Maury, 1917, Bull. Amer. Paleont., No. 29, p. 212, Pl. XXXVI, fig. 6; *Idem*, No. 30, p. 11.

Several internal molds of what appear to be this variety are in the Porto Rican collection. Traces of about fourteen ribs on the body and of about ten on the truncation still remain. The umbonal ridge is sharply angulated and the outline of the shell is trigonal.

Localities.—Near Quebradillas, Station 131; near Ponce, Stations 288, 289, 291.

Subgenus **Lævicardium** Swainson

Cardium (Lævicardium) serratum Linnæus

Cardium serratum Linnæus, 1758, Systema Naturæ, ed. X, p. 680; 1767, ed. XII, p. 1123.

Cardium lævigatum Lamarck, 1819, Anim. sans Vert., VI, pt. 1, p. 11. Not of Born, 1780, nor of Linnæus 1758.

Cardium (Lævicardium) serratum Dall, 1900, Trans. Wagner Inst. Sci., III, pt. 5, p. 1110; 1903, *Idem*, pt. 6, p. 1587.

Cardium (Lævicardium) serratum Brown and Pilsbry, 1911, Proc. Acad. Nat. Sci. Phila., p 367.

Cardium (Lævicardium) serratum Maury, 1917, Bull. Amer. Paleont., No. 29, p. 212, Pl. XXXVI, fig. 8; *Idem*. No. 30, pp. 10, 22, 23, 24.

Cardium (Lævicardium) serratum Vaughan, 1919, Bull. U. S. Nat. Mus. No. 103, p. 562.

My party found in the Miocene Bluffs of the Gurabo and Mao Rivers, Santo Domingo, fossil shells of *Lævicardium serratum* precisely like recent specimens on the beach at Monte Cristi. Dall records this species from Bowden, Jamaica, and Alum Bluff, Florida; the Pliocene of Florida and South Carolina; Pleistocene of Florida and the Antilles, and living from Cape Hatteras to Bahia, Brazil.

Among the molds of *Cardium* from Porto Rico collected by Reeds are some which seem undoubtedly to represent this species. We may thus extend its range eastward to Porto Rico.

Localities.—Near Quebradillas, Stations 126, 131; near Ponce, Station 291.

Genus **Clementia** Gray

This tropical genus is now reduced to some half dozen species living chiefly on the Philippine, Korean, and Australian coasts, the genotype being *Clementia papyracea* Gray. A single authentic recent species *C. solida* Dall, is on the West coast of Mexico. It is the only living member of the genus in American waters. During the Tertiary, however, *Clementia* lived on the East coast of America. Professor G. D. Harris has lately referred *Dosinia mercenaroidea* Aldrich, from the St. Maurice Eocene beds at the base of the Claiborne bluff, to *Clementia.* During the Miocene *Clementia inoceriformis* inhabited the Maryland shores and probably ranged north to Martha's Vineyard, Mass., since a mold like it has been found in the Gay Head Miocene clays. *Clementia grayi* Dall lived during the deposition of the Oak Grove sands, Florida, and *C. tæniosa* Guppy has been preserved in the Savaneta beds of Trinidad Island. The Isthmian species was *C. dariena* of which we have now found an ancestral form in the Middle Oligocene of Porto Rico.

This genus has never before been recorded from the Greater Antilles. The Trinidad species, *C. tæniosa* is subtriangular with the beaks nearly central.

Clementia rabelli, new species

Plate VI, Figures 2, 3

Shell closely resembling *Clementia dariena* Conrad, but far less ventricose and smaller than this later, Isthmian species. Original substances of shell very delicate and papery, handsomely sculptured with wave-like, concentric, rounded ridges, resembling the undulating sculpture of the modern genus *Raëta* and its Eocene precursor, *Pteropsis.* Older shells of the Clementia lose this sculpture and near their ventral margins show only close, concentric growth lines just as in aged specimens of *C. dariena.*

Dr. Reeds collected many molds of this common and very characteristic fossil of the Collazo shales. The molds are greatly deformed by disturbances of the strata in which they were deposited.

Many are flattened, while in others the pressure has acted on the anterior-posterior axis, fracturing the shell medially and compressing it into an oblong triangular form with a false, superficial aspect of *Inoceramus*. Measurements of various shells are as follows: Oval specimens—altitude 40 mm., length 45 mm., diameter 15 mm.; 33 x 38 x 12; 34 x 45 mm. Triangular compressed shell—38 x 24 x 20 mm.

This *Clementia* is an ancestral Oligocene precursor of the Miocene Gatun *C. dariena*. The affinity is so close that, had there been a less distant stratigraphic relationship, I would have called the Porto Rican shell a variety of the Gatun. But the Porto Rican *Clementia,* according to Dr. Reeds, underlies the *Orthaulax* zone. Apropos of this Vaughan's recent listing of an unidentified *Clementia* in the Culebra formation at Panama is interesting. This shell would be far more nearly synchronous with the Porto Rican *Clementia*.

Of recent shells, *Clementia rabelli* is most like specimens in the American Museum of *C. papyracea* from New Holland. This species is dedicated to Señor Narcisso Rabell Cabrero, the scientist and naturalist of San Sebastian, who most generously showed his collections to Dr. Reeds and pointed out the rich fossiliferous localities along Rio Collazo. The *Clementia* and its associated fauna were obtained from the green shales outcropping on the Collazo in the vicinity of the beautiful waterfalls on Señor Rabell's property.

Localities.—Rio Collazo near San Sebastian, Stations 23, 53, 54, 60, 61, 62.

Genus **Antigona** Schumacher

Antigona tarquinia Dall

Venus magnifica Heilprin, 1886, Trans. Wagner Inst. Sci., I, p. 116. Not *V. magnifica* Sowerby, 1853.

Venus tarquinia Dall, 1900, Trans. Wagner Inst. Sci., III, pt. 5, p. 1194. Pl. XXXVIII, figs. 2, 2a. Figure only.

Cytherea tarquinia Dall, 1903, Trans. Wagner Inst. Sci., III, pt. 6, p. 1274.

Antigona tarquinia Dall, 1915, Bull. 90, U. S. Nat. Mus., p. 147, Pl. XXVI, figs. 1, 2.

From the Collazo shales come two imperfect specimens which have the striking and very characteristic sculpture of *Antigona tarquinia,* described by Dall from the Tampa formation, and listed by him also from Santo Domingo. The species is remarkable for its very handsome sculpture which is *Corbis*-like, and consists of uniform, close-set, radial threads interrupted by regularly-spaced, concentric ridges.

One of the shells has been crushed into an eliptical form by pressure acting on the dorsal region. This enhances its false resemblance to a *Corbis*. The other is not distorted but is broken at the ends. Yet the shell shows a decided likeness in form, sculpture, and size to the Floridian type and the posterior dorsal margin also is nearly straight. The altitude is 40 mm. and diameter 25 mm., the corresponding measurements of the type were 41 x 26 mm.

Localities.—Rio Collazo near San Sebastian, Station 46. A crushed shell, probably this species from Station 63, same locality. From the limestone near Aguada, Station 117, is an internal mold, retaining traces of sculpture, which may be this species.

Antigona tarquinia antillica, new variety

Antigona tarquinia Maury, 1917, Bull. Amer. Paleont., No. 29, p. 217, Pl. XXXVII, fig. 4; *Idem*, No. 30, p. 27. Not *A. tarquinia* Dall, 1900.

Shell of medium size, roundly trigonal, with the posterior dorsal margin sloping rapidly; beaks low; surface sculptured with narrow, concentric ridges between which are conspicuous radial threads. Length of shell 36 mm., altitude 33 mm., semi-diameter 10 mm. Collected by my party at Zone H, Rio Cana, Santo Domingo, in 1916.

In describing this Dominican shell I noted that more material might prove it worthy of varietal rank.

The Porto Rican collection made by Dr. Reeds includes a single external mold in the limestone which strikingly resembles the Dominican valve. The umbo is broken away, but the mold agrees in its sloping posterior margin and in size and general aspect with the valve from the neighboring island.

This form appears to constitute a variety.

Locality.—Near Quebradillas, Station 130.

Antigona, species indet.

A very imperfectly preserved shell shows that a large *Antigona* was present resembling somewhat in form and sculpture *A. willcoxi* Dall from the Florida Pliocene, but smaller. In size the shell resembled the Miocene *A. caesarina* Dall from the Chipola marls, but in outline it is nearer *A. willcoxi*. Unfortunately it is too poorly preserved to describe.

Locality.—Near Ciales, Station 504.

Genus **Callocardia** A. Adams

Callocardia riocollazica, new species

Plate VI, Figure 9

Shell rather small, cordate, moderately convex, beaks rather low and curving forward over the small lunule. Hinge characters concealed by the matrix, hence the reference of the shell to this genus is tentative. Surface sculpture of very fine, even ridges barely seen without a lens. Length of shell 28 mm., altitude 20 mm., semi-diameter 8 mm.

Callocardia gatunensis Dall from the Miocene of the Isthmus and of Santo Domingo, is larger and the curve of the anterior basal margin is quite unlike that of the Porto Rican shell.

Locality.—Rio Collazo near San Sebastian, Station 53.

Genus **Chione** Mergele von Mühlfeldt

Chione woodwardi (Guppy)

Venus woodwardi Guppy, 1866, Quart. Jour. Geol. Soc. London, XXII, p. 292, Pl. XVIII, fig. 1; 1867, Proc. Sci. Assoc. Trinidad, p. 162.

Chione woodwardi Gabb, 1873, Trans. Amer. Phil. Soc., XV, p. 249.

Venus woodwardi Guppy, 1874, Geol. Mag. London, p. 442; 1876, Quart. Jour. Geol. Soc. London, XXXII, p. 536.

Chione woodwardi Dall, 1903, Trans. Wagner Inst. Sci., III, pt. 6, pp. 1291, 1587.

Chione woodwardi Maury, April, 1917, Bull. Amer. Paleont., No. 29, p. 218, Pl. XXXVII, fig. 6.

Chione woodwardi Pilsbry and Johnson, May, 1917, Proc. Acad. Nat. Sci. Phila., p. 199.

Guppy first described this species from a Jamaican shell, later he identified it at Cumana, Venezuela, and in 1876 found it among the left over specimens of the Heneken Collection from the Yaqui Valley, Santo Domingo. Dall also cites it from Bowden, Jamaica and Santo Domingo. In 1916, my party collected *Chione woodwardi* in abundance in Santo Domingo. The specimens correspond in all respects to casts made from many external molds in the Porto Rican limestone. These molds show the characteristic single radial riblets of *C. woodwardi* which are never paired, nor split into smaller ribs, as in related species. Curiously, Gabb failed to find *C. woodwardi* in Santo Domingo, and that is doubtless why Pilsbry and Johnson remark that it does not appear to occur there,—as it is not in the Gabb collection at Philadelphia. But Guppy, Dall, and the writer have all noted its presence in Santo Domingo. This pretty shell was evidently quite widespread in Porto Rico.

Localities.—Near Quebradillas, Stations 125, 129, 136; near Ponce, Station 299; near Ensenada, Stations 392, 393, 394; near Manati, not *in situ,* from boulders, Station 474.

Chione quebradillensis, new species

Plate VII, Figure 4

Shell subtrigonal, anterior end rounded, posterior end somewhat pointed. The surface is handsomely sculptured by about fifteen concentric, crenulated ridges which are cut by the deeply impressed lines defining the lunule, and then continue on over the lunule itself. Over the anterior and posterior areas of the valve the radial sculpture consists of very fine and close-set riblets more or less uniform, only the posterior are somewhat finer and closer. Upon the central portion of the valve the radial ribs are less crowded, although still close, and usually show a definite alternation of a comparatively broad, unpaired, rib with a very fine, linear rib. Length of shell 21 mm., height 16 mm., semi-diameter 9 mm.

This species is related to *Chione walli* Guppy, from the Manzanilla beds of Trinidad and also recorded from Bowden, Jamaica; but that shell has a great many more concentric ridges, and the central riblets alternating with the small intermediate ribs are paired. Lately Pilsbry and Johnson have briefly described, but not figured, a Dominican shell, *Chione santodomingensis,* which is apparently of the same group. The Floridian analogue is *C. chipolana* Dall. The Porto Rican collection afforded a single but very perfect external mold of this shell imprinted in the limestone.

Locality.—Near Quebradillas on Rio Guajataca, Station 134.

Chione quebradillensis guajatica, new variety

Plate VII, Figure 5

A fragmentary external mold was collected by Reeds which resembles the species described as *Chione quebradillensis,* but the ribs over the central area of the valve are *paired* and alternate with the fine, intermediate rib. This character is as in Guppy's *Chione walli,* but in the Porto Rican shell the concentric crenulated ridges are distant, while in *C. walli* they are very close, almost crowded.

Locality.—Near Quebradillas, Station 133.

Genus tellina (Linnæus) Lamarck

This genus is well represented in the collection, but nearly all the specimens are internal molds, too imperfect for specific identification. From the Quebradillas limestone comes a fragmentary imprint of a *Scissula* near *S. cercadica* Maury but probably not that species.

Subgenus **Angulus** (Mergele) Dall

Tellina (Angulus) disparoides, new species

Plate VI, Figure 1

Internal mold with short elliptical form; comparatively straight dorsal margin on either side of the low, acute beaks. Hinge characters and surface markings unknown.

On comparing this mold with recent species in the American Museum it was found to be strikingly like specimens labelled *Tellina* (*Tellinula*) *dispar* Conrad from California and from the Hawaiian Islands. When a shell of similar size of *Tellina dispar* was placed upon the mold it coincided at nearly every point.

Failing any evidence regarding the surface characters of the Porto Rican fossil, we can only say that judging from the form alone its relationship is seemingly with this recent Pacific species. Length of fossil 25 mm., altitude 18 mm., semi-diameter 6 mm.

Localities.—Rio Collazo near San Sebastian, Station 60. Imperfect mold, probably the same species, from Station 57. A smaller mold, perhaps identical, from Station 62.

Genus **Metis** H. and A. Adams

Metis trinitaria Dall

Tellina biplicata Guppy, 1866, Quart. Jour. Geol. Soc. London, XXII, p. 588; 1867, Proc. Sci. Assoc. Trinidad, p. 161; 1874, Geol. Mag. London, p. 441; 1876, Quart. Jour. Geol. Soc. London, XXXII, p. 530. Not *Tellina biplicata* Conrad, 1834, Jour. Acad. Nat. Sci. Phila., VII, p. 152.

Tellina sagræ Guppy and Dall, 1896, Proc. U. S. Nat. Mus., XIX, p. 329. Not *Tellina sagræ* d'Orbigny.

Metis trinitaria Dall, 1900, Trans. Wagner Inst. Sci., III, pt. 5, p. 1041, Pl. XLVI, fig. 24.

Metis trinitaria Maury, 1917, Bull. Amer. Paleont., No. 29, p. 226.

Internal molds of *Metis* are very abundant. Three external molds occur, casts of which correspond with Dall's figure of *Metis trinitaria,* except they are less truncate posteriorly. Still they vary in this respect, some being less produced than others. In one case the internal mold still rested within the external, thus removing all possible doubt as to whether the internal molds were of the same species.

This shell is easily known by its striking form, the right valve being medially constricted as though pressed in by the thumb, while the left valve is convex. This gives a peculiar aspect, different from any of the other Porto Rican fossils. The internal molds show an immense, rounded pallial sinus, which is slightly larger and higher in the left than in the right valve. The posterior end of both valves is sulcated, that of the right being noticably bisulcate. Surface smooth except for concentric lines of growth.

Dr. Guppy referred this Antillean shell to *Tellina biplicata* Conrad from the Miocene of Maryland, and in 1874 listed it from the Miocene of Barbuda, and Santo Domingo, from the Caroni Series of Trinidad, and the Tertiary of Cuba.

In 1900, Dall differentiated the Antillean fossil by the name *M. trinitaria* and recorded it from near Santiago de Cuba, at about two hundred and fifty feet above sea level along the ore railway.

A specimen was seen by Guppy in the Heneken collection from the Yaqui Valley, Santo Domingo, but both Gabb and the writer failed to collect it there. It has not been reported from Jamaica, but it ranged from Trinidad north to Barbuda and thence west to Porto Rico, Santo Domingo and southeastern Cuba. The number of specimens indicate very favorable conditions in Porto Rico.

On the one hand *Metis trinitaria* resembles the Chesapeake Miocene *M. biplicata* and on the other the Pleistocene and recent *M. intastriata* Say. The *Tellina sagræ* of Orbigny's unpublished Paleontologica Cubana pl. IV, figs. 8, 9, was an internal cast, according to Dall probably of *M. intastriata*.

Localities.—Rabell's Ranch, on Guajataca River, Station 110; near Quebradillas, Stations 125, 127, 128, 129, 130, 131, 133, 135, 136, 137, 138, 144.

Also a very poor internal mold possibly this species from near Guayanilla, Station 320.

Genus **Semele** Schumacher

Semele, species indet.

A number of distorted specimens of a *Semele* somewhat resembling *Semele chipolana* Dall come from the Collazo shales, but the shells are too deformed and imperfect for specific description. Attention is simply called to the presence of the genus in this formation.

Localities.—Rio Collazo near San Sebastian, Stations 36, 53, 54.

Genus **Tagelus** Gray
Section **Mesopleura** Conrad
Mesopleura hubbardi, new species

Plate VII, Figure 3

Shell transversely oblong-elliptical, compressed; anterior and posterior ends evenly rounded; basal margin gently arched; beaks very low, almost exactly central; muscle scar prominent; the most conspicuous character is the very strong, nearly straight, internal rib which is directed downward from the beak a varying distance towards the ventral margin. In the internal molds this rib appears in reverse as a strongly-marked groove. Length of shell 35 mm., altitude 14 mm. The thickness varies with the pressure to which the specimens have been subjected after deposition in the shales.

A number of specimens of a *Tagelus* somewhat resembling *Tagelus* (*Mesopleura*) *divisus* Spengler, and probably an ancestral form of that Pliocene to recent species were found in the Collazo shales. This species is named in honor of Mr. Bela Hubbard, as a token of appreciation of his very accurate and valuable paleontological work in northwestern Porto Rico and on Mona Island.

Localities.—Rio Collazo near San Sebastian, Stations 53, 62.

Genus **Psammosolen** Risso
Psammosolen cf. **sancti-dominici** Maury

Psammosolen sancti-dominici Maury, 1917, Bull. Amer. Paleont., No. 29, p. 228, Pl. XXXVII, fig. 13; *Idem.*, No. 30, p. 14.

A very imperfect mold shows the general characters of *Psammosolen,* and retains very clearly the characteristic, oblique surface markings of this genus. The shell may have been identical with the form we collected at Bluff 3, Cercado de Mao, Santo Domingo, and named *Psammosolen sancti-dominici,* as it is about the size, but it is too poorly preserved for specific identification.

Locality.—Near Quebradillas, Station 131.

Genus **Corbula** (Bruguière) Lamarck
Corbula collazica, new species

Plate VI, Figures 10, 11

Shell ovate-triangular, of medium size for the genus, anterior end rounded, posterior end produced, right valve somewhat larger than the left, its posterior end obliquely truncate, its surface sculptured with about twenty-five to thirty fine, close-set, even, subequal concentric ridges, alternating with linear interspaces; left valve somewhat smaller and pointed posteriorly to fit within the truncated end of the right valve, Concentric sculpture of both valves similar. Length of shell 13 mm., height 8 mm., semi-diameter 3.5 mm.

This *Corbula* is one of the commonest and most characteristic shells in the Collazo shales. Fossil species of this genus already described from the Greater Antilles are the following: *Corbula sericea* Dall, *C. heterogenea* Guppy, *C. vieta* Guppy, *C. viminea* Guppy, *C. dominicensis* Gabb, *C. cercadica* and *C. caimitica* Maury. From all of these the present species differs.

Owing to pressure resulting from the disturbance of the shales, the shells are more or less deformed, and at first it seemed as if two forms might be present, one more triangular, the other more nasute. But this difference seems due rather to accidents, as the sculpture and general aspect of all are similar, and I have selected as the type a specimen that seems to have suffered least from pressure and to represent what appears to have been the normal form.

Localities.—Rio Collazo near San Sebastian, Stations 23, 49, 53, 54.

Genus **Panopea** Ménard

Panopea, species indet.

An imperfect internal mold of what appears to represent a very large and extremely obese *Panopea* was found in the collection. The mold measures 90 mm. in length, 70 mm. in altitude and 76 mm. in diameter.

Locality.—Near Arecibo, Station 459.

Genus **Teredo** Linnæus

Teredo incrassata (Gabb)

Kuphus incrassatus Gabb, 1873, Trans. Amer. Phil. Soc., XV, p. 246; 1881, Jour. Acad. Nat. Sci. Phil., (2), VIII, p 342, Pl. XLIV, figs. 12a-e.
Teredo fistula? Guppy, 1876, Quart. Jour. Geol. Soc. London, XXXII, p. 529.
Teredo incrassata Dall, 1903, Trans. Wagner Inst. Sci., III, pt. 6, p. 1587.
Teredo incrassata Maury, 1917, Bull. Amer. Paleont., No. 29, p. 235, Pl. XXXIX, fig. 24; *Idem*, No. 30, p. 25.
Kuphus incrassatus Vaughan, 1919, Bull. 103 U. S. Nat. Mus., p. 558.

Gabb first described the tubes of this Teredo from Guayubin, Santo Domingo. Later he found it was abundant and widespread in the Miocene of that island, throughout the Samba Hills and also south of Samaná Bay. He states that, "it is a very common and characteristic fossil of the upper part of the Dominican Miocene." The writer's party in Santo Domingo also collected *Teredo incrassata* in abundance. The tubes were seen loose along the roadside from Los Quemados to Caimito. They were several feet long and resembled the roots of trees. At Caimito they were present in the Teredo limestone and occurred at Cercado in Bluff 3. Thus this species ran through both the *Sconsia lævigata* and *Aphera islacolonis* formations.

Dall lists *Teredo incrassata* from Bowden, Jamaica, in the Simpson and Henderson collection. Its range is now extended to Porto Rico, where Reeds found it in great quantities and, as the list of localities shows, extremely wide spread.

Besides its distribution in the Miocene of these three islands of the Greater Antilles, *Teredo incrassata* was also identified by Gabb at Sapote on Rio Reventazon, Costa Rica.

It is of interest that although such large numbers of the tubes have been found, no valves have yet been discovered. The shell therefore remains unknown. The descriptions and identifications rest entirely upon the tubes. These are wrinkled with annular growth lines, often somewhat gnarled and may attain several feet in length and an inch and a quarter in diameter. Smaller portions of the tubes are frequently divided into two by an internal septum.

Localities.—Rio Collazo near San Sebastian, Stations 24, 25, 33, 35, 36, 38, 39, 44, 45, 46, 48, 49, 51, 52, 54, 57, 58, 59, 61, 63; near Lares, Stations 82, 92; Rio Collazo, Station 95; Señor Rabell's Ranch, Rio Guajataca, Stations 110, 111, 112; near Aguada, Stations 117, 119, 122, 123; near Quebradillas, Station 126; near Juana Diaz, Stations 160, 163, 184, 189; near Ponce, Stations 288, 292, 299, 300; East Shore of Guánica Harbor, Stations 368, 373, 374, 375; near Guánica Central, Station 392; near Arecibo, Stations 441, 469; near Manati, Stations 474, 477, 478, 479, 480, 481, 482, 483; near Ciales, Stations 495, 498, 500, 502; near Arecibo, Station 509.

CLASS SCAPHOPODA

Genus **Dentalium** Linnæus

Dentalium diazicum, new species

Plate VII, Figure 1

Shell with no longitudinal sculpture, polished and entirely smooth except for faint miscroscopic, annular growth lines, tube curving, tapering considerably, circular in cross section. Length of fragment 19 mm., diameter of larger end 2.75 mm, of smaller end 1.50 mm.

This species is about the size and has the same curvature as apical fragments of *Dentalium dissimile* Guppy from the Miocene of Jamaica and Santo Domingo but is at once differentiated by its absence of longitudinal sculpture. *Dentalium haytense* Gabb from Santo Domingo is smooth and circular in cross section, but the tube is nearly straight. *Dentalium pyrum* Pilsbry and Sharp is ovate in section, while *D. præcursor,* another smooth form described by the same authors is oval in cross section. Among other Miocene Antillean *Dentalia* may be mentioned *D. calliglyptum, D. tryoni* and *D. cossmannianum* of Pilsbry and Sharp, and *D. glaucoterrarum* Maury which are all sculptured species.

Locality.—Near Juana Diaz, Station 185.

Genus **Cadulus** Philippi

Cadulus poncensis, new species

Plate VII, Figure 13

Shell small, curving, not very slender, circular in cross-section, slightly constricted at the larger extremity, evenly convex up to about two millimeters from the apex when it rather suddenly tapers. Just at the apex the shell seems very slightly swollen. The surface apparently was perfectly smooth. Length of shell 7 mm., greatest diameter 1.50 mm.

From a chalky phase of the limestone near Ponce comes a single specimen of a *Cadulus.* The shell substance appears to have been replaced, but the original form is well preserved. The small Dominican species, *Cadulus phenax* Pilsbry and Sharp (Proc. Acad. Nat. Sci. Phila., XLIX, p. 472, Pl. XI, figs. 23, 24, 1897) of which we collected hundreds of shells in the bluffs of Rio Mao, is about this length, but is a very much more slender and delicate shell. The Bowden form *C. dentalinus* Guppy, is characterized by circular rings around the smaller part of the tube. *Cadulus denticulustigris* Maury from Rio Gurabo, Santo Domingo, is about the length of the Ponce shell, but is much more inflated centrally.

Locality.—Near Ponce, Station 283.

CLASS GASTROPODA

Order Ctenobranchiata

Genus **Calyptræa** Lamarck

Calyptræa centralis (Conrad)

Infundibulm centralis Conrad, 1841, Amer. Jour. Sci., XLI, p. 348; 1845, Foss. Medial Tert., p. 80, Pl. XLV, fig. 5.

Trochita centralis Emmons, 1858, Geol. N. Car., p. 276, fig. 193.

Trochita collinsii Gabb, 1875, Jour. Acad. Nat. Sci. Phila., (2), VIII, p. 342, Pl. XLIV, figs. 11, 11a.

Calyptræa centralis Dall, 1892, Trans. Wagner Inst. Sci., III, pt. 2, p. 353.

This widespread Miocene species is represented by a single internal mold, but the characters of the pillar are concealed by the matrix. The recent analogue and probable descendant of *C. centralis* is *Calyptræa candeana* d'Orbigny, of which Dall and Simpson report finding a great number of dead shells at Mayaguez. *Calyptræa centralis* occurs according to Dall in the Chipola Miocene of Florida and in the Miocene of North and South Carolina, Virginia, Maryland and Sapota, Costa Rica.

Locality.—Near Quebradillas, Station 130.

Genus **Natica** Scopoli

There are many internal molds of Naticoid shells in the collection. They are evidently of various species but scarcely any can be specifically determined.

Natica cf. **canrena** (Linnæus) Moerch

Nerita camerna (Linnæus in part) Auct., Mœrch, 1877, Malak. Blatt., 24. p. 62.

Natica canrena Gabb, 1873, Trans. Amer. Phil. Soc., XV, p. 223.

Natica canrena Guppy, 1876, Quart. Jour. Geol. Soc., XXXII, p. 518.

Natica canrena Dall, 1892, Trans. Wagner Inst. Sci., III, pt. 2, pp. 364-365.

Natica canrena Brown and Pilsbry, 1912, Proc. Acad. Nat. Sci. Phila., p. 508.

Natica canrena Maury, 1917, Bull. Amer. Paleont., No. 29, p. 134, Pl. XXIII, fig. 10; *Idem*, No. 30, pp. 10 27.

Natica canrena Vaughan, 1919, Bull. 103 U. S. Nat. Mus., p. 561.

One specimen agrees well in form with *Natica canrena* and is probably that species, but since it is an internal mold, it cannot show the characteristic, tangential surface plicæ which would definitely determine the identification. *Natica canrena* is an ancient, static form ranging from the Tertiary to the recent. It is found as a fossil in Trinidad, Santo Domingo, Gatun, Costa Rica, and Florida. Its present range is from the Antilles to Pernambuco, Brazil.

Locality.—East shore of Guanica Harbor, Station 373.

Section **Stigmaulax** Moerch

Natica (Stigmaulax) sulcata (Born)

Nerita sulcata Born, 1780, Mus. Cæs. Vindobonensis, p. 400, Pl. XVII, figs. 5, 6.

Natica sulcata Guppy, 1866, Quart. Jour. Geol. Soc. London, XXII, p. 290, Pl. 18, figs. 14, 15; 1867, Proc. Sci. Assoc. Trinidad, p. 157.

Natica sulcata Gabb, 1873, Trans. Amer. Phil. Soc, XV, p. 223.

Natica sulcata Guppy, 1874, Geol. Mag. London, p. 437; 1876, Quart. Jour. Geol. Soc. London, XXXII, p. 518.

Natica (Stigmaulax) sulcata Dall, 1892, Trans. Wagner Inst. Sci., III, pt. 2, p. 366.

Natica sulcata Dall and Simpson, 1902, Bull. U. S. Fish Comm., XX, pt. 1, p. 438.

Natica (Stigmaulax) sulcata Dall, 1903, Trans. Wagner Inst. Sci., III, pt. 6, p. 1585.

Natica (Stigmaulax) sulcata Maury, 1917, Bull. Amer. Paleont., No. 29, p. 135, Pl. XXIII, fig. 13; *Idem*, No. 30, pp. 11, 22, 24, 27.

Natica (Stigmaulax) sulcata Jones, 1918, Jour. Geol. XXVI, p. 742.

As early as 1867, Guppy, the pioneer and indefatigable paleontologist of the West Indies, had listed this species from the Miocene of Cumana, Venezuela, and from Jamaica and Santo Domingo. Dall has also recorded it from Bowden, and Jones lately found it in the Maissade beds, Rivière L'Ayaye, Haiti. My Dominican expedition found it in abundance in the Miocene blue clays, the specimens from Bluff 3, Cercado de Mao, being particularly large and fine. Reeds obtained a single much broken shell from Porto Rico which though so imperfect has the groovings and form characteristic of this widespread species. This is one of the few cases where the Miocene shell has lived on unchanged to the present time. It is still found on the Porto Rican shores. *Natica sulcata* is easily recognized by its ornamentation of uniform groovings which traverse the entire surface, keeping parallel to the margin of the outer lip.

Locality.—Rabell's Ranch on Rio Guajataca, Station 110.

Genus **Amauropsis** Moerch

Amauropsis guppyi gurabensis Maury

Amauropsis guppyi gurabensis Maury, 1917, Bull. Amer. Paleont., No. 29, p. 138, Pl. XXIII, fig. 20; *Idem*, No. 30, p. 24.

Amauropsis guppyi gurabensis Jones, 1918, Jour. Geol. XXVI, p. 742.

An internal mold in the collection shows the broad form, short, acute spire, and broadly shouldered whorls that characterize this variety of Gabb's *Amauropsis guppyi* (*Amaura Guppyi* Gabb, Trans. Amer. Phil. Soc., XV, p. 224, 1873). The typical form has a more evenly sloping spire and proportionally longer body whorl.

My party found the variety, *gurabensis* rather commonly in the bluffs of Rio Gurabo, Los Quemados, Santo Domingo. Jones later obtained it from the Maissade beds, Rivière L'Ayaye, Haiti. The Porto Rican mold agrees well in form with our Dominican shells.

Locality.—Near Aguada, Station 123.

Genus **Xenophora** Fischer de Waldheim

Xenophora conchyliophora (Born)

Trochus conchyliophorus Born, 1778, Mus. Cæs. Vind., Index, p. 333.

Phorus reclusus Conrad, 1855, Proc. Acad. Nat Sci. Phil., VII, p. 262.

Phorus agglutinans Gabb, 1873, Trans. Amer. Phil. Soc., XV, p. 241.

Xenophora agglutinans De Gregorio, 1890; Mon. Eocene Ala., p. 144. Not of Lamarck.

Xenophora conchyliophora Dall, 1892, Trans. Wagner Inst. Sci, III, pt. 2, pp. 360-362; 1915, Bull. 90, U. S. Nat. Mus., p. 105, Pl. XV, figs. 1, 3.

Xenophora conchyliophora Dall, 1916, Proc U. S. Nat. Mus., LI, p. 518, Pl. LXXXVI, fig. 10.

Xenophora conchyliophora Maury, 1917, Bull. Amer. Paleont., No. 29, p. 133, Pl. XXIII, fig. 7; *Idem*, No. 30, pp. 22, 23.

The Porto Rican representatives of *Xenophora* are all internal molds; but almost undoubtedly they are the fillings of shells of *X. conchyliophora*. This ancient, static species dates from the Ripley Cretaceous of Alabama through Eocene, Oligocene, Miocene and Pliocene times down to the recent fauna. It is living in 14 to 250 fathoms from Hatteras to Guadeloupe and in the West Indies generally. The Dominican Miocene shells that my party gathered from the bluffs of Rio Gurabo were in all respects like those on the beaches of that island so it is no surprise to find this species in synchronous, Porto Rican deposits.

Localities.—Near Quebradillas, Stations 126, 128, 129.

Genus **Turritella** Lamarck

Turritella altilira culebrina, new variety

Plate VIII, Figure 4

Shell with uniform spirals in the concave central part of the whorls; two raised spiral ridges one near the proximal and one near the distal suture. The lower may have been slightly beaded, the upper is crested with a double row of beads. Grooved area between ridges sculptured with five or six uniform spiral threads. Altitude of most complete specimen 50 mm. greatest diameter (increased by flattening from pressure) 12 mm.

There are several Turritellas from the Collazo shales, which though flattened by pressure have retained the shell substance and sculpture. They are remarkably like the Gatun species *T. altilira* Conrad (*T. gabbi* Toula). It may seem strange to refer this species to the Gatun shell rather than to Guppy's *Turritella tornata* described from Cumana, Venezuela, and listed also from Jamaica. But these shells are so much more like Toula's, and Brown and Pilsbry's figures of the Gatun species than like Guppy's figure of the Cumana type that without a series of the actual fossils this identification seems truer.

Localities.—Rio Collazo near San Sebastian, Stations 54, 60, 61, 94.

Turritella collazica, new species

Plate VIII, Figure 5

Shell large and heavy, flattened by pressure but still retaining its characteristic and very striking sculpture. The unique fragment consists of four whorls each with a very heavy and prominent broad swollen band encircling the base just above the proximal suture. This band occupies about one-third of the whorl. The remaining portion is flat and shows traces of having been ornamented with about six coarse spirals. Height of four whorls 65 mm., greatest diameter (increased by flattening of the shell) 35 mm., least diameter 20 mm.

This species is at once recognized by the very heavy rounded ridge defining the base of each volution. The species with which it seems to be most closely related is the North American Eocene shell, *Turritella mortoni* Conrad. I know of no Antillean species at all resembling it. The fossil would seem to be a descendant of Conrad's shell with the ridge not sharp and carinate as in that species but broad, round and swollen.

Locality.—Rio Collazo near San Sebastian, Station 64.

Turritella poncensis, new species

Plate VII, Figure 6

Shell of medium size, tapering rather gradually from the base towards the apex. Whorls flattish, each usually marked by six stronger primary spiral threads between which are a varying number of fine secondary spirals visible only with a lens. Anteriorly the whorls are roundly carinated and project so as to partly overhang the suture immediately beneath them. This overhanging of the basal part of the volutions is the most conspicuous character of the shell and differentiates it at once from the common West Indian Miocene species, *Turritella planigyrata* Guppy. A fragment of about four whorls measures 28 mm. in length and 14 mm. in greatest diameter.

This species seems nearest akin to the larger Gatun shell, *Turritella mimetes* Brown and Pilsbry.

Locality.—Near Ponce, Station 285.

Turritella guanicensis, new species

Plate VII, Figure 7

Shell was fairly large, tapering rather rapidly towards the apex. The sculpture of the two whorls that precede the last volution consists on each of an anterior and a posterior pair of spiral, beaded ridges separated by a narrow groove. Between the whorls is a concave space in the center of which lies the suture. On the last shorl, in addition to the two pairs of beaded, spiral ridges, there is a somewhat smaller, basal carina, just beneath the anterior pair making them appear like three ridges and forming in all five instead of four ridges on the body whorl. On this whorl also there is a threadlike secondary spiral in the groove between the two pairs of beaded ridges. A fragment of about four volutions measures 22 mm. in length and 12 mm. in greatest diameter.

On the one hand, this species bears some resemblance to *Turritella forresti* Brown from Willoughby Bay, Antigua, but that shell is much smaller, about half the diameter of the Porto Rican, and has three major spiral ridges, beaded and paired, and between these three groups of major ridges are clusters of five, finer, secondary spirals. On the other hand, the aforementioned Ponce shell recalls in quite a striking manner the sculpture of the much later Floridian *Turritella apicalis tensa* Dall, which has also two pairs of beaded ridges to every whorl and seems to be the Pliocene analogue of the Porto Rican species.

Locality.—Guanica Harbor, Station 374.

Genus **Cerithium** Bruguière

Cerithium russelli arecibense, new variety

Plate VII, Figure 9

Each whorl ornamented with a row of small, nearly uniform beads, about eight to a half volution. Beneath this beaded row a series of rounded, not perfectly regular longitudinal ribs, about twelve to a volution. Entire surface marked by fine incised spirals, visible without the lens; on last whorl tending to alternate with secondary, microscopic spirals. Last two whorls measure 15 mm., in height and 11 mm., in greatest diameter.

This variety is founded upon a fragmentary external mold of a *Cerithium* resembling *C. russelli* Maury, from Los Quemados, Rio Gurabo, Santo Domingo. It differs notably in its smaller size and details of ornamentation. The sculpture of the Porto Rican shell is rather bolder, the ribs few, stronger and more regular than in the Dominican type.

Locality.—Near Arecibo, Station 471.

Cerithium utuadicum, new species

Plate VII, Figure 8

Whorls, three of which show in the rock imprint, slightly convex and ornamented with arching, rounded, longitudinal ribs, about nine to half a volution, separated by narrower interspaces. A few of the ribs can be traced from suture to suture across the whorl, but the majority are so interrupted posteriorly by an abrupt change of sculpture as to lose their identity. This change consists in the development of a band bearing, regular, uniform, bead-like nodules, twelve or more to half a volution. This beaded row comes out well in the artificial cast. Beneath it is a very fine row of nodules, best seen in the external mold, as it is too delicate to form a good impression. Beneath the row of fine nodules are about seven primary spiral threads, usually alternating with finer, secondary spirals. Height of fragment 16 mm., greatest diameter approximately 10 mm.

The specimen consists of the fragmentary mold of a richly-sculptured, turreted shell which at first glance one would think a *Terebra,* but on examination under a lens the ornamentation appears more like that of certain unusual Cerithia. This species has a decided general resemblance to the figure of *Cerithium corallicolum* Dall from the Upper Flint River beds, Georgia (Proc. U. S. Nat. Mus., LI, Pl. LXXXVII, fig. 6, 1917). But the Porto Rican shell is smaller, slenderer, with finer, more numerous ribs, a minor beaded row beneath the major, and is a more elegantly sculptured shell than the earlier Georgian form.

A recent specimen in the American Museum labelled *Vertagus faciatus* Bruguière, Jay Collection, from Ceylon, resembles the fossil in having a nodose band, giving the shell a *Terebra*-like aspect, but the ribs are lower, straighter, closer and more numerous and the spirals fewer than in the fossil species.

Locality.—About midway between Arecibo and Utuado, Station 471.

Subgenus **Campanile** Bayle

Section portoricia, new section

Shell large, many-whorled, turreted, very elongate-conic, tapering gradually from a comparatively narrow base to the apex. Suture very profoundly excavated. Whorls rounded, each showing distinct traces of a narrow, deep medial groove, perhaps representing surface sculpture.

The specimens are all in the form of internal molds. The cylindrical axial perforation represents the space occupied by the dissolved columella. The interior surface of this perforation has a coating of calcite crystals which obscures to some extent the structure, but there is no indication of any grooves representing in reverse columella plications. The pillar apparently was smooth.

Although so imperfect, the suggestion of a new section for these singular molds seems justified by their unique characters. In the very deep sutures, rounded whorls and curious Pleurotomarian-like groove they differ from such forms as *Campanile claytonense* Aldrich from the Midwayan Eocene of the Gulf States and also from the great *Cerithium giganteum* of the Paris basin Eocene. In a superficial way they bear more resemblance to *Halloysia biplicata* Briart and Cornet from the lower Eocene of Mons, but that has a plicate columella and its affinities are with *Nerinea.*

The presence in North America of large *Cerithiums* recalling those of the Paris basin Eocene was first noted by Dall in a letter[7] to Dr. Fischer regarding the basal Eocene beds of the Gulf States. He remarked: "Dans ces calcaires du Tertiaire inférieur se montrent des fragments d'un Cerithium de très grande taille, paraissant voisin du *C. giganteum* de l'Eocène du Bassin de Paris. Or, ce type est trouvé pour la première fois en Amerique." In 1894, Aldrich

[7]Published in Bull. Soc. Géol. de France, XVIII, (3) 1890, p. 327.

described *Cerithium* (*Campanile*) *claytonense* from the Midwayan Eocene of Alabama. This attains 125 mm., and has flattened whorls with the suture not excavated.

In a discussion of the Oligocene fauna of Bainbridge, Georgia, Dall remarks:[8] "A feature of somewhat unusual interest paleontologically is the presence in the upper bed of a relatively large number of species of the Cerithiidae, several of them of unusual size, recalling the analogous group in the Parisian Eocene of France, and not paralleled in any of the other Tertiary horizons of the United States as far as known."

These Porto Rican specimens are, however, very much larger than any Cerithiums from the Flint River Oligocene, nor are they like Dall's species. I know of no North American or Antillean fossil resembling these Porto Rican molds. I believe they represent a unique fauna having affinities with European Eocene forms, but of a younger geological period.

Campanile (Portoricia) laricum, new species

Plate VIII, Figures 1, 2

At the base of the Arecibo limestone a number of internal molds were collected for which I have suggested the above described new section *Portoricia*. The largest fragment consists of six whorls and shows evidences of pressure, resulting in distortion. The six volutions of this mold measure 80 mm., in height. Another fragment of three whorls is 33 mm. in height and 45 mm. in greatest diameter. All the fragments appear to have been the same species and all show interrupted traces of the medial groove, which looks like the markings on internal molds of Pleurotomarian shells, but was probably some surface sculpture that grooved the internal wall of the volution.

Localities.—Near Lares, Stations 57, 58, 59.

Genus **Strombus** Linnæus

Strombus cf. **haitensis** Sowerby

Strombus haitensis Sowerby, 1850, Quart. Jour. Geol. Soc. London, VI, p. 48, Pl. IX, fig. 7.

Strombus haitensis Guppy, 1867, Proc. Sci. Assoc. Trinidad, p. 157.

Strombus bituberculatus Gabb, 1873, Trans. Amer. Phil., Soc., XV, p. 233. Not of Lamarck.

[8]Proc. U. S. Nat. Mus., LI, 1917, p. 487; Pls. LXXXIII to LXXXVIII.

Strombus haitensis Guppy, 1874, Geol. Mag. London, p. 438; 1876, Quart. Jour. Geol. Soc. London, XXXII, p. 521.
Strombus haitensis Dall, 1903, Trans. Wagner Inst. Sci., III, pt. 6, p. 1584.
Strombus haitensis Maury, 1917, Bull. Amer. Paleont., No. 29, p. 118, Pl. XX, fig. 1; *Idem*, No. 30, pp. 10, 18, 22, 23, 24.

Several internal molds probably represent fillings of *Strombus haitensis*. When compared with shells of this species collected by the writer from the type region in the Yaqui Valley, Santo Domingo, the molds are seen to correspond to the interior of the shell. They also show traces of the stronger, upper row of spiny prongs. Absolute certainty is not possible, but in all probability the molds are those of *S. haitensis*. First described by Sowerby from Heneken's Dominican shells, this species has been later found in the Yaqui Valley by Gabb and the writer. Gabb referred his specimens to the living *Strombus bituberculatus*. The differences between the Miocene and the recent species are noted in my descriptions of Dominican fossils. Dall lists *S. haitensis* from Henderson's and Simpson's collection of Bowden fossils. The species thus seems to have lived on the Miocene shores of the adjacent islands of Santo Domingo, Jamaica and Porto Rico.

Localities.—Señor Rabell's Ranch, Rio Guajataca, Station 112; near Aguada, Station 117.

Strombus cf. **bifrons** Sowerby

Strombus bifrons Sowerby, 1850, Quart. Jour. Geol. Soc. London, VI, p. 48, Pl. IX, fig. 9.
Strombus bifrons Guppy, 1866, Quart. Jour. Geol. Soc. London, XXII, p. 287; 1867, Proc. Sci. Assoc. Trinidad, p. 157.
Strombus pugilis Gabb (in part) 1873, Trans. Amer. Phil. Soc., XV, p. 233. Not of Linnæus.
Strombus bifrons Guppy, 1874, Geol. Mag. London, p. 438.
Strombus bifrons Guppy, 1876, Quart. Jour. Geol. Soc. London, XXXII, p. 521.
Strombus bifrons Dall, 1890, Trans. Wagner Inst. Sci., III, pt. 1, pp. 176, 177; 1903, *Idem*, pt. 6, p. 1584.
Strombus bifrons Maury, 1917, Bull. Amer. Paleont., No. 29, p. 119, Pl. XX, figs. 2, 3; *Idem*, No. 30, pp. 10, 13, 18, 22, 23, 27.

In the collection is an internal mold which probably represents *Strombus bifrons* Sowerby. When compared with Dominican shells of that species, it corresponds in size and form to the interior; but no positive identification is possible because of the very imperfect preservation of the Porto Rican specimen. The type locality of

Strombus bifrons is the Yaqui Valley, Santo Domingo where it was first found by Colonel Heneken and described by Sowerby. Guppy and Dall have recorded its presence in the Bowden beds, Jamaica.

This very pretty and graceful shell of the Miocene shores of the Greater Antilles had for its analogues in Florida *Strombus aldrichi* Dall and *S. chipolanus* Dall. The Isthmian *S. gatunensis* Toula resembled it to a less degree as it lacked the shoulder spines. The living representative of this type of *Strombus* is *S. columba* of the oriental seas.

Locality.—Señor Rabell's Ranch, Rio Guajataca, Station 110.

Strombus cf. **proximus** Sowerby

Strombus proximus Sowerby, 1850, Quart. Jour. Geol. Soc. London, VI, p. 48, pl. IX, fig. 8.

Strombus proximus Guppy, 1867, Proc. Sci. Assoc. Trinidad, p. 157.

Strombus pugilis Gabb (in part) 1873, Trans. Amer. Phil. Soc., XV, p. 233. Not *S. pugilis* Linnæus. Exclude Gabb's other synonyms.

Strombus proximus Guppy, 1874, Geol. Mag. London, p. 438; 1876, Quart. Jour. Geol. Soc. London, XXXII, p. 521.

Strombus pugilis Dall (in part) 1890, Trans. Wagner Inst. Sci., III, pt. 1, p. 177. Not *pugilis* Linnæus.

Strombus proximus Maury, 1917, Bull. Amer. Paleont. No. 29, p. 119, Pl. XX, figs. 4, 5; *Idem*, No. 30, pp. 10, 13, 22, 27.

Strombus proximus Jones, 1918, Jour. Geol. XXVI, p. 741.

The type of *S. proximus* was collected by Colonel Heneken in the Yaqui Valley, Santo Domingo, seventy years ago. Twenty years and more later Gabb found it there also, but referred it erroneously to *Strombus pugilis.* Jones lately reports finding *S. proximus* in the Maissade beds, Riviere L'Ayaye, Haiti.

Several internal molds in the collection are probably of this species as they correspond to the form of the Dominican shells. Positive identification is not possible, but as far as the material at hand permits one to form an opinion, the three very characteristic Dominican Miocene species, *S. haitensis, S. bifrons* and *S. proximus* were also living in Porto Rico. The nearest living analogue of *Strombus proximus* seems to be *S. gracilior* Sowerby, from Panama.

Localities.—Near Ponce, Stations 289, 292.

Genus **Orthaulax** Gabb

Orthaulax aguadillensis, new species

Plate IX, Figure 4

Shell large and heavy, form of spire short and blunt, like that of *Orthaulax pugnax*. This at once distinguishes the shell from the Dominican species, *O. inornatus* Gabb, which is high-spired. A further characteristic of the shell is the evenly rounded form of the shoulder, which in cross-section would be almost perfectly circular. This marks it off very decisively from the Floridian, Chipolan species, *Orthaulax gabbi* Dall, which is markedly triangular at the shoulder. The spire measures 45 mm., in diameter.

A single specimen of this *Orthaulax* was collected by Reeds at Aguadilla. It is imperfect, but undoubtedly a typical member of this very important index genus.

The shell was submitted to Dall who compared it with the types of the various known species in the National Museum. He replied that "The *Orthaulax* is nearest to *O. pugnax* but as the margin of the spire is gone it is impossible to be certain. I think it is new."

One might be criticized for describing so incomplete a specimen as new were this a less rare and less stratigraphically important genus. Moreover, no complete adult shell of either *O. inornatus* or *O. pugnax* has ever been found. Though heavy and apparently strong the shells seem to go to pieces very easily and usually one finds only heads, as in this case or fragments of the heavy pillars.

No other molluscan shells were found associated with this *Orthaulax*, but an Echinoderm occurred.

It is a little surprising that the nearest ally of this Porto Rican *Orthaulax* should be not Gabb's *O. inornatus*,—from the adjacent island of Santo Domingo and in the Tampa and White Beach beds, Florida, but *O. pugnax*. The latter ranges geographically from the Tampa, Florida beds and those of Bainbridge, on the Flint River, Georgia to Cuba, Antigua and the Canal Zone, and geologically from the Middle Oligocene of Antigua to the Upper Oligocene of the Tampa and Flint River formations.

Locality.—Aguadilla, Station 3.

Genus **Cypræa** Linnæus

Cypræa sancti-sebastiani, new species

Plate VII, Figure 12

Molds of the usual oval-cylindrical *Cypræa*-shape, the outer lip extending considerably above the spire; exterior characters unknown. Length of smaller mold 18 mm., width 11 mm., thickness 9 mm.; corresponding measurements of the larger mold, which is figured, 29 x 17 x 12 mm.

A number of molds of *Cypræa* varying in size were obtained from the Collazo shales. The large specimens are so deformed that it is impossible to say whether they are identical with the less distorted smaller molds or not. Of the smaller specimens, described above, the first is about the size of the Miocene to recent species, *Cypræa spurca* Linnaeus, but is less contracted basally and more cylindrical. The other is in size like *C. spurcoides* Gabb, but less inflated and appears to be specifically the same as the smaller specimen.

Localities.—Rio Collazo near San Sebastian, Stations 24, 36.

Genus **Dolium** Lamarck

Subgenus **Malea** Valenciennes

Malea camura Guppy

Malea camura Guppy, 1866, Quart. Jour. Geol. Soc. London, XXII, p. 287, Pl. XVII, fig. 9; 1867, Proc. Sci. Assoc. Trinidad, pt. 3, p. 158.

Malea ringens Gabb (in part), 1873, Trans. Amer. Phil. Soc., XV, p. 223. Not *M. ringens* Swainson.

Malea camura Guppy, 1874, Geol. Mag. London, new ser., decade 2, I. p. 439; 1876, Quart. Jour. Geol. Soc., London, XXXII, p. 525.

Malea camura Dall, 1903, Trans. Wagner Inst. Sci., III, pt. 6, p. 1584.

Malea camura Brown and Pilsbry, 1911, Proc. Acad. Nat. Sci. Phil., p. 356.

Malea camura Maury, 1917, Bull. Amer. Paleont., No. 29, p. 112, Pl. XIX, fig. 3; *Idem*, No. 30, pp. 11, 13, 23, 24.

Malea camura Jones, 1918, Jour. Geol. XXVI, p. 741.

Malea camura Vaughan, 1919, Bull. 103 U. S. Nat. Mus., p. 561.

This species was first described by Guppy from an immature Jamaican shell. Later he identified it from Santo Domingo and Panama. Gabb referred his Dominican specimens to the recent West coast species, *Malea ringens* Swainson. Dall lists *M. camura* from the Henderson and Simpson collection of Bowden, Jamaica fossils; Pilsbry and Brown record it from Gatun; Jones has lately found it in the Maissade beds, Rivière L'Ayaye, Haiti. The writer has obtained it in abundance from Cercado de Mao and Los Quemados, Santo Domingo.

On comparing an external mold and its artificial cast from Porto Rico with Dominican specimens the agreement is almost line for line with some of our younger shells of *Malea camura,* leaving no doubt of complete identity. The closest ally and probable descendant of *Malea camura* is *M. ringens* Swainson living on the West Coast. Zetek in Los Moluscos de la Republica de Panama, p. 29, 1918, lists the latter shell from Panama.

The present distribution of the subgenus *Malea* is restricted to the West Coast of Central and South America to Polynesia and the Philippines. It has become strictly Pacific, while in Tertiary times it was abundant in the Antillean and Isthmian Atlantic waters.

Locality.—Near Quebradillas, Station 131.

Genus **Pyrula** Lamarck

Pyrula hoveyi, new species

Plate VIII, Figure 3; Plate IX, Figure 7

Shell fig-shaped, spire unusually high for the genus; entire surface reticulated by very close-set, sharply defined longitudinal ridges crossing the spiral sculpture and equalling in thickness the series of primary spirals. The spiral ornamentation consists of delicate, but sharp, primary spirals at intervals of two and a half to three millimeters apart, and between each pair of primaries are three much finer subequal threads. Thus the secondary thread which occupies the center of each interspace is only very slightly more pronounced than the two tertiaries which lie on either side of the secondary. The earliest whorls are not shown in the rock imprint of the shell, but the third from the body whorl shows the point at which the longitudinal ridges suddenly begin. The primary spirals clearly precede them, but how far back towards the apex they extended is unknown. Length of incomplete internal mold 42 mm., greatest width 26 mm. Very likely the shell when adult attained a much larger size.

From the above description it is clear that this Porto Rican shell is not of the Antillean and East Coast *Pyrula papyratia* stock, of which Burnett Smith has described an ancestral Bowden form as *Pyrula pilsbryi.* The *P. papyratia* race have pronounced secondary spirals, very much stronger than the tertiaries, resulting in a very different type of sculpture from our fossil, and the longitudinal lines are so inconspicuous that the surface is not reticulated. Nor is the Porto Rican fossil like Guppy's *Pyrula carbasea* from the Caroni series of Trinidad. That species has very characteristic sunken interspaces between the primaries, and appears to be an aberrant form.

Two molds of the *Pyrula,* one being a nearly complete internal mold and the other an impression in the rock, are present showing most of the spire and the upper part of the body whorl. The sculpture is perfectly preserved and an artificial cast of the external mold reveals every detail of the exquisitely fine ornamentation of the original.

This fossil is closer to the Isthmian species *Pyrula micronematica* Brown and Pilsbry from the Pecten bed in the Culebra Cut, but was larger, with a much higher spire and with very close-set longitudinal ridges instead of the wide-spaced axial threads of that species. Nor is there any knotting at the points of intersection of spirals and axials as noted in *P. micronematica*. Nevertheless, the kinship of the Porto Rican shell is with this species, because like it, its relationship is to the West Coast and not to the East Coast group of Pyrulas.

In the unusual prominence of the spire the Porto Rican fossil resembles recent specimens in the American Museum of *Pyrula dussumieri* Valenciennes, living in the China seas. In its sculpture it is almost precisely like a specimen of *Pyrula reticulata* Lamarck from Japan. Its affinities are very clearly with the recent Pacific fauna. The shell is named in honor of Dr. E. O. Hovey.

Localities.—Near Arecibo, Stations 468, 470.

Genus **Tritonium** Link

Subgenus **Colubraria** Schumacher

Colubraria juanica, new species

Plate IX, Figures 2, 3

Shell of medium size, broadly fusiform, somewhat flattened on the oral and aboral faces; suture distinct, whorls very slightly convex; outer lip bordered with a heavy, marginal varix, and within bearing about sixteen short, sharp liræ; body whorl with an obsolete varix on the center of the oral side; aperture elliptical; anterior canal short, strongly recurved; entire surface of shell sculptured with a very fine, even reticulation formed by the intersections of longitudinal and spiral ridges. Length of decollate shell 23 mm., greatest width 9 mm.

Dall mentions *Colubraria lanceolata* Menke from the Pliocene marl of the Caloosahatchie, a species which is also living in the Antilles. But that shell is much slenderer than the Porto Rican fossil.

Locality.—Near Juana Diaz, Station 185.

Genus **Phos** Montfort

Phos costatus Gabb

Phos costatus Gabb, 1873, Trans. Amer. Phil. Soc. XV, pp. 212, 213.
Phos costatus Maury, 1917, Bull. Amer. Paleont., No 29, p. 88, Pl. XIV, figs. 13, 14; *Idem*, No. 30, p. 13.
Phos costatus Jones, 1918, Jour. Geol. XXVI, p. 740.

Among the fossils is an external mold of a *Phos* which shows the robust form, deep suture, and strong, rather distant, rounded longitudinal ribs, characteristic of Gabb's Dominican species, *Phos costatus*. The type, which Gabb never figured, is with the main Gabb collection in the Philadelphia Academy; but the writer in 1916, obtained specimens of the shell from Cercado de Mao, Santo Domingo, and identified them by comparison with metatypes of Gabb's at Cornell University.

The Porto Rican rock imprint does not reveal the aperture as it is more a side view of the shell; but the form, sculpture, and ribbing are so evidently that of this rugged *Phos* that there seems no doubt of its complete identity with the Dominican species.

W. F. Jones reports *Phos costatus* from the Maissade beds on Rio Blanco, north of Maissade, and also in the same formation on Rivière L'Ayaye, Haiti. Until then it had never been identified outside of the Dominican Republic. Its Miocene range is now extended to the neighboring island of Porto Rico.

Like the following species this *Phos* is referable to the section *Strongylocera* Moerch which Dall has suggested might well be revived for these and kindred species.

Locality.—Near Quebradillas, Station 129.

Phos fasciolatus Dall

Phos (Stronglocera) fasciolatus, Dall, 1897, Proc. U. S. Nat. Mus. XIX, No. 1110, p. 311, Pl XXVIII, fig. 12.
Phos fasciolatus Maury, 1917, Bull. Amer. Paleont., No. 29, p. 88, Pl. XIV, figs 15, 16; *Idem*, No 30, pp. 13, 27.
Phos fasciolatus Jones, 1918, Jour Geol. XXVI, p. 741.

The type of *Phos fasciolatus* was collected by Bland at Potrero, on the Rio Amina, Santo Domingo, and described by Dall. The writer obtained this species in abundance at Caimito, Rio Cana, and it was also present at Cercado, Rio Mao, Santo Domingo,—occurring at both localities in the *Aphera islacolonis* formation. At

Cercado it was associated with *Phos costatus,* and it is interesting to note that Jones has since found these two species associated in the Maissade beds, Rivière L'Ayaye, Haiti.

Among the Porto Rican fossils is a single external mold of a *Phos* apparently this species. The impression in the rock is very clear and sharp and represents the dorsal side of the shell. The whorls are convex, suture deep and the imprinted portion of the last whorl shows six even, rounded ribs. The ribs are closer than in *Phos costatus* and the shell is more regular and less rugged and robust. The characters of the aperture of the Porto Rican shell are not shown by the material in hand, but judging from the dorsal aspect of the mold and its artificial cast, it is the same as the Dominican shells I referred to *Phos fasciolatus* Dall.

This species is now reported for the first time beyond the limits of Santo Domingo and Haiti. In Porto Rico also it is found associated with *Phos costatus.*

Locality.—Near Quebradillas, Station 131.

Genus **Alectrion** Montfort

External molds of two species of *Alectrion* from the Quebradillas limestone are perhaps identical with the Dominican Miocene forms, but they are too imperfect for definite determination.

Genus **Murex** Linnæus

Murex messorius Sowerby

Murex messorius Sowerby, 1840, Proc. Zool. Soc., p. 137.
Murex messorius Reeve, 1845, Conch. Icon., *Murex*, fig. 90.
Murex recurvirostris Gabb, 1873, Trans. Amer. Phil. Soc., XV, p. 201. Not *M. recurvirostris* Broderip.
Murex messorius Dall, 1890, Trans. Wagner Inst. Sci., III, pt. 1, p. 139.
Murex messorius Dall and Simpson, 1902, Bull. U. S. Fish Comm., XX, pt. 1, p. 407.
Murex messorius Brown and Pilsbry, 1911, Proc. Acad. Nat. Sci., Phila., p. 353.
Murex messorius Maury, 1917, Bull. Amer. Paleont., No. 29, p. 101, Pl. XVI, figs. 1, 2; *Idem*, No. 30, pp. 13, 21.
Murex messorius Zetek, 1918, Los Moluscos de la Republica de Panama, p. 23.
Murex messorius Vaughan, 1919, Bull. 103 U. S. Nat. Mus., p. 561.

This is a typically static species of wide geographic and geologic range. Abundant in the Antillean Miocene, it is still living on unchanged in the West Indies, and extends from Cedar Keys west to Texas and south to Colón, Panama. Recent shells differ in no respect from the fossil. The latter have been identified in the Gatun beds by Brown and Pilsbry; in the Dominican Miocene by Gabb (as *M. recurvirostris*); the writer has obtained them from Cercado and Los Quemados, Santo Domingo; and Jones has listed the species from the Maissade beds, Rivière L'Ayaye, Haiti. The range is now extended eastward to Porto Rico. The Porto Rican representatives are fragmentary imprints of the exterior of the shell; but the sculpture is so perfectly preserved and accords so exactly in every detail with that of Dominican Miocene specimens that the identification is conclusive.

Murex messorius has been found by Dall and Simpson living at Mayaguez, Porto Rico. Other recent species of this island's fauna are *Murex antillarum* Hinds, *M. rufus* Lamarck, *M. brevifrons* Lamarck, *M. pomum* Gmelin, *M. micromeris* Dall, *M. cellulosus* Conrad, and *M. intermedius* Adams.

Localities.—Near Quebradillas, Stations 130, 134, 135.

Genus **Marginella** Lamarck

Marginella coniformis Sowerby

Marginella coniformis Sowerby, 1850, Quart. Jour. Geol. Soc. London, VI, p. 45.

Marginella conformis Guppy, 1866, Quart. Jour. Geol. Soc. London, XXII, p. 288, Pl. XVII, fig. 2.

Marginella coniformis Gabb, 1873, Trans. Amer. Phil. Soc., XV, p. 221.

Marginella coniformis Guppy, 1876, Quart. Jour. Geol. Soc. London, XXXII, p. 528.

Marginella coniformis Guppy and Dall, 1896, Proc. U. S. Nat. Mus., XIX, No. 1110, p. 309.

Not *Marginella coniformis* Brown and Pilsbry, 1911, Proc. Acad. Nat. Sci. Phila., p. 348, Pl. XXIV, fig. 12.

Marginella coniformis Maury, 1917, Bull. Amer. Paleont., No. 29, p. 70, Pl. XI, figs. 5, 5a.

Marginella coniformis Vaughan, 1919, Bull. 103 U. S. Nat. Mus., p. 561.

Several external molds of a *Marginella* show the characters of the Santo Domingan Miocene species, *M. coniformis* Sowerby. On comparison with specimens of this species they are seen to agree in size, form, number and direction of the columellar plaits, and in the extension of the aperture to the apex of the spire.

This species has been erroneously reported from Cumana, Venezuela. The specimen Guppy listed from there he later found to be

M. cincta Kiener, while that from the Caroni Series of Trinidad is a *Persicula* near *obesa.* Its occurrence at Gatun also appears very doubtful, because the figure Pilsbry and Brown give of a Gatun specimen is very unlike Guppy's illustration of the Bowden shell, and unlike our specimens from the type locality, which was the Yaqui Valley, Santo Domingo. Moreover the figure of the Gatun shell distinctly shows that its aperture does not continue to the spire, whereas Sowerby says of the type of *M. coniformis,* "labii externi margine inflexo, lato, crasso, depresso, *ad apicem continuo.*" Whether Vaughan records this species in his 1919 list from an actual Gatun shell or from the Gatun report of Pilsbry and Brown I do not know. But it would seem that, as far as now known, *Marginella coniformis* was limited to the three neighboring Greater Antilles,—Santo Domingo, Jamaica, and Porto Rico.

Localities.—Señor Rabell's Ranch on Rio Guajataca, Station 112; near Quebradillas, Stations 131 and 134.

Genus **Mitra** Martyn

Mitra henekeni Sowerby

Mitra henekeri Sowerby, 1850, Quart. Jour. Geol. Soc. London, VI, p. 46, Pl. IX, fig. 5.
Mitra henekeni Guppy, 1867, Proc. Sci. Assoc. Trinidad, pt. 3, p. 160.
Mitra henekeni Gabb, 1873, Trans. Amer. Phil. Soc., XV, p. 219.
Mitra henekeni Guppy, 1874, Geol. Mag. London, new ser., decade 2, I. p. 440.
Mitra henekeni Guppy, 1876, Quart. Jour. Geol. Soc. London, XXXII, p. 528.
Mitra henekeri Dall, 1903, Trans. Wagner Inst. Sci., III, pt. 6, p. 1583.
Mitra henekeni Maury, 1917, Bull. Amer. Paleont., No. 29, p. 74, Pl. XII, figs. 5, 5a; *Idem*, No. 30, pp. 10, 19, 22, 26.
Mitra henekeni Jones, 1918, Jour. Geol. XXVI, p. 741.

The collection of Porto Rico fossils made by Dr. Reeds affords several incomplete external molds showing the characteristic sculpture of this handsome shell which is so common in the Miocene of Santo Domingo. One of the molds shows distinctly the three columella plaits, the posterior two being well defined and sharp, the anterior nearly obsolete as described by Sowerby in 1850. The type was collected in Santo Domingo by Colonel Heneken. Later this species was identified by Guppy in the Caroni Series of Trinidad and the Jamaican Miocene. Dall lists it from Bowden, Jamaica; it was obtained by the writer from Los Quemados, Caimito and Cercado de Mao, Santo Domingo; Jones has lately found it in the

Maissade beds, Rivière L'Ayaye, Haiti, and its range is now extended eastward to Porto Rico.

Adult examples of *Mitra henekeni* show a marked general resemblance to the figure of *M. antillensis* Dall of the living fauna, extending from Cape Lookout to the Island of Grenada. The recent shell is, however, much larger, attaining a length of 80 mm. against about 55 mm. in the fossil, and the living species has four strong columellar plications.

The genus *Mitra* is well represented in the recent Porto Rican fauna and includes *Mitra barbadensis* Gmelin, *M. nodulosa* Gmelin, *M. hanleyi gemmata* Sowerby, *M. straminea* Adams, and *M. microzonias* Lamarck.

Localities—Near Quebradillas, Stations 125, 130, 133.

Genus **Lyria** Gray

Lyria cf. **musicina** (Heilprin)

Voluta musicina Heilprin, 1887, Trans. Wagner Inst. Sci., I, p. 109, Pl. XV, fig. 45.

Lyria musicina Dall, 1890, Trans. Wagner Inst. Sci., III, pt. 1, p. 85.

Lyria musicina Dall, 1915, Bull. 90 U. S. Nat. Mus., p. 59, Pl. IX, figs. 1, 4.

A single imperfect internal mold of a Lyria in the collection shows traces of about five broad, longitudinal ribs on half of the last volution and a suggestion of a constricting band below the suture. On breaking away the part of the mold which filled the shell's aperture one sees very distinctly five or six very strong anterior grooves, the first two oblique, and a group of about the same number of faint, posterior grooves. These grooves show where the mud filling the aperture pressed against the folds on the columella of the shell which has since been wholly dissolved away. The evidence gathered from the mold proves that it is not a filling of the very common Dominican Miocene shell, *Lyria pulchella* Sowerby. That has far more numerous and narrow ribs and the anterior plaits are not so heavy and are transverse. Obviously, this is a member of the Eocene *Lyria costata* Sowerby group, which in the American Oligocene to Miocene was followed by the Floridian species, *Lyria musicina* Heilprin. The last whorl of *L. costata* is much more elongated in proportion to its width than that of the Porto Rican mold. It could not be that species, but it corresponds very well with the form of *Lyria musicina*. Very probably the mold is identical with that shell, but an exact identification is not possible.

Lyria musicina is recorded from the Upper Eocene (Jacksonian) of Ocala, Florida. The upper Oligocene of Tampa Bay, and the lower Miocene of the Chipola marls, Florida. With it Dall found *Lyria pulchella* in the Tampa formation. Now it appears that just as the latter Antillean Miocene species had emigrated to Florida, so the Florida species had established an exchange colony in Porto Rico.

Locality.—Near Aguada, Station 117.

Genus **Oliva** Martyn

Oliva cf. **brevispira** Gabb

Oliva brevispira Gabb, 1873, Trans Amer. Phil. Soc., XV, p. 215.
cf. *Oliva giraudi* Cossmann, 1913, Journ. de Conchyliologie, LXI, p. 56, Pl. V, figs. 1, 4-8.
Oliva brevispira Maury, 1917, Bull. Amer. Paleont., No. 29, p 68, Pl. X, figs 16, 17; *Idem*, No. 30, pp. 11, 13, 24, 26.

Several internal molds of a medium-sized, very short-spired Olive, on comparison with shells of *Oliva brevispira* Gabb, are seen to have the same general form that a filling of one of these shells would possess. No positive identification can be made with the material in hand; but the probabilities strongly suggest the identity of the Porto Rican molds with this Santo Domingan species.

Oliva brevispira was obtained in great abundance on the writer's Dominican expedition at Cercado, Los Quemados and Caimito, and was identified by comparisons with Gabb's metatypes at Cornell University. A very similar and seemingly identical form has been described by Cossmann as *Oliva giraudi* from Martinique. Otherwise this very common Dominican shell has not heretofore been found outside of that island.

This contrasts with the wide distribution of the much larger species, *Oliva cylindrica* described in 1850 by Sowerby from Heneken's Dominican collection, and closely allied to the recent *Oliva recticularis* Lamarck. Sowerby's species is found in the Isthmian deposits and those of Cumana, Venezuela, and in the insular Tertiary beds of Trinidad (Caroni series), Barbuda and Jamaica (Bowden). Jones has also lately found it in the Maissade beds, Rivière L'Ayaye, Haiti. It has not yet turned up in the Porto Rican collection, but is to be expected in this fauna.

The recent Olives living on the Porto Rican shores are *Oliva recticularis* Lamarck and *Oliva caribæensis* Dall and Simpson.

Localities.—Near Ponce, Station 285; near Guayanilla, Station 321.

Genus **Olivella** Swainson

Olivella muticoides (Gabb)

Oliva muticoides Gabb, 1873, Trans. Amer. Phil. Soc., XV, p. 215.
Olivella mutica variety *muticoides* Dall, 1890, Trans. Wagner Inst. Sci., III, pt. 1, p. 45.
Olivella muticoides Cossmann, 1913, Journ. de Conchyliologie, LXI, p. 60.
Olivella muticoides Maury, 1917, Bull. Amer. Paleont., No. 29, p. 68, Pl. XI, fig. 1; *Idem*, No. 30, pp. 24, 26.
Olivella muticoides Jones, 1918, Jour. Geol. XXVI, p. 741.

In the collection of Porto Rican fossils are a number of internal and external molds of a species of *Olivella*. Fortunately one of the latter is so oriented in the rock as to show the characters of the aperture. An artificial cast of this mold accords perfectly with shells of *Olivella muticoides* collected on my expedition to Santo Domingo at Los Quemados, Cercado de Mao and Caimito and identified by comparisons with Gabb's metatypes at Cornell University. The Porto Rican imprints show perhaps a slightly more deeply channelled suture, but in his original description Gabb mentions this deep channelling as a characteristic. It is carried to an extreme in the form *O. canaliculata* Gabb which is a broader variety as Gabb's metatypes show. *Olivella muticoides* is closely allied and probably ancestral to the recent *O. mutica* Say, in Mayaguez Harbor, Porto Rico, and elsewhere in the Antilles and ranging along the mainland from Cape Hatteras to Trinidad and from Florida west along the Gulf coast to Texas. But the fossil shell is slenderer than the recent and shows a series of plications on the columella which are not concealed by the callus. A related fossil species is *Olivella duplicata* Conrad. *Olivella boussaci* Cossmann, fossil, from Martinique, has somewhat the general aspect of the Dominican shell but the aperture is lower. Jones has lately identified *Olivella muticoides* in the Maissade beds, Rivière L'Ayaye, Haiti. It is now for the first time recorded outside of the Dominican and Haitian Republics.

Localities.—Near Quebradillas, Stations, 126, 135, 144; near Ponce, Station 299.

Genus **Cancellaria** Lamarck

Cancellaria lævescens Guppy

Cancellaria lævescens Guppy, 1866, Quart. Jour. Geol. Soc. London, XXII, p. 289, Pl. XVII, fig. 12; 1867, Proc. Sci. Assoc. Trinidad, p. 157.
Cancellaria lævescens Gabb, 1873, Trans. Amer. Phil. Soc. XV, p. 239.
Cancellaria lævescens Guppy, 1874, Geol. Mag. London, p. 438; 1876, Quart. Jour. Geol. Soc., XXXII, p. 520.
Cancellaria lævescens Maury, 1917, Bull. Amer. Paleont., No. 29, p. 64, Pl. X, fig. 6.

In the fossil Gastropod exhibit in the American Museum are specimens of *Cancellaria lævescens* Guppy, collected by Thomas Bland from the Bowden beds of Plantain Garden, St. Thomas, Jamaica. One of these is so like the figure of Guppy's type, which was also Jamaican, that it might pass for the original. The others show interesting variations in degrees of loss of sculpture on the body whorl. The shells are large and solid, the largest being 40 mm. x 21 mm. while the type was 45 mm. x 28 mm.

Gabb identified shells which he collected over forty-five years ago in Santo Domingo. My party did not find this species there, but I figured one of Gabb's shells. It was only 25 mm. in height but otherwise bore considerable resemblance to Guppy's shell.

Cancellaria lævescens portoricana, new variety

Plate VII, Figure 10

Mold with finely cancellated spire and body whorl smooth, except for a few spirals at the base. It appears to be a dwarfed variety of *Cancellaria lævescens*. It resembles Gabb's Dominican specimen of *C. lævescens* but is still smaller and is only a third the size of Guppy's type.

Locality.—Near Quebradillas, Station 130.

Cancellaria, species indet.

There are several fragmentary internal molds apparently of the later volutions of several species of *Cancellaria*. The molds show grooves representing in reverse the columella plaits, and the lirations marking the interior of the outer lip of this genus.

Localities.—Near Quebradillas, Stations 126, 128.

Genus **Terebra** Bruguière

Terebra cirrus Dall

Terebra (Acus) bipartita Sowerby variety *cirrus* Dall, 1895, Proc. U. S Nat. Mus., XVIII, p. 38.

Terebra (Oxymeris) bipartita variety *cirrus* Dall, 1903, Trans. Wagner Inst. Sci., III, pt. 6, Pl. LIX, fig. 28.

Terebra cirrus Maury, 1917, Bull. Amer. Paleont., No. 29, p. 25, Pl. III, fig. 17; *Idem*, No. 30, pp. 12, 24, 27.

The type of *Terebra cirrus* was described by Dall from Rio Amina, Santo Domingo, and in 1916 specimens were collected on the writer's expedition to that island at Caimito, Los Quemados and Cercado de Mao,—being in all cases from the *Aphera islacolonis* formation. In ornamentation *Terebra cirrus* resembles the Isthmian species *T. gatunensis* Toula but is easily distinguished from that shell by its biplicate columella which allies it to the Dominican group of *Terebra bipartita* Sowerby. *Terebra gatunensis* has a single, nearly obsolete plait on its pillar.

A fragmentary imprint of a fossil *Terebra* was found by Reeds in Porto Rico. An artificial cast of this shows the ornamentation very perfectly and is an excellent match of Dominican specimens of *Terebra cirrus*. This appears to be the first fossil *Terebra* recorded from Porto Rico. The scarcity of the genus there contrasts with the rich variety in the Miocene of the Yaqui Valley on the neighboring island of Santo Domingo where the writer obtained sixteen distinct specific forms. The recent fauna of Porto Rico comprises half a dozen Terebras of which Simpson has given brief descriptions in Mollusca of Porto Rico.

Locality.—Near Ponce, Station 285.

Terebra sansebastiana, new species

Plate VII, Figure 11

Specimen incomplete. Last whorl shows traces of about 15 longitudinal, nearly straight ribs, wider than their interspaces, surmounted by ribbed band about 2 mm., wide. Main ribs become slightly arched on penultimate whorl. Indistinct traces of spiral sculpture over entire surface. Height of fragment 23 mm., greatest diameter of flattened mold 16 mm., least diameter 6 mm.

This species is founded upon a distorted internal mold from the Collazo shales of what seems to be a *Terebra*, perhaps allied to

T. dislocata Say. The fact that this shell is a member of the odd fauna of the Collazo shales seems to be sufficient excuse for naming such an imperfect specimen a new species.

Locality.—Rio Collazo, near San Sebastian, Station 54.

Genus **Drillia** Gray

Drillia consors (Sowerby)

Pleurotoma consors Sowerby, 1850, Quart. Jour. Geol. Soc. London, VI, p. 50.

Pleurotoma consors Guppy, 1866, Quart. Jour. Geol. Soc. London, XXII, p. 280; 1867, Proc. Sci. Assoc. Trinidad, p. 159.

Turris (Drillia) militaris Gabb, 1873, Trans. Amer. Phil. Soc., XV, p. 207. Not *Drillia militaris* Hinds, 1843, Proc. Zool. Soc., p. 38.

Pleurotoma consors Guppy, 1876, Quart. Jour. Geol. Soc. London, XXXII, p. 527.

Pleurotoma sp. aff. Pl. alesidota (Dall) var. *macilenta* Toula, 1911, Jahrb. der k. k. Geol. Reichsanstalt Wien, LXI, p. 506, Pl. XXX, fig. 11. Not *alesidota* var. *macilenta* Dall, 1889.

Drillia consors Brown and Pilsbry, 1911, Proc. Acad. Nat. Sci. Phila., p 345.

Drillia consors Cossmann, 1913, Journ. de Conchyliologie, LXI, pp. 20-22, Pl. II, figs. 8-14.

Drillia consors Maury, 1917, Bull. Amer. Paleont., No. 29, p. 53, Pl. VIII, figs. 15, 16; *Idem*, No. 30, p. 18.

Drillia consors Jones, 1918, Jour. Geol. XXVI, p. 741.

Drillia consors Vaughan, 1919, Bull. 103 U. S. Nat. Mus., p. 561.

Several blocks of limestone contain fragmentary imprints which unquestionably represent the very beautiful and unmistakable form and sculpture of *Drillia consors.* The type of this fine species was collected seventy years ago by Colonel Heneken in the Yaqui Valley, Santo Domingo, and described by Sowerby; it is now in the British Museum. Guppy identified this species in 1866, in the Bowden beds of Jamaica, and later it has been recorded by various authors from Gatun, Mindi, and Martinique. Gabb referred his Dominican specimens to the recent West Coast species, *Drillia militaris* Hinds, but the resemblance is only a very general one. The fossil is very much more like the recent, deep sea, Barbadian shell, *Drillia alesidota macilenta* Dall, which may be its descendant. Toula first called attention to this interesting affinity. It is not surprising to find that *Drillia consors* was also living in Miocene times on the Porto Rican shores.

Localities.—Señor Rabell's Ranch, Rio Guajataca, Station 112; near Quebradillas, Stations 126, 131.

Drillia diazica, new species

Plate IX, Figure 1

Shell elongate, turreted, very slenderly fusiform, the last whorl extending into a very long, straight, anterior canal; aperture narrow; suture linear, wavy; sub-sutural channel smooth to the eye, but with six to eight extremely fine, microscopic spirals, and with delicate but sharp, microscopic, deeply arcuate growth-lines. Beneath the sub-sutural channel the whorls are sculptured with sharply defined, regular, evenly spaced, rounded, longitudinal ribs, numbering five to half a volution on the ultimate and the same on the penultimate whorl. On each of the later volutions are four major spiral threads which are strongest on crossing the crests of the ribs. Between every two major spirals are three, very fine, minor spirals, visible only with a lens. The longitudinal ribs terminate abruptly where the last whorl narrows to form the canal, but the two sets of spirals continue to the end of the canal although they become less regular and weaker. Estimated length of shell with tip of spire complete 37 mm., greatest width 11 mm.

The affinities of this species are clearly with the two Miocene Dominican forms, *Drillia fusiformis* (Gabb) and *D. cercadonis* Maury, and with the Gatun Miocene form *Drillia fusinus* Brown and Pilsbry. *Drillia fusiformis* (*Defrancia fusiformis* Gabb, Trans. Amer. Phil. Soc., XV, p. 209, 1873) has only about eight ribs, crossed by three major spirals. *Drillia cercadonis* has nine ribs, uniform spirals, and a smooth subsutural channel. The anterior canal of the Porto Rican fossil is also longer than that of these Dominican shells. The Gatun analogue, *Drillia fusinus* has a very long canal, but the ribs are feeble, and appear obsolete on the later whorls.

Locality.—Near Juana Diaz, Station 175.

Genus **Conus** Linnæus

Cone-shells are present from several of the Porto Rican horizons, but all are in the form of internal molds and usually very imperfect. With the exception of two, it would be unwise to hazard even a comparison.

Conus recognitus Guppy

Conus solidus Sowerby, 1850, Quart. Jour. Geol. Soc. London, VI, p. 45. Not *C. solidus* Sowerby, 1841, Proc. Zool. Soc., Conch. Illust., *Conus* No. 76, Pl. LVI, fig. 56.

Consus solidus Guppy, 1866, Quart. Jour. Geol. Soc., XXII, p. 287, Pl. XVI, fig. 1.

Conus recognitus Guppy, 1867, Proc. Sci. Assoc. Trinidad, p. 171.

Conus pyriformis Gabb, 1873, Trans. Amer. Phil. Soc., XV, p. 229. Not *C. pyriformis* Reeve, 1843, Conch. Icon. I, Pl. XIII, fig. 70.
Conus recognitus Guppy, 1876, Quart. Jour. Geol. Soc. London, XXXII, p. 527.
Conus recognitus Dall, 1903, Trans. Wagner Inst. Sci., III, pt. 6, p. 1583.
Conus recognitus Maury, 1917, Bull. Amer. Paleont. No. 29, p. 45, Pl. VII, fig. 9; *Idem*, No. 30, pp. 12, 21, 26, 27.

In the collection is an internal mold of a *Conus* of the same size as Dominican shells of *C. recognitus* Guppy, and showing the very characteristic pear-shaped or fig-shaped contours of that species. In all probability the mold is the filling of *C. recognitus*. My party found this species in the lower, or *Aphera* horizon in the Yaqui Valley, Santo Domingo. It is also at Bowden. The recent West Coast, *Conus pyriformis* Reeve is the descendant of migrants through the Isthmus.

Locality.—Near Aguada, Station 122.

Conus cf. **tortuosostriatus** Toula

Conus (Chelyconus) tortuosostriatus Toula, 1911, Jahrb. der k. k. Geol. Reichsanstalt Wien, LXI, p. 508, Pl. XXXI, fig. 22.
Conus (Hemiconus) tortuosostriatus Cossmann, 1913, Journ. de Conchyliologie, LXI, p. 40, Pl. III, figs. 28, 29.
Conus tortuosostriatus Maury, 1917, Bull. Amer. Paleont., No. 29, p. 41, Pl. VI, fig. 9; *Idem*, No. 30, pp. 22, 24.

Another internal mold from Aguada resembles in form the slender, high-spired, delicate, Isthmian shell, *Conus tortuosostriatus* Toula, and the Dominican forms that I collected and referred to that species. No positive identification is possible, but the Porto Rican mold is very probably of the same shell.

Locality.—Near Aguada, Station 122.

Order Opisthobranchia

Genus **Haminea** Leach

Haminea granosa (Sowerby)

Bulla granosa Sowerby, 1850, Quart. Jour. Geol. Soc. London, VI, p. 51, Pl. X, fig. 10.
Bulla granosa Guppy, 1867, Proc. Sci. Assoc. Trinidad, pt. 3, p. 155.
Bulla granosa Gabb, 1873, Trans. Amer. Phil. Soc. XV, p. 246.
Bulla granosa Guppy, 1874, Geol. Mag. London, p. 437; 1876, Quart. Jour. Geol. Soc. London, XXXII, p. 518.
Bullaria granosa Maury, 1917, Bull. Amer. Paleont., No. 29, p. 20, Pl. III, fig. 10; *Idem*, No. 30, p. 27.

Sowerby, in his description of the type of this species, which Heneken had collected in the Yaqui Valley, Santo Domingo, remarks on its resemblance in form to the recent *Bulla hydatis,* since made the geno-type of *Haminea* Leach.

Recent specimens labelled *Haminea hydatis* in the American Museum, from the Mediterranean are certainly very like in form and size to the fossil species. These recent shells are the *H. hydatis,* of most authors, but really *H. navicula* Da Costa. The true *hydatis* of Linnæus is oblong-oval and smaller while *navicula* is ventricose like the fossil species. But the resemblance there ceases. For the living shells are nearly or perfectly smooth while the most striking feature of the fossil is its strongly cancellated sculpture, which becomes granose at the points of intersection of the subequal spiral and longitudinal ridges.

Internal molds representing this species are common in the collection under examination. A number correspond perfectly in size and form to Sowerby's figured type. These molds retain the cancellation of the original surface and some even show the granular points of intersection. There seems no doubt of their complete identity with the Dominican species. These measure about 18 mm. in length; but there are some larger molds, about 25 mm. in length, which show the cancellated surface and seem to be only larger specimens. Possibly more material will show them worthy of varietal rank.

Many authors have quoted *Haminea granosa* from Santo Domingo, but the only definite locality known is Zone I at Caimito, Rio Cana, where they were collected by the Maury expedition in 1916. The species has not been found heretofore outside of the Dominican Republic, but the present collection shows it was also a common Porto Rican Miocene shell. Recent species of Haminea in Porto Rican waters are *H. elegans* Gray and *H. succinea* Conrad. These are both spirally striated, but have no longitudinal sculpture and are quite unlike the fossil species.

Localities.—Near Aguada, Station 117, near Quebradillas, Stations 126, 128, 129, 130, 131, 133, 135, 136; near Guayanilla, Station 321.

Haminea quebradillica, new species

Plate IX, Figure 5

External mold, ornamentation spiral but not cancellate, spirals sharply incised lines of uniform strength, almost microscopic, about nine lines to

5 mm. These alternate with perfectly flat bands. Occasionally, however, there is a wider band as if one line has been omitted. Altitude of incomplete mold 18 mm., diameter 13 mm.

As far as the dorsal aspect of the mold and its artificial cast permits one to judge, this pretty and delicate species must have been most nearly akin to the recent *Haminea elegans* Gray, living in the Antilles and from Florida to Rio de Janeiro. Dall and Simpson record one specimen taken at Mayaguez Harbor, Porto Rico. In this recent species the entire surface is also ornamented with incised lines, but they are not uniform as in the fossil, and very fine lines are mingled with coarser, unequally spaced grooves. The even, delicate uniform lines distinguish the Miocene from the living shell. The other living Porto Rican species of this genus is the smaller, cylindrical shell, *H. succinea* Conrad.

Of fossil Hamineas a Martinique Miocene species has been described by Cossmann as *Haminea ventripotens* (Journ. de Conchyliologie, LXI, p. 8, Pl. I, figs. 8-11, 1913) which he likens in some respects to *H. elegans.* But the Martinique shell has a perfectly smooth surface so that its resemblance to *H. elegans* and to this fossil is only one of general form. It is distinguished from *H. granosa* Sowerby by its different sculpture and absence of raised cords.

Locality.—Near Quebradillas, Station 125.

Genus **Bullaria** Rafinesque

Bullaria paupercula Sowerby

Bulla paupercula Sowerby, 1850, Quart. Jour. Geol. Soc. London, VI, p. 52.
Bulla paupercula Guppy, 1867, Proc. Sci. Assoc. Trinidad, pt. 3, p. 155.
Bulla paupercula Gabb, 1873, Trans. Amer. Phil. Soc. XV, p. 246.
Bulla paupercula Guppy, 1874, Geol. Mag. London, p. 437; 1876, Quart. Jour. Geol. Soc. London, XXXII, p. 518.
Bulla paupercula Dall, 1890, Trans. Wagner Inst. Sci., III, pt. 1, p. 18.
Bulla striata Dall, 1903, Trans. Wagner Inst. Sci., III, pt. 6, p. 1583.
Bullaria paupercula Maury, 1917, Bull. Amer. Paleont., No. 29, pp. 18-19, Pl. III, fig. 8; *Idem*, No. 30, pp. 12, 24, 26, 27.
Bullaria paupercula Jones, 1918, Jour. Geol. XXVI, p. 741.

From Ponce comes an internal mold of a *Bullaria* slightly larger than shells of *B. paupercula* Sowerby from the Yaqui Valley Miocene, Santo Domingo. In its form and size it is almost exactly like specimens in the American Museum labelled *B. occidentalis* Adams from the Pleistocene of North Creek, Florida; but its spire is much more deeply sunken. In this very deeply involute spire it resembles *B. paupercula* and although a trifle larger, it is really akin to it rather than to the recent Antillean *B. occidentalis.* The Miocene species, *B. paupercula* and *B. vendreyesiana* Guppy, the recent *B. occidentalis* and the Pliocene to recent *B. amygdala* Dillwyn are all members of the group of *B. striata* Bruguière and are often recorded as the latter species.

The true *Bullaria striata* is now restricted to the Mediterranean and Southern Europe, but during the Pliocene it had a much wider geographic range, as it has been found by Dall in deposits of that age in Florida and has also been recorded from synchronous beds in West Africa. This species has a characteristically somewhat hump-backed form due to its tapering at the upper end. *Bulla amygdala* is the recent American analogue of *striata* but the body is more cylindrical. It is living throughout the West Indies. Typical specimens are much larger, heavier and more solid than the Miocene ancestral shell, *B. paupercula.* The latter species is abundant along the bluffs of the upper Rio Cana and in general in the *Aphera islacolonis* formation, Santo Domingo. Dall lists *Bulla striata* from Bowden, Jamaica, which is probably the same as these. Jones has recorded *B. paupercula* from the Maissade beds, Rivière L'Ayaye, Haiti. Its Miocene range is now extended to Porto Rico.

Locality.—Near Ponce, Station 299.

Genus **Scaphander** Montfort

Section **Bucconia** Dall

Bucconia reedsi, new species

Plate IX, Figure 6

Internal mold distinctly and regularly spirally striated. On the dorsal side the striations are crossed by longitudinal ridges, more or less uniform and equidistant, but weaker than the spirals. Mold somewhat flattened in median dorsal region. Length of incomplete mold 34 mm., estimated complete length approximately 40 mm., greatest width 28 mm.

The species which seems most like this fossil is *Scaphander (Bucconia) grandis* Aldrich from the Jacksonian of Bunker Hill, Louisiana, and the Ocala beds of Central Florida. This mold especially resembles Dall's figure[9] of the Ocala shell and is less like Alrich's illustration of the type[10]. *Bucconia grandis* attained a

[9]Trans. Wagner Inst. Sci., 1890, III, pt. 1, Pl. X, fig. 9.
[10]Geol. Survey Ala., 1886, Bull. No. 1, p. 35, Pl. III, fig. 1.

length of 66 mm. against about 40 mm. in the Porto Rican shell. Moreover, both Aldrich's and Dall's figures represent *grandis* with very close-set transverse striæ, about 10 to a distance of 5 mm., while this mold shows only 6 to an equal distance.

The ornamentation of the dorsal side suggests the sculpture of *Haminea granosa* Sowerby, but that is more decidedly cancellated and the shell typically is only one-third the size of the form now described.

The imperfect state of preservation renders it impossible to determine positively the generic position of this shell; but it is tentatively referred to Dall's section *Bucconia*, which he describes as a thin-shelled *Sabatia* without the body-callus. This harmonizes with the globose form, thin shell, and distinct spiral striation which distinguish the Porto Rican species. As far as I am aware, this shell is wholly unique among Antillean fossils. Its unusual size and spiral sculpture at once differentiate it. The species is named in honor of Dr. Chester A. Reeds by whom it was discovered in 1915.

There is a very rare living deep sea species, dredged by the Challenger at 500 fathoms, off the Philippines, and described by Watson as *Scaphander niveus*. This is somewhat smaller and has more distant and weaker spirals than the Porto Rican fossil, but in its *Bullaria*-like form and large size it bears more resemblance to our species than any recent shell I know.

Locality.—Near Ponce, Station 285.

PLATE I

Fig. 1. *Ostrea sansebastiana,* new species; height 66 mm.
Fig. 2. *Arca (Scapharca) aguadica,* new species; length 17 mm.
Fig. 3. *Arca (Scapharca) guajatica,* new species; length 7 mm.
Fig. 4. *Arca (Scapharca) collazica,* new species; length 28 mm.
Fig. 5. *Arca (Scapharca) sansebastiana,* new species; length 18 mm.
Fig. 6. *Ostrea berkeyi,* new species; height 36 mm.
Fig. 7. *Ostrea collazica,* new species; flat valve; height 79 mm.

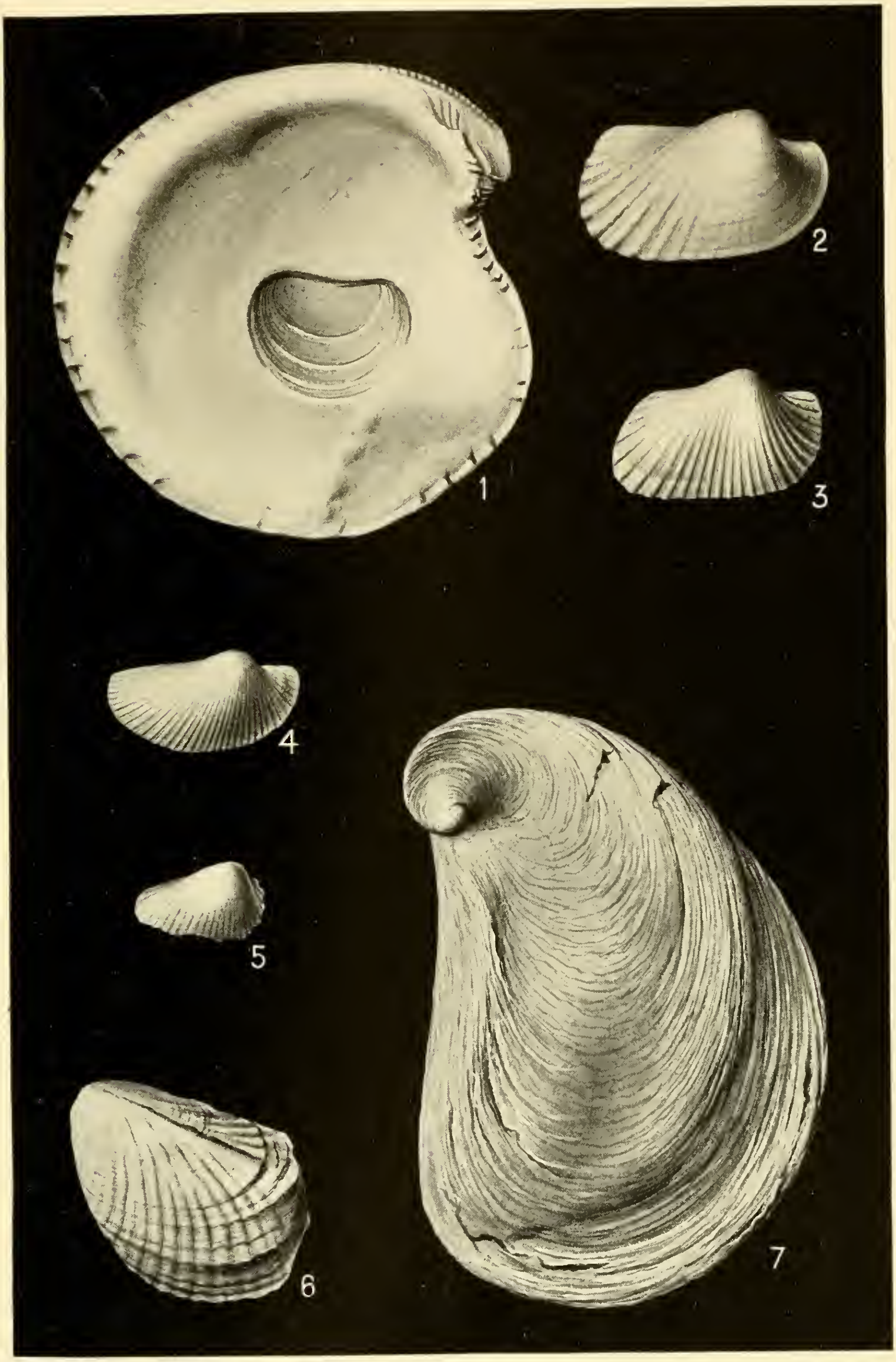
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PLATE II

Fig. 1. *Ostrea collazica,* new species; convex valve of a large individual; width 95 mm.

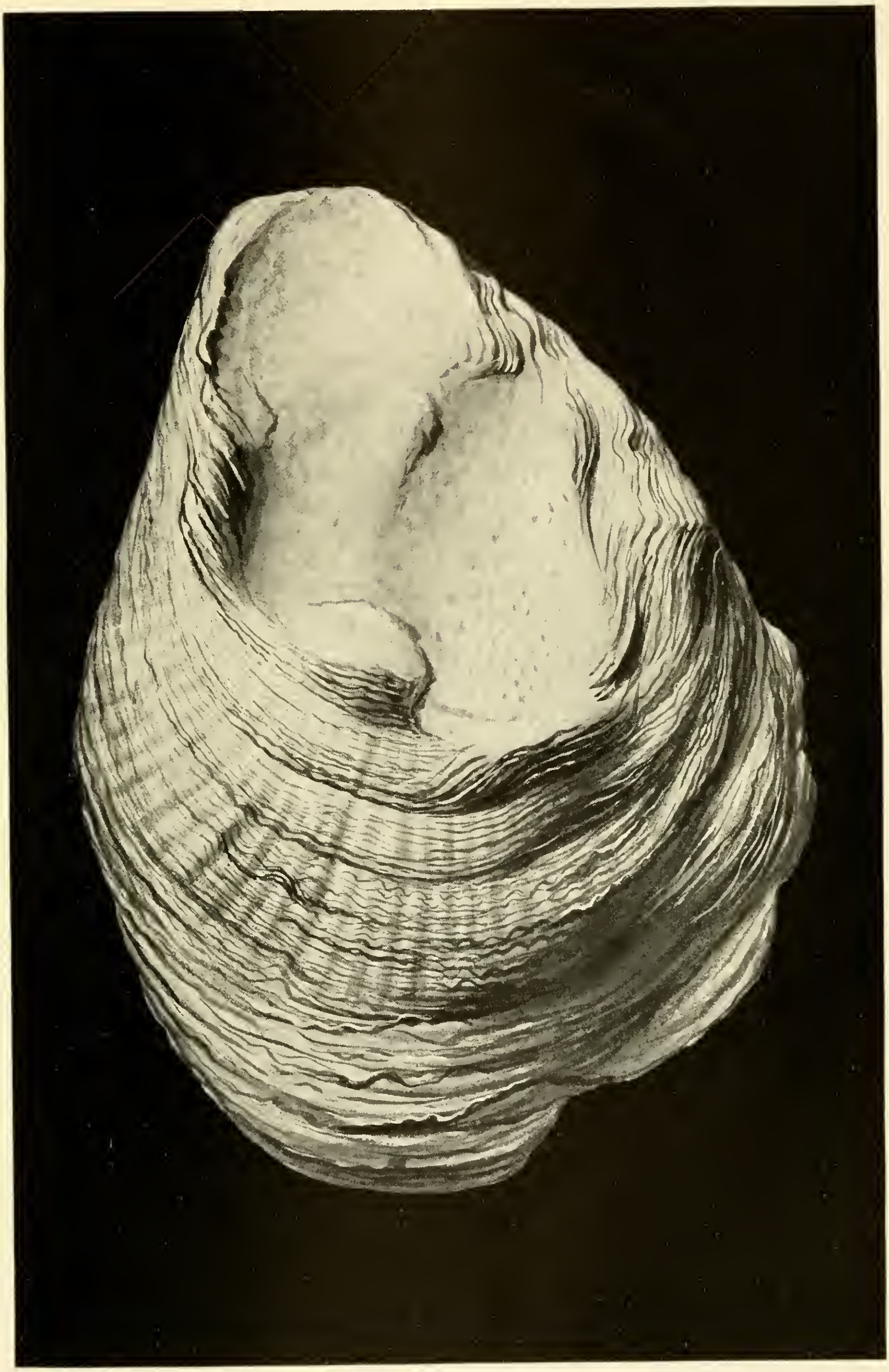

Plate III

Fig. 1. *Pecten sansebastianus,* new species; height of shell 35 mm.

Fig. 2. *Pecten mesenticus,* new species; height of shell 35 mm.

Fig. 3. *Amusium* (*Propeamusium*) *hollicki,* new species; convex valve; height 12 mm.

Fig. 4. *Amusium* (*Propeamusium*) *hollicki;* flat valve of another individual; height 16 mm.

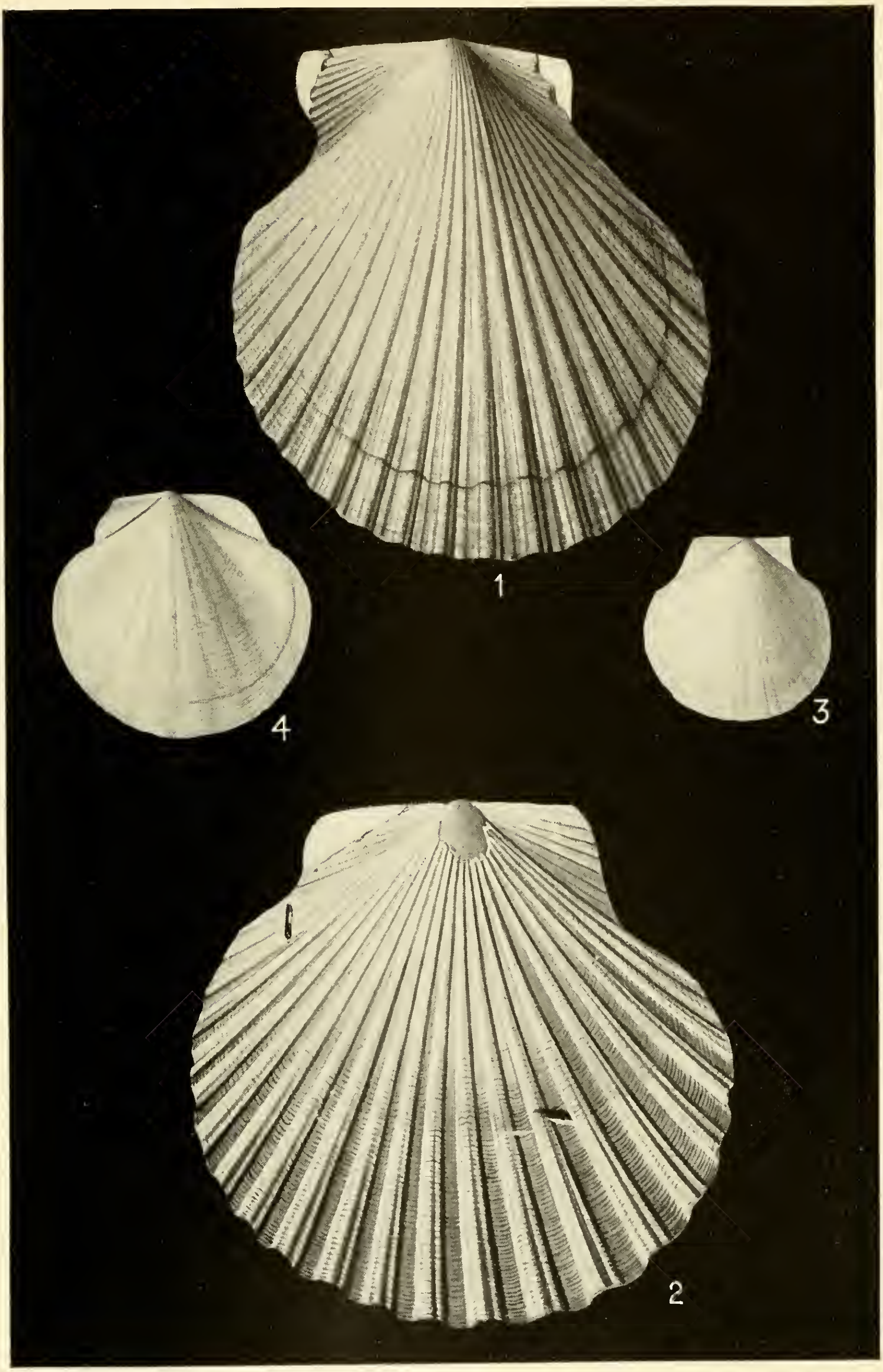
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Plate IV

Fig. 1. *Pecten guajatacus,* new species; operculate valve; approximate length 45 mm.

Fig. 2. *Pecten guajatacus,* new species; convex valve; height 55 mm.

Fig. 3. *Pecten sansebastianus laresianus,* new variety; height 31 mm.

Fig. 4. *Pecten guanicus,* new species; height 24 mm.

Fig. 5. *Pecten camuycensis,* new species; height 25 mm.

Fig. 6. *Crassatellites juanadiazus,* new species; length 28 mm.

Fig. 7. *Crassatellites juanadiazus,* new species; viewed from anterior end; height 16 mm.

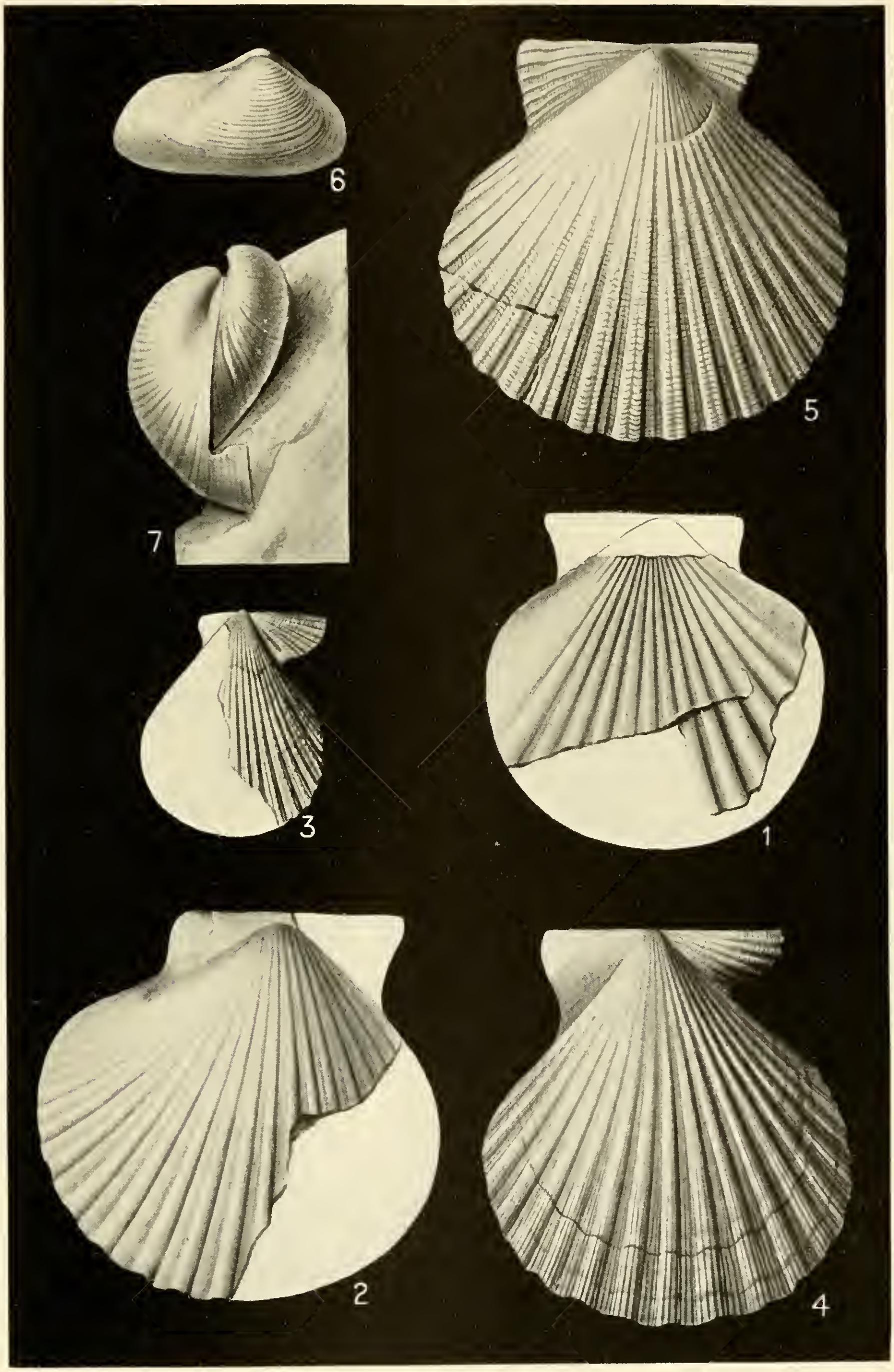
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PLATE V

Fig. 1. *Spondylus lucasi,* new species; height approximately 33 mm.

Fig. 2. *Thracia (Cyathodonta) reedsi,* new species; height 20 mm.

Fig. 3. *Cuspidaria islahispaniolæ* Maury, length 8 mm.

Fig. 4. *Cuspidaria juanadiaza,* new species; length 10 mm.

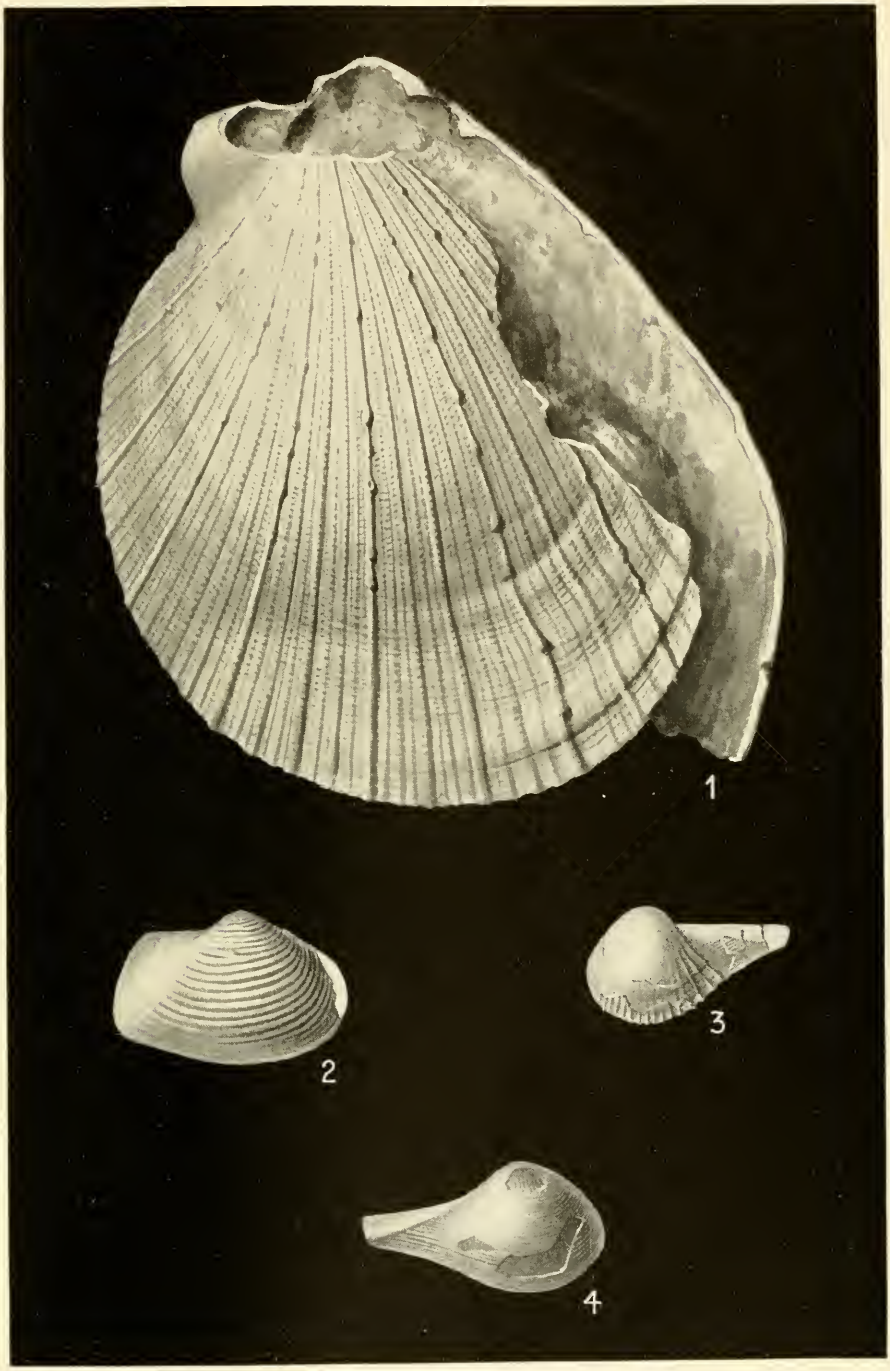
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Plate VI

Fig. 1. *Tellina disparoides,* new species; length 25 mm.

Fig. 2. *Clementia rabelli,* new species; normal form; height 39 mm., length 40 mm.

Fig. 3. *Clementia rabelli,* new species; crushed into triangular form by pressure and made more ventricose; height 43 mm., length 33 mm.

Fig. 4. *Cardium* (*Trigoniocardia*) *sancti-sebastiana,* new species; length 12 mm.

Fig. 5. *Venericardia juncalensis,* new species; height 29 mm.

Fig. 6. *Venericardia collazica,* new species; length 34 mm.

Fig. 7. *Venericardia rabelli,* new species; length 20 mm.

Fig. 8. *Phacoides* (*Here*) *quebradillicus,* new species; height 21 mm.

Fig. 9. *Callocardia riocollazica,* new species; length 28 mm.

Fig. 10. *Corbula collazica,* new species; right valve; length 13 mm.

Fig. 11. *Corbula collazica,* new species; another individual; left valve 12.5 mm.

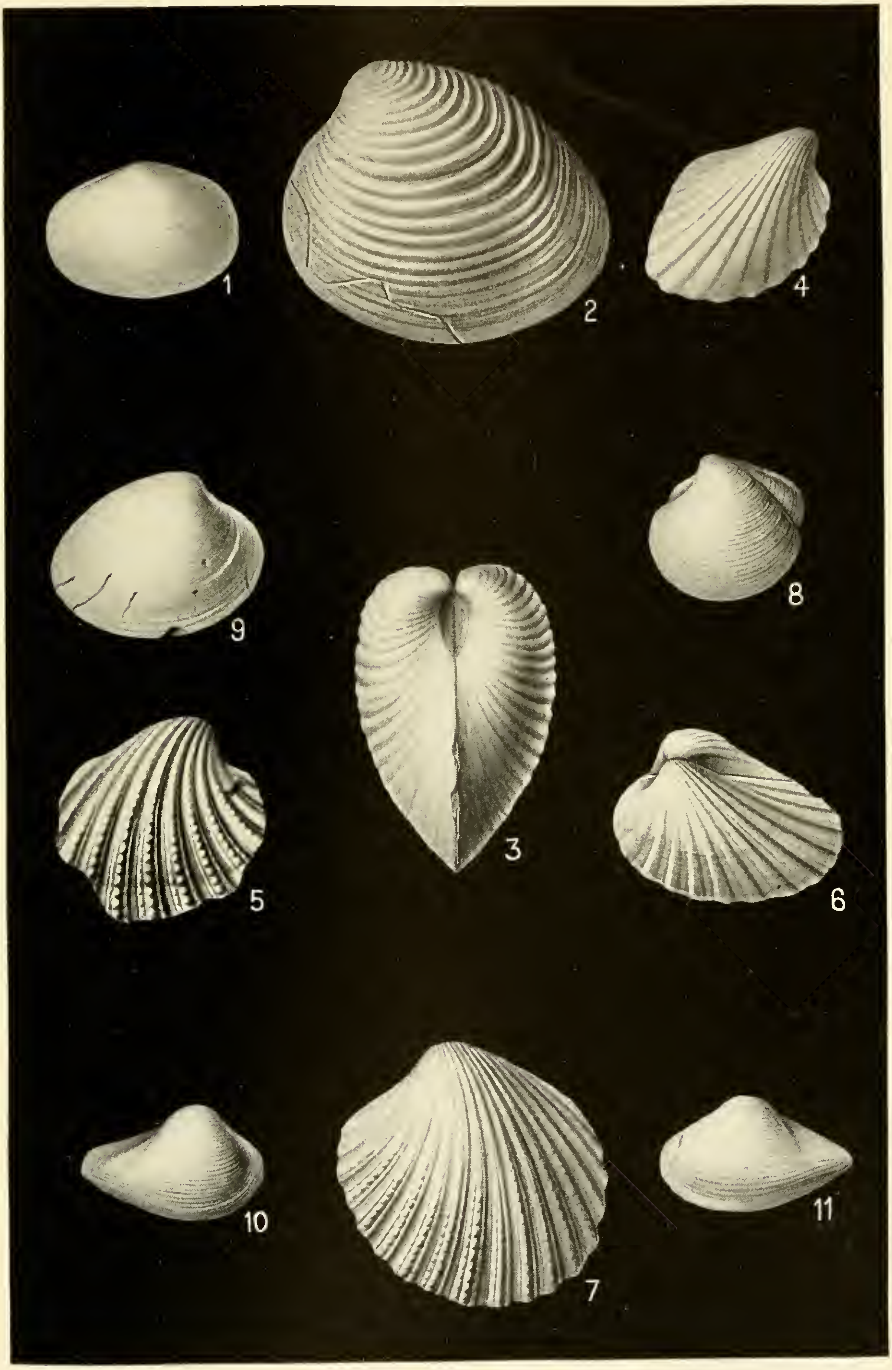
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Plate VII

Fig. 1. *Dentalium diazicum,* new species; length 19 mm.
Fig. 2. *Lucinisca hoveyi,* new species; from artificial cast of external mold; length 11 mm.
Fig. 3. *Tagelus (Mesopleura) hubbardi,* new species; internal mold; length 35 mm.
Fig. 4. *Chione quebradillensis,* new species; from artificial cast of external mold; length 21 mm.
Fig. 5. *Chione quebradillensis guajatica,* new variety; from artificial cast of external mold; length 20 mm.
Fig. 6. *Turritella poncensis,* new species; from artificial cast of external mold; height of fragment 28 mm.
Fig. 7. *Turritella guanicensis,* new species; height of fragment 22 mm.
Fig. 8. *Cerithium utuadicum,* new species; height of fragment 16 mm.
Fig. 9. *Cerithium russelli arecibense,* new variety; from artificial cast of external mold; greatest diameter 11 mm.
Fig. 10. *Cancellaria lævescens portoricana,* new variety; from artificial cast of external mold; greatest diameter 11 mm.
Fig. 11. *Terebra sansebastiana,* new species; height of fragment 22 mm.
Fig. 12. *Cypræa sancti-sebastiani,* new species; height 29 mm.
Fig. 13. *Cadulus poncensis,* new species; length 7 mm.

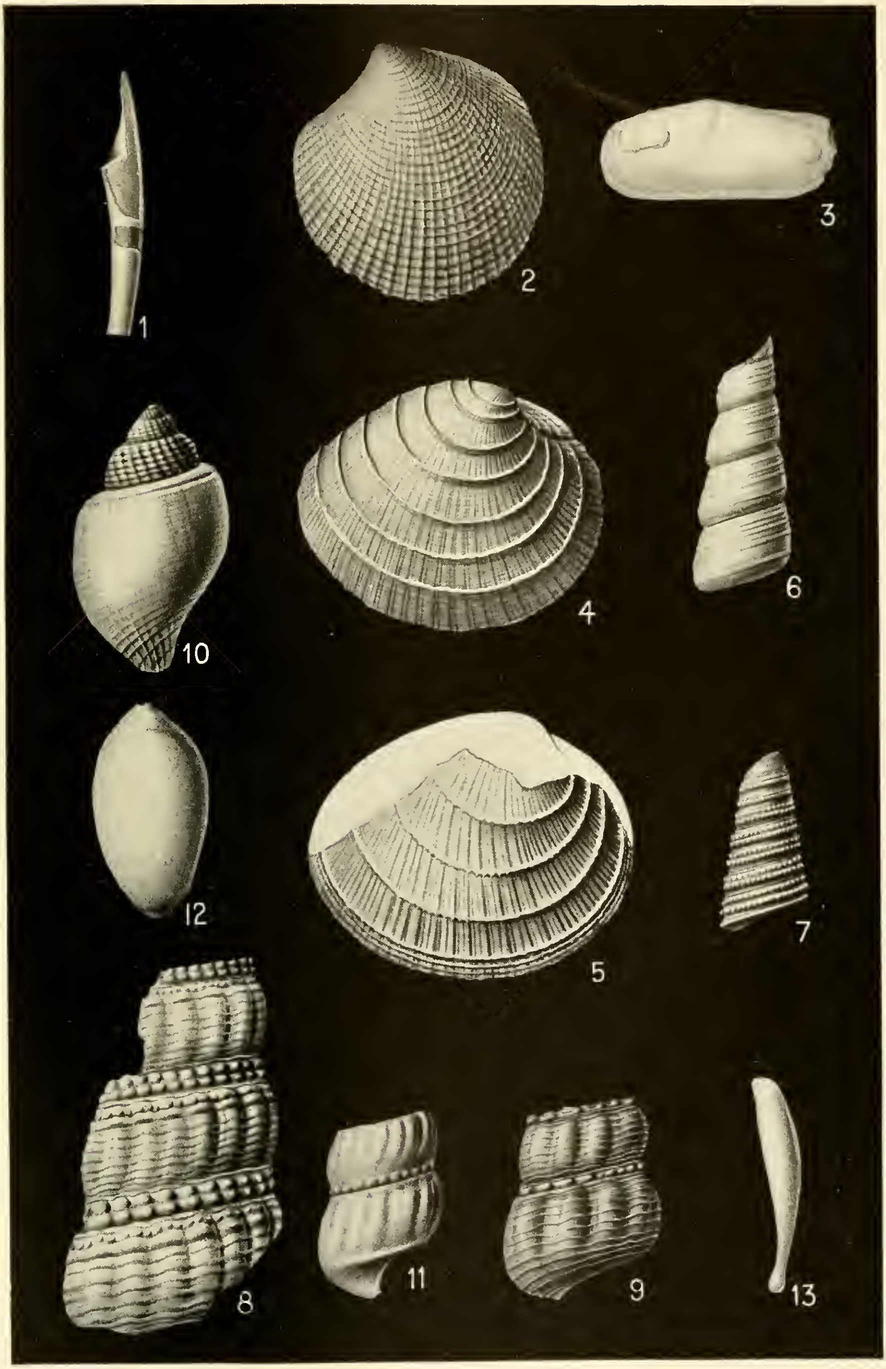
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PLATE VIII

Fig. 1. *Campanile (Portoricia) laricum,* new species; internal mold; height 33 mm., greatest diameter 45 mm.

Fig. 2. *Campanile (Portoricia) laricum,* new species; largest internal mold, somewhat flattened by pressure: height 80 mm.

Fig. 3. *Pyrula hoveyi,* new species; incomplete internal mold of a young shell; height 42 mm.

Fig. 4. *Turritella altilira culebrina,* new variety; drawn from the actual shell with fine details of sculpture restored from its external mold; length of fragment 39 mm.

Fig. 5. *Turritella collazica,* new species; incomplete internal mold; height 65 mm.

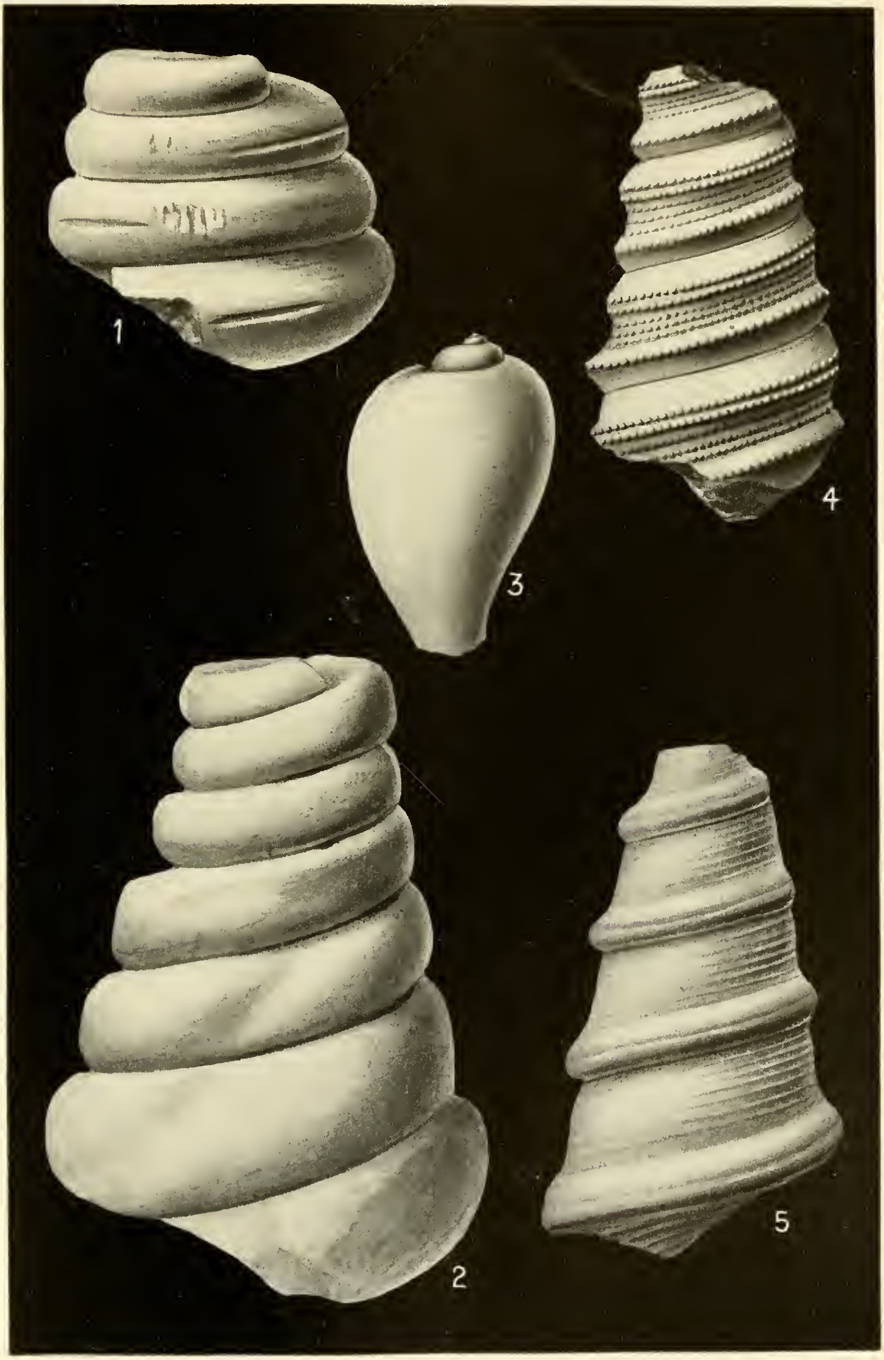
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Plate IX

Fig. 1. *Drillia diazica,* new species; height of decollate shell 33 mm.

Fig. 2. *Colubraria juanica,* new species; aboral aspect of shell; height 23 mm.

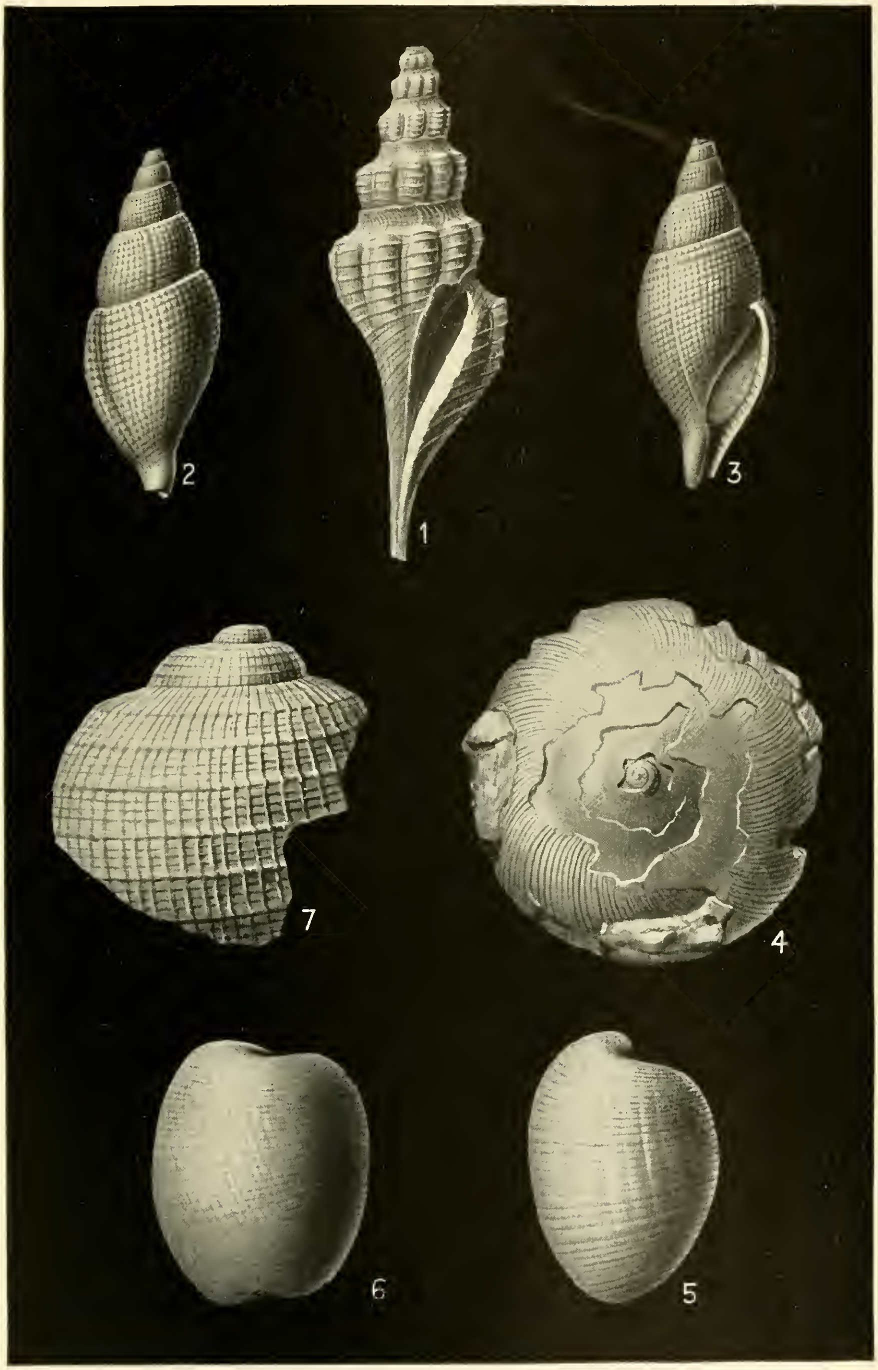
Fig. 3. *Colubraria juanica,* new species; oral aspect of the same shell; height 23 mm.

Fig. 4. *Orthaulax aguadillensis,* new species; view showing the extreme shortness of the spire and the circular outline of the shell at the shoulder. Unique specimen, mineralized; greatest diameter 45 mm.

Fig. 5. *Haminea quebradillica,* new species; from artificial cast of external mold; height 18 mm.

Fig. 6. *Scaphander (Bucconia) reedsi,* new species; incomplete internal mold; greatest diameter 28 mm.; estimated length when complete 40 mm.

Fig. 7. *Pyrula hoveyi,* new species; fragment of spire and of body whorl. From an artificial cost of an external mold; height 23 mm.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SCIENTIFIC SURVEY

OF

Porto Rico and the Virgin Islands

VOLUME III—Part 2

Tertiary Mollusca from the Lares District, Porto Rico—*Bela Hubbard*

NEW YORK:
Published by the Academy
1920

TERTIARY MOLLUSCA FROM THE LARES DISTRICT, PORTO RICO

By Bela Hubbard

INTRODUCTION

The material here described was collected in making a study of the geology of the Lares District in the summer of 1916, under the auspices of the New York Academy of Sciences and the Insular Government of Porto Rico. The present paper is a part of the report on the geology of the Lares District, the completion of which has been delayed two years by the war. As the section dealing with the general geology and stratigraphy has not yet been completed, the present report, dealing with the Tertiary Palaeontology, is published in advance. It will be noted under the descriptions of the species, that full use has been made of the material collected by Dr. C. P. Berkey in 1914, by Dr. D. R. Semmes in 1915, and by Dr. A. K. Lobeck in 1916, and in some cases their specimens have been used for illustration.

No attempt will be made here to describe the stratigraphy, but the following tabulation of the subdivisions* of the Younger Series of the north coast is given in explanation of the horizons referred to under the descriptions of the species.

Younger Series

San Juan formation (Berkey, 1915)		Pleistocene to Recent.
	UNCONFORMITY	
Arecibo Group (Arecibo formation of Berkey, Pepino formation of Hill and Vaughan)	Quebradillas limestone (Berkey, 1915)	Upper Oligocene (Bowden)
	Los Puertos limestone (Hubbard, 1917)	Upper Oligocene
	Cibao Limestone (Hubbard, 1917)	Middle Oligocene
	Lares formation (Hubbard, 1917)	Middle Oligocene
	San Sebastian shale (Berkey, 1915)	Middle Oligocene
	UNCONFORMITY	
	Older Series (Berkey, 1915)	Cretaceous

*These subdivisions were made and described by the writer in a short paper presented before the New York Academy of Sciences, Section of Geology and Mineralogy, in February, 1917.

Acknowledgments

Acknowledgments are made to Señor Narciso Rabell, of San Sebastian for aid in collecting fossils and for the interest which he took in the field work; to C. J. Maury for the opportunity of comparing some of the material with hers; to Miss A. L. Hepburn, Columbia University Library, for valuable assistance in securing the many necessary but scattered palaeontological references; and to Dr. A. W. Grabau for advice and assistance in describing many of the species.

FOSSIL LOCALITIES.

Field Numbers.

1. Lares road, north side, near K. 38 — San Sebastian shale.
7. On the cart road 1.75 miles north-east of Lares. — Lares limestone.
8. About 0.5 mile north of No. 7. — Lares limestone.
10. About 1 mile north-east of No. 8. — Lares limestone.
23. About 5.5 miles north of Lares, and about 2 miles north of Central Soller. — Echinoid zone of Cibao limestone.
24. About 6.5 miles north of Lares, on cart road to Camuy, at southern boundary of the belt of pepino hills. — Base of Los Puertos limestone.
41. On the cart road to Camuy, 0.25 mile south of the village of Cienega, near the Central Alianza. — Quebradillas limestone.
42. On the cart road to Camuy, 0.25 mile north of the Central Alianza. — Quebradillas limestone.

52(a). On the cart road to Collazo 1.75 miles south of Quebradillas, and a short distance north-west of the village of San Antonio. — Quebradillas limestone.

59. Valley of the Guajataca River, 1 mile south of Planas. — Los Puertos limestone.
61. On the upland surface near the valley, and 0.3 mile south of No. 59. — Los Puertos limestone.
62. About 0.6 mile south of No. 61, on the lowland just south of the belt of pepino hills. — Cibao limestone.
64. About 0.3 mile south of No. 62, on cart road to Collazo. — Cibao limestone.
65. On the cart road 2 miles north-east of Collazo. — Lares limestone.
72. Lares road at K. 28.6. — San Sebastian shale.
74. Lares road at K. 29.3. — San Sebastian shale.
75. Lares road at K. 30.4. — San Sebastian shale.
76. Lares road at K. 32.9. — San Sebastian shale.
83. Collazo Falls section, at top of second falls below the bridge. — San Sebastian shale.

84. Collazo Falls section, at base of second falls below the bridge. San Sebastian shale.

86. Collazo Falls section, at top of fourth falls below the bridge. San Sebastian shale.

89. Collazo Falls section, below the sixth falls below the bridge, in the lowest horizon exposed in the section. San Sebastian shale.

92. Lares road at K. 28.8, in ledge 12 feet above the road. San Sebastian shale.

100. Talus at base of the cuesta north of Lares. Lares limestone.

118. On the upland surface 0.25 mile north-west of Lares plaza. San Sebastian shale.

120. About 180 yards north-west of No. 118. San Sebastian shale.

126. Lares road, near K. 37. San Sebastian shale.

140. Base of the cuesta on west side of the Camuy River valley at the fork of the cart road to Utuado and the new road to Arecibo San Sebastian shale.

142. Cuesta at No. 140, in the limestone cliff overlying the basal shale. Lares limestone.

158. On cart road to Camuy, about 500 yards north-west of K. 19.5 of the new Arecibo-lares road. Cibao limestone.

161. About 500 yards north-west of No. 158, on the same cart road. Cibao limestone.

162. About 600 yards north-west of No. 161, on the same cart road. Echinoid zone, Cibao limestone

165. Near the point of emergence of the subterranean Camuy River. Cibao limestone.

167. A short distance north of No. 165, on the west side of the Camuy River. Cibao limestone.

174. About 0.5 mile north of No. 167, west side of the Camuy River on cart road to Camuy. Los Puertos limestone.

176. About 0.75 mile north of No. 174, on the same road. Los Puertos limestone.

179. About 0.4 mile north of No. 176, on the same road. Los Puertos limestone.

182. About 0.6 mile northwest of No. 179, and about 0.5 mile south of the ford where the cart road crosses to the east side of the Camuy River. Los Puertos limestone.

191. On the automobile road between Camuy and Quebradillas, near K. 40.5. Quebradillas limestone.

192. On the same automobile road, near K. 40. Quebradillas limestone.

198. On the automobile road west of Quebradillas, near K. 28.7. Quebradillas limestone.

204. Sea cliffs at the east mouth of the American Railroad tunnel at the mouth of the Guajataca River, north coast. Quebradillas limestone.

205. In the railroad cut 80 yards west of the railroad bridge over the Guajataca River, and 450 yards east from the automobile road grade crossing. Quebradillas limestone.

209. Guajataca River valley, west of the village of San Antonio. Quebradillas limestone.

216. About 1.75 miles south of K. 14.7 (Isabela-Aguadilla automobile road), on cart road near Arenales bajos. Quebradillas limestone.

217. Nearly 0.5 mile south of No. 216. Quebradillas limestone.

220. Near Arenales altos, about 2.5 miles south of No. 217, and 150 yards east of the cart road. Los Puertos limestone.

225. On the cart road near Robles, 25 feet below the summit of the cuesta. Top of the Lares limestone.

226. Zone about 90 feet below No. 225. Lares limestone.

227. A 40 foot exposure of marl on the cart road south of No. 226, and 250 feet below the summit of the cuesta. Lares limestone.

229. About 1 mile north of K. 17.5 (Lares road), on cart road near Hato arriba. Base of Lares limestone.

230. A short distance south of No. 229, and about 50 feet lower in elevation. Top of San Sebastian shale.

231. About 100 yards south of No. 230, at a slightly lower elevation. Coral zone of upper San Sebastian shale.

232. About 200 yards south of No. 231, and 1,350 yards north of K. 17.5 (Lares road), at an approximate elevation of 180 feet above the road. A five foot exposure of marl marking the *Clementia dariena* zone. San Sebastian shale.

232(b). A fifteen foot exposure immediately overlying No. 232, and remarkable for the abundance of *Turritella tornata.* San Sebastian shale.

233. On a small secondary cuesta a short distance south of No. 232. San Sebastian shale.

234. South of No. 233 on the same cuesta. San Sebastian shale.

235. South of No. 234, and 1,050 yards north of K. 17.5 (Lares road) at an elevation of 180 feet above the road. San Sebastian shale.

236. South of No. 235, and 900 yards north of K. 17.5. San Sebastian shale.

237. South of No. 236, and 820 yards north of K. 17.5, at an elevation of 100 feet above the road. San Sebastian shale.

241. On the cart road to Camuy, 1 mile north-east of Lares, in limestone quarry near summit of the cuesta. Lares limestone.

254-5-6. Talus from the cuesta north of Lares. Taken from the road along the Guajataca River, about 0.75 mile north of Lares plaza. Lares limestone.

261. Collazo Falls section, at base of second falls below the bridge, and overlying No. 84. San Sebastian shale.

262. Collazo Falls section, at top of third falls below the bridge. San Sebastian shale.

263. Collazo Falls section, half way between top and bottom of the fourth falls below the bridge. San Sebastian shale.

264. Collazo Falls section, immediately underlying No. 263. San Sebastian shale.

265. Collazo Falls section, at base of the fourth falls below the bridge. San Sebastian shale.

267. Collazo Falls section, near the base of the section, overlying No. 89. San Sebastian shale.

268. Collazo Falls section, in the red sandstone at the sixth falls below the bridge, and overlying No. 267. San Sebastian shale.

280. About 880 yards north of Moca on cart road. Lares formation, shale facies.

281. About 1,100 yards north of Moca on cart road. Lares formation, shale facies.

282. About 1,150 yards north of Moca on cart road. Lares formation, shale facies.

287. About 1.25 miles north on Moca on cart road. Top of the Cibao limestone.

313. Sea cliff 0.75 mile northeast of the Point Borinquen Light House, from a stratum 55 feet above sea level. Quebradillas limestone.

314. The same cliff, in a stratum 10 feet above sea level. Quebradillas limestone.

317. About 1.25 miles north of K. 2 (Aquadilla-Isabela automobile road), on cart road, 350 yards north of the American Railroad grade crossing. Quebradillas limestone.

318. A short distance south of No. 317, in railroad cut, about 200 yards northeast of grade crossing. Quebradillas limestone.

319. In quarry east of cart road, and about 0.6 mile north of K. 2 (Aguadilla-Isabela road). Quebradillas limestone.

324. Small limestone outlier about 300 yards south of K. 1.7 (Lares road). Lares limestone.

330. Southwest of bridge over Culebrines River near K. 2 (Aguadilla-Aguada automobile road). Lares limestone.

331. Aguadilla-Aguada road, south of sugar railroad crossing near K. 2. Lares limestone.

332. Same road, about 300 yards southwest of No. 331. Lares limestone.

333. On automobile road to Rincon, 1,150 yards west of Aguada. Exposure on north side of road. Lares limestone.

334. Same road, 100 yards west of No. 333. Lares limestone.

335. Same road, 290 yards west of No. 334. Lares limestone.

343. Same road, 640 yards northeast of bridge over the Rio Grande. Lares limestone.

344. Same road, south of No. 343, and 460 yards north of bridge over the Rio Grande. Lares limestone.

370. Exposure in sea cliff on south side of the American Railroad track at Point Jiguero, 930 yards northeast of the lighthouse. The San Juan formation may be seen here, plastered on the Tertiary limestone.
Lares limestone.

616. Uppermost stratum in quarry 0.5 mile south-east of Auguada, on south side of road, and northeast of the American Railroad grade crossing.
Lares limestone.

619. Same as No. 616, but from lowest exposure in the quarry.
Lares limestone.

621. Exposure on south side of railroad tracks, about 580 yards south-east of the Aguada railroad station. Lares limestone.

664. East side of Camuy River valley, 2.25 miles southeast of Camuy.
Quebradillas limestone.

670. East side of Camuy River valley, 1 mile southeast of No. 664.
Quebradillas limestone.

671. Same locality as No. 670, but from a stratum a few feet above the latter.
Quebradillas limestone.

678. East side of Camuy River valley, about 1.5 miles due south of No. 671, and about 0.75 mile north of No. 182. Quebradillas limestone.

749(a). On cart road, about 0.5 mile north of bridge at Collazo.
Lares limestone.

757. One mile northeast of Lares, on the cuesta, in quarry near No. 244.
Lares limestone.

758. Same locality as No. 757, but at a slightly higher horizon.
Lares limestone.

800. About 100 yards south-east of No. 24. Top of Cibao limestone.

801. In railroad cut at east end of railroad bridge over the Guajataca River, north coast. This locality is about 50 yards east of No. 205.
Quebradillas limestone.

The following localities are recorded from field notes of Dr. C. P. Berkey.

10. North of the military road in the vicinity of Carolina.
Quebradillas limestone.

77. Military road 1.5 kilometers west of Ponce. Upper Ponce formation.
(Corresponds with the Quebradillas limestone.)

78. Three kilometers west of Ponce. Upper Ponce formation.

95. Near K. 28 Lares road. San Sebastian shale.

96. A short distance west of Lares on the Lares road.
San Sebastian shale.

98. In the railroad cut near the bridge over the Guajataca River, north coast. Quebradillas limestone.

176. Vicinity of Moca. Lares formation, shale facies.

SYSTEMATIC DESCRIPTION OF SPECIES

Genus **Atrina** Gray

Atrina rabelli, new species

Plate X, Figure 1

Margins of shell are arcuate strongly folded upward, particularly the anterior and posterior portions; central convex zone with flat lateral slopes, the cross-section of the valve being broadly V-shaped; surface marked by small, regular concentric ripples which become obsolete on the lateral margins; central convex zone marked by two low radial ribs which die out near the ventral margin. Length 71 mm., semi-diameter 15 mm., height 100 mm.

A single external mold was found showing only the ventral half of the shell. It is a large, rapidly widening form of the type of *A. chipolana* Dall, but is distinct from any form yet described. This shell is named in honor of Señor Rabell, geologist, of San Sebastian, who has taken an active interest in the geological work of the N. Y. Academy of Sciences and rendered every possible assistance to the geologists in their field work.

Locality.—204.

Horizon.—Quebradillas limestone.

Genus **Pecten** Müller

Pecten (Pecten) laresense, new species

Plate X, Figures 2, 3

Shell small of the concavo-convex type; right valve extremely convex, left valve shallow concave; shell equilateral; ears small and strongly ribbed radially; right valve with twenty-seven square smooth ribs and nearly flat interspaces of equal width, marked by fine, sharp, raised concentric threads which rise on the sides of the ribs; left valve with similar ribs and interspaces but with ribs medially grooved distally; ears of left valve with imbricate radial threads; anterior ear of left valve concave and correspondingly convex in the right; byssal notch small, ctenolium apparently lacking; submargins on both valves absent, the ribs extending to the base of ear; interior grooved and lirate ventrally; cardinal crura obscure and irregular; small amorphous pair of auricular crura; provinculum distinct; adductor scars markedly posterior. A right valve measures in length 20 mm., height 17 mm., diameter 8.5 mm.; left valve measures in length 20 mm., height 17 mm., concave diameter 2 mm.

This shell is distinct from any other Pecten in the Porto Rican fauna.

Type localities.—231, 232, 233.

Other localities.—232 (b), 126, 118, 236, 1.

Horizon.—San Sebastian shale. (abundant and widely distributed.)

Pecten (Euvola) reliquus Brown and Pilsbry variety **portoricoensis**, new variety

Plate X, Figure 4

Only right valves were found, which agree closely with the specimens of *P. reliquus* in the Columbia University Gatun collections. The Porto Rican shell differs in having fewer, higher ribs with narrow interspaces, and in having the lateral slopes faintly ribbed instead of smooth as in the Gatun shell. The most perfect right valve has fourteen strong rounded ribs with several faint ones on each lateral slope. Length 35 mm., height 34 mm., diameter 3 mm. Fragments were collected showing a size of at least 50 mm.

The left valves seem to have been easily destroyed, as none were found in the Panama collections.

Type locality.—165.

Other localities.—161, 198.

Range.—Cibao limestone to Quebradillas limestone.

Pecten (Nodipecten) nodosus Linné

Plate X, Figure 5

Pecten nodosus Linnè, Syst. Nat., No. 164, 1758.

Pecten magnificus Gabb, Trans. Amer. Phil. Soc., XV, p. 256, 1873 (not of Sowerby).

Pecten (Nodipecten) nodosus Dall, Trans. Wagner Inst. Sci., III, pt. 4, p. 717, 1898.

Pecten (Nodipecten) nodosus Maury, Bull. Amer. Paleont., V, No. 29, p. 186, 1917.

The specimens show three prominent strongly nodose ribs, one in center of valve and two lateral. These alternate with two lower, subnodose ribs marked by a median and two lateral threads. The subnodose ribs break up into scaly threads adjacent to the submargins. The most perfect specimen measures in length 29 mm., height 28 mm., semi-diameter 7 mm., but fragments were found showing a height of 40 mm.

Type locality.—198.

Other locality.—42.

Horizon.—Quebradillas limestone (not abundant).

Pecten (Chlamys) collazoensis, new species

Plate XI, Figure 1

Shell small, slightly convex; surface with twenty-one to twenty-two rounded ribs and narrower rounded interspaces; ribs ornamented with fine, thin, erect scales extending the whole width of the rib, and on either side at juncture with the interspace, a row of minute, densely crowded, bead-like spinules, which are much smaller and more densely crowded than the scales on tops of the ribs. Submargins and ears sculptured with a continuous series of squamose radial threads; anterior ear (of right valve) longer than the posterior ear, and with deep byssal notch. Length 11.5 mm., height 12.5 mm., semi-diameter 2 mm.

No well preserved left valves were found. This shell is apparently the progenitor of *P. portoricoensis.*

Localities.—Collazo Falls, 232, 233?

Horizon.—Lower? San Sebastian shale. (some doubtful specimens were found in the upper part of the San Sebastian shale.)

Pecten (Chlamys) portoricoensis, new species

Plate XI, Figures 2, 3

The typical form is a moderate sized shell (length 24.5 mm., height 26.5 mm., diameter 9 mm), equivalve, sub-equilateral; ears moderately large, unequal (anterior larger); byssal notch large but not deep; ctenolium inconspicuous; single pair of cardinal crura; valves grooved within, and scalloped and lirate at ventral margin; surface with twenty-six to twenty-seven rounded ribs and slightly narrower, flatly rounded interspaces; ribs ornamented with one to three rows of fine spinose scales which in the young shells show a tendency toward the beaded ornamentation of *P. collazoensis.* This feature usually persists longer next the submargins than centrally. Following this *P. collazoensis* stage, the ribs and interspaces become smoother, the latter relatively broader; a medium thread or keel appears on each rib, and on this keel the small scales become narrower, more spinose and more widely spaced. When the shall is half grown, lateral keels, similarly spinose, appear low down on the sides of the ribs. These correspond in position with the lateral beads of the *P. collazoensis* stage but there is always a gap between the two where the sides of the ribs are smooth. Finally, in the adult, an interstitial thread, ornamented like the keels, appears in each interspace. In the last stage of some adult specimens an additional pair of spinose lateral keels appears one on each side of the median keel. On the lateral slopes next the submargins the ribs break up into densely squamose threads, which, decreasing in size, continue in unbroken series across the submargins and the ears. The right anterior ear differs from the others in having a strongly rugose area adjacent to the submargin, and above this the radial threads are strong and coarsely squamose. *Camptonectes* striation is very plain on unworn specimens.

This is an extremely variable shell, apparently related to *P. thetides* Sowerby. It is the most abundant *Pecten* in the Tertiary of north side of the island and numerous specimens show intergradations between the different varieties, thus fortunately preventing the error of making two or more species. The typical forms are especially interesting in that they show the species to have been derived from *P.* (*Chlamys*) *collazoensis,* which was not found in horizons above the San Sebastian shale. *P. portoricoensis* ranges from the San Sebastian shale through the Lares limestone, and has been found by Dr. Berkey in the Ponce limestone on the south side of the island.

This shell is obviously derived from *P. collazoensis*, and both might conceivably be included under one specific name. The latter, however, retains its typical ornamentation throughout, without the slightest tendency toward a change, whereas in *P. portoricoensis* the *P. collazoensis* stage has become so accelerated that it is unnoticeable in some specimens and absolutely lacking in variety *reticulatis.*

Type localities.—234, 235, 343.

Other localities.—232, 118, 261, 1, 332, 76, and Collazo Falls, 244.

Stratigraphic range.—Throughout the San Sebastian shale, and in the lower Lares limestone also found by Dr. Berkey in the Juana Diaz shale.

Pecten (Chlamys) portoricoensis, new species

variety **reticulatis**

Plate XI, Figure 4

Shell, while smaller than the type, is similar in every respect, except that in the young the ribs are crossed by fine, sharp, densely but evenly spaced concentric lamellae, which thicken slightly on crossing the ribs, the whole producing a reticulate ornamentation. This feature is most noticeable centrally, since adjacent to the submargins are the typical scales, which do not appear until later on the ribs of the central portion of the shell. The reticulate ornamentation persists until the shell has reached one-quarter or one-third adult size, and is then replaced by the typical spinose scale. The lateral spinose keels and the interstitial threads do not appear until the shell has reached maturity. Average size specimen measure in length 16.5 mm., height 18 mm., diameter 6 mm. The largest specimen measures 24 mm. in height.

Type localities.—343, 619.

Other locality.—74.

Range —San Sebastian shale and Lares formation.

Pecten (Chlamys) portoricoensis, new species

variety **grandis**

Plate XI, Figures 5, 6

This shell differs from the type and from variety *reticulatis* chiefly in its much greater size, and, except in gerontic individuals, in its relatively flatter valve. Unfortunately the specimens are all more or less worn in the umbonal region, but the *reticulatis* ornamentation seems to predominate in the young. Some specimens, however, show in the young shell in *P. collazoensis* ornamentation, especially near the submargins. In some individuals the interstitial thread does not appear until the last stages of growth. In others it appears early but is not spinose until the adult stage is reached. In still others the ribs remain unornamented until the adult stage, though this may be due partly to wear. In the largest shells there are five threads on the ribs in the last stages of growth, and two additional threads sometimes appear in the interspaces. The camptonectes striation is obscured by the growth lines, which are especially strong in this variety.

A large flat-valved specimen measures in length 36 mm., height 39 mm., semi-diameter 8.5 mm. In this specimen the ribs are low and broad. A gerontic shell from the San Sebastian shale measures, in length 30 mm., height 32 mm., semi-diameter 8.5 mm. These gerontic shells show a perodic swelling and contraction of the ribs and are notably convex. Superficially, they look like another species, especially when the ribs are worn smooth.

Type localities.—76, and K. 29.2 Lares road.

Other localities.—158, 229, 263, 72, 344, 233, 263 (bottom 3rd falls), 757, 165 ?, Collazo Falls, and vicinity of Collazo (float), 140, 1, 261, 244.

Range.—San Sebastian shale, Lares limestone, Cibao limestone.

Pecten (Chlamys) grabaui, new species

Plate XII, Figure 1

Shell transversely sub-ovate, equivalve, moderately convex with the greatest convexity toward the umbones; length 27 mm., height 26.5 mm., diameter 11.5 mm.; umbonal third of shell smooth, remainder with twenty-three low rounded ribs and slightly narrower shallow rounded interspaces; following the smooth stage appear faint regular widely spaced raised concentric threads, strongest on the ribs, which become more distinct as the ribs increase ventrally. These threads then become irregular, break up into three rows of fine sharp scales on the ribs. The ribs become threaded and grooved distally, the scales giving a squamose character to the threads. There are as many as five of these longitudinal threads on the distal portions of some ribs. Likewise, in the interspaces an interstitial thread appears which is similarly squamose. Thus in the final stage of growth there is a typical *Chlamys* ornamentation. On the lateral slopes the ribs break up into squamose radial threads, which continue across the submargins and ears; ears unequal, the anterior ears being longer and more strongly sculptured; byssal notch deep; ctenolium fine; double pair of cardinal crura; auricular crura low, indistinct; camptonectes striation strong.

In first going over the specimens it seemed as though three or four species were represented, but intermediate forms made it necessary to group them as variations of an exceedingly variable species, similar to *P.* (*Chlamys*) *indecisus* Dall, a form from the Vicksburg Oligocene. Like the latter, this shell shows variations which are intermediate between a true *Chlamys* and an *Amusium*. As the type of the species, that form is chosen which best illustrates the greatest number of characters common to the group.

Type localities.—343, 619.

Horizon.—Lares formation.

Pecten (Chlamys) grabaui, new species variety **aguadensis**

Plate XII, Figure 2

Shell moderately convex in umbonal region, nearly flat ventrally; surface nearly smooth, but with obsolete ribs visible chiefly as orange colored rays in the epidermis; camptonectes striation distinct; concentric lamellae, characteristic of the group, visible only under a lens. They are frequently worn off, leaving microscopic impressed lines in their place; submargins radially striate; ears rather strongly radially sculptured as in the other varieties; interior of shell strongly lirate, the lirae being paired and corresponding with the juncture of rib and interspace on the exterior. The interior is otherwise the same as in the other varieties; ctenolium distinct; length 18.5 mm., height 18.5 mm., semi-diameter 3.5 mm.

This interesting variety is a typical *Chlamys* in shape but has many of the characters of Amusium. It seems to be the primitive member of this group, since the other varieties pass through the smooth *aguadensis* stage more or less early in growth and develop the ribbed stage.

Localities.—619, 333, 331.

Horizon.—Lares formation.

Pecten (Chlamys) grabaui, new species variety **hatoensis**

Plate XII, Figure 3

Ribs appear very early, and become high and rounded; concentric lamellae regular and widely spaced, but becoming irregular near ventral margin where the ribs are radially grooved and interstitial thread appears in each interspace; submargins radially striate; ears strongly sculptured; ctenolium distinct; crura as in the type form; lirae obsolete except distally. Length 21.5 mm., height 21 mm., diameter 8.5 mm.

Some specimens do not reach the high ribbed stage, but ribs are rather low and rounded throughout, with the concentric lamellae crowded ventrally and showing a tendency to alternate in strength. Another specimen from a higher horizon and which may be a mutation from this variety, has high, strong ribs, in which the irregularity of the lamellae, grooving of ribs, and interstitial threads appear much earlier in the growth of the shell, and in the interspaces shows as many as thee interstitial threads in the final adult stage.

Type localities.—332, 225.

Other localities.—343, 229, 333, 287, 167 ?, 62.

Range.—Lares formation to Cibao limestone.

Pecten (Chlamys) grabaui, new species
variety **guayabensis**
Plate XII, Figure 4

Shell marked by smooth submargins. The specimens can be arranged into a series, as in variety *hatoensis*, varying from low to high, strong, rounded ribs, and with concentric lamellae varying from simple and distinctly spaced, to irregular and crowded. As in variety *hatoensis*, the ribs appear early, covering the entire shell except the prodissoconch. Interior of the shell faintly lirate throughout. Shell otherwise like the type form of the group. The largest specimen measures in length 17 mm., height 17.5 mm., semi-diameter 4.5 mm.

Type localities.—62, 332.

Other locality.—282.

Range.—Lares formation to Cibao limestone.

The probable relationship of the group is shown in the following table.

Table 1

Pecten (*Chlamys*) *grabaui*, new species		
Horizon	Group with smooth submargins	Group with striate submargins
Cibao limestone	variety *guayabensis* (shell ribbed)	variety *hatoensis* (shell ribbed)
Lares formation	variety *aguadensis* (shell smooth)	*P. grabaui* (type form) (partially ribbed)
San Sebastian shale	?	

Pecten (Chlamys) hodgii, new species

Plate XII, Figure 5

Shell sub-ovate, sub-equilateral, strongly convex in umbonal region, slightly convex in ventral region; ears sub-equal, deep byssal notch and strong ctenolium; surface with twenty rounded ribs and deep, rounded, narrower interspaces; both ribs and interspaces grooved with fine radial threads which are densely spinose; ears and the rather broad submargins marked by sub-spinose radial threads; inner margin strongly scalloped and interior grooved.

In the early stages of growth the ribs are not radically threaded, and the ornamentation consists of closely spaced, minute, sharp transverse scales on the ribs which join with raised concentric lamellae in the interspaces. When the shell has reached one third full size, the radial threads appear and the scales break up into minute densely spaced spines, which, ventrally, become elevated, curved, and U-shaped with concave side toward the beaks. Throughout most of the early stages the interspaces are devoid of threads and spinules, which appear much later than they do on the ribs. The concentric lamellae become obsolete ventrally.

This shell is apparently closely related to an unlabelled specimen in the Kemp collection from Gatun, which seems to be a new species. In the latter the transverse scale stage is retained longer, the concentric lamellae are noticeable throughout, and the spinules are not long or conspicuous as in the Porto Rican shell. If they are related, the Gatun shell would seem to be the more primitive of the two. It may be related to *P. oxygonum canalis* and *P. oxygonum optimum* of Brown and Pilsbry and to *P. gabbi* Dall. Dr. Maury has described a similar and apparently related shell *P. camuycencis* from the Quebradillas limestone. One complete right valve and some fragments were found. This shell is named in honor of Dr. Edwin T. Hodge, who studied the geology of the Coamo District, Porto Rico.

Locality.—314.

Horizon.—Quebradillas limestone (rare).

Pecten (Aequipecten) lobecki, new species

Plate XIII, Figure 1

Shell sub-orbicular, equilateral, moderately convex, ears large, smooth, apparently sub-equal (portion of anterior ear concealed); shell sculptured with fourteen strong rounded ribs and sub-equal rounded interspaces; concentric sculpture of fine raised lamellae, strong in the interspaces, obsolete on tops of the ribs; fine concentric striae in the interspaces between the lamellae, and from one to three radial threads in each interspace, which with the concentric lines produce a cancellate structure. The ribs are nearly smooth apparently because of wear, but occasionally show faint radial threads distally; submargins narrow, smooth, not depressed. Length 25 mm., height 24 mm., semi-diameter 4 mm.

A single left valve was found which resembled in some respects *P. cercadica* Maury.

Locality.—619.

Horizon.—Lares limestone.

Pecten (Plagioctenium) rabelli, new species

Plate XII, Figure 6

Shell suborbicular, slightly oblique in adult, sub-equivalve (right valve slightly more convex); ears small, subequal; shell with thirteen to fourteen strong, smooth, rounded ribs, with slightly narrower, smooth rounded interspaces; right anterior ear with faint radial theads, other ears smooth; submargins narrow, smooth, depressed, ctenolium distinct. The surface of the valves presents no very marked feature to the unaided eye, but under a strong lens, very minute, closely, evenly spaced and remarkably regular concentric lines are visible, crossing the entire shell, including the ears. In the largest specimens a gerontic character appears in the periodic swelling and contracting of the ribs. These gerontic shells are more convex than the others. Length 36 mm., height 34 mm., semi-diameter 8 mm. A smaller specimen has a semi-diameter of 5 mm.

Localities.—K. 29.2-29.3 Lares road, K. 25 Ponce-Adjuntas road, Juana Diaz, Yauco.

Horizon.—San Sebastian shale, Juana Diaz shale.

Pecten (Plagioctenium) cercadica Maury

Plate XIII, Figures 2, 3

Pecten cercadica Maury, Bull. Amer. Paleont., V, No. 29, p. 188, Pl. 34, fig. 11, 1917.

Shell bilaterally symmetrical, sub-equivalve (right valve of slightly greater convexity); submargins broad, smooth except for faint growth lines; ears large, sub-equal, nearly smooth, triangular in outline except the right anterior, which is marked by deep byssal notch and byssal sulcus below, and surface of ear with five imbricated radial threads; ctenolium absent or obscure; other ears marked by very faint radial threads or striation, strongest near base of ear; surfaces of valves similar and marked by fourteen to seventeen strong rounded ribs and slightly narrower interspaces, the whole crossed by fine close growth lines, periodically incised so as to give the effect of obscure beading of the ribs, a feature not evident on worn specimens; valves grooved within, but lirate only near ventral margins; single pair of strong cardinal crura. Average size;—length 21 mm., height 21 mm., semi-diameter 3.5 mm.; largest specimen;—length 26 mm., height 27 mm., semi-diameter 4.5 mm.

This shell resembles *P.* (*Plagioctenium*) *andersoni* Arnold of the Pacific Coast Miocene, but is smaller. The latter species differs in having the left valve more convex than the right. The shell here described appears to correspond to Maury's description which was based on a left valve only.

Type localities.—619, 333, 324.

Other localities.—331, 227 (top 30 feet).

Horizon.—Lares limestone.

Pecten (Plagioctenium) borinquenense, new species

Plate XIV, Figures 1, 2

Shell sub-orbicular, sub-equivalve, slightly oblique, sub-marginal slopes slightly concave (left valve slightly less); sculpture of the two valves dissimilar. Right valve with sixteen to nineteen strong flat ribs of T-rail cross-section, wider than interspaces, especially in the unworn specimens where the lateral overhang obscures the borders of the interspaces; interspaces rounded and sculptured with raised concentric threads, very regular and evenly spaced (one-fifth mm. apart in ventral part of shell); tops of ribs marked by obscure median keel; concentric threads cross the ribs and are bowed up in the form of lamellae on crossing the median keel. The ribs are usually worn smooth showing the lamellae on top as a series of V-shaped striations; ears sub-equal, small; hinge line less than half the length of shell, sub-margins nearly smooth; ctenolium obscure and marked by deep byssal groove bordering the line of teeth; byssal notch small; adductor scar large, central; left valve with seventeen to twenty-one strong, high, rounded ribs and sub-equal rounded interspaces; both ribs and interspaces crossed by fine raised concentric threads, somewhat irregular and more distantly spaced than in the right valve, and worn or obscure on crossing the ribs; ears sub-equal and sculptured by radial grooves and incremental lines; sub-margins as in the right valve. Interior of both valves smooth or faintly fluted, but strongly fluted and lirate around the ventral margins; greatest convexity in the umbonal region. The ribs of both valves are rounded in the nepionic stage. Adult shell measures in length 32 mm., height 31 mm., diameter of right valve 10 mm.

This shell has ribs similar to *P. diegensis* Dall of the Pacific Coast Pleistocene, but is otherwise a different shell. Maury's *P. caimitica,* a single left valve from the Santo Domingo Miocene is similar to the left valve of this shell.

Locality.—313.

Horizon.—Upper Quebradillas limestone.

Genus **Amusium** Bolten

Amusium papyraceum Gabb

Pleuronectia papyracea Gabb, Trans. Amer. Phil. Soc., V, p. 257, 1873.

Amusium papyraceum Dall, Trans. Wagner Inst. Sci., III, pt. 4, p. 718, 1898; *Idem*, pt. 6, p. 1586, 1903.

Amusium papyraceum Maury, Bull. Amer. Paleont., V, No. 29, p. 190, Pl. 26, fig. 22, 1917.

Found only in fragments, indicating a size of 35 by 36 mm.

Localities.—118, (talus), 261.

Horizon.—San Sebastian shale.

Amusium mauryi, new species

Plate XIV, Figure 3

Shell small, thick, moderately convex, entirely smooth except for very fine growth lines; ears sub-equal, large, sub-triangular; juncture of ears with shell slightly depressed, but not otherwise marked off. The interior of the valve is inaccessible, but there seem to be no internal ribs or else very obscure ones. They do not show on the exterior, and there are no radial rays or striations of any sort. The shell is unusually solid. It is probably related to *A. luna* Brown and Pilsbry, and to *A. mortoni* Ravenel, but differs from these in its small size and relatively much larger ears. Length 19 mm., height 19.5 mm., semi-diameter 3 mm.

A single left valve, which was at first included with the specimens of *A. papyraceum.* Dr. Maury, in looking over the specimens, pointed out the mistake.

Locality.—Collazo Falls.

Horizon.—San Sebastian shale.

Amusium (Propeamusium) hollicki Maury

Locality.—75.

Horizon.—San Sebastian shale.

Genus **Spondylus** Linné

Spondylus bostrychites? Guppy

Spondylus bifrons Sowerby, Quart. Jour. Geol. Soc., VI, p. 53, 1849; not of Goldfuss, Petref., II, p. 99, pl. 106, figs. 10a-c, 1835.

Spondylus bostrychites Guppy, Proc. Sci. Assoc. Trinidad, p. 176, 1867.

Spondylus bostrychites Gabb, Trans. Amer. Phil. Soc., XV, p. 257, 1873.

Spondylus bostrychites Dall, Trans. Wagner Inst. Sci., III, pt. 4, p. 758, 1898; pt. 6, p. 1586, 1903.

Spondylus bostrychites Maury, Bull. Amer. Paleont., V, No. 29, p. 190, pl. 32, fig. 4, 1917.

A small internal mold of a *Spondylus,* which, because of its small hinge area and sub-equal valves, is identified doubtfully with the above species. Length 22 mm., height 26 mm., diameter 15 mm.

Localities.—162, 23?, 126.

Range.—San Sebastian shale to Cibao limestone.

Spondylus gumanomocon Brown and Pilsbry

Spondylus americanus Gabb, Trans. Amer. Phil. Soc., V, p. 257, 1873; not of Lamarck.

Spondylus gumanomocon Brown & Pilsbry, Proc. Acad. Nat. Sci. Phila., p. 514, 1912 (footnote).

Spondylus gumanomocon Maury, Bull. Amer. Paleont., V, No. 29, p. 191, 1917.

An internal mold and a fragment of the external mold were found of a shell which is like *S. gumanomocon* but somewhat smaller. It may be a small variety or the young shell. Lower valve strongly convex, beak long, erect; surface with strong ribs 5 mm. apart, apparently spinose, and alternating with three or four small obscure ribs. The ribs are slightly wavy; upper valve orbicular, slightly convex; ribs known only from the internal mold but seem to be like those of the upper valve except that they are finer; hinge line about 24 mm. in length. The internal mold shows the beak of the lower valve to be considerably excavated. Length 55 mm., height of lower valve 66 mm., of upper valve 54 mm., diameter 29 mm.

From the proportions of the internal mold it will be seen that this shell is less elongate than *S. gumanomocon* as described from Santo Domingo. The upper valve is much flatter than the Gatun species, *S. scotti* Brown & Pilsbry, but the shell is about the same size as the latter and is similarly sculptured.

Localities.—140, 162.

Range.—San Sebastian shale to Cibao limestone.

Genus **Ostrea** (L) Lamarck

Ostrea antiguensis Brown

Plate XV, Figure 1

Ostrea antiguensis Brown, Proc. Acad. Nat. Sci. Phil., p. 614, Pl. 19, fig. 7; Pl. 20, figs. 1, 5, 6, 1913.

These shells were at first regarded as a variety of *O. haitensis*, but on comparison, were found to be the same as Dr. Maury's Porto Rican specimens, identified by Dr. Pilsbry as *O. antiguensis*, accordingly that determination is accepted, although it is difficult to believe that the reflexed character of the upper valve is a specific character.

All of the specimens here described were taken from a zone of yellow chalk in the upper Quebradillas exposed in sea cliffs near Pt. Borinquen. The abundance of these large oysters is remarkable. They reach an enormous size and thickness, but the largest specimen collected measures in length 140 mm., height 130 mm., diameter (the two valves together) 110 mm. These forms are obviously gerontite individuals. The lower valves are strongly curved upward ventrally toward the center, but are reflexed (or curved down) on the lateral margins. Likewise, the upper valves are curved down on the lateral margins, and strongly reflexed at the ventral margin, which results in a strong interlocking of the two valves. The upper valves are almost as thick as the lower ones. The upper valves reach their maximum thickness between the center and the ventral margin, and in both valves the animal has excavated its body cavity directly below the beaks by resorption of the prismatic layers at this point with increased deposition farther on toward the ventral margin. Thus as seen in a longitudinal section of the shell these layers resemble the stratification in a migrating sand dune. The excavated body cavity occupies but a small portion of the interior of the shell.

Other specimens were found which, although almost as large as those above described, are apparently not gerontic individuals. The reflexed character of the upper valve is slightly or altogether absent, and the shell does not attain a great thickness. The spinose ribs (about 9 in number) and rounded furrows are well shown on these specimens, whereas they are obsolete or extremely irregular on the gerontic forms. The adductor scar is high and nearly central in the thin shells, but well toward the anterior margin in the gerontic shells. It is deeply impressed in the latter. The resilifer is remarkably small for shells of this size.

Localities.—314; San Juan District (Semmes).

Horizon.—Upper Quebradillas limestone. Also reported from the "Guanica shaly limestone" by Dr. Maury.

Ostrea haitensis Sowerby

O. haitensis Sowerby, Quart. Jour. Geol. Soc. London, VI, p. 53, 1850.
O. haytensis Gabb, Trans. Amer. Phil. Soc., XV, p. 257, 1873.
O. veatchii Gabb, Pal. Cal., II, p. 34, Pl. 11, fig. 59; Pl. 17, fig. 21, 1869.
O. hermanni Conrad, Proc. Acad. Nat. Sci. Phila., V, p. 267, 1853.
O. vespertina Conrad, Pac. R. R. Rept., V, p. 325, Pl. 5, figs. 36-38, 1855; Gabb, Pal. Cal., II, p. 107, 1869.
O. virginica Guppy, Quart. Jour. Geol. Soc., XXII, p. 577, 1866. Not of Gmelin.
O. virginica var. *californica* Marcou, Geol. No. Am., 1858.
O. haitensis Guppy, Quart. Jour. Geol. Soc. London, XXXII, p. 532, 1876.
O. haitensis Dall, Trans. Wagner Inst. Sci., III, pt. 4, p. 685, 1898. *Idem*, pt. 6, p. 1586, 1903.
O. haitensis Maury, Bull. Amer. Paleont., V, No. 29, p. 182, Pl. 31, figs. 1, 2, 1917.

The shells are rather thin, orbicular in outline, and strongly plicate with seven or eight sharply angular ribs, very high centrally at the ventral margin, and sharply angular furrows between. The ribs are not noticeably spinose; resilifer shelf-like, due to excavated beak; adductor situated in central-posterior portion of vale. The shells do not attain a large size, the largest specimen measuring in length 72 mm., height 74 mm., diameter of lower valve about 30 mm.

Localities.—225, 800.

Range.—Lares limestone, Cibao limestone.

Ostrea haitensis Sowerby, variety?

Plate XV, Figures 2, 3

Some small shells were found in which the lower valves are sculptured like *O. haitensis,* with spinose ribs, frequently angular, while the upper valves are nearly smooth. The lateral inner margins adjacent to the beaks are finely crenulate, a feature not shown in the specimens of *O. haitensis.* Largest specimen measures in length 36 mm., height 43 mm., diameter lower valve 7 mm. A smaller more orbicular lower valve measures in length 22 mm., height 25 mm., diameter 6.5 mm. These little shells may be the young of *O. haitensis,* or a variety.

Locality.—62.

Horizon.—Cibao limestone.

Ostrea virginica Gmelin

O. virgiana of Lister and others.
O. virginica Gmelin, Syst. Nat., p. 3336, 1792; Dilwyn, Descr. Cat., 1, p. 277, 1817; Lam., Anim. s. Vert., VI, p. 207, 1819.
O. edulis Akerly, Am. Monthly Mag., II, p. 296, 1818 (not Linné).
O. virginiana Sowerby, Genera, *Ostrea*, f. 2, 1822.
O. borealis Lamarck, Anim. s. Vert., VI, p. 204, 1819.
O. canandenis Lamarck, *op. cit.*, p. 207, 1819.
O. triangularis Holmes, Proc. Elliot Soc., I, p. 29, 1856.
O. fundata Holmes, Post-Pl. Foss. S. Car., p. 11, Pl. 2, fig. 10, 1858.
O. semicylindrica Say, Jour. Acad. Nat. Sci. Phila. (1), II, p. 258, 1822.
O. virginica Gabb, Trans. Amer. Phil. Soc., XV, p. 257, 1873.
O. virginica Guppy, Quart. Jour. Geol. Soc. London, XXXII, p. 532, 1876.
O. virginica Dall, Trans. Wagner Inst. Sci., III, pt. 4, p. 687, 1898.
O. virginica Maury, Bull. Amer. Paleont., V, No. 29, p. 184, 1917.

The specimens show the usual great variation, but comparison with recent specimens of *O. virginica* shows no constant differences. The Porto Rican shells vary from elongate, subtriangular to ovate: beak of lower valve usually pointed, straight or slightly curved laterally; resilifer elongate in the large shells; lower valves are frequently of extreme convexity, while the upper valves are gently convex or flat, but very irregular; beak of lower valve excavated. An average seized lower valve measures in length 50 mm., height 90 mm., diameter 33 mm. Some are much broader, and a few specimens reach a much greater size and greater thickness. Color usually bluish, mottled with white.

Type locality.—282.

Other localities.—281, 65, 227 (top 30 ft.), 7 to 8 (on road-flat).

Horizon.—Upper lares limestone (very characteristic).

Ostrea sellæformis Conrad

variety **portoricoensis,** new variety

Plate XIII, Figures 4, 5, 6

Shell of moderate size, pear-shaped to elongate oval, never attaining very great thickness; valves dissimilar; lower valve with numerous radial ribs imbricated by raised laminae; resilifer deep; margins of ligament area marked by narrow groove which continues for some distance along the inner margins adjacent to the beak, and is denticulate (or marked by row of small pits) throughout; remainder of inner margin fluted by the ribs, or, in some specimens, smooth; adductor scar large, oval, nearly central; beak more or less curved laterally; upper valve smaller, convex to nearly flat; surface nearly smooth or marked usually by even, widely spaced, slightly raised concentric lamellae; beak curved laterally but less pointed than in lower valve, and with shorter ligament area; resilifer moderately impressed or even raised and convex in some individuals; lateral grooves indistinct or absent; inner margin crenulate adajacent to beaks, but smooth ventrally; adductor scar smaller than in lower valve and uniformly pear-shaped in all specimens. An average sized shell measures, lower valve, in length 62 mm., height 70 mm., upper valve, in length 42 mm., height 60 mm. Diameter (both valves) 19 mm. The upper valves of the young shells are more convex. A typical young upper valve measures in length 23 mm., height 33 mm., diameter 7 mm.

Type localities.—343, 333, 176, 59, 800.

Other localities.—619, 332, 64.

Range.—Lares limestone, Cibao limestone, Los Puertos limestone.

Ostrea collazica Maury

Shell sub-elongate to sub-orbicular, heavy, attaining great thickness in large individuals; valves dissimilar; lower valve convex, with numerous small irregular radial plications which divaricate from a median or slightly posterior zone; plications finely imbricated by thin, slightly raised laminae; beak strongly recurved laterally; ligamental area extremely long in large specimens; resilium deep but becoming shallow in gerontic individuals; margins of ligamental area marked off by narrow crenulated groove; inner margins near the beak finely crenulated; upper valve flat, with beak similarly recurved, usually more closely gyrate; surface smooth except for the thin laminae; interior similar to lower valve except for an amorphous, tooth-like process, located on the inner margin just anterior to the ligamental area, which is transversely denticulate or marked by cross grooves. In some specimens the margins of both valves are similarly marked near the beaks; adductor scars of both valves large and situated slightly posterior. Average size adult;—length 75 mm., height 85 mm.

Fragments indicate that the shell reaches a considerably larger size, in which the lower valve is greatly thickened. Two of these large lower valves were found in which the tendency of the beak to curve laterally has apparently been almost lost, the beak being long and pointed. An unusual feature of this shell is the small amount of prismatic structure. Some of the specimens are made up almost entirely of nacreous laminae of micaceous thinness.

This shell is of the *O. sellæformis divaricata* type, and the young individuals might readily be taken for a variety of *O. sellæformis*. The full grown flat upper valves with their closely gyrate beak bear a strong resemblance to *O. vaughni* Dall of the Tampa Silex beds.

Type localities.—7 to 8 (float), Lares road just east of Collazo bridge, K. 29.2 to 29.3 Lares road.

Other localities.—100, 226, 231, 233, 267, 89, 232(b), 236.

Range.—San Sebastian shale to Lares limestone. Characteristic of the San Sebastian shale, and occuring in the lowest fossiliferous zone of the latter.

Ostrea cahobasensis Pilsbry and Brown variety **portoricana**, new variety

Plate XVI, Figure 1; Plate XVII, Figure 1

Shells reach a very large size, and are characterized by their elongate form and long, pointed, and usually straight beak. The young shells are much less elongate in form. The body cavity tends to remain the same size during growth, most of the addition in height being in the beaks. The resilifer is shallow in the lower valve, and convex in the upper valve, and in both valves it is bordered by a broad, prominent ridge on each side. The latter are marked off from the lamellae of the lateral slopes by a deep impressed zone, in which there is no trace of dentition or crenulation. The beaks may be twisted or straight, and there is considerable variation in the outline of the shells due to the accidents of growth. The shells apparently grew in crowded colonies. The lower valve is convex, the upper slightly convex, or nearly flat in the younger shells. The beak of the lower valve always projects far beyond the beak of the upper valve, and in the young, is deeply excavated within, below the resilifer. The position of the adductor scar is variable, being rather high in the young, but travels ventrally with the growth of the shell, until, in the largest individuals, it is located at the ventral one-third or one-fourth of the shell. The large shells have an hour glass-shaped body cavity, consisting of a deep round cavity immediately below the resilifer, a contraction centrally, and a large crescent-shaped ventral cavity which begins opposite the adductor scar, and swings around below the scar, and close to the ventral margin. This is a fairly constant feature of the larger shells, and is strongly developed in some of the young or half grown shells. The surface of both valves is marked only by concentric lamellae, and shows no signs of radial fluting of ribs. The lamellae are, however, occasionally quite irregular. This shell, while apparently answering the description of the Haitian species, shows differences of varietal rank. The largest specimen measures in length 100 mm., height 270 mm., diameter (both valves together) 95 mm.

Localities.—West of Guanica Mill in basal limestone a few feet above the contact with the Older Series (Lobeck) Fragments of a similar shell were found in the Lares limestone, but their identity with the Guanica shell is by no means certain.

Horizons.—Ponce limestone, Lares limestone (doubtful).

Genus **Lithophaga** Bolten

Lithophaga nigra d'Orbigny

Lithodomus niger d'Orbigny, De la Sagra, Hist. Polit. y Nat. Isla de Cuba, pt. 2, V, p. 351, 1845; Atlas, VIII, Pl. 28, figs. 10, 11, 1855 (Spanish Ed.).
Modiola caribæa Philippi, Abbild. u. Beschr., III, p. 20, Pl. 2, fig. 5, 1847.
Modiola antillarum Philippi, *op. cit.* p. 20, Pl. 2, fig. 4, 1847; Zeitscher., p. 116 (not of d'Orbigny); young shell.
Mytilus lithophagus Gibbes, S. Car. Cat., p. 22, 1848; not of Linné.
Lithophagus nigra Morch, Cat. Yoldi, II, p. 56, 1853.
Lithophagus antillarum Reeve, Conch. Icon., X, Pl. 2, fig. 7, 1857.
Lithophaga nigra Dall, Trans. Wagner Inst. Sci., III, pt. 4, p. 799, 1898; Bull. 90, U. S. Nat. Mus., p. 129, 1915.
Lithophaga nigra Maury, Bull. Amer. Paleont., V., No. 29, p. 194, 1917.

This shell is known from the Tampa Silex beds, and continues to the recent fauna of the Antilles. The recent shell of Cuba as described by d'Orbigny, has a length of 50 mm. The Porto Rican fossils differ only in size, the largest measuring in length 30 mm., height 9 mm., diameter 8 mm. The occurrence is chiefly in the form of internal molds, but fragments of the shell show the vertical striae which end abruptly at a transverse oblique line extending from the beaks to the posterior ventral margin.

Locality.—225.

Horizon.—Upper Lares limestone.

Genus **Leda** Schumacher

Leda peltella Dall

Plate XVII, Figure 6

Leda acuta Gabb, Trans. Amer. Phil. Soc., XV, p. 255, 1873. Not *L. acuta* Conrad, 1832, nor Sowerby, 1837.
Leda peltella Dall, Trans. Wagner Inst. Sci., III, pt. 4, p. 579, Pl. 32, fig. 5; *Idem*, pt. 6, p. 1586, 1903.
Leda peltella Maury, Bull. Amer. Paleont., V, No. 29, p. 161, Pl. 26, fig. 9, 1917.

One of the most abundant fossils in the Quebradillas limestone. The posterior sulcation is always broad and distinct; anterior sulcation narrow and often indistinct. Length 11 mm., heigh 6.5 mm., semidiameter 3 mm. No specimens were found less than 9 mm. in length.

Type locality.—204.

Other locality.—660.

Horizon.—Quebradillas limestone.

Genus **Arca** Linné

Arca yaquensis Maury

Arca yaquensis Maury, Bull. Amer. Paleont., V, No. 29, p. 164, Pl. 30, fig. 14, 1917.

Several specimens were found of a very small *Arca* which closely resembles Maury's *A. vaquensis*, a somewhat doubtful species from the Santo Domingan Oligocene. The Porto Rican shells show no distinctive characters, and are placed with *A. yaquensis* because they correspond more closely to this than to any other species. The specimens are very numerous and all about the same size, hence it is unlikely that they are young individuals. Length 8 mm., height 4.5 mm.

Type locality.—204.

Other locality.—225.

Range.—Lares limestone to Quebradillas limestone.

Arca dariensis Brown and Pilsbry

Plate XV, Figure 5

Arca dariensis Brown and Pilsbry, Proc. Acad. Nat. Sci. Phila., p. 362, Pl. 22, fig. 10, 1911.

Umbo prominent, at anterior third of shell; surface with thirty-three flat ribs and sub-equal flat interspaces, the whole crossed by fine raised concentric lines, strongest on ribs and giving to the latter a nodular appearance; ribs broaden anteriorly and posteriorly, the ten posterior and the five or six anterior ribs medially grooved. Length 26 mm., height 16.5 mm., semi-diameter 5.5 mm.

This *Arca* is smaller than the Gatun species, and may be a variety of it. It also resembles the shell described by Toula as *Arca* cf. *consobrina* Moore.

Localities.—Collazo Falls, 261?, 232(b).

Horizon.—San Sebastian shale.

Arca (Scapharca) cf. **donacia** Dall

Plate XV, Figures 6, 7

Arca (*Scapharca*) *donacia* Dall, Trans. Wagner Inst. Sci., III, pt. 4, p. 649, Pl. 33, fig. 13, 1898.

The size and sculpture answers Dall's description of this species, especially the raised concentric threads in the interspaces of the left valve, a feature lacking on the right valve. It differs from the Bowden form in the number of ribs (27), and in having a shallow median depression, strongest in the left valve. Length 8.5 mm., height 6.5 mm. A smaller shell measures in length 6.75 mm., height 4.5 mm.

Locality.—204.

Horizon.—Quebradillas limestone.

Arca, species indet.

Plate XVII, Figures 2, 3

Shell small, very convex; beaks at anterior third; anterior and posterior ends equally rounded; hinge area broad, especially anteriorly, with beaks widely separate; surface with twenty-five broad, quadrate, rather low ribs and equally wide, shallow rounded interspaces; central ribs medially grooved distally; hinge margin three-fourths the length of shell and slightly raised above hinge area; hinge area transversely grooved or striate posteriorly; teeth fine, numerous; interior of valves unknown. Average size measures in length 19 mm., height 10.5 mm., diameter 12 mm. Largest specimen measures in length 25 mm., height 13.6 mm., diameter 16 mm.

Type locality.—230.

Other localities.—233, 232(b).

Horizon.—Upper San Sebastian shale.

Arca (Scapharca) collazica Maury

The material collected by the writer consists only of internal molds. An average sized specimen measures in length 16.5 mm., height 9.5 mm., diameter 7.5 mm.

Localities.—333, 619, 64, 232(b).

Range.—Upper San Sebastian shale to Cibao limestone. Very abundant.

Subgenus **Barbatia** Gray

Barbatia (Acar) reticulata Gmelin

Arca reticulata Gmelin, Syst. Nat., VI, p. 3311, 1792.

Arca reticulata Sheldon, Palaeontographica Americana, I, p. 20, Pl. 4, figs. 8-12, 1916.

Barbatia (Acar) reticulata Maury, Bull. Amer. Paleont., V, No. 29, p. 166, Pl. 30, fig. 16, 1917.

A single fragment was found, sufficiently complete to identify. Length indeterminate, height 6 mm.

Locality.—204.

Horizon.—Quebradillas limestone.

Barbatia cf. **bonaczyi** Gabb

Plate XIV, Figure 4

Barbatia bonaczyi Gabb, Trans. Amer. Phil. Soc., XV, p. 254, 1873.

Arca umbonata Dall, Trans. Wagner Inst. Sci., III, pt. 4, p. 620, Pl. 38, figs. 4, 4a, 1898. Not of Lamarck.

Barbatia cf. *bonaczyi* Maury, Bull. Amer. Paleont., V, No. 29, p. 165, Pl. 30, fig. 15, 1917.

A single external mold of a right valve resembling *B. bonaczyi* Gabb, but smaller. It is nearer the size of *B.* cf. *bonaczyi* described by Maury, but the sculpture is coarser. It is very probably a variety, but the specimen is too poor for complete description. The ribs are crowded centrally and sparser at the ends of the valve. Those on the posterior slope lose their bearded character and become scaly. Valve with shallow median sulcation. Length about 12 mm., height 6 mm.

Locality.—204.

Horizon.—Quebradillas limestone.

Genus **Glycimeris** Da Costa

Glycimeris portoricoensis, new species

Plate XV, Figure 6

Shell sub-orbicular; beaks not prominent; surface with about thirty strong sub-angular to rounded ribs and sub-angular interspaces, the whole crossed by fine raised concentric threads, regular and evenly spaced. The ribs near the ventral margin broaden rapidly at the expense of the interspaces, and become round in cross-section. Interior of shell unknown. Largest specimen measures in length 19 mm., height 17 mm., semi-diameter 4 mm.

This shell resembles *G. acuticostata* Sowerby, but has broader, more rounded ribs.

Localities.—204, 182, 318.

Range.—Upper Los Puertos limestone to Quebradillas limestone (typical of the latter).

Glycimeris collazoensis, new species

Plate XV, Figures 4, 5

Shell sub-orbicular, beaks not prominent; hinge area short; teeth numerous, in uninterrupted series; surface with thirty-four low angular ribs and angular interspaces; each rib with fine keel or thread on the apex, and with the appearance of a groove on either side of this median thread; inner margin scalloped ventrally; length 15 mm., height 16 mm., semi-diameter, 4 mm.

This shell resembles *G. gatunensis* Toula, but the latter is smaller and more transversely elongate. It also resembles *G. portoricoensis* of the Quebradillas limestone, of which it may posssibly be the progenitor. *G. portoricoensis* differs chiefly in its larger size, more rounded ribs, and strong concentric growth lines.

Locality.—261.

Horizon.—Lower San Sebastian shale.

Genus **Venericardia** Lamarck

Venericardia scabricostata? Guppy

Cardita scabricostata Guppy, Quart. Jour. Geol. Soc. London, XXII, p. 293, Pl. 18, fig. 10, 1866.

Cardita scabricostata Gabb, Trans. Amer. Phil. Soc., XV, p. 252, 1873.

Cardita scabricostata Guppy, Quart. Jour. Geol. Soc. London, XXXII, p. 531, 1876.

Venericardia scabricostata Dall,, Trans. Wagner, Inst. Sci., III, pt. 6, pp. 1428, 1586, 1903.

Venericardia scabricostata Maury, Bull. Amer. Paleont., V., No. 29, p. 198, Pl. 33, fig. 1, 1917.

Shell with prominent beaks; 18 to 20 high nodose ribs and narrower, V-shaped interspaces which are crossed by strongly marked growth lines; lunule broad, short, and distinct. Length about 4.5 mm., height 4 mm., semi-diameter 1.5 mm. The specimens found are much smaller than *V. scabricostata,* and yet seem to be mature shells; they may be a variety.

Locality.—225.

Horizon.—Lares limestone.

Venericardia cerrogordensis Maury, new variety

Venericardia cerrogordensis Maury, Bull. Amer. Paleont., V, No. 29, p. 199, Pl. 33, fig. 3, 1917.

A single fragment of anterior half of a left valve, which seems to be a variety of this species, somewhat larger than the Santo Domingo shell. About fourteen strong ribs with strongly beaded keel; interspaces wider than ribs, shallow, with wavy growth lines and showing an obscure crenulated radial thread on either side at base of rib. Length about 27 mm., height about 23 mm., semi-diameter, etc., 5.5 mm.

This may be a distinct species but the specimen is so incomplete that it has been identified with the nearest form. The specimen was found in a piece of road metal at K. 26.5 Lares road and its horizon is unknown. The rock is a white limestone like the Quebradillas and contains a mold of *Chione* cf. *woodwardi* Guppy.

Genus **Chama (Linné)** Bruguière

Chama involuta Guppy

Chama involuta Guppy, Geol. Mag. London, decade 2, I, p. 436, Pl. 17, figs. 5a-c, 1874; Quart. Jour. Geol. Soc. London, XXXII, p. 531, 1876.
Chama involuta Dall, Trans. Wagner Inst. Sci., III, pt. 6, pp. 1398, 1586, 1903.
Chama involuta Maury, Bull. Amer. Paleont., V, No. 29, p. 199, Pl. 33, figs. 4, 5, 6, 1917.

The Porto Rican specimens are unusually large, but apparently of this species. The largest specimen is fragmental, but shows a height of 52 mm. Judging from the specimens, it attaches by either valve. The beak is strongly prosogyrate, making over one complete turn. The lamellae are strongly fluted, almost spinose on one specimen.

Localities.—204, 98 (Berkey).

Horizon.—Quebradillas limestone.

Chama portoricana, new species

Plate XVII, Figure 5

Beak closely prosogyrate; surface with extremely crowded, thin, high lamellae, which on the largest specimen rise 8 mm. above the shell surface. These lamellae are quite regular, being gently fluted over the body of the shell, but spinose at the margin in the adult; shell marked by rounded umbonal ridge; inner margin finely crenulate; cardinal area pustulose; strong bifid and crenulate cardinal tooth in the right valve, with crenulate lateral; shell attaches by either valve, but the cardinal tooth remains in the right valve in either case; adductor scars large; pallial line distinctly impressed. Length 48 mm., height 35 mm., diameter of convex valve about 12 mm. A smaller attached valve measures length 22 mm., height 18 mm., diameter 9 mm.

This shell differs from *C. congregatoides* Maury in its more regular and higher lamellae, and in its more elongate form.

Locality.—204.

Horizon.—Quebradillas limestone.

Genus **Lucina** (Bruguière) Lamarck

Lucina collazoensis, new species

Plate XVIII, Figures 1, 2

Shell transversely ovate, convex, produced posteriorly, beaks being slightly forward of center and frequently so close together that they practically touch;

hinge line long and straight, nearly nine-tenths the length of the shell. The largest specimen, somewhat distorted so as to increase the convexity, measures in length 65 mm., height 40 mm., diameter 45 mm. A smaller shell, not distorted, measures in length 39 mm., height 31 mm., diameter 25 mm.

This is a ponderous shell of the type of *L. corpulenta* Dall, but unusual for its elongate form and long straight hinge line. It occurs chiefly as internal molds of both valves intact, but the form is often distorted by pressure. Fragments of external mold show the surface to be nearly smooth, marked only by fine growth lines, periodically incised at irregular intervals.

There is an undescribed shell in the Kemp collection from the lower Gatun beds which is apparently this species, or very close to it.

Localities.—74, 92, 86, Collazo (float).

Horizon.—San Sebastian shale (abundant at Collazo Falls).

Lucina cf. **chrysostoma** (Meuschen) Philippi

Plate XVIII, Figure 3

Tellina crysostoma Meuschen, Mus. Gevers., p. 482, 1787 (typographical error).

Lucina chrysostoma Philippi, Abb. und Beschr. neue Conchyl., II, p. 206, Pl. 1, fig. 3, 1847.

Venus edentula Chemnitz, Conch. Cab., VII, Pl. xl, figs. 427-9, 1784; Gmelin, Syst. Nat., VI, p. 3286, 1792; not of Linné, Syst. Nat., ed. 10, p. 689, 1758.

Anodontia alba Link, Beschr. Rostock Samml., p. 56, 1807.

Lucina edentula Reeve, Conch. Icon., *Lucina*, Pl. ii, fig. 9, 1850; Heilprin, Trans. Wagner Inst., I, pp. 102-3, 1886.

Loripes chrysostoma Arango, Fauna Mal. Cubana, p. 257, 1878.

Lucina chrysostoma Dall, Trans. Wagner Inst., III, pt. 6, p. 1354, 1903.

Loripes edentula Gabb, Trans. Amer. Phil. Soc., XV, p. 251, 1873.

Lucina chrysostoma Maury, Bull. Amer. Paleont., V, No. 29, p. 202, Pl. 35, fig. 2, 1917.

Resembles *L. chrysostoma* of the Caloosahatchie Pliocene, but the largest and most convex specimens resemble the recent *L. globosa* Forskol. Only internal molds have been found, which show lunule impression, and posterior sulcation close to dorsal margin. The specimens range in length 39 mm., height 36 mm., diameter 22 mm. to length 135 mm., height 115 mm., diameter 95 mm.

Localities.—205, 174. 10, 78, 98, 176? (Berkey). Mona Island, south side of Vieques Island, Guanica, and Ponce (Lobeck).

Horizons.—Los Puertos, Quebradillas limestones, and Ponce formation. These large shells are very abundant as internal molds in the Tertiary formations of the north and south coasts.

Genus **Phacoides** Blainville

Phacoides (Miltha) riocanensis Maury

Phacoides (*Miltha*) *riocanensis* Maury, Bull. Amer. Paleont., V, No. 29, p. 205, Pl. 35, fig. 7, 1917.

The Porto Rican shells are the same size as those of the Santo Domingan Oligocene. There seem to be no important differences. The former shells have a slight differentiation in the concentric lamellae, two lamellae of secondary strength alternating with each primary one. A shallow median sulcus is a noticeable feature near the ventral margin, but does not extend to the beak. Length about 47 mm., height about 45 mm., semi-diameter 7.5 mm.

Localities.—335, 204, 220, 225, 318, 317.

Range.—Lares limestone, Cibao limestone, Los Puertos limestone, Quebradillas limestone. This species is widespread but not abundant.

Phacoides (Miltha), species indet.

Plate XVIII, Figure 4

Shell of moderate size, convex, slightly inequalateral; hinge area narrow, short, beaks incurved and nearly in contact; anterior margin broadly rounded, posterior margin roundly truncate, basal margin nearly straight; posterior sulcus close to margin; concentric sculpture of fine, even, raised lamellae, about 1/3 mm. apart at ventral margin, and with fine growth lines in the spaces between. Height of shell about 24 mm., length about 34 mm., semi-diameter 7 mm.

Only a single fragment was found which was too incomplete for an accurate description, but differed from any other species. This shell resembles *P.* (*Miltha*) cf. *smithwoodwardi* Maury, a species from the same horizon, but is more elongate than the latter, and has the posterior sulcus much closer to the margin.

Locality.—204.

Horizon.—Quebradillas limestone.

Phacoides (Miltha), species indet.

Plate XVIII, Figure 5

Shell small, orbicular, moderately convex. Sculpture of fine concentric lamellae like *P. hillsboroense;* deep radial sulcus crossing the posterior one-quarter of shell and extending to ventral margin. Fine concentric striae between the lamellae are visible under a lens. Length 12 mm., height 12.5 mm., semi-diameter 3.5 mm.

Only one specimen was found, the external mold of a left valve. It may possibly be the young of a large species like *P. riocanensis.*

Locality.—52(a).

Horizon.—Quebradillas limestone.

Phacoides (Pseudomiltha) laresensis, new species

Plate XVIII, Figure 6

Shell sub-orbicular, nearly equilateral, moderately convex; surface with concentric lamellae of the type of *P. hillsboroense*, but very regular instead of wavy as in the latter; concentric striae between the lamellae; lunule narrow, deeply impressed; escutcheon large, marked off by a narrow sulcus which broadens at the posterior margin; concentric sculpture flexed sharply upward over the escutcheon, where it becomes coarser; surface of shell marked by faint radial striae; cardinal area edentulate; interior of shell unknown. The shell is thin, and in most of the specimens is worn partially or wholly away, leaving only the internal mold. Length 36 mm., height 34 mm., diameter 18 mm.

Localities.—262, Collazo Falls, 232(b)?

Horizon.—San Sebastian shale.

Phacoides (Lucinisca) calhounensis Dall

Plate X, Figure 6

Phacoides (*Lucinisca*) *calhounensis* Dall, Trans. Wagner Inst. Sci., III, pt. 6, p. 1371, Pl. 52, fig. 16, 1903.

Phacoides calhounsis Maury, Bull. Amer. Paleont., V, No. 29, p. 204, 1917. (Typographical error.)

These shells are variable but have the same general characters as the Florida form. The majority of the specimens are the same size as the latter, but occasionally attain a considerably greater size. The greater prominence and sparcity of the concentric ridges in the umbonal region is a noticeable feature. The radial ribs are finer and somewhat crowded on the posterior slope and to a lesser extent on the anterior slope. Dall does not mention this character but it may be observed in his illustration. The intersections of the radials with the concentric ribs have a tendency to form spinose nodes, especially in the adult stage near the lateral margins. This gives the shell a superficial resemblance to *P. hispaniolana* Maury, but the sculpture of the latter is much finer. The Porto Rican shell has a large and distinct lunule. An average size specimen measures in length 10 mm., height 9.5 mm., semi-diameter 2.5 mm. The largest specimen measures in length 13 mm., height 12 mm., semi-diameter 4 mm.

Type locality.—204.

Other localities.—52(a), 77(Berkey).

Horizon.—Quebradillas limestone (abundant); Ponce limestone.

Genus **Divaricella** Von Martens

Divaricella prevaricata Guppy

Divaricella prevaricata Guppy, Proc. U. S. Nat. Mus., XIX, No. 1110, p. 327, Pl. 30, fig. 4, 1896.

Divaricella prevaricata Dall, Trans. Wagner Inst. Sci., III, pt. 6. pp. 1389, 1587, 1903.

Divaricella prevaricata Maury, Bull. Amer. Paleont., V., No. 29, p. 207, Pl. 35, fig. 10, 1917.

The divaricate lines are finer than those of the Santo Domingo shell. The single specimen found measures in length 7 mm., height 5.75 mm.

Locality.—204.

Horizon.—Quebradillas limestone.

Genus **Codakia** Scopoli

Codakia (Jagonia) magnoliana Dall

variety **borinquenense**, new variety

Plate XVII, Figure 4

A single right valve was collected. It is slightly smaller than the shell described from the North Carolina Miocene, and the concentric sculpture is more pronounced. The radials are slightly wavy as in

Codakia orbicularis, and increase by intercalation. They vary in strength, parts of the shell being marked by ribs finer and more crowded than in adjacent portions of the surface. The shell is noticeably inequilateral. The lunule is long and narrow. Length 10 mm., height 8 mm., semi-diameter 4 mm.

Localities.—204, 671.

Horizon.—Quebradillas limestone.

Genus **Cardium** (Linné) Lamarck

Cardium (Lævicardium) cf. **serratum** Linné

Cardium serratum Linné, Syst. Nat., ed. 19, p. 680, 1758.

Cardium lævigatum Lamarck, Anim. s. Vert., VI, pt. 1, p. 11, 1819 (not of Born, Mus. Vind. Test., p. 47, 1780; nor of Linné, Syst. Nat., X, p. 680, 1758).

Cardium citrinum Wood, Gen. Conch., p. 223, Pl. 54, fig. 3, 1815.

Liocardium pictum Ravenel, Proc. Acad. Nat. Sci. Phila., for 1861, p. 44, 1862.

Cardium hiatus "Meuschen" *fide* Krebs, W. I. Cat. Shells, p. 115, 1864.

Cardium lineatum Krebs, *op. cit.*, not of Gmelin, 1792.

Cardium pristis Valenciennes, *fide* Krebs, *op. cit.*

Cardium oviputamen Reeve, Conch. Icon., *Cardium*, Pl. 7, fig. 36, 1844.

Cardium venustum Gabb, Trans. Amer. Phil. Soc., XV, p. 251, 1873.

Cardium serratum Dall, Proc. U. S. Nat. Mus., XIX, No. 1110, p. 327, 1896; not *serratum* of Pennant, 1778).

Cardium serratum Dall, (in part), Trans. Wagner Inst. Sci., III, pt. 5, p. 1110, 1900.

Cardium serratum Brown and Pilsbry, Proc. Acad. Nat. Sci. Phila., p. 367, 1911.

Cardium serratum Maury, Bull. Amer. Paleont., V, No. 29, p. 212, Pl. 36, fig. 8, 1917.

Numerous internal molds apparently of this species, and of about the same size as those of the Santo Domingo Oligocene were found. They average about 20 mm. in height. Fragments of external mold show numerous fine thread-like radial ribs. Some specimens show a slight radial sulcation anteriorly.

Localities.—204, 225, 333 ?, 64.

Range.—Lares limestone to Quebradillas limestone.

Cardium (Trachycardium) muricoides, new species

Plate XIX, Figure 1

Shell sub-ovate, convex; surface with about 36 spinose ribs and narrower, rounded, transversely striate interspaces; interior of valves grooved and scalloped at ventral margins. All ribs except the three anterior ones have a lateral keel on each edge at the top. The three anterior ribs have only one such keel, placed on the anterior side. The first ten ribs (including the three single keeled ones) are ornamnted with longitudinally ovate, long, erect, or slightly hooked spines along the anterior keel, but spreading out over the center of the rib. All the remaining ribs have the spines on the posterior side. From the eleventh rib to the eighteenth inclusive, the spines are like those of the ten anterior ribs, but commencing with the nineteenth rib the spines posteriorly become narrower, blade-like, set longitudinally on the rib, and curved posteriorly over the adjacent interspace. All the ribs are flat topped, but the posterior ribs have the tops sloping posteriorly. Length 30 mm., height 32.5 mm., semi-diameter 11 mm.

This shell is twice as large as *C. bowdenense* Dall. The ornamentation especially of the rib is nearer to that of *C. muricatum* than to that of any other species. It is apparently related to *C. (Trachycardium) gatunensis* Toula, and is one of the early members of the *C. muricatum* group.

Type locality.—179.

Other localities.—225, 24?, and (doubtfully) near Guanica Central (Lobeck).

Range.—Lares limestone, Cibao limestone, Los Puertos limestone.

Cardium (Trachycardium) cinderellæ Maury variety **alternatum,** new variety

Plate XIX, Figures 2, 3, 4

Shell equivalve, slightly inequilateral; beaks high, strongly incurved; hinge line rather long; surface with about thirty-six broad, flat ribs with narrow interspaces; ribs appear medially grooved when worn smooth. When perfect, they show a single row of high, vaulted, inverted V-shaped spinose scales, which cover the width of the rib, and are somewhat unevenly spaced, though not crowded. There is a strong tendency toward alteration of ribs with large and ribs with small spines. This is more marked in some specimens than in others. It is a feature not mentioned in Maury's description of the Santo Domingo shell, but shows in the illustration of the latter. The interspaces are faintly grooved radially, and strongly transversely striate; valves internally grooved, and inner margins strongly scalloped ventrally. Length 29 mm., height 33 mm., diameter 26 mm.

The sculpture is like *C. cinderellæ* Maury, but the shell is larger, shorter, and more convex. It may possibly deserve a specific name, but the specimens are too fragmental to warrant this.

Localities.—225, 226, 280, 281, 331.

Horizon.—Lares formation.

Cardium (Trigonocardia) sambaicum Maury variety **portoricoensis**, new variety

Plate XIX, Figures 5, 6

No complete shells were found, but fragments large enough to show the outline of the shell. They seem to be quite variable. There are some specimens in which the ribs are worn smooth as in Maury's illustration from Santo Domingo. Some specimens show the ribs slightly wider than the interspaces, but usually the reverse is true, especially in the ventral portion of the shell. Fine raised concentric threads cross the interspaces and cross the ribs between the nodes. These threads are much finer and more crowded where they cross the ribs. In the interspaces they are very irregular, and frequently end short at the center of the interspace. These terminated threads have a tendency to alternate from opposite sides of the interspace as though shearing or faulting had displaced them. The nodes on the ribs are high and prominent. The shells are smaller and less convex than the Santo Domingo form, but the number of ribs, truncation and outline of the shell are about the same. Length 13 mm., height 13 mm., semi-diameter 5 mm.

Locality.—204.

Horizon.—Quebradillas limestone.

Cardium, new species (aff. **C. sambaicum** Maury)

Plate XIX, Figure 7

Fragment indicating a shell of the size and general outline of *C. sambaicum* Maury, but with a somewhat different sculpture of the ribs. Shell with about 25 strong ribs, high and rounded on top, and slightly narrower U-shaped interspaces. The whole is crossed by fine, close concentric threads, quite irregular. and of which every second, third or fourth one on crossing the ribs expand into broad semi-cone shaped scales the pieces of which are toward the beak. These scales are irregularly spaced, and are especially crowded near the ventral margin. Where the ribs are worn, these scales appear as thin arched lamellae. Length of shell about 20 mm.

Locality.—204.

Horizon.—Quebradillas limestone.

Cardium (Trigonocardia) haitense Sowerby variety **cercadicum** Maury

Plate XIX, Figure 8

Cardium haitense Sowerby, Quart. Jour. Geol. Soc. London, VI, p. 52, Pl. 10, fig. 11, 1849 (in part).

Cardium (Trigonocardia) haitense variety *cercadicum* Maury, Bull. Amer. Paleont., V., No. 29, p. 212, Pl. 36, fig. 6, 1917.

This shell corresponds closely to Maury's variety *cercadicum* of Santo Domingo. The truncation is sharp; ribs with inverted V-shaped nodules; ribs on the truncation have a few scattered spinose nodules; ribs flat, those anterior to the truncation having the flat tops sloping anteriorly, thus giving the ribs an asymmetric V-shaped cross-section. There are nine ribs on the truncation, and fourteen on the main body of the shell. Concentric threads in the interspaces, which, in the anterior part of the shell occasionally cross the ribs. The nodules on the ribs are rather low and indistinct except on the rib which marks the truncation, where they are prominent. Length 10 mm., height 11 mm., semi-diameter, etc., 5 mm.

Localities.—204, 52(a), 192, 77 ? (Berkey).

Horizon.—Quebradillas limestone (characteristic), and in the Ponce limestone.

Cardium (Trigonocardia) haitense Sowerby variety **areciboense**, new variety

Plate XIX, Figure 9

Very close to *C. haitense cercadicum* Maury, but shorter and more sharply truncate, and with fewer, coarser ribs which are more decidedly angular. The ribs on the truncation near the dorsal margin have regularly spaced V-shaped spines, pointing sharply upward. The nodules and concentric threads are otherwise exactly like those of variety *cercadicum*. There are six ribs on the truncation and eleven on the remainder of the shell. Length 10 mm., height 14 mm., semi-diameter 6 mm.

Locality.—204. Also Berkey 77.

Horizon.—Abundant in the Quebradillas limestone and occurring also in the Ponce limestone.

Genus **Clementia** Gray

Clementia dariena Conrad

Plate XIX, Figures 10, 11, 12

Meretrix dariena Conrad, Pac. R. R. Rep., V, p. 328, Pl. 6, fig. 55, 1856.
Clementia dariena Gabb, Jour. Acad. Nat. Sci. Phila. (2) VIII, p. 344, Pl. 44, fig. 16, 16a, 1881.
Clementia dariena Dall, Trans. Wag. Inst. Sci., III, pt. 6, p. 1235, 1903.
Clementia dariena Toula, Jahrb. der K. K. Geol. Reichanst. Wien, LVIII, p. 725, Pl. 27, figs. 9, 10, 1908.
Clementia dariena Brown & Pilsbry, Proc. Acad. Nat. Sci. Phila., p. 371, Pl. 28, fig. 1, 1911.

The typical Porto Rican shells are smaller than those of the Panama region and Costa Rica, but otherwise show no marked differences. The Porto Rico shells are not dwarfed forms, but merely arrested in growth, the average adult being an exact replica of a Gatun shell when the latter is two-thirds grown. This might lead to the supposition that the Porto Rican analogue is a primitive form of the Gatun shell, except for the fact that the former occasionally reaches a size as great as the average Gatun shell and is exactly simliar, even to the loss of ribs near the ventral margin. To emphasize this point, an average specimen from Dr. Kemp's Gatun collection (in the Columbia University museum) is illustrated here together with one of the large Porto Rican shells, for comparison.

A comparison of the Porto Rican shells with available sources is shown in the following table.

Table 2

Source	Length mm.	Height mm.	Diameter mm.	Number of prominent ribs	Breadth of ventral ribless zone mm. (meas. vertical)
Gabb, illustration. Sapote, Costa Rica	57	47.5	33.5	26–35	10
Brown & Pilsbry, illustration. Gatun	65	63	?	26?	18
Toula, illustration. Gatun	67	56	?	28	19
Toula, description. Gatun	47	38	?	?	?
Kemp collection, specimen. Upper Gatun	63	61.5	36	33	23
Kemp collection, specimen. Lower Gatun	51	43	25.5	31	7
do	48	44	24.5	30	10
do (young shell)	27	25?	14	22?	0
Porto Rico, San Sebastian shale at Collazo Falls	48	44.5	26	27	13
Porto Rico, San Sebastian calcareous shale at Robles	41	34	19		
do	39	31	23		
do	38	33.5	20		
do	38	35.5	18.5		
do	37.5	33	19.5		
do	35	32.5	20		
do	35	32.5	17.5	25–30	0–5
do	35	33	17		
do	?	34	20		
do	?	33	15		
do	?	32	20		
do	?	29	17.5		
do	?	28	19		

It will be noticed from this table that there is considerable variation in size and proportions among the specimens. This is due in part to distortion by pressure as regards the proportions. If the average of these measurements is taken and the height and diameter expressed in terms of the length as unity, we have the following relationship:

	Length	Height	Diameter	Average length mm.
Gabb's illustration. Sapote, Costa Rica	1	0.83	0.59	57
Kemp's large specimen from the upper Gatun........	1	0.98	0.57	63
Kemp's smaller specimens from the lower Gatun...	1	0.88	0.51	42
Large Porto Rico specimen from the Collazo district	1	0.93	0.54	48
Smaller Porto Rico specimens from the Robles district	1	0.87	0.51	37

It will be noticed that in the larger specimens there is a relatively greater increase in the height and diameter, due to the slight change in shape of the shell with growth. The measurements from Gabb's illustration are of doubtful value in this comparison.

The uniformity of size and number of ribs is a feature brought out in the table. The Porto Rican shells have about the same number of ribs as the Gatun shells, and in the ribbed stage are about the same size. The Gatun shells usually, and the Porto Rican shells occasionally grow beyond this stage with loss of ribs, an ontogerontic character. The Gatun shells were longer lived, apparently living under more favorable conditions than those of the upper San Sebastian shale in Porto Rico.

Localities.—232(b), 233, Collazo Falls, 83, 84, Juana Diaz.

Horizon.—San Sebastian shale, Juana Diaz shale.

Genus **Cytherea** Bolten

Cytherea (Cytherea) berkeyi, new species

Plate XX, Figures 1, 2, 3

Shell large, convex, very inequilateral; right valve with two posterior bifid and one anterior simple cardinal teeth; left valve with one middle bifid and anterior and posterior simple cardinals; left anterior papilliform small out distinct; adductor scars and pallial line strongly impressed, the latter granulose; pallial sinus large, broad, rounded, ascending; inner margins minutely crenulate; small auxiliary adductor scars, situated close to dorsal margin between beaks and principal anterior adductor scars, and nearer to the latter; obscure, irregular impressed line in interior of each valve, descends vertically from anterior end of beak and dies out midway between beak and ventral margin; surface of valves marked by numerous small radial ribs, somewhat wavy, evenly spaced, and fairly uniform in size, but becoming coarser over the posterior third of the shell, where they alternate in strength, with occasionally two or three small ribs alternating with one lagrer one; the whole cut by fine, low, sharp, raised concentric lamellae, evenly spaced near the beaks, but gradually increasing to 2, 3, or 4 mm. apart toward the ventral margin, where they suddenly become irregularly spaced and crowded, apparently a gerontic character. These concentric lamellae are delicately fluted by the radials in the umbonal region. Minute growth lines cross the sculpture between the lamellae. The concentric sculpture is nowhere as prominent as the radial which increases in coarseness ventrally. The largest specimen, an internal mold collected by Dr. Berkey, measures in length 85 mm., height 68 mm., diameter 48 mm.

A large shell of the same type as *C. tarquinia* Dall and also resembling *C. lacerata* Hanley, a recent shell from China, and *C. antiqua* King, recent, from Chile and Patagonia. It differs from all of these in having the radial sculpture predominate over the concentric sculpture.

Localities.—318, 41, 78, 98(Berkey). Bayamon and Ponce (Lobeck).

Horizon.—Quebradillas limestone Ponce limestone.

Genus **Pitaria** Römer

Pitaria (Hyphantosoma) carbasea Guppy

Plate XVI, Figure 2

Cytherea (*Circe*) *carbasea* Guppy, Quart. Jour. Geol. Soc., XXII, p. 292, Pl. 18, fig. 13, 1866.

Callista carbasea Gabb, Trans. Amer. Phil. Soc., XV., p. 250, 1873.

Pitaria (*Hyphantosoma*) *carbasea* Dall, Trans. Wagner Inst. Sci., III, pt. 6, p. 1266, 1903.

This shell occurs abundantly as internal molds, but only one fragment of external mold was found showing the delicate sculpture. The pallial sinus is sub-angular, deep, reaching nearly to the middle of the valve; interior of shell smooth; exterior surface marked by fine, somewhat wavy or irregular concentric lamellae crossed by fine divaricate lines, strongest anteriorly, and forming two zigzag zones near the middle of the valve. These divaricate lines, when viewed under a lens are seen to consist of rows of pits in the lamellae; lunule large, demarked by fine sharp impressed line, and crossed faintly by the concentric lamellae, thus being rendered indistinct. The shells vary considerably in size, the largest internal mold measuring in length 32 mm., height 26 mm., diameter 16 mm.

Type localities.—64, 225.

Other localities.—619, 233, 343, 232(b).

Range.—San Sebastian shale, Lares limestone, and Cibao limestone. Abundant in the Cibao limestone.

Genus **Chione** Megerle von Mühlfeldt

Chione woodwardi Guppy

Plate XIII, Figure 7

Venus Woodwardi Guppy, Quart. Jour. Geol. Soc. London, XXII, p. 292, Pl. 18, fig. 1, 1866; *Idem.* XXXII, p. 530, 1876.
Chione Woodwardi Dall, Trans. Wagner Inst. Sci., III, pt. 6, p. 1291, 1903.
Chione Woodwardi Maury, Bull. Amer. Paleont., V, No. 29, p. 218, Pl. 37, fig. 6, 1917.

This is one of the most abundant fossils in the Quebradillas limestone. The shells show no differences from those described from Jamaica and Santo Domingo.

Localities—204, 217, 52(a), 670, 179, 225. Near Bayamon (Semmes and Lobeck). Near Guanica Central (Lobeck). Vieques Island (Lobeck). 77 (Berkey). Culenbrinas Point, Ponce, and K. 2.4 Ponce-Adjuntas road (Mitchell).

Horizons.—Lares limestone?, Quebradillas limestone, Ponce limestone.

Chione (Lirophora) hendersoni Dall

Venus paphia Guppy, Quart. Jour. Geol. Soc. London, XXII, p. 292, 1866. Not of Linné.
Chione paphia Gabb, Trans. Amer. Phil. Soc., XV, p. 249, 1873.
Venus paphia Guppy, Geol. Mag., decade 2, I, p. 442, 1874, etc., *ex parte.;* Quart. Jour. Geol. Soc., XXXII, p. 530, 1876.

Chione (*Lirophora*) *hendersoni* Dall, Trans. Wagner Inst. Sci., III, pt. 6, p. 1295, Pl. 55, fig. 22, 1903.

Chione (*Lirophora*) *hendersoni* Maury, Bull. Amer. Paleont, V, No. 29, p. 219, Pl. 37, fig. 8, 1917.

The Porto Rican shells are apparently closer to the Santo Domingo than to the Bowden shells. The specimens show the obscure crenulation at base of ribs, and the sudden thickening of the ribs over the anterior portion of shell. There are eleven or twelve large, widely spaced ribs. They are obsolete in the umbonal region. Interior of shell has deeply impressed pallial line and adductor scars; pallial sinus short and angular. An average specimen measures in length 31 mm., height 22 mm., diameter 14.5 mm. The largest measures in length 36 mm., height 27 mm., semi-diameter 8 mm.

Localities.—179, 331, 343, 64, 619 ?.

Range.—Lares limestone to Los Puertos limestone.

Genus **Tellina** (Linné) Lamarck

Tellina strophoidea, new species

Plate XX, Figures 4, 5

Shell moderately elongate, sub-equilateral; beaks inconspicuous; surface with numerous elevated, sharp concentric lamellae, which, on adult specimens, frequently merge on the posterior part of shell into fewer, coarser lamellae; numerous radial striae can be seen under a lens in transverse light. Ventrally they are interrupted by the lamellae, but toward the beaks they become more distinct and continuous, so that on the nuclear portion of the shell they are nearly as strong as the concentric sculpture, resulting in an extremely fine cancellate ornamentation; posterior slope with two radial folds and a moderately deep sulcus between. The upper fold is narrower and less pronounced; posterior dorsal margin marked by accentuation of the lamellae into a slight ridge. In the adult shells the lowest fold is, in the right valve, double, with a slight sulcus between. This is only noticeable at the distal end of the fold. The lamellae bend sharply upward on crossing the lower fold; lunule extremely narrow; interior of shell unknown. Length 48 mm., height 27 mm., semi-diameter 6 mm.

This shell is nearest to *T. strophia* Dall, which it resembles in sculpture, but is considerably less elongate.

Localities.—204, 216, 98(Berkey).

Range.—Throughout the Quebradillas limestone.

Tellina portoricoensis, new species

Plate XX, Figure 6

Shell resembling *T. strophoidea* but with much finer concentric sculpture. Shell sub-equilateral, slightly convex; beaks low; surface with fine, sharp, hardly raised concentric lamellae, at first uniform and evenly spaced, but ventrally becoming slightly irregular, with every fifth or sixth one more prominent than the others; low, inconspicuous double fold on the umbonal ridge, becoming almost obsolete distally, and over which the concentric lamellae are flexed sharply upward in crossing; fine obscure growth lines between the lamellae; faint radial rays seen only in oblique light; interior of shell unknown. Length 42 mm., height 23 mm., semi-diameter 5 mm.

Locality.—204.

Horizon.—Quebradillas limestone.

Tellina (Scissula) grabaui, new species

Plate XVI, Figures 3, 4

Shell small, elongate, slightly convex, sub-equilateral; anterior rounded, posterior roundly truncate; surface with fine growth lines, periodically incised, replaced on the umbonal ridge by widely spaced, sharp concentric lamellae, which cross a faint sulcus above the umbonal ridge and, decreasing in size and strength, continue to the dorsal margin; growth lines crossed by faint, wavy oblique lines, becoming more distinct as they approach the umbonal ridge, where they end suddenly, in contact with the concentric lamellae. These oblique lines begin near the anterior margin and slope downward toward the posterior. Interior of shell unknown. Length 20 mm., height 11 mm., semi-diameter 2.5 mm.

This shell is close to *T.* (*Scissula*) *lampra* Dall, of the Chipola Oligocene. It is also close to *T. rowlandi* Toula, a species from the Gatun formation. *T. caribea* d'Orbigny seems to be the living representative of these shells. *T.* (*Scissula*) *cercadica* Maury, a shell from the Santo Domingo Oligocene, is a similar but less elongate form.

Locality.—204.

Horizon.—Quebradillas limestone.

Tellina, species aff. **T. (Angulus) atossa** Dall

Plate XI, Figure 7

A single left valve of a Tellina of uncertain identity. Shell moderately convex, showing prominent lateral teeth; surface with fine sharp concentric lamellae, strongest near the ventral margin, and obscure growth lines between the lamellae. The latter are accentuated on the anterior slope; shallow radial sulcus located next to the posterior dorsal margin. Interior of shell unknown. In outline and general appearance, it resembles *T.* (*Angulus*) *atossa* of the Tampa Silex beds. Length about 20 mm., height 14 mm., semidiameter 4 mm.

Locality.—204.

Horizon.—Quebradillas limestone.

Genus **Metis** H. and A. Adams

Metis trinitaria Dall

Plate X, Figure 7

Metis trinitaria Dall, Trans. Wagner Inst. Sci., III, pt. 5, p. 1041, Pl. 46, fig. 24, 1900.

cf. *Tellina biplicata* Guppy, Quart. Jour. Geol. Soc., XXXII, p. 530, 1876. Not of Conrad.

Metis trinitaria Maury, Bull. Amer. Paleont., V, p. 226, 1917.

The specimens differ somewhat from Dall's description, being more nearly equilateral, and the pallial sinuses of the two valves being subequal and of equal height. The shell seems to be quite variable, however. Ventral margin arcuate, with broad median sinus in the right valve; sharp, rounded posterior fold with a second obscure fold higher up; surface marked by growth lines and faint radial striations, the latter fading out toward the lateral margins. There is some variation in the size and proportions as shown by the following measurements of internal molds:

Length 52 mm., Height 44 mm., Diam. 23 mm.
Length 54 mm., Height 44 mm., Diam. 19 mm.
Length 48 mm., Height 39 mm., Diam. 16 mm.

Some internal molds of this shell, collected in Porto Rico in 1915 by Dr. D. R. Semmes, were shown to Dr. Dall, who identified them as *M. trinitaria*. This species is reported from Trinidad and Cuba, and doubtfully from Santo Domingo. Specimens from Sombrero,

W. I., in the Columbia University collections seem to be of this species, but are considerably larger than the Porto Rican shells.

Localities.—204, 678, 61, 319, 801. 98(Berkey). San Juan district (Semmes). Culebrinas Point (Mitchell).

Horizon.—This shell is the chief horizon marker of the Quebradillas limestone along the north coast. The internal molds are found in great numbers in many localities. It occurs rarely in the Los Puertos limestone, and Ponce limestone.

Genus **Solen** Linné

Solen (Plectosolen) collazoensis, new species

Plate XI, Figure 8

Shell produced anteriorly, with beaks 7.5 mm. behind the anterior margin; both ends roundly truncate; height slightly less in middle of shell than at the ends; beaks inconspicuous; surface marked only by growth lines, strengthened on anterior slope, and a narrow furrow extending from the beaks to the anterior-ventral corner. Length 42 mm., height 11 mm., diameter 6.5 mm.

This is a small straight shell of the section *Plectosolen,* having a strong resemblance to the Eocene forms of the Paris Basin, such as *S. plagiaulax* Cossmann, and *S. laversinensis* Lef. and Wat. It is probably of the type of *S. obliquus* Sowerby. It also resembles a small *S. obliquus* Spengler, but is a true *Plectosolen.*

The description is based on a single specimen from the black shale at Collazo Falls. The specimen is badly fractured, though nearly complete.

Localities.—261, Juana Diaz, Yauco.

Horizon.—San Sebastian shale, Juana Diaz shale.

Genus **Psammosolen** Risso

Psammosolen sancti-dominici Maury

Psammosolen sancti-dominici Maury, Bull. Amer. Paleont., V, No. 29, p. 228, Pl. 37, fig. 13, 1917.

Only two fragments were found, but the marking is distinct and characteristic, and leaves no doubt as to the identity. One specimen seems to be about the same size as the Santo Domingo specimens described by Maury. The other specimen is smaller. The broad median sulcation is barely noticeable.

Locality.—204.

Horizon.—Quebradillas limestone.

Genus **Semele** Schumacher

Semele, species indet.

Shell equivalve, nearly equilateral; beaks low; ends of shell rounded; anterior and posterior dorsal margins make angle of 125°; umbonal ridge low, obscure; escutcheon long and narrow; lunule short, and same width as the escutcheon; surface sculpture of fine, even, sharp concentric lamellae; about fourteen to every 10 mm.; no radial striation visible. Length 35 mm., height 30 mm., diameter 14 mm.

This may be a new species, but the specimens are poor and do not permit an exact description, being known only from internal molds and a few fragments of external mold. The sculpture is finer than that of *S. claytoni* Maury. The shell resembles *S. chipolana* Dall, but is more elongate.

Locality.—225.

Horizon.—Lares limestone.

Genus **Thrachia** Blainville

Subgenus **Cyathodonta** Conrad

Cyathodonta reedsi Maury

Shell equivalve, sub-equilateral, moderately convex; anterior dorsal slope slowly descending, anterior rounded, posterior roundly truncate; sculpture of about twenty-five rounded to sub-angular concentric ripples, markedly wavy or irregular, and owing to the thinness of the shell, equally strong in the internal molds. The ripples have a strong tendency to become oblique on the anterior third of the shell; umbonal ridge low, rounded, beyond which the ripples die out, leaving the posterior dorsal smooth except for growth lines. A right valve shows a low obscure radial fold about one-third the distance from the umbonal ridge to the dorsal margin; beaks rather high and strongly incurved. Gerontic individuals show a complete loss of concentric ripples in the final stages of growth. Adult shell measures in length 27 mm., height 19 mm., semi-diameter 6 mm.

This shell is apparently nearest to *C. gatunensis* Toula but is more elongate, more nearly equilateral, and the smooth posterior slope higher and more produced. It is not as convex as the Gatun shell.

Type Locality.—204.

Other locality.—225 ?.

Range.—Lares ? limestone to Quebradillas limestone.

Genus **Corbula** Lamarck

Corbula collazica Maury

Localities.—Collazo Falls, and doubtfully at 120 and 225.

Horizons.—Typical of the San Sebastian shale, and occurs doubtfully as high as the Lares limestone.

Genus **Teredo** Linné

Teredo incrassata Gabb

Kuphus incrassatus Gabb, Trans. Amer. Phil. Soc., XV, p. 246, 1873; Jour. Acad. Nat. Sci. Phila., new ser., VIII, p. 342, Pl. 44, fig. 12a-e.
Teredo fistula? Guppy, Quart. Jour. Geol. Soc., XXXII, p. 529, 1876.
Teredo incrassata Dall, Trans. Wagner Inst. Sci., III, pt. 6, p. 1587, 1903.
Teredo incrassata Maury, Bull. Amer. Paleont., V, No. 29, p. 235, Pl. 39, fig. 24, 1917.

The tubes vary in diameter, but average 20 mm. They attain considerable length, but are usually found broken in short pieces.

Localities.—86, 10, Collazo Falls, 758, 162, 182, 179, 332, 619, 621, 616, 225, 23, 335, 330, 324, 74, 370, 749(a), 334.

Horizons.—San Sebastian shale, Lares limestone, Cibao limestone, Los Puertos limestone, Quebradillas limestone. Extremely abundant.

Outside the Lares District, this species has been found by Lobeck on Vieques Island (south and east sides), and in basal Tertiary beds near Yauco, P. R. It has been found by Berkey at localities 10, and 78, and by Mitchell in the Ponce formation and Juana Diaz shale.

Genus **Dentalum** Linné

Dentalium, species indet.

Shell long, slender, nearly straight, slowly tapering, circular in cross-section; shell thick, the aperture being only about one-half the diameter of the tube; surface polished, and marked with numerous fine, very regular, longitudinal threads, visible only under a hand lens and transverse light. The threads appear, under a lens, to be minutely beaded, but under a microscope, this appears to be the result of fine raised concentric growth lines, strongest in the interspaces between the longitudinal threads. There are about one hundred longitudinal threads on a tube of 1 mm. diameter. The shell structure is strongly fibrous, the fibrous striations appearing on the longitudinal threads as seen under the microscope. The apex is not shown in any of the specimens. The largest fragment, with a diameter of 1 mm. measures 13 mm. in length. The tapering of the tube is hardly discernible in this length.

Many fragments were found in the lower black shale of a minute *Dentalium*, the largest of which is only about 1 mm. in diameter, and the majority of which average less than ½ mm.

Locality.—261.

Horizon.—San Sebastian shale.

Genus **Calliostoma** Swainson

Calliostoma portoricoensis, new species

Plate XXI, Figure 1

Whorls seven, including a rather high protoconch of two smooth, round whorls; remaining whorls flat; suture narrow but deeply impressed; surface of whorls with six spirals and strongly marked oblique growth lines which cut the spirals, giving them a wavy appearance. The five uppermost spirals are small, sharply raised, with wider concave interspaces. The two spirals immediately below the suture are somewhat smaller and show a tendency to group together. The sixth spiral, immediately above the suture, is very much larger, broad, and bluntly rounded, and forms the peripheral keel; base with eight prominent, broad, flat spirals and fine raised oblique growth lines crossing the spirals and grooves between. Aperture and umbilical area not visible in the specimen. Length 11 mm., diameter 9 mm.

A single specimen was found of a *Calliostoma* remarkable for its elongate conical base (more than two-thirds as long as the spire).

Locality.—204.

Horizon.—Quebradillas limestone.

Genus **Turbo** Linné

Turbo fetkii, new species

Plate XXI, Figure 2

Shell small; whorls six; the first two flat topped, strongly keeled; the remaining whorls sub-round, but with slight angulation and broad flat shoulder, nearly one-third the axial width of the whorl; suture deeply channelled; rounded spirals of two to three different sizes, increasing by intercalation, with total of about twenty on the body whorl, and of these five are very prominent; entire surface crossed by oblique incremental lines, strongest between the spirals; spirals and incremental lines visible in the sutural channel. Height 13 mm., diameter 11 mm.

The above description is based on a single specimen, in which the anterior portion of the body whorl is missing. The shell is remarkable for its extremely deep, squarely channelled suture. The spirals are smooth or with microscopic crenulation produced by the crossing of the growth lines. The spiral anterior to the suture is never prominent. This shell is like *T. rhectogrammicus* Dall, of the Florida Pliocene, but differs from the latter chiefly in its smaller size and its deeply channelled suture. Its suture is like that of *T. spenglerianus* Gmelen, a recent shell from the West Indies, but the latter is much larger and has more spirals. This shell is named in honor of Dr. C. R. Fetke, who has worked on the Geology of the eastern end of Porto Rico.

Locality.—313.

Horizon.—Quebradillas limestone.

Turbo dominicensis Gabb

variety **quebradillensis,** new variety

Shell larger than the Santo Domingo variety, *T. dominicensis laloi* Maury, the internal mold measuring in height (with tip of spire missing) 37 mm., maximum diameter 33 mm. Like the Santo Domingo variety, the final whorl is angulated, as presumably are the earlier whorls, though this cannot be ascertained from the specimen. It is more like Gabb's type, however, in having the majority of the spirals crenulate. On the final whorl the spiral anterior to the suture is more strongly crenulate than the others. Anterior to this, on the shoulder, are four minor crenulate spirals, the two central ones being slightly more prominent than the other two. At the shoulder angulation is a very strong, plain spiral, which projects sharply upward, above the surface of the shoulder. The remainder of the whorl is ornamented with eight or more strong simple spirals, each alternating with a single minor crenulate spiral. The basal portion of the whorl is not preserved. From the small portion visible in the specimen, it seems that the ornamentation of the earlier whorls is similar, but with fewer spirals. The outer lip is lirate for a short distance, there being thirteen lirae and a posterior notch below the shoulder angulation.

This shell was found among the material collected by Dr. Lobeck in the Quebradillas limestone near Bayamon. It consists of a single internal mold and a portion of the external mold of the same specimen, which shows the sculpture of the final whorl and a small portion of the spire. A few internal molds, possibly of the same species were found in the Quebradillas limestone of the Lares district.

Locality.—Near Bayamon (Lobeck), 204?

Horizon.—Quebradillas limestone.

Genus **Liotia** Gray

Liotia (Arene) coronata Dall

variety **portoricoensis**, new variety

Plate XXI, Figure 3

Shell small, five whorls, including flat, smooth naticoid protoconch of two whorls. Two spiral keels appear on the third (or first post-nuclear) whorl. A third spiral appears on the fourth whorl just above the suture; suture deeply channelled; shoulder of third and fourth whorls marked by fine beaded spiral ridge immediately below the suture. Fine growth lines crossed the shoulder and produce a slight beading of the uppermost spiral keel; final whorl smooth except for strongly incised growth lines, which are stronger than the almost obsolete spirals. The final whorl tends to lose the coiling habit, becoming almost free from the preceding whorl. Only a single specimen was found, and the aperture and base of the shell are unknown. Height 5 mm., diameter 5 mm.

The first four whorls of this shell are quite similar to Dall's Tampa species. In the Porto Rican shell the longitudinal wrinkles, characteristic of the Tampa shell, become obsolete on the fourth whorl, but reappear strongly on the last whorl. The Porto Rican variety seems to have been derived from the Tampa species, and is an interesting example of a phylogerontic form.

Locality.—204.

Horizon.—Quebradillas limestone.

Genus **Xenophora** Fischer de Waldheim

Xenophora conchyliophora (Born)

Trochus conchyliophorus Born, Mus. Caes. Vind. p. 333, 1778.
Trochus agglutinans Lamarck, Anim. sans Vert., VII, XIV.
Phorus agglutinans Gabb, Trans. Amer. Phil. Soc., XV, p. 241, 1873.

Xenophora conchyliophora Dall, Trans. Wagner Inst. Sci., III, pt. 2, pp. 360-362, 1892; Bull. 90, U. S. Nat. Mus., p. 105, Pl. 15, figs. 1, 3, 1915.

Xenophora conchyliophora Maury, Bull. Amer. Paleont., V, No. 29, p. 133, Pl. 23, fig. 7, 1917.

The Porto Rican specimens show no differences from the typical forms of this species.

Localities.—204, 225, 24.

Range.—Lares limestone to Quebradillas limestone. Very abundant in the Quebradillas.

Genus **Neritina** Lamarck

Neritina (chipolana var.?) **collazoensis,** new species

Plate XXI, Figure 4

Shell small, fragile, polished, with low spire, and apparently three whorls. A single specimen was obtained, in which the spire has been crushed and the aperture is not visible. The outline of the shell and the surface markings are like *N. chipolana* Dall, but with the markings more crowded and numerous, and all being discontinuous. These lines show, however, the same arrangement in groups of three or four, with zig-zags and curves. The curves are frequently convex in opposite directions in adjacent lines, leaving circular areas between the lines, a feature which is also characteristic of the Chipola species, judging from Dall's illustration (Wagner Inst., III, pt. 4, Pl. 23, fig. 19, 1898). The lines are very narrow, and a dark reddish purple in color. The shell is slightly smaller than the Chipolan form, the height being 4 mm. and the maximum diameter 4.5 mm. In places where the epidermis has been chipped off, exceedingly fine and very regular growth lines may be seen with a lens.

This shell was obtained from a stratum of lignitic shale in the Collazo Falls section, and is associated with fossil leaves and minute, thin-shelled bivalves, apparently fresh water forms. This stratum is intercalated in marine beds, and is of interest in showing the conditions existing in this locality during deposition of the San Sebastian shale.

Locality.—261.

Horizon.—San Sebastian shale.

Genus **Hipponyx** Defrance

Hipponyx portoricoensis, new species

Plate XXI, Figures 5, 6

Shell small, obliquely conical; apex at or near posterior extremity, often overhanging, and slightly recurved; surface with irregular bifurcating radial ribs and less prominent fluted concentric lamellae; interior with faint but large horse-shoe shaped scar.

This shell is very variable, but in all specimens the apex is blunt and rounded. Some specimens show hardly any recurvature to the apex, while in others this feature is marked, and in all cases it is to be left. A strongly recurved specimen measures in diameter of aperture about 7 mm., height of apex above base 4 mm. A low flat shell without curvature measures in diameter 10 mm., height of apex 3 mm. The largest specimen measures in diameter 11 mm., height of apex 6.5 mm.

Localities.—204, 220, 23 ?.

Range.—Los Puertos limestone to Quebradillas limestone.

Genus **Calyptræa** Lamarck

Calyptræa cf. **centralis** Conrad

Infundibulum centralis Conrad, Am. Jour. Sci., XLI, p. 348, 1841; Med. Tert., p. 80, Pl. 45, fig. 5, 1845.

Trochita centralis Emmons, Geol. N. C., p. 276, fig. 193, 1858.

Infundibulum concentricum H. C. Lea, Trans. Amer. Phil. Soc., (2), IX, p. 249, Pl. 35, fig. 39, 1845 (young shell).

Crochita collinsii Gabb, Jour. Acad. Nat. Sci. Phila., (2), VIII, p. 342, Pl. 44, figs. 11, 11a, 1875.

Infundibulum candeanum d'Orbigny, Moll. Cuba, II, p. 190, Pl. 24, figs. 28, 29, 1842.

Galerus candeanus Dall, Hemphill's Shells, p. 335, 1883.

Galerus parvulus Dunker, Jahrb. Deut. Mal. Ges., p. 244, 1875.

Calyptrea candeana Dall, Blake Rept., p. 284, 1889.

Calyptrea centralis Dall, Trans. Wagner Inst. Sci., III, pt. 2, p. 353, 1892.

A single external mold was found which is apparently this species. Diameter of base 8 mm., height of apex 4 mm.

Locality.—204.

Horizon.—Quebradillas limestone.

Genus **Crucibulum** Schumacher

Crucibulum auricula Gmelin
variety **portoricoensis,** new variety

Plate XXI, Figures 7, 8

Cup typical of *C. auricula* Gmelin. Surface with fine, irregular, dichotomus radial lines, crossed by fine wavy growth lines. Form varies from high, acute apex to low apex with broad base. Cup uniform in size and shape in all the specimens. A shell with low apex measures in diameter of base 20 mm. height of apex 7 mm.

Localities.—204. (also Berkey 98).

Horizon.—Quebradillas limestone (fairly abundant).

Crucibulum auricula? variety

Plate XXI, Figure 9

This is probably one of the many variations of *C. auricula.* Only a few fragmental specimens were obtained, and the interior is unknown.

Apex sub-central; coarse radial ribs, somewhat irregular, bifurcating and trifurcating. Diameter 14 mm., height of apex 6 mm.

Locality.—204.

Horizon.—Quebradillas limestone.

Crucibulum (Dispotæa) collazum, new species

Plate XXI, Figure 10

Shell small, smooth; apex eccentric, sharp, strongly gyrate in the normal direction; basal margin sub-circular, with large rounded sinus on the side below the apex. On either side of the sinus the margin flares, or flattens out, and is thickened, being analogous to the thickened outer lip or varix of coiled gastropods; cup large, deep, and about one-half free from the shell wall. Most of the free half has been broken away in the specimen illustrated, but when perfect, it has a tortuous, or S-shaped curvature, and overhangs the apex cavity, being suggestive of the internal appendage of a *Calyptræa.* Diameter of aperture 7 mm., height of apex 4 mm.

Two specimens were collected, both showing the marginal sinus, which is therefore assumed not to be an accident of growth. The shell illustrated appears to be an adult specimen. The other shell is smaller, with a correspondingly smaller marginal sinus.

Localities.—84, 261.

Horizon.—San Sebastian shale.

Genus **Natica** Scopoli

Natica canrena? (Linne) Moerch

Nerita canrena (Linné in part) Auct., Moerch, Malak. Blatt., XXIV, p. 62, 1877.
Natica canrena Gabb, Trans. Amer. Phil. Soc., XV., p. 223, 1873.

Natica canrena Guppy, Quart. Jour. Geol. Soc., XXXII, p. 518, 1876.
Natica canrena Dall, Trans. Wagner Inst. Sci., III, pt. 2, pp. 364-365, 1892.
Natica canrena Brown and Pilsbry, Proc. Acad. Nat. Sci. Phila., p. 508, 1912.
Natica canrena Maury, Bull. Amer. Paleont., V, No. 29, p. 134, Pl. 23, fig. 10, 1917.

A small *Natica* was found which is probably the young of *N. canrena*. The specimen shows on the last whorl the faint oblique striations, which start at the suture. Diameter 7 mm. Several internal molds, possibly of this species, were found in the Cibao limestone at locality 22. The largest measures in height 22 mm., diameter 25 mm.

Locality.—204.

Horizon.—Quebradillas limestone.

Natica (Ampullina?) collazoensis, new species

Plate XXI, Figures 11, 12

Shell large, moderately high spired; suture deeply impressed; whorls six to eight; umbilicus partly covered by callus, or entirely open in some specimens, in which the callus may have been broken away. Some specimens show the last whorl strongly flattened below the suture, while in others the whorl is evenly rounded. This is probably a sex difference; shell thin; surface with numerous fine, impressed spiral lines, and much finer, almost microscopic growth line threads, periodically incised, marking a resting stage in the growth of the shell. The growth lines are remarkable for their evenness. Largest specimen measures in height 66 mm., diameter, 52 mm.

The shell in size and general appearance resembles *Ampullina amphora* Heilprin, and is probably related to the large Eocene forms. It has some resemblance to *Natica* species indet. Brown & Pilsbry (Proc. Acad. Nat. Sci. Phila., p. 360, Pl. 25, figs. 1, 2, 1911), a Gatun shell.

Localities.—262, 265, 86 (base of falls), Collazo Falls, 264 (bottom 3rd falls), 83, 235.

Horizon.—San Sebastian shale. (very abundant).

Genus **Epitonium** Bolten

Epitonium (Cirsotrema) collazoensis, new species

Plate XXII, Figures 1, 2

Shell with three and one-half whorls measures in height 25 mm., maximum diameter 13 mm.; whorls rounded; suture distinct, but not deep; whorls with about twenty-four slightly oblique, moderately strong longitudinal ribs and two opposite rows of sub-continuous varices, the last varix being at the outer lip; longitudinal ribs fluted by another series of oblique ribs of equal strength, descending to the left at about 45°, continuing from suture to suture, and being more or less interrupted by the longitudinal series of ribs. At base of body whorl, both series of ribs terminate against a strong, rugose or rope-like spiral, which encircles the umbilical area, and is interrupted only by the varices. Over the entire surface of the shell is a fine microscopic cloth-like texture composed of three intersecting series of threads, one series vertical, another parallel with the 45° ribs, and the third series descending to the right at about 45°. The three series are named in order of their relative strength, the vertical series being strongest, and locally obscuring the other two series. Aperture circular. In general appearance the shell is typical of the high spired forms of this group.

A single decollate specimen was found of an Epitonium which is remarkable for its microscopic texture, which is somewhat of the nature of that of *E. textuvestitum* Maury, but the shell is quite different from the latter. Apparently the nearest relatives of this shell are to be found in the Paris Basin beds. Two such forms, very similar, though smaller, are *Cirsotrema subspinosum* (Grat.) of the Aquitanien, and *C. bourgeoisi* de Boury, of the Helvetian. This relationship is of considerable significance in considering the age of the San Sebastian shale.

Locality.—K. 29.2-3 Lares road.

Horizon.—San Sebastian shale.

Genus **Turritella** Lamarck

Turritella tornata Guppy

variety **portoricoensis**, new variety

Plate XXI, Figures 13, 14

Shell corresponds with Guppy's description, except that in the last few whorls the anterior keel is double, and there are frequently as many as four spiral threads in the median concavity. There are also from one to two threads on the shoulder and likewise on the slope below the lower keel. The base is spirally threaded and marked by accentuated growth lines. The beading of the spirals is lacking or obscure, due probably to the poor state of preservation of the specimens. All specimens are decollate. The largest has a maximum diameter of 14 mm. and height (4 whorls) of 26 mm.; the average sized specimen has a maximum diameter of 10 mm.

This species is extremely abundant in the San Sebastian shale. Nearly all specimens are poorly preserved casts or internal molds, and the ornamentation is difficult to make out.

Type locality.—232(b).

Other localities.—225, 331, 333, 343, Collazo Falls, 226, 262, 83, 233.

Range.—San Sebastian shale to Lares limestone.

Turritella planigyrata Guppy

T. planigyrata Guppy, Proc. Sci. Assoc. Trinidad, p. 169, 1867; Geol. Mag., p. 408, Pl. 18, fig. 5, 1874.

T. planigyrata Gabb, Trans. Amer. Phil. Soc., XV, p. 240, 1873.

T. planigyrata Guppy, Quart. Jour. Geol. Soc., XXXII, p. 519, 1876.

T. planigyrata Maury, Bull. Amer. Paleont., V, No. 29, p. 129, Pl. 22, fig. 14, 1917.

A fragment comprising the last three whorls. Height 14 mm., maximum diameter 8.5 mm. The specimen agrees with the descriptions by Guppy and Gabb, and there seems to be no doubt of the identity.

Locality.—234.

Horizon.—San Sebastian shale.

Turritella mitchelli, new species

Plate XXII, Figure 3

A single decollate specimen with seven and one-half whorls. Shell large, high spired (apical angle 5°); whorls flat and continuous; suture indistinct or invisible; whorls marked by three prominent crenulated spirals and minor, minutely beaded spiral threads; the whole surface covered by minute spiral striae and longitudinal growth lines, the latter producing the crenulation in the spirals. In front of each suture is a flat area, less than one-third the axial width of the whorl, marked by two to three obscure spiral threads; next in order come a single primary spiral, followed by two fairly prominent secondary spirals in the median portion of the whorl. The anterior third of the whorl is marked by the two most prominent primary spirals with a narrow channel between them, giving the effect of a doubled spiral band. The anterior member of this pair is slightly larger than the other on the last two whorls. Of the microscopic sculpture above mentioned, the spiral striae are the most prominent on the primary ridges, and obsolete in the interspaces, whereas the reverse is true of the growth lines, which results in the strongest beading being on the minor spirals in the interspaces. The base is sulcated below the anterior primary spiral, and is moderately convex anterior to this sulcus. The surface of the base is marked only by the spiral striae and growth lines, which here are markedly wavy or vermicular. The suture is distinct on the last two whorls, but on the spire it is invisible, being concealed by the anterior primary spiral, which overhangs it. Height 59 mm., maximum diameter 22 mm.

As the protoconch and upper portion of the spire are missing, it is difficult to trace the relationship of this shell with other species. The succession and arrangement of spirals is similar to *T. halensis* Dall, a shell from the Flint River Oligocene. The finer sculpture and beading resemble *T. altilira* Conrad, of the Gatun formation, and *T. calostemma* Pilsbry & Brown, of the Oligocene of Haiti. This shell is undoubtedly a member of the *T. tornata—T. altilira* group, and is probably closest to *T. calostemma.* Berkey found a similar, and apparently related shell from the basal Tertiary near Juana Diaz. It differs in having four equally strong major spirals. This shell is named in honor of Dr. G. J. Mitchell.

Locality.—Collazo.

Horizon.—San Sebastian shale.

Turritella portoricoensis, new species

Plate XXI, Figure 15

Shell small; spire acute; about ten rounded whorls with about fifteen fine spiral threads with sub-equal intervals; suture distinct, but not channelled until the last three whorls; whorls at first evenly rounded with spiral threads of equal strength, but later becoming angulated by accentuation of spiral threads into a keel at periphery of whorl and another at anterior end of whorl, overhanging the suture; first three whorls loosely coiled; protoconch missing on all specimens. The angulation begins at about the seventh whorl. A specimen with nine whorls measures in height 13 mm., maximum diameter 4 mm.

The young of this shell has the whorls of *T. plebeia* Say, and in the adult, the whorls are like those of *T. æquistriata* Conrad, in some respects. The later whorls also resemble *T. subannulata acropora* Dall, but are not quite as angular as in the latter species. The nearest Antillean forms are *T. planigyrata* Guppy, of Santo Domingo, and *T. gatunensis* Conrad, of Panama. The Porto Rican shell is probably a less specialized member of this group.

Locality.—204.

Horizon.—Quebradillas limestone.

Turritella berkeyi, new species

Plate XXII, Figure 4

Shell extremely high spired, slender; whorls twenty-one; earliest whorls simple, with two keels of equal size; anterior and posterior slopes of whorls straight and of equal width; simple rounded median depression between the two keels; last ten whorls with the posterior keel becoming double and the shoulder of the whorl becoming gently convex, features which are quite prominent in the adult stage; beginning with the eighth or ninth whorl an obscure spiral appears on the anterior extermity of the whorl just above the suture and partially overlapped by the succeeding whorl; surface throughout is lacking in ornamentation. Height 73 mm., maximum diameter 11 mm.

This shell may possibly be a primitive form of *T. perattennuata* Heilprin. It resembles *T. alcida* Dall, but is very much more slender. Other somewhat similar forms are *T. altilirata* Conrad, and *T. variabilis* variety *alticosta* Conrad.

Locality.—204.

Horizon.—Quebradillas limestone.

Genus **Petaloconchus** Lea

Petaloconchus domingensis Sowerby

Petaloconchus domingensis Sowerby, Quart. Jour. Geol. Soc., VI, p. 51, Pl. 10, fig. 8, a, b, c, 1849.

Petaloconchus sculpturatus Gabb, Trans. Amer. Phil. Soc., XV, p. 240, 1873. Not of Lea.

Petaloconchus sculpturatus Guppy, Quart. Jour. Geol. Soc., XXXII, p. 519, 1876.

Vermetus (*Petaloconchus*) *sculpturatus* Dall (in part), Trans. Wagner Inst. Sci., III, pt. 2, pp. 305, 306, 1892.

Petaloconchus domingensis Brown and Pilsbry, Proc. Acad. Nat. Sci. Phila., p. 359, 1911.

Petaloconchus domingensis Maury, Bull. Amer. Paleont., V, No. 29, p. 128, Pl. 22, fig. 11, 1917.

A single specimen was found, showing part of the coiled portion of the shell. There seems to be no doubt as to the identity. The fragment with three whorls measures in height 8 mm., diameter 6 mm., diameter of whorl about 3 mm.

Locality.—204.

Horizon.—Quebradillas limestone.

Petaloconchus? collazoensis, new species

Plate XXI, Figure 16

Tube of small diameter (2.5 mm.); surface smooth except for faint growth lines; tip of spire missing in specimens, but one specimen shows a loosely, irregularly coiled cylindrical spire of five whorls; diameter of spire 10 mm.; whorls are in contact, but coiled with a 5 mm. radius, leaving large umbilical opening, the whole resembling the coiled steam pipes of a cylindrical boiler. The specimens show that the coiling habit ceases abruptly, the tubes then growing in all directions, almost tying knots.

Localities.—263, Collazo Falls.

Horizon.—San Sebastian shale.

Genus **Pyramidella** Lamarck

Pyramidella portoricoensis, new species

Plate XXI, Figure 17

Shell small, conic, smooth, rather low spired; seven flat whorls with sharp median spiral offset, forming, with the sharply beveled shoulder of the overlapping whorl, a broad, square sutural channel. The median offset, or angulation, continues around the body whorl; suture of earlier whorls is narrow; large circular perforation extends the entire length of the axis, and is very conspicuous as seen from the base; columella tri-plicate; posterior plication large and distinct; the other two small and obscure, of which the anterior one is situated at the extreme base of the columella; aperture oval; outer lip simple; height 4.75 mm., diameter 2 mm.

This shell resembles *P.* (*Longchœus*) *forulata* Guppy, but its umbilicus places it with the typical group of *Pyramidella*. The suture is of the type of *P. semicanaliculatus* Maury.

Locality.—204.

Horizon.—Quebradillas limestone.

Genus **Modulus** Gray

Modulus modulus Linné

variety **basileus** Guppy

Monodonta basilea Guppy, Geol. Mag., new ser. decade 2, I, p. 434, Pl. 16, fig. 2, 1874.

Modulus basilea Dall, Trans. Wagner Inst. Sci., III, pt. 2, p. 294, 1892.

Modulus modulus var. *basilea* Dall, Trans. Wagner Inst. Sci., III, pt. 6, p. 1585, 1903.

This shell is apparently the same as that described by Guppy from the Bowden. It agrees with Guppy's description, especially in its low spire, and tuberculated, carinate whorls. On the lower portion of the final whorl, however, it apparently differs somewhat from the Bowden shell in having spirals of variable size, the primaries alternating with one or more fine secondary threads. Judging from Guppy's illustration, the aperture of the Porto Rican shell is broader. The outer lip is denticulate, but the interior is not preserved, so as to show whether the lirate character exists or not. Height of shell is 14 mm., diameter 13 mm.

Apparently the modern representative of this shell is *M. lenticularis* (Chemn.) Auct., which according to Tryon is synonymous with *M. modulus* Linné.

Locality.—East side of Vieques Island (Collected by A. K. Lobeck).

Horizon.—Quebradillas limestone.

Genus **Bittium** (Leach M. S.) Gray

Bittium species indet.

Plate XXI, Figure 18

Whorls six (or more), with three raised spirals crossed by sharp ribs of equal height, and about twelve to a whorl; prominent nodes produced at intersections of ribs and spirals; suture deeply impressed; height (6 whorls) 11 mm., diameter 5 mm.

A single specimen, too imperfect to identify or describe fully.

Locality.—204.

Horizon.—Quebradillas limestone.

Genus **Cerithium** Adanson

Cerithium portoricoensis, new species

Plate XXII, Figures 5, 6

Shell small, slender; protoconch unknown; whorls twelve or thirteen, rounded, with obscure varices of irregular occurrence on the last six whorls, and usually a prominent varix on the body whorl; first three whorls with three primary spirals crossed by about twelve narrow rounded ribs, more prominent than the spirals, and slightly nodose where they cross the latter, the whole producing a cancellate structure with rectangular pits; a fourth primary spiral appears on the fourth whorl; beginning with the sixth whorl, secondary, less prominent spiral threads appear, two immediately above the suture, and one between each of the four primaries. The two uppermost secondaries do not appear until the seventh whorl; on last four whorls the ribs have increased to about twenty in number, are irregular, low, and obscure, being marked chiefly by the lines of nodes where they cross the primary spirals. The ribs usually become obsolete on the anterior two-thirds of the body whorl; aperture short, slightly more than half the length of the body whorl; posterior canal small, U-shaped; anterior canal not quite covered by inner lip; outer lip slightly thickened; three average specimens have the following measurements:

Height 20 mm., Maximum Diameter 6 mm.
Height 17 mm., Maximum Diameter 5 mm.
Height 16 mm., Maximum Diameter 5 mm.

This shell has a superficial resemblance to *C. coccodes* Dall, and to *Clava chipolana* Dall.

Locality.—204.

Horizon.—Quebradillas limestone (abundant).

Cerithium quebradillensis, new species

Plate XXI, Figures 7, 8

A single decollate specimen with six whorls; earliest whorls roundly angular, with shoulder and peripheral keel; last three whorls with about 12 high, rounded ribs, sub-nodose at the keel; all whorls with primary spirals and secondary spiral threads; last four whorls with very fine tertiary spiral threads; earliest whorls show two closely grouped primary spirals at the keel, the upper one slightly stronger and forming the periphery of the whorl; a third primary occurs at (just posterior to) the suture; these primaries persist throughout, and a fourth primary spiral occurs on the base, being covered in the preceding whorls. It lies close to the suture; the secondary spirals at first form a group of three on the shoulder, another group of three below the keel, and a single one between the primary spirals of the keel. The three on the shoulder are markedly stronger than the other secondaries, a feature which persists throughout; on the third whorl (of the decollate specimen) the tertiary spiral threads appear, the first just above the sutural primary, the next ones intercalated between the secondaries in the group below the keel. The tertiaries do not appear on the shoulder until the fourth whorl; the shoulder, adjacent to the suture, is, in all whorls, marked by a rather wide band, at first smooth, but later marked by from one to six tertiary threads; all whorls are marked by fine, raised growth lines, or longitudinal threads, which produce a minute beading on crossing the spirals, and which in the earlier whorls, produce with the spirals a fine cancellate ornamentation; the primary spirals of the later whorls have a secondary superimposed thread, which is beaded by the growth lines; the base is slightly concave, and is sculptured with spirals of four sizes, more or less alternating. The single primary, above described, is sculptured with numerous minute spiral threads; pillar smooth, with no callus, anterior notch small, short, recurved; slight suggestion of a posterior notch; aperture ovate. Height 32 mm., diameter 15 mm.

The most striking feature of this shell is the sudden change in the character of ornamentation of the whorls, with the appearance of the ribs. This final ribbed sculpture resembles that of *C. callisoma* Dall, from the Caloosahatchie Pliocene, but the Porto Rican shell differs from the latter in its concave base and general turritelolid aspect. It is apparently not closely related to any species of the Antillean region.

Locality.—204.

Horizon.—Quebradillas limestone.

Cerithium (Campanile) collazum, new species

Plate XXIII, Figures 1, 2

Shell large, conic, rapidly enlarging; whorls flattened to slightly rounded, with a median concavity in the later whorls of adult individuals; suture deeply impressed; each whorl with a flat, narrow shelf or shoulder projecting beyond the preceeding whorl; surface of whorls with medium fine, nodose spirals like those of *C. halense* Dall, but with different arrangement. Just behind the suture are one to two very finely nodose spiral threads, one of which is frequently obscured by the overlapping whorl. Behind these is the largest spiral, ornamented with small round nodes about 2 mm. apart. The remainder of the whorl is ornamented with finer spirals, nodose, and alternating in size. The median concavity of the later whorls comes immediately posterior to the large noded spiral above described. The interspaces are slightly narrower than the spirals; base flattened, slightly convex, smooth; aperture roundly quadrate; columella stout, with single prominent fold, anterior notch short, large, recurved. A large decollate specimen with six whorls measures in height 48 mm., maximum diameter 28 mm.

An interesting feature of this shell is the presence in the adult stage of an impressed spiral line near the periphery of the base, which marks the line of juncture with each succeeding whorl. This is an adult character, and is lacking in the earlier whorls. It is apparently an illustration of the inheritance of an acquired character. Another interesting feature is the change in form of the whorl from rounded in youth to flattened, and finally to a concave form in the final stages of old individuals.

It would seem that this shell is related to some of the large, conical forms from the Flint River Oligocene, such as *C. halense* Dall, as its ornamentation is quite similar to the latter. It differs notably in the shape of its whorls, and in this latter respect, is more like the large species of *Campanile* from the Paris Basin Eocene. Maury has described the internal mold of a larger, but similar shell from the San Sebastian shale *Campanile* (*Portoricia*) *laricum* Maury, which may be a related species or a variety. Maury's species differs chiefly in its flatter and more concave whorls, as well as in its considerably greater size.

Localities.—262, Collazo Falls, 142?, 236, 749(a).

Range.—San Sebastian shale to lower Lares limestone.

Genus **Strombus** Linné

Strombus proximus? Sowerby

Strombus proximus Sowerby, Quart. Jour. Geol. Soc., VI, p. 48, Pl. 9, fig. 8, 1849.

Strombus pugilis Gabb (in part), Trans. Amer. Phil. Soc., XV, p. 233, 1873. Not *pugilis* Linné. Exclude other synonyms.

Strombus proximus Guppy, Quart. Jour. Geol. Soc., XXXII, p. 521, 1876.

Strombus pugilis Dall (in part), Trans. Wagner Inst. Sci., III, pt. 1, p. 177, 1890. Not *pugilis* Linné.

Strombus proximus Maury, Bull. Amer. Paleont., V, No. 29, p. 119, Pl. 20, figs, 4, 5, 1917.

Only incomplete specimens were found, which are identified doubtfully with this species.

Localities.—204, Mona Island (Lobeck).

Horizon.—Quebradillas limestone, Ponce limestone.

Strombus bifrons? Sowerby

A single specimen was found among the material collected from the Quebradillas limestone near Bayamon by Dr. Lobeck. The internal mold shows that the shell is the same shape as *S. bifrons,* and measures in height (with tip of spire missing) 32 mm., diameter 19 mm. It is apparently an immature specimen, for the outer lip does not flare to any extent, and the anterior notch is not noticeably recurved. The ornamentation consists of spirals like those of *S. bifrons,* but with the nodes or spines rather obsolete on the final whorl, in which respect it resembles *S. gatunensis* Toula. *S. bifrons* is characteristic of the Aphera and Sconsia formations in Santo Domingo.

Locality.—Near Bayamon (Lobeck).

Horizon.—Quebradillas limestone.

Genus **Orthaulax** Gabb

Orthaulax gabbi? Dall

Plate XXIII, Figure 3

A single specimen was obtained from the sea cliff at the mouth of the Guajataca River in a stratum of very resistant limestone. The specimen had been exposed to the polishing action of the waves, and the original coloring, a light mottled brown, is preserved on the body of the shell near the aperture. The surface of the body whorl and spire are marked by the numerous faint longitudinal growth lines characteristic of the genus. Viewed from above, the outline is subcircular, with a slight triangularity as in *O. pugnax* Heilprin and *O. gabbi* Dall. The apical angle is about the same as that of *O. gabbi,* but considerably more acute than that of *O. aguadillensis* Maury, a shell apparently from the same horizon. A marked subangularity of the body whorl is very similar to that of *O. gabbi.* Above this angulation the whorl is strongly convex; below it, the whorl is concave, with a slight convexity midway between the angularity and the anterior end of the shell. The angularity is strongest at the aperture, on the inner lip, but is obsolete over the final two thirds of the body whorl. A slight shoulder is developed above the angulation on the final portion of the body. Height of shell 65 mm., diameter 38 mm.

This shell was examined by Dr. Dall, who states that while the specimen is too poor for positive identification, it is probably *O. gabbi,* a shell characteristic of the Chipola horizon. A comparison with *O. aguadillensis* Maury, a fragmental specimen, shows that the shell here described is quite a different species.

Locality.—204.

Horizon.—Quebradillas limestone.

Orthaulax portoricoensis, new species

Plate XXV, Figures 1, 2, 3, 4, 5

Under this heading are included all the large Strombus-like internal molds, which are among the most abundant forms to be found in the Quebradillas limestone. One of these internal molds was figured by Semmes, in his report on the San Juan District, as *Strombus,* species indet. The internal molds, taken by themselves, are generically indeterminate, but resemble the molds of a large *Strombus.* Fortunately, a few of these internal molds were found with portions of the external mold adhering to the specimens, which proves beyond a doubt that these large shells belong to the genus *Orthaulax.* They attain a size much greater than any species of *Orthaulax* yet known.

The specimens illustrated by figures 1 and 2 were examined by Dr. Dall, who states that:

1. Figure 1 is undoubtedly an *Orthaulax,* possibly the same species as Figure 2, but having a more acute or pointed spire.

2. Figure 2 is also an *Orthaulax,* new species, almost certainly the same species as an undescribed form from Santa Cruz.

3. Neither of these specimens is the same species as the shell described in this report as *O. gabbi?* Dall.

A large number of specimens, in addition to the two examined by Dr. Dall, show considerable variation in size and elevation, or acuteness of the spire. The fact that all these variations can be found in shells collected from a single fossiliferous pocket in the limestone, would indicate that they are for the most part variations of a single species, although more than one species of *Orthaulax* occur in the Quebradillas formation.

The apical angle as measured from the external molds, varies from 78° to 90° (largest specimen); and from the internal molds, varies from 60° to 85°. The following are measurements taken from a few of the internal molds:

	Height	Diameter	Apical Angle
1..........	155 mm.........	105 mm.........	83°
2..........	115	80	85
3..........	....	75	82
4..........	....	60	75
5...(Fig. 1)	....	40	60
6....(Fig. 2)	80	53	73
7..........	75	50	75
8..........	70	43	72
9..........	70	40	71
10..........	60	35	68

From these measurements, it will be observed that the smaller shells have a higher, more acute spire. This may be a varietal difference. Figures 3 and 4 show the internal mold of one of these smaller shells in which the final whorl has begun to envelop the spire, thus indicating that all of these small shells may be immature individuals. Figure 1 shows the internal mold of the spire, and the external mold of the enveloping dome of an adult shell. The curious openwork structure replacing the shell wall is the cast of the burrowing of a sponge or some other organism. This boring animal seems to have taken a special liking to the thick-shelled *Orthaulax* and other ponderous gastropods of the Quebradillas formation. The burrows became infiltrated with lime carbonate, which solidified with the surrounding limestone. The shell structures were then removed by solution, leaving the casts of these burrows in the form of a complex network resembling calcareous algae. Figure 5 shows the dome of an adult shell of the low spired type, and illustrating the degree to which the shell had been riddled with globular chambers, frequently connected by long worm-like passages.

Localities.—204, 41, 52(a), 801, and numerous other localities not recorded. An excellent specimen was collected by Dr. A. K. Lobeck on the east coast of Vieques Island.

Horizon.—Quebradillas limestone, Los Puertos limestone. Characteristic of the Quebradillas of the entire north coast of Porto Rico, as shown by the collections of Berkey and Semmes.

Genus **Cypræa** Linné

Cypræa spurcoides? Gabb

Cypræa spurcoides Gabb, Trans. Amer. Phil. Soc., V, p. 235, 1873.
Cypræa spurcoides Maury, Bull. Amer. Paleont., V, No. 29, p. 115, Pl. 19, figs. 7, 8, 9, 1917.

Apparently the same as the form described from Santo Domingo, except that the crenulations of the two lips are more nearly equal in number. Height 24 mm., maximum diameter 18 mm.

Locality.—204.

Horizon.—Quebradillas limestone.

Cypræa sancti-sebastiani Maury

Localities.—262, 232(b), 263?, 233, 235, 237, Juana Diaz.

Horizon.—San Sebastian shale, Juana Diaz shale.

Genus **Cassis** Lamarck

Cassis, species indet.

Plate XXII, Figure 9

Internal molds of a shell which may possibly be a new species. The distinguishing feature is the presence of a strong varix on the body whorl on the side opposite the aperture. Outer lip simple, apparently not thickened. The specimens are uniform in size and appear to be adult. The external sculpture, judging from impressions on the internal molds, consists of from eighteen to twenty broad spirals on the last whorl, with correspondingly fewer spirals on the earlier whorls. Height 30 mm., diameter 23 mm.

This shell is apparently of the type of *Phalium aldrichi* Dall, but is not quite as broad as the latter.

Localities.—232(b), 236.

Horizon.—San Sebastian shale.

Genus **Dolium** Lamarck

Subgenus **Malea** Valenciennes

Malea camura Guppy

Malea camura Guppy, Quart. Jour. Geol. Soc., XXII, p. 287, Pl. 17, fig. 9, 1866.
Malea ringens Gabb (in part), Trans. Amer. Phil. Soc., XV, p. 223, 1873.

Malea camura Guppy, Quart. Jour. Geol. Soc., XXXII, p. 525, 1876.
Malea camura Dall, Trans. Wagner Inst. Sci., III, pt. 6, p. 1584, 1903.
Malea camura Maury, Bull. Amer. Paleont., V, No. 29, p. 112, Pl. 19, fig. 3, 1917.

The specimens average about 37 mm. by 27 mm. Only internal molds were found with a few fragments of external mold.

Locality.—204; and Berkey 98.

Horizon.—Quebradillas limestone (abundant).

Genus **Columbella** Lamarck

Subgenus **Strombina** Moerch

Strombina portoricana, new species

Plate XXIII, Figure 4

Protoconch of two whorls, rather large, smooth, naticoid; post-nuclear whorls six to seven, moderately convex; suture distinct, but not channelled, and becoming obscure on last whorl; surface of whorls smooth except for faint growth striae, and by hump-like varices, or swellings, occurring as early as the third post-nuclear whorl; body whorl with spiral lines, alternating in strength, on the pillar and lower part of whorl, but very faint over the remainder of the whorl, and more closely spaced near the suture and on the pillar. A specimen with eight whorls and base of pillar missing measures in height 19.5 mm., diameter 9 mm. The largest specimen measures in height 33 mm., diameter 17 mm.

No complete specimens were found, and none showing the lip or aperture. This shell is apparently related to the group represented by *S. lessepsiana* Brown & Pilsbry, *S. prisma* Pilsbry & Johnson, and *S. cyphonotus* Pilsbry & Johnson.

Locality.—204.

Horizon.—Quebradillas limestone.

Genus **Phos** Montfort

Phos costatus Gabb

Plate XXII, Figure 10

Phos costatus Gabb, Trans. Amer. Phil. Soc., XV, p. 212, 1873.
Phos costatus Maury, Bull. Amer. Paleont., V, No. 29, p. 88, Pl. 14, figs. 13, 14, 1917.

The specimens correspond closely to those figured by Maury from Santo Domingo. Protoconch not preserved in any of the specimens.

An adult specimen measures in height 29 mm., diameter 14 mm. Number of whorls eight.

Locality.—204.

Horizon.—Quebradillas limestone (abundant).

Phos elegans Guppy

variety **portoricoensis**, new variety

Plate XXII, Figure 11

Shell small (height about 20 mm.), high spired; whorls rounded, with about fourteen rather sharply rounded ribs, crossed by primary, and frequently alternating smaller secondary spirals; small tubercules at intersections of spirals and ribs; occasionally two or three longitudinal threads between the ribs which do not cross the spirals; ribs irregularly spaced, especially on the body whorl, where a varix is formed at or near the aperture; ribs on the spire frequently vary in size, but do not form varices.

All the specimens are fragmental, but sufficient to show the entire shell except the protoconch. This variety is probably closest to the Santo Domingan occurrence of the species.

Locality.—192.

Horizon.—Quebradillas limestone.

Genius **Murex** Linné

Murex (Phyllonotus) cornurectus Guppy

M. (*Chicoreus*) *megacerus* Gabb, Trans. Amer. Phil. Soc., XV, p. 202, 1873. Not *M. megacerus* Sowerby.

M. cornurectus Guppy, Quart. Jour. Geol. Soc., XXXII, p. 521, Pl. 28, fig. 4, 1876.

M. (*Phyllonotus*) *cornurectus* Maury, Bull. Amer. Paleont., V, No. 29, p. 103, Pl. 16, figs. 9, 10, 1917.

An internal mold, together with a portion of the external mold, was found of a large *Murex* which seems to be this species. Height (of last three whorls) 80 mm., diameter (of internal mold) 45 mm.

Locality.—204.

Horizon.—Quebradillas limestone.

Genus **Alectrion** Montfort

Alectrion gurabensis Maury

variety **portoricoensis**, new variety

variety **varicum**, new variety

Plate XXII, Figures 12, 13, 14, 15

Plate XXIV, Figure 19

The Arecibo limestone contains an abundance of a small shell which is like *A. gurabensis* Maury, a Santo Domingan form, but which has some very evident differences from the latter. These shells fall into two distinct varieties, one with coarse ribs, the other with finer, more numerous ribs and a pronounced varix. The former are here called variety *portoricoensis,* the latter variety *varicum.* The former is by far the most abundant of the two. Both forms are smaller and have fewer whorls than the Santo Domingo type, but they are not young shells as shown by the uniformity in size among a large number of specimens. No specimen of either variety was found which measures more than 8 mm. in height.

The following table shows the relation of the two varieties to the type form from Santo Domingo, as described by Maury (Bull. Amer. Paleont., V, No. 29, p. 91, Pl. 15, fig. 21, 1917):

Locality.—204.

Horizon.—Quebradillas limestone.

Genus **Fusus** Lamarck

Fusus henekeni Sowerby

Plate XVIII, Figure 5

Fusus henekeri Sowerby, Quart. Jour. Geol. Soc., VI, p. 49, 1849.
Fusus henekeni Gabb, Trans. Amer. Phil. Soc., XV, p. 204, 1873.
Fusus henekeni Guppy, Geol. Mag., p. 439, 1874; Quart. Jour. Geol. Soc., XXXII, p. 524, Pl. 28, fig. 6 (type), fig. 2 (var. *haitensis*), 1876.
Fusus henekeri Dall, Trans. Wagner Inst. Sci., III, pt. 6, p. 1584, 1903.
Fusus henekeni Grabau, Smithsonian Misc. Coll., XLIV, No. 1417, p. 19, 1904.
Fusus henekeni Maury, Bull. Amer. Paleont., V, No. 29, p. 78, Pl. 12, fig. 1, 1917.

A single specimen was found, with protoconch and body whorl missing. Only primary and secondary spirals show on the specimen.

TABLE 3

Characters	*A. gurabensis* Maury Santo Domingo	*A. gurabensis* var. *portoricensis* Porto Rico	*A. gurabensis* var. *varicum* Porto Rico
Size	Height 11 mm. Diameter 6 mm.	Height 7 mm. Diameter 4.5 mm.	Height 8 mm. Diameter 4.5 mm.
Nuclear whorls	3 smooth	2–2.5	2?
Post-nuclear whorls	6	5	5
Character of post - nuclear whorls	Convex, angulated and shouldered; ribs narrow, round; wider interspaces.	Convex, sub-angular and shouldered.	Earlier whorls sub-angular—the last two are rounded.
Suture	Wavy	Wavy	Slightly wavy
Ribs on body whorl	11	12 Slightly oblique	13–14 Oblique
Spirals on spire.	Penultimate whorl 3 strong, widely spaced 3 weaker above 3 weaker below	Penultimate whorl same as in the Santo Domingo shell	3rd post-nuclear 1 weak posterior 3 strong median 2 weak anterior enultimate 3 weak posterior 3 strong median 4 weak anterior
Spirals on body	3 or 4 weak posterior 3 strong median 12 weak anterior	2–3 weak posterior 3–4 strong median 10–13 weak anterior	3 weak posterior 3 strong median 12 weak anterior
Spirals on pillar	8	6–7, arrangement—2 strong alternate with 2 weak	?
Aperture	Round	Sub-Round	Round
Outer lip	8 lirae	Thin 15 lirae, alternate long and short	Thickened by strong varix
Inner lip	Posterior denticle	Smooth, moderately thick callus. Posterior denticle absent or obscure.	Smooth, moderately thick callus. Posterior denticle
Anterior canal..	Well defined	Broad and deep	?

This is probably a small variety, otherwise very close to the type form, but more specimens are required for a complete description. The spire of eight whorls measures in height 20 mm., maximum diameter 8.5 mm.

Locality.—204.

Horizon.—Quebradillas limestone.

Genus **Turbinella** Lamarck

Turbinella chipolana Dall

variety **precursor,** new variety

Plate XXIII, Figures 6, 7

Shell small, fusiform, consisting of three and one-half nuclear whorls and three post-nuclear whorls; protoconch like *T. chipolana* Dall and *T. regina* Heilprin, in having a swollen tip, succeeded by smaller nuclear whorls. The tip consists of one and one-half volutions, is transversely ovate, and is peculiar in having a shallow median constriction. The two succeeding nuclear whorls considerably smaller in diameter, the first being gently convex, the last nearly flat. The latter is succeeded abruptly by sculptured whorls with seven rounded, not nodose ribs, and prominent spirals, of which there are four on the first two, and about twenty-three on the final whorl and pillar. The spirals are separated by wider interspaces. The whorls are marked by a prominent, narrow and wavy sub-sutural band or shoulder, sculptured with at first one and later with two spirals. The interspace immediately below the shoulder is strongly impressed. The spirals are of equal strength, except on the pillar, where faint intercalated threads appear. The entire post-nuclear surface is marked by fine raised longitudinal growth lines, strongest in the interspaces between the spirals. Height of shell 17.5 mm., maximum diameter 7 mm.; height of protoconch 3½ mm., diameter of tip of protoconch 2⅓ mm.

This shell is probably the ancestor of *T. chipolana* Dall. It is apparently adult, its small size being indicative of its primitive character. The same is true of variety *areciboense,* a mutation from the San Sebastian shell occurring in the Quebradillas limestone. All the material available was gone over thoroughly with the purpose of trying to find some molds or fragments which would show that these shells reach a larger size, but the results were negative. It seems, therefore, safe to assume that the primitive *Turbinellas* were small forms, which did not reach their maximum size until the Pliocene. Analogous cases may be seen in some of the genetic groups of *Fusus* (Grabau, A. W. Phyl. Fusus, Smithson. Miscl. Coll., XLIV, No. 1417, 1904).

Locality.—84.

Horizon.—San Sebastian shale.

Turbinella chipolana Dall

variety **areciboense,** new variety

Plate XXIII, Figure 8

A single specimen in which the lower half of the body whorl is missing. Protoconch like that of variety *precursor*, but without median construction of the tip, and with the third whorl almost entirely concealed by the overlapping of the first post-nuclear whorl, giving the appearance of a two-whorl protoconch. The tip is slightly larger (diameter 3 mm.) than that of *precursor*, and slightly more swollen when compared with the succeeding whorls. The whorl following the tip is nearly flat, whereas in *precursor* it is noticeably convex. The first post-nuclear whorl has ribs, spirals, and subsutural band, or shoulder, as in *precursor* and represents the *precursor* stage. On the next and following whorls, however, the ribs become nodose, and on later whorls there are more spirals than in *precursor*, with occasionally a fine intercalated spiral. The longitudinal growth lines are similar to those of *precursor*, but show a tendency to alternate in strength. The subsutural band, or shoulder, is prominent in the first two post-nuclear whorls and marked by a single spiral; on the third whorl it is inconspicuous, and marked by two spirals, as in the later whorls of *precursor*, while on the fourth and fifth (or final) whorls it has disappeared altogether. This fact is interesting in showing the tendency to lose a primitive character which has apparently been completely lost in the Chipolan shell. Height of fragment 20 mm., maximum diameter 11 mm.

This shell is a mutation from variety *precursor*, the *precursor*, or simple ribbed stage being accelerated and limited to the first post-nuclear whorl. The later whorls have nodose ribs and represent what may be termed the *areciboense* stage. This shell is best interpreted as a local mutation not in the direct line leading to *T. chipolana* and *T. regina*.

Locality.—204.

Horizon.—Quebradillas limestone.

Genus **Xancus** Bolten

Xancus validus Sowerby

Turbinellus validus Sowerby, Quart. Jour. Geol. Soc., VI, p. 50, 1849.
Turbinella valida Gabb, Trans. Amer. Phil. Soc., XV, p. 218, 1873.
Turbinellus validus Guppy, Geol. Mag., p. 438, 1874; Quart. Jour. Geol. Soc., XXXII, p. 523, 1876.
Turbinella scolymus Tryon (in part) Man. Conch., IV, p. 70, 1882. Not the recent shell.
Turbinella validus Dall, Trans. Wagner Inst. Sci., III, pt. 1, p. 99, 1890.
Turbinella scolymus Dall (in part), Trans. Wagner Inst. Sci., III, pt. 1, p. 97, 1890.
Xancus validus Maury, Bull. Amer. Paleont., V, No. 29, p. 83, Pl. 13, fig. 5, 1917.

Apparently rare. Only a few fragments were found, showing the sculpture.

Locality.—204.

Horizon.—Quebradillas limestone.

Xancus, new species?

Plate XXIII, Figure 9

Known only from fragments. Spire unknown; shell apparently like *X. validus* Sowerby and *X. wilsoni* Conrad, but differing chiefly in the greater number of tubercles, or spines, which are along a contracted zone below the rounded shoulder. There are four high, strong columellar folds, the anterior one being smaller than the others. The lower portion of the body whorl is sculptured with strong spirals as in *X. validus.* The exterior of the remainder of the shell is unknown, except for the presence of the tubercles. Height of body whorl 67 mm., maximum diameter about 50 mm.

Locality.—244, 254-5-6.

Horizon.—Lares limestone.

Genus **Mitra** Lamarck

Mitra henekeni Sowerby

Plate XXIV, Figure 1

Mitra henekeri Sowerby, Quart. Jour. Geol. Soc., VI, p. 46, Pl. 9, fig. 5, 1849.
Mitra henekeni Gabb, Trans. Amer. Phil. Soc., XV., p. 219, 1873.
Mitra henekeni Guppy (in part), Quart. Jour. Geol. Soc., XXXII, p. 528, 1876.
Mitra henekeni Maury, Bull. Amer. Paleont., V, No. 29, p. 74, Pl. 12, figs. 5, 5a, 1917.

A single fragmental specimen of a young shell. Protoconch missing. Seven whorls. Height 20 mm., diameter 7 mm.

Locality.—204.

Horizon.—Quebradillas limestone.

Mitra symmetrica Gabb

Mitra symmetrica Gabb, Trans. Amer. Phil. Soc., XV, p. 220, 1873.
Mitra symmetricus Maury, Bull. Amer. Paleont., V, No. 29, p. 75, 1917.

A single fragmental specimen, consisting of the last two whorls with anterior portion missing. Columellar folds not shown; whorls flattened, slightly convex; suture distinct, but not impressed; aperture elongate-ovate; surface with flattened spirals and much narrower grooves between, which are marked by growth lines. Height 25 mm., diameter 12 mm.

It has been suggested that *M. symmetrica* may be the young of *M. titan* Gabb.

Locality.—280.

Horizon.—Lares formation.

Genus **Olivella** Swainson

Olivella muticoides Gabb

variety **portoricoensis**, new variety

Plate XXIV, Figures 2, 3

The shells vary from high to low spired, and also in the number of columellar plications. They include the types represented by *O. muticoides* and *O. muticoides* variety *canaliculata* of Santo Domingo, and there are all gradations between. The sutural canal is extremely broad in all specimens; columellas callus very thick; three to four columellar plications, with several faint ones posterior to these; largest specimen measures in height 12 mm., diameter 4.5 mm.

Localities.—204, 671; Aguila Point, K 75.2 Ponce-Penuelas road (Mitchell).

Horizon.—Quebradillas limestone (extremely abundant); and Ponce limestone.

Olivella portoricoensis, new species

Plate XXIV, Figure 4

Shell small, smooth, moderately high spired; whorls about six; protoconch missing on all specimens; suture distinct, impressed below upper margin of the succeeding whorl, leaving a gap between top of whorl and surface of the preceding whorl; a raised spiral thread appears above the suture, barely showing above the upper margin of the overlapping whorl; columella with two spiral grooves; callus moderately thick; anterior notch shallow, inconspicuous. Height of shell 12 mm., diameter 5 mm.

The distinguishing feature of this shell is the spiral thread at the suture. This thread is not continued on the body whorl.

Localities.—204, 216.

Horizon.—Quebradillas limestone.

Genus **Cancellaria** Lamarck

Cancellaria lævescens Guppy

Plate XXIV, Figures 5, 6

Cancellaria lævescens Guppy, Quart. Jour. Geol. Soc., XXII, p. 289, Pl. 17, fig. 12, 1866.
Cancellaria lævescens Gabb, Trans. Amer. Phil. Soc., XV, p. 239, 1873.
Cancellaria lævescens Maury, Bull. Amer. Paleont., V, No. 29, p. 64, Pl. 10, fig. 6, 1917.
Cancellaria lævescens Dall, Trans. Wagner Inst. Sci., III, pt. 1, p. 43, 1890.

The specimens are smaller than the Jamaican shells, and show all variations between complete loss of cancellation on the body whorl and merely a diminution of strength of cancellation near the aperture. In the latter cases, the spirals continue, but the ribs are irregular in occurrence and indistinct or absent for considerable intervals. In some shells the ribs on the body whorl become merely irregular crowded growth lines; callus very thick; columella with at least three prominent plaits; aperture not widening anteriorly as does that of the Jamaican shell. An average shell measures in height 23 mm., diameter 14 mm. The largest complete specimen measures 26 mm. by 15 mm., while a fragment indicates that the shells attain a size slightly larger than this.

Locality.—204.

Horizon.—Quebradillas limestone (abundant).

Genus **Turris** Bolten

Turris albida Perry
variety **haitensis** Sowerby
Plate XXIV, Figure 7

Pleurotoma haitensis Sowerby, Quart. Jour. Geol. Soc., VI, p. 50, 1849.
Turris albida var. *haitensis* Maury, Bull. Amer. Paleont., V, No. 29, p. 50, Pl. 8, fig. 4, 1917.

A few specimens were collected which agree closely with this variety. The largest specimen (spire with body whorl missing) measures in height 22 mm., diameter 8 mm.

Locality.—204.

Horizon.—Quebradillas limestone.

Turris albida Perry
variety cf. **virgo** Lamarck

Pleurotoma virgo Lamarck, Anim. s. Vert., VII, p. 94, 1822.
Pleurotoma virgo Moore, Quart. Jour. Geol. Soc., IX, p. 130, 1853.
Turris (Surcula) virgo Gabb, Trans. Amer. Phil. Soc., XV, pp. 206, 207, 1873.
Turris albida var. *virgo* Maury, Bull. Amer. Paleont. V, No. 29, p. 50, Pl. 8, fig. 6, 1917.

A single fragment showing portions of the last two whorls, and indicating a shell of about 60 mm. height. An unusual feature is the absence of secondary spirals. It seems to be an adult form which has retained the form of the young variety *virgo*. Another special feature is the coarseness of the spirals, the prominent median keel being especially broad and thick, resembling the keels of *Ecphora quadricostata*. The suture is indistinct. Interspaces between spirals marked only by the characteristic oblique growth lines.

Locality.—204.

Horizon.—Quebradillas limestone.

Genus **Drillia** Gray

Drillia consors Sowerby
variety **portoricoensis,** new variety
Plate XXIV, Figures 8, 9

Shell small, moderately slender; whorls about nine; sutural band as in the type, but nearly half the axial width of the whorl; sculpture of from four to five prominent spirals, and about 18 sharp ribs which do not cross the sub-sutural band, the latter being smooth, and concave on either side of the spiral ridge which divides the band. The concavity below this spiral ridge is over twice the width of that above the ridge, and much more deeply concave. Height 15 mm., diameter 5 mm.

This shell is close to *D. consors,* but has some distinctive differences. One of the specimens shows the protoconch fairly well. It is rather large, smooth, naticoid, and apparently consists of two whorls. The first post-nuclear whorl is sculptured with ribs only, the spirals being too fine to observe (if present at all) and the sub-sutural band not appearing until the second sculptured whorl.

Locality.—204; Berkey 98.

Horizon.—Quebradillas limestone.

Drillia grabaui, new species

Plate XXIV, Figure 10

Shell small, slender; decollate specimen (5 whorls) measures in height 14 mm., diameter 4 mm.; protoconch of two smooth, rather large, globular whorls; post-nuclear whorls with sharp, widely spaced ribs and fine, flattened spiral threads, not crossing the ribs and slightly arcuate between the ribs; sub-sutural band like that of *D. consors*, but narrower and wavy, or fluted, and marked with faint spiral threads and arcuate growth lines indicating a fairly deep, semi-circular posterior sinus. On the penultimate whorl, there are six strong spirals, with three additional ones just below the band, which are fine, crowded, and about the same strength as those on the band. On the body whorl there are twenty-two spirals, and the ribs extend well toward the anterior portion of the shell before dying out. The ribs, spirals, and band appear together immediately following the protoconch stage.

This shell has a slight resemblance to *D. maonrisparum* Maury, of the Santo Domingan Oligocene, but differs in its slightly larger size, more slender form, different protoconch, and absence of any varix. It probably belongs to the *D. consors* group.

Locality.—204.

Horizon.—Quebradillas limestone.

Drillia portoricoensis, new species

Plate XXIV, Figures 11, 12

Shell with ten whorls, including protoconch of two smooth, globular volutions; post-nuclear whorls sculptured with low, straight longitudinal ribs and faint spirals, visible only between the ribs, except on the anterior half of the body whorl, where they are much stronger, and slightly nodose where they cross the ribs; sub-sutural band of the *D. consors* type, with dividing spiral ridge prominent in the earlier whorls, but becoming low and inconspicuous in the adult; band slightly wrinkled where it laps over the ribs of the preceding whorl; lower half of band slightly concave, and smooth except for faint, microscopic spiral lines, and growth lines indicating a broad, sub-angular posterior sinus; adult shells with a strong, thick varix at the outer lip. Height of shell 16 mm., diameter (excluding varix) 5.5 mm.

This shell is easily recognizable from its conspicuous varix, and its almost obsolete sculpture.

Locality.—204.

Horizon.—Quebradillas limestone.

Drillia semmesi, new species

Plate XXIV, Figure 13

Shell small, broader and lower spired than is usual in members of this genus; whorls seven, including a large protoconch of two smooth, rounded whorls, the first small, the second considerably larger; first post-nuclear whorl sculptured with about thirteen sharp ribs extending from suture to suture, and crossed by three raised spiral ridges, producing a cancellate sculpture; all post-nuclear whorls sharply shouldered, and the ribs, on crossing the shoulder, are strongly arched backward, a feature most noticeable in the later whorls; shoulders of the last four whorls are marked by obscure spirals; later whorls retain the three primary spirals, and on the fourth whorl, smaller intercalated secondary spirals appear. The uppermost primary spiral marks the shoulder angulation. The body whorl has about twelve prominent (or "primary") spirals, with some of the interspaces marked by one or two faint (or "secondary") spirals. All post-nuclear whorls show longitudinal growth lines, arcuate on the shoulder, indicating a wide U-shaped posterior notch. Aperture and anterior portion of shell unknown. Length of most complete specimen, with lower portion of body whorl missing, 8 mm., diameter 4 mm.

This shell is named in honor of Dr. D. R. Semmes, in recognition of his work on the San Juan District of Porto Rico.

Locality.—204.

Horizon.—Quebradillas limestone.

Genus **Cythara** Schumacher

Cythara cf. **elongata** Gabb

Mangilia elongata Gabb, Trans. Amer. Phil. Soc., XV, p. 211, 1873; Jour. Acad. Nat. Sci. Phila., VIII, p. 351, Pl. 46, fig. 34, 1881.

Cythara elongata Dall, Trans. Wagner Inst. Sci., III, pt. 6, p. 1583, 1903.
Cythara elongata Maury, Bull. Amer. Paleont., V, No. 29, p. 59, Pl. 9, fig. 12, 1917.

A single poorly preserved specimen, which seems to be this species or one very closely related. Height 7.5 mm., diameter 3 mm.

Locality.—204.

Horizon.—Quebradillas limestone.

Genus **Terebra** Adanson

Terebra quebradillensis, new species

Plate XXIV, Figure 14

Shell small, slender; protoconch of two smooth globular whorls, slightly larger than the succeeding post-nuclear whorl; twelve post-nuclear whorls, rounded as in *T. berlineræ* Maury; sub-sutural band nearly one-third the axial width of the whorl, marked off by deep, narrow furrow, and faintly striated by one or two spiral threads as in *T. wolfgangi* Toula; about eighteen arcuate ribs on each whorl, which cross the furrow and sub-sutural band without interruption or change of direction; remainder of whorl below sub-sutural band marked by about nine spiral threads (sixteen on last whorl) which vary in size. A prominent spiral is situated next to the furrow. The rest are finer, and crowded together in groups of two or three. In the earlier whorls they are more uniform in size and distribution; and fewer in number; columella short and non-plicate. The largest specimen measures in height 18 mm., diameter 4 mm.

This shell resembles *T. berlineræ* Maury in its convex whorls and the character of the spiral threads. It differs in its smaller size and wider sub-sutural band. It resembles *T. wolfgangi* Toula in its bisected or trisected sub-sutural band.

Localities.—204, and near Ponce (Mitchell).

Horizon.—Quebradillas limestone, Ponce limestone.

Genus **Conus** Linné

Conus catenatus Sowerby

Plate XXIV, Figure 15

Conus catenatus Sowerby, Quart. Jour. Geol. Soc., VI, p. 45, Pl. 9, fig. 2, 1849.
Conus interstinctus Guppy, Quart. Jour. Geol. Soc., XXII, p. 288, Pl. 16, fig. 3, 1866.
Conus catenatus Gabb, Trans. Amer. Phil. Soc., XV, p. 230, 1873.

Conus catenatus Guppy, Quart. Jour. Geol. Soc., XXXII, p. 527, 1876.
Conus catenatus Maury, Bull. Amer. Paleont., V, No. 29, p. 38, Pl. 5, fig. 4; Pl. 6, figs. 1, 2, 1917.

The specimens vary from concave to only slightly concave spire, from high to moderately low spire, and there is considerable range in size. Upper whorls carinated; last five whorls rounded on shoulder and broadly channelled above, with faint arcuate growth lines crossing the channels; posterior third of body whorl smooth; anterior two-thirds marked by spiral threads which alternate with much finer, obscure threads. There are many variations, some of the specimens resembling *C. cercadensis* Maury, other resembling *C. kitteredgei* Maury, but all evidently variations of *C. catenatus*. A typical shell measures in height 31 mm., diameter 17 mm.

Locality.—204. Also found by Berkey in the vicinity of Quebradillas.

Horizon.—Quebradillas limestone.

Conus cf. **marginatus** Sowerby

Plate XXIV, Figure 16

Conus marginatus Sowerby, Quart. Jour. Geol. Soc., VI, p. 44, 1849.
Conus marginatus Gabb, Trans. Amer. Phil. Soc., XV, p. 230, 1873.
Conus marginatus Guppy, Quart. Jour. Geol. Soc., XXXII, p. 528, Pl. 29, fig. 5, 1876.
Conus (Chelyconus) marginatus Cossmann, Jour. de Conch., LXI, pp. 44-46, Pl. 3, figs. 14, 15, 1913.
Conus marginatus Maury, Bull. Amer. Paleont., V, No. 29, p. 46, Pl. 7, fig. 11, 1917.

A small conus which has features in common with *C. marginatus* and may be the young of the latter. Whorls eight, including two nuclear; spire moderately high, scarcely concave; whorls carinate except last whorl, which is rounded at the shoulder; whorls of the spire flat above, while the final whorl is slightly channelled above; posterior half of body smooth; anterior half with twelve smooth, flat, spiral bands separated by deep grooves marked by raised longitudinal threads, which are limited to the grooves and do not cross the spiral bands. Height 7.5 mm., diameter 4 mm.

Locality.—204.

Horizon.—Quebradillas limestone.

Genus **Bullaria** Rafinesque

Bullaria paupercula Sowerby

Bulla paupercula Sowerby, Quart. Jour. Geol. Soc., VI, p. 52, 1849.
Bulla paupercula Gabb, Trans. Amer. Phil. Soc., XV, p. 246, 1873.
Bulla paupercula Guppy, Geol. Mag., p. 437, 1874; Quart. Jour. Geol. Soc., XXXII, p. 518, 1876.
Bulla paupercula Dall, Trans. Wagner Inst. Sci., III, pt. 1, p. 18, 1890.
Bulla striata Dall, Trans. Wagner Inst. Sci., III, pt. 6, p. 1583, 1903.
Bullaria paupercula Maury, Bull. Amer. Paleont., V, No. 29, p. 18, Pl. 3, fig. 8, 1917.

The specimens are internal molds, but their general outline seems sufficient to identify them with this species. Fragments of external mold show faint spiral grooves on the anterior part of the shell. Spire depressed. Height 15 mm., diameter 10 mm.

Localities.—204, 664, 235 ?.

Horizon.—Quebradillas limestone, Ponce limestone.

Bullaria portoricoensis, new species

Plate XXIV, Figure 17

Shell cylindrical, length nearly twice the diameter; spire sunken, imperforate; aperture longer than shell, extending above the truncate apex; surface with fine, slightly wavy impressed spiral lines, covering all of the shell except the summit, and crossed by slightly curved growth lines. An average specimen measures in height 20 mm., diameter 11.5 mm.

The most striking characteristic of this shell is its cylindrical form. The young shell is more globose in form, resembling one of the elongate forms of *B. granosa.*

Locality.—204.

Horizon.—Quebradillas limestone.

Bullaria granosa Sowerby

Plate XXIV, Figure 18

Bulla granosa Sowerby, Quart. Jour. Geol. Soc., VI, p. 51, Pl. 10, fig. 10, 1849.
Bulla granosa Gabb, Trans. Amer. Phil. Soc., XV, p. 246, 1873.
Bulla granosa Guppy, Geol. Mag., p. 437, 1874; Quart. Jour. Geol. Soc., XXXII, p. 518, 1876.
Bullaria granosa Maury, Bull. Amer. Paleont., V, No. 29, p. 20, Pl. 3, fig. 10, 1917.

The specimens are slightly more globular than the Santo Domingo shells. There is a great range in size, but the specimens fall into two groups, one of a large size averaging 20 mm. in height and 16.5 mm. in diameter, and the other a small size averaging 14 mm. in height and 11 mm. in diameter. The small shells have a large range in size and proportions, some of the measurements being:

Height	Diameter
17 mm.	15 mm.
11 mm.	8 mm.
16.5 mm.	12.5 mm.
11.5 mm.	10 mm.

The surface sculpture of the shells agrees closely with the shells from the Santo Domingo Oligocene.

Localities.—204, 209?, 216, 52(a), 191, 225, 678. San Juan district (Semmes). Culebrinas Point? (Mitchell).

Horizons.—Lares limestone to Quebradillas limestone, Ponce limestone? Extremely abundant in the Quebradillas limestone.

Plate X

Fig. 1. *Atrina rabelli* n. s.; nat. size; external mold.

Fig. 2. *Pecten (Pecten) laresense* n. s.; x 1.6; left valve.

Fig. 3. *Pecten (Pecten) laresense* n. s.; x 2; right valve.

Fig. 4. *Pecten (Euvola) reliquus* Brown and Pilsbry, var. *portoricoensis* n. var.; x 2.3.

Fig. 5. *Pecten (Nodipecten) nodosus* Linné; x 1.8.

Fig. 6. *Phacoides (Lucinisca) calhounensis* Dall; x 2.6; immature shell; gutta-percha cast.

Fig. 7. *Metis trinitaria* Dall; x 0.75; internal mold, left valve.

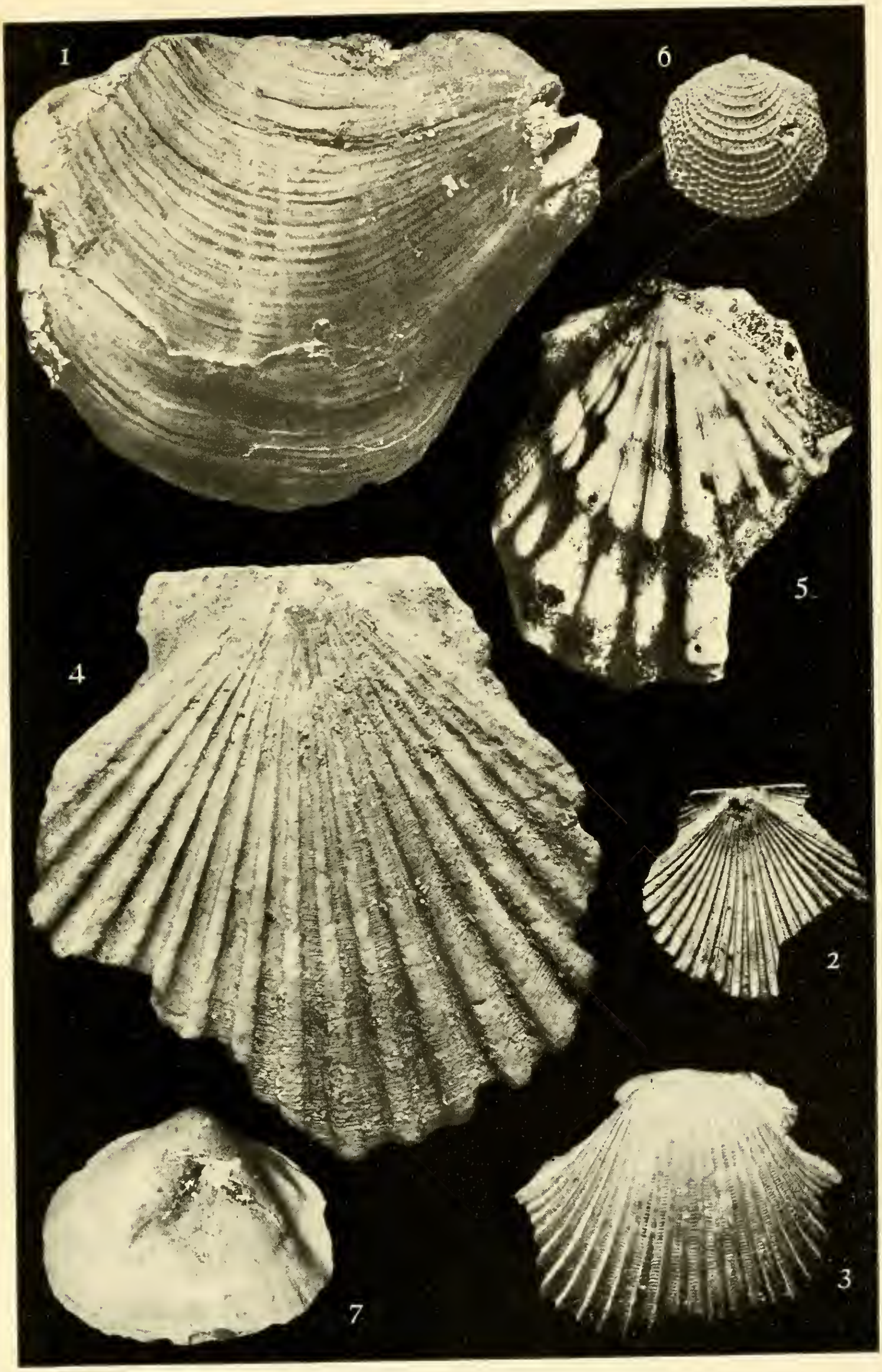
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Plate XI

Fig. 1. *Pecten* (*Chlamys*) *collazoensis* n. s.; x 3.5.
Fig. 2. *Pecten* (*Chlamys*) *portoricoensis* n. s.; x 2.25; right valve.
Fig. 3. *Pecten* (*Chlamys*) *portoricoensis* n. s.; x 2; left valve.
Fig. 4. *Pecten portoricoensis* var. *reticulatis;* x 2.25.
Fig. 5. *Pecten portoricoensis* var. *grandis;* x 3.3; fragment showing prominent ribs.
Fig. 6. *Pecten portoricoensis* var. *grandis;* x 3.3; fragment of another shell showing low ribs.
Fig. 7. *Tellina* sp. aff. *T.* (*Angulus*) *atossa* Dall; x 1.8; gutta-percha cast.
Fig. 8. *Solen* (*Plectosolen*) *collazoensis* n. s.; x 14.

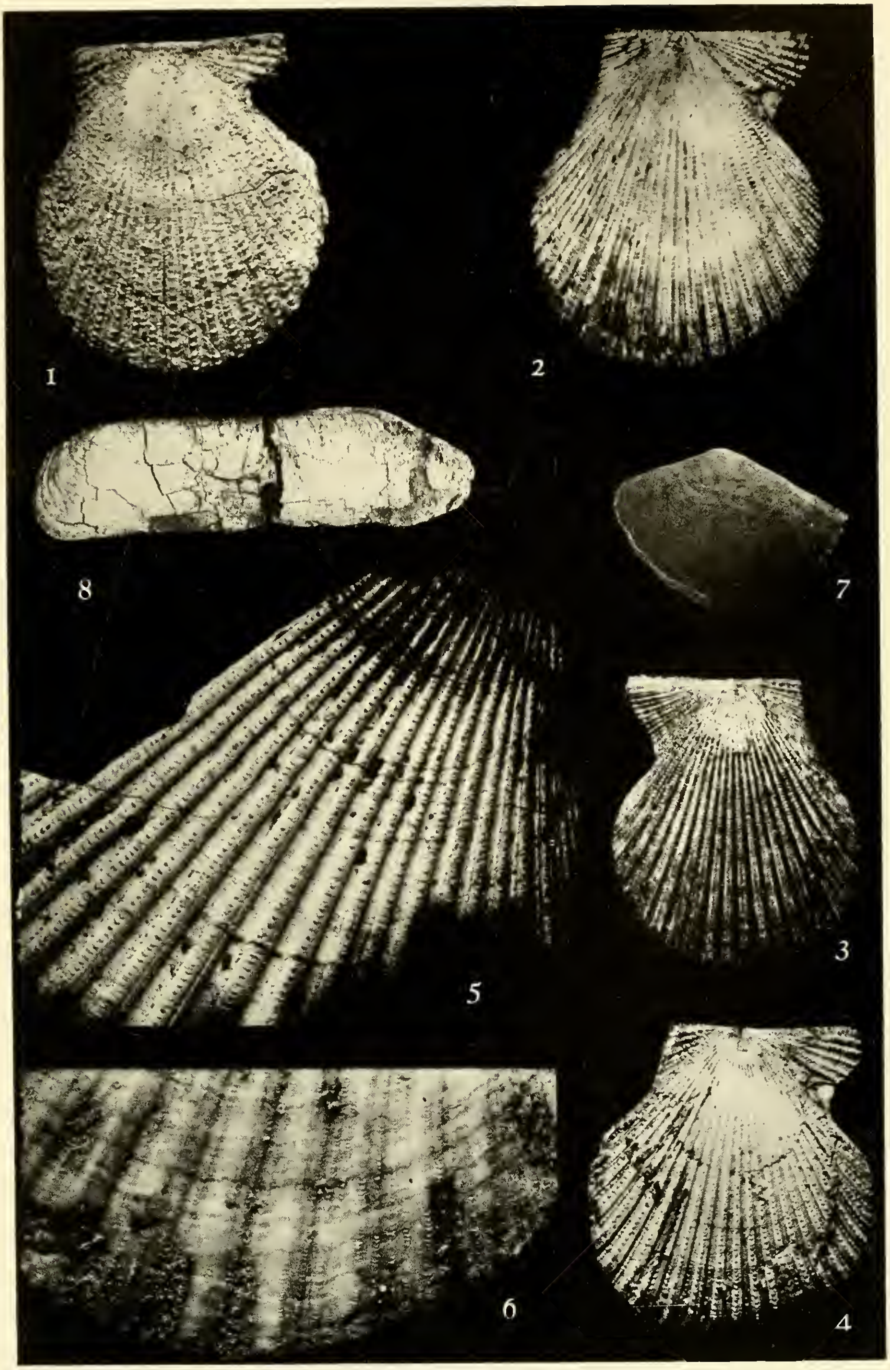
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Plate XII

Fig. 1. *Pecten (Chlamys) grabaui* n. s.; x 2.25.
Fig. 2. *Pecten grabaui* var. *aguadensis;* x 2.2.
Fig. 3. *Pecten grabaui* var. *hatoensis;* x 2.
Fig. 4. *Pecten grabaui var. guayabensis;* x 2; ears defective.
Fig. 5. *Pecten (Chlamys) hodgii* n. s.; x 2.8.
Fig. 6. *Pecten (Plagioctenium) sebastiensis* n. s.; x 1.4.

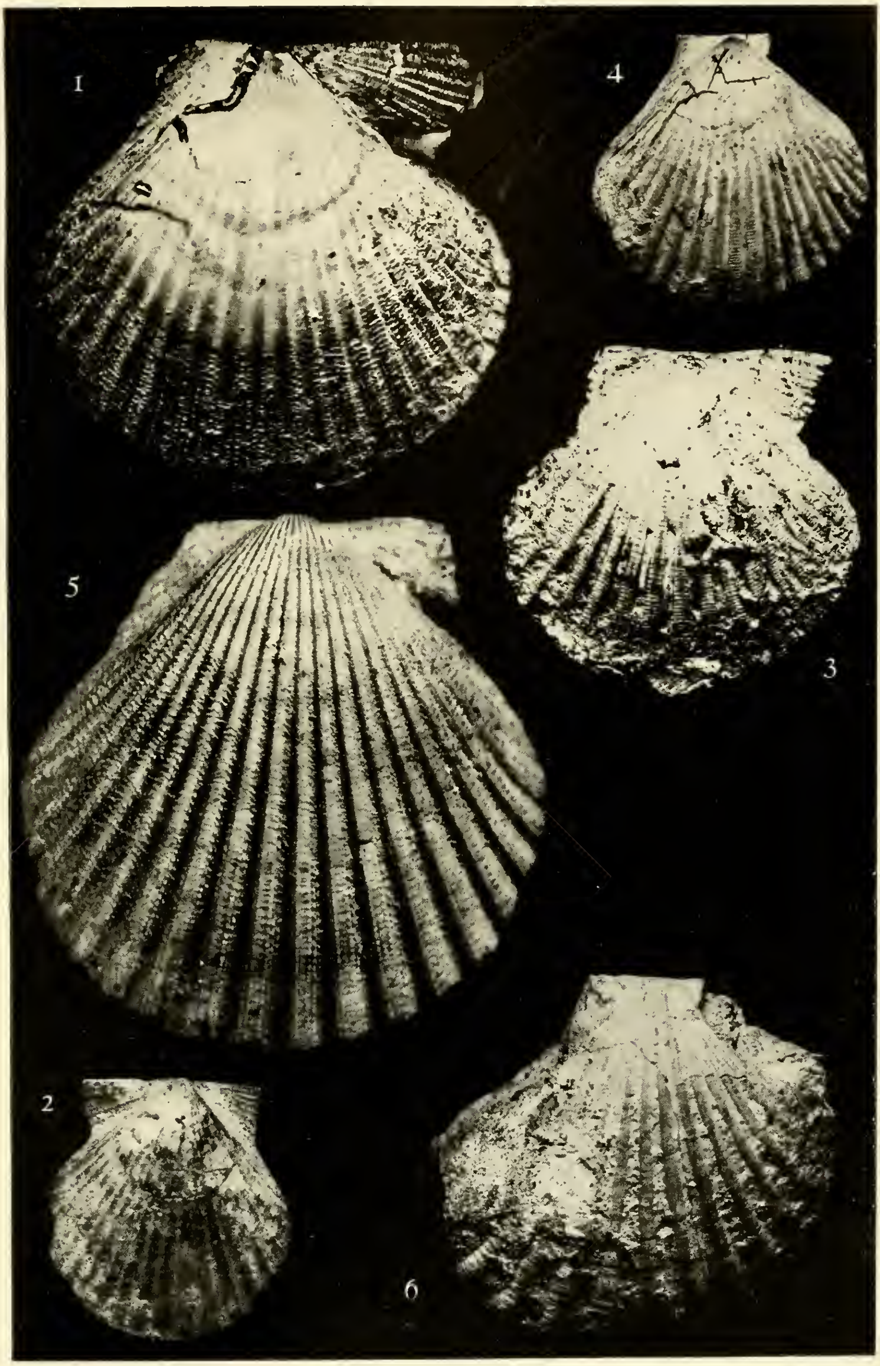
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Plate XIII

Fig. 1. *Pecten (Aequipecten) lobecki* n. s.; x 2.5.

Figs. 2, 3. *Pecten (Plagioctenium) cercadica* Maury; x 1.9.

Fig. 4. *Ostrea sellæformis* Conrad, variety *portoricoensis* n. var.; nat. size; lower valve, adult shell.

Figs. 5, 6. *Ostrea sellæformis* var. *portoricoensis;* nat. size; upper valves, exterior and interior; young.

Fig. 7. *Chione woodwardi* Guppy; nat. size; gutta percha cast.

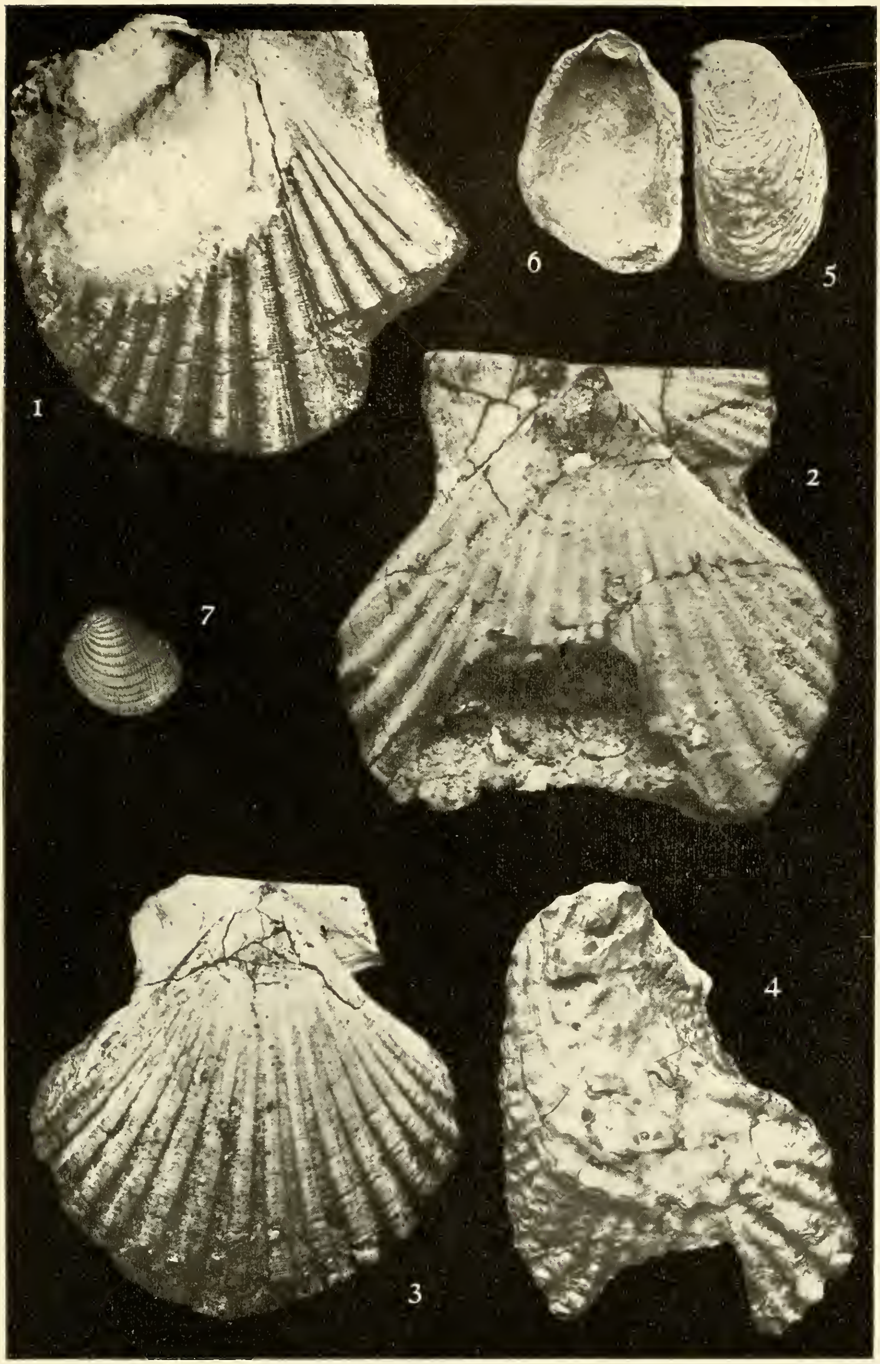
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Plate XIV

Fig. 1. *Pecten* (*Plagioctenium*) *borinquenense* n. s.; x 2.5; right valve.

Fig. 2. *Pecten borinquenense;* x 2.5; left valve.

Fig. 3. *Amusium mauryi* n. s.; x 3.4.

Fig. 4. *Barbatia* cf. *bonaczyi* Gabb; x 2.9; gutta-percha cast.

Fig. 5. *Arca dariensis* Brown and Pilsbry; x 2.2.

Fig. 6. *Arca* (*Scapharca*) cf. *donacia* Dall; x 3.7; right valve, gutta-percha cast.

Fig. 7. *Arca* cf. *donacia;* x 4; left valve, gutta-percha cast.


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Plate XV

Fig. 1. *Ostrea antiguensis* Brown; x 0.9; lower valve.
Fig. 2. *Ostrea haitensis* Sowerby var. ?; x 1.3; interior, young shell.
Fig. 3. *Ostrea haitensis* var. ?; x 1.3; exterior, young.
Figs. 4, 5. *Glycimeris collazoensis* n. s.; x 1.5.
Fig. 6. *Glycimeris portoricoensis* n. s.; x 1.5; gutta-percha cast.

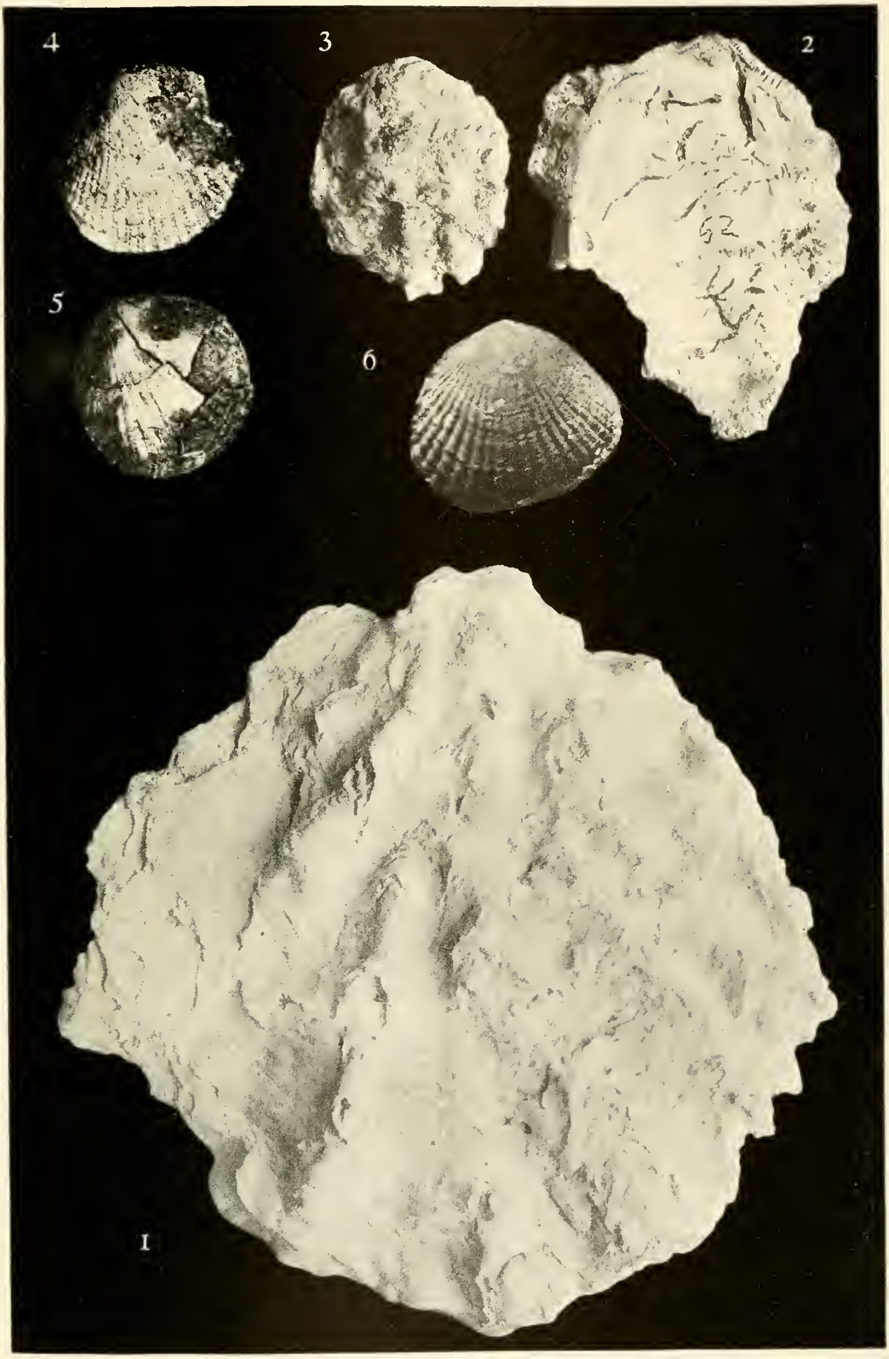
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Plate XVI

Fig. 1. *Ostrea cahobasensis* Pilsbry and Brown, variety *portoricana* n. var.; x 0.6; valves together; specimen collected by A. K. Lobeck.

Fig. 2. *Pitaria* (*Hyphantosoma*) *carbasea* Guppy; x 2.2; gutta-percha cast.

Figs. 3, 4. *Tellina* (*Scissula*) *grabaui* n. s.; x 2.5; gutta-percha casts.

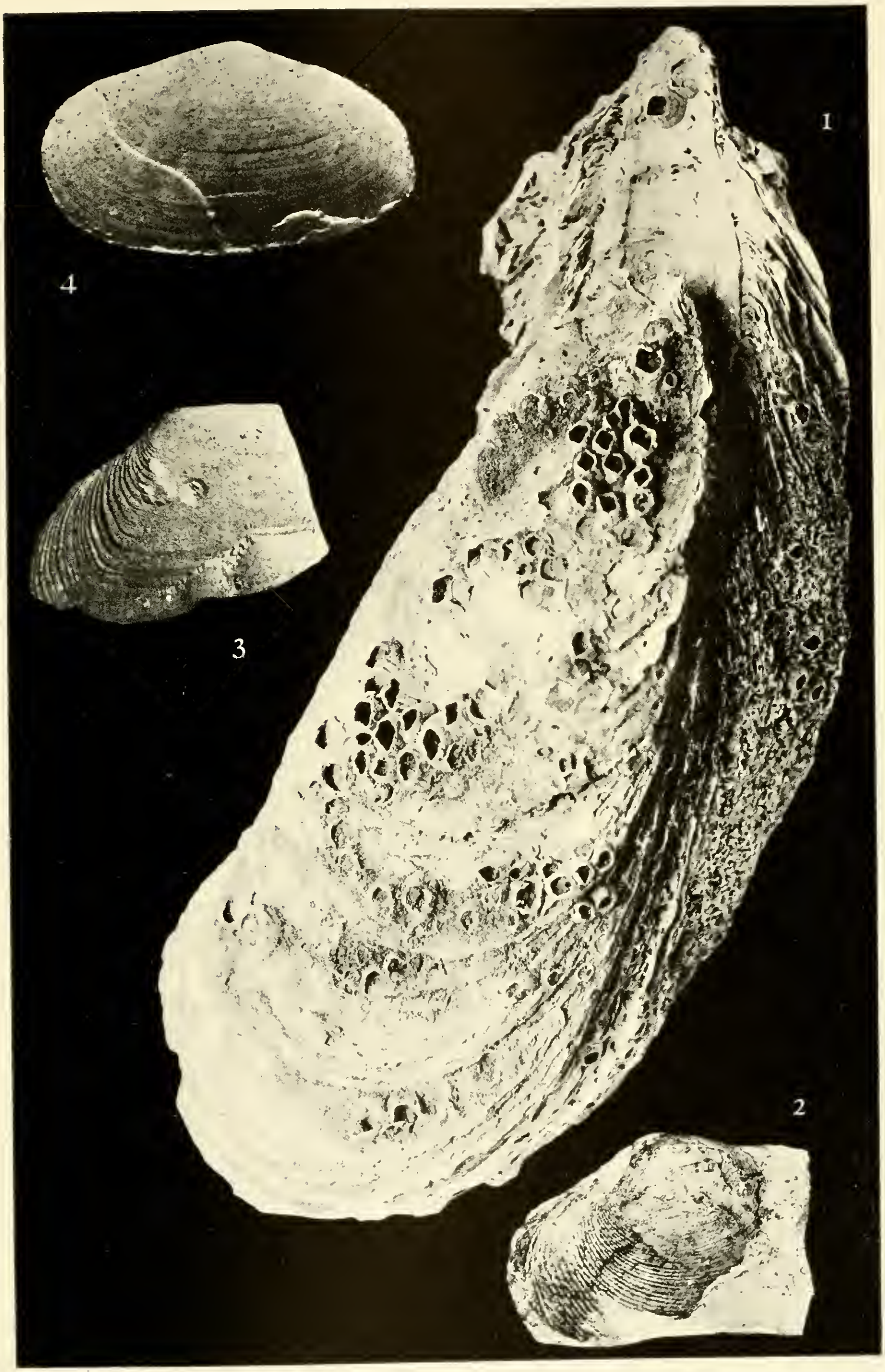
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Plate XVII

Fig. 1. *Ostrea cahobasensis* Pilsbry and Brown, variety *portoricana* n. var.; x 0.6; lower valve, specimen collected by Lobeck.

Figs. 2, 3. *Arca* sp. indet.; x 2.2.

Fig. 4. *Codakia* (*Jagonia*) *magnoliana* Dall, variety *borinquenense* n. var.; x 2.5; gutta-percha cast.

Fig. 5. *Chama portoricana* n. s.; x 0.8; internal mold with portions of external mold of the lamellae at the margin.

Fig. 6. *Leda peltella* Dall x 2.4; gutta-percha cast.

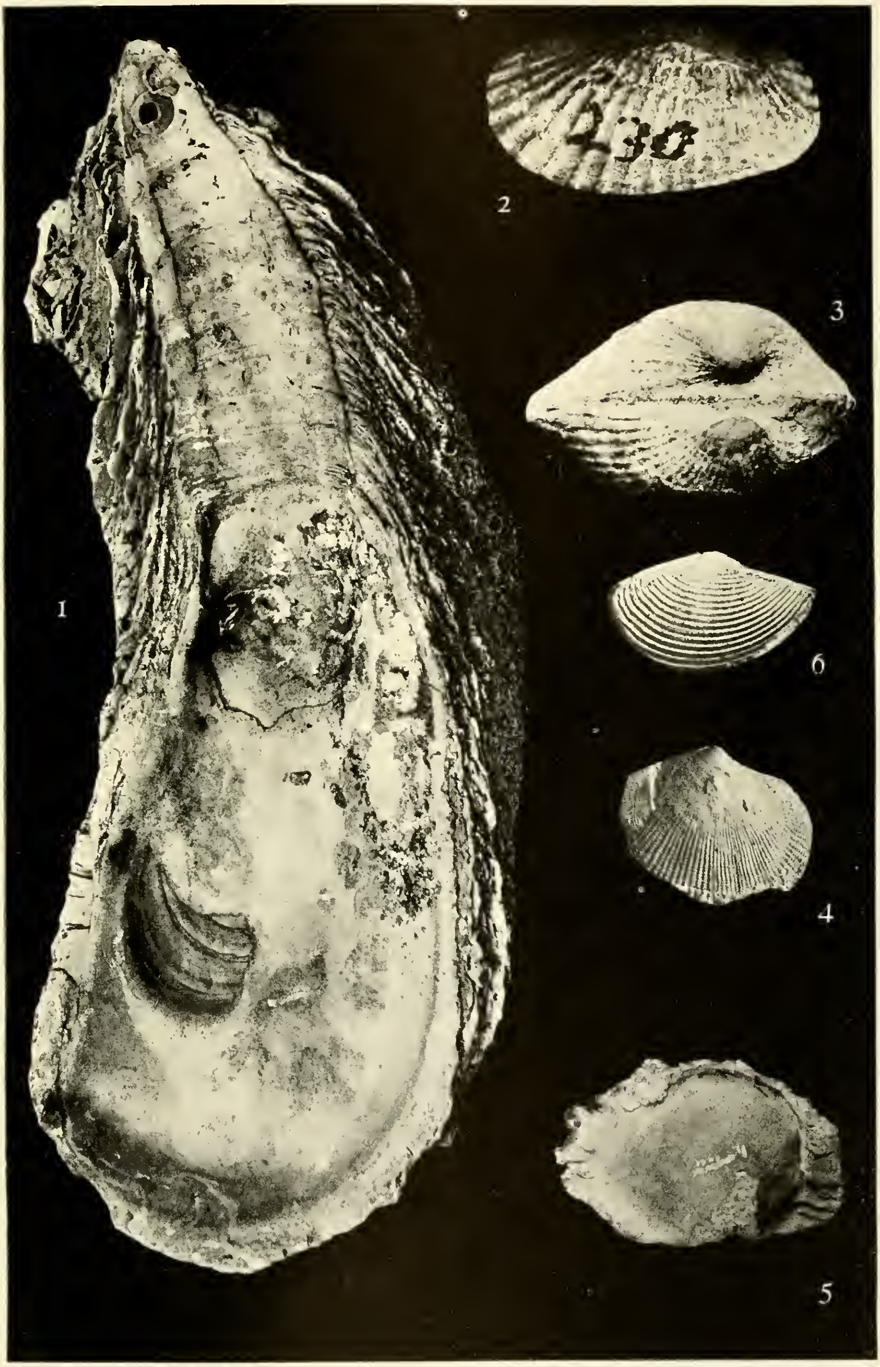
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Plate XVIII

Fig. 1. *Lucina collazoensis* n. s.; x 0.7; left valve, int. mold.

Fig. 2. The same specimen,—dorsal view; x 1.1.

Fig. 3. *Lucina* cf. *chrysostoma* (Meusch.) Philippi; nat. size; internal mold.

Fig. 4. *Phacoides* (*Miltha*) sp. indet.; x 1.4; gutta-percha cast.

Fig. 5. *Phacoides* (*Miltha*) sp. indet.; x 2.6; gutta-percha cast.

Fig. 6. *Phacoides* (*Pseudomiltha*) *laresensis* n. s.; x 1.4; internal mold, with portions of the shell preserved near the beak, showing the sculpture.


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Plate XIX

Fig. 1. *Cardium muricoides* n. s.; x 2.6; gutta-percha cast.

Fig. 2. *Cardium* (*Trachycardium*) *cinderellæ* Maury, variety *alternatum* n. var.; x 2.2; int. mold.

Figs. 3, 4. *Cardium cinderellæ* var. *alternatum;* x 2.6; gutta-percha casts showing variations in the sculpture.

Figs. 5, 6. *Cardium* (*Trigonocardia*) *sambaicum* Maury, variety *portoricoensis* n. var.; x 2; gutta-percha casts.

Fig. 7. *Cardium* n. s.? (aff. *C. sambaicum* Maury); x 2.5; gutta-percha cast.

Maury; x 2.5; gutta-percha cast.

Fig. 8. *Cardium* (*Trigonocardia*) *haitense* var. *cercadicum*

Fig. 9. *Cardium haitense* variety *areciboense* n. var.; x 2.5; gutta-percha cast.

Fig. 10. *Clementia dariena* Conrad; x 1.1 int. mold, specimen from Robles, P. R.

Fig. 11. *Clementia dariena* Conrad; x 0.95; int. mold, specimen from Collazo, P. R., somewhat distorted by pressure.

Fig. 12. *Clementia dariena* Conrad; x 0.95; specimen from the Gatun formation, Panama, collected by Prof. J. F. Kemp.

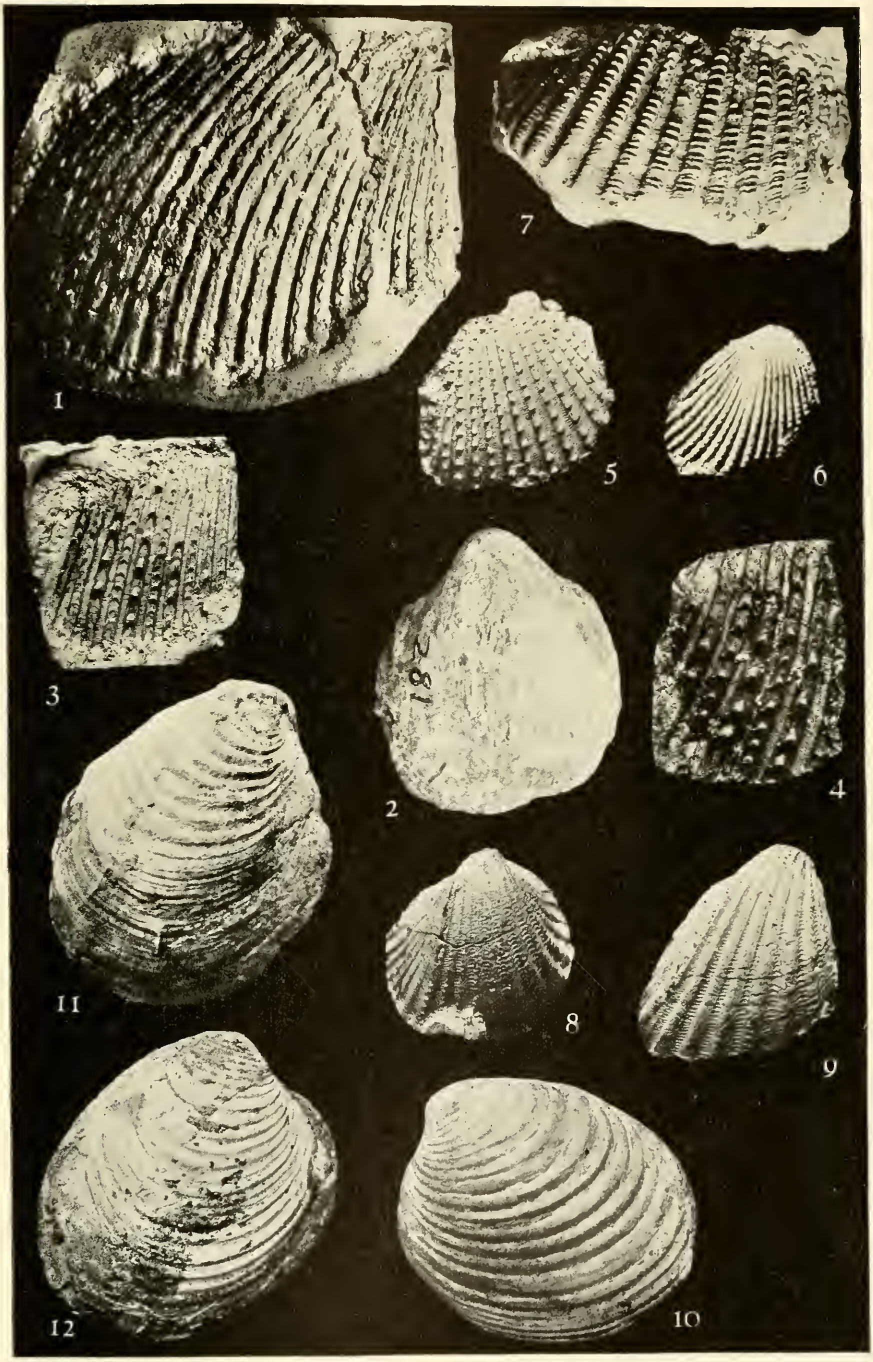
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Plate XX

Fig. 1. *Cytherea (Cytherea) berkeyi* n. s.; x 0.75; int. mold, specimen collected by Prof. Berkey.

Fig. 2. Same specimen, dorsal view; x 0.7.

Fig. 3. Same specimen; x 0.75; gutta-percha cast from fragment of the external mold.

Fig. 4. *Tellina strophoidea* n. s.; x 2.5; right valve, gutta-percha cast.

Fig. 5. *Tellina strophoidea;* x 1.3; left valve, gutta-percha cast.

Fig. 6. *Tellina portoricoensis* n. s.; x 1.5; right valve, gutta-percha cast.


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Plate XXI

Fig. 1. *Calliostoma portoricoensis* n. s.; x 2.5; gutta-percha cast.
Fig. 2. *Turbo fetkii* n. s.; x 2.6; gutta-percha cast.
Fig. 3. *Liotia (Arene) coronata* Dall, variety *portoricoensis* n. var.; x 4; gutta-percha cast.
Fig. 4. *Neritina (chipolana* var.?) *collazoensis* n. s.; x 2.
Fig. 5. *Hipponyx portoricoensis* n. s.; x 2; gutta-percha cast.
Fig. 6. *Hipponyx portoricoensis;* x 2; gutta-percha cast, showing variation with strongly recurved apex.
Fig. 7. *Crucibulum auricula* Gmelin variety *portoricoensis* n. var.; x 1.3; gutta-percha cast, specimen collected by Prof. Berkey.
Fig. 8. Same specimen; x 3.3; gutta-percha cast of the internal cup.
Fig. 9. *Crucibulum auricula?* var.; x 2.3; gutta-percha cast.
Fig. 10. *Crucibulum (Dispotæa) collazum* n. s.; x 2; interior, showing cup.
Fig. 11. *Natica (Ampullina?) collazoensis* n. s.; x 0.75; decollate shell with rounded whorls.
Fig. 12. *Natica collazoensis;* x 0.7; decollate shell with angulated whorls (int. mold).
Figs. 13, 14. *Turritella tornata* Guppy variety *portoricoensis* n. var.; x 1.1; int. molds.
Fig. 15. *Turritella portoricoensis* n. s.; x 2.7; gutta-percha cast.
Fig. 16. *Petaloconchus? collazoensis* n. s.; x 1.5.
Fig. 17. *Pyramidella portoricoensis* n. s.; x 3.6; gutta-percha cast.
Fig. 18. *Bittium* sp. indet.; x 2; gutta-percha cast.

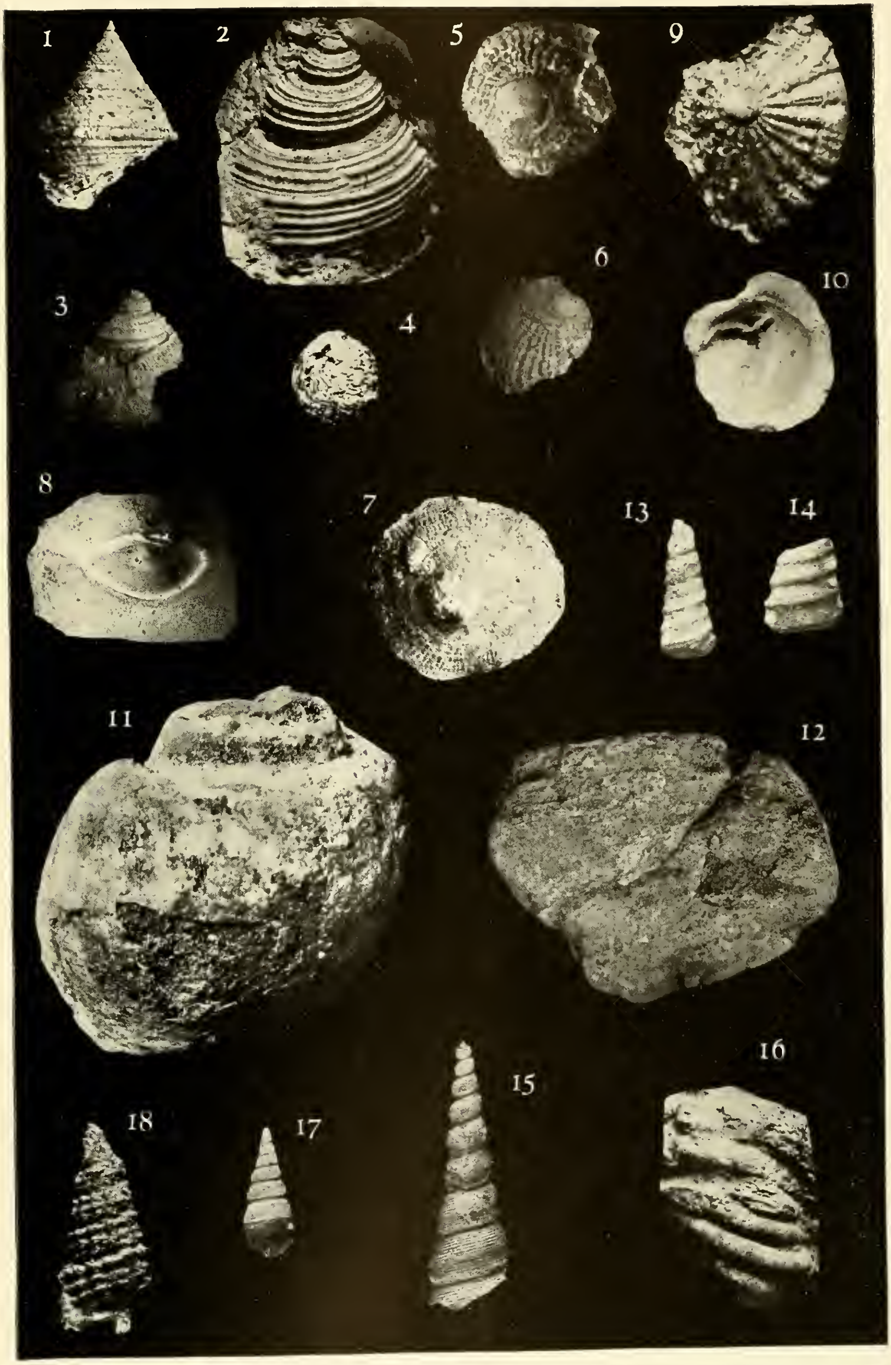
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Plate XXII

Fig. 1. *Epitonium* (*Cirsotrema*) *collazoensis* n. s.; x 2.2.
Fig. 2. Same specimen; x 1.5.
Fig. 3. *Turritella mitchelli* n. s.; x 1.4.
Fig. 4. *Turritella berkeyi* n. s.; x 0.85; gutta-percha cast.
Fig. 5. *Cerithium portoricoensis* n. s.; x 3.7; gutta-percha cast, showing protoconch.
Fig. 6. *Cerithium portoricoensis;* x 2.3; gutta-percha cast, showing varix on body whorl.
Fig. 7. *Cerithium quebradillensis* n. s.; x 2.6; plastolin cast.
Fig. 8. Same specimen; x 2.2; showing aperture and pillar.
Fig. 9. *Cassis* sp. indet.; x 0.8; int. mold.
Fig. 10. *Phos costatus* Gabb; x 0.8; gutta-percha cast.
Fig. 11. *Phos elegans* Guppy variety *portoricoensis* n. var.; x 1.4; gutta-percha cast.
Fig. 12. *Alectrion gurabensis* Maury variety *portoricoensis* n. var.; x 2.2; gutta-percha cast.
Fig. 13. *Alectrion gurabensis* var. *portoricoensis;* x 2.2; gutta-percha cast, showing aperture.
Figs. 14, 15. *Alectrion gurabensis* variety *varicum* n. var.; x 2.2; gutta-percha casts.


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Plate XXIII

Figs. 1, 2. *Cerithium* (*Campanile*) *collazum* n. s.; x 1.1.

Fig. 3. *Orthaulax gabbi?* Dall; x 0.9.

Fig. 4. *Strombina portoricana* n. s.; x 2.7; gutta-percha cast.

Fig. 5. *Fusus henekeni* Sowerby; x 2.3; gutta-percha cast.

Fig. 6. *Turbinella chipolana* Dall variety *precursor* n. var.; x 2.5.

Fig. 7. Same specimen; x 3.7; aperture view.

Fig. 8. *Turbinella chipolana* variety *areciboense* n. var.; x 2.6; gutta-percha cast.

Fig. 9. *Xancus* n. s.?; nat. size; int. mold of portion of body whorl.

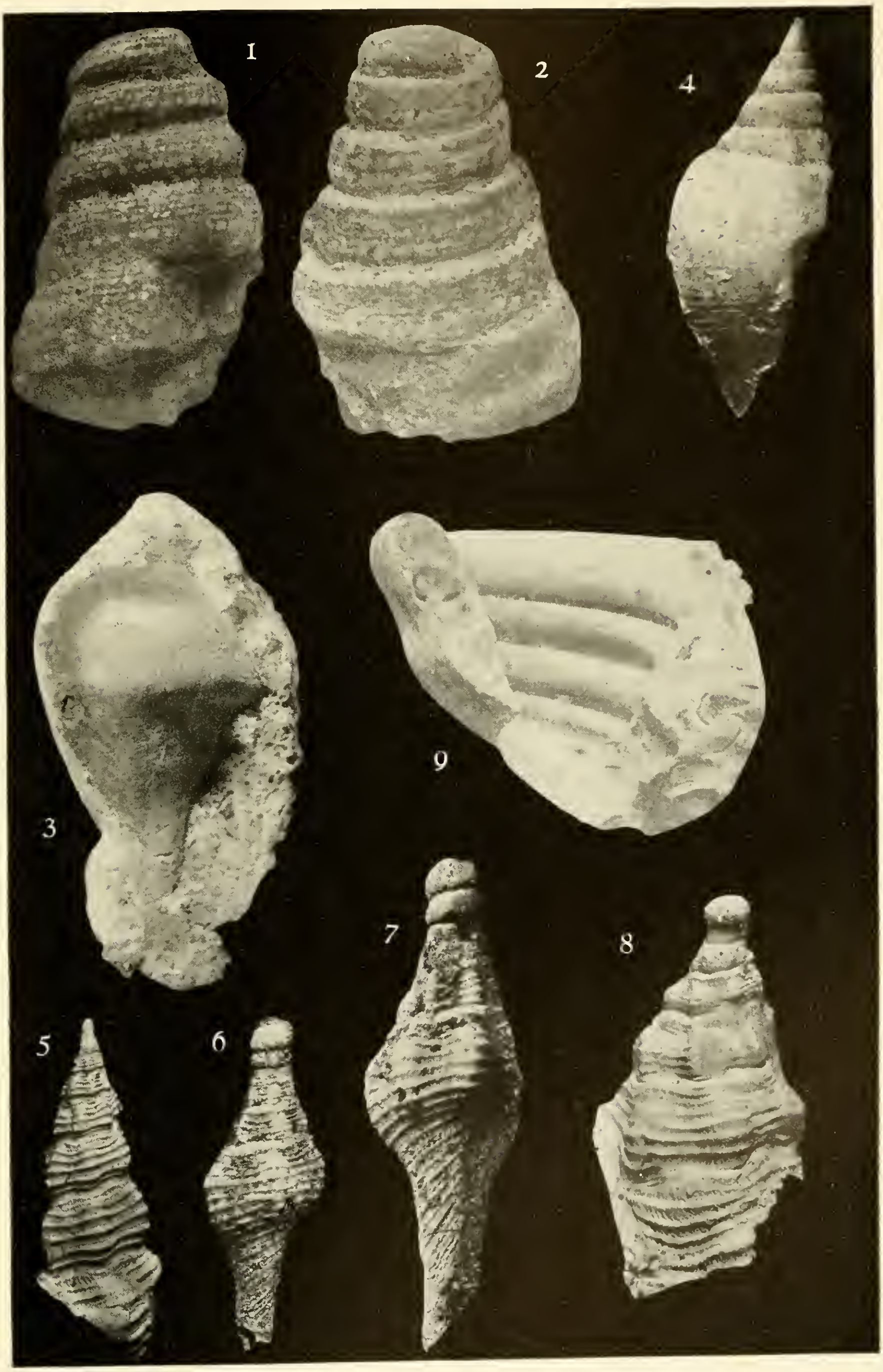
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Plate XXIV

Fig. 1. *Mitra henekeni* Sowerby; x 2; gutta-percha cast.

Fig. 2. *Olivella muticoides* Gabb variety *portoricoensis* n. var.; x 1.75; gutta-percha cast, showing a low spired shell.

Fig. 3. *Olivella muticoides* var. *portoricoensis;* x 1.75; gutta-percha cast, showing a high spired shell.

Fig. 4. *Olivella portoricoensis* n. s.; x 3.1; gutta-percha cast.

Fig. 5. *Cancellaria lævescens* Guppy; x 0.8; gutta-percha cast showing shell with smooth body whorl.

Fig. 6. *Cancellaria lævescens;* x 0.8; gutta-percha cast, showing reappearance of cancellate ornamentation on the final portion of the body whorl.

Fig. 7. *Turris albida* Perry variety *haitensis* Sowerby; x 1.4; gutta-percha cast.

Fig. 8. *Drillia consors* Sowerby variety *portoricoensis* n. var.; x 3.5; gutta-percha cast.

Fig. 9. *Drillia consors* var. *portoricoensis;* x 2.3; gutta-percha cast.

Fig. 10. *Drillia grabaui* n. s.; x 2.3; gutta-percha cast.

Fig. 11. *Drillia portoricoensis* n. s.; x 2.3; gutta-percha cast showing varix.

Fig. 12. *Drillia portoricoensis;* x 2.3; gutta-percha cast.

Fig. 13. *Drillia semmesi* n. s.; x 2.25; gutta-percha cast.

Fig. 14. *Terebra quebradillensis* n. s.; x 18; gutta-percha cast.

Fig. 15. *Conus catenatus* Sowerby; x 1.5; gutta-percha cast of specimen collected by Prof. Berkey.

Fig. 16. *Conus* cf. *marginatus* Sowerby; x 3.6; gutta-percha cast.

Fig. 17. *Bullaria portoricoensis* n. s.; x 2.2; int. mold.

Fig. 18. *Bullaria granosa* Sowerby; x 2.25; gutta-percha cast.

Fig. 19. *Alectrion gurabensis* Maury variety *portoricoensis* n. var.; x 4; gutta-percha cast, showing the aperture and pillar

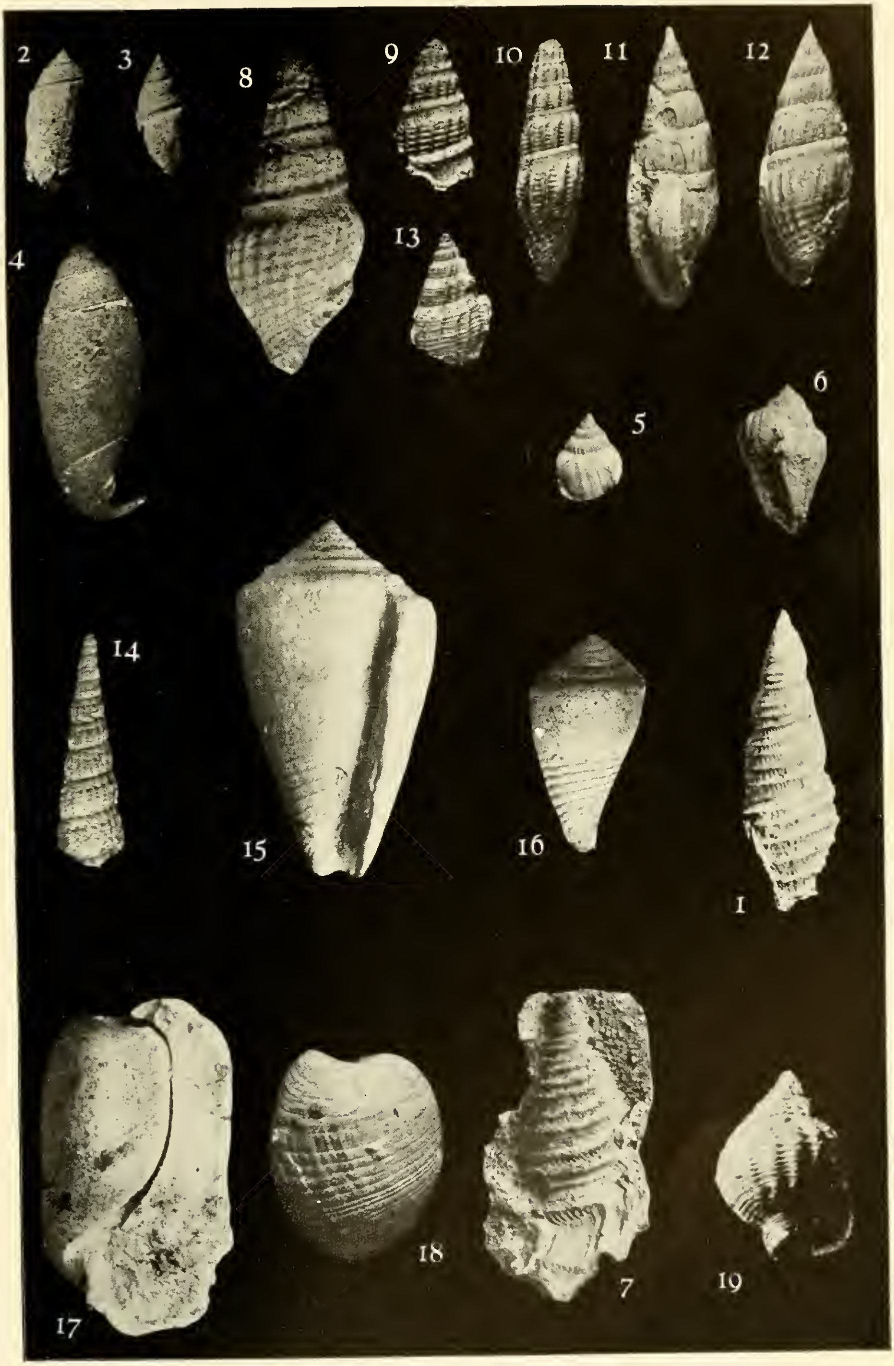
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Plate XXV

Fig. 1. *Orthaulax portoricoensis* n. s.; x 0.85; internal and external mold of the upper half of the shell showing most of the shell wall replaced by casts of a burrows made by a boring sponge or other organism.

Fig. 2. *Orthaulax portoricoensis;* x 0.85; internal mold of a large, low spired shell.

Fig. 3. *Orthaulax portoricoensis;* x 0.85; internal mold of a small, high spired shell, probably an immature individual.

Fig. 4. Reverse side of the same specimen shown in Fig. 3.

Fig. 5. *Orthaulax portoricoensis;* x 0.85; case of the upper portion of a mature shell, made up entirely of the burrow casts illustrated in Fig. 1.


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Fossil Corals of Porto Rico, with Descriptions also of a Few Recent Species—*H. N. Coryell and Violet Ohlsen*

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1929

FOSSIL CORALS OF PORTO RICO

With Descriptions also of a Few Recent Species

By H. N. Coryell and Violet Ohlsen

CONTENTS

(Those subtitles marked by an (*) were prepared jointly by H. N. Coryell and Violet Ohlsen and the remaining by the senior author.)

INTRODUCTION

Purpose and Résumé

The essential purpose of this paper is to include a specific and generic description of the corals collected by Doctors Chester A. Reeds and Bela Hubbard. Sixty-seven species and 24 genera are described. Thirteen of the species are new. Thirty-eight of the 67 species were from the San Sebastian, 13 from the Lares, 19 from the Cibao, 2 from the Los Puertos, 2 from the Quebradillas, 39 from the Ponce and 14 from the Pleistocene and Recent.

Every old species was identified by the aid of the original descriptions and figures, and their names have been corrected under the Laws of Nomenclature.

The correlation of the Porto Rican coral fauna with the stratigraphic distribution of other similar faunas in the Caribbean Region is given in Table No. I, pages 172-3. In Table II, page 175, are shown the probable equivalents of the formations of Porto Rico in other islands of the West Indies and in the subtropical and tropical portions of North America.

Collections Studied

In 1915 Dr. Chester A. Reeds and Mr. P. B. Hill visited Porto Rico for the purpose of making one of the most elaborate scientific collections of fossils that had ever been assembled from that island. Their work was to form the basis of a publication on the fossil fauna. Some of the groups of forms collected by them have already been studied by different students, and the results have been published either as separate numbers of the Scientific Survey of Porto Rico or have been incorporated within other reports of this survey.

The coral specimens were shipped to Washington, D. C., to Dr. T. Wayland Vaughan. He was recognized as an authority on Tertiary corals and was selected as the proper person to undertake the work, but Dr. Vaughan's other duties left no time for the identification and description of the specimens, many of which were similar to those he had already described. So after a few years they were returned to the headquarters of the New York Academy of Sciences and later forwarded to Columbia University, where they have been stored since 1927.

Dr. Bela Hubbard's geological studies on the Lares area of Porto Rico were published in 1923 after he had presented a report on the results of his field observation before the New York Academy of Sciences in 1917. The corals of his collections were forwarded from Porto Rico directly to Dr. T. Wayland Vaughan, Washington, D. C. They were set aside there with Dr. Reeds' specimens and later forwarded to New York and stored in Columbia University.

Nothing more was done with these two collections until the spring of 1928. At that time the work which has resulted in the present paper was initiated and the specimens gathered by both parties were studied.

Previous Work on West Indian Coral Fauna

The writers who have made incidental mention of the fossil corals of the West Indies are indeed very numerous. Those who have obtained a few specimens from the Islands and inserted a description of a new species or variety in a stratigraphic discussion of the Caribbean Region are less numerous, but yet make up a considerable list. Detailed reference to these students is given in the specific and generic descriptions.

The zoological and paleontological students who have made a systematic classification and study of the coral fauna of the lands around the Caribbean Sea are few. One of the earliest of these was Duncan, an English paleontologist, who obtained several collections of corals from the West Indies. He began his publications as early as 1884 in the Zoological Journal of the Linnean Society of London and followed these with a series of publications in the Quaterly Journal of the Geological Society of London, which appeared in volumes XIX to XXVIII.

A. E. Verrill was an enthusiastic worker in unravelling the life history of reef-making corals and in reorganizing the classification of the Hexacoralla. He published many genera and species from the Porto Rican region in the Transactions of the Connecticut Academy of Arts and Science for 1901.

The work of Dr. T. Wayland Vaughan in Bulletin 103 of the U. S. National Museum for 1919 probably ranks as the best organized systematic paper on fossil corals of the Caribbean Province among the several papers that he has published. It is the one found most useful in the work of identifying the Reeds and Hubbard collections.

Acknowledgments

The writers wish to take this opportunity to express their gratitude especially to Doctors Chester A. Reeds and Bela Hubbard, who collected the Porto Rican specimens, to Miss Marjorie Elton for her splendid assistance, to Miss Amy Hepburn for making available the numerous references and to Professor Howard A. Meyerhoff for many useful suggestions.

As the junior author was able to collaborate only during the study of a portion of the Reeds collection, those genera, species and pages of discussion that were prepared jointly are designated by an asterisk (*) preceding the subtitles, both in the index and the text.

CORRELATIONS BASED ON THE CORAL FAUNA

The Tertiary and later formations in Porto Rico are arranged in a series of irregular "off-lapping" beds upon a median eastward-westward axis of older rock. The youngest beds are along the north and south shores with the older members outcropping in irregularly parallel bands farther inland, leaving the older sediments and igneous masses exposed in the interior.

The detailed classification of the various divisions of the Tertiary are still under discussion as to their proper position in the geological time scale. Some of the determinations are based upon faunal evidences primarily, while others lay claim to their position upon the interpretation of the structural features.

The work on the coral collections here presented should not be expected to add much that is new to the stratigraphy. It should aid, however, in the correlation of the horizons determined in Porto Rico with those from which other coral faunas have been collected. One of the available works to form a basis for a correlation is that of Dr. T. Wayland Vaughan in Bulletin 103 of the U. S. National Museum.

The following table gives the range of the Tertiary and later corals of the Reeds and Hubbard collections in the Porto Rico formations and their occurrence in other formations as determined by Vaughan.

TABLE I

Species from Porto Rico	Porto Rican Horizons								Vaughan, Bull. 103, U.S.N.M.						
	Quebradillas.	Los Puertos.	Cibao.	Lares.	San Sebastian.	Ponce.	Juana Diaz.	Pleistocene & Recent.	Antigua	Anguilla.	Emperador.	Chattahoochee.	Culebra.	Bowden.	Pliocene, Pleistocene & Recent.
Acropora crassa, n. sp.						x		x							
Acropora palmata								x							x
Acropora panamensis				x	x	x			x		x				
Agaricia agaricites crassa								x							
Agaricia irregularis, n. sp.			x												
Agaricia sinuata, n. sp.			x			x									
Antiguastrea cellulosa		x		x	x	x	x	x	x	x					
Antiguastrea cellulosa curvata					x				x						
Astreopora antiguensis						x			x						
Astrocoenia decaturensis			x	x	x	x			x						
Astrocoenia guantanamensis					x				x						
Astrocoenia meinzeri						x			x						
Astrocoenia ornata					x										
Astrocoenia portoricensis				x	x	x			x						
Calamophyllia dendroidea, n. sp.						x									
Calamophyllia portoricensis, n. sp.		x		x	x	x									
Cyathomorpha antiguensis				x	x				x						
Cyathomorpha tenuis					x	x	x	x	x						
Diploastrea crassolamellata				x	x	x			x						
Favites expansa, n. sp.					x										
Favites irregularis, n. sp.					x										
Goniastrea crassa, n. sp.															
Goniastrea pectinata								x							
Goniopora canalis				x	x					x	x				
Goniopora cascadensis					x	x			x	x			x		
Goniopora clevei					x				x	x	x				
Goniopora decaturensis					x	x			x						
Goniopora decaturensis silicensis				x		x						x			

TABLE I (*Continued*)

Species from Porto Rico	Porto Rican Horizons								Vaughan, Bull. 103, U.S.N.M.						
	Quebradillas.	Los Puertos.	Cibao.	Lares.	San Sebastian.	Ponce.	Juana Diaz.	Pleistocene & Recent.	Antigua.	Anguilla.	Emperador.	Chattahoochee.	Culebra.	Bowden.	Pliocene, Pleistocene & Recent.
Goniopora hilli					x	x					x				
Goniopora imperatoris					x	x				x	x				
Goniopora jacobiana						x								x	
Goniopora panamensis					x	x				x	x				
Goniopora portoricensis				x	x				x						
Goniopora regularis					x	x			x						
Hydnophora hubbardi					x										
Lamellastraea crassa, n. sp								x							
Latomeandra lata, n. sp					x										
Leptoria areolata hispida								x							
Leptoria phrygia								x							
Maeandra antiguensis				x	x				x		x				
Maeandra labyrinthiformis								x							
Manicina willoughbiensis					x				x						x
Metastraea planulata, n. sp						x									x
Orbicella annularis	x					x									
Orbicella cavernosa					x	x									
Orbicella costata				x	x	x	x		x	x			x		
Orbicella limbata						x								x	
Orbicella tampaensis				x	x	x				x					
Pironastraea anguillensis					x				x	x					
Pironastraea antiguensis				x		x			x						
Pocillopora portoricensis, n. sp						x									
Porites anguillensis				x	x	x				x	x				
Porites astreoides			x			x									
Porites baracoaensis						x								x	
Porites douvillei			x	x	x	x	x				x				
Porites (Synaraea) macdonaldi					x					x	x				
Porites panamensis				x	x	x					x				
Porites porites								x							x
Porites toulai				x	x	x					x				
Stylophora affinis				x	x	x								x	
Stylophora goethalsi			x								x		x		
Stylophora granulata						x								x	
Stylophora macdonaldi	x			x		x					x				
Stylophora panamensis					x						x				
Stylophora ponderosa				x		x			x						
Stylophora portobellensis						x									
Siderastrea conferta					x				x	x			x		

Of the 67 species identified here, 42 occur in the Oligocene and Miocene beds as tabulated by Vaughan.

The Antigua is represented by 23 of the 42 species, 8 of which extend into the Anguilla or Emperador beds. The Antiguan corals were collected from the base of the formation. Of the 23 species, 19 occur in the San Sebastian Shale of Porto Rico as designated by Doctor Chester A. Reeds * and Professor Howard A. Meyerhoff.** The San Sebastian thus appears equivalent to the base of the Antigua formation.

Twenty-one of the 42 species occur in the Lares Limestone. Of these, 7 occur in the Antigua only, 4 in the Antigua and Anguilla, or Antigua and Emperador and 7 in the Anguilla or Emperador only. The Lares Limestone on this basis appears transitional, but on comparing the occurrence of the Lares species with the San Sebastian, it is found that 17 of the 21 from the Lares Limestone were collected also from the San Sebastian. The Lares Limestone then appears closely related to the later formation. Only two of the Lares species were found in the Cibao above.

Six of the 42 species occur in the Cibao as limited by Meyerhoff.* Of these, 1 occurs in the Antigua only, 0 in the Antigua and Anguilla or Antigua and Emperador, and 2 in the Anguilla or Emperador only. The Cibao appears to be related to the formations of Anguilla age rather than to older beds, but an impression based on so few species cannot be as conclusive as one could wish.

From the collections of Reeds and Hubbard, 39 species were identified from the Ponce formation as determined by Doctor Reeds in the field. Of these 39 species, 21 have been identified from the San Sebastian Shale, 17 from the Lares Limestone, 4 from the Cibao Limestone, 2 from Los Puertos and 2 from the Quebradillas Formation. The distribution indicates that the collection was made from the beds on the south side of Puerto Rico without any particular field recognition as to the zonal divisions or lithologic phases more readily determined in the field on the north side of the island. The Ponce Formation, as here determined from the coral collection, includes beds equivalent to the San Sebastian, Lares, Cibao, Los Puertos and Quebradillas of the northern section. The lower part of the Ponce Formation, as designated in the field by Reeds, would include the Guanica, Juana Diaz and Collazo beds as given by Vaughan.* This would leave only the upper limestone deposits to be included in the limited Ponce. With detailed field work added to the faunal studies still other limitations should be possible.

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* Reeds, C. A., Field Tabulation List, unpublished.

** Meyerhoff, H. A., personal communication.

* Meyerhoff, H. A., personal communication.

* Vaughan, T. Wayland, Bull. Geol. Soc. of Amer., XXXV, 1924, opposite p. 720.

Of the 42 species common to the collections of Vaughan and to those of Reeds and Hubbard, 10 have been identified from the Antigua Formation only, 8 from the Antigua and Anguilla or Antigua and Emperador, 8 from the Anguilla or Emperador only and 5 from the Bowden of Jamaica. The Antigua would thus include the lower Ponce, which is here correlated with the Guanica—Juana Diaz—Collazo horizon.* With no further division undertaken on the basis of the present information, the remaining Ponce beds are equivalent to the Anguilla-Bowden deposits.

The following table shows a possible correlation of the formations of Porto Rico, based on the present coral studies, with the formations elsewhere from which considerable coral faunas have been obtained.**

TABLE II

<table>
<tr><th colspan="2"></th><th colspan="2">Panama and Costa Rica</th><th>Lesser Antilles</th><th>Florida</th><th>Jamaica</th><th>Northern Porto Rico</th><th>Southern Porto Rico</th></tr>
<tr><td rowspan="2">Miocene</td><td>Middle</td><td colspan="2" rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td>Bowden</td><td rowspan="2">Quebradillas</td><td rowspan="4">Ponce</td></tr>
<tr><td>Lower</td><td></td></tr>
<tr><td rowspan="4">Oligocene</td><td rowspan="2">Upper</td><td rowspan="4">Culebra</td><td rowspan="2">Emperador</td><td rowspan="2">Anguilla</td><td rowspan="2"></td><td rowspan="4"></td><td>Los Puertos</td></tr>
<tr><td>Cibao</td></tr>
<tr><td rowspan="2">Middle</td><td rowspan="2"></td><td rowspan="2">Antigua</td><td rowspan="2">Chattahoochee</td><td>Lares</td><td>Guanica</td></tr>
<tr><td>San Sebastian</td><td>Juana Diaz</td></tr>
</table>

TABULATION OF THE COLLECTING LOCALITIES

The localities from which the corals were collected are grouped into two lists. The first one gives the stations visited by Dr. Chester A. Reeds and Mr. P. B. Hill during the months of June and July, 1915.

* Vaughan, T. W., Bull. Geol. Soc. of Amer., XXXV, 1924, opposite p. 720.

** Vaughan, T. W., Bull. 103, U. S. Nat. Mus., 1919.

The number 440 is the accession number allotted to the collection in the American Museum of Natural History. The other number or numbers designate the field locality. The description of each station is preceded by the age of the formation from which the collection was made as determined by the field interpretation and the study of the fossil specimens.

The second list groups in consecutive order, the stations visited by Dr. Bela Hubbard during his study of the Lares district. Many of the specimens in his collection are excellently preserved. He was fortunate in securing representatives of a number of genera not commonly present in a collection of Porto Rican fossils.

Collecting Localities of the Reeds Collection

440-3 *Los Puertos—Arecibo Limestone.* Near south edge of Aguadilla, about 150 feet above the sea on an old road leading eastward up the hill.

440-11 *Los Puertos—Arecibo Limestone.* Collection from rock wall in railroad cut just south of railroad station, Aguadilla.

440-14 *Los Puertos—Arecibo Limestone.* Collection from south end of cut just south of railroad station, Aguadilla.

440-17 *Los Puertos—Arecibo Limestone.* Collection from the field 1/4 mile east of the south edge of Aguadilla, about 300 feet above the sea.

440-18 *Recent.* Collection from the beach south of Aguadilla.

440-20 *San Sebastian.* Collection from shaly limestone south side of road near Km. post 33, on road from San Sebastian to Lares.

440-24, -25,-26,-27. *San Sebastian.* Collection from bank along road from San Sebastian to Lares at Km. post 28.4.

440-28 *San Sebastian.* Collection from the shales at Km. post 28.25 on road from San Sebastian to Lares.

440-33, -34,-35. *Lares.* Collection from the surface slope, 100 feet above the base of the formation, 1/4 mile west of the river near the edge of the limestone escarpment overlooking Culebrinas River valley. Collazo River near San Sebastian.

440-36 *San Sebastian.* Collection below the third fall, 100 feet below the bridge over Collazo River near San Sebastian, on the down stream side.

440-38, -39,-40,-41, -42,-43.	*San Sebastian.* Collection from the roadside near Collazo River on the road from San Sebastian to Lares.
440-44	*San Sebastian.* Collection from beneath overhanging cliff, 50-100 feet below the base of the Arecibo—Lares Limestone, near Km. 28, Hm. 8, on the road from San Sebastian to Lares.
440-45, -46,-47,-48, -49,-50,-51, -52.	*San Sebastian.* Collection from the talus slope beneath bluff, 50 feet high along roadside near Km. post 28, Hm. post 8, on the road from San Sebastian to Lares.
440-53	*San Sebastian.* Collection from Mr. Rabell's property below the 100 foot falls near the road below the bridge over the Collazo River on the road from San Sebastian to Lares.
440-55	*San Sebastian.* Collection from the shale zone along the road from San Sebastian to Lares near Km. post 32, Hm. post 8.
440-56	*San Sebastian.* Collection from the marly beds on the south side of the road between Km. post 33, Hm. post 5-6, on the road from San Sebastian to Lares.
440-57, -58,-59.	*San Sebastian.* Collection from the quarry on the north side of road from San Sebastian to Lares near Km. post 33, Hm. post 3. (This horizon is sometimes referred to the Lares formation, base of the Arecibo.)
440-62	*San Sebastian.* Collection from beds 20 feet below the top of the formation along roadside opposite Km. post 28, Hm. post 4, on road from San Sebastian to Lares near the bridge over the Collazo River.
440-63	*San Sebastian.* Collection from the bluish shale, 11-12 feet thick, exposed along the side of road No. 8, from San Sebastian to Lares near Km. post 29, Hm. post 3-4.
440-64	*San Sebastian.* Collection from the bed at the base of the Arecibo—Lares formation along the San Sebastian to Lares road near Km. post 29, Hm. post 3-4.
440-72, -73.	*San Sebastian.* Collection from the coral zone just above bench mark 75.5 meters on bridge at the waterfall near

Km. post 28, Hm. post 8, on road No. 8 from San Sebastian to Lares.

440-92 *Lares.* Collection from beneath a limestone cliff about ½ mile northeast of Lares.

440-105 *San Sebastian.* Collection from near Km. post 29, east of San Sebastian.

440-107 *San Sebastian.* Collection from the outcrop of green shales in the bank of the river 100 yards below the last falls (50 feet in height) in the Collazo River.

440-110 *Cibao.* Collection from an outcrop ½ mile north of Rabell's ranch house along the road leading northeast of San Sebastian about 10 Km.

440-116 *San Sebastian.* Collection from just below the last falls on the Collazo River.

440-117 *Lares.* Collection from the weathered marl beds along the roadside near Km. post 2, Hm. post 3, in an excavation for the roadway of road No. 2, leading from Aguadilla to Rincon.

440-119 *Lares.* Collection from weathered marly limestone in embankment on the roadside near Km. post 9, Hm. post 9, on road No. 2, leading from Aguadilla to Rincon.

440-123 *Lares.* Collection from weathered limestone on north bank of road near bridge at Km. post 7, Hm. post 5, on the government highway leading from Aguadilla to Rincon.

440-126, -129, -130, -131, -133, -134, -135. *Quebradillas.* Collection from the cut at west end of railroad bridge over Guajataca River near Quebradillas.

440-136, -137. *Quebradillas.* Collection from along the railroad tracks between the wagon road crossing and the railroad bridge over the river near Quebradillas.

440-142 *Quebradillas.* Collection from the cut along the roadside near Km. post 40, on road from Quebradillas to Camuy.

440-170 *Juana Diaz.* Collection from the "fifth ledge" of fossiliferous shaly limestone in Jacaguas River bed, 1-2 Km. northwest of Juana Diaz.

440-242 *Juana Diaz?* Collection from the road embankment 25 feet above the river on the west bank of Coamo River below Coamo Reservoir.

440-286, -291,-292, -293,-294, -296,-297. *Ponce.* Collection from embankment of rock in situ on the north side of the road near Km. post 1, Hm. post 8-9, on the highway leading from Ponce to Penuelas.

440-298, -299,-300. *Ponce.* Collection from a cliff bank on the north side of the road near Km. post 2, Hm. post 8-9, on the highway from Ponce to Penuelas about 5 Km. west of Ponce.

440-307 *Ponce.* Collection from the south wall of road near a prospective bridge over a stream near Km. post 5, Hm. post 2, on the highway from Ponce to Penuelas.

440-320, -321,-322, -323. *Ponce.* Collection from a reef in a northwardly-facing bluff along the roadside near Km. post 25, Hm. post 2, on the road from Penuelas to Guayamilla.

440-325, -326,-327, -328,-329, -330,-331. *Ponce.* Collection from a coral and algal reef in a high bluff along roadside near Km. post 25, Hm. post 1-3, on the road from Ponce to Penuelas and Guayamilla.

440-339, -340,-341, -342,-344, -346. *Ponce.* Collection from a small bat cave in a great wall of coral and foraminiferal reef limestone on the east shore of Guánica Harbor.

440-354, -355,-359, -360,-361, -362,-364, -365,-366, -367. *Ponce.* Collection from the cliff just south of the lighthouse pier, Guánica Harbor.

440-368, -369,-370, -373,-375, -376,-378, -380. *Ponce.* Collection from the face of cliff, 300 feet south of the small bat cave, east shore Guánica Harbor.

440-381, -383,-384, *Ponce.* Collection from the foraminiferal beds designated above (440-339, etc.) and with 30-40 feet of limestone

-385,-386. -387,-389. -390. overlying the reef at 340-389, east shore, Guánica Harbor.

440-401, -402,-403. -405,-407, -408,-409, -410,-412, -413,-415, -418. *Cretaceous.* Collection from the island ¼ mile southeast of Parguera, Porto Rico. The Island forms the east shore of the Parguera Harbor.

440-441, -442,-443, -444. *Lares.* Collection from the basal portion of the limestone overlying the tuff near Km. post 64, Hm. post 9, on the road from Arecibo to Ponce.

440-445, -446,-449, -450. *Lares.* Collection from the bluff on the west side of the road near Km. post 66, Hm. post 6-7, leading from Arecibo to Ponce.

440-451, -452,-453, -454,-455, -456,458. *Lares.* Collection from near Km. post 66, Hm. post 7-8, on the road from Arecibo to Ponce.

440-460, -461. *Cibao.* Collection from the talus slope and wash near Km. post 69, Hm. post 2.5, on the road from Arecibo to Ponce.

440-462 *Cibao.* Collection from a high bluff on the west side of the road, near Km. post 69, Hm. post 3, leading from Arecibo to Ponce.

440-465, -466,-467, -468. *Cibao.* Collection from a high bluff along the roadside near Km. 69, Hm. posts 6-7, on the highway from Arecibo to Ponce.

440-486 *Los Puertos.* Collection from blocks along roadway taken from boulders in the talus slope near Km. post 2, on the road from Manatí to Ciales.

440-490 *Cibao.* Collection from limestone *in situ* in the east bluff along the roadside near Km. post 1, Hm. post 6, on the highway leading from Manatí to Ciales.

440-507 *Lares.* Collection from a bluff 60 feet high and 200 feet long on the east side of the roadway near Km. post 9, on the road from Manatí to Ciales.

440-542 *Quebradillas.* Collection from a railroad cut in a bluff on the west bank of River Loiza, ¼ mile northwest of Central Canovanas, near Loiza.

COLLECTING LOCALITIES OF THE HUBBARD COLLECTION

800, 801, 802, 803, 804, 805, 806, 807, 808	Zone C, Km. 32.8, Lares Road.
811, 812, 814, 815	Zone C, Lares Road.
816, 817	Zone C, Collazo-Lares Road.
818, 819, 822	Zone C, Lares Road.
824, 826, 827	Zone D, Lares.
828, 829, 830, 833	Zone C, Collazo-Lares Road.
834, 835, 836	Zone C or D, West of San Sebastian.
839, 840	Zone C, Lares Road.
841	Zone D, Lares.

846
847
849
850
852
853 .... Zone C, Collazo-Lares Road.
854
855
856
857
859
860

863 .... Zone D, Lares.

864
865
866
867
868
869
870
874
877
878
879
880
881
882 .... Zone C, Collazo-Lares Road.
886
887
888
890
891
893
894
896
897
898
899
900
901
909

912, 913, 914, 916	Zone D, Lares.
917, 918	Zone C, East of Lares.
922, 924, 925, 933, 934, 935, 936, 937, 942, 943, 945, 948	Lares District.
955, 956	Zone C or D, East of Lares.
957, 958, 959, 960, 964, 968	Zone C, Lares Road.
974, 975	Lares District.
980	Zone G, South of Camuy.
982	Lares District.
984	Zone C. Collazo near Lares Road.
986, 987, 989	Zone C. Collazo-Lares Road.

990 }..................Zone H, Rincon Point.

991
993
995
996
998
999 }..................Lares District.
1000
1001
1004
1006
1089

H 1
H 2 }..................Lares District.
H 3

S 5
S 7 }..................Mona Island (Collected by N. L. Britton).

P.R. 82 a-d
P.R. 98 c-g }..........Zone C or D, Lares Reef.

* GLOSSARY

Calyx-ice ....The cup-shaped upper end of a corallite.

Coenenchyma ......Porous intercorallite tissue.

Colline ....A calcareous ridge separating series of calicular centers as in *Manicina.*

Columella ....A solid or porous rod of calcareous tissue that occupies the center of a corallite.

Corallite ....An individual of a corallum.

Corallum ....An entire skeleton of a compound coral.

Costae ....The extension of the septa outwardly beyond the theca or wall of the corallite.

Endotheca ....The inner wall of a corallite.

Exotheca ....A cellular structure between adjacent costae and forming the coenenchyma of the intercorallite area.

Gonioporid arrangement of septa....Six primaries extending directly to the columella, with a triplet group of a secondary and two tertiaries between each and often a directive plane.

Palus-i ....One of the slender, upright, calcareous growths that surround the central part of some corals.

Poritid arrangement of septa..........A solitary directive, four lateral pairs and a ventral triplet.

Septum-a ....One of the vertical, radial, calcareous, solid or porous plates projecting into the calyx.

Synapticula-ae .....One of the conical or cylindrical calcareous processes which extends between adjacent septa.

Trabecula-ae ......One of the numerous calcareous rods that serve as units to make up the network structure of the columella or septa in some corals.

Verrucae ....Small protuberances bearing calices. Example: *Pocillopora.*

SYSTEMATIC DESCRIPTION OF GENERA AND SPECIES

CLASS ANTHOZOA

Madreporaria Imperforata

* FAMILY SERIATOPORIDAE MILNE EDWARDS AND HAIME, 1849

Genus **Pocillopora** Lamarck, 1816

Pocilloporo Lamarck, Hist. Nat. Anim. sans Vert., II, 1816, p. 273; Lamarck, Hist. Nat. Anim. sans Vert., II, 1836, p. 441; Dana, Zoophytes, 1848, p. 523; Milne Edwards and Haime, Compte Rendu de l'Acad. des Sci., XXIX, 1849, p. 261; Milne Edwards and Haime, Hist. Nat. des Corall., III, 1860, p. 301; Verrill, Trans. Conn. Acad. Arts and Sci., 1, 1870, p. 519; Zittel, Traite de Paleontologie, I, 1883, p. 247; Vaughan, Carnegie Inst. Washington, Dept. Marine Biology, Pub. 213, 1918, p. 75; Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 342.

Genotype.—*Pocillopora acuta* Lamarck.

Pocillopora acuta Lamarck, Hist. Nat. Anim. sans Vert., II, 1816, p. 273.

Description.—Corallum forms massive or branching colonies with numerous small verrucae upon the entire surface; the calices are small, deep, oval or circular and present upon the verrucae and the spaces between; the individual calices are separated by compact coenenchyma on the sides of the branches or lobes, but closely crowded on the ends; the surface is granulose or hispid; there are six to twelve septa, the six major ones are conspicuous; tabulae are few; the wall is well developed and porous; a columella is present.

Range.—Tertiary to Recent.

Pocillopora portoricensis Coryell, n. sp.

Plate XXVI, Figure 1

Description.—The corallum forms palmate lobes and masses; the verrucae are very numerous, often only 1 to 2 mm. apart, measuring only 1 to 2 mm. in diameter and averaging 2.5 mm. in height; a few are elongate with a greater width of 3 mm. or more; the calices are small, oval or circular, ⅔ mm. in diameter and separated by a narrow wall or a thickness of coenenchymous tissue equal to or more than the diameter of the calyx; one to four calicular pits occur on a single verruca while only one or two are present upon the flattened area between; six strong septa are present and are joined to the well developed columella; in some calices two opposite septa are more strongly developed than the others; the entire surface is papillate.

Type.—23013, Reeds Collection, American Museum of Natural History.

Locality.—440-362, Reeds Collection, American Museum of Natural History.

Occurrence.—Ponce Formation.

Remarks.—This species is distinguished from *Pocillopora palmata* Palmer by the more numerous, smaller and more closely spaced verrucae.

* Genus Stylophora Schweigger, 1819

Stylophora Schweigger, Beobacht. auf Naturf., 1819, Pl. V; Schweigger, Hand. Naturg., 1820, p. 413; Blainville, Dict. Sci. Nat., LX, 1830, pp. 319, 351; Milne Edwards and Haime, Ann. Sci. Nat., ser. 3, Zool., XIII, 1850, p. 102; Milne Edwards and Haime, Hist. Nat. Corall., II, p. 133; Fromentel, Intr. Polyp. foss., 1861, p. 179; Duncan, Linn. Soc. London Jour., Zool., XVIII, 1884, p. 45.

Genotype.—*Madrepora pistillata* Esper.

Description.—Corallum forming cylindrical or palmate branches or incrustations; the calices are circular and separated by coenenchyma; costae are rudimentary; endotheca is present; septa are of two cycles, six extending to the prominent styliform columella.

Range.—Eocene to Recent.

* Stylophora affinis Duncan, 1863

Plate XXVI, Figures 2, 2a

Stylophora affinis Duncan, Geol. Soc. London Quart. Jour., 1863, XIX, p. 436, Pl. XVI, fig. 4; Duncan, Geol. Soc. London Quart. Jour., XXIV, 1867, p. 25; Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 336.

Reussia affinis Duchassaing and Michelotti, Sup. Mem. Corall. Antilles, 1866, p. 70; Duchassaing, Rev. Zooph. et Spong. Antilles, 1870, p. 26.

Description.—Corallum composed of nearly cylindrical branches: calices shallow, circular, 0.8 to 1.0 mm. in diameter, surrounded by a raised margin and from 0.8 to 1.0 mm. apart; six prominent septa reach to the large, dense and styliform columella; coenenchyma papillose, the granules often in rows.

Locality.—440-64,-300,-321,-339,-384,-454, Reeds Collection, American Museum of Natural History.

Occurrence.—San Sebastian Shale Ponce Formation and Lares Limestone.

* **Stylophora goethalsi** Vaughan, 1919

Plate XXVI, Figures 3, 3a

Stylophora goethalsi Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 338, Pl. LXXV, figs. 2-3.

Description.—Corallum composed of compressed branches with marginal protuberances; calices shallow, 0.5 to 0.75 mm. in diameter and from 0.5 to 1.5 mm. apart; six well developed septa extend to the prominent columella, short secondary septa occur; coenenchymal surface granulose.

Cotype.—No. 324767, U. S. National Museum.

Locality.—440-460, Reeds Collection, American Museum of Natural History.

Occurrence.—Cibao of the Arecibo group.

* **Stylophora granulata** Duncan, 1864

Plate XXVI, Figure 4

Stylophora granulata Duncan, Geol. Soc. London Quart. Jour., XXI. 1864, p. 10, Pl. II, fig. 3; Duncan, Geol. Soc. London Quart. Jour., XXIV, 1867, p. 25; Duncan, Geol. Soc. London Quart. Jour., XXIX, 1873, p. 551; Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 340.

Description.—Corallum composed of nearly cylindrical branches; calices deep, 0.75 to 1.25 mm. in diameter, irregularly spaced and surrounded by a raised margin formed by the septa and costae; six principal septa reach to the columella, secondary septa are present: the coenenchyma is conspicuously granulose and in places costate.

Locality.—440-327, Reeds Collection, American Museum of Natural History.

Occurrence.—Ponce Formation.

* Stylophora macdonaldi Vaughan, 1919

Plate XXVI, Figures 5, 5a

Stylophora macdonaldi Vaughan. U. S. Nat. Mus. Bull. 103, 1919, p. 339. Pl. LXXV, figs. 5-7a.

Description.—Corallum consisting of slender branches, compressed wherever bifurcating; calices shallow, 1.0 mm. in diameter and from 0.5 to 1.5 mm. apart; six well developed septa extend to the prominent columella with their outer edges raised at the margin of the calyx; coenenchymous tissue granulated.

Cotypes.—No. 324769, 324770, U. S. National Museum.

Locality.—440-117,-126,-321,-331, Reeds Collection, American Museum of Natural History, and 901, Hubbard Collection, Columbia University, New York City.

Occurrence.—Lares Limestone, Quebradillas Formation and Ponce Formation.

* Stylophora panamensis Vaughan, 1919

Plate XXVI, Figure 6

Stylophora panamensis Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 335. Pl. LXXV, figs. 1, 1a.

Description.—Corallum consists of irregularly shaped plates; calices shallow, 0.5 to 0.75 mm. in diameter, from 0.5 to 1.0 mm. apart and margins slightly elevated; six primary septa join the compressed columella; coenenchyma inconspicuously granulose.

Type.—No. 324768, U. S. National Museum.

Locality.—440-20,-39, Reeds Collection, American Museum of Natural History.

Occurrence.—San Sebastian Shale.

* Stylophora ponderosa Vaughan, 1900

Plate XXVI, Figure 7

Stylophora ponderosa Vaughan, U. S. Geol. Surv. Mono. 39, XXXIX, 1900, p. 132, Pl. XIII, fig. 16; Pl. XIV, figs. 1-1b; U. S. Nat. Mus. Bull. 103, 1919, p. 342.

Description.—Corallum large irregular masses; calices shallow, polygonal, 1 mm. in diameter; walls average 0.5 mm. in thickness, consisting of laminae of spinose coenenchyma; six well developed septa reach the styliform columella.

Type.—U. S. National Museum.

Locality.—440-340,-346,-442, Reeds Collection, American Museum of Natural History.

Occurrence.—Ponce Formation and Lares Limestone.

* **Stylophora portobellensis** Vaughan, 1919

Plate XXVI. Figures 8, 8a

Stylophora portobellensis Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 338, Pl. LXXVI, figs. 1-1a.

Description.—Corallum composed of compressed branches with somewhat flabellate terminals; calices shallow, 0.5 to 1.0 mm. in diameter and from 0.25 to 0.5 mm. apart; six well developed septa extend to the prominent, styliform columella; coenenchyma dense and granulose.

Type.—No. 324762, U. S. National Museum.

Locality.—440-331, Reeds Collection, American Museum of Natural History.

Occurrence.—Ponce Formation.

* FAMILY.—ASTROCOENIIDAE KOBY

* Genus **Astrocoenia** Milne Edwards and Haime, 1848

Astrocoenia Milne Edwards and Haime, Compte Rendu., XXVII, 1848, p. 469; Gregory, Palaeo. Indica, ser. 9, II, 1900, Pt. 2, p. 59.

Genotype.—*Astrea numisma* Defrance.

Description.—Corallum forms massive, lamellar, dendroidal or incrusting masses; corallites prismatic, contiguous and with thick walls; calices polygonal; eight principal septa extend to the styliform columella.

Range.—Triassic to Recent.

* **Astrocoenia decaturensis** Vaughan, 1919

Plate XXVI, Figure 9

Astrocoenia decaturensis Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 348, Pl. LXXVIII, figs. 3-4a.

Astrocoenia ornata Duncan, Geol. Soc. London Quart. Jour., XIX, 1863, p. 425, Pl. XIV, fig. 7; Duncan, Geol. Soc. London Quart. Jour., XXIV, 1867, p. 23.

Description.—Corallum large, dendroidal or massive, with irregular surface; calices shallow, polygonal, 1.5 to 2.5 mm. in diameter; the walls are thin, usually less than 1 mm. thick and surmounted by a raised line of granules; sixteen to twenty septa are present in each calice with eight or ten septa reaching the columella respectively; endothecal dissepiments are few and thin.

Type.—No. 324789, U. S. National Museum.

Locality.—440-45,-339,-341,-364,-442,-460, Reeds Collection, American Museum of Natural History.

Occurrence.—San Sebastian Shale, Ponce Formation, Lares Limestone and Cibao Limestone.

* **Astrocoenia guantanamensis** Vaughan, 1919

Plate XXVII, Figure 1

Astrocoenia guantanamensis Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 347, Pl. LXXIX, figs. 1-2.

Description.—Corallum massive, tuberose; calices shallow, polygonal, from 1.0 to 1.75 mm. in diameter; the walls from 0.25 to 0.5 mm. thick, marked by septal costae or dentations; there are sixteen septa, eight of which reach the styliform columella; the secondary septa taper inward and are about one-half as long as the primaries.

Type.—No. 324794, U. S. National Museum.

Locality.—440-59, Reed Collection, American Museum of Natural History, and 802, 957, 958, 960, Hubbard Collection, Columbia University, New York City.

Occurrence.—San Sebastian Shale.

* **Astrocoenia meinzeri** Vaughan, 1919

Plate XXVII, Figure 2

Astrocoenia meinzeri Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 349, Pl. LXXIX, figs. 3, 3a.

Description.—Corallum composed of branches elliptical in cross-section; calices from 2.5 to 3.0 mm. in diameter and from 1.25 to 1.5 mm. deep; the walls are from 0.5 to 1.5 mm. thick, with the upper surface ridged or grooved longitudinally; there are sixteen septa, with eight reaching the styliform columella where the ends of the septa thicken and fuse around the columellar mass; dissepiments are present.

Type.—No. 324791, U. S. National Museum.

Locality.—440-346, Reeds Collection, American Museum of Natural History.

Occurrence.—Ponce Formation.

* **Astrocoenia ornata** Milne Edwards and Haime, 1857

Plate XXVII, Figure 3

Astrocoenia ornata Milne Edwards and Haime, Hist. Nat. Corall., II, 1857, p. 357.

Description.—Corallum forms a rounded or hemispherical mass; calices polygonal, measuring from 2.0 to 2.5 mm. in diameter; walls thick and very granulose; the principal septa are thickest near the wall and join with the large columella at the center of the calyx.

Locality.—440-51, Reeds Collection, American Museum of Natural History.

Occurrence.—San Sebastian Shale.

* **Astrocoenia portoricensis** Vaughan, 1919

Plate XXVII, Figures 4, 4a

Astrocoenia portoricensis Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 350, Pl. LXXVI, figs. 4, 4a; Pl. LXXVIII figs. 1, 1a.

Astrocoenia ornata Vaughan, Geol. Soc. London Quart. Jour., LVII, 1901, p. 497; (not) Milne Edwards and Haime, Hist. Nat. Corall., II, 1857, p. 257.

Description.—Corallum composed of palmate branches; calices shallow, polygonal, from 1.0 to 1.5 mm. in diameter; walls from 0.2 to 0.5 mm. thick; there are sixteen septa, eight of which reach the compressed styliform columella; endothecal dissepiments present; interseptal spaces about as wide as the thickness of a septum; septal costae present but inconspicuous.

Type.—No. 324785, U. S. National Museum.

Locality.—440-20,-38,-39,-40,-46,-59,-321,-325,-331,-354,-355,-383,-454; Reeds Collection, American Museum of Natural History.

Occurrence.—San Sebastian Shale, Lares Limestone and Ponce Formation.

* FAMILY.—ORBICELLIDAE VAUGHAN

Genus **Antiguastrea** Vaughan, 1919

Antiguastrea Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 401.

Heterastraea Reis (not *Heterastraea* Tomes) preoccupied. Bayer. Geognost. Landesuntersuch. geognost. Jahrg, II. 1889, pp. 150-152.

Genotype.—*Antiguastrea cellulosa* (Duncan).

Astraea cellulosa Duncan, Geol. Soc. London Quart. Journ., XIX, 1863, pp. 417, 418, Pl. XIII, fig. 10.
Antiguastrea cellulosa Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 402, Pl. XCVIII, figs. 3-4a; Pl. XCIX, figs. 1-3a; Pl. C figs. 1-4a; Pl. CI, figs. 2-2a.
(For a more complete synonymy see the description of the species.)

Description.—The corallum forms dome-shaped, tuberose or explanate massive heads of variable sizes, ranging from a few inches to five or more inches in diameter; corallites are shallow, rounded or subpolygonal and vary from 2.0 to 10.75 mm. in diameter; intercalicular tissue is porous; calicular walls are thick; the costae are subequal and as numerous as the larger septa, and usually not present over the entire exothecal tissue; the columella is lamellar and usually conspicuous; the septa are arranged in four cycles, rarely in five; dissepiments are present.

Range.—Oligocene.

Remarks.—This genus is distinguished from *Orbicella* by its lamellar columella and less well developed costae.

Antiguastrea cellulosa (Duncan), 1863

Plate XXVIII, Figure 1

Astraea cellulosa Duncan, Geol. Soc. London Quart. Jour., XIX, 1863, pp. 417, 418, Pl. XIII, fig. 10.
Isastraea turbinata Duncan, Geol. Soc. London Quart. Jour., XIX, 1863, p. 423, Pl. XIV, figs. 1a-c; Duchassaing and Michelotti, Sup. Mém. Corall. Antilles, 1866, p. 89 (of reprint); Duncan, Geol. Soc. London Quart. Jour., XXIV, 1867, p. 25; Duchassaing, Rev. Zooph. et Spong. Antilles, 1870, p. 31.
Heliastraea cellulosa Duchassaing and Michelotti, Sup. Mém. Corall. Antilles 1866, p. 86 (of reprint); Duncan, Geol. Soc. London Quart. Jour., XXIV, 1867, p. 24; Duchassaing, Rev. Zooph. et Spong. Antilles, 1870, p. 30.
Orbicella cellulosa Vaughan, Geol. Soc. London Quart. Jour., LII, 1902, p. 497; Vaughan, Carnegie Inst. Washington Yearbook, No. 13, 1915, p. 360.
Antiguastrea cellulosa Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 402, Pl. XCVIII, figs. 3-4a; Pl. XCIX, figs. 1-3a; Pl. C, figs. 1-4a; Pl. CI, figs. 2-2a.

Description.—Corallum massive heads of variable shapes as tuberose, hemispherical and subplanate; the corallites are rounded or subpolygonal, usually antiguous, leaving small areas of interstitial tissue; the calicular depressions are shallow and vary in diameter from 2 to 9 mm., averaging about 4.5 mm.; septa are numerous, arranged in four cycles in the average-sized calices; the columella is small, usually distinct and composed of lamellate tissue; the walls of the calices are well developed and thick; costae are as numerous as the septa and usually not well developed.

Asexual reproduction takes place by submarginal or intercalcinal gemmation.

Type.—Coll. Geol. Soc. London; "Conglomerate" of Antigua.

Locality. — 440-14,-34,-40,-41,-92,-242,-339,-454, Reeds Collection, American Museum of Natural History, and 826, 863, 900, 984, and P. R. 82 (a) and (b), Hubbard Collection, Columbia University, New York City.

Occurrence.—Los Puertos Limestone, Lares Limestone, San Sebastian Shale, Juana Diaz ? and Ponce Formation.

Antiguastrea cellulosa curvata (Duncan)

Plate XXVII, Figure 5

Astraea cellulosa curvata Duncan, Geol. Soc. London Quart. Journ., XIX, 1863, p. 418.

Antiguastrea cellulosa curvata Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 408, Pl. XCVIII, figs. 4, 4a.

Description.—Corallum irregular and massive; the corallites are circular or compressed into oval forms as seen in cross-section and average 4.5 mm. in diameter; costae delicate and unequal; calicular walls thick; septa in four cycles, the primary are large and conspicuously denticulate; the columella consists of porous structure; dissepiments occur within the calices; exothecal tissue is abundant in the interspaces.

Asexual reproduction is by intercalicular or marginal gemmation.

Type.—Coll. Geol. Soc. London; "chert-formation" of Antigua.

Locality.—440-39,-46, Reeds Collection, American Museum of Natural History.

Occurrence.—San Sebastian Shale.

* **Orbicella** Dana, 1846

Orbicella Dana, U. S. Expl. Exped. Zooph., 1846, p. 205; Vaughan, Geol. Reichs Mus. Leiden Samml., ser. 2, II, 1901, p. 21; Verrill, Trans. Conn. Acad. Arts. and Sci., XI, 1902, p. 93; Vaughan, Carnegie Inst. Washington Pub. 213, 1918, p. 85.

Phyllocoenia Milne Edwards and Haime, Compte Rendu de l'Acad. des Sci., XXVII, 1848, p. 469.

Genotype.—*Madrepora annularis* Ellis and Solander.

(For a more complete synonymy see the description of the species.)

Description.—The following is the original description of the genus: "Cells nearly circular, more or less prominent, not sub-dividing by growth, or rarely so; stars (calices) with distinct limits formed by the coalescence laterally of the lamellae, and therefore cells appear tubular and separated by interstices."

Range.—Jurassic to Recent.

* **Orbicella annularis** (Ellis and Solander), 1786

Plate XXVIII, Figure 2

Madrepora annularis Ellis and Solander, Nat. Hist. Zooph., 1786. p. 169. Pl. LIII. figs. 1, 2.

Madrepora faveolata Ellis and Solander. Nat. Hist. Zooph., 1786. p. 166, Pl. LIII, figs. 5, 6; Gmelin, Linn. Syst. Nat., ed. 13, 1790, p. 3769.

Madrepora acropora Gmelin, Linn. Syst. Nat., ed. 13, 1790, p. 3767; Esper, Pflanzenth.. Fortsetz., I. 1797, p. 21. Pl. XXXVIII.

Astrea annularis Lamarck, Hist. Nat. Anim. sans Vert., II, 1816, p. 259: Lamouroux. Exp. Meth. Genres des Polyp., 1821, p. 58, pl. LIII, figs. 1, 2.

Explanaria annularis Ehrenberg, Corall. Roth. Meer., 1834, p. 84 (of reprint).

Astraea (Orbicella) annularis Dana, U. S. Expl. Exped. Zoophytes. p. 214, Pl. X, fig. 6.

Heliastraea annularis Milne Edwards and Haime, Hist. Nat. Corall., II, 1857, p. 473; Duchassaing and Michelotti, Mém. Corall. Antilles. 1861, p. 76 (of reprint); Duchassaing and Michelotti, Sup. Mém. Corall. Antilles, 1866, p. 84 (of reprint).

Heliastraea acropora Duchassaing and Michelotti, Mém. Corall. Antilles. 1861, p. 76 (of reprint); Duchassaing and Michelotti, Sup. Mém. Corall. Antilles. 1866, p. 84 (of reprint).

Heliastraea lamarcki Duchassaing and Michelotti. Mém. Corall. Antilles. 1861, p. 76 (of reprint); Sup. Mém. Corall. Antilles, 1866, p. 84 (of reprint).

Cyphastraea costata Duncan (part), Geol. Soc. London Quart. Journ.. XIX, 1863, pp. 441, 443; Duchassaing and Michelotti, Sup. Mém. Corall. Antilles, 1866, p. 85 (of reprint); Duncan, Geol. Soc. London Quart. Jour., XXIV, 1868, p. 24; Gregory, Geol. Soc. London Quart. Jour., LI, 1895. p. 274.

Astraea barbadensis Duncan, Geol. Soc. London Quart. Jour., XIX, 1863, pp. 421, 444, Pl. XV, figs. 6a, 6b.

Orbicella annularis Verrill. Mus. Comp. Zool. Bull., I. 1864, No. 3, p. 48; Verrill, Boston Soc. Nat. Hist. Proc., X, 1865, p. 323; Verrill, Trans. Conn. Acad. Arts and Sci., XI, 1901, p. 94, Pl. XV, fig. 1; Vaughan, Biol. Soc. Washington Proc., XV, 1902, p. 56; Duerden, Nat. Acad. Sci. Mem., VIII, 1903, p. 564, Pls. VIII-X, figs. 64-73; Vaughan, Washington Acad. Sci. Jour., V, 1915, p. 596; Vaughan, Carnegie Inst. Washington Year Book No. 14, 1916, p. 227.

Heliastraea barbadensis Duchassaing and Michelotti, Sup. Mém. Corall. Antilles, 1866, p. 85 (of reprint); Duncan, Geol. Soc. London Quart. Jour., XXIV, 1868, p. 24.

Echinopora franski Gregory, Geol. Soc. London Quart. Jour., LI, 1895, p. 274.

Orbicella acropora Vaughan, Geol. Reichs. Mus. Leiden Samml., ser. 2, II, 1901, p. 22; Vaughan, U. S. Fish Comm. Bull. for 1900, II, 1901, p. 301, Pls. VI, VIII.

Orbicella annularis stellulata Verrill, Trans. Conn. Acad. Arts and Sci., XI, 1901, p. 96, Pl. XV, fig. 2.

Orbicella hispidula Verrill, Trans. Conn. Acad. Arts and Sci., XI, 1901, p. 100, Pl. XV, figs. 3-3b.

Description.—Corallum composed of rounded, epithecated masses of variable size; calices deep, circular or nearly so, 1.5 to 2.5 mm. in diameter and from 0.5 to 2.0 mm. apart; the septa are in three complete cycles, the primaries and secondaries extend to the columella, the tertiaries have their inner ends free; the septa rise steeply from the deep center of the calyx, cross over the outer rim and form costae upon the surface of the intercorallite areas; endothecal and exothecal dissepiments occur; the columella consists of a tangle of the inner edges of the septa, its diameter varies from 1/3 to 1/2 of that of the calice.

Cotypes.—British Museum and No. 156455, U. S. National Museum.

Locality.—440-129,-294,-360,-361,-362,-366, Reeds Collection, American Museum of Natural History, and 801, 933, 934, 975, S 5, S 7, Hubbard Collection, Columbia University, New York City.

Occurrence.—Quebradillas Formation and Ponce Formation.

* **Orbicella cavernosa** (Linnaeus), 1766

Plate XXIX, Figure 1

Madrepora cavernosa Linné, Syst. ed. 12, 1767, p. 1276; Esper, Pflanzenth., Fortsetz. I, 1797, p. 18, Pl. XXXVII.

Madreport radiata Ellis and Solander, Nat. Hist. Zooph., 1786, p. 169, Pl. XLVII.

Favia cavernosa Oken, Lehrb. Naturg., 1815, p. 67.

Astrea radiata Lamarck, Hist. Anim. sans Vert., ed. 2, 1816, pp. 258, 259, 404; Lamouroux, Encycl. Meth., 1824, pp. 57, 131, Pl. XLVII (reprint of plate of Ellis and Solander).

Astrea (Orbicella) radiata and *A. (O.) argus* Dana, U. S. Expl. Exped. Zooph., 1846, pp. 206, 207, Pl. X, figs. 1a, 1b.

Astrea cavernosa Schweigger, Hand. Natur., 1820, p. 419; Edwards and Haime, British Fossil Corals, 1850, p. 39.

Heliastrea cavernosa Milne Edwards and Haime, Hist. Corall., II, 1857, p. 463.

Orbicella cavernosa Verrill, Bull. Mus. Comp. Zool., 1, 1864, p. 47; Verrill, Proc. Boston Soc. Nat. Hist., X, 1865, p. 323; Pourtales, Florida Reefs, 1871, p. 76; Quelch, Reef Corals, Chall. Exped., XVI, 1886, pp. 12, 106; Verrill, Trans. Conn. Acad. Arts and Sci., X, 1900, p. 553; Vaughan, Geol. Reichs. Mus. Leiden Samml., ser. 2, II, 1901, p. 27; Verrill, Trans. Conn. Acad. Arts and Sci., XI, 1901, p. 102; Vaughan, Wash. Acad.

Sci. Jour., V, 1915, p. 596; Carnegie Inst. Washington Yearbook No. 14, 1916, p. 227; U. S. Nat. Mus. Bull. No. 103, p. 380, Pl. LXXXVII, figs. 1-1c; Pl. LXXXVIII, figs. 1-3b.

Orbicella radiata Gregory, Quart. Jour. Geol. Soc., LI, 1895, p. 270; Vaughan, Bull. Mus. Comp. Zool., XXXIV, 1899, p. 156.

Description.—Corallum composed of irregularly arched, epithecated masses; calices nearly circular or elliptical, 8 to 11 mm. in diameter, 3 to 4 mm. deep and from contiguous to 6 mm. apart; individual corallites project from 6 to 7 mm. above the intercorallite tissue; the mature corallite has forty-eight septa, alternate ones extending to the columella; the outer ends of the septa form costae upon the margin of the corrallites and over the intercorallite surface; the columellar tangle is trabecular with a papillate surface and the larger ones measure 4 mm. in diameter.

Locality.—440-27,-326,-359, Reeds Collection, American Museum of Natural History, and 818, 933, 934, 935, 936, 990, S 5, S 7, P. R. 98 (c), Hubbard Collection, Columbia University, New York City.

Occurrence.—San Sebastian Shale and Ponce Formation.

* **Orbicella costata** (Duncan), 1863

Plate XXIX, Figure 2

Astraea costata Duncan, Geol. Soc. London Quart. Jour., XIX, 1863, p. 422, Pl. XIII, fig. 9.

Heliastraea costata Duncan, Geol. Soc. London Quart. Jour., XXIV, 1867, p. 24.

Orbicella costata Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 387, Pl. XCI, figs. 1-3a; Pl. XCII, figs. 1-3; Pl. XCIII, figs. 1, 1a.

Description.—Corallum composed of irregular masses and heads; calices deep upon raised corallite extensions, 7.5 to 8.25 mm. in diameter and separated by broad costated intercorallite areas; the costae are alternately large and small; walls are thin; the septa are arranged in six systems of irregular cycles; the columella is formed by the dissepiments of the longer septa and a central porous tangle of tissue; endotheca and exotheca are abundant.

Locality.—440-38,-47,-48,-105,-242,-364,-458, Reeds Collection, American Museum of Natural History, and 847, 909, Hubbard Collection, Columbia University, New York City.

Occurrence.—San Sebastian Shale, Juana Diaz Shale ?, Ponce Formation and Lares Limestone.

* Orbicella limbata (Duncan), 1863

Plate XXIX, Figure 3

Phyllocoenia limbata Duncan, Geol. Soc. London Quart. Jour., XIX, 1863, p. 433; Duchassaing and Michelotti, Sup. Mém. Corall. Antilles, 1866, p. 76 (of reprint); Duncan, Geol. Soc. London Quart. Jour., XXIV, 1867, p. 23; Duchassaing, Rev. Zooph, et. Spong. Antilles, 1870, p. 28.

Pleisiastraea ramea Duncan, Geol. Soc. London Quart. Jour., XX, 1864, p. 39, Pl. V, figs. 1a, 1b; Duchassaing and Michelotti, Sup. Mém. Corall. Antilles, 1866, p. 87 (of reprint); Duncan, Geol. Soc. London Quart. Jour., XXIV, 1868, p. 25; Duchassaing, Rev. Zooph. et Spong. Antilles, 1870, p. 30.

Phyllocoenia sculpta tegula Duncan, Soc. London Quart. Jour., XIX, 1863, p. 432.

Description.—Corallum composed of undulating epithecated plates; calices nearly circular, 2.0 to 3.25 mm. in diameter, from 1 to 3 mm. apart; corallites only slightly raised above the intercorallite area; septa in three cycles extend outward from the calices over the interspaces as costae; primaries and secondaries extend inward to the trabecular columella.

Locality.—440-362, Reeds Collection, American Museum of Natural History, and 991, Hubbard Collection, Columbia University, New York City.

Occurrence.—Ponce Formation.

Orbicella tampaensis Vaughan, 1919

Plate XXX, Figure 1

Orbicella tampaensis Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 390, Pl. XCV, figs. 1-3a.

Description.—The following is the original description:

"The corallum forms head-shaped masses up to the size of a man's fist.

"Calices deep, decidedly elevated, up to 4 or 4.5 mm.; diameter from 6 to 10 mm. Costae prominent, distant; there are none or only rudimentary costae corresponding to the last cycle of septa.

"Septa, distant, in four cycles, the fourth usually more or less incomplete. The primaries and some or all of the secondaries, occasionally a tertiary, reach the columella. Usually there are three or four different sizes. On the inner ends of the primaries are paliform teeth below which the margins fall steeply to the bottom of the fossa. Margins of the primaries exert as much as 1.5 mm.; those of the secondaries almost as prominent; those of the tertiaries less prominent; those of the quaternaries inconspicuous. Septa thickened in the wall.

"Columella much looser than in the other related species."

Type.—No. 324900, U. S. National Museum.

Locality.—The type came from the "silex" bed of the Tampa formation, Tampa, Florida. The specimens from Porto Rico are from the following localities: 440-27,-38,-40,-48,-50,-51,-286,-456, Reeds Collection, American Museum of Natural History, and 829, 846, 890, Hubbard Collection, Columbia University, New York City.

Occurrence.—San Sebastian Shale, Ponce Formation and Lares Limestone.

*FAMILY.—FAVIIDAE GREGORY

Genus **Calamophyllia** Blainville, 1830

Calamophyllia Blainville, Dict. des Sci. Nat., LX, 1830, p. 312; Milne Edwards and Haime, Ann. des Sci. Nat., ser. 3, XI, 1849, p. 261; Milne Edwards and Haime, Pol. foss. des terr. palaeoz., 1851, p. 80; Milne Edwards and Haime, Hist. Nat. des corall., II, 1857, p. 342; Zittel, Traité de Paleon., I, 1883, p. 257 (French edition); Zittel, Text Book of Paleon., I, 1913, p. 99 (Eastman edition).

Lithodendron (pars) Michelin, Icon. Zooph., 1843, p. 94.

Rhabdophyllia Milne Edwards and Haime, Pol. foss. des terr. palaeoz., 1851, p. 83; Milne Edwards and Haime, Hist. Nat. des corall., II, 1857, p. 347.

Genotype.—*Calamite striee* Guettard = *Calamophyllia striata* (Guettard), Mém. sur les Sci. et les Arts, II, 1770, p. 406, pl. XXXIV.

Description.—The corallum forms a fasciculate colony of long cylindrical or slightly conical stems that are free above the point of fission. The surface of the branches are incompletely epithecated, leaving the costae conspicuously visible; regular or irregular collarettes ornament the stems. The calices are terminal and shallow; the columella is rudimentary or composed of a network of calcareous tissue; septa are numerous, granulose and finely denticulated, dissepiments are few to numerous; synapticulae sometimes present.

Range.—Triassic, Jurassic and Tertiary.

Remarks.—This genus is easily distinguished from *Cladocora* Hemprich and Ehrenberg by its habit of reproduction.

Calamophyllia dendroidea Coryell, new species

Plate XXX, Figures 2, 3

Description.—The corallum consists of a group of cylindriform branches forming masses that vary from a cluster of a few stems to heads of several inches in diameter. The individual branches were formed by equal division of the parent polyp, growing upward as parallel unconnected stems with terminal polyps, either slightly contiguous or free. The calices are shallow. The individual stems vary from 10 mm. to 15 mm. in diameter except at or immediately before the point of fission, where the longer diameter of the dividing polyp often measures as much as 20 mm.

The outer surface is incompletely epithecated. Costal ridges are formed by the projecting ends of the septa of every cycle; the distance from the crest of one costa to the adjacent one measures 0.5 mm.; the thickness of the thecal wall is equal to the thickness of the primary septa at the junction with the theca.

From twenty-six to forty-two or more septa reach the central network structure that represents the columellar tangle of calcareous tissue, where several of the septa thicken or branch, forming a paliform structure. The lateral faces of the septa are finely granulose and in places spinelike projections rise and frequently form synapticulae. Dissepiments are rare.

Type.—No. 23003-4, American Museum of Natural History.

Locality.—440-327, Reeds Collection, American Museum of Natural History.

Occurrence.—Ponce Formation.

Calamophyllia portoricensis Coryell, new species

Plate XXX, Figure 4; Plate XXXI, Figures 1-4

Description.—The corallum forms heads of free or slightly contiguous, cylindrical or strongly compressed branches that range in diameter from 6 to 15 mm. for the cylindrical stems and from 2 to 5 and 10 to 20 mm. for the shorter and longer diameters of the compressed stems. The compression of the stems in some cases is accentuated by crushing even when about them occur undistorted branches.

A rudimentary epitheca is present. The outer edge of the septa of every cycle except the last forms a costal ridge or row of costal spines, that vary from 1 mm. to 1.5 mm. apart. The thecal wall is thick, equal to two or three times the thickness of the primary septa at the junction with the theca.

The septa are numerous; fifty-four septa occur in a corallite measuring 13 mm. in diameter. The septa of the last cycle are short and extend radially inward from the theca only about the thickness of the wall. The major septa reach the columellar tangle, where they thicken, forming paliform structures. A few spines are present on the lateral faces of the septa. No synapticulae were observed. Dissepiments are rare.

Calamophyllia portoricensis is easily distinguished from *C. dendroidea* by the wider spacing and spinose character of the costae.

Type.—No. 23001, American Museum of Natural History.

Locality.—440,-11,-20,-56,-321,-328,-341,-346,-384,-442,-443,-451,-452,-454, Reeds Collection, American Museum of Natural History, and 827, 852, 893, 894, 917, 925, P. R. 82 (d). Hubbard Collection, Columbia University, New York City.

Occurrence.—Los Puertos Limestone, San Sebastian Shale, Ponce Formation and Lares Limestone.

Genus **Favites** Link, 1807

Favites Link, Beschreib. Nat. Samml. Rostock, 1807, Pt. 3. p. 162: Vaughan, Geolog. Reichs Mus. Leiden Samml., ser. 2, II, 1901, p. 21; Verrill, Trans. Conn. Acad. Arts and Sci., XI, 1901, p. 92; Vaughan, Carnegie Inst. Washington Dept. of Marine Biol. Pub. 213, 1918, p. 109.

Genotype.—*Madrepora abdita* Ellis and Solander = *Madrepora favosa* Esper.

Description.—Corallum massive; corallites polygonal, often irregular; the individual walls separated by narrow intercorallite area; the septa well developed usually, in three cycles; paliform lobes present; the columella well developed and usually trabecular.

Range.—Tertiary to Recent.

Favites expansa Coryell, new species

Plate XXXII, Figures 1, 1a

Description.—Corallum forms massive heads spreading from a small base; the type specimen measures 4.75 inches in its greatest diameter and 2.25 inches in height; the corallites are of irregular shape but predominantly of a rounded form, varying from 2.5 to 10.0 mm. in diameter; the septa are numerous, well developed in the broad bottom of the calyx pits; the larger septa reach to the columella; the larger calices are deep, the younger ones are shallow; the walls of the individuals are separated from one another by an intercalicular area that varies from 0.5 to 2.0 mm. in width.

Type and *Locality.*—No. 828, Hubbard Collection, Columbia University, New York City.

Occurrence.—San Sebastian Shale.

Favites irregularis Coryell, new species

Plate XXXII, Figure 2

Description.—Corallum forms massive, thick, flabelliform colonies; the type specimen measures 2¾ inches in maximum thickness; the calices are irregular polygonal forms and of variable sizes measuring from 2 to 17 mm. across; the walls rise steeply above the bottom of the calices in many individuals and are separated from one another by an intercorallite area varying from 0.5 to 1.0 mm. in width; the septa are numerous and well developed in the bottom of the calicular pits but only represented as costal ridges upon the surrounding walls; the longer septa reach the well developed columella.

Type and *Locality*.—No. 864, Hubbard Collection, Columbia University, New York City.

Occurrence.—San Sebastian Shale.

Genus **Goniastrea** Milne Edwards and Haime, 1848

Goniastrea Milne Edwards and Haime, Compte Rendu de l'Acad. des Sci., XXVII, 1848, p. 495; Zittel, Traité de Paleontologie, 1, 1883, p. 259; Zittel, Text Book of Paleontology, I, 1913, p. 99; Vaughan, U. S. Nat. Mus. Bull. 103, p. 416.

Genotype.—*Astrea retiformis* Lamarck, Milne Edwards and Haime, Compte Rendu de l'Acad. des Sci., XXVII, 1848, p. 495.

Description.—Corallum forms massive heads with a domed or undulating upper surface; the calices are irregularly polygonal, separated by simple compact walls and reproduce by fission: the septa are well developed with pali occurring before the inner end of all except the last cycle; the columella is spongy.

Range.—Cretaceous to Recent.

Goniastrea crassa Coryell, new species

Plate XXXIII, Figure 1

Description.—The corallum forms heads 13 cm. or more in diameter; the calices are deep, irregularly polygonal, separated by thickened simple crested walls and vary from 4 to 10 mm. in their longer diameter and 3 to 5 mm. in the shorter diameters, measured from crest to crest of the walls; the septa are well developed, consisting of alternating long and short plates, the longer expanding at their inner ends to form paliform structures; the ends of only the last cycle of septa are free; from thirty-four to forty septa are present in the larger calices and from twenty-four to twenty-six in the average size, which are 5 mm. in their greater diameter; the columella is spongy, not well developed in the smaller individual corallites.

Type and *Locality*.—No. 986, Hubbard Collection, Columbia University, New York City.

Occurrence.—Arecibo group.

Remarks.—This species is distinguished from *Goniastrea canalis* Vaughan by the larger calices, fewer septa and thicker common wall. It differs from *Goniastrea variabilis* Duncan by the thicker common wall.

Goniastrea pectinata (Ehrenberg), 1834

Plate XXXIII, Figure 2

Astraea pectinata Ehrenberg, Korallenth. Roth. Meer., 1834, p. 96.
Astraea favistella Dana, U. S. Expl. Exped., Zooph., 1846, p. 241, Pl. XIII, figs. 2-2d.
Astraea sinuosa Dana, U. S. Expl. Exped., 1846, p. 243, Pl. XIII, figs. 5-5c.
Goniastraea pectinata Klunzinger, Korall. Roth. Meer., 1879, Pt. 3, p. 34, Pl. IV, fig. 6; Vaughan, Carnegie Inst. Washington, Dept. of Marine Biology, Pub. 213, 1918.
Goniastraea favus Klunzinger, Korall. Roth. Meer., 1879, Pt. 3, p. 35, Pl. IV, fig. 4, Pl. X, fig. 7.

Description.—Corallum forms massive heads; the corallites are polygonal, varying from 5 to 12 mm. in maximum diameter; the larger are oval in cross-section and present stages in reproduction by fission; the walls are thick, costated and with acute summits formed on the costa in the central part of the domed surface; the outer septal ends of adjacent calices meet upon the wall forming costa; often a large septum is opposed by a small one; the larger septa end in paliform lobes at the margin of the trabecular columella.

Locality.—440-367, Reeds Collection, American Museum of Natural History.

Occurrence.—Recent.

Genus.—**Hydnophora** Fischer de Waldheim, 1807

Hydnophora Fischer de Waldheim, Mus. Demidoff, III, 1807, p. 295, 1 pl.; Fischer de Waldheim, Recherches sur les Hydnophores, 1810, pp. 7-13, 1 pl.; Fischer de Waldheim, Oryctographie du gouvernement de Moscou, 1830-37, p. 155; Milne Edwards and Haime, Compte Rendu de l'Acad. des Sci., 1848, p. 493; Milne Edwards and Haime, Ann. des Sci. Nat., ser. 3, XI, 1849, p. 299; Milne Edwards and Haime, Hist. Nat. Corall., II, 1857, p. 418; Vaughan, Carnegie Inst. Washington, Dept. of Marine Biol. Pub. 213, 1918, p. 121.
Hydnophorella Delage and Hérouard, Traité de Zool. concrete, II, 1901, Pt. 2, p. 628.
Genotype.—*Hydnorphora demidorii* Fischer de Waldheim = *Madrepora exesa* Pallas, Elench. Zooph., 1766, p. 290.

Description.—Corallum forms massive expansions with flattened or undulating surfaces; the corallites are all confluent in branching or in osculating arrangement, separated by disconnected ridge-like or pyramidal collines; the corallite centers are more or less distinct; the valleys vary from 5 to 10 mm. in width with depths corresponding to the irregularity in height of the collines, 2 to 6 mm.; the septa are well developed, wavy, thin and dentate; there is no columella; transverse tissue abundant.

Range.—Cretaceous to Recent.

Hydnophora hubbardi Coryell, new species

Plate XXXIII, Figure 3

Description.—Corallum forms massive expansions with an undulating surface; the valleys are short, irregular and confluent, varying from 5 to 10 mm. in width; the collines form pyramids and straight, curved and branching ridges that vary from 2 to 5 mm. in height. The septa are well developed, curved and dentate, averaging eight to nine in 5 mm.

Type and *Locality.*—No. 859, Hubbard Collection, Columbia University, New York City.

Occurrence.—San Sebastian Shale.

Genus.—**Lamellastraea** Duncan, 1868

Lamellastraea Duncan, Geol. Soc. London Quart. Jour., XXIV, 1868, p. 19; Zittel, Traité de Paléontologie, I, 1883, p. 260.

Genotype.—*Lamellastraea smythi* Duncan.

Lamellastraea smythi Duncan, Geol. Soc. London Quart. Jour., XXIV, 1868, p. 20, Pl. I, figs. 2a, 2b.

Description.—The following is the original description of the genus:—"The corallum is compound; the corallites are united by their walls, and are more or less polygonal in transverse outline; the columella is essential and lamellar; the septa are alternately large and small; and the reproduction is principally by fissiparity through the solid columella, and occasionally by marginal gemmation."

Range.—Tertiary.

Lamellastraea crassa Coryell, new species

Plate XXXIII, Figure 4

Description.—Corallum massive, forming heads; the corallites are irregularly polygonal and united by their walls; the calices are of various sizes, the larger with their longer diameters equal to 9 mm. and their shorter 2.5 mm.; the smaller calices have diameters equal to from 2 to 3 mm.; the septa are of alternating long and short plates, the longer ones reach the columella or two may unite near the columella; the shorter septa are rudimentary; twelve to eighteen longer septa are present in the average size calices; paliform structures occur more or less well developed; the calicular walls are thick and strong; the columella is lamellar and well developed, especially in the elongated calices.

Type and *Locality*.—No. 875, Hubbard Collection, Columbia University, New York City.

Occurrence.—Recent.

Genus.—**Latomeandra** d'Orbigny, 1849

Latomeandra d'Orbigny, Milne Edwards and Haime, Ann. des. Sci. Nat., ser. 3, XI, 1849, p. 270; d'Orbigny, Notes sur des pol. foss., 1849, pp. 8, 9; Milne Edwards and Haime, Pol. foss. des terr. palaeoz., 1851, p. 85.

Axophyllia, *Microphyllia* and *Comophyllia* d'Orbigny, Notes sur des pol. foss., 1849, pp. 8, 9.

Oulophyllia d'Orbigny, Prodr. de paleont., I, 1850, p. 387 (not Milne Edwards and Haime).

Latimaeandra, Milne Edwards and Haime, Hist. Nat. des Corall., II, 1857, p. 543; Zittel, Traité Paléontologie, 1883, p. 261; Zittel, Text Book of Paleontology, 1, 1913, p. 98.

Genotype.—**Latomeandra plicata** (Goldfuss)

Lithodendron plicatum Goldfuss, Petref. Germ., 1826, p. 45, Pl. XIII, fig. 5.

Description.—Corallum forms massive or subdendroidal colonies; the corallites are distributed in short valleys; the collines are formed by the union of the walls of the adjacent series; the calicinal centers are quite distinct; the walls of the colony are finely striated and granulose; the epitheca is practically absent; the columella is rudimentary; the septa are numerous, thin, denticulate and granulose.

Range.—Triassic to Tertiary.

Latomeandra lata Coryell, new species

Plate XXXIII, Figure 5

Description.—Corallum massive with flattened or undulating surface; the corallites are arranged in short, shallow, irregularly broad and narrow valleys within which the calcinal centers are usually distinct; the width of the valleys vary from 10 mm. about the centers to 10 mm. between them; the septa are well developed, dentate, often curved and averaging seven to eight in 5 mm.; the collines are thin, irregularly curved and sharply crested; the columella is poorly developed.

Type and *Locality*.—No. 912, Hubbard Collection, Columbia University, New York City.

Occurrence.—San Sebastian Shale.

Genus.—**Leptoria** Milne Edwards and Haime, 1848

Leptoria.—Milne Edwards and Haime, Compte Rendu, XXVII, 1848, p. 493; Zittel, Traité de Paléontologie, I, 1883, p. 259; Zittel, Text Book of Paleontology (Eastman ed.), 1913, p. 99; Vaughan, Carnegie Inst. Washington, Dept. of Marine Biology, IX, Pub. 213, 1918, p. 117; Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 421.

Genotype.—*Madrepora phrygia* Ellis and Solander.

Madrepora phrygia Ellis and Solander, Nat. Hist. Zooph., 1786, p. 162, Pl. XLVIII, fig. 2.

Meandrina phrygia Milne Edwards and Haime, Compte Rendu de l'Acad. des Sci., XXVII, 1848, p. 493.

Description.—Columella forms massive heads with domed, flattened or undulating surfaces; the calices are confluent and arranged in long sinuous valleys separated by simple collines; the septa are numerous and nearly parallel; the columella is lamellar.

Range.—Jurassic to Tertiary.

Leptoria areolata hispida (Verrill), 1901

Plate XXXIV, Figure 1

Maeandra areolata hispida Verrill, Trans. Conn. Acad. Arts and Sci., XI, 1901, p. 83, Pl. XII, figs. 2, 3.

Description.—Corallum forms massive heads of large and small size, many averaging 3 to 5 inches in diameter. The valleys are wide, varying from 10 to 20 mm. across; the collines are simple in some places and double in others; they vary from 3 to 6 mm. in thickness. The septa are well developed, hispid and coarsely serrate, the longer extend to the lamellose columella.

Type.—From the Florida Reefs; Recent.

Locality.—H 1, H 3, Hubbard Collection, Columbia University, New York City.

Occurrence.—Pleistocene and Recent.

Remarks.—This species is placed in *Leptoria* because of the structure of the columella.

Leptoria phrygia (Ellis and Solander)

Plate XXXIV, Figure 2

Madrepora phrygia Ellis and Solander, Nat. Hist. Zooph., 1786, p. 162, Pl. XLVIII, fig. 2.

Leptoria phrygia Milne Edwards and Haime, Compte Rendu de l'Acad. des Sci., XXVII, 1848, p. 493; Vaughan, Carnegie Inst. Washington, Pub. 213, 1918, p. 117.

Description.—Corallum forms massive dome-shaped or explanate colonies with the upper surface flat or undulating; the calices are in long sinuous furrows, averaging 5 mm. wide, separated by colline walls 1 mm. thick; the septa are numerous; eight to nine in 5 mm., the longer reaching to or very near the lamelliform columella; the inner ends of the major septa are swollen, giving rise to paliform structures; the shorter septa are inconspicuous.

Type.—No. 324968a, U. S. National Museum.

Locality.—849, 913, 974, 982, 993, Hubbard Collection, Columbia University, New York City.

Occurrence.—Recent.

Genus.—**Maeandra** Oken, 1815

Maeandra Oken, Lehrb. Naturg., Th. 3, Abth. 1, 1815, pp. 68, 70; Ehrenberg, Corall. Roth. Meer., 1834, pp. 99, 101; Verrill, Trans. Conn. Acad. Arts and Sci., XI, 1901, p. 66; Vaughan, Carnegie Inst. Washington, Pub. 213, 1918, p. 119; Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 417.

Genotype.—*Madrepora labyrinthiformis* Linnaeus.

Madrepora labyrinthiformis Linnaeus, Syst. Nat., ed. 10, 1758, p. 794.

Description.—Corallum is massive with domed, flattened or undulating surfaces, forming hemispherical colonies that are often 5 or 6 feet in diameter; the calices are confluent and arranged in relatively long sinuous rows surrounded by simple collines; the septa are both long and short and slope downward from the crest of the collines into the actinal groove; the inner ends of the longer septa are thickened, forming structures, that appear like pali along the margin of the porous columella in the bottom of the groove; the upper margin of the septa are coarsely dentate or serrate.

Range.—Tertiary to Recent.

Maeandra antiguensis Vaughan, 1919

Plate XXXIV, Figure 3

Maeandra antiguensis Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 417; Pl. CIII, figs. 3-4a.

Description.—Corallum forms masses with undulating or domed surfaces; the furrows are relatively long and sinuous with an average width of 4.25 mm.; the calcinal centers are indistinct; the collines are simple with solid-appearing, narrow summits formed by the lamelliform wall that separates the valleys; the septa are dentate, crowded, thirty-two to thirty-six in 1 mm., alternately long and short and slope steeply toward the columellar groove; the longer septa reach the columella where they thicken, forming paliform structures; the columella is porous; dissepiments are present.

Cotype.—No. 325003, U. S. National Museum.

Locality.—914, 916, 922, 964, Hubbard Collection, Columbia University, New York City.

Occurrence.—Middle Oligocene.

Maeandra labyrinthiformis (Linnaeus), 1758

Plate XXXIV, Figure 4

Madrepora labyrinthiformis Linné, Syst. Nat., ed. 10, 1758, p. 794; Esper, Pflanzenth., Fortsetz., I, 1789, p. 74, Pl. III.

Madrepora meandrites var. *γ* Pallas, Elench, Zooph., 1766, pp. 292, 293.

Meandrina cerebriformis Lamarck, Hist. Nat. Anim. sans Vert., 1816, p. 246; Dana, Zooph. U. S. Expl. Exped., 1846, p. 263, Pl. XIV, fig. 2.

Diploria cerebriformis Milne Edwards and Haime, Compte Rendu de l'Acad. des Sci., XXVII, 1848, p. 493; Milne Edwards and Haime, Hist. Nat. Corall., II, 1857, p. 402; Pourtalés, Ill. Cat. Mus. Comp. Zool., No. 4, Mém. 2, 1871, p. 75; Verrill, Trans. Conn. Acad. Arts and Sci., X, 1900, p. 552.

? Maeandrina labyrinthiformis Pourtalés, Florida Reefs, Corals, 1880, Pl. IX, figs. 10-12.

Diploria labyrinthiformis Vaughan, Samml. Geol. Reichs and Mus., II, 1901, p. 45.

Diploria geographica Whitfield, Bull. Amer. Mus. Nat. Hist., N. Y., XIV, 1901, p. 223, Pls. XXIII, XXIV.

Maeandra labyrinthiformis Verrill, Trans. Conn. Acad. Arts and Sci., XI, 1901, p. 70, Pl. X, figs. 1-3.

Description.—Corallum forms massive heads often attaining a diameter of five or six feet; the corallites lie in long sinuous valleys separated by broad ridges; the collines consist of the calicular walls widely spaced with considerable intermural tissue and vary from 3 to 5 mm. in thickness; an intermural furrow, usually wide, lies upon the central portion of the dividing collines; where extracalicinal budding occurs, the collines broaden and the dividing walls between the older valleys and the new buds are simple; the double wall feature appears later; the columella is porous; the septa are numerous, strong, parallel, averaging eight to nine major ones in 5 mm. along the ridge, which unite with the columella or thicken to form the paliform structures.

Locality.—948, Hubbard Collection, Columbia University, New York City.

Occurrence and *Range.*—Pleistocene and Recent.

* Genus.—Manicina Ehrenberg, 1834

Manicina Ehrenberg, Corallenth. Roth. Meer., 1834, p. 101 (of reprint); Verrill, Trans. Conn. Acad. Arts and Sci., XI, 1901, p. 84.
Colpophyllia Milne Edwards and Haime, Compte Rendu de l'Acad. des Sci., XXVII, 1848, p. 492; Milne Edwards and Haime, Hist. Nat. des Corall., II, 1857, p. 384.
Genotype.—*Madrepora gyrosa* Ellis and Solander.

Description.—Corallum massive, wide-spreading, pedunculate mass; calices arranged in series that form deep, sinuous valleys with steep sides; the crest of the collines are marked by a groove which separates the walls of the individual series; costae present and visible upon the base of the corallum; columella present or absent; dissepiments present.

Range.—Tertiary to Recent.

* Manicina willoughbiensis Vaughan, 1919

Plate XXXV, Figure 1

Manicina willoughbiensis Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 422, Pl. CIV, figs. 2, 2a; Pl. CV.

Description.—Corallum forms a pedunculate expansion with flattened or curved surface; calcinal valleys deep, steep-sided, sinuous and often long, measuring 5 to 16 mm. in width and from 8 to 10 mm. in depth; calcinal centers distinct and from 9 to 21 mm. apart; collinal summits marked by a narrow furrow, 1.0 to 1.5 mm. wide; 19 to 22 septa in 1 cm.; columella present or absent; dissepiments well developed; the lower surface of the corallum is radially costated, the costae averaging 1 mm. apart.

Type.—No. 325006a, U. S. National Museum.

Locality.—110-72,-73. Reeds Collection, American Museum of Natural History.

Occurrence.—San Sebastian Shale.

Genus.—Metastraea Milne Edwards and Haime, 1857

Metastraea Milne Edwards and Haime, Hist. Nat. des Corall., II, 1857, p. 525.
Genotype.—*Prionastrea ? aegyptiaca* Milne Edwards and Haime, Ann. des Sci. Nat., ser. 3, XII, 1849, p. 137 (Recent).
Metastraea aegyptorum Milne Edwards and Haime, Hist. Nat. des Corall., II, 1857, p. 525, Pl. D9, fig. 1. (The species of the genotype was renamed by Milne Edwards and Haime in error. Art. 32, Inter. Rules. of Zool. Nomen.)

Description.—The corallum forms a massive hemispherical or plate-like expansion spreading from a basal center; the diameter of the expansion varies from a few to 15 inches or more; the base is free of epitheca and conspicuously costate; the corallites are large, of irregular polygonal shape and moderately deep; a rather simple wall separates the adjacent individuals; dissepiments are few; a cellulose columella is present.

Range.—Tertiary to Recent.

Metastraea planulata Coryell, new species

Plate XXXV, Figure 2; Plate XXXVI, Figure 1

Description.—The corallum forms plate-like expansions, the diameter of which varies from a few to more than 15 inches; the corallites are large and vary in shape from regularly polygonal to elongate or compressed polygonal forms; the shorter diameters range from 5 to 10 mm. and the greater from 9 to 30 mm.; the depth of the calices vary from 3 to 5 mm.; each corallite depression consists of a single septal center with a spongy columella and separated from the adjacent depressions by a rather simple, definite, thin wall; from thirty to fifty large septa reach to the center and between each a small one occurs, appearing often as an inconspicuous denticulate ridge on the corallite wall; dissepiments are few.

Holotype.—23011, American Museum of Natural History.

Locality.—440-339,-378, Reeds Collection. American Museum of Natural History.

Occurrence.—Ponce Formation.

* FAMILY.—AGARICIDAE VERRILL

* Genus **Agaricia** Lamarck, 1801

Agaricia Lamarck, Syst. Anim. sans Vert., 1801, p. 375; Lamarck, Hist. Nat. des Anim. sans Vert., 1815; Lamarck, Hist. des Anim. sans Vert., II, 1836, p. 380; Quelch, Voy. Chall. Zool., XVI, 1886, p. 116; Vaughan, Samml. des Geol. Reichs in Leiden, II, Heft 1, 1901, p. 63; Verrill, Trans. Conn. Acad. Arts and Sci., Vol. XI, 1901, p. 140.

Undaria Oken, Lehrb. Naturg., 1815, p. 68.

Agaricia (Mycedium) Dana, U. S. Expl. Exped. Zooph., 1846, pp. 333, 335.

Agaricia and *Mycedium* Milne Edwards and Haime, Hist. Nat. des Corall., III, 1860, pp. 72, 80; Duchassaing and Michelotti, Mém. Corall. Antilles, 1860, pp. 80, 81.

Genotype.—*Merulina undata* Ellis and Solander.

Description.—Corallum unifacial or bifacial, cup-shaped, turbinate, foliate or encrusting growth; calices stellate, arranged in concentric lines or grooves separated by collines or arranged irregularly; the septa are in two or four cycles usually fine and evenly serrulate.

Range.—Tertiary and Recent.

Agaricia agaricites crassa Verrill, 1901

Plate XXXVI, Figure 2

Agaricia crassa Verrill, Trans. Conn. Acad. Arts and Sci., XI, 1901, p. 145, Pl. XXX, fig. 6; Pl. XXXIV, fig. 2; Vaughan, Washington Acad. Sci. Jour., V, 1915, p. 596; Vaughan, Carnegie Inst. Washington Yearbook, 1916, No. 14, p. 228.
Agaricia agaricites crassa Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 427.

Description.—Corallum forms massive, spheroidal, hemispherical or explanate colonies, attaining a maximum diameter of six inches; the upper surface is regularly convex or undulating and covered with irregularly reticulated arrangement of collines; epitheca incomplete; the calices are deep, either separated or grouped in series of two or more by prominent crested collines, the diameter of the calices varies from 2 to 3 mm.; the septa are dentate, prominent, alternately large and small, and confluent with those of the adjacent individual pits; dissepiments are present; the columella appears solid.

Locality.—This species occurs in the reefs of the Bahamas. The specimen studied and figured here is from the island of Porto Rico, locality 945, Hubbard Collection, Columbia University, New York City.

Occurrence.—Recent.

* Agaricia irregularis Coryell and Ohlsen, new species

Plate XXXVII, Figure 1

Description.—Corallum consists of thin laminae growing in irregular funnel-shaped masses, attached at the apex of the cone; calices small, deep, conical, irregularly distributed on the inner surface only of the funnel; each calice is sunken below the general surface of the coenenchyma; the corallite pits consist of narrow, deep cones projecting below the intercorallite area with their apices converging toward the base of the corallum; the coenenchyma is covered with fine, longitudinal and serrated costae that coincide with the septa wherever a corallite lies in their path.

Type.—No. 23009, American Museum of Natural History.

Locality.—440-465,-466,-467,-468, Reeds Collection, American Museum of Natural History.

Occurrence.—Cibao Limestone.

* Agaricia sinuata Coryell and Ohlsen, new species

Plate XXXVII, Figure 2

Description.—Corallum consists of a thin lamina forming irregular funnel-shaped masses; calices are deep, conical cavities forming the lower tubular end of a very distinctly elongated, upwardly directed depression in the coenenchymous tissue; they are irregularly distributed over the inner surface only of the funnel; the corallites project below the coenenchyma as slender, cone-like shapes with their apices directed toward the base of the corallum; the intercorallite area is covered with fine, longitudinal and evenly serrated costae that join the septa as in *A. irregularis*.

Type.—No. 23008, American Museum of Natural History.

Locality.—440-462, Reeds Collection, American Museum of Natural History.

Occurrence.—Cibao Limestone.

* Genus.—**Pironastraea** d'Achiardi, 1875

Pironastraea d'Achiardi, Corall. eocen. del. Friuli, 1875, p. 76, Pl. XV, figs. 2a-3d; Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 432.

Genotype.—*Pironastraea discoides* d'Achiardi.

Description.—Corallum massive or consisting of undulating plates with finely costated basal epitheca, which is complete or incomplete; calices with centers either distinct or indistinct, separated by rounded collines; no interserial walls; septa thin, numerous, traceable across the intercorallite ridges and trabeculate near the false or papillose columella; synapticulae small and abundant.

Range.—Tertiary to Recent.

* **Pironastraea anguillensis** Vaughan, 1919

Plate XXXVII, Figure 3

Pironastraea anguillensis Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 433, Pl. CXI, figs. 1-1b; Pl. CXII, figs. 1, 1a.

Description.—Corallum massive, subhemispherical or plate-like; calcinal valleys deep with narrow bottoms; the collines steep with narrowly rounded crests; the septa in a single calyx, that is surrounded by an interseptal ridge, are numerous, averaging from thirty-eight to forty-five; eighteen septal costae occur in a distance of 5 mm. measured near the center of the collines; the columella position is marked by a pit; synapticulae are abundant.

Type.—No. 325174, U. S. National Museum.

Locality.—440-45, Reeds Collection, American Museum of Natural History and 824, 841, Hubbard Collection, Columbia University, New York City.

Occurrence.—San Sebastian Shale.

* **Pironastraea antiguensis** Vaughan, 1919

Plate XXXVIII, Figure 1

Pironastraea antiguensis Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 434, Pl. CXII, fig. 2, 2a; Pl. CXIII, fig. 1, 1a.

Description.—Corallum massive; calcinal series measure from 5.5 to 7.5 mm. from crest to crest of the collines; valleys shallow with broad bottoms and gently sloping sides; calcinal centers indicated by converging septa lie about 4.5 mm. apart; calcinal pits absent; septa numerous, forty-eight in an individual calyx measuring 6 mm. across; septal costae numerous, twenty-two in 5 mm. along the crest of the colline; synapticulae abundant; pseudocolumella present, marked by papillae.

Type.—No. 325177, U. S. National Museum.

Locality.—440-342,-451, Reeds Collection, American Museum of Natural History.

Occurrence.—Ponce Formation and Lares Limestone.

Genus.—**Siderastrea** Blainville, 1830

Siderastrea Blainville, Dict. Sci. Nat., LX, 1830, p. 335; Milne Edwards and Haime, Compte Rendu de l'Acad. des Sci., XXVII, 1848, p. 495; Quelch, Challenger Exped., 1886, Reef Corals, p. 133; Verrill, Dana's Corals and Coral Islands, ed. 3, 1890, p. 424; Vaughan, U. S. Geol. Surv. Mono. 39, 1900, p. 154; Vaughan, U. S. Nat. Mus. Bull. 59, 1907, p. 136; Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 435.

Astrea Lamarck, Syst. Anim. sans Vert., 1801, p. 371; Fromentel, Introd. à l'Étude des Polyp. foss., 1861, p. 235.

Astraea Oken, Lehrb. der Naturg., Th. 3, Abth. 1, 1815, p. 75; Milne Edwards and Haime, Hist. Nat. Corall., II, 1857, p. 505; Gregory, Geol. Soc. London Quart. Jour., LI, 1895, p. 277.

Astrea = *Astraea*, preoccupied by Bolten for a Mollusca, Mus. Boltenianum, 1798, p. 79.

Genotype.—*Madrepora radians* Pallas = *Astrea galaxes* Lamarck (genotype by elimination, Art. 30, I e and III k) = *Madrepora galaxea* Ellis and Solander.

Madrepora radians Pallas, Elench. Zooph., 1766, p. 322.

Madrepora astroites Linné, Syst. Nat., ed. 12, 1767, p. 1276 (not Pallas, 1766).

Madrepora galaxea Ellis and Solander, Nat. Hist. Zooph., 1786, p. 168.

Astrea radians astroites Oken, Lehrb. Naturg., Th. 3, Abth. 1, 1815, p. 65.

Astrea (Siderastrea) galaxea Blainville, Dict. Sci. Nat., LX, 1830, p. 335.

Description.—The following is the original description as given by Blainville:—

"Loges superficielles ou peu profondes, non marginées, à lamelles nombreuses, très-fines, peu saillantes, partant d'un centre excavé, et se portant jusqu' à celles d'une autre étoile avec lesquelles souvent elles se continuent."

The corallum forms massive hemispherical or dome-shaped colonies, often growing into heads several inches in diameter; the calices are polygonal, compressed and irregular in some species, varying in diameter from 2.0 to 8.25 mm., and usually shallow; the septa are numerous, arranged in three or four cycles, pronouncedly dentate, trabeculate and the shorter ones distinctly perforate; a true or false columella is present; synapticulae may be few or abundant.

Range.—Tertiary to Recent.

Siderastrea conferta (Duncan), 1863

Plate XXXVIII, Figure 2

Isastraea conferta Duncan, Geol. Soc. London Quart. Jour., XIX, 1863, p. 422, Pl. XIV, fig. 2; Duncan, Geol. Soc. London Quart. Jour., XXIV, 1868, p. 25.

Siderastrea conferta Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 451, Pl. CXVII, fig. 3; Pl. CXX, fig. 1-4; Pl. CXXI, figs. 1-2a.

Description.—Corallum massive, irregularly dome-shaped with somewhat explanate base; measuring as much as 4.5 inches or more in diameter; the calices are polygonal, shallow and vary from 2.5 to 7.5 mm. in diameter; the septa are numerous, seventy to eighty in the larger calices, conspicuously dentate on the upper margin, the outer ends often raised higher than the narrow walls of the calicular pit; synapticulae are abundant; the columella is not well developed.

Type.—Coll. Geol. Soc. of London; "Chert formation" of Antigua.

Locality and *Occurrence.*—The specimen is from the Reed Collection and occurs in the San Sebastian Shale.

FAMILY.—OULASTREIDAE VAUGHAN, 1919

Genus.—**Cyathomorpha** Reuss, 1868

Cyathomorpha Reuss, Denkschr. K. Akad. der Wiss. Math-Naturwiss. cl., XXVIII, 1868, p. 142, Pl. II, figs. 6 a-c; Zittel, Traité de Paléontologie, 1883, p. 260; Duncan, Linn. Soc. London Journ., Zool., XVIII, 1884, p. 105; Reis, Bayer, geognost. Landesuntersuch. Geognost. Jahresh., II, 1889, p. 147, Pl. III, figs. 17-19; Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 454.

Genotype.—*Cyathomorpha rochettina* (Michelin).

Astrea rochettina Michelin, Icongraph. Zoophytol., 1840-1847, p. 58, Pl. XII, fig. 2.

Agathiphyllia conglobata Reuss, Die Foraminif., Anthoz. u. Bryoz. von Oberburg, Denkschr. K. Akad. Wiss. Math.-Naturwiss. cl. Wein., XXIII, 1864, p. 15, Pl. II, figs. 10-11.

Cyathomorpha conglobata Reuss. Denkschr. K. Akad. der Wiss. Math.-Naturwiss. cl., XXVIII, 1868, p. 142, Pl. II, figs. 6 a-c.

Cyathomorpha rochettina Reis, Bayer, geognost. Landesuntersuch. Geognost. Jahresh., II, 1889, p. 147, Pl. III, figs. 17-19.

Description.—The corallum consisting of superimposed layers, forms turf-like, turbinate, massive, explanate or dome-shaped masses, some of which are more than 10 cm. in diameter; epitheca is absent or only represented by shreds; the calyx pits are subcircular, either contiguous or separated and commonly raised above the interstitial tissue; their diameter varies from 3.5 to 20.0 mm.; septa are numerous and in several cycles, the earlier ones are solid or only with few perforations, the later cycles and rudimentary septa are distinctly perforate, composed of fused trabeculae; the calicular rims and outer surface of the protuberant calicular cavities are costate; synapticulae and dissepiments are present and usually common; the columella is trabecular or composed of the twisted or fused end of the longer septa; pali well developed and often raised to form a crown showing above the septa.

Range.—Oligocene.

Remarks.—This genus is distinguished from *Orbicella* by its synapticulate and perforate structures.

Cyathomorpha antiguensis (Duncan), 1863

Plate XXXVIII, Figures 3-5

Astraea antiguensis Duncan, Geol. Soc. London Quart. Jour., XIX, 1863, p. 419, Pl. XIII, fig. 8.

? *Astroria affinis* Duncan, Geol. Soc. London Quart. Jour., XIX, 1863, p. 425; Duchassaing and Michelotti, Sup. Mém. Corall. Antilles, 1866, p. 83 (of reprint); Duncan, Geol. Soc. London Quart. Jour., XXIV, 1868, p. 24; Duchassaing, Rev. Zooph. Antilles, 1870, p. 30.

Astroria antiguensis Duncan, Geol. Soc. London Quart. Jour., XIX, 1863, p. 425; Duchassaing and Michelotti, Sup. Mém. Corall. Antilles, 1866, p. 83 (of reprint); Duchassaing, Rev. Zooph. Antilles, 1870, p. 30.

Heliastraea antiguensis Duchassaing and Michelotti, Sup. Mém. Corall. Antilles, 1866, p. 86 (of reprint); Duncan, Geol. Soc. London Quart. Jour., XXIV, 1867, p. 24; Duchassaing, Rev. Zooph. Antilles, 1870, p. 30.

Cyathomorpha antiguensis Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 463, Pl. CXXIX, fig. 2; Pl. CXXX, figs. 1-3; Pl. CXXXI, figs. 1-4; Pl. CXXXII, figs. 1-2b; Pl. CXXXIII, fig. 1.

Description.—The corallum forms turbinate, hemispherical or discoidal massive heads varying from 9 to 16 inches in diameter with only rudimentary epitheca on the basal surface; the individual corallites multiply by budding, apparently intercalcinal; the calices are rounded or subpolygonal, separated by porous tissue formed of costae and many synapticulae; the costae pass over the calcinal margin and unite with the septa; the calyx pits vary from 3 to 12 mm. in diameter and are usually shallow, but a few specimens have deep calices, some as much as 5 mm.; the walls are synapticulate; the septa are numerous, granulose, sometimes carinate and usually in four cycles, uniting with the costae over the calcinal margin; the longer septa extend to the well developed columellar tangle, the shorter ones sometimes are joined to the sides of the longer ones; the individual plates of the primary and secondary cycles appear imperforate; paliform lobes form a double circular feature, the inner circle is more distinct and associated with the primary and secondary septa, the outer circle is associated with the tertiary septa; synapticulae and dissepiments are common.

Type.—Coll. Geol. Soc. London; "Marl-formation" of Antigua.

Locality.—440-58,-119, Reeds Collection, American Museum of Natural History, and 805-8, 814, Hubbard Collection, Columbia University, New York City.

Occurrence.—San Sebastian Shale and Lares Limestone.

Cyathomorpha tenuis (Duncan), 1863

Plate XXXIX, Figure 1

Astraea tenuis Duncan, Geol. Soc. London Quart. Jour., XIX, 1863, p. 421, Pl. XIII, fig. 11.

Heliastraea tenuis Duncan, Geol. Soc. London Quart. Jour., XXIV, 1868, p. 24.

Orbicella tenuis Vaughan (part), Geolog. Reichs Mus. Leiden Samml., ser. 2, II, p. 33.

Cyathomorpha tenuis Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 467, Pl. CXXXII, figs. 3, 3a; Pl. CXXXIII, figs. 2-3b.

Description.—The corallum is a pulvinate mass, two to five inches in diameter, composed of rounded tubes separated from the adjacent corallites either by a narrow wall or by porous tissue that measures as much as 2 mm. in thickness; the calices are distinctly outlined, slightly raised and vary from 3 to 6 mm. in diameter; the costae, present on the calicular margins, extend down the outside of the calicular pits and meet those of adjacent calices; inwardly the costae unite with the numerous septa that vary in number from twenty-four to forty, arranged in four cycles; the principal septa bear paliform structures more distinct than the other primary and secondary septa; synapticulae form the wall of the tubular corallites and are numerous among the costae, where they form the coarsely porous interstitial tissue; the central network is not definitely arranged in a columella.

Type.—Coll. Geol. Soc. London; "Marl-formation," Antigua.

Locality.—440-39,-40,-46,-49,-51,-59,-242,-325,-385, Reeds Collection, American Museum of Natural History, and 804, 811, 815, 850, 853, 854, 855, 886, 888, P. R. 98 (f) and (g), Hubbard Collection, Columbia University, New York City.

Occurrence.—San Sebastian Shale, Juana Diaz Shale ? and Ponce Formation.

Genus.—**Diploastrea** Matthai, 1914

Diploastrea Matthai, Linn. Soc. London, Trans., Zool., ser. 2, XVII, 1914, p. 72; Vaughan, Dept. Marine Biology, IX, Pub. 213, 1918, p. 142; Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 469.

Genotype.—*Diploastrea heliopora* (Lamarck).

Astrea heliopora Lamarck, Hist. Nat. Anim. sans Vert., 1816, p. 265; ed. 2, 1836, p. 415.

Astraea glaucopsis Dana, U. S. Expl. Exped., Zooph., 1846, p. 208, Pl. X, figs. 2a, 2b.

Astraea patula Dana, U. S. Expl. Exped., Zooph., 1846, p. 209, Pl. X, figs. 14-14e.

Orbicella minikoiensis Gardiner, Fauna and Geog. Maldive and Laccadive Arch., II, 1904, p. 774, Pl. LXIII, fig. 35; Vaughan, Proc. U. S. Nat. Mus., XXXII, 1907, p. 252.

Diploastrea heliopora Matthai, Linn. Soc. London Trans., Zool., ser. 2, XVII, 1914, p. 72, Pl. XX, figs. 7, 8; Pl. XXXIV, fig. 9.

Matthai states: "This genus has been created for *Orbicella minikoiensis* Gardiner," 1904. He places this species in synonomy with *Astrea heliopora* Lamarck, 1816, which has been described by Lamarck as follows: "*A. planulata*; stellis orbiculatis, majusculis, multiradiatis, margine separatis lamellis extus superneque incrassatis; centro papilloso."

Description.—Corallum consists of incrusting or massive forms; epitheca incomplete; calices large, shallow and commonly raised above the intercalicular area from which they are separated by a wall; costae are present and in many places those of adjacent corallites are confluent upon the intercorallite areas and in other places alternate; the septa are coarsely dentate, coarsely perforate and thick near the calyx wall; synapticulae and dissepiments are present; paliform columns are absent but the innermost denticles of the major septa often rise above the surface and simulate pali; the columella is trabeculate.

Range.—Tertiary to Recent.

Remarks.—Diploastrea is distinguished from *Cyathomorpha* in its coarse perforation and dentation and in the absence of pali.

Agathiphyllia is similar to *Diploastrea* in having no pali according to Reuss. It is necessary to study the type specimen before the relation of these two genera can be determined and until that is done the genus of *Diploastrea* will be recognized.

Brachyphyllia cannot be recognized without further study of the type, *B. dormitzeri*.

Diploastrea crassolamellata (Duncan), 1863

Plate XXXIX, Figure 2

Astraea crassolamellata Duncan, Geol. Soc. London Quart. Jour., XIX, 1863, pp. 412-417, Pl. XIII, figs. 1-7.

Heliastraea crassolamellata Duchassaing and Michelotti, Sup. Corall. Antilles, 1866, p. 86 (of reprint); Duncan, Geol. Soc. London Quart. Jour., XXIV, 1868, p. 24; Duchassaing, Rev. Zooph. Antilles, 1870, p. 30.

Orbicella crassolamellata Vaughan, Geol. Soc. London Quart. Jour., LVII, 1901, p. 497.

Brachyphyllia sp. Vaughan, Geol. Soc. London Quart. Jour., LVII, 1901, p. 497.

Diploastrea crassolamellata Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 470, Pl. CXXXV, figs. 1-5b; Pl. CXXXVI, figs. 1-1b; Pl. CXXXVII, figs. 1-5.

Description.—Corallum massive, expending upward and outward from a small base, the upper surface flat or dome-shaped, deeply grooved between the calices; the lower surface is incompletely epithecated; the calices are large, shallow, raised above the intercalicular tissue and vary from 6.25 to 27.5 mm. in diameter; the septa are in several cycles (four to nine) and very porous; synapticulae and trabeculae are abundant within and without the calyx; the columella is well developed, large and trabeculate, often measuring 5 mm. in diameter; the calicular walls are porous; costae are present and observed wherever the epitheca is absent.

Type.—Coll. Geol. Soc. London; "Marl formation," Antigua.

Locality.—440-57,-58,-340,-378,-444, Reeds Collection, American Museum of Natural History, and 807, 817 Hubbard Collection, Columbia University, New York City.

Occurrence.—San Sebastian Shale, Ponce Formation and Lares Limestone.

Madreporaria Perforata

Family.—Acroporidae Verrill

Genus **Acropora** Oken, 1815

Acroporidae Verrill, Trans. Conn. Acad. Arts and Sci., XI, 1901, p. 163; (not Acroporidae Canu, 1913, which was made to include several genera of Cheilostome Bryozoa).

Genus—*Acropora* Oken, 1815.

Acropora Oken, Lehrb. Naturg., Th. 3, Abth. 1, 1815, p. 66; Verrill, Trans. Conn. Acad. Arts and Sci., XI, 1901, p. 164; 1902, p. 208; Vaughan, Carnegie Inst. Washington, Dept. of Marine Biol. Pub. 213, p. 159; Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 479; Zittel, Text Book of Paleon., I, 1913, p. 107.

Madrepora Lamarck (not Linné, ed. X, 1758, p. 792), Hist. Anim. sans Vert., II, 1816, p. 277; ed. 2, 1836, p. 445; Dana, Zooph., 1846, p. 435; Milne Edwards and Haime, Hist. Corall., III, 1860, p. 132; Rathbun, Catalog. U. S. Nat. Mus., X, 1887, pp. 10-19; Klunzinger, Korall. Roth. Meer., II, 1879, p. 2; Brook, Catalog. Mad. Brit. Mus., I, 1893, p. 22.

Isopora.—Studer (as subgenus), Monatsber. Akad. Wiss. Berlin, 1878, p. 535; Vaughan, Fossil Corals Curaco, 1901, p. 68; Vaughan, Bull. U. S. Fish Comm. for 1900, II, 1901, p. 312.

Heteropora Ehrenberg, Korall. Roth. Meer., Abhandl. K. Acad. Wiss. Berlin for 1832, 1834, p. 323; (not Blainville, whose genus was referred to a Bryozoan).

Acropora Reuss, Die fossilen Anthozoen und Bryozoan der Schichtenguippe von Crosaro, Denkschrift. der K. Akad. der Wissenschaft. Wein, XXIX, 1869, p. 277, was used for a Bryozoan species. In U. S. Nat. Mus. Bull. 106, 1920, pp. 318-320, Canu and Bassler added two new species of Cheilostome Bryozoa to the genus of Reuss. In Zittel, Traité de Paléontologie, 1883, *Acropora* (a Bryozoan genus) was included under *Vincularia* as a synonym. Further study is necessary to determine what should be done with the Bryozoan species now assigned to the genus *Acropora*, a name that can be properly used only for a coral species.

Genotype.—*Millepora muricata* Linnaeus.

Millepora muricata Linnaeus, Syst. ed. 10, 1758, p. 792.

Madrepora muricata Pallas, Elench. Zooph., 1766, p. 327; Linnaeus, Syst. ed. 12, 1767, p. 1279.

Madrepora cervicornis Lamarck, Hist. Anim. sans Vert., 1816, pp. 278, 281.

Acropora muricata Oken, Lehrb. Naturg., Th. 3, Abth. 1, 1815, p. 66.

Description.—Corallum forms branching, flabellate or palmate colonies; the calices are small, circular pits at the end of tubular projections raised above the surface of the porous coenenchyma; they protrude most conspicuously upon the upper surfaces of the palmate forms or nearer the ends of the branches in the branching colonies; the septa are often rudimentary and in two cycles; the two major or directive septa in some calices form a conspicuous partition; the columella is rudimentary or absent; the costal ridges are numerous or replaced by papillose tissue.

Range.—Tertiary to Recent.

Acropora crassa Coryell, new species

Plate XXXIX, Figure 3

Description.—Corallum forms bilaminate, palmate fronds or masses with the lamina on the lower side of the broad fronds much thinner and carrying a less number of corallites than the upper lamina; fronds vary in thickness from ½ to 3½ inches; the corallites are small, 0.5 to 0.8 mm. in diameter, circular in cross-section and separated from one another by a distance equal to or less than their diameter; the coenenchyma is coarsely porous; the calcinal walls are thick and often in contact in adjacent individuals; the directive septum is well developed and in many calices it unites with the opposite one.

Type.—No. 23006, American Museum of Natural History.

Locality.—440-346,-368,-369, Reeds Collection, American Museum of Natural History, and 918, 968, 987, 989, 1089, Hubbard Collection, Columbia University, New York City.

Occurrence.—Ponce Formation.

Remarks.—This species is distinguished from *Acropora palmata* by the thick, calcinal walls, closer average spacing of the corallites and the thicker and less undulating palmate corallum.

Acropora palmata (Lamarck), 1816

Plate XL, Figure 1

Madrepora palmata Lamarck, Hist. Nat. Anim. sans Vert., II, 1816, p. 279; Gregory, Ann. Mag. Nat. Hist., ser. 7, VI, 1900, p. 29.

Madrepora muricata palmata Brook, Brit. Mus. Cat. Madrep. corals, gen. *Madrepora*, 1893, p. 25.

Isopora muricata palmata Vaughan, U. S. Fish Comm. Bull. for 1900, II, 1901, p. 313, Pls. XXVI, XXVII.

Acropora muricata palmata Verrill, Trans. Conn. Acad. Arts and Sci., XI, 1901, p. 166.

Acropora palmata Vaughan, Washington Acad. Sci. Jour., V, 1915, pp. 597, 598; Vaughan, Nat. Acad. Sci. Proc., II, 1916, pp. 95, 100; Vaughan, Carnegie Inst. Washington Yearbook No. 14, 1916, pp. 227-230; Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 483.

Description.—Corallum forms undulating and palmate branching colonies; the corallites are circular and protrude above the finely porous coenenchyma, extending out farthest on the margins of the branches; the calcinal pits vary from 0.5 to 0.8 mm. in diameter; costal ridges are numerous; six septa are well developed, a single directive or two opposites are more prominent than the rest; the coenenchyma of well preserved or recent specimens is very spinous; calcinal walls are thin.

Locality.—937, H 2, Hubbard Collection, Columbia University, New York City.

Occurrence and *Range.*—Pleistocene and Recent.

Acropora panamensis Vaughan, 1919

Plate XL, Figure 2

Acropora panamensis Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 480. Pl. CXLI, figs. 1-2.

Description.—Corallum composed of thick branches varying from 12 to 20 mm. in diameter and becoming compressed below a point of bifurcation, where the greatest diameter often measures 30 mm.; the corallites are protuberant, projecting upward and outward; the average individual extends from 1.5 to 2.0 mm. above the coenenchyma; the diameters of the calices vary from 1.5 to 3.5 mm.; they are scattered over the branches irregularly, in some places more closely spaced than in others, but commonly separated from one another by a distance equal to the diameter of the calice; costal ridges are numerous; synapticulae are present; the septa occur in two cycles; the directives are well developed but do not form dimidiate calices; coenenchyma is porous and near a corallite protuberance it is covered with the extended costal ridges.

Type.—No. 325042a, U. S. National Museum; Emperador Limestone.

Locality.—440-51-,-62,-64,-330,-340,-454, Reeds Collection, American Museum of Natural History, and 880, 896, 897, Hubbard Collection, Columbia University, New York City.

Occurrence.—San Sebastian Shale, Ponce Formation and Lares Limestone.

Genus.—**Astreopora** Blainville, 1830

Astreopora Blainville, Dict. Sci. Nat., LX, 1830, p. 348; Milne Edwards and Haime, Compte Rendu de l'Acad. des Sci., XXVII, 1848, p. 258; Milne Edwards and Haime, Archi. du Mus. d'Hist. Nat., V, 1851, p. 141; Milne Edwards and Haime, Hist. Nat. des Corall., III, 1860, p. 167; Bernard, Brit. Mus. Cat. Madreporaria, II, 1896, p. 77; Vaughan, Carnegie Inst. Washington Pub. 213, 1918, p. 145; Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 483.

Genotype.—*Astreopora myriophthalma* (Lamarck).

Astrea myriophthalma Lamarck, Hist. Nat. Anim. sans Vert., 1816, p. 260.

Description.—Corallum consists of massive or branching colonies with porous coenenchymous tissue filling the spaces between each individual; the surface of the intercalicular area is smooth, canaliculate or bearing small spine-like structures; the calices are irregularly rounded, slightly protuberant; the septa are irregularly developed, consisting of a different number of cycles in different individuals of the same colony; a columella is present but often poorly developed.

Range.—Tertiary to Recent.

Astreopora antiguensis Vaughan, 1919

Plate XL. Figue 3

Astreopora antiguensis Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 484, Pl. CXXXIX, figs. 3, 3a; Pl. CXL, fig. 1.

Description.—Corallum consists of subterete or palmate branches; the calices are protuberant, irregular in outline, 2 to 4 mm. in diameter and varying from 1.5 to 2.5 mm. apart; the individual corallites are costate; the coenenchymous tissue appears somewhat smooth and porous except where the costae are present; the septa appear arranged in two or three incomplete cycles; the columella may or may not be present.

Type.—Museum of Comparative Zoology, Harvard University.

Locality.—440-321, Reeds Collection, American Museum of Natural History.

Occurrence.—Ponce Formation.

*FAMILY.—PORITIDAE DANA

* Genus.—**Goniopora** Blainville, 1830

Goniopora Blainville, Dict. Sci. Nat., LX, 1830, p 359; Quoy and Gaimard, Voyage de l'Astrolabe, Zool., IV, 1833, p. 218.

Genotype.—*Goniopora pedunculata* Quoy and Gaimard.

Description.—Corallum forms compressed or cylindrical branches, lamelliform foliations or subhemispherical masses; calices polygonal, 1.5 to 4.0 mm. in diameter; wall costated, spiny or granular; the septa, usually 24 in number, are arranged in the gonioporid plan, six primaries extending directly to the columella with a triplet group of a secondary and two tertiaries between each, and sometimes a directive plane formed by two opposite primaries can be distinguished; the columella is composed of a network tangle of calcareous tissue; synapticulae and pali are present.

Range.—Tertiary and Recent.

* Goniopora canalis Vaughan, 1919

Plate XL, Figure 4

Goniopora canalis Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 494, Pl. CXLVI, figs. 1-3.

Description.—Corallum forms compressed branches; the calices are polygonal, varying in diameter from 2 to 4 mm. and on unweathered surfaces have a depth of 1.0 to 1.25 mm.; the walls are costate, reticulate, ridge-like, enclosing a single calice or a longitudinal series of two to four and varying in thickness from 0.75 to 1.25 mm.; the septa are gonioporoid, tapering inward with two cycles reaching the inconspicuous columella tangle; no pali observed.

Tye.—No. 325052, U. S. National Museum.

Locality. — 440-39,-451, Reeds Collection, American Museum of Natural History, and 870, 878, 891, 996, Hubbard Collection, Columbia University, New York City.

Occurrence.—San Sebastian Shale and Lares Limestone.

* Goniopora cascadensis Vaughan, 1919

Plate XL, Figure 5

Goniopora cascadensis Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 497, Pl. CXLVI, figs. 6-9.

Description.—Corallum forms small subcylindrical branches; the calices are polygonal and vary in diameter from 1.5 to 2.5 mm.; the walls are thin, costate and reticulate or apparently absent in some places; the septa are in three cycles, two of which reach the well developed, often styloform columellar tangle; the pali are slightly developed as a cycle of thickenings around the columella.

Type.—No. 325072, U. S. National Museum.

Locality.—440-38,-339,-373, Reeds Collection, American Museum of Natural History.

Occurrence.—San Sebastian Shale and Ponce Formation.

* Goniopora clevei Vaughan, 1919

Plate XL, Figure 6

Goniopora clevei Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 496, Pl. CXLV, figs. 1-6a.

Description.—Corallum forms irregularly shaped branches; the calices are subcircular and shallow; the walls consist of a reticulate structure that fills the intercalcinal spaces, the thickness of which varies from a thin synapticular zone to a reticulated mass measuring 1 mm. across; the septa are poritid in arrangement and number, except that the major ones are peripherally bifurcated; the columella is well developed and centrally dense; the pali aggregation consists of six structural elements.

Type.—University of Upsala.

Locality.—440-24,-25,-27,-38,-39,-40,-46,-48,-49,-50,-51,-58, Reeds Collection, American Museum of Natural History, and 866, 867, 868, 869, 874, 877, 879, 882, P. R. 95 (b), Hubbard Collection, Columbia University, New York City.

Occurrence.—San Sebastian Shale.

* **Goniopora decaturensis** Vaughan, 1919

Plate XL, Figure 7

Goniopora decaturensis Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 490, Pl. CXLIII, figs. 1, 1a.

Description.—Corallum consists of superimposed, undulating, foliated lamellae; calices are shallow, polygonal and vary from 2.5 to 3.0 mm. in diameter; the walls are thin or absent; septa are gonioporid in arrangement and number, of variable thickness, the longer reaching the conspicuous columellar tangle; trabeculae and synapticulae are present in many interseptal loculi.

Type.—No. 325031, U. S. National Museum.

Locality.—440-40,-339,-341,-366,-389, Reeds Collection, American Museum of Natural History.

Occurrence.—San Sebastian Shale and Ponce Formation.

* **Goniopora decaturensis silicensis** Vaughan, 1919

Plate XL, Figure 8

Goniopora decaturensis var. *silicensis* Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 491, Pl. CXLIII, figs. 2, 2a.

Description.—It is only necessary here to give the characters that make it convenient to support the erection of this variety. These are as follows: calices vary in diameter from 2.5 to 4.0 mm. and the septa are thin.

Type.—No. 325026, U. S. National Museum.

Locality.—440-33,-320,-323,-346, Reeds Collection, American Museum of Natural History.

Occurrence.—Lares Limestone and Ponce Formation.

* **Goniopora hilli** Vaughan, 1919

Plate XLI, Figure 1

Goniopora hilli Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 488, Pl. CXLII, figs. 1, 1a.

Description.—Corallum is large, consisting of superimposed, irregularly flattened plates; the calices are polygonal, varying from 3 to 4 mm. in diameter and from 1.0 to 1.5 mm. in depth on unweathered surfaces; the intercalcinal walls are from 0.75 to 1.25 mm. in thickness; the narrow walls are crossed by septa extensions (costae), the thicker walls consist of a reticulate structure; the septa are gonioporid in number and arrangement and usually of three cycles, the first and second extending to the columellar tangle which forms the bottom of the calices; pali are inconspicuous.

Type.—No. 325058, U. S. National Museum.

Locality. — 440-42,-107,-339,-340,-341,-344,-390, Reeds Collection, American Museum of Natural History, and 1004, P. R. 98 (a), Hubbard Collection, Columbia University, New York City.

Occurrence.—San Sebastian Shale and Ponce Formation.

* **Goniopora imperatoris** Vaughan, 1919

Plate XLI, Figure 2

Goniopora imperatoris Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 493, Pl. CXLII, figs. 3, 3a.

Description.—Corallum forms compressed, lobate columnar masses; the calices are polygonal, varying from 1.5 to 2.5 mm. in diameter and are as much as 0.75 mm. deep where the surface is unweathered; the walls are costate and consist of reticulate tissue measuring from 0.75 to 1.25 mm. in thickness; the septa are gonioporid, thin and with two cycles reaching the very conspicuous columellar tangle; pali are well developed.

Type.—No. 325049, U. S. National Museum.

Locality.—440-46,-48,-344, Reeds Collection, American Museum of Natural History.

Occurrence.—San Sebastian Shale and Ponce Formation.

* Goniopora jacobiana Vaughan, 1919

Plate XLI, Figure 3

Goniopora jacobiana Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 492, Pl. CXLIV, figs. 1-3a.

Description.—Corallum forms a hemispherical or columniform mass of superimposed lamellae; the calices are polygonal and vary from 2.5 to 3.5 mm. in diameter; the walls are thin, costated or having a reticulate structure where the thickness reaches 1 mm.; septa are gonioporid and thin; the columella is inconspicuous and apparently absent in some calices; no pali observed.

Type.—No. 325077, U. S. National Museum.

Locality.—440-342, Reeds Collection, American Museum of Natural History and 942, 943, Hubbard Collection, Columbia University, New York City.

Occurrence.—Ponce Formation.

* Goniopora panamensis Vaughan, 1919

Plate XLI, Figure 4

Goniopora panamensis Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 489, Pl. CXLII, figs. 2-2b.

Description.—Corallum is large, consisting of superimposed, flattened or domed plates; the calices are polygonal, varying from 2.5 to 3.5 mm. in diameter and often reaching a depth of 2.0 mm.; in many places the calices occur in series surrounded by a definite, common, ridge-like wall; the individual walls are thick, reticulated, and at the junction angles, acervuline; the septa are gonioporid in arrangement and number, two cycles of which reach the small columellar tangle; pali are inconspicuous.

Type.—No. 325053, U. S. National Museum.

Locality.—440-39,-47,-50,-366, Reeds Collection, American Museum of Natural History, and 860, Hubbard Collection, Columbia University, New York City.

Occurrence.—San Sebastian Shale and Ponce Formation.

* Goniopora portoricensis Vaughan, 1919

Plate XLI, Figure 5

Goniopora portoricensis Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 495, Pl. CXLVI, figs. 4, 5.

Description.—Corallum forms cylindrical or compressed branches; the calices are polygonal, shallow and vary in diameter from 1.5 to 2.0 mm.;

the walls are thin and appear as if formed by the fusion of the ends of the septa; the septa are thin and in three cycles; the columella is inconspicuous; the pali are not always sufficiently developed to be distinguished from the septal structures.

Type.—No. 325061, U. S. National Museum.

Locality.—440-38,-57,-62,-454, Reeds Collection, American Museum of Natural History.

Occurrence.—San Sebastian Shale and Lares Limestone.

* **Goniopora regularis** (Duncan), 1863

Plate XLII, Figures 1, 1a

Alveopora daedalaea var. *regularis* Duncan, Geo. Soc. London Quart. Jour., XIX, 1863, p. 426, Pl. XIV, figs. 4a, 4c.

Alveopora daedalaea Duncan, Geol. Soc. London Quart. Jour., XXIV, 1867, p. 25.

Alveopora regularis Vaughan, Geol. Reich. Mus. Leiden Samml., ser. 2, II, p. 71.

Goniopora regularis Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 491.

Description.—Corallum is of an undulate, turbinate or lobulate columniform shape; calices are polygonal, varying from 1.5 to 2.5 mm. in diameter; the walls are distinct in places, consisting of reticulate structure; the septa are thin, granular and gonioporid in arrangement and number; the plate-like pali are conspicuous.

Locality.—440-320, Reeds Collection, American Museum of Natural History, and 865, Hubbard Collection, Columbia University, New York City.

Occurrence.—San Sebastian Shale and Ponce Formation.

* Genus.—**Porites** Link, 1807

Porites Link, Beschreib. Natur. Samml. Rostock, 1807, p. 162; Vaughan, Samml. Geol. Reichs. Mus. Leiden, ser. 2, II, 1901, p. 73; Vaughan, U. S. Comm. of Fish and Fisheries Bull. for 1900, II, 1901, p. 314, Pl. XXVIII; Vaughan, Proc. Biol. Soc. Wash., XV, 1902, p. 56; Bernard, Porites of the Indo-Pacific Region, 1905, p. 333, (35 plates); Bernard, Porites of the Atlantic and West Indies, 1906, p. 144, (17 plates); Vaughan, Carnegie Inst. Washington Pub. 213, 1918, p. 138.

Genotype.—*Madrepora porites* Pallas.

Description.—Corallum forms foliaceous or ramose tuffs, incrustations, hemispherical or lobed masses with a basal epitheca; corallites with trabeculate walls; calices small, polygonal; septa trabeculate, spinose, twelve in number; columella a network tangle at the center of the corallite and often surmounted by a styliform trabecula; pali five or six, often indistinct, forming a circle about the columellar tangle; synapticules and dissepiments occur; tabulæ are porous.

Range.—Cretaceous to Recent.

* **Porites anguillensis** Vaughan, 1919

Plate XLII, Figure 2

Porites anguillensis Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 504, Pl. CXLIX, figs. 1-1b; Pl. CL, fig. 5.

Description.—Corallum composed of thin, undulating, superimposed laminae; calices shallow, subcircular, 1.7 to 2.3 mm. in diameter; walls of dense, costate and perforate coenenchymous tissue, 0.8 to 1.0 mm. in thickness; the twelve septa thick, in poritid arrangement; the six pali are before the inner ends of the septal groups; synapticulae are well developed, forming three rows in the wall and a ring about the pali; trabeculae in columellar tangle are coarse; an axial tubercle is present.

Type.—University of Upsala.

Locality. — 440-40,-45,-46,-50,-119,-344,-446,-458. Reeds Collection, American Museum of Natural History, and P. R. 98 (b), Hubbard Collection, Columbia University, New York City .

Occurrence.—San Sebastian Shale, Lares Limestone and Ponce Formation.

* **Porites astreoides** Lamarck, 1816

Plate XLII, Figures 3, 3a

Porites astreoides Lamarck, Hist. Nat. Anim. sans Vert., II, 1816, p. 269; Rathbun, U. S. Nat. Mus. Proc., X, 1887, p. 354; Vaughan, U. S. Fish Comm. Bull. for 1900, II, 1901, p. 317, Pl. XXXII; Pl. XXXIII; Pl. XXXIV, figs. 1, 2; Verrill, Trans. Conn. Acad. Arts and Sci., XI, 1902, p. 160, Pl. XXXI, fig. 4; Vaughan, Carnegie Inst. Washington Yearbook No. 10, 1912, pp. 148-156, Pl. IV, figs. 3a, 3d, 3e; Pl. V, fig. 5b; Pl. VI, figs. 1c, 2e; Vaughan, Washington Acad. Sci. Jour., V, 1915, p. 597; Vaughan, Nat. Acad. Sci. Proc., II, 1916, p. 98; Vaughan, Carnegie Inst. Washington Yearbook No. 12, 1916, pp. 226-228, 231; Duerden, Nat. Acad. Sci. Mem., VIII, 1903, p. 550, Pls. III-V.

Porites verrilli Verrill, Trans. Conn. Acad. Arts and Sci., XI, 1902, p. 161, Pl. XXXI, fig. 5.

Description.—Corallum massive, subhemispherical, with a regularly curved or knobby surface; calices polygonal, deep, 1 to 2 mm. in diameter; there are twelve principal porous septa with dentate upper margins and arranged in regular poritid form; walls are thin; the columella is composed of a network tangle; the pali are poorly developed.

Locality.—440-18,-367,-462, Reeds Collection, American Museum of Natural History.

Occurrence.—Recent, Ponce Formation ? and Cibao Limestone ?.

* **Porites baracoaensis** Vaughan, 1919

Plate XLII, Figure 4

Porites baracoaensis Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 499, Pl. CXLVII, figs. 1, 1a.

Description.—Corallum composed of slender branches; calices shallow, polygonal, 1.25 to 2.25 mm. in diameter; walls thin, costate and with squamae present within most of the calices; septa of poritid arrangement; there are usually six pali, one before the inner end of each group of septa and united at the base of the calyx to the columellar tangle.

Type.—No. 325069, U. S. National Museum.

Locality.—440-362, Reeds Collection, American Museum of Natural History, and 955, Hubbard Collection, Columbia University, New York City.

Occurrence.—Ponce Formation.

* **Porites douvillei** Vaughan, 1919

Plate XLII, Figures 5-7

Porites douvillei Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 501, Pl. CXLIX, figs. 2, 2a; Pl. CLI, figs. 1, 1a.

Description.—Corallum composed of compressed branches; calices shallow, polygonal, 1.25 to 2.0 mm. in diameter; walls thin, denticulate along the upper margin and usually straight; septa in poritid arrangement; pali well developed; synapticulae occur in a palar ring and in a ring midway between the center of the calyx and the wall, coinciding with a ring of septal granules; the columellar tangle has radial extensions to the pali and central tubercle.

Cotype.—No. 325106, U. S. National Museum.

Locality.—440-21,-25,-26,-27,-33,-35,-38,-39,-40,-44,-45,-46,-47,-49,-50,-52,-57,-61,-119,-123,-242,-362,-376,-451,-462, Reeds Collection, American

Museum of Natural History, and 995, 998, 999, 1000, Hubbard Collection, Columbia University, New York City.

Occurrence.—San Sebastian Shale, Lares Limestone, Cibao Limestone, Juana Diaz Shale ? and Ponce Formation.

Porites (Synaraea) macdonaldi Vaughan, 1919

Plate XLIII, Figure 1

Porites Synaraea macdonaldi Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 506, Pl. CLII, fig. 1-5a.

Description.—Corallum rises from an explanate base into lobes and irregular protuberances; the calices average 1.5 mm. in diameter and are arranged separately or in series varying from two to eleven calices surrounded by a costate or coarsely reticulate colline, within which the calcinal centers are definite and the individual walls indistinct; papillae occur in many places on the reticulate tissue between the calicular depression, especially at the junction angles of adjacent calices; the arrangement of the septa cannot always be determined; a ventral directive with lateral triplets can sometimes be observed; a ring of septal granules and another composed of synapticulae occur near the wall; pali and palar synapticulae can be differentiated in some calices; the columellar tangle is present.

Cotype.—No. 325046a, U. S. National Museum; Upper Oligocene.

Locality.—833, 881, 1001, 1006, Hubbard Collection, Columbia University, New York City.

Occurrence.—San Sebastian Shale.

* **Porites panamensis** Vaughan, 1919

Plate XLIII, Figure 2, Plate XLIV, Figure 1

Porites panamensis Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 503, Pl. CXLVIII, figs. 1-3a.

Description.—Corallum composed of broad, compressed, branch-like expansion with somewhat irregular surfaces; calices shallow, confluent in series of not more than three and measuring from 1.5 to 2.0 mm. in diameter; walls coarse, forming a zig-zag or straight ridge about the confluent series; twelve septa in typical poritid arrangement; the septal granules are irregular and do not form a mural ring; the pali, from six to eight in number, are irregularly placed; synapticulae few and better developed around the columellar tangle.

Type.—No. 325063, U. S. National Museum.

Locality. — 440-25,-26,-43,-52,-340,-341,-342,-361,-365,-366,-386,-452, Reeds Collection, American Museum of Natural History, and 887, Hubbard Collection, Columbia University, New York City.

Occurrence.—San Sebastian Shale, Ponce Formation and Lares Limestone.

Porites porites (Pallas), 1766

Plate XLIV, Figure 2

Madrepora porites Pallas, Elench. Zooph., 1766, p. 324; Linnaeus, Syst. Nat. ed. 12, 1767, p. 1279; Ellis and Solander, Nat. Hist. Zooph., 1786, p. 172, Pl. XLVII, figs. 1, 2; Esper, Pflanzenth. 1, 1789, p. 135, Pl. XXI, Gmelin, Syst. Nat. ed. 13, 1790, p. 3774; Lamarck, Syst. Anim. Sans vert., 1801, p. 371; Schweigger, Handb. Naturg., 1820, p. 413.

Porites polymorphus Link, Beschreib. Natur. Samml., Rostock, 1807, p. 162.

Porites clavaria Lamarck, Hist. Nat. Anim. sans vert., II, 1816, p. 270; Lesueur, Mem. Mus. Hist. Nat., VI, 1820, p. 289, Pl. XVII, fig. 17; Lamouroux, Exp. Meth., 1821, p. 61, Pl. XLVII, figs. 1, 2; Deslongchamps, Encycl. Meth. Zooph., 1824, p. 652; Blainville, Dict. Sci. Nat., XLIII, 1826, p. 50; LX, p. 361; Ehrenberg, Abh. k. Akad. Wiss., 1834, p. 341; Dana, Zooph. Explor. Exped. Wilkes, VIII, 1848, p. 554; Duchassaing, Anim. Rad. Ant., 1850, p. 17; Milne Edwards and Haime, Ann. Sci. Nat. Zool., ser. 3, XVI, 1851, p. 26; Milne Edwards and Haime, Hist. Nat. Corall., III, 1860, p. 174; Duchassaing and Michelotti, Mem. Roy. Accad. Sci., Tor., ser. 2, XIX, 1861, p. 358; Verrill, Bull. Mus. Comp. Zool., I, 1864, p. 42; Duchassaing and Michelotti, Suppl. Mém. Cor. Ant. Mem. Roy. Accad. Sci. Tor., ser. 2, XXIII, 1866, p. 189; Duchassaing, Rev. Zooph. Ant., 1870, p. 32; Pourtalès, Ill. Cat. Mus. Comp. Zool. No. 4, 1871, p. 84; Lindstrom, Handl. k. Svensk. Vet.-Okad., XIV, 1877, No. 6, p. 24; Pourtalès, Mem. Mus. Comp. Zool., VII, 1880, Pt. 1, Pl. XII, figs. 4-6; Quelch, Zool. Challenger Exped., Pt. 46, 1886, p. 179; Rathbun, Proc. U. S. Nat. Mus., X, 1887, p. 356, Pl. XVI; Pl. XVII, fig. 2; Pl. XVIII; Pl. XIX, fig. 1; Rehberg, Nat. Ver. Hamburg, XII, 1892, Pt. 1, p. 47; Vaughan, *P.* forma *clavaria*, U. S. Fish Comm. Bull. for 1900, II, 1901, p. 316, Pl. XXIX; Pl. XXXI, fig. 2; Vaughan, Carnegie Inst. Washington Yearbook No. 10, 1912, pp. 148, 152, 156, Pl. IV, fig. 4c; Pl. VI, figs. 3, 4; Vaughan, Washington Acad. Sci. Jour., V, 1915, p. 597; Vaughan, Nat. Acad. Sci. Proc., II, 1916, pp. 95, 98; Vaughan, Carnegie Inst. Washington Yearbook No. 14, 1916, p. 228; Gregory, Quart. Jour. Geol. Soc. London, LI, 1895, p. 182.

Porites flexuosa Dana, Zooph. Explor. Exped. Wilkes, 1848, p. 554, Pl. LIII, fig. 6; Milne Edwards and Haime, Ann. Sci. Nat. Zool., ser. 3, XVI, 1851, p. 31; Milne Edwards and Haime, Hist. Nat. Corall., III, 1860, p. 176; Duchassaing and Michelotti, Mem. Roy. Accad. Sci. Tor., ser. 2, XIX, 1860, p. 358, Suppl. Mém. Corall., Ant. Mém. Roy. Accad. Sci.

Tor., ser. 2, XXIII, 1866, p. 191; Duchassaing, Rev. Zooph. Ant., 1870, p. 32.

Porites flabelliformis Lesueur, Mem. Mus. Hist. Nat., VI, 1820, p. 289; Deslongchamps, Encycl. Meth. Zooph., 1824, p. 652; Milne Edwards and Haime, Ann. Sci. Nat. Zool., ser. 3, XVI, 1851, p. 31; Milne Edwards and Haime, Hist. Nat. Corall., III, 1860, p. 178; Duchassaing and Michelotti, Suppl. Mém. Roy. Accad. Sci. Tor., ser. 2, XXIII, 1866, p. 190; Duchassaing, Rev. Zooph. Ant., 1870, p. 32.

Porites solanderi Duchassaing and Michelotti, Mem. Roy. Accad. Sci. Tor., ser. 2, XIX, 1861, p. 358, Suppl. Mém. Roy. Accad. Sci. Tor., ser. 2, XXIII, 1866, p. 189; Duchassaing, Rev. Zooph. Ant., 1870, p. 32; Quelch, Zool. Challenger Exped., Pt. XLVI, 1886, p. 13.

Porites plumieri Duchassaing and Michelotti, Suppl. Mém. Roy. Accad. Sci. Tor., ser. 2, XXIII, 1866, p. 190, Pl. X, fig. 14; Duchassaing, Rev. Zooph. Ant., 1870, p. 32; Quelch, Zool. Challenger Exped., Pt. XLVI, 1886, p. 13.

Porites macrocephala Duchassaing and Michelotti, Suppl. Mém. Roy. Accad. Sci. Tor., ser. 2, XXIII, 1866, p. 189, Pl. X, fig. 15; Duchassaing, Rev. Zooph. Ant., 1870, p. 32.

Porites recta Lesueur, Mem. Mus. Hist. Nat., VI, 1820, p. 288, Pl. XVII, fig. 16; Deslongchamps, Encycl. Meth. Zooph., 1824, p. 651; Dana, Zooph. Explor. Exped. Wilkes, 1848, p. 556.

Porites valida Duchassaing and Michelotti, Suppl. Mém. Roy. Accad. Sci. Tor., ser. 2, XXIII, 1866, p. 94 (of reprint).

Porites nodifera Klunzinger, Die Korallenthiere des Rothen Meeres, Pt. 2, p. 41.

Porites porites Vaughan, Biol. Soc. Washington Proc., XV, 1902, p. 56; var. Vaughan, Carnegie Inst. Washington Yearbook No. 7, 1909, p. 135.

Description.—The corallum forms ramose tufts with basal epitheca; the calices are shallow pits or even flush with the surface, varying from 1.5 to 2.0 mm. in diameter; the twelve septa are trabeculate, and often show a bilateral symmetry; they are grouped as follow, a single directive, four lateral pairs and a ventral triplet; a palus is present before each septal group, forming a ring of six (sometimes five) about the columellar tangle; the upper end of the columella may end in a single tubercle or appear papillose; the wall is porous and varies considerably from a thin division among the younger polyps on the end of the branches to as much as 0.5 mm. on the older portion of the corallum; synapticulae and dissepiments are present.

Locality.—This species occurs in the Bermudas, Bahamas, Florida, Vera Cruz and other Caribbean regions, also in the Indian Ocean reefs. The specimen in the Hubbard Collection of Columbia University is from Porto Rico, locality 935.

Occurrence and *Range.*—Miocene to Recent. The specimen that forms the basis of this description is Recent.

* **Porites toulai** Vaughan, 1919

Porites toulai Vaughan, U. S. Nat. Mus. Bull. 103, 1919, p. 501, Pl. CL, figs. 1-4.

Description.—Corallum composed of slender, subcylindrical or slightly compressed branches; calices shallow, 1.5 to 2.5 mm. in diameter, either surrounded by an individual wall or a wall enclosing several calices in longitudinal series with indistinct divisions separating each calyx; the septal arrangement is irregularly poritid; synapticular tissue forms a palar ring and also a circle near the wall; an irregularly developed ring of five or six pali surrounds and is connected to the columellar tangle by radial extensions; in some cases a central tubercle is present on top of the columella.

Type.—No. 32105a, U. S. National Museum.

Locality. — 410-24,-25,-27,-33,-38,-39,-44,-45,-46,-48,-49,-50,-51,-52,-56,-58,-62,-63,-64,-92,-123,-299,-325,-330,-331,-339,-362, -383, -442, -451,-452,-454, Reeds Collection, American Museum of Natural History, and 924, Hubbard Collection, Columbia University, New York City.

Occurrence.—San Sebastian Shale, Lares Limestone and Ponce Formation.

Other fossil corals from Porto Rico, not included in this paper but described by T. W. Vaughan in U. S. Nat. Mus. Bull. 103, are as follows:

Astreopora portoricensis Vaughan, p. 485. *Diploastrea crassolamellata magnifica* (Duncan), p. 470.

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Plate XXVI

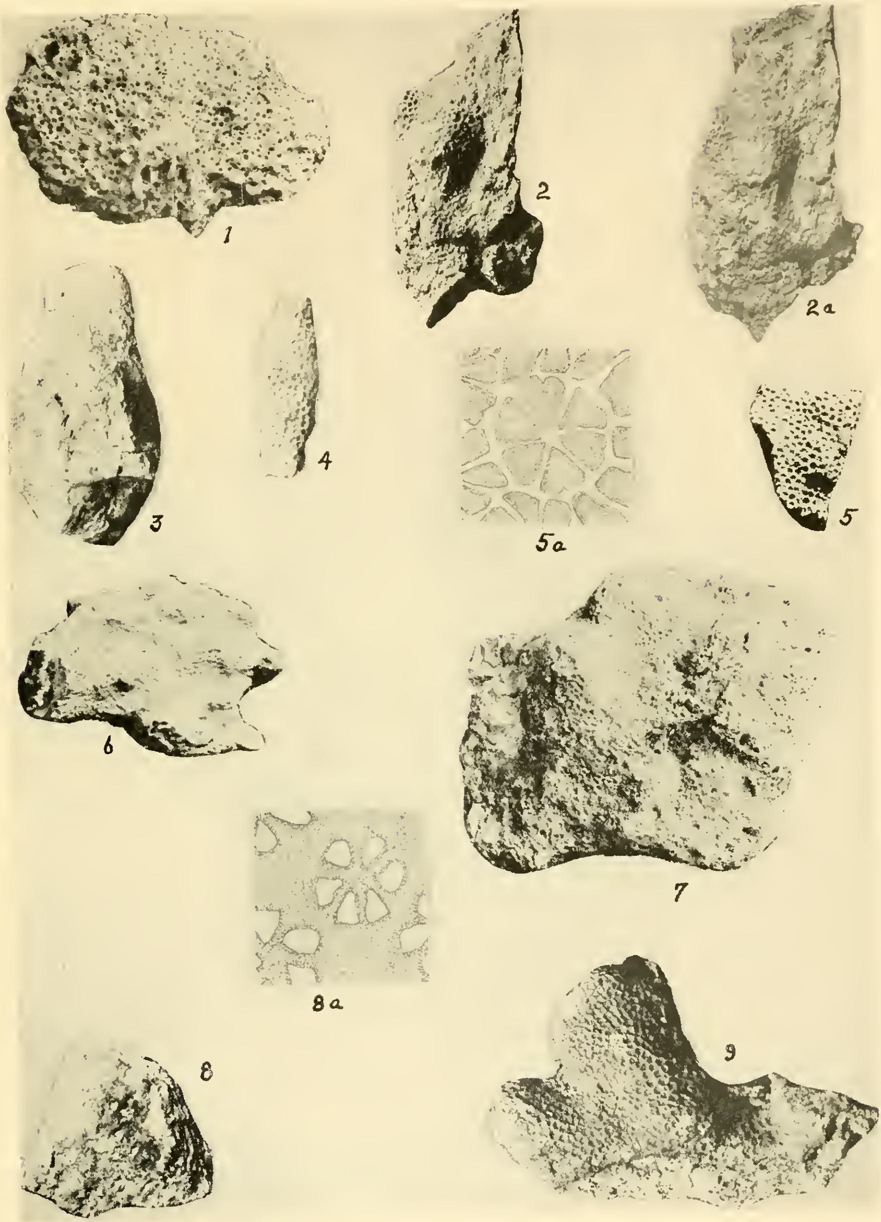
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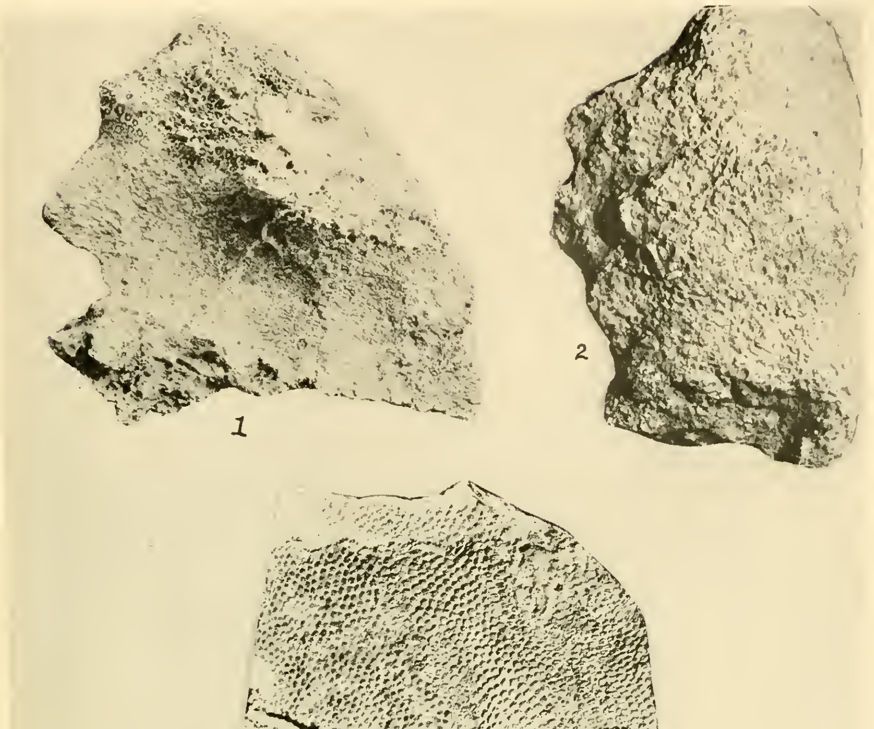
Plate XXVII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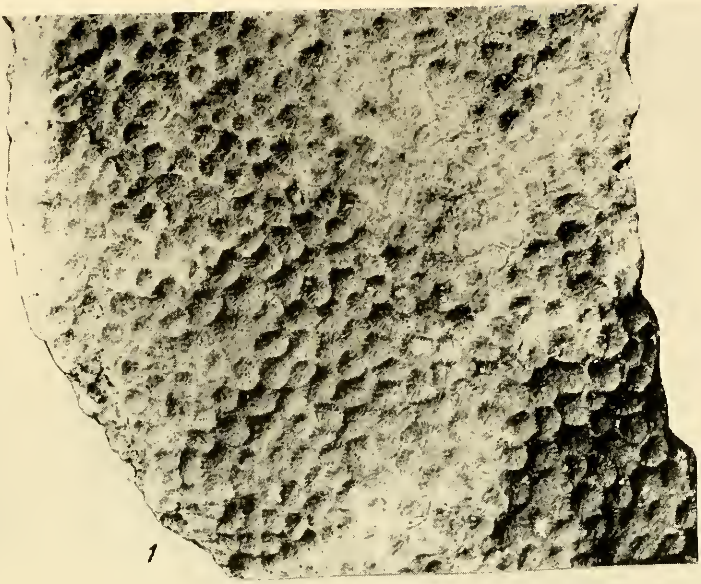

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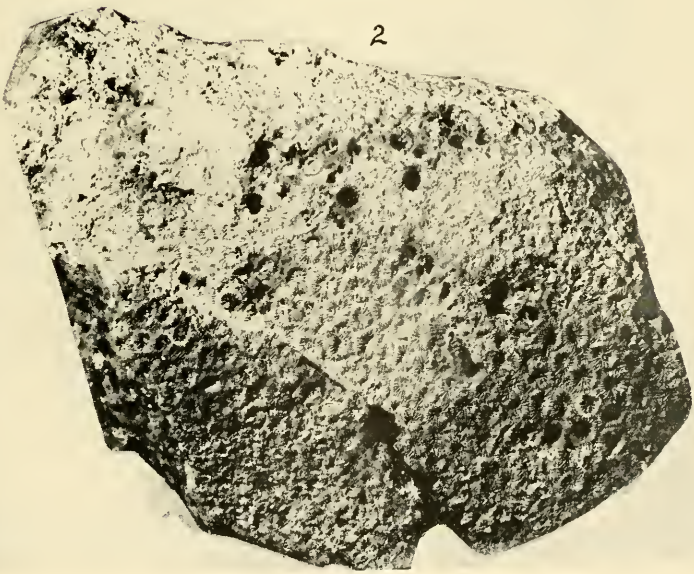

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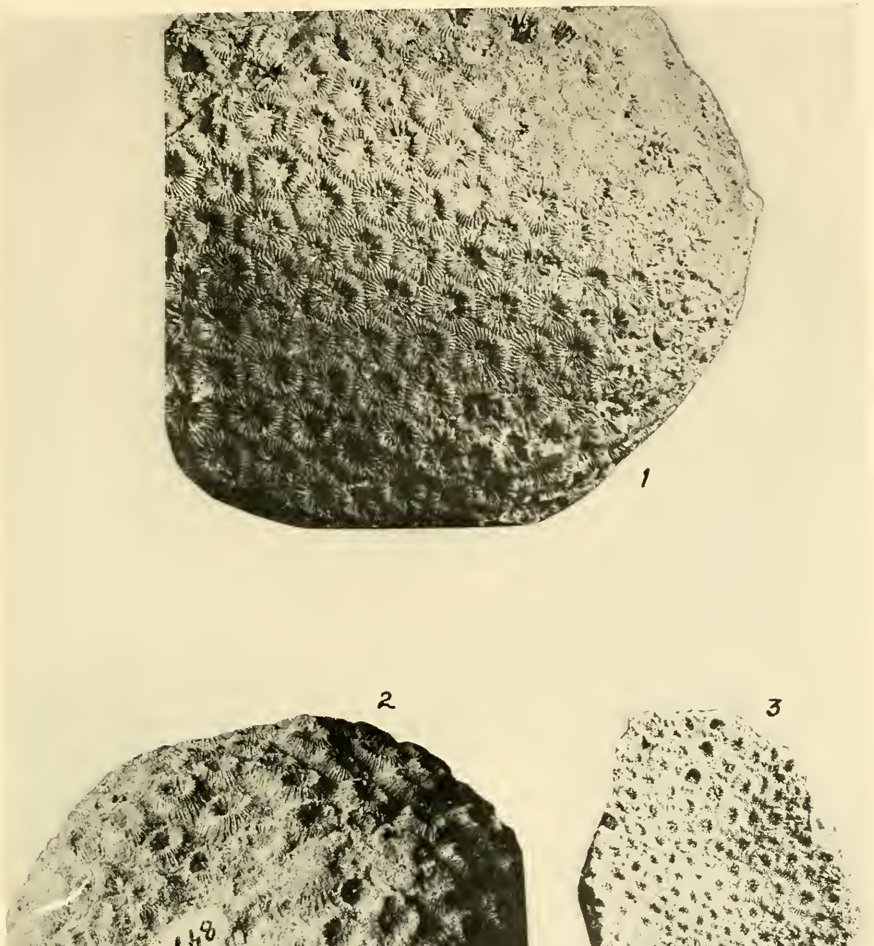
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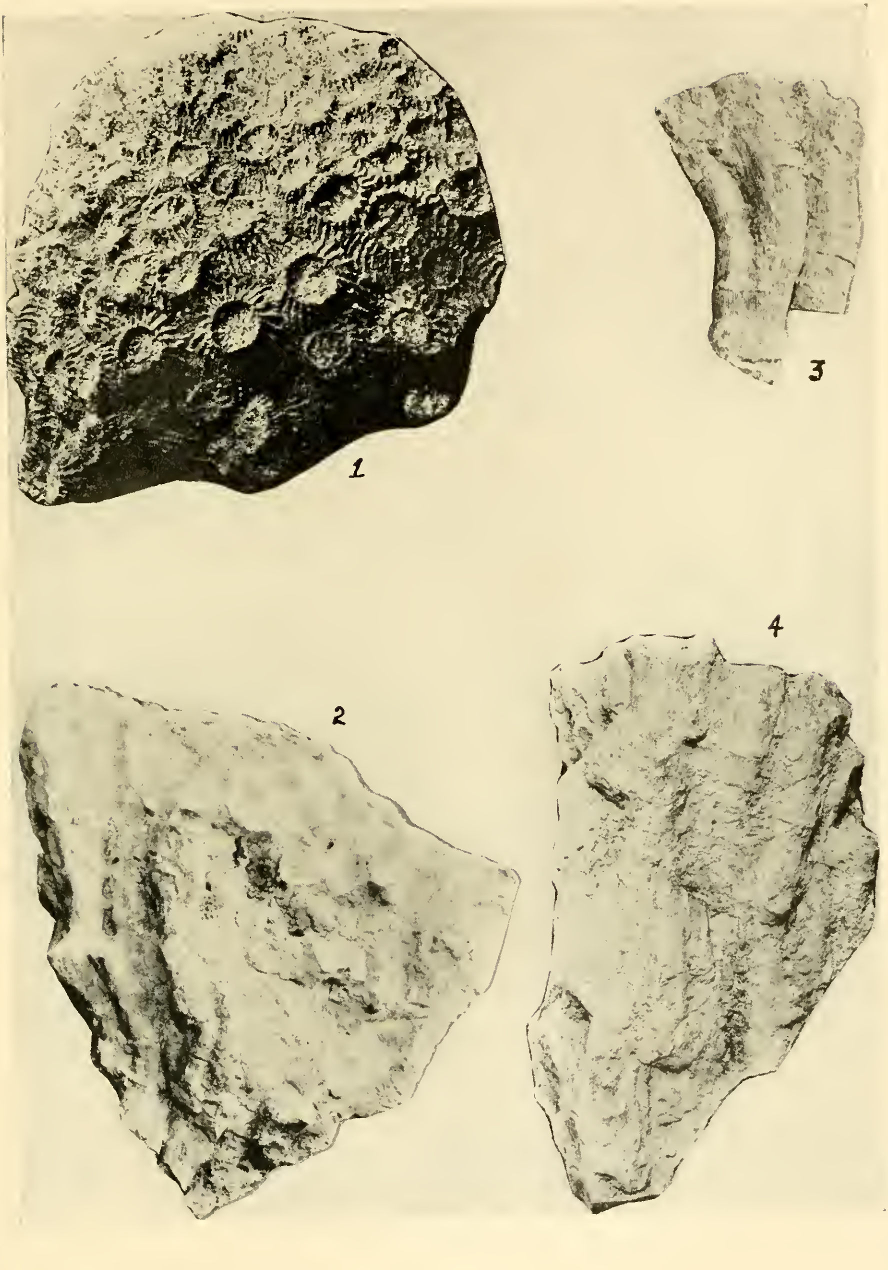
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PLATE XXXI

Fig. 1. Another specimen somewhat weathered, showing the coarse costa and the manner of branching, about x 4/5

Fig. 2. End view of the specimen in fig. 1, about x 4/5

Fig. 3. Lateral view of the type specimen, about 5/6

Fig. 4. End view of the type specimen, showing rounded and compressed stems, about x 5/6


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Plate XXXII

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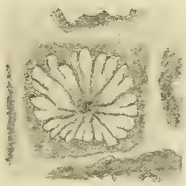

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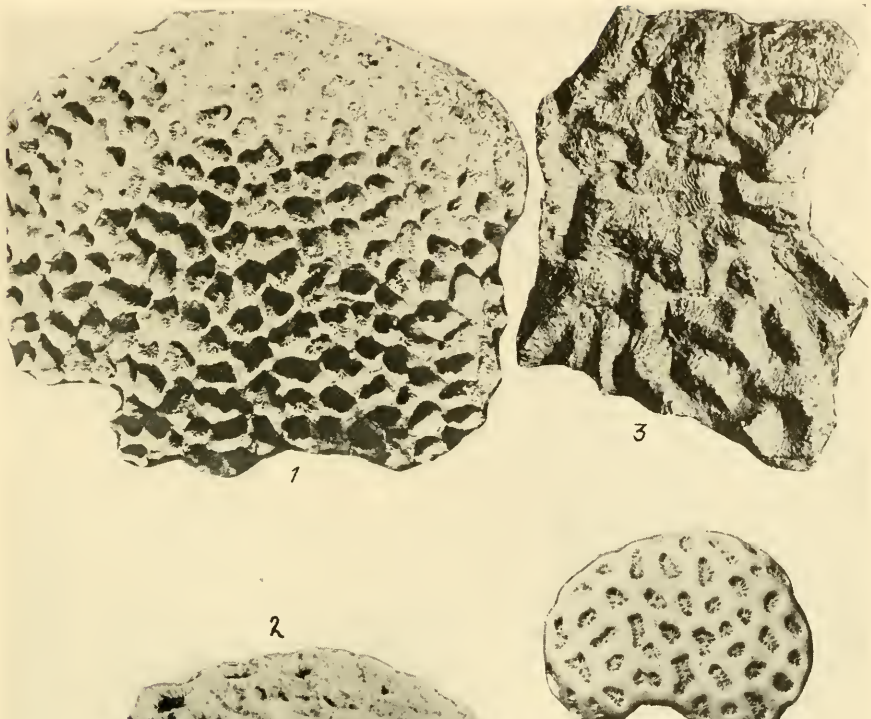
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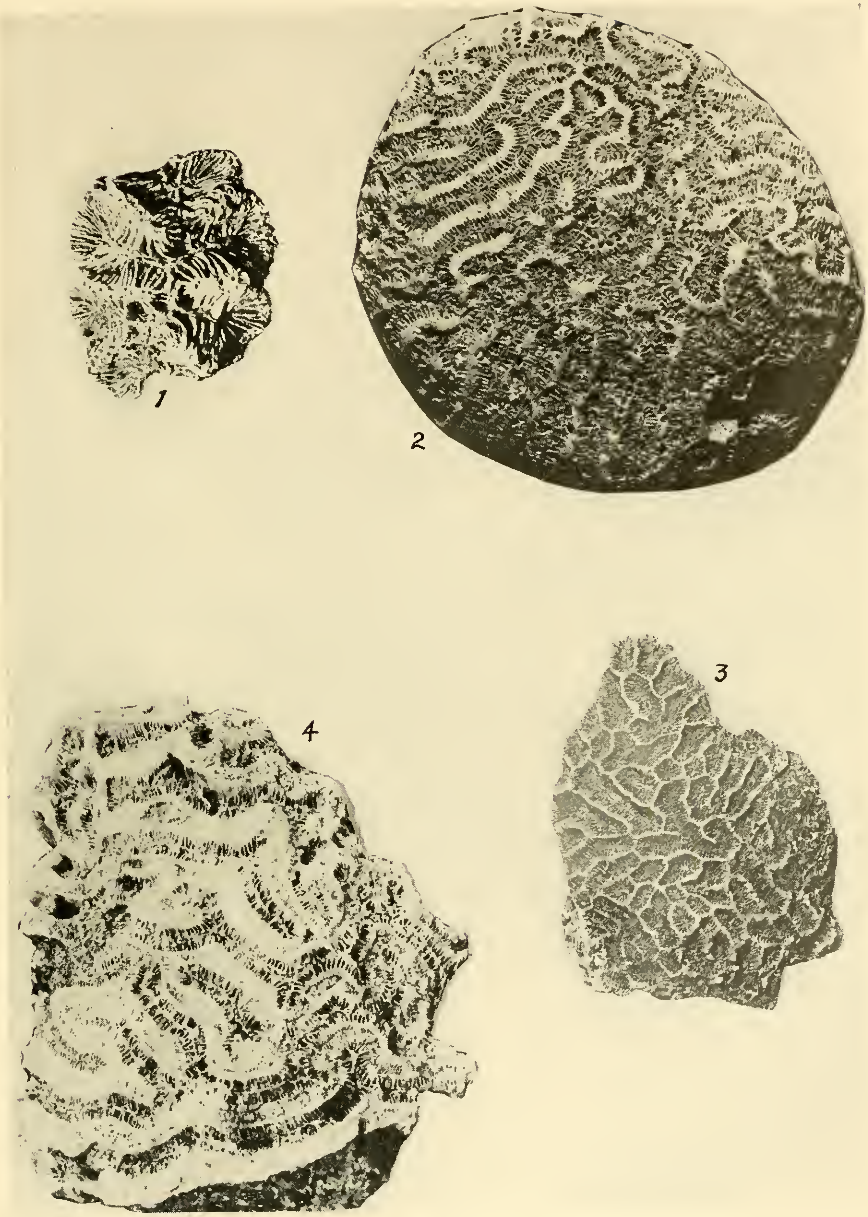
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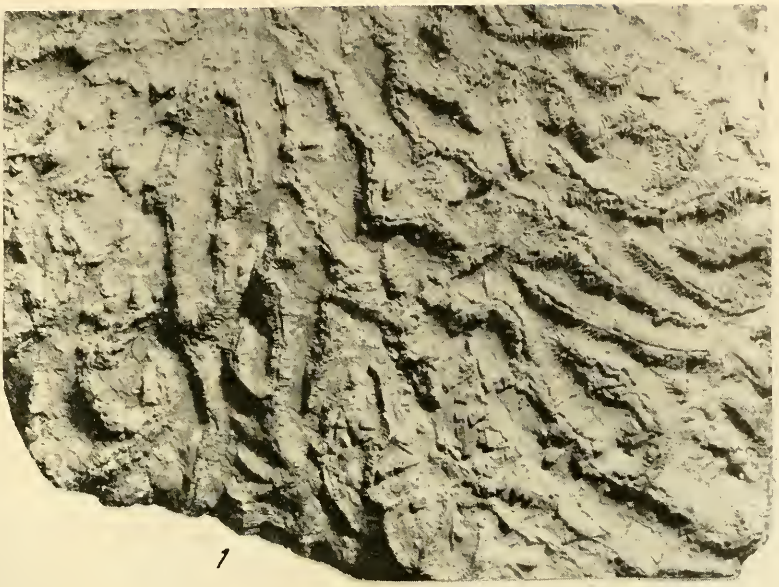

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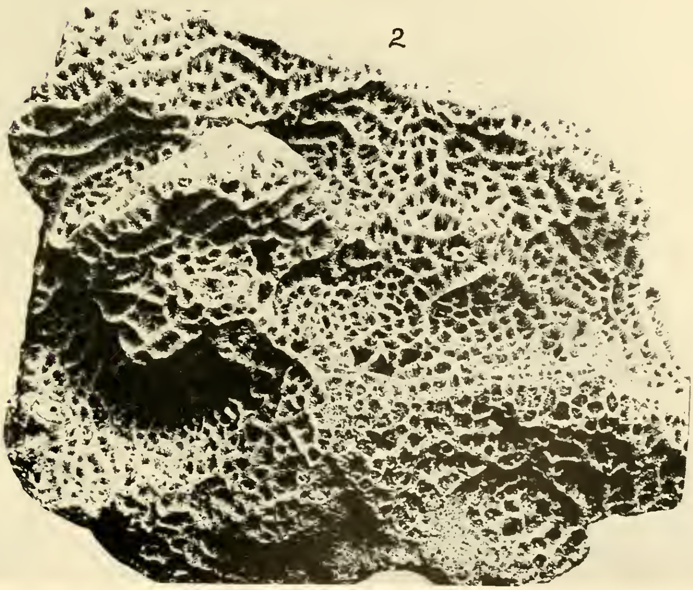

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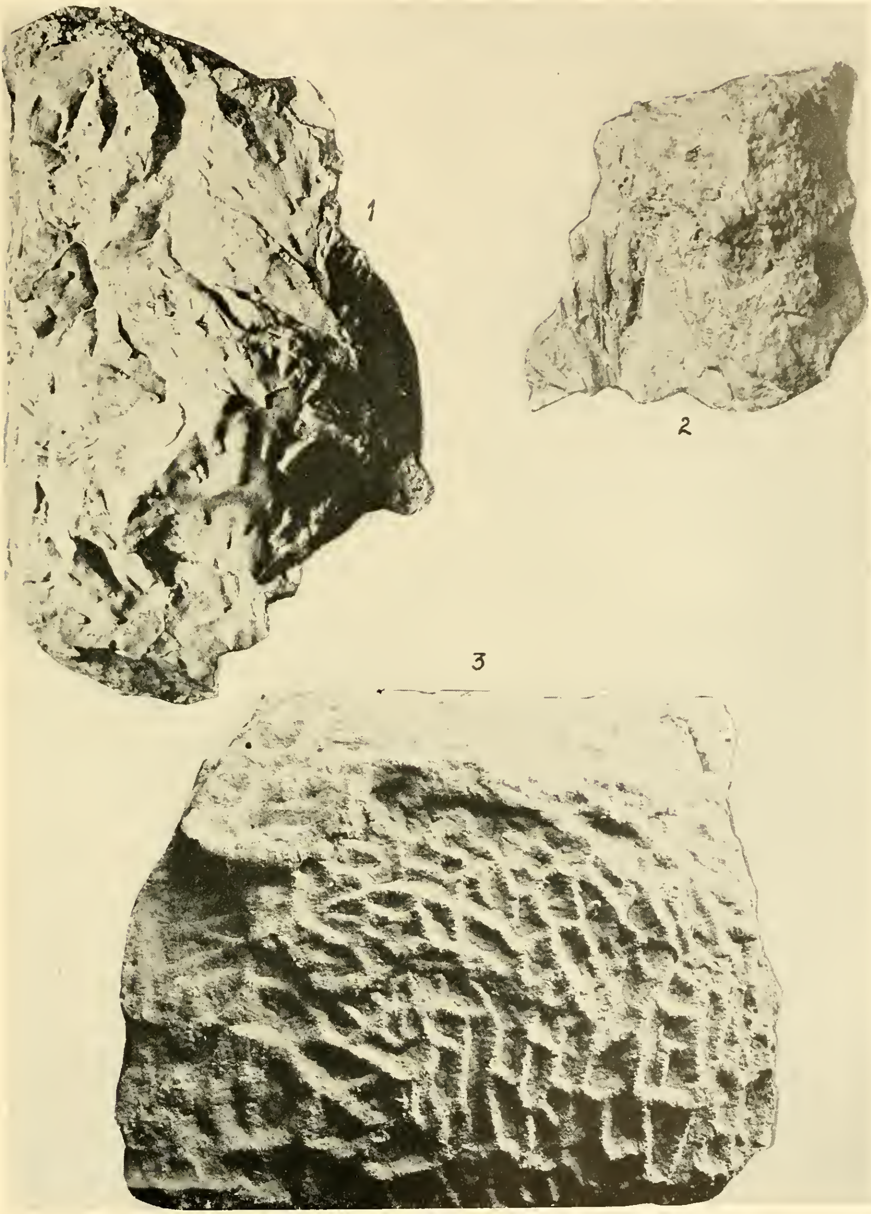
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Plate XXXVIII


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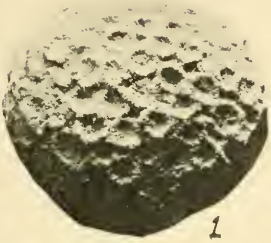

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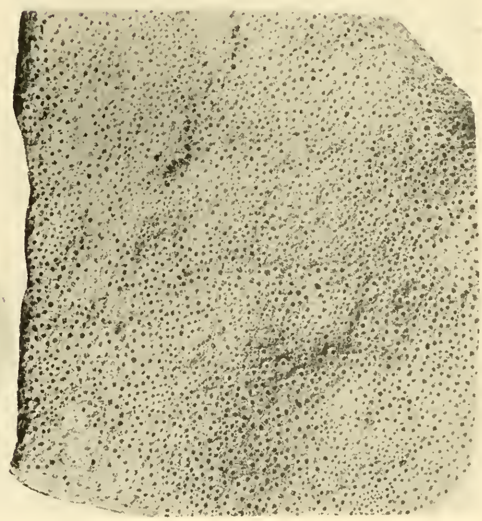

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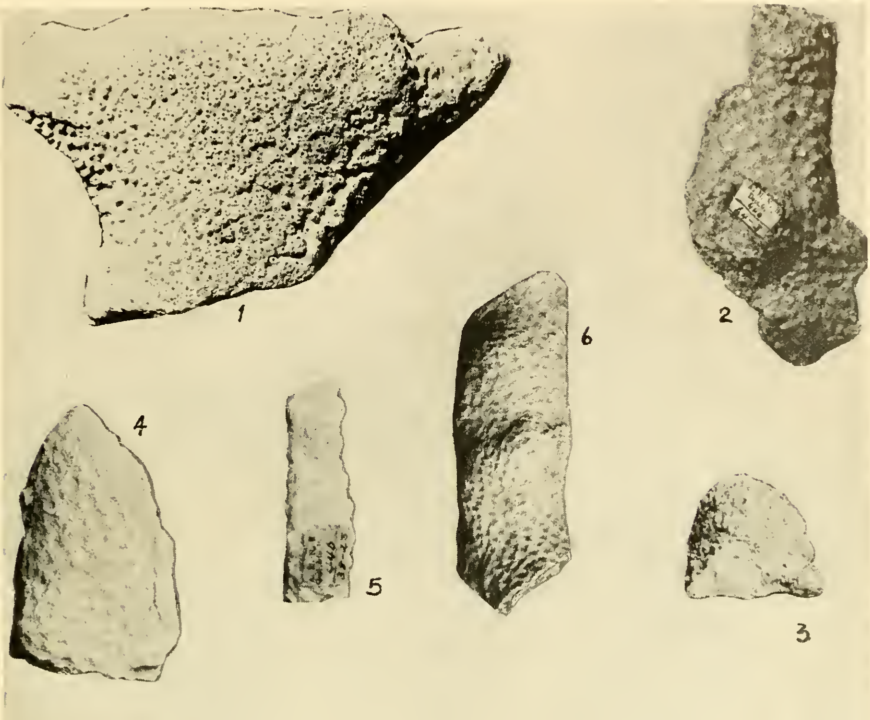
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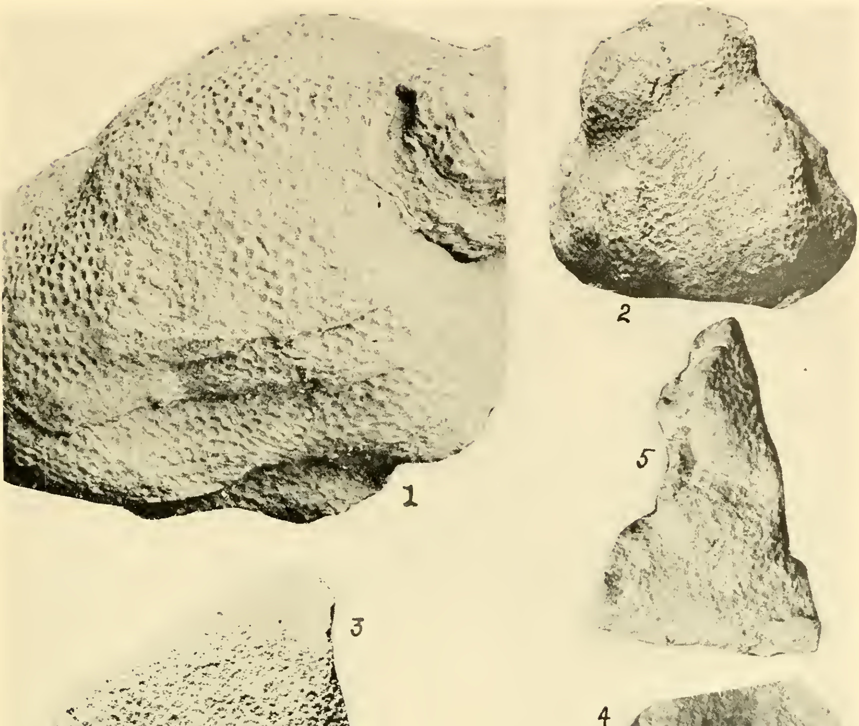
Plate XLI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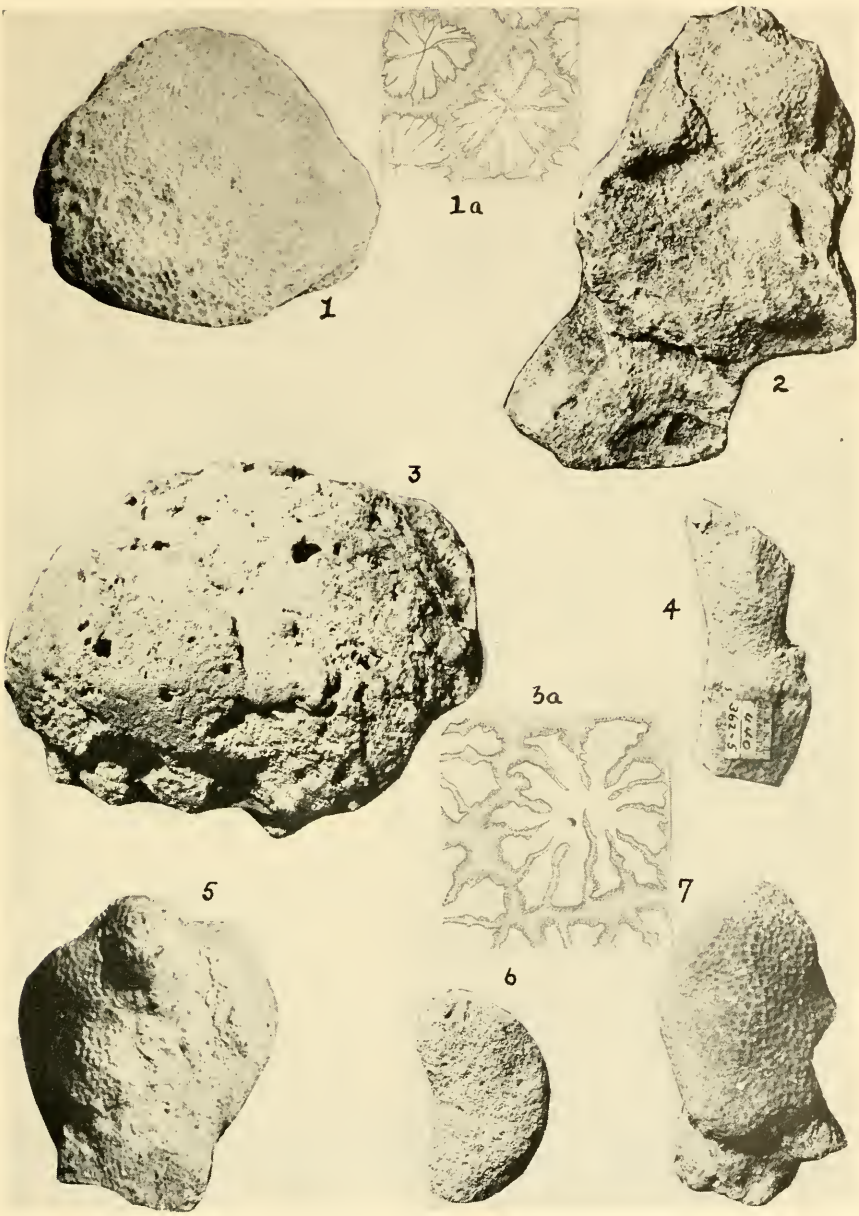
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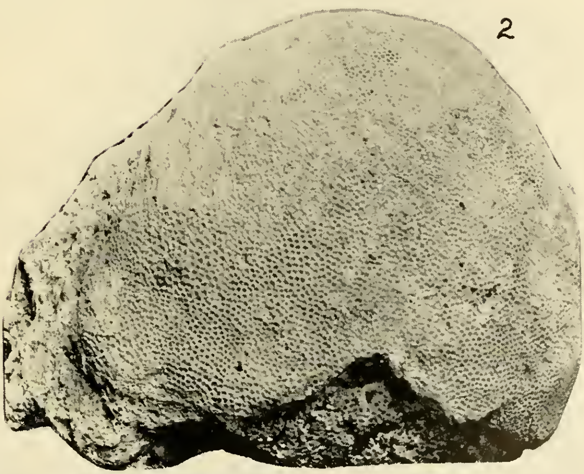

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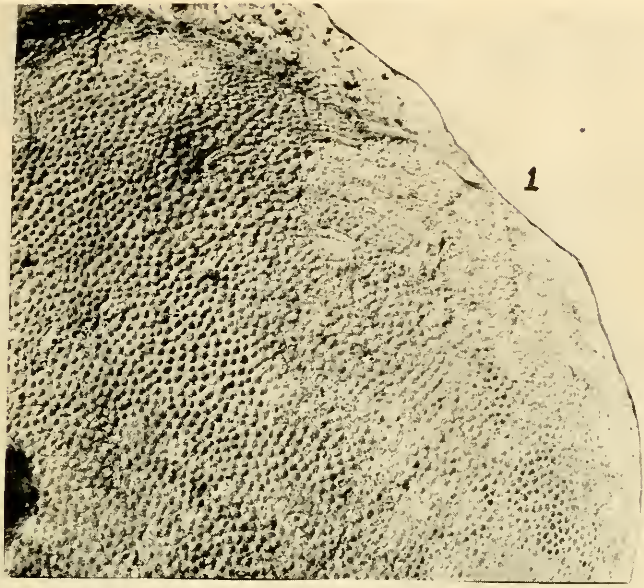

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THE NEW YORK ACADEMY OF SCIENCES

SCIENTIFIC SURVEY

OF

PORTO RICO and the VIRGIN ISLANDS

VOLUME III—Part 4

The Tertiary Foraminifera of Porto Rico

J. J. Galloway and Caroline E. Heminway

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SCIENTIFIC SURVEY OF PORTO RICO AND THE VIRGIN ISLANDS

This natural history survey of Porto Rico and the Virgin Islands, conducted by The New York Academy of Sciences, was established in 1913. Continuous publication of the results of this survey is made possible through contributions from the Department of Agriculture and Commerce of Porto Rico, and the University of Porto Rico.

THE TERTIARY FORAMINIFERA OF PORTO RICO

By J. J. Galloway* and Caroline E. Heminway†

CONTENTS

INTRODUCTION

On the island of Porto Rico, rocks of Tertiary age outcrop in two east-west belts on the north and south sides of the large area of Cretaceous igneous and metamorphic rocks which compose the greater part of interior Porto Rico. The northern area of Tertiary rocks is made up of five formations which strike nearly east-west and dip gently northward. The younger formations overlap to the east so that at the eastern end of the north shore of the island only the Quebradillas, the uppermost Tertiary formation, is present, while in the northwestern part of the island all five formations are found. In order of descending age, these formations are the Quebradillas, the Los Puertos, the Cibao, the Lares, and the San Sebastian, the basal part of which, sometimes called the Collazo shale, lies unconformably on the Cretaceous basement rocks.

The Southern area of Tertiary rocks includes two formations, an older one, the Juana Diaz, which probably corresponds in age to the San Sebastian of the north shore, and a younger formation, the Ponce, which probably is the equivalent of several of the north shore formations.

The exact position of these various formations within the Tertiary is still not well substantiated, although their local relationships are

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clear. For the present, we are accepting the age assignments made by Meyerhoff in his recent work on the geology of Porto Rico.[1]

	North Shore	Thickness
Lower Miocene	Quebradillas limestone	700–1500
	Los Puertos limestone	600–1000
Upper Oligocene	Cibao limestone	250–1000
	Lares limestone	1200–1300
Middle Oligocene	San Sebastian formation	700

The Ponce formation of the south shore is considered upper Oligocene and lower Miocene in age. Its thickness is about 2,000 feet, while the underlying Juana Diaz is reported as up to 3,000 feet in thickness.

CHARACTERISTICS OF THE FAUNA

The total foraminiferal assemblage from the Tertiary of Porto Rico represents 25 families, 99 genera with 275 species and varieties,—88 of which are new. With the exception of the very small fauna from the Lares formation, the north shore formations are all of about the same size. The Ponce formation of the south shore is thought to represent a greater stratigraphic interval than any single one of the north shore formations and this idea is supported by the greater size of the Ponce fauna,—both as to number of families and as to number of genera and species.

Table 1

Formation	No. of families	No. of genera	No. of species	No. of species restricted to the formation	
San Sebastian	15	34	75	23	31%
Lares	5	6	10	2	20%
Cibao	15	34	64	29	45%
Los Puertos	11	24	48	10	21%
Quebradillas	16	34	66	13	20%
Ponce	21	60	180	114	63%

An examination of the number of species in each formation which is restricted to that formation illustrates again the greater time interval represented by the Ponce formation, and demonstrates the closer relationship between the various north shore formations than between any one of these formations and the south shore formation.

The accompanying check list (TABLE 2) shows the occurrence of the various species in the north shore and south shore formations.

[1] Meyerhoff, H. A. Monog. Univ. Porto Rico, ser. B. no. 1. 1933.

TABLE 2

CHECK LIST OF THE NORTH SHORE AND SOUTH SHORE FORMATIONS

	North Shore					South Shore
	Middle Olig.	Upper Olig.		Lower Mio.		Upper Olig. and Lower Mio.
	San Sebastian	Lares	Cibao	Los Puertos	Quebradillas	Ponce
LAGYNIDAE						
Pseudarcella patella n. sp.		×				
ASTRORHIZIDAE						
Rhabdammina irregularis W. B. Carpenter						×
SPIRILLINIDAE						
Spirillina vivipara Ehrenberg			×			×
Patellina corrugata Williamson						×
MILIOLIDAE						
Spiroloculina antillarum d'Orbigny				×	×	×
Spiroloculina elongata d'Orbigny				×		
Spiroloculina oculina n. sp.				×		
Quinqueloculina akneriana d'Orbigny	×		×			
Quinqueloculina apiculata n. sp.	×					
Quniqueloculina audacula n. sp.				×		
Quinqueloculina laevigata d'Orbigny	×					
Quinqueloculina maculata n. sp.	×					
Quinqueloculina philippi Reuss				×		
Quinqueloculina ponceana n. sp.						×
Quinqueloculina pygmaea Reuss	×			×	×	
Quinqueloculina seminulum (Linné)	×		×			
Quinqueloculina vulgaris d'Orbigny	×			×	×	×
Triloculina austriaca d'Orbigny	×	×			×	×
Triloculina brongniartiana d'Orbigny						×
Triloculina cervicula n. sp.	×					
Triloculina elliptica n. sp.	×					
Triloculina gibba d'Orbigny	×			×	×	×
Triloculina inflata d'Orbigny	×			×	×	×
Triloculina laevigata d'Orbigny	×			×		×
Triloculina longissima n. sp.	×					
Triloculina oblonga (Montagu)	×	×		×	×	×
Triloculina quadrilateralis (d'Orbigny)	×			×		
Triloculina tricarinata d'Orbigny						×
Miliolinella circularis (Bornemann)				×		×
Pyrgo bougainvillei (d'Orbigny)	×					
Pyrgo clypeata (d'Orbigny)	×	×	×	×	×	×
Pyrgo inornata (d'Orbigny)	×			×	×	
Pyrgo lunula (d'Orbigny)	×			×	×	×
Pyrgo oblonga (d'Orbigny)	×	×	×	×	×	×
Pyrgo peruviana (d'Orbigny)	×		×	×		×
Pyrgo subspherica (d'Orbigny)	×	×		×	×	×
Prygoella globulus (Bornemann)						×
Massilina decorata Cushman				×		
Massilina inaequalis d'Orbigny				×		
Hauerina sansebastianensis n. sp.	×					
SORITIDAE						
Dendritina preëlegans n. sp.				×		
Peneroplis carinatus d'Orbigny	×				×	×
Peneroplis proteus d'Orbigny	×			×	×	
Archaias aduncus (Fichtel & Moll)	×			×	×	×
Archaias angulatus (Fichtel & Moll)	×			×	×	×
Archaias compressus d'Orbigny	×					

TABLE 2 (*Continued*)

	North Shore					South Shore
	Middle Olig.	Upper Olig.		Lower Mio.		Upper Olig. and Lower Mio.
	San Sebastian	Lares	Cibao	Los Puertos	Quebradillas	Ponce
TROCHAMMINIDAE						
Trochamminoides approximatus n. sp.				×		
LITUOLIDAE						
Cyclammina acutidorsata (Hantken)						×
ATAXOPHRAGMIIDAE						
Valvulina oviedoiana d'Orbigny	×					×
Valvulammina cornucopia n. sp.	×					×
Verneuilina mexicana Nuttall						×
Dorothia caribaea Cushman						×
Dorothia cylindrica (Nuttall)						×
Dorothia praelonga (Karrer)						×
Gaudryina asiphonia Andrea						×
Gaudryina glabrata maxima n. var.			×			
Gaudryina karreriana Cushman					×	×
Gaudryina puertoricana n. sp.	×					
Gaudryina (Pseudogaudryina) atlantica (Bailey)						×
Liebusella byramensis (Cushman)						×
Listerella *cf.* communis (d'Orbigny)						×
Clavulina tricarinata d'Orbigny	×			×	×	×
Calvulinoides polygonalis n. sp.					×	
Clavulinoides triangularis (Nuttall)						×
TEXTULARIIDAE						
Textularia agglutinans d'Orbigny	×		×			
Textularia articulata d'Orbigny	×					
Textularia broussardi Howe & Wallace						×
Textularia candeana d'Orbigny	×					×
Textularia gramen d'Orbigny	×					
Textularia grenadana Hedberg						×
Textularia indenta n. sp.			×			
Textulariella barrettii (P. & J.)			×		×	×
Vulvulina pachyheilus Hadley			×		×	×
Vulvulina pennatula (Batsch)						×
NODOSARIIDAE						
Saracenaria arcuata (d'Orbigny)						×
Astacolus insolitus (Schwager)						×
Astacolus ovatus n. sp.			×			
Astacolus sublituus (Nuttall)			×			×
Hemicristellaria fragraria (Gümbel)					×	
Vaginulina faba n. sp.						×
Vaginulina mexicana (Nuttall)						×
Vaginulina siliquoidea n. sp.						×
Marginulina insulensis n. sp.						×
Marginulina subcrassa Schwager						×
Amphicoryne obliqua n. sp.						×
Glandulina comatula (Cushman)						×
Glandulina gallowayi (Cushman)			×			×
Glandulina mauricensis Howe & Roberts						×
Dentalina advena (Cushman)						×
Dentalina halkyardi Cushman						×
Dentalina halkyardi ponceana n. var.						×
Dentalina hillaeformis n. sp.						×
Dentalina multilineata Bornemann						×

TABLE 2 (*Continued*)

	North Shore					South Shore
	Middle Olig.	Upper Olig.		Lower Mio.		Upper Olig. and Lower Mio.
	San Sebastian	Lares	Cibao	Los Puertos	Quebradillas	Ponce
NODOSARIIDAE—*Continued*						
Dentalina semilaevis Hantken						×
Nodosaria halkyardi antillana P. & B.			×			
Nodosaria longiscata d'Orbigny						×
Nodosaria obliquata (Batsch)						×
Nodosaria pariana Hedberg						×
Nodosaria raphanistrum (Linné)						×
Nodosaria scalaris (Batsch)						×
Nodosaria simplex Silvestri						×
Lagena ampulla n. sp.	×					×
Lagena bullosa n. sp.						×
Lagena impressa n. sp.						×
Lagena nuttalli n. sp.						×
Lagena strumosa Reuss						×
Robulus calliferus (Stache)						×
Robulus chambersi Garrett			×		×	×
Robulus cibaoensis n. sp.			×			
Robulus convergens (Bornemann)			×			×
Robulus falcifer (Stache)					×	
Robulus iota (Cushman)						×
Robulus occidentalis torridus (Cushman)						×
Robulus planulus n. sp.			×			
Robulus plummerae Cole						×
Robulus protuberans (Cushman)						×
Robulus subpapillosus (Nuttall)						×
Lingulina ponceana n. sp.						×
Lingulina semicostata n. sp.						×
Fissurina laevis Seguenza						×
Fissurina marginata (Montagu)						×
POLYMORPHINIDAE						
Polymorphina terquemiana (Fornasini)				×		
Guttulina basalis n. sp.					×	
Apiopterina cylindroides (Roemer)						×
Raphanulina gibba globosa (von Münster)	×					
NONIONIDAE						
Nonion chapapotense Cole	×					
Nonion dilatatum n. sp.			×			
Nonion multiporatum n. sp.			×			
Nonion nicobarense Cushman			×		×	×
Nonion pompilioides (Fichtel & Moll)			×			×
Nonion subgrateloupi n. sp.	×			×		×
Pseudononion papillatum n. sp.			×			
Nonionella modesta n. sp.	×					
Pullenia bulloides (d'Orbigny)						×
Elphidium lanieri (d'Orbigny)						×
Elphidium lens n. sp.	×					
Elphidium lobatum n. sp.		×			×	
Elphidium nautiloideum n. sp.	×				×	
Elphidium owenianum (d'Orbigny)	×		×	×		×
Elphidium poeyanum (d'Orbigny)	×	×		×	×	
Elphidium puertoricense n. sp.	×			×	×	
Elphidium sagrai (d'Orbigny)	×		×	×	×	×
Elphidium sagrai crassum n. var.	×			×	×	×
Antillesina marielensis (Palmer)	×					×

TABLE 2 (*Continued*)

	North Shore					South Shore
	Middle Olig.	Upper Olig.		Lower Mio.		Upper Olig. and Lower Mio.
	San Sebastian	Lares	Cibao	Los Puertos	Quebradillas	Ponce
Rotaliidae						
Globorotalia menardii d'Orbigny					×	
Lamarckina echinata n. sp.						×
Valvulineria maclureaformis n. sp.			×			
Valvulineria nuttalli Palmer & Bermudez						×
Valvulineria palmarealensis Nuttall						×
Valvulineria paucilocula (Cushman)				×		×
Eponides advena Cushman			×			
Eponides ellisorae Garrett						×
Eponides exiguus Brady	×					
Eponides ornatissimus n. sp.	×		×	×		×
Eponides parantillarum n. sp.					×	×
Eponides pulvinus n. sp.			×		×	
Eponides repandus (Fichtel & Moll)					×	
Eponides ventricosus n. sp.			×		×	×
Eponides vortex n. sp.			×			
Gyroidina *cf.* soldanii d'Orbigny						×
Gyroidina stellifera n. sp.			×			
Rotalia byramensis Cushman						×
Rotalia choctawensis Cushman & McGlamery	×					
Rotalia mexicana Nuttall						×
Rotalia mexicana mecatepecensis Nuttall						×
Rotalia meyerhoffi n. sp.						×
Rotalia tholus n. sp.						×
Discorbis floridanus Cushman	×			×		
Discorbis havanensis Cushman & Bermudez				×	×	×
Discorbis multisectus n. sp.	×					
Discorbis oligospiratus n. sp.			×			
Discorbis pelliculatus n. sp.					×	
Discorbis subaraucanus Cushman	×			×		×
Epistomaria pontifera n. sp.						×
Anomalina alazanensis Nuttall						×
Anomalina nucleata (Seguenza)			×			×
Anomalina pompilioides n. sp.			×			
Cycloloculina cubensis Cushman & Bermudez	×			×		×
Cibicides americanus Cushman	×		×			
Cibicides choctawensis Cushman & McGlamery			×			
Cibicides floridanus Cushman			×		×	×
Cibicides io Cushman					×	
Cibicides lobatus (d'Orbigny)	×		×	×	×	×
Cibicides mexicanus Nuttall						×
Cibicides perlucidus Nuttall						×
Cibicides pseudoungerianus (Cushman)				×		
Cibicides scalenus n. sp.			×			
Cibicides sinistralis Coryell & Rivero			×			
Cibicides spirolimbatus n. sp.					×	
Planulina crassa n. sp.					×	
Planulina depressa (d'Orbigny)						×
Planulina marialana Hadley					×	×
Planulina mexicana Cushman					×	×
Planulina zigzag n. sp.			×			
Cibicidella variabilis (d'Orbigny)	×					
Siphonina advena Cushman	×	×	×	×	×	×
Siphonina tenuicarinata Cushman						×
Planorbulinella larvata (Parker & Jones)			×		×	

Table 2 (*Continued*)

	North Shore					South Shore
	Middle Olig.	Upper Olig.		Lower Mio.		Upper Olig. and Lower Mio.
	San Sebastian	Lares	Cibao	Los Puertos	Quebradillas	Ponce
Acervulinidae						
Rupertia verrucosa n. sp.						×
Carpenteria bulloides n. sp.					×	
Carpenteria proteiformis Goës					×	×
Gypsina discus (Goës)					×	×
Sphaerogypsina globulus (Reuss)	×		×		×	×
Sphaerogypsina pilaris (Brady)					×	×
Asterigerinidae						
Amphistegina angulata (Cushman)					×	×
Amphistegina floridana Cushman & Ponton	×		×		×	×
Chilostomellidae						
Chilostomella czizeki Reuss						×
Chilostomella globata n. sp.						×
Chilostomella ovoidea Reuss						×
Chilostomella urceolus n. sp.						×
Sphaeroidina bulloides d'Orbigny					×	×
Orbulinidae						
Globigerina bulloides d'Orbigny	×		×	×	×	×
Globigerina dutertrei d'Orbigny	×		×		×	×
Globigerina inflata d'Orbigny						×
Globigerina ouachitaensis Howe & Wallace			×		×	×
Globigerina pachyderma (Ehrenberg)						×
Globigerina pseudotriloba White	×		×			×
Globigerina trilocularis d'Orbigny	×		×		×	×
Orbulina universa d'Orbigny	×		×		×	
Pegidiidae						
Sphaeroidinella seminulina (Schwager)					×	
Heterohelicidae						
Pavonina advena Cushman		×				
Bolivina byramensis Cushman			×			
Bolivina elongata Hantken						×
Bolivina heineae n. sp.						×
Bolivina jacksonensis Cushman & Applin	×					
Bolivina matanzana convexa n. var.	×		×			
Bolivina mexicana aliformis Cushman						×
Bolivina tectiformis Cushman						×
Bolivina ventricosa n. sp.						×
Loxostomum hiwanneense Howe			×			
Loxostomum normale n. sp.			×			
Plectofrondicularia trinitatensis Cushman & Jarvis						×
Plectofrondicularia vaughani Cushman						×
Buliminidae						
Reussella glabrata (Cushman)	×			×	×	×
Bulimina socialis Bornemann						×
Cassidulinidae						
Cassidulina laevigata d'Orbigny			×	×		
Cassidulina subglobosa Brady						×
Cassidulina tricamerata n. sp.						×
Ehrenbergina caribbea n. sp.						×
Ehrenbergina serrata gibbera n. var.						×

TABLE 2 (*Continued*)

	North Shore					South Shore
	Middle Olig.	Upper Olig.		Lower Mio.		Upper Olig. and Lower Mio.
	San Sebastian	Lares	Cibao	Los Puertos	Quebradillas	Ponce
UVIGERINIDAE						
Uvigerina bulbacea n. sp.			×			
Uvigerina elongata Cole						×
Uvigerina fusiformis n. sp.						×
Uvigerina gallowayi Cushman			×			
Uvigerina gardnerae Cushman						×
Uvigerina mantaensis Cushman & Edwards						×
Uvigerina mexicana Nuttall						×
Uvigerina mexicana bulbosa n. var.						×
Uvigerina mexicana ranunculus n. var.						×
Uvigerina postica n. sp.			×			
Uvigerina vicksburgensis Cushman & Ellisor						×
Siphogenerina costostriata n. sp.						×
Siphogenerina cumingsi n. sp.						×
Siphogenerina hubbardi n. sp.						×
Siphogenerina mexicana Cushman						×
Siphogenerina multicostata Cushman & Jarvis						×
Angulogerina cibaoensis n. sp.			×			
Angulogerina cooperensis Cushman			×			
Angulogerina decorissima n. sp.					×	
Angulogerina ponceana n. sp.						×
Trifarina bradyi Cushman						×
PLEUROSTOMELLIDAE						
Pleurostomella bierigi Palmer & Bermudez						×
Pleurostomella elliptica n. sp.						×
Pleurostomella gerontica n. sp.						×
Nodosarella constricta granulifera n. var.						×
Nodosarella crassielegans Nuttall						×
Nodosarella paucistriata Galloway & Morrey			×			×
Nodosarella verneuili (d'Orbigny)			×			
Ellipsoglandulina exponens (Brady)						×
Ellipsoidina ellipsoides abbreviata Seguenza						×
CAMERINIDAE						
Operculinella sinuata n. sp.					×	
Heterostegina antillea Cushman	×					
ORBITOIDIDAE						
Lepidocyclina *cf.* parvula Cushman	×					×
Lepidocyclina (Nephrolepidina) *cf.* tournoueri L. & D.	×					×
Miogypsinoides complanata (Schlumberger)	×		×	×		×

The following table (TABLE 3) shows the relationship among the faunas of the Porto Rican formations. The numbers show how many species the two formations have in common, while the percentage given is the ratio of this number to the number of species in the smaller of the two formations involved.

TABLE 3

	San Seb.	Lares	Cibao	Los P.	Queb.	Ponce
San Sebastian...	– – –	7 70%	21 33%	32 67%	30 45%	39 52%
Lares..........	7 70%	– – –	3 30%	6 60%	8 80%	6 60%
Cibao..........	21 33%	3 30%	– – –	11 23%	20 31%	28 44%
Los Puertos....	32 67%	6 60%	11 23%	– – –	24 50%	29 60%
Quebradillas....	30 45%	8 80%	20 31%	24 50%	– – –	41 62%
Ponce..........	39 52%	6 60%	28 44%	29 60%	41 62%	– – –

Because of the small size of the Lares fauna, the figures for that formation are of no significance. The percentages for the Ponce formation are likewise of rather little significance, except as they show that the Ponce formation covers a wider stratigraphic range than any one of the north shore formations, and that it contains elements which may be correlated with the stratigraphic horizon of each of those formations.

The percentages for the north shore formations show that they have rather closely related faunas, the smallest percentage of correlation being 23% between the Cibao and Los Puertos formations.

In sharp contrast with the figures given above, are figures for the comparison of the Porto Rican formations with Oligocene and Miocene faunas from other areas in the gulf coast and West Indian region. In no case, except for the Ponce formation, was a percentage of more than 14% discovered, although analyses were made with several faunas, among them the Alazan of the Tampico region in Mexico[2]; the lower Oligocene of Cuba[3]; the Oligocene of Ecuador[4]; the Miocene of eastern United States[5]; the middle Miocene of Buff Bay, Jamaica[6]; the middle Miocene of Haiti[7]; the middle Tertiary Carapita formation of Venezuela[8]; the Tertiary of Trinidad[9]; and others. The Porto Rican faunas seem, therefore, to be in part provincial, in part pelagic, but in most part cosmopolitan and long ranging. With a few exceptions, which will be mentioned under the discussion of the various formations, they cannot be closely correlated with any faunas as yet published.

Available data on depth distribution[10] of the various families which predominate in the Porto Rican formations lead us to postulate its accumulation at relatively shallow depths. The presence of the

[2] **Nuttall, W. L. F.** Jour. Paleont. **6**: 3–35. 1932.
[3] **Palmer, D. K. & Bermudez, P. J.** Mem. Soc. Cubana Hist. Nat. **10**: 227–316. 1936.
[4] **Galloway, J. J. & Morrey, M.** Bull. Am. Paleont. **15**: 1–57. 1929.
[5] **Cushman, J. A. & Cahill, E. D.** U. S. Geol. Surv. Prof. Pap. **175A**: 1–51. 1933.
[6] **Cushman, J. A. & Jarvis, P. W.** Jour. Paleont. **4**: 353–368. 1930.
[7] **Coryell, H. N. & Rivero, F. C.** Jour. Paleont. **14**: 324–344. 1940.
[8] **Hedberg, H. D.** Jour. Paleont. **11**: 661–697. 1937.
[9] **Nuttall, W. L. F.** Quart. Jour. Geol. Soc. **84**: 57–112. 1928.
[10] **Norton, R. D.** Bull. Scripps Inst. Oceanog. Tech. ser. **2**: 331–388. 1930.

families, Camerinidae, Soritidae, and abundant representatives of the Miliolidae; the common occurrence of such genera, as *Elphidium, Gypsina, Sphaerogypsina,* and *Clavulina tricarinata;* and the absence of uvigerines or many Nodosariidae in the formations of the north shore, seem to point conclusively to their accumulation in water of less than 60 fathoms. The presence of numerous Uvigerinidae and Nodosariidae at certain localities of the Ponce formation indicates that the south shore formation was deposited, in part, at greater depths.

Certain characteristics of each fauna should be mentioned. In the San Sebastian formation, 69% of the species belong to only four families: 39% to the Miliolidae and Soritidae combined; 15% to the Nonionidae; and another 15% to the Rotaliidae. Many of these species are common or even abundant, so that more than 69% of the fossils found would fall in these four families. These percentages, and the presence of Camerinidae and Orbitoididae, seem to agree with conditions at Norton's Zone A, with depth of 0 to 5 fathoms.

In the Lares formation, 5 of the 10 species are milioloids, 2 are species of *Elphidium,* and 2 are rotaloids.

In the Cibao formation, the dominant family is the Rotaliidae which includes 30% of the total number of species. The Nodosariidae are next with 12% and the Nonionidae third with 11%. The absence of the Soritidae, and the presence of only five species of milioloids, but several species of *Uvigerina,* suggest accumulation at depths comparable to Norton's Zone B which extends from 5 to 60 fathoms. Norton finds none of the uvigerine species at depths of less than 60 fathoms, so it seems probable that depth conditions were near the upper limit of 60 fathoms. The presence of *Elphidium* and *Miogypsinoides* is, however, suggestive of more shallow conditions than that indicated by the rest of the fauna.

The Los Puertos fauna is dominantly porcelaneous, with 53% of the species belonging to the Miliolidae and Soritidae. The Rotaliidae with 9 species, or 19%, are second, and the Nonionidae with 6 species, or 13%, are third. This distribution is almost identical with that of Norton's zone A, with depth 0 to 5 fathoms.

The Quebradillas formation can be assigned to Norton's zone B, with depth 5 to 60 fathoms. The Miliolidae and Soritidae constitute 25% of the number of species, the Rotaliidae another 25%, and the Nonionidae 11%. Since several species of *Elphidium* are present, it is probable that the depth of deposition was about 16 fathoms, since Norton found that *Elphidium* is rare below that depth.

The Ponce fauna is unusually large and upon close inspection it is found to contain elements of both deep and shallow water faunas.

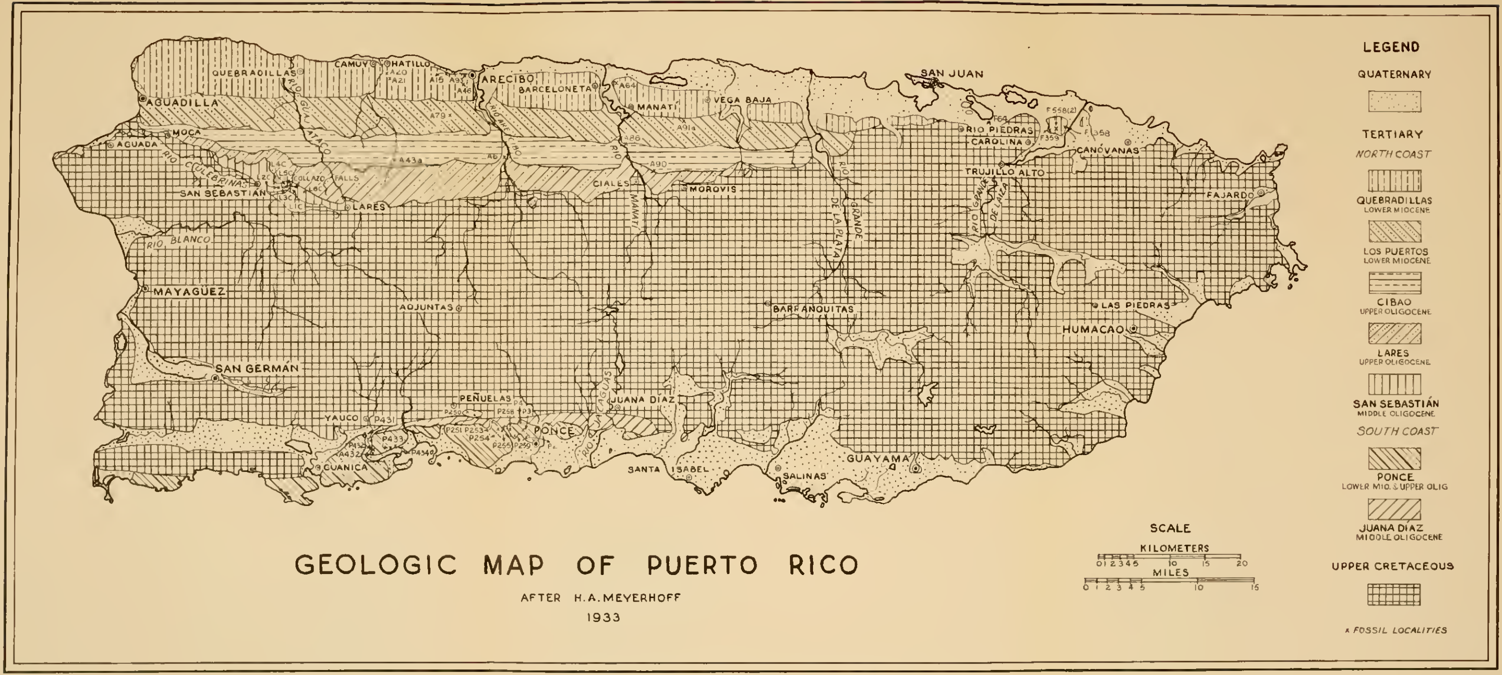

FIGURE 1 Geologic Map of Porto Rico showing localities at which foraminiferal material was collected

As a whole, the Ponce fauna contains 23% Nodosariidae, 16% Rotaliidae, 9% Miliolidae, and 8% Uvigerinidae. Smaller percentages, but of importance in the determination of ecologic conditions, are the Chilostomellidae with 4 species, the Globigerinidae with 7 species, the Cassidulinidae with 4 species, the Nonionidae with 9 species, and the Orbitoids with 3 species. A deep water environment such as Norton's zone D is suggested by the 23% of Nodosariidae, the 8% of Uvigerinidae, and the presence of Chilostomellidae, Globigerinidae, and Cassidulinidae. But a much shallower environment is indicated by the presence of orbitoids and by the presence of *Archaias* and *Peneroplis*, "which are almost never found below 60 fathoms."

AGE OF THE FORMATIONS

At the initiation of this study it was hoped that new light could be thrown on the exact age of the Porto Rican Tertiary formations and on their correlation with other West Indian and gulf coast localities. The fauna as a whole is a large one and that of the Ponce formation particularly so, but there is a surprisingly low percentage of correlation with other described faunas from the same general region. A formation by formation tabulation of the species and their stratigraphic ranges (TABLE 4) has been made and from these tabulations the age of all the Porto Rican formations is seen to lie in the Oligocene or Miocene, evidently not lower than lower Oligocene, nor higher than middle Miocene. This corroborates the age determinations which were made by Meyerhoff in 1933.

The presence of large numbers of *Elphidium* in all except the very youngest part of the Tertiary succession, namely the Quebradillas and the upper part of the Ponce, is unusual since *Elphidium* is rarely found in any abundance below the Miocene. Other constituents of these faunas, however, are definitely Oligocene,—namely the orbitoids and camerines. These are found in all except the Quebradillas and the upper part of the Ponce formation.

A middle Oligocene age for the San Sebastian is indicated by its more than 10% correlation with species of the Byram of southeastern United States, and by the presence of significant middle Oligocene index fossils, such as *Rotalia choctawensis, Heterostegina antillea, Miogypsinoides complanata,* and *Lepidocyclina* cf. *parvula.*

The Lares and Cibao formations have fewer reliable index fossils. The middle and upper Oligocene index fossil *Miogypsinoides complanata* is abundant in the Cibao formation, so it seems probable that these formations, which overlie the San Sebastian, are of upper Oligocene age, as postulated by Meyerhoff.

Meyerhoff (1933) assigns a lower Miocene age to both the Los Puertos and the Quebradillas formations. The fauna of the Los Puertos is so totally unlike any other known fauna that we can draw no definite conclusions as to its age, although the presence of *Miogypsinoides complanata* suggests an upper Oligocene rather than a lower Miocene horizon. The Quebradillas formation, however, seems to be late lower Miocene or possibly early middle Miocene in age. This is indicated by the absence of Oligocene markers, namely the larger foraminifera, and by the fairly high degree of correlation between the Quebradillas fauna and the fauna of several middle Miocene localities in the West Indian region,—namely 12% with the lower Miocene of Trinidad, 14% with the middle Miocene of Haiti, and 14% with the middle Miocene of Jamaica.

Evidence of the Oligocene age of some of the Ponce was afforded by the comparisons made with other faunas. The percentage of correlation with Oligocene faunas ranged from 15 to 20%; the percentage of correlation with middle Miocene faunas ranged only from 10 to 12%. The foraminiferal fauna of the Ponce therefore shows both Oligocene and Miocene elements, but the Oligocene trend seems more pronounced, at least for the lower part of the Ponce which is the part of the Ponce most abundantly represented in our collections.

Some of the Ponce is as old as lower Oligocene. The exact percentage of correlation with Oligocene faunas were as follows: 18% with the lower Oligocene of Cuba, 20% with the lower Oligocene of Mexico described by Nuttall, 16% with the lower Oligocene described by Dorr from the Alazan (1933. Jour. Paleont. 7) 15% with the Carapita of Venezuela, of probable upper Oligocene age. A number of specialized forms which occur only in beds of lower Oligocene age furnish additional proof. Among these are *Verneuilina mexicana, Dorothia cylindrica, Vaginulina mexicana, Antillesina marielensis, Valvulineria palmarealensis, Rotalia mexicana mecatepecensis, Uvigerina vicksburgensis, Siphogenerina mexicana*, and others.

It is probable that the middle and upper Ponce are much younger than lower Oligocene. The 10 and 12% correlations with middle Miocene faunas suggests that upper Ponce is about lower Miocene in age. An examination of the known stratigraphic ranges of the Ponce species shows two times of most abundant species,—namely the lower Oligocene in which 69 of the Ponce species occur, and the middle Miocene in which 51 of the Ponce species occur. Faunas of other ages include only 25 or fewer of the species which occur in the Ponce (TABLE 4).

TABLE 4

CHECK LIST SHOWING ABUNDANCE* AND STRATIGRAPHIC DISTRIBUTION OF THE PORTO RICAN FORAMINIFERAL FAUNAS

Localities						SAN SEBASTIAN FAUNA	Eocene			Oligocene			Miocene			Pliocene	Pleistocene	Recent
L1C	L2C	L3C	L4C	L5C	L6C		Lower	Middle	Upper	Lower	Middle	Upper	Lower	Middle	Upper			
	R				C	Quinqueloculina akneriana								×	×	×	×	×
					R	Quinqueloculina apiculata n. sp.												
C	C		R	R	C	Quinqueloculina laevigata		×	×									×
			R		C	Quinqueloculina maculata n. sp.												
					R	Quinqueloculina pygmaea								×	×	×	×	×
					R	Quinqueloculina seminulum		×	×	×	×	×	×	×	×	×	×	×
R			R		R	Quinqueloculina vulgaris				×	×	×	×	×	×	×	×	×
R	R		R		C	Triloculina austriaca								×				
					R	Triloculina cervicula n. sp.												
R						Triloculina elliptica n. sp.												
R	C	R	R		A	Triloculina gibba			×					×	×	×	×	×
	R					Triloculina inflata								×				
	R		R			Triloculina laevigata												×
			R		C	Triloculina longissima n. sp.												
	R				R	Triloculina oblonga		×	×	×	×	×	×	×	×	×	×	×
	R		R	R	R	Triloculina quadrilateralis							×					×
			R		R	Pyrgo bougainvillei												×
	C	R	R	R	R	Pyrgo clypeata								×				
			R			Pyrgo inornata				×	×			×				
	R	C	A		R	Pyrgo lunula								×	×	×	×	×
R	R		R		C	Pyrgo oblonga												×
			C		C	Pyrgo peruviana												×
R	C	R	R	R	C	Pyrgo subspherica								×	×	×	×	×
					C	Hauerina sansebastianensis n. sp.												
C	R	R	R		R	Peneroplis carinatus									×			×
R					R	Peneroplis proteus							×			×		×
					A	Archaias aduncus												×
R			R		R	Archaias angulatus										×		×
C					R	Archaias compressus								×	×	×	×	×
			R		C	Valvulina oviedoiana												×
			R		R	Valvulammina cornucopia n. sp.												
					R	Gaudryina puertoricana n. sp.												
R		R	R	R	R	Clavulina tricarinata				×			×	×	×			×
C	R	R			R	Textularia agglutinans				×	×	×	×	×	×	×	×	×
C				R		Textularia articulata								×	×			
	R	R				Textularia candeana					×	×	×	×	×	×	×	×
C	C					Textularia gramen					×	×	×	×	×	×		
R	R				R	Lagena ampulla n. sp.					×							
	R			C		Raphanulina gibba globosa			×		×	×	×	×	×	×	×	×
					R	Nonion chapapotense			×									
			R	C		Nonion subgrateloupi n. sp.												
C		R			R	Nonionella modesta n. sp.												
	R	C	C	A	A	Elphidium lens n. sp.												
C	R			R	R	Elphidium nautiloideum n. sp.												
R	C	A	C	C	C	Elphidium owenianum												×
C		R				Elphidium poeyanum				×	×		×	×	×	×	×	×
R	R		C	R	R	Elphidium puertoricense n. sp.												
C	R	R		R	C	Elphidium sagrai					×			×	×	×	×	×
R	R				R	Elphidium sagrai crassum n. var.												
R						Antillesina marielensis				×								
	R	R				Eponides exiguus												×
	C					Eponides ornatissimus n. sp.												
R						Rotalia choctawensis					×							
R				R		Discorbis floridanus								×	×	×	×	×
		R		C		Discorbis multisectus n. sp.												
	R	R		C		Discorbis subaraucanus			×	×	×				×	×	×	×
		R	C			Cycloloculina cubensis			×									
C	C					Cibicides americanus				×	×	×	×	×				
R			R	R		Cibicides lobatus			×	×	×		×	×		×	×	×
			C		R	Cibicidella variabilis										×	×	×

* R, rare; C, common; A, abundant.

TABLE 4 (*Continued*)

Localities: L1C	L2C	L3C	L4C	L5C	L6C	SAN SEBASTIAN FAUNA	Eocene: Lower	Eocene: Middle	Eocene: Upper	Oligocene: Lower	Oligocene: Middle	Oligocene: Upper	Miocene: Lower	Miocene: Middle	Miocene: Upper	Pliocene	Pleistocene	Recent
R				R		Siphonina advena			×	×	×							
R		R	R			Sphaerogypsina globulus			×			×	×	×				×
C	R	C	A	C		Amphistegina floridana				×			×					
R						Globigerina bulloides	×	×	×	×	×	×	×	×	×	×	×	×
R						Globigerina dutertrei				×								×
R						Globigerina pseudotriloba	×											
				R		Globigerina trilocularis				×				×				
R					R	Orbulina universa					×		×	×	×	×	×	×
R						Bolivina jacksonensis			×	×								
R						Bolivina matanzana convexa n. var.												
	C					Reussella glabrata				×	×			×				
		R		R		Heterostegina antillea					×							
			R			Lepidocyclina *cf.* parvula					×							
			R			Lepidocyclina (Nephrolepidina) *cf.* tournoueri					?	?						
C	R	R	A	A	C	Miogypsinoides complanata					×	×						

TABLE 4 (*Continued*)

Locality A6	LARES FAUNA	Eocene: Lower	Eocene: Middle	Eocene: Upper	Oligocene: Lower	Oligocene: Middle	Oligocene: Upper	Miocene: Lower	Miocene: Middle	Miocene: Upper	Pliocene	Pleistocene	Recent
C	Pseudarcella patella n. sp.												
C	Triloculina austriaca								×				
R	Triloculina oblonga		×	×	×	×	×	×	×	×	×	×	×
R	Pyrgo clypeata								×				
C	Pyrgo oblonga												×
A	Pyrgo subspherica								×	×	×	×	×
R	Elphidium lobatum n. sp												
R	Elphidium poeyanum				×	×		×	×	×	×	×	×
R	Siphonina advena			×	×	×							
R	Pavonina advena					×							

TABLE 4 (*Continued*)

Locality A43a	Locality A86	CIBAO FAUNA	Eocene Lower	Eocene Middle	Eocene Upper	Oligocene Lower	Oligocene Middle	Oligocene Upper	Miocene Lower	Miocene Middle	Miocene Upper	Pliocene	Pleistocene	Recent
	R	Spirillina vivipara			×	×								×
	R	Quinqueloculina akneriana								×	×	×	×	×
R		Quinqueloculina seminulum		×	×	×	×	×	×	×	×	×	×	×
	R	Pyrgo clypeata								×				
R		Pyrgo oblonga												×
	R	Pyrgo peruviana												×
C		Gaudryina glabrata maxima n. sp.												
C		Textularia agglutinans				×	×	×	×	×	×	×	×	×
R		Textularia indenta n. sp.												×
	R	Textulariella barrettii			×			×		×				×
	C	Vulvulina pachyheilus				×		×						
	R	Astacolus ovatus n. sp.												
	R	Astacolus sublituus				×		×						
	R	Glandulina gallowayi				×								
	R	Nodosaria halkyardi antillana				×								
	C	Robulus chambersi					×	×	×	×				
	R	Robulus cibaoensis n. sp.												
	R	Robulus convergens			×	×	×							×
	C	Robulus planulus n. sp.												
R		Nonion dilatatum n. sp.												
R		Nonion multiporatum n. sp.												
R	R	Nonion nicobarense		×	×	×				×		×		×
	R	Nonion pompilioides				×		×	×	×	×	×	×	×
A		Pseudononion papillatum n. sp.												
R	C	Elphidium owenianum												×
	R	Elphidium sagrai					×			×	×	×	×	×
	R	Valvulineria maclureaformis n. sp.												
R		Valvulineria paucilocula				×								
	R	Eponides advena				×	×							
R	R	Eponides ornatissimus n. sp.												
	C	Eponides pulvinus n. sp.												
	A	Eponides ventricosus n. sp.												
	C	Eponides vortex n. sp.												
	R	Gyroidina stellifera n. sp.												
	R	Discorbis oligospiratus n. sp.												×
	R	Anomalina pompilioides n. sp.			×				×					
	R	Cibicides americanus				×	×	×	×	×				
C		Cibicides choctawensis					×							
	A	Cibicides floridanus			×	×		×	×	×	×			×
R	R	Cibicides lobatus			×	×	×		×	×		×	×	×
R		Cibicides scalenus n. sp.												
	R	Cibicides sinistralis								×				
	C	Planulina zigzag n. sp.												
C	C	Siphonina advena			×	×	×							
	A	Planorbulinella larvata				×	×	×						×
	C	Sphaerogypsina globulus			×			×	×	×				×
	C	Amphistegina floridana				×			×					
C	R	Globigerina bulloides	×	×	×	×	×	×	×	×	×	×	×	×
R	C	Globigerina dutertrei				×								×
	C	Globigerina ouachitaensis		×	×									
C		Globigerina pseudotriloba	×											
	A	Globigerina triloculаris				×				×				
	C	Bolivina byramensis				×	×	×	×	×				
C		Bolivina matanzana convexa n. var.												
R		Loxostomum hiwanneense				×								
R		Loxostomum normale n. sp.												
R		Cassidulina laevigata										×	×	×
	C	Uvigerina bulbacea n. sp.												
	R	Uvigerina gallowayi				×								
	C	Uvigerina postica n. sp.												
	C	Angulogerina cibaoensis n. sp.												
	R	Angulogerina cooperensis			×									
	C	Nodosarella paucistriata			×	×			×	×				
	C	Nodosarella verneuili				×	×	×	×	×				
	C	Miogypsinoides complanata					×	×						

TABLE 4 (*Continued*)

Locality A79	Locality A91a	LOS PUERTOS FAUNA	Eocene			Oligocene			Miocene			Pliocene	Pleistocene	Recent
			Lower	Middle	Upper	Lower	Middle	Upper	Lower	Middle	Upper			
C		Spiroloculina antillarum				×								×
R		Spiroloculina elongata										×		
R		Spiroloculina oculina n. sp.												
R		Quinqueloculina audacula n. sp.												
R	R	Quinqueloculina philippi						×						
C		Quinqueloculina pygmaea								×	×	×	×	×
C		Quinqueloculina vulgaris				×	×	×	×	×	×	×	×	×
R		Triloculina gibba			×					×	×	×	×	×
R		Triloculina inflata								×				
R		Triloculina laevigata												×
	R	Triloculina oblonga		×	×	×	×	×	×	×	×	×	×	×
R		Triloculina quadrilateralis							×					×
R		Miliolinella circularis					×							×
R		Pyrgo clypeata								×				
C		Pyrgo inornata				×	×			×				
R	R	Pyrgo lunula								×	×	×	×	×
R		Pyrgo oblonga												×
	R	Pyrgo peruviana												×
C	R	Pyrgo subspherica								×	×	×	×	×
R		Massilina decorata			×	×								
R		Massilina inaequalis							×					×
C		Dendritina preëlegans n. sp.												
R		Peneroplis proteus							×			×		×
R		Archaias aduncus												×
C		Archaias angulatus										×		×
	R	Trochamminoides approximatus n. sp.												
C		Clavulina tricarinata				×			×	×	×			×
R		Polymorphina terquemiana										×	×	×
R		Raphanulina gibba globosa			×		×	×	×	×	×	×	×	×
A		Nonion subgrateloupi n. sp.												
A		Elphidium owenianum												×
C		Elphidium poeyanum				×	×		×	×	×	×	×	×
R		Elphidium puertoricense n. sp.												
C		Elphidium sagrai					×			×	×	×	×	×
C	R	Elphidium sagrai crassum n. var.												
R		Valvulineria paucilocula				×								
C		Eponides ornatissimus n. sp.												
R		Discorbis floridanus								×	×	×	×	×
A		Discorbis havanensis			×									
A		Discorbis subaraucanus			×	×	×				×	×	×	×
C		Cycloloculina cubensis			×									
A		Cibicides lobatus			×	×	×		×	×		×	×	×
R		Cibicides pseudoungerianus			×	×	×							×
R		Siphonina advena			×	×	×							
R		Globigerina bulloides	×	×	×	×	×	×	×	×	×	×	×	×
C		Reussella glabrata				×	×			×				
R		Cassidulina laevigata										×	×	×
A		Miogypsinoides complanata					×	×						

TABLE 4 (*Continued*)

QUEBRADILLAS FAUNA

Species	Recent	Pleistocene	Pliocene	Miocene Upper	Miocene Middle	Miocene Lower	Oligocene Upper	Oligocene Middle	Oligocene Lower	Eocene Upper	Eocene Middle	Eocene Lower	Localities A93	A15	A64	A20	A21	F358	F358(2)	F359	A46	F64
Spiroloculina antillarum	×								×													R
Quinqueloculina pygmaea	×	×	×	×	×																	R
Quinqueloculina vulgaris	×	×	×	×	×	×	×	×	×				R	R						R		
Triloculina austriaca					×																	R
Triloculina gibba	×	×	×	×	×					×							R					
Triloculina inflata					×													R		R		
Triloculina oblonga	×	×	×	×	×	×	×	×	×	×	×							R				
Pyrgo clypeata					×										R			R				
Pyrgo inornata					×			×	×											R		
Pyrgo lunula	×	×	×	×	×								R						R	C		
Pyrgo oblonga	×																			R		
Pyrgo subsphaerica	×	×	×	×	×										R		R			R		C
Peneroplis carinatus	×			×																		
Peneroplis proteus	×		×			×									R							
Archaias aduncus	×																			R		
Archaias angulatus	×		×																	R		
Verneuilina mexicana									×				R									
Gaudryina karreriana				×	×	×										R						
Clavulina tricarinata	×			×	×	×			×											R		R
Clavulinoides polygonalis n. sp.																						R
Textulariella barrettii	×				×		×			×			R				R					
Vulvulina pachyheilus							×		×				R									
Hemicristellaria fragraria											×					R	C					
Robulus chambersi					×	×	×	×								C	R					
Robulus falcifer										×							A					
Guttulina basalis n. sp.															R		R					
Raphanulina gibba globosa	×	×	×	×	×	×	×	×		×					R							
Nonion nicobarense	×		×		×				×	×	×						R					
Elphidium lobatum n. sp.																				R		
Elphidium nautiloideum n. sp.																						R
Elphidium poeyanum	×	×	×	×	×	×		×	×									C		R		C
Elphidium puertoricense n. sp.																				R		
Elphidium sagrai	×	×	×	×	×			×						R				C		A	R	R

TABLE 4 (*Continued*)

QUEBRADILLAS FAUNA—*Cont.*

	Recent	Pleistocene	Pliocene	Miocene Upper	Miocene Middle	Miocene Lower	Oligocene Upper	Oligocene Middle	Oligocene Lower	Eocene Upper	Eocene Middle	Eocene Lower	Localities A93	A15	A64	A20	A21	F358	F358(2)	F359	A46	F64
Elphidium sagrai crassum n. var.																		R		C		R
Globorotalia menardii	×			×	×	×	×	×	×				A				C					
Eponides parantillarum n. sp.					×								R			C	A					
Eponides pulvinus n. sp.														R								
Eponides repandus	×					×											R					
Eponides ventricosus n. sp.																	R					
Discorbis havanensis										×										C		C
Discorbis pelliculatus n. sp.																	C					
Anomalina nucleata					×	×	×	×	×	×			R									
Cibicides floridanus	×			×	×	×	×		×	×						C	C					
Cibicides io	×				×												R					
Cibicides lobatus	×		×		×	×		×	×	×							R					R
Cibicides spirolimbatus n. sp.													R									
Planulina crassa n. sp.													C	R		C	A					
Siphonina advena								×	×	×			R	R		C	A	R				
Planorbulinella larvata	×						×	×	×							R	A					
Carpenteria bulloides n. sp.																	C					
Carpenteria proteiformis	×					×	×										C				A46: R	
Gypsina discus	×																C			R		
Sphaerogypsina globulus	×				×	×	×			×								R				
Sphaerogypsina pilaris					×										C		C			C		
Amphistegina angulata					×	×	×											C		A		
Amphistegina floridana						×			×				C	C			C			R		
Sphaeroidina bulloides	×	×	×			×	×		×									R				
Globigerina bulloides	×	×	×	×	×	×	×	×	×	×	×	×				R	R					
Globigerina dutertrei	×								×								R					
Globigerina ouachitaensis										×	×						R					
Globigerina triloculairs					×				×				C	R		R	C					
Orbulina universa	×	×	×	×	×	×		×					C	R		R				R		
Sphaeroidinella seminulina	×	×	×														A					
Reussella glabrata					×			×	×								R					
Angulogerina decorissima n. sp.																	R					
Operculinella sinuata n. sp.																R	R					

TABLE 4 (*Continued*)

PONCE FAUNA	Recent	Pleistocene	Pliocene	Miocene Upper	Miocene Middle	Miocene Lower	Oligocene Upper	Oligocene Middle	Oligocene Lower	Eocene Upper	Eocene Middle	Eocene Lower	Localities P433	P434	A432	P432	P431	P259	P258	P255	P254	P253	P2	P3	P4	P251
Rhabdammina irregularis	×																						R	C		
Spirillina vivipara	×								×	×						R										
Patellina corrugata	×															R										
Spiroloculina antillarum	×								×										R							
Quinqueloculina ponceana n. sp.									×												R		R			
Quinqueloculina vulgaris	×	×	×	×	×	×	×	×	×								C	R	C							
Triloculina austriaca					×												R									
Triloculina brongniartiana	×																		C							
Triloculina gibba	×	×	×	×	×					×										R						
Triloculina inflata					×												R									
Triloculina laevigata	×																									R
Triloculina oblonga	×	×	×	×	×	×	×	×	×	×	×						R									
Triloculina tricarinata	×		×			×											R					R				
Miliolinella circularis	×							×									R						R			
Pyrgo lunula	×	×	×	×	×											R			C	C	R					
Pyrgo oblonga	×																C									R
Pyrgo peruviana	×																		R							
Pyrgo subspherica	×	×	×	×	×									R					A							R
Pyrgoella globulus								×												R						
Peneroplis carinatus	×			×															R							
Archaias aduncus	×													R				C	C							R
Archaias angulatus	×		×																C							
Cyclammina acutidorsata	×							×	×	×														R		
Valvulina oviedoiana	×																		R							
Valvulammina cornucopia n. sp.																			C							
Verneuilina mexicana									×														R	R		
Dorothia caribaea	×								×											R						
Dorothia cylindrica									×											R			R			
Dorothia praelonga					×																		R			
Gaudryina asiphonia							×	×	×														R	R		
Gaudryina karreriana				×	×	×														R			R			
Gaudryina (Pseudogaudryina) atlantica	×				×				×															R		
Liebusella byramensis								×	×											R				R		
Listerella cf. communis	×	×	×	×	×															R			R			
Clavulina tricarinata	×			×	×	×			×							R		R	A	R	R					
Clavulinoides triangularis					×	×			×											A	C		R	A		

TABLE 4 (*Continued*)

PONCE FAUNA—*Cont.*

	Recent	Pleistocene	Pliocene	Miocene Upper	Miocene Middle	Miocene Lower	Oligocene Upper	Oligocene Middle	Oligocene Lower	Eocene Upper	Eocene Middle	Eocene Lower	Localities P433	P434	A432	P432	P431	P259	P258	P255	P254	P253	P2	P3	P4	P251
Textularia broussardi										×													R			
Textularia candeana	×	×	×	×	×	×	×	×											R							
Textularia grenadana							×													R	R		R	R		
Textulariella barrettii	×				×		×			×						R										
Vulvulina pachyheilus							×		×											C	R		C	R		
Vulvulina pennatula	×	×	×			×	×			×										A	C		A	C		
Saracenaria arcuata	×				×																R		R	R		
Astacolus insolitus	×	×	×																	R	R		R	R		
Astacolus sublituus							×		×											R						
Vaginulina faba										×														R		
Vaginulina mexicana									×														R	R		
Vaginulina siliquoidea n. sp.								×	×		×												R			
Marginulina insulensis n. sp.																							R			
Marginulina subcrassa		×	×						×		×									R	R		R			
Amphicoryne obliqua n. sp.																							R			
Glandulina comatula	×					×	×		?											R			C	R		
Glandulina gallowayi									×												R					
Glandulina mauricensis											×										R					
Dentalina advena	×			×	×	×														R	R		R			
Dentalina halkyardi										×													R			
Dentalina halkyardi ponceana n. var.																				R			R	R		
Dentalina hillaeformis n. sp.	×																						R			
Dentalina multilineata								×	×	?											R					
Dentalina semilaevis									×															R		
Nodosaria longiscata					×	×	×	×	×	×	×										R			R		
Nodosaria obliquata	×						×																	R		
Nodosaria pariana							×	×	×												R					
Nodosaria raphanistrum	×					×	×	×	×											R				R		
Nodosaria scalaris	×																			R	R		R			
Nodosaria simplex	×	×	×																				R			
Lagena bullosa n. sp.																							R			
Lagena impressa n. sp.																							R			
Lagena nuttalli n. sp.						×	×													C	R		R			
Lagena strumosa	×				×		×		×											C				R		
Robulus calliferus						×	×	×													R		R			
Robulus chambersi					×	×	×	×													R			R		C

TABLE 4 (*Continued*)

PONCE FAUNA—*Cont.*

PONCE FAUNA—*Cont.*	Eocene Lower	Eocene Middle	Eocene Upper	Oligocene Lower	Oligocene Middle	Oligocene Upper	Miocene Lower	Miocene Middle	Miocene Upper	Pliocene	Pleistocene	Recent
Robulus convergens			×	×	×							×
Robulus iota				×				×	×			×
Robulus occidentalis torridus								×				×
Robulus plummerae			×									
Robulus protuberans				×	×	×						
Robulus subpapillosus				×								
Lingulina ponceana n. sp.												
Lingulina semicostata n. sp.												
Fissurina laevis							×	×	×			
Fissurina marginata												×
Apiopterina cylindroides	×	×	×	×	×	×	×	×	×	×	×	×
Nonion nicobarense		×	×	×				×		×	×	×
Nonion pompilioides				×		×	×	×	×	×	×	×
Nonion subgrateloupi n. sp.												
Pullenia bulloides				×				×		×	×	×
Elphidium lanieri							×	×	×	×	×	×
Elphidium owenianum												×
Elphidium poeyanum				×	×		×	×	×	×	×	×
Elphidium puertoricense n. sp.												
Elphidium sagrai					×			×	×	×	×	×
Elphidium sagrai crassum n. var.												
Antillesina marielensis				×								
Lamarckina echinata n. sp.												
Valvulineria nuttalli				×				×				
Valvulineria palmarealensis				×								
Valvulineria paucilocula				×								
Eponides ellisorae					×	×	×	×				
Eponides ornatissimus n. sp.												
Eponides parantillarum n. sp.								×				
Eponides ventricosus n. sp.												
Gyroidina *cf.* soldanii				×		×	×					×
Rotalia byramensis				×	×	×						
Rotalia mexicana			×?									
Rotalia mexicana mecatepecensis				×								
Rotalia meyerhoffi n. sp.												
Rotalia tholus n. sp.												

Localities	P251	P4	P3	P2	P253	P254	P255	P258	P259	P431	P432	A432	P434	P433
Robulus convergens			C			C	C							
Robulus iota				R										
Robulus occidentalis torridus			C	C			C							
Robulus plummerae						R								
Robulus protuberans				R										
Robulus subpapillosus			R				R							
Lingulina ponceana n. sp.			R											
Lingulina semicostata n. sp.				R										
Fissurina laevis				R										
Fissurina marginata						R	R							
Apiopterina cylindroides									R					
Nonion nicobarense						R								
Nonion pompilioides			C	C		C	C			R				
Nonion subgrateloupi n. sp.	R				A			A	C					
Pullenia bulloides						R	R							
Elphidium lanieri								A	A					
Elphidium owenianum						R								
Elphidium poeyanum							R	C	C					
Elphidium puertoricense n. sp.									C					
Elphidium sagrai								C	C					
Elphidium sagrai crassum n. var.								R	R				R	
Antillesina marielensis			R	R		A	A	R						
Lamarckina echinata n. sp.		R												
Valvulineria nuttalli			R											
Valvulineria palmarealensis			R	R										
Valvulineria paucilocula		A								C				
Eponides ellisorae						R								
Eponides ornatissimus n. sp.				R										
Eponides parantillarum n. sp.			R											
Eponides ventricosus n. sp.	R								R					
Gyroidina *cf.* soldanii			R											
Rotalia byramensis										C				
Rotalia mexicana		C			C						C			
Rotalia mexicana mecatepecensis										A				
Rotalia meyerhoffi n. sp.										C				
Rotalia tholus n. sp.										C				

TABLE 4 (*Continued*)

Localities														PONCE FAUNA—*Cont.*	Eocene			Oligocene			Miocene			Pliocene	Pleistocene	Recent
P251	P4	P3	P2	P253	P254	P255	P258	P259	P431	P432	A432	P434	P433		Lower	Middle	Upper	Lower	Middle	Upper	Lower	Middle	Upper			
							A	R						Discorbis havanensis			×									
							C							Discorbis subaraucanus			×	×	×				×	×	×	×
							C							Epistomaria pontifera n. sp.												×
		R			R									Anomalina alazanensis				×								
R					R									Anomalina nucleata			×	×	×	×	×	×				
					R	R			R					Cycloloculina cubensis			×									
	C		C		C									Cibicides floridanus			×	×		×	×	×	×			×
R		R			R		C		C	C				Cibicides lobatus			×	×	×		×	×		×	×	×
R		R	A			A								Cibicides mexicanus				×		×						
R														Cibicides perlucidus				×								
						R								Planulina depressa								×	×			×
R		C	A		A	C								Planulina marialana				×		×						
					R									Planulina mexicana			×	×								
R										R				Siphonina advena			×	×	×							
			R		C	R								Siphonina tenuicarinata			×	×		×		×				
	A													Rupertia verrucosa n. sp.												
									C	C				Carpenteria proteiformis						×	×					×
	R													Gypsina discus												×
			R							C			C	Sphaerogypsina globulus			×			×	×	×				×
							A							Sphaerogypsina pilaris								×				
							A	C				R	C	Amphistegina angulata						×	×	×				
	R	R	R				A	A	C	A		R		Amphistegina floridana				×			×					
					R	R								Chilostomella czizeki								×				
					R	R								Chilostomella globata n. sp.												
						R								Chilostomella ovoidea				×				×				×
	R	C	C		R	R								Chilostomella urceolus n. sp.												
R		C	C		R	R			R					Sphaeroidina bulloides				×		×	×			×	×	×
		C	R		R	R								Globigerina bulloides	×	×	×	×	×	×	×	×	×	×	×	×
		C	C							R				Globigerina dutertrei				×								×
R														Globigerina inflata		×	×	×		×						×
R		R	R			C								Globigerina ouachitaensis		×	×									
					R									Globigerina pachyderma											×	×
		C	A		C									Globigerina pseudotriloba	×											
		R	R		R	R								Globigerina triloculari̇s				×				×				
						R								Bolivina elongata				×								
			C											Bolivina heineae n. sp.												

TABLE 4 (*Continued*)

PONCE FAUNA—*Cont.*

Species	Recent	Pleistocene	Pliocene	Miocene Upper	Miocene Middle	Miocene Lower	Oligocene Upper	Oligocene Middle	Oligocene Lower	Eocene Upper	Eocene Middle	Eocene Lower	P433	P434	A432	P432	P431	P259	P258	P255	P254	P253	P2	P3	P4	P251
Bolivina mexicana aliformis							×		×											R	R		C	C		
Bolivina tectiformis									×	?													R			
Bolivina ventricosa n. sp.																					R					
Plectofrondicularia trinitatensis									×	×														R		
Plectofrondicularia vaughani					×		×		×	×											R		R	R		
Reussella glabrata					×			×	×										R							
Bulimina socialis	×			×	×			×	×	×		×								R	R		A	C		
Cassidulina subglobosa	×					×	×		×	×											R		R	R		
Cassidulina tricamerata n. sp.																				C	C		R	R		
Ehrenbergina caribbea n. sp.					×																		R			
Ehrenbergina serrata gibbera n. var.																							R			
Uvigerina elongata									×		×									R	R					
Uvigerina fusiformis n. sp.																				R	R		R	R		
Uvigerina gardnerae										×											R					
Uvigerina mantaensis									×												R			R		
Uvigerina mexicana									×											R			R	R		
Uvigerina mexicana bulbosa n. var.																							R			
Uvigerina mexicana ranunculus n. var.																							R			
Uvigerina vicksburgensis									×	×																R
Siphogenerina costostriata n. sp.																					R					
Siphogenerina cumingsi n. sp.																				R			C	R		
Siphogenerina hubbardi n. sp.																				C			C	C		
Siphogenerina mexicana									×														R	R		
Siphogenerina multicostata					×	×	×		×												R		R			
Angulogerina ponceana n. sp.																					R					
Trifarina bradyi	×								×															R		
Pleurostomella bierigi									×												R		C	R		
Pleurostomella elliptica n. sp.										×													C			
Pleurostomella gerontica n. sp.																							R	R		
Nodosarella constricta granulifera n. sp.																							R			
Nodosarella crassielegans						×	×			×														C		
Nodosarella paucistriata					×	×			×	×										C	C		C	R		
Ellipsoglandulina exponens			×	×	×	×	×			×	×	×											R			
Ellipsoidina ellipsoides abbreviata					×	×	×													R			A	R		
Lepidocyclina *cf.* parvula								×																		C
Lepidocyclina (Nephrolepidina) *cf.* tournoueri							×	?																		R
Miogypsinoides complanata							×	×															R		R	

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All of the types are catalogued and deposited in the Paleontological laboratory at Indiana University.

SYSTEMATIC DESCRIPTION OF SPECIES

Family **LAGYNIDAE** Schultze 1854

PSEUDARCELLA Spandel 1909

Pseudarcella patella NEW SPECIES

PLATE 1, FIGURES 1a, b

Test unilocular, discoidal, concavo-convex; edge narrowly rounded; dorsal side convex with a small, inconspicuous round knob in the center of the dorsal surface; wall calcareous, readily and completely soluble in dilute acid, hyaline in appearance, pores not observable; wall material not chitinous or arenaceous but calcareous with precisely the same appearance as specimens of hyaline, finely perforate forms such as the Nodosariidae and the Polymorphinidae; aperture in the center of a circular depression on the concave side of the test, circular in shape. Diameter, from 0.25 to 0.55 millimeter; maximum height, 0.16 millimeter.

Holotype No. 3950, locality A6, Lares formation.

Common at A6 of the Lares formation, from which half a dozen specimens were obtained.

P. patella is larger in diameter and thinner than *P. arenata* Cushman (1930. Fla. Geol. Surv. Bull. **4**).

Family ASTRORHIZIDAE Brady 1881

RHABDAMMINA M. Sars 1869

Rhabdammina irregularis Carpenter

Plate 1, figure 2

Rhabdammina irregularis Carpenter (1869) Proc. Roy. Soc. London **18**: 60.—Cushman (1918) Bull. U. S. Nat. Mus. **104** (1): 17. pl. 8, fig. 1. Recent, Bay of Biscay, Pacific Ocean along western coast of America as far north as Gulf of California, East Indies.

Rhabdammina abyssorum Brady (1884) Rep. Voy. Challenger Zool. **9**: 268. pl. 21, fig. 9 only. Recent, northwest of Ireland.

Test unilocular, consisting of a dichotomously or irregularly branching tubular chamber of nearly uniform diameter; wall of firmly cemented sand grains, exterior rather rough, interior more smoothly finished; ends of the tube serving as apertures. Average diameter, 0.83 millimeter; length of figured specimen, about 4 millimeters.

Plesiotype No. 3972, locality P3, Ponce formation.

Common at P3; rare at P2 of the Ponce formation.

Family SPIRILLINIDAE Reuss 1861

SPIRILLINA Ehrenberg 1843

Spirillina vivipara Ehrenberg

Plate 1, figures 3a, b

Spirillina vivipara Ehrenberg (1841) Abh. k. Akad. Wiss. Berlin 422. pl. 3, sec. 7, fig. 41. Recent, off coast of Mexico.—Brady (1884) Rep. Voy. Challenger Zool. **9**: 630. pl. 85, figs. 1–5. Recent, world wide.—Cushman (1915) Bull. U. S. Nat. Mus. **71** (5): 3. pl. 1, figs. 1, 2. Recent, north Pacific; (1931) Bull. U. S. Nat. Mus. **104** (8): 3. pl. 1, figs. 1–4. Recent, West Indies.

Test discoidal, slightly biconcave, planispiral, composed of a single tubular chamber in several coils, slowly increasing in diameter and only slightly involute; coils flattened and both sides of test somewhat flattened; periphery rounded; spiral suture somewhat depressed; aperture simple at the end of the tubular chamber. Diameter, 0.27 by 0.30 millimeter; thickness, 0.04 millimeter.

Plesiotype No. 3993, locality A86, Cibao formation.

Rare at A86 of the Cibao formation and at P432 of the Ponce formation.

PATELLINA Williamson 1858

Patellina corrugata Williamson

Plate 10, figures 5a–c

Patellina corrugata Williamson (1858) Rec. Foram. Great Britain 46. pl. 3, figs. 86–89. Recent, off Great Britain.—Cushman (1930) Contr. Cushman Lab. Foram. Res. **6**: 15 pl. 3, fig. 5. Tertiary to Recent; (1931) Bull. U. S. Nat. Mus. **104** (7): 11. pl. 2, figs. 6, 7. Recent, east and west borders of North Atlantic.

Test conical, apical angle nearly 90 degrees; ventral side nearly flat; several whorls of chambers visible on the dorsal side, early tubular chamber obscure but apparently comprising 2 or 3 whorls; later chambers shortening to 2 to a whorl; lobate ornamentation on dorsal side of the chambers, usually attributed to presence of secondary septa or septula, lobes sometimes simple, but more frequently double near the outer edge of the chamber; lower side with secondary deposits in knobs and meandering lines; wall thin, translucent, not definitely perforate; aperture a slit on the ventral side between the last 2 chambers with valvular lip. Diameter, 0.31 millimeter; height, 0.16 millimeter.

Plesiotype No. 3944, locality P432, Ponce formation.

Rare at P432 of the Ponce formation.

P. advena Cushman (1922. U. S. Geol. Surv. Prof. Pap. **129F**) is closely related to *P. corrugata* but differs, as stated in the original description, in the much finer division by internal septa and in a lower spire which makes a broad flaring test.

Family **MILIOLIDAE** d'Orbigny 1839

SPIROLOCULINA d'Orbigny 1826

Spiroloculina antillarum d'Orbigny

PLATE 1, FIGURES 6a–c

Spiroloculina antillarum d'Orbigny (1839) in De la Sagra, Hist. Phys. Pol. Nat. Cuba Foraminifères 166. pl. 9, figs. 3, 4. Recent, off Cuba.—Brady (1884) Rep. Voy. Challenger Zool. 9: 155. pl. 10, figs. 21a, b. Recent, south Atlantic.—Cushman (1921) Proc. U. S. Nat. Mus. 59: 63. pl. 14, figs. 14, 15. Recent, off Jamaica; (1932) Bull. U. S. Nat. Mus. 161 (1): 36. pl. 9, figs. 3–5. Recent, tropical Pacific.

Test oval in side view, biconcave, narrowly oval in end view; chambers subcircular in transverse section, rather thick; surface marked by numerous longitudinal striae; aperture terminal at the end of a neck with a plate-like tooth. Length, 1.07 millimeters; width, 0.63 millimeter; thickness, 0.22 millimeter.

Plesiotype No. 3994, locality A79, Los Puertos formation.

Rare at F64 of the Quebradillas formation, and P258 of the Ponce formation. Common at A79 of the Los Puertos formation.

Spiroloculina elongata d'Orbigny

PLATE 1, FIGURES 5a–c

Spiroloculina elongata d'Orbigny (1826) Ann. Sci. Nat. 7: 298, No. 11. Pliocene, Italy.—Fornasini (1904) Mem. R. Accad. Sci. Istit. Bologna Sez. Sci. Nat. VI. 1: 5. pl. 1, figs. 10a–c. (After d'Orbigny's unpublished figure of 1826.)

Test elongate, elliptical in side view; biconcave; back of the test broad, gently rounded; chambers elongate, with rounded back and concave sides in transverse section, tapering from the broadly rounded peripheral back of the chamber toward the center of the test, with an angled or nearly carinate contact between the back and sides of the chambers; aperture round, with plate-like tooth, at the end of a neck. Length, 1.41 millimeters; width, 0.75 millimeter; maximum thickness, 0.61 millimeter.

Plesiotype No. 3995, locality A79, Los Puertos formation.

Rare at A79 of the Los Puertos formation.

Spiroloculina oculina NEW SPECIES

PLATE 1, FIGURES 4a–c

Test regularly oval in side view; oval in end view, sides slightly concave, with carinae at the junction between back and sides of the chambers; chambers closely appressed, 5 visible on one side, 6 on the other side of the test, with portions of the keeled edge of earlier chambers visible on both sides; aperture terminal, round, with a short neck and T-shaped tooth. Length, 1.52 millimeters; width, 0.85 millimeter; thickness, 0.41 millimeter.

Holotype No. 3996, locality A79, Los Puertos formation.

Very rare at A79 of the Los Puertos formation.

S. oculina has fewer chambers and is thicker than *S. excavata* d'Orbigny from the Vienna Miocene.

QUINQUELOCULINA d'Orbigny 1826

Quinqueloculina akneriana d'Orbigny

PLATE 2, FIGURES 1a–c

Quinqueloculina akneriana d'Orbigny (1846) Foram. Foss. Vienne 290. pl. 18, figs. 16–21. Middle Miocene, Vienna.

Quinqueloculina seminulum Cushman (1918) Bull. U. S. Nat. Mus. **103**: 78. pl. 28, figs. 1a–c (not figs. 2, 3). Middle Miocene, Panama Canal Zone.

Test elongate, ovate in side view, width ⅔ length; ¾ as thick as wide; edge rounded; chambers distinct, of uniform diameter, nearly circular in cross section, successive chambers enlarging regularly in size; sutures depressed; apertural end without a definite neck; aperture terminal, circular, with a simple tooth. Length, 0.68 millimeter; width, 0.47 millimeter; thickness, 0.33 millimeter.

Plesiotype No. 3961, locality L6C, San Sebastian formation.

Rare at L2C; common at L6C of the San Sebastian formation. Rare at A86 of the Cibao formation.

We are following the generally accepted usage of restricting the name *Q. seminulum* (Linné) to those short, ovate quinqueloculines with subangular edge.

Quinqueloculina apiculata NEW SPECIES

PLATE 2, FIGURES 2a–c

Test about twice as long as wide, ⅔ as thick as wide; periphery rounded; chambers distinct, lengthening rapidly, somewhat inflated, distal end of last chamber with a short blunt apicule; sutures distinct, moderately depressed; surface of holotype poorly preserved; apertural end of last chamber extended into a neck; aperture terminal, circular, with a narrow, simple tooth. Length, 0.49 millimeter; width, 0.23 millimeter; thickness, 0.14 millimeter.

Holotype No. 3962, locality L6C, San Sebastian formation.

Very rare at L6C of the San Sebastian formation.

This species has resemblance to *Q. laevigata*, but has a definite, distinctive neck.

Quinqueloculina audacula NEW SPECIES

PLATE 1, FIGURES 7a–c

Test somewhat longer than wide; chambers polygonal in transverse section, with conspicuous angles or carinae; back flat or slightly concave between the carinae; sutures distinct, slightly depressed; aperture round, with simple tooth, at the end of a short, round neck. Length, 1.60 millimeters; width, 1.00 millimeter; thickness, 0.67 millimeter.

Holotype No. 3963, locality A79, Los Puertos formation.

Rare at A79 of the Los Puertos formation.

This species has more pronounced peripheral carinae and is less regularly oval in side view than *Q. badenensis* d'Orbigny from the Vienna Miocene.

Quinqueloculina laevigata (d'Orbigny)

PLATE 1, FIGURES 8a–c

Quinqueloculina laevigata d'Orbigny (1826) Ann. Sci. Nat. 7: 301. No. 6. Middle Eocene, Paris Basin; in Barker, Webb, & Berthelot (1839) Hist. Nat. Îsles Canaries 2 (2): Foraminifères 143. pl. 3, figs. 31–33. Recent, Canaries.—Cushman (1922) Carnegie Inst. Wash. Publ. 311: 65. pl. 13, fig. 2. Recent, Tortugas; (1935) U. S. Geol. Surv. Prof. Pap. 181: 11. pl. 2, figs. 13–15. Upper Eocene, Mississippi.

Test elongate, subovate in side view, about 2½ times as long as wide, ⅔ as thick as wide; periphery rounded; chambers distinct, somewhat inflated, enlarging gradually; sutures depressed; surface poorly preserved; apertural end slightly extended; aperture terminal, circular, with a narrow, simple tooth. Length, 0.81 millimeter; width, 0.38 millimeter; thickness, 0.25 millimeter.

Plesiotype No. 3964, locality L6C, San Sebastian formation.

Common at L6C, L1C, and L2C; rare at L4C and L5C of the San Sebastian formation.

Although named by d'Orbigny in 1826, this species was a *nomen nudum* until 1839, when it was figured by d'Orbigny in his paper on the Foraminifera of the Canaries. In 1905, d'Orbigny's original figure of the species was published by Fornasini. This figure differs from that of *Q. laevigata* in the Canaries paper, but the earlier published figure, that of the Canaries paper, is necessarily taken as the type figure.

Quinqueloculina maculata NEW SPECIES

PLATE 2, FIGURES 3a–c

Test oval in side view, subquadrate in end view, length nearly twice breadth, thickness ¾ breadth; periphery angled; chambers distinct, subtriangular in cross section; sutures only slightly depressed; wall of all chambers finely punctate; apertural end not produced; aperture oval. Length, 1.03 millimeters; width, 0.63 millimeter; thickness, 0.45 millimeter.

Holotype No. 3965, locality L6C, San Sebastian formation.

Rare at L4C; common at L6C of the San Sebastian formation.

This species is distinctive in its ornamentation. It much resembles *Massilina jacksonensis* Cushman (1933. Contr. Cushman Lab. Foram. Res. **9**) but it has no spiroloculine stage and, in any case, is less compressed. *Q. jamaicensis* Cushman and Jarvis which was described from the Eocene of Jamaica (1931. Contr. Cushman Lab. Foram. Res.) is more compressed and has pits arranged in definite nearly longitudinal lines.

Quinqueloculina philippi Reuss

PLATE 2, FIGURES 4a–d

Quinqueloculina philippi Reuss (1856) Sitz. k. Akad. Wiss. Wien **18**: 252. pl. 9, figs. 87a–d. Upper Oligocene, Germany.

Test very slender and elongate, compressed, narrowly oval in end view; edge angled with the suggestion of a keel; length nearly three times the width; width more than twice the thickness; chambers tubular, of fairly uniform diameter; aperture terminal, round, at the end of a definite neck, tooth not seen. Length, 0.73 millimeter; width, 0.26 millimeter; thickness, 0.11 millimeter.

Plesiotype No. 3966, locality A79, Los Puertos formation.

Very rare at A79 and A91a of the Los Puertos formation.

This species is close to *Q. angustissima* which was described by Reuss from the middle Miocene and which occurs also with *Q. philippi* in the upper Oligocene. It differs from *Q. angustissima* in having a distinctly angled edge. The Porto Rican form is slightly more slender than the original figure of *Q. philippi.*

Quinqueloculina ponceana NEW SPECIES

PLATE 2, FIGURES 5a–c

Quinqueloculina angusta Galloway & Morrey (1929) Bull. Am. Paleont. **15** (55): 8. pl. 3, figs. 3a, b. Probably lower Oligocene, Ecuador.

Test small, compressed, elliptical in side view; edge sharply rounded; both apical and apertural ends slightly produced; aperture at end of a short neck, round with a small, simple tooth. Length, 0.42 millimeter; width, 0.21 millimeter; thickness, 0.11 millimeter.

Plesiotype No. 3967, locality P2, Ponce formation.

Very rare at P2 and P254 of the Ponce formation.

Q. ponceana differs from *Q. anguina* Terquem (1878. Mém. Soc. Géol. France III. **1**) in that it is shorter, it lacks the conspicuous, rather long neck, and the edge is more sharply rounded.

Quinqueloculina pygmaea Reuss

PLATE 2, FIGURES 7a–c

Quinqueloculina pygmaea Reuss (1859) Denksch. k. Akad. Wiss. Wien **1**: 384. pl. 50, fig. 3. Middle Miocene, Austria.

Miliolina pygmaea Brady (1884) Rep. Voy. Challenger Zool. **9**: 165. pl. 113, figs. 16a, b. Recent, south Pacific and west coast of South America.

Quinqueloculina seminulum Cushman (1930) Fla. Geol. Surv. Bull. **4**: 19. pl. 2, figs. 2a–c (not fig. 1). Middle and upper Miocene, Florida.

Test very slender and elongate, oval in end view; three times as long as wide; thickness two-thirds of the width; periphery rounded; chambers distinct, tubular, of uniform diameter; sutures depressed; apertural end with a slight neck; aperture terminal, circular with a simple tooth. Length, 0.54 millimeter; width, 0.18 millimeter; thickness, 0.12 millimeter.

Plesiotype No. 3968, locality L6C, San Sebastian formation.

Rare at L6C of the San Sebastian formation. Common at A79 of the Los Puertos formation. Rare at F64 of the Quebradillas formation.

Quinqueloculina seminulum (Linné)

Plate 2, figures 8a–c

Serpula seminulum Linné (1758) Sys. Nat. ed. 10. 786. Recent, Adriatic Sea.
Quinqueloculina seminulum d'Orbigny (1826) Ann. Sys. Nat. 7: 303. no. 44. Recent, north Atlantic coast of Europe, Adriatic Sea, Mediterranean; Plioceno, Italy.—Cushman (1929) Bull. U. S. Nat. Mus. **104** (6): 24. pl. 2, figs. 1, 2. Recent, northeast coast of North America; (1929) Contr. Cushman Lab. Foram. Res. 5: 60. pl. 9, figs. 16–18; (1933) U. S. Geol. Surv. Prof. Pap. **175A**: 9. pl. 2, figs. 2a–c. Middle and upper Miocene, Atlantic coastal plain.

Test short ovate in side view; in end view subovate, edge narrowly rounded to subangular; chambers distinct, of uniform diameter, subtriangular in cross section, successive chambers enlarging regularly in size; sutures distinct, very little depressed; apertural end without a definite neck; aperture terminal, oval, with a simple narrow tooth. Length, 0.90 millimeter; width, 0.67 millimeter; thickness, 0.42 millimeter.

Plesiotype No. 3969, locality L6C, San Sebastian formation.

Rare at L6C of the San Sebastian formation, and at A43a of the Cibao formation.

Quinqueloculina vulgaris d'Orbigny

Plate 2, figures 6a–c

Quinqueloculina vulgaris d'Orbigny (1826) Ann. Sci. Nat. 7: 302. no. 33. Recent, Mediterranean, Adriatic, Antilles.—Fornasini (1902) Mem. R. Accad. Sci. Istit. Bologna Sez. Sci. Nat. V. **10**: 21. fig. 13. (d'Orbigny's unpublished figure of Recent, Adriatic Sea specimen.)—Cushman (1922) U. S. Geol. Surv. Prof. Pap. **129F**: 142. pl. 32, figs. 9, 10. Lower Oligocene, Mississippi; (1929) Bull. U. S. Nat. Mus. **104** (6): 25. pl. 2, fig. 3a–c. Recent, eastern Atlantic.

Test small for the genus, short and rather stout, subcircular in side view, rounded triangular in end view; edge narrowly rounded; chambers distinct, subtriangular in cross section, successive chambers increasing rather rapidly in size; sutures distinct, depressed; apertural end not produced; aperture oval, elongate parallel to the plane of coiling of the chamber, with a simple tooth (bifid in d'Orbigny's figure in Fornasini). Length of figured specimen, 0.29 millimeter; width, 0.25 millimeter; thickness, 0.11 millimeter. Average specimen length, 0.56 millimeter; width, 0.43 millimeter; thickness, 0.19 millimeter.

Plesiotype No. 3970, locality L6C, San Sebastian formation.

Rare at L1C, L4C, and L6C of the San Sebastian formation. Common at A79 of the Los Puertos formation. Rare at A15, A93, and F359 of the Quebradillas formation. Rare at P259; common at P258 and P431 of the Ponce formation.

TRILOCULINA d'Orbigny 1826

Triloculina austriaca d'Orbigny

PLATE 3, FIGURES 1a–c

Triloculina austriaca d'Orbigny (1846) Foram. Foss. Vienne 275. pl. 16, figs. 25–27. Middle Miocene, Vienna.

Test irregularly oval in front view, subtriangular in apertural view; chambers unevenly convex, somewhat narrower toward apertural end of each chamber so that only the lower part and one side of the last formed chamber are visible in front view; sutures deep; aperture subcircular with a broad bifid tooth. Average specimen length, 0.83 millimeter; width, 0.58 millimeter; thickness, 0.70 millimeter.

Plesiotype No. 4006, locality L6C, San Sebastian formation.

Rare at L1C, L2C, L4C; common at L6C of the San Sebastian formation. Common at A6 of the Lares formation. Rare at F64 of the Quebradillas formation, and at P431 of the Ponce formation.

Triloculina brongniartiana d'Orbigny

PLATE 3, FIGURES 2a–c

Triloculina brongniartiana d'Orbigny (1839) in De la Sagra, Hist. Phys. Pol. Nat. Cuba Foraminifères 152. pl. 9, figs. 5–7. Recent, off Cuba.

Test rather heavy in appearance, oval in side view, with the last chamber projecting apically beyond the earlier chambers; little compressed in end view; chambers distinct, marked by numerous fine longitudinal striae which extend up onto the neck, about 7 striae on each chamber on each side of the test; aperture at the end of a distinct neck, round with simple, narrow tooth. Length, 1.05 millimeters; width, 0.75 millimeter; thickness, 0.60 millimeter.

Plesiotype No. 4007, locality P258, Ponce formation.

Common at P258 of the Ponce formation.

Bermudez (1935) reports that this species is common in the Recent off northern Cuba but unfortunately gave no figure.

Triloculina cervicula NEW SPECIES

PLATE 3, FIGURES 3a–c

Test elongate, spindle shaped in side view; chambers smoothly rounded in end view; sutures depressed; surface smooth; aperture terminal, at the end of a slender neck, circular, with a simple tooth. Length, 0.43 millimeter; width, 0.21 millimeter; thickness, 0.16 millimeter.

Holotype No. 4008, locality L6C, San Sebastian formation.

Very rare at L6C of the San Sebastian formation.

This species differs from *T. gracilis* in its greater width and from *T. oblonga* in the presence of a conspicuous neck.

This species is not as slenderly proportioned as *T. gracilis* which was described by d'Orbigny from the Recent of Cuba. The presence of a conspicuous neck distinguishes it from *T. oblonga* (Montagu).

The specific name *cervicula* means "a small neck."

Triloculina elliptica NEW SPECIES

PLATE 2, FIGURES 9a–d

Test elongate, slightly tapering, subovate in side view with a slight neck, subtriangular in end view; chambers elongate, with width greater than the thickness; sutures slightly depressed; aperture terminal, nearly circular with lip and small simple tooth. Length, 0.52 millimeter; diameter, 0.22 by 0.23 millimeter.

Holotype No. 4009, locality L1C, San Sebastian formation.

Rare at L1C of the San Sebastian formation.

Triloculina gibba d'Orbigny

PLATE 3, FIGURES 4a–c

Triloculina gibba d'Orbigny (1826) Ann. Sci. Nat. 7: 299. no. 3. Recent, Adriatic near Rimini; Pliocene, Castel-Arquato; (1846) Foram. Foss. Vienne 274. pl. 16, figs. 22–24. Middle Miocene, Vienna.

Test ovate in front and side views, approximately a rounded equilateral triangle in end view; chambers curved and symmetrical toward both ends, last chamber wider than preceding chambers so that in front view the last chamber is visible on all sides of the two earlier chambers; outside of chambers flattened; chamber angles rounded; sutures distinct, depressed; surface smooth; aperture crescentic, terminal, without a neck. Average length, 0.74 millimeter; breadth, 0.49 millimeter; thickness, 0.53 millimeter.

Plesiotype No. 4010, locality L4C, San Sebastian formation.

Rare at L1C, L3C, L4C; common at L2C; and abundant at L6C of the San Sebastian formation. Rare at A79 of the Los Puertos formation, at A21 of the Quebradillas formation, and at P255 of the Ponce formation.

Triloculina inflata d'Orbigny

PLATE 3, FIGURES 5a–c

Triloculina inflata d'Orbigny (1846) Foram. Foss. Vienne 279. pl. 17, figs. 13–15. Middle Miocene, Vienna.

Test somewhat elongate, subovate in side and end views; chambers tapering a little toward the apertural end, with thickness and width nearly equal; sutures distinct, somewhat depressed; aperture terminal without definite neck or lip; nearly circular with a simple tooth. Length, 0.49 millimeter; width, 0.29 millimeter; thickness, 0.21 millimeter.

Plesiotype No. 4011, locality L3C, San Sebastian formation.

Very rare at L2C of the San Sebastian formation. Rare at A79 of the Los Puertos formation, at F358 and F359 of the Quebradillas formation, and at P431 of the Ponce formation.

Triloculina laevigata d'Orbigny

Plate 3, figures 6a–c

Triloculina laevigata d'Orbigny (1826) Ann. Sci. Nat. 7: 300. no. 15. Recent, Mediterranean. —Schlumberger (1893) Bull. Zool. Soc. France 18: 63. pl. 1, figs. 45–47. Recent, Gulf of Marseille.—Fornasini (1905) Mem. R. Accad. Sci. Istit. Bologna Sez. Sci. Nat. VI. 2: 61. pl. 1, fig. 10 (from d'Orbigny's unpublished figure).

Test elongate, subovate in side view, roundly subovate in end view; chambers elongate, tapering toward the proximal end, with width and thickness nearly equal; sutures distinct, depressed; aperture terminal, without a neck, semicircular in shape with a simple tooth. Length, 0.95 millimeter; width, 0.50 millimeter; thickness, 0.33 millimeter.

Plesiotype No. 4013, locality L4C, San Sebastian formation.

Rare at L2C and L4C of the San Sebastian formation, and at A79 of the Los Puertos formation. Very rare at P251 of the Ponce formation.

Triloculina longissima new species

Plate 3, figures 7a–c

? *Triloculina oblonga* Cushman (not Montagu) (1922) U. S. Geol. Surv. Prof. Pap. 129E: 104. pl. 28, figs. 3, 4. Middle Oligocene, Byram marl, Mississippi.

Test very small, narrowly elongate, subcylindrical; subovate in end view; chambers narrow, slightly larger at the distal end, with thickness and width about equal; sutures distinct, depressed; surface smooth; aperture terminal at end of a very slight neck, semicircular with a bifid tooth. Length, 0.57 millimeter; width, 0.22 millimeter; thickness, 0.12 millimeter.

Holotype No. 4012, locality L6C, San Sebastian formation.

Rare at L4C; common at L6C of the San Sebastian formation.

Triloculina oblonga (Montagu)

Plate 3, figures 8a–c

Vermiculum oblongum Montagu (1803) Test. Brit. 522. pl. 14, fig. 9. Recent, off British Isles.
Triloculina oblonga d'Orbigny (1826) Ann. Sci. Nat. 7: 300. no. 16. Recent, Adriatic, Mediterranean, North Atlantic, Antilles; middle Eocene to Pliocene, France and Italy; Modèles, no. 95. Calcaire grossier de Paris.—Cushman (1917) Bull. U. S. Nat. Mus. **71** (6): 69. pl. 26, fig. 3, text figs. 35, 36. Recent, north Pacific; (1929) Bull. U. S. Nat. Mus. **104** (6): 57. pl. 13, figs. 4, 5. Recent, widely distributed in Atlantic.

Test olive-shaped, slightly compressed, oval in side view, short oval in end view; chambers elongate, wider aborally; sutures only slightly depressed, those bounding the third chamber frequently oblique to general axis of the test; aperture terminal, without a neck, nearly circular in shape with a narrow simple tooth. Length, 0.43 millimeter; width, 0.20 millimeter; thickness, 0.12 millimeter.

Plesiotype No. 4014, locality L6C, San Sebastian formation.

Rare at L2C and L6C of the San Sebastian formation, at A6 of the Lares formation, at A91a of the Los Puertos formation, at F358 of the Quebradillas formation, and at P431 of the Ponce formation.

Triloculina quadrilateralis d'Orbigny

Plate 3, figures 9a–c

Triloculina quadrilateralis d'Orbigny (1839), in De la Sagra, Hist. Phys. Pol. Nat. Cuba Foraminifères 179. pl. 10, figs. 15–17. Recent, off Cuba.—Cushman (1921) Proc. U. S. Nat. Mus. **59**: 71. text fig. 11. Recent, off Jamaica.—Cushman & Ponton (1922) Fla. Geol. Surv. Bull. **9**: 53. pl. 7, fig. 1. Lower Miocene, Florida.

Test irregularly oval in front view, width less than the thickness, subquadrate in apertural view; axes of chambers not parallel to each other; chambers rather square in section, narrower and less convex at the apertural end of each chamber; chambers flattened but not concave on the back, especially the last two, thus producing the quadrangular outline; angles not carinate; sutures deep; preservation as internal molds, surface smooth; aperture oval with distinct short neck, probably with a bifid tooth. Average specimen length, 0.80 millimeter; width, 0.38 millimeter; thickness, 0.58 millimeter.

Plesiotype No. 4015, locality L6C, San Sebastian formation.

Rare at L2C, L4C, L5C, and L6C of the San Sebastian formation, and at A79 of the Los Puertos formation.

Triloculina tricarinata d'Orbigny

Plate 3, figures 10a, b

Triloculina tricarinata d'Orbigny (1826), Ann. Sci. Nat. 7: 299. no. 7; Modèles, no. 94. Recent, Red Sea.—Cushman (1917) Bull. U. S. Nat. Mus. **71** (6): 66. pl. 25, figs. 1, 2, text fig. 32. Recent, north Pacific; (1932) Bull. U. S. Nat. Mus. **161** (1): 59. pl. 13, figs. 3a, b. Recent, tropical Pacific.

Test of symmetrical proportions, the edges of the test sharply angled, whole test somewhat longer than wide; in transverse section an equilateral triangle; chambers little inflated, shape of chambers subordinate to that of the test; sutures slightly depressed; aperture without a neck, round with a narrow tooth. Length, 0.43 millimeter; width, 0.29 millimeter; thickness, 0.26 millimeter.

Plesiotype No. 4016, locality P253, Ponce formation.

Rare at P431 and P253 of the Ponce formation.

MILIOLINELLA Wiesner 1931

Miliolinella circularis (Bornemann)

PLATE 4, FIGURES 8a–c

Triloculina circularis Bornemann (1855) Zeitschr. deutsch. geol. Ges. 7: 349. pl. 19, fig. 4 Middle Oligocene, Germany.—Cushman (1929) Bull. U. S. Nat. Mus. **104** (6): 58. pl. 13 figs. 6, 7, pl. 14, figs. 1, 2. Recent, widespread.

Test circular in side view; in end view broadly oval, back rounded; chambers inflated; sutures distinct, depressed; aperture a narrow crescentiform slit. Length, 0.63 millimeter; diameter, 0.57 by 0.65 millimeter.

Plesiotype No. 3997, locality P2, Ponce formation.

Very rare at P2 and P431 of the Ponce formation. Rare at A79 of the Los Puertos formation.

The Porto Rican form is more perfectly circular in side view than is the original figure of this species.

PYRGO Defrance 1824

Pyrgo bougainvillei (d'Orbigny)

PLATE 4, FIGURES 1a–c

Biloculina bougainvillei d'Orbigny (1839) Voy. Amér. Mérid. 5 (5): Foraminifères 67. pl. 8, figs. 22–24. Recent, off west coast of South America.

Test small for the genus, elongate, oval in front and side views, broadly oval in end view with width about twice the thickness of the test; edge shouldered near the suture; chambers symmetrical, compressed; sutures slightly curved in side view; aperture oval, tooth bifurcate. Length, 0.40 millimeter; width, 0.24 millimeter; thickness, 0.18 millimeter.

Plesiotype No. 3953, locality L6C, San Sebastian formation.

Rare at L4C and L6C of the San Sebastian formation.

Pyrgo clypeata (d'Orbigny)

PLATE 4, FIGURES 2a–c

Biloculina clypeata d'Orbigny (1846) Foram. Foss. Vienne 263. pl. 15, figs. 19–21. Middle Miocene, Vienna.

Test somewhat compressed, oval in front view, narrowly oval in edge and end views; edge shouldered; chambers little inflated; sutures slightly depressed, slightly concave toward the penultimate chamber in edge view; aperture oval with narrow bifid tooth. Length, 0.45 millimeter; width, 0.35 millimeter; thickness, 0.29 millimeter.

Plesiotype No. 3954, locality A79, Los Puertos formation.

Rare at L3C, L4C, L5C, and L6C; common at L2C of the San Sebastian formation. Rare at A6 of the Lares formation, at A86 of the Cibao formation, at A79 of the Los Puertos formation, and at A64 and F358 of the Quebradillas formation.

Pyrgo inornata (d'Orbigny)

PLATE 4, FIGURES 3a–c

Biloculina inornata d'Orbigny (1846) Foram. Foss. Vienne 266. pl. 16, figs. 7–9. Middle Miocene, Vienna.

Test rotund, oval in front and edge views, subcircular in end view, thickness of test equal to or slightly greater than the width; edge rounded; chambers inflated; sutures slightly depressed, curved in side view with the aboral end of the last chamber overlapping and covering the preceding chamber; aperture round with bifid tooth partly filling the opening. Length, 0.48 millimeter; width, 0.33 millimeter; thickness, 0.36 millimeter.

Plesiotype No. 3955, locality A79, Los Puertos formation.

Rare at L4C of the San Sebastian formation and F359 of the Quebradillas formation. Common at A79 of the Los Puertos formation.

Pyrgo lunula (d'Orbigny)

PLATE 4, FIGURES 4a–c

Biloculina lunula d'Orbigny (1846) Foram. Foss. Vienne 264. pl. 15, figs. 22–24. Middle Miocene, Vienna.

Test biconvex, of average size for the genus, nearly circular in front view; biconvex in side view, edge angled; chambers somewhat inflated; aperture narrow and elongate with a broad flat tooth nearly filling the opening. Length, 0.74 millimeter; width, 0.67 millimeter; thickness, 0.45 millimeter.

Plesiotype No. 3956, locality P258, Ponce formation.

Rare at L2C and L6C; common at L3C; abundant at L4C of the San Sebastian formation. Rare at A91a and A79 of the Los Puertos formation. Rare at A93 and F358(2); common at F359 of the Quebradillas formation. Rare at P254 and P432; common at P255 and P258 of the Ponce formation.

P. depressa of d'Orbigny (Model no. 91) is more compressed than *P. lunula,* although the two species have many points of similarity.

Pyrgo oblonga (d'Orbigny)

PLATE 4, FIGURES 5a–c

Biloculina oblonga d'Orbigny (1839) in De la Sagra, Hist. Phys. Pol. Nat. Cuba Foraminifères 163. pl. 8, figs. 21–23. Recent, Cuba.

Test small for the genus, moderately elongate, oval in front and side views, subcircular in end view; shoulder near suture rounded; chambers only slightly compressed, wider at the aboral than at the oral end; sutures slightly depressed, curved in side view; aperture oval with a broad tooth. Length, 0.37 millimeter; width, 0.21 millimeter; thickness, 0.26 millimeter.

Plesiotype No. 3957, locality P251, Ponce formation.

Rare at L1C, L2C, L4C; common at L6C of the San Sebastian formation. Common at A6 of the Lares formation. Rare at A43a of the Cibao formation, at A79 of the Los Puertos formation, at F359 of the Quebradillas formation. Rare at P251; common at P431 of the Ponce formation.

P. oblonga is considerably less elongate than *P. elongata* from the Eocene at Gironde, a species with which *P. oblonga* seems to have been confused by many authors. *P. oblonga* also has less symmetrical chambers, which are wider at the aboral than at the oral end. In this characteristic and in the curvature of the suture in edge view, *P. oblonga* differs also from *P. bougainvillei* which was found by d'Orbigny off the west coast of South America.

Pyrgo peruviana (d'Orbigny)

PLATE 4, FIGURES 6a–c

Biloculina peruviana d'Orbigny (1839) Voy. Amèr. Mèrid. 5 (5): Foraminifères 65. pl. 9, figs. 1–3. Recent, off Peru.

Test ovoid; oval in front and apertural views; width of test only slightly greater than the thickness; broadly oval or subcircular in side view; shoulder next to suture rounded; chambers strongly inflated, sutures depressed; in side view the line of contact between the two chambers curving forward due to broadening of the last chamber so that only the last formed chamber is visible at the distal end of the test; last formed chamber noticeably larger and broader than next to last chamber, being wider near apertural end of the test, tapering toward the distal end, and of an inverted pear shape as seen from the front of the test; surface smooth; aperture broadly oval with wide, bifid tooth which is infrequently and poorly preserved. Length, 0.70 millimeter; width, 0.57 millimeter; thickness, 0.54 millimeter.

Plesiotype No. 3958, locality L4C, San Sebastian formation.

Common in the San Sebastian formation at L4C and L6C. Rare at A86 in the Cibao formation, at A91a of the Los Puertos formation, and at P258 of the Ponce formation.

Pyrgo subspherica (d'Orbigny)

PLATE 4, FIGURES 7a–c

Biloculina subspherica d'Orbigny (1839) in De la Sagra, Hist. Phys. Pol. Nat. Cuba Foraminifères 162. pl. 8, figs. 25–27. Recent, Cuba and Jamaica.

Pyrgo subspherica Cushman (1929) Bull. U. S. Nat. Mus. **104** (**6**): 68. pl. 18, figs. 1, 2. Recent, Atlantic, Jamaica, Cuba, Porto Rico, Tortugas, Florida, and Bahamas.

Test small, rotund, broadly oval in front view, slightly longer than wide; width of test only a little greater than the thickness; edge rounded; chambers inflated, more so at posterior end; sutures deep, sinuous in side view; in apertural view chambers semicircular; surface smooth; aperture broadly oval with large bifid tooth that does not fill the aperture. Length, 0.37 millimeter; width, 0.29 millimeter; thickness, 0.29 millimeter.

Plesiotype No. 3959, locality L2C, San Sebastian formation.

Rare at L1C, L3C, L4C, and L5C; common at L2C and L6C of the San Sebastian formation. Abundant at A6 of the Lares formation. Rare at A91a; common at A79 of the Los Puertos formation. Rare at A64, A21, and F359; common at F64 of the Quebradillas formation. Rare at P251 and P434; abundant at P258 of the Ponce formation.

This form is very close to *P. bulloides* (d'Orbigny) from the Recent of Cuba, but is less elongate, has a sinuous suture, broader aperture and characteristic posterior inflation of the chambers as seen in side view.

PYRGOELLA Cushman & White 1936

Pyrgoella globulus (Bornemann)

PLATE 4, FIGURES 9a–c

Biloculina globulus Bornemann (1855) Zeitsch. deutsch. geol. Ges. **7**: 349. pl. 19, figs. 3a, b. Middle Oligocene, Hermsdorf.

Test globular, circular in front, side and end views; shoulder rounded near suture; chambers strongly inflated, last chamber larger than the preceding in all dimensions; sutures slightly depressed; concave toward the penultimate chamber in side view; aperture triangular, nearly filled by a triangular tooth. Length, 0.48 millimeter; width, 0.45 millimeter; thickness, 0.45 millimeter.

Plesiotype No. 3960, locality P255, Ponce formation.

Very rare at P255 of the Ponce formation.

P. sphaera d'Orbigny (1839. Voy. Amér. Mérid. **5** (5) Foraminifères) is very similar to this species but differs in proportions of the triangular aperture and in relative size of the two chambers. Both *P. globulus* and *P. sphaera* are rare species.

MASSILINA Schlumberger 1893

Massilina decorata Cushman

Plate 5, figure 1

Massilina decorata Cushman (1922) U. S. Geol. Surv. Prof. Pap. **129F**: 143. pl. 34, fig. 7. Mint Spring Marl, lower Oligocene, Mississippi.—Howe & Wallace (1932) La. Dept. Cons. Geol. Bull. **2**: 20. pl. 2, fig. 6. Jackson, upper Eocene, Louisiana.—Cushman (1935) U. S. Geol. Surv. Prof. Pap. **181**: 13. pl. 3, figs. 14–16. Jackson, upper Eocene, Mississippi.

Test subovate in side view, slightly longer than wide with apical and apertural ends projecting a little; in edge view much compressed with sides parallel; edge rounded; early milioloid stage small, about 5 chambers in the planispiral portion of the test; surface ornamented by "very fine pits giving a finely granular matte appearance to the test"; aperture terminal, with short, round neck, tooth not known. Length, 0.90 millimeter; width, 0.63 millimeter.

Plesiotype No. 3932, locality A79, Los Puertos formation.

Very rare at A79 of the Los Peurtos formation.

Massilina inaequalis d'Orbigny

Plate 5, figures 2a–c

Massilina inaequalis Cushman (1921) Proc. U. S. Nat. Mus. **59**: 72. pl. 17, figs. 12, 13. Recent, off Jamaica.—Cushman & Ponton (1932) Fla. Geol. Surv. Bull. **9**: 46. pl. 3, figs. 4a–c. Chipola formation, lower Miocene, Florida.

Test elongate, biconcave, slender with both apical and apertural ends tapering; in end view with flat back forming the thickest part of the test; acute angle between the back and sides of the chambers; aperture at the end of a neck, quadrate in outline with a T-shaped tooth. Length, 1.25 millimeters; width, 0.60 millimeter; thickness, 0.32 millimeter.

Plesiotype No. 3933, locality A79, Los Puertos formation.
Rare at A79 of the Los Puertos formation.
This species might equally well be placed under *Spiroloculina.*

HAUERINA d'Orbigny 1839

Hauerina sansebastianensis NEW SPECIES

PLATE 5, FIGURES 3a–c, and 4a–c

Test discoidal, nearly equally biconvex and biumbilicate, immature specimens relatively more convex; periphery subacute; 4 chambers in last whorl of the adult, 3 in immature forms; chambers subtriangular in shape, increasing rapidly in size, occasionally involute, more commonly with a few milioline chambers showing in the umbilical region; sutures sharply depressed; surface smooth; aperture in the young an elongate slit with bluntly serrate margin extending the full length of the last septal face, in the adult a tuberculate trematophore. Adult specimen diameter, 0.84 by 1.05 millimeters; maximum thickness, 0.37 millimeter.

Holotype No. 3925a, Paratype 3925b, locality L6C of the San Sebastian formation.

Common at L6C of the San Sebastian formation.

This species resembles *H. compressa* d'Orbigny from the Miocene of the Vienna Basin, but is thicker and differs in character of the aperture and in shape of the chambers. It differs from *H. bradyi* Cushman (1917. Bull. U. S. Nat. Mus. **71** (**6**)) in its greater thickness and different shape of the chambers.

Family SORITIDAE Ehrenberg 1840

DENDRITINA d'Orbigny 1826

Dendritina preëlegans NEW SPECIES

PLATE 5, FIGURES 5a, b

Test compressed, biumbilicate; subcircular to oval in side view, close coiled in the early part tending to become evolute in the later part; edge rounded; chambers about 12 in the last whorl, short and wide, enlarging gradually; sutures distinct, little depressed; wall ornamented with fine longitudinal striae which are not continuous from chamber to chamber; aperture an elongate, oval dendritic opening in the middle of the last septal face. Diameter, 1.00 by 1.33 millimeters; thickness, 0.33 millimeter.

Holotype No. 3889, locality A79, Los Puertos formation.

Common at A79 of the Los Puertos formation.

This new species is closely related to *Peneroplis elegans* d'Orbigny from the Recent of Cuba, but differs in the character of the aperture which is dendritic and not perforate. It differs from *Dendritina antillarum* d'Orbigny, also from the Recent of Cuba, in that it is less involute and the aperture is different. The aperture of *D. preëlegans* is more regularly dendritic and it is restricted to an oval area in the center of the apertural face, not occupying the entire apertural face as it does in *D. antillarum.*

PENEROPLIS Montfort 1808

Peneroplis carinatus d'Orbigny

PLATE 5, FIGURES 6a, b

Peneroplis carinatus d'Orbigny (1839) Voy. Amér. Mérid. 5 (5): Foraminifères 33. pl. 3. figs. 7, 8. Recent.—Cushman (1930) Bull. U. S. Nat. Mus. 104 (7): 36. pl. 12, figs. 7–10, pl. 14, fig. 1. Recent, Atlantic Ocean, West Indies.

Peneroplis pertusus carinatus Cushman (1917) Bull. U. S. Nat. Mus. 71 (6): 87. pl. 37, fig. 4. Recent, north Pacific.

Test subcircular or oval, lenticular, asymmetrical, usually biumbonate, closely coiled and completely involute; periphery slightly lobulate, edge sharply angled; chambers short, 14–18 in the last whorl; sutures strongly recurved, scarcely at all depressed, appearing limbate; surface smooth; aperture a group of pores on the apertural face. Average specimen diameter, 1 millimeter; thickness, 0.40 millimeter.

Plesiotype No. 3945, locality L6C, San Sebastian formation.

Common at L1C, rare at L2C, L3C, L4C, and L6C of the San Sebastian formation. Rare at F358 of the Quebradillas formation and at P258 of the Ponce formation.

P. carinatus differs from *P. proteus* in that the chambers are involute and do not become evolute and flaring.

Peneroplis proteus d'Orbigny

PLATE 5, FIGURES 7a, b

Peneroplis protea d'Orbigny (1839) in De la Sagra, Hist. Phys. Pol. Nat. Cuba Foraminifères 60. pl. 7, figs. 7–11. Recent, off Cuba and Jamaica.

Peneroplis dubia d'Orbigny (1839) in De la Sagra, Hist. Phys. Pol. Nat. Cuba Foraminifères 62. pl. 6, figs. 21, 22. Recent, off Cuba.

Orbiculina adunca Brady (in part) (1884) Rep. Voy. Challenger Zool. 9: pl. 14, figs. 3, 4. Recent, off Bermuda.

Peneroplis proteus Cushman (1930) Bull. U. S. Nat. Mus. 104, (7): 37. pl. 13, figs. 1–17, Recent, Atlantic Ocean; off north coast Jamaica, Tortugas, Florida, Bermuda, Bahamas, Porto Rico.—Cushman & Ponton (1932) Fla. Geol. Surv. Bull. 9: 71. pl. 10, figs. 7–11, 14. Lower Miocene, Florida.

Test oval or irregular in outline, ovate in edge view, moderately compressed, thickest portion in umbonal region, peripheral portions thinner, often quite flat and compressed; periphery bluntly rounded; chambers numerous, in early involute stage about 9 chambers, short and wide, later chambers becoming semi-annular, evolute and flaring; sutures distinct, slightly depressed, strongly curved; surface smooth; aperture a single row of pores on the apertural face. Diameter of coiled portion, 0.83 millimeter; thickness of coiled portion, 0.43 millimeter; thickness of evolute chambers, 0.10 millimeter.

Plesiotype No. 3946, locality L6C, San Sebastian formation.

Rare at L1C and L6C of the San Sebastian formation. Rare at A79 of the Los Puertos formation, and at A64 of the Quebradillas formation.

ARCHAIAS Montfort 1808

Archaias aduncus (Fichtel & Moll)

PLATE 5, FIGURES 8a–c

Nautilus aduncus Fichtel & Moll (1803) Test. Micr. 115. pl. 23, figs. a–e. Recent, Arabian Sea.

Orbiculina adunca d'Orbigny (1839) in De la Sagra, Hist. Phys. Pol. Nat. Cuba Foraminifères 64. pl. 8, figs. 10–16 (not 8, 9). Recent, off Cuba.

Archaias angulatus Cushman (1930) Bull. U. S. Nat. Mus. 104 (7): 46. pl. 16, 17. Recent, Porto Rico, Tortugas, Bermuda.

Test biconvex near the center, rest of the test explanate, very thin; edge truncate; chambers numerous, short and very wide, early ones involute to the center, later ones tending to become annular, the arc of the chamber being around 120 degrees in the young chambers and 180 or more in the adult chambers; aperture consisting of numerous large, closely but irregularly arranged pores covering the entire apertural face. Diameter, 1.56 by 2.06 millimeters; thickness, 0.17 millimeter.

Plesiotype No. 3868, locality P258, Ponce formation.

Abundant at L6C of the San Sebastian formation. Rare at A79 of the Los Puertos formation, and at F359 of the Quebradillas formation. Rare at P251 and P434; common at P258 and P259 of the Ponce formation.

Many authors have discarded this species and have considered these forms as adult forms of the species *A. angulatus*. The Los Puertos material shows specimens of two types, each of which is sufficiently distinct to merit specific rank.

A. aduncus differs from *A. angulatus* in the following ways:

1. larger diameter
2. thinner test, both relatively and actually
3. general appearance: *angulatus* is nautiloid with angled edge, *aduncus* is explanate with truncate edge
4. the arc of chamber width is about 180° (120° minimum) in *aduncus* and only 90° in *angulatus*
5. the last chambers of *angulatus* are involute to the umbilicus

It seems obvious that these cannot be adult forms of *A. angulatus*, particularly on points 2–5 above.

Archaias angulatus (Fichtel & Moll)

PLATE 5, FIGURES 9a, b

Nautilus angulatus Fichtel & Moll (1803) Test. Micr. 113. pl. 22, figs. a–c. Recent, Arabian Sea.
Orbiculina adunca d'Orbigny (1839) in De la Sagra, Hist. Phys. Pol. Nat. Cuba Foraminifères 64. pl. 8, figs. 8, 9. Recent, off Cuba.

Test lenticular, nearly bilaterally symmetrical; periphery bluntly rounded; chambers involute; sutures limbate, with transverse connecting ridges corresponding to the secondary septa which are slightly offset in successive chambers and spiral outward toward the periphery; wall calcareous, imperforate; aperture a series of pores in several rows on the apertural face. Diameter, 0.41 to 1.36 millimeters; thickness, 0.25 to 0.70 millimeter.

Plesiotype No. 3869, locality L1C, San Sebastian formation.

Rare at L1C, L4C, and L6C of the San Sebastian formation. Common at A79 of the Los Puertos formation. Rare at F359 of the Quebradillas formation. Common at P258 of the Ponce formation.

Archaias compressus (d'Orbigny)

PLATE 5, FIGURES 10a, b

Orbiculina compressa d'Orbigny (1839) in De la Sagra, Hist. Phys. Pol. Nat. Cuba Foraminifères 73. pl. 8, figs. 4–7. Recent, West Indies.—Cushman (1919) Carnegie Inst. Wash. Publ. 291: 70. pl. 7, fig. 6. Bowden formation, Miocene, Jamaica.
Archaias compressus Cushman (1930) Bull. U. S. Nat. Mus. **104** (7): 48. pl. 17, figs. 1, 2. Recent, West Indies; late Tertiary, Jamaica, Florida, Panama.

Test compressed, discoidal, subcircular in outline; chambers involute in early portion, later portion annular; earlier involute portion about twice the thickness of annular part of test; chambers in nucleoconch simple, later chambers with chamberlets; wall calcareous, imperforate; aperture consisting of irregularly arranged pores on the periphery. Diameter of adult form, 1.83 millimeters; thickness, 0.17 millimeter.

Plesiotype No. 3870, locality L1C, San Sebastian formation.

Common at L1C; rare at L6C of the San Sebastian formation.

Family TROCHAMMINIDAE Schwager 1877

TROCHAMMINOIDES Cushman 1910

Trochamminoides approximatus NEW SPECIES

PLATE 6, FIGURES 1a, b

Test small, subcircular in side view, the two sides nearly exactly alike, biconcave, asymmetrically planispiral, composed of about 5 volutions, each volution embracing about half of the previous volution, and increasing gradually in thickness; periphery moderately lobulate; edge regularly rounded; chambers about 12 in the last volution, increasing gradually in size; sutures distinct, slightly depressed, narrow, mostly nearly straight, some curved slightly outward and backward, discernible from the proloculum outward; the concameration is not due to irregular constrictions but due to normal septation; wall white, very finely arenaceous, consisting of very fine, angular grains of calcite bound together with a small amount of white, calcareous cement; surface finely granular; aperture a narrow arch at the base of the septal face. Diameter, 0.66 millimeter; thickness, 0.12 millimeter.

Holotype No. 4064, locality A91a, Los Puertos formation.

Rare at A91a of the Los Puertos formation.

This species differs from *T. proteus* (Karrer), from the Cretaceous of the Vienna Basin, in lacking an early tubular portion, in having a greater number of whorls, more nearly planispiral symmetry, definite septation and small aperture. It also differs from Recent specimens identified with *T. proteus* Brady (1884. Rep. Voy. Challenger Zool. pl. 40) in the planispiral symmetry of the early spire, more regular concameration, and the smaller aperture, as well as the smaller size and greater number of volutions. It is quite unlikely that the large number of forms from Jurassic, Cretaceous, Tertiary, and Recent ages which have been identified with *T. proteus* (Karrer) actually belong to that species.

Family LITUOLIDAE Reuss 1861

CYCLAMMINA Brady 1876

Cyclammina acutidorsata (Hantken)

PLATE 6, FIGURES 2a, b

Haplophragmium acutidorsatum Hantken (1868) Magyar. földt. târsulat munkâlatai 4: 82. pl. 1, figs. 1a, b; (1876) Mitth. Jahrb. k. ungar. geol. Anstalt 4: 12. pl. 1. figs. 1a, b. Upper Eocene and lower Oligocene, Hungary.—Andreae (1884) Abh. geol. Specialkarte Elsaas-Loth. 2 (3): 197. pl. 7, figs. 5a, b. Middle Oligocene, Alsace.

Test planispiral, compressed, nearly completely involute, biumbilicate; periphery bluntly angled, very slightly lobulate; 10–11 chambers in the last whorl; septal face triangular in apertural view; sutures very slightly depressed; wall coarsely arenaceous, made of calcareous sand grains; aperture crescentiform, at base of the last septal face, on the periphery. Diameter, 0.95 millimeter; thickness, 0.32 millimeter.

Plesiotype No. 3887, locality P3, Ponce formation.

Very rare at P3 of the Ponce formation.

Family **ATAXOPHRAGMIIDAE** Schwager 1877

VALVULINA d'Orbigny 1826

Valvulina oviedoiana d'Orbigny

Plate 6, figures 3a, b

Valvulina oviedoiana d'Orbigny (1839) in De la Sagra, Hist. Phys. Pol. Nat. Cuba Foraminifères 103. pl. 2, figs. 21, 22. Recent, Cuba.—Cushman (1921) Proc. U. S. Nat. Mus. 59: 51. pl. 11, figs. 11–14. Recent, north coast Jamaica; (1922) Carnegie Inst. Wash. Publ. 311: 29. pl. 2, figs. 7, 8. Recent, Tortugas; (1922) Bull. U. S. Nat. Mus. 104 (3): 64. pl. 11, figs. 2–5. Recent, Florida, Bahamas, etc.; (1937) Cushman Lab. Foram. Res. Spec. Publ. 8: 10. pl. 2, figs. 4, 5. Recent, Bermuda, Florida, and West Indies.

Test large for the genus, tetrahedral, an inverted three-sided pyramid in shape, initial end pointed, the sides rapidly diverging, losing the three-sided form so that the apertural end is subcircular in shape; chambers triserially arranged, rapidly increasing in size; sutures depressed; wall coarsely arenaceous with much calcareous cement; aperture along the inner margin of the last chamber with a large projecting tooth or valve. Height of test, 1.2 millimeters; diameter of apertural end, 1.01 by 1.20 millimeters.

Plesiotype No. 4026, locality L6C, San Sebastian formation.

Common at L6C; rare at L4C of the San Sebastian formation. Rare at P258 of the Ponce formation.

VALVULAMMINA Cushman 1933

Valvulammina cornucopia new species

Plate 6, figures 4a–c

Test shaped like a small, twisted cornucopia, widening very rapidly from the pointed initial end; spire of medium height, last whorl constituting about half the height of the test; 4 to 5 chambers in the last whorl (in no case as many as 6), chambers loosely appressed, inflated, increasing rapidly in size in width, but not in length or height; sutures distinct, depressed; wall medium coarsely arenaceous, smoothly finished with much calcareous cement; aperture large, at the base of the last septal face, with short, wide, valvular tooth; apertural face large, flaring, constituting about half of the last whorl on the ventral side of the test. Height, 0.70 millimeter; diameter of apertural end, 0.90 by 1.13 millimeters.

Holotype No. 4025, locality L6C, San Sebastian formation.

Rare at L4C and L6C of the San Sebastian formation. Common at P258 of the Ponce formation.

This species is very close to *Valvulammina deformis* (d'Orbigny) as figured by Fornasini (1904. Mem. R. Accad. Sci. Istit. Bologna Sez. Sci. Nat. VI. **1**) from the Eocene of France, but the test is higher, the chambers are fewer in each whorl and do not increase as rapidly in width, the last chamber is not as large, and the apertural valve is less well formed.

It differs from *V. affinis* Cushman and Bermudez from the Eocene of Cuba (1937. Contr. Cushman Lab. Foram. Res. **13**) in having fewer chambers in the last whorl, and more depressed sutures.

VERNEUILINA d'Orbigny 1840

Verneuilina mexicana Nuttall

PLATE 6, FIGURE 5

Verneuilina mexicana Nuttall (1932) Jour. Paleont. **6**: 6. pl. 2, figs. 1, 2. Lower Oligocene, Tampico Embayment, Mexico.

Karreriella mexicana Cushman (1937) Cushman Lab. Foram. Res. Spec. Publ. **9**: 130. pl. 15, figs. 13, 14.

Test short, stout fusiform in shape, broadest across the middle of the last three chambers; apertural end rounded, initial end acute; nearly circular in cross section; chambers indistinct, last whorl constituting the major portion of the test; sutures obscure, flush with the surface; wall of medium arenaceous texture; aperture a short, straight or slightly curved oval slit located slightly above and parallel to the base of the last septal face; apertural face slightly concave. Length, 0.77 millimeter; maximum diameter, 0.60 millimeter.

Plesiotype No. 4031, locality P2, Ponce formation.

Rare at P2 and P3 of the Ponce formation, and at A93 of the Quebradillas formation.

We have several complete adult specimens of this species, none of which show an early 4 or 5 chambered stage or an adult 2 chambered stage. It seems probable, therefore, that this is a true *Verneuilina*.

DOROTHIA Plummer 1931

Dorothia caribaea Cushman

PLATE 6, FIGURES 6a, b

Dorothia caribaea Cushman (1936) Cushman Lab. Foram. Res. Spec. Publ. 6: 31. pl. 5, figs. 3a–c. Recent, Cuba.

Test short and stout, broadly rounded at both ends, sides almost parallel, nearly round in cross section; chambers closely appressed, early whorls with 4 or 5 chambers in a whorl, 2 to 3 pairs in biserial part of the test; sutures slightly depressed, somewhat oblique; wall coarsely arenaceous made of calcite grains with calcareous cement so that the surface is fairly smooth; aperture a high arched opening constricted at the base and extending up onto the last septal face. Length, 1.00 millimeter; width, 0.60 millimeter; thickness, 0.50 millimeter.

Plesiotype No. 3901, locality P255, Ponce formation.

Rare at P255 of the Ponce formation.

Dorothia cylindrica (Nuttall)

PLATE 6, FIGURES 7a–c

Gaudryina cylindrica Nuttall (1932) Jour. Paleont. 6: 7. pl. 2, fig. 7. Lower Oligocene, Mexico.

Dorothia cylindrica Cushman (1937) Cushman Lab. Foram. Res. Spec. Publ. 8: 88. pl. 9, fig. 25. Lower Oligocene, Mexico.

Test elongate, compressed cylindrical, with triserial part of test slightly trihedral in shape; triserial portion constituting only about ⅓ or less of the test; chambers closely appressed, 4–5 pairs in the biserial part of the test; sutures narrow, slightly depressed, rather indistinct; wall arenaceous with fine to medium size grains and much cement; aperture a high arch extending up onto the last septal face with low upper lip. Length, up to 1.82 millimeters; diameter, 0.6 millimeter.

Plesiotype No. 3916, locality P2, Ponce formation.

Rare at P2 and P255 of the Ponce formation.

Dorothia praelonga (Karrer)

PLATE 6, FIGURES 8a, b

Gaudryina praelonga Karrer (1877) Abh. k. k. geol. Reichs. 9: 374. pl. 16a, fig. 6. Middle Miocene, Vienna Basin.

Dorothia praelonga Cushman (1937) Cushman Lab. Foram. Res. Spec. Publ. 8: 90. pl. 10, figs. 2, 3. Miocene, Vienna Basin, and Bulgaria.

Test small, elongate, cylindrical except for a very brief trihedral initial end, nearly circular in cross section; chambers numerous, 6 pairs or more in biserial part of test, closely appressed; sutures distinct, slightly depressed, nearly straight and transverse to axis of test; wall finely arenaceous with much cement, surface smooth; aperture a low arch at the base of the septal face. Length, 0.88 millimeter; breadth, 0.30 millimeter; thickness, 0.34 millimeter.

Plesiotype No. 4046, locality P2, Ponce formation.

Rare at P2 of the Ponce formation.

GAUDRYINA d'Orbigny 1839

Gaudryina asiphonia Andreae

PLATE 7, FIGURES 1a, b

Gaudryina siphonella asiphonia Andreae (1884) Abh. Geol. Specialkarte Elsass-Loth. **2** (3): 200. pl. 7, fig. 7. Middle Oligocene, Alsace.
Gaudryina asiphonia Nuttall (1932) Jour. Paleont. **6**: 7. pl. 2, fig. 2. Lower Oligocene, Tampico Embayment, Mexico.—Hadley (1934) Bull. Am. Paleont. **20** (70A): 8. pl. 1, fig. 6. Oligocene, probably upper, north coast of Cuba.

Test of average size for the genus, elongate, slightly tapering, oval in cross section; triserial portion very short constituting only about ¼ of the length of the test; 4 pairs of chambers in the biserial portion of the test, these chambers subglobular in shape, more inflated than the chambers in triserial part of the test; sutures distinct, depressed in biserial part of test; wall finely arenaceous, surface rather smooth; aperture an arched opening on the inner margin of the last septal face. Length, 1.10 millimeters; breadth, 0.45 millimeter; thickness, 0.35 millimeter.

Plesiotype No. 4045, locality P2, Ponce formation.

Rare at P2 and P3 of the Ponce formation.

Specimens of *G. asiphonia* from Porto Rico are larger than those reported by Nuttall from Mexico, which were only 0.60 millimeter long.

Gaudryina glabrata maxima NEW VARIETY

PLATE 7, FIGURES 2a, b

Test large, stout, early triserial portion very short, later biserial portion constituting most of the test; test lozenge shaped in cross section; chambers numerous, quite distinct, with the lower side excavated so that the test has a transversely rugose appearance; early and middle portion without the transverse rugae but with papillae which more or less obscure the sutures; sutures depressed, nearly horizontal or slightly convex toward the aperture in the middle; wall arenaceous with much cement; surface moderately rough; aperture an elongate, low arch at the base of the last septal face. Length of figured specimen, 1.11 millimeters; breadth, 0.7 millimeter; thickness, 0.45 millimeter.

Plesiotype No. 4050, locality A43a, Cibao formation.

Common at A43a of the Cibao formation.

This variety differs from *G. glabrata* (Cushman) (1937. Cushman Lab. Spec. Publ. 7) in the much larger size and the presence of papillae.

Gaudryina karreriana Cushman

PLATE 7, FIGURES 6a, b

Gaudryina karreriana Cushman (1936) Cushman Lab. Foram. Res. Spec. Publ. 6: 8. pl. 1, figs. 18a, b. Miocene, Hungary.

Test large for the genus, elongate, tapering, enlarging abruptly at the initial end which is rather sharp, enlarging more gradually toward the apertural end; the early triserial portion of the test comprising about 2/5 of the test, trihedral in shape with rounded angles, the remaining biserial portion quadrangular to subcircular in cross section; 2 or usually 3 pairs of chambers in the biserial part of the test; sutures narrow, slightly depressed, nearly horizontal; wall of medium arenaceous texture with much cement; surface moderately rough; aperture a low arched opening on the inner margin of the last septal face. Length, 2.21 millimeters; breadth, 1.20 millimeters; thickness, 1.18 millimeters.

Plesiotype No. 3917, locality P2, Ponce formation.

Rare at A20 of the Quebradillas formation. Rare at P2 and P255 of the Ponce formation.

Gaudryina puertoricana NEW SPECIES

PLATE 7, FIGURES 7a, b

Test small, flattened triangular in the early portion, becoming thicker and rounded in the later portion; triserial portion about half the length of the test; two sides flat, the third rounded; angles sharp but not keeled; chambers indistinct, not inflated except the last two; sutures flush with the surface, inconspicuous, thickened with calcite in the triserial portion; wall very finely arenaceous, composed of calcareous grains and calcareous cement, white in color; surface rather smooth; aperture a small, low arch at the base of the last septal face. Length, 0.33 millimeter; width, 0.20 millimeter.

Holotype No. 3918, locality L6C, San Sebastian formation.

Very rare in the San Sebastian formation at L6C only.

This species differs from *G. atlantica* (Bailey) as figured by Bailey and also by Cushman (1937. Cushman Lab. Foram. Res. Spec. Publ. 7) in being much smaller, having a relatively shorter triserial portion, less inflated chambers, more inconspicuous sutures, finer wall material, flat apertural face, and absence of keels on the angles of the test.

Gaudryina (Pseudogaudryina) atlantica (Bailey)

PLATE 7, FIGURES 3a, b

Textularia atlantica Bailey (1851) Smiths. Contr. 2: 12. pl., figs. 38–43. Recent, off northeast coast USA.

Gaudryina (*Pseudogaudryina*) *atlantica* Cushman (1937) Cushman Lab. Foram. Res. Spec. Publ. 7: 95. pl. 14, figs. 4, 5. Recent, off northeast coast of USA; Miocene, Jamaica.

Test large, elongate, tapering gradually from the pointed initial end; triangular in section; sides concave, edges angled; chambers distinct, not inflated although last chamber or two may be slightly rounded; sutures slightly depressed; wall coarsely arenaceous, surface rather smoothly finished; aperture an elongate arch in a reentrant of the inner margin of the last septal face. Length 1.52 millimeters; diameter, 0.7 millimeter.

Plesiotype No. 4085, locality P3, Ponce formation.

Very rare at P3 of the Ponce formation.

G. jacksonensis Cushman (1926. Contr. Cushman Lab. Foram. Res. 2) seems quite close but has more concave sides, stronger carinae, more chambers, and is made of finer material than *G. atlantica*.

LIEBUSELLA Cushman 1933

Liebusella byramensis (Cushman)

PLATE 6, FIGURES 9a, b

Clavulina byramensis Cushman (1922) U. S. Geol. Surv. Prof. Pap. 129-E: 92. pl. 16, fig. 1; (1923) U. S. Geol. Surv. Prof. Pap. 133: 22. pl. 2, fig. 3. Oligocene, Mississippi.

? *Clavulina cylindrica* Palmer & Bermudez (1936) Mem. Soc. Cubana Hist. Nat. 10: 245. pl. 14, figs. 3–5, pl. 19, figs. 1, 2. Lower Oligocene, Cuba.

Liebusella byramensis Cushman (1937) Cushman Lab. Foram. Res. Spec. Publ. 8: 164. pl. 19, figs. 16–18. Lower Oligocene, coastal plain U. S. and Mexico.

Test elongate subcylindrical, circular in transverse section; early portion of test triserial and slightly bulbous, major portion of test uniserial with 2–4 chambers which constitute about two-thirds of the length of the test; wall of the test very thick, composed of agglutinated calcareous grains which are mainly small hyaline foraminifera such as *Bolivina* and *Globigerina*, not labyrinthic or vesicular but appearing so on eroded surfaces; interior of the chambers in transverse section shows indefinite radial projections extending inward a short distance but chamber interiors are not labyrinthic; surface arenaceous but smoothly finished with a great deal of calcareous cement; aperture round, terminal and central at the end of a tapering neck-like projection of the last chamber. Length, 1.81 to 2.71 millimeters; maximum diameter, 0.71 to 0.86 millimeter.

Plesiotype No. 4132, locality P255, Ponce formation.

Rare at P3 and P255 of the Ponce formation.

This Porto Rican species has decided resemblances to *Cubanina alavensis* Palmer (1936. Mem. Soc. Cubana Hist. Nat. **10**) and it is uncertain just what the significant differences may be. These specimens are more like the topotypes figured by Cushman (1937. Monog. Valvulinidae) than like the original figure of *L. byramensis*.

LISTERELLA Cushman 1933

Listerella *cf.* communis (d'Orbigny)

PLATE 6, FIGURES 10a, b

Clavulina communis d'Orbigny (1826) Ann. Sci. Nat. 7: 268, No. 4. Recent, Adriatic; Miocene, France; Pliocene, Italy; (1846) Foram. Foss. Vienne 196. pl. 12, figs. 1, 2. Middle Miocene, Vienna.—Cushman & Jarvis (1930) Jour. Paleont. 4: 356. pl. 32, fig. 4. Miocene, Jamaica.

Listerella communis Cushman (1937) Cushman Lab. Foram. Res. Spec. Publ. 8: 148. pl. 17, figs. 4–9. Miocene to Recent, Mediterranean region.

Test elongate, subcylindrical; chambers few, height in uniserial part of test about ⅔ the diameter; sutures distinct, slightly depressed; wall finely arenaceous, smoothly finished; aperture terminal, round, occasionally with a very short neck. Length, up to about 1.50 millimeters; average diameter, 0.27 millimeter.

Plesiotype No. 4056, locality P255, Ponce formation.

Rare to common at P2 and P255 of the Ponce formation.

Our specimens do not have the early part preserved.

CLAVULINA d'Orbigny 1826

Clavulina tricarinata d'Orbigny

PLATE 7, FIGURES 8a, b

Clavulina tricarinata d'Orbigny (1839) in De la Sagra, Hist. Phys. Pol. Nat. Cuba Foraminifères 111. pl. 2, figs. 16–18. Recent, Cuba.—Cushman (1937) Cushman Lab. Foram. Res. Spec. Publ. 8: 22. pl. 3, figs. 1–3. Recent, West Indian region; Miocene, Florida.

Clavulina cf. C. tricarinata Cushman & McGlamery (1938) U. S. Geol. Surv. Prof. Pap. 189D: 104. pl. 24, fig. 3. Middle Oligocene, Mississippi.

Test elongate, tapering, increasing in diameter toward the apertural end, triangular in cross section, sides concave; chambers numerous, triserial portion short, 3 to 7 chambers in uniserial part of test;

chambers of triserial part of test obscure, those of the uniserial part more distinct, each extended posteriorly over the preceding chamber on the angulations of the test; sutures in uniserial part distinct, slightly depressed with a goniatitic outline due to the aboral deflection of the chambers; wall arenaceous but smoothly finished; aperture terminal, nearly circular, without a neck, with large valvular tooth. Length, up to 1.52 millimeters; maximum diameter, 0.54 millimeter.

Plesiotype No. 3885, locality L3C, San Sebastian formation.

Rare at all San Sebastian localities, except L2C. Common at A79 of the Los Puertos formation. Rare at F64 and F359 of the Quebradillas formation. Rare at P254, P255, P259, and P432; abundant at P258 of the Ponce formation.

CLAVULINOIDES Cushman 1936

Clavulinoides polygonalis NEW SPECIES

PLATE 7, FIGURES 4a, b

Test small, consisting of a triangular early third, a middle polygonal portion of variable length, and a terminal round portion; chambers closely appressed, about 3 in the middle part and 1 to 3 in the apertural part; sutures obscure, nearly flush with the surface; wall very finely arenaceous with a moderate amount of cement; surface rather smooth but distinctly granular; aperture terminal, polygonal, oval or round, with raised rim. Length, 0.75 millimeter; diameter, 0.3 millimeter.

Holotype No. 4091, locality F64, Quebradillas formation.

Rare at F64 of the Quebradillas formation.

This form resembles Cole's species *C. guayabalensis* (1927. Bull. Am. Paleont. **14**), but differs in lacking the concave sides, in having 3 to 6 sides, and in having a round terminal portion.

Clavulinoides triangularis (Nuttall)

PLATE 7, FIGURES 5a, b

Clavulina triangularis Nuttall (1932) Jour. Paleont. 6: 8. pl. 2, fig. 4. Lower Oligocene, Mexico.

Clavulinoides jarvisi Cushman (1936) Cushman Lab. Foram. Res. Spec. Publ. 6: 23. pl. 3, figs. 18a, b. Miocene, Trinidad; (1937) Cushman Lab. Foram. Res. Spec. Publ. 7: 135, pl. 19, figs. 3–5. Miocene, Trinidad, and Venezuela.

Clavulinoides triangularis Cushman (1937) Cushman Lab. Foram. Res. Spec. Publ. 7: 133. pl. 18, figs. 31, 32. Lower Oligocene, Mexico.

Test triangular in section throughout, sides flat to slightly concave, angles subacute; sides of test nearly parallel; triserial portion short, a little inflated, uniserial portion constituting most of the test, but containing few chambers, 2 to 4; chambers closely appressed, obscure; sutures indistinct, slightly depressed; wall finely arenaceous with much cement, surface rather smooth; aperture terminal, round or oval. Length, up to 1.7 millimeters; diameter, up to 0.65 millimeter.

Plesiotype No. 4086, locality P3, Ponce formation.

Rare at P2; common at P254; abundant at P3 and P255 of the Ponce formation.

We see no reliable distinction between *C. triangularis* and *C. jarvisi* Cushman.

Family **TEXTULARIIDAE** d'Orbigny 1846

TEXTULARIA Defrance 1824

Textularia agglutinans d'Orbigny

PLATE 8, FIGURES 2a–c

Textularia agglutinans d'Orbigny (1839) in De la Sagra, Hist. Phys. Pol. Nat. Cuba Foraminifères 144. pl. 1, figs. 17, 18, 32–34. Recent, Cuba.—Cushman (1922) U. S. Geol. Surv. Prof. Pap. **129E**: 89. pl. 14, figs. 1a, b. Upper Oligocene, Mississippi; (1922) Bull. U. S. Nat. Mus. **104** (3): 7. pl. 1, figs. 4, 5. Recent, West Indies.—Cushman & Cahill (1933) U. S. Geol. Surv. Prof. Pap. **175A**: 7. pl. 1, figs. 8a, b. Miocene, Florida, North Carolina, Virginia, Maryland.

Test elongate, tapering, slightly compressed; ovate in apertural view; edge rounded; chambers inflated, increasing gradually in height toward the apertural end, 7–8 pairs of chambers in average tests; sutures distinct, depressed, except in earliest portion of test; wall rather coarsely arenaceous but smoothly finished, consisting in Porto Rican material of calcareous grains; aperture a flat arch at the base of the last septal face. Length, 0.82 millimeter; width, 0.44 millimeter; thickness, 0.32 millimeter.

Plesiotype No. 3996, locality L1C, San Sebastian formation.

Rare at L2C, L3C, L6C; common at L1C of the San Sebastian formation. Common at A43a of the Cibao formation.

These Porto Rican specimens differ from typical *T. agglutinans* in being slightly more compressed. Nuttall makes the same comment on his specimens of *T. agglutinans* from the Lower Miocene of Trinidad. The first few chambers are more compressed than the rest of the test, with an almost subangular edge. In general there are fewer chambers than in typical *T. agglutinans*.

Textularia articulata d'Orbigny

Plate 8, figures 1a, b

Textularia articulata d'Orbigny (1846) Foram. Foss. Vienne 250. pl. 15, figs. 16–18. Middle Miocene, Vienna.—Cushman (1933) U. S. Geol. Surv. Prof. Pap. 175A: 8. pl. 1, figs. 12a, b. Miocene, Virginia, Maryland; upper Miocene, Florida.

Test of average size for the genus, elongate, both ends pointed, gradually tapering, slightly compressed, ovate in apertural view; periphery subangular; chambers inflated, increasing gradually in height toward the apertural end; sutures distinct, depressed except in earlier half of test; wall rather coarsely arenaceous but smoothly finished; aperture a low arch at the base of the last septal face. Length, 1.20 millimeters; width, 0.50 millimeter; thickness, 0.34 millimeter.

Plesiotype No. 3998, locality L1C, San Sebastian formation.

Rare at L5C; common at L1C of the San Sebastian formation.

Textularia broussardi Howe & Wallace

Plate 8, figures 3a, b

Textularia broussardi Howe & Wallace (1932) La. Dept. Cons. Geol. Bull. 2: 18. pl. 1, fig. 3. Upper Eocene, Louisiana.

Test short and thick, subtriangular in side view, oval in apertural view; edge slightly angular near the apex, becoming broadly rounded toward the apertural end; chambers 4 to 5 pairs, the early ones indistinct, the later ones inflated; sutures distinct only between the later chambers; wall finely but distinctly arenaceous; surface rather smooth for the genus; aperture a low slit at the base of the apertural face, with indistinct lip. Length, 1.2 millimeters; breadth, 1.1 millimeters; thickness, 0.8 millimeter.

Plesiotype No. 4092, locality P2, Ponce formation.

Rare at P2 of the Ponce formation.

The Porto Rican specimens differ from the Louisiana ones mainly in the finer wall texture.

Textularia candeana* d'Orbigny

Plate 8, figures 5a–c

Textularia candeiana d'Orbigny (1839) in De la Sagra, Hist. Phys. Pol. Nat. Cuba Foraminifères 143. pl. 1, figs. 25–27. Recent, Cuba, Martinique, St. Thomas.

Textularia candeiana Cushman (1921) Proc. U. S. Nat. Mus. 59: 50. pl. 11, figs. 7, 8. Recent, north coast Jamaica; (1922) Carnegie Inst. Wash. Publ. 311: 23. pl. 2, fig. 2. Recent, Tortugas; (1922) Bull. U. S. Nat. Mus. 104 (3): 8. pl. 1, figs. 1–3. Recent, West Indies.—Cole & Gillespie (1930) Bull. Am. Paleont. 15 (57B): 5. pl. 2, fig. 11. Middle Oligocene, Mexico.—Cushman & Ponton (1932) Fla. Geol. Surv. Bull. 9: 41. pl. 8, figs. 4a, b. Miocene, Florida.

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* The correct spelling of this species is evidently *candeana*. Incorrectly spelled "*candeiana*" by d'Orbigny in 1839, he corrected the spelling to "*candeana*" in the Spanish edition of his Cuba paper in 1840.

Test elongate, club shaped, broadly oval in apertural view, early part of test narrow and much compressed, edge angled; near apertural end test widens and thickens rapidly and edge becomes broadly rounded; chambers numerous, compressed in early part of test, much inflated in last part; sutures distinct, depressed, except in earlier compressed part of test where the sutures are flush; wall rather coarsely arenaceous; aperture a slit at the base of the last septal face. Length, 0.69 millimeter; width, 0.56 millimeter; thickness, 0.40 millimeter.

Plesiotype No. 3999, locality L3C, San Sebastian formation.

Rare at L2C and L3C of the San Sebastian formation, and at P258 of the Ponce formation.

Textularia gramen d'Orbigny

PLATE 8, FIGURES 4a–c

Textularia gramen d'Orbigny (1846) Foram. Foss. Vienne 248, pl. 15, figs. 4–6. Middle Miocene, Vienna.—Cushman (1930) Fla. Geol. Surv. Bull. 4: 17, pl. 1, figs. 5a, b. Middle and upper Miocene, Florida.—Cushman & Cahill (1933) U. S. Geol. Surv. Prof. Pap. 175A: 7, pl. 1, figs. 9a, b. Miocene, Florida and northward.

Test small, width about ⅔ the length, expanding rapidly from the initial end; edges angled; about 8 pairs of chambers very little inflated except for the last one or two; sutures inconspicuous, nearly flush with the surface, oblique; wall finely arenaceous, composed of small calcareous grains with much calcareous cement; surface smooth to slightly roughened; aperture a narrow arch at the base of the last septal face. Length, 0.73 millimeter; width, 0.47 millimeter; thickness, 0.27 millimeter.

Plesiotype No. 4003, locality L1C, San Sebastian formation.

Common at L1C and L2C of the San Sebastian formation.

Textularia grenadana Hedberg

PLATE 8, FIGURES 6a, b, and 7

Textularia grenadana Hedberg (1937) Jour. Paleont. 11: 667, pl. 90, figs. 5a, b, 6. Upper Oligocene, Venezuela.

Test lanceolate in side view, compressed in early part of test with biconvex cross section, becoming thicker and ovoid in cross section near the apertural end; edge subangular in early part of the test, narrowly rounded in later part; periphery slightly lobulate; chambers closely appressed, 15 or more pairs, overlapping nearly half of their width; sutures distinct, slightly depressed, nearly horizontal near the periphery; wall very finely arenaceous, surface smooth; apertural face truncate; aperture a low, transverse arch. Length of largest specimen, 1.6 millimeters; width, 0.6 millimeter; thickness, 0.4 millimeter.

Plesiotypes No. 4002a, b, locality P3, Ponce formation.

Rare at P2, P3, P254, and P255 of the Ponce formation.

Textularia indenta NEW SPECIES

PLATE 8, FIGURES 8a–c

Textularia rugosa Brady (not Reuss) (1884) Rep. Voy. Challenger Zool. **9**: 363. pl. 42, fig. 24 (not 23). Recent, Pacific.—Cushman (1921) Bull. U. S. Nat. Mus. **100** (4): 114. pl. 23, figs. 3, 4. Recent, Pacific.

Test large, rather stout, sides and edges nearly parallel throughout most of the test; roughly hexagonal in cross section; chambers biserially arranged throughout, numerous, about 10 pairs, closely appressed; chambers with distinct lobes at the basal border, one or two on each side of the test; sutures distinct, recurved adorally between the lobes; wall rather coarsely arenaceous with much cement, smoothly finished; surface irregular due to the apically projecting lobes which form a series of deep indentations; aperture a low, elongate opening at the inner margin of the last-formed chamber in a slight re-entrant. Length of holotype, 1.77 millimeters; width, 0.81 millimeter; thickness, 0.61 millimeter.

Holotype No. 4051, locality A43a, Cibao formation.

Rare at A43a of the Cibao formation.

Forms similar to this species have been found many times and have usually been confused with Reuss's species, which he called *Plecanium rugosum* (1869. Sitz. Akad. Wiss. Wien **59**). Reuss shows a form with fairly straight sutures without the lobate extensions which characterize *T. indenta*. Brady (1884) gives two figures of a form which he calls *Textularia rugosa* (Reuss), neither of them being *T. rugosa* as described and figured by Reuss. The forms figured by Brady, with the lobate projections and irregularly excavated chambers seem to be identical with that found by us in the Cibao formation, for which we here propose the name *indenta*.

Cushman proposed the name *Gaudryina rugulosa* (1932. Bull. U. S. Nat. Mus. **161 (1)**) and placed both of Brady's figures in synonymy, but it is evident from Cushman's type figure that he had in mind a form in which the test has conspicuous, nearly horizontal corrugations separated by "excavated" areas.

It is probable that the genus is *Textularia*, since a section of the earliest part of the test showed nothing but biserial chambers. The sections made show no indication of septula, so the species cannot be *Textulariella,* although it looks very much like Hofker's figure of *Textularia rugosa.*

TEXTULARIELLA Cushman 1927

Textulariella barrettii (Jones & Parker)

PLATE 7, FIGURES 9a, b

Textularia barrettii Jones & Parker (1863) Rep. Brit. Assoc. Newcastle Meeting, 80, 105. Recent, Jamaica; (1876) Ann. Soc. Mal. Belg. **11**: 99. woodcut. Miocene, Jamaica.
Textularia pseudotrochus Cushman (1922) Bull. U. S. Nat. Mus. **104 (3)**: 21. pl. 5, figs. 1–3. Recent, West Indies and southeast U. S.
Textulariella barrettii Cushman (1937) Cushman Lab. Foram. Res. Spec. Publ. **8**: 66. pl. 7, figs. 5–8. Miocene, Jamaica, and Santo Domingo; Recent, Florida and West Indies.

Test forming a low broad cone with height and breadth nearly equal, the apical end bluntly angled, the apertural end flattened or concave; about 5 pairs of chambers in the biserial part of the test, the interior of the chambers divided by partitions which extend inward from the periphery; aperture a low elongate arch at the base of the last chamber. Width, 1.00 millimeter; thickness, 0.95 millimeter; height, 0.95 millimeter.

Plesiotype No. 4004, locality A86, Cibao formation.

Rare at A86 of the Cibao formation, at A21 and A93 of the Quebradillas formation, and at P432 of the Ponce formation.

The Porto Rican specimens are smaller than those typically referred to as *T. barrettii,* although Cushman mentions small individuals of this species from the Miocene of Venezuela.

VULVULINA d'Orbigny 1826

Vulvulina pachyheilus Hadley

PLATE 7, FIGURES 10a, b

Vulvulina pachyheilus Hadley (1934) Bull. Am. Paleont. **20 (70A)**: 7. pl. 1, figs. 2–4. Oligocene, probably upper, Cuba.—Palmer & Bermudez (1936) Mem. Soc. Cubana Hist. Nat. **10**: 241. pl. 14, figs. 12, 13, 16. Lower Oligocene, Cuba.

Test tapering from the pointed initial end with greatest breadth near the apertural end; in cross section diamond shaped thinning from the thickened central portion to an acute edge; chambers numerous, short and wide, biserial throughout except for the final chamber which is uniserial; sutures nearly straight, forming an oblique angle with the edge of the test, slightly elevated, except for the last one which is depressed; wall made of fine arenaceous material with much cement; surface smooth; aperture terminal, a fissurine slit with thickened lip. Length of figured specimen, 0.92 millimeter; breadth, 0.60 millimeter; thickness, 0.20 millimeter. Maximum length, 1.75 millimeters.

Plesiotype No. 4032, locality A93, Quebradillas formation.

Common at A86 of the Cibao formation. Rare at A93 of the Quebradillas formation. Rare at P3 and P254; common at P2 and P255 of the Ponce formation.

Vulvulina pennatula (Batsch)

PLATE 7, FIGURES 11a, b

Nautilus (Orthoceras) pennatula Batsch (1791) Conch. Seesandes no. 13, pl. 4, figs. 13a–d. Recent, Adriatic.

Bigenerina capreolus Nuttall (1928) Quart. Jour. Geol. Soc. London 84: 73. pl. 3, fig. 2. Upper Eocene and lower Miocene, Trinidad.

Bigenerina pennatula Nuttall (1928) Quart. Jour. Geol. Soc. London 84: 73. pl. 3, fig. 3. Lower Miocene, Trinidad.

Vulvulina pennatula Cushman (1932) Contr. Cushman Lab. Foram. Res. 8: 76. pl. 10, figs. 1–5. Recent, West Indies; Pliocene, Sicily.

Test compressed, elongate, the microspheric form widening gradually from a rather sharp apical end, the megaspheric form wider at the apical end; sides of the test biconvex outward in biserial part of the test, nearly parallel in uniserial part; chambers closely appressed, earliest part of the test planispiral, followed by numerous low, curved biserial chambers, then 1 to 4 higher uniserial chambers; early part of test thicker than uniserial part; edge angled; sutures in planispiral and biserial part of test limbate and raised, depressed in uniserial part of test; wall finely arenaceous, with much cement; surface smooth; aperture terminal, fissurine, parallel to the compression of the test. Dimensions of the figured specimen, which is one of the largest found in the Porto Rican material: length, 2.13 millimeters; width, 1.23 millimeters; thickness, 0.33 millimeter.

Plesiotype No. 4033, locality P2, Ponce formation.

Common at P3 and P254; abundant at P2 and P255 of the Ponce formation.

Family NODOSARIIDAE Schultze 1854

SARACENARIA Defrance 1824

Saracenaria arcuata (d'Orbigny)

PLATE 9, FIGURES 6a–c

Cristellaria arcuata d'Orbigny (1846) Foram. Foss. Vienne 87. pl. 3, figs. 34–36. Middle Miocene, Vienna.

Cristellaria acutauricularis Brady (not Fichtel & Moll) (1884) Rep. Voy. Challenger Zool. 9: 543. pl. 114, fig. 17. Recent, off Australia.

Test subovate in side view, triangular in transverse section, outer peripheral angle sharply rounded, not carinate; chambers closely appressed, early chambers coiled, later chambers evolute, extending back nearly to the point of coiling of the earlier chambers; sutures flush with the surface, marked by clear shell material; wall smooth; apertural face broad, slightly convex; aperture radiate, at the outer margin of the last septal face. Length, 1.03 millimeters; width, 0.45 millimeter; thickness, 0.38 millimeter.

Plesiotype No. 3982, locality P3, Ponce formation.

Rare at P2, P3, and P254 of the Ponce formation.

This species is much like many forms which have been referred to *acutauricularis* of Fichtel and Moll. It differs from the original of Fichtel and Moll in the absence of a conspicuous keel in the early stages, in the thinner, less inflated test, and in the shape of the apertural face, which is subtriangular in *S. arcuata* and oval in *S. acutauricularis*.

ASTACOLUS Montfort 1808

Astacolus insolitus (Schwager)

PLATE 8, FIGURES 9a, b

Cristellaria insolita Schwager (1866) Novara-Exped. Geol. 2: 242. pl. 6, fig. 85. Pliocene, Kar Nikobar.

Cristellaria crepidula Brady (1884) Rep. Voy. Challenger Zool. 9: pl. 67, fig. 17 (not 19, 20).

Test elongate oval, compressed; edge narrowly rounded; about 10 chambers in the test, last chambers increasing rapidly in length; chambers involute in varying amounts; sutures distinct, flush with the surface, narrowly limbate; aperture terminal, peripheral, round and radiate. Length, 1.05 millimeters; width, 0.42 millimeter; thickness, 0.12 millimeter.

Plesiotype No. 4037, locality P254, Ponce formation.

Rare at P2, P3, P254, and P255 of the Ponce formation.

A. insolita differs from *A. crepidula* of Fichtel and Moll (1798. Test. Micr.) in the irregular overlapping of the chambers in side view.

Astacolus ovatus NEW SPECIES

PLATE 8, FIGURES 10a, b

Test elongate, compressed, the early chambers coiled, later chambers becoming somewhat evolute; about 8 chambers visible, increasing regularly in size; sutures distinct, not depressed; wall smooth; aperture terminal on the outer margin of the last chamber, radial. Length, 0.70 millimeter; width, 0.38 millimeter; thickness, 0.24 millimeter.

Holotype No. 3871, locality A86, Cibao formation.

Rare at A86 of the Cibao formation.

Astacolus ovatus differs from *A. crepidula* in being less elongate and thicker.

Astacolus sublituus (Nuttall)

PLATE 8, FIGURES 11a, b

Cristellaria sublituus Nuttall (1932) Jour. Paleont. **6**: 11. pl. 1, figs. 13. 14. Lower Oligocene, Mexico.

Test elongate, much compressed; edge subacute, sharper on the back especially in the early part; early part with a narrow keel; chambers distinct, enlarging gradually in length, the last 2 or 3 not reaching back to the preceding whorl; sutures narrow, oblique, flush with the surface, very slightly limbate; aperture round and radiate, at the outer margin of the last chamber. Length, 0.71 millimeter; width, 0.26 millimeter; thickness, 0.07 millimeter.

Plesiotype No. 3872, locality A86, Cibao formation.

Rare at A86 of the Cibao formation and at P255 of the Ponce formation.

HEMICRISTELLARIA Stache 1864

Hemicristellaria fragaria (Gümbel)

PLATE 9, FIGURES 7a, b

Marginulina fragaria Gümbel (1870) Abh. k. bay. Akad. Wiss. München Math.-Phys. Cl. **10**: 635. pl. 1, figs. 58a, b (not c). Eocene, northern Alps.

Test elongate, planispirally coiled in early portion, most of the test evolute with sutures curved but tending to become at right angles to axis of the test; test oval in transverse section, angled on outer margin, carinate when one of the costae comes on the edge of the test; chambers closely appressed, not inflated; sutures flush with the surface, obscured by the ornamentation; test ornamented by longitudinal costae and elongate nodes which in places merge into continuous costae, the nodes are also in transverse ranks marking the chambers; aperture near the outer edge of the last chamber, produced, with short slit extending onto the septal face, and with vestigial radiations. Length, 1.42 millimeters; width, 0.6 millimeter; thickness, 0.32 millimeter.

Plesiotype No. 4053, locality A21, Quebradillas formation.

Common at A21; rare at A20 of the Quebradillas formation.

VAGINULINA d'Orbigny 1826

Vaginulina faba NEW SPECIES

PLATE 9, FIGURES 3a–c

Marginulina sp. Howe & Wallace (1932) La. Dept. Cons. Geol. Bull. **2**: 34. pl. 7, fig. 3. Upper Eocene, Louisiana.

Test large, elongate, bean shaped, oval in section; about 15 chambers in the test, rather short in comparison with their width, enlarging very gradually; edges angled in early part of test, later narrowly rounded; sutures flush with the surface, narrow in early part becoming broad and limbate in evolute part of test; aperture large, round and radiate, at the outer edge of the septal face. Length, 1.81 millimeters; width, 0.51 millimeter; thickness, 0.25 millimeter.

Holotype No. 4024, locality P3, Ponce formation.

Very rare at P3 of the Ponce formation.

Vaginulina mexicana Nuttall

PLATE 9, FIGURES 4a, b

Vaginulina elegans mexicana Nuttall (1932) Jour. Paleont. **6**: 16. pl. 3, figs. 12, 16. Lower Oligocene, Alazan, Mexico.—Palmer & Bermudez (1936) Mem. Cubana Hist. Nat. **10**: 277. pl. 14, figs. 23, 24. Lower Oligocene, Cuba.

Test large, elongate, compressed; test biformed, the early coiled portion being much smaller than the later evolute part of the test; rectilinear portion of the test sharply rounded on the outside, sharply angled on the inside, frequently with a narrow keel; sutures conspicuously raised along the middle of each side of the test; chamber width greater than the length, thickness and length being about the same; aperture oval, vestigially radiate, located at the outer margin of the last septal face. Length of broken specimen, 2.0 millimeters; width, 0.9 millimeter; thickness, 0.56 millimeter.

Plesiotype No. 4090, locality P3, Ponce formation.

Very rare at P2 and P3 of the Ponce formation.

Vaginulina siliquoidea NEW SPECIES

PLATE 9, FIGURES 5a, b

Vaginulina legumen elegans Cushman (1923) U. S. Geol. Surv. Prof. Pap. **133**: 30. pl. 4, fig. 8. Lower and Middle Oligocene, Mississippi and Alabama.—?Cole (1927) Bull. Am. Paleont. **14** (51): 21. pl. 3, fig. 10 (not 11). Guayabal, middle Eocene, Mexico.

Test small, elongate, oval in cross section; about 7 chambers in the test, enlarging gradually in size; sutures flush with the surface, marked by clear shell material, wide, greatest width on apertural side of the test; sutures slightly convex upward, nearly at right angles to the axis of the test; last chamber shouldered on one side, with the aperture on the other side which is slightly produced; aperture small, round, obscurely radiate. Length, 0.70 millimeter; width, 0.20 millimeter; thickness, 0.10 millimeter.

Holotype No. 4052, locality P2, Ponce formation.

Rare at P2 of the Ponce formation.

V. siliquoidea is quite different from *V. elegans* d'Orbigny (Model no. 54) in that it lacks the raised sutures. It differs from *V. legumen* (Linné) in its smaller size, fewer chambers, and the absence of a spine.

MARGINULINA d'Orbigny 1826

Marginulina insulensis NEW SPECIES

PLATE 9, FIGURES 1a–c

Test elongate with nearly parallel sides; transverse section subtriangular, with the angles rounded; early part close coiled, last 3 or 4 chambers uncoiled, only those in the uncoiled part inflated; sutures gently curved in the early coiled part of the test, oblique in the rest of the test meeting the periphery at an angle of about 45 degrees, nearly flush with the surface in the early part of the test, slightly depressed between the uncoiled chambers; aperture nearly terminal or toward the outer margin of the last septal face, round and radiate. Length, 0.76 millimeter; width, 0.21 millimeter; maximum thickness near apertural end of test, 0.16 millimeter.

Holotype No. 4062, locality P2, Ponce formation.

Rare at P2 of the Ponce formation.

Marginulina subcrassa Schwager

PLATE 9, FIGURES 2a, b

Marginulina subcrassa Schwager (1866) Novara-Exped. Geol. 2: 240. pl. 6, fig. 82. Pliocene, Kar Nikobar.

Marginulina eximia (?) Cushman (1939) Contr. Cushman Lab. Foram. Res. 15: 56. pl. 9, figs. 27, 28. Eocene, submarine core off eastern North America.

Test slightly curved, stout, circular in cross section; chambers in early part coiled, later part uncoiled, uniserial; chambers closely appressed, the last chamber fairly elongate, tapering to the aperture; sutures oblique, slightly depressed, more so on the concave side of the test; surface smooth; aperture produced, radiate, terminal on convex side of the test. Length, 0.85 millimeter; diameter, 0.29 millimeter.

Plesiotype No. 4057, locality P2, Ponce formation.

Rare at P2, P254, and P255 of the Ponce formation.

AMPHICORYNE Schlumberger 1881

Amphicoryne obliqua NEW SPECIES

PLATE 9, FIGURES 8a, b

Test biformed, the outer edge sharply angled, the early part compressed consisting of several chambers arranged as in *Vaginulina*, later part nodosarian, not compressed, consisting of only one globular chamber; sutures somewhat depressed; surface ornamented by diagonal costae, about 18 on the last chamber and fewer on the vaginuline part of the test; costae discontinuous across the sutures; a few costae extend up onto the lower part of the neck, the upper part of which is ornamented with a few obscure horizontal rings; aperture terminal, round, not definitely radiate. Length, 0.73 millimeter; width, 0.27 millimeter.

Holotype No. 3861, locality P2, Ponce formation.

Very rare at P2 of the Ponce formation.

This species differs from *A. falx* (Jones and Parker) (1860. Quart. Jour. Geol. Soc. London **16**) particularly in the oblique and discontinuous costae.

GLANDULINA d'Orbigny 1839

Glandulina comatula (Cushman)

PLATE 10, FIGURES 6a–c; PLATE 11, FIGURES 1a, b

Nodosaria comatula Cushman (1923) Bull. U. S. Nat. Mus. **104** (4): 83. pl. 14, fig. 5. Recent, Gulf of Mexico, West Indies, Caribbean.—Nuttall (1928) Quart. Jour. Geol. Soc. London **84**: 84. pl. 5, fig. 3. Lower Miocene, Trinidad.

Test short and stout, gradually enlarging from the first chamber, initial end broadly rounded, usually with a short, stubby spine, apertural end tapering to the aperture; chambers few, 2 to 5, slightly inflated, gradually enlarging; sutures obscure, slightly depressed; surface ornamented by numerous low, rounded, longitudinal costae, continuous from chamber to chamber, close together, 35–45 on the last-formed chamber; in the adult, the apertural end of the last chamber may be smooth; aperture terminal, central, distinctly radiate. Length, 1.20 millimeters; diameter, 0.35 millimeter.

Plesiotypes No. 3919a, b, locality P2, Ponce formation.

Common at P2; rare at P3 and P255 of the Ponce formation.

Glandulina gallowayi (Cushman)

PLATE 11, FIGURES 2a, b

Glandulina comata Galloway & Morrey (1929) Bull Am. Paleont. **15** (55): 13. pl. 1, fig. 7a, b. Lower Oligocene, Ecuador.

Pseudoglandulina gallowayi Cushman (1929) Contr. Cushman Lab. Foram. Res. **5**: 87. pl. 13, fig. 13. Oligocene, or Miocene, Ecuador.

Test pyriform, maximum diameter above the middle of the test, form ratio 1.4; initial end subacute, apertural end conical; chambers few, obscure, uniserial in arrangement; sutures obscure; surface ornamented by 20 to 24 high, rather heavy, round costae which are continuous from the apical end to near the apertural end; apertural face smooth; aperture terminal, slightly produced, round, with radiating slits. Length, 0.55 millimeter; diameter, 0.41 millimeter.

Plesiotype No. 3951, locality A86, Cibao formation.

Rare at A86 of the Cibao formation and P254 of the Ponce formation.

Although forms which are identified as *Lagena strumosa* Reuss occur in the Porto Rican material, they do not come from the same localities as the specimens of *G. gallowayi* and, in any event, it seems improbable that they could be young specimens of *G. gallowayi* as was stated by Cushman in 1929 for the following reasons:

1. The shape of the apical end of the test is different in the two forms, that of *G. gallowayi* being much more tapering.
2. The aperture is distinctly radiate in *G. gallowayi* but is not in *L. strumosa*.

Glandulina mauricensis Howe & Roberts

PLATE 10, FIGURE 7

Pseudoglandulina mauricensis Howe & Roberts (1939) La. Dept. Cons. Geol. Bull. **14**: 48. pl. 6, fig. 10. Middle Eocene, Louisiana.

Test small, stout, circular in cross section, composed of two spheroidal chambers, last chamber overlapping about a third of the earlier one; suture depressed; initial chamber with an apical spine; aperture terminal, round and radiate. Length, 0.38 millimeter; diameter, 0.22 millimeter.

Plesiotype No. 4047, locality P254, Ponce formation.

Rare at P254 of the Ponce formation.

DENTALINA d'Orbigny 1839

Dentalina advena (Cushman)

PLATE 9, FIGURES 9a, b

Nodosaria advena Cushman (1923) Bull. U. S. Nat. Mus. **104** (4): 79. pl. 14, fig. 12. Recent, Gulf of Mexico, Caribbean Sea, and off northeastern U. S.
Dentalina communis Cushman & Cahill (1933) U. S. Geol. Surv. Prof. Pap. **175A**: pl. 5, fig. 2. Miocene, Florida.

Test elongate, slender, slightly tapering, slightly curved, circular in cross section; chambers numerous, about 7 in the complete test, those near the apertural end inflated a little; sutures oblique, slightly depressed, more so on the convex edge of the test; surface smooth, unornamented; aperture radiate, eccentric, nearer the concave side of the test. Length, 1.55 millimeters; diameter, 0.28 millimeter.

Plesiotype No. 3895, locality P254, Ponce formation.

Rare at P2, P254, and P255 of the Ponce formation.

Many forms which have been referred to *D. communis* (d'Orbigny) probably belong to *D. advena*. The features of d'Orbigny's species are well shown by Fornasini in his reproduction of d'Orbigny's unpublished figure (1898. Mem. R. Accad. Sci. Ist. Bologna V. **7**) in which the test has 12 chambers and an apical spine.

D. advena bears a strong resemblance to *D. debilis* Hantken (1875. Mitt. Jahr. k. ungarn geol. Anstalt **4 (1)**).

Dentalina halkyardi Cushman

PLATE 9, FIGURES 10a, b

Dentalina halkyardi Cushman (1933) Contr. Cushman Lab. Foram. Res. 9: 9. pl. 1. fig. 20. Upper Eocene, South Carolina and Biarritz.

Test elongate, very slightly tapering; chambers about 5, subglobular, the early ones more closely appressed than the later ones; early sutures obscure, nearly flush with the surface of the test, later sutures depressed; surface conspicuously ornamented, the early chambers ornamented by discontinuous longitudinal costae, about 7 visible on each side of the test, the next chambers with spinose projections developing at the apical ends of the interrupted costae, the last chamber with a series of fine pustules in longitudinal lines; aperture round, terminal and slightly produced, not definitely radiate. Length, 1.00 millimeter; diameter of last chamber, 0.30 millimeter.

Plesiotype No. 3892, locality P2, Ponce formation.

Very rare at P2 of the Ponce formation.

Dentalina halkyardi ponceana NEW VARIETY

PLATE 9, FIGURES 11a, b

Test elongate, tapering, slightly arcuate, circular in cross section; apical end blunt, with a short, stout spine; about 8 chambers in the test, increasing slowly in size, early chambers slightly wider than long, last chamber nearly equidimensional; first few chambers very slightly inflated, sutures nearly flush with the surface; later chambers inflated, widest near the basal part of each chamber, separated by depressed sutures; surface ornamented by 12–14 diagonal costae which are continuous on the first 3–4 chambers and which extend to the final chamber; costae become discontinuous after the first 4 chambers with apically pointing spines or prickles on the costae of penultimate chamber and finally break up into spines on the lower two-thirds of the last chamber, apertural third of the final chamber being unornamented; apertural end of final chamber slightly produced, aperture eccentric, round and radiate. Length, 2.37 millimeters; diameter, 0.53 millimeter.

Holotype No. 3893, locality P3, Ponce formation.

Rare at P2, P3, and P255 of the Ponce formation.

This variety differs from *D. halkyardi* Cushman (1933. Contr. Cushman Lab. Foram. Res. **9**) in the strongly oblique character of the longitudinal costae, the presence of an apical spine, and the presence of separate spines on the final chamber only.

Dentalina hillaeformis NEW SPECIES

PLATE 9, FIGURE 12

Nodosaria pauperata Cushman (not d'Orbigny) (1923) Bull. U. S. Nat. Mus. **104** (4): pl. 14, fig. 13. Recent off northeastern U. S.

Test stout, curved, with short apical spine; round in cross section; chambers few, 4 to 5, somewhat inflated; sutures narrow, slightly oblique, slightly depressed, more so on the convex side of the test; aperture terminal, radiate, eccentric. Length, 0.73 millimeter; diameter, 0.18 millimeter.

Holotype No. 3890, locality P2, Ponce formation.

Rare at P2 of the Ponce formation.

D. hillaeformis (sausage-shaped) differs from *D. pauperata* d'Orbigny (1846. Foram. Foss. Vienne) in having fewer chambers, and short, stouter test.

Dentalina multilineata Bornemann

PLATE 9, FIGURE 13

Dentalina multilineata Bornemann (1855) Zeitsch. deutsch. geol. Ges. **7**: 325. pl. 13, fig. 12. Middle Oligocene, Germany.—Cushman (1927) Jour. Paleont. **1**: 152. pl. 24, figs. 7, 8. Lower Oligocene, Alazan, Mexico.—Nuttall (1932) Jour. Paleont. **6**: 14. pl. 3, fig. 5. Lower Oligocene, Alazan, Mexico.

Test elongate, slender, with apical spine; chambers elongate; sutures slightly depressed; surface ornamented by numerous continuous, rather fine, longitudinal costae which are oblique on the first few chambers; apertural end not observed. Length of broken specimen, 1.5 millimeters; diameter, 0.25 millimeter.

Plesiotype No. 4035, locality P254, Ponce formation.

Rare at P254 of the Ponce formation.

Dentalina semilaevis Hantken

Plate 9, figure 14

Dentalina semilaevis Hantken (1876) Magyar kir. földt. int. évkön. 4: 32. pl. 4, fig. 6, pl. 12, fig. 13. Lower Oligocene, Hungary.—Nuttall (1932) Jour. Paleont. 6: 15. pl. 3, fig. 8. Lower Oligocene, Mexico.

Test slender, elongate, slightly arcuate; chambers numerous, about 12 in the adult test; sutures oblique to the main axis of the test, limbate, flush with the surface in most of the test, being slightly depressed between the last few chambers; surface ornamented by about 14 oblique, longitudinal costae, which extend from the apical end as far as the lower half of the last or next to the last chamber; aperture not preserved on the Porto Rican specimens. Length of broken specimen, 1.7 millimeters; diameter, 0.3 millimeter.

Plesiotype No. 3894, locality P3, Ponce formation.

Rare at P3 of the Ponce formation.

NODOSARIA Lamarck 1812

Nodosaria halkyardi antillana Palmer & Bermudez

Plate 10, figure 2

Nodosaria halkyardi antillana Palmer & Bermudez (1936) Mem. Soc. Cubana Hist. Nat. 10: 269. pl. 16, fig. 3. Lower Oligocene, Cuba.

Test incomplete; last chamber top-shaped, tapering abruptly at the apertural end to a distinct, rather long neck, with ring-like costae; surface of the test ornamented by about 15 sharp, longitudinal costae which extend from the base of the neck about half the length of the chamber, terminating in spines; surface of the lower half of the chamber irregularly papillate and hispid; aperture terminal, round. Diameter of the test, 0.37 millimeter.

Plesiotype No. 4060, locality A86, Cibao formation.

Very rare at A86 of the Cibao formation.

The Porto Rican form has fewer costae and less globular chambers than the type figure of *N. halkyardi antillana*.

Nodosaria longiscata d'Orbigny

Plate 11, figure 8

Nodosaria longiscata d'Orbigny (1846) Foram. Foss. Vienne 32. pl. 1, figs. 10–12. Middle Miocene, Vienna.—Nuttall (1928) Quart. Jour. Geol. Soc. 84: 81. pl. 4, fig. 13. Lower Miocene, Trinidad.—Hedberg (1937) Jour. Paleont. 11: 671. pl. 91, figs. 3, 4. Oligocene, Venezuela.

Test slender, stem-like except for the inflated first chamber; first chamber globular, succeeding chambers indistinct, much smaller in diameter, cylindrical in shape; sutures obscure, flush with the surface, at right angles to the length of the test; surface smooth; apertural end not found. Length, 1.5 millimeters; diameter of globular chamber, 0.32 millimeter; diameter of stem-like portion of test, 0.2 millimeter.

Plesiotype No. 3934, locality P3, Ponce formation.

Rare at P3 and P254 of the Ponce formation.

Nodosaria obliquata (Batsch)

Plate 11, figure 5

Nautilus (Orthoceras) obliquatus Batsch (1791) Conch. Seesands pl. 2, figs. 5a–d. Recent, Rimini.

Nodosaria obliquata Cushman (1931) Contr. Cushman Lab. Foram. Res. 7: 65. pl. 8, figs. 15–19. Recent, Rimini.—Hadley (1934) Bull. Am. Paleont. 20 (70A): 12. pl. 1, fig. 13. Oligocene, probably upper, Cuba.

Test elongate, curved, blunt apically with a stout spine; tapering at the apertural end; 7 chambers, somewhat longer than wide, becoming slightly more elongate toward the apertural end of the test; sutures obscure, flush between the early chambers, depressed between the last few chambers; surface ornamented with 8–10 low, longitudinal, oblique costae, extending from the apical end to the lower part of the last chamber, the upper part of the last chamber being smooth; aperture terminal, round, not definitely radiate. Length, 1.4 millimeters; diameter, 0.18 millimeter.

Plesiotype No. 3935, locality P3, Ponce formation.

Very rare at P3 of the Ponce formation.

The Porto Rican form is similar to *N. vertebralis*, but it is nearer the topotype figure of *N. obliquata* given by Cushman (1931. pl. 8, fig. 19). It differs from the original figures by Batsch in the fewer costae.

Nodosaria pariana Hedberg

Plate 11, figure 7

Nodosaria longiscata Cole & Ponton (1930) Fla. Geol. Surv. Bull. 5: 33. pl. 6, fig. 4. Lower Oligocene, Florida.

Nodosaria pariana Hedberg (1937) Jour. Paleont. 11: 672. pl. 91, fig. 5. Oligocene, Venezuela.

Test small, elongate, consisting of a bulbous proloculum and from 2 to 5 keg-shaped chambers of smaller diameter than the proloculum; sutures slightly depressed, obscure, transverse; surface smooth; the proloculum is provided with a large apical spine; aperture not seen in the fragmentary specimens. Length of incomplete specimen, 0.7 millimeter; diameter of later chambers, 0.2 millimeter.

Plesiotype No. 4099, locality P254, Ponce formation.
Rare at P254 of the Ponce formation.

Nodosaria raphanistrum (Linné)

Plate 11, figure 6

Nautilus raphanistrum Linné (1758) Sys. Nat. ed. 10. 710. Recent.
Nodosaria raphanistrum Cushman (1918) Bull. U. S. Nat. Mus. **103**: 59. pl. 21, fig. 10. Oligocene, Panama Canal Zone.—Nuttall (1928) Quart. Jour. Geol. Soc. **84**: 82. pl. 4, fig. 21. Lower Miocene, Trinidad; (1932) Jour. Paleont. **6**: 16. pl. 3, fig. 10. Lower Oligocene, Mexico.

Test large, long and stout, tapering very slightly if at all; circular in cross section; chambers a little wider than high, slightly inflated, enlarging gradually; sutures depressed; surface ornamented by about 14 prominent, heavy ribs which are continuous across the sutures and extend up to the aperture; aperture terminal, round, slightly produced. Length of broken specimen, 2.5 millimeters; diameter, 1.3 millimeters.

Plesiotype No. 4097, locality P3, Ponce formation.
Rare at P3 and P255 of the Ponce formation.

Nodosaria scalaris (Batsch)

Plate 10, figure 4

Nautilus (Orthoceras) scalaris Batsch (1791) Conch. Seesandes 91. pl. 95, figs. B–M. Recent, Adriatic.
Nodosaria scalaris Brady (1884) Rep. Voy. Challenger Zool. **9**: 510. pl. 63, figs. 28–31. Recent, Pacific, north Atlantic.

Test cylindrical, composed of few, nearly spherical chambers; apical end blunt, usually with an apical spine; chambers increasing rather rapidly in size; sutures depressed; surface ornamented by numerous longitudinal costae, 10–12 visible from one side of the test; aperture terminal, round, faintly radiate, at the end of a fairly long neck. Length, 0.85 millimeter; diameter, 0.38 millimeter.

Plesiotype No. 3936, locality P255, Ponce formation.
Rare at P2, P254, and P255 of the Ponce formation.

Nodosaria simplex Silvestri

Plate 10, figure 3

Nodosaria simplex Silvestri (1872) Atti. Accad. Gioenia Sci. Nat. III. **7**: 95. pl. 11, figs. 268–272. Pliocene, Italy.—Cushman (1923) Bull. U. S. Nat. Mus. **104** (4): 68. pl. 14, fig. 10. Recent, western Atlantic.
Nodosaria sp. Cushman (1933) Bull. U. S. Nat. Mus. **161** (2): 14. pl. 3, fig. 11. Recent, tropical Pacific.

Test short, consisting of only two chambers, closely appressed; suture depressed; apical end with a short, slender spine; apertural end constricting rapidly to form a tapering neck; apertural end of neck broken. Length, 0.62 millimeter; diameter, 0.30 millimeter.

Plesiotype No. 4061, locality P2, Ponce formation.

Very rare at P2 of the Ponce formation.

LAGENA Walker & Boys 1784

Lagena ampulla NEW SPECIES

PLATE 11, FIGURES 9a, b

Ovulina tenuis Bornemann (1855) Zeitsch. deutsch. Geol. Ges. 7: 317. pl. 12, fig. 3*a, b (not fig. 3a, b which we here select as the type of Bornemann's species). Middle Oligocene, Hermsdorf.

Test flask shaped, nearly circular in cross section, body of test subcylindrical; neck moderately long, gradually contracted from the body of the test; surface ornamented with 10 medium sized costae which begin at or near the apex and extend up onto the beginning of the neck; upper part of neck unornamented; apical end broadly rounded; aperture simple, round, terminal. Length, 0.42 millimeter; diameter, 0.17 millimeter.

Holotype No. 3926, locality L6C, San Sebastian formation.

Rare at L1C, L2C, and L6C of the San Sebastian formation, and at P2 of the Ponce formation.

This species differs from *L. amphora* Reuss (1862. Sitz. k. Ak. Wiss. Wien **46 (1)**) in having fewer costae, a shorter neck, and a more abruptly tapering apertural end. *L. raricosta* (d'Orbigny) (1839. Voy. Amèr. Mèrid. **5 (5):** Foraminifères) is less elongate and has a shorter neck. *L. tenuis* (Bornemann), as designated above, is similar neither in shape nor ornamentation.

Lagena bullosa NEW SPECIES

PLATE 11, FIGURES 10a, b

Test spheroidal with long neck and short, blunt apical spine; surface covered with round knobs of different sizes, the neck covered with short, transverse ridges; aperture terminal, round, without phialine lip, but with radial petaloid depressions. Length, 0.7 millimeter; diameter, 0.47 millimeter.

Holotype No. 4079, locality P2, Ponce formation.

Rare at P2 of the Ponce formation.

Although there are numerous spinose forms of *Lagena* the combination of the knobby surface, rugose neck, and apical spine seems not to have been recognized. It may have evolved from a *Lagenonodosaria,* such as the form figured by Brady in the Challenger Report (pl. 63, fig. 16).

Lagena impressa NEW SPECIES

PLATE 10, FIGURES 10a–c

Test small, globular with flat base and conical apertural end, broadly oval in end view; surface ornamented with a whorl of small costae on one side, suggestive of a finger print, and with small, vertical, dividing and anastomosing costae on the opposite side; aperture small, terminal, round, neither radiate nor with a neck or phialine lip. Length, 0.5 millimeter; breadth, 0.44 millimeter; thickness, 0.36 millimeter.

Holotype No. 4094, locality P2, Ponce formation.

Rare at P2 of the Ponce formation.

The ornamentation of this species is similar to that of *L. curvilineata* (Cushman (1923) Bull. U. S. Nat. Mus. **104 (4)**: pl. 2, figs. 5–7), but the species are otherwise dissimilar.

Lagena nuttalli NEW SPECIES

PLATE 10, FIGURES 8a, b

Lagena sulcata Nuttall (not Walker & Jacob) (1928) Quart. Jour. Geol. Soc. London **84**: 79. pl. 4, fig. 3. Oligocene and Miocene, Trinidad.

Test subglobose, slightly longer than wide, with large, inflated neck, constricted at the base and tapering rapidly to the apertural end; apical end broadly rounded, with a few inconspicuous spinose projections; surface of the test ornamented by about 26 fine, longitudinal costae which extend from the base of the test to the apertural end of the neck; sometimes decreasing by merging and sometimes increasing by implantation; aperture terminal, round, without lip. Length, 0.53 millimeter; diameter, 0.35 millimeter.

Holotype No. 4054, locality P254, Ponce formation.

Rare at P2 and P254; common at P255 of the Ponce formation.

Lagena strumosa Reuss

PLATE 10, FIGURES 9a, b

Lagena strumosa Reuss (1858) Zeitsch. geol. Ges. 434; (1863) Sitz. Akad. Wiss. Wien **46** (1): 328. pl. 4, fig. 49. Oligocene, Pietzpuhl, Germany.

Lagena striata strumosa Cushman (1913) Bull. U. S. Nat. Mus. **71** (3): 20. pl. 7, figs. 7–10. Recent, Pacific; (1918) Bull. U. S. Nat. Mus. **103**: 58. pl. 21, fig. 7. Lower Gatun formation, middle Miocene, Panama Canal Zone.

Test subglobular; apical end with a short stout spine; apertural end with an elongate neck; surface of the test ornamented with about 30 low, round costae, several of which extend up onto the neck; costae terminate near the base of the test with spinose projections; aperture terminal, round, at the end of an elongate neck. Length, 0.61 millimeter; diameter, 0.36 millimeter.

Plesiotype No. 4055, locality P255, Ponce formation.

Common at P255; rare at P3 of the Ponce formation.

ROBULUS Montfort 1808

Robulus calliferus (Stache)

PLATE 11, FIGURES 12a, b

Cristellaria callifera Stache (1864) Novara-Exped. Geol. **1**: 236. pl. 23, figs. 15a, b. Middle Tertiary, Auckland.

Test round, strongly biconvex, with a narrow, angled keel of clear shell material; 9 to 10 chambers in the last whorl, enlarging very gradually in size; sutures flush with the surface, marked by broad bands of clear shell material, curved, merging at the center with a small umbonal area of clear shell material; aperture peripheral, at the outer margin of the last septal face, a narrow slit extending down into the last septal face, finely radiate on the outer sides, not on the septal face. Diameter, 1.1 millimeters; thickness, 0.67 millimeter.

Plesiotype No. 4096, locality P2, Ponce formation.

Rare at P2 and P254 of the Ponce formation.

This species is similar to *R. arcuatostriatus carolinianus* Cushman (1933. Contr. Cushman Lab. Foram. Res. **9**) but differs in being thicker, with narrower keel, flush sutures, and non-protruding aperture.

Robulus chambersi Garrett

PLATE 12, FIGURES 1a, b

Robulus chambersi Garrett (1939) Jour. Paleont. **13**: 576. pl. 65, figs. 8, 9a, b. Middle Tertiary, Texas.

Robulus clericii Coryell & Rivero (1940) Jour. Paleont. **14**: 332. pl. 43, figs. 7a–b. Middle Miocene, Haiti.

Test thick, lenticular, biumbonate; edge angled with narrow keel of clear shell material; 5 to 6 chambers in the last whorl; sutures limbate, flush with the surface or slightly raised, sharply curved near the umbonal region, then oblique to the periphery; umbonal region filled with clear shell material; aperture radiate at outer margin of the last chamber with a short, narrow slit extending down onto the last septal face. Diameter, up to 0.73 by 0.85 millimeters; thickness, 0.45 millimeter.

Plesiotype No. 3973, locality P254, Ponce formation.

Common at A86 of the Cibao formation. Rare at A21; common at A20 of the Quebradillas formation. Rare at P3 and P254; common at P251 of the Ponce formation.

As was stated by Garrett, *R. chambersi* differs from *R. clericii* (Fornasini), "in having fewer chambers, very prominent sutures and prominent umbones".

Robulus cibaoensis NEW SPECIES

PLATE 12, FIGURES 8a, b

Test subcircular tending to be pentagonal in side view, thick discoidal in edge view; 5 to 6 chambers in the last whorl, last chamber most inflated especially in apertural view; sutures flush with the surface except between the last two chambers where it is a little depressed; edge with narrow keel; aperture at the outer margin of the last septal face, elongate and radiate; apertural face very wide, with strongly convex sides. Diameter, 0.48 by 0.56 millimeters; thickness, 0.35 millimeter.

Holotype No. 4036, locality A86, Cibao formation.

Rare at A86 of the Cibao formation.

R. cibaoensis is somewhat similar to Brady's figure of *Cristellaria articulata* (1884. Rep. Voy. Challenger Zool.) but it is thicker, has fewer chambers, and a wider apertural face.

Robulus convergens (Bornemann)

PLATE 12, FIGURES 3a, b

Cristellaria convergens Bornemann (1855) Zeitsch. deutsch. geol. Ges. 7: 327. pl. 13, fig. 16. Middle Oligocene, Germany.—Brady (1884) Rep. Voy. Challenger Zool. 9: 546. pl. 69, figs. 1–4. Recent, Atlantic and Pacific Oceans.—Cushman (1923) U. S. Geol. Surv. Prof. Pap. 133: 28. pl. 4, fig. 2. Lower Oligocene, Mississippi and Alabama; (1927) Jour. Paleont. 1: 152, pl. 23, fig. 12. Alazan, lower Oligocene, Mexico.

Lenticulina convergens Cole & Gillespie (1930) Bull. Am. Paleont. 15 (57B): 7. pl. 3, fig. 1. Middle Oligocene, Meson formation, Mexico.

Test lenticular, biconvex; broadly oval in side view; edge subangular with narrow margin of clear shell material; about 6 chambers in the last whorl, enlarging rather rapidly, with the lateral faces of the last chamber drawn together so as to form an extremely narrow septal face; sutures limbate, rather oblique, flush with the surface of the test; aperture radiate at the outer margin of the last chamber with a slit extending down onto the last septal face. Diameter, 0.83 by 1.10 millimeters; thickness, 0.40 millimeter.

Plesiotype No. 3974, locality P3, Ponce formation.

Rare at A86 of the Cibao formation. Common at P3, P254, and P255 of the Ponce formation.

Robulus falcifer (Stache)

PLATE 12, FIGURES 5 and 6

Cristellaria falcifer Stache (1864) Novara-Exped. Geol. 1: 240. pl. 23, figs. 19a, b. Upper Eocene, Auckland.

Cristellaria subalata Chapman (1926) New Zealand Geol. Surv. Paleont. Bull. 11: 65. pl. 4, fig. 19 (not 25, 26). Upper Eocene, New Zealand.

Test nearly circular in side view, close coiled, biconvex; edge sharply angled with a narrow keel; 9 to 11 chambers in the last whorl, increasing very slowly in size; sutures strongly curved, limbate and raised, ending in a raised umbonal area; aperture peripheral, at the outer margin of the last septal face, radiate, with a slit extending down into the last septal face. Diameter, 0.53 by 0.60 millimeter; thickness, 0.33 millimeter.

Plesiotypes No. 4074a and b, locality A21, Quebradillas formation.

Abundant at A21 of the Quebradillas formation.

Robulus iota (Cushman)

PLATE 12, FIGURES 7a, b

Cristellaria iota Cushman (1923) Bull. U. S. Nat. Mus. 104 (4): 111. pl. 29, fig. 2. Recent, Atlantic; (1930) Fla. Geol. Surv. Bull. 4: 25. pl. 4, fig. 1. Miocene, Florida.

Test large, circular in side view, gently biconvex, with umbonal bosses of clear shell material; edge acute with thin carina of clear shell material; chambers 12–13 in the adult whorl, short and wide; sutures flush with the surface, limbate, radial near the umbonal region, curving more and more to the periphery; aperture at the outer margin of the last septal face, radiate outside, with a slit extending down onto the septal face. Diameter, 1.7 millimeters; thickness, 0.6 millimeter.

Plesiotype No. 3976, locality P2, Ponce formation.

Rare at P2 of the Ponce formation.

Our specimens differ from typical *R. iota* in lacking the wide, sharp keel. They are much like the Florida Miocene specimens.

Robulus occidentalis torridus (Cushman)

PLATE 12, FIGURES 4a, b

Cristellaria occidentalis torrida Cushman (1923) Bull. U. S. Nat. Mus. 104 (4): 105. pl. 25, fig. 1. Recent, Gulf of Mexico.

Robulus occidentalis torrida Cushman & Jarvis (1930) Jour. Paleont. 4: 357. pl. 32, figs. 8a, b. Miocene, Jamaica.

Test biconvex, umbonate with relatively small umbonal filling of clear shell material where sutures converge; edge angled with keel of clear shell material about 0.17 millimeter wide; 5–6 chambers in last whorl, subtriangular in shape, enlarging gradually; sutures curved, broadly limbate, flush with the surface; aperture a slit just below the outer point of the last chamber, radiate on the outer edge. Average dimensions: diameter, 1.24 by 1.48 millimeters; thickness, 0.68 millimeter.

Plesiotype No. 4096, locality P3, Ponce formation.

Common at P2, P3, and P255 of the Ponce formation.

Robulus planulus NEW SPECIES

PLATE 11, FIGURES 14a, b

Test small, compressed, nearly flat on the sides, biumbilicate, consisting of about 2 whorls of chambers, all visible on both sides of the test; chambers 6 to 7 in the last whorl, enlarging gradually, slightly inflated; sutures distinct, limbate, with limbation continuing along the periphery forming a narrow border, outside of which is a narrow, flat keel set off from the border by a square shoulder; surface smooth; septal face concave; aperture a narrow slit extending down into the septal face, finely but distinctly radiate outside, the throat of the aperture showing through the clear shell material. Diameter, 0.42 by 0.61 millimeters; thickness, 0.12 millimeter.

Holotype No. 3979, locality A86, Cibao formation.

Common at A86 of the Cibao formation.

This pretty little species is distinctive in its much compressed test, and shouldered and flanged edge. This form might be placed in the genus *Planularia* by some students of Foraminifera, but that genus is evolute and triangular in side view and more like *Vaginulina* than *Robulus,* as an inspection of the type figure will demonstrate.

Robulus plummerae Cole

PLATE 12, FIGURES 9a, b

Robulus plummerae Cole (1928) Bull. Am. Paleont. 14 (53): 8. pl. 3, fig. 10. Upper Eocene, Chapopote formation, Mexico.

Test small, subcircular, strongly biconvex, involute beyond umbo; edge acute with narrow keel which narrows orad and disappears on the last chamber; chambers few, 4 or 5 in the last whorl; sutures flush with the surface, gently curved, bordered with clear shell material, meeting in the umbonal region but not making a boss; surface smooth; apertural face crescentic, concave; aperture a narrow triangular slit extending down into the septal face, finely radiate laterally. Diameter, 0.53 by 0.66 millimeter; thickness, 0.35 millimeter.

Plesiotype No. 3977, locality P254, Ponce formation.

Rare at locality P254 of the Ponce formation.

Cole's description and figure are inadequate for certain recognition of his species. Our specimens are smaller but seem otherwise identical. This species reminds one of *Cristellaria crassa* d'Orbigny (1846. Foram. Foss. Vienne), and the Cuban specimens referred to that species by Palmer and Bermudez (1936. Mem. Soc. Cubana Hist. Nat. **10:** 252), which they say is "without any robuline slit". In our experience species of *"Cristellaria"* with a round aperture are extremely rare or probably nonexistent, excepting strongly evolute forms properly referable to other genera. All discoidal forms have robuline apertures.

Robulus protuberans (Cushman)

Plate 11, figures 13a, b

Cristellaria protuberans Cushman (1918) Bull. U. S. Nat. Mus. 103: 61. pl. 22, fig. 2. Lower Culebra formation, Oligocene, Panama Canal Zone.

Test large, biconvex but thin; the umbonal region ornamented with large, round knobs; edge angled with prominent keel of clear shell material which narrows and disappears on the last chamber; chambers essentially planispiral in arrangement, tending to become evolute, 10 in the last whorl; chambers inflated, separated by deep, nearly radial sutures; aperture produced near the outer margin of the last septal face, radiate outside, with a small slit extending down onto the apertural face and becoming oval; apertural face flat, narrowly elliptical. Maximum diameter, 2.75 millimeters; thickness, 0.30 millimeter.

Plesiotype No. 3980, locality P2, Ponce formation.

Very rare at P2 of the Ponce formation.

The specimen figured is a little asymmetrical. It is interesting to note that the species which most closely resembles this unusual form of *Robulus* is *Cristellaria karreri* Rzehak from the Miocene of Czecho-Slovakia. *R. protuberans* differs in that it has more chambers, a narrower keel, and is more evolute.

Robulus subpapillosus (Nuttall)

Plate 12, figures 2a, b

Cristellaria subpapillosa Nuttall (1932) Jour. Paleont. 6: 12. pl. 1, fig. 12. Lower Oligocene, Mexico.

Test biconvex, ovate in side view, tending to become evolute; edge acute, without distinct keel, but with thin, flat, short, spinose projections at the ends of most of the sutures; 9 to 10 chambers in the last whorl, increasing more rapidly in width than in length; sutures distinct, depressed or flush with the surface between the last few chambers, slightly raised with beadlike ornamentation between the earlier chambers of the last whorl, the beads larger near the umbo; septal face flat, narrow; aperture at the outer margin of the last septal face, slightly produced, large, oval and coarsely radiate. Length, 1.28 millimeters; width, 0.9 millimeter; thickness, 0.44 millimeter.

Plesiotype No. 4095, locality P3, Ponce formation.

Rare at P3 and P255 of the Ponce formation.

R. subpapillosa differs from *R. gutticostatus* (Gümbel) in that it has no keel. Although not figured, the forms referred to *Cristellaria gutticostata* by Palmer and Bermudez from the Lower Oligocene of Cuba probably belong to this species. They state that, "specimens referred to this species differ from the type in the development of short, peripheral spines, frequently without an intervening flange" (1936. Mem. Soc. Cubana Hist. Nat. **10**).

Young specimens of *R. subpapillosus* are like *R. brevispinosus* (Nuttall) (1928. Quart. Jour. Geol. Soc. London **84**).

LINGULINA d'Orbigny 1826

Lingulina ponceana NEW SPECIES

PLATE 11, FIGURES 11a, b

Test moderately compressed; smoothly ovate, not lobulate, in side view, slightly longer than wide, apical and apertural ends equally rounded, greatest width midway of the test; biconvex in cross section, edge narrowly rounded with a border of clear shell material; chambers few, usually 4, increasing rapidly in size as added, the lower margin of each chamber slightly overhanging the preceding chamber along the periphery; sutures flush with surface of test except for the last one which is slightly depressed; wall smooth and polished; aperture terminal, an elongate slit parallel to the compression of the test. Length, 1.50 millimeters; width, 1.27 millimeters; thickness, 0.63 millimeter.

Holotype No. 3927, locality P3, Ponce formation.

Rare at P3 of the Ponce formation.

This species most closely resembles *L. cubensis* Cushman and Bermudez from the Eocene of Cuba (1937. Contr. Cushman Lab. Foram. Res. 13) but differs in its larger size, in the absence of a "distinct, sharp keel", and the absence of any coiled early stage.

Lingulina semicostata NEW SPECIES

PLATE 10. FIGURES 11a, b

Test ovate in side view, thickly elliptical in end view, composed of two chambers, the latter one constituting about two-thirds of the test; edge sharply rounded; sutures depressed; earlier chamber ornamented with narrow, low costae, those near the edge being continuous across the rounded base of the test; later chamber smooth and unornamented except for 5 obscure costae paralleling each edge of the chamber, the middle one being the widest; aperture an elongate slit, terminal and parallel to the compression of the test. Length, 0.85 millimeter; width, 0.72 millimeter; thickness, 0.54 millimeter.

Holotype No. 3928, locality P2, Ponce formation.

Rare at P2 of the Ponce formation.

FISSURINA Reuss 1850

Fissurina laevis Seguenza

PLATE 11, FIGURES 3a, b

Fissurina laevis Seguenza (1862) Foram. Monotal. Miocen. Messina 58. pl. 2, figs. 22, 23. Miocene, Italy.

Test oval in side view; edge sharply angled with two small subsidiary carinae; surface smooth; aperture terminal, fissurine. Length, 0.31 millimeter; width, 0.27 millimeter; thickness, 0.20 millimeter.

Plesiotype No. 4043, locality P2, Ponce formation.

Rare at P2 of the Ponce formation.

Fissurina marginata (Walker & Boys)

PLATE 11, FIGURES 4a, b

Serpula (Lagena) marginata Walker & Boys (1784) Test. Min. 2. pl. 1, fig. 7. Recent, England.
Vermiculum marginatum Montagu (1803) Test. Brit. 524.

Test oval in side view, the basal end broadly rounded, apertural end tapering; thick elliptical in end view; entire test bordered by a thin, moderately wide keel of clear shell material; surface smooth; aperture terminal, fissurine, bordered by a thickened lip, and with the sides of the neck excavated. Length, 0.54 millimeter; width, 0.37 millimeter; thickness, 0.17 millimeter.

Plesiotype No. 4044, locality P254, Ponce formation.

Rare at P254 and P255 of the Ponce formation.

Family **POLYMORPHINIDAE** d'Orbigny 1846

POLYMORPHINA d'Orbigny 1826

Polymorphina terquemiana Fornasini

PLATE 13, FIGURES 3a–c

Polymorphina amygdaloides terquemiana Fornasini (1902) Mem. Accad. Istit. Sci. Bologna V. 9: 72. fig. 25 (in text). Pliocene, Island of Rhodes.
Sigmomorphina semitecta terquemiana Cushman (1930) Proc. U S. Nat. Mus. 77 (6): 129. pl. 33, figs. 4, 5. pl. 34, figs. 2, 3, pl. 35, fig. 1. Recent, Mediterranean; Pliocene, Italy; Miocene, France; Eocene, France, Alabama, Georgia.

Test elongate oval in side view, with abruptly tapering initial end and more rounded apertural end, maximum width of the test about midway of the length of the test; in apertural view somewhat compressed; chambers elongate, all extending down nearly to the base, with earlier chambers showing on both sides of the test; sutures scarcely depressed, distinct between the last few chambers; aperture terminal, elliptical, radiate. Length, 0.45 millimeter; width, 0.25 millimeter; thickness, 0.19 millimeter.

Plesiotype No. 4088, locality A79, Los Puertos formation.

Rare at A79 of the Los Puertos formation.

GUTTULINA d'Orbigny 1839

Guttulina basalis NEW SPECIES

PLATE 13, FIGURES 4a–c

Test elongate oval in side view, maximum width slightly below the middle, tapering to the apertural end, flat at the base; chambers elongate, most of the chambers reaching back beyond the proloculum, the last chamber reaching only about half way back to the base; final chamber most inflated; sutures slightly depressed in the early part of the test, strongly depressed between the last chambers; aperture terminal, round and obscurely radiate. Length, 0.79 millimeter; width, 0.24 millimeter; thickness, 0.22 millimeter.

Holotype No. 4049, locality A21, Quebradillas formation.

Rare at A21 and A64 of the Quebradillas formation.

The Porto Rican species differs from *G. kishinouyi* Cushman and Ozawa (1930. Proc. U. S. Nat. Mus. 77 (6)) in flat apical end and much shorter final chamber.

APIOPTERINA Zborzewski 1834

Apiopterina cylindroides (Roemer)

PLATE 13, FIGURES 1a–c

Polymorphina cylindroides Roemer (1838) Neues Jahrb. Min. Geol. Pal. 385. pl. 3, fig. 26. Middle Oligocene, Germany.

Pyrulina cylindroides Cushman & Ozawa (1930) Proc. U. S. Nat. Mus. 77 (6): 56. pl. 14, figs. 1–5. Cretaceous to Recent; Eocene and Miocene of Trinidad; Velasco shale, upper Cretaceous, Mexico.

Test small, slender, elongate fusiform, greatest breadth slightly above the middle; chambers elongate, scarcely overlapping, each succeeding chamber farther removed from the base; sutures depressed, distinct; wall smooth; aperture terminal, small, radiate. Length, 0.48 millimeter; width, 0.17 millimeter; thickness, 0.10 millimeter.

Plesiotype No. 4089, locality P259, Ponce formation.

Very rare at P259 of the Ponce formation.

RAPHANULINA* Zborzewski 1834

Raphanulina gibba globosa (von Münster)

PLATE 13, FIGURES 2a–c

Polymorphina globosa von Münster in Roemer (1838) Neues Jahrb. Min. Geol. Pal. 386. pl. 3, fig. 33. Oligocene and Miocene, northern Germany.

Globulina gibba globosa Cushman & Ozawa (1930) Proc. U. S. Nat. Mus. 77 (6): 64. pl. 17, figs. 8, 9. Recent, northern Atlantic, Mediterranean, southern Pacific; Tertiary, Europe, southeastern U. S., Mexico and Central America.

Test subglobular, broadly oval in cross section; chambers few, 3 or 4 visible; sutures narrow, flush with the surface of the test; aperture terminal, radiate. Length, 0.58 millimeter; width, 0.45 millimeter; thickness, 0.36 millimeter.

Plesiotype No. 3971, locality L2C, San Sebastian formation.

Rare at L2C; common at L5C of the San Sebastian formation. Rare at A79 of the Los Puertos formation, and at A64 of the Quebradillas formation.

Family NONIONIDAE Reuss 1860

NONION Montfort 1808

Nonion chapapotense Cole

PLATE 13, FIGURES 8a, b

Nonion chapapotensis Cole (1928) Bull. Am. Paleont. 14 (53): 210. pl. 1, figs. 18, 19. Upper Eocene, Mexico.—Cushman (1939) U. S. Geol. Surv. Prof. Pap. 181: 6. pl. 2, figs. 1–3. Upper Eocene, southeastern U. S.

* *Raphanulina* is incorrectly called *Globulina* by most authors, although Zborzewski's name is valid and has priority by five years.

Test small for the genus, slightly compressed; nearly circular in side view, periphery smooth; oval in apertural view; back evenly rounded; umbilical areas filled with clear shell material around which is a groove; 8 chambers in the last whorl, increasing gradually in size; sutures narrow, flush with the surface and marked by clear shell material, gently curving, nearly radial; apertural face slightly convex, median height two-thirds the width; aperture a low arched slit at the base of the last chamber. Diameter, 0.3 millimeter; thickness, 0.13 millimeter.

Plesiotype No. 3937, locality L6C, San Sebastian formation.

Very rare at L6C of the San Sebastian formation.

Our specimens have fewer chambers and smaller umbos than the types of this species.

Nonion dilatatum NEW SPECIES

PLATE 13, FIGURES 6a–c

Test small, broadly ovate in side view with lobulate periphery; ovate in apertural view, bilaterally symmetrical or nearly so, involute beyond the umbilical area on both sides of the test with lobate extensions of the last chamber covering both umbilical areas; back broadly rounded; chambers planispirally arranged, inflated, rapidly enlarging, 6 to 7 in the last whorl; sutures only slightly curved, depressed; aperture at the base of the apertural face on the periphery not reaching to the umbilical areas, in shape a low arch with small upper lip. Diameter, 0.35 by 0.42 millimeters; thickness, 0.29 millimeter.

Holotype No. 4081, locality A43a, Cibao formation.

Rare at A43a of the Cibao formation.

Nonion multiporatum NEW SPECIES

PLATE 13, FIGURES 7a–c

Test oval in side view with lobulate periphery; not quite planispirally coiled, involute just to umbilicus but umbilicate on both sides; chambers rapidly enlarging, particularly in thickness, about 6 in the last whorl; surface smooth and very finely perforate; sutures strongly depressed and slightly curved on both sides; aperture a series of small, round pores at the base of the septal face. Length, 0.35 millimeter; breadth, 0.22 millimeter; thickness, 0.22 millimeter.

Holotype No. 4083, locality A43a, Cibao formation.

Rare at A43a of the Cibao formation.

This is one of the few species of *Nonion* which has a series of pores instead of the usual crescentic aperture.

Nonion nicobarense Cushman

PLATE 10, FIGURES 1a, b

Nonionina umbilicatula Brady (1884) Rep. Voy. Challenger Zool. **9**: 726. pl. 109, figs. 8, 9. Recent, West Indies and all oceans.—Cushman (1914) Bull. U. S. Nat. Mus. **71** (4): 24. pl. 17, fig. 1a–c. Recent, all oceans; (1918) U. S. Geol. Surv. Bull. **676**: 69. pl. 26, fig. 6a, b. Middle Miocene, Maryland.—Cushman & Applin (1926) Bull. Am. Assoc. Pet. Geol. **10**: 182. pl. 10, figs. 14, 15. Upper Eocene, Texas.

Nonion umbilicatulus var. Cushman (1927) Jour. Paleont. **1**: 156. pl. 25, figs. 12, 13. Lower Oligocene, Mexico.

Nonion cf. *umbilicatulus* var. Cole (1927) Bull. Am. Paleont. **14** (51): 23. pl. 5, fig. 6. Eocene, Guayabal formation, Mexico.

Nonion nicobarensis Cushman (1936) Contr. Cushman Lab. Foram. Res. **12**: 67. pl. 12, fig. 9a, b. Pliocene, Kar Nicobar.

Test small for the genus, subcircular in side view, periphery smooth not lobulate; subelliptical in apertural view; back rounded; test biumbilicate; 9–11 chambers in the last whorl, gradually increasing in size; sutures nearly radial, slightly curved, meeting the umbilical ring at an angle of about 60°; sutures flush with the surface, limbate and fusing around the umbilicus to form a continuous limbate ring; wall smooth, coarsely perforate; apertural face convex, nearly equidimensional; aperture a narrow elongate arch on the inner margin of the last septal face, with strong lip. Diameter, 0.24 by 0.32 millimeters; thickness, 0.18 millimeter.

Plesiotype No. 3938, locality P254, Ponce formation.

Rare at A43a and A86 of the Cibao formation, at A21 of the Quebradillas formation, and at P254 of the Ponce formation.

Nonion pompilioides (Fichtel & Moll)

PLATE 14, FIGURES 1a, b

Nautilus pompilioides Fichtel & Moll (1798) Test. Micr. 31. pl. 2, figs. a–c. Recent, Mediterranean; Pliocene, Italy.

Nonionina pompilioides Brady (1884) Rep. Voy. Challenger Zool. **9**: 727. pl. 109, figs. 10–11. Recent, widespread.

Nonion pompilioides Galloway & Morrey (1929) Bull. Am. Paleont. **15** (55): 43. pl. 6, figs. 15a, b. Lower Oligocene, Ecuador.—Cushman (1929) Contr. Cushman Lab. Foram. Res. **5**: 89. pl. 13, figs. 25a, b. Middle Tertiary, Ecuador, Venezuela, and Trinidad.

Test of average size for the genus, very thick; subcircular in side view, nearly as broad as long, closely coiled; broadly ovate in apertural view; back smooth, broadly rounded; umbilici moderately large and deep; 6–8 chambers in last whorl, enlarging slowly and uniformly in all dimensions; sutures narrow, nearly radial, marked by clear shell material, flush with the surface except between the last few chambers where they are slightly depressed; wall smooth, polished, coarsely perforate; apertural face convex, subrectangular in shape, much wider than high; aperture an elongate arch at base of the apertural face.

Diameter of average specimen, 0.38 by 0.47 millimeters; thickness, 0.37 millimeter.

Plesiotype No. 3939, locality P2, Ponce formation.

Rare at A86 of the Cibao formation. Common at P2, P3, P254, and P255; rare at P431 of the Ponce formation.

Nearly all of the Porto Rican specimens are slightly asymmetrical. This is shown in figures by various authors and this slight degree of asymmetry seems to be permissible in the genus *Nonion*, since there is no umbilical extension of the last chamber on either side of the test.

Nonion subgrateloupi NEW SPECIES

PLATE 14, FIGURES 2a, b, and 3a, b

Test of average size for the genus; ovate in side view, periphery smooth; elliptical in edge view; edge rounded, more sharply so in early portion of the last whorl; umbilici small, ornamented by about 30 rather small papillae; chambers 12–13 in the last whorl, elongate, increasing most rapidly in a radial direction, last few chambers tending to uncoil; sutures very little depressed, gently curved; wall smooth, polished, very finely perforate; apertural face convex, with slightly convex or nearly parallel sides, height nearly twice the width; aperture a narrow arch at base of the apertural face. Length, 0.57 millimeter; width, 0.37 millimeter; thickness, 0.23 millimeter.

Holotypes No. 3940a, b, locality L5C, San Sebastian formation.

Rare at L4C; common at L5C of the San Sebastian formation. Abundant at A79 of the Los Puertos formation.

Rare at P251; common at P259; abundant at P253 and P258 of the Ponce formation.

This species is thicker than typical *N. grateloupi* (d'Orbigny) from the Recent of Cuba, and has distinctive papillate ornamentation in the umbilical region. There are obvious similarities between this and the topotype figures of *N. elongatum* (d'Orbigny) as figured by Cushman (1939. U. S. Geol. Surv. Prof. Pap. **191**), but *N. subgrateloupi* has a more compressed test and less pronounced umbilical filling.

PSEUDONONION Asano 1936

Pseudononion papillatum NEW SPECIES

PLATE 14, FIGURES 4a–c

Test asymmetrical, broadly oval in side view, narrowly oval in edge view; chambers arranged in a very low, nearly planispiral coil, early whorls showing on one side, umbilicate on the other side with papillate filling of secondary shell material which extends out for a varying distance along the sutures; edge evenly rounded; periphery slightly lobulate; about ten chambers in the last whorl; sutures distinct, gently curved, slightly depressed; wall very finely perforate; aperture a low arch with lip on the inner periphery at the base of the last septal face, not extending into the umbilicus. Diameter, 0.41 by 0.55 millimeter; thickness, 0.29 millimeter. Other specimens range up to 0.7 millimeter in diameter.

Holotype No. 4072, locality A43a, Cibao formation.

Abundant at A43a of the Cibao formation.

Since the test is asymmetrical and therefore not *Nonion,* and none of the chambers extend into the umbilicus as they do in *Nonionella,* these specimens are referred to Asano's new genus, *Pseudononion* (1936. Trans. Paleont. Soc. Japan **15**). The form resembles *Globorotalia* except for the nonionine aperture.

NONIONELLA Cushman 1926

Nonionella modesta NEW SPECIES

PLATE 13, FIGURES 5a–c

Test broadly ovate and very little lobulate in side view; narrowly oval in edge view; dorsal side partially involute, umbilicate, with a small part of the spire showing; ventral side involute with a narrow, raised, lobate extension of the last chamber covering the umbilicus; back evenly rounded, becoming more broadly rounded in the latter part of the last whorl; 9–10 chambers in the last whorl, slightly inflated in last 2 or 3 chambers, increasing gradually in height and more rapidly in width (radially) as added; sutures distinct, gently curved, slightly depressed between last few chambers; wall smooth, finely perforate; apertural face convex, elongate, with subparallel sides; aperture a narrow arch at the base of the last chamber on the periphery, extending onto the ventral side. Length, 0.30 millimeter; width, 0.21 millimeter; thickness, 0.12 millimeter.

Holotype No. 3941, locality L1C, San Sebastian formation.

Rare at L3C and L6C; common at L1C of the San Sebastian formation.

This form has more chambers and is thinner than *N. pauciloba* Cushman (1935. Contr. Cushman Lab. Foram. Res. 11). It has fewer chambers and is less lobulate than *N. auris* (d'Orbigny) (1839. Voy. Amer. Merid.). It is not typical *N. pseudo-auris* Cole (1931. Fla. Geol. Surv. Bull. **6**) since it has more chambers and is more compressed. *N. modesta* is not trochoid on the dorsal side as *N. danvillensis* Howe and Wallace (1932. La. Dept. Cons. Geol. Bull. **2**).

PULLENIA Parker & Jones 1862

Pullenia bulloides (d'Orbigny)

PLATE 15, FIGURES 4a, b

Nonionina bulloides d'Orbigny (1826) Ann. Sci. Nat. **7**: 293. Pliocene, Italy; (1846) Foram. Foss. Vienne 107. pl. 5, figs. 9–10. Middle Miocene, Vienna.
Pullenia spheroides Cushman (1924) Bull. U. S. Nat. Mus. **104** (5): 40. pl. 8, figs. 3, 4. Recent, western Atlantic.
Pullenia bulloides Galloway & Morrey (1929) Bull. Am. Paleont. **15** (55): 43. pl. 6, fig. 16. Lower Oligocene, Ecuador.

Test small, globular, bilaterally symmetrical with axial and equatorial diameters nearly equal; 4 chambers in the last whorl enlarging gradually; sutures nearly flush, narrow, almost radial; wall very finely perforate; aperture a narrow slit at the base of the low septal face with narrow upper lip. Diameter, 0.31 millimeter; thickness, 0.28 millimeter.

Plesiotype No. 4087, locality P254, Ponce formation.

Rare at P254 and P255 of the Ponce formation.

ELPHIDIUM Montfort 1808

Elphidium lanieri (d'Orbigny)

PLATE 14, FIGURES 7a, b

Polystomella lanieri d'Orbigny (1839) in De la Sagra, Hist. Phy. Pol. Nat. Cuba Foraminifères 54. pl. 7, figs. 12, 13. Recent, Cuba.
Elphidium lanieri Cushman (1939) U. S. Geol. Surv. Prof. Pap. **191**: 55. pl. 15, fig. 4. Recent, Florida, Jamaica, Cuba; Miocene, Cuba.

Test of medium size, lenticular, subcircular in side view, elliptical in edge view with sharply rounded back, sharper in young stages; periphery smooth, not lobulate; umbilical regions filled, forming the greatest thickness of the test but forming a continuous smooth line with the sides; chambers not inflated, short, closely appressed, 18–20 or more chambers in the last whorl; sutures curved slightly, marked by elongate septal bridges, about 10 between the last two chambers on one side of the test, separated by oval depressions; septal bridges slightly oblique, merging into oblique ridges; umbilical filling ornamented by numerous pores, nodes or irregular welts; aperture consisting of several small round openings at the base of the apertural face. Diameter, 0.71 by 0.88 millimeter; thickness, 0.55 millimeter.

Plesiotype No. 4102, locality P258, Ponce formation.

Abundant at P258 and P259 of the Ponce formation.

This species is larger than *E. sagrai* and the edge is narrower.

Elphidium lens NEW SPECIES

PLATE 14, FIGURES 10a, b

Test rather large, subcircular in side view, periphery not lobulate; elliptical in edge view, thickness less than half the diameter, back narrowly rounded; umbilical region evenly umbonate and filled with clear shell material bearing 10–15 irregularly arranged subcircular pits; umbilical filling separated by a distinct, shallow, curved depression from the chambers of the last half volution; chambers closely appressed, 28–30 in the last whorl; sutures not depressed at the periphery but depressed slightly toward the umbo, marked by 15–20 septal bridges between the last 2 chambers on one side of the test; septal bridges very short, about ½ chamber in length, and only slightly elongate in direction of coiling enclosing elliptical depressions; septal bridges of successive sutures form lines that spiral outward from the umbonal region; aperture a series of pores at the base of the last septal face, and several pits on the last septal face. Diameter, 0.83 by 0.98 millimeter; thickness, 0.42 millimeter.

Holotype No. 3905, locality L4C, San Sebastian formation.

Abundant at L5C and L6C; common at L3C and L4C; rare at L2C of the San Sebastian formation.

E. lens differs from *E. craticulatum* (Fichtel & Moll) (1798. Test. Micr.) in the smaller size, fewer chambers, thinner test, rounded edge, smaller umbonal region, and more curved sutures. It is possible that *Polystomella craticulata* Cushman (not Fichtel & Moll) (1918. Bull. U. S. Nat. Mus. **103**) from the Culebra formation of the Panama Canal Zone should be placed in synonymy with *E. lens*. The Panama Canal form seems to differ only in having about 40 instead of 28–30 chambers in the last whorl.

E. lens differs from *E. lanieri* (d'Orbigny) from the Recent of Cuba in being relatively thinner and in being elliptical rather than diamond shaped in edge view, with smaller umbonal region and more chambers. It differs from *E. chapmani* Cushman (1936. Contr. Cushman Lab. Foram. Res. **12**) in its elliptical not rhomboidal edge view, in its higher apertural face, and in its smaller test.

Elphidium lobatum NEW SPECIES

PLATE 14, FIGURES 8a, b

Test small for the genus, nearly involute with a slight umbilicus, subelliptical in side view, early part of test much thinner than the later part where inflation of the last few chambers increases rapidly; periphery lobate; back broadly rounded; chambers numerous, 9–10 in the last whorl, increasing rapidly in size, inflated, last chamber becoming nearly circular in apertural view, except for the impressed zone of the previous whorl; sutures distinct, sharply depressed, smoothly curved, marked by a series of broad retral processes and 8–10 small semi-circular depressions; aperture a row of pores at the inner margin of the last septal face. Diameter, 0.17 to 0.45 millimeters; thickness, 0.23 to 0.27 millimeters.

Holotype No. 3906, locality A6, Lares formation.

Rare at A6 of the Lares formation and at F359 of the Quebradillas formation.

The specific name *lobatum* refers to the markedly lobate outline of the test in side view.

This species differs from *E. poeyanum* in that the chambers are more inflated, the sutures are more depressed, the periphery is more lobate, and the shape of the apertural face is more nearly circular.

Elphidium nautiloideum NEW SPECIES

PLATE 14, FIGURES 5a, b

Test small for the genus, nautiloid, sides nearly parallel in edge view, subcircular in side view, not lobulate, except very slightly in the last few chambers; back makes a parabolic curve with the sides of the test; umbilici about 1/4 the diameter of the test, depressed and papillate; chambers distinct, 12–15 in the last whorl; sutures slightly curved, radial, only a little depressed, marked by inconspicuous, short retral processes and small oval depressions, 12–15 between the last two chambers on one side of the test; surface smooth; wall finely perforate; height of the apertural face in median line about 2/3 the maximum width which comes in line with base of last septal face on the periphery; aperture a series of pores at the base of the last septal face, and a few scattered pores on the septal face. Average specimen, 0.34 by 0.41 millimeter in diameter and 0.21 millimeter thick. Maximum size, 0.45 by 0.49 millimeter; thickness, 0.21 millimeter.

Holotype No. 3907, locality L5C, San Sebastian formation.

Rare at L2C, L5C, and L6C; common at L1C of the San Sebastian formation. Rare at F64 of the Quebradillas formation.

E. nautiloideum differs from *E. poeyanum* (d'Orbigny) in the more numerous chambers and less lobulate periphery; from *E. australe* Cushman and Parker (1931. Proc. U. S. Nat. Mus. **80 (3)**) in having less depressed sutures and less papillate ornamentation; and from *E. incertum* (Williamson) (1858. Recent Foram. Gt. Brit.) in having papillate umbilici, more chambers, nearly radial sutures and more retral processes.

Elphidium owenianum (d'Orbigny)

PLATE 14, FIGURES 9a, b

Polystomella Oweniana d'Orbigny (1839) Voy. Amér. Mérid. **5** (5): Foraminifères 30. pl. 3, figs. 3, 4. Recent, "coast of Patagonia, to the south of the Rio Negro."

Elphidium owenianum Cushman (1930) Bull. U. S. Nat. Mus. **104** (7): 21. pl. 8, figs. 10–12. Recent, Falkland Islands.

Test of medium size for the genus, lenticular; periphery subacute; margin entire, with narrow keel; test lenticular in peripheral view, greatest thickness at the umbilical regions which are not distinctly umbonate but are filled with clear shell material, usually pitted; chambers numerous, distinct, 16–20 in the last whorl; sutures limbate, with elongate, rod-like retral processes which extend almost the entire height of the chamber; near the periphery the limbate sutures curve posteriorly and merge with a keel of clear shell material; in a normal ephebic form about 15 retral processes between the last two chambers on one side of the test; apertural face subtriangular; aperture consisting of round pores at the base of the septal face and scattered round openings on the apertural face. Average specimen, 0.71 by 0.81 millimeter in diameter and 0.28 millimeter thick. Figured specimen, 0.64 by 0.72 millimeter in diameter and 0.28 millimeter thick.

Plesiotype No. 3908, locality L5C, San Sebastian formation.

Rare at L1C; common at L2C, L4C, L5C, and L6C; abundant at L3C of the San Sebastian formation. Rare at A43a; common at A86 of the Cibao formation. Abundant at A79 of the Los Puertos formation. Rare at P254 of the Ponce formation.

This form is with difficulty distinguishable from *E. crispum*. *E. owenianum* is smaller, less umbonate, and more definitely keeled.

Elphidium poeyanum (d'Orbigny)

PLATE 14, FIGURES 6a, b

Polystomella Poeyana d'Orbigny (1839) in De la Sagra, Hist. Phys. Pol. Nat. Cuba Foraminifères 55. pl. 6, figs. 25, 26. Recent, Cuba, Jamaica.—Cushman (1922) Carnegie Inst. Wash. Publ. **311**: 55. pl. 9, figs. 9, 10. Recent, Tortugas.

Elphidium poeyanum Cushman (1930) Bull. U. S. Nat. Mus. 104 (7): 25. pl. 10, figs. 4, 5. Recent, West Indies; (1933) U. S. Geol. Surv. Prof. Pap. 175A: 21. pl. 7, figs. 7a, b. Miocene, West Indies and coastal plain of eastern U. S.

Test small for the genus, compressed, subcircular in side view, with lobate margin, oval in peripheral view; back rounded; umbilical regions slightly depressed; 8–11 chambers in the last whorl, distinct, slightly inflated; sutures nearly radial, slightly depressed, marked by short, broad septal bridges and oval pores, 12–15 between the last two adult chambers on one side of the test; surface smooth; apertural face about as high as wide; aperture a series of rounded openings at the base of the septal face and a few scattered pores on the septal face. Diameter, 0.27 by 0.33 millimeter; thickness, 0.14 millimeter. Maximum size: diameter, 0.38 by 0.45 millimeter; thickness, 0.28 millimeter.

Plesiotype No. 3909, locality L1C, San Sebastian formation.

Common at L1C; rare at L3C of the San Sebastian formation. Rare at A6 of the Lares formation. Common at A79 of the Los Puertos formation. Rare at F359; common at F64 and F358 of the Quebradillas formation. Rare at P255; common at P258 and P259 of the Ponce formation.

Elphidium puertoricense NEW SPECIES

PLATE 15, FIGURES 2a, b

Test subcircular in side view, margin entire, slightly lobulate in last few chambers; sides nearly parallel in apertural view; back broadly rounded; umbilici small, very slightly depressed, with small tubercles; chambers 12–15 in last whorl, in last portion distinct, very little inflated; sutures not depressed except between the last few chambers, marked by long, narrow septal bridges which are continuous over the early part of the test to form ridges slightly oblique to the periphery, in a normal ephebic form about 16–20 septal bridges between the last two chambers on one side of the test; depressions between septal bridges very narrow and long, usually in a double series; apertural face wider than high; aperture a series of small round openings at the base of the apertural face, and scattered pores on the septal face. Diameter, 0.54 by 0.68 millimeter; thickness, 0.38 millimeter.

Holotype No. 3911, locality L6C, San Sebastian formation.

Rare at L1C, L2C, L5C, and L6C; common at L4C of the San Sebastian formation. Rare at A79 of the Los Puertos formation, and at F359 of the Quebradillas formation. Common at P259 of the Ponce formation.

This species differs from *E. sagrai* in being larger, and broader and flatter along the back; the apertural face is lunate in outline, not subtriangular; the number of septal bridges along the sutures is greater, 18 instead of 7 or 8 as in *sagrai;* the ridges formed by the continuous septal bridges in the early part of the test are finer and not as conspicuously spiral as in *E. sagrai.*

E. puertoricense differs from *E. sagrai crassum* in having a more lobulate outline, in being umbilicate instead of umbonate, and in having more septal bridges (15–18 instead of 10–12) which are not as clearly continuous from chamber to chamber and are not raised into ridges.

Elphidium sagrai (d'Orbigny)

PLATE 15, FIGURES 3a, b

Polystomella Sagra d'Orbigny (1839) in De la Sagra, Hist. Phys. Pol. Nat. Cuba Foraminifères 55. pl. 6, figs. 19, 20. Recent, Cuba.
Elphidium sagrum Cushman (1929) Bull. U. S. Nat. Mus. 104 (7): 24. pl. 9, figs. 5, 6. Recent, West Indies; late Tertiary, West Indies, Florida.—Cushman (1933) U. S. Geol. Surv. Prof. Pap. 175A: 22. pl. 7, figs. 9a, b. Miocene of West Indies, Florida, North Carolina.

Test small for the genus, not compressed, subcircular in side view, subovate in edge view, widest portion of test in last chamber midway between umbilicus and periphery; periphery not lobate; edge rounded; umbilical regions somewhat depressed; chambers numerous, 10–12 in last adult whorl, last formed chambers slightly inflated; sutures not depressed except between last 2 or 3 chambers and marked by retral processes which are continuous over early part of test to form spiral ridges, oblique to the periphery; aperture a series of small round openings at base of the apertural face. Diameter, 0.27 by 0.36 millimeter; thickness, 0.20 millimeter.

Plesiotype No. 4139, locality L1C, San Sebastian formation.

Rare at L2C, L3C, and L5C; common at L1C and L6C of the San Sebastian formation. Rare at A86 of the Cibao formation. Common at A79 of the Los Puertos formation. Rare at F64, A46, and A15; common at F358; abundant at F359 of the Quebradillas formation. Common at P258 and P259 of the Ponce formation.

This species was evidently named by d'Orbigny for his patron, De la Sagra, and the form of the specific name should therefore be *sagrai* instead of *sagra* or *sagrum.*

There is considerable individual variation within this species. The larger individuals are thicker in proportion, have more septal bridges and a broader apertural face. All intermediate stages may be found.

Elphidium sagrai crassum NEW VARIETY

PLATE 15, FIGURES 1a, b

Test of medium size for the genus, little compressed; periphery not lobulate; edge broadly rounded, more rounded near the apertural end; chambers numerous, 11–12 in the last whorl; sutures not depressed, rather obscure, marked by longitudinal septal bridges which form continuous ridges with a somewhat spiral pattern on the earlier portions of the test; depressions between septal bridges are narrow and slit-like; 14 septal bridges between last 2 chambers on each side of test; apertural face lunate, twice as wide as high; aperture a row of round pores at base of last septal face. Diameter, 0.36 by 0.43 millimeters; thickness, 0.27 millimeter.

Holotype No. 3910, locality L1C, San Sebastian formation.

Rare at L1C, L2C, and L6C of the San Sebastian formation. Rare at A91a; common at A79 of the Los Puertos formation. Rare at F64 and F358; common at F359 of the Quebradillas formation. Rare at P258, P259, and 434 of the Ponce formation.

E. sagrai crassum differs from *E. chipolense* (Cushman) (1921. U. S. Geol. Surv. Prof. Pap. **128B** 72. pl. 11, fig. 23) in being smaller and thicker. It differs from *E. sagrai* (d'Orbigny) in that the sutural depressions of *E. sagrai crassum* are more elongate, and the apertural face is more lunate without the sharply rounded peripheral angle. It differs from *E. puertoricense* in that the spiral costae are stronger, and the test thickens more rapidly. It differs from *E. rugosum* (d'Orbigny) from the Vienna Basin Miocene in being thicker and in the resultant different shape of the apertural face.

ANTILLESINA NEW GENUS

Genotype, *Nonion ? mariclensis* Palmer (1936) Mem. Soc. Cubana Hist. Nat. **10**: 127. text figs. 1–3. Lower Oligocene, Cuba.

Test free, planispiral throughout, involute, non-umbilicate, becoming more embracing as more chambers are added; round on the back; chambers numerous, 4 to 7 in the last whorl, inflated; sutures depressed; wall calcareous, finely perforate; surface costate; aperture absent or represented by small pores on the septal face. Length, 0.24 to 0.50 millimeter. Shallow water marls. Eocene of Egypt, Oligocene of West Indies.

Although we have about 40 specimens, many of them well preserved, not one shows a crescentic aperture and even the pores on the septal face are scarcely larger than the pores elsewhere on the test.

This species and the form figured by Schwager as *Polystomella* ? *obscura* from the Eocene of Egypt (1883. Paleontogr. **30 (2):** 138. pl. 27, figs. 2a–c) are the only known members of this new genus.

The significant characteristics of this genus, whereby it differs from *Nonion,* are its aperture, its completely involute test, and its costate ornamentation. The most closely related genus is *Pullenia,* rather than *Nonion. Antillesina* differs from *Pullenia* only in its porous aperture and costate ornamentation.

Antillesina marielensis (Palmer)

Plate 10, figures 12a, b and 13a–c

Nonion ? *marielensis* Palmer (1936) Mem. Soc. Cubana Hist. Nat. **10:** 127. text figs. 1–3. Lower Oligocene, Cuba.

Test small, mature specimens nearly spherical; back broadly rounded; 4 to 6 chambers in the last whorl, increasing rapidly in size, inflated; the axial diameter of the last chamber varies from 3 to 5 times that of the earliest, smallest chamber in the last whorl; chambers planispirally arranged, involute to umbilicus, or more, the later chambers progressively more embracing with a smaller number in the latest whorl; in apertural view the maximum thickness of the final chamber is seen, and it is about three times the thickness of the earliest chamber of the last whorl; sutures depressed, nearly radial; apertural face convex, low and broad; aperture obscure, evidently consisting of the scattered pores on the last septal face; wall hyaline, finely perforate; surface of test ornamented by numerous fine, narrow, low, longitudinal costae which continue down onto the last septal face but which are not continuous across the sutures, 7 to 10 costae on each side of the test, more prominent on the last few chambers. Diameter, 0.24 by 0.31 millimeter; thickness, 0.24 millimeter.

Plesiotypes No. 4063, locality L1C, San Sebastian formation, and No. 3943, locality P254, Ponce formation.

Rare at L1C of the San Sebastian formation. Abundant at P254 and P255; rare at P2, P3, and P258 of the Ponce formation.

Family ROTALIIDAE Reuss 1860

GLOBOROTALIA Cushman 1927

Globorotalia menardii (d'Orbigny)

PLATE 16, FIGURES 5a–c

Rotalia menardii d'Orbigny (1826) Ann. Sci. Nat. 7: 273. no. 26; Model no. 10. Recent, Adriatic.

Pulvinulina menardii Brady (1884) Rep. Voy. Challenger Zool. 9: 690. pl. 103, figs. 1, 2. Recent, world wide.—Nuttall (1928) Quart. Jour. Geol. Soc. London 84: 101. pl. 7, fig. 20. Oligocene and lower Miocene, Trinidad.

Globorotalia menardii Cushman (1930) Fla. Geol. Surv. Bull. 4: 60. pl. 12, fig. 1. Middle and upper Miocene, Florida.—Nuttall (1932) Jour. Paleont. 6: 29. pl. 4, fig. 16. Lower Oligocene, Mexico.—Hadley (1934) Bull. Am. Paleont. 20 (70A): 25. pl. 3, figs. 12, 13. Oligocene, Cuba.—Coryell & Rivero (1940) Jour. Paleont. 14: 336. pl. 42, figs. 34, 35. Middle Miocene, Haiti.

Test compressed, moderately convex on the ventral side, less convex on the dorsal side; edge with a conspicuous, rounded keel; test generally oval in side view, periphery lobulate, the lobulation being more pronounced in the last few chambers; early whorls showing on the dorsal side, involute and umbilicate on the ventral side; 5 to 7 chambers in the last whorl, increasing rather rapidly in size; sutures distinct, gently curved on the dorsal side, nearly radial ventrally; slightly depressed on the ventral side, limbate and flush or slightly raised on the dorsal side; ventral surface near aperture covered with granulations; aperture large, ventral, opening into the umbilicus with a slight valvular lip. Diameter, 0.68 by 0.88 millimeter; thickness, 0.36 millimeter.

Plesiotype No. 4082, locality A21, Quebradillas formation.

Common at A21; abundant at A93 of the Quebradillas formation.

LAMARCKINA Berthelin 1881

Lamarckina echinata NEW SPECIES

PLATE 15, FIGURES 5a–c

Test minute, oval in side view, pyriform in edge view, biconvex, dorsal side moderately convex, ventral side deep, with large umbilicus; periphery lobulate and spinose; edge sharply rounded to broadly rounded; whorls about 2, rapidly enlarging; chambers about 5 in the last whorl, rapidly increasing in size in all dimensions as added, the last chamber making up about half the test on the ventral side; sutures on both sides obscure, slightly curved and slightly depressed, not limbate; surface covered with small, close-set spines, variable in size, largest on the last chamber and on the margin and back, smallest on the ventral septal face; wall finely but conspicuously perforate, the perforations not covered by the spines but continuing between them as the spines are built; aperture a low arch at the base of the septal face, at one side of the umbilicus but opening into it, with small upper lip. Longest diameter, 0.36 millimeter; thickness of last chamber, 0.24 millimeter.

Holotype No. 4111, locality P4, Ponce formation.

Rare at P4 of the Ponce formation.

This species is most like *"Discorbina" tuberculata* Balkwill & Wright, but differs in the larger umbilicus, more highly spinose surface; the pores do not emerge at the ends of the spines, and the aperture is farther toward the periphery.

VALVULINERIA Cushman 1926

Valvulineria maclureaformis NEW SPECIES

PLATE 16, FIGURES 1a–c

Test oval in side view, with nearly smooth periphery; biconvex, the dorsal side nearly flat, ventral side very deep; edge narrowly rounded to truncate in the last chambers; chambers not inflated, about 7 in the last whorl, enlarging rapidly radially and in thickness but not in length; less than 2 whorls; sutures on the dorsal side strongly and regularly curved, limbate and slightly raised, marked by broad bands of clear shell material; sutures on the ventral side slightly curved, slightly raised, marked by broad bands of clear shell material; ventral side with large, deep umbilicus; dorsal side with a slight amount of secondary wall material, thickest near the middle, slightly obscuring the spire; wall finely but distinctly perforate; aperture a slit opening into the umbilicus and extending less than half way towards the periphery, partly covered by a valvular lip. Diameter, 0.73 millimeter; thickness, 0.45 millimeter.

Holotype No. 4113, locality A86, Cibao formation.

Rare at A86 of the Cibao formation.

This form somewhat resembles forms which have been included in *Cibicides* (1935. U. S. Geol. Surv. Prof. Pap. **181:** pl. 23), but neither the aperture nor the mural pores are like those of *Cibicides*. The specific name was suggested because of the resemblance of this form to the gastropod genus *Maclurites*.

Valvulineria nuttalli Palmer & Bermudez

Plate 16, figures 2a–c

? *Cancris sagra* Nuttall (1932) Jour. Paleont. 6: 27. pl. 6, figs. 6, 7. Lower Oligocene, Mexico.
Valvulineria nuttalli Palmer & Bermudez (1936) Mem. Soc. Cubana Hist. Nat. 10: 300. pl. 19, figs. 3–5. Lower Oligocene, Cuba.
Valvulineria inaequalis Coryell & Rivero (1940) Jour. Paleont. 14: 338. pl. 43, figs. 26a–c. Middle Miocene, Haiti.

Test large, biconvex, elongate oval in side view, narrowly elliptical in edge view; periphery smooth; edge narrowly rounded; about 2 whorls in the test, earlier whorls visible on the dorsal side, involute on the ventral side with chambers terminating in slightly elevated lobes around the umbilicus; chambers enlarging rather rapidly in all three dimensions, closely appressed, 7 to 8 in the last whorl; sutures narrow, on dorsal side flush with the surface, slightly curved between early chambers, tending to become radial between the last few chambers, on ventral side radial, depressed near the umbilicus; aperture obscure due to poor preservation, opening into the umbilicus and covered by a valvular process. Length, 1.29 millimeter; width, 0.73 millimeter; thickness, 0.49 millimeter.

Plesiotype No. 4028, locality P3, Ponce formation.

Rare at P3 of the Ponce formation.

As stated by Palmer and Bermudez, *V. nuttalli* differs from *V. inaequalis* (d'Orbigny) (1839. Voy. Amer. Merid. **5 (5)**) in having "fewer chambers in the final whorl and a more broadly oval outline in side view".

Valvulineria palmarealensis (Nuttall)

Plate 16, figures 3a–c

Globorotalia palmarealensis Nuttall (1932) Jour. Paleont. 6: 30. pl. 7, figs. 1–3. Lower Oligocene, Mexico.

Test somewhat compressed, biconvex, ventral side more so than the dorsal; edge narrowly rounded; test broadly oval in side view, periphery smooth; dorsally with two whorls visible, ventrally umbilicate; 9 chambers in the last whorl, enlarging rather rapidly; sutures distinct, gently curved on the dorsal side, nearly radial on the ventral side; sutures narrowly limbate, flush with the surface; wall finely perforate; aperture ventral, opening into the umbilicus and extending part way to the periphery, with a large, lobate, overhanging valvular extension of the last chamber. Diameter, 0.60 millimeter; thickness, 0.27 millimeter.

Plesiotype No. 4029, locality P3, Ponce formation.

Very rare at P2 and P3 of the Ponce formation.

This species is very close to *Valvulineria nuttalli,* which was described by Palmer and Bermudez from the Oligocene of Cuba. Both forms were found by Nuttall in the Alazan of Mexico and it may be that better suites of specimens will show that they are the same species. *V. nuttalli,* "differs in having fewer chambers, a more oval outline in side view and a greatly enlarged final chamber".

Valvulineria paucilocula Cushman

PLATE 16, FIGURES 4a–c

Valvulineria paucilocula Cushman (1935) Contr. Cushman Lab. Foram. Res. **11**: 37. pl. 5, figs. 7a–c. Lower Oligocene, Mississippi.

Test oval in side view, narrowly ovate in edge view; back broadly rounded; periphery lobate; chambers distinct, inflated, typically 5 in the last whorl, enlarging rapidly, last chamber constituting about one-third of the test, particularly on the ventral side; dorsally with the early whorls depressed below the final whorl; ventrally umbilicate; sutures distinct, depressed, oblique and slightly curved on the dorsal side, nearly radial on the ventral side; wall conspicuously perforate except for a clear area above the aperture on each chamber on the ventral side of the test; aperture at the base of the last chamber opening into the umbilical vestibule with a slight valvular projection of the last chamber. Diameter, 0.54 by 0.70 millimeter; thickness, 0.40 millimeter.

Plesiotype No. 4030, locality P4, Ponce formation.

Rare at A79 of the Los Puertos formation and at A43a of the Cibao formation. Common at P431; abundant at P4 of the Ponce formation.

This species differs from *V. cubana* Palmer and Bermudez from the Eocene of Cuba (1936. Mem. Soc. Cubana Hist. Nat. **10**) in the open umbilicus and absence of fingerlike processes near the umbilicus; also the last chamber is larger than in *V. cubana.*

EPONIDES Montfort 1808

Eponides advena (Cushman)

PLATE 17, FIGURES 5a–c

Rotalia advena Cushman (1923) U. S. Geol. Surv. Prof. Pap. **133**: 46. pl. 7, figs. 4–6. Lower Oligocene, Alabama.

Eponides advena Cole & Ponton (1930) Fla. Geol. Surv. Bull. **5**: 42. pl. 11, figs. 11, 12. Lower Oligocene, Florida.

Test nearly circular in side view, unequally biconvex, the ventral side the deeper; periphery not lobulate; edge bluntly angled; 5 to 6 chambers in the last whorl, not inflated, enlarging gradually; whorls about 3, the earlier ones on the dorsal side covered with secondary material, the last whorl barely discernible; ventral side with small umbilical depression, not covered with secondary material; sutures on the dorsal side narrowly limbate, flush with the surface, oblique and tangential to the previous whorl; sutures on the ventral side nearly straight and radial, slightly depressed; surface on both sides smooth; aperture a small arch midway between umbilicus and periphery, at the base of the septal face, with slight upper lip. Diameter, 0.8 millimeter; thickness, 0.5 millimeter.

Plesiotype No. 4104, locality A86, Cibao formation.

Rare at A86 of the Cibao formation.

The form figured by Palmer and Bermudez from the Oligocene of Cuba (1936. Mem. Soc. Cubana Hist. Nat. **10:** pl. 19, figs. 16, 17) as *E. nana* (Reuss), is almost identical with the Porto Rican form here referred to *E. advena*, the differences being the smaller size, and as stated in their description, "ventral surface umbonate", although this does not seem particularly conspicuous in their figure.

Eponides ellisorae Garrett

PLATE 17, FIGURES 4a–c

Eponides ellisorae Garrett (1939) Jour. Paleont. **13**: 579. pl. 66, figs. 6–8. Middle Tertiary, Texas.

Test subcircular, with slightly lobulate periphery, biconvex, a little deeper on the ventral side, with small umbilicus; edge angled but not carinate; whorls 2 to 3, those on the dorsal side obscured by a slight secondary deposit; chambers about 6 in the last whorl, enlarging very little as added; ventral sutures nearly radial and slightly curved, very little depressed and not limbate; dorsal sutures slightly curved, tangential to the previous whorl, flush with the surface and marked by clear shell material which runs out onto the periphery; surface smooth; aperture an elongate slit extending from near the umbilicus to near the periphery, enlarging outwardly, with strong upper lip. Diameter, 0.67 millimeter; thickness, 0.41 millimeter.

Plesiotype No. 4100, locality P254, Ponce formation.

Rare at P254 of the Ponce formation.

This species bears obvious resemblances to "*Pulvinulina*" *byramensis* Cushman (1922. U. S. Geol. Surv. Prof. Pap. **129E**) and to *Rotalia advena* Cushman ((1923) U. S. Geol. Surv. Prof. Pap. **133**), but differs from both in the lobulate periphery, sharper edge, and less dorsal deposit.

Eponides exiguus (Brady)

PLATE 17, FIGURES 1a–c

Pulvinulina exigua Brady (1884) Rep. Voy. Challenger Zool. 9: 696. pl. 103, figs. 13, 14. Recent, Atlantic and Pacific Oceans.
Eponides exigua Cushman (1931) Bull. U. S. Nat. Mus. 104 (8): 44. pl. 10, figs. 1, 2. Recent, north Atlantic.

Test small for the genus, about equally biconvex; edge bluntly angled; slightly lobulate in dorsal view, usually 6 chambers in the last whorl, about 2½ whorls in the test; chambers of uniform shape, gradually increasing in size as added, slightly inflated ventrally; spiral suture on dorsal side marked by clear shell material; sutures on the dorsal side obliquely curved, flush with the surface, marked by clear shell material, on the ventral side nearly radial and somewhat depressed; aperture obscure, apparently a narrow slit at the inner margin of the last formed chamber on the ventral side. Diameter, 0.28 by 0.32 millimeter; thickness, 0.13 millimeter.

Plesiotype No. 3912, locality L2C, San Sebastian formation.

Rare at L2C and L3C of the San Sebastian formation.

Eponides ornatissimus NEW SPECIES

PLATE 17, FIGURES 2a–c

Test delicate, planoconvex, dorsal side convex, ventral side flat with relatively large round or oval umbilical depression; edge angled; test nearly circular in side view, periphery not lobulate but with minute irregularities where the costae reach the periphery; as many as 3 whorls in the test, all visible from the dorsal side, only the last whorl from the ventral side, 12 to 15 chambers in the last whorl, enlarging very slowly; sutures radial but sharply curved near the periphery on both sides of the test; wall finely perforate; dorsal side of test conspicuously ornamented by raised spiral sutures and radial costae which are not continuous from whorl to whorl and which approximate the position of the sutures and usually bifurcate near the periphery with one branch following the curvature of the sutures; aperture a low slit at the base of the last chamber on the ventral side extending from midway of the base of the septal face nearly to the periphery; aperture obscure in most of the specimens. Diameter, 0.23 by 0.28 to 0.38 by 0.41 millimeter; thickness, 0.11 millimeter.

Holotype No. 3913, locality L2C, San Sebastian formation.

Common at L2C of the San Sebastian formation. Rare at A43a and A86 of the Cibao formation. Common at A79 of the Los Puertos formation. Rare at P2 of the Ponce formation.

There are strong resemblances between *E. ornatissimus* and *"Planulina" camagueyana* Bermudez from the Eocene of Cuba (1927. Mem. Soc. Cubana Hist. Nat. **11**). *E. ornatissimus* has fewer chambers, more regular ornamentation on the dorsal side, and is smaller in size.

Eponides parantillarum NEW SPECIES

PLATE 18, FIGURES 1a–c

Eponides antillarum Cushman & Jarvis (1930) Jour. Paleont. 4: 364. pl. 33, figs. 14a–c, pl. 34, fig. 2. Miocene, Jamaica.

Test biconvex, usually with dorsal side more convex than the ventral; edge angled, with narrow keel, nearly circular in dorsal or ventral view, periphery smooth, or very slightly lobate in the last few chambers; about 3½ whorls in the test, early ones obscure on the dorsal side of the test, only those of the last whorl being distinct; 6 to 7 chambers in the last whorl, enlarging slowly, closely appressed; sutures on the dorsal side flush with surface, oblique, narrowly limbate, on ventral side nearly radial, flush, or slightly depressed near the periphery, becoming limbate and raised near the umbilical region where they become fused into a ring surrounding a small but deep umbilical depression; aperture an elongate arch with lip at the base of the last chamber on the ventral side midway between the umbilicus and periphery. Diameter varies from 0.36 by 0.41 to 0.84 by 0.93 millimeter; thickness, 0.30 to 0.54 millimeter.

Holotype No. 3914, locality A21, Quebradillas formation.

Rare at A93; common at A20; abundant at A21 of the Quebradillas formation. Rare at P3 of the Ponce formation.

This species is related to *E. antillarum* (d'Orbigny) from the Recent of Cuba, but differs consistently in several respects. The sutures on the dorsal side are more oblique, the last whorl is narrower, and the periphery is not lobulate. Several other species from Eocene-Oligocene formations of the Gulf Coast and West Indian region are similar in some respects. Most of these lack the characteristic raised limbate ornamentation of the ventral side. Those that have similar ornamentation differ in having radial, not oblique dorsal sutures, as *E. mexicana* Cushman (1925. Am. Assoc. Petr. Geol. **9**) and *E. guayabalensis* Cole (1927. Bull. Am. Paleont. **14**), or in having more chambers as in *E. byramensis cubensis* Palmer and Bermudez (1936. Mem. Soc. Cubana Hist. Nat. **10**).

Specimens at P3 which are referred to this species differ consistently in that they are much more flat on the dorsal side. This may be a variety of *E. parantillarum* or may merely show the extreme individual variation of the species.

Eponides pulvinus NEW SPECIES

Plate 18, figures 2a–c

Test subcircular in side view, unequally biconvex, slightly convex on the ventral side, strongly convex to conical on the dorsal side; periphery not lobulate; edge sharply angled; whorls about 4, on the ventral side involute leaving a very small umbilicus, the earlier whorls on the dorsal side covered by smooth secondary wall material, obscuring the spire; 5 chambers in the last whorl, increasing slowly in size; sutures on the ventral side nearly radial, very slightly curved, flush with the surface excepting between the last few chambers where they are depressed; sutures on the dorsal side somewhat limbate, slightly curved and tangential to the earlier whorls; surface of both sides smooth; aperture a slit at the base of the septal face extending and widening from near the umbilicus to two-thirds of the way to the periphery, with prominent upper lip. Diameter, 0.65 millimeter; thickness, 0.35 millimeter.

Holotype No. 4103, locality A15, Quebradillas formation.

Common at A86 of the Cibao formation. Rare at A15 of the Quebradillas formation.

This species differs consistently from *E. advena* (Cushman) (1923. U. S. Geol. Surv. Prof. Pap. **133**) in being deeper on the dorsal side and shallower on the ventral side. It has fewer chambers and is higher dorsally than *E. jacksonensis* (Cushman and Applin) (1935. U. S. Geol. Surv. Prof. Pap. **181**).

Eponides repandus (Fichtel & Moll)

Plate 17, figures 3a–c

Nautilus repandus Fichtel & Moll (1798) Test. Micr. 35. pl. 3, figs. a–d. Recent, Mediterranean.

Eponides repandus Montfort (1808) Conch. Syst. 1: 127. 32e genre. Recent, Mediterranean.—Cushman & Ponton (1932) Fla. Geol. Surv. Bull. 9: 92. pl. 13, figs. 9a–c. Lower Miocene, Florida; Recent, off Florida and the West Indies.

Pulvinulina repanda Brady (1884) Rep. Voy. Challenger Zool. 9: 684. pl. 104, figs. 18a–c. Recent, widespread.

Test subcircular, with slightly lobulate periphery, biconvex, slightly deeper on the ventral side; edge sharp and narrowly carinate; chambers 6 to 7 in the last whorl, closely appressed, flat on the dorsal side, slightly inflated on the ventral side, the last chamber with a lobed extension; sutures strongly curved and raised on the dorsal side, moderately curved and depressed on the ventral side; wall finely perforate, with scattered large pores on the last septal face; aperture an arch at the base of the septal face, highest near the umbo, without upper lip. Diameter, 1.1 millimeters; thickness, 0.5 millimeter.

Plesiotype No. 4093, locality A21, Quebradillas formation.

Rare at A21 of the Quebradillas formation.

Our specimens lack the ventral limbate sutures usually ascribed to this species, and have an umbonal lobe not seen in Brady's figure in the Challenger Report. They are much like the Florida Miocene specimens.

Eponides ventricosus NEW SPECIES

PLATE 18, FIGURES 3a–c

Test subcircular in side view, strongly and almost equally convex, the dorsal side smoothly hemispherical, the ventral side slightly convex just beneath the periphery; periphery smooth, but sometimes slightly lobulate in the last few chambers; edge sharply angled to sharply rounded, sometimes appearing keeled, whorls about 3, narrow, only the last one or part of the last one visible on the dorsal side, which is covered with a smooth, mottled secondary deposit; chambers 11 to 13 in the last whorl, enlarging gradually; ventral side with strong, smooth, imperforate umbo; dorsal sutures slightly curved, oblique, broadly limbate but not raised, the spiral suture also limbate but not raised; ventral sutures curved, narrowly limbate, flush with the surface, except for the last few which may be broadly depressed; ventral surface finely mottled; wall finely perforate, the perforations seeming to continue through the secondary deposit on both sides of the test; appearing on the dorsal umbo as coarse puncta, so that the form might be mistaken for Cibicides; aperture a low arch midway between umbo and periphery, with slight upper lip. Diameter, 0.5 millimeter; thickness, 0.33 millimeter.

Holotype No. 4116, locality A86, Cibao formation.

Abundant at A86 of the Cibao formation. Rare at A21 of the Quebradillas formation, and at P251 and P259 of the Ponce formation.

Eponides vortex NEW SPECIES

PLATE 18, FIGURES 4a–c

Test biconvex, somewhat compressed, central portion of dorsal and ventral sides inflated with last whorl thinner, forming a somewhat explanate border; ventral side umbonate; early whorls on the dorsal side obscure, 10 chambers in the last whorl, short and wide, enlarging very gradually in size; periphery not lobate; edge sharp; sutures strongly and nearly equally curved on both sides of the test, nearly flush with the surface and marked by clear shell material, the last few on the ventral side raised; wall very finely perforate; aperture a low arch near the periphery on the inner margin of the last chamber on the ventral side, with lip. Diameter, 0.83 millimeter; thickness, 0.36 millimeter.

Holotype No. 3915, locality A86, Cibao formation.

Common at A86 of the Cibao formation.

This species is quite distinctive, but has some points of resemblance to *"Anomalina" subtenuissima* Nuttall (1928. Quart. Jour. Geol. Soc. London **84**). It differs in being thicker, without depressed sutures, and with a narrower final whorl on the dorsal side of the test.

GYROIDINA d'Orbigny 1826

Gyroidina cf. soldanii d'Orbigny

PLATE 15, FIGURES 7a–c

Gyroidina soldanii d'Orbigny (1826) Ann. Sci. Nat. 7: 278. no. 5, Modèles no. 36. Recent, Adriatic.

Test small, subcircular in top view, dorsal side nearly flat, the last whorl flat or depressed, the earlier whorls slightly convex, ventral side unusually deep for the genus, with a moderately large umbilicus; chambers about 6 in the last whorl; dorsal sutures slightly curved and moderately oblique, not depressed or raised, obscured by a slight deposit of secondary material; ventral sutures slightly curved, nearly radial, flush with the surface, narrow; entire surface smooth; aperture a long slit at the base of the septal face midway between umbilicus and periphery, with small upper lip. Diameter, 0.64 millimeter; thickness, 0.5 millimeter.

Plesiotype No. 4114, locality P3, Ponce formation.

Rare at P3 of the Ponce formation.

This form is unusually deep ventrally and has fewer chambers than most other species of the genus. There are fewer chambers in the last whorl, and the dorsal surface of the final whorl is more flattened than in d'Orbigny's model of *G. soldanii*.

Gyroidina stellifera NEW SPECIES

PLATE 15, FIGURES 6a–c

Test subcircular in side view, biconvex, thick dorso-ventrally, dorsal side moderately convex, ventral side very convex; periphery not lobulate; edge sharply angled; whorls about 3; chambers about 6 in the last whorl, enlarging gradually; sutures on the dorsal side curved and long, oblique, tangential to the earlier whorl, limbate but scarcely raised, the spiral suture limbate and raised; dorsal side covered with a smooth secondary deposit obscuring the sutures, thicker over the earlier whorls; ventral sutures slightly curved, scarcely depressed, nearly flush with the surface; ventral side smooth, with secondary deposit around the small umbilicus, raised, in the form of a star, with a lobe just posterior to each suture; aperture a small arch at the base of the septal face, midway between umbilicus and periphery, with slight upper lip. Diameter, 0.76 millimeter; thickness, 0.53 millimeter.

Holotype No. 4105, locality A86, Cibao formation.

Rare at A86 of the Cibao formation.

ROTALIA Lamarck 1804

KEY TO THE PORTO RICAN SPECIES

A. Whorls involute on dorsal side .... *R. meyerhoffi*, page 381.
AA. Whorls not embracing on dorsal side
  B. Test domed on dorsal side .... *R. tholus*, page 382.
  BB. Test about equally biconvex
    C. Periphery strongly spinose .... *R. byramensis*, page 378.
    CC. Periphery not strongly spinose
      D. Dorsal surface nearly smooth..... *R. mexicana*, page 380.
      DD. Dorsal surface rough; edge not keeled
        E. Ventral ornamentation regular
          R. mexicana mecatepecensis, page 380.
        EE. Ventral ornamentation irregular
          R. choctawensis, page 379.

Rotalia byramensis Cushman

PLATE 19, FIGURES 1a–c

Rotalia byramensis Cushman (1922) U. S. Geol. Surv. Prof. Pap. 129E: 99. pl. 23, fig. 1. Middle Oligocene, Mississippi.—Cushman & McGlamery (1938) U. S. Geol. Surv. Prof. Pap. 189D: 110. pl. 27, fig. 3. Middle or upper Oligocene, Alabama.

Test unequally biconvex, ventral side the deeper; periphery lobulate, with a short peripheral spine on each chamber located slightly anterior to the midpart of the chamber; chambers rotaloid in arrangement, not involute on the dorsal side, 6 to 7 in the last whorl; earlier whorls on the dorsal side covered by secondary material, making a prominent boss; only the last whorl visible on the ventral side; sutures on the dorsal side slightly curved, limbate and flush with the surface; sutures on the ventral side radial, narrow and depressed, particularly between the last few chambers; in the umbilical region there is a circular boss with the sutures ending in a depressed ring around it; surface finely papillate on the dorsal side, coarsely papillate near the periphery on the ventral side; aperture a low arch at the base of the septal face between the umbilicus and the periphery, without definite lip. Diameter, 0.5 millimeter; thickness, 0.24 millimeter.

Plesiotype No. 4106, locality P431, Ponce formation.

Common at P431 of the Ponce formation.

The Porto Rican specimens seem to differ somewhat from the original figures of *R. byramensis,* particularly in the much smaller size (0.5 millimeter instead of 2 millimeters), fewer chambers, and less pointed chambers, but inasmuch as the Choctaw Bluff forms, which seem identical with the Porto Rican form, have been referred to this species, we are for the present placing our material in this species.

Rotalia choctawensis Cushman & McGlamery

Plate 19, figures 2a–c

Rotalia choctawensis Cushman & McGlamery (1938) U. S. Geol. Surv. Prof. Pap. **189D**: 110. pl. 27, fig. 4. Middle Oligocene, Alabama.

Test subcircular in side view, biconvex, the ventral side slightly deeper; periphery irregular; edge bluntly angled; ventral side with round, prominent umbo; 10 to 12 chambers in the last whorl, gradually enlarging, somewhat irregular in size; sutures on the dorsal side slightly curved, raised, obscure; sutures on the ventral side nearly radial, depressed; surface on both sides, more on the dorsal side, covered with secondary wall material in irregular, lumpy masses; aperture a small slit at the base of the septal face, about midway between umbo and periphery, with slight upper lip. Diameter, 0.56 millimeter; thickness, 0.31 millimeter.

Plesiotype No. 4107, locality L1C, San Sebastian formation.

Rare at L1C of the San Sebastian formation.

This species is scarcely distinguishable from *R. mexicana,* differing mainly in the rougher surface. It is noteworthy that *R. choctawensis* does not occur in the Ponce formation, which has at least five other species of *Rotalia,* nor does any other species of *Rotalia* occur in the San Sebastian formation, so far as our collections show.

Rotalia mexicana Nuttall

PLATE 19, FIGURES 3a–c

Rotalia mexicana Nuttall (1928) Jour. Paleont. 2: 374. pl. 50, figs. 6–8. Upper Eocene, Mexico.

Test subcircular in side view, biconvex, deeper on the ventral side; edge angled to sharply rounded; periphery even and papillate except for the last few chambers which are extended radially into blunt points, giving an angularly lobate outline to the test; whorls not involute on the dorsal side; 10 to 12 chambers in the last whorl, obscure on the dorsal side, distinct on the ventral side, not inflated; sutures slightly curved and flush dorsally, nearly radial and conspicuously depressed ventrally, meeting near the umbilicus to form a narrow, depressed ring around an umbonal boss of clear material; surface of the dorsal side smooth or granular; surface of the ventral side papillate near the periphery and granulate with small, irregular depressions up to the central boss; aperture a narrow slit at the base of the septal face between umbo and periphery, nearer the periphery, without definite lip. Diameter, 0.6 millimeter; thickness, 0.45 millimeter.

Plesiotype No. 4109, locality P253, Ponce formation.

Common at P4, P253, and P432 of the Ponce formation.

Our specimens are uniformly deeper ventrally than dorsally. Nuttall states, "the dorsal side strongly convex and the ventral flattened". He may have been using the words "dorsal" and "ventral" in the opposite sense from that of general usage, or have made an error. Otherwise, our form is very similar to Nuttall's.

Rotalia mexicana mecatepecensis Nuttall

PLATE 19, FIGURES 4a–c

Rotalia sp. Cushman (1927) Jour. Paleont. 1: 166. pl. 26, fig. 5. Alazan Clays, Eocene or lower Oligocene, Mexico.

Rotalia mexicana mecatepecensis Nuttall (1932) Jour. Paleont. 6: 26. pl. 4, figs. 11, 12. Lower Oligocene, Mexico.

Test large, biconvex, ventral side the deeper; subcircular in side view; periphery smooth but papillate in the early part of the last whorl becoming slightly lobate in the later part; edge subangular in young specimens to narrowly rounded in adult; 11 to 13 chambers in the last whorl, enlarging gradually; test involute to umbo on the ventral side, with a large round or oval central boss and several small bosses of clear shell material; dorsal side with some of the later chambers distinct, the last half whorl usually raised above the earlier whorls, the earlier whorls and much of the last whorl covered with secondary wall material in a rough and papillate manner; ventral side covered with secondary material, thickest near the periphery, making an intricate pattern of radial and concentric knobs; sutures on the ventral side distinct, radial, depressed particularly toward the umbo; sutures on the dorsal side slightly curved, obscure except for the last few chambers where they are depressed; aperture a short slit at the base of the septal face, nearer the periphery than the umbo, obscured by the secondary deposit, without definite lip. Diameter, 1.15 millimeters; thickness, 0.58 millimeter. The largest specimens are nearly 2 millimeters in diameter.

Plesiotype No. 4075, locality P431, Ponce formation.

Abundant at P431 of the Ponce formation.

This variety differs from *R. mexicana* in the rougher surface, and from *R. choctawensis* (1938. U. S. Geol. Surv. Prof. Pap. **189D**) in the regularity of the ventral ornamentation.

Rotalia meyerhoffi NEW SPECIES

PLATE 20, FIGURES 1a–c

Test small, oval in side view, the later part of the last whorl being very broad radially; biconvex and biumbonate, the ventral side more strongly convex, involute more than half the width of a whorl on the dorsal side, tending to become evolute on the ventral side, exposing more than the last whorl to view; periphery not particularly lobulate but with a slight projection at the anterior periphery of the last few chambers where there is a short spine; edge angular in the last few chambers, somewhat rounded by papillate secondary wall tissue in most of the last whorl; whorls few; chambers 9 to 11 in the last whorl, increasing gradually in length, very broad radially, only those of the last whorl, or less, visible on the dorsal side due to secondary shell material which covers the earlier whorls and makes an umbo; ventrally the umbilical region is filled by a boss of clear shell material; surface smooth on the ventral side, granulate on the dorsal side and papillate on and near the periphery on both sides of the test; sutures on the ventral side nearly radial, narrow and depressed, on the dorsal side slightly curved, limbate and more or less raised; aperture a narrow slit at the base of the last septal face between the umbo and the periphery, nearer the periphery, with small upper lip. Diameter, 0.7 millimeter; thickness, 0.32 millimeter.

Holotype No. 4108, locality P431, Ponce formation.

Common at P431 of the Ponce formation.

This species differs from all associated species of *Rotalia*, and from nearly all other species of the genus, in being partially involute on the dorsal side, yet with very wide chambers radially. It most nearly resembles *R. aculeata* (d'Orbigny) (1846. Foram. Foss. Vienne pl. 8).

We take pleasure in naming this species for Dr. Howard A. Meyerhoff, Professor of Geology at Smith College, who has devoted many years to the study of the geology of Porto Rico, and who collected the foraminiferal material for the present study.

Rotalia tholus NEW SPECIES

PLATE 20, FIGURES 2a–c

Test subcircular in side view, dome shaped in edge view, slightly convex ventrally, strongly convex, domal or even campanulate dorsally; edge angled but not keeled; periphery slightly lobulate, a little irregular but not erose; chambers 9 to 10 in the last whorl, increasing gradually in size, not inflated; whorls not involute on the dorsal side, the earlier ones obscured by strongly papillate or knobbed secondary shell material, most marked on the sutures; ventral side with a strong umbilical plug of clear shell material, separated by a groove from the chambers; sutures on the dorsal side gently curved, limbate and flush with the surface or raised, only those of the last whorl distinct; sutures on the ventral side slightly depressed, more so at the inner ends, not limbate, nearly straight, radial; surface of the ventral side unornamented except for a crescentic addition of secondary material on the inner ends of the chambers; aperture a slit at the base of the septal face, midway between umbo and periphery, without upper lip. Diameter, 0.55 millimeter; thickness, 0.33 millimeter.

Holotype No. 4110, locality P431, Ponce formation.

Common at P431 of the Ponce formation.

This species differs from *R. alabamensis* Cushman and McGlamery (1938, U. S. Geol. Surv. Prof. Pap. **189D**) in the flatter ventral side, more domed dorsal side, more chambers, and smoother, non-keeled edge. The specific name refers to the cupola or dome-shaped dorsal side of the test, from the Latin noun, *tholus*.

DISCORBIS* Lamarck 1804

Discorbis floridanus Cushman

PLATE 21, FIGURES 5a–c

Discorbis floridana Cushman (1922) Carnegie Inst. Wash. Publ. 311: 39. pl. 5, figs. 11, 12. Recent, Tortugas; (1933) U. S. Geol. Surv. Prof. Pap. 175A: 29. pl. 9, figs. 12, 13. Middle and upper Miocene, southeastern U. S.

Test planoconvex, dorsal side convex, ventral side flat, or a little concave; edge narrowly rounded; test oval in side view, somewhat lobulate; 5–6 chambers in the last whorl, increasing gradually in size; sutures on the dorsal side obliquely curved, slightly depressed except for the earlier ones which are narrowly limbate, sutures on the ventral side nearly radial, depressed; wall finely but conspicuously perforate; aperture an elongate low arch at the base of the last chamber on the ventral side extending from the umbilicus nearly to the periphery. Diameter, 0.41 by 0.50 millimeter; thickness, 0.16 millimeter.

Plesiotype No. 3897, locality L5C, San Sebastian formation.

Rare at L1C and L5C of the San Sebastian formation, and at A79 of the Los Puertos formation.

Discorbis havanensis Cushman & Bermudez

PLATE 20, FIGURES 3a–c

Discorbis havanensis Cushman & Bermudez (1937) Contr. Cushman Lab. Foram. Res. 13: 19. pl. 2, figs. 15, 16. Eocene, Cuba.

Test compressed, round in side view, with lobulate periphery; dorsal side moderately convex and umbonate, ventral side flat or slightly convex; edge acute with narrow keel; chambers distinct, 4 to 5 in the last whorl, increasing gradually in size as added, not inflated on the dorsal side, slightly inflated on the ventral side, the last chamber extending nearly a third of the circumference of the test; dorsal sutures distinct, strongly curved, limbate but little raised, distinct in the last whorl, the earlier whorls usually covered by a secondary deposit; ventral sutures narrow, depressed, slightly curved, usually bordered on one or both sides by thin lines of secondary tissue extending outward from the umbilicus; umbilicus modified by addition of secondary tissue, leaving several small, lobate depressions; the exact forms made by the ventral secondary tissue varies considerably from specimen to specimen; wall finely perforate on both sides; aperture a slit opening into the umbilicus, covered by a thin, valvular

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* The gender of *Discorbis* is masculine since the Latin word *orbis* is masculine. Adjectival specific names should therefore have a masculine ending, a point which has been generally overlooked heretofore.

flap extending from the inner, middle edge of the last chamber. Diameter, 0.74 by 0.64 millimeter; thickness, 0.24 millimeter.

Plesiotype No. 4112, locality P258, Ponce formation.

Abundant at A79 of the Los Puertos formation. Common at F64 and F359 of the Quebradillas formation. Rare at P259; abundant at P258 of the Ponce formation.

Perhaps this species belongs in the genus *Globorotolia*.

Discorbis multisectus NEW SPECIES

PLATE 20, FIGURES 4a–c

Test planoconvex, dorsal side convex forming a low cone, ventral side umbilicate, chambers only slightly convex, with general ventral surface slightly concave; edge bluntly angled; nearly 3 whorls in the test, 4 chambers in the last whorl, enlarging gradually, last chamber occupying more than a third of the periphery of the test; ventral margin of last chamber lobulate due to apertural recess, previous apertural recesses covered with a flap of shell material; sutures on the dorsal side narrow, obliquely curved, not limbate, flush with the surface except for the last one which is slightly depressed, sutures on the ventral side slightly depressed, primary sutures short, nearly radial, secondary sutures with sigmoid curve; wall distinctly, but not coarsely, perforate; aperture large, ventral, near the umbilicus. Average diameter, 0.31 by 0.36 millimeter; thickness, 0.16 millimeter.

Holotype No. 3898, locality L5C, San Sebastian formation.

Common at L5C; rare at L3C of the San Sebastian formation.

This species seems related to the *D. mirus-orbicularis* group. It differs from *D. mirus* Cushman (1922. Carnegie Inst. Wash. Publ. **311**) in having a smooth, not lobulate outline; nonlimbate, more oblique dorsal sutures; fewer chambers, and a smaller test. It differs from *D. orbicularis* (Terquem) (1876. Ess. Anim. Plage Dunkerque (**2**)) in being less circular, and in having less elongate chambers.

The specific name *multisectus* refers to the secondary sutures on the ventral side.

Discorbis oligospiratus NEW SPECIES

PLATE 21, FIGURES 1a–c

Discorbina globularis Flint (not d'Orbigny) (1899) Ann. Rept. U. S. Nat. Mus. **1897**: 327. pl. 72, fig. 2. Recent, off Florida.

Test of average size for the genus, planoconvex, nearly flat on the ventral side, convex on the dorsal side; on dorsal side somewhat involute, early whorls depressed; umbilicate on the ventral side, the lobate inner ends of the chambers forming a star-shaped umbilicus; periphery smooth; edge subangular in early part of the test becoming broadly rounded and shouldered on the dorsal side in most of the last whorl of the test; six chambers in the last whorl, enlarging rapidly in thickness, the last chamber constituting nearly a third of the test on the ventral side; sutures distinct, marked by a filling of clear shell material, curved on both sides of the test, flush with the surface except between the last two chambers where it is depressed; aperture an arched opening near the umbilicus on the ventral side of the test, partially covered by a thin, plate-like extension of the chamber. Diameter, 0.64 by 0.80 millimeter; thickness 0.46 millimeter.

Holotype No. 3899, locality A86, Cibao formation.

Rare at A86 of the Cibao formation.

Discorbis pelliculatus NEW SPECIES

PLATE 21, FIGURES 6a–c

Test small, nearly circular in side view; dorsal side low conical with concave slopes and prominent umbo; ventral side slightly convex to flat, not concave, with low, median umbo; periphery smooth, not lobulate; edge angled but neither sharp nor carinate; chambers very broad, 4 in last whorl, the last comprising more than one-third of the circumference of the test, each ventral chamber with an umbonal extension, similar to those seen in *Tetrataxis;* whorls about three, the early ones obscure; dorsal sutures curved and tangential to the earlier whorl, narrow and flush with the surface, the last one or two slightly depressed, only those of the last whorl visible; ventral sutures obscure, consisting of two outward curves and one inward curve, narrow and flush with the surface; wall very finely perforate, as seen after removal of the pellicle by acid; surface matt mostly covered on both sides by a thin smooth layer or pellicle of opaque shell material, thickest on the dorsal umbo; aperture a small, thin arch in the front, outer curve of the ventral part of the last chamber, not under the umbilical extension. Diameter, 0.69 millimeter; thickness, 0.30 millimeter.

Holotype No. 4141, locality A21, Quebradillas formation.

Common at locality A21 of the Quebradillas formation.

This species is obviously similar to several forms as yet included in *D. orbicularis* (Terquem), particularly the Florida Miocene form (1932. Fla. Geol. Surv. Bull. **9**), but it differs from more typical forms of *D. orbicularis* (such as Brady 1884. Rep. Voy. Challenger Zool. **9**: pl. 88, fig. 5, from the Bermudas, and Cushman 1931. Bull. U. S. Nat. Mus. **104** (8): pl. 6, fig. 3, from Jamaica) in lacking the concave ventral side, the carinate edge and the coarse perforations, and in the presence of the umbos and the pellicle of secondary shell material.

Discorbis subaraucanus Cushman

PLATE 21, FIGURES 2a–c

Discorbis subaraucana Cushman (1922) Carnegie Inst. Wash. Publ. **311**: 41. pl. 7, figs. 1, 2. Recent, Tortugas.—Cole & Gillespie (1930) Bull. Am. Paleont. **15** (**57B**): 11. pl. 3, figs. 2, 3. Middle Oligocene, Meson, Mexico.—Cushman (1935) U. S. Geol. Surv. Prof. Pap. **181**: 43. pl. 18, figs. 1a–c. Upper Eocene, Alabama.

Test planoconvex, very slightly convex on the dorsal side, and nearly flat on the ventral side except for the last chamber which is somewhat inflated and the concave depression in the umbilical region; edge subacute; two and a half whorls in the test, 6 to 7 chambers in the last whorl, early chambers enlarging gradually in size, last few chambers enlarging more rapidly, the last chamber in the adult form being arcuate on the dorsal side, and constituting nearly $\frac{1}{3}$ of the ventral side of the test; sutures on both sides, and early part of spiral suture on the dorsal side marked by clear shell material, last few sutures more narrowly limbate; sutures obliquely curved on the dorsal side, flush with the surface except for the last few which are slightly depressed, sutures on the ventral side curved, more so in the earlier part of the test; wall finely but conspicuously perforate; aperture a slit at the base of the last chamber on the ventral side extending from the umbilicus to near the periphery, with a slight lip. Diameter, 0.40 by 0.45 millimeter; thickness, 0.16 millimeter.

Plesiotype No. 3900, locality L5C, San Sebastian formation.

Rare at L2C and L3C; common at L5C of the San Sebastian formation. Abundant at A79 of the Los Puertos formation. Common at P258 of the Ponce formation.

EPISTOMARIA Galloway 1933

Epistomaria pontifera NEW SPECIES

PLATE 24, FIGURES 2a–c

Discorbina polystomelloides Heron-Allen & Earland (1915) Trans. Zool. Soc. London **20** (**2**): pl. 52, figs. 19–23. Recent, Kerimba Archipelago.

Test rotaloid, convex on the dorsal side, with depressed spire, concave on the ventral side, broadly oval in side view; periphery lobulate; back smoothly rounded; chambers 7 to 8 in the last whorl, inflated, increasing rapidly in size as added; whorls about 2; early whorls on the dorsal side separated from the last whorl by a depressed spiral suture; on the ventral side secondary shell material forms triangular places over part of each chamber converging at the umbilicus; dorsal sutures nearly radial, distinct, depressed, marked by clear shell material; ventral sutures depressed, radial, narrow between the secondary deposits; between the chambers on the back of the test there are one or two retral processes or septal bridges similar to those in *Elphidium;* wall coarsely and plainly perforate, the perforations continuing through the ventral secondary deposits; aperture a wide slit at the base of the septal face, usually closed by secondary material, and elongate secondary apertures between the chambers on both sides near the periphery, the accessory apertures being outlined by thin bands of clear shell material; there are no accessory apertures at the outer edges of the triangular umbilical plates. Diameter, 0.87 by 0.62 millimeter; thickness, 0.33 millimeter, for the medium-sized figured specimen.

Holotype No. 4115, locality P258, Ponce formation.

Common at P258 of the Ponce formation.

This species differs from the Recent Arctic species, *E. rimosa* (Parker and Jones) (1865. Phil. Trans. Roy. Soc. London **155**) in having septal bridges and lacking the openings at the outer ends of the triangular umbilical plates. The septal bridges are similar to those in *D. polystomelloides* (Parker and Jones), but are fewer, there are fewer chambers, and the deposits are thinner and smoother.

Our form seems to be identical with the form identified with *Discorbina polystomelloides* by Heron-Allen and Earland, from the Kerimba Archipelago, in an extraordinary provincial fauna.

ANOMALINA d'Orbigny 1826

Anomalina alazanensis Nuttall

PLATE 22, FIGURES 1a–c

Anomalina alazanensis Nuttall (1932) Jour. Paleont. **6**: 31. pl. 8, figs. 4, 8, 9. Lower Oligocene, Mexico.—Palmer & Bermudez (1936) Mem. Soc. Cubana Hist. Nat. **10**: 311. pl. 19, figs. 11–13. Lower Oligocene, Cuba.

Test plano-convex, dorsal side slightly convex, ventral side flat or slightly concave; periphery smooth, not lobate; edge rounded; chambers more involute on the ventral side, dorsal side showing 2½ whorls, ventral side showing about 1½ whorls; about 14 chambers in the last whorl, enlarging very slowly in size; sutures conspicuous, limbate, slightly raised, gently curved on both sides of the test; spiral sutures not raised; wall coarsely perforate; aperture a narrow arch at the base of the last chamber on the periphery and extending about one chamber length onto the dorsal side. Diameter, 0.67 by 0.55 millimeter; thickness, 0.20 millimeter.

Plesiotype No. 3866, locality P3, Ponce formation.

Very rare at P3 and P254 of the Ponce formation.

Anomalina nucleata (Seguenza)

PLATE 22, FIGURES 2a–c

Truncatulina nucleata Seguenza (1880) Atti R. Accad. Lincei III. **6**: 64. pl. 7, fig. 8. Lower Miocene, Italy.

Truncatulina trinitatensis Nuttall (1928) Quart. Jour. Geol. Soc. London **84**: 97. pl. 7, figs. 3, 5, 6. Upper Eocene to Miocene, Trinidad.

Cibicides nucleata Galloway & Morrey (1929) Bull. Am. Paleont. **15** (55): 31. pl. 4, fig. 9. Lower Oligocene, Ecuador.

Cibicides trinitatensis Nuttall (1932) Jour. Paleont. **6**: 33. pl. 7, fig. 9. Lower Oligocene, Mexico.—Hadley (1934) Bull. Am. Paleont. **20** (70A): 29. pl. 4, figs. 10, 11. Upper Eocene and Oligocene, Cuba.

Anomalina nucleata Coryell & Rivero (1940) Jour. Paleont. **14**: 334. pl. 44, figs. 2a–c. Middle Miocene, Haiti.

Test subcircular in side view, biconvex and biumbonate, nearly planispiral, dorsal side moderately convex, ventral side strongly convex; periphery smooth, not lobulate; edge sharply to evenly rounded; involute on both sides, more so on the ventral side; on the dorsal side the last whorl is wide, the early whorls covered by a thick, flat or convex boss of clear shell material; chambers 12 to 15 in the last whorl, enlarging gradually as added; dorsal sutures gently curved, strongly raised and marked by clear shell material between the early chambers of the last whorl, somewhat depressed between the last few chambers; ventral sutures gently curved, flush or slightly raised, merging into a thin or thick layer of transparent secondary material covering the early whorls and making an umbo; wall coarsely and conspicuously perforate, some of the pores showing in the limbate sutures and in the bosses; aperture a low arch at the base of the septal face on the inner periphery and extending a short distance toward the ventral umbo and dorsally for a distance of several chambers between the last two whorls, with slight upper lip. Diameter, 0.73 millimeter; thickness, 0.37 millimeter.

Plesiotype No. 4041, locality P254, Ponce formation.

Rare at P251 and P254 of the Ponce formation, and at A93 of the Quebradillas formation.

We include this form in *Anomalina* because of the nearly planispiral coiling and because the spire on neither side is completely covered by the last whorl. Other forms similar or identical with this species are *Anomalina umbonata* Cushman (in Howe 1939. La. Dept. Cons. Geol. Bull. **14**) and *Anomalina nolani* Hedberg (1937. Jour. Paleont. **11**).

There is considerable variation in the amount of sutural limbation and thickness of the umbos in this species (or these species), depending more on the ontogenetic age of the specimens than on the geologic age. They all occur between the middle Eocene and middle Miocene.

Anomalina pompilioides NEW SPECIES

PLATE 22, FIGURES 3a–c

Anomalina grosserugosa Cole (not Gümbel) (1928) Bull. Am. Paleont. **14** (53): 18. pl. 1, figs. 16, 17. Upper Eocene, Chapapote formation, Mexico.—Nuttall (not Gümbel) (1928) Quart. Jour. Geol. Soc. London **84**: 99. pl. 7, fig. 18 (not 19). Upper Eocene and lower Miocene, Trinidad.

Test small for the genus, nearly bilaterally symmetrical, subcircular in side view; periphery lobate; broadly elliptical in edge view, back broadly rounded; involute on ventral side, not completely involute on dorsal side; chambers inflated, rather large, regularly and gradually enlarging, 5 to 6 in the last whorl; sutures radial, nearly straight, depressed; wall coarsely perforate; aperture a low arch on the inner margin of the last septal face on the periphery; apertural face convex, lunate in shape, slightly more than twice as wide as its median height. Diameter, 0.32 by 0.39 millimeter; thickness, 0.23 millimeter.

Holotype No. 3867, locality A86, Cibao formation.

Rare at A86 of the Cibao formation.

This species differs from *A. grosserugosa* (Gümbel) (1870. Abh. k. bay. Akad. Wiss. München Math. Phys. Cl. **10**) in its greater thickness and fewer chambers.

As Thalmann pointed out in 1932, Brady's specimens in the Challenger Report are not true *A. grosserugosa* (Gümbel), but neither are they the same as this Porto Rican species. Brady's form has more chambers in the last whorl, *i. e.* eight.

CYCLOLOCULINA Heron-Allen & Earland 1908

Cycloloculina cubensis Cushman & Bermudez

PLATE 21, FIGURES 3a, b, and 4

Cycloloculina cubensis Cushman & Bermudez (1936) Contr. Cushman Lab. Foram. Res. **12**: 61. pl. 11, figs. 15, 16. Eocene, Cuba.

Test discoidal, compressed, the two sides much alike; edge narrowly rounded; about 5 rapidly enlarging chambers in the early part of the test, followed by 3 to 6 annular chambers; sutures indistinct except near the periphery where they are slightly depressed; surface finely granular and ornamented by scale-like additions of secondary tissue, most prominent on the last chamber, and radial depressions, the scales and radial depressions of each chamber independent of those on adjacent chambers, giving a crenulate appearance to the inner margins of the chambers; aperture not observed. Diameter, 0.57 millimeter; thickness, 0.12 millimeter.

Plesiotypes No. 3888, locality L3C, San Sebastian formation, and No. 3886, locality A79, Los Puertos formation.

Rare at L3C; common at L4C of the San Sebastian formation. Rare at P254, P255, and P431 of the Ponce formation. Common at A79, Los Puertos formation.

CIBICIDES Montfort 1808

Key to the Porto Rican Species

A. Ventral side umbilicate, without umbo of secondary material
  B. Involute nearly to spire on dorsal side
    C. Test oval; later chambers gradually lengthening
      C. choctawensis, page 391.
    CC. Test round; later chambers rapidly lengthening
      C. americanus, page 390.
  BB. Not involute on dorsal side
    C. Test round; later chambers gradually enlarging
      D. Without dorsal umbo........... *C. mexicanus*, page 394.
      DD. With dorsal umbo...................... *C. io*, page 392.
    CC. Test oval; later chambers rapidly enlarging
      D. Periphery strongly lobate.......... *C. lobatus*, page 393.
      DD. Periphery slightly lobate.......... *C. scalenus*, page 396.
AA. Ventral side strongly umbonate with secondary material
  B. Last whorl wide, tending to be involute dorsally
    C. Dorsal secondary ornamentation weak
      C. pseudoungerianus, page 395.
    CC. Dorsal secondary ornamentation strong.. *C. floridanus*, page 392.
  BB. Last whorl narrow, not involute dorsally
    C. Spiral suture not raised; dorsal deposit thin
      D. Whorls less than 3; pores very coarse
        C. perlucida, page 394.
      DD. Whorls more than 3; pores coarse. *C. sinistralis*, page 396.
    CC. Spiral suture raised................ *C. spirolimbatus*, page 397.

Cibicides americanus (Cushman)

Plate 24, figures 3a–c

Truncatulina americana Cushman (1918) U. S. Geol. Surv. Bull. 676: 63. pl. 20, figs. 2, 3, pl. 21, fig. 1. Miocene, Atlantic coastal plain, U. S.

Cibicides americanus Cole & Gillespie (1930) Bull. Am. Paleont. 15 (57B): 14. pl. 4, fig. 4. Meson formation, Mexico, middle Oligocene.—Cushman & Cahill (1933) U. S. Geol. Surv. Prof. Pap. 175A: 34. pl. 13, figs. 2a–c. Miocene and Oligocene of Atlantic coastal plain; late Tertiary of California, Panama, and northern South America.

Test small for the genus, planoconvex, dorsal side nearly flat, ventral side moderately convex; edge subacute; periphery smooth except for the last few chambers which are slightly lobulate; 8 to 11 chambers in the last adult whorl, rather rapidly increasing in size; in most specimens the last few chambers do not extend to the umbilicus either dorsally or ventrally; sutures distinct, slightly limbate on both sides in the early chambers, slightly depressed between later chambers; wall smooth, coarsely perforate; aperture at the base of the septal face extending onto the dorsal side only one chamber width and extending to the umbilicus on the ventral side; aperture with slight lip. Diameter of figured specimen, 0.29 by 0.38 millimeter; thickness, 0.13 millimeter. Maximum diameter, 0.50 millimeter.

Plesiotype No. 3952, locality L1C, San Sebastian formation.

Common at L1C and L2C of the San Sebastian formation. Rare at A86 of the Cibao formation.

Cibicides choctawensis Cushman & McGlamery

PLATE 23, FIGURES 1a–c

Cibicides choctawensis Cushman & McGlamery (1938) U. S. Geol. Surv. Prof. Pap. 189D: 111. pl. 28, fig. 6. Oligocene, Alabama.

Test small, subcircular or broadly oval in dorsal view, planoconvex, dorsal side flat or slightly concave and nearly or quite involute to the middle of the spire, ventral side very convex, with small umbilicus, with truncate base and nearly straight sides, increasing rapidly in thickness with successive chambers; edge square to subacute, but not keeled; periphery smooth, not lobulate; chambers about 9 in the last whorl, increasing gradually in size, the last few increasing more rapidly in all dimensions; sutures on the dorsal side strongly curved, slightly limbate, flush with the surface but depressed near the center of the spire; ventral sutures very little curved, limbate, flush with the surface except the last few which are a little depressed; surface smooth; wall finely but conspicuously perforate; aperture a small arch at the base of the septal face on the inner periphery, with upper lip, continuing on the dorsal side between the last four chambers and the previous whorl. Diameter, 0.37 millimeter; thickness, 0.15 millimeter.

Plesiotype No. 4117, locality A43a, Cibao formation.

Common at A43a of the Cibao formation.

This form is more involute on the dorsal side and is much more finely perforate than is true of typical *Cibicides*.

Cibicides floridanus (Cushman)

PLATE 23, FIGURES 2a–c

Truncatulina floridana Cushman (1918) U. S. Geol. Surv. Bull. **676**: 62. pl. 19, fig. 2. Miocene, Florida.—Nuttall (1928) Quart. Jour. Geol. Soc. London **84**: 98, pl. 7, figs. 14, 16. Miocene, Trinidad.

Truncatulina lobatula ornata Cushman (1918) U. S. Geol. Surv. Bull. **676**: 61. pl. 18, figs. 1, 2. Miocene, Florida, Virginia.

Cibicides floridana Cushman (1931) Bull. U. S. Nat. Mus. **104** (8): 122. pl. 23, figs. 3–5. Recent, off Florida; (1930) Fla. Geol. Surv. Bull. 4: 61. pl. 12, fig. 3. Miocene, Florida.

Cibicides cf. *floridana* Palmer & Bermudez (1936) Mem. Soc. Cubana Hist. Nat. **10**: 315. pl. 20, figs. 1–3. Lower Oligocene, Cuba.

Cibicides floridanus Coryell & Rivero (1940) Jour. Paleont. **14**: 334. pl. 44, figs. 10a–c. Middle Miocene, Haiti.

Test small, subcircular in side view, equally biconvex or rather flat dorsally and strongly convex ventrally; edge subacute; periphery smooth, not lobulate, with border of clear shell material; the last whorl broad dorsally, tending to become involute, the early whorls covered with a thick, secondary deposit; ventral side with strong umbo of hyaline secondary material; chambers 10 to 12 in the last whorl, increasing slowly in length and thickness but more rapidly in width; dorsal sutures gently curved, limbate and raised, except for the last few which may be depressed; ventral sutures gently curved, limbate and raised, merging with the umbo and the border; wall coarsely perforate, the pores enlarged by the secondary material on the dorsal side; aperture a small arch, with upper lip, at the base of the septal face on the inner periphery, extending dorsally for a distance of one or two chambers. Diameter, 0.45 millimeter; thickness, 0.2 millimeter.

Plesiotype No. 4118, locality A86, Cibao formation.

Common at P2, P4, and P254 of the Ponce formation. Abundant at A86 of the Cibao formation. Common at A20 and A21 of the Quebradillas formation.

This species is characterized by the strong secondary deposits in the form of covered spire and raised spiral and radial sutures. It has the wide last whorl which is partially involute on the dorsal side, also seen in *C. pseudodoungerianus* and *C. io*.

Cibicides io Cushman

PLATE 22, FIGURES 4a–c

Cibicides pseudoungeriana io Cushman (1931) Bull. U. S. Nat. Mus. **104** (8): 125. pl. 23, figs. 1, 2. Recent, off Florida.

Cibicides io Coryell & Rivero (1940) Jour. Paleont. **14**: 334. pl. 44, fig. 11. Miocene, Haiti.

Test subcircular in side view, nearly flat on the dorsal side, convex on the ventral side; periphery not lobulate; edge sharply rounded to broadly rounded; whorls few, about two, the last whorl on the dorsal side increasing rapidly in width, considerably involute, the early whorls covered by secondary material, separated by a groove from the limbate and raised spiral suture; ventral side with small umbilicus, but without umbo of secondary material; chambers about 10 in the last whorl, enlarging gradually in length but rapidly in width as added; sutures on the dorsal side slightly curved, limbate and raised, except the last ones which may be slightly depressed; ventral sutures very little curved, nearly radial, narrowly limbate and flush with the surface or slightly depressed; aperture a low, broad arch at the base of the septal face, on the inner periphery, extending slightly ventrally and dorsally, with narrow upper lip. Diameter, 0.56 millimeter; thickness, 0.22 millimeter.

Plesiotype No. 4123, locality A21, Quebradillas formation.

Rare at A21 of the Quebradillas formation.

This species lacks the ventral umbo and raised sutures of *C. floridanus*, but has a dorsal umbo.

Cibicides lobatus (d'Orbigny)

PLATE 24, FIGURES 4a–c

Truncatulina lobata d'Orbigny (1839) in Barker, Webb & Berthelot, Hist. Nat. Îles Canaries **2** (**2**): Foraminifères 134. pl. 2, figs. 22–24. Recent, Canaries.

Truncatulina lobatula d'Orbigny (1846) Foram. Foss. Vienne 168. pl. 9, figs. 18–23. Middle Miocene, Vienna.—Brady (1884) Rep. Voy. Challenger Zool. **9**: 660. pl. 92, fig. 10, pl. 93, fig. 1 (not 4 and 5). Recent, all latitudes.—Cushman (1918) U. S. Geol. Surv. Bull. **676**: 16. pl. 1, fig. 10. Pliocene, North Carolina.

Cibicides lobatula Cushman (1931) Bull. U. S. Nat. Mus. **104** (**8**): 118. pl. 21, figs. 3a–c. Recent, north Atlantic.

Cibicides lobatulus Cushman (1935) U. S. Geol. Surv. Prof. Pap. **181**: 52. pl. 22, fig. 4 (not 5 and 6). Upper Eocene, southeastern U. S.—Cole & Gillespie (1930) Bull. Am. Paleont. **15** (**57B**): 15. pl. 4, fig. 2. Middle Oligocene, Mexico.

Test of average size for the genus, planoconvex, flat or concave on the dorsal side, convex on the ventral side; periphery only slightly lobate; edge acute; chambers somewhat inflated, increasing gradually in size, 4 to 8 in the last whorl; sutures flush with the surface, curved and marked by clear shell material on the dorsal side, on the ventral side depressed, nearly radial; wall coarsely perforate; aperture on the periphery with slight lip, and extending both dorsally and ventrally along the base of the last chamber. Diameter of figured specimen, 0.65 by 0.74 millimeter; thickness, 0.20 millimeter.

Plesiotype No. 3884, locality L4C, San Sebatian formation.

Rare at L1C, L4C, and L5C of the San Sebastian formation, and at A43a and A86 of the Cibao formation. Abundant at A79 of the Los Puertos formation. Rare at A21 and F64 of the Quebradillas formation. Rare at P3, P251, and P254; common at P258, P431, and P432 of the Ponce formation.

C. lobata (d'Orbigny) is distinct from *C. lobatulus* (Walker and Jacob), the type figure of which is conspicuously lobate.

Cibicides mexicanus Nuttall

Plate 22, figures 5a–c

Cibicides mexicana Nuttall (1932) Jour. Paleont. 6: 33. pl. 9, figs. 7–9. Lower Oligocene, Mexico.

Test plano-convex, dorsal side flattened except for a moderate convexity of the early whorls, the last whorl being flat or even slightly concave, ventral side strongly convex, hemispherical; edge subacute, shouldered; early whorls indistinct on the dorsal side due to a thin layer of secondary shell material; 9 to 11 chambers in the last whorl, enlarging gradually in size; chambers involute ventrally, with slight umbilical depression; sutures gently curved, somewhat oblique on the dorsal side, gently curved radial on the ventral side, marked by clear shell material on both sides of the test, flush with the surface or slightly depressed on the dorsal side, flush or slightly raised on the ventral side; wall coarsely perforate; aperture an elongate slit at the base of the septal face running from the periphery less than half way to the umbilicus, and extending on the dorsal side between the last two whorls for a distance of about 4 chambers, with upper lip. Diameter, 0.95 millimeter; thickness, 0.6 millimeter.

Plesiotype No. 3924, locality P3, Ponce formation.

Abundant at P2 and P255; rare at P251 and P3 of the Ponce formation.

Cibicides perlucidus Nuttall

Plate 23, figures 4a–c

Cibicides perlucida Nuttall (1932) Jour. Paleont. 6: 33. pl. 8, figs. 10–12. Lower Oligocene, Mexico.

Test subcircular in side view, unequally biconvex, dorsal side slightly elevated, ventral side strongly convex; edge subacute to sharply rounded; periphery smooth, not lobulate; chambers 9 to 11 in the last whorl, enlarging gradually as added; whorls few, only two or a little more, the last not involute beyond the periphery of the previous whorl, the early whorls slightly obscured by a thin, smooth secondary deposit; spiral suture flush, bordered by a thick band of clear shell material; dorsal sutures narrowly limbate and flush with the surface; ventral sutures narrowly limbate and slightly depressed, merging with the central boss of clear shell material; wall very coarsely and conspicuously perforate, the wall material being translucent; aperture a low arch at the base of the septal face, on the inner periphery, with slight lip, and extending a short distance ventrally and dorsally. Diameter, 0.77 millimeter; thickness, 0.4 millimeter.

Plesiotype No. 4119, locality P251, Ponce formation.

Rare at P251 of the Ponce formation.

This species differs from *C. floridanus* and *C. pseudoungerianus* in the narrower last whorl which does not tend to be involute, and in lacking the thick, secondary deposit on the dorsal side. It has fewer whorls and is deeper ventrally than *C. pseudoungerianus sinistralis* and *C. pseudoungerianus evolutus*. *C. mexicanus* is hemispherical ventrally, whereas *C. perlucidus* is conical.

Cibicides pseudoungerianus (Cushman)

PLATE 23, FIGURES 5a–c

Truncatulina pseudoungeriana Cushman (1922) U. S. Geol. Surv. Prof. Pap. **129E**: 97. pl. 20, fig. 9. Middle Oligocene, Mississippi.

Cibicides pseudoungeriana Cushman (1931) Bull. U. S. Nat. Mus. **104** (8): 123. pl. 22, figs. 3–7. Recent, Atlantic.

Test small, biconvex, slightly more convex on the ventral side, subcircular in side view; periphery not lobulate, with border of clear shell material; edge angled to sharply rounded; whorls 2 to 3, usually coiled dextrally, the last one only slightly overlapping earlier whorls; early whorls on the dorsal side covered by a thin, smooth layer of shell material; ventral side with large umbo of clear shell material; chambers 9 to 11 in the last whorl, gradually enlarging in size as added; sutures on both sides gently curved, narrowly limbate, flush with the surface excepting on the ventral side between the last few chambers, where they are slightly depressed; aperture a small arch, with upper lip, at the base of the septal face on the inner periphery, continuing a short distance ventrally and for a distance of two or three chambers dorsally. Diameter, 0.43 millimeter; thickness, 0.23 millimeter.

Plesiotype No. 4120, locality A79, Los Puertos formation.

Rare at A79 of the Los Puertos formation.

This species is not well defined and not definitely recognizable, since several different forms have been included in it by its author. It is scarcely distinguishable from *C. floridanus*. As we distinguish the species, *C. pseudoungerianus* has little limbation and thin secondary deposits; *C. floridanus* has strong limbation on both sides, thick secondary deposit on the dorsal side in which the mural pores are enlarged. The difference in number of chambers and relative convexity is not significant.

Cibicides scalenus NEW SPECIES

PLATE 23, FIGURES 3a–c

Test very small, oval in side view, dorsal side flat or slightly convex, ventral side very convex, with small umbilicus; whorls about 2; chambers about 8 in the last whorl, increasing gradually up to the last few chambers when the chambers increase very rapidly in all dimensions; edge sharp, but not keeled; periphery smooth up to the last few chambers when it becomes lobulate, bordered by clear shell material; sutures on the dorsal side gently curved, limbate but not raised, the spiral suture being both limbate and raised; ventral sutures strongly curved, the outer ends limbate but not raised; wall conspicuously perforate; aperture a small arch on the inner periphery at the base of the last septal face, with upper lip, extending on the dorsal side for a distance of about two chambers. Diameter, 0.32 millimeter; thickness, 0.16 millimeter.

Plesiotype No. 4121, locality A43a, Cibao formation.

Rare at 43a of the Cibao formation.

The Porto Rican form resembles *C. westi* Howe (1939. La. Dept. Cons. Bull. **14**), but *C. scalenus* is less conical on the ventral side, and the ventral sutures are not strongly sigmoid.

Cibicides sinistralis Coryell & Rivero

PLATE 24, FIGURES 5a–c

Cibicides sinistralis Coryell & Rivero (1940) Jour. Paleont. **14**: 335. pl. 44, figs. 12a–c. Middle Miocene, Haiti.

Test subcircular in side view, nearly equally biconvex, coiled sinistrally; periphery not lobulate; edge subangular; whorls 3½, gradually enlarging, not overlapping the earlier whorls on the dorsal side; chambers 10 to 11, gradually enlarging; dorsal side covered by a thin, transparent secondary deposit; ventral side with strong umbo of clear shell material; dorsal sutures curved, slightly limbate but not raised; ventral sutures slightly curved, the later one sometimes sigmoid, narrowly limbate but flush with the surface; wall coarsely but not conspicuously perforate; aperture a small arch at the base of the septal face on the inner periphery, with upper lip, extending a very short distance ventrally and extending dorsally for a distance of 2 or 3 chambers. Diameter, 0.43 millimeter; thickness, 0.23 millimeter.

Plesiotype No. 4101, locality A86, Cibao formation.

Rare at A86 of the Cibao formation.

This species differs from *C. floridanus* and *C. pseudoungerianus* in having a narrower last whorl which does not overlap earlier whorls on the dorsal side. It differs from *C. perlucida* in the fewer whorls and less conspicuous pores. It differs from *C. pseudoungerianus evolutus* (1935. Contr. Cushman Lab. Foram. Res. **11**: 64. pl. 9, fig. 11) only in coiling to the left. The sinistral coiling seems to be of little significance, in view of the fact that many species of Foraminifera coil normally both sinistrally and dextrally. It must be admitted, however, that there are races, varieties or even species, which coil in only one direction for a given locality and geologic age.

Cibicides spirolimbatus NEW SPECIES

PLATE 25, FIGURES 1a–c

Test of medium size for the genus, subcircular in side view, biconvex and biumbonate, the ventral side slightly deeper; periphery not lobulate; edge sharply rounded, not keeled; whorls about 4, unusually narrow for the genus, not increasing much in width as growth proceeds, not overlapping on the dorsal side; about 12 chambers in the last whorl, gradually increasing in size as added; dorsal sutures slightly curved, moderately oblique, more and more limbate toward the center of the test, but not much raised, the spiral suture limbate and raised with clear shell material; the growth of the secondary material on the sutures obscures the spire especially toward the center but leaving the mural perforations in the reduced rhomboidal areas corresponding to the chambers; sutures on the ventral side slightly curved, narrowly limbate and flush with the surface, merging into the umbo of clear shell material; aperture a low arch just below the periphery with upper lip, extending on the dorsal side between the whorls for a distance of one or two chambers. Diameter, 0.87 millimeter; thickness, 0.40 millimeter.

Holotype No. 4122, locality A93, Quebradillas formation.

Rare at A93 of the Quebradillas formation.

This species differs from *C. mundula* (Brady, Parker and Jones) (1890. Trans. Zool. Soc. London **12**) in being ventrally umbonate, in the curved sutures and the aperture not on the inner periphery. The narrow whorls and spiral limbation are characteristic.

PLANULINA d'Orbigny 1826

Planulina crassa NEW SPECIES

PLATE 25, FIGURES 2a–c

Test nearly circular in side view, compressed in edge view yet rather thick, dorsal side flat or slightly concave, ventral side flat or slightly convex; back flat or slightly concave, a little oblique to the two sides; whorls 2 to 3, scarcely at all involute on the ventral side, slightly involute on the dorsal side; chambers 9 to 10 in the last whorl, increasing gradually in size as added; sutures on the dorsal side much curved and strongly raised, merging with the raised border; ventral sutures strongly curved and raised; wall coarsely perforate, the ventral surface strongly granulate between the sutures and on the sutures, and finely granulate on the dorsal surface over the early whorls; aperture at the base of the septal face on the inner periphery, with upper lip, not extending onto the ventral side but extending onto the dorsal side between the last two whorls for a distance of one or two chambers. Diameter, 0.45 millimeter; thickness, 0.13 millimeter.

Holotype No. 4065, locality A21, Quebradillas formation.

Abundant at A21; rare at A15; common at A20 and A93 of the Quebradillas formation.

This species differs from *P. ariminensis* d'Orbigny in that it is much thicker and the chambers are narrower in proportion to their length.

Planulina depressa (d'Orbigny)

PLATE 25, FIGURES 3a–c

Truncatulina depressa d'Orbigny (1839) Voy. Amér. Mérid. 5: Foraminifères 39. pl. 6, figs. 4–6. Recent, off South America.

Planulina depressa Cushman (1930) Fla. Geol. Surv. Bull. 4: 60. pl. 12, fig. 2. Miocene, Florida.

Test large, subcircular in side view, much compressed, concavo-convex to plano-convex, ventral side moderately convex but without an umbilical boss of secondary shell material; edge sharply angular; periphery lobulate, more strongly so in the last half whorl, with narrow, limbate border; some of the earlier whorls show on both sides of the test, the early dorsal spire covered with a thin, granular, secondary deposit; chambers short and wide, a little inflated on the ventral side, enlarging more rapidly in width than in length or thickness, about 9 in the last whorl; ventral sutures most distinct between the chambers of the last half whorl where they are conspicuously depressed, nearly radial near the center of the test, sharply curved near the periphery; dorsal sutures strongly curved, flush with the surface or slightly depressed, slightly limbate on the outer end where the limbation merges into the border; wall moderately coarsely perforate; aperture a small, high arch, with strong upper lip, at the base of the septal face on the inner periphery, extending onto the dorsal side for a distance of 3 or 4 chambers. Diameter, 1.38 millimeters; thickness, 0.26 millimeter.

Plesiotype No. 4124, locality P255, Ponce formation.

Rare at P255 of the Ponce formation.

Planulina marialana Hadley

PLATE 25, FIGURES 4a–c

Planulina wuellerstorfi Nuttall (not Schwager) (1932) Jour. Paleont. **6**: 31. pl. 4, figs. 14, 15. Lower Oligocene, Mexico.

Planulina marialana Hadley (1934) Bull. Am. Paleont. **20** (**70A**): 27. pl. 4, figs. 4–6. Oligocene, probably upper, Cuba.—Palmer & Bermudez (1936) Mem. Soc. Cubana Hist. Nat. **10**: 313. pl. 20, figs. 10–12. Lower Oligocene, Cuba.

Test large, nearly circular, biconvex, much compressed; periphery smooth, except for the last few chambers; edge angled, with narrow peripheral keel of clear shell material, more distinct on the earlier chambers of the last whorl; dorsal side of test showing 2½ to 3 rapidly widening whorls, ventral side involute nearly to umbilicus; chambers short and wide, 10 to 12 in the final whorl of the adult; dorsal sutures broadly curved, limbate, usually raised with the raised limbation more conspicuous on the early whorls; ventral sutures broadly curved, the later ones sigmoid, limbate, usually raised; the largest specimens umbilicate; wall coarsely perforate; aperture at the base of the last chamber on the inner periphery, extending a short distance onto the dorsal side between the last two whorls. Diameter, 1.52 millimeter; thickness, 0.25 millimeter.

Plesiotype No. 4125, locality P2, Ponce formation.

Rare at P251; common at P3 and P255; abundant at P2 and P254 of the Ponce formation.

It is quite possible that the forms figured by Hadley (umbonate, 9 chambers) and that figured by Palmer and Bermudez (umbilicate, 12 to 14 chambers) represent two different species, both of which are represented in the Porto Rican material.

Planulina mexicana Cushman

PLATE 26, FIGURES 3a–c

Planulina mexicana Cushman (1927) Contr. Cushman Lab. Foram. Res. **3**: 113. pl. 23, figs. 5a, b. Alazan, upper Eocene and lower Oligocene, Mexico.—Cole & Ponton (1930) Fla. Geol. Surv. Bull. **5**: 47. pl. 6, fig. 2. Lower Oligocene, Florida.—Nuttall (1932) Jour. Paleont. **6**: 31. pl. 7, fig. 7. Lower Oligocene, Alazan, Mexico.—Hadley (1934) Bull. Am. Paleont. **20** (**70A**): 28. pl. 4, fig. 12. Oligocene, Cuba.

Planulina cocoaensis cooperensis Cushman (1933) Contr. Cushman Lab. Foram. Res. **9**: 20. pl. 2, fig. 12; (1935) U. S. Geol. Surv. Prof. Pap. **181**: 52. pl. 22, fig. 8. Upper Eocene, South Carolina.

Test large, much compressed, complanate, sides flattened; edge narrowly rounded, not keeled; periphery slightly lobulate; early whorls visible on both sides of the test, becoming less involute with age, the final half whorl just touching the preceding whorl; chambers short and evenly curved, 7 to 8 in the last whorl; sutures distinct, sharply curved, limbate, flush with the surface or very slightly raised except between the last few chambers where they are depressed; wall coarsely perforate; aperture a low arch with slight lip at the base of the last chamber extending on the dorsal side about half a chamber length. Diameter, 0.82 by 1.04 millimeter; thickness, 0.11 millimeter.

Plesiotype No. 4066, locality P254, Ponce formation.

Rare at P254 of the Ponce formation.

This is one of the least involute species of the genus, the complete spire being visible on both sides of the test.

Planulina zigzag NEW SPECIES

PLATE 26, FIGURES 4a–c

Test oval in side view, much compressed, nearly planispiral, the dorsal side flat, or with slight spiral depression inside the last whorl, rarely slightly convex, as in the specimen figured; ventral side slightly convex, with large, shallow umbilical depression; edge truncate or slightly concave, with sharp, continuous keel of clear shell material extending from the dorsal side, the ventral side with discontinuous keel formed by the outer edges of the sutural limbation; periphery smooth, formed by the dorsal keel; dorsal sutures nearly straight, radial, limbate and raised, the limbation continuing in a zigzag line from chamber to chamber, just inside the carina, the spiral suture limbate but not raised, sometimes depressed; whorls about 2, only slightly involute on each side; eight chambers in the last whorl, enlarging rapidly, not inflated; ventral sutures limbate and strongly raised, straight, radial, the raised limbation continuing in a conspicuous zigzag line around the outer edge of the chambers, somewhat inside the dorsal carina, not joining to form a continuous carina; the radial and zigzag ridges on both sides of the test have fine, longitudinal striae on them; wall very coarsely and conspicuously perforate where the preservation is good; surface smooth, except for the raised ridges; septal face finely granulate; aperture a short slit at the base of the septal face, not continuing onto either dorsal or ventral side, with slight upper lip. Diameter, 0.53 by 0.72 millimeter; thickness, 0.11 millimeter.

Holotype No. 4126, locality A86, Cibao formation.

Common at A86 of the Cibao formation.

It is probably that *P. zigzag* is related to *P. alavensis* Palmer (1938. Mem. Soc. Cubana Hist. Nat. **12:** 345, 346, text fig.), but *P. zigzag* differs in the zigzag line of the peripheral limbation and the absence of peripheral secondary apertures.

CIBICIDELLA Cushman 1927

Cibicidella variabilis (d'Orbigny)

PLATE 24, FIGURES 1a–c

Truncatulina variabilis d'Orbigny (1826) Ann. Sci. Nat. 7: 279. no. 8: refers to 22 plates of illustrations by Soldani, 1789–1798. Recent, Mediterranean.—Parker, Jones & Brady (1871) Ann. Mag. Nat. Hist. IV. 8: 177. pl. 12, fig. 138. (One of Soldani's figures, on which d'Orbigny named his species.)—Terquem (1878) Mém. Soc. Géol. France III. 1: 20. pl. 1, figs. 18–25. Upper Pliocene, Isle of Rhodes.

Test large, ovate in side view; periphery lobulate; edge round; dorsal side irregularly concave; ventral side strongly convex and umbilicate; chambers 6 or 7 in the last formed whorl, inflated ventrally and sometimes dorsally, enlarging rapidly in all dimensions, especially the last few chambers, the last few chambers distorted but still retaining their normal position in a rotaloid coil, sometimes tending to become evolute; dorsal sutures flush and limbate in the early test, depressed in the later portion; ventral sutures strongly depressed, nearly linear and radial; wall coarsely perforate, about 0.01 millimeter in diameter, with little if any secondary material; aperture a single, high arch, with upper lip, on the inner periphery at the base of the septal face. Length, 1.36 millimeter; width, 0.85 millimeter; thickness, 0.2 millimeter. Some specimens are much larger and thicker.

Plesiotype No. 4127, locality L4C, San Sebastian formation.

Common at L4C; rare at L6C of the San Sebastian formation.

Our specimens are all much alike and not much removed from the ancestral *Cibicides*, and are like the figures in the references above. They are not like the figure in d'Orbigny's Canaries paper, nor like the specimens from the Miocene of Florida (1932. Fla. Geol. Surv. Bull. **9:** pl. 15).

SIPHONINA Reuss 1850

Siphonina advena Cushman

PLATE 26, FIGURES 1a–c

Siphonina advena Cushman (1922) U. S. Geol. Surv. Prof. Pap. 129E: 98. pl. 22, figs. 1, 2. Middle Oligocene, Mississippi; (1927) Proc. U. S. Nat. Mus. 72 (20): 7. pl. 1, fig. 7. Oligocene, gulf coast and Mexico.—Cole & Ponton (1930) Fla. Geol. Surv. Bull. 5: 43. pl. 11, figs. 7, 8. Lower Oligocene, Florida.

Test of moderate size, subcircular to oval in side view, biconvex, the ventral side slightly more convex; periphery not lobulate; edge subangular, not keeled; chambers in about 2 whorls, 4 to 5 in the last whorl, enlarging gradually; dorsal sutures obscure, slightly curved and oblique, flush with the surface, somewhat broadened with clear shell material; ventral sutures distinct, narrow, slightly curved, radial, a little depressed; wall very coarsely and conspicuously perforate, except over the early dorsal spire where the pores are obscure; aperture peripheral, slightly ventral, elliptical with short neck and phialine lip. Diameter, 0.42 millimeter; thickness, 0.2 millimeter.

Plesiotype No. 3988, locality A20, Quebradillas formation.

Rare at L1C and L5C of the San Sebastian formation, and at A6 of the Lares formation. Common at A43a and A86 of the Cibao formation. Rare at A79 of the Los Puertos formation. Rare at A15, A93, and F358; common at A20; abundant at A21 of the Quebradillas formation. Rare at P251 and P432 of the Ponce formation.

Siphonina tenuicarinata Cushman

PLATE 26, FIGURES 2a–c

Siphonina tenuicarinata Cushman (1927) Jour. Paleont. 1: 166. pl. 26, figs. 11, 12. Lower Oligocene, Alazan, Mexico; (1929) Contr. Cushman Lab. Foram. Res. 5: 100. pl. 14, fig. 9. Middle Tertiary, Venezuela and Trinidad.—Hedberg (1937) Jour. Paleont. 11: 679. pl. 92, fig. 4. Oligocene, Venezuela.—Coryell & Rivero (1940) Jour. Paleont. 14: 337. pl. 43, figs. 22, 29. Middle Miocene, Haiti.

Test asymmetrically coiled, biconvex, the ventral side slightly more so; edge acute with a wide keel of clear shell material, in which there are pores extending out from the edge of the chamber; whorls about 3; chambers about 5 in the last whorl, increasing uniformly in size, the last ones somewhat inflated on the ventral side; dorsal sutures nearly straight, tangential to the previous whorl, flush with the surface and very obscure; ventral sutures slightly curved, radial, flush with the surface and obscure excepting the last one or two, which may be slightly depressed; wall moderately coarsely but conspicuously perforate; aperture slightly below the periphery on the ventral side, elliptical, with very short neck and broad lip. Diameter, 0.6 millimeter; thickness, 0.26 millimeter.

Plesiotype No. 4128, locality P254, Ponce formation.

Rare at P2 and P255; common at P254, Ponce formation.

PLANORBULINELLA Cushman 1927

Planorbulinella larvata (Parker & Jones)

PLATE 26, FIGURES 5a–c

Planorbulina vulgaris larvata Parker & Jones (1860) Ann. Mag. Nat. Hist. III. 5: 294. Recent.
Planorbulina larvata Parker & Jones (1865) Phil. Trans. 155: 380. pl. 19, figs. 3a, b. Recent, Indian Ocean.—Brady (1884) Rep. Voy. Challenger Zool. 9: 658. pl. 92, figs. 5, 6. Recent, south Pacific—"exclusively tropical."—Hadley (1934) Bull. Am. Paleont. 20 (70A): 30. pl. 5, fig. 9. Upper Oligocene, Cuba.

Test subdiscoidal, more flattened on attached dorsal side; chambers in central part of test covered by laminae and fine, elongate knobs, only the chambers of the outermost whorl being unobscured; edge rounded; apertures oval, two to each chamber, at the ends of the chamber in the median line. Diameter, 0.88 to 1.44 millimeter; thickness, 0.15 millimeter

Plesiotype No. 3947, locality A21, Quebradillas formation.

Abundant at A86 of the Cibao formation. Rare at A20; abundant at A21 of the Quebradillas formation.

Family **ACERVULINIDAE** Schultze 1854

RUPERTIA Wallich 1877

Rupertia verrucosa NEW SPECIES

PLATE 27, FIGURES 9a–c

Test large, attached in life by the concave dorsal side, irregularly tuberose, not columnar; early chambers close coiled like *Cibicides* for one whorl or more, followed by irregularly arranged chambers forming a tuberose mass of round or elongate, loosely or closely appressed chambers; wall calcareous, thick, coarsely perforate; surface in the young smooth, showing the closely spaced, large pores; in the adult the surface is usually covered with a rough, nodular deposit of secondary calcareous, shell material; aperture a slit or large irregular arch at the base of the last septal face, with upper lip, never on the upper side of the test, nor tubular. Diameter, up to 4 millimeters; height, up to 3 millimeters. Diameter of figured specimen, 3.1 millimeters; height, 3 millimeters.

Holotype No. 4130, locality P4, Ponce formation.

Abundant at P4 of the Ponce formation.

This species differs from *R. stabilis* Wallich in the tuberose rather than columnar and bulbous shape, in the rough coating of secondary shell material in the adult test, in the lateral rather than terminal position of the aperture, and in the larger size.

CARPENTERIA Gray 1858

Carpenteria bulloides NEW SPECIES

PLATE 27, FIGURES 1 to 4

Test multilocular, irregularly cylindrical or columnar in the adult, globigerinoid in the young; chambers subglobular, increasing gradually in size from the apical, attached end, and arranged in an alternating series, 6 chambers in the adult test; sutures distinct, depressed; test attached in life, the place of attachment being on the first 2 or 3 chambers as shown by the cicatrix; aperture with a short neck of clear, imperforate shell material located on the side of the test opposite the point of attachment, in the adult terminal, not opening into the sutures or into an umbilical depression; aperture in the young oval in shape with a short flaring neck, in the adult round with a short conical neck; surface with large pores which are emphasized by deposits of secondary shell material, pores missing and the surface of the test smooth around the neck. Length of adult specimen, 1.61 millimeters; diameter, 1.21 millimeters.

Holotypes No. 3881a, b, c, d, locality A21, Quebradillas formation.

Common at A21 of the Quebradillas formation.

C. bulloides lacks the broad basal attachment of *C. lithothamnica* Uhlig from the middle Eocene of West Galicia (1886. Jahrb. Geol. Reichsanstalt **36:** 189. pl. 5, figs. 1, 2). It resembles even more closely *C. alternata* Chapman and Crespin from the middle Tertiary of Victoria (1930. Proc. Roy. Soc. Victoria **43** **(1):** 99. pl. 5, figs. 9, 10) but differs in the coarsely perforate character of its surface and in the position and character of its aperture.

We are not satisfied with the generic disposition of this species, but do not wish to redefine the genus at this time.

Carpenteria proteiformis Goës

PLATE 27, FIGURE 5

Carpenteria balaniformis proteiformis Goës (1882) Kongl. Svensk. Vet. Akad. Handl. **19:** 94. pl. 6, figs. 208–214, pl. 7, figs. 215–219. Recent, Caribbean Sea.

Carpenteria proteiformis Cushman (1931) Bull. U. S. Nat. Mus. **104** **(8):** 140. pl. 26, fig. 1. Recent, West Indies.

Test attached by a flat base, tending to be columnar, the basal portion more or less spreading; chambers inflated, the later chambers making an irregular subcylindrical column of several chambers which may be low or higher with staggered uniserial chambers; wall coarsely perforate, with a cellular, areolate surface suggestive of the mushroom *Morchella esculenta;* aperture circular, often with a tubular neck which is imperforate; position of aperture variable and several chambers may show apertures at once. Length of incomplete specimen, 2.0 millimeters; diameter, 1.0 millimeter.

Plesiotype No. 4131, locality A21, Quebradillas formation.

Common at A21; rare at A46 of the Quebradillas formation. Common at P431 and P432 of the Ponce formation.

Our specimens are not as elongate as specimens usually considered typical of this species, and the wall is more coarsely cellular or reticulate. Perhaps they belong with *C. utricularis.* The species of *Carpenteria* vary so widely that it is difficult to identify any of them.

GYPSINA Carter 1877

Gypsina discus (Goës)

Plate 28, figure 4

Tinoporus vesicularis Goës (not P. and J.) (1882) Kongl. Svenska Vet. Akad. Handl. My Följd **19**: 104. pl. 7, figs. 245–247. Recent, Caribbean Sea.

Gypsina vesicularis discus Goës (1896) Bull. Mus. Comp. Zool. **21**: 74. pl. 7, figs. 4–6. Recent, west coast Central America.

Test discoidal, biconvex; nearly circular in side view; edge sharply rounded; surface conspicuously reticulate, due to the chambers, the outer walls of which are usually broken away; the test consists of chambers added eccentrically around a small, coiled nucleoconch; the chambers are higher in the median region than on the flatter sides of the test; there is no median layer of chambers, as in the orbitoids, and the chambers are not in rays, as in *Sphaerogypsina;* the chambers are oval or subrhomboidal, as seen from the outside of the test and in parallel sections, averaging 0.13 millimeter in longer diameter; height of chambers, as seen in cross section, averaging 0.06 millimeter; wall finely perforate; apertures, other than the perforations, absent. Diameter of test, up to 3 millimeters; thickness, up to 1 millimeter.

Plesiotype No. 4129, locality A21, Quebradillas formation.

Common at A21; rare at F359, Quebradillas formation. Rare at P4, Ponce formation.

The Tertiary Porto Rican specimens seem to be identical with the specimens figured by Goës, in the reference above.

SPHAEROGYPSINA Galloway 1933

Sphaerogypsina globulus (Reuss)

PLATE 27, FIGURE 7

Ceriopora globulus Reuss (1847) Haidinger's Naturwiss. Abh. 2: 33. pl. 5, fig. 7. Middle Miocene, Austria.

Gypsina globulus Brady (1884) Rep. Voy. Challenger Zool. 9: 717. pl. 101, fig. 8. Recent, British Islands.—Cushman (1919) Carnegie Inst. Wash. Publ. 291: 44. pl. 4, fig. 7. Upper Oligocene or early Miocene, Santo Domingo; (1935) U. S. Geol. Surv. Prof. Pap. 181: 54. pl. 23, figs. 4, 5. Upper Eocene, southeastern U. S.

Sphaerogypsina globulus Galloway (1933) Manual of Foraminifera 309. pl. 28, figs. 13, 14.

Test small, spheroidal; surface pustulose, or pitted, with a more or less regular polygonal network formed by the walls of the outside chambers; wall finely perforate, with no distinct aperture other than the perforations. Diameter, 0.27 to 1.11 millimeters.

In cross section the chambers are seen to be rotaloid in the early portion with a microspheric nucleoconch (no megaspheric observed although several sections were made); the later chambers are concentrically arranged in radial lines, enlarging mainly in width, very little in height toward the periphery; the later chambers are nearly equidimensional, circular or subcircular in shape near the center of the test, becoming more rectangular or oval near the periphery, the elongation being parallel to the periphery with maximum length up to 1½ times the height; average diameter of chambers, 0.044 millimeter; average height, 0.033 millimeter; layers of chambers relatively few, 8 to 14, outside of the nucleoconch.

Plesiotype No. 3889, locality F358, Quebradillas formation.

Rare at L1C, L3C, and L4C of the San Sebastian formation. Common at A86 of the Cibao formation. Rare at F358 of the Quebradillas formation. Rare at P2; common at P432 and P433 of the Ponce formation.

Our specimens are identical in all respects with topotypes from the Miocene Leithakalk near Vienna, Austria.

Sphaerogypsina pilaris (Brady)

PLATE 27, FIGURE 8

Tinoporus pilaris Brady (1876) Ann. Soc. Mal. Belg. 11: 103. Miocene, Jamaica.

Gypsina globulus Hill (1899) Bull. Mus. Comp. Zool. 34: 147. Miocene, Jamaica.

Gypsina globulus (Reuss) var. *pilaris* Cushman (1919) Carnegie Inst. Wash. Publ. 291: 44. pl. 9, figs. 1, 2. Miocene, Cuba.

Test spherical, large, the surface appearing almost smooth when observed megascopically, under the microscope with a coarsely areolate or pustulose surface showing the outlines of the outer chambers; wall finely but conspicuously perforate, with no aperture other than the perforations. Diameter, up to 3.2 or 4 millimeters.

In cross section the microspheric nucleoconch is rotaloid, with later chambers added concentrically and arranged in radial lines; the radial tiers of chambers are conspicuous in natural cross sections of broken specimens as well as in laboratory sections; the later chambers are very numerous, in many concentric layers; chambers oval in shape, elongate parallel to the periphery with the length about twice the height, averaging 0.14 millimeter in diameter, height 0.067 millimeter.

Plesiotype No. 3990, locality P258, Ponce formation.

Common at A21, F359, and A64 of the Quebradillas formation. Abundant at P258 of the Ponce formation. *S. pilaris* occurs also in abundance in the calcareous strata 8.5 kilometers west of Isabel II on the north shore of the Island of Vieques, just east of Porto Rico. Meyerhoff correlates these beds with the upper part of the Ponce formation.

S. pilaris differs from *S. globulus* in being generally larger in size, with much coarser areolation on the surface; in cross section the chambers are much more numerous, more closely appressed radially, and elongate rather than nearly equidimensional in shape.

Family **ASTERIGERINIDAE** d'Orbigny 1839

AMPHISTEGINA d'Orbigny 1826

Amphistegina angulata (Cushman)

PLATE 28, FIGURES 6a–c

Asterigerina angulata Cushman (1919) Carnegie Inst. Wash. Publ. **291**: 45, pl. 13, figs. 1a–c. Lower Miocene or upper Oligocene, Santo Domingo.

Test rotaliform, nearly circular in side view; dorsal side moderately convex, convexity variable; ventral side strongly convex to conical; acutely angled at the edge but not carinate; about 14 chambers in the last whorl, of nearly uniform size; sutures flush with the surface, marked by clear shell material; sutures on dorsal side obliquely recurved, on ventral side "with the sutures ending in an angle about midway between the center and the periphery, from which a secondary chamber is developed to the umbilical region, alternating with the main chambers; umbilical region solid, of clearer shell material" than the chamber walls; surface smooth except for fine papillae on the ventral side around the aperture and extending along the periphery; aperture rather long and narrow at the base of the last chamber on the ventral side of the test. Diameter, 0.67 (young specimens) to 1.38 millimeters; thickness, up to 0.83 millimeter.

Plesiotype No. 3862, locality F359, Quebradillas formation.

Common at F358; abundant at F359 of the Quebradillas formation. Common at P259 and 433; rare at P434; abundant at P258 of the Ponce formation.

Only one whorl shows on the dorsal side of the test, not all the whorls of the spire as in *Asterigerina*.

Amphistegina floridana Cushman & Ponton

Plate 28, figures 5a–c

Amphistegina floridana Cushman & Ponton (1932) Fla. Geol. Surv. Bull. 9: 96. pl. 14, figs. 6, 7. Lower Miocene, Florida.

Amphistegina chipolensis Cushman & Ponton (1932) Fla. Geol. Surv. Bull. 9: 96. pl. 15, figs. 1a–c. Lower Miocene, Florida.

Asterigerina choctawensis Cushman & McGlamery (1938) U. S. Geol. Surv. Prof. Pap. 189D: 111. pl. 28, figs. 2a–c. Middle Oligocene, Alabama.

Test planoconvex to biconvex, umbonal region more prominent on the ventral side; edge subacute with slight keel; chambers numerous, 10–15 in the last whorl, increasing slowly in size, frequently with transparent alar prolongations over the umbonal region on the dorsal side of the test through which the earlier whorls are more or less clearly visible; sutures flush with the surface, marked by clear shell material, on dorsal side recurved about half way to the periphery, on ventral side nearly radial to junction with secondary sutures, then curving to the periphery which is met at an angle of about 45 degrees; secondary sutures appearing about midway between umbo and periphery; wall finely perforate; surface smooth except near the base of the aperture and along the periphery for a distance of about two chambers where the surface is strongly papillate; aperture ventral, at the base of the last septal face. Average diameter, 1 millimeter; thickness, 0.50 millimeter.

Plesiotype No. 3863, locality L4C, San Sebastian formation.

Rare at L2C; common at L1C, L3C, L5C; abundant at L4C of the San Sebastian formation. Common at A86 of the Cibao formation. Rare at F359; common at A15, A21, and A93 of the Quebradillas formation. Rare at P2, P3, P4, and 434; common at P431; abundant at P258, P259, and P432 of the Ponce formation.

There seems to be no appreciable difference between this species and *A. chipolensis* which was made at the same time as *A. floridana* and which comes from the same formation although from a slightly lower horizon.

Family CHILOSTOMELLIDAE Brady 1881

CHILOSTOMELLA Reuss 1850

Chilostomella czizeki Reuss

PLATE 28, FIGURES 3a–c

Chilostomella czizeki Reuss (1850) Denkschr. Akad. Wiss. Wien. 1: 380. pl. 48, fig. 13. Middle Miocene Austria.—Schwager (1877) Boll. R. Com. Geol. Ital. 8: 26. pl., fig. 70. Tertiary, Italy.—Cushman (1926) Contr. Cushman Lab. Foram. Res. 1: 74. pl. 11, fig. 2.

Test small, smoothly elliptical in side view, the sides gently convex, the ends broadly rounded, not quite twice as long as thick, nearly circular in cross section but more sharply curved on the back; the last chamber covering two-thirds to three-fourths of the preceding chamber, the line of contact being deeply concave on the back of the test, sometimes exposing a little of several earlier chambers, including the allomorphinoid chambers and proloculum; wall very finely perforate; surface smooth and sometimes mottled with yellow and white mosaic; aperture a narrow crescent comprising about one-fourth of the circumference of the test, with thick but not strongly everted lip. Length, 0.64 millimeter; diameter, 0.39 millimeter. Some specimens are larger.

Plesiotype No. 4133, locality P254, Ponce formation.

Rare at P254 and P255 of the Ponce formation.

This species resembles *C. cylindroides* Reuss but it is shorter and has more convex sides.

Chilostomella globata NEW SPECIES

PLATE 28, FIGURES 2a–c

Test small, subglobular, the last chamber considerably larger than the previous one and constituting about two-thirds of the external test; subcircular in cross section; the suture line is only slightly concave on the back of the test; wall very finely perforate; surface smooth; aperture a narrow crescentic slit, comprising about one-fourth of the circumference of the test, with large, strongly everted, slightly undulating and fimbriate lip. Length, 0.38 millimeter; diameter, 0.33 millimeter. Other specimens up to 0.8 millimeter in diameter.

Holotype No. 4134, locality P254, Ponce formation.

Rare at P254 and P255 of the Ponce formation.

Chilostomella ovoidea Reuss

PLATE 28, FIGURES 1a–c

Chilostomella ovoidea Reuss (1850) Denkschr. Akad. Wiss. Wien 1: 380. pl. 48, figs. 12a–e. Middle Miocene, Austria.—Cushman (1924) Bull. U. S. Nat. Mus. 104 (5): 2. pl. 1, figs. 2, 3. Recent, Bermuda.

Test ovoid, three-fourths as broad as long, nearly circular in cross section, tapering and more pointed at the apical than at the apertural end; greatest thickness above the middle of the test; the last chamber forms from two-thirds to three-fourths of the outside of the test; the suture line between the last two chambers nearly straight and transverse except for a slight apicad bend on the back of the test; wall finely perforate; surface smooth; aperture an arched opening comprising about one-fourth of the circumference of the test, with thick, flaring lip. Length, 0.69 millimeter; diameter, 0.52 millimeter.

Plesiotype No. 4135, locality P255, Ponce formation.

Rare at P255 of the Ponce formation.

Chilostomella urceolus NEW SPECIES

PLATE 27, FIGURES 6a, b

Test ovoid, circular in transverse section, broadly rounded at both apical and apertural ends, 3/5 as broad as long; greatest width more than twice that at the aperture; last chamber covering practically all of the preceding chamber, the line of contact between the two chambers being straight and at right angles to the axis of the test; wall smooth; aperture curved, at the base of the last chamber with a flaring lip. Length, 1 millimeter; diameter, 0.60 millimeter.

Holotype No. 3883, locality P2, Ponce formation.

Rare at P254, P255, and P4; common at P2 and P3 of the Ponce formation.

This new species resembles *C. ovoidea* Reuss in many respects, but differs in that *C. urceolus* is rounded both apically and aperturally, is more elongate, and the line of contact between the last 2 chambers is not deflected posteriorly as in *C. ovoidea*. It is smaller than *C. grandis* and the suture is without posterior deflection.

SPHAEROIDINA d'Orbigny 1826

Sphaeroidina bulloides d'Orbigny

PLATE 30, FIGURES 1a, b

Sphaeroidina bulloides d'Orbigny (1826) Ann. Sci. Nat. 7: 267. no. 1; Modèles, no. 65. Recent, Adriatic; Pliocene, Italy.—Cushman (1914) Bull. U. S. Nat. Mus. 71 (4): 18. pl. 10, fig. 7, pl. 12, fig. 1. Recent, north Pacific; (1924) Bull. U. S. Nat. Mus. **104** (5): 36. pl. 7, figs. 1–6. Recent, Caribbean, Gulf of Mexico, and western Atlantic from Brazil to Cape Cod.

Test subspherical, exterior formed of a few chambers, usually 4 or 5; chambers slightly inflated, closely appressed; sutures moderately depressed; aperture a small arched opening with a flat tooth at the inner margin of the last chamber. Diameter, 0.46 by 0.55 millimeter; thickness, 0.40 millimeter.

Plesiotype No. 3991, locality P254, Ponce formation.

Rare at F358 of the Quebradillas formation. Rare at P251, P254, P255, P431; common at P2 and P3 of the Ponce formation.

Family **ORBULINIDAE** Schultze 1854

GLOBIGERINA d'Orbigny 1826

Globigerina bulloides d'Orbigny

PLATE 29, FIGURES 1a, b

Globigerina bulloides d'Orbigny (1826) Ann. Sci. Nat. 7: 277. no. 1; Modèles no. 76. Recent, Adriatic Sea; (1829–1844) Foraminifères, Guérin-Menéville's Cuvier, Iconographie, Mollusques 3: 9. pl. 2, fig. 12. Recent, Adriatic.—Brady (1884) Rep. Voy. Challenger Zool. 9: 593. pl. 77, figs. 3–7. Recent, world wide; Cretaceous to Recent.—Galloway & Wissler (1927) Jour. Paleont. 1: 40. pl. 7, fig. 4. Pleistocene, California.—Cole & Gillespie (1930) Bull. Am. Paleont. 15 (57B): 12. pl. 2, fig. 16. Middle Oligocene, Meson formation, Mexico.

Test of average size for the genus, longer than wide, consisting of about 2½ whorls arranged in a trochoid spire; chambers about 12 in number, inflated, somewhat appressed, subglobular, rapidly enlarging, four constituting the last whorl; sutures deeply depressed; wall thick, finely reticulate; aperture large, semicircular, opening into the umbilicus. Length, 0.30 millimeter; width, 0.24 millimeter; thickness, 0.19 millimeter.

Plesiotype No. 3920, locality L1C, San Sebastian formation.

Rare at L1C of the San Sebastian formation. Rare at A86; common at A43a of the Cibao formation. Rare at A79 of the Los Puertos formation. Rare at A20 and A21 of the Quebradillas formation. Rare at P2, P254, and P255; common at P3 of the Ponce formation.

Globigerina dutertrei d'Orbigny

PLATE 29, FIGURES 2a, b

Globigerina dutertrei d'Orbigny (1839) in De la Sagra, Hist. Phys. Pol. Nat. Cuba Foraminifères 84. pl. 4, figs. 19–21. Recent, off Cuba, Martinique, Guadeloupe.—Brady (1884) Rep. Voy. Challenger Zool. 9: 601. pl. 81, figs. 1a–c. Recent, Antarctic, south Pacific, West Indies.—Cushman (1921) Proc. U. S. Nat. Mus. 59: 55. pl. 12, figs. 7a–c. Recent, north coast Jamaica.

Test rotaliform, low spired, small for the genus; 5 chambers in last whorl; periphery lobulate; chambers inflated, slightly appressed; size of chambers rapidly increasing in early stages, the 5 chambers of the last whorl being more nearly equal in size; sutures depressed; wall finely reticulate; aperture a low arched opening into the umbilicus. Diameter, 0.28 by 0.36 millimeter; thickness, 0.20 millimeter.

Plesiotype No. 3921, locality L1C, San Sebastian formation.

Very rare at L1C of the San Sebastian formation. Rare at A43a; common at A86 of the Cibao formation. Rare at A21 of the Quebradillas formation. Rare at P432; common at P2 and P3 of the Ponce formation.

This species differs from *G. dubia* Egger (1857. Neues Jahrb. Min. Geol. Pal.) in the lower spire.

Globigerina inflata d'Orbigny

PLATE 29, FIGURES 3a–c

Globigerina inflata d'Orbigny (1839) in Barker, Webb & Berthelot, Hist. Nat. Îles Canaries 2 (2): Foraminifères 134. pl. 2, figs. 7–9. Recent, Canaries.—Cushman (1924) Bull. U. S. Nat. Mus. **104** (5): 12. pl. 3, figs. 1–3. Recent, mostly off New England.

Test rotaloid, dorsal side nearly flat, ventral side very deep due to the rapid increase in height of the chambers; periphery moderately lobulate; edge flatly rounded with sharply rounded shoulder; whorls 2 to 3, the last usually having 4 chambers; sutures moderately depressed, slightly curved; wall finely perforate; surface smooth, the older tests covered with small, secondary knobs on the ventral side and on the dorsal early whorls; aperture a high arch on the ventral side extending from umbilicus to periphery, with thin upper lip. Diameter, 0.53 millimeter; height, 0.38 millimeter.

Plesiotype No. 4137, locality P251, Ponce formation.

Rare at P251 of the Ponce formation.

Globigerina ouachitaensis Howe & Wallace

PLATE 29, FIGURES 4a–c

Globigerina ouachitaensis Howe & Wallace (1932) La. Dept. Cons. Geol. Bull. **2**: 74. pl. 10, figs. 7a, b. Upper Eocene, Louisiana.—Howe (1939) La. Dept. Cons. Geol. Bull. **14**: 83. pl. 12, figs. 18, 19. Middle Eocene, Louisiana.

Test small, subglobular; periphery lobate; about 12 chambers visible on the dorsal side, 4 in the last whorl, differing very little in size in dorsal view, but increasing rapidly in thickness dorso-ventrally; chambers inflated; sutures distinct, depressed; aperture a fairly high opening on the ventral side into the umbilical area, with previous apertures visible in the umbilical depression. Diameter, 0.40 by 0.42 millimeter; thickness, 0.30 millimeter.

Plesiotype No. 4048, locality A21, Quebradillas formation.

Common at A86 of the Cibao formation. Rare at A21 of the Quebradillas formation. Rare at P2, P3, and P251; common at P255 of the Ponce formation.

Globigerina pachyderma (Ehrenberg)

PLATE 29, FIGURES 5a–c

Aristerospira pachyderma Ehrenberg (1861) Monatsber. k. preuss. Ak. Wiss. Berlin 303. Recent, Davis Strait; (1873) Abh. k. Akad. Wiss. Berlin pl. 1. fig. 4.
Globigerina pachyderma Brady (1884) Rep. Voy. Challenger Zool. 9: 600. pl. 114, figs. 19, 20. Recent, northern oceans.—Heron-Allen & Earland (1909) Jour. Roy. Micr. Soc. 438. pl. 18, figs. 4, 5. Tertiary, Sussex.—Galloway & Wissler (1927) Jour. Paleont. 1: 43. pl. 7, figs. 13a–c. Pleistocene, California.

Test small, depressed subglobular; periphery slightly lobulate; edge broadly rounded; whorls 2 or 3, the last consisting of 4 subequal chambers, the earlier whorls usually obscured by a secondary, granular deposit; sutures slightly depressed, nearly straight and radial; dorsal side slightly convex, occasionally flat or slightly concave; ventral side very convex, slightly umbilicate; wall coarsely and conspicuously perforate, thick; surface smooth or more usually covered with a secondary deposit of fine granules which obscure the pores; aperture a short, low arch at the base of the last chamber opening into the shallow umbilicus, with thin upper lip. Length, 0.33 millimeter; width, 0.28 millimeter; thickness, 0.26 millimeter.

Plesiotype No. 4138, locality P254, Ponce formation.

Rare at P254 of the Ponce formation.

It is surprising to find this boreal species in subtropical deposits. The Porto Rican form seems to be typical in every way.

Globigerina pseudotriloba White

PLATE 29, FIGURES 6a, b

Globigerina pseudotriloba White (1938) Jour. Paleont. 2: 194. pl. 27, figs. 17a, b. Cretaceous to Eocene, Mexico.

Test longer than wide, composed of 2 whorls arranged in a low trochoid spire; chambers inflated, very little appressed, rapidly and regularly enlarging, 3 comprising the last whorl; sutures deep; aperture a semi-circular opening at the base of the last septal face, opening into the umbilical region. Length, 0.29 millimeter; width, 0.21 millimeter; thickness, about 0.15 millimeter.

Plesiotype No. 3922, locality L1C, San Sebastion formation.

Rare at L1C of the San Sebastian formation. Common at A43a of the Cibao formation. Common at P3 and P254; abundant at P2 of the Ponce formation.

This species is very similar to *G. triloba* Reuss (1850. Denkschr. k. Akad. Wiss. Wien **1**) and has frequently appeared in the literature of that species. Unlike *G. triloba*, *G. pseudotriloba* has only one aperture and that is located on the ventral side.

Globigerina triloculäris d'Orbigny

PLATE 29, FIGURES 7a, b,

Globigerina trilocularis d'Orbigny (1826) Ann. Sci. Nat. 7: 277. no. 2. Miocene, near Bordeaux, France.—Fornasini (1898) Rendi. Sess. R. Accad. Sci. Istit. Bologna 2: 12. pl. 0, fig. 2. (from d'Orbigny's unpublished plates of 1826.)—Galloway & Morrey (1929) Bull. Am. Paleont. 15 (55): 10. pl. 3, fig. 9. Lower Oligocene, Ecuador.

Test subglobular, consisting of 6 to 9 chambers arranged in a rotaloid coil of 2 whorls, with 3 chambers in the last whorl; periphery broadly rounded, slightly lobulate; chambers inflated, closely appressed, enlarging rapidly; sutures slightly depressed; wall thick, reticulate; aperture an arched opening at the base of the last chamber opening into the umbilicus. Diameter of average specimen, 0.36 by 0.50 millimeter.

Plesiotype No. 3923, locality L5C, San Sebastian formation.

Rare at L5C of the San Sebastian formation. Abundant at A86 of the Cibao formation. Rare at A15 and A20; common at A21 and A93 of the Quebradillas formation. Rare at P2, P3, P254, and P255 of the Ponce formation.

The Porto Rican forms are very similar to *G. triloculinoides* Plummer ((1926). Univ. Texas Bull. **2644**), but lack the peculiar apertural flap of that species.

ORBULINA d'Orbigny 1839

Orbulina universa d'Orbigny

PLATE 30, FIGURE 3

Orbulina universa d'Orbigny in Barker-Webb & Berthelot (1839) Hist. Nat. Îles Canaries 2 (2): Foraminifères 123. pl. 1, fig. 1. Recent, Canaries.—Cushman (1924) Bull. U. S. Nat. Mus. **104** (5): 28. pl. 5, figs. 2–9. Recent, Caribbean Sea, and widely distributed elsewhere.

Test globular, consisting of only one exterior chamber; wall finely reticulate; aperture, when present, a simple round opening. Diameter of test, 0.26 millimeter.

Plesiotype No. 3942, locality L6C, San Sebastian formation.

Rare at L1C and L6C of the San Sebastian formation. Common at A93 of the Quebradillas formation. Rare at A15, A20, and F359 of the Quebradillas formation.

Family **PEGIDIIDAE** Heron-Allen & Earland 1928

SPHAEROIDINELLA Cushman 1927

Sphaeroidinella seminulina (Schwager)

PLATE 30, FIGURES 4a, b

Globigerina seminulina Schwager (1866) Novara-Exped. Geol. Theil **2**: 256. pl. 7, fig. 112. Pliocene, Kar Nikobar.
Sphaeroidinella dehiscens Cushman (not Parker & Jones) (1924) in part, Bull. U. S. Nat. Mus. **104** (5): 38. pl. 7, figs. 7, 8. Recent, Gulf of Mexico, and Atlantic Ocean.

Test small for the genus, subglobular to broadly ovate, young specimens showing early globigerinoid chambers, adult forms with 3 chambers making up the entire visible portion of the test; sutures in the young test flush or very slightly depressed, the final suture of the adult fissure-like on the ventral side of the test, with jagged edges; wall thick with conspicuous, large pores which in some specimens make the surface rough; aperture a small round opening at the bottom of the fissure-like suture. Length, 0.59 millimeter; diameter, 0.43 by 0.46 millimeter.

Plesiotype No. 3992, locality A21, Quebradillas formation.

Abundant at A21 of the Quebradillas formation.

This species is distinctive in its slight development of a sutural fissure, and the complete absence of a sutural fissure on the dorsal side of the test. No specimens of the form commonly referred to *S. dehiscens* (1865. Phil. Trans. **155**) were found, hence it is improbable that these are young or immature specimens of that species.

Family **HETEROHELICIDAE** Cushman 1927

PAVONINA d'Orbigny 1826

Pavonina advena Cushman

PLATE 30, FIGURES 2a, b

Pavonina advena Cushman (1923) U. S. Geol. Prof. Pap. **133**: 24. pl. 1, fig. 10. Middle Oligocene, Mississippi; (1926) Proc. U. S. Nat. Mus. **67** (25): 22. (Summary of the genus.)

Test very small, probably immature, flabellate, compressed; chambers broadening very rapidly, tending to become annular, most of them arranged in an indefinite biserial manner, the later ones having radial depressions on the inner side (as if it were crimping due to bending of a tube, a feature seen in many bent, tubular forms); sutures slightly depressed, not limbate; wall finely and evenly perforate; surface smooth but minutely granular; apertures absent excepting for the small mural pores on the septal face. Length, 0.24 millimeter; breadth, 0.22 millimeter; thickness, 0.05 millimeter.

Plesiotype No. 4136, locality A6, Lares formation.

Rare at A6 of the Lares formation.

We have only a single specimen of this rare genus and species. It has the fine pores of *P. advena*, differing from most other species of the genus, and lacks the limbate sutures and lateral carina of other species. Our specimen is in shape very similar to the early stages of *P. flabelliformis*, as figured by Heron-Allen and Earland (1915. Trans. Zool. Soc. London **20:** pl. 48, fig. 4). This form bears some resemblance to the early stages of *Cyloloculina*, but the chambers are not arranged in a uniformly spiral manner, and moreover this form does not occur with the numerous specimens we have from the Ponce and San Sebastian formations.

BOLIVINA d'Orbigny 1839

Bolivina byramensis Cushman

PLATE 30, FIGURES 11a, b

Bolivina caelata byramensis Cushman (1923) U. S. Geol. Surv. Prof. Pap. **133:** 19. pl. 1, fig. 9. Middle Oligocene, Mississippi.

Bolivina byramensis Cushman (1937) Cushman Lab. Foram. Res. Spec. Publ. **9:** 69. pl. 8, figs. 18–20. Lower and middle Oligocene, southeastern U. S.; lower Oligocene, Texas; Oligocene or Miocene, Venezuela and Trinidad.—Coryell & Rivero (1940) Jour. Paleont. **14:** 341. pl. 44, figs. 17a–c. Middle Miocene, Haiti.

Test small, tapering, about 1½ times as long as wide, rhomboidal in apertural view, oval in side view; edge acute; chambers about 10 pairs, a little inflated near the center of the test becoming more compressed near the edge; sutures oblique, curved, all except the last few obscured by the ornamentation; surface, except for the last 1 or 2 chambers, ornamented by a coarsely reticulate pattern of costae; aperture an elongate slit on the periphery at the base of the last chamber extending up onto the last septal face, bordered by a strong lip. Length, 0.57 millimeter; width, 0.31 millimeter; thickness, 0.13 millimeter.

Plesiotype No. 3872, locality A86, Cibao formation.

Common at A86 of the Cibao formation.

Bolivina elongata Hantken

PLATE 30, FIGURES 5a, b

Bolivina elongata Hantken (1876) A magy. kir. földt. int. évkönyve **4:** 55. pl. 7, fig. 14; (1881) Mitt. Jahrb. k. ungarn. geol. Anstalt **4:** 65. pl. 7, fig. 14. Lower Oligocene, Hungary.—Cushman (1937) Cushman Lab. Foram. Res. Spec. Publ. **9:** 51. pl. 6, figs. 31, 32.

Test elongate, very slightly tapering, a little more than three times as long as wide, somewhat compressed; sides flat; edges rounded;

chambers enlarging gradually, about 8 pairs in the megaspheric form of the test; sutures oblique, near the edge of the test curving toward the apex, flush with the surface of the test and limbate except between the last few chambers where the sutures are slightly depressed and less conspicuously limbate; wall finely perforate; aperture an elliptical opening in the last septal face, parallel to the compression of the test and extending upward from the base of the last chamber. Length, 0.73 millimeter; width, 0.22 millimeter; thickness, 0.15 millimeter.

Plesiotype No. 3875, locality P255, Ponce formation.

Very rare at P255 of the Ponce formation.

This species resembles Cushman's figure (1937. pl. 6, fig. 32) of the topotype of *B. elongata* Hantken, although it does not have the striations which are mentioned in the description and which are not shown in the figure of either the type or the topotype.

Bolivina heineae NEW SPECIES

PLATE 30, FIGURES 6a, b, and 7

Test small, regularly oval in side view, thick in the middle and thinning in all directions, widest and thickest part of the test midway between the apical and apertural ends; thickly elliptical in apertural view; chambers indistinct, obscured by the ornamentation, 7 to 9 pairs, low and broad, slightly overlapping, enlarging rather rapidly; sutures oblique, slightly curved, obscured by the ornamentation except for the last one near the apertural end; edge angular; surface ornamented by an anastomosing pattern of longitudinal costae which begin at the apical end, branch and are connected at irregular intervals by oblique cross costae; last chamber unornamented; aperture elongate, narrow, with lip. Length, 0.38 millimeter; width, 0.26 millimeter; thickness, 0.15 millimeter.

Holotypes No. 3874a, b, locality P2, Ponce formation.

Common at P2 of the Ponce formation.

We take pleasure in naming this species for Professor Aida A. Heine who was one of the first paleontologists to take an interest in the foraminifera of Porto Rico.

This species resembles *B. byramensis* Cushman, but is a smaller, thicker, more oval form, not compressed, with reticulation that tends to be more longitudinal. Although *B. heineae* resembles *B. reticulata* Hantken (1875. Mitt. Jahrb. d. k. ung. geol. Anstalt 4) in general shape and size and fineness of reticulation, it differs in being thicker and having more definitely longitudinal costae which almost completely obscure the sutures.

Acid treatment was used to remove the surface ornamentation of one specimen and show the number of chambers and typical bolivine structure of this species.

Bolivina jacksonensis Cushman & Applin

Plate 30, figures 8a, b

Bolivina jacksonensis Cushman & Applin (1926) Bull. Am. Assoc. Petr. Geol. **10**: 167. pl. 7, figs. 3, 4. Upper Eocene, gulf coastal plain, U. S. and Mexico.—Cushman (1937) Cushman Lab. Foram. Res. Spec. Publ. **9**: 57. pl. 7, figs. 17, 18.

Test small, compressed; ovate in side view, gradually tapering, broadest part of test about ¾ distance from the apical end; narrowly ovate in apertural view; edge subacute but not carinate; chambers distinct, compressed, 8 or 9 pairs; sutures flush with the surface except between the last few chambers where they are a little depressed, marked by clear shell material, strongly recurved in earlier part of test, nearly straight and oblique to the edge in last part of the test; aperture narrow, at base of the last septal face, extending up toward a terminal position, with slight lip. Length, 0.33 millimeter; width, 0.15 millimeter; thickness, 0.05 millimeter.

Plesiotype No. 3876, locality L1C, San Sebastian formation.

Rare at L1C of the San Sebastian formation.

Bolivina matanzana convexa new variety

Plate 30, figures 9a, b, and 10a, b

Test small, subrhomboidal in side view, diamond shaped in end view, bluntly pointed at the apical end and rounded at the apertural end, broadest part of test about ⅔ of the distance from apical end, near base of the last pair of chambers; edge acutely angled, slightly keeled; about 9 pairs of chambers in the test; sutures strongly curved, slightly raised, marked by clear shell material; wall conspicuously perforate, some of the perforations extending through the limbate sutures; aperture extending from the base of the last septal face to a nearly terminal position, in shape elliptical with a raised rim. Length, 0.39 to 0.43 millimeter; width, 0.23 to 0.28 millimeter; thickness, 0.09 to 0.15 millimeter.

Holotype No. 4038, locality A43a, Cibao formation. Paratype No. 4039, locality L1C, San Sebastian formation.

Rare at L1C of the San Sebastian formation. Common at A43a of the Cibao formation.

This variety is almost identical with *B. matanzana* Palmer and Bermudez from the Oligocene of Cuba (1936. Mem. Soc. Cubana Hist.

Nat. **10**), but differs in its smaller size and proportionally greater thickness.

Bolivina mexicana aliformis Cushman

PLATE 31, FIGURES 1a, b

Bolivina mexicana aliformis Cushman (1926) Contr. Cushman Lab. Foram. Res. **1**: 82. pl. 12, figs. 3, 4. Lower Oligocene, Alazan formation, Mexico; (1937) Cushman Lab. Foram. Res. Spec. Publ. **9**: 66. pl. 8, figs. 9, 10. Oligocene, Mexico and Cuba.

Test compressed, much thicker along the median line, elongate, tapering, 1.5 to 2.3 times as long as wide, greatest width near the apertural end; edge acutely angled with a broad, transparent keel, irregular in width, extending around the edges and apical end of the test; chambers numerous, about 12 pairs in the test, those of the early part low and broad, gradually increasing in height so that the last formed chambers are more nearly equidimensional; sutures distinct, limbate, those in the latter part of the test expanded toward the central part of the test; median thickness of the test due to a knoblike inflation of the inner ends of the chambers; wall finely but conspicuously perforate; aperture elongate, narrow, with a slight lip. Length, 0.23 to 1.00 millimeter; width, 0.14 to 0.50 millimeter; thickness, up to 0.20 millimeter.

Plesiotype No. 4040, locality P3, Ponce formation.

Rare at P254 and P255; common at P2 and P3 of the Ponce formation.

B. alazanensis venezuelana Hedberg (1937. Jour. Paleont. **11**) from the middle Tertiary Carapita formation of Venezuela has a marked resemblance to this species, but differs in the absence of a broad keel.

Bolivina tectiformis Cushman

PLATE 31, FIGURES 2a, b

Bolivina tectiformis Cushman (1926) Contr. Cushman Lab. Foram. Res. **1**: 83. figs. 6a, b. Oligocene, Mexico; (1937) Cushman Lab. Foram. Res. Spec. Publ. **9**: 67. pl. 8, figs. 12–14. Oligocene, Mexico.

Test small, elongate, oval in side view, nearly 2½ times as long as wide, rhomboid in apertural view; edge sharply rounded; periphery smooth; chambers closely appressed, about 8 pairs in the test, width greater than the length, enlarging gradually; sutures distinct, slightly curved, limbate, raised, fusing in the median line to form a rounded longitudinal costa or ridge; wall conspicuously but not coarsely perforate; surface of the early portion ornamented by obscure longitudinal grooves and costae; aperture nearly terminal, elliptical, with a thickened lip, extending from the base of the last chamber, up onto the septal face. Length, 0.40 millimeter; width, 0.17 millimeter; thickness, probably 0.08 or 0.10 millimeter.

Plesiotype No. 3878, locality P2, Ponce formation.

Very rare at P2 of the Ponce formation.

Bolivina ventricosa NEW SPECIES

PLATE 31, FIGURES 5a–c

Test small with slight tendency to twist near the apical end, thickest in the middle of the test about midway of the length, tapering not only to the edges but also toward the apical and apertural ends; test widening more rapidly after the first 3 or 4 pairs of chambers, apical end narrowly rounded, apertural end broadly rounded; edge angled, keeled; chambers closely appressed, about 9 pairs in the test, increasing markedly in width after the first 4 pairs, increasing very gradually in chamber length (*i. e.* adorally), greatest thickness at inner end of each chamber, the chamber thickness increasing rapidly for the first third of the test, decreasing equally rapidly for the last third of the test with maximum thickness of chambers about midway between apical and apertural ends; sutures conspicuously curved, flush with the surface, continuous with the narrow keel of clear shell material that borders the test; aperture narrow, parallel to the compression of the test extending up onto the last septal face from the base of the last chamber on the periphery. Length, 0.35 millimeter; width, 0.30 millimeter; thickness, 0.17 millimeter.

Holotype No. 3879, locality P254, Ponce formation.

Rare at P254 of the Ponce formation.

This species is quite different from all other species of *Bolivina*, particularly in its unusual thickness and the rapid widening of its test in side view. The shape of *B. ventricosa* suggests *Ehrenbergina*, but the planispirally coiled early portion is lacking and the aperture is straight, narrowly elliptical and nearly terminal, rather than lateral, in position.

LOXOSTOMUM Ehrenberg 1854

Loxostomum hiwanneense Howe

PLATE 31, FIGURES 3a, b

Loxostoma hiwanneense Howe (1930) Jour. Paleont. 4: 329. pl. 27, fig. 7. Lower Oligocene, Mississippi.—Ellisor (1933) Bull. Am. Assoc. Petr. Geol. 17: 1322, 1323. pl. 3, fig. 7. Lower Oligocene, Texas.

Test small, elongate, ovate in side and apertural views, tapering rapidly near the apical end with slight apical spine; edge rounded;

chambers numerous, about 8 pairs; sutures straight, forming an oblique angle with the side of the test, flush with the surface, somewhat obscured by the ornamentation; all except the last chamber of the test ornamented by numerous fine, irregularly sinuous, longitudinal costae which are continuous across the suture lines; aperture small and elliptical, nearly terminal in position. Length, 0.39 millimeter; width, 0.18 millimeter; thickness, 0.11 millimeter.

Plesiotype No. 3929, locality A43a, Cibao formation.

Very rare at A43a of the Cibao formation.

Loxostomum normale NEW SPECIES

PLATE 31, FIGURES 4a, b

Test small, elongate, about 2½ times as long as wide, tapering at both ends, thick and slightly twisted on the axis, widest a little above the middle; periphery slightly lobulate, especially in the early part of the test; edge broadly rounded; chambers slightly inflated, about 5 pairs, increasing rapidly in size, the last chamber uniserial; sutures slightly depressed, oblique and slightly curved; wall very finely perforate; surface smooth; aperture terminal, elongate to ovate, parallel to the sides of the test, with slight lip. Length, 0.43 millimeter; width, 0.16 millimeter; thickness, 0.09 millimeter.

Holotype No. 3930, locality A43a, Cibao formation.

Rare at A43a of the Cibao formation.

This species is close to the Recent species *L. rostrum* Cushman (1933. Contr. Cushman Lab. Foram. Res. **9:** 82. pl. 8, fig. 13) from the tropical Pacific, but differs in that *L. normalis* is smaller, is more tapering at the apical end, and has oblique sutures that become less oblique as chambers are added, rather than more oblique.

PLECTOFRONDICULARIA Liebus 1902

Plectofrondicularia trinitatensis Cushman & Jarvis

PLATE 31, FIGURES 6a, b

Plectofrondicularia trinitatensis Cushman & Jarvis (1929) Contr. Cushman Lab. Foram. Res. 5: 11. pl. 2, fig. 16. Upper Eocene, Trinidad.

Test lanceolate, sides nearly parallel except toward the apical end where the test is gently tapering, initial end subacute; about 4 pairs of chambers in the early biserial part of the test, most of the test consisting of uniserial chambers which are slightly equitant; uniserial chambers increasing gradually in height; sutures obscured by the ornamentation which consists of several low costae, continuous from the initial to the apertural end, one on each edge and 4 on either side of the test; apertural end broken off. Length of broken specimen, 0.85 millimeter; width, 0.21 millimeter; thickness, 0.09 millimeter.

Plesiotype No. 4068, locality P3, Ponce formation.

Very rare, only one specimen being found at P3 of the Ponce formation.

Plectofrondicularia vaughani Cushman

PLATE 31, FIGURES 7a, b

Plectofrondicularia vaughani Cushman (1927) Contr. Cushman Lab. Foram. Res. **3**: 112. pl. 23, fig. 3. Lower Oligocene, Mexico; (1929) Contr. Cushman Lab. Foram. Res. **5**: 92. pl. 13, figs. 21, 22. Middle Tertiary, Ecuador, Venezuela.—Cushman & Jarvis (1930) Jour. Paleont. **4**: 361. pl. 33, fig. 4. Miocene, Jamaica.—Hadley (1934) Bull. Am. Paleont. **20** (**70**): 15. pl. 2, figs. 5, 6. Oligocene, probably upper, Cuba.—Coryell & Rivero (1940) Jour. Paleont. **14**: 341. pl. 42, fig. 28. Middle Miocene, Haiti.

Test elongate, compressed, oval in front view, initial end narrow, bluntly pointed; proloculum subspherical followed by several biserially arranged chambers, the major portion of the test consisting of about 5, very slightly inflated, equitant, chambers; sutures marked with clear shell material, slightly depressed; aperture terminal, fissurine, not radiate. Length, 1.13 millimeters; width, 0.35 millimeter; thickness, 0.07 millimeter.

Plesiotype No. 3949, locality P2, Ponce formation.

Very rare at P2, P3, and P254 of the Ponce formation.

The original description of this species states that, "this species is peculiar in the retention of the alternating character of the chambers as shown by the apertures pointing first to one side and then the other in succeeding chambers and the incurved portion of the wall even after the alar projections are developed", but it is evident from subsequent figures published by the originator of *P. vaughani* that this alternating character of the chambers throughout most of the test is not an essential differentiating characteristic. *P. vaughani* is essentially an elongate, oval form of moderate width with relatively few chambers, usually 5 to 7 equitant chambers following a short biserial portion of a few chambers. *P. advena* (Cushman) (1923. Bull. U. S. Nat. Mus. **104** (**4**)) is very similar, but is narrower and tends to be more irregular, or phylogerontic.

Family **BULIMINIDAE** Jones 1876

REUSSELLA Galloway 1933

Reussella glabrata (Cushman)

PLATE 31, FIGURES 8a, b

Verneuilina spinulosa glabrata Cushman (1922) U. S. Geol. Surv. Prof. Pap. 129E: 92. Middle Oligocene, Byram, Mississippi.

Reussia spinulosa Cushman & Ponton (not Reuss) (1932) in part, Fla. Geol. Surv. Bull. 9: 84. pl. 12, fig. 15 (not figs. 14, 16.) Arca zone of Choctawhatchee, middle Miocene, Florida.

Test small, inverted pyramidal in shape, 3-sided, greatest diameter near the apertural end; triangular in cross section, the sides somewhat concave; initial end and edges of the test angled, without spines or carinae; chambers closely appressed, regularly triserial in arrangement; sutures narrow, flush with the surface; surface smooth; aperture a small transverse slit at the inner edge of the last chamber. Length, 0.33 millimeter; diameter, 0.20 millimeter; breadth of one face, 0.24 millimeter.

Plesiotype No. 4073, locality A79, Los Puertos formation.

Common at L2C of the San Sebastian formation, and at A79 of the Los Puertos formation. Rare at A21 of the Quebradillas formation, and at P258 of the Ponce formation.

BULIMINA d'Orbigny 1826

Bulimina socialis Bornemann

PLATE 31, FIGURES 9a, b

Bulimina socialis Bornemann (1855) Zeitsch. deutsch. geol. Gesell. 7: 342. pl. 16, fig. 10. Middle Oligocene, Germany.—Cushman (1937) Contr. Cushman Lab. Foram. Res. 13: 36. pl. 4, figs. 1a–c. Middle Oligocene, Germany.

Bulimina ovata Brady (1884) Rep. Voy. Challenger Zool. 9: 400. pl. 50, figs. 13a–b. Recent, north and south Atlantic and Pacific.—White (1929) Jour. Paleont. 3: 49. pl. 5, fig. 11. Mendez, upper Cretaceous, Mexico.—Nuttall (1932) Jour. Paleont. 6: 19. pl. 2, fig. 8. Lower Oligocene, Mexico.

Bulimina sp. Cushman & Applin (1926) Bull. Am. Assoc. Petr. Geol. 10: 169. pl. 7, figs. 10–11. Upper Eocene, Texas.

Test oval in front view, about 1½ times as long as wide, widest about midway between apical and apertural ends, both ends of test rounded; test circular or nearly so in end view; 2 whorls of chambers visible; chambers slightly inflated, the 3 chambers of the last whorl constituting about ¾ of the test; sutures distinct, somewhat depressed; wall finely perforate; aperture virguline, with a vertical, curved tooth. Length, 0.60 to 1.16 millimeters; diameter, 0.32 to 0.68 millimeter.

Plesiotype No. 3880, locality P254, Ponce formation.

Rare at P254 and P255; common at P3; abundant at P2 of the Ponce formation.

Since 1846, when *B. ovata* was first named by d'Orbigny, workers on foraminifera have consistently used this name for all smooth specimens of *Bulimina* with generally oval shape in side view, circular cross section, slightly depressed sutures and relatively few chambers. Several authors, among them Cushman in 1922, Nuttall in 1932, and Palmer and Bermudez in 1936, have noted that two types of smooth Buliminas have been included in *B. ovata*, namely that of the original figure, and another which differs, "from the original figure of the species in being broader in proportion to the length, with the final whorl of chambers covering about three-fourths of the length of the test". (Palmer & Bermudez p. 287.) A comparison of the Porto Rican specimens with the original figure of *B. socialis* Bornemann and the figures of *B. socialis* published by Cushman in 1937 shows that the non-typical forms of *B. ovata* which have been erroneously included under *B. ovata* should be called *B. socialis*, a name which was proposed by Bornemann in 1855. It is improbable that the thicker type of *Bulimina* which we here call *B. socialis*, is the megaspheric form of *B. ovata* since only the *B. socialis* type occurs in the Porto Rican material, and not both types as would be expected if the two are the megaspheric and microspheric forms of the same species.

B. socialis differs from *B. ovata* in the following respects:

1. the apical and apertural ends are narrowly to broadly rounded in shape, not sharply rounded or angular
2. the test is stouter; the form ratio (length divided by breadth) being 1.4 to 1.90, while *B. ovata* ranges from 2 to 2.4. The type figuie of *B. socialis* was 1.57, of *B. ovata* 2.20.

Family **CASSIDULINIDAE** d'Orbigny 1839

CASSIDULINA d'Orbigny 1826

Cassidulina laevigata d'Orbigny

PLATE 32, FIGURES 1a, b

Cassidulina laevigata d'Orbigny (1826) Ann. Sci. Nat. 7: 282. pl. 15. figs. 4, 5; Model no. 14. Recent.—Brady (1884) Rep. Voy. Challenger Zool. 9: 428. pl. 54, figs. 1–3. Recent, widespread.—Cushman (1918) U. S. Geol. Surv. Bull. 676: 9. pl. 1, figs. 5a, b. Pliocene, North Carolina.

Test lenticular, nearly equally biconvex, biumbonate; nearly circular in side view with slightly lobate outline; edge angled but not carinate; chambers short and wide with nearly parallel edges, about 5 pairs in the last whorl; sutures slightly curved, limbate, flush with the surface or very slightly depressed near the edge of the test; wall smooth, finely perforate; aperture an elongate virguline slit on the face of the last chamber nearly parallel to the periphery. Diameter, 0.24 by 0.26 millimeter; thickness, 0.13 millimeter.

Plesiotype No. 4142, locality A43a, Cibao formation.

Rare at A43a of the Cibao formation, and at A79 of the Los Puertos formation.

Cassidulina subglobosa Brady

PLATE 32, FIGURES 2a, b

Cassidulina subglobosa Brady (1881) Quart. Jour. Micr. Soc. 21: 60; (1884) Rep. Voy. Challenger Zool. 9: 430. pl. 54, figs. 17a–c. Recent, Atlantic and Pacific Oceans.—Galloway & Morrey (1929) Bull. Am. Paleont. 15 (55): 40. pl. 6, fig. 6. Lower Oligocene, Ecuador.—Hedberg (1937) Jour. Paleont. 11: 680. pl. 92, fig. 5. Upper Oligocene, Venezuela.

Test subglobular, only slightly compressed on the sides; broadly oval in side and edge views; edge broadly rounded; chambers few, 3 pairs in the last whorl, inflated; sutures somewhat depressed; surface smooth, wall finely perforate; aperture a large virguline opening extending up onto the last septal face, obliquely to the plane of coiling. Diameter, 0.40 millimeter; thickness, 0.32 millimeter.

Plesiotype No. 4180, locality P2, Ponce formation.

Rare at P2, P3, and P254 of the Ponce formation.

Cassidulina tricamerata NEW SPECIES

PLATE 32, FIGURES 3a–c

Test subequally biconvex, biumbonate, not quite planispirally coiled, subcircular to broadly oval in side view; periphery very slightly lobulate; edge sharply rounded, not keeled; chambers large, closely appressed, very little inflated, 3 pairs in the last whorl, enlarging rapidly, the last chamber constituting from one-third to two-fifths of the circumference of the test; sutures narrowly limbate, a little depressed, slightly curved, nearly parallel on the two sides of each chamber; wall very finely perforate; surface smooth; aperture a narrow, curved slit in the plane of coiling, extending about one-sixth of the circumference of the test or about one-half the circumferential dimension of the septal face, without upper lip, but with lower, undulating, plate-like tooth; septal face narrow, convex, with outer, inflated rim. Diameter, 0.53 by 0.60 millimeter; thickness, 0.30 millimeter.

Holotype No. 4143, locality P255, Ponce formation.

Rare at P2 and P3; common at P254 and P255 of the Ponce formation.

This species differs from *C. delicata* Cushman (1927. Scripps Inst.

Oceanog. tech. ser. **1**: 168. pl. 6, fig. 5) in the fewer chambers and much shorter aperture. It differs from *C. rarilocula* Cushman (1933. Contr. Cushman Lab. Foram. Res. **9**: 93. pl. 10, fig. 4), from the tropical Pacific, in the less inflated chambers, sharper edge, longer aperture, and larger size. Perhaps *C. "delicatula"* Cushman (obviously an error for *"delicata"*) (1929. Contr. Cushman Lab. Foram. Res. **5**: 101. pl. 14, fig. 12, Tertiary, Venezuela) is the same as our species, but the chambers are rather too inflated and the sutures too much curved.

EHRENBERGINA Reuss 1850

Ehrenbergina caribbea NEW SPECIES

PLATE 32, FIGURES 4a–d

Ehrenbergina bradyi Coryell & Rivero (not Cushman) (1940) Jour. Paleont. **14**: 342. pl. 44 fig. 22. Middle Miocene, Haiti.

Test short subtriangular in side view, oval in edge view, pyramidal in apertural view; dorsal side convex, ventral side more strongly convex, with a broad, flat ridge down the center, bounded by concave slopes; edge sharp, with a short, flat spine at the end and upper side of each chamber and a few, small spines on the apical, ventral end; chambers closely appressed, not inflated, about 7 pairs; dorsal sutures curved, overlapping about half their length, limbate, mostly flush with the surface, the middle part of the later ones raised; ventral sutures obscure, nearly flush with the surface, curved and overlapping on the ventral ridge; wall very finely perforate; surface smooth except for the raised sutures and spines on the edge and apical end; aperture a thin, curved slit just under the terminal part of the periphery, nearer the sutural side of the chamber, with thin lower lip. Length, 0.61 millimeter; width, 0.56 millimeter; thickness, 0.30 millimeter.

Holotype No. 4140, locality P2, Ponce formation.

Rare at P2 of the Ponce formation.

This species is similar to *E. bradyi* Cushman (1927. Proc. U. S. Nat. Mus. **70 (16)**: 5. pl. 2, fig. 1.) from deep water of the Pacific, but it lacks the median ventral groove and spines, the fine peripheral spines, and it is shorter. The subtropical middle Tertiary forms from Haiti and Porto Rico seem to be identical, and are readily distinguishable from the cold water Recent forms from the Pacific.

E. navalis Hadley (1934. Bull. Am. Paleont. **20 (70A)**) seems very close to *E. caribbea*, but it is more slender, has more delicate spines, and lacks the small spines on the apical, ventral end of the test.

Ehrenbergina serrata gibbera NEW VARIETY

PLATE 32, FIGURES 5a–d

Test subtriangular in dorsal view, oval in edge view, the early part as thick as the later part; biconvex, oval in cross section with the back humped (hence the name *gibbera*), the later part uncoiled and perhaps also the earlier part, the exact nature of which is not determinable because of the addition of spines and other secondary material; edge sharply rounded in the earlier part, angled and slightly carinate in the later part; earlier part with a round spine extending out from the edge of each chamber and other spines on the apical end and on the early, ventral side; chambers 6 to 7 pairs, on the dorsal side short and wide, overlapping each other by about half their width; sutures on the back of the test limbate but flush with the surface, curved in three parts, usually orad, sometimes apicad; ventral sutures depressed, obscured by secondary material; surface smooth except for the spines; aperture elongate, narrow and curved, near the middle of the test, nearly parallel to the margin, with fimbriate lower lip and welt-like upper lip. Length, 0.60 millimeter; width, 0.55 millimeter; thickness, 0.30 millimeter.

Holotype No. 3902, locality P2, Ponce formation.

Rare at P2 of the Ponce formation.

This species differs from *E. serrata* Reuss (1850. Denkschr. k. Akad. Wiss. Wien **1:** 377. pl. 48, fig. 7), from the Miocene of Austria, in the less definitely coiled and more spinose early stage, the humped back, and fewer chambers.

Family **UVIGERINIDAE** Galloway & Wissler 1927

UVIGERINA d'Orbigny 1826

Uvigerina bulbacea NEW SPECIES

PLATE 33, FIGURES 1, 2

Test small, elongate bulbous, more than twice as long as wide, enlarging rapidly from the rounded apical end to the greatest width, about one-third of the length from the apical end, thence gradually tapering to the aperture; chambers in about 3 whorls, closely appressed, little inflated, regularly triserial in the first third, becoming more inflated and fewer to a whorl up to the terminal chamber which is uniserial; sutures flush and obscure in the first third, depressed and plain in the later two-thirds; wall finely perforate; apical end of the test provided with very small spines, not in lines, the later part of the last chamber and apertural neck finely granulate; most of the test with fine, low, round costae, not continuous across the sutures, about 20 on one side of the test or 16 to 20 in a width of 0.2 millimeter; last chamber without shoulders, the last chamber tapering into a short neck, without phialine lip. Length, 0.51 millimeter; diameter, 0.21 millimeter. Variation in length from 0.32 to 0.54 millimeter; diameter from 0.18 to 0.24 millimeter; form ratio from 1.8 to 2.7 millimeters, averaging 2.2 millimeters.

Holotype No. 4144, paratype No. 4144a, locality A86, Cibao formation.

Common at A86 of the Cibao formation.

This form is like *U. postica*, with which it occurs, but differs consistently in the following ways: it is smaller, the greatest width is nearer the apical end, the tapering to the aperture is more marked, the spines are smaller on the apical end and absent on the apertural end, and the costae are smaller. We have considered the possibility that one form is megaspheric and the other microspheric, but find no proof. Note the greater magnification of *U. bulbacea*.

Uvigerina elongata Cole

PLATE 33, FIGURE 5

Uvigerina elongata Cole (1927) Bull. Am. Paleont. **14** (51): 26. pl. 4, figs. 3, 4. Middle Eocene, Mexico.—Cushman (1937) Contr. Cushman Lab. Foram. Res. **13**: 78. pl. 11, figs. 15, 16. Middle Eocene, Mexico.

Test small, elongate, greatest width below the middle of the test; early chambers closely appressed, enlarging rather rapidly in size, tending to become uniserial in the later part of the test; sutures obscure in the early part of the test, depressed in the later part; surface hirsute, *i. e.* with small fine spines irregularly arranged; apertural end sloping with a neck; aperture terminal, round. Length, 0.52 millimeter; diameter, 0.18 millimeter.

Plesiotype No. 4017, locality P254, Ponce formation.

Rare at P254 and P255 of the Ponce formation.

Uvigerina fusiformis NEW SPECIES

PLATE 33, FIGURE 6

Test small, fusiform, tapering toward both ends, apertural end tapering to the slender, cylindrical neck; chambers about six on a side, rather loosely appressed; sutures distinct, depressed; surface of the last few chambers ornamented by fine, irregularly arranged spines; earlier part of the test with fine spines in vertical lines, apical end of the test finely spinose; aperture round at the end of a slender, tapering neck, with lip. Length, 0.44 millimeter; diameter, 0.18 millimeter.

Holotype No. 4018, locality P2, Ponce formation.

Rare at P2, P3, P254, and P255 of the Ponce formation.

This species differs from *U. pygmaea* d'Orbigny (1826. Ann. Sci. Nat. 7) in the finer striae. It seems close to *U. elongata,* but is shorter, more regular in shape, and has the spines in lines on the early part of the test.

The specific name *fusiformis* is used because of the fusiform shape of the test.

Uvigerina gallowayi Cushman

PLATE 33, FIGURE 8

Uvigerina alata Galloway & Morrey (not Cushman & Applin) (1929) Bull. Am. Paleont. 15 (55): 38, pl. 6, fig. 1. Oligocene, Ecuador.

Uvigerina gallowayi Cushman (1929) Contr. Cushman Lab. Foram. Res. 5: 94. pl. 13, figs. 33, 34. Oligocene, Ecuador.

Test of medium size, stout fusiform, with pointed apical end and shouldered apertural end; length twice the thickness, greatest thickness above the middle; chambers regularly triserial, closely appressed, little inflated; sutures slightly depressed, marked by clear shell material; surface ornamented with 14 to 16 strong costae which begin below the proloculum, cross the sutures and fade out on the last chamber or two; aperture round with small lip, at the end of a short neck, situated in an encircling depression. Length, 0.75 millimeter; diameter, 0.40 millimeter.

Plesiotype No. 4145, locality A86, Cibao formation.

Rare at A86 of the Cibao formation.

Uvigerina gardnerae Cushman

PLATE 33, FIGURES 13a, b

Uvigerina gardnerae Cushman (1926) in Cushman & Applin, Bull. Am. Assoc. Petr. Geol. 10: 175. pl. 8, figs. 16, 17. Upper Eocene, Texas.—Cushman & Edwards (1937) Contr. Cushman Lab. Foram. Res. 13: 79. pl. 11, figs. 19, 20. Upper Eocene, Atlantic and gulf coastal plain.

Test large, stout, widest at or above the middle; ends rounded; chambers regularly triserial, inflated; sutures depressed but indistinct; surface ornamented by about 20 plate-like costae, 5 or 6 in a width of 0.2 millimeter, not continuous with those on adjacent chambers, partly breaking up into spines or disappearing on the last chamber; aperture round, at the end of a short neck, with small lip. Length, 0.83 millimeter; diameter, 0.45 millimeter; form ratio 1.8.

Plesiotype No. 4019, locality P254, Ponce formation.

Rare at P254 of the Ponce formation.

This form is not, "much elongated, slender", as stated in the descriptions of *U. gardnerae*, and the measurements in the descriptions and in the plates do not agree. *U. gardnerae* belongs to the *U. peregrina* group, but differs in being thicker and shorter, with fewer costae, and absence of a granular surface. It is much like *U. gardnerae cubana* Hadley (1934. Bull. Am. Paleont. **20** (**70A**)) which lacks spines on the last chamber. It is also much like *U. capayana* Hedberg (1937. Jour. Paleont. **11**: 677. pl. 91), but is much larger and has much coarser costae.

The various groups of species of *Uvigerina* have been insufficiently differentiated for definite recognition.

Uvigerina mantaensis Cushman & Edwards

Plate 33, figure 7

Uvigerina proboscidea Galloway & Morrey (not Schwager) (1929) Bull. Am. Paleont. 15 (55): 39. pl. 6, fig. 4. Lower Oligocene, Ecuador.
Uvigerina mantaensis Cushman & Edwards (1938) Contr. Cushman Lab. Foram. Res. 14: 84. pl. 14, fig. 8. Oligocene, Ecuador.

Test stout, about 1½ times as long as wide, broadly fusiform in shape; chambers rather few, inflated; sutures distinct, depressed; wall hispid throughout; shoulders broad; aperture terminal, with a short, cylindrical neck and phialine lip. Length, 0.59 millimeter; diameter, 0.32 millimeter.

Plesiotype No. 4076, locality P3, Ponce formation.

Rare at P3 and P254 of the Ponce formation.

U. mantaensis differs from *U. proboscidea* Schwager (1866. Novara-Exped. Geol. Theil **2**) in that it has a less tapering test and broad, not sloping, shoulders.

Uvigerina mexicana Nuttall

Plate 33, figure 9

Uvigerina mexicana Nuttall (1932) Jour. Paleont. 6: 22, pl. 5, figs. 12, 13. Lower Oligocene, Mexico.

Test short, stout fusiform in shape; apical end subacute or pointed; thickest part of the test near or below the middle; lower ⅔ of the test ornamented by numerous low, round, longitudinal costae, which are continuous from chamber to chamber, and increase by division, less frequently by implantation; last chamber unornamented; early chambers rather obscure, little inflated, last chamber slightly inflated; sutures flush with the surface, obscure in the early part of the test, last few marked by clear shell material; aperture round, at the end of a short cylindrical neck which is set in a depression or on a flattened area of the last septal face. Length, 0.70 millimeter; maximum diameter, 0.44 millimeter.

Plesiotype No. 4021, locality P2, Ponce formation.

Rare at P2, P3, and P255 of the Ponce formation.

Uvigerina mexicana bulbosa NEW VARIETY

PLATE 33, FIGURE 10

This variety differs from typical *U. mexicana* in being subglobular in shape, and broadly rounded, not tapering at both apical and apertural ends. Length, 0.54 millimeter; diameter, 0.48 millimeter.

Holotype No. 4077, locality P3, Ponce formation.

Rare at P3 of the Ponce formation.

Uvigerina mexicana ranunculus NEW VARIETY

PLATE 33, FIGURE 11

Test stout, circular in cross section, more tapering at both ends than typical *U. mexicana;* maximum diameter about midway the length of the test; apical end with a flat, spine-like process formed by the union of several costae; other characteristics like typical *U. mexicana.* Length, 0.92 millimeter; diameter, 0.50 millimeter.

Holotype No. 4022, locality P2, Ponce formation.

Rare at P2 of the Ponce formation.

Uvigerina postica NEW SPECIES

PLATE 33, FIGURES 3, 4

Test elongate, about twice as long as wide, bulbous, the later two-thirds converging to the apical end, enlarging rapidly from the apical end to the greatest width below the middle; apical end pointed, sometimes with short apical spine; chambers in about 4 whorls, closely appressed and regularly triserial in the first third of the test, slightly inflated and tending to become biserial in the second third, and considerably inflated and tending to become uniserial in the final third of the test; sutures flush with the surface in the first third of the test, marked by clear shell material, somewhat depressed in the later two-thirds; wall finely perforate; surface of the apical and apertural ends provided with small spines which are not in definite lines; most of the test ornamented by fine, low, round longitudinal costae, not continuous across the sutures, about 20 on one side of the test or 13 in a width of 0.2 millimeter; shoulders of last chamber round and sloping; aperture with a short, tapering neck, not set in a depression, without lip or with a very narrow phialine lip. Length, up to 0.66 millimeter; diameter, 0.30 millimeter. Form ratio (length over diameter) 1.9 to 2.28, averaging 2.1.

Holotype No. 4146a, paratype No. 4146b, locality A86, Cibao formation.

Common at A86 of the Cibao formation.

This species is similar to *U. striata* d'Orbigny in the fine costae, but scarcely deserves comparison. The comparison with *U. bulbacea* is given under that species. The specific name *postica* refers to the enlarged posterior part of the test, above the pointed apical end.

Uvigerina vicksburgensis Cushman & Ellisor

PLATE 33, FIGURES 12a, b

Uvigerina vicksburgensis Cushman & Ellisor (1931) Contr. Cushman Lab. Foram. Res. 7: 54. pl. 7, figs. 7a, b. Lower Oligocene, Texas.—Ellisor (1933) Bull. Am. Assoc. Petr. Geol. 17: pl. 3, fig. 10.—Cushman & Edwards (1938) Contr. Cushman Lab. Foram. Res. 14: 76. pl. 13, figs. 10, 11. Lower Oligocene, gulf coastal plain of U. S. and Mexico.

Test regularly fusiform, over twice as long as wide, greatest width near the middle; chambers in about three whorls, closely appressed, regularly triserial to near the apertural end, where the chambers become biserial and tend to be uniserial; sutures slightly depressed, obscure; surface ornamented, from apex to apertural neck, with about 18 or 20 strong, sharp costae, about 5 in a width of 0.2 millimeter, which curve considerably; some costae are confined to one chamber, others cross the sutures; aperture terminal, round, at the end of a short neck, which is not set in a depression, with small lip. Length, 0.73 millimeter; width, 0.35 millimeter.

Plesiotype No. 4020, locality P251, Ponce formation.

Rare at P251 of the Ponce formation.

This is one of the better characterized species of the genus, with its fusiform shape and part of the costae crossing the sutures.

SIPHOGENERINA Schlumberger 1883

Siphogenerina costostriata NEW SPECIES

PLATE 34, FIGURES 5a, b

Test of medium size, slender, the early part conical, the later part somewhat compressed; the early part sharply rounded, gradually expanding to the broadly rounded apertural end; chambers triserial and closely appressed in the first third of the test, becoming biserial in the middle third and uniserial in the final third, progressively more inflated from the middle to the oral end; sutures obscure in the first third, depressed in the later two-thirds; surface ornamented with fine striae in the first one-third of the test, about 20 in a width of 0.2 millimeter; the later two-thirds with thin, low costae, 5 to 6 in a width of 0.2 millimeter, between each pair of which there are 2 or 3 much smaller, raised striae; neither the costae nor striae cross the sutures; aperture oval, without phialine lip, at the end of a short neck, which is not set in a depression. Length, 0.78 millimeter; width, 0.26 millimeter; thickness, 0.21 millimeter.

Holotype No. 4147, locality P254, Ponce formation.

Rare at P254 of the Ponce formation.

This species has just passed from the *Uvigerina* to the *Siphogenerina* stage. It differs from described species of both genera in the two sets of costae, and in other ways.

Siphogenerina cumingsi NEW SPECIES

PLATE 34, FIGURES 6 and 7

Test elongate, subcylindrical; apical end pointed in the more elongate, microspheric form, bluntly rounded in the stouter megaspheric form; triserial stage very short, uniserial stage with about 7 chambers which are about ⅔ as long as wide; sutures flush with the surface, curved adorally between the costae; wall ornamented by 7 to 8 longitudinal costae, each continuous the length of the test except for the last chamber; apical end spinose; triserial portion of megaspheric test with short costae intercalated between the primary costae; apertural end rounded with a short neck; aperture terminal, round, with slight phialine lip. Dimensions of average megaspheric form: length, 0.94 millimeter; diameter, 0.26 millimeter. Dimensions of figured microspheric form: length, 0.86 millimeter; diameter, 0.26 millimeter. Maximum size of microspheric form: length, 1.26 millimeters; diameter, 0.30 millimeter.

Holotype No. 3983, locality P3, paratype No. 3984, locality P2, Ponce formation. Holotype is megaspheric form; paratype microspheric.

Rare at P3 and P255; common at P2 of the Ponce formation. Both megaspheric and microspheric forms occurred at all three localities.

S. cumingsi differs from *S. spinosa* Bagg (1904. Md. Geol. Surv. Mio.; refigured by Cushman & Cahill, 1933. U. S. Geol. Surv. Prof. Pap. **175A**) in the lower costae and more slender test in both megaspheric and microspheric forms, and in the absence of spines on the costae. The lip is also less flaring. *S. lamellata* Cushman (1918. U. S. Geol. Surv. Bull. **676**) has lamellae rather than costae.

This species is named in honor of Professor E. R. Cunings, who, as head of the Department of Geology at Indiana University, has fostered scientific research for many years.

Siphogenerina hubbardi NEW SPECIES

PLATE 34, FIGURE 2

Test elongate, cylindrical, nearly circular in cross section; triserial portion about ⅓ the length of the test, 4 chambers in uniserial part of the test; apical end either blunt in what is evidently the megaspheric form, or pointed in the microspheric form; most specimens with small spinosities near the apical ends of the costae; chambers slightly inflated, uniserial chambers broader than long; sutures depressed in early part of the test, only slightly depressed in later part; wall ornamented by about 20 longitudinal costae most of which are continuous from chamber to chamber; aperture terminal, circular with rounded lip at the end of a definite neck. Total length, 1.00 millimeter; diameter, 0.30 millimeter; length of neck, 0.06 millimeter.

Holotype No. 3985, locality P2, Ponce formation.

Common at P2, P3, and P255 of the Ponce formation.

S. hubbardi differs from *S. multicostata* Cushman and Jarvis (1929. Contr. Cushman Lab. Foram. Res. **5**) in that the costae are continuous from chamber to chamber and the apical spinosity is less pronounced.

This species is named in honor of Dr. Bela Hubbard who has made important contributions to the stratigraphy and paleontology of Porto Rico.

Siphogenerina mexicana Cushman

PLATE 34, FIGURES 1a, b

Siphogenerina mexicana Cushman (1926) Proc. U. S. Nat. Mus. 67 (25): 15. pl. 5. figs. 4a, b. Lower Oligocene, Alazan, Mexico.

Test small, slender, subcylindrical, the first third of the test triserial, tapering from a subacute initial end, the rest of the test uniserial with about 5 rectilinear chambers; chambers distinct, very slightly inflated; sutures distinct, nearly flush with the surface, marked by clear shell material; wall with conspicuous pores, surface ornamented with numerous fine, longitudinal striae; apertural end without a neck, truncate; aperture small, nearly circular, surrounded by a raised rim or lip. Length, 0.75 millimeter; diameter, 0.18 millimeter.

Plesiotype No. 3986, locality P2, Ponce formation.

Rare at P2 and P3 of the Ponce formation.

Siphogenerina multicostata Cushman & Jarvis

Plate 34, figures 3 and 4

Siphogenerina multicostata Cushman & Jarvis (1929) Contr. Cushman Lab. Foram. Res. 5: 14. pl. 3, fig. 6. Miocene, Trinidad.—Cushman (1929) Contr. Cushman Lab. Foram. Res. 5: 95, pl. 13, fig. 38. Middle Tertiary, Venezuela.—Hadley (1934) Bull Am. Paleont. 20 (70A): 17. pl. 2. fig. 8. Oligocene, probably upper, Cuba.

Test small, elongate, subcylindrical to fusiform, 3 to 4 times as long as wide, greatest width in the later half of the test; uniserial chambers occupying nearly half the length of the test; chambers distinct, slightly inflated, uniserial chambers shorter than wide, except for the last chamber which is approximately equidimensional; sutures depressed; surface ornamented by 18 to 20 narrow, low, longitudinal costae which extend up to the base of the neck; costae on each chamber usually independent of those on adjacent chambers; costae somewhat spinose on triserial part of the test; apertural end tapering to a short neck; aperture terminal, circular. Length, 0.74 millimeter; diameter, 0.20 millimeter.

Plesiotypes Nos. 3987a and 3987b, locality P254, Ponce formation.

Rare at P2 and P254 of the Ponce formation.

The Porto Rican specimens have the phialine lip broken off.

ANGULOGERINA Cushman 1927

Angulogerina cibaoensis new species

Plate 34, figures 12a, b

Test small, short, thick, bulbous at the lower end, apical end pointed and rapidly expanding to the greatest width at about two-fifths of the length of the test from the apical end, thence tapering to the apertural end; test triangular throughout, with angled edges; chambers regularly triserial and closely appressed in the early part, becoming biserial and tending to become uniserial, not inflated; sutures indistinct, little depressed; surface smooth at apical and apertural ends, provided with 3 or 4 small, low costae on each face in the middle of the test, about 4 in a width of 0.2 millimeter; the costae do not cross the sutures; aperture oval, at the end of a short neck, with small lip. Length, 0.62 millimeter; width, 0.36 millimeter; form ratio 1.7.

Holotype No. 3864, locality A86, Cibao formation.

Common at A86 of the Cibao formation.

This species is shorter than *A. cooperensis*, with which it occurs, and lacks the apical costae.

Angulogerina cooperensis Cushman

Plate 34, figures 13a, b

Angulogerina cooperensis Cushman (1935) U. S. Geol. Surv. Prof. Pap. 181: 42. pl. 16, fig. 9. Upper Eocene, South Carolina.

Test of average size, slender, apical end pointed and rapidly expanding to the greatest width about one-third of the length of the test from the apical end, thence tapering to the apertural end, triangular throughout, with angled edges; chambers regularly triserial in the first third, becoming biserial and the final third uniserial, closely appressed but irregularly inflated; sutures indistinct, little depressed; wall finely perforate; surface ornamented with low, indistinct costae on the first two-thirds, disappearing on the final third, not crossing the sutures, 3 to 6 on each face of the test, 6 in a width of 0.2 millimeter; aperture at the end of a long neck, subtriangular, with slight lip. Length, 0.74 millimeter; width, 0.31 millimeter; form ratio 2.4.

Plesiotype No. 4148, locality A86, Cibao formation.

Rare at A86 of the Cibao formation.

The Porto Rican form differs from the type figure of *A. cooperensis* in having the greatest width nearer the apertural end, and in having a longer neck. Such differences may be of varietal or even specific rank, particularly since the Porto Rican form is nearly twice as large as the type specimens from the Eocene.

Angulogerina decorissima new species

Plate 34, figures 8 to 10

Test small, short fusiform, tending to be bulbous, greatest width a little below the middle of the test; triangular in cross section, sharply angled at the edges; chambers relatively few, closely appressed, flat on the faces of the test; sutures slightly depressed; surface ornamented by numerous striae which cover the entire test up to the base of the neck and are discontinuous from chamber to chamber; neck subtriangular of moderate length; aperture terminal, round, with a slight phialine lip. Length of holotype, 0.53 millimeter; diameter, 0.28 millimeter.

Holotype No. 3865a, paratypes Nos. 3865b and 3865c, locality A21, Quebradillas formation.

Rare at A21 of the Quebradillas formation.

This species has a slight resemblance to *A. albatrossi ornata* Cushman (1932. Contrib. Cushman Lab. Foram. Res. 8), but is more regular in shape, with striae on all the chambers. It differs from *A. occidentalis* (Cushman) (1933. U. S. Geol. Surv. Prof. Pap. **175A**) in having finer striae and less lobulate chambers with triangular cross section throughout the test.

Angulogerina ponceana NEW SPECIES

PLATE 34, FIGURES 11a–c

Test small, stout, 1½ times as long as wide; apical end broadly rounded; apertural end truncate; in end view subtriangular with rounded angles; chambers few, 4 to 6, regularly triserial, somewhat inflated, overhanging previous chambers; sutures depressed deeply in some places and shallow in others, undulating, with the uneven chamber inflation producing a knotty appearance to the test; wall finely perforate; surface ornamented with 9 to 12 low, obscure costae, mostly confined to the early and middle part of the test, all fading out on the last chamber; aperture terminal, with short neck set in an encircling depression in the last septal face, with slight lip. Length, 0.45 millimeter; thickness, 0.33 millimeter.

Holotype No. 4023, locality P254, Ponce formation.

Rare at P254 of the Ponce formation.

This species differs from *A. naranjoensis* Cushman and Bermudez (1937. Contrib. Cushman Lab. Foram. Res. **13:** 16, pl. 1, fig. 56) in the shorter form, broadly rounded apical end, less inflated chambers, and in the presence of low costae. It is much like the paratype of that species (figs. 57, 58), which seems to be costate. The authors say in the original description (p. 17), "wall generally smooth", and in the discussion again, "smooth wall". The costae in the Porto Rican form are so small and inconspicuous that they might be overlooked.

TRIFARINA Cushman 1923

Trifarina bradyi Cushman

PLATE 35, FIGURES 4a, b

Rhabdogonium tricarinatum Brady (1884) Rep. Voy. Challenger Zool. **9:** 525. pl. 67, figs. 1–3. Recent, Atlantic Ocean.

Trifarina bradyi Cushman (1923) Bull. U. S. Nat. Mus. **104** (4): 99. pl. 22, figs. 3–9. Recent, Gulf of Mexico, Caribbean Sea, and off southeastern U. S.; (1929) Contr. Cushman Lab. Foram. Res. **5:** 96. pl. 13, fig. 39. Middle Tertiary, Venezuela.

Test small, elongate, tapering toward both apical and apertural ends; triangular in cross section, concave on all three sides, with carinae at the three angles running from the initial end to the aperture; chambers triserial for about ½ the length of the test; sutures not depressed; aperture terminal, round, at the end of a short neck. Length, 0.52 millimeter; diameter, 0.24 millimeter.

Plesiotype No. 4005, locality P3, Ponce formation.

Rare at P3 of the Ponce formation.

Family **PLEUROSTOMELLIDAE** Reuss 1860

PLEUROSTOMELLA Reuss 1860

Pleurostomella bierigi Palmer & Bermudez

PLATE 35, FIGURES 2a–c

Pleurostomella bierigi Palmer & Bermudez (1936) Mem. Soc. Cubana Hist. Nat. **10**: 294. pl. 17, figs. 7, 8. Lower Oligocene, Cuba.

Test stout in appearance, oval in side view, nearly circular in end view, apical end obtusely angled or rounded, maximum width about midway of the test; chambers inflated, last one constituting more than half the length of the test; aperture in a depression of the final chamber, an arcuate slit, with subsidiary vertical notch. Length, 0.58 millimeter; width, 0.41 millimeter; thickness, 0.43 millimeter.

Plesiotype No. 4069, locality P3, Ponce formation.

Rare at P3 and P254; common at P2 of the Ponce formation.

The Porto Rican forms are slightly different from the type figures of *P. bierigi* in that they are more rounded at the apical end.

Pleurostomella elliptica NEW SPECIES

PLATE 35, FIGURES 3a, b

Pleurostomella alternans Cushman & Harris (not Schwager) (1927) Contr. Cushman Lab. Foram. Res. **3**: 129. pl. 25, fig. 28. Eocene, Trinidad.

Test small, elongate, elliptical to fusiform in shape; 6 to 8 chambers in the test, regularly alternating, increasing gradually in size, little inflated; sutures slightly depressed; surface unornamented; aperture in an oval depression on the side of the last septal face, consisting of a lunate opening with two small teeth on the lower side. Length, 0.66 millimeter; diameter, 0.16 millimeter.

Holotype No. 4070, locality P2, Ponce formation.

Common at P2 of the Ponce formation.

P. elliptica differs from *P. alternans* Schwager (1866. Novara-Exped. Geol. **2**: 238. pl. 6, fig. 79, which we here designate as the type of *P. alternans;* not fig. 80) in that the test has fewer chambers, is less tapering and is more rounded at the apical end. It differs from *P. jacksonensis* Cushman and Applin (1926. Bull. Am. Assoc. Petr.

Geol. **10**) in the less pointed apical end and absence of any, "series of depressions in longitudinal lines".

Pleurostomella gerontica NEW SPECIES

PLATE 35, FIGURES 1a–d

Test stout, regularly oval in front view, both apical and apertural ends narrowly rounded; subcircular in end view; 5 to 6 chambers in the test, biserially arranged, enlarging rapidly with the exception of the final chamber which is unusually small, the second and third chambers from the last constituting about ⅔ of the test; aperture subterminal, an arcuate slit in a slight depression on the septal face. Length, 0.67 millimeter; width, 0.50 millimeter; thickness, 0.46 millimeter.

Holotype No. 4071, locality P2, Ponce formation.

Rare at P2 and P3 of the Ponce formation.

We have several specimens, all of which have the small final chamber and distinctive aperture.

P. gerontica is distinctive in the shape of its stout test, with small final chamber and subterminal, crescentic aperture without a tooth. In general appearance it is very similar to *P. bierigi*, but differs in the small final chamber and in the character of the aperture.

NODOSARELLA Rzehak 1885

Nodosarella constricta granulifera NEW VARIETY

PLATE 35, FIGURES 5a, b

This variety differs from typical *N. constricta* Cushman and Bermudez (1937. Contr. Cushman Lab. Foram. Res. **13**) in having a finely granular surface. Length, 0.83 millimeter; diameter, 0.33 millimeter.

Holotype No. 4059, locality P2, Ponce formation.

Rare at P2 of the Ponce formation.

Nodosarella crassielegans (Nuttall)

PLATE 35, FIGURES 6a, b

Nodosaria crassielegans Nuttall (1928) Quart. Jour. Geol. Soc. London **84**: 80. pl. 4, figs. 6, 7. Upper Eocene and lower Miocene, Trinidad.

Test elongate, arcuate, round in section, consisting of 6 to 10 chambers which are longer than thick, and more closely appressed in the early part of the test; sutures transverse, depressed, marked by clear shell material; apical end of the test with one, rarely two, short, eccentric spines; surface smooth; aperture produced, crescentic. Length, 1.77 millimeters; diameter, 0.26 millimeter.

Plesiotype No. 4078, locality P3, Ponce formation.

Common at P3 of the Ponce formation.

This species differs from *N. paucistriata* Galloway and Morrey in the absence of the septal bridges, and from *N. cocoaensis* (Cushman) in the inflated chambers.

Nodosarella paucistriata Galloway & Morrey

Plate 35, figures 7 to 9

? *Nodosaria catenulata* Cushman (1923) U. S. Geol. Surv. Prof. Pap. **133**: 28. pl. 3, fig. 14. Lower Oligocene, Alabama.

Nodosaria intermittens Nuttall (1928) Quart. Jour. Geol. Soc. London **84**: 82. pl. 4, fig. 17. Upper Eocene and lower Miocene, Trinidad.

Nodosarella paucistriata Galloway & Morrey (1929) Bull. Am. Paleont. **15** (**55**): 42. pl. 6, figs. 12a, b. Lower Oligocene, Ecuador.—Coryell & Rivero (1940) Jour. Paleont. **14**: 343. pl. 42, figs. 21–23. Middle Miocene, Haiti.

Ellipsonodosaria verneuili paucistriata Cushman (1929) Contr. Cushman Lab. Foram. Res. **5**: 97. pl. 14, figs. 4, 5. Middle Tertiary, Ecuador and Trinidad.

Test elongate, slender, slightly curved; about 11 chambers in the adult test, most of the chambers inflated; sutures depressed, or flush with the surface between the early uninflated chambers; apical end blunt, with a short, stout, eccentic spine; surface unornamented except for about 6 septal bridges on the depressed sutures, flush sutures unornamented; aperture terminal, crescentic in shape, at the end of a neck-like constriction of the last chamber. Length, up to 2.53 millimeters; diameter, up to 0.40 millimeter.

Plesiotypes No. 4058a and 4058b, locality P3; and No. 3891, locality P2, Ponce formation.

Common at A86 of the Cibao formation. Rare at P3; common at P2, P254, and P255 of the Ponce formation.

The septal bridges of this species are very small and easily overlooked.

Nodosarella verneuili (d'Orbigny)

Plate 35, figures 10a, b

Dentalina verneuili d'Orbigny (1846) Foram. Foss. Vienne 48. pl. 2, figs. 7, 8. Middle Miocene, Vienna.

Ellipsonodosaria verneuili Cushman (1929) Contr. Cushman Lab. Foram. Res. **5**: 96. pl. 14, figs. 1–3. Middle Tertiary, Ecuador, Venezuela, Trinidad.—Cushman & Jarvis (1930) Jour. Paleont. **4**: 364. pl. 33, fig. 12. Middle Miocene, Jamaica.—Palmer & Bermudez (1936) Mem. Soc. Cubana Hist. Nat. **10**: 295. pl. 18, figs. 1, 2, 14–16. Lower Oligocene, Cuba.

Test slender, elongate, slightly curved, gradually tapering from the initial end which terminates in a spine; early part of the test with parallel, straight sides, later part with the chambers slightly inflated; chambers increasing rather slowly in size, being usually slightly shorter than wide; sutures distinct, of clear shell material, flush with the surface in the early part of the test and slightly depressed in the later part; apertural end produced; aperture terminal, crescentic, with small, pointed tooth. Length of average specimen, 1.33 millimeters; diameter, 0.25 millimeter.

Plesiotype No. 4034, locality A86, Cibao formation.

Common at A86 of the Cibao formation.

ELLIPSOGLANDULINA Silvestri 1900

Ellipsoglandulina exponens (Brady)

Plate 36, figures 1a, b

Ellipsoidina exponens Brady (1892) in Jukes-Brown & Harrison, Quart. Jour. Geol. Soc. **48**: 198. Upper Tertiary, Barbados.—Guppy (1894) Proc. Zool. Soc. London, 650. pl. 41, fig. 13. Miocene, Trinidad.

Ellipsoglandulina laevigata Silvestri (1900) Att. Rend. R. Acad. Sci. Lett. Arti. Zelanti, Acireale, Me. Cl. Sci. **10**: 9. pl. 1, figs. 3–10, 12, 13. Upper Miocene or basal Pliocene, Sicily.

Ellipsoglandulina exponens Nuttall (1928) Quart. Jour. Geol. Soc. **84**: 95. pl. 6, fig. 17. Oligocene and Miocene, Trinidad.—Cushman (1928) Contr. Cushman Lab. Foram. Res. **4**: 103. pl. 14, fig. 17. Upper Cretaceous, Trinidad.

Ellipsoglandulina principiensis Cushman & Bermudez (1937) Contr. Cushman Lab. Foram. Res. **13**: 18. pl. 2, figs. 1–3. Eocene, Cuba.

Test oval in side view, narrowly rounded at the apical end, slightly tapering at the apertural end; chambers 3 to 4, overlapping so that the final chamber constitutes nearly one-half of the test; sutures distinct, slightly depressed; aperture terminal, crescentic. Length, 1.20 millimeters; diameter, 0.70 millimeter.

Plesiotype No. 3903, locality P2, Ponce formation.

Rare at P2 of the Ponce formation.

ELLIPSOIDINA Silvestri 1923

Ellipsoidina ellipsoides abbreviata Seguenza

Plate 36, figures 2 and 3

Ellipsoidina abbreviata Seguenza (1859) Eco. Peloritano II. 5: 14. pl., figs. 5a, b. Miocene, Italy.

Ellipsoidina ellipsoides abbreviata Brady (1868) Ann. Mag. Nat. Hist. IV. **1**: pl. 13, fig. 3. Miocene, Italy.—Silvestri (1925) Atti Soc. Ital. Sci. Nat. **64**: 51. text fig. 1. Molasse, Tertiary, Italy.

Ellipsoidina ellipsoides Hadley (not Seguenza) (1934) Bull. Am. Paleont. **20** (70A): 19. pl. 2, figs. 18, 19. Oligocene, probably upper, Cuba.

Test smoothly ovoid, apical end slightly more pointed than apertural end; chambers uniserial, enlarging rapidly, last chamber completely embracing earlier chambers; aperture terminal, an arcuate slit with raised lip; shape of slit varies from a short arc to a short U or V shape. Length, 1.35 millimeters; diameter, 1.17 millimeters.

Plesiotypes No. 3904a and 3904b, locality P2, Ponce formation.

Rare at P3 and P255; abundant at P2 of the Ponce formation.

E. abbreviata is, as the name indicates, much shorter in proportion than *E. ellipsoides* Seguenza (1859. Eco. Peloritano II. 5:).

Family CAMERINIDAE Meek & Hayden 1865

OPERCULINELLA Yabe 1918

Operculinella sinuata NEW SPECIES

PLATE 36, FIGURES 4a–c

Test very small for the genus, compressed, biconvex, biumbonate, nearly bilaterally symmetrical; edge narrowly rounded but not keeled; periphery smooth; whorls about two, involute to umbos, only the last whorl exposed, part of the earlier whorl visible through the clear umbonal material; chambers 10 to 12 in the last whorl; sutures distinct, marked by clear shell material, flush with the surface, strongly curved, meeting the periphery with a small angle, recurved onto the umbo, making the sutures sigmoid in the last half whorl; the two sides of the test nearly identical; wall very finely perforate; aperture a small slit, with small upper lip, at the base of the septal face on the inner periphery, not extending beyond the edge of the test on either side. Diameter, 0.55 millimeter; thickness, 0.16 millimeter.

Holotype No. 4067, locality A21, Quebradillas formation.

Rare at A20 and A21 of the Quebradillas formation.

There are few described species with which to compare this Porto Rican form. It is smaller and has fewer chambers than *O. dia* Cole and Ponton (1930. Fla. Geol. Surv. Bull. 5).

HETEROSTEGINA d'Orbigny 1826

Heterostegina antillea Cushman

PLATE 36, FIGURE 5

Heterostegina antillea Cushman (1919) Carnegie Inst. Wash. Publ. 291: 49. pl. 2, fig. 1b, pl. 5, figs. 1, 2. Middle Oligocene, Antigua; (1921) U. S. Geol. Surv. Prof. Pap. 128E: 131. pl. 20, figs. 13, 14. Middle Oligocene, Antigua, Virgin Islands, St. Croix, Santa Domingo.

EXTERIOR.—Test discoid, eccentrically biumbonate, the central portion 2 to 3 times as thick as the broad, complanate portion; edge sharply rounded; surface ornamented with a smooth boss which is surrounded by low, oval and elongate papillae, and with raised lines of transversely elongate papillae and discontinuous raised lines along the sutures in the later part of the test; the sutures between the chamberlets are less raised, but are frequently slightly raised at their outer ends and confluent with the raised sutures between the chambers; aperture not observed. Diameter of test, 4 to 6 millimeters; thickness, central part 0.8 to 1 millimeter; thinner edge, 0.33 to 0.4 millimeter.

Median section.—Chambers short, 20 or more in the last whorl, 0.16 to 0.22 millimeter long in the direction of coiling, broad radially and strongly and evenly curved, meeting the edge with a small angle; chamberlets rectangular, the later ones half as wide as long, 0.2 by 0.1 millimeter, alternating in position with those in prior and succeeding chambers, so that the walls between chambers are markedly zigzag; the earlier chamberlets are wider and shorter than the later ones, the earliest ones being highly arched (ogival) to trapezoidal in shape; proloculum spherical, 0.09 millimeter in diameter, followed by two oval chambers of nearly the same size.

Vertical section.—The spherical proloculum and rectangular median chambers are covered with numerous laminae making up the lateral zones; the laminae are composed of vertical fibers of calcium carbonate, and are more transparent at the outer ends of the chambers, with indications of pillars radiating from the proloculum.

Plesiotype No. 4149, locality L3C, San Sebastian formation.

Rare at L3C and L5C of the San Sebastian formation.

In some of the specimens the raised sutures between the chambers and between the chamberlets are more pronounced than in the figured specimen, but not as pronounced as in *H. ocalana* Cushman (1921. U. S. Geol. Surv. Prof. Pap. **128E:** pl. 21).

Family **ORBITOIDIDAE** Schubert 1920

In the San Sebastian and Ponce formations, there occur small specimens of orbitoids, 1 to 3 millimeters in diameter which are very much like *Lepidocyclina parvula* Cushman, and *Lepidocyclina* (*Nephrolepidina*) *tournoueri* Lemoine and Douvillé, as described and figured by Vaughan (1933. Smith. Misc. Coll. **89**). While the specimens are insufficient for adequate study description and figures, they are sufficient to demonstrate the Oligocene age of the beds in which they occur.

Lepidocyclina cf. *parvula* Cushman is rare at L4C of the San Sebastian formation, and common at P251 of the Ponce formation.

Lepidocyclina (*Nephrolepidina*) cf. *tournoueri* Lemoine and Douvillé is rare at L4C of the San Sebastian formation, and at P251 of the Ponce formation.

MIOGYPSINOIDES Yabe & Hanzawa 1928

Miogypsinoides complanata (Schlumberger)

PLATE 36, FIGURES 6 to 10

Miogypsina complanata Schlumberger (1900) Bull. Soc. Géol. France III. 28: 330. pl. 2, figs. 13–16, pl. 3, figs. 18–21. Upper Oligocene, France.—Silvestri (1930) Boll. Soc. Geol. Ital. 48: 210; (1923) Boll. Soc. Geol. Ital. 42: pl. 1, fig. 19. Oligocene, Italy.—Nuttall (1933) Jour. Paleont. 7: 176. pl. 24, figs. 7, 9, 11–14. Middle Oligocene, Mexico.

EXTERIOR.—Test flabelliform, irregularly discoidal, nearly equally biconvex, the initial end narrow with smooth outline, the outer margin serrate, due to the large median chambers which are not covered by lateral laminae; surface papillate, the apical portion with very small papillae, about 0.02 millimeter in diameter, the outer portion with papillae more variable in size, 0.03 to 0.08 millimeter in diameter, and the early middle portion with the largest papillae, about 0.1 millimeter in diameter. Only microspheric forms were found. Length, from 0.8 to 2.5 millimeters; width, 0.7 to 2.7 millimeters; thickness, up to 0.35 millimeter.

MEDIAN SECTION.—The coiled nucleoconch of an average specimen (1.3 millimeters in diameter) is located near the periphery at the apex of the test, and consists of a globular proloculum about 0.1 millimeter in diameter, with wall about 0.028 millimeter thick, followed by one to two whorls of chambers; the proloculum and a few slightly smaller chambers, subtriangular to rectangular in shape with radial dimension increasing gradually, are followed by spatulate chambers for a half whorl to a whorl, then by diamond shaped chambers for the remainder of the test.

LONGITUDINAL VERTICAL SECTION.—The median chambers are oval and appressed, about 0.1 millimeter in length and 0.15 millimeter in diameter, constituting about half the thickness of the test; the chamber walls are fibrous crosswise; the lateral laminae are rather thick and transversely fibrous, and traversed by fibrous pillars around the nucleoconch, the pillars appearing at the surface as knobs. There is a light-colored structure at the outer edge of many of the median chambers. No apertures were observed in either median or vertical sections.

Plesiotypes No. 4150a, 4150b, 4150c, and 4150d, locality L4C; and No. 4151, locality L6C, San Sebastian formation.

Rare at L2C and L3C; common at L1C and L6C; abundant at L4C and L5C of the San Sebastian formation. Common at A86 of the

Cibao formation. Abundant at A79 of the Los Puertos formation. Rare at P2 and P4 of the Ponce formation.

The presence of lateral laminae rather than lateral chambers places these specimens in the genus *Miogypsinoides*. The Porto Rican specimens are smaller than the French types of the species, but are of the same size as the Mexican specimens.

LIST OF NEW FORMS

New Genus

New Species

New Varieties

FOSSIL LOCALITIES

The foraminifera which are described in this paper were collected from 35 different localities and represent all five formations from the northern area, and the Ponce formation from the south shore. All of the collecting localities are marked on the geologic map which accompanies this report.

San Sebastian formation

All of the San Sebastian localities are upper San Sebastian in age and are close together stratigraphically. A 100 foot vertical range just below the Lares would encompass them all, with the exception of the L1C which may be slightly lower.

L1C Collazo Falls, base of Lower Fall on north side of the road at kilometer 26.7 on San Sebastian-Lares road.

L2C Outcrop at kilometer 26.6 on San Sebastian-Lares road.

L3C Outcrop at kilometer 27.1 on San Sebastian-Lares road.

L4C Outcrops between kilometer 27.2 and 27.4 on San Sebastian-Lares road.

L5C Outcrops at kilometers 27.7 and 28.7 on San Sebastian-Lares road.

L6C Outcrop at kilometer 31 on San Sebastian-Lares road.

Lares formation

A6 Small road quarry at kilometer 66.3 on Arecibo-Utuado road, in valley of Rio Arecibo; 2.45 kilometers north of Lares-Cretaceous contact. Approximately middle Lares.

Cibao formation

A43a At kilometer 19.8 on Arecibo-Lares road. Lower Cibao, about 150–200 feet above the base.

A86 At kilometer 5.5 on the Manati-Ciales road. Probably upper Cibao.

Los Puertos formation

A79	At kilometer 13, Los Canos-Bayanez cane railroad. Lower Los Puertos, probably less than 150 feet above the base.
A91a	At kilometer 4, Morovis-Vega Baja road. Upper or upper middle Los Puertos.

Quebradillas formation

F64	Northernmost of three Tertiary hills lying north of kilometer 3.6 on Rio Piedras-Carolina road. Although located in the lower third of the formation, this may not be lower Quebradillas since basal members drop out by overlap to the east.
A46	About 2.5 kilometers S. S. W. of Arecibo on Hato Abajo road. Middle Quebradillas, possibly lower middle.
F359	Quarried hillside 0.5 kilometers north of abandoned Central at Hoyo Mulas, north of Canovas-Carolina road. Probably middle Quebradillas.
F358(2)	Outcrop about 1 kilometer southwest of F358, about 100 feet stratigraphically above F359 and below F358. Probably middle Quebradillas.
F358	Quarry, north of Canovanas and railroad bridge at Central Canovanas, west bank of Rio Grande de Loiza. Probably middle Quebradillas.
A21	At kilometer 2.1–2.2 on road south of Hatillo. Upper middle Quebradillas.
A20	Roadcut 1.9–2 kilometers south of Hatillo, approximately 75 feet higher in the section than A21. Upper middle Quebradillas.
A64	Quarry between Barcelonita and Manati, northeast of San Juan-Arecibo highway, and east of Rio Manati. Upper Quebradillas.
A15	Quarry 0.3 kilometers south of Arecibo-Hatillo road at 88.2–88.3 kilometers. Upper Quebradillas.
A93	From quarry at kilometer 0.7, Arecibo-Lares road. Upper Quebradillas.

Ponce formation

Ponce-Peñuelas area

P251	From kilometer 251.3–251.5 on Peñuelas-Ponce road. Lowest Ponce.
P4	From kilometer 4.7 on Ponce-Arecibo road, less than 0.7 kilometers from Cretaceous Tertiary contact. Lower Ponce.
P3	From kilometer 3.7 on Ponce-Arecibo road; higher stratigraphically than P4. Lower Ponce.
P2	From kilometer 2.8–2.9 on Ponce-Arecibo road; stratigraphically higher than P3. Lower Ponce.
P253	From kilometer 253.3 on Peñuelas-Ponce road. Lower Ponce, but higher stratigraphically than P251.
P254	Outcrops between kilometer 254.7 and 254.9 on Peñuelas-Ponce road. Lower Ponce, but higher stratigraphically than P251.
P255	Outcrop between kilometer 255.1 and 255.2 on Peñuelas-Ponce road. Lower Ponce, but higher stratigraphically than P251.
P258	Outcrop between kilometer 258.2 and 258.5 on Peñuelas-Ponce road. Higher stratigraphically than P253, P254 and P255. Probably middle Ponce.
P259	Outcrop at kilometer 259.4 on the Peñuelas-Ponce road. Higher stratigraphically than P253, P254 and P255. Probably middle Ponce.

Rio Yauco section

P431	Approximately 1.3 to 1.4 miles S. S. E. of Yauco railroad station in shallow cuts along road that follows valley of Rio Yauco. Upper part of lower Ponce.
P432	Outcrop about 2½ to 3 miles S. S. E. of Yauco on road that follows valley of Rio Yauco. Lower part of middle Ponce.
A432	Outcrop 4 to 5 kilometers S. S. E. of Yauco in valley of Rio Yauco. Lower part of middle Ponce.
P434	Outcrop east of A432 along American Railroad near kilometer 246.5. About middle part of middle Ponce.
P433	Same locality as P434, at higher stratigraphic horizon. About upper middle Ponce.

EXPLANATION OF PLATES

All figured specimens catalogued and deposited in the Paleontological Laboratory, Indiana University.

Plate 1

PAGE

Figure 1. *Pseudarcella patella* n. sp. × 53; a, ventral view; b, side view; Holotype No. 3950, locality A6, Lares formation. 298

Figure 2. *Rhabdammina irregularis* Carpenter. × 8; Plesiotype No. 3972, locality P3, Ponce formation. 299

Figure 3. *Spirillina vivipara* Ehrenberg. × 93; a, side view; b, edge view; Plesiotype No. 3993, locality A86, Cibao formation. 299

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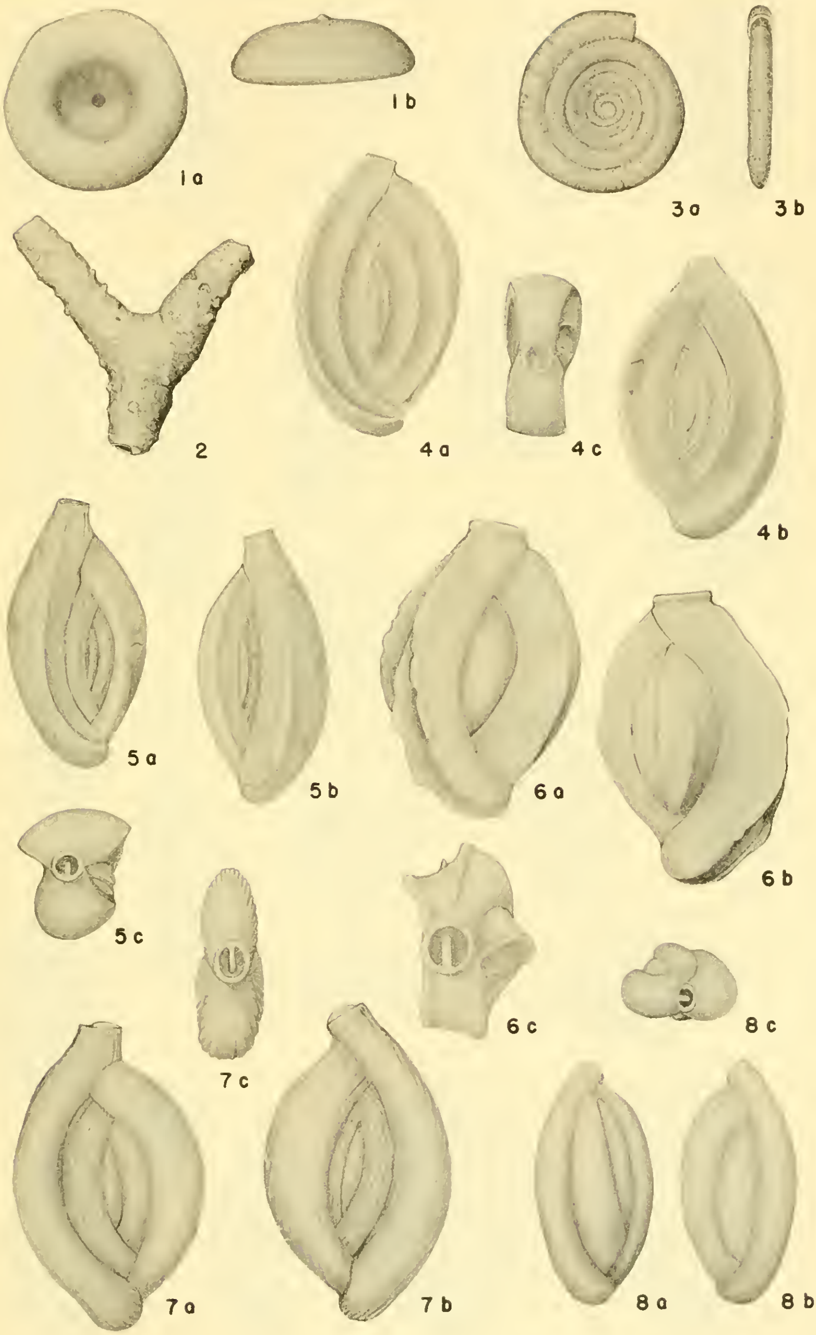

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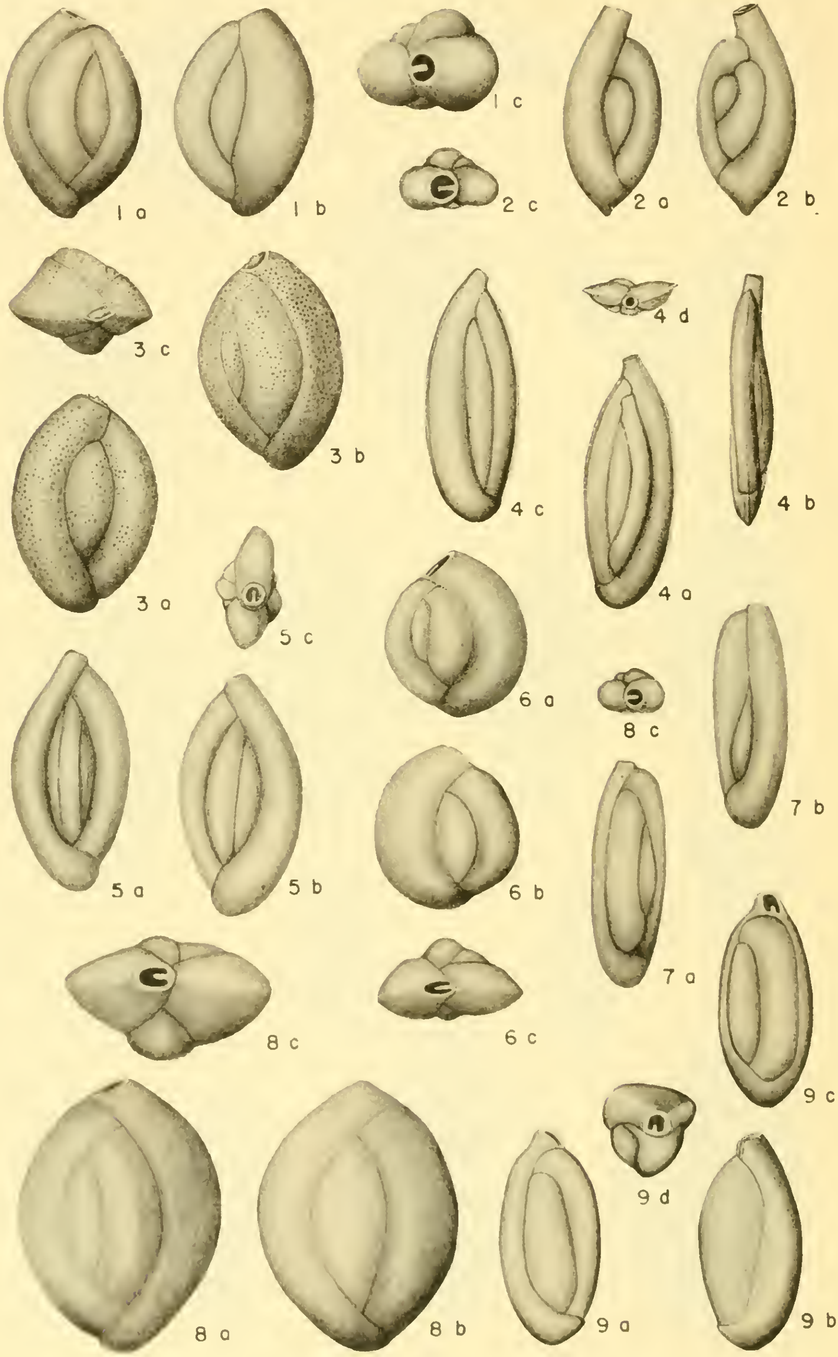

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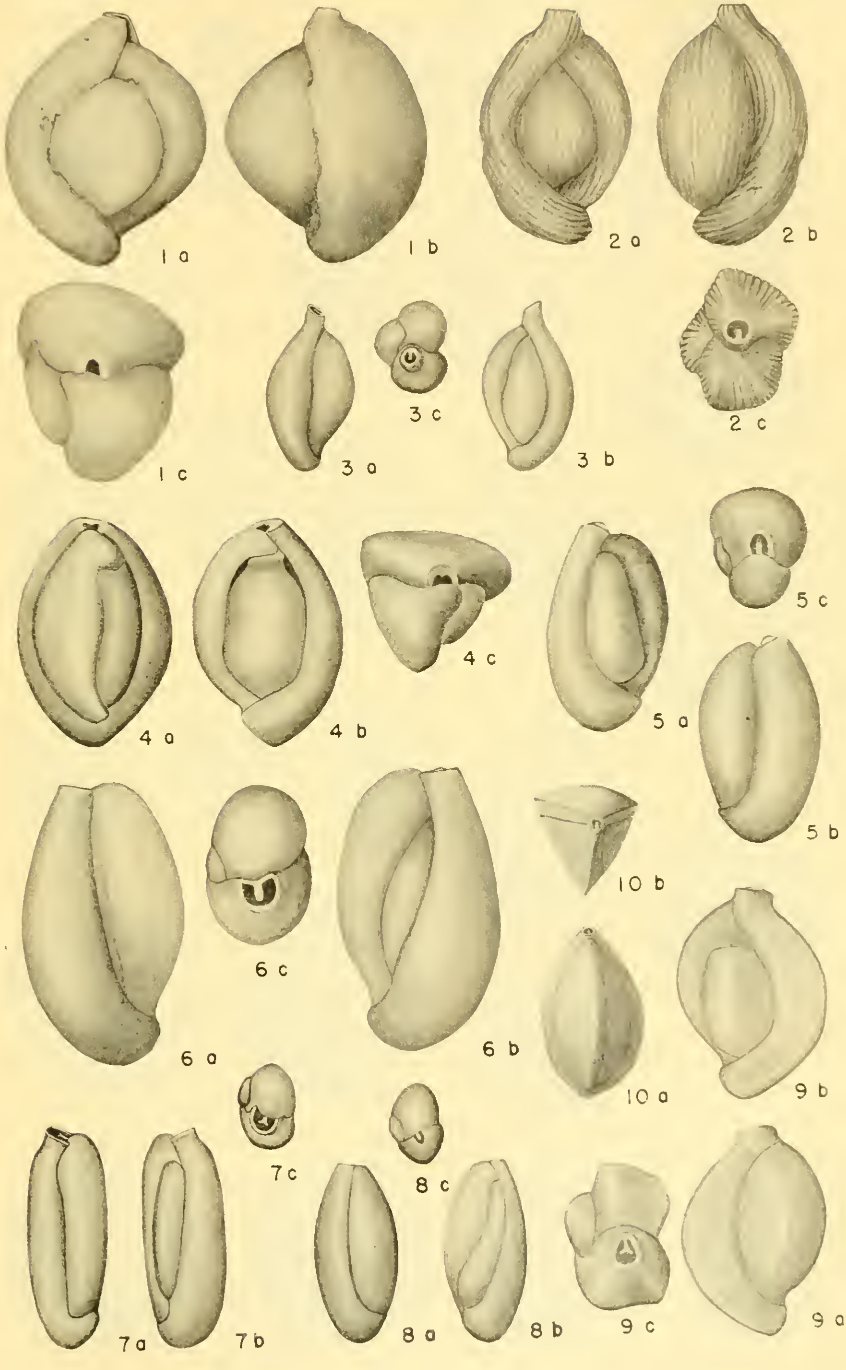

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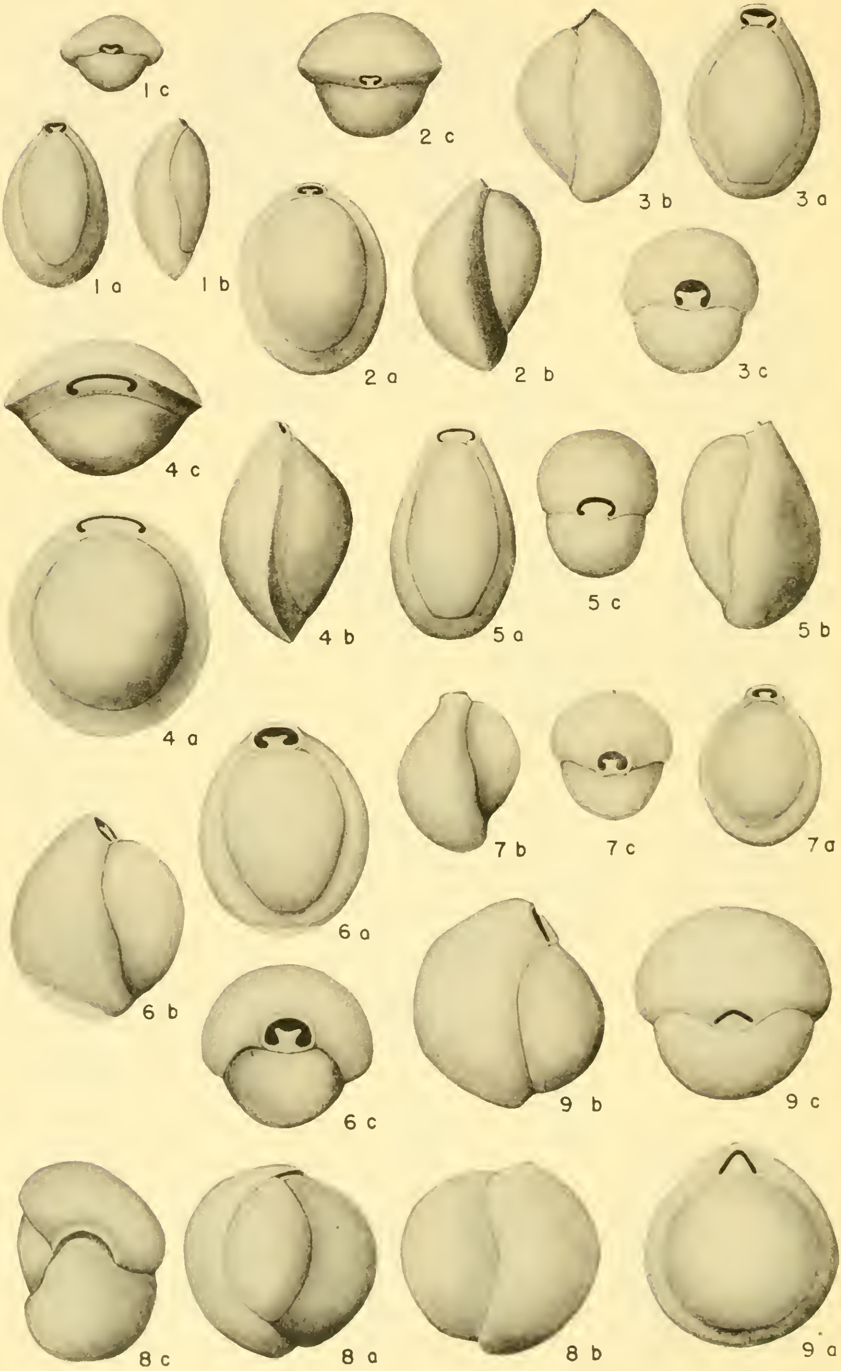

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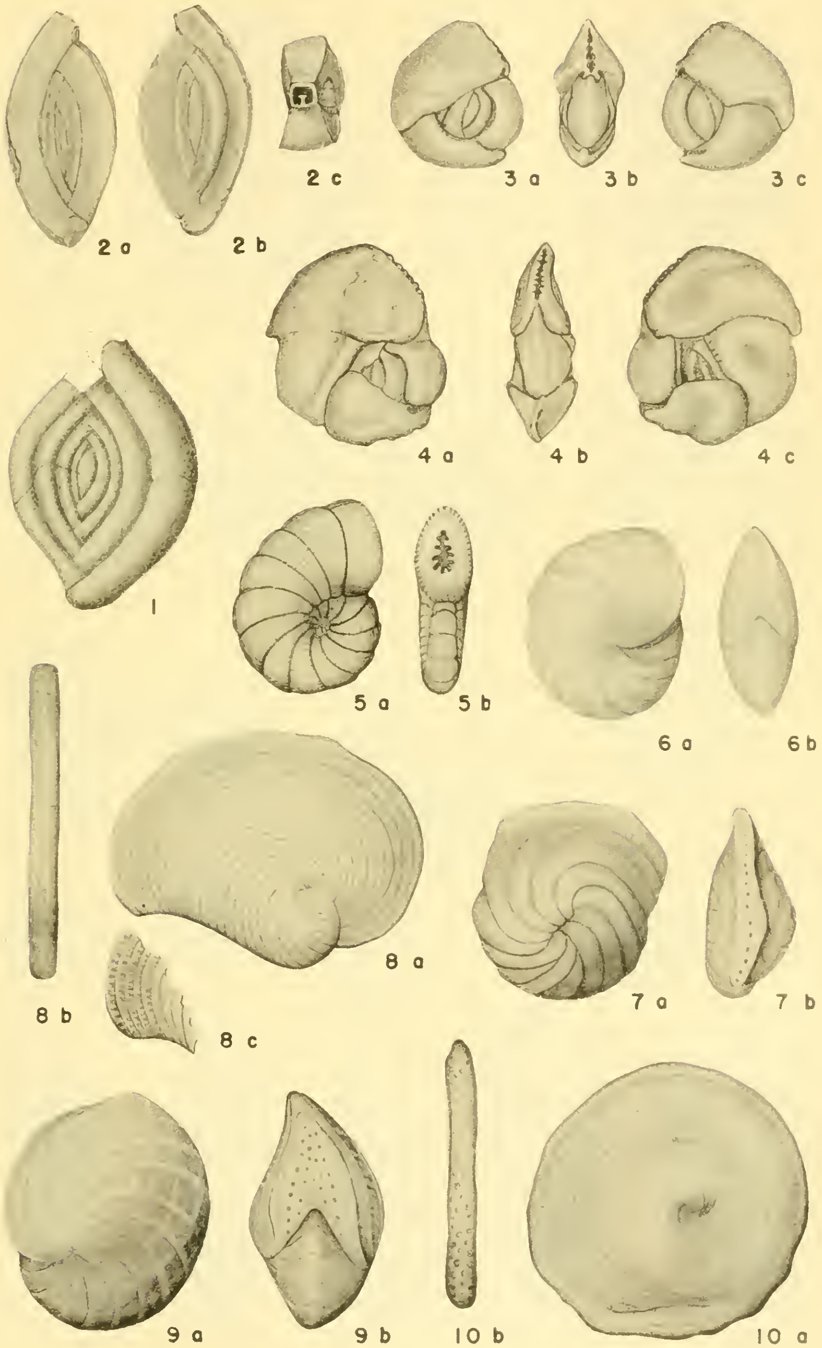

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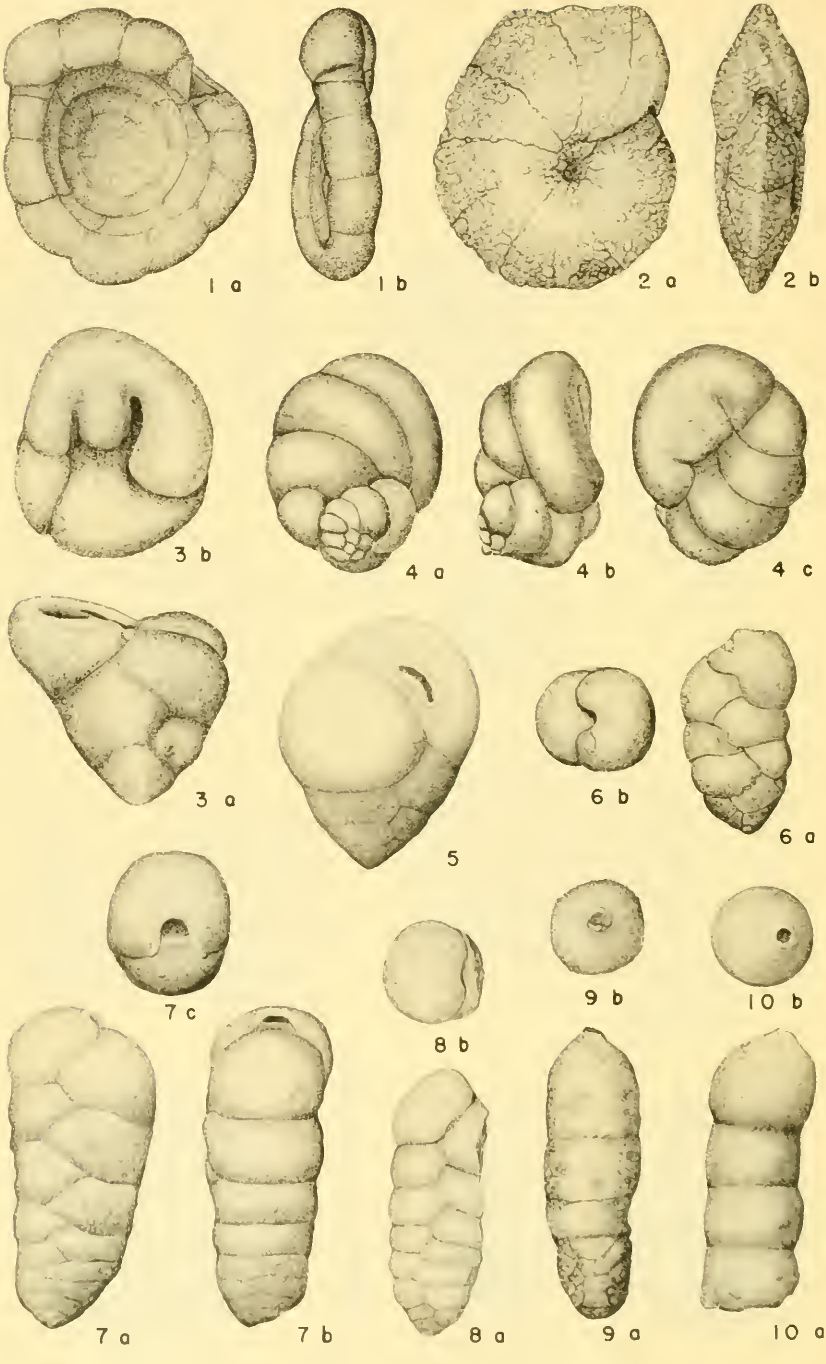

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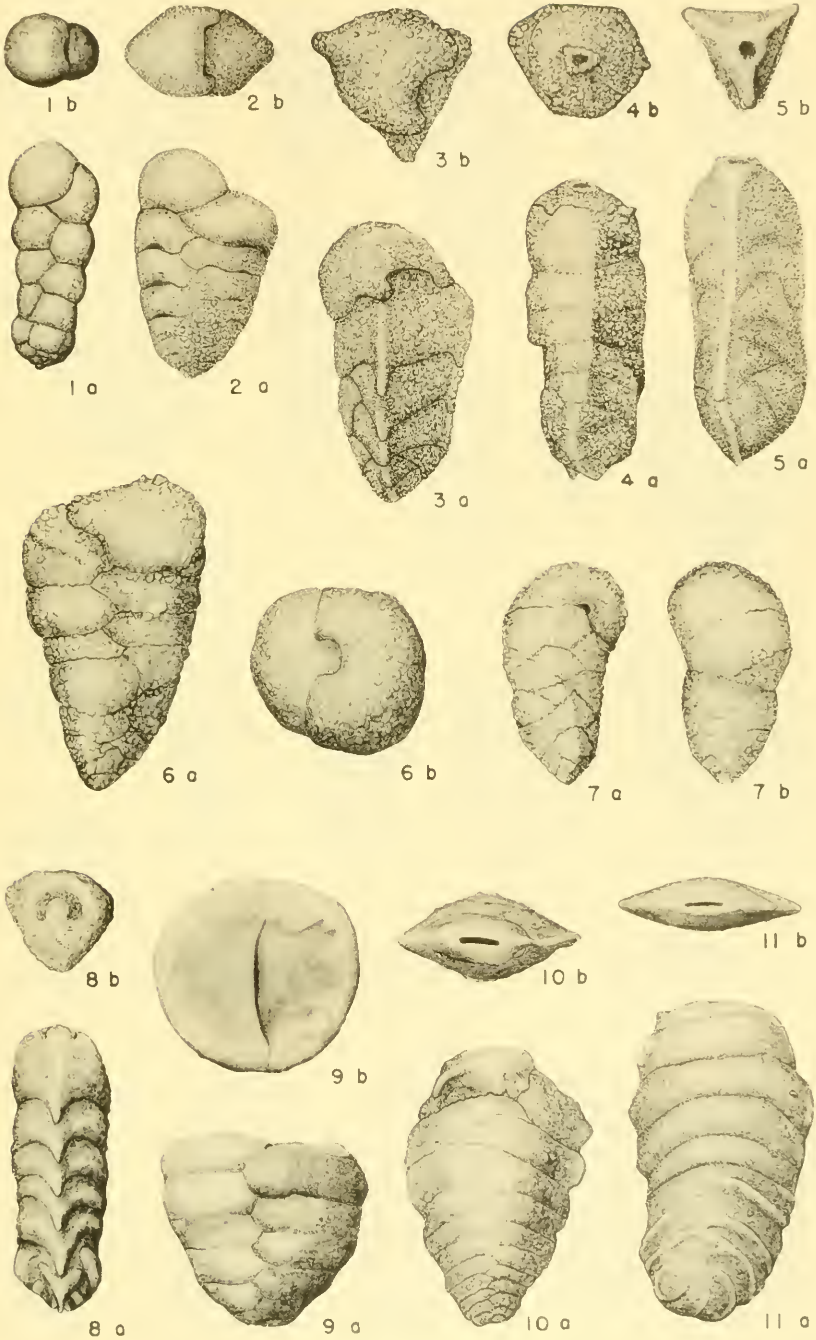

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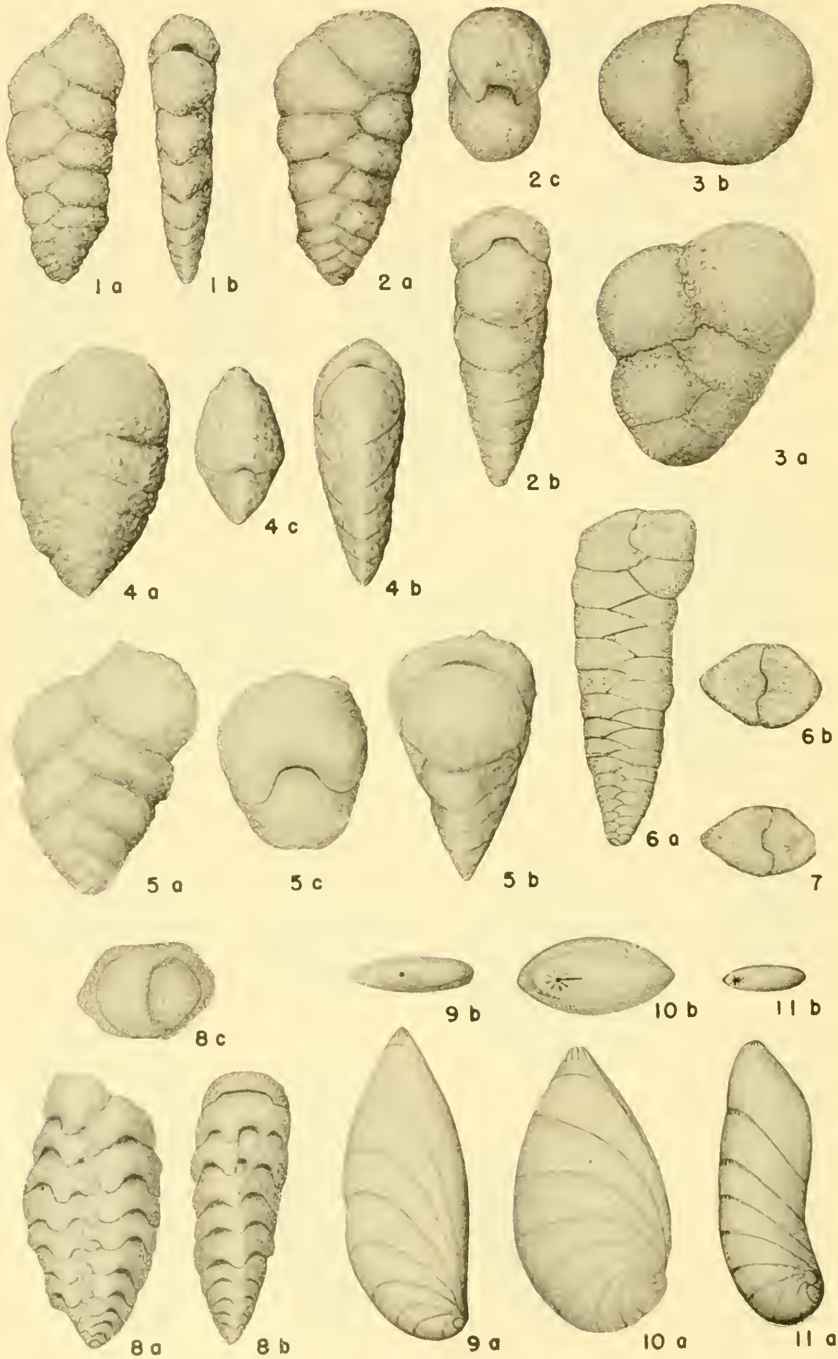

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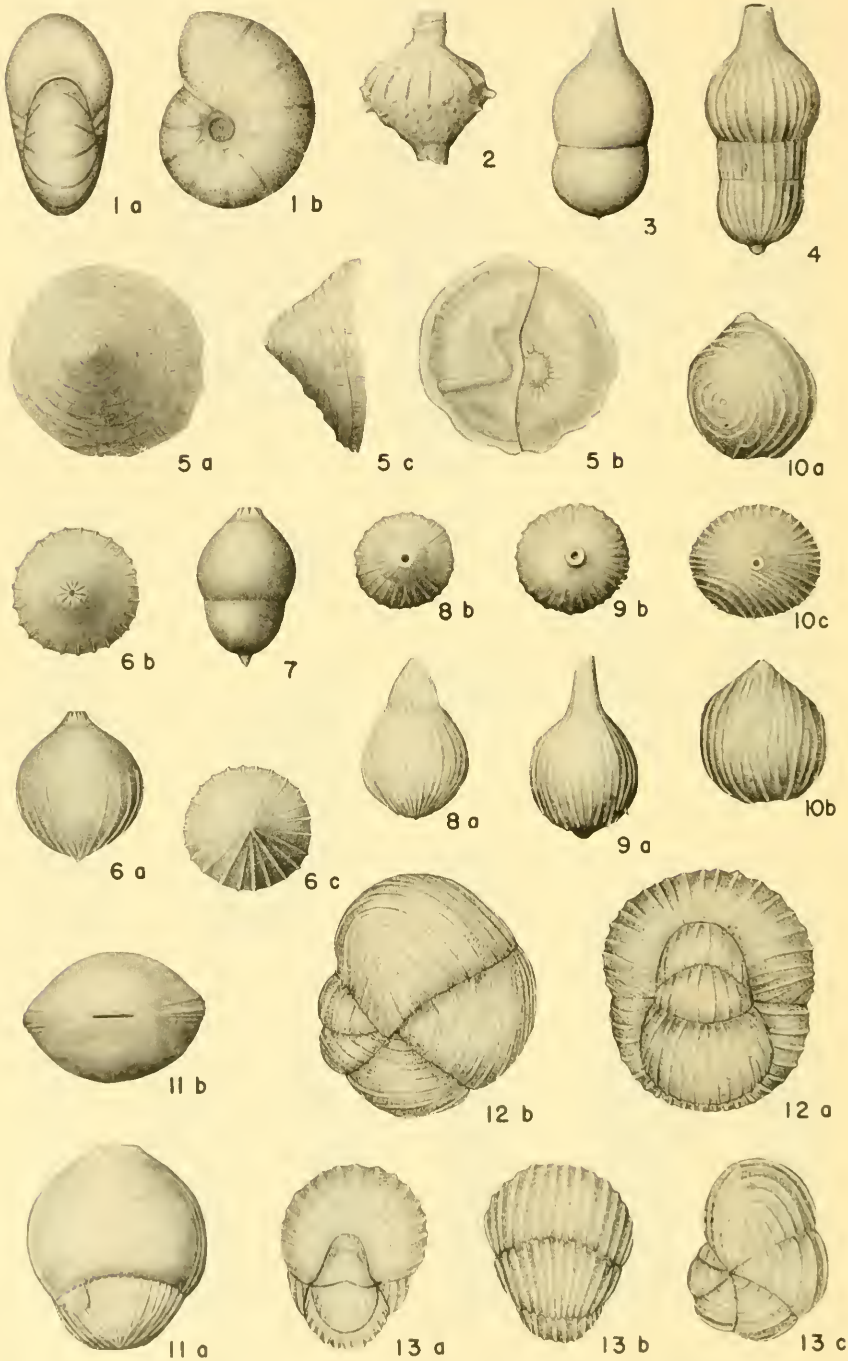

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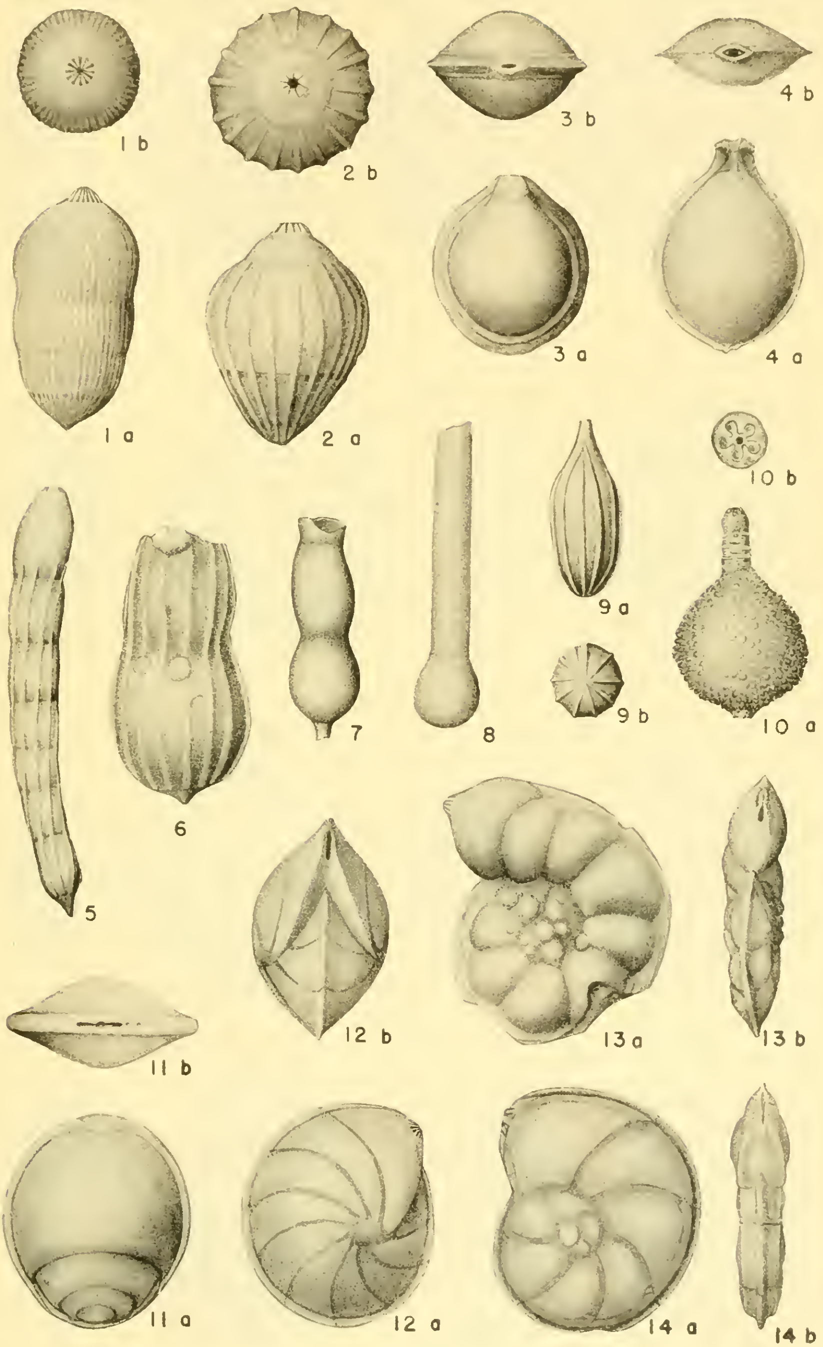

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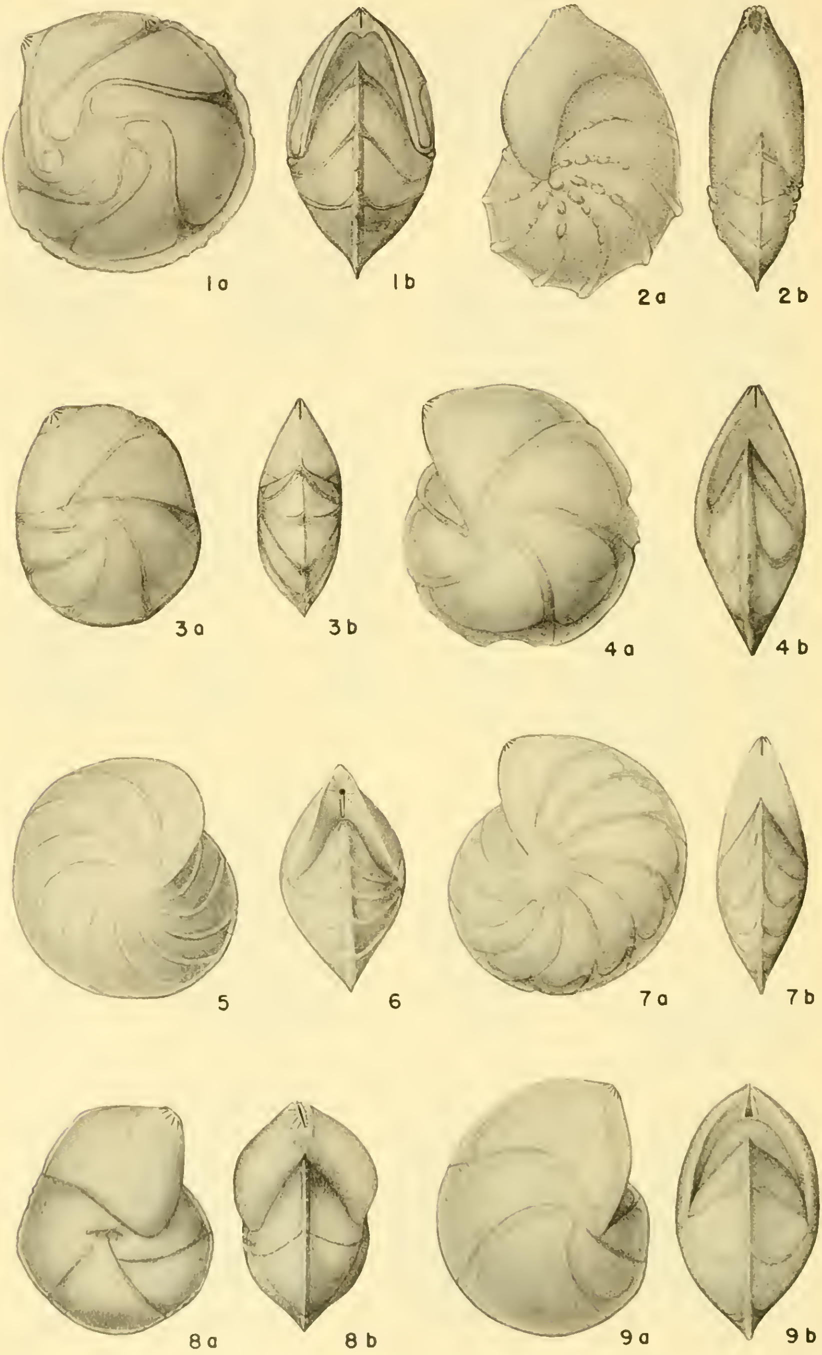

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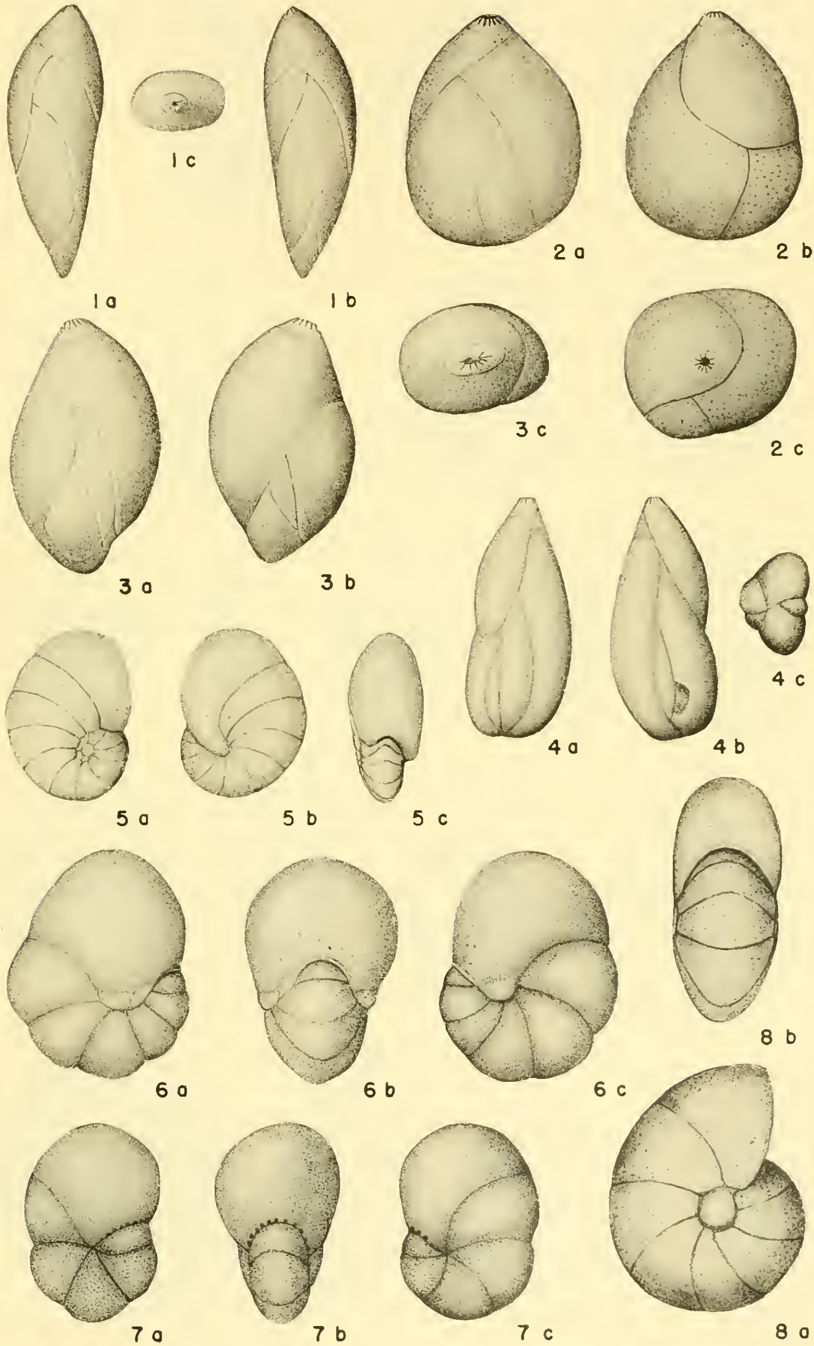

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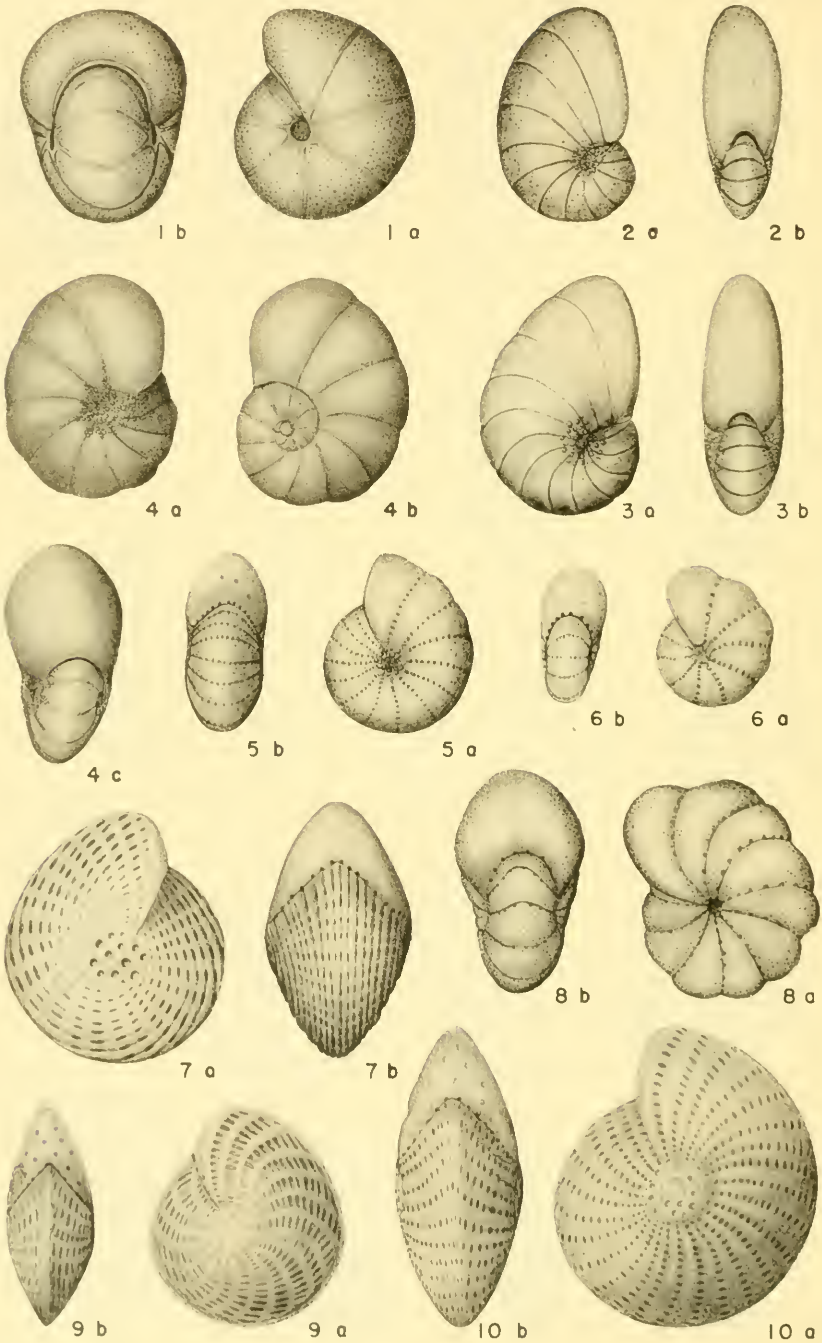

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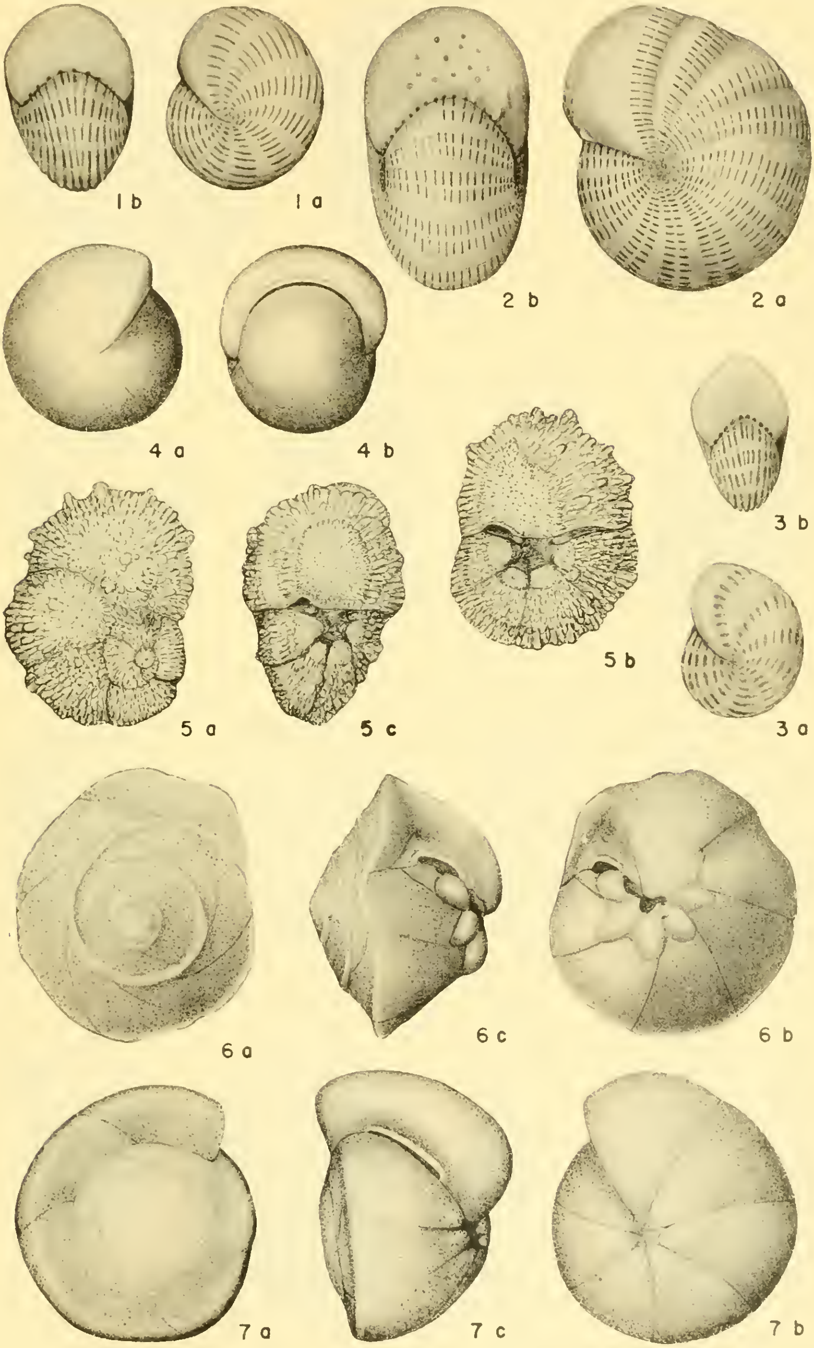

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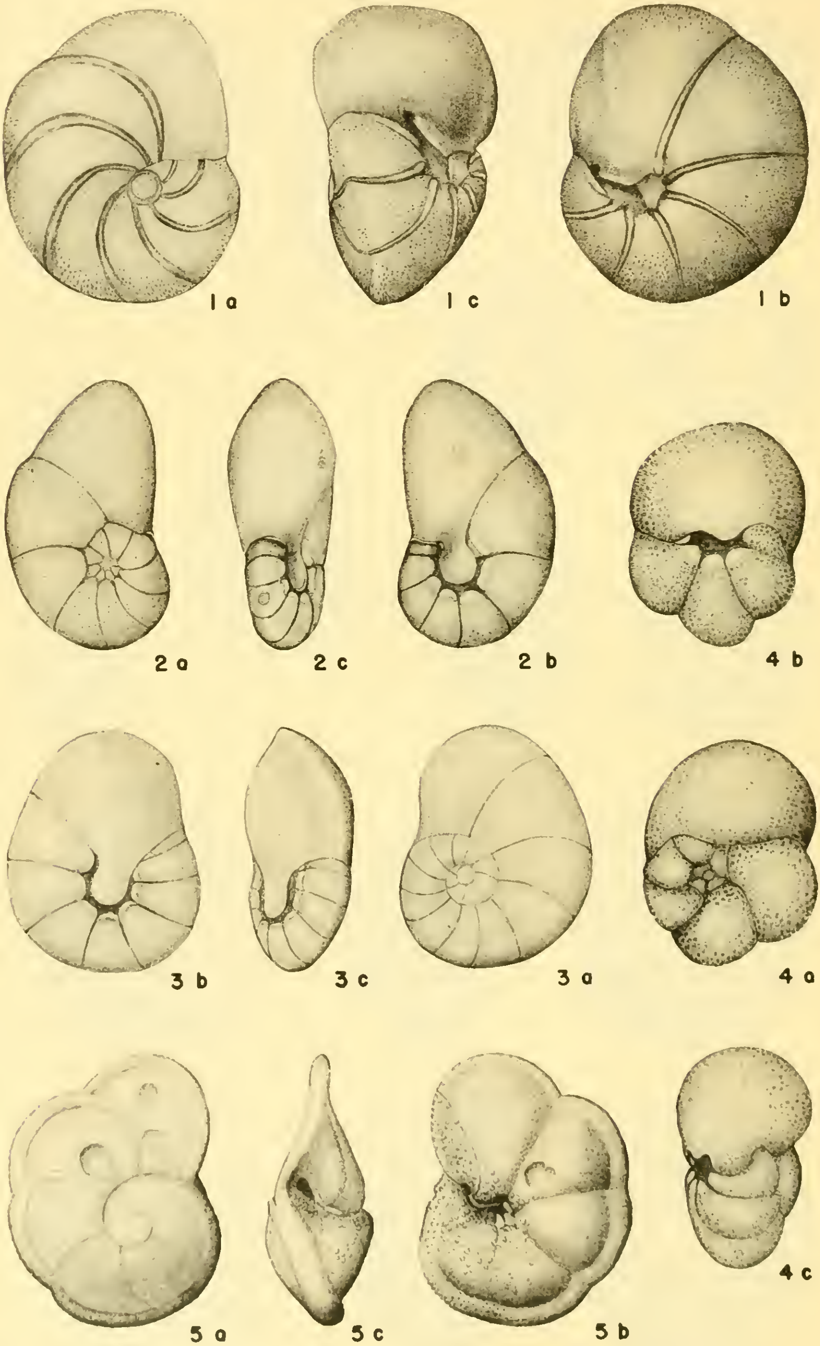

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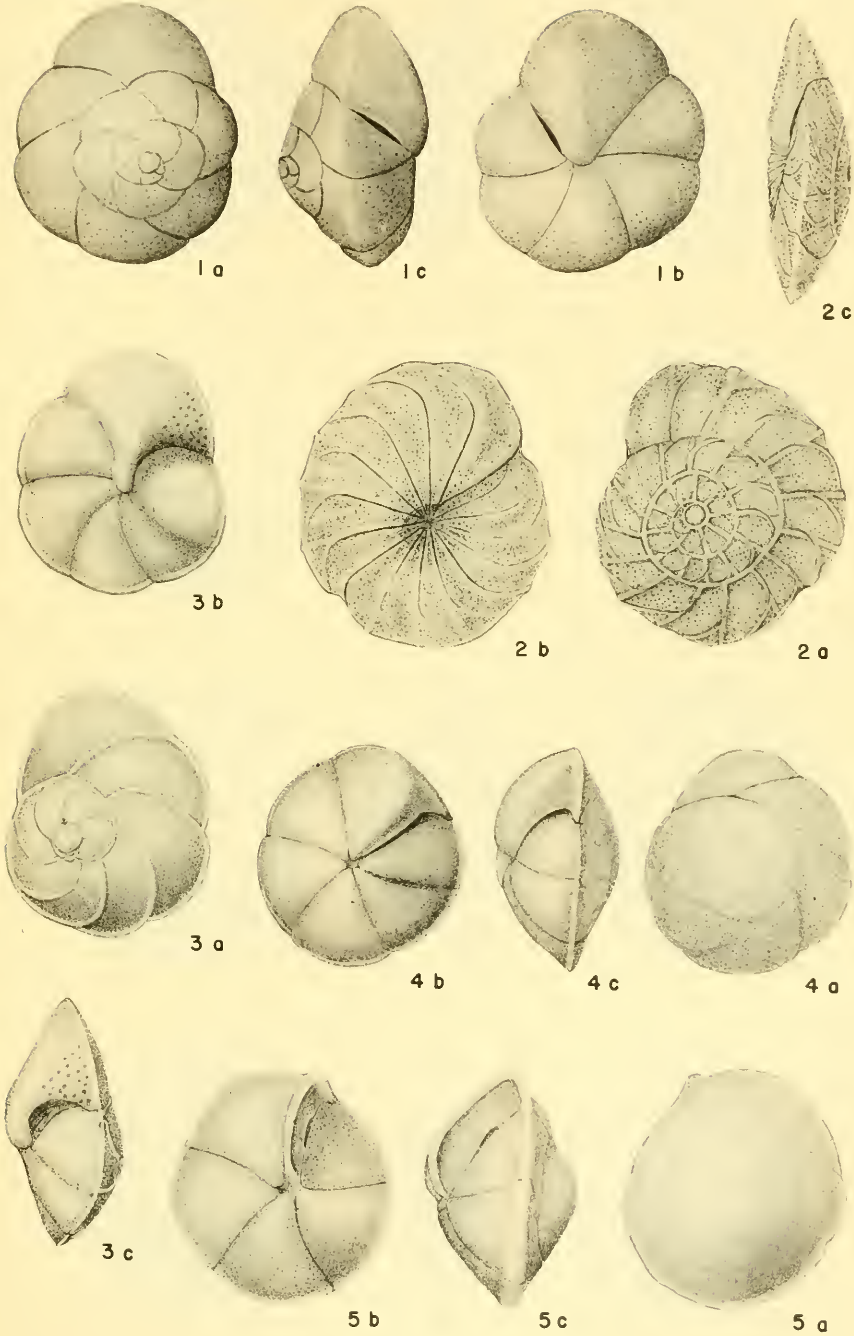

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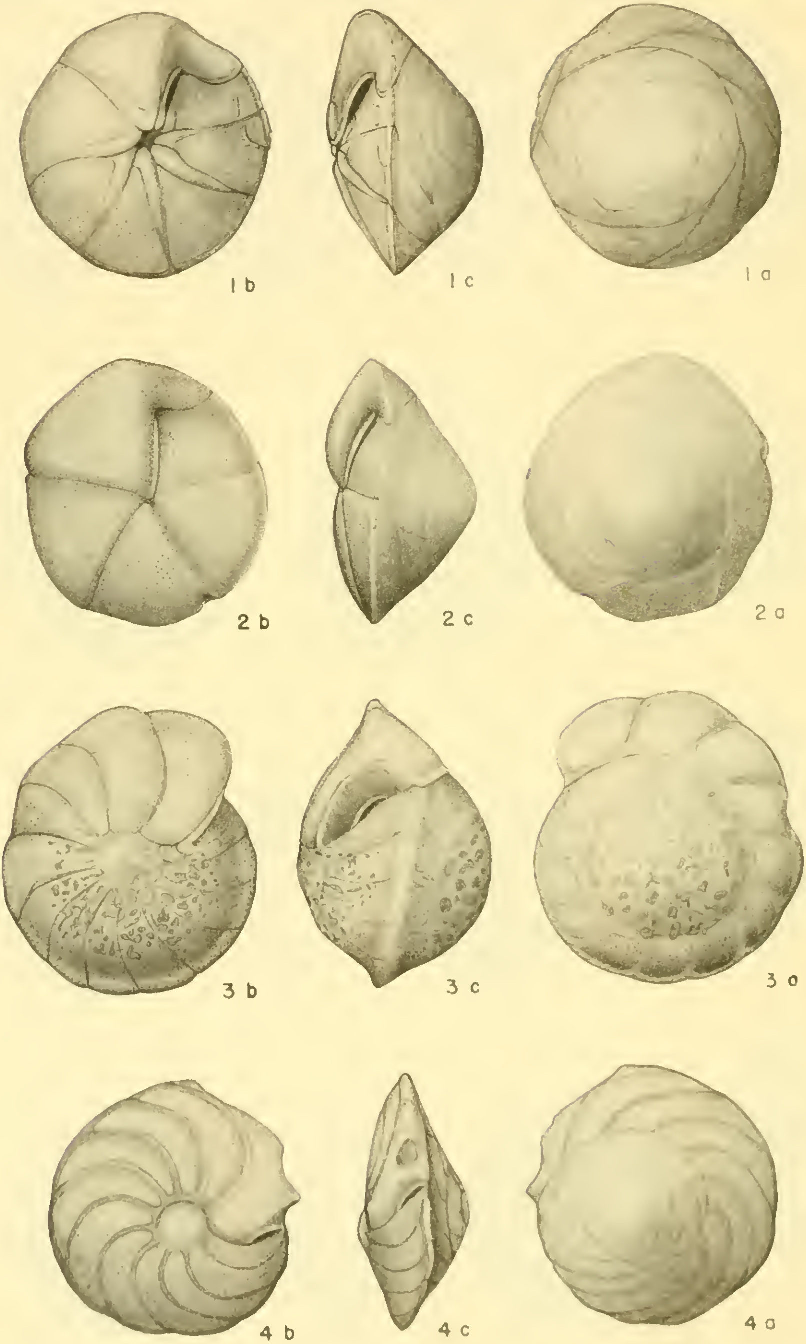

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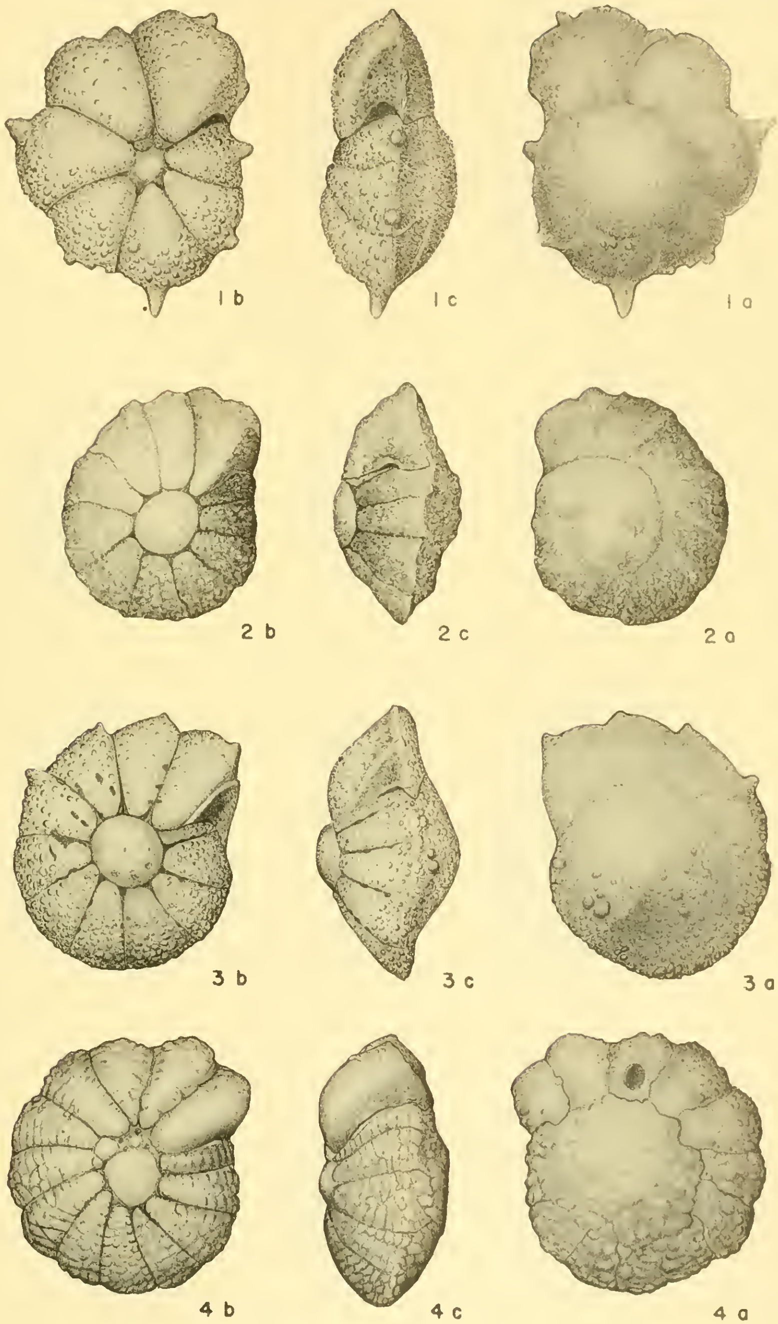

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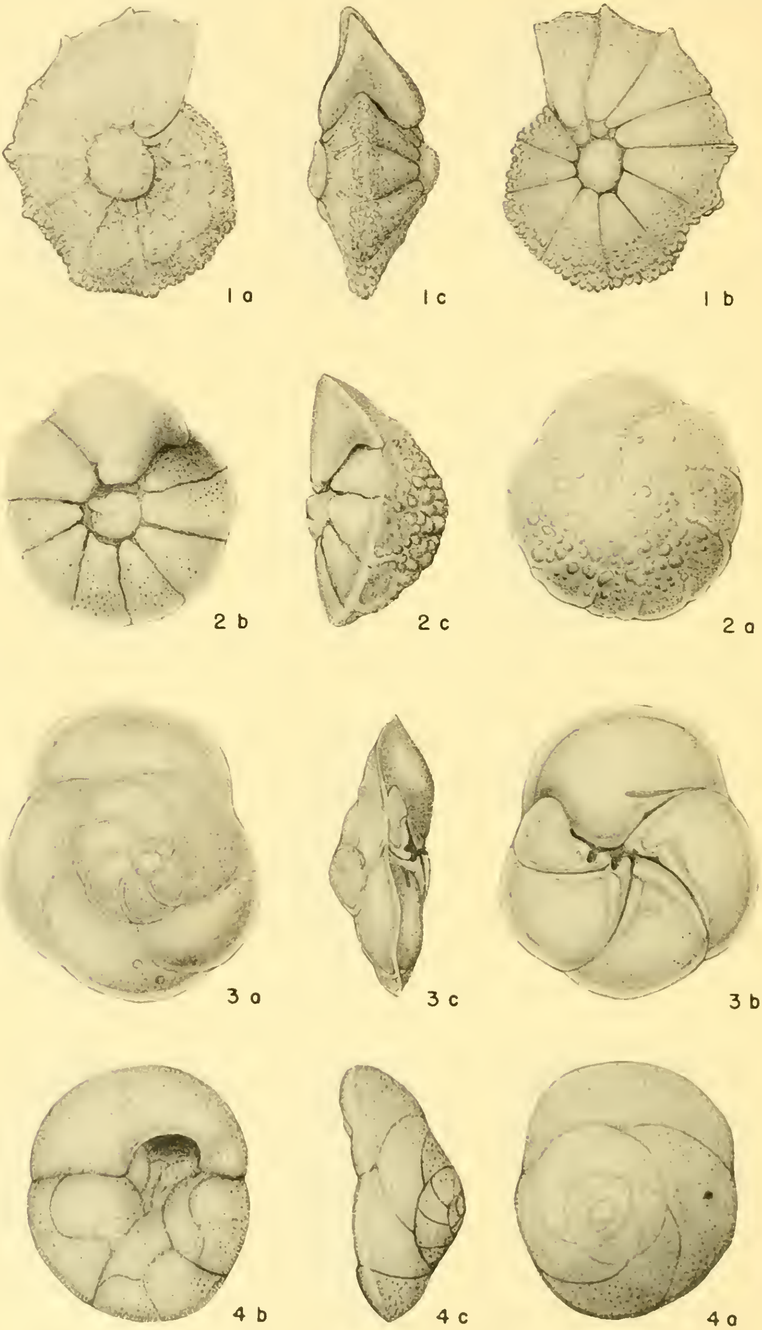

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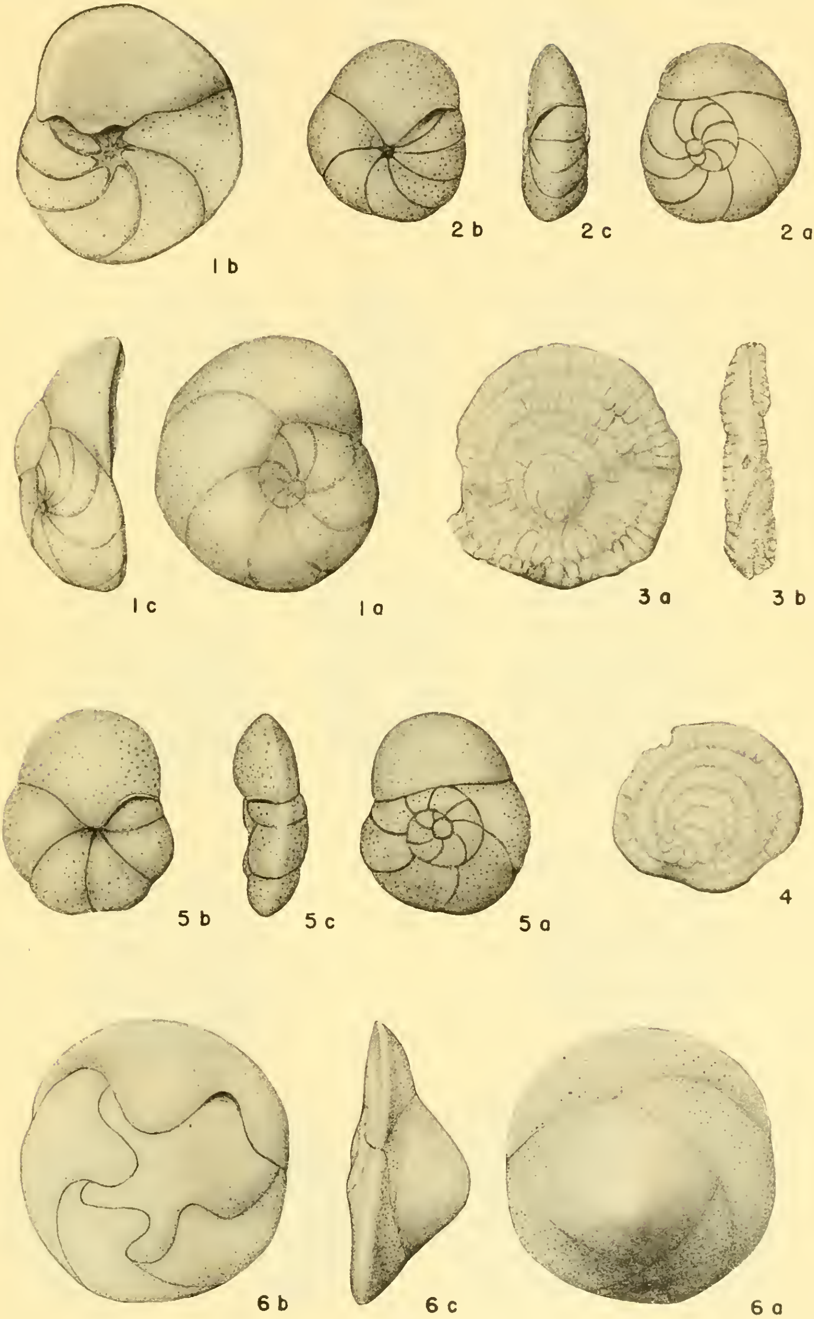

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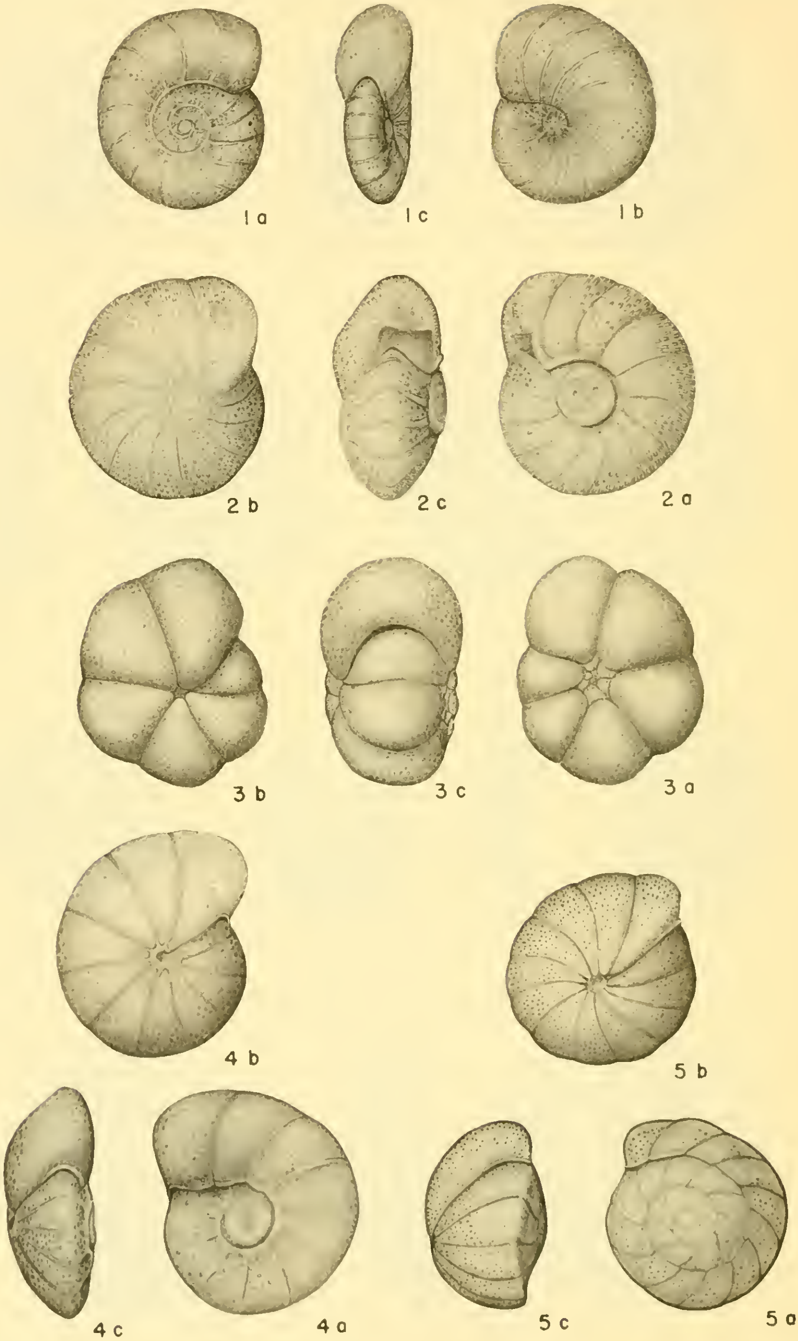

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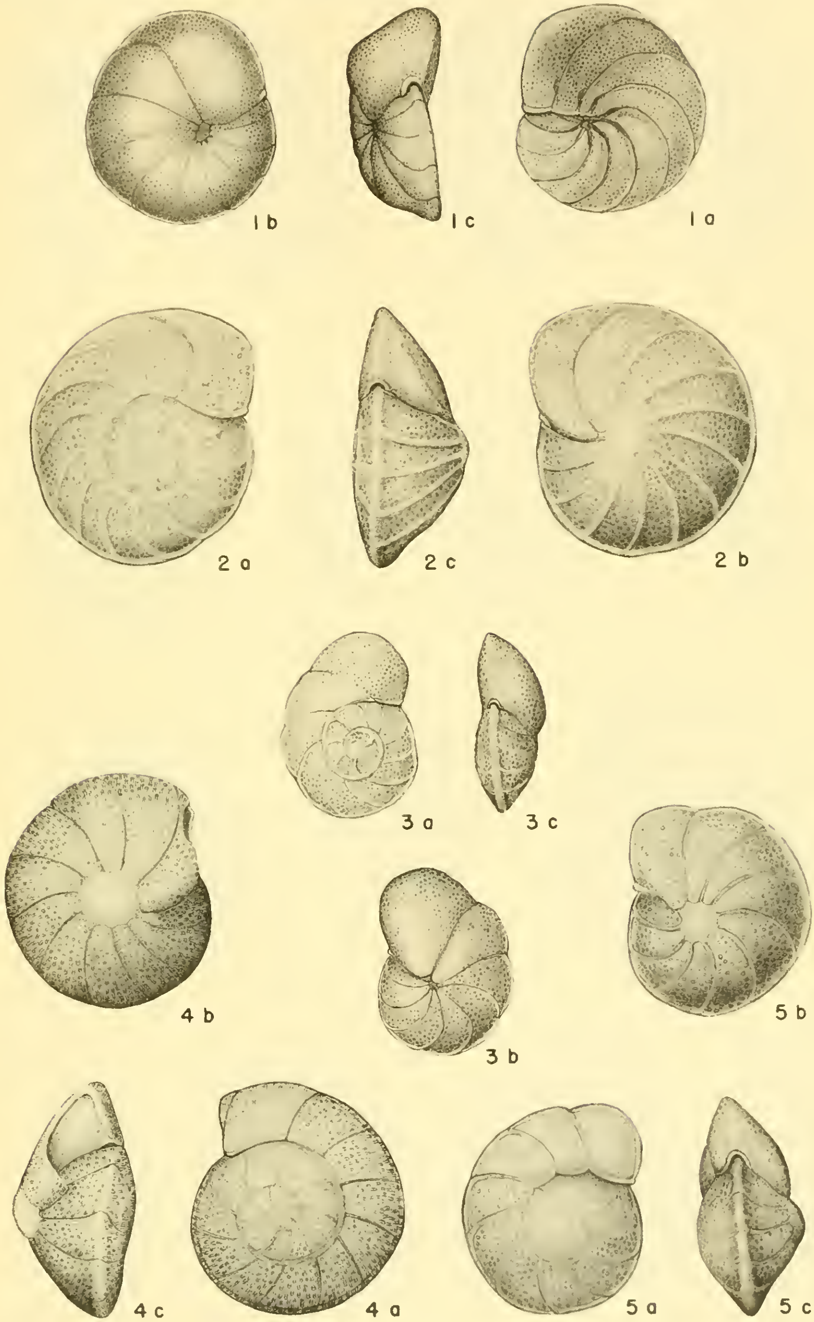

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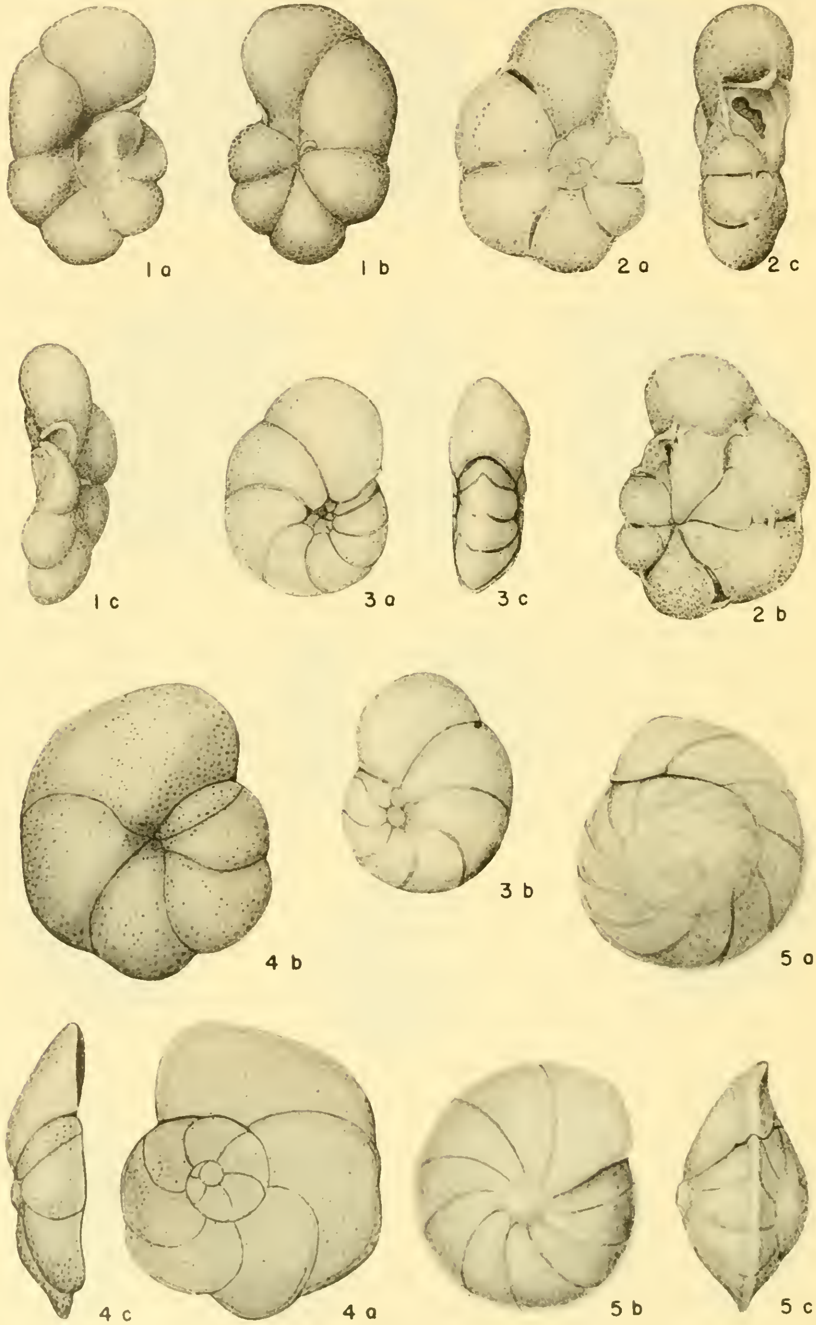

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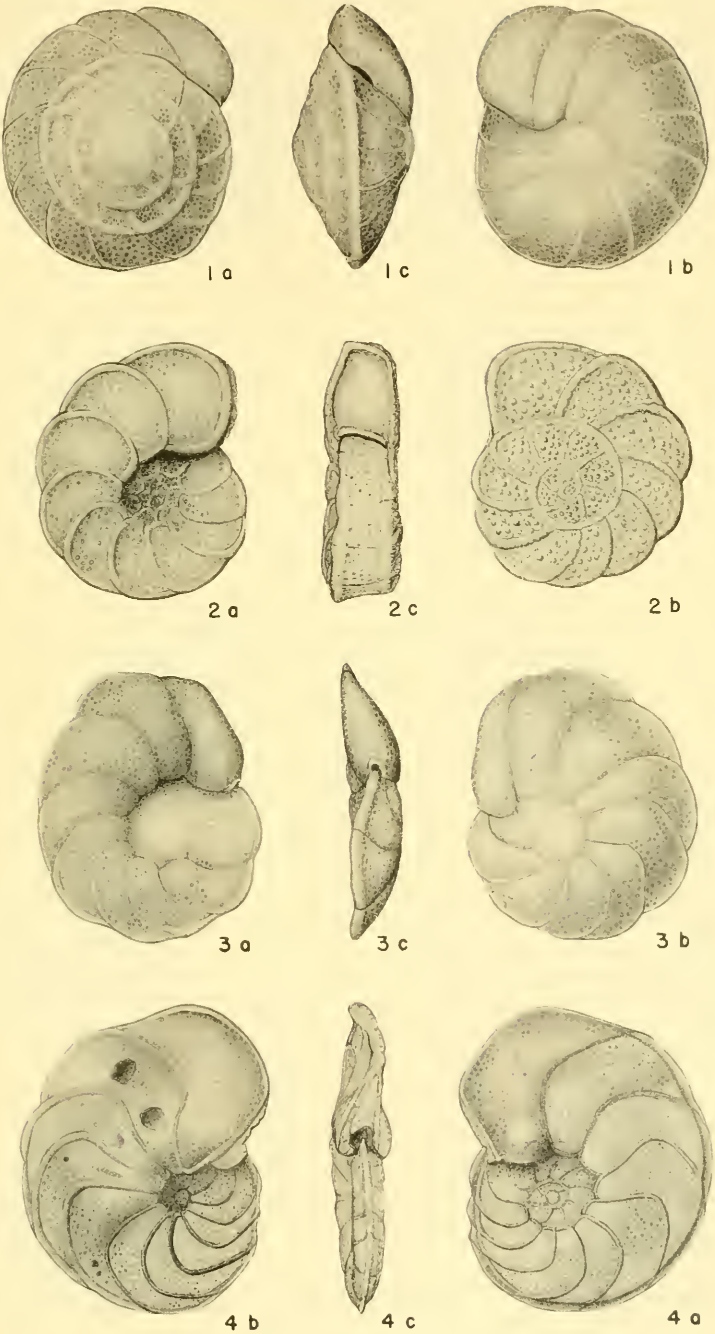

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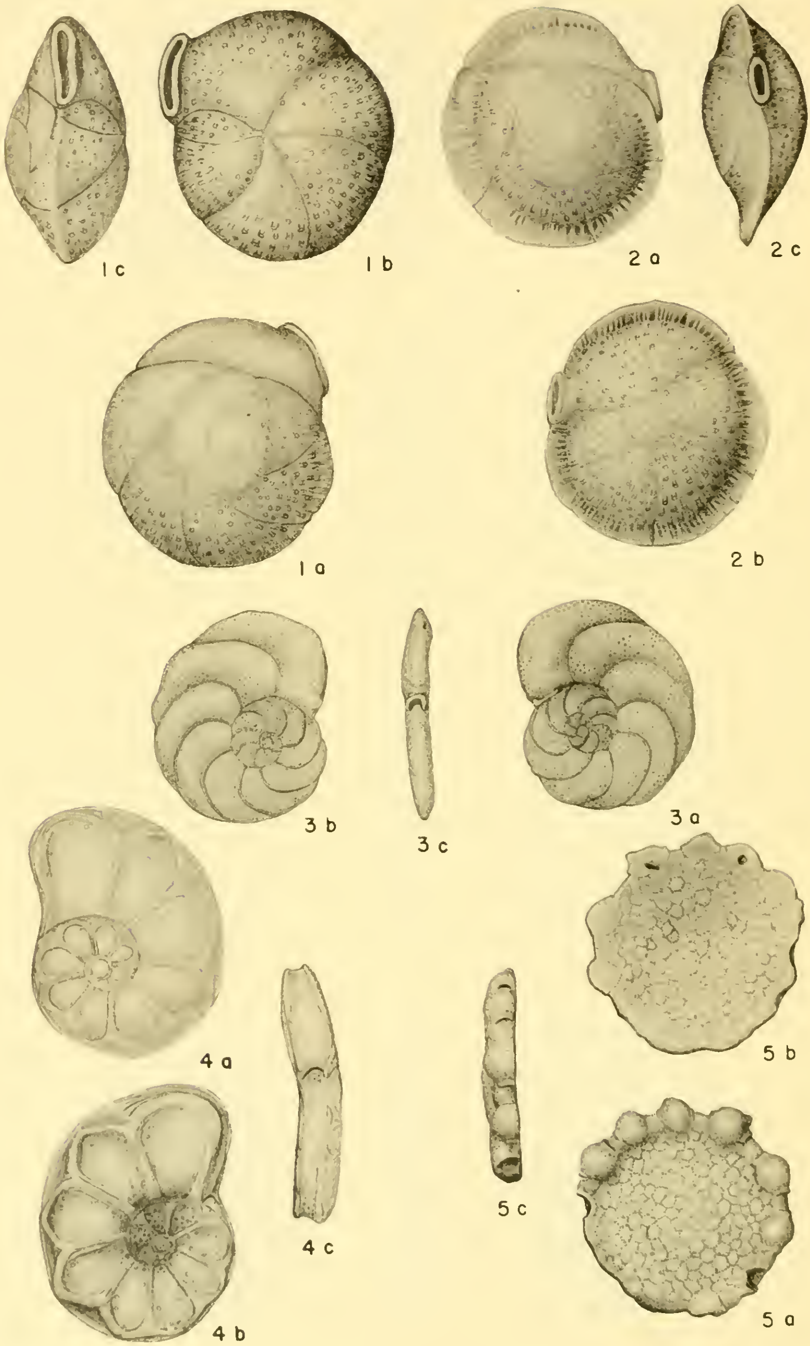

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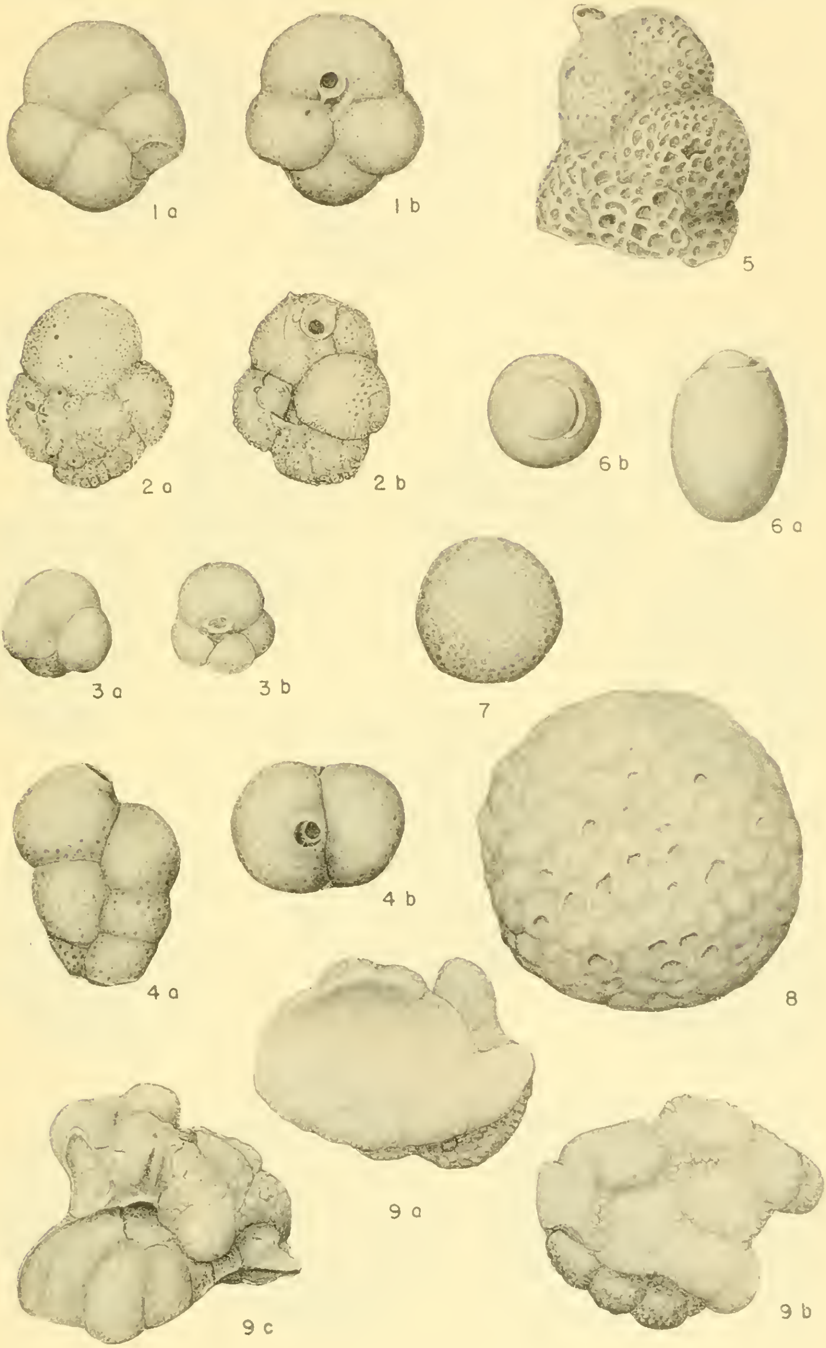

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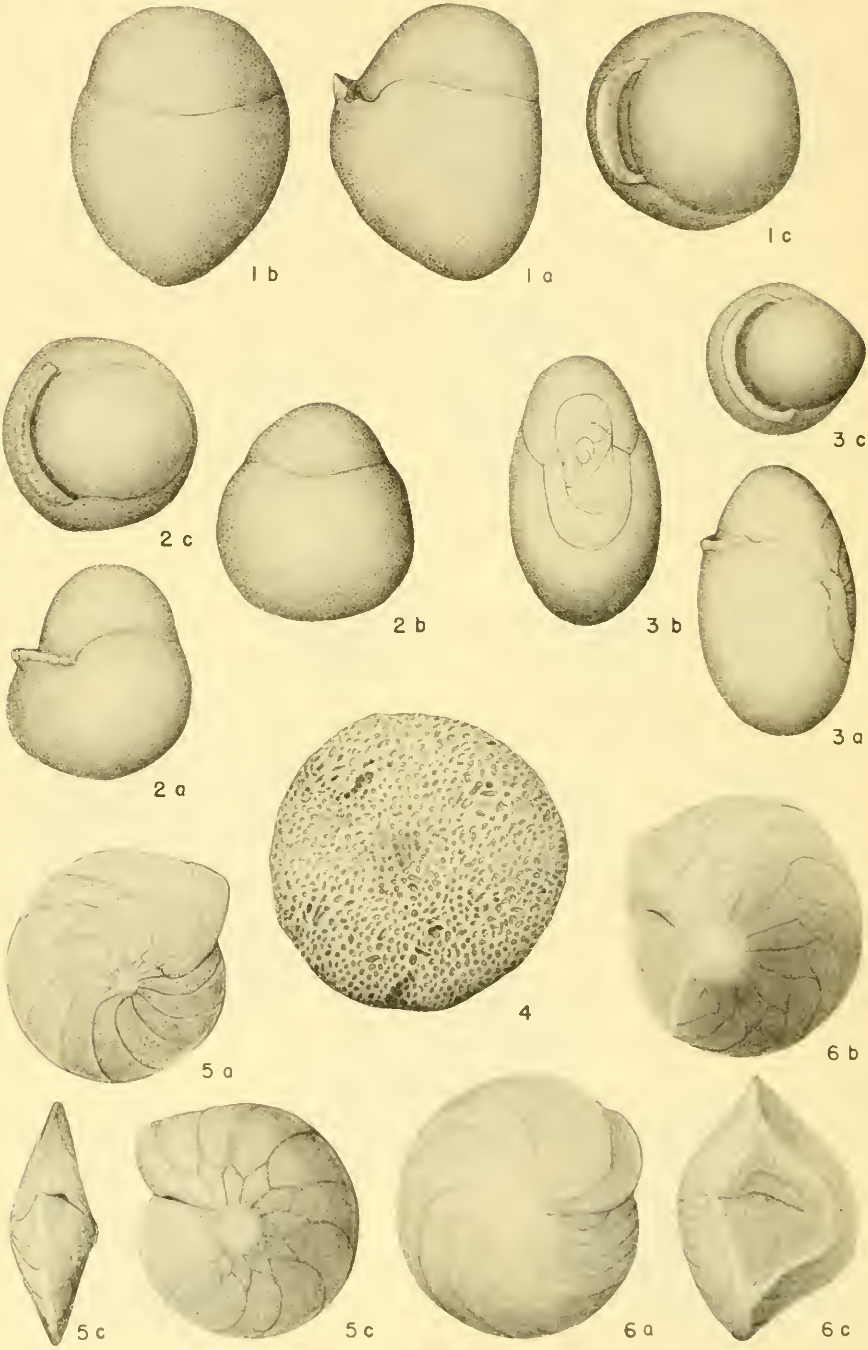

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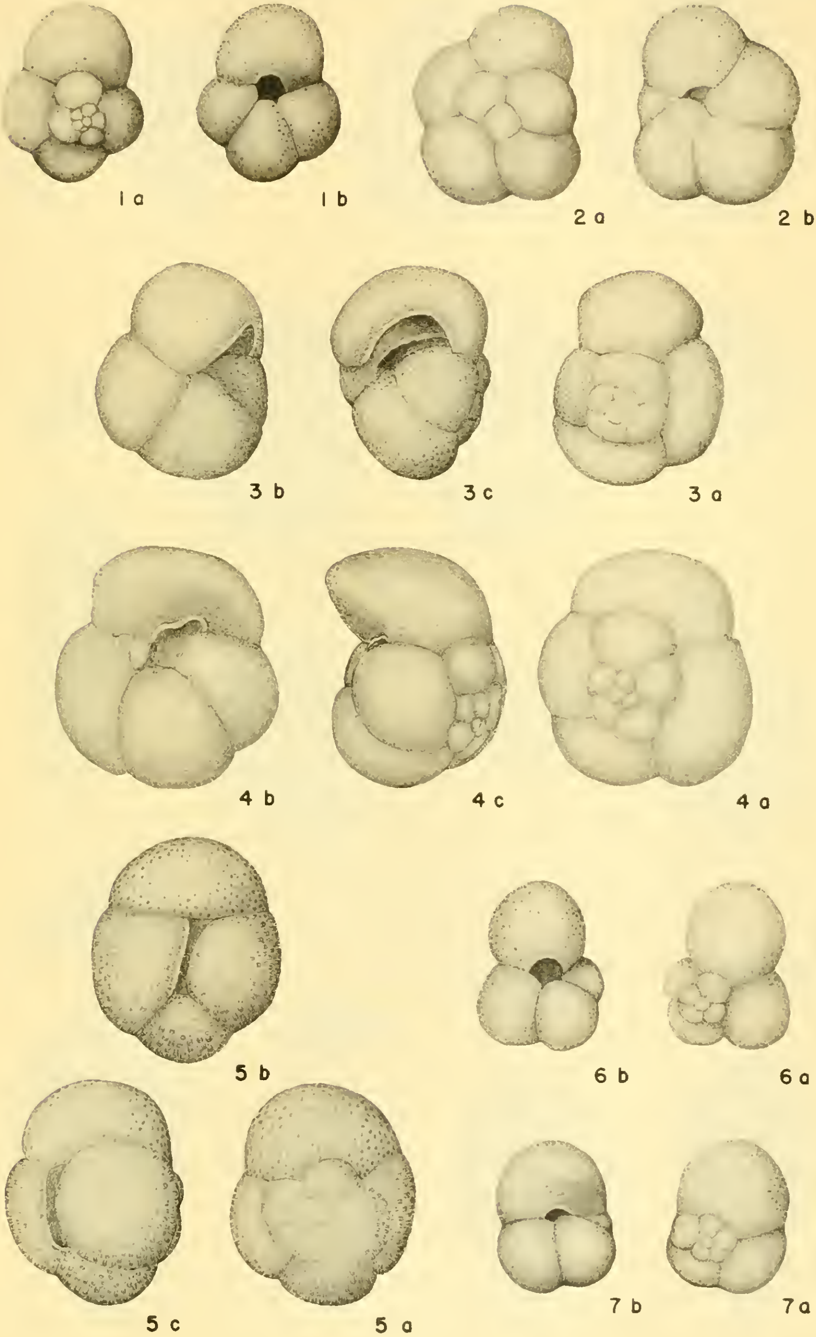

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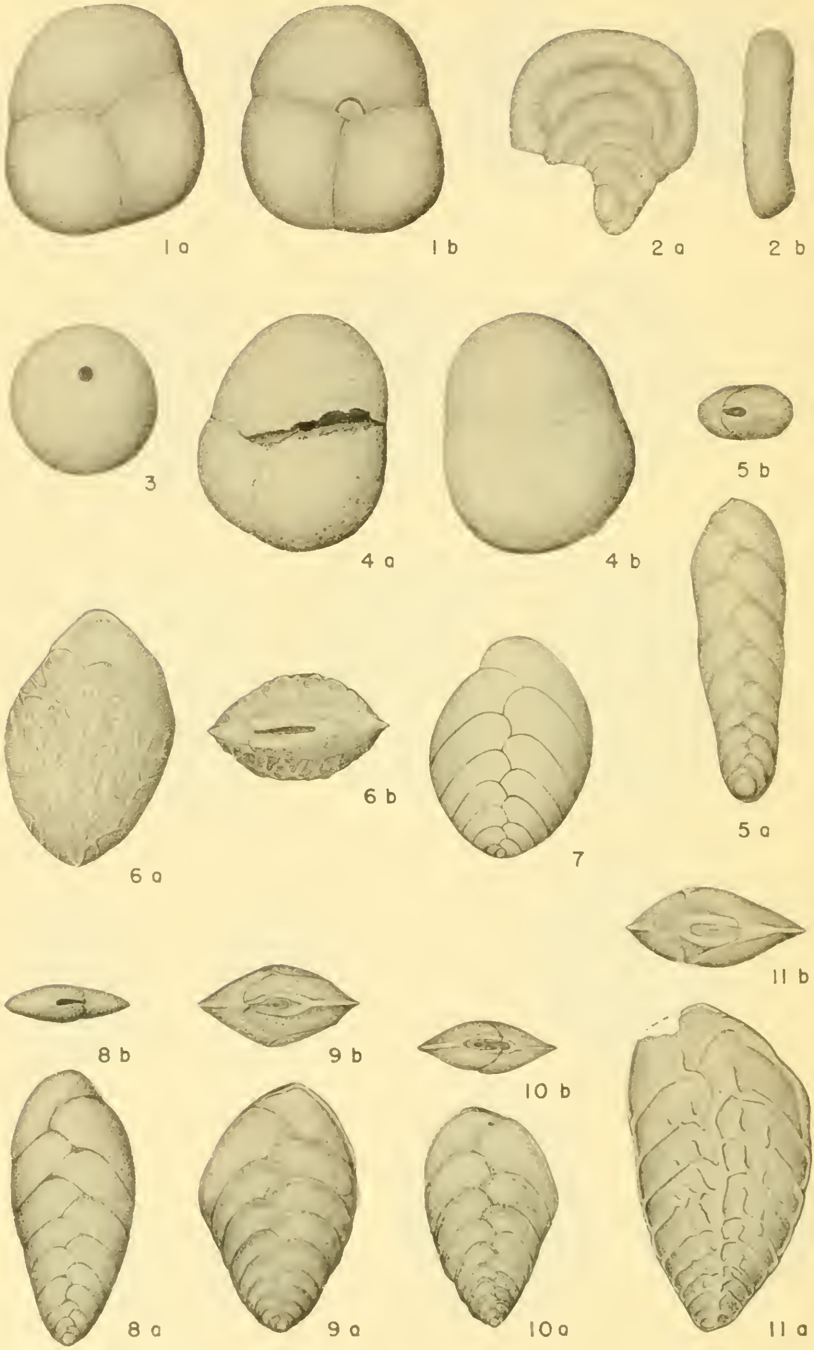

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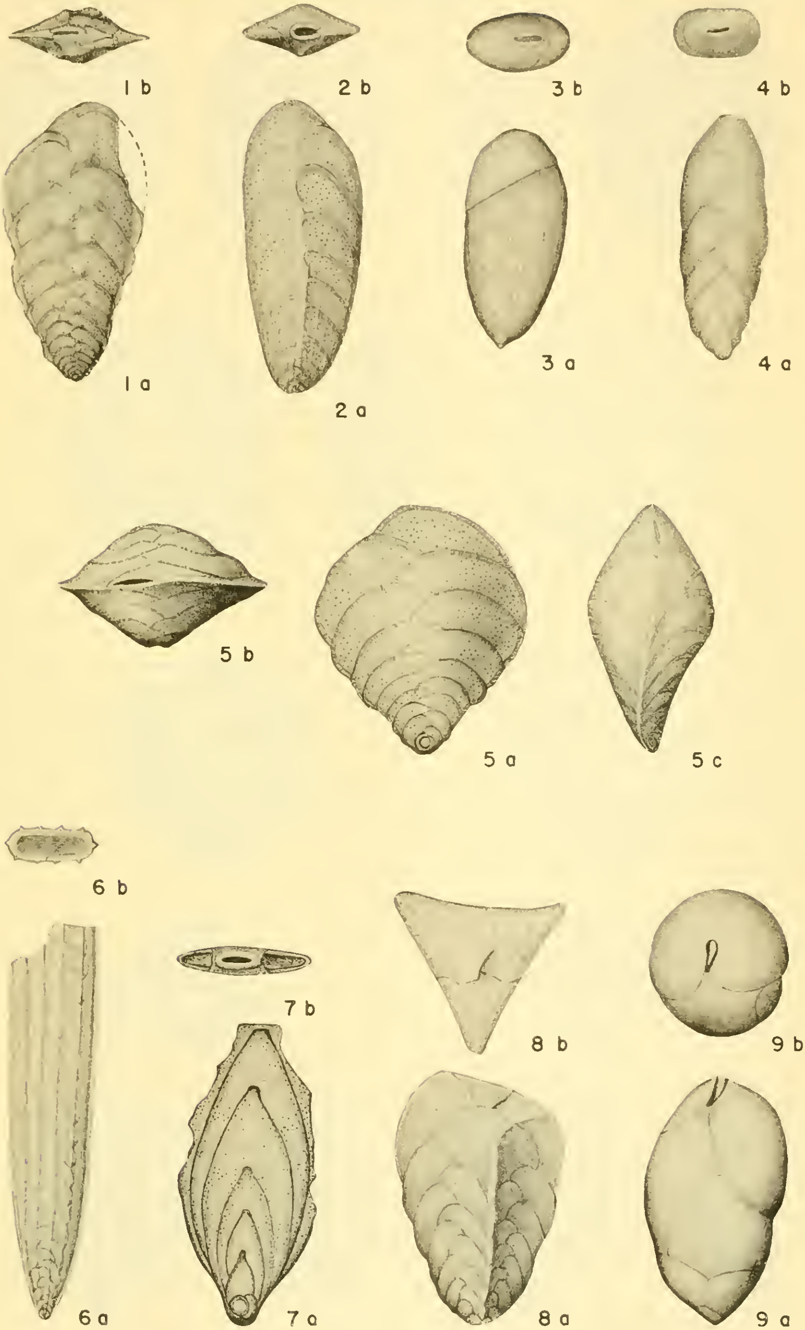

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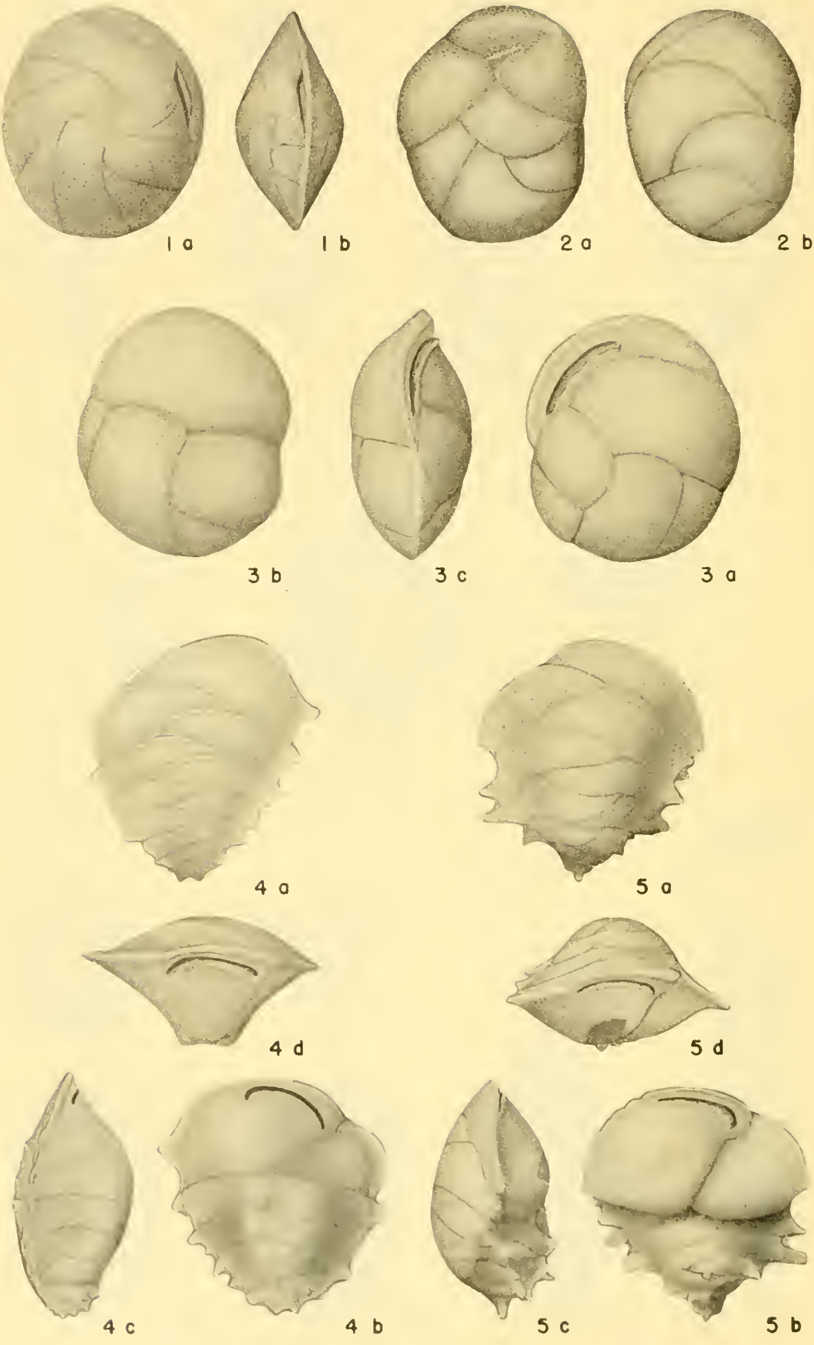

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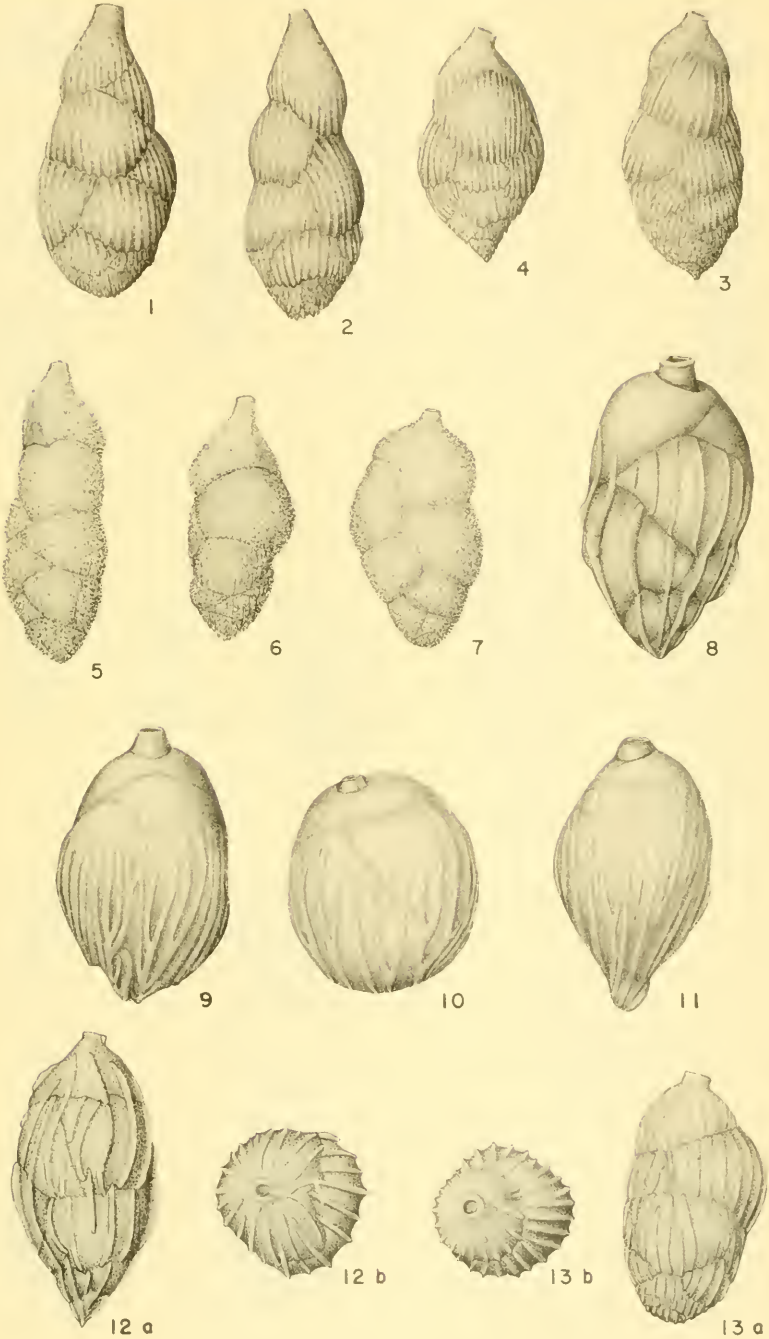

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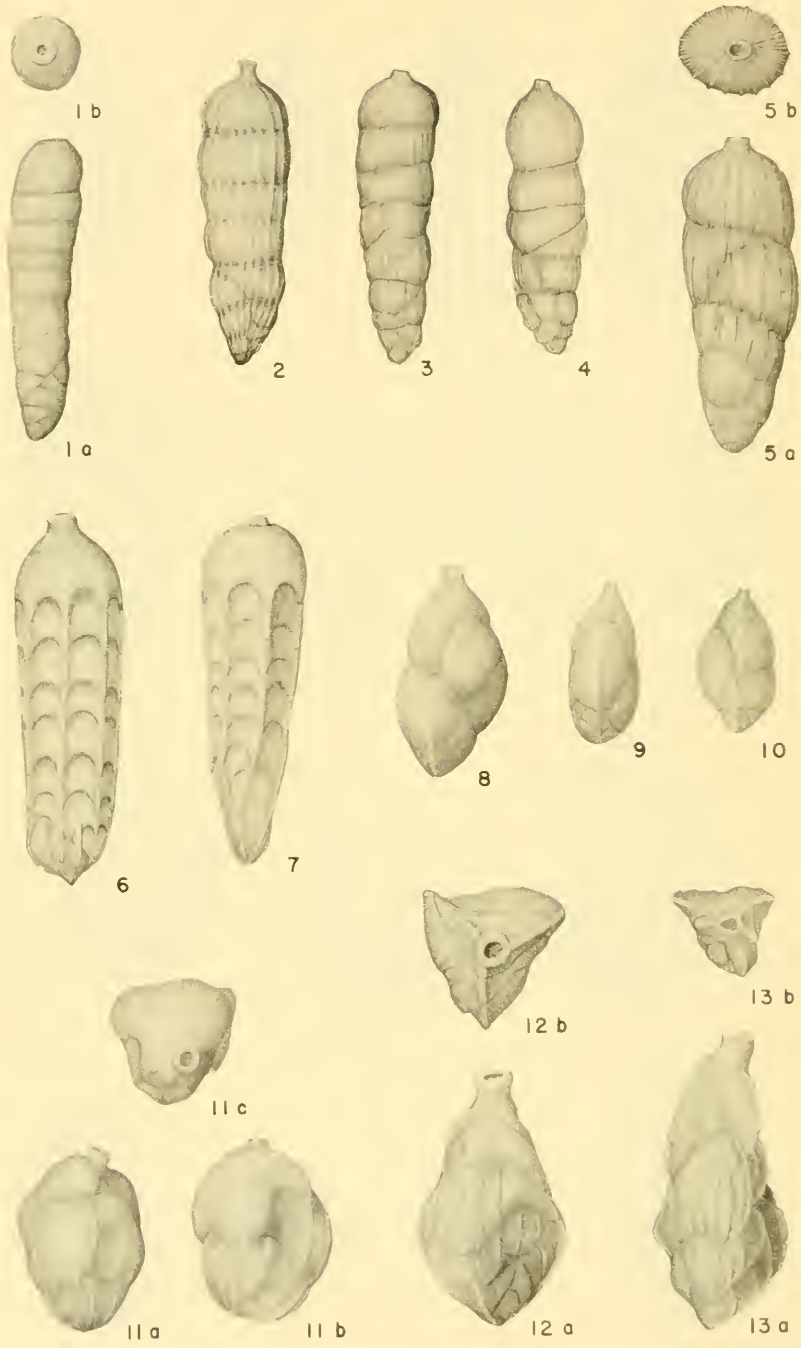

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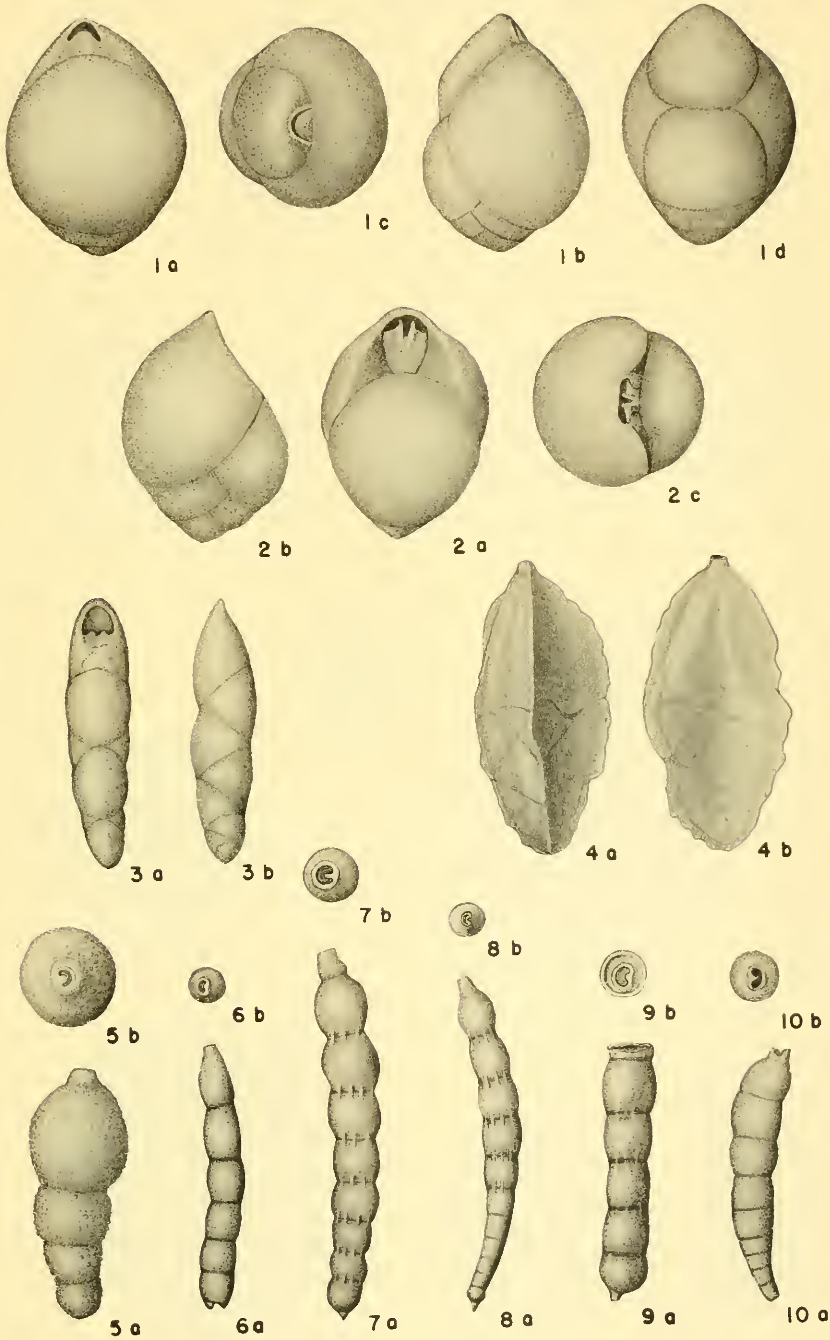

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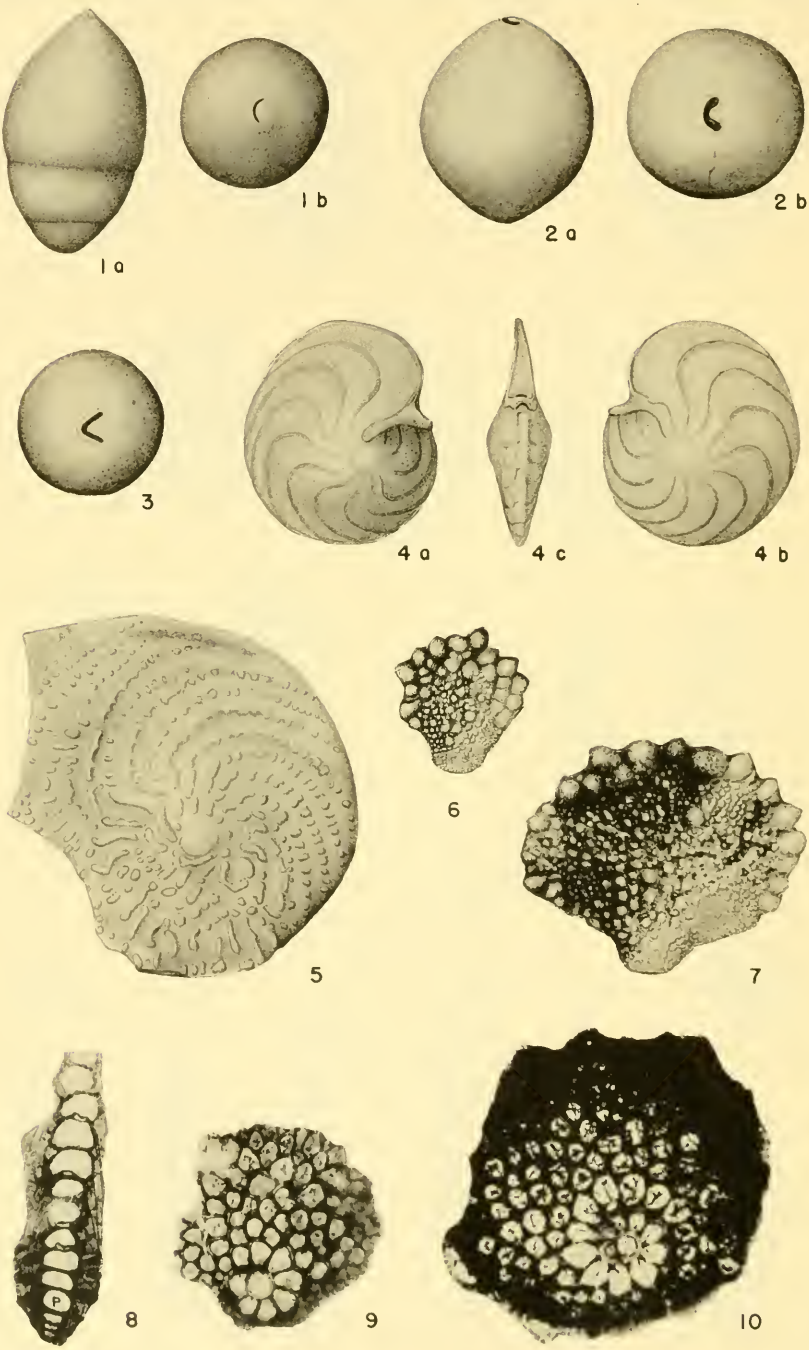

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