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## Contributions to the Paleontology of Northern Peru: The Cretaceous of the Amotape Region

By

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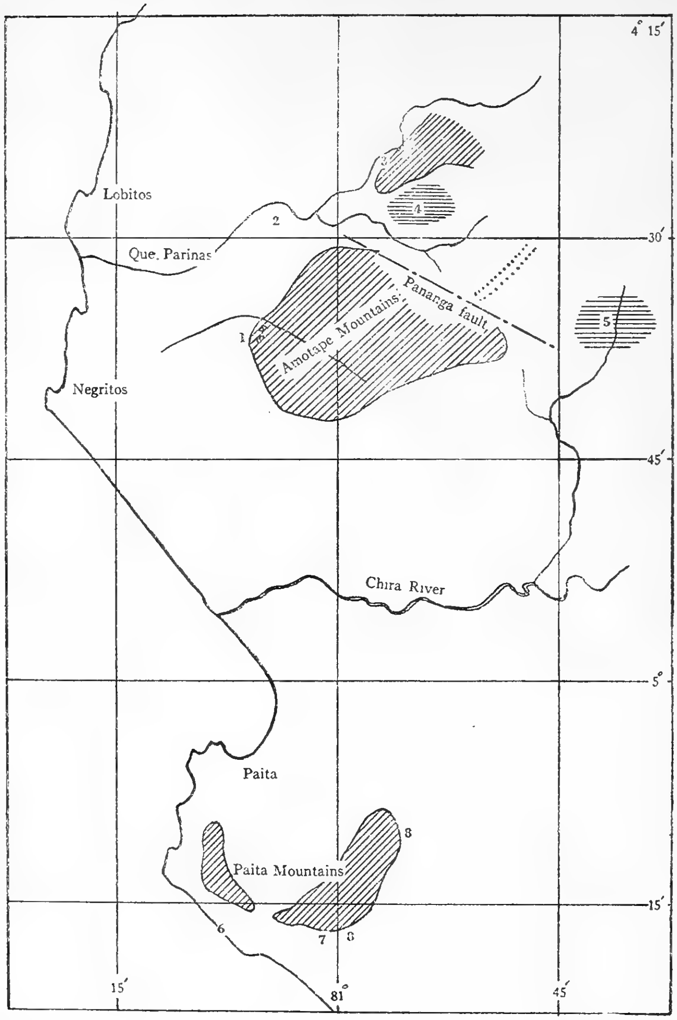


Fig. 1. Sketch map of a part of the Paita and Amotape region of northern Peru, showing the approximate location of outcrops of Cretaceous rocks.

Loc. 1. *Pan de Azucar near La Brea.* 4° 36′*S. Lat.*, 81° 6′ 30″ *W. Long.*
 ″ 2. *Quebrada Monte Grande and vicinity.* 4° 28′ 30″*S. Lat.* 81° 4′*W. Long.*
 ″ 3. *Quebrada Muerto, Upper Parinas*
 ″ 4. *Region of Quebrada Pazuil, north of the Pananga fault*
 ″ 5. *Region of Copa Sombrero in upper Quebrada Leonora and Saman.*
 ″ 6. *Playa Tortugas (Gerth)*
 ″ 7. *Actaeonellen-Hippurtenkalkstein of Gerth*
 ″ 8. *Sphenodiscus Schichten of Gerth*

*Diagonally lined areas show the outcrop of mountain rocks consisting of granite and Upper Pennsylvanian slates and other metamorphics.*

CONTENTS

## INTRODUCTION

Of the sedimentary rocks which take part in the building of the Peruvian Andes, particularly of the central and western Cordillera, those of Cretaceous age have the most important development. This fact was first made known by Humboldt[1] who in 1802 with his two companions, Bonpland and Montufar, travelled extensively through the Andean region of southern Ecuador and northern Peru. The account of this journey which resulted in so many important scientific discoveries, is a classic in the annals of South American Geology and the part dealing with Humboldt's observations on the Cretaceous region of northern Peru is here quoted. "We remained for seventeen days in the hot valley of the Upper Maranon or Amazons. In order to pass from thence to the shores of the Pacific, the Andes have to be crossed at the point where, between Micuipampa and Caxamarca (in 6° 57' S. Lat. and 78° 34' W. Long. from Greenwich), they are intersected according to my observations, by the magnetic equator. Ascending to still higher elevation among the mountains, the celebrated silver mines of Chota are reached, and from thence with few interruptions the route descends until the low ground of Peru are gained; passing intermediately over the ancient Caxamarca, where 316 years ago the most sanguinary drama in the annals of the Spanish Conquista took place, and also over Aroma and Gangamarca. Here, as almost everywhere in the Chain of the Andes and in the Mexican mountains, the most elevated parts are picturesquely marked by tower-like outbreaks of porphyry (often columnar) and trachyte. Masses of this kind give to the crest of the mountains sometimes a cliff-like and precipitous, and sometimes a dome-shaped character. They have here broken through calcareous rocks, which, both on this and on the northern side of the equator, are largely developed; and which, according to Leopold von Buch's researches, belong to the Cretaceous group. Between Guambos and Montan, 12000 French (12,790 English) feet above the sea, we found marine

[1] Humboldt, 1808, Ansichten der Natur. English translation by Mrs. Sabin as Aspects of Nature in different lands and different climates: The Plateau of Caxamarca the ancient capital of the Inca Atahuallpa and The first view of the Pacific Ocean from the crest of the Andes: pp. 281-283.

fossils, (Ammonites nearly fifteen English inches in diameter, the large *Pecten alatus,* oyster shells, Echini, Isocardias, and *Exogyra polygona*). A species of Cidaris, which according to Leopold von Buch, cannot be distinguished from that which Brongniart found in the lower part of the chalk series at the Perte du Rhone, was collected by us, both at Tomependa in the basin of the Amazon and at Micuipampa,—stations of which the elevations differ 9900 (1055°) English feet. - - - - Abrich's excellent observations in the Caucasus would thus appear to have confirmed in the most brilliant manner, Leopold von Buch's geological views on the mountain development of the cretaceous group." The fossils collected along this route together with some others obtained in Colombia, were the first fossil remains brought from South America to Europe but it remained until 1839 before they were described and figured by von Buch. Von Buch considered the entire collection as Cretaceous but *Pecten alatus* is now known to be a Lower Jurassic species.

The field studies of D'Orbigny[2] and Forbes[3] deal principally with the geology of southern Peru, Chile and Bolivia but D'Orbigny likewise described a number of Cretaceous fossils from Colombia, collected by Boussingault, some of which also occur in northern Peru. While serving as Geologist on the Wilkes Expedition, Professor Dana[4] had the opportunity to collect a few fossils from the Lower Cretaceous beds exposed in the cliffs of San Lorenzo island near Callao. These included a *Turbo, Trigonia Lorentii* and *Nautilus tenui-planatus.* The cast of an Ammonite (*A. Pickeringi* Dana) was obtained by Dr. Pickering near the head of the Chancay valley at an elevation of 15,000 feet. These fossils together with two, unnamed forms from Trujilla (a large oyster which is probably *Ostrea Nicaisei* and an Ammonite) were described in the appendix to Dana's monumental work on Geology, forming volume 10 of the Wilkes Exploration.

[2]D'Orbigny, 1842, Voyage dans l'Amérique méridionale. 3. Géologie pp. 1-289, vol. 4, Paleontologie pp. 1-188.

[3]Forbes, 1861, Reports on the Geology of South America, Pt. 1. Bolivia and southern Peru. Quart. Jour. Geol. Soc., vol. 17, pp. 1-84.

[4]Dana, 1849, Geology of the United States exploring expedition under the command of Ch. Wilkes during 1838-1842, Geology, vol. 10, pp. 1-756, 21 pls.

To this period also belongs the work of Dr. Antonio Raimondi covering a space of nearly 50 years of systematic research on the geography and topography of Peru. Raimondi made important observations on geology, incorporating most of this information on his maps and he apparently used the fossils he collected as a guide in determining the age and distribution of the sedimentary formations. He sent his fossils to Wm. Gabb[5] for description, accompanying them with a letter in which he gave a concise and interesting outline of the geographic distribution of the sedimentary formations in Peru. According to his idea, Cretaceous together with Jurassic and Triassic rocks are principally distributed in the Western Cordillera while the Eastern Cordillera is of greater age and composed mainly of schists and older rocks.

The collection obtained by Raimondi was described and figured in 1877 by Wm. Gabb[6]. Gabb seldom ventured an opinion on the age of the scattered collections and in most cases he simply stated the age of the beds according to the opinion of Raimondi.

It is principally through the research of Steinmann and his associates that we owe most of our general knowledge of the geology of the Andean region, these studies being embodied in a series of papers entitled, *Beiträge zur Geologie und Paleontologie von Südamerika.* Steinmann's[7] first paper appeared in 1881 and dealt with the description of a collection of fossils from the so-called coal-bearing formation of Pariatambo. They were determined as indicating an Albian age while Gabb had previously considered this horizon as Liassic. These faunas were further studied by Gerhardt[8] (1897) and by Schlagintweit[9] (1911) and

[5]Gabb, 1867, Letter from Sr. Don Antonio Raimondi, of Lima, Peru to Wm. Gabb. Proc. Calif. Acad. Sci., vol. 3, pp. 359-360.

[6]Gabb. 1877, Description of a collection of fossils, made by Dr. Antonio Raimondi of Peru. Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. 8, pp. 262-336, pls. 35-43.

[7]Steinmann, 1881, Über Tithon und Kreide in den peruanischen Anden. N. Jahrb. Min. etc., vol. 2, pp. 130-153, pls. 6-8.

[8]Gerhardt, 1897, Beitrag zur Kenntnis der Kreideformation in Venezuela und Peru. Beitr. z. Geol. u. Pal. v. Südamerika, N. Jahrb. Min. etc. BB. BB. vol. 11, pp. 65-117, 2 pls.

[9]Schlagintweit, 1911, Die Fauna des Vracon und Cenoman in Peru, op. cit., vol. 33, pp. 43-135, pls. 5-7.

Sommermeir[10] (1910, 1913). Schlagintweit proved the extensive distribution of the black shales and bituminous limestones of the Pariatambo horizon in the Andean region of northern South America. As this fauna seemed to show both Upper Albian and Lower Cenomanian affinities, it was referred to the Vranconnian stage of Renevier. Schlaginwelt insisted on the dissimilarity of the Chilian-Argentine Cretaceous fauna from that of northern Peru, arguing that the two regions had been separated by a transverse land mass. He also showed that the Middle Cretaceous or Cenomanian sea was principally regressive in the Peruvian region. Sommermeier papers which appeared in two parts, added further to our knowledge of the Albian fauna in Peru as well as of the underlying limestones characterized by *Knemiceras* and certain other species common to the Upper Aptian of Europe. The above papers which dealt principally with the paleontology of the Apt-Gault complex were supplemented by other contributions of the same series, such as the studies of Neumann[11], Brüggen[12], Paulcke[13] and Fritze[14] which extended our knowledge to the Lower and Upper Cretaceous measures.

Other collections of Cretaceous fossils, principally from the Trujillo region have been described by Lüthy[15], Douville[16] and Basse[17]. Drs. Bravo and Lisson of Lima, have contributed several papers with description and illustration of Cretaceous species while Lisson's[18] Checklist is a storehouse of valuable data

[10]Sommereier, 1910, Die Fauna des Aptien und Albien im nordlichen Peru, op. cit., vol. 30, pp. 313-382, Pls. 7-15: also 1913, op. cit., vol. 36, p. 370-412, pls. 14-15.

[11]Neumann, 1907, Beitrag zur Kenntnis der Kreideformation in Mittel-Peru, op. cit., vol. 24, pp. 69-132, pls. 1-5.

[12]Brüggen, 1910, Die Fauna des unteren Senons von Nord-Peru, op. cit., vol. 30, pp. 717-788, pls. 25-29.

[13]Paulcke, 1903, Über die Kreideformation in Südamerika und deren Beziehingen zu andered Gebieten, op. cit., vol. 17, pp. 252-312, pls. 15-17.

[14]Fritzsche, 1923, Neue Kreidefaunen aus Südamerika, op. cit., vol. 50, pp. 1-56, 313-334, pls. 1-4.

[15]Lüthy, 1918, Beitrag zur Geologie und Palaentologie von Peru, Abhandlungen der Schweizerischen palaeontologischen Gesellschaft vol. 43.

[16]Douville, 1906, Sur des Ammonites du Crétacé Sud-Americain. Annales de la Société Royale zoologique et malacologique de Belgique. vol. 41, pp. 142-155, pls. 1-4.

[17]Basse, 1928, Quelques Invertébres crétacés de la Cordillère andine, Bull. Soc. Geol. France, 4th series, vol. 28, pp. 113-147, pls. 7, 8.

[18]Lisson, 1917, Edad de los Fosiles Peruanos y Distribucion de sus Depositos, 2nd Eddition.

on the regional and stratigraphic occurrence of Peruvial fossils. The most recent contribution is that of Gerth[19], describing a small collection of Cretaceous fossils from the Paita region. As the Paita mountains are geologically related to the Amotapes, the work of Gerth will be considered at greater length elsewhere in this paper.

In addition to the above papers which are principally paleontological in character, regional studies by the geologists of the Peruvian Bureau of Mines have made known the character and areal distribution of the Cretaceous formations in many parts of Peru. Sievers[20], during his reconnaissance in northern Peru, in part re-examined the geology along the route travelled by Humboldt while Stappenbeck's[21] work in the Chicama district is a study of a critical region which has a most important bearing on the structure of the Western Cordillera and the geology of the Andean geosyncline in northern Peru.

The Peruvian Cretaceous attains its most complete development in the Andes of northern and central Peru or in the region extending from Cajatambo or Cerro de Pasco to Cajamarca. The continuation of these formations northward into southern Ecuador is still poorly known, our geologic knowledge of this region being principally limited to the line of traverse made by Sievers from Chiclayo througth Ayabaca to Loja. In the Tertiary region of northwestern Peru extending from about 7 degrees South Latitude to the Ecuadorian border near Tumbez at 3° 30' South Latitude and west of the 80 degree of Longitude, outcroppings of Cretaceous rocks resting on a floor of Pennsylvanian metamorphics (the Amotape slate) and granites have been observed at several localities and they probably lie buried beneath the coastal Tertiaries over a large area. Their exposures are usually small and represent merely erosional remnants around the margins of the Amotape and Paita mountains. Somewhat larger areas have been found in parts of Quebrada Parinas,

[19]Gerth, 1928, Neue Faunen der oberen Kreide mit Hippuriten aus Nord-Peru, Leidsche Geologische Mededeelingen, Deel 2, Afl. 4 V 1928, pp. 231-241, 4 figures.

[20]Sievers, 1914, Reise in Peru und Ecuador, ausgefuhrt 1909, Leipzig.

[21]Stappenbeck, 1929, Geologie des Chicamatals in Nordperu und seiner Antracitlagerstäten, Geologische und Palaeontologische Abhandlungen, Neue Folge, Band 16, Heft. 4.

Pazuil and the Chira river valleys while large masses of Cretaceous limestones occur in a rubble zone or mud-flow in the Eocene rocks of Quebrada Culebra near Caleto Mero. Boulders of Cretaceous limestone containing *Inoceramus* have also been observed in the Eocene conglomerates which form the Chanduy hills on the Santa Elema peninsula of Ecuador.

Bosworth[22] in his Geology of Northwest Peru, gives only a very brief mention of the pre-Tertiary formations. He referred two groups of rocks to the Mesozoic, the Pananga limestones to the Cretaceous and a Tablones group questionably considered as Jurassic. Pananga is the name of a small settlement or hacienda situated near the divide between Quebrada Pazuil and Quebrada Leonora on the trail leading from Muerto to Sullana. This region is crossed by a large Northwest-Southeast trending fault system (the Pananga fault) along which a large area of Cretaceous rocks have been downfaulted on the north side while the higher mountains on the south side are composed of slates and granite. The Pananga limestone is described as a member of which one portion is a hard limestone made up mainly of a large cypraea or similar shell (*Actaeonella* and *Peruvia*) two or three inches long, accompanied by some other gasteropods, lamellibranchs and ammonites. The rocks to which Bosworth gave the name of the Tablones group is not definitely known. The Tablones ridge forms the watershed between Quebrada Pazuil and Rio Chira but the geology of this region is not known.

Dr. J. Bravo[23] during a visit to northern Peru in 1921, collected a few Pennsylvanian and Cretaceous fossils from the rocks exposed along Quebrada Muerto in the upper part of the Parinas valley. Bravo made special mention of the physical and faunal resemblance of these rocks with those of the Cretaceous deposits of the south but his stratigraphic section is incorrect as he shows the light colored limestone with *Actaeonella* as lying above the black shales and limestones with *Inoceramus*. This interpretation is the opposite of the true condition as the *Actaeonella* and *Nerinea* limestones are the older and are overlain by bituminous

[22]Bosworth, 1922, Geology of the Tertiary and Quaternary periods in the North-West part of Peru, pp. 147, 151.

[23]Bravo, 1921, Reconocimiento de la regíon costanera de los Departamentos de Tumbes y Piura. Archivos de la Associacion Peruana por el Progreso de la Ciencia, Lima. vol. 1.

limestone and black shales. Dr. Bravo was doubtless misled by the faulted character of the rocks and in part by confusing certain dark-colored Pennsylvanian slates with the younger Cretaceous shales. The fossils collected by Bravo were submitted to Steinmann who noted them in his Geologie von Perú and they were later more fully studied by Gerth.

In connection with our geological studies devoted principally to the investigation of the Tertiary formations of northern Peru, some opportunities were also found for the examination of the older rocks. A brief statement of results of these studies, was presented in a paper by Iddings and Olsson[24] in 1928, in which the Cretaceous rocks were divided into three groups or formations. Further studies have shown the need of a slight revision of this section and the addition of a black shale formation lying directly beneath the Monte Grande formation and separated from the Copa Sombrero shales by a middle series of hard sandstones and conglomerates.

In 1928, there appeared an important paper by H. Gerth[25] of the Leyden Museum on some Cretaceous fossils collected by the geologists of the Bataafsche Petroleum Company in the Amotape and Paita regions. The localities near Paita are found principally on the southern and eastern slopes of the Silla de Paita, an isolated group of slate and granite mountains which rise above the barren tablazo plain of the Sechura desert. These outcrops are not personally known to me and since their fauna has not been fully described or figured, some uncertainty exists as to their correlation with the Cretaceous section of the Amotape region. Gerth recognized three groups. Localities 1 and 3 have an unmistakable Upper Cretaceous fauna and should be correlated with the Monte Grande group but may be a little older than the typical Monte Grande sandstones and conglomerates. The age of the Actaeonellen-Rudistoid limestone of Locality 2 is more uncertain. Gerth considers this fauna as Upper Cretaceous principally from the evidence of the Rudistid *Pironaea* but if

[24] Iddings and Olsson, 1928, Geology of Northwest Peru, Bull. Am. Ass. Petroleum Geologist, vol. 12, No. 1, pp. 8, 9.

[25] Gerth, 1928, Neue Faunen der oberen Kreide mit Hippuriten aus Nord-Peru, Leidsche Geologische Medeelingen, Deel 2, Afl. 4, V 1928, pp. 231-241.

*Actaeonella* (*Volvulina*) cf. *laevis* should prove to be the same as the common species in the Pananga limestone (*A. peruviana* n. sp.) a Lower Cretaceous age would be indicated. Gerth's grouping of the Cretaceous of Paita is as follows:

1. Graue Sandsteine und konglomeratische Breccien der Playa Tortugas. Playa Tortugas is a small fishing port on the southwest side of the Silla de Paita and approximately 22 kilometers nearly due south of Paita. The deposit is described as being formed of broken down older rocks derived from the Silla de Paita after the removal of the cementing material. The fauna is characterized by large, thick-shelled bivalves, the following species being recorded.

*Trigonia crenulata* var. *peruana* Paulcke
*Boudaireia Drui* Munier Chalmas
*Cyprina* aff. *Ligeriensis* d'Orbigny
*Cucullaea* (*Trigonarca*) aff. *Matheroniana* d'Orbigny
*Alectryonia* sp.
*Turritella* sp.
*Glauconia* (*Pseudoglauconia*) sp.
*Ammonites* sp.

This is probably an Upper Cretaceous fauna but apparently older than that of the Monte Grande formation.

2. Actaeonellen-Rudistenkalkstein

A brown-colored coarse, sandy limestone which is filled with the following fossils.

*Actaeonella* (*Volvulina*) cf. *laevis* d'Orbigny ? *A. peruviana* n. sp.
*Cardita* sp.
*Pironaea peruviana* Gerth

These fossils are from three nearby stations on the south side of the Silla de Paita. Gerth considered this fauna as of Maestrichtian age and probably equivalent to the *Sphenodiscus* schichten of No. 3.

3. Sphenodiscus-Schichten

A yellowish-brown, fossiliferous, marly limestone which occurs like the Actaeonellen-Rudistenkalkstein as small erosional remnants on the south and east side of the Silla de Paita. The fossils have suffered through weathering and long exposure to the desert winds. This fauna is referred to the Maestrichtian by Gerth.

*Sphenodiscus pleurisepta* Conrad var. *peruviana* Gerth

*Roudaireia* sp.
*Trigonia* sp. nov.
*Cuculaea* sp. nov.
*Inoceramus* cf. *balticus* J. Bohm (*Cripsii* Goldf.)
*Modiola concentrice-costellata* F. Rom.
*Ostrea* sp.
*Plicatula* sp.
*Neara* sp.
*Astarte* sp.
*Turritella* sp. several new species.
*Cerithium* cf. *Hoeninghausi* Kfst
*Melanatria* sp.
*Volutilithes* cf. *Arizpensis* Boese

## STRATIGRAPHY

A general subdivision of the Cretaceous deposits of the Amotape region into three parts was proposed by Iddings and Olsson[26] in 1928, the formations recognized being the following:

Monte Grande formation.
Copa Sombrero formation.
Pananga formation.

These divisions consist briefly of a massive and rather pure limestone member at the base (Pananga formation), followed by a series of bituminous, calcareous beds passing upward into black shales (the Copa Sombrero formation) and thirdly a younger group of coarse sandstones and conglomerates with a late Cretaceous fauna (Monte Grande formation). Along Quebrada Monte Grande, the black shales with *Inoceramus* and *Clavulina* which lie directly beneath the Monte Grande formation, are downfaulted against an older group of conglomerates and quartzitic sandstones. Since the Monte Grande formation appears to be Maestrichtian in age, the *Clavulina* shales are probably not older than the Campanian. On the other hand, the Copa Sombrero shales of Quebrada Muerto and Quebrada Pazuil as they lie directly over limestones which contain Upper Aptian and Albian fossils cannot be much younger than the Middle Cretaceous or Cenomanian. Thus it would appear that we have in the Amotape region of northern Peru, the whole or greater part of the Cretaceous system between the Upper Aptian and the Maestrichtian and that the older conglomerates of Monte Grande form a middle member separating two formations consisting

[26]Iddings and Olsson, 1928, Geology of Northwest Peru, Bull. Am. Ass. Petroleum Geologist, vol. 12, No. 1, pp. 8, 9.

principally of black shales. On stratigraphic grounds, the older conglomerates of Monte Grande are tentatively referred to the Cenomanian-Turonian and indicate the regressive character of the Middle Cretaceous sea in this part of the Andean geosyncline.

## THE PANANGA FORMATION

Bosworth in his description of the pre-Tertiary formations of the Amotape Mountains north of Cerro Buenos Aires and the Pananga fault zone referred briefly to a limy member in the Cretaceous as the Pananga limestone. As previously noted, this horizon was described as a hard limestone of which one portion is made up mainly of a large *Cypraea* or similar shell, accompanied by some other gastropods, lamellibranchs and ammonites. The fossil referred to as *Cypraea* is doubtless an *Actaeonella* or *Peruvia* and together with the highly fossiliferous character of the formation, clearly identifies the Pananga limestone of Bosworth with the lower or basal Cretaceous horizon of Pan de Azucar and Quebrada Muerto. In this paper, the Pananga formation will be restricted to include only the lower limestone horizon characterized faunally by *Actaeonella peruviana, Peruvia gerthi, Nerinea* (*Teleoptyxis*) *peruviana* and *Oxytropidoceras parinense.*

The Pananga limestone is seen to good advantage near La Brea capping the small hill known as Pan de Azucar. Here the formation has a thickness of about 50 feet and rest on the Amotape slates of Upper Pennsylvanian age. A much larger area of the Pananga limestone occurs at Muerto in the Upper Parinas valley and in parts of the valley of Quebrada Pazuil. Large blocks of the Pananga limestone are found in Quebrada Culebra near Caleto Mero where they occur as detached, angular masses in a mud-flow or rubble zone in the Saman Eocene.

The Pananga limestone is very constant in lithology. It is a massive, hard and nearly pure limestone, usually light-gray in color and often highly fossiliferous. In most cases because of the hardness of the rock, extraction of fossils from the outcrop is difficult but the characteristic sections of *Actaeonella* and *Nerinea* are usually abundant and easily recognized. Towards the base, the rock becomes a calcareous sandstone or conglomerate containing boulders of slate, quartzite and other mountain rocks.

Fossils are locally common in the Pananga limestone, the forms collected indicating a rich and diversified fauna. However, most specimens weather or break from the rock in the form of casts or internal molds and exact identification is not always possible. The following species is a partial list of forms collected at Pan de Azucar.

Pelecypoda:
- *Cucullaea* sp.
- *Trigonarca gerhardti* Olsson
- *Trigonia longa* Agassiz
- *Trigonia subcrenulata peruana* Paulcke
- *Trigonia hondaana* Lea
- *Neithea* cf. *alpina* d'Orbigny
- *Lima* (*Plagiostoma*) *pananga* Olsson
- *Modiolus mutisus* Olsson
- *Myopholas peruvian* Olsson
- *Anatina anchana* Olsson
- *Arctica* sp.
- *Astarte debilidens* Gerhardt
- *Crassatella caudata* Gabb
- *Cardium* sp.
- *Protocardium* sp.
- *Isocardia wiedeyi* Olsson
- *Isocardia pananga* Olsson
- *Ptychomya lissoni* Sommerier
- *Icanotia peruviana* Olsson
- *Mactra* sp.
- *Panope berryi* Olsson
- *Corbula* sp.

Gastropoda:
- *Glauconia* (*Paraglauconia*) *pananga* Olsson
- *Nerinea* (*Teleoptyxis*) *peruviana* Olsson
- *Peruvia gerthi* Olsson
- *Actaeonella* (*Volvulina*) *peruviana* Olsson
- *Turbo* sp.
- Several undetermined species.

Cephalopoda:
- *Placenticeras* sp.
- *Puzosia emerici* Rasp.
- *Schloenbachia* ? sp.
- *Oxytropidoceras parinensis* Olsson
- *Oxytropidoceras karsteni* Stieler

Echinodermata:
- *Holectypus planatus numismalis* Gabb

## THE COPA SOMBRERO FORMATION

At Muerto and along the mountain front bordering the north side of the Pazuil valley, the massive, bedded and highly fossiliferous Pananga limestones are overlain by black, well-bedded limestone layers which in turn grade upward into black shales. Although these rocks are fossiliferous, most of the species are different from those of the Pananga limestone. *Nerinea* and *Actaeonella* are both absent while species of *Exogyra, Inoceramus* and fish-scales are the dominant forms. A species of *Oxytropidoceras* occurs in Muerto limestones together with several other Ammonites.

Dr. Bravo[27] visited Quebrada Muerto in 1921 and published a short paper recording the occurrence of Cretaceous and Pennsylvanian rocks at that locality. In his profile, Bravo showed a shale complex with *Inoceramus* as underlying a limestone with *Actaeonella gigas* and *Agria* cf. *Blumenbachi.* This is quite obviously an error of observation as the limestone underlies and not overlies the Cretaceous black shales. Dr. Bravo probably mistook a part of the Amotape shales of Pennsylvanian age (which are less metamorphosed at this locality than usual) as the same as certain nearby but isolated outcrops of Cretaceous black shales with *Inoceramus.* It may be definitely stated that the *Inoceramus* shales of Muerto overlie the Pananga formation and grade downward into the bituminous limestones.

Black shales with calcareous concretions have an extensive outcrop in the valley of Quebrada Pazuil where they contain layers of sandstone, quartzite and seams of chert. At certain places in this region, the Cretaceous shales are overlain by small remnants of Eocene sandstones belonging to the Saman formation and having the typical Chira valley facies. On the south side of the Tablones range or the divide separating the Parinas and Chira drainage, black Cretaceous shales cover a rather large area and extend from the west branch of Quebrada Leonora, east past Copa Sombrero, Lancones and Alamor into southern Ecuador. These rocks are somewhat harder than the black

[27] Bravo, 1921, Reconocimiento de la regíon costanera de los Departamentos de Tumbes y Piura. Archivos de la Associacion Peruana por el Progreso de la Ciencia, vol. 1.

shales of Pazuil, their greater induration or metamorphism being partly the result of the intrusion of dikes or small plugs of a basic igneous rock. In places the formation is quite sandy or composed to a large extent of contorted and irregular bedded zones of sandstones. Limestone concretions are also present. Because of their intensely fractured condition fossils are difficult to collect and preserve. *Schloenbachia leonora* and a species of *Inoceramus* have been collected in concretions in Quebrada Leonora near Copa Sombrero. To the south, the Copa Sombrero formation is directly overlain by the Saman sandstones of late Upper Eocene age.

## THE CLAVULINA SHALES

The *Clavulina* shales have only been recognized along Quebrada Monte Grande which is a small tributary of Quebrada Parinas midway between Quebrada Mogollon and Quebrada Pazuil. The *Clavulina* shales resemble the shales of the Copa Sombrero formation as well as certain of the darker Talara shales of Upper Eocene age. Locally they contain small foraminifera of the genus *Clavulina,* fragments of *Inoceramus* and other fossils. They are usually badly fractured and break down into small, needle-like splinters.

The *Clavulina* shales are best distinguished by their stratigraphic relations to nearby formations. At some places along Quebrada Monte Grande, the *Clavulina* shales are overlain unconformably by Middle Eocene sandstones belonging to the shore facies of the *Clavilithes* series (see Plate 1, fig. 1) but usually the contacts are faults. Upstream, the outcrop of the *Clavulina* shale is limited by a large normal fault along which they have been downfaulted against an older series of conglomerates and sandstones. In the small branch stream which leads from Triangulation Station 266, a section is exposed which shows the *Clavulina* shales interbedded with green sandstones containing *Roudaireia, Eusebia gregoryi, Pseudoliva, Calytrophorus hopkinsi* and other species of the Monte Grande fauna. The typical, fossiliferous Monte Grande sandstones are exposed higher along the same stream so it is quite clear, that the *Clavulina* shales lie directly beneath the Monte Grande formation.

Note.—Better material proves **Eusebia** a synonym of **Pseudocucullæa.** See p. 23.

## The Monte Grande Formation

The type exposures of the Monte Grande formation have a very limited development in the hills just west of Quebrada Monte Grande surrounding Triangulation Station 266 of the La Brea-Parinas Estate. They are composed principally of yellowish or brownish sandstones and conglomerates. The rocks are usually more conglomeratic above while sandstones predominant in the lower part but the exposures are obscured by the basal conglomerates of the Tertiary and by a thick cover of gravels belonging to the breccia fan. Fossils are abundant both in the sandstones and in the conglomerates but are most easily collected from loose specimens lying on the surface. Usually such specimens are poorly preserved through long exposure to the desert winds and hot, tropical sun. Most of the species belong to thick-shelled forms adapted to life in shallow, near-shore waters. Locally large fragments or nests of Rudistids (Plate 1, fig. 2) may be seen on the outcrop or lying partly embedded in the rock.

The fossils from the Monte Grande formation include the following species.

Pelecypoda:
- *Trigonarca meridionalis* Olsson
- *Eusebia gregoryi* Olsson
- *Melina woodsi* Olsson
- *Ostrea (Lopha) stappenbecki* Olsson
- *Spondylus hopkinsiana* Olsson
- *Plicatula harrisiana* Olsson
- *Mytilus signatus* Olsson
- *Modiplus portunus* Olsson
- *Pholadomya houghti* Olsson
- *Venericardia weberbaueri* Olsson
- *Roudaireia auressensis* Coquand
- *Roudaireia jamaicensis peruviana* Olsson
- *Sphaerulites (Lapeirousia)* cf. *nicholosi* Whitefield
- *Orbignya pacifica* Olsson
- *Durania* sp.
- *Cardium* cf. *lissoni* Bruggen
- *Cardium amotapense* Olsson
- *Linearia bomarea* Olsson
- *Tellina* sp.

*Antigona*
- *Corbula montegrandensis* Olsson

Gastropoda:
- *Desmieria peruviana* Olsson
- *Calytraea* sp.
- *Turritella forgemoli* subsp.

*Mesalia inca* Olsson
*Mesalia peruviana* Olsson
*Cerithium* sp.
*Pugnellus* sp.
*Pugnellus ? cypraeformis* Olsson
*Calyptraphorus hopkinsi* Olsson
*Pseudoliva* sp.
*Fasciolaria ? calappa* Olsson
*Fasciolaria* (*Cryptorhytis*) cf. *Bleicheri* Thomas and Peron
Several undeterminable species.

Cephalopoda:
*Helicoceras* sp.

## AGE AND CORRELATION

On San Lorenzo island and at other localities near Lima, occurs a series of sedimentary rocks referred by some authors to the early Neocomian or Valanginian and by Lisson[28] to the late Portlandian. These deposits were formed during a brief or marginal incursion of the sea in central Peru but through the greater part of the Andean geosyncline from Peru northward into Colombia and Venezuela, the formation of a thick series of continental and often coal-bearing rocks took place. The rather limited flora known from these beds, has been generally interpretate as indicating a Wealden or Neocomian age although Salfeld[29] and more recently Berry[30] have also emphasized its Jurassic affinities. The age of these continental beds is therefore somewhat doubtful but it appears probable that they may embrace part of the early Cretaceous or extend from late Jurassic to Hauterivian times. These land-formed rocks are usually succeeded by a second marine series, generally beginning with limestones followed by black shales. These deposits were formed during a marine transgression which in some localities may have commenced in the Barremian but attained its maximum development during the Upper Albian or Lower Cenomanian with the Andean sea again dwindling during the Middle Cretaceous. The Upper Cretaceous witnessed a third transgression but which

[28]Lisson, 1917, Edad de los Fosiles Peruanos y Distribucion de sus Depositos, 2nd edicion, p. 33.
[29]Salfeld, 1911, In Hauthal Reisen in Bolivien und Peru, Wissenschaftliche Veröffentlichungen der Gesellschaft für Erdkunde zu Leipzig, Siebenter band, pp. 211-217.
[30]Berry, 1922, The Mesozoic Flora of Peru, The Johns Hopkins University Studies in Geology, No. 4, p. 49.

never quite equalled in extent that of the late Albian or Vranconnian invasion.

In the Amotape region only a partial development of this Cretaceous section occurs. The Wealdenian plant-bearing rocks are lacking (unless Bosworth's undefined Tablones group should prove to belong here) so that this region was sufficiently elevated at that time to be one of erosion and not of deposition. Thus the Cretaceous deposits of the Amotapes rest directly on a basement of Pennsylvanian slates, schists and granites. These older Cretaceous rocks are the massive Pananga limestones. Fossils from this lower limestone member show that it is the approximate equivalent of the similar limestones of the region to the south and referred by Steinmann and his associates to the Aptian. The Ammonite genus *Knemiceras* so characteristic of the Aptian in the Trujillo region has not been found in the Pananga limestone while the genus *Oxytropidoceras* and certain other forms such as *Crassatella caudata* and *Astarte debilidens* would seem to indicate that the Pananga limestone most be a little younger than the typical *Knemiceras* horizon and that they may possibly belong to the Lower Albian. The Ammonite genus *Oxytropidoceras* is usually regarded as strictly Albian but until the several South American species have been fully differentiated and accurately zoned, too much reliance for exact age determination cannot be based on its occurrence alone. In the Pananga limestones there are at least two species of *Oxytropidoceras* which occur with *Trigonia longa, hondaana, Neithea alpina* subsp. and *Puzosia emerici* or species which in Europe, characterize the Upper Aptian. Steinman's[31] record of *Agria* cf. *Blumenbachi* from the Pananga limestone of Muerto and indicating a Barremian age cannot be given much weight. Tentatively we may refer the Pananga limestone to the Late Aptian or Early Albian, thus indicating a progressive expansion or overlap of the Cretaceous sea northward and westward over the Amotape region.

The highly fossiliferous Pananga limestones are separated from the overlying limestones and black shales of Muerto by a sharp faunal and physical change but whether this break marks a disconformity and hence a brief withdrawal of marine waters

[31]Steinman, 1929, Geologie von Perú, p. 115.

or merely a shift in character of deposition, has not been determined. Our collections from these upper horizons is very meager although the rocks are quite fossiliferous, containing fish scales, several species of Ammonites, *Inoceramus* and *Exogyra*. They are thought to be equivalent to the similar beds of Pariatambo, Hacienda Montan and Yauli, characterized by *Oxytropidoceras peruviana* von Buch and *multifida* Steinmann and usually referred to the Albian. Bravo recorded *Schloenbachia* (*Oxytropidoceras*) *peruviana* from Muerto and his material was doubtless collected from these upper calcareous horizons.

Very few fossils have been found in the Copa Sombrero formation. They include fragments of *Inoceramus* and a large *Schloenbachia* related to *varians* of Sowerby and indicate a lower Cenomanian age. The Copa Sombrero formation consists principally of black shales with large limy concretions and zones of contorted and irregularly bedded gray sandstones. The presence of much sand in the beds of Copa Sombrero, in contrast to the nearly pure shale and limestone formation of Muerto, show that the Cretaceous sea was already receding from the Amotape region and that uplift and deformation were in progress. If the older series of quartzitic sandstones and conglomerates of Monte Grande are correctly placed between the Copa Sombrero formation and the Clavulina shales of Senonian age, they would furnish proof of a nearly complete withdrawal of marine waters from this region in Middle Cretaceous times. Stappenbeck[32] has described certain quartizites from the region north of Chicama and near Cajamarca whose age is placed as Turonian since they seem to occupy a stratigraphic position above Cenomanian limestones and beneath fossiliferous Emscherian. These quartzites would thus correspond closely in age with the older conglomerates of Monte Grande.

The Monte Grande formation and the *Clavulina* shales, together with the *Sphenodiscus* Schichten of Gerth belong to the Upper Cretaceous. Their faunas contain such characteristic late Cretaceous species as *Roudaireia*, *Venericardia* of the *beaumonti* group, large *Plicatulae*, *Sphenodiscus* and several species

[32]Stappenbeck, 1924, Das Chicamatal in Nordperu. Zeitschrift der Gesellschaft für Erdkunde zu Berlin p. 6. Also in Geologie das Chicamatals in Nordperu und seiner Antracitlagerstätten. Geologische und Paleontologische Abhandlungen, Neue Folge, Band 16, Heft. 4, p. 19.

of Rudistids. The Senonian age of these beds cannot be disputed.

The coarse sandstones and conglomerates which make up the Monte Grande formation were formed during the closing stage of a marine transgression which culminated during the deposition of the middle part of the *Clavulina* shales and the equivalent horizons containing *Sphenodiscus* and *Pironaea* in the Paita region. At Cajamarca and Trujillo, rocks of Lower Senonian age with *Actaeonella gigantea* Sby, (*oviformis* Gabb), *Ostrea Nicaisei, Buchiceras, Lenticeras* etc., are known but these horizons are apparently absent from the Amotape region and would thus indicate a northward and westward transgression of the Senonian sea in northern Peru.

Gerth[33] considered his *Sphenodiscus* Schichten as being of Maestrichtian age while he postulated a probable Campanian age for his *Actaeonella-Pironaea* limestone. The Monte Grande fauna is composed principally of mollusks of large size and thick shells, fitted for life in turbulent near-shore waters. Only a fragment of an Ammonite (*Helicoceras*) has been found but the coarse character of the Monte Grande sediments was not favorable to the preservation of their delicate shells. There are three species of Rudistids and one reef coral.

Aside from the Rudistids, the outstanding species in the Monte Grande fauna are *Roudaireia auressensis* Coquand, *jamaicensis peruviana* Olsson, *Eusebia gregoryi* Olsson, *Cardium amotapense* Olsson, *lissoni* Brüggen, *Plicatula harrisiana* Olsson, *Ostrea stappenbecki* Olsson, etc.

The Monte Grande specimens of *Roudaireia auressensis* are very similar to the forms figured from North Africa. According to Pervinquière and other students of the African fauna, this species ranges through the whole Senonian but it is most abundant and typical in rocks of Maestrichtian age. *Roudaireia jamaicensis peruviana* is a large species differing from typical *jamaicensis* of Trechmann described from the Upper Cretaceous rocks of Jamaica by its less terminal beaks. *Eusebia gregoryi* is a peculiar species related to *Eusebia stantoni* Maury recently

[33]Gerth, 1928, Neue Faunen der oberen Kreide mit Hippuriten aus Nordperu Leidsche Geologische Mededeelingen, Deel 2, Afl. 4, V 1928, p. 240.

*(Opposite page 21)*

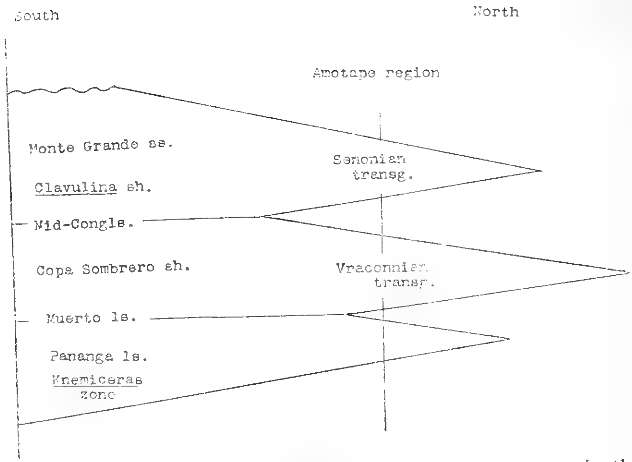


Figure 2. Strandline migration of the Cretaceous sea in the Amotape region

described from the *Roudaireia* beds of eastern Brazil. The common oyster in the rocks of Monte Grande is *Ostrea stappenbecki,* a species related to *Ostrea arizpensis* Böse from the Maestrichtian of Mexico but the Peruvian shell is a larger and more highly developed form. Other Maestrichtian species which have closely related forms in the Monte Grande fauna are *Antigona Rohlfsi* Quass and *Turritella forgemoli* Coquand. Among the Rudistids, *Sphaerulites nicholasi* Whitfield was first discovered in the late Cretaceous limestones of Jamaica. The presence of species of *Pseudoliva, Cerithium, Melanatria, Calytraphorus* and *Mesalia* which are more commonly Eocene genera, show that the Monte Grande fauna must belong to the closing part of the Cretaceous period.

Much work still remains to be done on the Cretaceous rocks of the Amotape region before a final correlation and classification can be given. The Pananga and Monte Grande faunas are fairly well known and as they characterize zones of comparatively narrow stratigraphic limits at the base and near the top of the Cretaceous deposits, they must furnish the basis for present correlations. Between these horizons, there lies a great thickness of shales, sandstones and conglomerates which have yielded only a few fossils and consequently some changes in the classification of these intermediate rocks can be expected when more fully known. The general succession and character of the Cretaceous beds show quite clearly that they were formed during two major depositional cycles or invasions of marine waters which spread northward from the deeper portions of the Andean geosyncline. The first or older transgression began with the formation of the Pananga limestone and culminated during the widespread deposition of the Copa Sombrero shales. The last transgression resulted in the formation of the *Clavulina* shales and the Monte Grande sandstones with the sea again receding towards the close of the Cretaceous. The general features of this strandline migration of the Cretaceous sea in the Amotape region is shown graphically in the following chart.

# SYSTEMATIC DESCRIPTION OF SOME CRETACEOUS FOSSILS FROM NORTH-WEST PERU

## Class PELECYPODA

### Order PRINONODESMACEA

### Superfamily ARCACEA

### Family ARCIDAE

### Genus PSEUDOCUCULLÆA Solger

**Pseudocucullæa gregoryi**, n. sp. Pl. 3, fig. 1

Shell large, massive, broadly subovate in outline, inequilateral, a little oblique, convex; beaks small, situated near the anterior one-third and separated by the cardinal area; the anterior side of the shell is evenly rounded; in the middle of the ventral margin, the shell is more strongly curved but straightening again between this point and the posterior extremity; the posterior extremity is somewhat angled, above which the side is straight, sloping obliquely to the hinge-margin; the valves are moderately convex, smooth or with a simple sculpture of growth-lines; hinge-plate arched, a little shorter in front than behind; hinge taxodont, with a series of small vertical teeth along the middle of the cardinal border and two or more, greatly enlarged teeth at the anterior and posterior extremities; the cardinal area is of moderate width and striated with a series of ligamental grooves which are inclined downward in front of the beak and nearly parallel with the hinge-line in front of the beak; interior of shell cavity unknown.

Length 92.00 mm.; height 95.00 mm.; semidiameter 28.00 mm.

*Remarks.*—The remarkable genus *Pseudocucullæa* was described by Solger (Deutsche Geologische Gesellschaft, vol. 55, (1903) p. 76.) from the Cretaceous of the Cameroon, West Africa, its type species being *P. lens* Solger, a moderate-size, rounded, *Glycymeris*-like form. Two other species of *Pseudocucullæa* were described by Solger from the same locality. Later a typical species was described by Harris and Hodson from the Cretaceous of Venezuela as *P. parijana* (Bulletins of American Paleontology, vol. 49 (1927) p. 1, pl. 1, fig. 4; pl. 2, figs.

1, 3, 4; pl. 3, fig. 1. In 1930, Maury[34] described *Eusebia stantoni* as a new genus and species from the Upper Cretaceous of eastern Brazil. Maury's material was rather meager but there appears to be no doubt but that her shell is but another species of *Pseudocucullœa*. The genus *Lopatinia* of Schmidt (genotype *"Pectunculus" petschorae* Keyserling from Siberia has been considered synonymous with *Pseudocucullœa* (see Addenda to Maury's paper, pp. 301-305) but since its geographical and stratigraphical position are so remote from the South American and African there is some question as to their exact generic equivalency. *Pseudocucullœa* has a taxodont hinge which in some respects, is similar to that of *Cucullaea* and to certain large gerontic species of *Glycymeris* to which it appears most closely related. The most remarkable characters of the hinge is the presence of one or two large anterior and posterior lateral teeth bordered by strongly striated sockets. The cardinal area is of moderate width and marked with several deep furrows which are roughly parallel to the hinge margin. Between the laterals there is a medial zone of numerous, small vertical teeth of irregular form.

The Peruvian species here described as *Pseudocucullœa gregoryi* is represented in the Monte Grande collection by several specimens, usually as closed valves. The hinge is shown on two left valves but the dentition is not well preserved or it is partly covered with matrix which cannot be removed. Young shells are more depressed and inequilateral but with age become subcircular or subequilateral in form and externally resemble a large, thick-shelled *Glycymeris*. The surface sculpture consists of coarse lines of growth without marks of radial ribs or striae. The ventral margin appears to have been smooth.

In eastern Brazil (State of Parahyba), *Pseudocucullœa stantoni* occurs with *Roudaireia auressensis, Trigonarca, Plicatula, Venericardia* (of the *beaumonti* group) in rocks of Upper Cretaceous age. The discovery of a species of this remarkable genus in the Cretaceous rocks of northern Peru associated with a similar fauna, has an important bearing on problems of correlation and of the probable routes along which faunal migration

[34]Maury, 1930, O Cretaceo da Parahyba do Norte, Monographia, No. 8, Servico Geologico e Mineralogico do Brasil, p. 207, Pl. 6, figs. 5, 6, pl. 8, fig. 2.

**Note.— Better material proves *Eusebia* a synonym of *Pseudocucullœa*.** **See p. 23.**

could take place. The Peruvian species differs from *stantoni* by its larger size, less depressed form, more prominent umbos and by the greater length of its hinge.

The Peruvian species is named for the late Professor J. W. Gregory, as a tribute to his outstanding achievements in geology and exploration.

*Locality and Geologic Occurrence.*—Monte Grande formation, Monte Grande.

### Genus TRIGONARCA Conrad

**Trigonarca meridionalis**, n. sp. Plate 2, figs. 1, 3

Shell of medium to large size, stout, subquadrate in outlines and moderately convex; length slightly exceeding the height; anterior margin broadly rounded, passing evenly into the ventral margin which is nearly straight on the posterior half; the posterior margin is straight, sloping, meeting with the anterior margin at an acute angle which is a little less than 90 degrees; the umbonal angle is strong and well-marked behind which the posterior submargins are strongly contracted, flattened or feebly depressed along a median zone; the rest of the shell is moderately and evenly convex; umbos quite prominent, with small adjacent beaks rising a little above the cardinal area; hinge-line long, straight in the middle portion, curving ventrally at the ends; the hinge teeth are small, numerous and vertical in the middle but become larger and oblique on the anterior and posterior extremities of the hinge line; surface with coarse lines of growth tending to become spaced in bands simulating resting intervals; interior not known.

| | | | |
|---|---|---|---|
| Length | 70.00 mm.; height 67.00 mm.; | semidiameter | 31 mm. |
| " | 84.00 mm.; " 76.00 mm.; | " | 37.00 mm. |

*Remarks.*—This is a large species distinguished by its strongly angled umbonal ridge and sharply truncated posterior submargins. There seems to be no closely related species. Probably nearest to the Peruvian form is *Trigonarca capensis* Greisbach[35]

[35]Woods, 1906, The Cretaceous Fauna of Pondoland Annals of the South African Museum, vol. 4, p. 288, pl. 34, figs. 1, 2.

from Pondoland and *Trigonarca jessupae* Maury[36] from eastern Brazil but both these species are smaller and have a longer and more produced posterior extremity.

*Locality and Geologic Occurrence.*—Monte Grande formation, Monte Grande.

**Trigonarca gerhardti** n. sp. Plate 7, figs. 5, 6

*Cucullaea brevis* Gerhardt, 1897, Beitrag zur Kenntniss der Kreideformation in Columbien, N. Jahrb. f. Min., etc., BB., vol. 11, pp. 182, 183, pl. 5, fig. 4. not d'Orbigny 1842.
*Arca (Cucullaea) brevis* Steinmann, 1929, Geologie von Perú, p. 125, textfigure 140.

Shell small or medium size; outlines subrhomboidal, the beaks and umbos a little anterior of the middle; anterior side well-rounded, the posterior side straight, oblique, meeting with the ventral margin at an angle roughly 80 degrees; the shell is moderately convex and quite thick; surface smoothish or marked with strong lines of growth; the internal casts have the umbos more pronounced, the hinge-line shortened and the umbonal slope higher and more vaulted; muscle impression of medium size, the posterior one lying in an impressed zone limited by a groove which extends from the beak to near the posterior-ventral extremity; a deep cavity in front of the beaks on internal casts.

| | | | |
|---|---|---|---|
| Length | 61.00 mm.; height | 50.00 mm.; semidiameter | 25.00 mm. |
| " | 45.00 mm.; " | 41.00 mm.; " | 31.50 mm. (internal cast). |

*Remarks.*—Our specimens from Pan de Azucar compare favorably with Gerhardt's figure of a Colombian shell, identified with D'Orbigny's *Cucullaea brevis* and originally described from the Province of Santa Fe. D'Orbigny's[37] *brevis* was based on an internal cast of a large, rounded, more convex and *Cardium*-like form which doubtless belongs to a true *Cucullaea,* while Gerhardt's figure of the hinge of his Colombian specimen show that it is a *Trigonarca.* Gabb[38] referred to a small shell

[36]Maury, 1930, O Cretaceo da Parahyba do Norte, Monographia No. 8, Servico Geologico e Mineralogico do Brasil. p. 211, pl. 6, figs. 2, 3.
[37]D'Orbigny, 1842, Voyage dans l'Amerique méridionale, vol. 3, pt. 4, Paléontologie, p. 89, pl. 20, figs. 2-4.
[38]Gabb, 1877, Description of a collection of fossils made by Dr. Antonio Raimondi in Peru, Journ. Acad. Nat. Sci. Philadelphia. 2nd series, vol. 8, p. 291.

from near Cajamarca as *Trigonarca brevis,* believing that it was the young of that species. *Trigonarca peruviana* Gabb[39] described from near Ollon is a more elongated species with very low umbos and small beaks. *Trigonarca Orbignyana,*[40] also from near Ollon is a large species of probable Upper Cretaceous age.

*Locality and Geologic Occurrence.*—Pananga formation, Pen de Azucar.

### Superfamily PTERIACEA

### Family MELINIDAE

### Genus MELINA

**Melina woodsi** n. sp. Plate 4, fig. 1

Shell of medium size to large, aviculoid, with flattened, nearly smooth valves; the height of the shell is nearly one-third greater than its length; the anterior ear is small or nearly absent, the posterior ear large and passing smoothly into the general surface of the valves; the anterior side is broadly rounded, the ventral margin is obliquely rounded while the anterior side is straight to sinuous in the middle and inclined a little forward; the valves are but slightly convex along the umbonal slope, being noticeably flattened on the anterior portion; the posterior submargin which passes into the posterior ear is depressed to excavated; the anterior margin is feebly expanded or open for the passage of the byssus; hinge margin, straight with a wide, cardinal area and numerous, vertical ligament pits; interior unknown.

Height 92.00 mm.; length 72.00 mm.; diameter 24.00 mm.

*Remarks.*—This species is distinguished by its flattened, aviculoid or subquadrate form. The ligament pits along the hinge line occur on one specimen.

*Locality and Geologic Occurrence.*—Monte Grande formation, Monte Grande.

### Genus INOCERAMUS Sowerby

**Inoceramus** sp.

No species of *Inoceramus* have been noticed in the Pananga formation but they are common in the Muerto limestones and

[39]Gabb, 1877, op. cit., p. 291, pl. 41, figs. 9, 9a.
[40]Gabb, 1877, op. cit., p. 290, pl. 41, figs. 7, 7a, 8, 8a.

overlying black shales. A small, right valve from Muerto belongs to a smooth species of the group of *I. crippsi* Mantell. This specimen has lost the beak and part of the dorsal margin but its growth-lines show that its outline was similar to that figured for *I. crippsi* from England. Woods gives the range of *crippsi* as extending from the Upper Albian into the Cenomanian.

Our collection contains a fragment of a large *Inoceramus* which was found with *Schloenbachia leonora* Olsson in the Copa Sombrero shales. It is a large, slightly convex species with strong, concentric ribs, separated by wide, excavated intervals. This species probably possessed a long straight, hinge-line and a broadly elliptical to subquadrate outline. Its length is estimated to have been 140 to 150 millimeters. It bears some resemblance to Pervinquiére's[41] figure of *I. Siccensis* from Tunis but has heavier and more regular, concentric sulci.

Remains of *Inoceramus* have also been found in the *Clavulina* shales of Monte Grande but they are very fragmentary.

### Superfamily OSTRACEA

### Family OSTREIDAE

### Genus OSTREA Linné

### Subgenus OSTREA s. s.

### Section LOPHA Bolten

**Ostrea stappenbecki,** n. sp. Plate 3, figs. 4, 5

Shell of medium or large size, typically sickle-shaped but quite variable in form; the region of the beak is generally flattened and smooth but below this, the surface becomes sharply folded and fluted, especially along the ventral margin; at the same time, the shell increases in thickness; typically the valves have four, sharply folded ribs along the ventral margin but these rapidly fade out dorsally; the two central ribs have an excessive development, the other two, one on each side being small and often merely a marginal fold; the posterior-dorsal side is deeply concave, curved in harmony with the sickle form of the shell; the posterior side of the beak is marked with series of fine, narrow, crenulations and similar but smaller crenulations may occur on the anterior

[41]Peruvinquiére, 1912, Etudes de Paléontologie Tunisie, Pt. 2, p. 116, pl. 8, figs. 2, 3, 4a-b.

side as well; interior shallow with a wide, ligamental groove.

| | | |
|---|---|---|
| Length 57.00 mm.; | height 54.00 mm.; | diameter 37.00 mm. |
| " 57.00 mm.; | " 47.00 mm.; | " 60.00 mm. |
| " 59.00 mm.; | " 53.00 mm.; | " 45.00 mm. |

*Remarks.*—*Ostrea arizpensis* described by Böse[42] from Upper Senonian of Mexico, is the nearest related species. The Peruvian species is larger, heavier and with much higher and more sharply folded ribs, hence the thickness of the valves are nearly twice that of *arizpensis*. *Ostrea stappenbecki* is one of the characteristic species of the Monte Grande fauna. It is named for Dr. R. Stappenbeck, who has done so much valuable work on the Geology of South America.

*Locality and Geologic Occurrence.*—Monte Grande formation, Monte Grande.

### Superfamily TRIGONIACEA

### Family TRIGONIIDAE

### Genus TRIGONIA Bruguiere

**Trigonia subcrenulata peruana** Paulcke

cf. *Trigonia subcrenulata* d'Orbigny, 1842, Coquilles et Echinodermes fossils de Colombie recueillis par Mr. Boussignault, ~~Voyage dans~~ l'Amérique meridionale; ~~vol. 3, pt. 4~~, p. 52, pl. 4, figs. 7-9.

cf. *Trigonia subcrenulata* Gerhardt, 1897, Beitrag zur Kenntnis der Kreideformation in Columbien, N. J. Min. etc. BB., vol. 11, p. 184.

*Trigonia crenulata* Lam. var. *Peruana* Paulcke, 1903, Über die Kreideformation in Südamerika und deren Beziehungen zu anderen Gebieten. N. J. Min. etc. BB., vol. 17, p. 272, pl. 15, figs. 9, 9a, 9b.

*Trigonia subcrenulata* Sommermeier, 1913, Die Fauna des Aptien und Albien in nördlichen Peru, pt. 2, p. 382.

*Trigonia subcrenulata* Steinmann, 1929, Geologie von Perú, p. 126, text-figure, 141.

? *Trigonia subcrenulata* White, 1888, Contributions to the Paleontology of Brazil, Archivos do Museu Nacional do Rio Janeiro, vol. 7, p. 70, pl. 5, figs. 2, 3.

This *Trigonia* is very abundant in the Pananga limestones but most of our specimens are either internal casts or the shell has been recrystallized to such an extent that the surface details have been destroyed. In outlines, the Peruvian shell resembles *Trigonia crenulata* Lamarck of the French Upper Cretaceous but has fewer and more widely spaced ribs.

D'Orbigny's figure of *subcrenulata* from Colombia, shows a subelongate, sickle-like shape with a rather narrow and strongly

[42]Böse, 1913, Algunas faunas del Cretacico superior de Coahuila y Regiones Limitrofes, Instituto Geologico de Mexico, Boletin Numero 30, pp. 48, 49, pl. 8, figs. 7-17.

sculptured posterior area. Our shells from the Pananga limestones are broadly hatchet-shaped and the posterior area is wide and plainly sculptured. For these reasons it seems preferable to separate the Peruvian form as the subspecies *peruana* Paulcke which was originally proposed as a variety of *crenulata* Lamarck.

The shell figured by Reeside's[43] as *Trigonia crenulata peruana* from Ecuador, has the elongated form of *subcrenulata* but the posterior area is wide and flat. It does not resemble any of the Peruvian forms. It is listed with *Trigonia hondaana* Lea and said to be Turonian in age.

*Locality and Geologic Occurrence.*—Pananga formation, Pan de Azucar.

**Trigonia hondaana** Lea

*Trigonia Hondaana* Lea, 1840, Notice of the Oolitic Formation in America, with Descriptions of some of its Organic Remains. Transactions American Philosophical Society, 2nd ser. vol. 7, p. 256, pl. 9, fig. 9.

*Trigonia Boussingaulti* d'Orbigny, 1842, Coquilles et Echinodermes fossiles de Colombie recueillis par Mr. Bossignault, ~~Voyage dans l'Amérique meridionale, vol. 3, pt. 4~~, p. 50, pl. 4, figs. 1-3.

*Trigonia Hondaana* d'Orbigny, 1842, op. cit., p. 85.

*Trigonia Hondaana* Coquand, 1866, Monographie de l'Etage Aptien de l'Espange, p. 326, pl. 24, figs. 1, 2.

*Trigonia Hondaana* Gerhardt, 1897, Beitrag zur Kennthis der Kreideformation in Columbien, N. J. Min. etc., vol. 11, p. 183, pl. 5, figs. 6a, b, c.

*Trigonia Hondaana* Choffat, 1904, Le Crétacique dans l'Arrabida et dans la contree d'Ericeira, p. 183, pl. 5, fig. 6.

*Trigonia Hondaana* Sommermeier, 1913, Die Fauna des Aptien und Albien in nördlichen Peru, pt. 2, p. 381.

cf. *Trigonia* aff. *T. hondaana* Reeside, 1927, in Wasson and Sinclair, Geological Explorations East of the Andes in Ecuador. Bulletin of the American Association of Petroleum Geologist, vol. 11, pp. 1270, 1279, pl. 11, fig. 7.

*Trigonia Hondaana* Steinmann, 1929, Geologie von Perú, p. 127, test-figure 142.

This species is readily recognized by its quadrate form and strongly differentiated posterior area which is well-marked even on the casts. Our specimens are poorly preserved and show only patches of the surface markings along the ventral margin. The species grows to a large size. It is known as an Aptian fossil in Spain and Portugal.

*Locality and Geologic Occurrence.*—Pananga formation, Pan de Azucar.

[43]Reeside, 1927, In Wasson and Sinclair, Geological Explorations East of the Andes in Ecuador. Bulletin of the American Association of Petroleum Geologists, vol. 11, pp. 1270, 1279, pl. 11, figs. 5, 6.

**Trigonia longa** Agassiz

*Trigonia longa* Agassiz, 1840, Etudes critiques sur les Mollusques fossiles. Mémoire sur les Trigonies, p. 47, pl. 8, fig. 1.
*Trigonia longa* d'Orbigny, 1843, Paléontologie Française, Terrains Crétacés, vol. 3, p. 130, pl. 285, figs. 1-6.
*Trigonia Lajoyei* Deshayes, 1842, Leymerie, Mémoire de la Socióté Géologieque de France, vol. 5, p. 7, pl. 8, fig. 4.
*Trigonia Lajoyei* d'Orbigny, 1842, Coquilles et Echinodermes fossiles de Colombie recueillis par Mr. Boussignault, Voyage dans l'Amérique méridionale, vol. 3, pt. 4, pp. 53, 87, pl. 4, figs. 10, 11.
*Trigonia longa* Pictet and Renevier, 1858, Description des fossiles du terrain aptien de la Perte du Rhone et des environs de Sainte Croix. Materiaux pour la Paléontologie Suisse, series 1, no. 1, p. 102, pl. 14, figs. 3, a, b.
*Trigonia longa* Coquand, 1866, Monographie de l'Etage Aptien de l'Espagne, p. 324.
*Trigonia longa* Gerhardt, 1897, Beitrag zur Kenntnis der Kreideformation in Columbien, p. 184.
*Trigonia longa* Paulcke, 1903, Über die Kreideformation in Südamerika und deren Beziehungen zu anderen Gebieten. N. J. Min. etc., BB. vol. 17, p. 291.

Examples of this species from the Pananga limestones are not well preserved but as near as can be determined, there seems to be no distinguishing difference between the Peruvian form and the figures of *Trigonia longa* from Colombia and Europe. In Colombia this species according to Gerhardt, occurs with *Trigonia subcrenulata* and *hondaana* in rocks believed to be of Aptian age Specimens identified as *Trigonia longa* together with a new variety *undulostriata* have been recorded from the Lower Cretaceous rocks of the Cordillera de Copiapo in Chile by Paulcke, the specimens having been collected by Steinmann. Agassiz and D'Orbigny characterized *Trigonia longa* as a Neocomian species of the Jura region of eastern France and Switzerland. At the Perte du Rhone, it was located more precisely by Pictet and Renevier in zone d or *Gres dur* at the top of the Upper Aptian which according to Haug[44] corresponds to the horizon of Clansayes with *Douvilleiceras nodosocostatum.* A specimen was also recorded from zone h or the *marne jaune* at the base of the Lower Aptian. In Spain according to Coquand, *Trigonia longa* is found in the Upper Aptian.

*Locality and Geologic Occurrence.*—Pananga formation, Pan de Azucar.

[44]Haug, 1920, Traité de Géologie, pt. 2, Les Périodes géologiques, p. 1257.

**Superfamily PECTINACEA**

**Family PECTINIDAE**

**Genus NEITHEA Drouet**

**Neithea alpina** d'Orbigny, subspecies.

cf. *Janira alpina* d'Orbigny, 1843, Paléontologie Française, Terrains Crétacés, vol. 3, p. 643, pl. 446, figs. 4-8.

cf. *Vola subalpina* Böse, 1910, Monografía Geológica y paleontológica del Cerro de Muleros, Bol. Inst. Geol. de Mexico, No. 25, p. 96, pl. 15, figs. 5, 7, 8, 9.

cf. *Neithea subalpina* Kniker, 1918, Comanchean and Cretaceous Pectinidae in Texas, Bull. Univ. of Texas, no. 1817, pp. 28, 29, pl. 5, fig. 4.

cf. *Pecten (Neithea) subalpina* Adkins, 1928, Handbook of Texas Cretaceous Fossils, Bull. Univ. of Texas, no. 2838, p. 127, pl. 17, figs. 1, 3.

In the collection from Pan de Azucar, are five lower valves of a large *Neithea* belonging to the group of *N. alpina* d'Orbigny. There are six primary ribs, between each pair of which, there are two secondary ribs of the same width as the primaries but less prominent in size. Well preserved specimens have the secondary and primary ribs separated by strong, regular grooves which are nearly as wide as the ribs themselves. The valves are quite thick and a moderate degree of surface weathering generally results in bringing into greater sharpness, the contrast between the secondary and primary ribs, the primaries remaining large while the secondaries become reduced to narrow ridges separated by very wide, flat interspaces. The primary ribs extent through the substances of the shell, leaving their impressions as low, rounded ridges on the internal casts.

The Peruvian shell resembles D'Orbigny's figure of *Janira alpina* from Europe but the lower valve of the Peruvian form may be a little more convex and the secondary ribs appear heavier and nearly equal the primaries in strength. These differences are probably not of great importance and their exact value can only be determined through the direct comparison of abundant French and Peruvian material which would indicate the extent of variation. The Peruvian shell may be larger than the French, our largest specimen having a height of about 70 millimeters.

Several species of *Neithea* belonging to the group of *N. alpina* have been described from the Comanchean rocks of Texas and their equivalent strata in Mexico. They have the common character of two secondary ribs between each pair of the six primaries and absence of tertiaries. In Roemer's *N. texana,* the ribs are subequal in size, the primaries being but a little larger than the secondaries and noticeably flat-topped. *N. subalpina,* first described by Böse from Mexico but since discovered in Texas, is closer to the Peruvian form. According to Böse, it differs from the French *alpina,* principally by its broader form, stronger primary ribs and smaller secondaries.

*Vola quinquecostata* var. *Morrisi* Pict. and Ren. has been figured by Steinmann[45] from the Aptian rocks of Huanambra near Celendin. This shell is quite small, with three secondary riblets in each primary interspace. Basse[46] who probably had the same species from Hacienda Padrerrume near Celendin, identified his specimens with *Pecten (Neithea) Shawi* Peruvinquiere.

*Locality and Geologic Occurrence.*—Pananga formation, Pan de Azucar.

### Family SPONDYLIDAE

### Genus SPONDYLUS Linné

**Spondylus hopkinsi** n. sp. Plate 3, fig. 6

Shell of medium size, ponderous, inequivalve and strongly convex; the shell is somewhat irregular in form, the lower or right valve being a little larger than the left valve and more irregular in its growth; he left valve is moderately convex and nearly equilateral but with the posterior side a little produced at its ventral end; the right valve is irregularly elongate along with vertical axis, its beak being turned towards the posterior side; area of attachment rather small; surface ornamentation consisting of primary riblets which carry an occasional spine, separated by wide intervals ornamented with finer secondary and tertiary threads; the right valve has a few rather coarse foliated, concentric lamellae along the anterior side of the umbo and beak; interior not exposed.

Height 78.00 mm.; length 73.00 mm.; diameter 52.00 mm.

*Remarks.*—This species from Monte Grande is represented by a single specimen. The left valve which has been exposed to the weather is deeply corroded so that the surface details have been partly obliterated. The right valve is partly encrusted with rock. It is sculptured with spine-bearing primary riblets separated by

[45]Steinmann, 1929, Geologie von Perú, p. 123, textfigure 139.

[46]Basse, 1928, Quelques Invertébrés crétaces de la Cordillere Andine, Bull. Soc. Géol. de France, 4th series, vol. 28, p. 123.

wide intervals which have a series of finer secondary and tertiary threads.

*Locality and Geologic Occurrence.*—Monte Grande formation, Monte Grande.

### Genus PLICATULA Lamarck

**Plicatula harrisiana** n. sp. Plate 3, figs. 2, 3

Shell of medium or large size, subequivalve, compressed to slightly convex; outlines suboval to subspatulate; with the height of the shell greater than its width; beaks small, inconspicuous and situated along the median line of the valves; the two valves are similarly sculptured with riblets of medium strength which extend in regular fashion from the beaks to the ventral margin; the riblets are strongest in the middle zone but become much smaller towards the sides; they number approximately 34 to 36; the riblets are crossed by coarse growth lines, the resulting sculpture becoming scabrous; interior not known.

| | | |
|---|---|---|
| Height 73.00 mm; | width 61.00 mm.; | diameter 21.50 mm. |
| " 52.00 mm.; | " 52.00 mm.; | " 16.00 mm. |

*Remarks.*—The general appearance of this species is similar to *Plicatula Flattersi* Coquand[47] of the Santonian of northern Africa but *Flattersi* in common with the other African species is more rounded in form and its sculpture is coarser with secondaries showing near the ventral margin. Young shells of *pacifica* are nearly circular in form but with age increase in height so that the ratio of width to height becomes as 2 1-2 to 3. A much larger species of *Plicatula* is also present in the Monte Grande collection. In this species the sculpture is very coarse on the nepionic part of the valves but doubles on the ventral half through the intercalations of secondaries.

*Locality and Geologic Occurrence.*—Monte Grande formation, Monte Grande.

### Family LIMIDAE

### Genus LIMA Bruguiere

### Subgenus PLAGIOSTOMA Sowerby

**Lima (Plagiostoma) pananga** n. sp. Plate 7, figs. 1, 2,

Shell large, obliquely sub-ovate to sub-elliptical in form; the anterior ear is small but well-marked; the posterior ear is not

[47]Coquand, 1862, Géologie et Paléontologie de la Région Sud de la Province de Constantine, p. 221, pl. 16, figs. 11-13.

preserved on our specimens; the length of the hinge-margin is small and straight; shell is rather thick, smooth or ornamented principally with lines of growth; the internal casts are rounded in form, the posterior margin especially being rounded or curved in the middle; the impression of the ventral edge of the mantel is well-marked and is situated a little above the ventral margin of the shell; there is often a deep impression a short distance above the middle of the valves due to excessive thickening of the center of the valves just posterior of the adductor muscle; the adductor muscle scar is usually not well defined but sometimes shows a faint impression above the anterior end of the mantel line; a deep grove along the posterior-dorsal margin made by the thickened edge of the valve in tthis region.

| | | | |
|---|---|---|---|
| Height 75.00 mm.; | width 75.00 mm.; | diameter 34.00 mm. | (type) |
| " 75.00 mm.; | " 75.00 mm.; | " 35.00 mm. | (cast) |

*Remarks*—This species is fairly common in the Pananga limestones but generally obtained only in the form of internal casts. When complete, this shell resembled the well-known *Lima* (*Plagiostoma*) *gigantea* Sowerby but was less convex and proportionately higher and narrower in form.

*Locality and Geologic Occurrence.*—Pananga formation, Pan de Azucar.

### Superfamily MYTILACEA

### Family MYTILIDAE

### Genus MODIOLUS Lamarck

**Modiolus mutisus** n. sp. Plate 4, figs. 3, 7

Shell of medium size, obliquely elongate, moderately ventricose; umbos and beaks nearly but not quite terminal; umbonal slope strongly arched and ventricose, extending in an oblique direction across the umbos to the posterior-ventral extremity; the dorsal margin is straight, the ventral margin is inflexed in the middle and slopes downward towards the ventral margin; surface of shell is neatly sculptured with concentric lines and fine radial striae; the radial striae begin approximately in the middle of the shell and extend over the umbonal slope to the posterior submargin but fade away before reaching the cardinal margins; the concentric threads are strongest on the dorsal-posterior slope but become nearly smooth or absent from the middle and anterior portions: interior unknown.

Length 53.00 mm. (imperfect); height 36.00 mm.; diameter 24.50 mm.
" 60.00 mm.; height 30.00 mm.; diameter 20.00 mm.

*Remarks.*—This beautiful species is represented by two fairly complete specimens from the Pananga limestones. It is related to the *Modiolus reversus* Fitton (*M. Fittoni* d'Orbigny[48]) from the French Neocomian, but the European shell is smaller, more slender and its radial striae is limited to a smaller area between the center and the umbonal slope.

*Locality and Geologic Occurrence.*—Pananga formation, Pan de Azucar.

**Modiolus portunus**, n. sp. Plate 4, fig. 5

Shell small, broadly elongated, convex; beaks small, adjacent and situated quite close to the anterior end; umbos prominent, wide, obscurely divided in the middle by a depressed zone which becomes deeper and stronger towards the ventral margin; the posterior-umbonal ridge is strongly arched and more expanded than the anterior side; the ventral margin is inflexed in the middle; surface smooth or ornamented by irregular lines of growth. Length 31.00 mm.; height 16.00 mm.; diameter 16.00 mm.

*Remarks.*—In form, this species resembles *Mytilus semiradiatus* d'Orbigny[49] from the French Turonian but differs in that the furrow divides the shell more equally and in lacking radial striae. Our collection contains but one specimen.

*Locality and Geologic Occurrence.*—Monte Grande formation, Monte Grande.

### Genus MYTILUS Linne

**Mytilus signatus** n. sp. Plate 7, fig. 4

Shell small, obliquely elongated, its anterior side narrowly contracted, flattened, forming a strong, ridge-like angle; the middle and posterior side of the shell is flattened to slightly convex; hinge-margin narrow, straight but curving at its end into the posterior side; surface sculptured with numerous, small, simple riblets further increased with additional riblets appearing in their interspaces; at maturity, the growth of the shell be-

[48]D'Orbigny, 1843, Paléontologic Française, Terrains Crétacés, vol. 3, p. 264 pl. 337, figs. 1, 2.
[49]D'Orbigny, 1843. Paléontologie Française, Terrains Crétacés, vol. 3, p. 277, pl. 341, figs. 1, 2.

comes irregular and interrupted by frequent resting marks; interior unknown.

Height 32.00 mm.; length 25.00 mm.; semidiameter 7.50 mm.

*Remarks.*—This species resembles Trechmann's[50] *Septifer acutus* from Jamaica but its beak is straight while that of the Jamaican species is narrowed and recurved. It is possible that the Peruvian form should be referred to the genus *Septifer* but the interior is completely concealed.

*Locality and Geologic Occurrence.*—Monte Grande formation, Monte Grande.

### Orer ANOMALODESMACEA

### Superfamily ANATINACEA

### Family PLEUROMYACIDAE

### Genus MYOPHOLAS Douville

**Myopholas peruviana** n. sp. Plate 5, fig. 7

Shell of medium size, elongate-elliptical or *Pholas*-like in form; umbos very wide, situated at the anterior one-third and ending in small, adjacent beaks; valves are moderately convex, the greatest inflation being situated a little above and anterior of the middle zone of the umbones; the sculpture is *Pholas*-like or consists of strong, widely spaced, noded riblets, these riblets being placed as follows—a wide, smooth zone at the anterior extremity of the shell, succeeded by a series of 11 riblets, the most posterior ones becoming obsolete along the dorsal-posterior margin; in the middle of the valves, the riblets are spaced 3.50 to 5.00 millimeters apart; the riblets are divided into elongate nodes by widely spaced, concentric lines; interior unknown.

Length 49.00 mm.; height 25.50 mm.; diameter 20.50 mm.

*Remarks.*—The genus *Myopholas* was proposed by Douvillé[51] in 1907 with *Pholadomya multicostata* Agassiz as genotype. It differs from the true Pholadomyas by its straighter, more elon-

[50]Trechmann, 1927, The Cretaceous Shales of Jamaica, Geological Magazine, vol. 64, p. 50, pl. 3, fig. 9.

[51]Douvillé, Henri, 1907, Les Lamellibranches cavicoles ou Desmodontes, Bull. Géol. Soc. France, vol. 7, pp. 107, 108.

gate form and in possessing the hinge structure of *Gresslya.* In the genotype, a groove corresponding to the internal nymph-like callosity appears on the molds of the right valve behind the beaks.

Our material from Pan de Azucar consists of two specimens. In form and character of sculpture, *peruviana* is strikingly like that of a *Pholas.* The holotype is unfortunately worn along the hinge line so that no trace of a *Gresslya* groove has been preserved, but the right valve appears to be larger than the other as characteristic of *Gresslya.*

An incomplete right valve of a related species was figured by Sommermeier[52] as *Pholadomya* cf. *nodulifera* Münster from the Aptian of the Department of Ancash. It has the *Pholas*-like type of sculpture of distantly noded riblets but the form of the valves is more oblique with the posterior side shown as being widely expanded.

*Locality and Geologic Occurrence.*—Pananga formation, Pan de Azucar.

### Family PHOLADOMYA

#### Genus PHOLADOMYA Sowerby

**Pholadomya houghti,** n. sp. Plate 5, fig. 2

Shell a little inequilateral, subelliptical in outlines, with nearly central beaks; the valves are moderately convex in the middle but compressed on the sides; posterior side a little longer than the anterior with the dorsal slope on each side nearly straight but becoming rounded at the ends; ventral margin is straight in the middle zone and rounded on the anterior and posterior sides; surface marked with distinct and closely spaced, radiating costæ which are strongest in the middle, fading on the sides; these costæ seem to be absent from the anterior-dorsal submargins but continue over the posterior-dorsal submargins; the costæ number approximately 23; growth-lines at times developing into deep resting marks.

Length 50.00 mm.; height 39.0 mm.; semidiameter 11.00 mm.

*Remarks.*—The above description is based on a specimen of the right valve, the interior and hinge being concealed in rock

[52]Sommermeier, 1913, Die Fauna des Aptien und Albien im nordlichen Peru II, N. Jahrb. f. Min., BB., vol. 36, p. 376, pl. 14, fig. 5.

matrix. The shell is referred with some hesitation to the genus *Pholadomya* as its outline is more equilateral than usually seen in that genus. The costæ numbering approximately 23, are closely spaced, low riblets which seem to fade out on the posterior submargins. A narrow zone on the anterior submargins appears to be smooth.

This species is named for Mr. Oscar Haught whose interest and aid in collecting a part of the Cretaceous material from Peru is greatly appreciated.

*Locality and Geologic Occurrence.*—Monte Grande formation, Monte Grande.

### Family ANATINIDAE

### Genus ANATINA Lamarck

**Anatina anchana,** n. sp. Plate 5, fig. 4

Shell of medium size, thin, elongate-ovate, slightly convex; beaks small, inconspicuous, situated a little anterior of the middle; dorsal and ventral margins nearly straight and parallel, becoming rounded at the ends; anterior-dorsal margin, strongly impressed and flattened; the surface is smooth except on the anterior portion which is marked with regular, concentric undulations which fade out towards the center; the medial region is faintly impressed; interior unknown.

Length 65.00 mm. (imperfect); height 36.00 mm.; diameter 20.00 mm.

*Remarks.*—This species resembles the *Anatina Royana* d'Orbigny[53] from the French Turonian but is longer anteriorly with the anterior-dorsal margin strongly impressed. *Anatimya prisca* Jaworski recorded by Sommermeier[54] from Ancahuaina, is distinguished from *A. anchana* by its narrowed and produced posterior side. *Anatimya prisca* appears closely related to *Anatina (Cercomya) semiradiata* Whiteaves[55] from the Lower Cretaceous of Queen Charlotte Island, British Colombia.

*Locality and Geologic Formation.*—Panaga formation, Pan de Azucar.

[53] D'Orbigny, 1843, Paléontologie Française Terrains Crétacés, vol. 3, p. 377, pl. 371, figs. 5, 6.

[54] Sommermeier, 1913, Die Fauna des Aptien und Albien im nördlichen Peru, II, N. Jahrb. f. Min. etc., BB., vol. 36, p. 376, pl. 14, fig. 4.

[55] Whiteaves, 1900, Mesozoic fossils, Geol. Survey of Canada, vol. 1, p. 288, pl. 37, fig. 4.

**Order TELEODESMACEA**

**Superfamily CYPRICARDIACEA**

**Family PLEUROPHORIDAE**

**Genus ROUDAIREIA Munier-Chalmas**

The genus *Roudaireia* was proposed by Munier-Chalmas[56] in 1881 with *Roudaireia Drui* Munier-Chalmas from Tunis, as genotype. The close affinities of *Roudaireia* with the earlier genus *Cicatrea* of Stoliczka[57] based on *Cyprina cordialis* Stoliczka from the Upper Cretaceous of India, was recognized by Munier-Chalmas but Stoliczka's figure of the hinge of *cordialis* showed certain differencies in structure from those possessed by *Drui* and it was principally these supposed differences Munier-Chalmas utilized in differentiating his new genus. *Cicatrea cordialis* was later identified by H. Douvillé[58] in a collection of fossils from Madagascar. Although the material was fragmentary, Douvillé was able to reconstruct the hinge armature which proved to be that of a normal *Cyprina* and similar to that of *Roudaireia Drui.* The hinge of *cordialis* having been incorrectly figured by Stoliczka, it is evident that *Cicatrea* and *Roudaireia* are synonymous. H. Douvillé rejected *Cicatrea* on the grounds that it had been incorrectly defined and this course was followed by Pervinquière, Fourtau and all later European writers. Bullen-Newton has referred the species of *Roudaireia* to the genus *Veniella* Stoliczka (*Venilia* Morton) with *Veniella conradi* Morton as genotype. Wade, in 1926, cited *Drui* as a species of *Veniella.* This procedure as maintained by Pervinquière is not justified as *Roudaireia* is easily separated from *Veniella* by its heavier shell, more massive ribs and sharp umbonal ridge.

**Roudaireia auressensis Coquand** Plate 6, figs. 1, 2

*Trigonia Auressensis* H. Coquand, 1862 Géologie et Paléontologie de la Région Sud de la Province de Constantine, Mém. Soc. emulation Province, p. 203, pl. 12, figs. 10, 11.

*Trigonia distans* Frass, 1867, Aus dem Orient, Pt. 1. Geologische Beobachtungen am Nil, auf der Sinai-Halbinsel und in Syrien, p. 93, pl. 1, fig. 14, not Conrad, nor Coquand.

[56]Munier-Chalmas, 1881, In Roudaire, Mission dans les Chotts tunisiens, Archives des Missions Scientifique et Litteraires, 3rd ser. vol. 7, pp. 303-304.

[57]Stoliczka, 1871, Cretaceous fauna of Southern India, vol. 3. The Pelecypoda. Memoirs of the Geological Survey of India.

[58]Douvillé, 1904, Sur quelques fossiles de Madagascar. Bull. Geol. Soc. de France, 4th series, vol. 4, pp. 215-217.

*Cyprina acute-carinata* Coquand, 1880, Etudes supplémentaires sur la Paléontologie algerienne, Bull. de l'Academie d'Hippone, no. 15, p. 112.

*Lyriodon auressensis* Coquand, 1880, Op. cit. p. 387.

*Roudairia Drui* Munier-Chalmas, 1881, in Roudaire, Mission dans les Chotts tunisiens, Archives des Missions Scientifique et Litteraires, 3rd ser. vol. 7, pp 305-306, pl. 4, figs. 1-7.

*Roudaireia Auressensis* Peron, 1890, Invertebres fossiles des terrains Cretaces de la region sud des Hauts-Plateaux, Exploration Scientifique de la Tunisie, p. 299, pl. 29, figs. 10-12.

*Roudairia Drui* Quaas, 1902, Beitrag zur Kenntniss der Fauna der obersten Kreidebildungen in der libyschen Wuste (Overwegischichten und Blatterthone), Paleontographica, vol. 30, p. 221, pl. 24, figs. 20-22.

*Roudairia Auressensis* Krumbeck, 1906, Beitrage zur Geologie und Palaeontologie von Tripolis, Paleontolgraphica, vol. 53, p. 110, pl. 9, fig. 1.

*Roudaireia Drui* Pervinquiere, 1912, Etudes de Paleontologie Tunisienne, Pt. 2, p. 230, pl. 15, figs. 9a-b, 10, 11c-d, 12a-b, 13a-b.

*Roudaireia auressensis* Di Stefano, 1912, Faune cretaciche del Deserto arabico, p. 169.

*Roudaireia Drui* Parona, 1914, Tripolitania, p. 21.

*Roudaireia auressensis* Fourtau, 1917, Catalogue des Invertébres fossiles de l'Egypte. Terrains Crétacés, 2me partie, Mollusque Lamellibranches, pp. 63-65, pl. 3, figs. 2, 2a, 3, 3a.

*Roudaireia auressensis* Greco, 1917, Fauna Cretacea dell'Egitto, parte terza, Palaeontographica Italica, p. 135, pl. 16 (15), fig. 22.

*Roudaireia auressensis* Haug, 1920, Traité de Géologie, Pt. 2, Les Périodes géologiques, p. 1331, fig. 399.

*Roudairia Drui* Gerth, 1928, Neue Faunen der oberen Kreide mit Hippuriten Leidsche Geologische Mededeelingen, V 1928, p. 234.

*Roudairia brasiliensis* Maury, 1930, O Cretaceo da Parahyba do Norte, Monographia No. 8, Servico Geologico e Mineralogico do Brazil,, pp. 224-226, pl. 8, fig. 10.

The occurrence of this characteristically North African species in the Upper Cretaceous rocks of northern Peru has already been recorded by Gerth from examples collected along the south side of the Silla de Paita. The Monte Grande specimens are large with a strongly sculptured shell of solid texture. The concentric ribs or folds are well developed anterior of the umbonal ridge. A small rib or fold is usually visible in the middle of the posterior area, being most conspicuous near the beaks. This secondary rib is well-shown in Peron's figure. The shells vary from moderately elongated forms to others which are rather high and elevated.

Peron considered *Roudaireia Drui* as the same species as the earlier described *Trigonia Auressensis* of Coquand and most recent workers such as Di Stefano, Fourtau and Greco have shared in this view. This opinion was contested by Quass and more particularly by Pervinquière, who studied the types of Coquand and Munier-Chalmas. According to Pervinquière, the variability of *Roudaireia Drui* is of limited degree, the shell is heavier in texture than Coquand's type of *auressensis* which has a noticeably produced posterior extremity. Pervinquière described the type *Drui* as triangular, squarely truncated, the escutcheon forming a right angle with the rest of the shell and ornamented only with spaced laminæ of growth. In Peron's figure 11 (Plate 29), a secondary rib is shown lying in the center of the posterior-dorsal area. This figure, according to Pervinquière, is inaccurate and was drawn from several specimens, none of which show as marked a secondary rib as figured. Finally it was noted that the types of Coquand's *Trigonia Auressensis* were indicated as coming from the Cenomanian while *Roudaireia Drui* was described from the Senonian. On the other hand, Fourtau and Greco from their study of abundant Egyptian material, have accepted Peron's contention of the specific identity of *Roudaireia Drui* with *auressensis*. Fourtau found the variation of *Drui* to be much greater than admitted by Pervinquière. In Fourtan's figure 2a, the dorsal-posterior area is shown as being sculptured only with growth-lines.

The Peruvian material is notably variable, some specimens being short and high while others are elongated with a pointed, posterior extremity. Except in such specimens which have suffered through excessive weathering, some indication of a secondary rib is seen on the posterior-dorsal area, in many cases quite as strong as shown in Peron's figure. For these reasons I have followed Peron, Fourtau and Greco in considering *Roudaireia Drui* as a complete synonym of Coquand's *auressensis*.

*Roudaireia crassoplicata* Noetling[59] from the Maestrichtian beds of Mari Hills in Baluchistan should be mentioned. This species which was described from a fragmentary right valve is obviously closely related to *auressensis* as recognized by Noetling but it is said to be distinguished by its comparatively longer and

[59]Noetling, 1897, Fauna of the Upper Cretaceous (Maestrichtian) beds of the Mari Hills. Memoirs of the Geological Survey of India, Palaeontologica Indica, ser. 16, vol. 1, pt. 3, p. 49, pl. 12, figs. 8, 8a.

narrower folds on the anterior part of the shell. In view of the great variability shown by the Peruvian forms of *aurессensis*, I am inclined to place the recently described *Roudareia brasiliensis* of Maury from the Upper Cretaceous of eastern Brazil, as a synonym or subspecies of *auressensis*. Maury's figure shows a high, quadrate form similar to that shown by many of the Peruvian shells but with somewhat finer and more regular concentric folds. The posterior area has the secondary rib of *auressensis*.

Coquand described his *Trigonia Auressensis* from the Carentonian (Cenomanian) of Batna, Algeria, but as suggested by Peron, Coquand may have been mistaken as to the exact locality and formation of his type specimens. It was indicated as an Upper Cretaceous species by Peron in Algeria and Tunis while Pervinquière recorded *Roudaireia Drui* from the Coniacian and Maestrichtian. In Tripoli, it was shown to be a Maestrichtian species by Krumbeck and Parona. According to Quaas, it occurs in Egypt in the zone of *Exogyra overwegi* or in beds of Maestrichtian age while Fourtau has listed *Roudaireia auressensis* at several localities in his Aturian stage which embraces the Campanian and Maestrichtian. It was found to be a Maestrichtian species by Di Stefano in the Arabian desert. It would thus appear from these records that *Roudaireia auressensis* although found in the greater part of the Upper Cretaceous other than the Danian, is most commonly a Maestrichtian species. It has also been recorded by Solger[60] from the Upper Cretaceous of the Cameroons.

*Locality and Geologic Occurrence.*—Monte Grande formation, Monte Grande, both in the Monte Grande conglomerates and in the upper part of the underlying black shales.

**Roudaireia jamaicensis peruviana,** n. sp. **Plate 2, fig. 6**

cf. *Roudaireia jamaicensis* Trechmann, 1927, The Cretaceous Shales of Jamaica, The Geological Magazine, vol. 64, p. 58, pl. 2, figs. 1, 2.

Shell large, solid and widely cordate; beaks prosogyrate, nearly touching and situated near the anterior end but never quite terminal; the posterior-umbonal ridge is strong, flange-like and defines a wide, posterior submargin or slope which is typically

[60]Solger, 1904, Die Fossilien der Mungokreide in Kamerum und ihre Geologische Bedeutung mit besonderer berucksichtigung der Ammoniten, Beitrage zur Geologie von Kamerun von Drs. E. Esch, F. Solger, M. Oppenheim und Prof. O. Jaekel, p. 230.

flattened along the sides but vaulted or convex in the middle zone; in front of the posterior ridge, the shell is widely depressed but becomes again strongly convex on the anterior half; the lunule is widely cordate and sunken; the young shell and the umbonal portion of older specimens is sculptured with strong, concentric ribs or undulations which are strongest on the anterior half of the valves but generally fade out before reaching the posterior-umbonal ridge; usually these concentric ribs become obsolete rather early so that larger and older shells are quite smooth except for growth-lines or the deeper grooves of resting intervals; hinge not seen.

Length 69.00 mm.; height 70.00 mm.; diameter 62.00 mm.
59.00 mm;. 52.00 mm.; semidiameted 23.00 mm.

*Remarks.*—This *Roudaireia* is easily distinguished from *auressensis* by its larger size, less elongate form, smoother sculpture and absence of a secondary fold or rib in the middle of the posterior submargins. Our largest specimen has a length of 70.00 millimeters. *Roudaireia jamaicensis* Trechmann from the Upper Cretaceous rocks of Jamaica, is very near the Peruvian form but according to Trechmann's figure and description of the adult form, has its beaks nearly terminal in position. The small specimen collected near Catadupa, Jamaica, and shown by Trechmann's figure 2 may possibly belong to another species.

*Locality and Geologic Occurrence.*—Monte Grande formation, Monte Grande.

### Superfamily ASTARTACEA

### Family ASTARTIDAE

### Genus ASTARTE Sowerby

**Astarte debilidens** Gerhardt

*Astarte debilidens* Gerhardt, 1897, Beiträge zur Kenntniss der Kreideformation in Colombien, N. Jahrb. f. Min., etc., BB., vol. 11, p. 102, pl. 2, figs. 7a, b, c.
*Astarte debilidens* Steinmann, 1929, Geologie von Peru, p. 138, fig. 164.

*Remarks.*—Several specimens of this species were collected at Pan de Azucar. It is a small shell with a length of about 10 millimeters and sculptured with coarse, concentric ribs. It was originally described by Gerhardt from the Albian rocks of Pariatambo.

*Locality and Geologic Occurrence.*—Pananga formation, Pan de Azucar.

### Family CRASSATELLIDAE

#### Genus CRASSATELLA Lamarck

**Crassatella caudata** Gabb Plate 4, figs. 4, 6

*Crassatella caudata* Gabb, 1877, Description of a collection of fossils made by Dr. Antonio Raimondi in Peru, Journ. Acad. Nat. Sci. Phila., 2nd ser., vol. 8, p. 287, pl. 40, fig. 18.
*Cyrena Durfeldi* Steinmann, 1881, Über Tithon und Kreide in den peruanischen Anden, N. J., Min. etc., vol. 2, p. 144, pl. 8, figs. 6, 7.
*Crassatella* (*Crassatella*) *caudata* Gerhardt, 1897, Beitrag zur Kenntnis der Kreide-formation in Venezuela und Peru, N. J. Min. etc., BB., vol. 11, pp. 107, 108, pl. 2, figs. 11a, b.
*Crassatella caudata* Steinmann, 1929, Geologie von Peru, p. 138, texa-figure 168.

This species was described by Gabb from the black shales of the so-called coal mine of Pariatambo. Steinmann in his discussion of a collection of fossils from this locality, referred *caudata* to *Cyrena* believing it to be a non-marine species but subsequently Gerhardt was able to reaffirm Gabb's original reference of the form to *Crassatella.* This species together with *Astarte debilidens* Gerhardt have been considered by Gerhardt and Steinmann as chacteristically Albian species as both are common in the black shales of the Pariatambo horizon. However both *Crassatella caudata* and *Astarte debildens* are quite common in the typical Pananga limestone of Pan de Azucar associated with a fauna generally regarded as Aptian elsewhere in Peru so that these two fossil forms are among the few known species whose stratigraphic range embraces both formations.

Specimens from Pan de Azucar are sometimes well preserved but usually the thick shell is broken during collecting and only the smooth internal mold remains. Our shells appear somewhat more cuneate than the forms figured by Gerhardt.

*Locality and Geologic Occurrence.*—Pananga formation, pan-de Azucar.

### Superfamily CARDITACEA

### Family CARDITIDAE

#### Genus VENERICARDIA Lamarck

**Venericardia weberbaueri,** n. sp. Plate 6, figs. 3, 5

Shell of medium size, subcircular and moderately convex; beaks small, adjacent and situated at the anterior one-fourth;

umbos wide, passing into the full convexity of the shell which is somewhat posterior and above the middle; the umbonal slope is weakly defined, showing principally in a change of sculpture and size of ribbing; on the center and ventral portion of the shell, the ribs become heavier and wider but the interspaces usually remain deep and wider than the ribs themselves; in some forms, the ribs are very heavy and cord-like, between deep, grooved intervals; the ribs number about 21 to 23, there being 16 or 17 anterior of the umbonal angle and 5 or 7 on the posterior slope; the ribs on the posterior slope are smaller and more crowded than the ribs elsewhere; interior unknown.

Length 30.00 mm.; height 29.00 mm.; diameter 20.00 mm.

*Remarks.*—This *Venericardia* is common at Monte Grande but from long exposure to weathering, the details of sculpture have been destroyed on most specimens. On the umbos the ribs are thin-edged and separated by deep, wide intervals; but it is not known whether the ribs were smooth or beaded in their original state. Considerable variation may be noted in the sculpturing of the adult shell. In some cases, the ribs remain narrow over the anterior and middle portion of the shell while in others, the ribs are broad and heavy on the umbonal slope with narrow or simply grooved intervals. It is interesting to note, that in the number of ribs (21 to 23), *Venericardia weberbaueri* shows its affinities with the Peruvian Eocene group of *Venericardia planicosta* and was probably the direct percursor of these latter forms.

In respect to size and form, *Venericardia weberbaueri* bears some resemblance to *Venericardia beaumonti* d'Archiac originally described from the Maestrichtian beds of India since found to be a widely distributed species in beds of the same age in northern Africa and elsewhere. The Peruvian species differs from *beaumonti* by its simpler sculpture and plain intervals. Maury's[61] *Venericardia maris australis* from the *Roudaireia* beds of eastern Brazil has strongly noded ribs and sculptured interspaces and is probably more closely related to *beaumonti* than to *weberbaueri*.

This species is dedicated to Professor A. Weberbauer of Lima and author of the well-known "Die Pflanzenwelt der peruan-

[61] Maury, 1930, O Cretaceo da Parahyba do Norte, Monographia No. 8, Serviço Geologico e Mineralogico do Brazil, p. 219, pl. 8, fig. 9.

ischen Anden" of inestimable value to all geological and biological students of the Andean region.

*Locality and Geologic Occurrence*.—Monte Grande formation, Montet Grande.

### Superfamily RUDISTACAE

With the exception of the records of the remains of Rudistids in the Lower Cretaceous limestones of northern Venezuela by Karsten[62] and others at the famous caverns of Guachero (the El Cantil formation of Liddle[63]) but never described nor figured, and the description of *Hippurites chilensis* from Chile by d'Orbigny[64], the occurrence of these fossils on the mainland of South America has only recently been proven.

In 1842, d'Orbigny gave the name *Hippurites chilensis* to certain fossil remains from the Cretaceous limestones of Coquimbo which appeared to be cross-sections of a colonial Rudistid related to *Hippurites organisans* of Europe. Douville[65] referred briefly to *chilensis* as a questionable *Agria* and it appears probable that this form will prove to be the same species as the widely distributed colonial Rudistid recorded by Steinmann[66], Fritzsche[76] and Gerth[68] as *Agria Blumenbachi* in the Lower Cretaceous rocks of Peru. According to Steinmann[69], the *Hippurites boliviensis* of Berry[70] from Bolivia is not of organic origin and was derived from rocks of Lower Silurian and not Cretaceous age.

In 1928, Iddings and Olsson[71] mentioned the association of Rudistids with *Roudaireia* in the Upper Cretaceous rocks of

[62] Hermann Karsten, 1886, Géologie de l'Ancienne Colombie Bolivarienne, p. 9.

[63] Liddle, The Geology of Venezuela and Trinidad, p. 133.

[64] D'Orbigny, 1842, Voyage dans l'Amérique Méridionale, vol. 3, pt. 3, p. 92, pt. 4, p. 103, p. 107, pl. 22, fig. 16.

[65] Douville, 1910, Etudes sur les Rudistes. Rudistes de Sicile, d'Algerie, d'Egypte du Liban et de la Perse. Mem. No. 41, Paléontologie, Société Géologique de France, p. 6.

[66] Steinmann, 1929, Geologie von Peru, p. 114, figs. 127, 128.

[67] Fritzsche, 1923, Neue Kreidefaunen aus Sudamerika (Chile, Bolivia, Peru, Columbie) N. J. Min. etc. BB. vol. 50, pp. 321-323.

[68] Gerth, 1928, Neue Faunen der oberen Kreide mit Hippuriten aus Nordperu, Leidsche Geologische Mededeelingen, Deel 11, V 1928, p. 237.

[69] Steinmann, 1929, Geologie von Peru, p. 178.

[70] Berry, 1922, Hippurites from South America, Pan-American Geologist, vol. 37, pp. 272-274, pl. 29.

[71] Iddings and Olsson, 1928, Geology of Northwest Peru, Bull. Amer. Assoc. of Petro. Geologists, vol. 12, p. 9.

Monte Grande. Shortly after, appeared the description of Gerth's[72] *Pironaea peruviana* from the Paita region. *Pironaea peruviana* was considered by Gerth as a Campanian species as it appeared to be related to *Pironaea polystyla* Pirona of northern Italy. Gerth also recorded *Agria* cf. *Blumenbachi* on the basis of specimens collected by Dr. Bravo from the Pananga limestones of Muerto.

Three species of Upper Cretaceous Rudistids belonging to the genera *Orbignya* (a Hippurite), *Sphaerulites* (a Radiolite) and *Durania* have been discovered at Monte Grande. The *Orbignya* is a short, stubby species distinguished by its small body-cavity and very wide, porcellaneous layer. The surface of the upper valve is partly covered with rock matrix while weathering has destroyed the surface details on the exposed portion. The Radiolite is a large species measuring 10 inches or more in diameter and belongs to the group of *Sphaerulites foliaceous* Lamarck. It is identified with *Sphaerulites nicholasi* Whitfield from the Upper Cretaceous rocks of Jamaica. It is abundant as fragments of the outer or foliaceous layer which may be recognized by their finely lamellated, non-cellular structure and branching vascular-like markings. The material of *Durania* consists of a fragment of the outer layers of two individuals which had grown together so that this species is probably a colonial type. It is recognized as belonging to the subfamily *Sauvagesinae* by the cellular structure of the outer layer. The body-cavity shows no cardinal furrow (l'arete cardinale) or the remains of teeth or pseudopillars so that the fossil is provisionally referred to Douville's genus *Durania*. A related species is *Durania curasavica* (Martin) MacGillavry[73] from Curacao but the Peruvian species was probably larger and more coarsely sculptured.

With the exception of Gerth's *Pironaea peruviana,* the previous records of Rudistids in South America have been noticed only from Lower Cretaceous rocks. The discovery of a rich Hippurite and Radiolite fauna at Monte Grande of Maestrichtian or late Cretaceous age is therefore of exceptional interest.

[72]Gerth, 1928, op. cit. under 7, pp. 235, 236, figs. 2, 3.

[73]MacGillavry, 1932, The Rudist Fauna of Seroe Teintje Limestone (Northern Curaçao), Proceedings of the Royal Academy Science of Amsterdam (Koninklijke Akademie van Wetenshappen te Amsterdam) vol. 35, pp. 385-389, pls. 1, figs. 7, 8. pl. 2, figs. 1-6, textfigures 3, 4, 5.

Through *Sphaerulites nicholasi* and *Roudaireia jamaicensis,* the Monte Grande fauna shows its close affinities with the late Cretaceous or *Barrettia* beds of Jamaica, Cuba and Honduras and through *Roudaireia auressensis* and others with North Africa and eastern Brazil. It was to this sea and its extensions, inhabited by the Cretaceous Rudistids and Orbitolinas and later by the Tertiary Orbitoidal foraminifera that Douville[74] proposed the name Mésogée as a particular phase of the old Central Mediterranean of Neumayr and the Tethys of Suess.

**Orbignya pacifica,** n. sp. Plate 8, figs. 1, 2

Shell rather large with a diameter of 100 to 110 millimeters across the upper valve, ponderous; upper valve, low, cap-like, with its apex lying approximately in the middle; the lower valve is much larger and heavier, the details of its surface destroyed by weathering; the upper valve is finely costated with numerous, subregular riblets which are few and coarser in the apical portion but increase by bifurcation in the marginal zone; in the apical portion, these ribs number about 26 doubling in the middle zone and quadrupling or more, nearer the margin; the riblets are sculptured or finely crenulated (serrated) by rows of small granules; pores are probably present but due to weathering and re-crystallization, these have not been preserved; the right or ligamental side of the upper valve is impressed with the valve arched along the zone extending from the anterior to the posterior side; cross-section of the lower valve shows the following internal features: the external prismatic layer has an average width of 6 millimeters on holotype and is brown in color; the internal or porcellaneous layer is much wider (20 to 30 millimeters) and light-colored; the contact line of the inner and outer layer is very sinuous and costated; the body-cavity is small, broadly bean-shaped, its concave side facing the brachial pillar; no ligament furrow (*l'arete cardinale*); the anal and brachial furrows are well developed, showing as deep, spatulate extensions; cross-section of the anterior adductor is large, narrow and arcuate in outlines; the posterior adductor, lying opposite the end of the anal furrow is rounded in form and of medium

[74]Douville, 1900, Sur la distribution géographique des Rudistes, Bull. Géol. Soc. de France, vol. 28, pp. 222, 223, 228.

size; there are two cardinal teeth, the posterior one is rather small; no auxiliary body-cavity.

Upper valve, anterior-posterior diameter 110.00 mm. diameter, across right-left sides 107.00 mm.

Height of shell 75.00 mm.

*Remarks.*—Deep weathering has destroyed the posterior-left side of the upper valve, exposing the anal and brachial furrows and a part of the interior of the lower valve. Due to this excessive weathering and recrystallization, the finer markings of the surface have not been preserved on such parts as are uncovered by rock matrix. The ligamental furrow or l'arete cardinale is absent or shows only as a depressed zone on the right side of the upper valve. The body-cavity is unusually small and occupies but a small part of the shell and lies posterior of the center. The inner or porcellaneous layer is greatly thickened, its width ranging from 20 millimeters on the anterior side to 30 millimeters on the right side. The line of contact between the inner and outer layers is strongly sinuous due to the deeply ribbed or costated outlines of the inner layer. The inner layer is coarse in texture and was probably originally occupied with empty spaces now filled with recrystallized deposits of lime.

*Locality and Geologic Occurrence.*—Monte Grande formation, Monte Grande.

### Genus SPHAERULITES Delametherie

#### Subgenus LAPEIROUSIA Bayle

**Sphaerulites (Lapeirousia)** cf. **nicholasi** Whitfield **Plate 8, fig. 4**

cf. *Radiolites* (*Lapeirousia*) *nicholasi* Whitfield, 1897, Bull. Am. Mus. Nat. Hist., vol. 9, pp. 186-188, Pls. 6-9, all figures.
cf. *Radiolites nicholasi* Trechmann, 1922, The Barretia beds of Jamaica, The Geol. Mag., vol. 59, p. 507.

The most abundant remains of Rudistids at Monte Grande are fragments of the foliaceous segments of the lower valve of a large *Sphærulites.* These fragments are frequently two or three inches thick with a fine, lamellar, algal-like, cellular structure. The upper surface is marked with rather widely-spaced, forked vascular lines.

A few specimens (not collected) showing a part of the body-cavity were observed. In the photograph, parts of the body-cavity of four individuals may be seen and their relative size may be judged by comparison with the prospecting pick which has a length of 13½ inches. The size of the largest specimens seen, have a diameter of about 10 inches. The Jamaican specimens, according to Whitfield, may attain a diameter of 15-18 inches for the lower valve. Trechmann records *Radiolites nichlosi* as occurring with *Barrettia* but is much less plentiful.

*Locality and Geologic Occurrence.*—Monte Grande formation, Monte Grande.

### Genus DURANIA H. Douville

**Durania**, sp. Plate 8, fig. 3

This record is based on a fragment consisting of part of the outer layers and impressions of the body-cavities of two Rudistids which have grown together. The texture of the wall or outer layer is coarsely lamellated, each lamina being subdivided by minute partitions into numerous, small cells. The ventral surface of the outer layer is undulated and coarsely reticulated, its cell walls being a little elevated above their smooth interiors.

The body-cavity is deep and wide, separated from the thick, coarsely cellular wall by a thin layer, light-brown in color and marked with sinuated growth-lines and fine, longitudinal striæ. The cardinal furrow (*l' arete cardinale*) is absent or it is represented simply by a small rib which does not extend into the cavity of the shell or enter into the outer layer. The pseudopillars of *Lapeirousia* are also absent. The coarsely reticulate, cellular walls shows that this species belongs to the *Sauvagesinæ* while the lack of a cardinal furrow and pseudopillars indicates that the form probably belongs to the genus *Durania* proposed by Douvillé in 1908 with *Biradiolites cornu-pastoris* des Moulins as genotype. From the described species of *Durania* in the old world, the Peruvian form differs by its strongly lamellated texture of its outer layer while that of typical *Durania* is coarsely cellular. *Durania curasavica* (Martin) recently redescribed and figured by MacGillavry[75] from the Upper Cretaceous rocks of

[75]MacGillavry, 1932, The Rudist Fauna of Seroe Teintje Limestone (Northern Curaçao) Proceedings of the Royal Academy of Science of Amsterdam (Koninklijke Akademie van Wetenschappen te Amsterdam) vol. 35, pp. 385-389, pls. 1, figs. 7, 8 pl. 2, figs. 1-6; text fig. 3, 4. 5.

Curacao is probably related to this species but the Peruvian form is apparently larger and its outer layer has a much coarser structure. Our material is too incomplete for a full characterization and additional specimens are greatly needed.

*Locality and Geologic Occurrence.*—Monte Grande formation, Monte Grande.

### Superfamily CARDIACEA

### Family CARDIIDAE

### Genus CARDIUM Linne

**Cardium amotapense,** n. sp. Plate 5, fig. 1

Shell of medium size, in form like *Fragum* with a sharp, umbonal angle and impressed and inflexed, posterior area; umbos prominent, the beaks small and adjacent; the shell is moderately convex; the sculpture consists of strong, triangular ribs and deep interspaces, about 24 ribs on the anterior side of the umbonal angle; these ribs on the holotype are strong, regular on the central part of the shell (3mm. from crest to crest) but on the anterior side diminish very rapidly in size; on the posterior area, there are about 10 ribs which are at first large and strong near the umbonal angle but become lower and irregular towards the margins; the summit of the ribs are sharp and keel-like but faint traces suggests the former presence of irregular nodes and beads; ventral margin deeply fluted in a saw-tooth manner by the ends of the ribs and their interspaces.

Length 40.00 mm.; height 49.00 mm.; semidiameter 22.00 mm.

*Remarks.*—To this species belongs the common *Cardium* of the Monte Grande formation but no specimen with well-preserved sculpture is known. The shell is *Fragum*-like in form with a strong umbonal angle and a deeply impressed posterior area. In recent *Fragum* and in the American species placed by Stewart in *Americardia*, the ribs are flattened between narrow, groove-like interspaces but in this species, the ribs are sharply angled with deep, triangularly shaped intervals. On some specimens, there are obscure traces which appear originally to have been irregularly spaced nodes along the summit of the ribs.

The hinge is poorly preserved on two right valves. The posterior cardinal is large, hook-shaped. The position of the laterals is difficult to determine with certainty but both laterals appear to be closely crowded against the cardinals. There is no lunu'e or impressed zone in front of the beaks.

*Locality and Geologic Occurrence.*—Monte Grande formation, Monte Grande.

**Cardium, cf. Lissoni** Brüggen Plate 5, fig. 3

*Cardium Lissoni* Brüggen, 1910, Die Fauna des unteren Senons von Nord-Peru, N. J. Min. etc. BB., vol. 30, p. 756, pl. 26, fig. 1.

Shell large, thin, ventricose; the umbos are very wide, inflated with small beaks, closely adjacent and coiled over the hinge-line; the umbos are nearly central or with the posterior side a little longer than the anterior; there is no differentiated, posterior dorsal area; the sculpture consists of low, but regular ribs separated by well-marked grooved spaces; these ribs are numerous, numbering more than 50; they are flat, plain or mesially divided near the ventral margin; the interspaces are flattened grooves without evidence of former spines; hinge and interior unknown.

Length 60.00 mm.; height 60.00 mm.; semidiameter 24.00 mm.

*Remarks.*—Three specimens from Monte Grande represent the material of this species. They are poorly preserved, the shell being crushed and distorted while the surface is deeply weathered so that their identification with Brüggen's species, although probable, is not certain. They also bear some resemblance to *Cardium Coniacium* d'Orbigny[76] from the French Cretaceous but the Peruvian shell appears to be more inflated.

*Locality and Geologic Occurrence.*—Monte Grande formation, Monte Grande.

### Superfamily ISOCARDIACEA

### Family ISOCARDIIDÆ

### Genus ISOCARDIA Lamarck

**Isocardia wiedeyi,** n. sp. Plate 2, figs. 4, 5

Shell of medium size to large, inflated with wide, prominent umbos and a well-marked posterior-dorsal area; the general outlines of the shell is broadly sub-quadrate, the ventral margin is slightly curved with rounded anterior extremity and subtruncated posterior margins; beaks prosogyrate and approximate, rising above and behind a deep area which is, however, not a typical

[76]D'Orbigny, 1843, Paléontologie Française, Terrain Crétacés, vol. 3, p. 28, pl. 244, figs. 1, 2.

lunule; the shell is quite convex, attaining its greatest inflation in a broad arch or bulge in the region of the anterior one-third and from which the surface slopes gently towards the posterior umbonal ridge; the posterior submargin is limited by an umbonal angle above which the surface is concave or depressed along a medium zone; the shell originally thin has a simple sculpture of concentric striæ and growth-lines; hinge unknown.

Length 55.00 mm.; height 52.00 mm.; semidiameter 23.00 mm.

*Remarks.*—This species is well characterized by its general *Isocardia* form with well-marked posterior areas and elevated, closely approximate beaks. The shell is thin and delicate in texture, the specimens being represented principally by internal casts partly covered by a thin, crystallized coating which has replaced the original shell. The pallial line lies close to the ventral margin.

Certain species of *Anisocardia* Munier-Chalmas bear much resemblance to this form but in *Anisocardia,* the posterior slope is merely rounded and without differentiated submargins. Several species from the Cretaceous rocks of Sergipe in eastern Brazil have been described by C. A. White as belonging to the genus *Isocardia. I branneri*[77] seems to approach nearest to our form but is smaller and narrower.

*Myophoria spiralis* Gabb[78] from Pariatambo should probably be referred to *Isocardia* rather than *Myophoria.* Gabb's species is much smaller than *wiedeyi,* the posterior-dorsal area is flatter and narrower in form and the umbos and beaks more nearly central. Gabb referred his shell without hesitation to *Myophoria* Bronn, a Triassic genus and it was partly because of the occurrence of this form together with *Ammonites carbonarius* (*Oxytropidoceras peruvianum* von Buch) which seemed to have Jurassic rather than Cretaceous affinities, that Gabb referred the fossil beds of Pariatambo to the Lower Liassic.

*Locality and Geologic Occurrence.*—Pananga formation, Pan de Azucar.

[77]White, 1888 Contributions to the Paleontology of Brazil, Archivos do Museu Nacional do Rio Janeiro. vol. 7, p. 81, pl. 6, figs. 18, 19, 20.

[78]Gabb, 1877, Description of a Collection of Fossils, made by Doctor Antonio Raimondi in Peru, Journ. Acad. Nat. Sci. Philadelphia, 2nd. series, vol. 8, p. 289, pl. 41, figs. 4, 4a.

**Isocardia pananga, n. sp.** Plate 2, fig. 2

Shell of medium size, with high and very prominent umbos and small, pointed beaks; in outlines, the shell is subovate to subcircular, except in so far as this contour is modified by the great prominence of the umbos; ventral margin short, rounded with a tendency to become nearly straight or truncate on the anterior and posterior extremities; the valve is strongly convex, this inflation reaching its maximum in the anterior zone or along a line extending from the beaks to the anterior one-third of the ventral margin; the posterior-dorsal region is depressed and limited by an angled, umbonal ridge; valves were originally thin and probably ornamented only with growth lines; interior unknown.

Height 62.00 mm.; length 55.00 mm.; semidiameter 21.00 mm.

*Remarks.*—This species resembles *Isocardia wiedeyi* but is distinguished by its outlines and higher umbos. *Isocardia zitteli* Hzl[79]. from the German Cretaceous is somewhat similar to this species but is larger and with strongly curved beaks.

*Locality and Geologic Occucrrence.*—Pananga formation, Pan de Azucar.

### Superfamily VENERACEA

### Family VENERIDAE

### Genus ANTIGONA Schumacher

**Antigona, sp.** Plate 5, fig. 6

Shell of medium-size, solid, rounded and strongly convex; beaks at the anterior one-third, are closely adjacent, coiled over the flattened lunule; umbones full and wide; posterior-dorsal side curved and strongly arched between the ligamental margin is deeply excavated; the valves are strongly convex, the greatest inflation being located in the middle; the anterior and posterior extremities are evenly rounded and nearly equally produced; the ventral margin is but little rounded; lunule is rather large, flattened and limited by a groove; interior unknown.

Length about 37mm.; height 32 mm.

*Remarks.*—There are several species of Venerids in the Monte Grande collection but their state of preservation is too poor to permit of exact determination. The species here described and figured is the commonest form. It is a medium-sized shell with an average length of about 37 millimeters and

[79]Holzapfel, 1889, Die Mollusken der Aachenar Kreide, Palaeontographica, vol. 35, p. 177, pl. 15, figs. 2, 3, 4a, 4b.

has a surface sculpture of coarse, crowded riblets. It bears some resemblance to Quaas' figures of his *Cytherea Rohfsi* from the Egyptian Cretaceous. Another species from Monte Grande has a sculpture of thin and distantly spaced riblets similar to the surface markings of some species of *Antigona*. There is also a large Venerid at Monte Grande with strongly convex valves and nearly smooth sculpture. It has a length of about 80 millimeters.

*Locality and Geologic Occurrence.*—Monte Grande formation, Monte Grande.

### Genus PTYCHOMYA Agassiz

**Ptychomya, cf. lissoni Sommermeier**

cf. *Ptychomya Lissoni* Summermeier, 1913, Die Fauna des Aptien und Albien im nördlichen Peru, Pt. 2, p. 383, pl. 14, fig. 1.

cf. *Ptychomya Lissóni* Steinmann, 1929, Geologie von Perú, p. 127, textfigure 143.

Our collection contains a fragment of a *Ptychomya* from the Pananga limestones. The specimen is too poorly preserved for exact determination, but in the finer ribbed sculpture on its posterior submargins, it bears considerable resemblance to *Ptychomya lissoni* of Sommermeier and very likely belongs to that species. Sommermeier described *Ptychomya lissoni* from the Hacienda Calluan in the valley of Condebamba where it is found associated with a *Knemiceras* fauna. Lisson[80] has recorded *Ptychomya buchiana* Karsten from the same beds in the Provinces of Cajamarca, Chota and Contumaza.

*Locality and Geologic Occurrence.*—Pananga formation, Pan de Azcuar.

### Genus ICANOTIA Stoliczka

**Icanotia peruviana**, n. sp. Plate 5, fig. 5

Shell of medium size, elongate-ovate or subelliptical; umbos low, inconspicuous, situated at the anterior one-third; the dorsal side is straight; the ventral side is somewhat shorter, curving at the end into the anterior and posterior extremities; the shell is but slightly convex, the greatest inflation lying just above the middle of the valves; the external sculpture is weak; the middle and anterior portions of the surface is smooth and marked only with few widely spaced lines of growth; on the posterior portion

[80]Lisson, 1917, Edad de los Fósiles Peruanos y Distributión de sus Depósitos en toda la Republica. Segunda Edición, pp. 43, 44.

there are strong, radial costae which increase in number and become smaller in size anteriorly, fading away before reaching the middle of the valve; interior unknown.

Length 53.00 mm. (imperfect); height 24.00 mm.; semidiameter 3.50 mm.

*Remarks.*—This species is described from a single valve, the anterior side of which is broken. Other fragments occur in the same rock as the holotype but do not furnish additional information. The shell was thin, smooth, except for growth-lines and strong radial costæ on the posterior portion. Several species of *Icanotia* have been described from Cretaceous rocks and among these, *Icanotia peruviana* is nearest related to *Icanotia Studeri* Pictet and Renevier from the Lower Aptian of Sainte-Croix. Known species of this genus are the following.

*Icanotia escheri* Pictet et Campiche (Valanginian)g Sta. Croix.
*Icanotia intermedia* Pictet et Campiche (Middle Neocomian) Sta. Croix.
*Icanotia studeri* Pictet et Renevier (Lower Aptian) Sta. Croix.
*Icanotia impar* Zittel (Turonian) Gosau Austria.
*Icanotia elegans* d'Orbigny (Turonian) France.
*Icanotia discrepans* d'Orbigny (Turonian) France.
*Icanotia elicita* Stoliczka Arrialoor group, India.
*Icanotia pulchra* Wade Ripley Tennesee.
*Icanotia* sp. Woods Upper Greensands, England.

*Locality and Geologic Occurrence.*—Pananga formation, Pan de Azucar.

### Superfamily TELLINACEA

### Family TELLINIDAE

### Genus LINEARIA Conrad

**Linearia bomarea,** n. sp. **Plate 6, fig. 4**

Shell of medium size, tellinoid, subequilateral, subelliptical; the valves are but moderately convex, the right valve a little more inflated than the left through the flexing of the ventral margin; beaks small, approximate and situated a little posterior of the middle so that the anterior side is a little longer than the posterior; the anterior-dorsal margin is straight, the posterior is more sloping with the two extremities broadly and equally rounded; the ventral margin is widely rounded; surface marking consists of regular, fine, radiating and concentric riblets producing an even, cancellated sculpture; this sculpture is the same over most of the valve surface except on the posterior submargins where the radiating lines become coarse riblets; interior unknown.

Length 47.00 mm.; height 35.50 mm.; diameter 16.50 mm.

*Remarks.*—The above description is based on a specimen with tightly sealed valves. In outline and surface sculpturing, the shell resembles some species of *Semele*. It also bears some resemblance to *Linearia metastriata* Conrad from the North American Cretaceous but is less elongate and differs as well in surface details.

*Locality and Geologic Occurrence.*—Monte Grande formation, Monte Grande.

### Superfamily MYACEA

### Family CORBULIDAE

### Genus CORBULA Lamarck

**Corbula montegrandensis**, n. sp. Plate 6, fig. 7

Shell large for the genus, strongly and equally gibbous, *Leda*-form; valves similar, that of the right being somewhat larger and overlapping the left valve along the posterior side of the ventral margin; ventral side of valves rounded or somewhat contracted; umbos wide, with the small beaks situated a little anterior of the middle; the valves are strongly and equally convex, this inflation greatest in the zone extending across the umbos to the anterior-ventral one-quarter; the posterior side is produced, somewhat flexuous and bluntly pointed at its end; the anterior-dorsal region is flattened; sculpture consists of strong, regular, concentric riblets which number about 12 on the nepionic valves but become merely crowded growth-lines on the ventral portion; interior of valves unknown.

Length 28.00 mm.; height 17.00 mm.; diameter 16.50 mm.

*Remarks.*—Among the recent and Tertiary groups of *Corbula,* this species resembles the members of the subgenus *Caryocorbula* Gardner (genotype, *C. alabamiensis* Lea, Claiborne) but is much larger than most species of this group. In shape, the shell resembles a large *Saccella* (*Leda*) but the valves are somewhat flexuous, less regular in form and with a larger right valve slightly overlapping the left valve along the posterior ventral region. The sculpture consists of strong, regular, concentric riblets which pass into crowded, growth-lines towards the ventral margin.

*Locality and Geologic Occurrence.*—Monte Grande formation, Monte Grande.

### Family SAXICAVIDAE

### Genus PANOPAEA Menard

**Panopaea berryi**, n. sp. Plate 7, fig. 3

Shell of medium size, elongate-ovate; umbos wide and rather prominent ending in the small beaks situated approximately at the anterior one-third; ventral and dorsal margins nearly straight and parallel; the posterior extremity rounded and gaping; the anterior extremity produced and more narrowly rounded, closed; valves are moderately convex, the greatest inflation being located approximately in the middle; surface smooth or ornamented only by lines of growth.

Length 96.00 mm.; height 46.00 mm.; diameter 35.00 mm.

*Remarks.*—This species resembles *P. neocomiensis* d'Orbigny[80] and *P. rostrata* d'Orbigny[81] (figured as *P. arcuata* d'Orb). from the Neocomian of France. *P. neocomiensis* is proportionately longer while in *rostrata,* the greatest inflation of the valves is in the umbonal region.

This species is named for Professor E. W. Berry of John Hopkins University.

*Locality and Geologic Occurrence.*—Pananga formation, Pan de Azucar.

### Glass GASTROPODA

### Subclass STREPTONEURA

### Order ASPIDOBRANCHIA

### Suborder RHIPIDOGLOSSA

### Family NERITIDAE

### Genus DESMIERIA (Bayle) Douville

**Desmieria peruviana**, n. sp. Plate 4, fig. 8

Shell of medium size, with a large body-whorl and small, flattened, eroded spire-whorls; the sculpture consists of two rows of large nodes, one situated near the posterior end of the body-

[81]D'Orbigny, 1843, Paléontologie Française, Terrains Crétacés, vol. 3, p. 329, pl. 353, figs. 3 - 8.
[82]D'Orbigny, op. cit., p. 333, pl. 355, figs. 3, 5.

whorl, a short distance in front of the suture and forming a small shoulder, while the other row lies approximately around the middle; the nodes tend to be a little scabrous and face towards the aperture; between, these rows of nodes, the surface is smooth or simply marked by the coarse, crowded lines of growth; on the sutural side of the posterior row, the growth-lines are at times raised into narrow rib-like extensions which connect these nodes with the suture; between the lower row and the umbilical edge, the ornamentation is principally formed by coarse growth-lines, except that in the center of this zone there are a few obscure traces of spirals; aperture and columellar margin covered with matrix; outer lip oblique.

Height 23.50 mm.; greater diameter 28.00 mm.

*Remarks.*—The aperture and columellar wall is unfortunately covered with a hard matrix which cannot be removed without damage to the specimen and therefore the reference of this species to true *Nerita* or to *Desmieria* cannot be definitely established. The genus *Desmieria* has been fully discussed by Douvillé. It is distinguished from *Nerita*, s. s. in having a series of numerous, large and subregular teeth on the columellar border while in *Nerita*, there are but two small teeth in the same place. In sculpture, *peruviana* would seem to belong to *Desmieria* rather than to *Nerita*. *D. peruviana* bears some resemblance to *D. persica* Douvillé from the Persian Maestrichtian but has only two rows of nodes instead of three, and no spirals.

*Locality and Geologic Occurrence.*—Monte Grande.

### Order CTENOBRANCHIATA

### Superfamily TAENIOGLOSSA

### Family TURRITELLIDAE

### Genus TURRITELLA Lamarck

**Turritella forgemoli,** n. subsp.

cf. *Turritella Forgemolli* Coquand, 1862, Géologie et Paléontologie de la Region Sud de la Province de Constantine, p. 265, pl. 30, fig. 3.

cf. *Nerinea Quettensis* Noetling, 1897, Fauna of the Upper Cretaceous (Maestrichtien) beds of the Mari Hills. Palaeontologica Indica, ser. 16, vol. 1, p. 57, pl. 14, figs. 12, 12a, 13.

cf. *Turritella Forgemolli* Quaas, 1902, Beitrag zur Kenntniss der Fauna der obersten Kreidebildungen in der libyschen Wuste (Overwegischichten und Blatterthone), Palaeontographica, vol. 30, p. 247, pl. 25, figs. 38-40.

cf. *Turritella Morgani* Douvillé, 1904, Mission scientique en Perse par J. de Morgan, vol. 3, Etudes Géologiques, pt. 4, p. 332, pl. 47, figs. 7, 8.
cf. *Turritella Forgemoli* Krumbeck, 1906, Beitrag zur Geologie und Paleontologie von Tripolis, Palaeontographica, vol. 53, p. 114, pl. 9, figs. 4a-b.
cf. *Turritella (Torcula) Forgemoli* Peruvinquiére, 1912, Etudes de Paléontologie Tunisienne, pl. 2, p. 42, pl. 3, figs. 1, 2, 3, 4, 5a-b.
cf. *Turritella Forgemoli* De Stefani, 1912, Fossili della Creta superiore della Tripolitania, Palaeontographica Italica vol. 19, p. 293, pl. 27, figs. 11-14.
*Turritella* cf. *forgemolli* Trechmann, 1927, The Cretaceous Shales of Jamaica, The Geological Magazine, vol. 64, p. 37, pl. 1, fig. 4.

*Turritella forgemoli* is a common species in the late Cretaceous beds of North Africa and probably extended eastward through Persia into Baluchistan. It has also been recorded by Trechmann from Jamaica. According to Coquand, the type of *Turritella forgemoli* was obtained from Lower Eocene beds in Algeria. The species is characterized by its slender form, flat-whorls and usually has a pronounced swelling about the upper suture. The Peruvian shells are similar but lack the sutural swelling or at most it is poorly developed. There are also minor differences in sculpture, the Peruvian subspecies being somewhat coarser sculptured. The shells figured by Peruvinquiere from Tunis have a fine spiral sculpturing while those figured by Quaas from Egypt are nearly smooth. Under the name of *Turritella Morgani,* Douvillé has figured a number of shells of varied aspect but his figures 7 and 8 as suggested by Pervinquière, seem to be typical *forgemoli.*

Our shells are weathered, the intact surface sculpture being preserved on only parts of the shell. There are four primary but not very prominent spirals on each whorl. These spirals are evenly spaced between wide, flat intervals or the anterior pair are slightly wider apart than the posterior pair. They are beaded by the sinuous lines of growth. The growth-lines belong to Guillaume's Class 1.

*Locality and Geologic Occurrence.*—Monte Grande formation, Monte Grande.

### Genus MESALIA Gray

**Mesalia peruviana,** n. sp. Plate 10, fig. 4

Shell of medium size, rather short or stubby in form; nucleus and early spire-whorls unknown; post-nuclear whorls comparatively few in number, there being four preserved on the holotype; they increase rapidly in size so that the shell has a rapid taper; the spire-whorls are sculptured with two, strong spiral ridges which are heaviest on the whorls of the spire but fade away on the body-whorl so that its contour is merely rounded; secondary spirals were present but these are not well-preserved on our specimens; on the spire-whorls, there is a strong spiral lying in the zone between the central carina and the upper suture; on the body-whorl, the spirals number six or more and all are medium in strength and widely spaced; growth-lines sinuous, with a wide sinus in the middle and a forward, basal lobe which as in *Mesalia* extends beyond the general plane of the aperture; the columella appears to have been strongly twisted.

Length 45.00 mm.; diameter 26.00 mm.

*Remarks.*—The material of this species from Monte Grande although abundant is not well preserved, the shells having suffered through exposure to wind erosion or are encrusted with rocky matrix. When adult, the shell is moderately large with rapidly tapering whorls and pointed spire. It thus bears some resemblance to the Eocene group of *Woodsalia negritosensis* Woods[84] of the Negritos formation but the last whorl is not contracted as in *Woodsalia* and the growth-lines are like those of typical *Mesalia.* The two primary spirals which are strong and prominent on the spire-whorls disappear almost entirely on the last whorl while the growth-lines tend to form a costated or rib-like sculpture.

*Locality and Geologic Occurrence.*—Monte Grande formation, Monte Grande.

**Mesalia inca,** n. sp. Plate 10, fig. 5

Shell small, stout; nucleus and early spire-whorls unknown; post-nuclear whorls five or more, the whorls having a rapid taper; they are sculptured with two, strong, primary spirals so that the spire-whorls are biangled in contour; on the last whorl, the primary spirals have diminished somewhat in size leaving the face of this whorl rounded in form; the space between the two primary spirals is rather widely concave, sometimes smooth or it

[84]Olsson, 1929, Eocene Mollusca and Brachiopoda, Bull. Amer. Paleontology, vol. 15, pp. 13, 14, pl. 4, figs. 5, 6.

carries a single spiral thread which increases in strength on the body-whorl; the outer or sutural side of the primary spiral is bordered by a flat or concave space of the same width as the central one; a secondary spiral is present in the lower sutural zone while additional spirals to the number of 9 or 10 may be seen on the rounded base; growth-lines sinuous and *Mesalia*-like, the lower lobe projecting beyond the upper so that the plane of the aperture is inclined forward at the base; these growth-lines may become quite strong, producing a costated sculpture; outer lip thin, the columella slightly twisted.

Length 33.00 mm.; diameter 17.00 mm.

*Remarks.*—This is a much smaller species than *peruviana* with a less rapid taper to its spire and more uniform sculpture. The form of the shell is more nearly that of *Woodsalia* but the growth-lines are like those of *Mesalia*. Douville's[85] figures of *Mesalia fasciata* Lamarck from beds of Maestrichtian age in Persia bear much resemblance to this species but the mature shell of *inca* has a more rounded body-whorl and weaker sculpture.

*Locality and Geologic Occurrence.*—Monte Grande formation, Monte Grande.

### Family MELANIIDAE

### Genus PARAGLAUCONIA Steinmann

**Paraglauconia pananga**, n. sp. Plate 10, fig. 8

Shell of medium size, melanoid; nucleus and early spire-whorls unknown; the body-whorl and the two preceding turns are a little convex in form and ornamented with three, low, finely beaded spiral cords, separated by wide, smooth intervals; these cords are disposed in the following order: a posterior cord bordering the upper suture and partly concealing it, a second spiral situated at the posterior one-third and the same interval below this and above the lower suture, lies a third spiral; a small, plain fourth spiral borders the lower suture and on the body-whorl emerging from the posterior side of the aperture forms the periphery of the body-whorl; base of body-whorl rounded ,smooth except for growth-lines and very minute spirals; growth-lines sinuous noding the spiral cords; the growth-lines form a wide, shallow sinus across the face of the whorl, its axis lying above

[85]Douville, 1904, Mission Scientifique en Perse par J. de Morgan. vol. 3, Etudes Géologiques, Mollusques Fossiles, pp. 329, 330, pl. 47, figs. 23-27.

the middle and along the upper spiral; there is also a very shallow sinus across the base of the body-whorl; outer lip sinuated.

Length 33.00 mm. (imperfect); diameter 17.00 mm.

*Remarks.*—In 1923, Fritzsche[86] proposed *Pseudoglauconia* as a subgenus of *Pleurocera* Rafinesque, the type selected being *Muricites strombiformis* Schlotheim. This group was distinguished from *Glauconia* to which its species had been referred, by its more slender shell and form of aperture. Unfortunately, the name *Pseudoglauconia* had already been used by Douville[87] for a genus of Cerithids of which the genotype is *Pseudoglauconia lissoni* of the Peruvian Eocene. This fact was noted by Lisson[88] but he did not propose a new name. In his Geologie von Perú, Steinmann[89] figured *strombiformis* var. *peruana* Fritzsche under the name of *Paraglauconia,* evidently with the intention of substituting this new name for *Pseudoglauconia* but no direct mention of the change is made.

*Paraglauconia pananga* occurs sparingly in the Pananga limestones at Pan de Azucar. The forms described by Fritzsche as *Pseudoglauconia strombiformis peruana* and *Studeri* are not closely related to our species and belong to a much lower horizon in the Cretaceous section of Peru.

*Locality and Geologic Occurrence.*—Pananga formation, Pan de Azucar.

**Family NERINEIDAE**

**Genus NERINEA Defrance**

**Subgenus PTYGMATIS Sharpe**

**Section TELEOPTYXIS n. sect.**

**Type.—Nerinea peruviana**, n. sp.

The following is a description of the section *Teleoptyxis*.

Shell slender, turriculate, with numerous whorls; the face of the whorls are flattened to concave or excavated in the middle, with smooth or coronated sutures; pillar generally solid, more rarely perforate at intervals; columellar bearing two folds, the

[86]Fritzsche, 1923, Neue Kreidefaunen aus Südamerika (Chile, Bolivia, Perú, Columbia) Beitr. z. Geol. u. Pal. v. Südamerika. 27 N. Jahrb. Min., BB. vol. 50, p. 37.

[87]Douville, 1921, Journ. de Conchyl., vol. 66, p. 9, fig. 1, pl. 2, fig. 1.

[88]Lissón, 1926, Appendice a la obra. "Edad de los Fósiles peruanos y distribución de sus depósitos en toda la república. Soc. Geol. del Perú, vol. 2, p. 45.

[89]Steinmann, 1929, Geologie von Perú, p. 112, fig. 125.

lower (anterior) one much the larger; a hook-shaped parietal fold, curving outward and a large labial fold pointing anteriorly; these folds (except the most posterior columellar one) are large, thickening at the end and along the side, leaving only a narrow, complicated passage for the body of the animal.

*Remarks.*—In his subgenus *Ptygmatis,* Sharpe[90] included two groups of species which have in common, a similar arrangement of their internal folds. The first group or section A, included such species as *Nerinea Conimbrica, Olisponensis* and *Fleuriausa* d'Orbigny which have a solid or merely perforate pillar. In section B, were grouped such species as *Nerinea bruntrutana* Thurm. of the European Oxfordian which have a widely open umbilicus. Sharpe did not designate any type and his description covers both sections but he figured a section of *Nerinea bruntrutana* to illustrate his subgenus. Cossmann[91] has restricted the Subgenus *Ptygmatis* to forms related to *Nerinea bruntrutana* which he selected as the genotype. Typical *Ptygmatis* is principally Jurassic in its stratigraphic range but two Valanginian species have recently been described by Pcelincev[92] from the Caucasus. The Cretaceous species referred to this genus by Cossmann belong elsewhere.

*Teleoptyxis* differs from *Ptygmatis* by its typically solid pillar which is produced anteriorly into a short beak. In some cases, the pillar may be slightly perforate between the sutures but the columella is essentially solid at most stages in the growth of the shell. The internal folds like those of *Ptygmatis* give rise to a complicated internal structure but in other respects are very regular in number and form. The posterior columellar fold (unlike that of *Nerinea bruntrutana*) is much smaller than the others, often showing as a mere protuberance in the cavity between the enlarged anterior columellar and parietal folds. In both *Ptygamatis* and *Teleoptyxis,* the folds have enlarged to such a degree that they leave only a narrow passage of complicated form for

[90]Sharpe, 1850, On the secondary rocks of Portugal, Quart. Journ. Geol. Soc. London, vol. 6, p. 104.

[91]Cossmann, 1896, Essais de Paléoconchologie comparée, vol. 2, p. 32.

[92]Pcelincev, 1927, The Jurassic and Lower Cretaceous Fauna of the Crimea and the Caucasus, Mémoires du Comité Geologique, Lenigrad n. s. no. 172.

the body of the animal which give as expressed by Sharpe, a very whimsical appearance to the sections of the shell. *Teleoptyxis* appears to be restricted to the Cretaceous and includes the following species.

*Nerinea Conimbrica* Sharpe, Portugal
*Nerinea Eschwegii* Sharpe, Portugal
*Nerinea Olisponensis* Sharpe, Portugal
*Nerinea Fleuriansa* d'Orbigny, France

**Nerinea (Teleoptyxis) peruviana**, n. sp. Plate 10, figs. 1, 3

Shell slender, turriculate with numerous, slowly tapering whorls; each whorl is approximately three times as wide as high, excavated in the middle so that the sutures are angled or carinated; internal structure as figured with four folds, there being two folds placed on the pillar and one each on the parietal and labial walls; the posterior columellar fold is very small; shell non-umbilicated; the pillar is enlarged just anterior of the middle of each whorl or in the zone of the anterior columellar fold and a section of the pillar shows the presence of an internal cavity in this region.

Length 115.00 mm.; diameter 30.50 mm.
49.00 mm.; 37.00 mm. (imperfect specimen.

*Remarks.*—This species appears to be related to *Nerinea conimbrica* Sharpe[93] from the Lower Cretaceous of Portugal but differs by its concave, excavated whorls and elevated sutures while those of *conimbrica* are flattened with consequently appressed sutures.

*Nerinea peruviana* is an abundant species in the Pananga limestones and sections of this shell along with those of *Actæonella* are frequently seen on the smooth surface of this rock. *Mrhilaia* cf. *nerinaeformis* Coquand has been recorded by Paulcke[94] (as *Nerinea*) from Hualgayoc but since Paulcke's material was poorly preserved it may possibly represent this species. It is also Gerth's[95] *Nerinea* cf *incavata.*

*Locality and Geologic Occurrence.*—Pananga formation, Pan de Azucar, Muerto, Que. Culebra.

[93] Sharpe, 1850, op. cit. pp. 114, 115, pl. 13, figs. 4a, 4c.
[94] Paulcke, 1903, Ueber die Kreideformation in Sudamerika, etc., N. J. Min. BB., vol. 17, p. 275.
[95] Gerth, 1928, Neue Fauna aus Nordperu, p. 233.

### Family CERITHIIDAE

### Genus CERITHIUM Brugiére

**Cerithium**, sp. Plate 10, fig. 8

The only specimen of this species represented in our collection from Monte Grande is unfortunately very poorly preserved, the shell having been flattened through lateral pressure and the surface deeply weathered. The shell is of medium size (length of six whorls, 53.00 millimeters) with a fairly rapid taper and a sculpture formed by strong, fold-like ribs. The suture is filled with matrix but appears to have been deep and excavated by the ends of the ribs which project above it. By its form and sculpture, this species resembles *"Cerithium" negritosense* Woods from the Salina and Parinas formations of the Negritos region but the poor preservation of the specimen from Monte Grande renders a closer comparison of little value.

*Locality and Geologic Occcurrence.*—Monte Grande formation, Monte Grande.

### Family STROMBIDAE

### Genus PUGNELLUS Conrad

**Pugnellus**, sp. Plate 9, fig. 5

Three specimens of a *Pugnellus* were collected in the sandstones of Monte Grande. These appear to belong to an undescribed species but they are too poorly preserved to be fully characterized. *Pugnellus tumidus* Gabb[96] from Chile is probably related to this species. Gabb's figure of *tumidus* is poor but it shows a strongly angled body-whorl and with callus covering the the long, slender anterior canal and the spire. Philippi's[97] figure of a *Pugnellus* as *tumidus* from Hualpen and the excellent illustration by Wilckens[98] of a specimen from the Cretaceous of Quiriquina do not agree well with Gabb's figure although probably representing the same species. The shells figured by Philippi and Wilckens are stubbier in form, the anterior canal is recurved and the lip and spire are thickly covered with callus. In the Peruvian form, the shells are not noticeably angled, the shoulder

[96]Gabb, 1861, Description of some new species of Cretaceous fossils from South America, Proc. Acad. Nat. Sci. Philadelphia for 1860, p. 197, pl. 3, figs. 13, 14.

[97]Philippi, 1887, Die Tertiaren und Quartaren Versteinerungen Chiles, p. 34, pl. 1, fig. 3.

[98]Wilckens, 1904, Revision der Fauna der Quiriquina-Schichten, N. J., Min. etc., BB., vol. 18, p. 205, pl. 18, figs. 2a, b.

nodes are larger and more widely spaced and there is less callus on the spire and outer lip.

Stewart[99] considered *Pugnellus tumidus* as being related to *hamulus* Gabb from the Californian Cretaceous and these species were referred by Stewart to the genus *Conchothyra* "McCoy" Hutton from New Zealand but as may be seen from the excellent figures given by Wilckens[100] of *Conchothyra parasitica* "McCoy" Hutton, the genotype, the American species are so fundamentially different that they can hardly belong to this peculiar genus of the New Zealand region.

*Locality and Geologic Occurrence.*—Monte Grande formation, Monte Grande.

**Pugnellus ? cypræformis**, n. sp. Plate 9, figs. 4, 6

Shell of medium size; spire small, pointed but at maturity concealed wholly or partly by thick callus; body-whorl, subcylindrical, convex, smooth or having on the shoulder a series of small, linear nodes; anterior canal small and slightly recurved; aperture linear,the outer lip, straight, heavy, the inner lip covered by a thick deposit of callus, the two joining above, around a broad, posterior canal; interior of aperture and columellar region concealed.

| | | | |
|---|---|---|---|
| Length | 53.50 mm.; | diameter | 30.00 mm. |
| | 44.00 mm.; | | 28.50 mm. |

*Remarks.*—The generic reference of this perculiar species to *Pugnellus* is tentative, pending the discovery at Monte Grande or elsewhere of better preservel material. Young shells are *Strombus*-like with a small, pointed spire and straight, slightly thickened outer lip. Old shells, through the increased thickening of the outer lip and spread of callus growth on the inner wall and around the posterior canal, assume a *Cypraea* or *Marginella*-like form. The callus deposit is thickest around the posterior canal, covering the spire and adding to the length of the outer lip. Unfortunately, the interior of the aperture is concealed by hard, rocky matrix. On the back of the body-whorl, there are usually six or more node-like undulations similar to those seen

[99]Stewart, 1926, Gabb's California Fossil Type Gastropods, Proc. Acad. Nat. Sci. Philadelphia, vol. 78, p. 358.

[100]Wilckens, 1922, Geol. Sur. of New Zealand, Paleontology, Bull. 9, pp. 14-17, pl. 3, figs. 1-6; pl. 4, figs. 1, 2.

on many species of *Pugnellus.*

*Locality and Geologic Occurrence.*—Monte Grande formation, Monte Grande.

### Genus CALYTRAPHORUS Conrad

**Calyptraphorus hopkinsi,** n. sp. Plate 10, fig. 2

Shell of medium size, subfusiform; spire long, acute, composed of several whorls with the sutures concealed by a film of callus; the body-whorl of medium size with the anterior canal a little shorter and more tapering than the spire; aperture narrow, ending at the upper end in a posterior canal which is continued to the tip of the spire and then down the opposite side to the middle of the body-whorl; due to the extension of the posterior canal, the whorl section appears to be compressed or flattened; surface smooth, with a small rib or fold developed on the back of the body-whorl; with the callus film removed, the spire-whorls are seen to be ornamented with straight, widely spaced, fold-like ribs; these ribs are nearly in line or extend across the sutures; there are 10 ribs to each turn, strongest on the earliest whorls but disappear before reaching the penultimate; spirals absent.

Length 32.00 mm. (imperfect); diameter 24.00 mm.

*Remarks.*—The genus *Calyptraphorus* is most characteristic of Eocene deposits and its occurrence in the late Cretaceous rocks of northern Peru is therefore of interest, especially since it is still unknown in the Peruvian Eocene where its place is taken by *Aulacodiscus.* Two other species of *Calyptraphorus* have been described from Cretaceous deposits. *Calyptraphorus septentrionalis* Stanton[101] from the Cannonball marine member of the Lance formation of North Dakota and *Rostellaria palliata* Forbes[102] from the Arrialoor group of India. Neither of these species resemble *hopkinsi.* *Calyptraphorus ? chelonites* White[103] from the Maria Farinha beds of eastern Brazil, is a small, delicate form, probably of Eocene age.

[101]Stanton, 1920, The Fauna of the Cannonball Marine Member of the Lance Formation, U. S. Geol. Survey, Prof. Paper 128-A, p. 39, pl. 7, figs. 5a-5d, 6.

[102]Stoliczka, 1868, Cretaceous fauna of southern India, Palaeontographica Indica, vol. 2, pl. 2, figs. 18-20.

[103]White, 1888, Contributions to the Paleontology of Brazil, Archivos de Museu Nacional do Rio Janeiro, vol. 7, p. 174, pl. 11, figs. 17-19.

*Locality and Geologic Occurrence.*—Monte Grande formation, Monte Grande.

### Superfamily RACHIGLOSSA

### Family BUCCINIDÆ

### Genus PSEUDOLIVA Swainson

**Pseudoliva,** sp.

One specimen of a large *Pseudoliva* was collected from a hard, green sandstone interbedded amongst black shale in the bed of a small tributary of Quebrada Monte Grande. Only a part of the ventral side of the body-whorl is visible, the spire being concealed by matrix and the outer lip is broken.

The spire is slightly elevated, conic, with a large expansive body-whorl forming more than four-fifths of the whole shell. The shoulder was ornamented or notched with strong, fold-like ribs which extend not quite to the middle of the whorl beyond which the dominate sculpture is formed by coarse, revolving grooves. The anterior canal is narrowly umbilicate or perforate. Above the basal grooves, the surface of the whorl aside from axial ribs appears to be smooth.

Compared with similar species, the Peruvian form resembles *Pseudoliva libyca* Quaas[104] from the Overweigischichten of Egypt both species having the axial ribs continued downward over the face of the whorl. In the Egyptian shell, the surface is sculptured with strong spirals and the basal grooves are apparently weaker than in the Peruvian form. *Pseudoliva dechordata* White[105] (as *Harpa*) from the Maria Farinha beds of eastern Brazil is also very similar, the only marked difference being the higher spire and weaker basal spirals. According to White, the surface of the anterior volution is apparently plain except that a little forward of the middle, it has a slender, impressed revolving line. *Sulcobuccinium Michelini* Coquand[106] from the Suessonian of Constantine has a higher spire with shorter ribs

[104]Quaas, 1902, Beitrag zur Kenntnis der Fauna der obersten Kreidebildungen in der libyschen Wüste, Palaeontographica, vol. 30, p. 274, pl. 27, figs. 1, 2.

[105]White, 1888, Contributions to the Paleontology of Brazil, Archivos do Museu Nacional do Rio Janeiro, vol. 7, p. 136, pl. 13, figs. 7, 8.

[106]Coquand, 1862, Géologie et Paléontologie de la Region Sud de la Province de Constantine, p. 268, pl. 30, figs. 1, 2.

confined principally to the shoulder. In a similar way, the Eocene species from Peru such as the group of *Pseudoliva mutabilis* Woods and especially its subspecies *woodsi* Olsson differs by its shorter, more knob-like, shoulder ribs while the whole surface is lined with spirals.

*Locality and Geologic Occurrence.*—Monte Grande formation, Monte Grande.

### Family FASCIOLARIIDAE

### Genus FASCIOLARIA Lamarck

**Fasciolaria ? calappa,** n. sp. Plate 4, fig. 2

Shell large, solid, volutiform; spire elevated, about one-third the length of the shell; nucleus and early spire-whorls unknown; the body-whorl is large with a strong shoulder keel between which and the suture there is a wide, flattened or concave area; on the body-whorl, the shoulder is a heavily carinated ridge, below which the face of the whorl is slightly contracted; surface of shell smooth or ornamented only by growth-lines; character of inner and outer lip unknown.

Height 128.00 mm.; diameter 93.00 mm.

*Remarks.*—There are several worn and imperfect specimens of this peculiar species in our collection. In form the shell resembles certain types of the *Volutidæ* but the columellar wall exposed on a broken, adult specimen is smooth or shows no traces of folds and plaits. The shell also resembles the aberrant genus *Thersitea* Coquand (genotype, *Thersitea gracilis* Coq.) of the North African Eocene by its strongly thickened shoulder keel but it differs by its non-contracted anterior canal and outer lip. Until more perfect specimens are known, this very characteristic species of the Monte Grande formation, is referred tentatively to *Fasciolaria*.

*Locality and Geologic Occurrence.*—Monte Grande formation, Monte Grande.

### Subgenus CRYPTORHYTIS Meek

**Fasciolaria (Cryptorhytis) cf. Bleicheri**, Thomas and Peron

cf. *Fusus Bleicheri* Peron, 1889, Invertébrés fossiles des terrains Crétacés de la region sud des Hauts-Plateaux, p. 90, pl. 22, figs. 5, 6.
cf. *Fasciolaria* (*Cryptorhytis*) *Bleicheri* Pervinquière 1912, Etudes de Paléontologie Tunisienne, pt. 2, p. 70, pl. 5, figs. 12a, b, 13, 14, 15a, b.
*Fusus Bleicheri* Brüggen, 1910, Die Fauna des unteren Senons von Nord-Peru, N. J. Min. etc. BB. vol. 30.
*Fusus Bleicheri* Steinmann, 1929, Geologie von Peru, p. 164, text figure 199.

This record is based on a sandstone cast of the body-whorl and a small part of the preceding turn. This specimen measures 117 millimeters but in its perfect form probably equaled 145 millimeters. It resembles Brüggen's figure of a specimen from Otusco near Cajamarca and identified with *Fusus Bleicheri* of North Africa. Peron's figure of the original specimen from Tunis show a shorter and broader form but like our shell is imperfect, lacking the spire. Pervinquière united with *F. Bleicheri*, a series of shells showing considerable variation, from slender forms approaching *Fusus Assaillyi* Thomas and Peron to the more typical shell illustrated by his figures 15a and b. In Africa *F. Bleicheri* is recorded by Pervinquière only from the Lower Senonian or the Coniacian.

*Locality and Geologic Occurrence.*—Monte Grande formation, Monte Grande.

### Subclass EUTHYNEURA

### Order OPISTHOBRANCHIA

### Suborder TECTIBRANCHIATA

### Family ACTEONIDAE

### Genus ACTAEONELLA d'Orbigny

**Actæonella peruviana**, n. sp. Plate 9, fig. 7

*Actaeonella (Volvulina)* spec. Gerth, 1928, Neue Faunen der oberen Kreide mit Hippuriten aus Nordperu, Leidsche Geologische Mededeelingen, Deel 11, Aflevering 4, V 1928, p. 233.

Shell large, elongate, cylindrical, somewhat broader in the anterior portion than in the posterior; body-whorl completely enveloping the preceding turns but with the posterior portion of the shell somewhat contracted and produced; section of the shell shows numerous whorls which are not reabsorbed; columella with three plaits; external surface smooth; aperture narrow, linear, following the contour of the shell.

Length 100.00 mm.; diameter 30.00 mm.

*Remarks.*—To the species of *Actæonella* such as *A. lævis* d'Orbigny, Stoliczka in 1868, proposed the name *Volvulina* but Meek in 1863 had already designated *A. lævis* as type of true *Actæonella.* For the species with an exerted spire with *A. gigantea* Sowerby as genotype, the name, *Trochactaeon* was given by Meek at the same time.

*Actæonella peruviana* together with *Nerinea peruviana* and *Peruvia gerthi* are the most common and characteristic fossils present in the Pananga limestones. Young shells of *Actæonella peruviana* are less evenly cylindrical than the adult form, the posterior or apical portion being more widely contracted and produced. With maturity, the shell becomes large, cylindrical or cigar shaped. The average size of the adult is about 100 millimeters but fragments indicating a length exceeding 115 millimeters are also known. The columella has three folds. The *Actæonella* (*Volvulina*) cf. *lævis* recorded by Gerth[107] from the *Actæonella-Rudistenkalkstein* on the south slopes of the Silla de Paita is probably not this species.

*Locality and Geologic Occurrence.*—Pananga formation, Pan de Azucar, Muerto, Que. Culebra.

### Genus PERUVIA, n. gen.

**Type.—Peruvia gerthi,** n. sp.

The following is a description of the genus *Peruvia*.

Shell ovate, globose; the spire is pointed, its sides impressed but completely enveloped by the last whorl; base of shell is rounded with a short, projecting beak; aperture narrow, somewhat wider in front and extending the full length of the shell; the pillar and anterior portion of each whorl is strongly thickened with callus deposit; columellar folds are absent at maturity or they are reduced to a single, small plait situated at the upper edge of the callus on the parietal wall.

*Remarks.*—Although one of the commonest fossils in the Pananga limestone, a perfect specimen of this curious form is not known. In its usual weathered and fragmentary state, *Peruvia* is easily mistaken for *Actæonella gigantea* Sowerby and doubtless such a specimen was the basis of Gerth's record of *Actæonella* cf. *gigantea* from Pan de Azucar. The spire is pointed, attenuated with impressed sides but completely enveloped by the body-whorl as occurs in *Actæonella laevis* d'Orbigny but true columellar plaits such as those of *Actæonella* appear to be absent from mature shells. A transverse section reveals a pronounced thickening of the columella and anterior wall of each whorl filling the space between them. This callus deposit increases with

[107]Gerth, 1928, op. cit., p. 235.

age and in full-grown shells forms a thick growth materially diminishing the cavity formerly occupied by the soft parts of the mollusk. The early whorls show two small, fold-like wrinkles, the posterior one being constantly a little stronger and situated on the parietal wall at the upper end of the callus. On the last few turns only the posterior wrinkle has persisted the others being submerged in callus growth. If these plait-like wrinkles seen on the earlier whorls are true folds they might indicate a remote relationship with *Actæonella* which *Peruvia* resembles by its enveloped spire and general external form but the folds are on the parietal wall and not on the pillar while the exaggerated callus-growth of the pillar and lower aperture is quite foreign to any of the known species of that genus.

**Peruvia gerthi**, n. sp. Plate 9, figs. 1, 2, 3

Shell of medium size, ovate, globose; spire completely enveloped by the last turn but with the posterior or apical portion of the shell somewhat produced and pointed; the sides of the whorls in the posterior region are noticeably impressed, while just below the whorl appears slightly shouldered; the base of the body-whorl is rounded ending in a small, projecting beak; surface smooth except for lines of growth; characters of complete aperture unknown; pillar solid without folds; internal characters as described above.

Height 50.00 mm.; diameter 34.00 mm.

*Locality and Geologic Occurrence.*—Pananga formation, Pan de Azucar.

### Class CEPHALOPODA

### Subclass TETRABRANCHIATA

### Order AMMONOIDEA

### Suborder EXTRASIPHONATA

### Family TURRILITIDAE

### Genus HELICOCERAS d'Orbigny

**Helicoceras**, sp. Plate 10, fig. 6

The sole record of the occurrence of Ammonites in the Monte Grande fauna is based on a small fragment showing a quarter turn of a spirally coiled species. The whorls are rounded in section with two rows of coarse tubercles, the first or most posterior set situated just above the middle, the other and larger row placed on the edge of the base. The space between these rows of tubercles is smooth but have on their outer or sutural sides, a series of small ribs which extend into the umbilical region. The coiling was probably right-handed and the species is provisionally referred to the genus *Helicoceras* of d'Orbigny.

*Locality and Geologic Occurrence.*—Monte Grande formation, Monte Grande.

**Puzosia emerici** Raspail

*Ammonites Emerici* Raspail, 1831, Ann. des Sc. d'Observation, vol. 3, pl. 12, figs. 6.

*Ammonites Emerici* d'Orbigny, 1840, Paléontologie Francaise, terrains Crétacés, vol. 1, p. 160, pl. 51, figs. 1-3.

*Puzosia* cf. *Emerici* Sommermeier, 1910, Die Fauna des Aptien und Albien im nördlichen Peru, Part 1, Cephalopoden, N. J. Min. etc., BB. vol. 30, p. 373.

*Puzosia Emerici* Steinmann, 1929, Geologie von Perú, p. 123, textfigure 135.

This species is represented in the collection from Pan de Azucar by a slightly weathered specimen measuring 155 millimeters in its greater diameter. It resembles the figure given by Steinmann of a specimen from Cashapucro, W Sihuas except that the umbilicus (nearly filled with matrix) appears to be slightly smaller. There are marks of seven, radial furrows while eight are shown on the specimen figured by Steinmann. D'Orbigny's figure of *Ammonites Emerici* shows a much smaller shell with relatively wider umbilicus and nearly circular section to its body-whorl. Section of the body-whorl of the Peruvian shell is broadly elliptical. Doubtless the Peruvian and French forms are closely related but whether they are exactly conspecific cannot be determined with the material at present known. According to Sommermeier, *Puzosia emerici* is an index fossil for the Upper Aptian.

*Locality and Geologic Occurrence.*—Pananga formation, Pan de Azucar.

### Family DIPOLOCERATIDAE

#### Genus OXYTROPIDOCERAS Stieler

**Oxytropidoceras parinense**, n. sp. Plate 11, fig. 1, 4

*Schloenbachia acuto-carinata* Gerhardt, 1897, Beitrag zur Kenneniss der Kreideformation in Columbien, N. J. Min. etc., BB. vol. 11, pp. 195-196, pl. 5, fig. 19. (not Shumard).

*Schloenbachie (Mortoniceras) Royssiana* Gerth, 1928, Neue Faunen der oberen Kreide mit Hippuriten, Leidsche Geologische Mededeelingen, Deel 2, Aflevering 4, V 1928, p. 233, (not of d'Orbigny).

Shell large, with numerous, sigmoidal ribs and wide, thin keel; the coiling is polygral, sub-angustumbilicate (umbilicus about one-fourth the diameter); whorl section compressed with the sides flattened to slightly convex, then curving more strongly on the dorsal and ventral sides; the venter is alticarinate or provided with a wide, thin keel which is approximately one-fifth of the whorl section; the ornamentation consists of numerous, regular, sigmoidal ribs which are either single or bifurcate on parts of the shell; the ribs are separated by spaces which are twice the width of their summits or upper section; these ribs are oblique, curving forward at their dorsal ends but are less oblique in their middle portion and then bending into a smooth curve as they approach the umbilicus; the sides of the ribs appear to be nearly equally steep; a forking of the ribs takes place in the zone bordering the suture but seldom extends beyond the dorsal quarter; on the holotype, there are 49 to 50 ribs on the last half volution; characters of the inner whorl are not known; suture lines not preserved.

*Remarks.*—Among some fossils collected by Humboldt and Bonpland at Montán, during their crossing of the Peruvian Andes in 1802, were fragments of a large Ammonite later described by Von Buch[108] as *Ammonites peruvianus.* The original specimens of Humboldt-VonBuch have been studied by Schlagintweit together with additional material collected in the same region by Sievers. According to Schlagintweit,[109] the types of *Ammonites peruvianus* are casts which were derived from the black, bituminous limestones ("Stinkkalk") of the so-called upper Albian

[108]Buch, L. v., 1839, Pétrifications recueillies en Amérique par M. Alexandre de Humboldt et par Mr. Charles Degenhardt. Berlin, pp. 5, 6, figs. 5, 6, 7.

[109]Schlagintweit, 1911, Die Fauna des Vracon und Cenoman in Peru, N. J. Min. etc., BB. vol. 33, pl. 71.

(or Vraconian) series of Central and Northern Paru, and thus belong to a formation, equivalent to beds 6 to 10 of Steinmann's section along the Central Railway of Peru between Yauli and Viscas; to the black shales of Pariatambo and to the Upper Muerto limestones of Upper Parinas. *Ammonites carbonarius* Gabb[110] from Pariatambo must be held a synonym of *peruvianus* as maintained by Schlagintweit and Lisson.[111] *Ammonites acutocarinatus* Shumard from Texas was identified with *peruvianus* by Marcou but as noted by White[112] and by Adkins,[113] Shumard's figure is so badly drawn that this species most remain doubtful until the types have been refigured. The common *Oxytropidoceras* in Texas currently identified as *acutocarinatum* is a species of the *peruvianum* group. Schlagintweit, who adopted an ultra-conservative course, placed *peruviana, carbonaria* and *acutocarinata* together with White's[114] *buarquiana* from eastern Brazil as synonymous with d'Orbigny's *Roissyana,* but in the light of recent knowledge this view cannot be accepted.

*Schloenbachia multifida* Steinmann[115] originally described as a variety of *peruviana* is probably a distinct species as held by Spath[116] differing by its narrower whorl section and by its persistently forked ribs, this branching beginning along the middle line of the whorl. In *acutocarinata* according to Spath (probably true also of *peruviana*), the ribs may bifurcate in the young but they are mainly simple on the outer whorl. The specimens which Douglas[117] figured as *Schloenbachia multifida* from Saco

[110]Gabb, 1877, Description of a collection of fossils, made by Dr. Antonio Raimondi in Peru, Journ. Acad. Nat. Sci. Philadelphia, 2nd series, vol. 8, p. 269, pl. 38, figs. 2, 2a, 2b.

[111]Lisson, 1917, Edad de los Fósiles Peruanos y Distributión de sus Depositos en toda la Republica, Segunda Edictión, p. 114.

[112]White, 1888, Contributions to the Paleontology of Brazil, Archivos do Museu Nacional do Rio Janeiro, vol. 7, p. 224.

[113]Adkins, 1928, Handbook of Texas Cretaceous fossils, University of Texas Bulletin, No. 2838.

[114]White, 1888, op. cit, under 5, p. 222, pl. 24, figs. 3-6, pl. 25, figs. 7, 8.

[115]Steinmann, 1881, Über Tithon und Kreide in den peruanischen Anden, N. J. Min. etc., vol. 2, p. 139, pl. 7, fig. 1.

[116]Spath, 1928, Ammonoidea of the Gault, Mon. Pal. Soc. London, p. 351.

[117]Douglas, 1921, Geological Sections through the Andes of Peru and Bolivia, Pt. 3, Quart. Journ. Geol. Soc. London, vol. 77, p. 267, pl. 16, figs. 2-5.

near Oroya, have the wide, flattened unbranched ribs and grooved interspaces of *peruviana* and doubtless belonged to this species rather than *multifida*. On the other hand, Reesides,[118] specimens from near Archidona in eastern Ecuador and identified as *Oxytropidoceras* (*Manuaniceras*) *carbonarium* Gabb should be referred to *multifidum*.

*Oxytropidoceras peruvianum* and *multifidum* form a natural group of large species with wide, flattened ribs separated by narrow intervals or simply grooved interspaces. Specimens fully half a meter in size are mentioned by Schlagintweit. To this group belongs the Texan form generally identified as *acutocarinatum*. The Peruvian species are probably restricted in their stratigraphic range to the bituminous limestones and black shales of the Upper Albian series in Peru.

*Oxytropidoceras parinense* is probably the species recorded by Gerth as *Schloenbachia* (*Mortoniceras*) *Royssiana* from Pan de Azucar. The French species, *roissyanum* which is the genotype of *Oxytropidoceras* Steiler[119] (and *Pseudophacoceras* Spath,[120] 1921) differs from *parinense* by its smaller size, more rounded sides and hence broader whorl section, the keel is less high and the ribs are fewer and heavier. Among Texan species, *Oxytropidoceras parinense* resembles some of the forms figured by Adkins[121] and grouped with *belknapi* Marcou but true *belknapi* has fewer and stronger ribs while the other forms associated with this species by Adkins have only simple, unbranched ribs. The fragment figured by Gerhardt from Colombia as *Schloenbachia acuto-carinata* may belong to this species but certain identification is not possible. The form figured by Douvillé as Schloenbachia cf. *Roissyana* from Truxillo appears to be a species of

[118]Reeside, 1927, In Wasson and Sinclair, 1927, Bull. Amer. Assoc. of Petroleum Geologists, vol. 11, pp. 1271, 1272, pl. 12, figs. 18-20.

[119]Steiler, 1920, Über sogenannten Mortoniceraten des Gault, Centrb. f. Min. etc., p. 346.

[120]Spath, 1922, Cretaceous Ammonoidea from Angola. Trans. Royal Society of Edinburgh, vol. 53, pt. 1, p. 98.

[121]Adkins, 1928, op. cit. under 6.

*Pervinquièria.*

From the group of *Oxytropidoceras peruvianum,* this new species is distinguished by its wider umbilicus, narrower whorl section, flattened and nearly parallel sides and by its numerous, elevated ribs which occasionally fork in the dorsal quarter. To this species should probably be referred the specimen figured by Douglas[122] as *Schloenbachia* sp, [cf. *acutocarinata* (Schumard)] Böse from near Oroya. *Oxytropidoceras parinense* is very common in the Pananga limestones and thus occurs at a lower horizon than the members of the *peruvianum* group.

*Locality and Geologic Occurrence.*—Pananga formation, Pan de Azucar.

**Oxytropidoceras** cf. **karsteni** Stieler Plate 11, fig. 3, 5

*Oxytropidoceras Karsteni* Stieler, 1920, Uber sogenannten Mortoniceraten des Gault, pp. 395-397, figs. 8, 9.
*Venezoliceras karsteni* Spath, 1928, Ammonoidea of the Gault, Mon. Pal. Soc. London, p. 349.

A fragment consisting of a quarter turn of the last whorl but lacking the venter and keel, is tentatively referred to *Oxytropidoceras karsteni* Stieler from Venezuela. A cross-section of the whorl shows the compressed form and flattened sides of *karsteni.* The ribs are strong, nearly straight from the dorsum angle to the ventral quarter where they curve forward towards the keel. The ribs number 14 to 15 on the quarter turn as described for *karsteni.* The fragment figured by Reeside[123] as *Oxytropidoceras,* n. sp. aff. *O. belknapi* Marcou from near Archidona in eastern Ecuador, somewhat resembles this species but its whorl section is quite different.

*Locality and Geologic Occurrence.*—Pananga formation, Pan de Azucar.

### Genus SCHLOENBACHIA Neumayr

**Schloenbachia leonora,** n. sp. Plate 11, figs. 2, 6

Shell of medium size, robust; early whorls unknown; cross-section of the last whorl more than twice as high as wide, the sides slightly convex to flattened, nodosely-shouldered on the dorsum and ventral angle, with the slope of the venter flat and

[122]Douglas, 1921, op. cit. under 10, p. 269, pl. 16, fig. 1.
[123]Reeside, 1927, In Wasson and Sinclair, Geological Explorations East of the Andes in Ecuador, Bull. Amer. Assoc. Petr. Geologists, vol. 11, p. 1280, pl. 13, figs. 1, 2.

probably carinate in the middle; coiling polygral, sub-latumbilicate or with the umbilicus one-third the diameter of the shell; sculpture of last whorl consists of weak but well-formed ribs which are strongest on the middle and dorsal sides but tend to fade away near the ventral shoulder; these ribs have each 3 or 4 sharp nodes, those along the dorsal angle being the strongest; near the ventral angle, a small, low rib may appear between the primary ones so that they appear to fork; the ribs number about 16 or 17 on the last whorl, there being 8 preserved on the type specimen; the ventral shoulder is angled and carries strong, undulated and rather sharp nodes; ventral slope flattened and probably provided with a small median keel; aperture and sutures unknown.

Diameter 170.00 mm.; umbilicus 65.00 mm.

*Remarks.*—This species is based on two fragments collected from limestone concretions in the Copa Sombrero shales of Quebrada Leonora. Both specimens show only the right side of half of the last whorl. The characteristic features are the well-formed ribs which are roughly nodose on their summits and with smaller ribs appearing between them as well as the strongly undulate-carinate shoulder angle. A ventral keel was probably present but this character is merely indicated on the type specimen. *Schloenbachia rhombifera* Gerhardt from Cundimarca Colombia is distantly related to *leonora* but the ribs are less well-formed in the Colombia species. In Europe the zone of *Schloenbachia varians* Sowerby and *subtuberculata* Sharpe characterize the Lower Chalk.

*Locality and Geologic Occurrence.*—Copa Sombrero formation, Que. Leonora near Copa Sombrero.

**Subphylum ECHINOZOA**

**Class ECHINOIDEA**

**Order EXOCYCLOIDA**

**Suborder HOLECTYPINA**

**Family PYGASTERIDAE**

**Genus HOLECTYPUS Desor**

**Holectypus planatus numismalis** Gabb

*Discoidea numismalis* Gabb, 1877, Description of a collection of fossils, made by Dr. Antonio Raimondi in Peru. Journ. Acad. Nat. Sci.

Phila., 2nd. ser., vol. 8, p. 300, pl. 43, fig. 3.
*Holectypus numismalis* Paulcke, 1903, Uber die Kreideformation in Sudamerika und deren Beziehungen zu anderen Gebieten. N. J. Min. etc., BB. vol. 17, p. 261.
*Holectypus Paulckei* Bravo, 1905, Apuntes sobre la Paleontologia de Yauli, Boletin del Cuerpo de Ingenieros de Minas del Peru, p. 9, pl. 1, figs. 1-8.
?*Holectypus* sp. n. sp. Salfeld, 1911, Fossilien aus der oberen Kreide von Peru, in Hauthal, Reisen in Bolivien und Peru, p. 219, pl. 4, fig. 1.
*Holectypus planatus* Roemer var. *numismalis* Sommermeier, 1913, Die Fauna des Aptien und Albien im nordlichen Peru, Part 2, N. J. Min. etc., BB. vol. 36, pp. 394-395, pl. 15, figs. 1-3.
*Holectypus, planatus* F. Roe. var. *numismalis* Steinmann, 1929, Geologie von Peru, pp. 130, 131, textfigure 153.
*Holectypus planatus* Roemer, var. *numismalis* Weaver, 1931, Paleontology of the Jurassic and Cretaceous of West Central Argentine, Memoirs of the University of Washington, vol. 1, pp. 170, 171, pl. 12, figs. 20-22.

Sommermeier and Lisson[125] have recorded this echinoid from several localities in beds of Aptian age in Peru. From typical *planatus* of Texas, the Peruvian subspecies differs in being more depressed with flatter sides and lower apex as shown in the figures given by Sommermeier and Steinmann. Our single specimen from Pan de Azucar is deeply eroded on one side but the right side and a small part of the base is well preserved. The profile of this specimen is intermediate between that of true *planatus* and Gabb's *numismalis*. As our specimen is too poorly preserved to give an adequate figure, the following dimensions may serve to show its general proportions. Basal diameter 72.00 mm.; height 31.00 mm. Douglas[126] recorded this echinoid together with *Enallaster texanus* Roemer (also an Aptian species) at Kilometer 225 on the Lima-Oroya railroad from a limestone which he referred to the Cenomanian as this horizon appeared to overlie beds of Albian age with *Schloenbachia multifida*. As the rocks in this region have been greatly disturbed, this section is probably inverted with the *Holectypus* limestone

[125]Lisson, 1917, Edad de los Fosiles Peruanos y Distribucion de sus Depositos en toda la Republica. Segunda Edicion, pp. 41-46.

[126]Douglas, 1921, Geological Sections through the Andes of Peru and Bolivia, III. From the Port of Callao to the river Pirene, Quart. Jour. Geol. Soc. of London, vol. 77, pp. 246.

belonging normally beneath the Albian beds as elsewhere in Peru. Weaver has recently recorded *numismalis* from the upper portion of the Agrio formation in northern Argentine in beds which are correlated with the Aptian. According to Adkins,[127] *Holectypus planatus* Roemer is found in the Frederickburg and Washita division of the Texan Comanchean.

*Locality and Geologic Occurrence.*—Pananga formation, Pan de Azucar.

[127]Adkins, 1928, Handbook of Texas Cretaceous Fossil, University of Texas, No. 2838, p. 282.

# EXPLANATION OF PLATES

(Plates furnished by the author)

## PLATE I

## EXPLANATION OF PLATE 1

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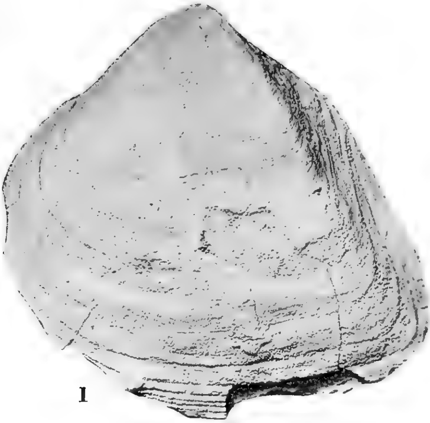
2

Explanation of Plate 2

## EXPLANATION OF PLATE 2

| Figure | | Page |
|---|---|---|
| 1. | **Trigonarca meridionalis**, n. sp.<br>Holotype, length 74.00 mm.<br>Monte Grande. | 24 |
| 2. | **Isocardia pananga**, n. sp.<br>Holotype, height 62.00 mm.<br>Pan de Azucar. | 54 |
| 3. | **Trigonarca meridionalis**, n. sp.<br>Paratype, length 83.00 mm.<br>Monte Grande. | 24 |
| 4. | **Isocardia wiedeyi**, n. sp.<br>Holotype, length 52.00 mm.<br>Pan de Azucar. | 52 |
| 5. | **Isocardia wiedeyi**, n. sp.<br>Paratype, length 50.00 mm.<br>Pan de Azucar. | 52 |
| 6. | **Roudaireia jamaicensis peruviana**, n. sub. sp.<br>Holotype, length 62.00 mm.<br>Monte Grande. | 42 |



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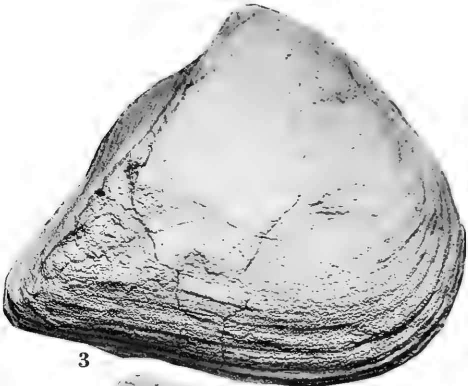

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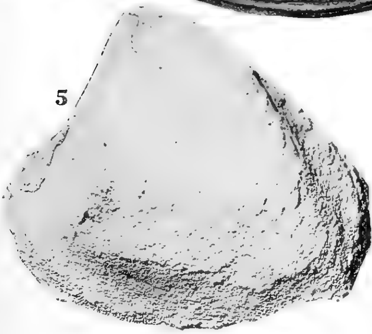

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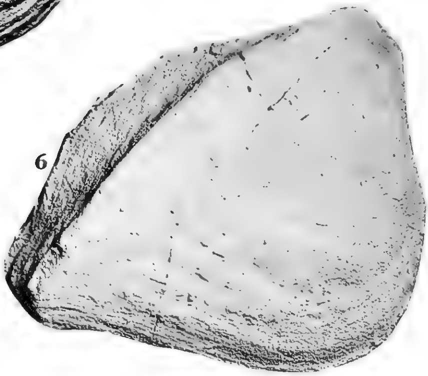

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Explanation of Plate 3

## EXPLANATION OF PLATE 3

| Figure | | Page |
|---|---|---|
| 1. | **Pseudocucullæa gregoryi,** n. sp.<br>Holotype, length 92.00 mm.<br>Monte Grande. | 22 |
| 2. | **Plicatula harrisiana,** n. sp.<br>Paratype, height 52.00 mm.<br>Monte Grande. | 33 |
| 3. | **Plicatula harrisiana,** n. sp.<br>Holotype, height 73.00 mm.<br>Monte Grande. | 33 |
| 4. | **Ostrea (Lopha) stappenbecki,** n. sp.<br>Holotype, length 57.00 mm.<br>Monte Grande. | 27 |
| 5. | **Ostrea (Lopha) stappenbecki,** n. sp.<br>Paratype, length 48.00 mm.<br>Basal view.<br>Monte Grande. | 27 |
| 6. | **Spondylus hopkinsi,** n. sp.<br>Holotype, height 81.00 mm.<br>View of left valve.<br>Monte Grande. | 32 |

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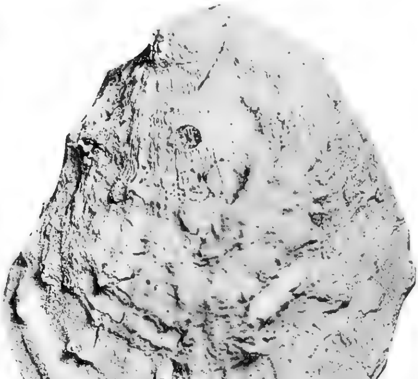

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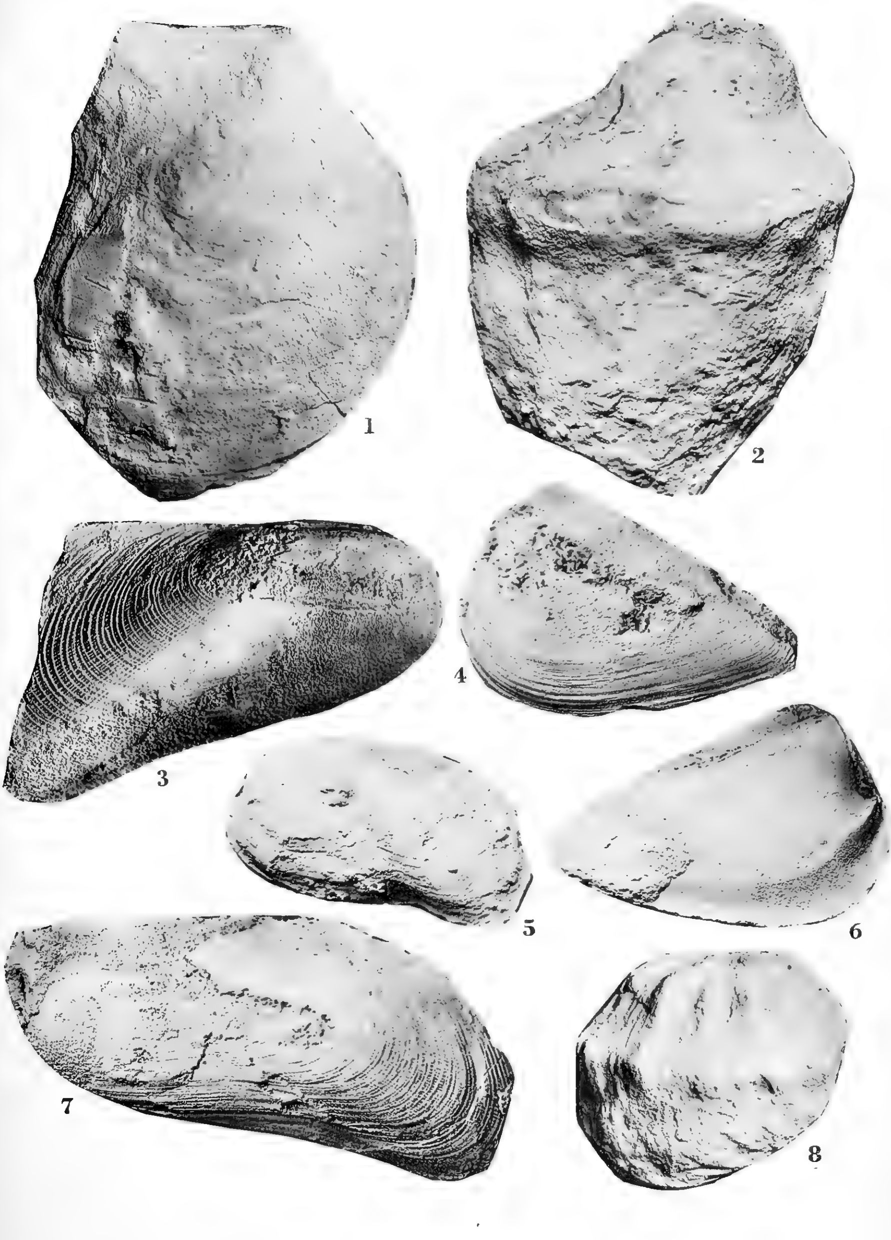
Explanation of Plate 4

## EXPLANATION OF PLATE 4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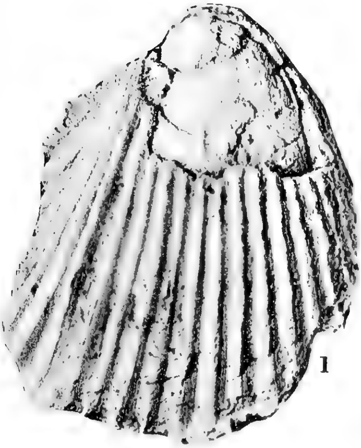
Explanation of Plate 5

## EXPLANATION OF PLATE 5

| Figure | | Page |
|---|---|---|
| 1. | **Cardium amotapense,** n. sp.<br>Holotype, height 49.00 mm.<br>Monte Grande. | 51 |
| 2. | **Pholadomya houghti,** n. sp.<br>Holotype, length 50.00 mm.<br>Monte Grande. | 37 |
| 3. | **Cardium** cf. **Lissoni,** n. sp.<br>Height 60.00 mm.<br>Monte Grande. | 52 |
| 4. | **Anatina anchana,** n. sp.<br>Holotype, length 65.00 mm.<br>Pan de Azucar. | 38 |
| 5. | **Icanotia peruviana,** n. sp.<br>Holotype, length 53.00 mm.<br>Pan de Azucar. | 55 |
| 6. | **Antigona,** sp.<br>Length about 37 mm.<br>Monte Grande. | 54 |
| 7. | **Myopholas peruviana,** n. sp.<br>Holotype, length 49.00 mm.<br>Pan de Azucar. | 36 |



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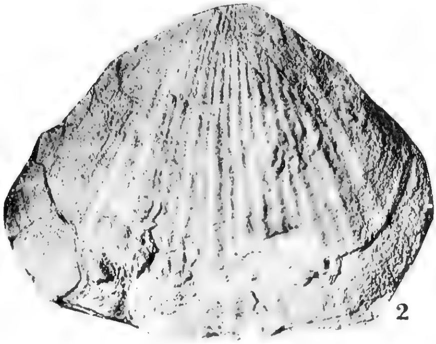

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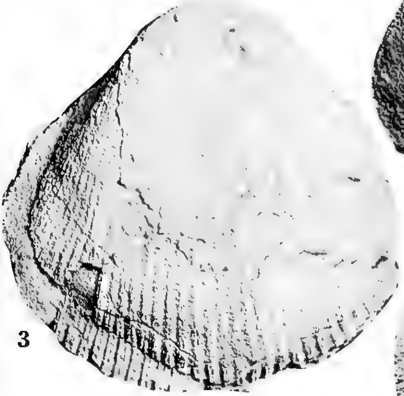

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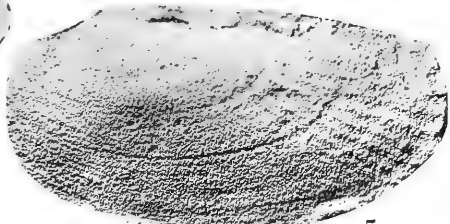

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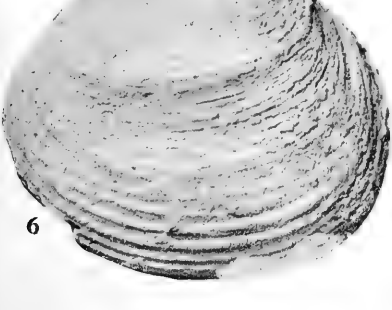

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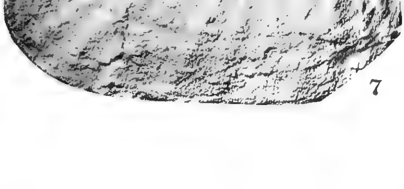

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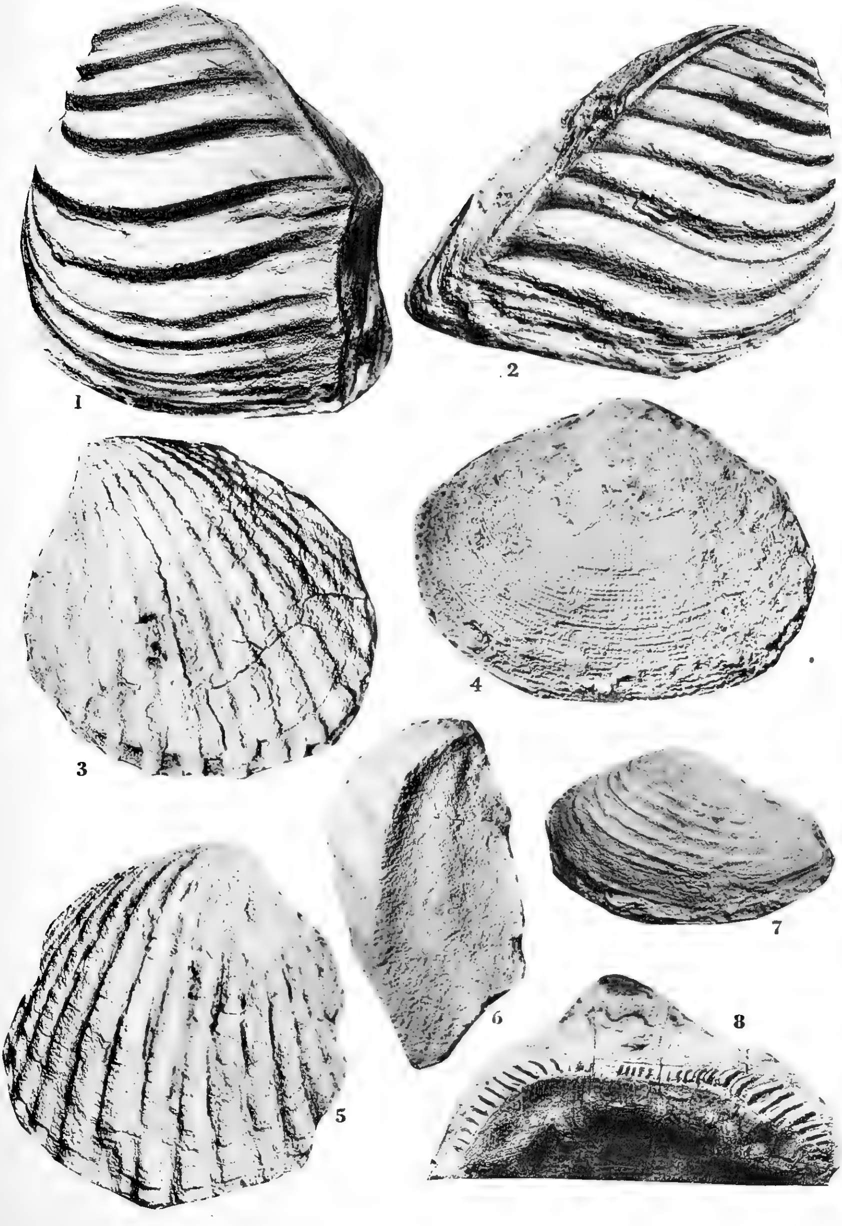
Explanation of Plate 6

## EXPLANATION OF PLATE 6

| Figure | | Page |
|---|---|---|
| 1. | **Roudaireia auressensis** Coquand<br>The normal form, height 56.00 mm.<br>Monte Grande. | 39 |
| 2. | **Roudaireia auressensis** Coquand<br>An elongated example, length 71.50 mm.<br>Monte Grande. | 39 |
| 3. | **Venericardia weberbaueri,** n. sp.<br>Holotype, length 30.00 mm.<br>Monte Grande. | 44 |
| 4. | **Linearia bomarea,** n. sp.<br>Holotype, length 47.00 mm.<br>Monte Grande. | 56 |
| 5. | **Venericardia weberbaueri,** n. sp.<br>Paratype, length 32.00 mm.<br>Form with broad ribs.<br>Monte Grande. | 44 |
| 6. | **Roudaireia auressensis,** n. sp.<br>View of posterior area showing the secondary rib.<br>Height 44.00 mm.<br>Monte Grande. | 39 |
| 7. | **Corbula montegrandensis,** n. sp.<br>Holotype, length 28.00 mm.<br>Monte Grande. | 57 |
| 8. | **Trigonarca meridionalis,** n. sp.<br>Hinge of the Holotype, length 63.00 mm.<br>Monte Grande. | 24 |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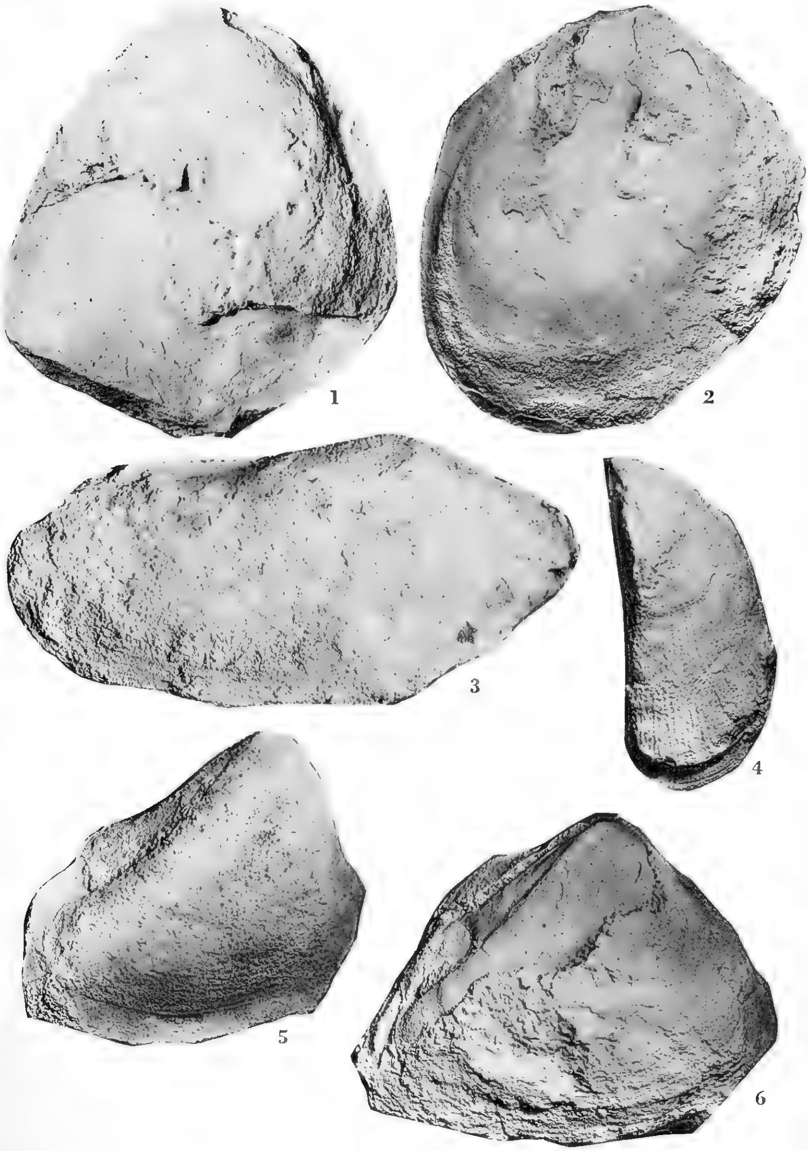
Explanation of Plate 7

## EXPLANATION OF PLATE 7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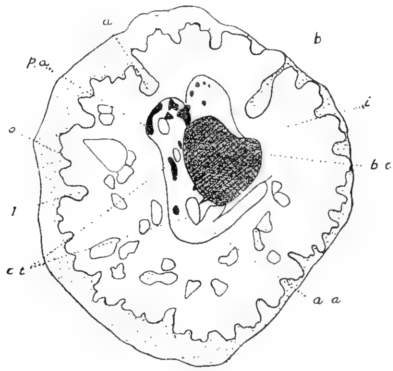
## Explanation of Plate 8

## EXPLANATION OF PLATE 8

Figure | Page
---|---
| |

1. **Orbignya pacifica**, n. sp. ........ 48
   Holotype, greater diameter 110.00 mm.
   Dorsal view. Shows the external surface of the dorsal valve, partly destroyed by weathering on the anterior side so that the inner surface of the lower valve has been exposed.
   Monte Grande.

2. **Orbignya pacifica**, n. sp. ........ 48




Cross-section of the lower valve of the Holotype.

a anal inflection
b brachial inflection
l ligamental inflection
i inner layer
o outer layer

a. a anterior adductor column
p. a posterior adductor column
b. c body-cavity
c. t cardinal teeth

3. **Durania** ?, sp. ........ 50
   Cross-section of the cellular wall of a colonial specimen. The position of the body impression is shown by the concave indentation on the left side.
   Length of specimen 87.00 mm.
   Monte Grande.

4. **Sphaerulites** cf. **nicholasi** Whitfield ........ 49
   Height of specimen 118.00 mm.
   Fragment of the foliaceous segment of the lower valve.
   Monte Grande.

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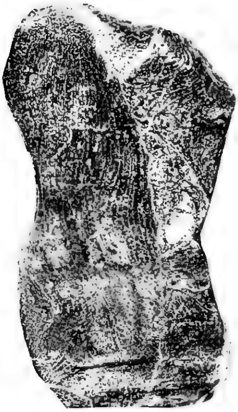

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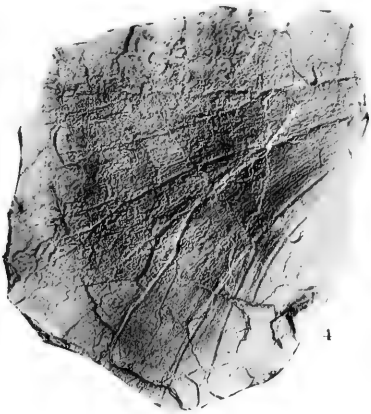

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Explanation of Plate 9

## EXPLANATION OF PLATE 9

Figure Page

1. **Peruvia gerthi,** n. sp. ........ 73
   Paratype, height 50.00 mm.
   Dorsal view.
   Pan de Azucar.

2. **Peruvia gerthi,** n. sp. ........ 73
   Same specimen, partly exfoliated on one side.

3. **Peruvia gerthi,** n. sp. ........ 73
   Holotype, height 62.00 mm.
   Cross-section of a large specimen showing internal structure and enveloping whorls.
   Pan de Azucar.

4. **Pugnellus ? cypraeformis,** n. sp. ........ 67
   Paratype, length 44.00 mm.
   Ventral view of a mature specimen.
   Monte Grande.

5. **Pugnellus,** sp. ........ 66
   Length 27.00 mm.
   Monte Grande.

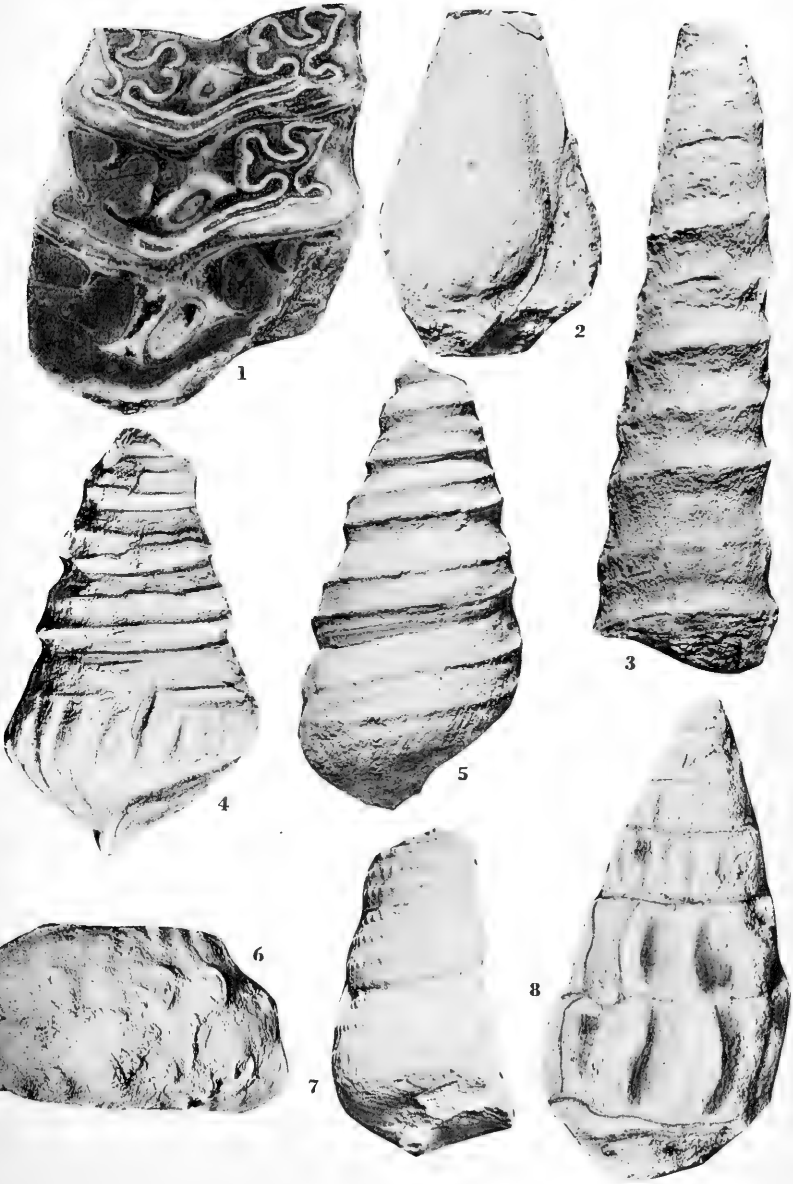
6. **Pugnellus ? cypraeformis,** n. sp. ........ 67
   Holotype, length 54.00 mm.
   Monte Grande.

7. **Actaeonella (Volvulina) peruviana,** n. sp. ........ 71
   Holotype, length 103.00 mm.
   Pan de Azucar.

Explanation of Plate 10

## EXPLANATION OF PLATE 10

| Figure | | Page |
|---|---|---|
| 1. | **Nerinea (Teleoptyxis) peruviana,** n. sp.<br>Holotype, length of height 46.00 mm.<br>Cross-section showing internal structure.<br>Pan de Azucar. | 65 |
| 2. | **Calytraphorus hopkinsi,** n. sp.<br>Holotype, length 32.00 mm.<br>Monte Grande. | 68 |
| 3. | **Nerinea (Teleoptyxis) peruviana,** n. sp.<br>Paratype, length 114 mm.<br>Pan de Azucar. | 65 |
| 4. | **Mesalia peruviana,** n. sp.<br>Holotype, length 45.00 mm.<br>Monte Grande. | 60 |
| 5. | **Mesalia (Woodsalia) inca,** n. sp.<br>Holotype, length 33.00 mm.<br>Monte Grande. | 61 |
| 6. | **Helicoceras,** sp.<br>Fragment, length 35.00 mm.<br>Monte Grande. | 73 |
| 7. | **Paraglauconia pananga,** n. sp.<br>Holotype, length 33.00 mm.<br>Pan de Azucar. | 62 |
| 8. | **Cerithium** "Poorly" preserved specimen, length 53.00 mm.<br>Monte Grande. | 66 |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Explanation of Plate 11

## EXPLANATION OF PLATE 11

| Figure | | Page |
|---|---|---|
| 1. | **Oxytropidoceras parinense,** n. sp.<br>Holotype.<br>Pan de Azucar. | 75 |
| 2. | **Schloenbachia leonora,** n. sp.<br>Holotype, diameter 170 mm.<br>Copa Sombrero. | 78 |
| 3. | **Oxytropidoceras** cf. **karsteni** Steiler<br>Pan de Azucar. | 78 |
| 4. | **Oxytropidoceras parinense,** n. sp.<br>Whorl section. | 75 |
| 5. | **Oxytropidoceras** cf. **karsteni,** Steiler<br>Whorl section. | 78 |
| 6. | **Schloenbachia leonora,** n. sp.<br>Whorl section. | 78 |

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**BULLETINS**

**OF**

**AMERICAN PALEONTOLOGY**

**Vol. 20**

*

**No. 70 A**

# Some Tertiary Foraminifera from the North Coast of Cuba

By

WADE H. HADLEY, JR.

*May 21, 1934*

Paleontological Research Institution,
Ithaca, New York
U. S. A.

## INTRODUCTION

The foraminifera described in this paper were collected by Mr. Norman E. Weisbord, of the Atlantic Refining Company, during the fall of 1932 and January of 1933. The material was sent to Professor G. D. Harris of Cornell University; and the samples were turned over to me by Professor Harris.

The writer would like to express his appreciation to Mr. Weisbord, who collected the material, and to Dr. R. E. Dickerson of the Atlantic Refining Company, for his permission to publish this work. I am indebted to Professor G. D. Harris who gave me the opportunity to study and describe the foraminifera of the samples which are dealt with in this paper and his interest, encouragement, and suggestions have been of great value during its preparation. I would like to take this opportunity to thank Dr. S. M. Herrick for the use of foraminiferal literature from his private library. To Dr. Henry V. Howe, of Louisiana State University, I would like to express my appreciation for his aid and interest in describing the new genus—*Cibicorbis*.

## LOCATION OF STATIONS FROM WHICH MATERIAL WAS EXAMINED

### Station 0-1

From white marl in bank 50 meters southeast of the entrance gate to the Cuban Naval Academy, Marel, Pinar del Rio Province, a intersection with the road which goes up the hill toward La Merced.

This fine white marl breaks down readily when soaked in water; and after being washed in a fine sieve, the residue is made up largely of Globigerina tests and a small amount of consolidated material. As much of the fine material is lost in washing, the remaining foraminifera are fairly well concentrated. This sample contained a greater number of species and individuals than any of the others. This sample appears to be of Oligocene age, probably upper.

Station 0-2

From basal marl of the Yumuri River Gorge near the town of Matanzas, (Matanzas Province) Cuba.

The material is well calcified and breaks down only after prolonged boiling in a strong alkali solution. The foraminiferal tests are all very white and usually have a varying amount of the calcareous material adhering to them. This sample is probably of Oligocene age but the fauna is not closely related to that of station 1-0

Station E-1

In cut on railroad between Nuevitas and Pastelillo, about 1½-2 kilometers north of the Nuevitas railway station on Nuevitas Bay, north coast of Cuba.

In addition to the small foraminifera, this sample contained many of the larger forms (Lepidocyclinas). The material is of Upper Eocene age.

Many of the species found at these stations have been described from Mexico, Trinidad, and Venezuela. The accompanying table shows the distribution of some of the common forms in the Gulf of Mexico and Caribbean regions.

From the above stations, 61 species and varieties of foraminifera are described in this paper. Eight species and three varieties are considered as new. The holotypes and plesiotypes of all the species described have been deposited in the Paleontological Research Institution, 126 Kelvin Place, Ithaca, New York.

# TABLE SHOWING THE DISTRIBUTION OF THE CUBAN SPECIES IN OTHER AREAS OF THE GULF OF MEXICO AND CARIBBEAN REGIONS

| CUBA | TRINIDAD[1] | MEXICO[2] | VENEZUELA[3] |
|---|---|---|---|
| [4]Bolivina mexicana var. aliformis | | X | |
| Bulimina inflata | X | X | X |
| Cassidulina subglobosa | X | X | X |
| Cibicides maxicana | | X | |
| Cibicides trinitatensis | X | X | |
| Dentalina adolphina | | | X |
| Ellipsonodosaria verneuili | X | | X |
| Entoselenia staphyllearia | X | | X |
| Gaudryina asiphonina | | X | |
| Globigerina bulloides | X | X | |
| Globorotalia menardii | X | X | |
| Lenticulina calcar | X | | X |
| Lenticulina formosa | X | | |
| Lenticulina papillosa | X | | |
| Lenticulina subpapillosa | | X | |
| Lepidocyclina subglobosa | X | | |
| Nodosaria erbessina | X | | |
| Nonion pompilloides | X | | X |
| Orbulina universa | X | | |
| [5]Planulina mexicana | | X | |
| Plectofrondicularia vaughani | | X | X |
| Pleurostomella alterans | X | | X |
| Pleurostomella brevia | X | | |
| Siphogenerina multicostata | | | X |
| Siphogenerina transversa | X | | |
| Siphonina tenuicarinata | X | | |
| Uvigerina pigmae | X | X | |
| Vulvulina pennatula | X | | |

[1]Nuttall, 1928, Quart. Jour. Geol. Soc. of London, vol. 84.
[2]Nuttall, 1932, Journal Paleontology, vol. 6, pt. 1.
[3]Cushman, 1929, Contrib. Cushman Lab. Foram, Res., vol. 5, pt. 4.
[4]Cushman, 1926, Contrib. Cushman Lab. Foram. Res., vol. 1, pt. 4, p. 82, figs. 3, 4 ab.
[5]Cushman, 1927, Contrib. Cush. Lab. Foram. Res., vol. 3, pt. 2, p. 113, pl. 23, figs. 5 a,b.

## TABLE SHOWING THE FORAMINIFERA FOUND AT EACH STATION

| SPECIES | Sta. O-1 | Sta. O-2 | Sta. E-1 |
|---|---|---|---|
| Planulina matanzasensis | | X | |
| Planulina marialana | X | | |
| Bolivina mexicana var. aliformis | X | | |
| Bulimina aculeata | | | X |
| Bulimina inflata | X | | |
| Caneris sagra | | X | |
| Cassidulina subglobosa | X | | |
| Cibicorbis herricki | | X | |
| Chilostomella sp. | | | X |
| Cibicides mexicana | X | | |
| Cibicides trinitatensis | | X | X |
| Clavulina communis | X | X | |
| Marginulina cymboides | X | | |
| Cycloclypeus papillosa | | | X |
| Dentalina adolphina | X | | |
| Dentalina elegantissima | X | | |
| Ehrenbergina navalis | X | | |
| Ehrenbergina serrata | X | | |
| Ellipsoidina ellipsoides | X | | |
| Ellipsonodosaria crypticosta | X | | |
| Ellipsonodosaria tuckerae | X | | |
| Ellipsonodosaria verneuili | X | | X |
| Entoselenia staphyllearia | X | | |
| Eponides ponderosa | | | X |
| Guadryina asiphonina | X | | |
| Globigerina bulloides | X | | |
| Globorotalia menardii | | X | |
| Gypsina globulus | | | X |
| Hantkenina alabamensis | | | X |
| Lagena formosa | X | | |
| Laticarinina pauperata | X | | |
| Lenticulina calcar | | X | |
| Lenticulina formosa | X | | |
| Lenticulina papillosa | | | X |
| Lenticulina subpapillosa | X | | |
| Lepidocyclina subglobosa | | | X |
| Nodosaria mexicana | | | X |
| Nodosaria erbessina | X | | |
| Nodosaria obliquata | X | | |
| Nonion pompilloides | X | | |
| Operculina ocalana | | | X |
| Operculina sp. | | | X |
| Orbulina universa | | X | |
| Planorbulina larvata | X | X | |
| Planularia sp. | X | | |
| Planulina mexicana | | X | |
| Plectofrondicularia vaughani | X | | |
| Pleurostomella alterans | X | | |
| Pleurostomella brevis | X | | |
| Ramulina globulifera | X | | X |
| Siphogenerina multicostata | X | | |

| | | | | |
|---|---|---|---|---|
| Siphogenerina transversa | X | | | |
| Siphonia tenucarinata | X | | | |
| Textularia sp. | | | | X |
| Uvigerina canariensis var. spinulosa | | X | | |
| Uvigerina gardnerae var. cubana | | | X | |
| Uvigerina pigmae | | | | X |
| Vulvulina pachyheilus | X | | | |
| Vulvulina pennatula | X | | | |

## DESCRIPTION OF SPECIES

### Family TEXTULARIIDAE

#### Genus TEXTULARIA Defrance, 1824

**Textularia** sp. Plate 1, fig. 1

Test large, elongate, gradually tapering, with greatest width near apertual end; periphery broadly angular; chambers numerous, wider than high; sutures depressed; wall finely arenaceous but not smooth; aperture a low opening located near the center of the test at the base of the last chamber.

Length, 1.45 mm.; greatest breadth, .96 mm.

#### Genus VULVULVINA d'Orbigny, 1826

**Vulvulina pachyheilus**, n. sp. Plate 1, figs. 2-4

Test tapering from the pointed initial end and reaching its greatest breadth near the apertural extreme; biserial throughout except for the final chamber which is extended, flattened and curving to one side; chambers numerous, much wider than high; sutures nearly straight, slanting, slightly elevated; test composed of fine arenaceous material with much cement; main body of test made up of a thickened central portion, thinning to form an irregular keel with scattered, flattened spines along its border; aperture an elongate, much compressed slit with thick rounded lips.

Length of type, 1.65 mm.; maximum breadth of type, 1.00 mm.

Rare at station 0-1.

Holotype from station 0-1.

Some of the forms are rounded at the initial end and suggest coiling. The well developed forms showing the uniserial final chamber are very rare, the majority of the tests being biserial throughout.

The above form differs from *V. pectinata*[6] in being thicker

[6]Cushman, 1932; Contrib. Cushman Lab. Foram Res., vol. 8, pt. 4; page 82, plate 10, fig. 12.

and more rounded through the central portion, in having a more pronounced keel, and a final chamber which is not set off from the others.

**Vulvulina pennatula** (Batsch)

*Nautilus pennatula* Batsch, Conch. Seesandes, 1791; No. 13, pl. 4, figs. 13, a-d.
*Bigenerina pennatula* Nuttall, Quart. Jour. Geol. Soc. of London, vol. 84, 1928; p. 73, pl. 3, fig. 3.
*Vulvulina pennatula* Cushman, Contrib. Cushman Lab. Foram. Res., vol. 8, pt. 4, 1932; p. 76, p. 10, figs. 1-5.

Specimens of this species are very rare in the Cuban material, but their development is typical.

Length, 1.07 mm.; greatest breadth, .58 mm. Very rare at station 0-1.

### Family VERNEUILINIDAE

### Genus GAUDRYINA d'Orbigny

**Gaudryina asiphonia** (Andreae) Plate 1, fig. 6

*Gaudryina siphonella* var. *asiphonia* Andreae, Abh. Geol. Specialkarte Elass-Lothr., vol. 2, 1884; p. 200, pl. 7, fig. 7.
*Gaudryina asiphonia* Nuttall, Jour. Pal., vol. 6, no. 1, 1932; p. 7, pl. 2, fig. 3.

Initial end rounded, sides of test nearly parallel except near the extreme ends; early chambers triserial and making up about one third of the test's total length; later and major portion of test uniserial; chambers rounded, later ones inflated; sutures depressed, plainly visible; wall composed of fine arenaceous material, well cemented; aperture an arched opening on the inner margin of the final chamber.

Length, 1.00 mm. Rare at station 0-1.

### Family VERNEUILINIDAE

### Genus CLAVULINA d'Orbigny

**Clavulina Communis** d'Orbigny Plate 1, fig. 5

*Clavulina communis* d'Orbigny, Ann. Sci. Nat., vol. 7, 1826; p. 268.
*Clavulina communis,* d'Orbigny, Foram. Foss. Vienne. Basin, 1846; p. 196, pl. 12, figs. 1, 2.
*Clavulina communis* Cushman, U. S. Nat. Mus. Bull. no. 103, 1918; p. 57, pl. 20, fig. 6.

Test elongate, initial end with a short triserial portion which is not typically triangular in cross section, later and major portion of test uniserial and circular in cross section; axis of test often bent where the triserial and uniserial portions join; early sutures indistinct, later ones depressed, the amount of depression increasing toward the anterior end of the uniserial portion; wall of fine arenaceous material and with a large proportion of cement; aperture terminal, rounded, slightly protruding.

Length, 2.00 mm. Very rare at stations 0-1, and 0-2.

**Clavulina** sp. Plate 1, fig. 7

Uniserial portion circular in cross section, sides of tests parallel; chambers compact, wider than high; sutures slightly depressed; test made up of rather coarse angular sand grains and with a moderate amount of cement; aperture central, slightly protruding.

Rare at station 0-1.

Only a few specimens were found and none of them bore the initial triserial portion; the tests are much larger than the corresponding parts of *Clavulina communis*.

**Clavulina** sp. Plate 1, fig. 8

Test triangular in cross section, early portion triserial, followed by the uniserial portion which makes up most of the test; carinae thin and rounded, lateral outline straight, sides plain except for the depressed sutures; wall of moderately fine arenaceous material well cemented; aperture at the center of the final chamber, not protruding.

Length, 1.45 mm. Common at station 0-1.

### Family LAGENIDAE

#### Genus MARGINULINA d'Orbigny, 1826

**Marginulina cymboides** (d'Orbigny) Plate 1, figs. 9, 10

*Cristellaria cymboides* d'Orbigny; Forams. Foss. du Bassin Tert. de Vienne, 1848; p. 85, pl. 3, figs. 30, 31.

Test elongate, moderately compressed; coiled portion very small; greatest width occuring about midway between the two ends; periphery rounded and lacking a keel; six to eight chambers making up the average test, the length of the chambers gradually increasing toward the apertural end; sutures distinct, flush with the test, smoothly curving from the center to the periphery; wall calcareous, smooth, and polished; initial end rounded; aperture radiate and terminal.

Length, 1.10 mm.; maximum breadth, .37 mm.; thickness, .20 mm. Rare at station 0-1.

### Genus DENTALINA d'Orbigny

**Dentalina adolphina** d'Orbigny

*Dentalina adolphina* d'Orbigny, Foram. Fosse. Vienne. Basin, 1848; p. 51, pl. 2, figs. 18-20.
*Dentalina adolphina* d'Orbigny, Cushman, Contrib. Cushman Lab. Foram. Res., vol. 5, pt. 4, 1929; p. 86, pl. 13, figs. 3, 4.

Test elongate and slender, slightly arcuate; chambers sperical, gradually enlarging toward the anterior, the lower half of each chamber is decorated with a transverse row of short downward pointing spines; sutures greatly constricted, the chambers are separated by rather long necks, especially in the later portion of the test; well preserved specimens show a small anterior spine; aperture simple, protruding.

Length, 1.16 mm. Rare at station 0-1.

Forms showing both one and two rows of spines were found in the material.

**Dentalina elegantissima** d'Orbigny Plate 1, fig. 19

*Dentalina elegantissinia* d'Orbigny, Foram. Foss. de Vienne Basin, 1846; p. 55, pl. 2, figs. 33-35.

Test greatly elongate and extremely slender, slightly arcuate; initial end pointed, slowly increasing in diameter from the posterior end to about midway along the central axis, later half of test of about uniform size; chambers numerous, somewhat higher than wide, early chambers indistinct, later ones separated by slight constrictions; test calcareous, decorated with six sharp longitudinal costæ which extend unbroken for the entire length of the test; aperture terminal, slightly protruding.

Length, 2.20 mm. Very rare at station 0-1.

This species is very rare in the Cuban material but its development is typical.

### Genus LAGENA Walker and Jacob

**Lagena formosa** Schwager Plate 1, fig. 20

*Lagena formosa* Schwager, Novara-Exped., Geol. Theil; vol. 2, 1866, p. 206, pl. 4, figs. 19a, 19d.

Test compressed, ovate in outline, slightly higher than wide; with a wide, thin wing extending completely around the periphery; this wing is decorated with sharp minute radiating costæ; there is an angular thickening where the wing joins the test; wall smooth, aperture simple, protruding, and with a delicate neck.

Length, .72 mm.; greatest breadth, .49 mm. Very rare at station 0-1.

### Genus LENTICULINA Lamarck

**Lenticulina calcar** (Linnæus)

*Nautilus calcar* Linnæus, Syst. Nat., ed. 12, 1767; p. 1162, no. 272.
*Cristellaria calcar* Cushman, Bull. U. S. Nat. Mus. no. 104, pt. 4, 1923; p. 115, pl. 30, fig. 7; pl. 31, figs. 4, 5.
*Robulus calcar* Cushman, Contrib. Cushman Lab. Foram. Res., vol. 5, pt. 4, 1929; p. 84, pl. 12, fig. 18.

Test involute, gibbous; periphery with a low thick, rounded keel, with a few small rounded spines extending from the outer margin; chambers few, five to six in the last whorl; surtures curved, flush with the test; wall calcareous, smooth, and thick; aperture radiate, located at the apex of the apertual face.

Diameter, .72 mm. Rare at station 0-2.

The above species differs from *Lenticulina formosa* in having a smaller number of chambers and peripheral spines which are rounded in cross section and not compressed.

**Lenticulina formosa** (Cushman) Plate 1, fig. 11

*Cristellaria formosa* Cushman, U. S. Nat. Mus. Bull. no. 104, pt. 4, 1923; p. 110, pl. 29, fig. 1; pl. 30, fig. 6.

Test involute, rather thick through the central portion; periphery sharp and angular, with a thin keel and a row of flat transparent spines; ten to twelve chambers in the last whorl; sutures strongly curved, flush with the sides of the test; wall smooth, the central area with a prominent elevation of shell material; aperture at the apex of the apertual face, radiate.

Maximum diameter, 1.25 mm., usually much less. Very rare at station 0-1.

*Lenticulina calcar* can be distinguished from *L. formosa* by its lesser number of chambers and by its rounded spines.

**Lenticulina papillosa** (Fichtel and Moll) Plate 1, fig. 15

*Cristellaria papillosa* Fichtel and Moll, Test. Micro., 1803; p. 82, pl. 14, figs. a-c.
*Cristellaria papillosa* Nuttall, Quart. Jour. Geol. Soc. of London, vol. 84, no. 1, 1928; p. 89, pl. 6, fig. 6.

Test large, planispiral, involute; periphery broadly angular and with a very low rounded keel; ten chambers in the final whorl of the average adult test; sutures elevated and developed into more or less rounded beads which become smaller toward the periphery; wall calcareous and thick; aperture radiate, located at the apex of the apertural face, only slightly protruding.

Diameter, 1.10 mm. Rare at station E-1.

**Lenticulina subpapillosa** (Nuttall)

*Cristellaria subpapillosa* Nuttall, Jour. Pal., vol. 6, no. 1, 1932; p. 12, pl. 1, fig. 12.

Only one specimen of this species was found but it is identical to Nuttall's type figure.

Diameter, 1.15-1.45 mm. Station O-1.

### Genus NODOSARIA Lamarck

**Nodosaria erbessina** Schwager Plate 1, fig. 12

*Nodosaria erbessina* Schwager, Boll. R. Com. Geol. Ital., 1878; p. 520, pl. 1, fig. 3.

*Nodosaria erbessina* Nuttall, Quart. Jour. Geol. Soc. of London, vol. 84, pt. 1, 1928.

Test elongate, straight or slightly curved, early portion tapering, sides of later chambers nearly parallel; about six chambers making up the average test, chambers circular in cross section, slightly broader than high; sutures transverse, constricted, not sharply set off from the adjacent chambers; wall clacareous and decorated with about twenty-five costæ which are parallel to the axis of the test and usually extend unbroken across the sutures; aperture circular and central, not extended.

Length, 1.15 mm. Rare at station O-1.

**Nodosaria mexicana** Cushman Plate 1, fig. 18

*Nodosaria mexicana* Cushman, Contrib. Cushman Lab. Foram, Res., vol. 1, no. 1, 1925; pl. 5, figs. 3, 4, page 5.

Test elongate, slightly arcuate, initial end rounded; typically developed chambers widening in the central portion where they develop a sharp equatorial elevation, chambers at either extreme more spherical; sutures constricted, transverse; wall calcareous, smooth; aperture simple, protruding.

Length, 2.12 mm., Common in the upper Eocene.

**Nodosaria obliquata** (Batsch) Plate 1, fig. 13

*Nautilus (O.) obliquatus* Batsch, Sechs Kupfertafeln mit Conchylien des Seesandes, 1791.

*Nodosaria obliquatus* (Batsch), Cushman, Contrib. Cushman Lab. Foram. Res., vol. 7, pt. 3, 1931; p. 65, pl. 8, figs. 15-19.

Test elongate, straight or slightly curved; division between early chambers not distinct, later ones becoming constricted, sutures transverse; early chambers with their height and width about equal, later ones increasing in height; wall calcareous, decorated with from fifteen to twenty sharp longitudinal costæ which extend unbroken across the sutures; the costæ are slightly oblique.

Fragments up to 2.50 mm. in length were found. Very rare at Station O-1.

All of the tests found were broken and no portions bearing the final aperture were encountered.

### Genus PLANULARIA Defrance

**Palnularia** sp. Plate 5, fig. 8

Test large, planispiral, showing one and a half whorls; compressed sides of test nearly parallel; periphery acute and with a well developed keel; chambers much broader than high, of nearly equal height throughout, becoming broader as the coiling progresses, twelve chambers in the final whorl; sutures nearly straight, limbate, early ones elevated, irregular but not becoming beaded, those near the center of the coil developing a few irregular elevations, later sutures becoming flush with the test and finally depressed before the last chamber is reached; aperture at the peripheral margin of the apertual face, protruding and radiate; wall calcareous, smooth, and thick.

Greatest diameter, 3.62 mm.; minimum diameter, 3.19 mm. At station O-1 a single specimen of the above form was found.

*Palanularia advena* Cushman[7] resembles the above species closely and differs from it only by showing a stronger tendency toward uncoiling.

## Family POLYMORPHINIDÆ

### Genus RAMULINA Rupert Jones

**Ramulina globulifera** Brady

*Ramulina globulifera* Brady, Quart. Jour. Micro. Sci., vol. 19, 1869; p. 58, pl. 8, figs. 32, 33.

*Ramulina globulifera* Brady, Rep. Voyage *Challenger,* 1884, vol. 9, Zoology; p. 587, pl. 76, figs. 22-28.

Composed of a subglobular chamber with radiating stolen tubes; surface of chamber and tubes decorated with short spines; wall hyaline.

Rare at stations O-1 and E-1.

[7]Cushman, 1932; Proc. U. S. Nat. Mus. No. 2914; p. 24, pl. 8, figs. 1, 2.

### Family NONIONDÆ

### Genus NONION Montfort

**Nonion pompilioides** (Fichtel and Moll) Plate 2, figs. 1, 2

*Nautilus pompilioides* Fichtel and Moll, Test. Micro., 1803; p. 31, pl. 2, figs. a-e.

*Nonion pompilipodes* Cushman, Contrib. Cushman Lab. Foram, Res., vol. 5, pt. 4, 1929; p. 89, pl. 13, figs. 25 a, b.

Test small, involute, planispiral; periphery broadly rounded; usually eight chambers in the last whorl; sutures straight and slightly elevated, radiating from a small umbilicus on either side and extending unbroken across the periphery; wall smooth, calcareous, and distinctly punctate; aperture a low central arch at the base of the last chamber.

Diameter .35 mm. Rare at station O-I.

### Family CAMERINIDÆ

### Genus CYCLOCLYPEUS W. B. Carpenter

**Cycloclypeus papillosus**, n. sp. Plate 1, fig. 17

Test discoidal, much compressed; chambers planispiral, early ones arranged in the normal manner, later ones becoming annular; chambers are divided into chamberlets by radiating depressed lines, these lines extend unbroken from their origin to the periphery and are not staggered; chamberlets practically square in outline; central portion covered by a granular growth of shell material which thins toward the periphery and leaves about three rings of chamberlets exposed.

The large central area of granular shell material and the unbroken radial lines characterize this species.

Diameter of type, 1.00 mm. Very rare at station E-I.

Holotype from station E.- I

The above species differs from *Cycloclypeus gumbelanus*[8] in having the chamberlets more numerous and smaller, the central boss extending much nearer the periphery, and the radial sutures unbroken.

### Genus OPERCULINA d'Orbigny

**Operculina ocalana** Cushman Plate 2, fig. 3

*Operculina ocalana* Cushman, U. S. Geol. Survey, Prof. Paper, No. 128, 1920; p. 129, pl. 19, figs. 4, 5.

Test planispiral, much compressed, composed of about two and a half wholrs; periphery rounded, thicker than the adjoining portion of the test; sutures elevated, rounded, evenly curving,

[8]Brady, H. B., 1881; Quart. Jour. Micro. Sci., vol. 21, N. S., p. 66.

broken and irregular near the central area; space between sutures concave; chambers numerous, eighteen to twenty in the final whorl, about four times as long as wide; central portion of test with a rounded elevation; wall calcareous, thick, and smooth.

Diameter, 6.52 mm. Common in the upper Eocene.

The specimens were all more or less broken, and no complete forms showing the aperture were found.

**Operculina** sp. Plate 1, fig. 14

Planispiral, evolute, much compressed, of about equal thickness throughout; periphery rounded; made up of about two and a half whorls, the final coil with twelve to fifteen chambers; sutures gently curved, flush with the test or slightly elevated; aperture peripheral and at the base of the apertural face.

Diameter, 1.30 mm. Common at station E-1.

### Family HETEROHELICIDÆ

### Genus PLECTOFRONDICULARIA Liebus

**Plectofrondicularia vaughani** Cushman Plate 2, figs. 5, 6

*Plectofrondicularia vaughani* Cushman, Contrib. Cushman Lab. Foram. Res., vol. 3, pt. 2, 1927; p. 112, pl. 23, fig. 3.

*Plectofrondicularia vaughani* Cushman, Contrib. Cushman Lab. Foram. Res., vol. 5, pt. 4, 1929; p. 92, pl. 13, figs. 21, 22.

Test elongate, much compressed, initial end rounded, with greatest width about half way between the extreme ends; early portion of test coiled, major portion with chambers uniserial and extending back on both sides; sutures depressed, well defined; wall calcareous and smooth; aperture terminal.

Length, 95 mm., greatest width, 43 mm. Rare at station O-1.

In addition to the typical *Plectofrondicularia vaughani* as described above, there is a form occurring with it which has a pointed initial end. This form is referred to *P. vaughani* with doubt.

### Family HANTKENINIDÆ

### Genus HANTKENINA Cushman

**Hantkenina alabamensis** Cushman Plate 2, fig. 4

*Hantkenina alabamensis* Cushman, Proc. U. S. Nat. Mus., vol. 66, art, 30, 1924; p. 3, pl. 1, figs. 1-6; pl. 2, figs. 5.

Test planispiral, compressed; periphery rounded, peripheral outline smooth in many forms, becoming slightly lobate in the later portion of a few strongly developed individuals; chambers inflated, five to six in the final whorl; each chamber bears a well developed peripheral spine which points anteriorly; wall smooth, finely preforate; aperture an arched peripheral opening and with a flap on each side of the final chamber.

Common at station E-1. Diameter, .67 mm.

### Family BULIMINIDÆ

#### Genus BOLIVINA d'Orbigny

**Bolivina mexicana** Cushman var **aliformis** Cushman Plate 2, fig. 7

*Bolivina mexicana* Cushman var. *aliformis* Cushman, Contrib. Cushman Lab. Foram. Res., vol. 1, pt. 4, 1926; p. 82, pl. 12, figs. 3, 4a-c.

Biserial, much compressed, gradually tapering from the rounded initial end; chambers gradually increasing in height toward the apertural end, later chambers inflated; sutures distinct, wide, of clear shell material; test with a thin, broad, transparent keel which extends entirely around the periphery; wall calcareous, smooth; aperture an elongate slit which reaches the base of the final chamber.

Length, .96 mm. Common at station O-1.

#### Genus BULIMINA d'Orbigny

**Bulimina aculeata** d'Orbigny

*Bulimina aculeata* d'Orbigny, Ann. Sci. Nat., vol. 7, 1826; p. 269, model no. 7.

*Bulimina aculeata* H. B. Brady, *Challenger* Report, vol. 9, Zoology, 1884; p. 406; pl. 51, figs. 7-9.

*Bulimina aculeata* Plummer, Univ. Texas Bull. no. 2644, 1926, p. 73, pl. 4, fig. 3.

Initial end pointed and with an apical spine; rapidly enlarging toward the anterior extreme, later chambers inflated and overlapping; wall calcareous, early portion of test with short spines projecting from the body of the chambers as well as from their margins; later chambers smooth and lacking decoration; sutures depressed; aperture a rather large comma-shaped opening situated near the central axis of the test and at the inner margin of the final chamber.

Length, .58 mm. Common at station E-1.

The spines of the above specimens are not as well developed as those of the recent forms figured by Brady. The form here described is considerably larger than that from the Midway of Texas; otherwise they are very similar.

**Bulimina inflata** Seguenza Plate 2, fig. 9

*Bulimina inflata* Seguenza, Atti. Acad. Gioenia Sci. Nat., ser. 2, vol. 18, 1862; p. 109, pl. 1, fig. 10.

*Bulimina inflata* Seguenza, Nuttall, Quart. Jour. Geol. Soc. of London; vol. 84, pt. 1, 1928; p. 77, pl. 3, fig. 19.

*Bulimina inflata* Seguenza, Nuttall, Jour. Pal.; vol. 6, no. 1, 1932; p. 20, pl. 5, fig. 2.

Test triserial, circular in transverse section, initial end pointed, rapidly widening toward the anterior; chambers strongly overlapping, with crenulate margins, the crenulations extend below the chambers as spines and above the margin of the chambers as stirae for a short distance, the remainder of the chambers are smooth; wall calcareous; aperture loop-shaped, central and nearly terminal.

Length, .75 mm. Rare at station 0-1.

### Genus ENTOSOLENIA Ehrenberg

**Entosolenia staphyllearia** (Schwager) Plate 2, figs. 10, 11

*Fissurina staphyllearia* Schwager, Novara-Exped., Geol. Theil., pt. 2, 1866; p. 209, pl. 5, fig. 24.

*Entosolenia staphyllearia* (Schwager), Cushman, Contrib. Cushman Lab. Foram. Res., vol. 5, pt. 4, 1929; p. 96, pl. 13, fig. 10.

Test small, compressed, nearly circular in outline when viewed from the broad side; wall finely rugose, undecorated except for four sharp, transparent basal spines which are placed at regular intervals on the median line; aperture a simple, elongate slit, slightly protruding, with an internal tube which is plainly visible through a small transparent area just below the aperture.

Length, 1.22 mm. Common at station 0-1.

### Genus SIPHOGENERINA Schlumberger

**Siphogenerina multicostata** Cushman and Jarvis Plate 2 ,fig. 8

*Siphogenerina multicostata* Cushman and Jarvis, Contrib. Cushman Foram. Res., vol. 5, pt. 1, 1929; p. 14, pl. 3, fig. 6.

Test elongate, circular in cross section, composed of an early triserial portion and a late, much longer, uniserial portion; both ends slightly tapering, greatest diameter near the middle of the test; chambers distinct, slightly inflated, the uniserial ones nearly twice as wide as high; sutures depressed but the separation between the chambers is not pronounced; wall calcareous, decorated with numerous (about twenty per chamber) narrow, slightly raised, parallel, longitudinal costæ which do not extend unbroken to adjacent chambers; the early chambers bear a few short, blunt spines which are independent of the costæ; aperture with a short circular neck and a phialine lip.

Length, .52 mm.; greatest breadth, .49 mm. Rare at station 0-1.

**Siphogenerina transversa** Cushman Plate 2, fig. 15

*Siphogenerina raphanus* (Parker and Jones) var. *transversus* Cushman, U. S. Nat. Mus. Bull. no. 103, 1918; p. 64, pl. 22, fig. 8. Nuttall, Quart. Jour. Geol. Soc. of London, vol. 84, 1928; p. 94, pl. 6, fig. 14.
*Siphogenerina transversa* Cushman, Contrib. Cushman Lab. Foram. Res., vol. 7, pt. 1, 1931; p. 10, pl. 2, figs. 5, 6.

Test elongate, practically cylindrical, initial end rounded; early portion made up of spirally arranged chambers, major portion of test made up of the later uniserial ones; sutures depressed; test decorated with about ten thin longitudinal costæ which are well elevated and extend unbroken from the early portion of the test to near the anterior end; aperture with a short tubular neck and a lip.

Length, .75 mm. Rare at station 0-1.

Both microspheric and megalospheric forms were found; the former forms have a pointed initial end.

### Genus UVIGERINA d'Orbigny

**Uvigerina canariensis** d'Orbigny var. **spinulosa** n. var. Plate 2, fig. 17

Var. of *Uvigerina canariensis* d'Orbigny, Hist. Nat. Iles Canaries, 1839; vol. 2, pt. 2; p. 138, pl. 1, figs. 25-27. Brady, Rep. of *Challenger* Voyage, 1884; p. 573, pl. 74, figs. 1-3. Nuttall, Jour. Pal., vol. 6, pt. 1, 1932; p. 22, pl. 5, fig. 9.

Triserial, elongate, roughly circular in cross section; initial end rounded or bluntly pointed, with a short, sharp terminal spine; chambers numerous, later ones inflated and somewhat overlapping; wall calcareous, smooth except for faint striæ and small downward pointing spines near the initial end; the decorations become fainter toward the anterior end and disappear before the final chamber is reached; aperture with a tubular neck and thin flaring lip, the neck is located in a depression in the final chamber.

This variety differs from the typical in the development of small anterior spines as well as the terminal one.

Length of type including spine and neck, .70 mm. Common at station 0-1.

Holotype from station 0-1.

*Uvigerina canariensis* may bear faint costæ, but their development into spines in this form gives sufficient variation for the erection of a new variety. The shape and the arrangement of chambers and the pit in which the apertual neck is located agree with the development found in the typical species.

**Uvigerina gardnerae** Cushman and Applin var. **cubana** n. var. Plate 2, fig. 12

Var. of *Uvigerina gardnerae* Cushman and Applin, Bull. Amer. Assoc. Petr. Geol., vol. 10, no. 2, 1926! p. 175, pl. 8, figs. 16, 17.

*Uvigerina gardnerae* Nuttall var., Jour. Pal., vol. 6, no. 1, 1932; p. 22, pl. 5, fig. 11.

Initial end bluntly rounded, greatest diameter near the apertural end; chambers numerous, somewhat overalpping, inflated; wall calcareous, decorated with numerous heavy costæ which are not continuous from chamber to chamber, the general trend of the costæ is longitudinal but they sometimes make a considerable angle with the axis of the test; aperture usually broken, but a few forms show a short tubular neck and a slight lip.

The above variety differs from the typical species in the possession of coarser costæ and the costæ do not break up into spines near the anterior end.

Length of type, .72 mm.; greatest diameter, .41 mm. Abundant at station 0-2.

Holotype from station 0-2.

**Uvigerina pigmae** d'Orbigny Plate 2, fig. 16

*Uvigerina pigmae* d'Orbigny, Ann. Sci. Nat., vol. 7, 1826; p. 269, pl. 12, figs. 8-9.

*Uvigerina pigmae* d'Orbigny; Cushman, Contrib. Cushman Lab. Foram. Res., vol. 6, pt. 3, 1930; p. 62, pl. 9, figs. 14-20.

Test small, fusiform, practically circular in transverse section; chambers triserially arranged, inflated; sutures depressed, distinct; wall calcareous, decorated with sharp longitudinal costæ, those of each chamber being independent of the adjacent ones, the last chamber bears very faint costæ at its base, the remainder being covered with fine short spines; aperture terminal, with a neck and lip.

Length, .52 mm.; greatest diameter, .26 mm. Common at station E-1.

These specimens agree closely to d'Orbigny's original figures, differing only in not being quite as elongate.

### Family ELLIPSOIDINIDÆ

### Genus ELLIPSOILINA Seguenza

**Ellipsoidina ellipsodies** Seguenza Plate 2, figs. 18, 19

*Ellipsoidina ellipsoides* Seguenza, Eco. Peloritans, ser. 2, vol. 5, 1859; fasc. 9, p. 12; figs. 1-3.

Test composed of a rectilinear series of ovate chambers; as each chamber is added, it completely embraces the younger ones and it connected with them by a small tube, thus externally the adult test appears to consist of a single chamber; wall calcareous, smooth, and polished; aperture a narrow, curved slit surrounded by slightly raised lips; located almost at the anterior extremity of the test.

Length, .99 mm. Rare at station O-I.

### Genus ELLIPSONODOSARIA A. Silvestri

**Ellipsodonosaria verneuili** (d'Orbigny) Plate 3, figs. 4-6

*Dentalina verneuili* d'Orbigny, Forams. Foss. Bass. Tert. Vienne., 1846; p. 48, pl. 2, figs. 7, 8.
*Nodosaria verneuili* Nuttall, Quart. Jour. Geol. Soc. of London, vol. 84, 1928; p. 81, pl. 4, figs. 14, 15.
*Ellopsonodosaria verneuili* Cushman, Contrib. Cushman Lab. Foram. Res., vol. 5, no. 4, 1929; p. 96, pl. 14, figs. 1-3.

Test elongate, arcuate; early chambers with parallel sides and sutures not constricted, later ones inflated and with constricted sutures; sutures transverse, thick, composed of clear shell material; wall calcareous, smooth; initial end rounded and with an eccentrically located spine; aperture at the end of a tubular neck.

The microspheric form of this species is larger and more tapering.

Length, 2.17 mm. Abundant at stations E-I? and O-I.

There were forms found in the upper Eocene material which closely resemble the above species and they are here referred to it.

**Ellipsonodosaria cryptocosta** n. sp. Plate 3, fig. 3

Small, axis of test straight, initial end rounded and with a sharp, transparent central spine; test gradually enlarging toward the distal end, made up of four rather compact chambers in the normal development; sutures transverse, slightly depressed; wall calcareous, evenly covered with small short spines, thus giving the test a hispid appearance; aperture terminal and central, situated at the end of a sharp pointed neck, around this neck there are three or four little wavy costæ, each of the early chambers has a neck similar to that of the final one.

Length of type including spine, .87 mm. Common at station O-I.

Holotype from station O-I.

There is always a varying amount of the matrix adhering to the tests, and where this covering is not too thick there are faint traces of longitudinal costæ.

*Nodosaria spinocosta*[9] has prominent longitudinal costæ which develop into spines near the lower portion of the chambers and lacks the hispid development of the above species.

**Ellipsonodosaria tuckerae**, n. sp. Plate 3, figs. 1, 2

Test small, slightly arcuate, initial end rounded; average form made up of four chambers, chambers gradually becoming larger and more elongate toward the initial end, final chamber inflated and much larger than the one just below it; sutures transverse, depressed; wall calcareous, uniformly covered with fine, short spines; aperture central and terminal, protruding, slightly elliptical in cross section and with a small rounded lip; the chambers are connected by a delicate, centrally located, internal tube.

Length of type, .90 mm. Some forms reach a length of 1.16 mm. Common at station 0-1.

Holotype from station 0-1.

The axis of the above species is always slightly arcuate, the exterior is evenly covered with short spines, and the aperture is at the end of a short gently compressed neck.

### Genus PLEUROSTOMELLA Reuss

**Pleurostomella alterans** Schwager Plate 2, fig. 13

*Pleurostomella alterans* Schwager, Novara-Exped., Geol. Theil, pt. 2, 1866; p. 238; pl. 6, figs. 79-80.

Test elongate, initial end bluntly pointed; early chambers arranged biserially, later ones alternating; later chambers inflated; sutures well defined; aperture situated within a depression, sharply arched, and with a vertical notch which is bordered by two teeth.

Length, .93 mm. Very rare at station 0-1.

This form is wide spread in the Tertiary deposits of the Caribbean and Gulf of Mexico areas.

**Pleurostomella brevis** Schwager Plate 2, fig. 14

*Pleurostomella brevis* Schwager, Novara-Exped., Geol. Theil., pt. 2, 1866; p. 239, pl. 6, fig. 81.

*Pleurostomella brevis* Schwager; Nuttall, Quart. Jour. Geol. Soc. of London, vol. 84, pt. 1, 1928; p. 74, pl. 3, fig. 12.

Test small, compact slightly compressed; chambers biserially arranged, enlarging very rapidly; initial end may be pointed or

[9] D'Orbigny, 1846, Foram. Foss. Bass. Test. de Vienne., p. 37, pl. 1, figs. 32, 33.

rounded; sutures slightly depressed; wall calcareous and smooth; aperture a T-shaped slit located within a concavity in the final chamber.

Length, 1.28 m.. Rare at station o-1.

### Family ROTALIIDÆ

### Genus CANCRIS Montfort

**Cancris sagra** (d'Orbigny) Plate 3, figs. 7, 8

*Rotalia sagra* d'Orbigny, Hist. Fist. Pol. Nat. de Cuba, 1839; p. 77, pl. 5, figs. 13-15.

*Pulvinulina sagra* (d'Orbigny), Cushman, U. S. Nat. Mus. Bull. no. 103, 1918; p. 70, pl. 24, figs. 6 a, b.

Test trochoid, nearly equally biconvex; periphery angular, peripheral outline ovate; chambers rapidly enlarging, six in the last whorl, later ones inflated, final chamber much enlarged on the ventral side; sutures curved, those on the dorsal side flush with the test; ventral sutures slightly depressed; wall calcareous, smooth; aperture a low slit on the ventral side at the inner border of the last formed chamber.

Greatest diameter, .72 mm. Rare at station o-2.

### Genus EPONIDES Montfort

**Eponides ponderosa**, n. sp. Plate 3, figs. 9-11, 14

Trochoid, about equally biconvex, periphery narrow and with a rounded ridge extending along its border; chambers gradually enlarging as the coiling progresses, about nine making up the final whorl; dorsal sutures limbate, elevated, nearly straight, slightly slanting; spiral sutures much elevated and rounded, extending unbroken along the last one and a half whorls, breaking up into oblong elevations and small rounded knobs in the earlier central portion; ventral sutures depressed, slightly curved, radiating from an umbilical area filled with small rounded and irregular shaped elevations; wall calcareous, thick, and finely punctate; aperture a long low opening at the base of the final chamber, located about midway between the periphery and the umbilicus.

Maximum diameter of type, 1.45 mm. Common at station E-1.

Holotype from station E-1.

The area of broken or beaded sutures on *Eponides ponderosa* is limited to a small central area on the dorsal side while *Rotalia papillosa*[10] has the sutures broken or beaded for their entire

[10]Brady, H. B., 1884; Rep. Voy. **Challenger**, Zoology, vol. 9; p. 708, pl. 106, fig. 9.

length on both sides.

### Genus SIPHONINA Reuss

**Siphonina tenuicarinata** Cushman,

*Siphonia tenuicarinata* Cushman, Jour. Pal., vol. 1, no. 2, 1927; p. 166, pl. 26, figs. 11, 12.

Test trochoid, almost equally biconvex; periphery angular and with a thin keel, peripheral outline nearly circular; last whorl made up of five chambers, the last of which is somewhat inflated; sutures indistinct, flush with the test on the dorsal side, ventral sutures slightly depressed; wall calcareous, smooth, punctate; aperture located on the ventral side just below the periphery, elliptical in cross section, with a thick lip and a very short neck.

Diameter, .52 mm. Common at station 0-1.

## Family CASSIDULINIDÆ

### Genus CASSIDULINA d'Orbigny

**Cassidulina subglobosa** H. B. Brady

*Cassidulina subglobosa* H. B. Brady, Quart. Jour. Micr. Soc., vol. 21, 1881; p. 60.

Test subglobular, gently depressed; periphery broadly rounded, peripheral outline slightly lobate; chambers somewhat inflated, irregularly alternating; sutures slightly depressed, obscure; wall calcareous, smooth, and polished; aperture a twisted loop-shaped opening on the face of the projecting final chamber.

Diameter, .52 mm. Common at station 0-1.

### Genus EHRENBERGINA Reuss

**Ehrenbergina navalis**, n. sp. Plate 5, figs. 4, 5

Dorsal side convex, smooth, chambers moderately high; ventral side with a rounded median ridge but lacking the furrow which is present in some species; sutures flush with the test on both sides, dorsal sutures plainly visible, ventral ones very faint or invisible; periphery with a short delicate spine projecting from each chamber, these spines usually point directly outward from the edges of the test but are occasionly pointing slightly downward; test lacking other ornamentation; wall calcareous, smooth; aperture a narrow, slightly curved slit, located close to the dorsal margin of the apertual face.

Length of type, .72 mm.; greatest width, .49 mm. Abundant at station 0-1.

Holotype from station O-1.

The above species differs from *E. pacifica*[11] in the absence of the raised ridges along the ventral angle of the chambers and by having smaller and shorter spines.

**Ehrenbergina serrata** Reuss Plate 5, figs. 6, 7

*Ehrenbergina serrata* Reuss, Denkschr. Akad. Wiss. Wien., vol. 1, 1850; p. 377, pl. 48, figs. 7a-c.
*Ehrenbergina serrata* Cushman, Proc. U. S. Nat. Mus., vol. 70, art. 16, 1927; p. 2, pl. i, figs. 2a-c.

Test small, somewhat compressed on the ventral side, nearly as broad as long; dorsal side convex and smooth, chambers large; lower half of ventral side covered with smooth shell material which hides the underlying chambers and sutures; later chambers with small spines along the periphery; wall calcareous and smooth; aperture elongate, slightly curved, located near the border of the last chamber.

Length, .46 mm.; greatest width, .43 mm. Rare at station O-1.

### Family CHILOSTOMELLIDÆ

### Genus CHILOSTOMELLA Reuss

**Chilostomella species** Plate 2, figs. 20, 21

Test elongate, ends rounded, the end fartherest from the aperture being slightly larger, circular in transverse section; greatest diameter near the center of the test; early chambers partially exposed on one side; length equal to about twice the width; wall calcareous, smooth; aperture a small slit and with a weakly developed lip.

Length, .61 mm. Rare at station E-1.

This form closely resembles *Chilostomella czizeki* Reuss[12] but with the few specimens available specific identification does not seem practical.

### Family GLOBIGERINIDÆ

### Genus GLOBIGERINA d'Orbigny

**Globigerina bulloides** d'Orbigny Plate 1, fig. 16

*Globigerina bulloides* d'Orbigny, Annales Sci. Nat., vol. 7, 1826; Model no. 76.
*Globigerina bulloides* Brady, *Challenger* Report, Zoology, vol. 9, 1884; p. p. 593, pl. 79, figs. 3-7.
*Globigerina bulloides* Nuttall, Jour. Pal., vol. 6, no. 1, 1932; p. 29, pl. 6, figs. 13-15.

[11]Cushman, 1927 Proc. U. S. Uat. Mus., vol. 70, art. 16; p. 5, pl. 2, figs. 2 a-c.

[12]Reuss, 1850, Denkschr. Akad. Wiss. Wien, vol. 1; p. 380, pl. 48, figs. 13 a-d.

Dorsal side convex, showing eight chambers (two whorls), ventral side exposing four chambers, with a deep umbilicus; chambers spherical, inflated; wall calcareous, evenly covered with numerous well defined pits; major aperture a rounded opening on the inner side of the final chamber, located near the umbilicus, some of the earlier chambers have independent apertual openings

Diameter, .52 mm. Abundant at station 0-1.

#### Genus ORBULINA d'Orbigny

**Orbulina universa** d'Orbigny

*Orbulina universa* d'Orbigny, Hist. Fis. Pol. Nat. de Cuba, 1839; "Foraminiferes", p. 3, pl. 1, fig. 1.

Exterior consisting of a single spherical chamber which completely incloses the early globigerina-like portion; test calcareous, finely hispid, and with a small circular opening which comprises the aperture.

Diameter, .52 mm. Common at station 0-2.

These forms appear identical to those living in the present seas.

### Family GLOBOROTALIIDÆ

#### Genus GLOBOROTALIA Cushman

**Globorotalia menardii** (d'Orbigny) Plate 3, figs. 12, 13

*Rotalia menardii* d'Orbigny, Ann. Sci. Nat., vol. 7, 1826; p. 273, no. 26, model no. 10.

*Discorbina sacharina* Schwager, Novara-Exped. Geol. Theil, 1866; p. 257, pl. 7, fig. 106.

*Globorotalia menardii* Nuttall, Jour. Pal., vol. 6, no. 1, 1932; p. 29, pl. 4, fig. 16.

Test trochoid, compressed, dorsal side slightly convex, ventral side much more so; periphery angular and with a low thickened keel, lobate in outline in the last half of the final whorl; test made up of about two and a half whorls, all of which are visible from the dorsal side, five chambers in the last whorl; chambers on the ventral side triangular in outline and inflated; dorsal sutures smoothly curved, thickened, and slightly elevated; sutures on the ventral side radiate and depressed; wall smooth, calcareous, and perforate; aperture a slit on the ventral side reaching from the umbilicus to near the periphery; with a weakly developed flap or lip extending from the final chamber's apertul face.

Greatest diameter, .59 mm. Common at station o-2.

### Family ANOMOLINIDÆ

### Genus CIBICORBIS Hadley, New Genus

Genotype, **Cibicorbis herricki**, n. sp.

Test trochoid; dorsal side flattened; ventral side convex and involute, chambers on this side becoming more gibbous as the coiling progresses, final chamber with a flap-like projection which extends toward the umbilical region; periphery angled and forming a distinct division between the dorsal and ventral side; wall calcareous and perforate; aperture located on the ventral side, a slit between the body of the test and the extension of the final chamber, extending from near the umbilicus to the periphery.

The genotype of *Valvulineria* (*V. californica* Cushman)[13] has a rounded periphery across which the sutures extend unbroken and thus differs from *Cibicorbis.*

The cotypes of this genus are deposited in the Paleontoligical Research Institution, Ithaca, New York.

### Genus CIBICORBIS

**Cibicorbis herricki,** n. sp. Plate 5, figs. 1-3

Test trochoid, dorsal side flattened or slightly convex on young specimens, showing all of the chambers (two whorls); ventral side convex, later chambers much thickened; periphery angular and with a rounded thickening of shell material around its border, peripheral outline becoming lobate in the final portion of the last whorl; final chamber with an extension which covers the umbilicus, final chamber's apertual face strongly convex and bordered on either side by a low rounded flange; sutures thick, those on the dorsal side slightly elevated, ventral sutures flush with the test; wall calcareous, thick, and smooth; aperture a slit between the final whorl and the extension of the last chamber, located on the ventral side and extending from the umbilicus to the periphery.

The distinct rounded and elevated border on either side of the apertual face is a constant character of this species.

Greatest diameter of type, 85 mm. Common at station o-2.

Holotype from the basal marl of the Yumuri River Gorge near the town of Matanzas, (Matanzas Province) Cuba.

[13]Cushman, 1926; Contrib. Cushman Lab. Foram. Res., vol. 2, pt. 3; page 59; plate

Some of the specimens are dextrally coiled while others show sinistral coiling.

### Genus PLANULINA d'Orbigny, 1826

**Planulina marialana**, n. sp. Plate 4, figs. 4-6

Test slightly trochoid, much compressed, equally biconvex; periphery angular and with a low thin keel except for the final chamber which has a flattened apertual face and outer border; ventral side showing only the final whorl; some of the early chambers are exposed on the dorsal side, but they are more or less hidden by small irregular elevations of shell material; chambers reaching their greatest height at a point about midway between the center of the test and the periphery, tapering at their inner and outer margins, nine chambers in the final whorl; sutures slightly limbate and elevated, strongly curving on both sides but not angular, ventral sutures radiate from a small slightly depressed area; test calcareous, coarsely punctate, otherwise smooth; aperture a low arch over the periphery at the base of the final chamber's apertual face and extending for a short distance on the ventral side.

Diameter of type, .5 mm. Common at station 0-1.

Holotype from station 0-1.

A few forms of the above species were found which are slightly larger than the average specimen, possess a flattened ventral side, and show a weaker development of the keel; although this form is included under the above species it is not typical.

The sutures of *Planulina marialana* are not as much thickened and elevated as those of *Planulina wuellorstorfi*[14]. The angled and keeled periphery distinguishes this species from related forms.

**Planulina matanzasensis**, n. sp. Plate 4, figs. 1-3

Test slightly trochoid, biconvex, ventral side slightly more so; periphery angular and with a low rounded keel; twelve chambers in the last whorl; ventral side involute, with the umbilicus smoothly filled; on the dorsal side the entire area within the final whorl is filled with small bead-like structures which hide all of the early chambers; sutures on both sides elevated and slightly curving; aperture located at the base of the last formed chamber.

[14]Cushman, 1929, Contrib. Cushman Lab. Foram, Res., vol. 5; p. 102; pl. 15.

Greatest diameter of type, .50 mm. Common at station 0-2.

Holotype from station 0-2.

*Anomalina mantaensis*[15] differs from the above by having the dorsal side flattened and by lacking the bead-like structures on the central portion of that side. *Truncatulina pseudoungeriana*[16] is more coarsely punctate, has fewer chambers in the final whorl, and the central area of shell material on the dorsal side is not broken up into well defined nodes or elevations.

### Genus PLANULINA d'Orbigny

**Planulina mexicana** Cushman — Plate 4, fig. 12

*Planulina mexicana* Cushman, Contrib. Cushman Lab. Foram. Res., vol. 3, pt. 2, 1927; p. 113, pl. 23, figs. 5a, b.

Planispiral, involute, strongly compressed; periphery broadly rounded; chambers numerous, all visible from either side, about twelve in the last whorl of an adult test, much wider than high; sutures strongly curved, thickened, flush with the test; wall calcareous, smooth, coarsely perforate; aperture a low arch, peripheral, at the base of the final chamber.

Diameter, .81 mm. Common at station 0-2.

### Genus CIBICIDES Montfort

**Cibicides mexicana** Nuttall — Plate 4, figs. 7, 8

*Cibicides mexicana* Nuttall, Jour. Pal., vol. 6, no. 1, 1932; p. 33, pl. 9, figs. 7-9.

Test plano-convex, dorsal side practically flat, ventral side strongly convex and rounded so as to give the test a hemispherical appearance when viewed from that side; periphery rounded and without a keel; about ten chambers making up the last whorl; dorsal side with a low, wide boss which covers all of the chambers on that side except those composing the last whorl; dorsal sutures oblique, slightly curved somewhat depressed, obscure; ventral sutures gently curved, radiating from a slight central depression, slightly raised; wall smooth; calcareous and distinctly punctate; aperture a low slit at the base of the apertual face extending from the periphery about half the distance to the umbilicus.

Diameter, .96 mm. Common at station 0-1.

[15]Galloway and Morrey, 1929; Bull. Amer. Pal., vol. 15, no. 55; p. 28; pl. 4; fig. 5.

[16]Cushman, 1921; U. S. Geol. Survey Prof. Paper no. 129; p. 97; pl. 20, fig. 9.

**Cibicides trinititatensis** (Nuttall) Plate 4, figs. 10, 11

*Truncatulina trinitatensis* Nuttall, Quart. Jour. Geol. Soc. of London, vol. 84, 1928; p. 97, pl. 7, figs. 3, 5, 6.
*Cibicides trinititatensis* Nuttall, Jour. Pal., vol. 6, no. 1, 1932; p. 33, pl. 7, fig. 6.

Dorsal side slightly convex, ventral side much more so; periphery rounded, without a keel; chambers numerous, much wider than high, about fifteen making up the last whorl; early chambers on the dorsal side covered with a low, rounded, central boss, this mass of shell material is sharply set off from the final whorl by a pronounced depression; sutures evenly curving on both sides, those on the dorsal side are slightly more elevated; ventral side with a small, low central boss; wall calcareous, smooth, and punctate; aperture arched, at the base of the final chamber.

Diameter, .70. Common at stations E-1 and O-2.

### Genus LATICARININA Galloway and Wissler

**Laticarinina pauperata** (Parker and Jones) Plate 4, fig. 9

*Pulvinulina repanda*, var. *menardii*, subvar. *pauperata* Parker and Jones, Philos. Trans. Roy. Sov. London, vol. 155, 1865; p. 395, pl. 16, figs. 50, 51.
*Pulvinulina pauperata* H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884; p. 696, pl. 104, figs. 3-11.
*Laticarinina pauperata* Cushman, U. S. Nat. Mus., Bull. No. 104, part. 8, 1931; p. 114, pl.

Test plano-convex, slightly trochoid, loosely coiled; chambers inflated, all visible from either side, nine in the last whorl; chambers separated by straight, deeply constricted sutures; wall calcareous, smooth, hyaline; with a wide, thin carina of clear shell material; aperture a narrow slit located along the periphery on the ventral side and at the anterior end of the final chamber.

Greatest diameter, 1.10 mm. Very rare at station 0-1.

This form lacks the large initial chabler that is often exhibited by this species.

## Family PLANORBULINIDÆ

### Genus GYPSINA Carter

**Gypsina globulus** (Reuss)

*Ceriopora globulus* Reuss, Haidinger's Naturw. Abhandl., vol. 2, 1847; p. 33, pl. 5, fig. 7.
*Gypsina globulus* H. B. Brady, *Challenger* Voyage, vol. 9, Zoology, 1884; p. 717, pl. 101; fig. 8.

Test a spherical mass of chambers; exterior surface covered with a net-work which is formed by elevated chamber walls.

Diameter, .93 mm. Rare at station E-1.

### Genus PLANORBULINA d'Orbigny

**Planorbulina larvata** Parker and Jones Plate 5, fig. 9

*Planorbulina vulgaris* d'Orbigny, var. *larvata* Parker and Jones, Ann. Mag. Nat. Hist., ser. 3, vol. 5, 1860; p. 294.

*Planorbulina larvata* Cushman, U. S. Geol. Sur. Prof. Paper no. 133, 1923; p. 39, pl. 6, figs. 7, 8.

Test discoidal, much flattened, attached by the dorsal surface; early chambers coiled, later ones irregularly arranged about the periphery in a single layer; sutures depressed; central portion obscured by an irregular growth of shell material; test calcareous, coarsely perforate; apertures numerous, often with lips.

Diameter, .61 mm. Rare at stations 0-1 and 0-2.

### Genus LEPIDOCYCLINA Gumbel

**Lepidocyclina subglobosa** Nuttall Plate 5, fig. 10

*Lepidocyclina subglobosa* Nuttall, Quart. Jour. Geol. Soc. of London, vol. 84, 1928; p. 104, pl. 8, figs. 3, 5, 6, 7.

Test discoidal, central portion elevated, thinning toward the periphery, peripheral border with small lobes of shell material; surface decorated with numerous small, irregular depressions which are separated by thickened partitions of shell material, the depressions becoming larger and the partitions thicker as they approach the central area.

Diameter, 1.30 mm. Common at station E-1.

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**CORRECTION !**

Change Bulletin Numbers on these plates to **70A** in place of **70.**

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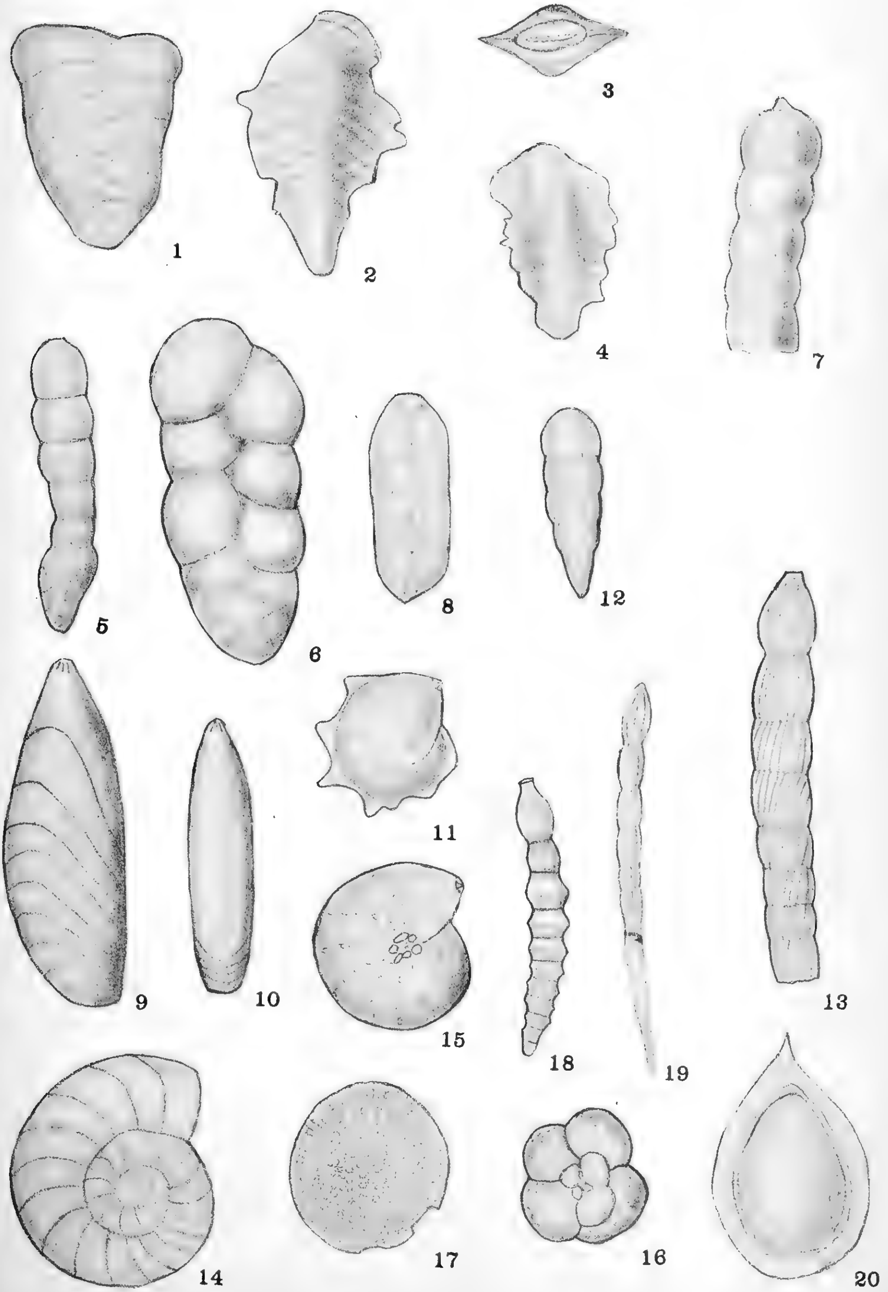
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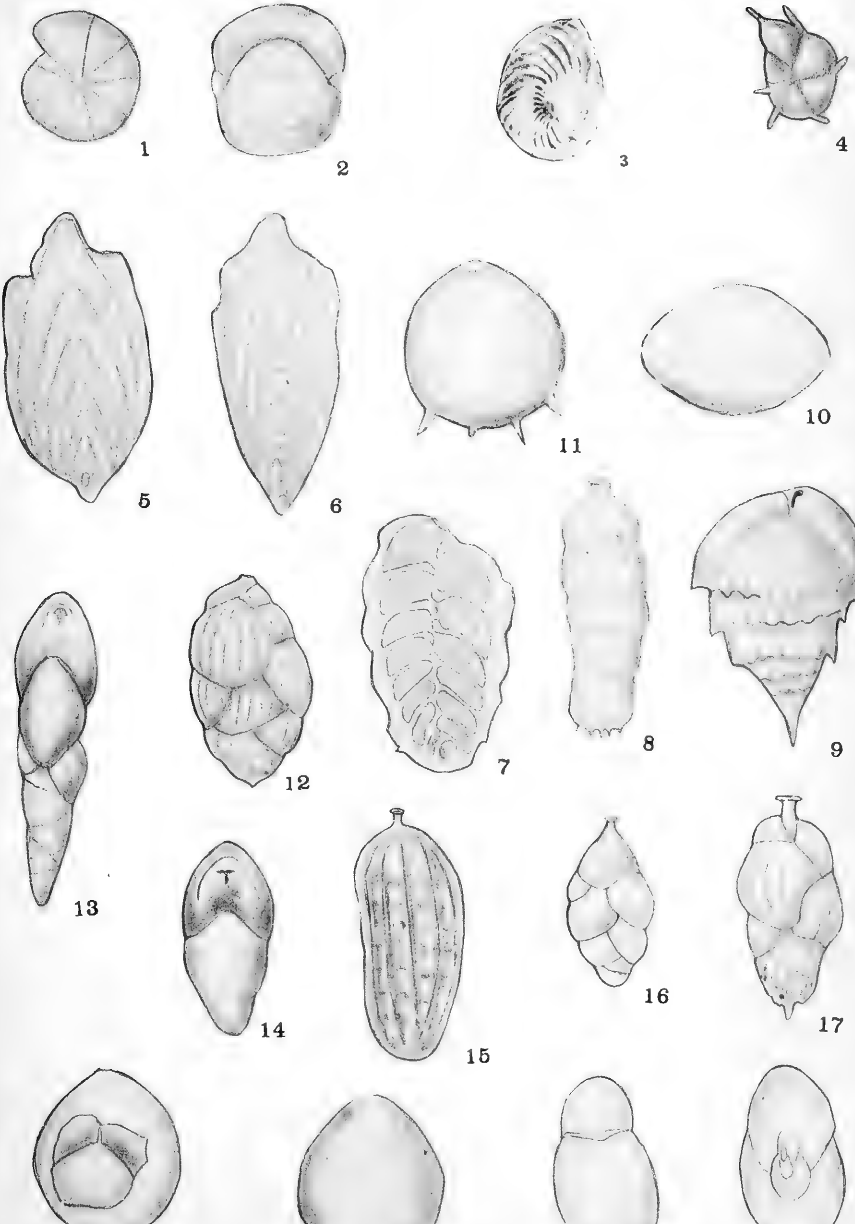
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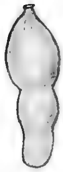
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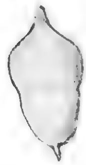
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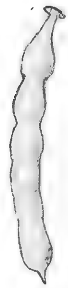
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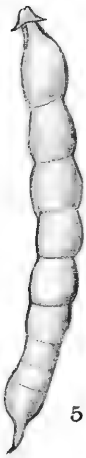
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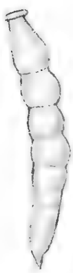
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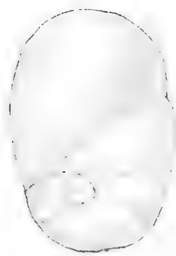
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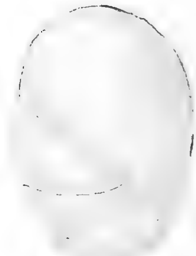
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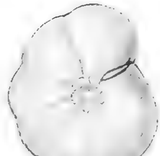
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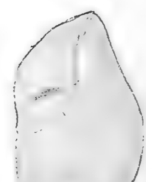
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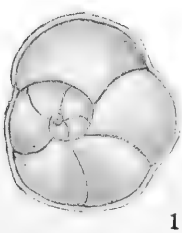
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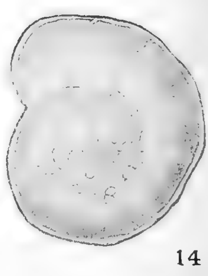
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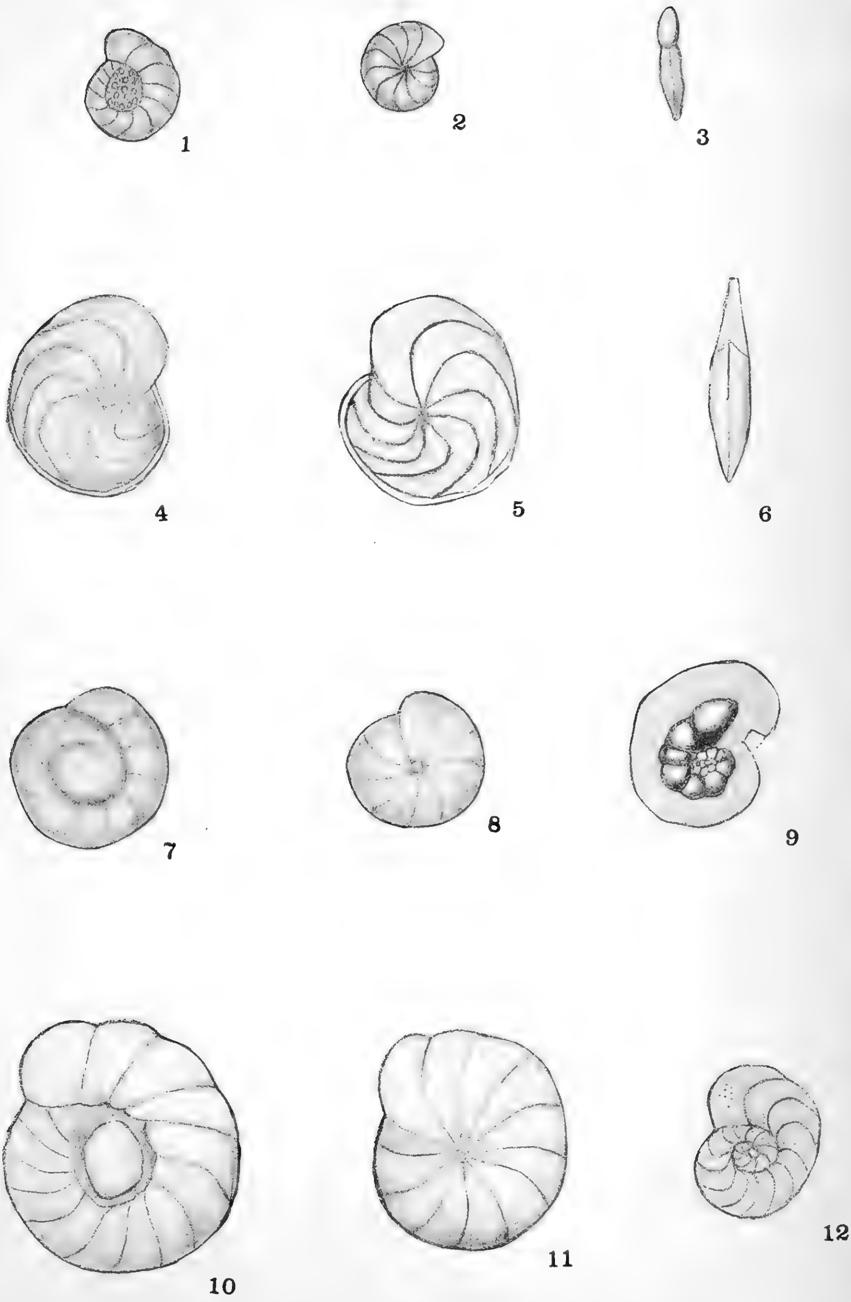
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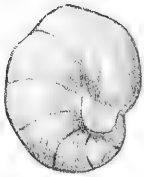
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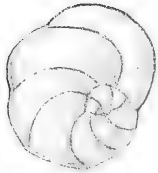
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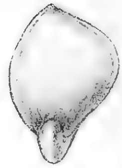
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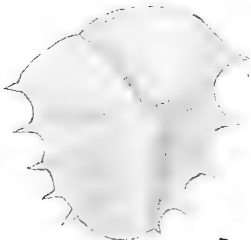
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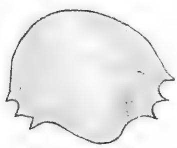
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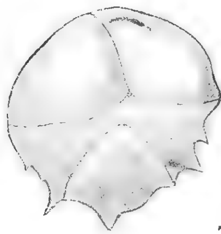
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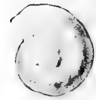
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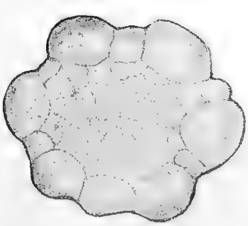
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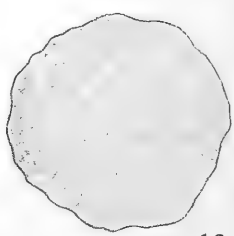
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BULLETINS

OF

AMERICAN PALEONTOLOGY

Vol. 20

*

No. 70 B

# Eocene Corals

## Part I: From Cuba

## Part II: A New Species of Madracis from Texas

BY JOHN W. WELLS

*June 9, 1934*

Paleontological Research Institution,
Ithaca, New York
U. S. A.

## *PART I: EOCENE CORALS FROM CUBA*

### INTRODUCTION

The specimens described in this paper were collected in the province of Camaguey, Cuba, in 1932 by N. E. Weisbord, who kindly offered them to the author for description. It has been a pleasure to work up this collection which adds materially to our knowledge of the corals of the West Indian Eocene.

No correlation of the formation containing these corals in the province of Camaguey is at present available, but from the corals it would appear that it is approximately equivalent to the upper Eocene St. Bartholomew limestone (Priabonian-Ludian-Jacksonian). This is suggested by the presence of *Astrocoenia incrustans* both in Camaguey and St. Bartholomew and by the lack of any species indicative of the middle and lower Eocene formations of the West Indian islands. The presence in Camaguey of two species identified with two occurring in the limestone above the conglomerate on Mogote Peak near Guantanamo, Cuba, may also indicate an equivalency.

Besides the 7 new and 3 old species discussed in the present paper, there are in the collections from Camaguey province poorly preserved specimens of 6 other species of Madreporaria, including one faviid, one poritid, and a species of *Metethmos* or *Frechia,* one well-preserved hydrocoral (*Errina* ?), and a number of fragments of several species of lithothamnioids. The whole fauna is indicative of fairly shallow water but not of true reef-building conditions.

# DESCRIPTION OF SPECIES

## MADREPORARIA

### Family TROCHOSMILIIDÆ Pourtalès

### Genus TROCHOSMILIA Milne Edwards & Haime 1848

**Trochosmilia raymondi,** n. sp. Plate 1, figs. 1, 2

*Description.*—Corallum free, very much compressed, cuneiform, expanding rapidly from a small base. Height of corallum, 23.5 mm.; diameters of the calice, 10 x 47 mm.; depth of calice, 8 mm. Costæ rounded, with single rows of low beads, equal in size with narrow interspaces and distinct down to within two-thirds of the distance from the calice margin to the base. Septa numerous, alternating regularly in size and length, extending to the center of the corallum at the bottom of the calice. They number about 20 in a space of 10 mm.,—nearly 200 in the whole corallum. Columella absent. Endothecal dissepiments slightly developed near the wall.

*Holotype.*—Paleontological Research Institution.

*Occurrence*: *Type locality.*—Loma Calixto near Nuevitas, Camaguey, Cuba.

*Remarks.*—This species, which is unlike any other form of the genus now known from the West Indian Tertiary, belongs to de Angelis d'Ossat's second group[1], that of *T. complanaat,* which includes species with a cuneiform corallum and a much-elongated calice, most of which are found in the Cretaceous and are practically unknown in the Eocene. The lack of a lamellar columella distinguishes it from *Placosmilia,* and the presence of dissepiments and a theca from *Placotrochus,* species of which resemble this form occur in the West Indies.

### Family ASTROCOENIIDÆ Koby

### Genus ASTROCOENIA Milne Edwards & Haime 1848

Including the two new species described in the present paper, there are known at present 8 species of this genus in the Eocene of the West Indies. Besides these, the author has described in manuscript a ninth from the middle Eocene Yellow Limestone of Jamaica. A Key for the differentiation of these species, with

[1]de Angelis d'Ossat, G. Coralli del cretacico inferiore della Catalogna. **Palaeontographica Italica,** vol. 11, p. 221, 1905.

the exception of the last, follows:

I. Styliform columns or pillars between calices.
   1. Corallum massive, calices shallow ........ *A. duerdeni*
   2. Corallum ramose, calices deep ........ *A. calixtoensis*

II. Styliform pillars absent.
   1. Calices averaging 2.0 mm., or larger.
      A. Corallum ramose.
         a. Septal dentations coarse ........ *A. d'achiardi*
         b. Septal dentations fine ............ *A. meinzeri*
      B. Corallum massive .............. *A. decaturensis*
   2. Calices averaging less than 2.0 mm.
      A. Corallum ramose ................ *A. nuevitasensis*
      B. Corallum massive or encrusting.
         a. Calices 0.75-1.0 mm., corallum encrusting .................... *A. incrustans*
         b. Calices 1.5-1.75, corallum massive ......................... *A. guantanamensis*

**Astrocoenia calixtoensis**, n. sp. Plate 1, figs. 3-17

*Description.*—Corallum ramose with short stubby branches averaging 8 mm. in diameter. Calices small, polygonal or rounded-polygonal, with fused walls about 0.25 mm. thick, averaging 1.5 mm. in diameter (range 1.0-1.75 mm.) and from 1.0 to 2.0 mm. in depth. Inner wall of calices vertical. Septa 16 in number, 8 large and 8 small ones, the former only reaching to the columella. Laterally the septa are smooth, but their upper margins are notched by distant teeth. The columella is small and styliform, projecting upwards from the bottom about one-third of the distance to the upper edge of the calice. Dissepiments present.

*Types.*—Paleontological Research Institution.

*Occurrence*: *Type locality.*—Loma Calixto near Nuevitas, Camaguey, Cuba.

*Remarks.*—This species, like *A. duerdeni* Vaughan[2], has all the characteristics of *Stylocoenia,* except for the denate septa.

[2]Vaughan, T. W. Some Cretaceous and Eocene Corals from Jamaica. **Bull. Mus. Comp. Zool.,** vol. 34, p. 235, pl. 37, figs. 1-4, 1899.

If the type of *Stylocoenia, S. emarciata* (Lamarck), really has smooth septal margins, then that genus is a Eusmilid, and it may prove desirable in that case to separate from *Astrocoenia* a generic group with styliform pillars to include the present form, *A. duerdeni*, and others.

*A. duerdeni* differs from *A. calixtoensis* by its more massive growth-form and shallower calices.

**Astrocoenia nuevitasensis**, n. sp. Plate 1, figs. 8, 9, 18

*Description.*—Corallum ramose, with somewhat compressed branches averaging 10 x 12 mm. in diameters; height variable. Calices rounded-polygonal, ranging in diameter from 1.0 to 1.5 mm., shallow, with thick, rounded, fused walls. The surface of the specimens are worn and no ornamentation can be seen. The septa are 16 in number, corresponding to two cycles and one-third of the third, arranged in 8 equal systems. The eight larger ones extend to the columella and are thickened at the point of meeting. The eight others are small. Their upper margins are dentate and laterally they are lightly granulated. Columella small and styliform. Endothecal dissepiments present. The under surface of the basal portion of the colony is epithecate.

*Types.*—Paleontological Research Institution.

*Occurrence (Type locality).*—Loma Calixto near Nuevitas, Camaguey, Cuba.

*Remarks.*—The two other ramose species of the genus from the Eocene of the West Indies are *A. d'achiardi* (Duncan)[3] and *A. meinzeri* Vaughan[4]. In both of these species the calices are, on the average, twice as large as in the present form.

**Astrocoenia incrustans** (Duncan) Plate 1, figs. 10, 11

*Stephanocoenia incrustans* Duncan 1873. Q. J. G. S. London, vol. 29, p. 553, pl. 20, fig. 6.

*Stephanocoenia incrustans* Vaughan 1899. Bull. Mus. Comp. Zool., vol. 34, p. 229.

*Astrocoenia incrustans* Vaughan 1919. Bull. U. S. Nat. Mus., 103, p. 347.

[3]Duncan, P. M. On the older Tertiary formations of the West Indian Islands. **Quart. Jour. Geol. Soc. London.**, vol. 29, p. 554, pl. 20, figs. 7, 7a, 1873.

[4]Vaughan, T. W. Fossil Corals from Central America, etc. **Bull. U. S. Nat. Mus.**, 103, pp. 349-350, pl. 79, figs. 3, 3a, 1919.

*Types.*—University of Upsala.

*Plesiotypes.*—Paleontological Research Institution.

*Occurrence (Type locality).*—St. Bartholomew limestone, Island of St. Bartholomew. *Other locality.*—Loma Calixto near Nuevitas, Camaguey, Cuba. (Plesiotypes).

*Remarks.*—I am referring to this species two specimens from Cuba. Both of them agree with Duncan's figure and description and with Vaughan's later description. One specimen shows the encrusting growth-form; the other is a small, nodular, pedunculated head with a height of 20 mm. and a diameter of 23 mm. Both have the same type of calices and septal arrangement and there seems to be no reason to distinguish them as being separate species. The calices vary in size from 0.75 to 1.25 mm. and contain 16 septa, alternately long and short. There is no evidence of any columns between the calices.

**Astrocoenia guantanamensis** Vaughan Plate 1, figs. 12, 13

*Astrocoenia guantanamensis* Vaughan 1919. Bull. U. S. Nat. Mus., 103, p. 347, pl. 79, figs. 1, 1a, 2.

*Type.*—U. S. N. M. No. 324794.

*Other specimens.*—Paleontological Research Institution.

*Occurrence (Type locality).*—Mogote Peak, near Guantanamo, Cuba, 375 feet a. t. *Other localities.*—Jackass Point, St. John, Antigua, (Vaughan); Tonosi, Panama, (Vaughan); Loma Calixto, near Nuevitas, Camaguey, Cuba, (Weisbord).

*Remarks.*—Four well-preserved specimens from Loma Calixto have been examined and seem to belong to this species. They represent fragments from what were apparently massive, tuberous, colonies. The calices are shallow, ranging in diameter from 1.5 to 1.75 mm., with 16 septa, arranged in 8 equal systems. The upper margins of the septa are strongly dentate with from 4 to 6 dentations on each (Vaughan gives 3 as the number in the type). The wall is broad with an acute margin crossed by costæ or simply dentate.

### Family FAVIIDÆ Gregory

### Genus FAVIA Oken 1815

**Favia weisbordi**, n. sp. Plate 2, fig. 8

*Description.*—Corallum massive, with a rounded upper surface. Lower surface covered with a thin, wrinkled, epitheca.

Calices of medium size, circular, oblong, elliptical or subangular in outline, separated by intercorallite areas from 0.5 to 1.5 mm. across. Cavities deeply excavated. Walls thin and acute on the upper edge, deeper down much thicker. Septa thin, dentate on their upper margins, laterally spinulose, slightly exsert at the margins of the calice. They vary in number, depending on the size of the calice. This, in calice no. 1 there are 32, in no. 2, 38, and 44 in no. 3. In a section it is seen that they alternate in length so that one-half of them extend to the columella where they are slightly thickened. Costae correspond to all the septa, well-developed, but short and non-confluent between calices, and the middle of the intercorallite areas is usually smooth or slightly granular or spinulose. Margins of the costæ not seen. Columella poorly developed, formed by the inner ends of the septa and lying deep in the calice. Thin dissepiments present although the mural elements are frequently thickened so that the exotheca is lost. Reproduction by fission.

*Dimensions.*—

| *Calice No.* | *Greater diameter* | *Lesser diameter* |
|---|---|---|
| 1 | 3.5 mm. | 3.0 mm. |
| 2 | 5.0 | 4.0 |
| 3 | 5.5 | 3.5 |

*Holotype.*—Paleontological Research Institution.

*Occurrence (Type locality).*—Loma Calixto near Nuevitas, Camaguey, Cuba.

*Remarks.*—The only American species of *Favia* with which this form can be compared, and to which it is closely related, is the well-known *Favia fragum* (Esper), now living in the West Indies and known also from the Pleistocene reefs of the same region. Both species have the same size and type of calices with about the same number of septa. The intercorallite areas of *F. fragum* are marked by tall spines or spinulose costæ. The same may have been true of *F. weisbordi* but the holotype is worn on the upper surface. The columellas of the two forms differ in that it is more fully developed in the living species.

The main distinction is the relatively shallow, sharp-walled calices with slightly exsert septa of *F. weisbordi* as compared to the deep calices and highly exsert septa of *F. fragum*.

### Family MUSSIDÆ Verrill

### Genus SYZYGOPHYLLIA Reuss 1860

**Syzygophyllia hadleyi**, n. sp. Plate 2, figs. 3, 4

*Description.*—Corallum relatively low, expanding rapidly from a narrow base. The costæ are equal in size, large, with single rows of coarse dentations. No traces of an epitheca. The calice is shallow with broad, gently curved and slightly reflexed margins. The septa, about 120 in number, are alternately thick and thin, with coarse, spinulose, mussaoid dentations which average 1.5 mm. in length at the base with a height of 1.0-1.5 mm. Their upper margins are gently rounded, peripherally descending and merging with the costæ, centrally descending to the columella, which is met by the first three cycles. The columella is indistinct but large and compressed. Endothecal dissepiments abundant and well-developed.

*Dimensions.*—

| *Height* | *Calicular Diameters* |
|---|---|
| ca. 32 mm. | 50 x 50 mm. |

*Holotype.*—Paleontonogical Research Institution.

*Occurrence (Type locality).*—In the railway cut between 1.5 and 2 km. north of Nuevitas railway station. Camaguey, Cuba. This horizon is apparently equivalent to that found at Loma Calixto.

*Remarks.*—A single specimen in a fair degree of preservation is here made the type of a new species. It has suffered some distortion due to pressure and the extreme end of the base is broken off. The septal teeth are not all preserved but enough remain to show their mussaoid character. The apparent absence of an epitheca may well be due to post-mortem wear.

*S. hayesi* Vaughan[5] from the upper Eocene Brito formation

[5]Vaughan, T. W. Bossil Corals from Central America, etc. **Bull. U. S. Nat. Mus.**, 103, p. 424, pl. 106, figs. 1, 1a, 1b, 1919.

of Nicaragua, is a larger species, externally covered by a thick epitheca, with more and thicker septa than *S. hadleyi*. *S. gregorii* Vaughan, of the Bowden (Miocene) marl of Jamaica, resembles this species very closely, according to Duncan's[6] figures of *Antillia ponderosa* (=*S. gregorii*).

### Family TROCHOSERIDÆ Wells

### Genus TROCHOSERIS Milne Edwards & Haime 1849

**Trochoseris meinzeri** Vaughan — Plate 1, figs. 14-17

*Trochoseris meinzeri* Vaughan 1919. Bull. U. S. Nat. Mus., 103, p. 426, pl. 106, figs. 2, 2a, 2b.

*Holotype.*—U. S. N. M. No. 325228.

*Other specimens.*—Paleontological Research Institution.

*Occurrence (Type locality).*—Mogote Peak, near Guantanamo, Cuba. *Other locality.*—Loma Calixto near Nuevitas, Camaguey, Cuba.

*Remarks.*—Five specimens are referred to this species, not, however, without some doubt. They are all smaller than the type specimen, as shown by the following dimensions:

| *Height* | *Calicular Diameters* |
|---|---|
| 19 mm. | 35 x 40 mm. |
| 13 | 32 x 33 |
| 13 | 25 x 30 |
| 13.5 | 25 x 28 |
| 17 | 26 x 28 |

The wall is solid, marked by small rounded, equal or slightly alternating costæ which number from 9 to 12 in a space of 5 mm. The septa are numerous and crowded. About 30 of them extend to the center and the total number probably exceed 200. In the type, a larger specimen, there are about 280.

One of the specimens (the second in the above table) possesses a much higher number of septa, averaging 9 in a space of 2 mm., and probably more than 400 altogether, but is otherwise very much like the rest, is here distinguished for the present as *Trochoseris meinzeri camagueyensis*, n. var. (Pl. 1, figs. 14, 15.)

[6]Duncan, P. M. On the fossil corals on the West-Indian Islands. Quart. Jour. Geol. Soc. London, vol. 19, pl. 16, figs. 6a, 6b, 1863.

### Family PORITIDÆ Dana

### Genus GONIOPORA Quoy & Gaimard 1833

**Goniopora taberi,** n. sp. Plate 2, figs. 5-7

*Description.*—Corallum apparently ramose, consisting of thick compressed branches. The holotype is a fragment of a branch 50 mm. long and about 15 x 17 mm. in diameter. Calices polygonal, shallow, averaging 2.75 mm. in diameter (maximum, 3.0 mm.). The wall is distinct, usually formed by a single row of trabecular elements united by synapticulæ. Occasionally the wall may consist of 2 or 3 united rows of such united elements or rods. The septa are about equal in thickness, 24 in number, composed of 4-6 trabeculæ fused in a row. The upper terminations of the trabeculæ form rounded dentations on the upper margins. The septal arrangement is typical for the genus,—six primaries extending to the center and uniting to the columella, with a triplet group of a secondary and two tertiaries between each pair. Pali six in number, styliform, forming a crown around the columella. Columella a single style.

*Holotype.*—Paleontological Research Institution.

*Occurrence (Type locality).*—Loma Calixto near Nuevitas, Camaguey, Cuba.

*Remarks.*—There are two other species of *Goniopora* in the upper Eocene of the West Indies. They both occur in the St. Bartholomew limestone and are still undescribed. They have been noted as *Goniopora new species* 1 and *Goniopora new species* 2 by Vaughan[7]. The first was identified by Duncan as *Actinacis rollei* Reuss and the second was placed by him in *Porites ramosa,* Catullo[8]. Both of these species are European forms and neither is identical with the St. Bartholomew or Cuban species.

## ALCYONARIA

### Family HELIOPORIDÆ Moseley

### Genus HELIOPORA de Blainville 1834

**Heliopora bennetti,** n. sp. Plate 2, figs. 1, 2

*Description.*—The corallum forms a thin incrustation from 1

[7]Vaughan, T. W. Fossil Corals from Central America, etc. **Bull. U. S. Nat. Mus.,** 103, p. 194, 1919.

[8]Duncan, P. M. On the Older Tertiary Formations of the West-Indian Islands. **Quart. Jour. Geol. Soc. London,** vol. 29, p. 561, 1873.

to 3 mm. in thickness with a regularly convex upper surface. The autopores are more or less regularly spaced from 1.0 to 1.5 mm. apart and average 0.75 mm. in diameter. They are deep with a few horizontal tabluæ and with an average of 24 pseudo-septa. Their walls are thin, surrounded by a circumferential ring of pores formed by the external extensions of the pseudo-septa into the coenenchyme. The pseudo-septa are well-developed and may reach one-half of the distance from the wall toward the axis. The small siphonopores of the coenenchyme are regularly spaced so that 6-8 of them occupy 1 mm. On the surface their openings form a meshwork of circular orifices. In a vertical section they are seen to consist of small tubes with fused walls and thin, horizontal, tabular, dissepiments.

*Holotype.*—Paleontological Research Institution.

*Occurrence* (*Type locality*).—Loma Calixto near Nuevitas, Camaguey, Cuba.

*Remarks.*—This species is particularly interesting because it is the first record of *Heliopora* in the West Indies, either fossil or recent. Only one other species of the family is known at present from the North American region,—*Polytremacis ? hancockensis* Wells[9] of the lower Glen Rose formation (Aptian) of Central Texas. This was founded on an external mould and may well belong to *Heliopora,* since the only real difference between the two genera is the thicker wall of *Polytremacis*[10]. *P. ? hancockensis* has slightly larger autopores than *H. benetti* and fewer pseudo-septa (18). *Heliopora* (*Polytremacis*) *bellardi* Haime[11] is one of the few European Eocene species. It possesses slightly larger autopores, smaller siphonopores, and a lobed, massive growth-form. *H. coerulea* (Pallas), type of the genus and a recent Indo-Pacific form, has a branching or lobed growth-habit, autopores 0.5 mm. in diameter with only 12 pseudo-septa.

9Wells, J. W Corals of the Trinity Group of the Comanchean of Central Texas. **Jour. Pal.,** vol. 6, p. 256, pl. 35, fig. 5, 1932.

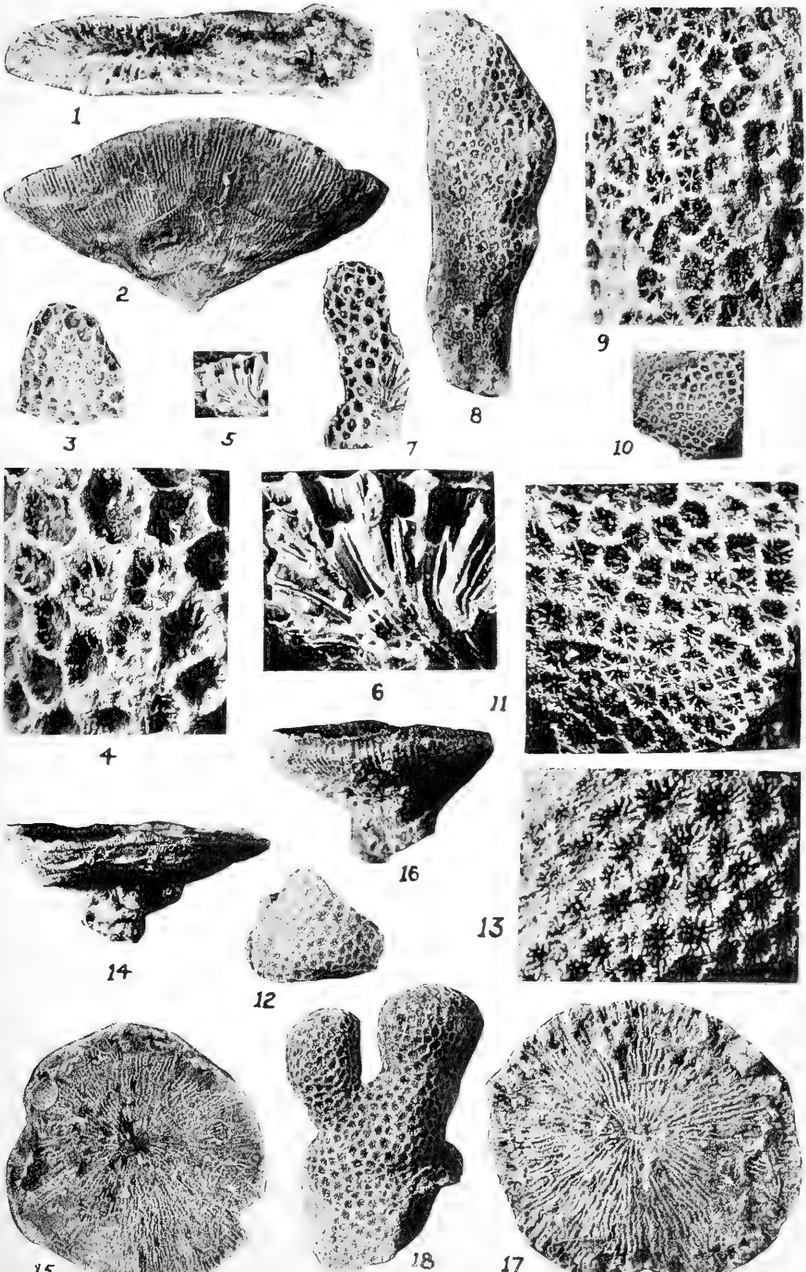
10Gregory, J. W. **Polytremacis** and the Ancestry of Helioporidæ. **Proc. Royal Soc.,** vol. 66, p. 299. 1899.

11Haime, J. Foss. Numm. Nice. **Mem. Soc. geol. France,** ser. 2, vol. 4 p. 289, pl. 22, fig. 7, 1852.

## Part I

### Explanation of Plate 1

## EXPLANATION OF PLATE 1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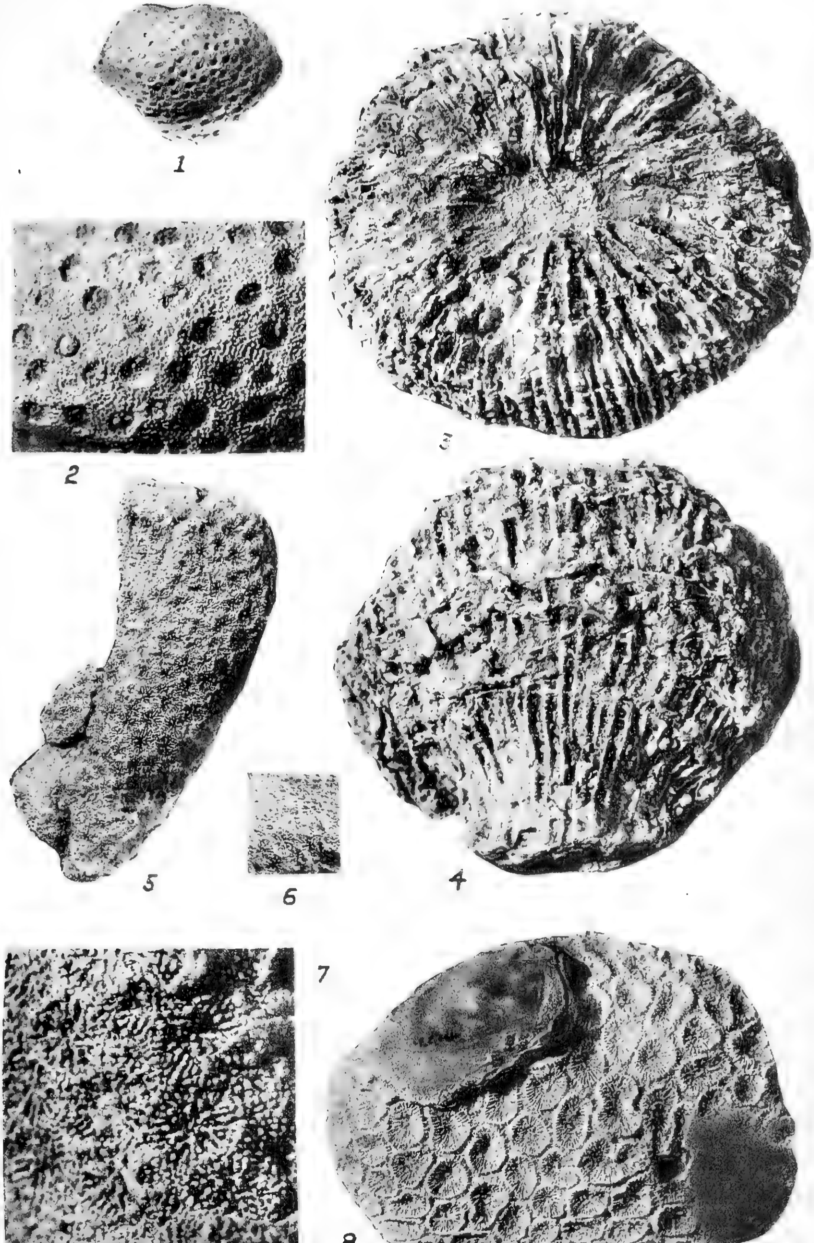
Part I

Explanation of Plate 2

**CORRECTION !**

Change Bulletin Numbers on these plates to **70B** in place of **70A.**

## EXPLANATION OF PLATE 2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## *PART II: A NEW SPECIES OF MADRACIS FROM THE EOCENE OF TEXAS*

The specimen which is the subject of this note was collected by the author in the spring of 1930. Besides the new species represented by this specimen, the following corals were collected at the time at the same locality:

Trochocyathus sp.
Caryophyllia texana Vaughan 1900
Archohelia singleyi (Vaughan) Vaughan
Balanophyllia irrorata coniformis Vaughan 1900
Balanophyllia irrorata mortoni (Gabb & Horn)

### Genus MADRACIS Milne Edwards & Haime 1849

**Genotype.—Madracis asperula** E. & H. 1850. Recent Maderia. (By subsequent designation, E. & H., 1850).

**Madracis herricki,** n. sp. Plate 1, figs. 1, 2

*Description.*—Corallum massive with low proliferations from the upper surface. The holotype measures 26 x 37 mm.; the maximum height of the four projections is 6 mm. Calices shallow, irregular and polygonal in outline, crowded together and united by fused walls which are produced into a thin ridge at the line of fusion on the surface. Coenenchyme little or none. Diameter of calices from 1.0 to 3.0 mm., average 2.5 mm. Septa 20, representing two cycles and part of the third, arranged in ten equal systems, non-exsert, laterally granulate with finely dentate upper margins. Ten larger ones extend to the columella to which they are fused. The remaining ten are thinner and extend less than one-third of the distance to the axis. The columella is styliform and secondarily thickened so that it is usually two-thirds the calicular diameter. The junction of septum and columella is marked by a low knob on the upper surface of the latter. Endotheca horizontal, thin, and well-developed.

*Holotype.*—Paleontological Research Institution, Ithaca, N. Y.

*Occurrence (Type locality).*—In the Weches clay of the Mt. Selman formation (Claibornian) on the east bank of Colorado

River about 100 yards upstream from the highway bridge, Smithville, Bastrop County, Texas.

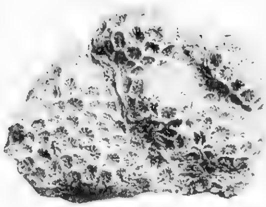
*Remarks.*—There are three other species of this genus in the Eocene of the Coastal Plain,—*M. ganei* Vaughan[1], *M. johnsoni* Vaughan[2], and *M. Gregorioi* Vaughan[3]. The present form is distinguished from all these by the presence of 10 relatively well-developed secondary septa. It also differs by its more massive growth-form, but this character may be due to a difference of environment. In *M. ganei* and *M. johnsoni* the calices are rounded and separated by coenenchyme. In *M. gregorioi* and the new species they are crowded together and separated only by the thickness of the corallite walls. *M. hericki* is probably most closely related to *M. gregorioi* (Chickasawan stage, Alabama), with which it agrees in every way but for the presence of well-developed intermediate septa and more closely appressed calices with thinner walls.

[1]Vaughan, T. W. Eocene and Lower Oligocene Coral Faunas of the United States, etc. **U. S. Geol. Surv. Mon. 39,** p. 128, pl. 13, figs. 1-7, 1900.
[2]**Ibid.** p. 129, pl. 13, figs. 8-11.
[3]**Ibid.** p. 130, pl. 13, figs. 12, 12a.

## Part II

### Explanation of Plate 1

## EXPLANATION OF PLATE 1



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BULLETINS

OF

AMERICAN PALEONTOLOGY

Vol. 20

*

No. 70C

# Some Cretaceous and Tertiary Echinoids from Cuba

By Norman E, Weisbord

*July 7, 1934*

Paleontological Research Institution,
Ithaca, New York
U. S. A.

# INTRODUCTION

The echinoids described herewith were collected by the writer in the years 1931 to 1933 while engaged in a study of the geology of Cuba for The Atlantic Refining Company of Philadelphia. Permission to publish this paper has been generously granted by this company through the intercession of Dr. Roy E. Dickerson, its chief geologist, to whom the writer is indebted for this and for his many helpful suggestions.

The writer also wishes to express his appreciation to Professor G. D. Harris for the use of the facilities of the paleontological labratory of Cornell University and of the new-born Paleontological Research Institution, of which he is founder. The types of the new species described in this article are deposited in the Paleontological Research Institution at Ithaca, New York, in a fire-proof building recentlty constructed by Professor Harris. In this connection it might be well to state that most of the types of new species collected by the students of Professor Harris are to be deposited here where they can be properly cared for and safe from the hazards of fire. By express provision of the charter of the Institution, all collections contained therein may be studied by any *bona-fide* student of paleontology.

Whenever any doubt exists in the identity of the Cuban species with those in other parts of the world, the writer has preferred to call the Cuban species new, calling attention, however, to its similarity to the form with which it has been compared. Even slight differences, if specific and not individual, may be of stratigraphic importance, and until such time as the stratigraphy and paleontology of the West Indies are more thoroughly known, it seems advisable to separate species if reasonable doubt exists concerning their similarity. This attitude may seem inconsistent when it is observed that the writer has lumped many differently shaped forms into one species, as for example in *Lanieria lanieri* (d'Orbigny), *Oligopygus sanchezi* Lambert and *Jacksonaster acunai* Roig. In these species the differences of various specimens are individual rather than specific and actually intergrade as can be seen by studying the large number of examples in our collection. On the other hand, when there are not many specimens available for comparison, as in the various species of *Peronella,* it is necessary to split species on the evidence adduced from the forms available. The justification of such a procedure will be determined when large collections are obtained in the future.

## LOCALITIES

The Cuban echinoids discussed in this report come from five different localities. These localities, in ascending stratigraphic sequence, are the following:

1. On the property of Central San Antonio, 150 meters northwest of the sugar cane loading rack at Esperanza switch. This switch lies on the private railroad of Central San Antonio, about 10 kilometers east of the mill and town of Madruga, near the eastern boundary of Habana Province.

2. In road cut at Loma Calisto, approximately 800 meters southwest of the south end of the town of Nuevitas, on the road leading toward Belen, Province of Camagüey. Nuevitas lies on the north coast of Cuba, on Nuevitas Bay.

3. From cut along the railroad between Neuvitas and Pastelillo, about two kilometers southeast of Neuvitas railroad station, Province of Camagüey. This railroad is a branch line of the Ferrocarril Central de Cuba, extending to Camagüey City. It should not be confused with the Ferrocarril del Norte which lies a short distance north of and parallel to it, but which terminates at Puerto Tarafa, not Pastelillo.

4. On road between Entronque Paso Real and Son Diego de Los Baños, 3 kilometers northwest of Entronque Paso Real, Pinar del Rio Province. Entronque Paso Real is a road junction on the Carretera Central (Central Highway), 49 kilometers east of Pinar del Rio City.

5. From the Central Highway of Cuba, 150 meters east of kilometer post 440, between the towns of Jatibonico and Ciego de Avila, Province of Camagüey.

## GEOLOGIC HORIZONS

*Locality No.* 1.—On property of Central San Antonio, 150 meters northwest of Esperanza switch on the Central San Antonio railroad, about 10 kilometers east of the town of Madruga, near the eastern boundary of Habana Province.

*Age.*—Lower part of the Upper Cretaceous, between the Cenomanian and Coniacian.

This locality was discovered by Dr. Robert L. Palmer and shown to the writer by William D. Chawner. The fossils collected here by the writer were found in a newly ploughed field, in earth derived from underlying marls. The rock adhering to some of the specimens is a tan, marly limestone, rather porous in texture when weathered. The indurated limestone is composed primarily of calcareous sand grains and some foraminifera, the sand grains having been derived from the calcareous tests of various invertebrate organisms.

The echinoids from this locality are the following:

Goniopygus supremus Hawkins
Codiopsis ciae Lambert
Coenholectypus cubae Hawkins
Lanieria lanieri (d'Orbigny)
Echinobrissus cubensis Weisbord, n. sp.
Cassidulus cubensis Weisbord, n. sp.
Catopygus jeanneti Lambert
Clypeopygus habanensis Weisbord, n. sp.
Hemiaster cf. antillensis Cotteau
Hemiaster madrugensis Weisbord, n. sp.
Hemiaster siboneyensis Weisbord, n. sp.

*Goniopygus supremus* Hawkins from Cuba is identical with the species originally described from Jamaica by Hawkins. In Jamaica it occurs in the Rudistid Limestone which is believed by Woolacott[1] and Hawkins[2] to be of possible Turnonian age The species is nearly identical with *Goniopygus menardi* Agassiz, particularly the variety *globosa,* which ranges from the Ceno-

[1]Annals and Mag. Nat. Hist., vol. 10, 9th ser., p. 535, 1922.
[2]Geol. Mag., vol. 61, No. 721, p. 315, 1924.

manian to the lower Senonian in Europe. It also may be compared with *Goniopygus major* Agassiz from the Cenomanian of France, although this species has three, instead of four excavations in the genitals at the periproct.

*Codiopsis ciae* Lambert is so close to *Codiopsis arnaudi* Cotteau from the lower Senonian of France that Cotteau, who originally named *arnaudi,* mistakenly identified the Cuban species as the same. Lambert[3], in reviewing the work of Cotteau and Egozcue[3a], noted that the Cuban *Codiopsis "arnaudi"* is quite different from the type species described from France and renamed it *Codiopsis ciae.* The Cuban form may also be compared to *Codiopsis texana* from the Buda Limestone (Cenomanian) of Texas, U. S. A.

*Coenholectypus cubae* Hawkins and *Lanieria lanieri* (d'Orbigny), two very interesting species which occur together and strongly resemble one another, have no close affinities, except perhaps for *Metholectypus trechmanni* from the *Barretia* beds of Jamaica. The *Barretia* beds are older than the Rudistid Limestone horizon of Jamaica, hence possibly Cenomanian in age.

The genus *Echinobrissus* is well developed in the Neocomian, Cenomanian and Senonian of France. The Cuban species *Echinobrissus cubensis* Weisbord, n. sp. is more closely allied to the Cenomanian and Senonian forms of that country than to the Neocomian. It resembles *Echinobrissus similis* d'Orbigny from Etage 20 of the Cenomanian, and is even more closely allied to *Echinobrissus minimus* d'Orbigny from Etage 22 of the Senonian. The Senonian aspect is somewhat further heightened by the distant relationship of our form to *Echinobrissus texanus* Clark from the Austin Chalk of Texas, U. S. A. The Austin Chalk may be equivalent to a portion of the Coniacian of lower Senonian age.

*Cassidulus cubensis* Weisbord, n. sp. is quite distinct from hitherto described species so that a comparison cannot be made between it and other forms. *Catopygus jeanneti* Lambert is also without near relationship, although it may be compared with

[3]Revue Critique de Paléozoologie, vol. 2, p. 30, 1898.
[3a] Bol. Comision Mapa Geol. de España, vol. 22, pp. 14, 15, pl. 1, figs. 10-15, 1897.

*Botriopygus rudistarum* Hawkins from the Rudistid Limestone age in Jamaica, and *Catopygus oviformis* Conrad from the Vincentown Sand of Maestrichtian age in New Jersey, U. S. A. Roig[4] reports a *Catopygus rodriguezi* from the Senonian at Central Stewart, Ciego de Avila, Province of Camagñey, but *Catopygus jeanneti* is decidedly different from that species.

To *Clypeopygus habanensis* Weisbord, n. sp., the Brazilian *Echinobrissus fretasi* White, from the lower part of the Upper Cretaceous, invites comparison, though the resemblance is superficial only. Yet of all the forms with which *habanensis* has been compared, the Brazilian one oddly enough is the closest.

The three species of *Hemiaster* show a greater resemblance to forms found elsewhere in the lower part of the Upper Cretaceous, although one species, *Hemiaster siboneyensis* Weisbord recalls in a general way *Hemiaster parastatus* (Morton) and *Hemiaster stella* (Morton) both of the Vincetown Sand (Maestrichtian) of New Jersey. However *Hemiaster* cf. *antillensis* Cotteau far more closely resembles *Hemiaster fourneli* Desor from the Turonian of Europe and northern Africa; and *Hemiaster nucleus* Disor from the base of the Senonian (Coniacian or Emscherian) in France. The third species of *Hemiaster, Hemiaster madrugensis* Weisbord, n. sp. finds its nearest analogue in *Hemiaster vicinus* Stoliczka from the Ootatoor Group (Cenomanian) of southern India.

Of the eleven species described from this locality, nine of them resemble forms found outside of Cuba in the lower or middle part of the Upper Cretaceous, or to use the European terminology, in horizons between the Cenomanian and the Lower Senonian (Coniacian). Two of the species may be compared in a very general way to Maestrichtian forms, but the relationships here are not nearly so close as are the majority of specimens to Cenomanian and Lower Senonian forms. It would be unwise to attempt to assign the echinoids of this locality to a more precise subdivision of the Upper Cretaceous.

*Locality No. 2.*—In road cut at Loma Calisto, approximately 800 meters southwest of the south end of the town of Nuevitas, on the road leading toward Belen, Province of Camagüey.

*Age.*—Upper Eocene.

[4]Boletin de Minas, Habana, No. 10, p. 71, pl. 10, figs. 1-3, 1926.

| Loma Calisto Echinoids | Related Species | Localities | Geologic Horizon |
|---|---|---|---|
| **Cidaris aff. loveni Cotteau** | Sidaris loveni Cotteau | St. Bartholomew | Eocene |
| Diadema principeana Weisbord, **n. sp.** | Hebertia simplex Hawkins | Jamaica | ? Middle Eocene |
| Jacksonaster acunai Roig | - - - - - | - - - - | - - - - |
| Jacksonaster sanchezi Roig | - - - - - | - - - - | - - - - |
| Peronella cubae Weisbord, n. sp. | Peronella mirabilis Jackson | Trinidad | Upper Eocene |
| Peronella caribbeana Weisbord, n. sp. | Peronella mirabilis Jackson | Trinidad | Upper Eocene |
| Oligopygus sanchezi Lambert | Oligopygus haldermani (Conrad) | Florida, U. S. A. | Upper Eocene |
| | Oligopygus hypselus Arnold and Clark | Jamaica | Eocene ? |
| **Paraster camagüeyensis Weisbord,n.sp.** | Paraster subcylindricus Cotteau | St. Bartholomew | Eocene |
| Agassizia caribbeana **Weisbord, n. sp.** | Agassizia inflata Jackson | St. Bartholomew | Eocene |
| Brissus camagüeyensis Weisbord, n. sp. | Brissus exiguus Cotteau | Trinidad | Miocene ? |
| | | Anguilla | Upper Oligocene |
| **Eupatagus siboneyensis Weisbord,n.sp.** | Eupatagus carolinensis Clark | North Carolina, U. S. A. | Eogene |

The strata around Loma Colisto are composed for the most part of cream-colored to light yellow marls which are frequently quite soft. The dip is low, undulatory, but regionally toward the north. The beds are richly fossiliferous, yielding in particular a profusion of larger foraminifera and a moderate abundance of echinoids, molluscs, corals and crustacea.

The foregoing table gives a list of the echinoids found in this locality, the species with which they have been compared and locality and geologic horizons of the analagous forms.

Using the similarity of forms as a criterion for age determination, the species in the above list show the closest relationships to those from the Upper Eocene of the West Indies and southern United States. *Oligopygus sanchezi* Lambert is a particularly diagnostic species since it is so closely allied to *Oligopygus haldermani* (Conrad) from the Ocala Limestone of Upper Eocene age in Florida. It is also virtually identical to certain so-called forms of *"Oligopygus ovum-serpentis"* (Guppy) from the Upper Eocene of Trinidad, but does not resemble the type of that species. *Eupatagus siboneyensis* Weisbord n. sp. is nearly identical with *Eupatagus carolinensis* Clark from the Upper Eocene or Lower Oligocene of North Carolina, and checks the evidence already set forth as to the probable Upper Eocene age of the Loma Calisto marls.

Mrs. Dorothy K. Palmer has examined some of the foraminifera from Loma Calisto and found such distinctive Eocene genera as *Discocyclina* and *Dictyoconus,* as well as *Lepidocyclina ocalana* var. and *Lepidocyclina* cf. *subraulini* Cushman.

Although the writer feels that the echinoids themselves suggest an Upper Eocene age for this locality, it is interesting to note that with them occurs the tubiculous annelid *Serpula* cf. *clymenoides* (Guppy[5]) which is found in the San Fernando beds of Upper Eocene age in Trinidad.

In Dr. Roig's publication, "Los Equinodermos Fósiles de Cuba," Boletin de Minas, No. 10, 1926, the following echinoids

[5]Quart. Journ. Geol. Soc. London, vol. 22, p. 584, pl. 26, fig. 10, 1866.

from Loma Calisto are mentioned or described:

Jacksonaster acunai Roig
Jacksonaster acunai var. nuevitasensis Roig
Jacksonaster sanchezi Roig
Jacksonaster torrei Roig
*Amblypygus douvillei Lambert and Roig
*Echinodiscus crustuloides Morton
Oligopygus ovum-serpentis (Guppy)
Oligopygus wetherbyi de Loriol
Oligopygus haldermani (Conrad)
*Brissoides stefanini Lambert and Roig
*Brissoides carolinensis Clark

The starred species, listed on page 5 of the Boletin de Minas, were identified by Lambert, but were neither described nor figured in that publication. Lambert's *"Brissoides carolinensis"* Clark may very likely be *Eupatagus siboneyensis* described by the writer. The other three starred species do not answer in our collection, but have been described in a paper entitled "Neuvas Especies de Equinodermos Fósiles Cubanos" by Lambert and Roig in the Memoria de los Trabajos Realizados en el Instituto Nacional de Investigaciones Cientificas y Museo de Historia Natural, vol. 1, 1929.

*Jacksonaster acunai* var. *nuevitasensis* Roig is probably one of the variable shaped forms of *acunai* and should not, in the writer's opinion, be given a varietal designation. *Jacksonaster acunai* changes considerably in shape and in the depth of the excavation of the petals, but such differences are incidental and not constant. Both *Jacksonaster acunai* and *Jacksonaster sanchezi* appear in our collection, but not *Jacksonaster torrei* Roig.

The writer has not found in this locality the forms identified by Roig as *Oligopygus ovum-serpentis* Guppy, *Oligopygus wetherbyi* de Loriol and *Oligopygus haldermani* (Conrad). One of these species is undoubtedly what the writer has identified as *Oligopygus sanchezi* Lambert, a species which varies a great deal in shape, some of the specimens resembling in particular *Oligopygus haldermani.* The majority of the Cuban forms however, appear to be sufficiently distinct from *haldermani* so that the writer hesitates to unite the Cuban species with it.

In assigning an Oligocene age to the Loma Calisto marls, Roig undoubtedly followed Clark and Twitchell's[6] Oligocene designation for the Ocala Limestone. Prior to 1916 the Ocala Limestone was generally considered Oligocene, but in that year this was changed to Upper Eocene by Cooke[7]. Finding what he believed to be both *Oligopygus haldermani* and *Oligopygus wetherbyi* in the Loma Calisto marls, Dr. Roig logically correlated the Cuban marls with the Ocala Limestone. This correlation may eventually prove quite correct, but although the writer tentatively accepts the correlation, he follows Cooke in considering the Ocala Limestone as Upper Eocene in age.

*Locality No.* 3.—From cut along the railroad between Nuevitas and Pastelillo, about two kilometers southeast of Nuevitas railroad station, Province of Camagüey.

*Age.*—Upper Eocene.

This locality lies about four kilometers east-northeast of Loma Calisto, along the regional strike of the area. The formation is composed for the most part of poorly bedded to lenticular white marls. These marls probably occupy the same general stratigraphic position as those of Loma Calisto, and appear to form an integral part of the same series.

The echinoids obtained here are the following:

*Jacksonaster acunai Roig (rare)
*Jacksonaster sanchezi Roig (abundant)
Laganum cubanum Weisbord, n. sp.
Peronella quinquenodulata Weisbord, n. p.
*Peronella caribbeana Weisbord, n. sp.
*Peronella cubae Weisbord, n. sp.
Scutella cubae Weisbord, n. sp.
Scutella camagüeyana Weisbord, n. sp.
*Oligopygus sanchezi Lambert
Echinolampas nuevitasensis Weisbord, n. sp.
Paraster nuevitasensis Weisbord, n. sp.
*Paraster camagüeyensis Weisbord, n. sp.
Paraster pastelilloensis Weisbord, n. sp.

*These species have been found also at Loma Calisto.

6Clark, W. B. and Twitchell, M. W., The Mesozoic and Cenozoic Echinodermata of the United States: U. S. Geol. Survey Mon. 54, 1915.

7U. S. Geol. Survey, Prof. Paper 95, pp. 107-117, 1916.

Paraster cubitabellæ Weisbord, n. sp.

*Laganum cubanum* Weisbord, n. sp. does not closely resemble any other form the writer has seen, so that comparisons cannot be made. *Peronella quinquenodulata* Weisbord, n. sp. is akin to *Peronella mirabilis* Jackson from the Upper Eocene (*fide* Harris) of Trinidad, differing in its smaller size and character of its tubercles.

The genus *Scutella* is rare in the Tertiary of the West Indies but there are two species here that are questionably referable to it. *Scutella cubae* Weisbord, n. sp. is very much like *Scutella tuomeyi* Twitchell from the Claiborne (Middle Eocene) of South Carolina. The other species, *Scutella camagüeyana* Weisbord, n. sp. has been named from a broken specimen, but its shape seems so different from that of *cubae,* that it seems best to specifically differentiate it. So far as the writer has been able to determine, it has no close analogue.

*Echinolampas nuevitasensis* Weisbord, n. sp. differs somewhat in shape from *Echinolampas clevei* Cotteau from the Eocene of St. Bartholomew. Otherwise the two species are identical.

The genus *Paraster* is well represented in the Cuban Eocene. *Paraster nuevitasensis* Weisbord, n. sp. may be compared with *Paraster loveni* (Cotteau) from the Oligocene of Anguilla and Porto Rico, and to *Schizaster armigeri* Clark from the Upper Eocene of Alabama. *Paraster pastelilloensis* Weisbord, n. sp. is unrelated to known forms, but *Paraster cubitabellae* Weisbord, n. sp. is very near *Paraster subcylindricus* (Cotteau) from the Eocene of St. Bartholomew.

The species mentioned above are comparable with forms ranging from Middle Eocene to the Oligocene. Most of them closely resemble forms from the Eocene of St. Bartholomew, so that the writer has no hesitation in assigning an Eocene age to the echinoids from this locality. Many of the species found at Loma Calisto occur here, and it is believed that when more complete collections are made most of the species found in Loma Calisto will also be found in this locality. Inasmuch as the horizon from which the echinoids of this locality come is probably part of the same series of marls at Loma Calisto, it is believed that the rocks of this locality are also of Upper Eocene age.

*Locality No.* 4.—On road between Entronque Paso Real and San Diego de Los Baños, three kilometers northwest of Entronque Paso Real, Province of Pinar del Rio.

*Age.*—Upper Eocene.

For a distance of about three kilometers from the Central Highway at Paso Real junction, northwestward toward San Diego de Los Baños, are a series of limestones, mottled clays, gravels and limestone conglomerates. The dip of the strata is to the southeast, the inclination of the beds increasing from about ten degrees near the Central Highway to roughly twenty-six degrees at the base of the section, with very little change in the direction of strike. The dips are not numerous, but using those found along the Paso Real-San Diego road, the thickness of the section exposed from the Central Highway to a point three kilometers northwest of it, is about 2150 feet. The upper part of this section is composed of fossiliferous "rubble" limestone interbedded with mottled clays and gravels. The limestone in places is crowded with *Teredo* tubes resembling those of *Teredo incrassata* Gabb from the Miocene of Costa Rica. Other molluscan genera which occur are *Ostrea, Lucina, Antigona,* and ?*Natica.* Corals are also present, as well as such foraminifera as *Amphisorus* and *Archaias.** This portion of the section, from its fossiliferous content and lithology, is believed to be Miocene in age.

The lower part of the section becomes more conglomeratic, interbedded with hard, whitish limestones and marls of various kinds. The dip is steeper than in the beds of the upper part of the section, although the increase in dip is not sudden.

At a point about three kilometers northwest from Paso Real, near the base of a hill through which the automobile road runs, the marl-limestone-conglomerate series overlies with definite angular unconformity, a steeply dipping group of well-bedded brown sandstones, shales and granule conglomerates. These brown sandstones and shales are not very fossiliferous but contain occasional worn rudistids, a few lamellibranchs and some

*The foraminifera have been identified by Mrs. Dorothy K. Palmer.

poorly preserved foraminifera. The rudistids would ordinarily indicate that these beds are Cretaceous but the foraminifera, according to Mrs. Dorothy K. Palmer may be of Eocene age. If the rudistids are reworked as they appear to be, the paleontological evidence insofar as can be determined, indicates that these beds are of Eocene age. Lithologically the brown sandstones and shales closely resemble those exposed at Capdevila on the highway between Habana and Santiago de Las Vegas in the Province of Habana, and at El Cano, about 18 kilometers south of the city of Habana. Lewis[8] refers them to the El Cano formation (presumably named from the town of El Cano at which these sandstones and shales are exposed) and calls them Upper Cretaceous in age. According to Mrs. Palmer however, the meagre foraminiferal content of these rocks is similar to that of the sandstones and shales on the Paso Real-San Diego road, and her tentaive conclusion is that the El Cano beds are also Eocene rather than Cretaceous in age.

The echinoids described from Locality No. 4 come from the very base of the marl-conglomerate series, just above the unconformable contact with the Middle (?) Eocene brown sandstones. Stratigraphically then, the echinoid horizon is post-Middle (?) Eocene and pre-Lower Miocene. In the 2150 feet of section between the unconformable contact and the Central Highway at Paso Real there possibly may be represented Oligocene strata between the echinoid horizon and the Lower Miocene, but as yet this has not been proved.

The echinoids from the base of the marl-conglomerate series are:

Pauropygus clarki Lambert
Tarphypygus notabilis Arnold and Clark
**Paraster nuevitasensis Weisbord, n. sp.
***Paraster camagüeyensis Weisbord, n. sp.

*Pauropygus clarki* Lambert may be compared with *Haimea caillaudi* Michelin from the Upper Eocene of Jamaica. The geologic horizon of *Tarphypygus notabilis* Arnold and Clark, al-

**Also occurs between Neuvitas and Pastelillo, Province of Camagüey.
***Also occurs at Loma Calisto and between Nuevitas and Pastelillo, Province of Camagüey.

[8]Amer. Assoc. Petrol. Geologists Bull., vol. 16, No. 6, p. 539, 1932.

so from Jamaica, is not recorded, but the writer's surmise is that it comes from the Eocene. On the basis of stratigraphy and the occurrence here of two of the same species which are found in the Upper Eocene of Nuevitas, it is thought that the echinoids from Locality No. 4 are also of Upper Eocene age.

If the determination of the Middle Eocene age for the brown sandstones, and Upper Eocene age for the echinoid-bearing marl-conglomerates is correct, the marked angular unconformity between the two formations indicates a great period of movement after the deposition of the Middle Eocene. Mr. William H. Butt† has found inliers of Eocene in the heart of the Organos Mountains in western Pinar del Rio Province surrounded by Jurassic and/or Cretaceous sediments, and has deduced from this that the Organos Mountains were uplifted in post-Eocene time. The marked unconformity on the SanDiego road may further substantiate this conclusion and more precisely fix the age of one period of uplift of the Organos Mountains to the interval between the middle and upper Eocene.

*Locality No.* 5.—From cut in the Central Highway of Cuba, 150 meters east of kilometer post 440, between the towns of Jatibonico and Ciego de Avila, Province of Camagüey.

*Age.*—Oligocene.

The following three echinoids come from this locality.

Echinolampas cf. semiorbis Guppy
Echinolampas camagüeyensis Weisbord, n. sp.
Agassizia camagüeyensis Weisbord, n. sp.

*Echinolampas semiorbis* Guppy is found in the Oligocene of Anguilla. The Cuban species is somewhat distorted and broken, but what there is of it seems identical with the Anguillan form. *Echinolampas camagüeyensis* Weisbord, n. sp. recalls two other Oligocene species, *Echinolampas lycopersicus* Guppy and *Echinolampas anguillae* Cotteau, both of which are also found in Anguilla. No close analogue has been found for *Agassizia camagüeyana* Weisbord, n. sp.

†Personal communication.

The writer ventures the opinion that the echinoids from this locality are Oligocene in age because of the occurrence of *Echinolampas semiorbis* from the Oligocene of Anguilla, because of the resemblance of *Echinolampas camagüeyensis* to Oligocene species from Anguilla and because, to quote Hawkins[10], "most species of similar [*i.e.,* large] size are of Oligocene date."

## SYSTEMATIC DESCRIPTIONS

### Upper Cretaceous Species

**Goniopygus supremus** Hawkins Pl. 1. figs. 1-3

*Goniopygus supremus* Hawkins, Geol. Mag., vol. 61, No. 721, pp. 313-316, pl. 18, figs. 1, 2, 1924.
*Goniopygus supremus* Arnold and Clark, Mus. Comp. Zool. Mem., vol. 50, No. 1, p. 12, 1927.
*Goniopygus supremus* Lambert, Bull. Soc. Geol. France, vol. 1, Sér. 5, p. 301, 1931.

Apical system large and robust. Ocular plates all exsert, pentagonal. Gential plates large, hexagonal, the aboral ends projecting somewhat further than the aboral terminations of the oculars. Five genital pores, one on each genital plate, occur at the outer extremities. On genitals 1, 5 and 3 there is a slight excavation around the triangular periproct.

Ambulacra narrow, gradually increasing in size from the apical disc adorally, with a single row of pore-pairs in each poriferous avenue, except at the peristomial margin where there are three pore-pairs. Plates compound, with three pore-pairs to a plate. There is a row of about 13 tubercles on each side of an ambulacrum which increases in size toward the ventral side of the ambitus where they are largest, decreasing therefrom rapidly in size toward the peristomial area. The tubercles are small, with smooth bosses and imperfocate namelons. Along the medial suture of each ambulacrum a smaller, secondary tubercle is staggered with each primary tubercle.

The interambulacra are about two and a half times as wide as the ambulacra, with about seven tubercles on each side, the tubercles at the ambitus being much larger than the others, and even still larger than the tubercles of the ambulacra. The inter-

[10]Geol. Mag., vol. 61, No. 721, p. 319, 1924.

ambulacral tubercles are imperforate, also with smooth bosses, surrounded by faint, granular areolas. Between each primary tubercle there is apt to be a secondary in the adambulacral area, and two secondary tubercles near the medial line, with faint miliary granules along the medial suture of the interambulacrum and along the outer edge contiguous to the poriferous avenue of the ambulacra.

*Dimensions.*—Diameter, 26.5 mm.; height, 15 mm.

*Remarks.*—The Cuban species is identical with the one described from Jamaica. It is readily distinguished by its robust, decagonal apical system, its triangular periproct with excavations in genitals 1, 5 and 3, its nearly parallel-sided ambulacra and by the large tubercles on the interambulacra at the ambitus.

*Comparisons.*—The most closely related forms described in the literature seem to be those from the Cenomanian of Europe. This species is very near *Goniopygus menardi* Agassiz[11] found abundantly in the Cenomanian and rarely in the Senonian of France, Belgium and Prussia. Aside from a slight variance in the second and miliary tuberculation, the two species seem identical. *Goniopygus menardi* is usually smaller than the Cuban species, but a variety called *globosa* is about the same size. From *Goniopygus major* Agassiz[12], also from the Cenomanian, this species is distinguished by having three excavations in the genitals at the periproct instead of four, and having fewer tubercles on the ambulacra. *Goniopygus sanchezi* Lambert[12a] from the Cretaceous of Ciego de Avila, Camagüey Province, Cuba, may be o young form of the Jamaican species *supremus*, and *Goniopygas ameri* Lambert[12b] from the same locality may be a very large form of *supremus.*

*Reported Geologic Horizon.*—Upper Cretaceous (Turonian?) of Jamaica.

[11]See Paléontologie Française, Terrains Crétacés, vol. 7, p. 734, pl. 1179, figs. 7-14, and pl. 1180, 1862-1867.

[12]See Paléontologie Française, Terrains Crétacés, vol. 7, p. 740, pl. 1181 and pl. 1182, figs. 1-4, 1862-1867.

[12a] Bull. Soc. Geol. France, vol. 1, Sé. 5, p. 300, pl. 17, figs. 17, 18, 1931.

[12b] **Ibid,** p. 301, pl. 17, fig. 16, 1931.

*Localities.*—From the Rudistid Limestone, Great River Valley, near Catadupa, St. James Parish, Jamaica (Hawkins); near the west ranch of the Rio Nuevo, not far from Pembroke Hall, St. Mary Parish, Jamaica (Arnold and Clark).

*Cuban Locality.*—Esperanza, Habana Province (Locality No. 1).

**Codiopsis ciae** Lambert Pl. 1, figs. 4-6

*Codiopsis Arnaudi* Cotteau [from Cuba, not Cotteau from France], Bol. Com. Mapa Geol. de España. vol. 22, p. 14, pl. 1, figs. 10-15, 1897.
*Codiopsis ciae* Lambert, Rev. Critique de Paléozoologie, vol. 2, p. 30, 1898.
*Codiopsis arnaudi* Jackson, Carnegie Inst. Washington, pub. 306, p. 24, 1922.
*Codiopsis ciae* Roig, Bol. de Minas, Habana, No. 10, p. 42, 1926.

Translation of Cotteau's original description of *Codiopsis Arnaudi* from France (Paléontologie Francaise, Terrains Crétaces, vol. 7, p. 786, pl. 1192, figs. 12-18, 1862-67).

Species of very small size, subcircular, inflated and hemispherical above, sharp and carinate below the ambitus, flat and slightly puckered on the lower face. Poriferous zones straight, composed of simple, regularly superposed, very small pores, deviating a little from the straight line at the approach to the peristome. Ambulacral areas narrow, slightly raised, decorated on the upper face with numerous, granuliferous, scattered, unequal impressions, and on the lower face with two rows of small, memmillated tubercles, in the number of two or three per series. Interambulacral areas relatively rather large, provided like the ambulacra, on the upper face, with numerous, granuliform, unequal impressions, grouping themselves at certain points into very closely spaced, longitudinal lines, and at the base, with some small tubercles identical with those that occur on the ambulacra, and forming over the ambitus, at the marginal carina, a more or less prominent, horizontal row. Peristome widely open, somewhat puckered, subcircular, flattened at the margins. Periproct subpentagonal. Apical disc rugose, granular, projecting somewhat above the test; genital plates angulate, elongate, perforate near their extremities; ocular plates much smaller, pentagonal, inserted between the genital plates.

Height, 4 mm.; diameter, 6 mm.

*Localities.*—Martigues (Bouches-du-Rhône); Gourde de l'Arche (Dordogne). Very rare. Lower (?) Senonian horizon.

Translation of Cotteau's description of *Codiopsis Arnaudi* from Cuba, with remarks by Egozcue.

Species of very small size, pentagonal, with the angles arched; upper face subhemispheric, somewhat depressed; lower face flat, slightly concave. Both faces form at their junction a pronounced angle which forms a sharp keel. Periproct subpentagonal, of average diameter. Peristome very large, subcircular, which encompasses the greater part of the lower face. Apical disc well displayed, composed of five genital plates, each one of which is provided with its corresponding circular and rather large genital pore, and of five other inter-genital plates, in which the ocular pores are not visible in the Cuban example. Ambulacra straight, their width scarcely one third that of the interambulacra. They are bounded by narrow poriferous zones composed of simple pairs of circular pores, which in the vicinity of the apex are somewhat smaller, are deviated a little from the rectilinear direction they previously carried. The interporiferous zones are composed of rather wide plates, and are adorned on the upper face with faint and slightly visible wrinkles or granulations, and on the lower face with two rows of tubercles in number from three to four per series; further, if one observes carefully, it is seen that these two rows are prolonged to the apical rosetta by means of some small and faint tubercles, situated near the poriferous zones. The upper face of the ambulacra and the lower, is limited by a festoon of six or seven tubercles also identical with those of the ambulacra, which design in their entirety a pentagon of concave sides.

Dimensions: Diameter, 14 mm.; height, 8 mm.

Relations and Differences: According to Mr. Cotteau, this species is distinguished from its congeners not only by its very small size, but by its hemispheric form above and flatness below, by its ambitus forming a keel, its test granulose, peristome flattened at the margins and somewhat projecting, rugose and granulose disc.

*Localities.*—The example from Cuba comes from the Cretaceous deposits of Santa Lucía, Province of Santa Clara.

*Explanation of Figures.*—Plate 1, fig. 10. Upper face of the example of *Codiopsis Arnaudi* Cotteau, from the Cretaceous of the Island of Cuba. Fig. 11. Lower face of the same example. Fig. 12. Lateral view. Fig. 13. Ambulacral area enlarged. Fig. 14. Interambulacral area enlarged. Fig. 15. Apical disc enlarged.

In reviewing the work of Cotteau and Egozcue, Lambert recognized that the Cuban *Codiopsis arnaudi* is quite different from the type species described in France, noting that "*Codiopsis Arnaudi* Cotteau, from the same horizon [i. e. Cretaceous of Santa Lucía] is certainly very different from the type by its size, by the expansion of its peristome, the disposition of its tubercles and the arrangement of the larger ones; it is not only larger than *C. regalis* but evidently a new species". For the Cuban form he gave the new name of *Codiopsis ciae*.

Although the Cuban species is confessedly very similar to the one from France, the writer believes that Lambert was quite correct in giving it a new name. The most obvious point of difference, other than size, is the character of the ambulacral plates on the two species. The plates of *Codiopsis arnaudi* from France as shown in figure 15, plate 1192, Paléontologie Francaise, Terrains Crétacés, 1862-67, are simple primaries, whereas in the Cuban species as shown in figure 13, plate 1, Boletin de la Comision del Mapa Geológico de España, vol. 22, 1897, a primary plate is flanked above and below by a demi-plate, the demi-plate being small and terminating perradially at the suture between the primary plates.

The specimen in our collection, although worn and somewhat larger than the dimensions given by Cotteau, seems to be referable to *Codiopsis ciae* Lambert. The striking feature of the species is the row of tubercles on the sharp margin of the ambitus, which at the ambulacra form a rosette. On the ambulacra of the lower surface of our specimen, near the margins, are two columns of tubercles, decreasing in size toward the peristome. The dorsal surface is impressed with wavy, longitudinal ridges, which are barely discernible, giving the test a shagreen texture.

*Dimensions.*—Diameter, 20 mm.; height, 11 mm.

*Comparisons.*—This species is superficially so close to *Codiopsis arnaudi* Cotteau, that Cotteau himself mistook its identity with the French form. It differs, as stated above, in the compound character of its ambulacral plates. *Codiopsis texana* Whitney[13], from the Buda Limestone (Cenomanian) of Texas, U. S. A., resembles the Cuban species in shape, but differs in being somewhat convex ventrally, lacks the sharp marginal keel with its row of tubercles, has somewhat wider ambulacra on which the tuberculation is more complex, and has a smaller peristome.

*Reported Geologic Horizon.*—Upper Cretaceous.

*Locality.*—Santa Lucía, Santa Clara Province (Cotteau).

*Present Locality.*—Esperanza, Habana Province (Locality No. 1).

**Lanieria lanieri** (d'Orbigny) Pl. 1, figs. 11-20

*Galerites Lanieri* d'Orbigny, de la Sagra, Historia física, política y natural de Cuba, vol. 8, pl. 8, figs. 11-14, 1855.
*Echinoconus Lanieri* Cotteau, Mém. Soc. géol. Belgique, vol. 9, p. 11, pl. 1, figs. 7-13, 1881.
*Echinoconus Lanieri* (?) Agassiz, Mus. Comp. Zool. Mem., vol. 10, No. 1, p. 88, 1883.
*Lanieria Lanieri* Duncan, Journ. Linn. Soc., vol. 23, p. 168, 1891.
*Echinoconus Lanieri* Cotteau, Bol. Com. Mapa Geol. de España, vol. 22,

[13]Bull. Amer. Pal., vol. 5, No. 26, p. 7 (91), pl. 3, figs. 1-4, 1916.

p. 19, pl. 2, figs. 7-13, 1897.
*Lanieria Lanieri* Hawkins, Geol. Mag., new ser., decade 5, vol. 10, p. 200, text-figure A, 1913.
*Lanieria lanieri* Jackson, Carnegie Inst. Washington, pub. 306, p. 28, pl. 2, figs. 2-5, 1922.
*Lanieria Lanieri* Roig, Bol. de Minas, Habana, No. 10, p. 45, 1926.
*Lanieria Lanieri* Lambert, Compt. Rend. Somm. et Bull. Geol. Soc. France, sér. 4, vol. 28, p. 20, 1928.

Although d'Orbigny did not describe this species, he gave it its name and illustrated in it in de la Sagra's "Historia física, política y natural de Cuba", in the atlas pertaining to volume 8 of 1855 (?) in plate 8, figures 11 to 14. The species was later described and refigured by Cotteau in 1881.

A translation of Cotteau's original description is as follows:

> Species of small size, tall, circular, globose; upper face rounded, somewhat subconical; lower surface pulvinate, flat around the peristome. Apical disc central. Poriferous zones composed of very small, closely spaced pores, separated by a light, granuliform swelling, very directly superposed on the whole of the upper face, showing at the ambitus and near the peristome a more or less pronounced tendency to group themselves in triple pairs. Tubercles small, crenulate, perforate, scrobiculate, increasing somewhat in size on the lower face, disposed rather irregularly in horizontal and vertical series, the number of which vary according to the size of the individual. On each of the ambulacral or interambulacral areas, two rows, a little stronger than the others which are very faint, reach nearly to the apex. The intermediate space between the tubercles is occupied by fine and closely spaced granules grouped around the scrobicules. Peristome small, cirlar, scarcely grooved. Periproct elliptical, rather large, acuminate at its outer part, situated on the lower face very near the peristome. Apical disc prominent, pentagonial; five genital plates, widely perforate, the madreporite extending to the center of the disc; ocular plates small, subtriangular, intercallated in the angle of the genital plates, very finely perforate.
>
> Height, 19 mm.; diameter, 21 mm. Young individual: height, 13 mm.; diameter, 16 mm. Subconical individual and flat on the lower face: height, 11 mm.; diameter, 19 mm.
>
> This pretty species presents some variations that I must mention. The form is in general subglobular, rounded above and strongly pulvinate below. In one of our examples, the upper face, less elevated, is somewhat conical, and the lower face quite flat. In this individual, the ambulacral pores instead of assuming a trigeminate arrangement in the inframarginal region, are simple and directly superposed from the apex to the peristome. The other characters are the same and despite this important difference, we do not consider this specimen as a variety of *Echinoconus Lanieri*. The tubercles at the base vary a little in their arrangement; the largest frequently assume a very irregular vertical arrangement. Sometimes, however, the tubercles in the ambulacral areas as in the interambulacral areas, form very distinct longitudinal

columns.

Similarities and Differences: This small species which we describe, is clearly distinguished, among *Echinoconus*, from all of its congeners by reason of its globose form; its small size and its rounded upper face resembles somewhat *Echinoconus desorianus* d'Orbigny; it is distinguished from it by its more regularly globose form, by its greater developed peristome, by the wholly different position of its periproct and the structure of the apical system which is provided with five perforated genital plates, a character which has never been described in *Echinoconus*.

*Locality.*—Cienfuegos (island of Cuba), rather common. Cretaceous (?) horizon.

Collections: Dewalque, "Moens (Lede", Vidal (Barcelona), my collection.

Explanation of Figures: Pl. 1, fig. 7, *Echinoconus Lanieri*, from my collection, side view; fig. 8, upper face; fig. 9, lower face; fig. 10, apical disc enlarged; fig. 11, another example of small size, from the collection of Mr. Dewalque; fig. 12, portion of the ambulacral area situated on the lower face, enlarged; fig. 13, interambulacral plates enlarged.

There are some 60 specimens of this interesting species in our Cuban collection, showing at least four differently shaped groups. Extremes of these groups, if seen alone, would perhaps be regarded as distinct varieties, yet there are enough specimens to show that there is a definite intergrading and that differences are individual rather than subspecific. One type is slightly higher than broad, roundly ovate in outline, with the ambitus subcircular and situated about midway between the peristome and apical disc. The specimens of this description are rather small, with a height of about 17.5 mm. and a diameter of 16.5 mm. The ovate type just described grades into a nearly spherical type, 20 mm. in height and 20.5 mm. in diameter. This is shaped like the holotype of the species, described by Hawkins as being "almost globular with no appreciable flattening of the adoral surface". The third type is broader than high, with a circular ambitus and distinctly flattened at the base, measuring 22 mm. in diameter and 16 mm. in height. The fourth type is obtusely pentagonal, usually broader than high, but not infrequently somewhat pear-shaped.

The apical system is central, slightly raised above the test proper, with five small pentagonal ocular plates extending to the central madreporite, and five larger pentagonal genital plates, each with a rather large genital pore in the center of the plate.

Occasionally some of the oculars also show a minute pore. The peristome is rather large, central, circular in outline, with serrations at the margin. The periproct is elongate-pentagonal, with the truncated end toward the peristome. It is situated below the ambitus close to the peristome, inclined from the horizontal at an angle depending on the globosity of the test.

The ambulacra are straight, rather narrow, widest at the ambitus, apetalous. The poriferous avenue is very narrow, consisting on each side of a single row of pore-pairs inclined slightly adorally, descending in a fairly straight line to the ambitus where, particularly on the ventral side, they frequently, but not always, become staggered and grouped into double, or more rarely, triple pairs. They again become universal toward the peristomial margin. The succession of plates on the ambulacra is as follows: a very small demi-plate extending a short distance perradially, followed adorally by a wide primary plate, this succeeded by a narrow primary. This tripartite arrangements extends over the greater part of the test. There is usually one triad and an adjacent demi-plate of the succeeding triad to one interambulacral plate. The medial suture is zigzag near the apex, but then becomes nearly straight.

The interambulacra are nearly three times as wide as the ambulacra, composed of about 30 plates per column, separated by a zigzag line, which may or may not become straight below the apex, though generally the zigzag element is more noticeable near the apex.

There are about 9 subequal, scrobiculate tubercles on the plates of the interambulacra at the ambitus so arranged that there are two oblique rows adradially followed by three tubercles nearer the adoral margin of the plate, with two staggered tubercles near the medial suture. On the ambulacra at the widest part, are three columns of subequal tubercles about the same size as those on the interambulacra, the adradial ones slightly larger than the perradial ones. The tuberculation on all the specimens is more pronounced actinally than abactinally. The surface between the tubercles is finely granulate.

Some specimens are tinged with purple and this may conceivably have been the color of the living form.

*Dimensions.*—Ovate type, height, 17.5 mm.; diameter, 16.5 mm.
Spherical type, height, 20 mm.; diameter, 20.5 mm.
Depressed type, height, 16 mm.; diameter, 22 mm.
Pentagonal type, height, 16.5 mm.; diameter, 18 mm.

*Remarks.*—This species is distinguished by the character of the ambulacral plates, composed of triads consisting of a demi-plate followed adorally by a wide, rectangular primary, and this in turn by a narrow, rectangular primary. The wide primary on one side of the medial suture abuts against the narrow primary of the other side, so that there is given to the test a characteristic alternation of plates. Rarely the plates have a tendency to be subequal in width, approaching *Coenholectypus cubae* Hawkins which will be discussed subsequently.

The genus *Lanieria* was separated from *Echinoconus* by Duncan because of its five genital pores, *Echinoconus* having only four.

*Comparisons.*—*Lanieria lanieri* may be distinguished from *Echinoconus antillensis* Cotteau[14] in its circular peristome and in the character of the ambulacral plates. The peristome of *antillensis* is elliptical and according to Cotteau's figure 2, the primary plates of the ambulacra, particularly at the peristome, are triangular instead of rectangular as in *lanieri*.

With this species there occurs rather abundantly a form which superficially may be readily mistaken for *Lanieria lanieri.*. It exhibits the same variation in form, but differs in the character of the ambulacral plates. In *Lanieria lanieri,* the ambulacral plates are in a triad composed of a very small demi-plate, followed adorally by a rectangular primary, and this in turn by a narrow, rectangular primary. In the related form, however, the plates over the greater portion of the test are subequal, very numerous, rectangular primaries and the pore-pairs are usually in a simple series, not tending to become bigeminate on the central side of the ambitus. To this form Hawkins[15] has given the name *Coenholectypus cubae.*

[14]Annales Soc. géol. de Belgique, vol. 9, p. 13, pl. 2, figs. 1, 2, 1881.
[15]Geol. Mag., new ser., decade 5, vol. 10, p. 202, 1913.

The pentagonal variety of *Lanieria lanieri* superficially resembles *Metholectypus trechmanni* Hawkins[16] from the Cretaceous *Barretia* Limestone, Haughton Hall, Green Island, Jamaica, but is at once differentiated by its five genital pores as compared to he four genital pores on the Jamaican species.

*Localities.*—Cienfuegos, Santa Clara Province, Cuba (Cotteau); Ciego de A'vila, Camagüey Province, Cuba (Roig). Agassiz lists this species from the Miocene of Guadeloupe, but Jackson believes this to be erroneous.

*Reported Geologic Horizon.*—Cretaceous.

*Present Locality.*—Esperanza, Habana Province (Locality No. 1).

**Coenholectypus cubae** Hawkins Pl. 1, figs. 7-10

*Echinoconus Lanieri* var. Cotteau, Soc. géol. Belgique Mem., vol. 9, p. 11, 1881.

*Echinoconus Lanieri* Cotteau, Bol. Comision de Mapa Geol. de España, vol. 22, p. 20, 1897.

*Coenholectypus cubae* Hawkins, Geol. Mag., new ser., decade 5, vol. 10, p. 202, text-figure 4 B, 1913.

*Hawkensia cubae* Lambert, Compt. Rend, Somm. et Bull. Soc. géol. de France, sér. 4, vol. 28, p. 19, 1928.

*Hawkensia cubae,* Lambers, Bull. Soc. Geol. France, vol. 1, sér. 5, p. 302, 1931.

This species occurs in moderate abundance together with *Lanieria lanieri* (d'Orbigny), which it closely resembles superficially and to which it must be intimately related. It varies in shape much the same as does *Lanieria lanieri,* has the same type of apical disc with the exsert oculars, the pentagonal genitals with five genital pores, the central madreporite, the central, circular peristome and ovately-pentagonal periproct close to the peristome, the same type of interambularcral plates and a similar manner of tuberculation. The main point of difference is in the character of the ambulacral plates. As stated previously, a very short demi-plate is followed adorally by a rectangular, wide primary plate, and this in turn by a narrower primary in *Lanieria lanieri.* In this species, however, the ambulacral plates are usually rectangular, of equal width, narrow (4 to an interambulacral plate), separated by a zigzag medial suture. Near

[16]Geol. Mag., new ser., decade 6, vol. 60, No. 5, p. 201, pl. 9, figs. 1-3, 1923.

the peristome there is a tendency for the plates to develop in much the same way as in Hawkins' text-figure 4 B, with a demi-plate occurring between two primaries. There does not seem to be the same regularity of this arrangement in our specimens, but the manner of division seems to be similar.

Another minor difference between the two species is in the arrangement of the pore-pairs. In *Lanieria lanieri* the pore-pairs have a tendency to be bigeminate or trigeminate at the ventral side of the ambitus, though this is by no means always true. In *Coenholectypus cubae* the pore-pairs are usually simple and directly superposed.

Despite the difference in the character of the ambulacral plates, the two species are more specifically and generically alike than in difference of plates would indicate, for occasional specimens of *Lanieria lanieri* have a notable tendency to develop equal-sized plates as in *Coenholectypus cubae,* while on the other hand, occasional specimens of *Coenholectypus cubae* tend to alternate the size of the primary plates as in *Lanieria lanieri.* Moreover, *lanieri* frequently shows the pore-pairs continuing as a simple series thoroughout, whereas the pore-pairs of *cubae* have an occasional tendency to become bigeminate. This indicates to the writer that were a sufficient number of specimens available, a series might show a complete gradation between *Lanieria lanieri* and *Coenholectypus cubae.*

*Dimensions.*—Subjentagonal variety, height, 14 mm.; diameter 15 mm.
Subglobular variety, height, 17 mm.; diameter, 20.5 mm.
Depressed variety, height, 11 mm.; diameter, 18 mm.

Of the generic designation of this species, Lambert says as follows:

> "It is known that the *Lanieria* figured by these authors [Cotteau and Egozcue] pertain, according to Mr. Hawkins to two different genera. Only the typical form, that of figures 7 to 10 of Cotteau, represents the true *Lanieria lanieri* d'Orbigny (Galerites); its ambulacra are composed of plates that resemble the form of *Conulus.* In regard to the form of Cotteau's figure 11, also with five genital pores at the apex, but smaller, more globose, with the periproct still closer to the

peristome, and ambulacra composed above of simple primaries, below of primaries alternating with demi-plates, without the little external plate fitting in, Hawkins specifically separates under the name of *cubae*, and places it in the so-called *Coenholectypus* of Pomel.. This generic designation does not seem acceptable to me, because for me the Cretaceous *Holectypus*, whose fifth gonad, atrophied in the Jurassic forms by the position of the mesentery, has ceased to reappear, continues to be *Holectypus* and ought not constitute a separate genus. It is known also that the type of the so-called genus of Pomel is *Discoides macropygus* Agassiz, from the Neocomian. Now the species *cubae* differs from that generically by its general form, its smaller peristome, the position of its periproct and likewise by the disposition of its odd ambulacrum. If one wishes to maintain *Lanieria* as a separate genus, it would be proper to make this type a particular genus: *Hawkensia.*''

*Localities.*—Cienfuegos, Santa Clara Province, Cuba( Cotteau) ; Ciego de A'vila, Camagüey Province, Cuba (Lambert).

*Reported Geologic Horizon.*—Cretaceous.

*Present Locality.*—Esperanza, Habana Province, (Locality No. 1).

**Echinobrissus cubensis** Weisbord, n. sp. Pl. 2, figs. 1-3

Test small to moderate in size, rather depressed, subquadrate in marginal outline, broader posteriorly than anteriorly. Abactinal surface convex medially, obliquely truncate behind. Actinal surface longitudinally concave. Margins moderately swollen, except at the posterior face where they are somewhat compressed.

Apical system somewhat excentric anteriorly. Disc small, with four perforated genital plates, the pores of 2 and 3 slightly closer together than those of 1 and 4. Madreporite extending from the right anterior genital into the center of the disc.

Ambulacra unequal, petaloid, flush, the petals not reaching the margin. Petals of the trivium subequal, slightly shorter than those of the bivium which are in addition closer together than the anterior. Ambulacral areas widen midway between the disc and the margins, become constricted somewhat at the ends of the petaloid portions, the posterior pair diverging on either side of the periproctal groove, converging again below the ambitus. Interporiferous zone slightly wider than the poriferous area. Poriferous area with conjugate, subequal, nearly horizontal pore-pairs. Interambulacral plates wider abactinally, narrower and more numerous actinally, those on the abactinal surface with curved sutures, convex adorally.

Peristome small, pentagonal, excentric in front, impressed within the longitudinal sulcus, with incipient bourrelets and rudimentary phyllodes. Periproct situated in a deep, narrow groove on the very oblique truncation of the posterior face.

Ornamentation consisting of small, closely spaced, scrobiculate tubercles, very numerous on the abactinal surface, a trifle larger and less abundant around the peristome.

*Dimensions.*—Holotype, length, 25 mm.; width, 21 mm.; height, 14 mm.

*Comparisons.*—In France, *Echinobrissus* is well developed in the Neocomian, Cenomanian and Senonian. The Cuban species appears to be more closely akin to the Cenomanian and Senonian forms than to the Neocomian. It resembles *Echinobrissus similis* d'Orbigny[17] from Etage 20 of the Cenomanian, but differs primarily in size, (*similis* being 11 mm. in length), and in its narrower, more deeply excavated posterior groove in which the periproct is situated. The Cuban species is even more closely allied to *Echinobrissus minimus* d'Orbigny[18] from Etage 22 of the Senonian, differing again in its more elongated, deeply excavated periproctal groove. In the United States, this species distantly recalls *Echinobrissus texanus* Clark[19] from the Austin Chalk, Upper Cretaceous of Texas, but differs in its greater and more minute tuberculation and in the narrower and stronger posterior excavation in which lies the periproct.

*Geologic Horizon.*—Upper Cretaceous.

*Locality.*—Esperanza, Habana Province (Locality No. 1).

*Holotype.*—Paleontological Research Institution.

**Cassidulus cubensis** Weisbord, n. sp. Pl. 2, figs. 9-11

This species is described from a broken specimen, the anterior of which is missing and whose abactinal surface is obscured by adhering rock. Nevertheless the parts that are visible seem to

[17]See Paléontologie Française, Terrains Crétacés, vol. 6, p. 405, pl. 958, figs. 1-6, 1853-1860.
[18]Ibid. p. 414, pl. 962, figs. 1-6, 1853-1860.
[19]See U. S. Geol. Survey Mon. 54, p. 70, pl. 28, figs. 2a-f, 1915.

be distinct from any other *Cassidulus,* and hence the writer is taking the liberty of describing this species as new.

Test large, robust, elongate-pentagonal in outline, presumably subtruncate in front, decidedly rostrate behind. Dorsal surface moderately high, rather swollen at the margins, the face broadly triangular when viewed from above due to a rather pronounced, rounded carina in the posterior interradium which extends to the top of the periproct. Base inferred to be somewhat convex anteriorly; at the peristome it is rather depressed, but the margins laterally are moderately tumid. Extending longitudinally from the peristome to the posterior margin is a distinct elevation, on either side of which, the face is slightly concave, more distinctly so near the margins. Posterior face obliquely truncate dorsally.

Peristome apparently subcentral, equipped with strong, projecting, knobby bourrelets between which radiate short, widely petaloid phyllodes, unclosed at their ends. At the peristomial end of each phyllode are two pores in the deeply sunken plates between the bourrelets. Periproct in the posterior truncation, occupying a long, sharply triangular opening.

Apical disc obscured, as well as most of the ambulacra, though sufficient of the ambulacra is observable to state that they are flush and petaloid, the petaloid portions extending part way to the margins, the petals open distally. The ambulacra are widest at the margin, where they are composed of simple, rectangular, primary plates. The interporiferous zone is believed to be somewhat wider than the poriferous area (which is itself rather wide), bearing oblique, conjugate pore-pairs, the outer pores of which are more elongate than the inner.

Corona ornamented with numerous, small, imperforate, scrobiculate tubercles, somewhat larger and less abundant on the actinal surface, very faintly developed on the ventral, posterior carina.

*Dimensions.*—Holotype, length, inferred, 58 mm.; width, 45 mm.; height, 26 mm.

*Remarks.*—This species is distinguished by its sharply rostrate posterior, pronounced carinations on both the dorsal and ventral surfaces and the sharply triangular periproctal opening on the oblique, posterior truncation.

*Geologic Horizon.*—Upper Cretaceous.

*Locality.*—Esperanza, Habana Province (Locality No. 1).

*Holotype.*—Paleontological Research Institution.

**Catopygus jeanneti** Lambers Plate 2, figs. 4-8

*Catopygus jeanneti* Lambert, Bull. Soc. Géol. France, vol. 1, ser. 5, p. 303, pl. 17, figs. 19-23, 1931.

Translation from Lambert's original comments:

> *Catopygus Jeanneti* Lambers. Test very swollen, globular, with a convex oral face, rounded anteriorly, presenting above a very feeble posterior carination which is terminated above the periproct, and measuring 16 mm. in length, 13 in width and 12.5 mm. in height. Peristome excentric anteriorly, pentagonal, surrounded by an elevated margin deflected toward the ambulacra, with very distinct phyllodes. Apex excentric anteriorly with four genital pores, but concerning which it cannot be decided if it is really tetrabasal. Five homogeneous petals, with very narrow poriferous zones; pores rounded, conjugate. Periproct posterior, marginal, at the extremity of the posterior swelling which takes the place of the carina, oval, elongate, in a slight projecture. Tubercles homogeneous, distributed upon all the areas in a very fine granulation; no sternal zone.
>
> If the form of our species recalls that of *C. cylindricus*, the position of its periproct in a slight projecture separates it from all its congeners. This periproct recalls that of *Echinanthus enormis* Duncan and Sladen which by the way is a remarkable, small *Echinanthus*. The apex of *Catopygus Jeanneti* makes it necessary to compare it with *Neocatopygus* which it resembles by its petals and the slight projecture of the periproct, but the latter is oval, elongated and not rounded. *Catopygus Rodriguezi* Lambert and Sanchez Roig, from this same horizon of Ciego de A′vila, differs from our *C. Jeanneti* by its subconical form, its much less convex oral face, its more anteriorly excentric peristome, its wider petals with unequal pores and more developed poriferous zones. The small *C. californicus* Kew does not even seem to be comparable.

This species occurs in abundance with *Lanieria lanieri* (d'-Orbigny). It assumes two slightly different shapes, one variety being cylindroid, longer than broad, subpentagonal, with a tendency to be rostrate behind and subtruncate in front, slightly broader posteriorly than anteriorly. The test of this variety is swollen, with tumid margins. Both the abactinal and actinal surfaces are somewhat convex, the actinal surface less so than the abactinal. The posterior face is somewhat keeled.

The second variety is not so high as the first, only slightly longer than broad and giving the appearance of being somewhat less swollen. It is also subpentagonal in outline, with the broadest part posterior to the apical disc. Margins swollen, dorsal face moderately convex, ventral surface slightly convex. Aside from the slight difference in shape, the two varieties are identical in all other essential characters and hence both are considered as the same species.

Peristome small, transversely pentagonal, well excentric in front, the margins thickened to form bourrelets where the interambulacra join it. Occasional partially unweathered specimens show the phyllodes to be rather well developed. Periproct longitudinally ovate, situated on the posterior face well down below the abactinal surface sloping inward at an angle of about 35 degrees with the vertical above the periproct terminates in a projecting arch which forms part of a low carina bisecting the posterior interambulacrum.

Apical disc excentric anteriorly. Basal plates with four pores, those of genitals 2 and 3 closer together than 1 and 4. Madreporite in the right anterior genital, extending obliquely over the disc, separating the posterior genital plates. Radial plates small.

Ambulacra flush, petaloid, subequal, the petals of the bivium slightly longer than those of the trivium. The petals do not quite reach the margin, but are contracted distally where they are nearly closed. Interporiferous zone about twice the width of the poriferous avenue. Pore-pairs not quite horizontal. Pores subequal to unequal, the outer pores of a pair comma-shaped, the inner more rounded; on some young specimens the pores seem to be subequal.

Ornamentation consisting of closely spaced, numerous, scorbiculate tubercles, about equally distributed on the corona except perhaps in a narrow zone extending posteriorly from the peristome where the tubercles seem to be fainter and somewhat less abundant than elsewhere.

*Dimensions.*—Cylindroid type, length, 21 mm.; width, 18 mm.; height, 16 mm.

Broad form, length, 26 mm.; width, 24 mm.; height, 17 mm.

Comparisons: This species superfically resembles *Botriopygus rudistarum* Hawkins[20] from the Rudist Limestone of Cretaceous age from Great River Valley, below Catadupa, Jamaica. In the Jamaician species ambulacra II, III and IV are near together, while I and V are more widely apart. In the Cuban species the angles of divergence of the petals are nearly, though not quite, equal. The Jamaican species has a sulcate area below the periproct whereas the Cuban species has not. The peristome of *Botriopygus rudistarum* is elliptical and very oblique, whereas that of *Catopygus Jeanneti* is pentagonal.

In the state of New Jersey, U. S. A., *Catopygus oviformis* Conrad[21] from the Vincetown Sand of the Upper Cretaceous is quite similar to this species but differs in having a sulcus below the periproct and in being less tumid anteriorly. The ambital outline, however, is suggestive of that of the Cuban form. Roig reports *Catopygus rodriguezi* Lambert and Roig[22] from the Senonian at Central Stewart, Ciego de Avila, Province of Camagüey, Cuba. His specimen is quite worn but there seems to be no close relationship to this species. *Catopygus rodriguezi* is more conical, seemingly more circular in outline, considerably larger, showing no carination on the posterior interambulacrum, and with its peristome less excentric anteriorly.

*Geologic Horizon.*—Upper Cretaceous.

*Localities.*—Esperanza, Habana Province (Locality No. 1); Ciego de Avila, Camagüey Province (Lambert).

**Clypeopygus habanensis** Weisbord, n. sp. Pl. 3, figs. 1-3

Test large, subquadrate, rounded in front, subtruncate behind, slightly wider posteriorly than anteriorly. Abactinal surface convex, the greatest height of the test at the apex. Actinal surface flat near the margin, concave somewhat at the peristome. Posterior face concave truncate at the periproct.

Peristome obscured. Periproct in the posterior truncation, large, triangular, indented. Apical disc small, subcentral with four perforated gentials, the pores of genitals 1 and 4 much wid-

[20]Geol. Mag., vol. 60, p. 213, pl. 9, figs. 7-9, 1923.
[21]See U. S. Geol. Survey Mon. 54, p. 72, pl. 29, figs. 2a-f, 1915.
[22]Bol. de Minas, Habana, No. 10, p. 71, pl. 10, figs. 1-3, 1926.

er apart than those of 2 and 3. Madreporite extends from the right anterior genital to the center of the disc which it nearly encompasses.

Ambulacra petaloid, flush, somewhat unequal, ambulacrum III and the posterior laterals of about the same size, the anterior pair somewhat shorter. Petals pointed distally, extending only part way to the margin, nearly but not quite closed at the ends. Petals of the bivium diverge at a very small angle. Interporiferous zones about one and a half times as wide as the poriferous areas. Pore-pairs oblique, conjugate, the pores very unequal, the outer elongate, the inner rounded. Posterior interradium with a faint carina extending to the top of the periproct.

Tuberculation consisting of small, numerous, imperforate, scrobiculate tubercles, somewhat less abundant on the ventral surface, arranged in obscure patterns on the dorsal surface.

*Dimensions.*—Holotype, length, 53 mm.; width, 48 mm.; height, 23 mm.

*Remarks.*—It is difficult to state the genus of this form because of the inaccesibility of the area around the peristome. If the floscelle is rudimentary or absent it would be referable to the subfamily Echinobrissinæ; if the bourrelets and phyllodes are subsequently found to be strongly developed, it should be assigned to the family Cassidulidæ. Because of the close superficial resemblence to some of the species of *Clypeopygus,* the writer questionably refers this form to that genus in the family Cassidulidæ.

Comparisons: Curiously enough this species recalls *Echinobrissus freitasi* White[23] from the middle-upper Cretaceous of the Province of Sergipe, Brazil. It may readily be distinguished from the Brazilian form by being somewhat higher, with a rather marked slope both anterior and posterior to the apex as compared with the depressed, nearly flat abactinal surface on *freitasi,* in the more closely set petals of the bivium and larger size of the periproct. The Brazilian species is the nearest related form that the writer has seen.

*Geologic Horizon.*—Upper Cretaceous.

*Locality.*—Esperanza, Habana Province (Locality No. 1).

[23]Mus. Nac. Rio de Janeiro Arch., vol. 7, p. 259, pl. 28, figs. 14-16, 1887.

*Holotype*.—Paleontogolical Research Institution.

**Hemiaster** cf. **antillensis** Cotteau Pl. 2, figs. 12-14

*Hemiaster antillensis* Cotteau, Annales Soc. géol. Belgique, vol. 9, p. 31, pl. 3, figs. 1-4, 1881.
*Hemiaster antillensis* Agassiz, Mus. Comp. Zool. Mem., vol. 10, No. 1, p. 93, 1883.
*Hemiaster antillensis* Cotteau, Bol. Comision Mapa Geol. de España, vol. 22, p. 72, pl. 24, figs. 1-4, 1897.
*Hemiaster antillensis* Jackson, Carnegie Inst. Washington, pub. 306, p. 73, 1922.
*Hemiaster antillensis* Roig, Bol. de Minas, Habana, No. 10, p. 124, 1926.

Translation of Cotteau's original description:

> Species of small size, narrow and indented in front, wide at the middle, subacuminate and obliquely truncate behind, subsinuous at the ambitus; upper face thick, swollen, subcarinate in the posterior region, slightly sloping in front, having the greatest height back of the apical disc; lower face regularly swollen. Apical disc somewhat excentric anteriorly. Anterior sulcus straight, deep, swollen at the margins, starting at the apical disc, strongly incising the ambitus, extending to the peristome where it becomes weaker. Paired ambulacra excavated, the anterior subflexuous, divergent, more developed than the posterior which form two small petals relatively a little closer to the posterior carina. Poriferous zones wide, open at the end, composed of narrow, nearly equal pores, the anterior seeming a little more developed than the others; the interporiferous zone is relatively rather large, but narrower than the poriferous zone. Interambulacra projecting and pinched in the neighborhood of the apex. Peristome excentric anteriorly, a little removed from the margin, subcircular. Periproct flush, elliptical in the direction of the antero-posterior diameter, opening at the top of the posterior face. Peripetalous fasciole sinuous; subanal fasciole not distinct.
>
> Height, 20 mm.; length, 28 mm.; width, 27 mm.
>
> Relations and Differences: This species in its general form and its somewhat sinuous ambitus resembles *H. Scillae* Wright from the Miocene terrain of the Island of Malta; it differs from it by its less swollen upper face, more oblique slope in front, more noticeably carinate in the posterior region, more sharply truncate behind, by its deeper anterior sulcus, the ambitus more strongly excavated and marked at its margins by a more apparent thickening.
>
> Locality: Cienfuegos (Cuba). Rather rare. Eocene?
>
> Collection: Dewalque.
>
> Explanation of Figures: Pl. 3, fig. 1, *H. antillensis*, side view; fig. 2, upper face; fig. 3, lower face; fig. 4, ambulacrum enlarged.

Our collection contains one weathered and somewhat distorted example that seems to be very close to Cotteau's species. The apical disc on our specimen is situated subcentrally, the anterior petals somewhat more curved, and the peristome a trifle closer to the margin than on the form figured by Cotteau. These slight inconsistencies are believed to be of individual rather than specific nature hence the writer refers his specimen to *antillensis.*

*Comparisons.*—*Hemiaster antillensis* closely resembles two Cretaceous forms, one *Hemiaster nucleus* Desor[24] from the base of the Senonian, the other, *Hemisaster fourneli* Desor[25] from the Turonian of France, Spain, Portugal and Algeria in northern Africa. From *Hemiaster nucleus* the Cuban species differs somewhat in shape, being rather less obviously cordiform, with a deeper anterior sulcus at the margin, and in being less obliquely truncate than the French species. *Hemiaster fourneli* is somewhat larger than the Cuban species, more regular in marginal outline, with its apical system somewhat excentric posteriorly and with a shallow, instead of a deep sulcus in the anterior margin. The similarity of *antillensis* to Cretaceous forms is as striking as Cotteau's comparison of it to *Hemiaster scillae* from the Miocene of Malta.

*Hemiaster,* sp. indet, Hawkins[26] from the Rudistid Limestone of Jamaica if uncrushed would probably be very close to this species. As it is the Jamacian specimen seemingly differs in being less obviously cordiform than the Cuban species, a difference perhaps not so valid when it is considered than there is apt to be some variation in the marginal outline of the species.

*Locality.*—Santa Lucía and La Concepcion, district of Cienfuegos, Province of Santa Clara (Cotteau).

*Reported Geologic Horizon.*—Cotteau questionably recorded this species from the Eocene, but Roig later asserted that the locality called Eocene by Cotteau "may be considered pertaining to the Cretaceous of Cienfuegos".

*Present Locality.*—Esperanza, Habana Province (Locality No. 1).

**Hemiaster madrugensis** Weisbord, n. sp. Pl. 3, figs. 4-6

Test of moderate size, ovately cordiform, widest just anterior to the apex. Dorsal surface evenly convex, moderately inflated; ventral surface also somewhat convex behind the peristome but only to a slight degree. Lateral margins swollen; anterior margin rather deeply grooved at the ambulacral sulcus, otherwise

[24]See Paléontologie Française, Terrains Crótacés, vol. 6, p. 240, pl. 876, 1853-1860.

[25]**Ibid,** p. 234, pl. 877, 1853-1860.

[26]Geol. Mag., vol. 61, No. 721, p. 316, pl. 18, fig. 3, 1924.

evenly rounded; posterior margin truncate.

Peristome transverse, broadly ovate, well excentric anteriorly, about 8 mm. from the marginal groove, bounded posteriorly by a labrum. Periproct in the posterior truncation, somewhat nearer the dorsal than the ventral face, large, seemingly subquadrate(?). Apical system subcentral, its details obscure, although one weathered specimen which is believed to be this species does show what seems to be a genital pore in interambulacrum 1 and in interambulacrum 4. The rest of the disc is so weathered that further observations cannot be made.

Ambulacra diverse, the anterior in a deep sulcus which is widest just above the margin, extending to the peristome. Antero-laterals divergent, somewhat flexuous, also deeply sunken, (though not quite so much as ambulacrum III), petaloid, the petals extending nearly to the margins where they tend to close somewhat, the ambulacra continuing in a very shallow depression which extends to the ambitus. Postero-laterals also petaloid, somewhat shorter than the antero-laterals, open distally, diverging from the disc at a very small angle so that they nearly parallel the interradium separating them. Poriferous zones form the sides of the ambulacral depressions, the interporiferous area, the base. Both areas are of equal width. The antero-lateral ambulacra have, in one specimen, about 31 pairs of pores, in another 26, the ambulacra of the bivium having about 22 pairs. The pores of a pair are nearly horizontal, subequal, somewhat elongated, conjugate. The pores of ambulacrum III are closely spaced, less elongate than those of the other ambulacra, very oblique.

Posterior interambulacrum somewhat carinate dorsally. A peripetalous fasciole encircles the petaloid parts of the ambulacra. Plastron slightly tumid. Ornamentation faint on our specimens, but so far as can be discerned, the tubercles seem to be small and crenulate, largest actinally near the margin and on the sternum, smaller and possibly more abundant abactinally, particularly near the apex, with abundant miliaries.

*Dimensions.*—Holotype, length, 33 mm.; width, 30 mm.; height, 22 mm.

*Remarks.*—The distinguishing features of this species are the deeply sunken ambulacra and the regularity of contour whereby the anterior and posterior ends are of about the same height.

*Comparisons.*—Of the two Cretaceous species of *Hemiaster* reported from Cuba, this form is closer to *Hemiaster antillensis* Cotteau[27] from Santa Lucía, and La Concepcion Cienfuegos, Province of Santa Clara. *Hemiaster antillensis* has much the same marginal outline but it is considerably higher posteriorly than anteriorly, whereas *madrugensis* is about the same height in front and behind.

*Hemiaster* sp. indet. Hawkins[28] from the Rudistid Limestone of Jamaica is not unlike this species despite its seemingly more quadrate form which may be due to crushing. However, Hawkins states that the highest point of the test is at the periproct, whereas in the Cuban form the highest is at the apical disc. Superficially *Schizaser brachypetalus* Arnold and Clark[29] from Jamaica is very much like the Cuban form but is distinguished from it by having "only a faint indication of depression at the ambitus in ambulacrum III." In *madrugensis* the anterior groove is strongly pronounced.

Although geographically remote, this species may also be compared with *Hemiaster vicinus* Stoliczka of the Ootatoor group (Cenomanian) south of Moraviatoor, southern India[30]. The Indian species is quite like our form but differs in the greater angle of divergence of the petals of the postero-lateral ambulacra and in the greater number of pore-pairs of the ambulacra.

*Geologic Horizon.*—Upper Cretaceous.

*Locality.*—Esperanza, Habana Province (Locality No. 1).

*Holotype.*—Paleontological Research Institution.

**Hemiaster siboneyensis** Weisbord, n. sp. Pl. 3, figs. 7-9

Test of moderate size, cordiform, rather acuminate posteriorly. Dorsal face somewhat convex, appressed, strongly sloping from behind toward the anterior margin. Ventral surface moderately swollen centrally. Lateral margins tumid, anterior margin some-

[27] Annales Soc. géol. Belgique, vol. 9, p. 31, pl. 3, figs. 1-4, 1881.
[28] Geol. Mag., vol. 61, No. 721, p. 316, pl. 18, fig. 3, 1924.
[29] Mus. Comp. Zool. Mem., vol. 50, No. 1, p. 59, pl. 11, figs. 14-16, 1927.
[30] Paleontologica Indica, Geol. Soc. India Mem., vol. 4, No. 3, p. 13, pl. 2, figs. 1-1c, 1873.

what compressed, grooved at the anterior ambulacrum. Posterior face obliquely truncate, the angle of obliquity about 15 degrees from the vertical.

Peristome very close to the anterior margin, transverse, semilunate, with a subdued labrum. Periproct small, lengitudinally ovate, in the posterior truncation well up toward the dorsal surface, just under the carination of the posterior interambulacrum. Apical disc very excentric posteriorly. Ambulacra unlike, the odd anterior ambulacrum in a deep, moderately broad groove which extends over the ambitus to the peristome. The anterolateral ambulacra are petaloid for some distance toward the margin, flexuous, divergent, deeply grooved, the petals open distally, continuing in a shallow sulcus to the margins. Petals of the bivium very short, diverging at a moderate angle from the apex, also deeply incised and somewhat open at their ends.

Poriferous zones of the antero and postero-lateral ambulacra slightly wider than the area separating them. In the anterolaterals there are about 24 pairs of nearly horizontal, conjugate pores, and about 16 to 18 pairs in the petals of the bivium. The pores of a pair on the anterior and posterior petals are elongated, slit-like, equal. The pores of ambulacrum III are less elongate than the others.

Interambulacra compressed into sharp ridges at the apical disc, flattening out toward the margins. Posterior interambulacrum with a moderate carina extending from the apex to the periproct.

Peripetalous fasciole very faint, presumably sinuous. Plastron weathered, slightly raised above the ventral surface, somewhat convex. Tuberculation not clearly visible but the corona seems to be covered with small tubercles between which may be miscrscopic granules. The tubercles probably become larger toward the margins and on the plastron.

*Dimensions.*—Holotype, length, 29 mm.; width, 27 mm.; 27 mm.; height posteriorly, 20 mm.

*Remarks.*—This species is at once characterized by its deeply excavated ambulacra, the marked posterior excentricity of its apical disc, the equally marked anterior excentricity of the peristome which is very close to the margin, and the inward obliquity of the posterior truncation.

*Comparisons.*—This species in a general way invites comparison with *Hemiaster parastatus* (Morton)[31] and *Hemiaster stella* (Morton).[32] *Hemiaster parastatus* from the Vincentown Sand (Maestrichian) of New Jersey, U. S. A., and the Ripley formation (Upper Cretaceous) of Alabama, U. S. A., differs from the Cuban species in being somewhat larger, vertically truncate posteriorly instead of obliquely, and in having its peristome further removed from the anterior margin. *Hemiaster stella* also from the Vincentown Sand is not quite so acuminate posteriorly, is also vertically, instead of obliquely truncate and has its peripetalous fasciole bordering the petaloid ends of the ambulacra without entering the angles of the interambulacra. In this species, though by no means clearly outlined, the fasciole is seemingly more sinous.

*Geologic Horizon.*—Upper Cretaceous.

*Locality.*—Esperanza, Habana Province (Locality No. 1).

*Holotype.*—Paleontological Research Institution.

## UPPER EOCENE SPECIES

**Cidaris** aff. **loveni** Cotteau Pl. 3, fig. 10

*Cidaris loveni* Cotteau, Kongl. Svens. Vet. Akad. Handl., vol. 13, No. 6, p. 10, pl. 1, figs. 11-14, 1875.

*Cidaris loveni* Guppy, Scientific Assoc. Trinidad Proc., part 12, p. 195, 1882.

*Cidaris loveni* Jackson, Carnegie Inst. Washington, pub. 306, p. 19, pl. 1, figs. 8-10, 1922.

*Cidaris loveni* Arnold and Clark, Mus. Comp. Zool. Mem., vol. 50, No. 1, p. 11, pl. 1, figs. 1, 2, 1927.

Translation of Cotteau's original description:

> Species of medium size, subcircular, slightly pentagonal, about equally depressed above and below. Ambulacral areas sunken. Poriferous zones relatively rather large, subundulate, nearly straight at the approaches to the apex and peristome, composed of oval, very open pores, disposed nearly horizontally; each pair of pores is separated by a transverse swelling, which at first sight are somewhat like the pores of *Rhabdocidaris,* although this resemblance is more apparent than real, and the pores, not conjugate by a groove, are clearly those of true *Cidaris.* Interporiferous zones everywhere very narrow, ornamented with two rows of regular, close, homogeneous granules, situated at the margin of the poriferous zones; the intermediate space is occupied by two other, less regular rows, composed of smaller granules, more un-

[31]See U. S. Geol. Survey Mon. 54, p. 92, pl. 48, figs. 1a-n, 1915.
[32]Ibid, p. 93, pl. 48, figs. 2a-d, 1915.

equal and not leaving between them any open space. Interambulacral tubercles prominent, strongly mammillate, perforate, noncrenulate, to the number of six per series; the scrobicules which surround them are moderately developed, round on the upper face, subelliptical at the approaches to the peristome; they are bordered by a prominent circle of mammillate granules. Miliary zone rather large, ornamented everywhere with unequal and irregularly disposed granules.

Height, 15 mm.; diameter, 26.5 mm.

Similarities and Differences: This species in its general physiognomy closely resembles *C. Melitensis*, yet it has seemed to us to be distinguished from it positively by the structure of its ambulacral areas, the interporiferous zones of which, are noticeably narrower and provided with quite differently disposed granules; it likewise differs from it by its much more granulose miliary zone.

*Locality.*—Island of St. Bartholomew. Very rare. Eocene terrain.

Collection of Dr. Cleve.

*Explanation of figures.*—Pl. 1, fig. 11, *C. loveni*, side view; fig. 12, upper face; fig. 13, lower face; fig. 14, ambulacral area and tubercles enlarged.

In our collection is a fragment of a specimen of *Cidaris* consisting of a portion of an interambulacrum, seemingly of the dorsal surface near the ambitus, studded with four primary tubercles. The tubercles away from the apex are larger than the others; all are prominent, scrobiculate, mammilate, perforate. Areolas circular, fringed with granules which are somewhat larger than the granules of the interspaces. The areolas touch each other longitudinally, are rather far removed transversely. The interspaces are composed of subequal, homogeneous granules, closely spaced, and somewhat smaller than the granules which fringe the areolas.

Only the adradial poriferous avenues are present on our specimens. The avenues are narrow, composed of nearly horizontally disposed pore-pairs margined by prominent, horizontal peripodia; the pores are oval, subequal in size.

*Dimensions.*—Width of the interambulacrum at the widest part, 14 mm.

*Remarks.*—This fragment is from a specimen undoubtedly much larger than the one from St. Bartholomew. In other details the Cuban form is identical to the species originally described by Cotteau except in one particular. Cotteau states that the miliary granules are unequal and irregularly disposed, whereas on our fragment the miliary granules are subequal and regularly disposed. However the disposition of the granules on the form figured by Jackson seem to be quite regular and equal, and it is to Jackson's figured holotype that the Cuban fragment is compared.

Reported Localities: St. Bartholomew (Cotteau) ; in the vicinity of Easington, just west of the Yallahs river and in the region of Seven Rivers, near Great River, St. James Parish, Jamaica (Arnold and Clark).

*Geologic Horizon.*—Eocene.

*Present Locality.*—Loma Calisto, Camagüey Province (Locality No. 2).

**? Diadema principeana** Weisbord, n. sp. Pl. 3, figs. 11-13

Test somewhat fragile, of rather small size, perfectly circular in outline, very depressed dorsally, nearly flat or a trifle concave ventrally, with regularly tumid margins.

Apical disc and periproct broken. Peristome roughly circular, quite large.

Ambulacra straight, lanceolate, increasing in width from the apex to the ambitus where they are widest (5 mm.) and decreasing therefrom toward the peristomial margin. Poriferous zones much narrower than the area separating them, with slightly sinuous pore-pairs which are uni-serial from the apex to near the peristome, where they become bigeminate and possibly trigeminate. There are four and a half pore-pairs to an ambulacral plate, the last pore-pair stationed at the suture between two plates. The pores are subequal, transversely ovoid. Plates presumably compound but the sutures are not visible. There are two vertical columns of primary tubercles which have well rounded mamelons and which are largest at the ambitus, gradually diminishing in size therefrom on the ventral and dorsal surface. The tubercles are weathered so that it cannot be said with certainty that they are perforate, though they most probably are. There are about 12 tubercles in each column, one to every eight pore-pairs. Along the perradial and adradial suture are a series of small miliary granules and occasional granules around the base of the primary tubercles.

The interambulacra are 7 mm. in width at the ambitus, thus being only slightly wider than the ambulacra, also with two column of primary tubercles disposed in much the same manner as those in the ambulacra, one to each plate, largest at the ambitus, approximately the same size as those in the ambulacral areas. Miliary granules occur along the perradial suture. These are subequal in size and simewhat variable in number to a plate. Occasionally granules occur sporadically along the margins of the plates, while along the adradial margin, contiguous to the poriferous avenue of the adjacent ambulacra, is a somewhat staggered column of rather closely spaced granules.

*Dimensions.*—Holotype, diameter, 20.; height, 7.5 mm.

*Remarks.*—The outstanding characteristics of this interesting little species are its perfectly circular outline, its wheel?like shape, the 20 columns of subequal, primary tubercles, and the larger peristome.

*Comparisons.*—This species strongly resembles in miniature the rather larger *Echinopedina cubensis* Cotteau[33] from the Eocene of Cienfuegos, Santa Clara Province, Cuba. It is readily distinguished however, by its much narrower interambulacra, by its more appressed form and by its smaller size. In *? Diadema principeana* the interambulacra are only silghtly wider than the ambulacra, whereas in *Echinopedina cubensis* the interambulacra are nearly three times as wide. The height of *? Diadema principeana* is a little less than one-third the diameter, while in *Echinopedina cubensis* the height is a little less than one-half the diameter.

This species is even more closely related perhaps to *Hebertia simplex* Hawkins[34] from the Yellow Limestone (Middle Eocene) of Jamaica, but differs in being somewhat larger, more appressed, circular in outline instead of subpentagonal, with slightly narrower interambulacra and a larger peristome.

Hawkins states that his *Heberita simplex* may be an immature

[33]Annales Soc. géol. Belgique, vol. 9, p. 9, pl. 1, figs. 1-6, 1881.
[34]Geol. Mag., vol. 61, No. 721, p. 317, pl. 18, figs. 4, 5, 1924.

form of Cotteau's *Echinopedina cubensis,* but in view of the pentagonal outline of the Jamaican form and its narrower interambulacra, the writer believes Hawkins is quite justified in specifically separating his species from Cotteau's.

Both Hawkins and Roig[35] refer the genus *Echinopedina* to *Hebertia* described by Michelin[36] in 1859. Duncan[37], however, in his "Revision of the Genera and Great Groups of the Echinoidea" regards *Hebertia* as synonymous with *Diadema* described by Schynvoet[38] in 1711. So far as the writer can determine, the species under discussion seems referable to the genus *Diadema* equally as well as to the genus *Hebertia.* If the two genera are synonymous as stated by Duncan it is correct to use the older designation; hence the writer refers his species to the genus *Diadema* with question.

*Geologic Horizon.*—Upper Eocene.

*Locality.*—Loma Calisto, Camagüey Province (Locality No. 2).

*Holotype.*—Paleontological Research Institution.

**Jacksonaster acunai** Roig Pl. 3, fig. 14 pl. 4, figs. 1-4.

*Jacksonaster Acunai* Roig, Bol. de Minas, Habana, No. 10, p. 59, pl. 13, figs. 6, 7, 9, 1926.

Cf. *Jacksonaster Acunai* var. *nuevitasensis* Roig, Bol. de Minas, Habana, No. 10, p. 60, pl. 13, fig. 9, 1926.

Test measuring 48 mm. in length, by 35 mm. in width and 12 mm. in height, ovular, linguiform, with swollen margins, but upper face depressed; lower face nearly flat. Peristome very slightly excentric anteriorly, barely sunken, round, from which radiate five ambulacral sutures, confined to the region near the peristome, finely granulose; periproct round, slightly distant from the margin. Apex excentric anteriorly, completely covered with tubercles and the granulation of the test, with four very small genital pores slightly distant from the center, with no trace of a fifth pore; oculars indistinct; the pores are replaced by four small, microscopic, sinuous fissures. Petals very unequal, broad, straight, closed, extending to the margin, with wide poriferous zones composed of very close zygopores and a narrow interporiferous zone, carrying nevertheless, more than one column of tubercles. On the margins the pores become imperceptible, and on the oral face the ambulacra widen and are not separated but by an interambulacral band. The pores reappear in the peristomial sutures; there they are quite numerous but miscroscopic, becoming yet smaller between the granules of the ambulacral area. The whole surface of the test has small, scro-

35Bol. de Minas, Habana, No. 10, p. 36, 1926.
36Bull. Soc. Geol. France, ser. 2, vol. 17, 1859.
37Jour. Linnean Soc., vol. 23, p. 60, 1891.
38Thes. Imag. Pisc. etc., p. 2, pl. 14, 1711.

biculate, homogeneous, scattered tubercles, separated by an extremely fine, miliar granulation.

Some broken specimens allow observation of the internal partition system. This is exclusively marginal and consists of partitioned pillars like those of the living type of the genus, *J. conchatus* Clelland.

This species varies a little in its form which is more or less compressed and sinuous on the sides. One individual, probably a victim of an accident during its life (No. 1310), is irregular, with a posterior cavity, its periproct displaced and situated marginally, opening itself into the cavity but clearly diverted to the right. It is a terralogical example.

A young specimen (No. 1302) is distinguished by its more elongate form and with its periproct even closer to the margin.

Type No. 1304. Collection, Sanchez Roig.

Translation of Roig's description of *Jacksonaster acunia* var. *nuevitasensis.*

*Jacksonaster acunai* var. *nuevitasensis* Roig, Bol. de Minas, Habana, No. 10, p. 60, pl. 13, fig. 9, 1926.

Under this name I refer to *Jacksonaster Acunai* a form (No. 1306) that is distinguished from the type by its somewhat narrower petals with an interporiferous zone carrying a single column of tubercles. This individual measures 37 mm. in length, 27 mm. in width and 8 mm. in height.

I know of no species that can be mistaken with *Jacksonaster Acunai.*

*Jacksonaster ellipticus* Agassiz, of the Pliocene, but especially known from present seas, is less elongate, has its petals shorter and shows five, well separated genital pores at the apex.

Type of the variety, No. 1306. Collection, Sanchez Roig.
Geologic Horizon: Oligocene.
Locality: Loma de Calisto, Nuevitas, Camagüey.
Note: *Jacksonaster Acunai* and the variety *nuevitasensis* are found in the same locality. Sr. Julian Acuña brought us more than 50 specimens of this species and the variety.

This species is quite variable in shape, though in the main it assumes two general forms. In one of these the outline is elongate-pentagonal, rostrate in front, subtruncate behind, with a moderately pronounced stricture in the lateral margins below the apical regions. In this general group some of the specimens are more elongate than others in proportion to their width. The second group is elliptical in outline, longer than broad, generally rounded in front and behind with subparallel margins with only a tendency to develop the lateral sulci which are rather pronounced on the pentagonal forms. Inasmuch as both forms come from the same horizon and show a marked tendency to intergrade even in the relatively few forms in our collection, it seems unwise to set up varietal forms of this species. The degree of excavation of the petals and depression of the abactinal surface varies on some of the specimens, but the variation is as great in one group as in the other.

Margins swollen, usually rather sinuous, somewhat thicker anteriorly than posteriorly. Adapical surface usually sunken below the tumid margins, but occasionally the top of the dorsal face is level with the top of the margins; adoral surface flat, with a slight depression centrally causing the surface to appear somewhat bent.

Peristome in the antero-posterior plane of symmetry, excentric anteriorly, pentagonal in outline, slightly sunken. From it radiate five ambulacral sutures, those corresponding to the trivium subequal in size and slightly shorter than those corresponding to the bivium, the sutures extending only a short distance from the peristome. Periproct in the antero-posterior plane of symmetry, not far from the posterior margin, rather large, rounded to obtusely pentagonal, slightly sunken. Apical disc excentric anteriorly, with four genital pores, one each in genitals 2, 1, 4, and 3, the pores of 2 and 3 closer together than 1 and 4.

Ambulacra slightly to moderately sunken in the dorsal surface, petaloid, nearly closed distally, extending to, and overlapping, on the lower flanks of the margins. The petals of the bivium are the longest, that of the odd, anterior ambulacrum next in size, and those of the antero-laterals, shortest, though only a trifle shorter than that of ambulacrum III. Poriferous zones much wider than the interval that separates them. Pore-pairs numerous, conjugate, with minute, equal granules on the platforms separating the canals. Outer pores of a pair are elongate, very much longer than the inner pores. Inner pores are also slit-like distally but becoming less so toward the apex. Interporiferous zones convex, with either one or two columns of scrobiculate tubercles impinged thereon.

Surface ornamentation consists of numerous, subequal, scrobiculate tubercles which are interspersed with very fine, miliary granules. The tubercles are less numerous on the dorsal surface than on the ventral surface, and are even more abundant, though a trifle smaller, on the margins.

*Dimensions.*—Large pentagonal type, length, 50 mm.; width, 39 mm.; height, 9 mm.

Moderate-sized pentagonal type, length, 39 mm.; width, 24 mm.; height, 7 mm.

Large elliptical form, length, 51 mm.; width, 39 mm.; height, 12 mm.

Small elliptical form, length, 32 mm.; width, 22 mm.; height, 7 mm.

*Remarks.*—Roig's varietal form *nuevitasensis* is hardly valid since there may be one or two columns of tbuercles in the interporiferous zones, as well as somewhat varying width of the petals, both of which characters are used by Roig to designate the variety.

*Comparisons.*—This species can usually be distinguished from *Jacksonaster sanchezi* Roig[39] discussed in the following pages, by being less elongate, less prominently strictured at the lateral margins and with less deeply excavated ambulacra. Nevertheless there are occasional intermediate forms which are very close to *sanchezi* and it is difficult to determine to which of the two species to assign them. This shows that the two forms *acunai* and *sanchezi* are much closer than Roig's statement, "I know of no species that can be mistaken with *Jacksonaster acunai*," would indicate, although it is freely admitted that extreme types of the two species are easily separable.

The writer follows Roig in using Lambert's generic designation, *Jacksonaster.*

*Reported localities.*—Loma Calisto, Nuevitas, Camagüey (Roig).

*Reported Geologic Horizon.*—Oligocene (Roig).

*Present Localities.*—Loma Calisto, Province of Camagüey (Locality No. 2); between Nuevitas and Pastelillo, Province of Camagüey (Locality No. 3).

**Jacksonaster sanchezi** Roig Pl. 3, fig. 15; pl. 4, figs. 5-7

*Jacksonaster Sanchezi* Roig, Bol. de Minas, Habana, No. 10, p. 61, pl. 13, figs. 4, 5, 8, 1926.

Translation of Roig's original description:

This species (No. 1308) recalls the preceding (*Jackson-*

[39]Bol. de Minas, Habana, No. 10, p. 61, pl. 13, figs. 4, 5, 8, 1926.

*aster Acunai* var. *nuevitasensis*) in its general shape, but is narrower, more elongate, and differs absolutely from it as from all the known Laganidae, by the width and depression of its petals.

It measures 40 mm. in length, 27 mm. in width and 10 mm. in height. The margins are swollen and the upper face rather profoundly depressed in all the petaloid part. The details of the apex, uniformly covered with scrobiculate tubercles, are barely distinct, but there cannot be seen in it any trace of a fifth genital pore. The unequal petals, the laterals much shorter than the others, are wide and not allowing the interambulacra to reach the apex except by a narrow band; all the petals reach the swollen part of the margin and are (there lightly impressed. Near the margin the interambulacra overhang the petals and the latter appear as strongly depressed; the poriferous zones are very wide, and the interporiferous zone very narrow, lineal, not bearing but a single column of irregular, scrobiculate tubercles; the unpaired petal is deprived of it. The development of the poriferous zones, the width of the petals and its obtuse shape are characters quite unusual in a *Laganum.*

In the interior of the test are partitions and pillars with canals at the margin of the test, the whole center of which remains open. It is nearly the disposition observed in the preceding species and in the living *Jacksonaster.*

No known species can be confused with *Jacksonaster Sanchezi.*

Note: We possess a series of varieties of this species brought by Sr. Julian Acuña. Type No. 1308, Lambert collection, Paris. We posses some 30 cotypes in our collection.

*Geologic Horizon.*—Oligocene.

*Locality.*—Loma Calisto, Nuevitas, Camagüey.

This unique species has a thick, slipper-shaped, elongated test, somewhat elliptical in shape with a pronounced stricture at the lateral margins below the apical system. Usually the widest part of the test is in front of the apical system. Usually too, though not invariably, the anterior portion of the test is thicker than the posterior. The abactinal surface (excluding the petals) is slightly concave within the swollen margins, but may be nearly flat or even very slightly convex. The actinal surface is invariably slightly concave.

The peristome is somewhat excentric anteriorly, small, subpentagonal, slightly sunken. From it radiate five, narrow ambulacral grooves for a short distance, not reaching the ambitus. The grooves of ambulacra III, V and I are of approximately the same length, those of the anterior pair shorter, conforming more or less in proportion to the length of the petals on the abactinal surface.

The periproct is moderately large (2.5 mm. in diameter), circular, infra-marginal, in the antero-posterior plane of symmetry.

The apical disc is somewhat excentric anteriorly. On none of the writer's specimens can its structure be determined, but it is believed to be similar to *Jacksonaster acunai* Roig, with four genital pores, one in each genital except that of the posterior interradium.

Ambulacra petaloid, not quite closed distally, deeply excavated into the test. The petals of the bivium are slightly longer than that of ambulacrum III, while the anterior pair are the shortest, about two-thirds as long as the posterior. Usually all the petals are about equally excavated. The poriferous zones are much wider than the interporiferous area. Pore-pairs numerous, conjugate, the connecting canals being nearly horizontal except at the distal tip where they diverge.

The whole of the corona is ornamented with equal, imperforate and scrobiculate tubercles of small size. The interporiferous zones are covered with a single column of tubercles which are slightly smaller, but of the same kind as those on the corona. The tubercles in the column are staggered, that is, not in the same plane. Occasionally there may be two tubercles in a row due to the marked inequality of the spacing.

*Dimensions.*—Large adult specimen, length, 53 mm.; width, 33 mm.; height anteriorly, 13 mm.; height subcentrally, 11 mm.

*Remarks.*—This species was collected in the same locality from which Roig's holotype was described.

*Comparisons.*—*Jacksonaster torrei* Roig[40] found in the same locality differs from this species in being ovately subpentagonal and in having its ambulacral petals lightly impressed.

*Reported Localities.*—Loma Calisto, Nuevitas, Camagüey (Roig).

*Reported Geologic Horizon.*—Oligocene (Roig).

*Present Localities.*—Loma Calisto, Province of Camagüey (Locality No. 2); between Nuevitas and Pastelillo, Province of Camagüey (Locality No. 3).

**Laganum cubanum** Wesibord, n. sp. Pl 4, figs. 8-10

Test thin, elongate, subpentagonal to polygonal in outline, usually slightly wider anteriorly than posteriorly, with a sug-

[40]Bol. de Minas, Habana, No. 10, p. 61, pl. 12, figs. 1-3, 1926.

gestion of a marginal stricture posterior to the apical system. Adapical surface depressed below the margins. The maximum depression occurs marginally, from which area the abactinal surface rises slightly to the apical system, thus making the surface itself slightly convex. The apex, however, does not quite reach the level attained by the upper surface of the margins. The adoral surface is nearly flat, with a tendency toward concavity at the peristome. The margins are swollen, somewhat sinuous, slightly thicker anteriorly than posteriorly.

Peristome slightly excentric anteriorly, small, pentagonal, somewhat sunken.

Periproct infra-marginal, subcircular, as large as the peristome, in the antero-posterior plane of symmetry.

Details of the apical system not visible, though it is situated somewhat excentric anteriorly.

Ambulacra subpetaloid, slightly convex, extending from the apical disc to, and on, the lower slope of the margins. The petals of the bivium are slightly longer than that of ambulacrum III, while the anterior pair are shortest. The petals are not quite closed marginally. The widest part of the poriferous zones is near the distal end where the width is about the same as the interporiferous zone. Pore-pairs conjugate, the canals converging toward the apex distally, nearly horizontal apically. Interporiferous zones nearly lineal, increasing slightly in width away from the apex.

Interambulacral areas wider than the ambulacral, with a low, elongate fold occurring between the ambulacra of the bivium, extending from the margin about half way to the apex where it loses its identity. This ridge does not occur on all the specimens.

The dorsal surface of the test is strewn with scattered, small, subequal, scrobiculate tubercles on the interambulacra, while the interporiferous zones of the ambulacra contain two or three rows of tubercles of the same size and kind. On the margins, particularly at the ambitus proper, the tubercles are subequal, much more numerous than those on the abical surface, and seemingly more deeply scrobiculate. On the oral surface the tubercles are also subequal, indiscriminately but closely spaced, with fine miliary punctations between them. The oral surface is much more closely tuberculated than the apical surface, but not quite so much so as the margins. From the peristome radiate five ambulacral sutures, subequal in length, extending part way to the margins, ornamented within and around by miliary tubercles.

*Dimensions.*—Holotype, length, 40 mm.; width, 32 mm.; height, 4 mm.

*Remarks.*—The essential features of this unusual species is its pentagonal to polygonal shape, its rather large size for the genus, its thinness, its depressed abactinal surface, the apex of which does not quite reach the level of the dorsal margins, and its posterior carination on the abactinal surface.

*Geologic Horizon.*—Upper Eocene.

*Locality.*—Between Nuevitas and Pastelillo, Province of Camagüey (Locality No. 3).

*Holotype.*—Paleontological Research Institution.

**Peronella quinquenodulata** Weisbord, n. sp. Pl. 5, figs. 1-3

cf. *Echinodiscus crustuloides* Lambert and Roig (not Morton), Inst. Nac. de Investigaciones Cientificas Mem., vol. 1, p. 144, 1929.

Test very small, disc-shaped, subovate, slightly longer than wide. Both the adoral and adapical surfaces are depressed below a ribbon-like margin which is clearly defined as a rim around the test. This rim is probably due to weathering, but this cannot be stated unreservedly since there is only one specimen which can be definitely assigned to this species. Adapical surface convex, rather flattened at the apex, the apex rising above the level of the margins. Ventral surface barely concave, inset below the rimmed margin.

Peristome subcentral, rather large for the size of the test. Periproct infra-marginal, subovate (?).

Apical disc subcentral. Plates of the oculo-genital ring unobservable. Ambulacral petals subequal in size, broad near the disc, pointed and apparently closed at the inner margin of the rim to which they extend. Poriferous zones much narrower than the slightly convex interporiferous zones. Around the apical disc are 5 unequally sized, prominent granules, one on each petal, rising above the disc. On ambulcarum III the granule is a little right of the medial line; on ambulacrum II the granule is the smallest of the group, to the left of the medial line of the petal; on ambulacrum I the granule is toward the antero-posterior line of symmetry; on ambulacrum V it is toward ambulacrum IV, and on ambulacrum IV the granule lies toward ambulacrum V. Whether this granulation is of specific importance or whether it is developed as a growth on this particular specimen cannot be determined without more material. Other specimens of *Peronella* in the collection do not show this development but these specimens also show some differences in their tuberculation, hence are presumed to be different species.

On the dorsal surface of the test, excluding the apical disc, are small, scattered, subequal, lightly impressed, scrobiculate tubercles. In the center of the apical disc are three larger, scrobiculate tubercles. On the dorsal side of the rimmed margin the tubercles are less numerous than on the ventral side of the rim where, in addition, they seem to be more deeply scrobiculate. The ventral surface is like the dorsal in tuberculation. Over the whole corona are numerous, miliary granules occurring between the tubercles. No unusually large tubercles can be observed in the interambulacral areas as in *Peronella mirabilis* Jackson[41] from the Eocene of San Fernando, Trinidad.

*Dimensions.*—Holotype, length, 13 mm.; width, 11.5 mm.; height, 2 mm.

*Remarks.*—This remarkable species is at once characterized by its disc-like shape, small size and granulations on the apex. Due to the obscurity of the ocular and genital plates of the oculo-genital system, the writer does not know if this species is correctly placed generically. The species superficially is so like *Peronella mirabilis* Jackson that the writer is following Jackson in his generic nomenclature. The form is therefor assumed to have four genital pores. It is interesting to note however, that Duncan[42] regards *Peronella* as synonymous with *Laganum,* asserting that *Laganum* may have either four or five genital pores.

*Comparisons.*—This species is very probably the form referred to by Lambert and Roig as *"Echinodiscus" crustuloides* (not *"Scutella" crustuloides* Morton). Their specimen is from the same general locality as ours and their sketchy description of it seems to fit our specimen. The writer doubts however, that *Echinodiscus crustuloides* Lambers and Roig is the same as Mor-

[41]Carnegie Inst. Washington, pub. 306, p. 47, pl. 9, fig. 3, 1922.
[42]Journ. Linnean Soc., vol. 23, p. 156, 1891.

ton's *crustuloides* since one of the characteristics of the form from the United States is its very thick, somewhat sinuous margins as compared with the very thin margins of the Cuban form. Also the Cuban form is characterized by five granulations, one on each ambulacrum, whereas on Clark and Twitchell's[42a] figures of *crustuloides* granulations occur only on ambulacra II and I. The occurrence of granulations may presumably vary, but the distinct difference in the thickness of the margins is sufficient to distinguish the Cuban form from *crustuloides.* The writer therefore, proposes the name *Peronella quinquenodulata.*

This species differs from *Peronella mirabilis* Jackson in its smaller size, in having five granulations on the ambulacral petals at the apical disc, in lacking the larger tubercles in the interambulacral areas, and in its wider, definitely closed petals with wider interporiferous avenues.

*Geologic Horizon.*—Upper Eocene.

*Localities.*—Between Nuevitas and Pastelillo, Province of Camagüey (Locality No. 3); Loma Calisto, Province of Camagüey (Lambert and Roig)?

*Holotype.*—Paleontological Research Institution.

**Peronella caribbeana** Weisbord, n. sp. Pl. 5, figs. 7-9

Test much larger than the foregoing species of *Peronella,* suborbicular in outline, notably thicker anteriorly than posteriorly. Dorsal surface gently convex in front, less so toward the rear, with a faint broad ridge in the posterior interradium extending to the margin. Ventral surface moderately concave. Peristome and periproct not visible, the latter probably a short distance from the posterior margin, and presumably small and flush.

Apical disc somewhat excentric anteriorly. Ambulacra subequal, petaloid, wide at the disc, pointed distally, closed, not extending to the margins. Interporiferous areas about twice as wide as the poriferous avenues at the disc, gently convex. Poriferous zones nearly flush, with oblique, conjugate pore-pairs.

Ornamentations consisting of subequal, scobiculate tubercles, scattered, less numerous on the dorsal surface than at the margins and beneath. On the disc are several tubercles slightly larger than the average but impressed about the same. There are

[42a]See U. S. Geol. Survey Mon. 54, p. 122, pl. 57, figs. 5a-d; 6a-d, 1915.

however, six tubercles larger and more deeply scrobiculate than any of the others. Three of these are in interambulacrum 2 and three in interambulacrum 3. In interambulacrum 2, two of the tubercles are anteriorly situated close together near the apical disc, the other somewhat removed but also anteriorly situated near the middle of the adjacent ambulacrum. In interambulacrum 3 the tubercles are situated posteriorly, arranged in a row extending outward from the apical area, touching each other.

*Dimensions.*—Holotype, length, 30 mm.; width, 28 mm.; height, 7 mm.

*Comparisons.*—This species is like *Pereonella mirabilis* Jackson[43] from the Upper Eocene of San Fernando, Trinidad, but is larger, with a concave ventral surface and with a different arrangement of its large tubercles.

*Geologic Horizon.*—Upper Eocene.

*Localities.*—Between Nuevitas and Pastelillo, Province of Camagüey (Locality No. 3); doubtfully from Loma Calisto, Province of Camagüey (Locality No. 2).

*Holotype.*—Paleontological Research Institution.

**Peronella cubae** Weisbord, n. sp. Pl. 5, figs. 4-6

Test very small, thin, subovate, longer than broad, slightly thicker at the anterior margin than at the posterior. Dorsal face somewhat conical, low, rising somewhat above the level of the margins, with a subdued ridge in the posterior interradium extending from near the disc to the margin.

Peristome subcentral, perhaps a bit excentric anteriorly. Periproct flush, subpentagonal, a short distance from the posterior margin, in the antero-posterior plane of symmetry.

Apical disc slightly excentric anteriorly. Ambulacral petals subequal, petaloid, broad at the disc, pointed and closed distally, not quite reaching the margin. Interporiferous zone moderately convex, about twice as wide as the poriferous zone which is virtually flush, and arrayed with oblique, conjugate pore-pairs, the pores of a pare not distinct but seemingly subequal.

[43]Carnegie Inst. Washington, pub. 306, p. 47, pl. 9, fig. 3, 1922.

The test is ornamented with rather small, lightly scrobiculate tubercles, less numerous and fainter dorsally than ventrally. At the apex are three or four tubercles somewhat larger than the average, tho impressed about the same. In addition to these there are four tubercles larger than any of the others and more prominently scrobiculate, two of which are in interambulacrum 2, and one each in interambulacra 3 and 4, situated near the distal ends of the petals. Whether this tuberculation is a constant feature cannot as yet be determined. One of the two specimens which is being relegated to this species shows only three larger tubercles, two in interambulacrum 2 and one in interambulacrum 3; the tubercle in interambulacrum 4 does not seem to be present, hence the question is raised whether the tuberculation is constant.

*Dimensions*.—Holotype, length, 13 mm.; width, 12 mm.; height, 2.5 mm.

*Comparisons*.—This species differs from *Peronella mirabilis* Jackson[44] in having wider ambulacral petals which are closed distally and in its fewer and differently arranged large tubercles. *Peronella mirabilis* has six large tubercles, two each in interambulacra 1 and 4, and one each in interambulacra 2 and 3. *Peronella cubae* has two large tubercles in interambulacrum 2, and one each in interambulacra 3 and 4. Were it not for this difference in tuberculation, the two species would be virtually identical.

For the present also the writer is considering this species distinct from *Peronella quinquenodulata* Weisbord, since it lacks the prominent granules of *quinquenodulata* and possesses five large interambulacral tubercles not observed on *quinquenodulata*.

*Geologic Horizon*.—Upper Eocene.

*Localities*.—Loma Calisto, Province of Camagüey (Locality No. 2); doubtfully from between Nuevitas and Pastelillo. Province of Camagüey (Locality No. 3).

*Holotype*.—Paleontological Research Institution.

[44]Carnegie Inst. Washington, pub. 306, p. 47, pl. 9, fig. 3, 1922.

**Scutella cubae** Weisbord, n. sp. Pl. 5, figs. 10-12

Test of medium size, nearly flat except for the subdued elevation of the apex. Marginal outline subovate, rather angulate behind, broadly and gently acuminate toward the front. The posterior margins are truncate at the posterior interambulacrum and opposite the petals of the bivium. The margin is thin, wafer-like, somewhat thicker anteriorly than behind. The dorsal surface is nearly flat distally, rising in a gentle dome at the apex. Ventral surface plane, slightly concave.

Peristome slightly excentric anteriorly, rather small, probably subcircular, nearly flush. Ambulacral furrows not visible. Periproct small, circular, in the antero-posterior plane of symmetry, 7 mm. from the posterior margin.

Apical disc a bit excentric anteriorly, its details obscured. Ambulacra on the abactinal surface flush, petaloid, extending not quite to the margin, where the petals are closed. The petals are slightly unequal in size, those of the bivium longest (18 mm.), the odd anterior next (17 mm.) and the antero-laterals shortest, measuring 16 mm. Interporiferous zones somewhat more than twice as wide as the poriferous avenues. Pore-pairs numerous, oblique. Pores seemingly very unequal, the outer slit-like, the inner oval.

Corona ornamented with numerous, small subequal, imperforate, scrobiculate tubercles, more closely spaced at and near the margins than on either face.

*Dimensions.*—Holotype, length, 51 mm.; width, 45.5 mm.; height, 9 mm. Thickness of anterior margin, 4 mm.; posterior margin, 2 mm.

*Remarks.*—Although the ambulacral furrows cannot be distinguished, the other characters of the test appear to pertain to the genus *Scutella.* This genus is rare in the Tertiary of the West Indies.

*Comparisons.*—This species resembles *Scutella tuomeyi* Twitchell[45] from the McBean formation of the Claiborne group (Middle Eocene) in Orangeburg County, South Carolina, U. S. A. The species from South Carolina, however, is not so angulate posteriorly and lacks the thickened anterior margin. In addition the poriferous and interporiferous zones are of nearly equal width, and the petals are somewhat open distally. On this

[45]U. S. Geol. Survey Mon. 54, p. 126, pl. 60, figs. 1a-d, 1915.

species the interporiferous zone is more than twice as wide as the poriferous and the petals are closed at their ends.

*Geologic Horizon.*—Upper Eocene.

*Locality.*—Between Nuevitas and Pastelillo, Province of Camagüey (Locality No. 3).

*Holotype.*—Paleontological Research Institution.

**Scutella camagüeyana** Weisbord, n. sp. Pl. 5, figs. 13, 14

This species is described from a broken specimen, the posterior end of which is missing. The test is of moderate size, subpentagonal or subpolygonal in outline, strongly rostrate in front, angulate at the marginal ends of the antero-lateral ambulacra. Margin thin, slightly thicker in front than on the sides. Dorsal surface flat or barely concave marginally, rising into a low, broad, appressed dome at the apex. Ventral surface flat.

Peristome subcentral, perhaps slightly excentric anteriorly, its shape obscured by adhering rock; periproct missing. Apical disc subcentral possibly situated a mite forward, its details unobservable.

Ambulacra petaloid on the abactinal surface. Petals pointed and closed distally, slightly unequal in size, the postero-laterals longest, followed by the odd anterior, and this by the antero-laterals, measuring 19, 18, and 17 mm. respectively.

Interporiferous areas somewhat tumid, about twice the width of the slightly sunken poriferous avenue. Small, subequal, numerous, imperforate, scrobiculate tubercles adorn the corona, the tubercles most numerous near, and at the compressed ambitus.

*Dimensions.*—Holotype, height, 52 mm.; width, 50 mm.; height, 9.5 mm.

*Remarks.*—This may be a variant of the preceding species, *Scutella cubae* Weisbord, but differs from it primarily in shape. *Scutella cubae* is broadly and gently acuminate in front, the widest part of the test below the apex. This species is sharply rostrate and angulate in front, its greatest width just above the apex. On this species too, the interporiferous areas are somewhat convex, whereas in cubae they are flush. This may be of no diagnostic importance, but taken with the difference in outline of the test, it seems well to separate it from *cubae* until more specimens are available for final judgment.

*Geologic Horizon.*—Upper Eocene.

*Locality.*—Between Nuevitas and Pastelillo, Province of Camagüey (Locality No. 3).

*Holotype.*—Paleontological Research Institution.

**Pauropygus cf. clarki** Lambert Pl. 6, figs. 1-3

*Pauropygus Clarki* Lambert, Bull. Soc. Géol. France, vol. 1, sér. 5, p. 294, pl. 17, figs. 10-12, 1931.

Translation of Lambert's original comments:

> *Pauropygus Clarki* Lambert. This species has been found with *Oligopygus Collignoni*, Ciego de Avila (Cuba), and the largest of the individuals sent measures 23 mm. in length by 20 in width and 12 in height. Its test is accordingly oblong, equally rounded in front and behind, largely swollen upon its margins and slightly convex on top; the subconvex oral face shows a little, almost circular, central periproct somewhat elongated in the direction of the axis, and very slightly depressed; the very small, circular periproct is very close to the peristome. This oral face carries four light depressions corresponding to the paired ambulacra; the posterior alone are in the form of slight ridges; no depression for the odd ambulacrum. Apex monobasal, having four genital pores, slightly excentric anteriorly. Petals homogeneous having somewhat depressed poriferous zones and convex interporiferous zones, a condition which gives them a clearly costulated aspect; one counts for petal I, 25 zygopores, 21 for II and 24 for petal III. These rather wide and fully opened petals extend nearly to the margin and beyond the pores are lost in the general graunlation of the test; neither bourrelets nor phyllodes around the peristome.
>
> This species is readily distinguished from almost all its congeners by the neighboring position of the periproct to the peristome. *Pauropygus latus* L. Clark which represents the same characteristic is more circular; its larger petals, wider at their ends, are not costulate; its oral face is deprived of ambulacral ridges.

A single specimen in our collection from the Province of Pinar del Rio seems to be similar to Lambert's species, even though it is somewhat artificially depressed behind due to crushing. The test is small, oblong to subovate, slightly higher anteriorly than posteriorly. Dorsal surface nearly flat. Ventral surface cushion-like, slightly thicker in front than behind, concave around the peristome, but swollen above and below. Margins rounded.

Peristome subcentral to somewhat excentric anteriorly, its shape indeterminate. Periproct small, circular, situated just below the peristome.

Apical disc somewhat excentric anteriorly. Ambulacral areas subpetaloid, wide open distally. Petals extend to the ventral margin and continue from there around the ambitus as lightly incised sutures. Interporiferous zones slightly convex, somewhat wider than the poriferous areas. Poriferous areas with subequal pore-pairs which are strongly conjugate.

Small, rather numerous, somewhat scattered, scrobiculate and imperforate tubercles cover the corona.

*Dimensions.*—Length, 17 mm.; width, 13 mm.; height, 8 mm.

*Remarks.*—Since the details of the oculo-genital system are not observable and the shape of the peristome is indeterminate, it is difficult to place this species generically. Superficially the form is close to *Oligopygus,* but *Oligopygus* usually has a transverse depression at the peristome with the periproct situated between the peristome and the margin. In this species there is no peristomial depression and the periproct is just below the peristome. It seems to be more closely allied to the genus *Haimea* of Michelin[46] which is characterized by a pentagonal peristome with the periproct just under it. Lambert[47] thinks the two genera *Oligopygus* and *Haimea* may be synonymous and raises the question if it "would not be preferable to unite *Oligopygus* with *Haimea* whether their peristome is pentagonal, quadrate or transverse, since the general physiognomy remains identical?" However the genus *Oligopygus* as established by de Loriol[48] is characterized by a peristome which is "dans une dépression très profonde de la face inférieure." Such a depression is lacking in *Haimea,* hence the two genera are probably distinct. On the other hand the genus *Pauropygus* of Arnold and Clark[49] is exceedingly close to *Haimea* and may perhaps be the same. Our species seems to fit Michelins' *Haimea* as well as it does Arnold and Clark's *Pauropygus,* hence it would seem as if *Haimea* might be correct. However, the writer tentatively prefers to use Lambert's generic designation on the basis of the slight dif-

[46]Rev. et Mag. Zoologie, sér. 2, vol. 3, p. 92, pl. 2, figs. 2, 2a, b, 1851.
[47]Compt. Rend. Somm. Seances Soc. Géol. France, No. 17, p. 232, 1925.
[48]Recueil Zool. Suisse, sér. 1, vol. 4, p. 394, 1886-1888.
[49]Mus. Comp. Zool. Mem., vol. 50, No. 1, p. 30, 1927.

ference in the petals of the two genera.

*Comparisons.*—This species recalls *Haimea caillaudi* Michelin[50] from the Upper Eocene of Jamaica. *Haimea caillaudi* was named by Michelin in 1851 for a specimen without locality in the Museum of Natural History of Nantes. He surmised that the specimen might be of Cretaceous age. In 1925, some 75 years later, Lambert[51] discovered that the Nantes Museum specimen was identical with a form that Trechmann found in the Upper Eocene of Jamaica, and assumed that the locality of the original specimen was Jamaica.

The Cuban species differs from *caillaudi* in being less tumid, in lacking the posterior truncation and in having its apical disc somewhat excentric anteriorly rather than posteriorly as in the Jamaican form. The peristome of *caillaudi* is said to be definitely pentagonal, but inasmuch as the Cuban specimen is weathered it is difficult to state just what shape its peristome has.

In the Jacksonian (Priabonian) of Trinidad are two forms, *Oligopygus kugleri* Jeannet[52] and *Aligopygus christi* Jeannet,[53] which closely resemble this species. *Oligopygus kugleri* is more globose than the Cuban specimen which in addition lacks the prominent, transverse peristomial depression. *Oligopygus christi* is roughly suborbicular while our species is more elongate, with the further difference that the periproct of *Pauropygus clarki* is nearer the peristome.

This species is even more closely allied to *Pauropygus latus*[54] Arnold and Clark from Jamaica, seemingly different in its uniformly smaller size and in the slight anterior excentricity of the apical disc. *Pauropygus latus* is 33 mm. in length whereas what seem to be adult specimens of *Pauropygus clarki* are 20 mm. in length.

*Geologic Horizon.*—Upper Eocene.

*Localities.*—Between Paso Real and San Diego de Los Baños, Province of Pinar del Rio (Locality No. 4), Ciego de Avila (Lambert).

[50]Rev. et Mag. Zoologie, sér. 2, vol. 3, p. 92, pl. 2, figs. 2, 2a, b, 1851.
[51]Compt. Rend. et Somm. Seances Soc. Géol. France, No. 17, p. 232, 1925.
[52]Soc. Paléont. Suisse Mem., vol. 48, p. 6, pl. 1, figs. 1-7, 1928.
[53]**Ibid,** p. 10, pl. 1, figs. 16-19, 1928.
[54]Mus. Comp. Zool. Mem., vol. 50, No. 1, p. 35, pl. 4, figs. 4-6, 1927.

**Oligopygus sanchezi** Lambert Pl. 6, figs. 4-15

Cf. *Oligopygus Haldermani* Roig (not Conrad), Bol. de Minas, Habana, No. 10, p. 83, pl. 41, figs. 6, 7, 1926.
*Oligopygus Sanchezi* Lambert, Bull. Soc. Geol. France, vol. 1, ser. 5, p. 292, pl. 17, fig. 8, 1931.

Translation of Lambert's original comments:

> *Oligopygus Sanchezi* Lambert. Another species from the lower Oligocene of Loma Calisto, Nuevitas, described on p. 83 and figured on plate 41, figures 6 and 7 by Mr. Sanchez (Roig) and by me under the name of *O. Haldermani* Conrad (*Discoidea*) but differing from the latter by its more elongated form, its non-costulate test, its more projecting, less open petals, by its well developed cavity and its less marginal periproct. It measures 33 mm. in length, by 28 in width and 8 mm. in height; it does not show any trace of phyllodes in the cavity and is provided with a rather regularly pentagonal peristome, the sides of the pentagon corresponding to the ambulacral areas, and the angles to the interambulacra, contrary to what is true among the generality of echinoids, but a feature which is explained by the narrowness of the ambulacra at the margins of the peristome.

This robust species varies considerably in shape. Generally it is ovately pentagonal in outline with a tendency to be somewhat acuminate in front and subtruncate behind. Some specimens are rather markedly acuminate in front, others obtusely so; some are difinitely truncate behind, others are rounded; some specimens are pentagonal in outline, others ovate; some specimens are quite narrow, others are broader, tho the species is always longer than broad. The test appears to be bent over due to the presence of a prominent, transverse sulcus or depression at the peristome. Most of the specimens are thicker anteriorly than posteriorly, though this feature is not invariable. The dorsal surface is gently arched and usually flattened on top, but occasionally there is a tendency to become broadly conical. Ventrally the test is somewhat convex except at the peristome where it is deeply concave. There is at times a faint suture in the interambulacral areas extending from a point midway between the apical disc and the ambitus, around the ambitus to the peristomial depression. These sutures roughly bisect the interradii.

Ambulacra lanceolate to subpetaloid on the abactinal surface, the petal of ambulacrum III slightly longer than the anterior and posterior pairs which are of approximately the same size. Dorsally, the ambulacra cease to be petaloid near the margins where there is usually a slight constriction. The ambulacra are widest at the ambitus, gradually narrowing to the peristome and apex. Interporiferous areas as wide as, or wider, than the poriferous zones, having a row of four or five tubercles at the widest part of the petaloid portion of the ambulacra on the dorsal surface. Poriferous areas with subequal to slightly unequal pores, conjugate to the end of the petaloid portion of the ambulacra. From there the pore-pairs are arranged in a simple series around the ambitus to the peristome.

Tubercles rather small, scrobiculate, abundant, of similar size on the ambulacra and interambulacra, with fine granulations around them.

Apical system subcentral, usually a trifle excentric posteriorly, although sometimes slightly excentric anteriorly. Genital pores four, of which the anterior pair are set more closely together than the posterior.

Peristome deeply incised, roughly pentagonal, set into a deep, transverse depression. This depression is an important generic feature according to Arnold and Clark,[55] differentiating the genus *Oligopygus* from the genus *Pauropygus*.

Periproct small, circular, usually a short distance from the margin, occasionally at the margin itself.

*Dimensions.*—Length, 36 mm.; width, 28 mm.; height, 16 mm.
Largest specimen, length, 51 mm.; width, 39 mm.; height, 28 mm.

*Remarks.*—This species, although variable in its shape, in the width of the petals of the ambulacra and the distance of the periproct from the margin nevertheless may be recognized by its deep, transverse flexure at the peristome and its usually appressed dorsal surface.

The writer was at first inclined to regard this species as one of the variant forms of *Pauropygus ovum-serpentis* (Guppy) the well known Eocene index fossil of the West Indies, but as shown by Arnold and Clark[56] *ovum-serpentis* is a *Pauropygus*, a new genus set up by these authors and differing from *Oligopygus* in not having a peristomial furrow. The holotype of

[55]Mus. Comp. Zool. Mem., vol. 50, No. 1, p. 31, 1927.
[56]Mus. Comp. Zool. Mem., vol. 50, No. 1, p. 36, pl. 5, figs. 7-12, 1927.

Guppy's *ovum-serpentis* is considered by Arnold and Clark as figure $4^b$ of plate 19 in the Quarterly Journal of the Geological Society of London, vol. 22, 1866. This species does not have a pronounced peristomial furrow, hence is distinct from the Cuban form under discussion both specifically and generically.

*Comparisons.*—As a general rule this species may be differentiated from *Oligopygus haldermani* (Conrad)[57] from the Upper Eocene of Florida and Georgia, U. S. A. in having more lanceolate ambulacra and in being more appressed on the dorsal surface. Occasional specimens, however, are subconical and develop wider ambulacral petals. These forms are extremely difficult to distinguish from *haldermani,* yet the writer hesitates to call the Cuban form *haldermani* when the majority of specimens are uniformly distinguishable by the more flattened dorsal surface. This species is undoubtedly the same as that which Roig[58] caled *Oligopygus haldermani,* since it comes from the same locality. The writer believes that it is better to separate the Cuban species from Conrad's *haldermani* for the reason stated above.

*Oligopygus sanchezi* is also very similar to the cotypes of "*Echinolampas*" *ovum-serpentis,* U. S. National Museum No. 115389, from San Fernando, Trinidad as figured by Jackson[59] and for that reason the writer was at first inclined to regard our species as the same. Close inspection reveals, however, that the Cuban form has a more prominent transverse depression than has the ctoype of *ovum-serpentis* and for that reason it seems better to consider the Cuban form distinct, particularly since the peristomial depression is a constant feature. It must be admitted that Jackson's *ovum-serpentis* is as close to the genus *Oligopygus* as it is to *Pauropygus* and the question arises whether *Pauropygus* should be considered a distinct genus or not.

*Oligopygus ovum-serpentis* (Guppy) var. *baldryi* Brighton from the Atascadero Limestone (Eocene) of Peru[60] looks a great deal like the Cuban species, but our form may be at once distinguished by having a very prominent peristomial depression, whereas in the Peruvian species the depression is barely notice-

[57]See Clark and Twitchell, U. S. Geol. Survey Mon. 54, p. 167, pl. 78, figs. 4a-d, 5a-d, 1915.

[58]Bol. de Minas, Habana, No. 10, p. 83, pl. 41, figs. 6, 7 1926.

[59]Carnegie Inst. Washington, pub. 306, p. 60, pl. 10, figs. 4, 5, 1922.

[60]Geol. Mag., vol. 63, p. 361, pl. 26, figs. e-h; text-figures la-g, 1926.

able, if present at all. The Peruvian species would fit presumably Arnold and Clark's new genus *Pauropygus.*

One of the most closely related forms to *sanchezi* is *Oligopygus hypselus* Arnold and Clark[61] from Jamaica, but the Jamaican species is much higher in proportion to its length than is *sanchezi.*

Summing up, it appears that despite its many relationships the Cuban species *Oligopygus sanchezi* is perhaps distinct. It is more appressed than *haldermani* with usually more lanceolate ambulacra; its peristomial depression is more marked than the common *ovum-serpentis;* and its height, which is somewhat less than half its length, serves to distinguish it from *hypselus* in which the height of the test is about two thirds of its length.

*Geologic Horizon.*—Upper Eocene.

*Localities.*—Loma Calisto, Province of Camagüey (Locality No. 2); between Nuevitas and Pastelillo, Province of Camagüey (Locality No. 3).

**Tarphypygus notabilis** Arnold and Clark Pl. 7, figs. 1-3

*Tarphypygus notabilis* Arnold and Clark, Mus. Comp. Zool. Mem., vol. 50, No. 1, p. 43, pl. 6, figs. 13-15, 1927.
*Tarphypygus notabilis* Lambert, Bull. Soc. Geol. France, vol. 1, ser. 5, p. 299, 1931.

One specimen of this interesting species is represented in our Cuban collection occurring with *Pauropygus clarki* Lambert with which it may at first be confused. The test is subovate, considerably flattened dorsally, slightly convex ventrally in front and behind, with a slight depression around the peristome. The margins are tumid, the anterior slightly thicker than the posterior.

Ambulacral areas subpetaloid on the dorsal surface, the petals extending to near the margin. Just above the ambitus the ambulacra widen rapidly, the plates becoming as wide, or perhaps slightly wider than the plates of the interambulacra. On the dorsal surface the plates are simple, narrow, strongly anchylosed perradially, thereby producing a very zigzag radial suture. From the ventral side of the ambitus toward the peristome, the ambulacral plates are broader and not so strongly wedged into the plates on the opposite side of the suture. At the ambitus there may be seen on occasional ambulacral plates fine, irregular ser-

[61]Mus. Comp. Zool. Mem., vol. 50, No. 1, p. 28, pl. 4, figs. 6-8, 1927.

rations which are characteristic, according to Arnold and Clark, of the genus. The poriferous avenues are not quite so wide as the intervals separating them, composed of oblique, conjugate pore-pairs, the pores round and subequal, the outer ones perhaps a rifle larger than the inner ones.

Coronal plates quadrate, with rather irregular margins which are also finely serrate, resembling on a minute scale the styliolitic structure which is frequently developed in marble.

Apical disc subcentral, its details obscured. Peristome subcentral, slightly sunken, its shape obscured by adhering material. Periproct small, apparently circular, situated just below the peristome.

*Dimensions.*—Length, 20 mm.; width, 18 mm.; height, 7 mm.

*Remarks.*—The single, somewhat crushed and broken specimen from Cuba seems to be identical in every way with the Jamaican species. It is characterized by its rather evenly subovate outline, the subcentral position of its peristome and apical system, by the proximity of the periproct to the peristome and the serration of the coronal and ambulacral plates, a feature which defines the genus and differentiates it from *Oligopygus* and *Pauropygus.*

Although no geologic horizon is given for this species, the writer surmises that it may come from the Eocene of Jamaica.

*Comparisons.*—This species differs from *Tarphypygus ellipticus* Arnold and Clark[62] from Jamaica in being subovate instead of subpentagonal in outline, in being more compressed, and in having its apical system subcentrally situated instead of excentric anteriorly as in *ellipticus.* It also differs from *Echinocyamus avilensis* Lambert[62a] in being much more appressed and hence not subglobular.

*Reported Locality.*—Seven Rivers district, St. James Parish, Jamaica (Arnold and Clark).

*Geologic Horizon.*—Upper Eocene.

*Cuban Locality.*—Between Paso Real and San Diego de Los Baños, Province of Pinar del Rio (Locality No. 4).

[62]Mus. Comp. Zool. Mem., vol. 50, No. 1, p. 43, pl. 6, figs. 10-12, 1927.
[62a] Bull. Soc. Géol. France, vol. 1, sér. 5, p. 298, 1931.

**Echinolampas nuevitasensis** Weisbord, n. sp. Pl. 7, figs. 4-6

This form is so close to *Echinolampas clevei* Cotteau[63] that a translation of Cotteau's original description of *clevei* is given herewith:

> Species of medium size, very elongate, narrow, subcylindrical; upper face thick, inflated, subangulate in front and behind, marked in the posterior region by a vague and attenuated carina; lower face pulvinate, somewhat projecting in the posterior interambulacral area, rounded at the margins. Apical disc very excentric anteriorly. Ambulacral areas rather large, petaloid, non-costate, contracted at their extremity which nevertheless is slightly open, particularly in the anterior pair of ambulacral areas, unequal, the odd anterior ambulacrum very narrow and nearly straight, the paired anterior areas relatively very short, the posterior much longer; poriferous zones not depressed, composed of unequal pores, the internal rounded, the external elongated, straight, oblique. The poriferous zones cease to be petaloid at a great distance from the margin. Tubercles scrobiculate, dispersed, crowded, abundant. Peristome small, subpentagonal, appearing to open on a level with the test. Periproct little developed, oval, subtriangular, wholly infra-marginal.
>
> Height, 25 mm.; antero-posterior diameter, 45 mm.; transverse diameter, 30 mm.
>
> We refer to this same species a specimen of large size whose height is 53 mm., the antero-posterior diameter, 80 mm. and the transverse diameter, 55 mm. Despite the enormous difference in size, this remarkable example has not seemed to us to be distinguished from the specimens which we have just described in any essential characteristic.
>
> Resemblances and Differences: This species, by reason of its elongate, inflated, subcylindrical form, ought not to be confused with any of its congeners. Its form gives it, at first sight, some resemblance with *Echinolampas ellipsoidalis* d'Archiac†, from the Eocene terrain of Biarritz, but it is more cylindrical, longer, more angulate and narrower in front and behind; it is moreover distinguished by its shorter ambulacral areas, less open at their extremity, and by its periproct much less developed.
>
> Locality: Isle of St. Bartholomew. Rather rare. Eocene terrain. Collection of Dr. Cleve, Museum of Upsala.
>
> Explanation of figures: Plate 4, fig. 1, *E. clevei*, view of the upper face; fig. 2, another specimen, side view; fig. 3, upper face; fig. 4, specimen of very large size, side view; fig. 5, young individual, view of the lower face.

†d'Archiac, Description des foss. nummulitiques des environs de Bayonne, Mem. Soc. géol. de France, 2 série. t. 2, p. 203, pl. 6, fig. 3.

There are two large specimens in our Cuban collection which, aside from a slight variation in shape and somewhat larger periproct, seem very close to the species described by Cotteau. However the Cuban species cannot be called *clevei* for the evidence of

[63] Kongl. Svens. Vet. Akad. Handl., vol. 13, No. 6, p. 23, pl. 4, figs. 1-5, 1875.

the two specimens militates against the identity. A large suite may show that the Cuban form grades into the one from St. Bartholomew, but until such a suite is available the two species must be separated.

The smaller specimen in our collection is ovoid in shape with a definite tendency to be rostrate posteriorly and subtruncate anteriorly. The larger specimen exhibits this to a degree, but the marginal angulation is less pronounced. Our specimens are both large, higher anteriorly than posteriorly, subtruncate in front. The highest part of the test is at the apical system. On the dorsal face the test is quite evenly rounded from the apical disc around the upper part of the ambitus anteriorly, but from the apical disc posteriorly there is a gentle declivity, somewhat more pronounced on the smaller specimen. Both specimens show the subdued carina in the posterior interambulacrum on the dorsal face as in *clevei*. Ventral surface slightly convex at the interradii, particularly at 5, but depressed at the peristome. Peristome somewhat wider transversely than longitudinally, rather large, pentagonal, flush, bordered by bourrelets of the interradii. Periproct at the posterior margin, subtriangular, large, seemingly somewhat larger than the peristome. The rest of the test is like *clevei*.

*Dimensions.*—Holotype, length, 54 mm.; width, 41 mm.; height, 30 mm. Larger specimen, length, 58 mm.; width, 45 mm.; height, 37 mm.

*Comparisons.*—This species differs but slightly from *Echinolampas clevei* Cotteau in being somewhat more rostrate posteriorly and in having a larger periproct. In describing the St. Bartholomew species Cotteau says that the periproct is "little developed, oval, subtriangular" while in our species the periproct is quite large and, on the larger specimen, definitely pentagonal.

The Cuban species is very close to another *clevei*-like form known as *Echinolampas altissima* Arnold and Clark[64] from Jamaica. The shape of the holotype is nearly identical with the shape of *altissima* except that *altissima* is somewhat more truncate anteriorly. The principal difference is that *altissima* is a higher form, being as high as it is wide, whereas in *nuevitasensis* the height is 10 mm. or so less than the width.

[64]Mus. Comp. Zool. Mem., vol. 50, No. 1, p. 47, pl. 9, figs. 1-4, 1927.

Another comparison may be made with *Echinolampas castori* Cotteau[65] from the Eocene of Santiago de Cuba, Oriente Province, and "Matanzas," but a difference may be noted in the position of the apical disc which is much more excentric anteriorly in *nuevitasensis.*

*Geologic Horizon.*—Upper Eocene.

*Locality.*—Between Nuevitas and Pastelillo, Province of Camagüey (Locality No. 3).

*Holotype.*—Paleontological Research Institution.

**Paraster nuevitasensis** Weisbord, n. sp. Pl. 7, figs. 7, 8

Test attaining a large size for the genus, elongate-cordiform, evenly expanded and ovate anteriorly, tapering posteriorly. Dorsal face high, angularly convex with a somewhat more pronounced anterior than posterior slope. Oral surface moderately convex. Margins swollen.

Peristome well anterior, rather large, seemingly transversely elliptical. Below the peristome the test is somewhat carinate but this may be due to distortion of the specimen. Periproct at the posterior margin, below the sharply carinate ridge of interambulacrum 5.

Apical disc somewhat excentric posteriorly. Ambulacra narrowly petaloid, very unequal, deeply excavated. The petal of ambulacrum III is the longest and most deeply incised, extending nearly to the ambital margin, from which it continues to the peristome as a narrow fissure. The anterolateral petals are closed distally, not quite so deeply excavated as the odd anterior petal, about three fifths as long, slightly flexuous, with a tendency to be divergent distally. The petals of the bivium are narrow, deeply cut, about half the size of the antero-lateral pair, diverging at such a small angle from the disc that they nearly parallel the carina of the interambulacrum between them.

Although not clearly discernible, the poriferous area seems to be wider than the interporiferous zone. Pore-pairs are not abundant, occurring as nearly horizontal slits, the outer pores somewhat longer than the inner. The pore-pairs are lightly conjugate.

[65]Annales Soc. géol. Belgique, vol. 9, p. 19, pl. 2, figs. 5, 6, 1881.

Peripetalous fasciole very sinuous, closely following the margins of the petals. The lateral fasciole diverges from the peripetalous fasciole near the middle of the antero-lateral petals, passing beneath the periproct.

Tubercles numerous, perforate, gradually increasing in size from the adapical surface of the corona toward the ventral surface, the largest tubercles occurring on the ventral surface below the ambitus. Numerous fine granules are interspersed between the disc-like platforms on which the bosses of the tubercles rest.

*Dimensions.*—Holotype, length, 42 mm.; width, 31 mm.; height, 26 mm.

*Remarks.*—The outstanding feature of this species is the deep excavation of the petals.

*Comparisons.*—This species is closely akin to *Paraster loveni* (Cotteau)[66] from the Oligocene of Anguilla and from the Collazo and San Sebastian shales of Porto Rico. The Cuban form differs in being somewhat more elongate and in the more closely spaced petals of the bivium. This species also recalls *Schizaster armiger* Clark[67] from the St. Stephens limestone of Upper Eocene age at Cocoa, Alabama, U. S. A., but can be distinguished from the Alabama form by its somewhat shorter petals of the bivium and somewhat larger peristome.

*Geologic Horizon.*—Upper Eocene.

*Localities.*—Between Nuevitas and Pastelillo, Province of Camagüey (Locality No. 3); doubtfully from Loma Calisto, Province of Camagüey (Locality No. 2); between Paso Real and San Diego de Los Baños, Province of Pinar del Rio (Locality No. 5).

*Holotype.*—Paleontological Research Institution.

**Paraster camagüeyensis** Weisbord, n. sp. Pl. 7, figs. 9-11

Test thin, rather small, pentagonal in outline, truncate anteriorly, rostate posteriorly, the lateral margins very slightly diverging from the anterior toward the posterior. The dorsal face is swollen, with a marked downward slope from the posterior por-

[66]Kongl. Sven. Vet. Akad. Handl., vol. 13, No. 6, p. 29, pl. 5, figs. 9-13, 1875.
[67]U. S. Geol. Survey Mon. 54, p. 152, pl. 70, figs. 1a-d, 1915.

tion of the test toward the anterior. Ventral surface barely convex. The test is highest behind where it is vertically truncated. Lateral margins rounded and swollen; anterior margin somewhat less swollen than the lateral margins, with a very slight indentation in the ambitus at ambulacrum III.

Peristome a short distance from the anterior margin, not clearly defined but apparently narrow, semilunar, with a somewhat projecting posterior labrum. Periproct moderately large, circular, flush, in the posterior truncation below interambulacrum 5 which projects over it in eave-like fashion.

Apical disc markedly excentric posteriorly. The anterior ambulacrum III is the longest, deeply incised (more so near the apex than at the margin), straight, subpetaloid. The petaloid area of ambulacrum III extends from the disc to within a short distance of the anterior margin, where unclosed, it extends as a very shallow, wide sulcus to the peristomial margin. The paired anterior ambulacra are deeply excavated, somewhat shorter than ambulacrum III, flexuous and slightly divergent, not quite closed distally, extending to within a short distance of the margins. From the distal end of the antero-lateral petals a narrow suture may or may not extend part way on the ambitus. The bivium is composed of two very short, wide petals, only moderately excavated, rounded and nearly closed distally. The petals of the bivium diverge from the disc at a rather sharp angle and tend to converge posteriorly. The interambulacra are swollen and pinched between the petals.

The character of the pores in the odd, anterior ambulacrum is obscure. In the antero-lateral ambulacra and in the bivium, the poriferous areas are much wider than the interporiferous zones. The pore-pairs are only moderately numerous, slit-like, the outer pores of a pair slightly longer than the inner.

The peripetalous fasciole is very sinuous. Around the petal of ambulacrum III the fasciole is staple-shaped, not quite parallel to the margins of the petal. In the interambulacra between the odd anterior petal and those of the antero-laterals, the fasciole forms a sharp angle and skirts around the distal ends of the lateral petals. There is a somewhat less prominent lateral fasciole which diverges from the peripetalous fasciole near the middle of the antero-lateral petals.

The corona is covered with numerous, unequal tubercles, the mamelons of which are perforated. The tubercles are largest at the ambitus and in the area below the peristome. Small, irregular granules occur numerously between the tubercles.

*Dimensions.*—Holotype, length, 25 mm.; width, 21 mm.; height, 18 mm.

*Remarks.*—This species is characterized by its swollen test, pentagonal shape, the markedly posterior situation of the apical system and the very short petals of the bivium.

*Comparisons.*—The nearest West Indian species to which this form is allied is *Paraster subcylindricus* (Cotteau)[68] from the Eocene of St. Bartholomew. The Cuban species differs primarily in the manner in which the peripetalous fasciole encircles the ambulacra, following the margins of the petals more closely than in *subcylindricus.* Other than this difference the two seem identical if the figures in Cotteau's work are reliable. Jackson states however, that some liberty has been taken in the drawing of the figures. The photographs given in Jackson's paper[69] show *subcylindricus* to be considerably wider than the Cuban form and differs as much in appearance from *camagüeyensis* as Cotteau's own figures of *subcylindricus.*

*Paraster camagüeyensis* is also very much like *"Schizaster" cubensis* d'Orbigny[70] but *camagüeyensis* is less cordate and with a more decided posterior truncation.

*Geologic Horizon.*—Upper Eocene.

*Localities.*—Loma Calisto, Camagüey Province (Locality No. 2); between Nuevitas and Pastelillo, Province of Camagüey (Locatily No. 3); between Paso Real and San Diego de Los Baños, Province of Pinar del Rio (Locality No. 4).

*Holotype.*—Paleontological Research Institution.

**Paraster pastelilloensis** Weisbord, n. sp. Pl. 7, figs. 12-14

Test of moderate size, narrowly cordate in outline. Dorsal surface tumid, higher posteriorly than anteriorly, obliquely truncated behind. Ventral surface nearly flat, with a narrow, elon-

[68]Kongl. Sven. Vet. Akad. Handl., vol. 13, No. 6, p. 31, pl. 5, figs. 14-17, 1875.
[69]Carnegie Inst. Washington, pub. 306, p. 78, pl. 13, fig. 10; pl. 14, figs. 1, 2, 1922.
[70]La Sagra, Hist. física, política y nat. de Cuba, vol. 8, pl. 8, figs. 4-6, 1842-59.

gated carina extending from the base of the peristome part way down to the anterior margin.

Peristome anterior, a short distance from the margin, widely pentagonal, flush with the surface. Periproct well up on the posterior truncation, circular, just under the sharp carination in the middle of interambulacrum 5.

Apical disc subcentral, possibly excentric a bit anteriorly. Ambulacral areas well excavated, the petals of the antero-lateral ambulacra subequal in size, wide, nearly twice as long as those of the bivium which are also somewhat narrower. Ambulacrum III extends unclosed to the dorsal edge of the ambitus whence it continues as a wide, deep sulcus to the edge of the peristome. The petals of the antero-lateral ambulacra are as wide or wider than the odd, anterior petal, barely flexuous, with a tendency to diverge distally. The petals of the bivium diverge from the apex at a very small angle nearly paralleling the carina of the interambulacrum between them. The petals of the antero-lateral and postero-lateral ambulacra tend to, but do not close distally. The pore-pairs in ambulacrum III are not visible; in the other petals the poriferous area is much wider than the zone which separates them. Pore-pairs not numerous, represented by nearly horizontal, long slits of about equal length on each half of the petals.

The peripetalous fasciole borders the distal edge of the petals of the trivium. On the posterior side of the antero-lateral petals however, the fasciole tends to parallel the margins of the petals for some distance toward the apex, then swerves sharply to border the distal ends of the petals of the bivium. A faint lateral fasciole diverges from the peripetalous fasciole at the marginal end of the antero-lateral petals continuing under the periproct.

Tubercles numerous, perforate, gradually increasing in size from the adapical surface to the adoral surface, attaining their largest size around the peristome. Fine granules are numerously interspersed between the disc-like platforms on which the bosses of the tubercles rest.

*Dimensions.*—Holotype, length, 26 mm.; width, 19 mm.; height, 17 mm.

*Remarks.*—This species may be recognized by the nearly central position of the apical disc, the subequal size of the petals of the trivium, the widely pentagonal peristome, the nearly flat ventral surface and the subequal size of the pores of the poriferous zones.

*Geologic Horizon.*—Upper Eocene.

*Locality.*—Between Nuevitas and Pastelillo, Province of Camagüey (Locality No. 3).

*Holotype.*—Paleontological Research Institution.

**Paraster cubitabellae** Weisbord, n. sp. Pl. 7, figs. 15, 16

This species is described from a broken specimen on which one side and the posterior face is missing. The test when whole reaches a rather large size for the genus, is regularly ovate in outline. Dorsal surface convex, moderately high, the greatest height of the test inferred to be at the apex. Ventral surface slightly convex, the plastron somewhat more so than the nearly flat surface immediately next to it. Anterior margin swollen, imperceptibly indented where the anterior ambulacrum crosses the ambitus.

Peristome excentric anteriorly, transversely pentagonal (?), flush with the surface, bounded posteriorly by a moderately prominent labrum. Periproct broken, presumably on the posterior face in the antero-posterior plane of symmetry. Apical disc partially missing, situated somewhat excentrically posteriorly.

Ambulacra diverse. The odd anterior ambulacrum is straight, in a moderately shallow groove which expands somewhat toward the margin. The groove dies out near the margin, the ambulacrum continuing nearly flush in a barely perceptible sulcus to the edge of the peristome. The antero-lateral ambulacra are petaloid on the dorsal face, excavated, divergent, flexuous, the petals not quite reaching the margin where they are nearly closed. The ambulacra continue to the margins in a very shallow groove. The bivium is composed of very short, rather wide petals, less than half the length of the antero-laterals, also excavated, but on this specimen not so much as the antero-laterals. The interambulacra are pinched at the apex.

The pores on the odd ambulacrum cannot be discerned. On the other ambulacra the poriferous area is slightly wider than the interporiferous zone. The antero-laterals are composed of about 25 pore-pairs, the pores of which are subequal, elongate, not quite horizontal, conjugate. Postero-laterals with about 15 pore-pairs.

The plastron is not well defined from the ventral surface proper, but is somewhat more convex.

Peripetalous fasciole distinct, rather broad, starting anteriorly where the anterior groove of ambulacrum III has played out, skirting the distal ends of the antero-lateral ambulacra without entering the angles of the interambulacra. It follows the posterior margin of the antero-laterals, then skirts the end of the petals of the bivium. The lateral fasciole cannot be traced.

Tubercles rather numerous, subequal, becoming larger at the anterior margin and around the peristome as well as on the plastron. The tubercles are much smaller but more numerous on the dorsal face around the apical disc and near the margins. The tubercles are low, perforate, situated on semilunate discs. The large tubercles are absent on the ambulacral paths and along the sides of the plastron. Small granules, however, appear everywhere.

*Dimensions.*—Holotype, length approximated, 32 mm.; width approximately, 27 mm.; height at the apical disc, 23 mm.

*Remarks.*—The outstanding features of this species are its regular, ovate outline, even tumidity and very short postero-lateral petals.

*Comparisons.*—This species at once recalls *Paraster subcylindricus* Cotteau[71] from the Eocene of St. Bartholomew, but differs in having its apical disc not quite so excentric posteriorly. Whether this is a constant difference cannot be ascertained since there is only the one specimen in our collection. It seems well to designate the Cuban form by a new name until more material is available since the position of the apical disc is very important in differentiating the various forms of *Paraster* in Cuba.

This species also seems very similar to Jackson's *Paraster* sp. *a*[72] from the Yellow Limestone (Eocene) of Jamaica which has

[71]Kongl. Sven. Vet. Akad. Handl., vol. 13, No. 6, p. 31, pl. 5, figs. 14-17, 1875.
[72]Carnegie Inst. Washington, pub. 306, p. 79, 1922.

a high upper face "obliquely inclined from the highest point posteriorly." Unfortunately the posterior portion of our specimen is missing but so far as the writer can determine, the highest part of our specimen is at the apical disc and not posteriorly.

Hawkins[73] compares two specimens from the Yellow Limestone of Jamaica to Cotteau's *subcylindricus.* The Jamaican specimens differ only in having a slight curvature of the anterolateral petals. If this is the only difference, then our specimen must also be different from the Jamaican forms in having the apical disc more subcentral than that of the forms compared with *subcylindricus.*

*Paraster cubitabellae* differs from *Paraster pastelilloensis* and *Paraster nuevitasensis* described by the writer, in having a much less prominent anterior groove which does not extend around the ambitus to the peristome. It is much closer to *Paraster camagüeyensis* Weisbord but may be distinguished from it by its more subcentral apical disc and by the character of the peripetalous fasciole. On *camagüeyensis* the fasciole enters well into the interradii between ambulacrum III and the antero-laterals, whereas in *cubitabellae* the fasciole is not flexuous anteriorly.

*Geologic Horizon.*—Upper Eocene.

*Locality.*—Between Nuevitas and Pastelillo, Province of Camagüey (Locality No. 3).

*Holotype.*—Paleontological Research Institution.

**Agassizia caribbeana** Wisberod, n. sp. Pl. 8, figs. 1-6

Test of moderate size, ovate, slightly wider anteriorly than posteriorly. Dorsal face moderately high, quite convex, evenly rounded in front, somewhat sloping behind to the top of the posterior truncation, the greatest height being at the apical disc. Ventrally the corona is somewhat tumid below the ambitus, but the plastron is nearly flat with perhaps a tendency toward convexity. The posterior face is concavely truncate, the slope of the truncation diverging somewhat from the vertical from the ventral surface. Margins tumid. Plastron shield-like in shape, elevated somewhat above the level of the adoral surface. The sternum increases somewhat in elevation from the posterior end where it is barely visible, to the labrum where it is somewhat

[73]Geol. Mag., vol. 61, No. 721, p. 319, 1924.

more pronounced and considerably wider, though the sternum cannot be said to be dominantly projecting as in *Agassiz. inflata* Jackson.

The peristome is well anterior, about 7 mm. from the border, transversely labiate, bordered posteriorly by a rather prominent labrum. The periproct is large, seemingly diamond-shaped (?) on the holotype, subpentagonal (?) on the paratype, situated on the posterior face just below the low carina of the posterior interambulacrum.

Apical disc strongly excentric posteriorly. Ambulacrum III in a shallow, but moderately broad depression, straight, extending not quite to the anterior margin where it is terminated by a narrow, lunate ridge. The paired anterior ambulacra are subpetaloid, extending to the dorsal slope of the ambitus, weaker distally than apically. The anterior row of pores are absent or not visible, but the posterior row is well developed dorsally, weaker marginally. The pore-pairs are not numerous, the outer pores somewhat longer than the more ovate inner pores. The ambulacra of the bivium are very short, moderately well excavated, petaloid, the petals closed or nearly closed distally, with both rows of pore-pairs developed, the outer row of a pair slit-like, the inner somewhat ovate. Interporiferous zones very narrow, hardly discernible. Posterior interambulacrum with a low carina.

Plastron ornamented with rows of tubercles diverging homogenerously from the sternum to the edge of the plastron. These tubercles are not scrobiculate but are perforate, occupying the anterior corner of pentagonally oblong platforms on which they rest. These platforms are somewhat concave. Both tubercles and platforms decrease in size from the labrum toward the posterior end of the plastron. The rest of the corona is covered with numerous, subequal to unequal perforate tubercles resting on disc-like platforms, surrounded by miliary granules. The tubercles of the abactinal surface are fainter than those on the ambitus.

The test has both a peripetalous and marginal fasciole. The peripetalous fasciole encircles the distal ends of the petals of the bivium, enters interradii 2 and 4, curving downward at the posterior distal ends of the antero-lateral petals to join the marginal fasciole. The marginal fasciole encircles the ambitus forming a "V" below the periproct.

*Dimensions.*—Holotype, length, 35 mm.; width, 28 mm.; height, 23 mm.
Paratype, length, 21 mm.; width, 18 mm.; height 15 mm.

*Comparisons.*—This species closely resembles *Agassiz. inflata* Jaskson[74] from the Eocene of St. Bartholomew, and *Agassizia clevei* Cotteau[75] from the Oligocene of Anguila. From *Agassizia inflata* the Cuban species may be distinguished by being less high in proportion to its length, by its less strongly projecting sternum and nearly flat plastron. From *Agassizia clevei* our species differs in having its apical system even more excentric posteriorly. With a larger suite of specimens, this latter difference may be shown not to hold, yet the position of the apical disc is distinctly enough different to tentatively regard the Cuban form as new.

*Geologic Horizon.*—Upper Eocene.

*Localities.*—Loma Calisto, Camagüey Province (Locality No. 2); between Nuevitas and Pastelillo, Comogüey Province (Locality No. 3).

*Holotype.*—Paleontological Research Institution.

**Brissus camagüeyensis** Weisbord, n. sp. Pl. 9, figs. 1, 2

A single specimen in our collection seems to be new, and although broken posteriorly possibly warrants a description.

Test of moderate size, ovoid, somewhat wider anteriorly than posteriorly, rounded in front with an imperceptible groove designating the position of the odd, anterior ambulacrum. Margins swollen, slightly less so anteriorly than laterally. Dorsal surface moderately convex, with a slight slope from the anterior to the posterior part of the test. Ventral surface nearly flat at the anterior margin of the peristome, but somewhat swollen behind. Posteriorly the corona is inferred to be subcarinate.

Peristome partially destroyed, but probably large, semicircular (?), 8 mm. from the anterior margin. Periproct not vis-

[74]Carnegie Inst. Washington, pub. 306, p. 70, pl. 12, figs. 2-4, 1922.
[75]Kongl. Sven. Vet. Akad. Handl., vol. 13, No. 6, p. 33, pl. 6, figs. 2-8; not 9, 10 (fide Jackson), 1875.

ible.

Apical disc small, well excentric anteriorly, the four genital plates perforated, the pores of interambulacra 2 and 3 smaller and closer together than the pores of interambulacra 1 and 4. The latter are not equal in size, the pore of interambulacrum 4 being the larger. Ambulacra II and IV show a small pit at the apical disc and these may possibly be the perforations of the ocular plate. The ambulacra of the bivium also show these pits but there they are not so clearly defined. The madreporite extends from the right anterior genital centrally then posteriorly, separating the postero-lateral genial and ocular plates.

Ambulacra diverse. Ambulacrum III is virtually flush, with an imperceptible furrow, elongate, narrow, with small tubercles and miliary granules. The poles are not visible. The antero-lateral ambulacra are very divergent nearly forming a straight transverse line, with a slight tendency to curve anteriorly at their ends. These ambulacra are petaloid, nearly closed distally, extending not quite to the margin, lightly excavated. Poriferous areas much wider than the intervals separating them, with somewhat unequal pore-pairs, the outer pores of a pair somewhat more elongate than the inner. Bivium petaloid, the petals longer than those of the antero-lateral ambulacra, diverging from the disc at a sharp angle, and reaching only part way down the abactinal surface. They appear to be slightly deeper than the antero-lateral ambulacra, diverging from the disc at a sharp angle, and reaching only part way down the abactinal surface. They appear to be slightly deeper than the antero-laterals and have no tendency to curve distally. Poriferous area, pore-pairs and interporiferous zone like that on ambulacra II and IV.

Peripetalous fasciole faintly inscribed, sinuous. In interambulacra 2 and 3 the fasciole makes a "U"-shaped loop anterior to the antero-lateral petals, then skirts them distally. In interambulacra 1 and 4 the fasciole curves well toward the apex before skirting the petals of the bivium. Posteriorly its contour is not known.

Corona with unequal tubercles. On the dorsal surface the tubercles tend to be larger and stronger anteriorly than marginally, particularly in the area adjoining the odd, anterior ambulacrum. On the ambitus and ventral surface the tubercles are somewhat larger than those on the central and posterior part of the dorsal surface. Many small, subequal granules are interspersed between the tubercles.

*Dimensions.*—Holotype, length inferred, 40 mm.; width, 32 mm.; height, 26 mm.

*Comparisons.*—So far as the writer is aware, this species is quite distinct from any other recorded in the West Indies. It is readily distinguished from *Brissus exiguus* Cotteau[76] from the Oligocene of Anguilla and Miocene (?) of Trinidad by its larger size and with its widest part anteriorly instead of posteriorly as in *exiguus.* D'Orbigny's figures of *Brissus columbaris*[77] Agassiz somewhat resembles *Brissus camagüeyensis,* but *columbaris* is widest posteriorly, and the antero-lateral ambulacra tend to diverge posteriorly instead of anteriorly as in *camagüeyensis.* Incidentally Jackson[78] lists *columbaris* as synonymous with *Brissus brissus* (Leske).

*Geologic Horizon.*—Upper Eocene.

*Locality.*—Loma Calisto, Camagüey Province (Locality No. 2).

*Holotype.*—Paleontological Research Institution.

**Eupatagus siboneyensis** Weisbord, n. sp. Pl. 8, figs. 7, 8

Cf. *Brissoides carolinensis* Lambert (not *Clarki*), Bol. de Minas, Habana, No. 10, p. 5, 1926.

The generic designation of this species is doubtful having been determined from two broken specimens. One of these shows the actual surface nearly entire but with the anterior portion missing; the other shows very faintly a part of ambulacrum III, a portion of interambulacrum 2, the distal end of ambulacrum II, most of interambulacrum 1 and ambulacrum I and a portion of the posterior interambulacrum. The forms show no trace of any fascioles and hence would seem to fall in the division Adetes of the family Spantangidae. The absence of fascioles, however, is believed to be due to the weathering of the specimens, and the writer thinks that better preserved material will show them to be present. If fascioles are present as suspected the genus would seem to be *Eupatagus.*

76Kongl. Sven. Vet. Akad. Handl., vol. 13, No. 6, p. 35, pl. 6, figs. 16-18, 1875.

77La Sagra, Historia físcia, política y nat. de Cuba, vol. 8, pl. 8, figs. 7-10, 1842-59.

78Carnegie Inst. Washington, pub. 306, p. 87, 1922.

Test rather large, ovoid, slightly broader anteriorly than posteriorly. Dorsal surface moderately convex, low. Ventral surface flat anteriorly, concave at and around the peristomial depression, and rather strongly convex posteriorly. Margins swollen, the anterior broken so that it is not known if it is regularly rounded or notched, though the writer's surmise is that it may be lightly sulcate. Posteriorly the test is subtruncate.

The peristome is large, excentric anteriorly, the details of its structure unknown. Plastron smooth, worn-looking elevated posteriorly, with a low, irregular elevation at the margins forming the projection of the postero-lateral ambulacra. Periproct in the posterior face, probably large.

Apical disc excentric anteriorly, its details completely obliterated by adhering rock. The odd, anterior ambulacrum seemingly flush, non-petaloid, probably with small pores. The lateral ambulacra unequal in size, the anterior pair shorter than the posterior, nearly flush. The antero-laterals seem to be somewhat open distally, but this may be due to the weathering at their outer end. The posterior pair are nearly closed distally. On both pairs the poriferous area is equal to or a trifle wider than the zone between them. Pore-pairs not numerous, slightly sunken, the pores of a pair nearly equal in size, slit-like in character.

The ornamentation of the test consists of unequally sized perforate and crenulate primary tubercles. On the dorsal surface the tubercles are few in number, situated on the interradii around the apical disc. The rest of the ventral surface is nearly smooth except for faint granules occurring on it. The areolar area of the tubercles is granulate. The margins are nearly smooth, but ventrally the tubercles grow stronger and larger in size from the margins inward. The tubercles are largest and of equal size in the interradii bordering the plastron, situated on platforms whose posterior edges merge with the test and whose anterior edges obliquely project.

Around the peristome the ambulacral system is stellate and punctate.

*Dimensions.*—Holotype, length approximated, 53 mm.; width anteriorly, 38 mm.; height posteriorly, estimated, 20 mm.

*Comparisons.*—This interesting species is very much like *Eupatagus carolinensis* Clark[79] from the Castle Hayne Limestone of Eogene age at Wilmington, North Carolina, U. S. A. The Cubian form may be distinguished from it by its somewhat more elongate shape and by its more prominent posterior keel on the ventral surface. The Cuban form may also be compared with *Eupatagus alatus* Arnold and Clark[80] from Jamaica but may be differentiated by its more regular and less angulate outline and by its prominent posterior carination on the actinal face.

This species may be the one referred to as *Brissoides carolinensis* by Lambert[81]. While Roig's publication "Los Equinodermos Fósiles de Cuba" was in press he received, and inserted in his introduction, a letter from Lambert stating the results of his study of a number of Cuban forms which had been sent him by Roig. In Lambert's list of species occurs the name *Brissoides carolinensis* from Loma Calisto, the same locality of the species under discussion. It seems quite probable that Lambert's *Brissoides carolinensis* is *Eupatagus siboneyensis* described herein by the writer, Lambert considering the Cuban species identical with that of Clark's from North Carolina, calling it under the generic name of *Brissoides* instead of *Eupatagus.* In the writer's opinion the Cuban species, though certainly very close to the ones from North Carolina, is not the same as *carolinensis,* differing in being more elongate and having a more elevated keel posteriorly. Hence the new name of *Eupatagus siboneyensis* is suggested.

This species is very similar to *Brissoides stefaninii*[81a] Lmbert and Roig also from Loma Calisto, Camagüey Province, Cuba, but differs in having shorter posterior petals and smaller tubercles.

*Geologic Horizon.*—Upper Eocene.

*Locality.*—Loma Calisto, Camagüey Province (Locality No. 2).

*Holotype.*—Paleontological Research Institution.

## OLIGOCENE SPECIES

[79]U. S. Geol. Survey Mon. 54, p. 153, pl. 71, figs. 3a-d, 4, 1915.
[80]Mus. Comp. Zool. Mem., vol. 50, No. 1, p. 63, pl. 13, figs. 4-7, 1927.
[81]Bol. de Minas, Habana, No. 10, p. 5, 1926.
[81a] Mem. Inst. Nac. de Investigaciones Científicas, vol. 1, p. 148, figure on top of page 149, 1929.

**Echinolampas cf. semiorbis** Guppy Plate 9, figs. 3,4

*Echinolampas semiorbis* Guppy, Quart. Journ. Geol. Soc. London, vol. 22, p. 299, pl. 19, fig. 7, 1866.
*Echinolampas semiorbis* Cotteau, Kongl. Sven. Vet. Handl., vol. 13, No. 6, p. 24, pl. 5, figs. 1, 2; pl. 6, fig. 1, 1875.
*Echinolampas semiorbis* Cotteau, Annales Soc. géol. Belgique, vol. 9, p. 23, 1881.
*Echinolampas semiorbis* Cotteau, Paléont. Française, Terrains. Tert., vol. 2, p. 153.
*Echinolampas semiorbis* Cotteau, Bol. Comision Mapa Geol. de España, vol. 22, p. 55, pl. 17, figs. 1, 2, 1897.
*Echinolampas semiorbis* Lambert, Mem. Soc. d'Agric. de l'Aube (Troyes), vol. 79, p. 20, 1915.
*Echinolampas semiorbis* Jackson, Carnegie Inst. Washtingon, pub. 306, p. 58, pl. 10, figs. 1-3, 1922.
*Echinolampas semiorbis* Vaughan, Carnegie Inst. Washington, pub. 306, pp. 114, 115, 121, 1922.
*Echinolampas semiorbis* Roig, Bol. de Minas, Habana, No. 10, p. 76, 1926.

A somewhat distorted specimen of large size seems to be referable to this species. The margins are sharper and the actinal surface much more concave than in typical forms from Anguilla, but it is presumed that this difference is due to crushing.

*Dimensions.*—Length, 100 mm.; width approximated, 98 mm.; height approximated, 45 mm.

*Reported Localities.*—Anguilla - Crocus Bay Hill, roadside descent to Crocus Bay from valley (Vaughan). Crocus Bay, and southwest side of Crocus Bay (Vaughan). From the Anguilla formation, Upper Oligocene.

Panama - Las Cascadas, Gaillard Cut, Panama Canal Zone (MacDonald and Vaughan). From the Emperador Limestone of Oligocene age.

Cuba - Finca Carillo, near Hanabana River, El Caimito, Province of Pinar del Rio (de-la-Tore), Oligocene. San Martin, Province of Matanzas (Cotteau). Finca Cervantes, San José de Las Lajas, Habana Province (Roig), probably Upper Oligocene. Near the city of Holguin, Oriente Province (Roig). Alcalá y Baguanos, Holguin, Oriente Province (Roig).

*Reported Geologic Horizon.*—Oligocene.

*Present Locality.*—K-440, central highway of Cuba, Province of Camagüey (Locality No. 5).

**Echinolampas camagüeyensis** Weisbord, n. sp. Pl. 8, figs. 9-11

Test large, suborbicular, slightly longer than wide. Dorsal surface moderately convex, maximum convexity at the apex. Ventral surface slightly tumid, somewhat concave except at the peristome where there is a marked depression.

Peristome moderately large (7 mm. in diameter), pentagonally transverse, sunken, somewhat excentric anteriorly. Periproct broken, but apparently situated at the margin, large, probably transversely ovate as in *Echinolampas anguillae* Cotteau.

Apical disc subcentral. Ambulacral areas petaloid or subpetaloid, open distally, extending not quite to the dorsal margin, continuing around the ambitus as thin, lightly incised sutures. The ambulacra are usually widest on the ambitus, but occasionally they are widest in the central part of the petal. There is usually a slight constriction at the distal end of the petaloid portion of the ambulacra. Petals subequal to unequal in length and width with no apparent consistency on the two specimens in the collection. Poriferous avenues about one third or one fourth as wide as the interporiferous zones. Pore-pairs rather numerous, somewhat oblique, strongly conjugate, the outer pores slit-like, the inner pores rounder. Interporiferous areas slightly convex, with about 11 tubercles in a row in the widest parts.

Numerous, small, subequal, scrobiculate and imperforate tubercles ornament the corona, those around the peristomial depression somewhat larger and less numerous than those on the adapical surface and on the ambitus.

*Dimensions.*—Holotype, length, 64 mm.; width, 59 mm.; height, 26 mm.

This species resembles *Echinolampas lycopersicus* Guppy[82] and *Echinolampas anguillae* Cotteau[83]. It differs from the Oligocene *lycopersicus* in being larger, somewhat more orbicular and less high in comparison to its length. The height of *lycopersicus* is about half its length, whereas the Cuban species is less than half as high as it is long. This form is even closer to *Echinolampas anguillae*, but seemingly differs in again being less high and in having the apical disc subcentral instead of excentric anteriorly as in *anguillae*.

*Geologic Horizon.*—Oligocene.

[82]Quart. Journ. Geol. Soc. London, vol. 22, p. 300, pl. 19, fig. 8, 1866.
[83]Kongl. Sven. Vet. Akad. Handl., vol. 13, No. 6, p. 24, pl. 4, figs. 6-8, 1875.

*Locality.*—K-440, central highway of Cuba, Province of Camagüey (Locality No. 5).

**Agassizia camagüeyana** Weisbord, n. sp. Pl. 9, figs. 5, 6

This species is characterized by its flattened test, a character somewhat unusual in the genus. The single specimen is somewhat distorted and the flattening may be due of course to crushing, but the writer believes that although this is true to a certain extent, the form is normally appressed.

Test fragile, subovate, moderate in size, somewhat truncated posteriorly. Upper face depressed, somewhat convex; lower face slightly convex at the margins, flat across the plastron. Margins moderately swollen.

Peristome well excentric anteriorly, transverse, semilunar in shape, with a posterior labrum. Periproct obscure, but presumably in the posterior truncation. Apical disc somewhat excentric posteriorly, its details obscured.

Ambulacra diverse, the anterior in a shallow depression which extends to the margin. Its pores cannot be seen. The antero-lateral ambulacra are divergent, open, in a depression somewhat shallower than that of ambulacrum III. Anterior column of pore-pairs absent, the posterior column with horizontal, subequal, comma-shaped pores, the widest part of the pores adradial, the more pointed end, perradial. Postero-lateral ambulacra very short, somewhat more deeply impressed than the others, with two normal columns of pore-pairs, the pores subequal, the interporiferous zones extremely narrow. The posterior interambulacrum with a subdued carina extending from the disc toward the posterior margin.

A peripetalous fasciole borders the distal ends of the petals of the postero-lateral ambulacra, enters the angles of interambulacra 1 and 4, curving near the ends of ambulacra II and IV, to join a lateral fasciole which passes around the test below the periproct.

The plastron is flat, somewhat elevated, triangular.

In the area of the trivium, up to the peripetalous fasciole, are numerous, scrobiculate, perforate tubercles surrounded by granulate areolas. In the depression of ambulacrum III only miliary granules occur, as well as in the interspaces separating the pore-pairs of the antero-lateral ambulacra. Below the peripetalous fasciole and at the apical disc posterior to ambulacra II and IV are somewhat smaller tubercles resting on lunate platforms with miliary granulation between them. On the ventral surface the tubercles become larger, less numerous off the plastron, more abundant on it.

*Dimensions.*—Holoytpe, length, 29 mm.; width, 26 mm.; height, 15 mm.

*Remarks.*—This interesting species is characterized by its compressed form and unique tuberculation.

*Geologic Horizon.*—Oligocene.

*Locality.*—K-440, central highway of Cuba, Province of Camagüey (Locality No. 5).

## PLATES

Plates furnished by the author

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| 3. | Side view of same specimen | |
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| 4. | View of dorsal surface, somewhat enlarged | |
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| 6. | Ventral surface of same specimen, about natural size | |
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| 17. | Upper surface of figure 12, x 1.5 | |
| 18. | Upper surface of another specimen of the pentagonal variety, x 2 | |
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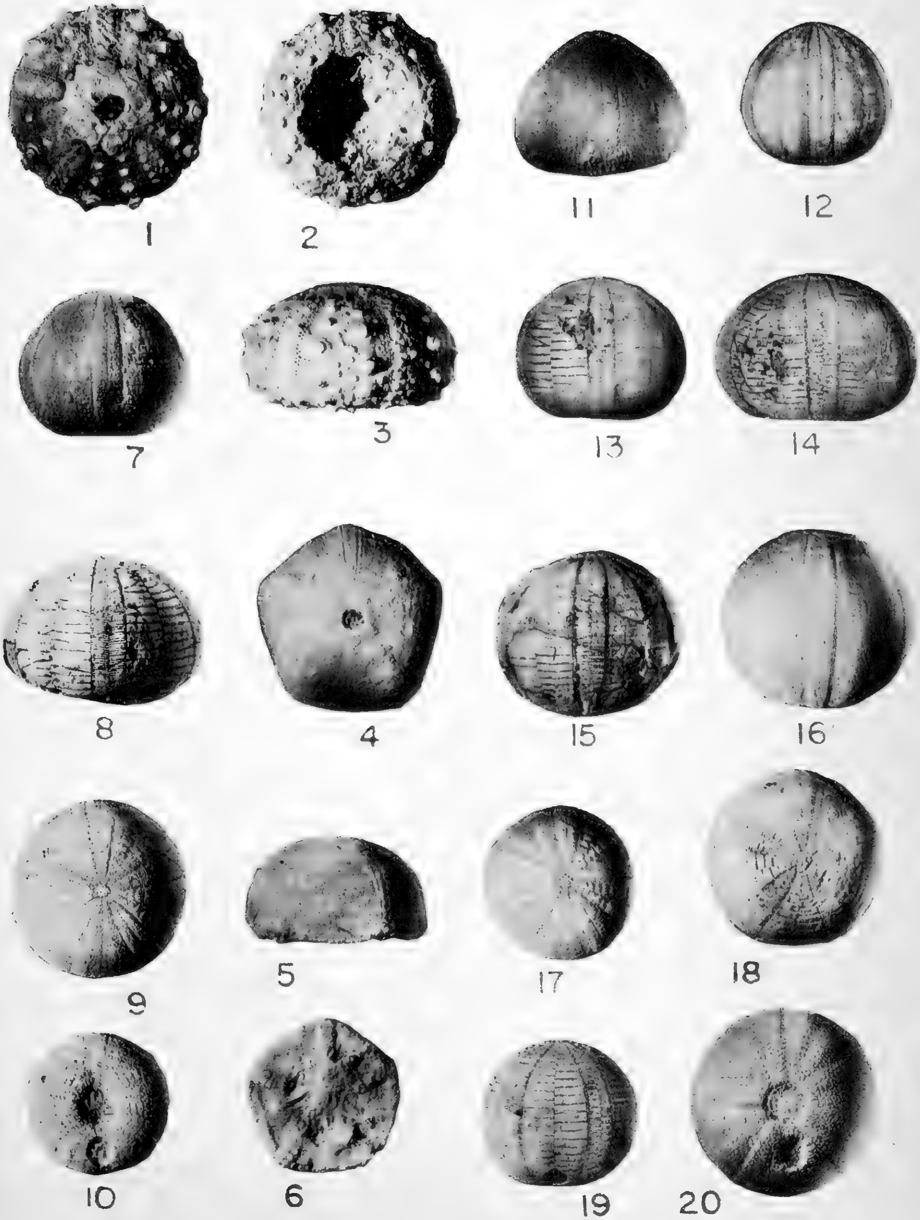
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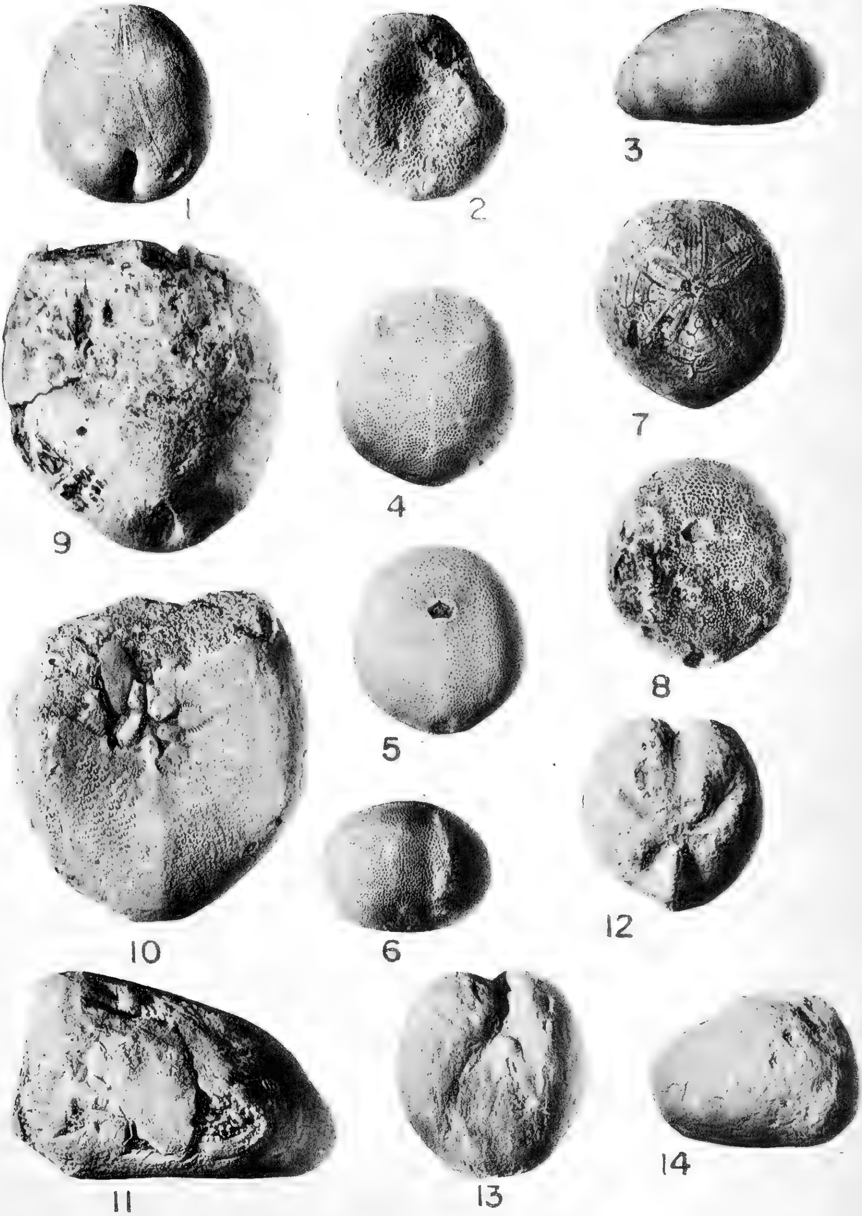
## Explanation of Plate 2

## EXPLANATION OF PLATE II

### Upper Cretaceous Species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EXPLANATION OF PLATE 3

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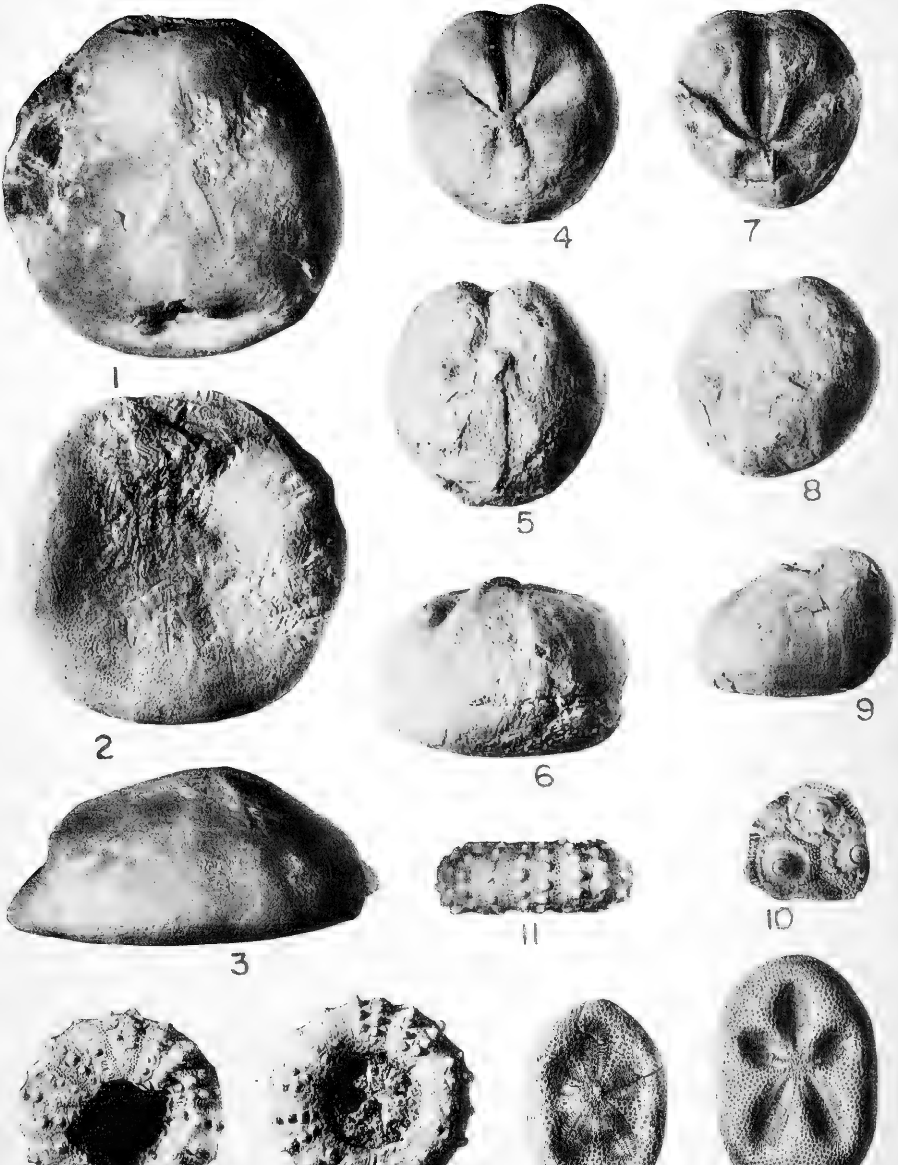
14. Dorsal surface of a young specimen, x 1.25. Pentagonal variety

**Jacksonaster** cf. **sanchezi** Roig ........................ 46

15. Dorsal surface of a young specimen, x 1.25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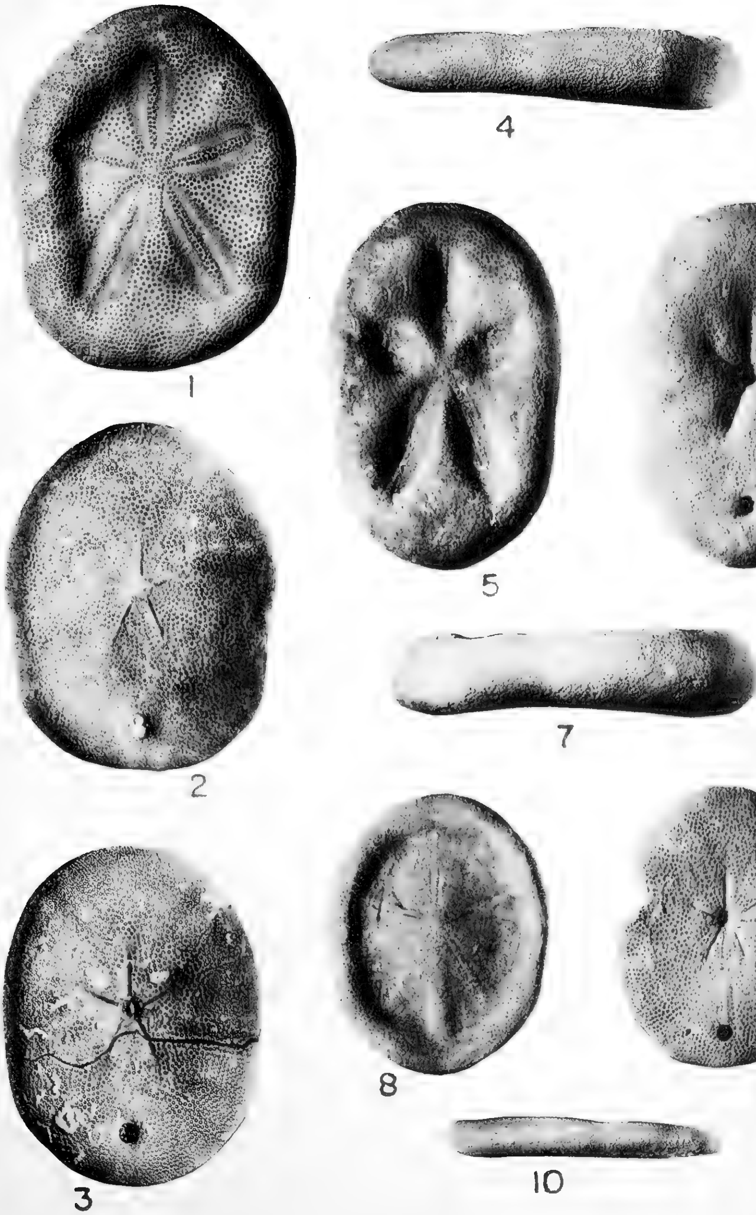
| | **Laganum cubanum** Weisbord, n. sp. | 48 |
| 8. | Upper surface of test, slightly reduced. Holotype | |
| 9. | Lower surface of the paratype, slightly reduced | |
| 10. | Side view of the holotype, about natural size | |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| 3. | Side view of the same specimen | |
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| 8. | Ventral surface of the same specimen, x 1.5. Periproct missing | |
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| | **Scutella cubae** Weisbord, n. sp. | 55 |
| 10. | Upper surface of test, slightly reduced. Holotype | |
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| 12. | Side view of the same specimen, about natural size | |
| | **Scutella camagüeyana** Weisbord, n. sp. | 56 |
| 13. | Upper surface of a portion of the test, somewhat reduced. Holotype | |
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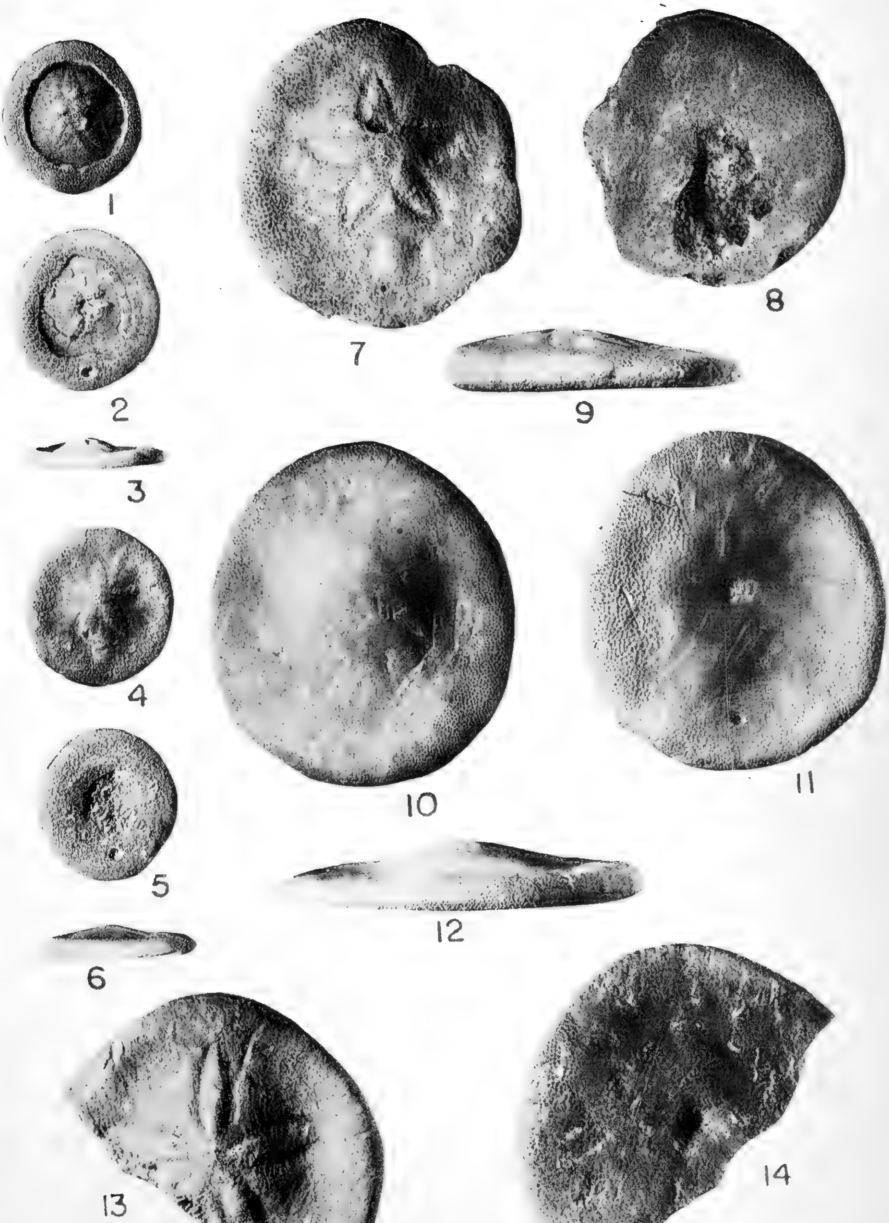
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| 5. | Ventral surface of the same specimen | |
| 6. | Side view of the same specimen. Anterior end to the right | |
| 7. | Dorsal surface of another specimen, about natural size | |
| 8. | Side view of the same specimen. Anterior end to the left. Although not clearly shown. the anterior end is slightly thicker than the posterior, but not so much so as in figure 4 | |
| 9. | Dorsal surface of still another specimen about natural size. Very close to **Oligopygus haldermani** (Conrad) from the Ocala Limestone (Upper Eocene) of Florida, U. S. A. | |
| 10. | Dorsal surface of a third specimen, natural size | |
| 11. | Ventral surface of same specimen | |
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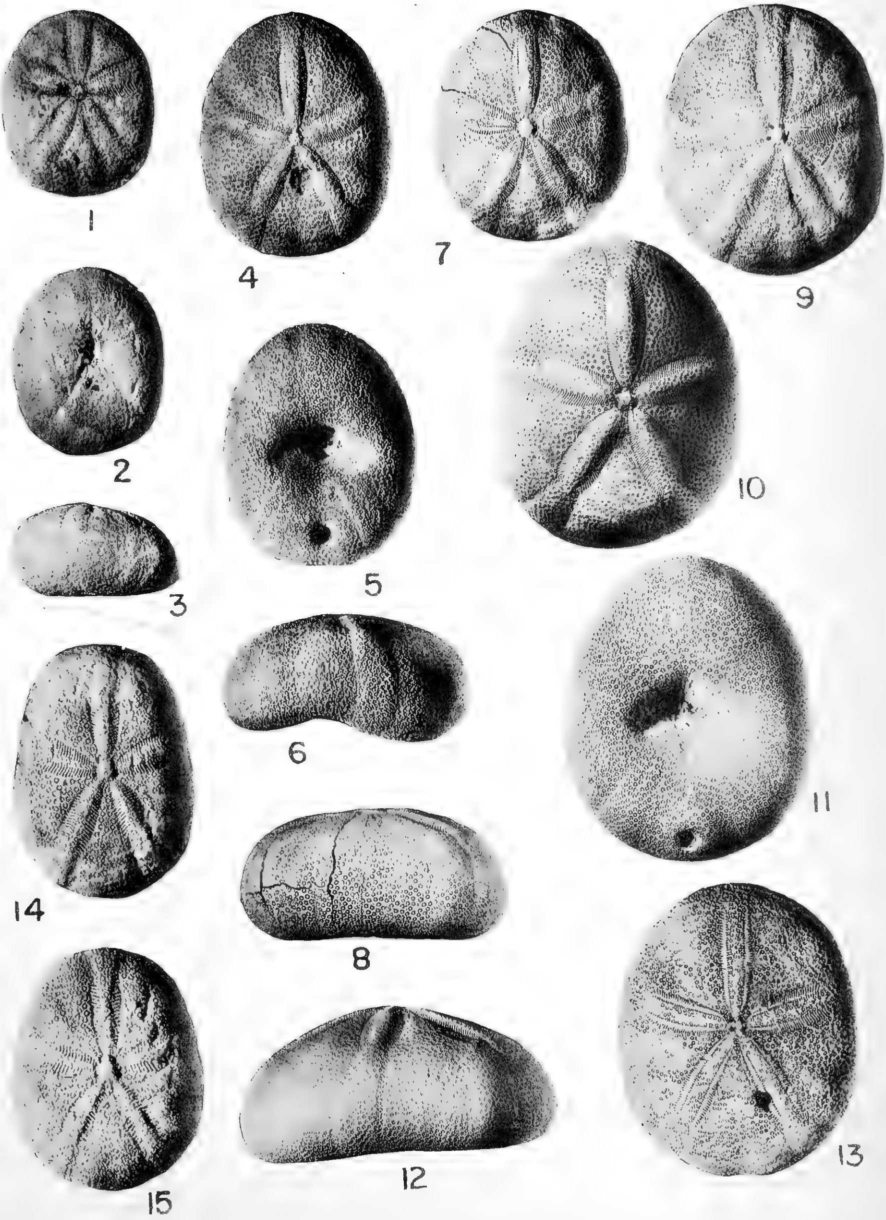
| 13. | Dorsal view of a specimen, questionably referable to this species, natural size | |
| 14. | Dorsal surface of a young specimen, x 1.75 | |
| 15 | Another young specimen x 1.75 | |



Explanation of Plate 7

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### Upper Eocene Species

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| | **Paraster camagüeyensis** Weisbord, n. sp. | 68 |
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| | **Paraster cubitabellae** Weisbord, n. sp. | 72 |
| 15. | Dorsal surface of broken specimen, about natural size. Holotype | |
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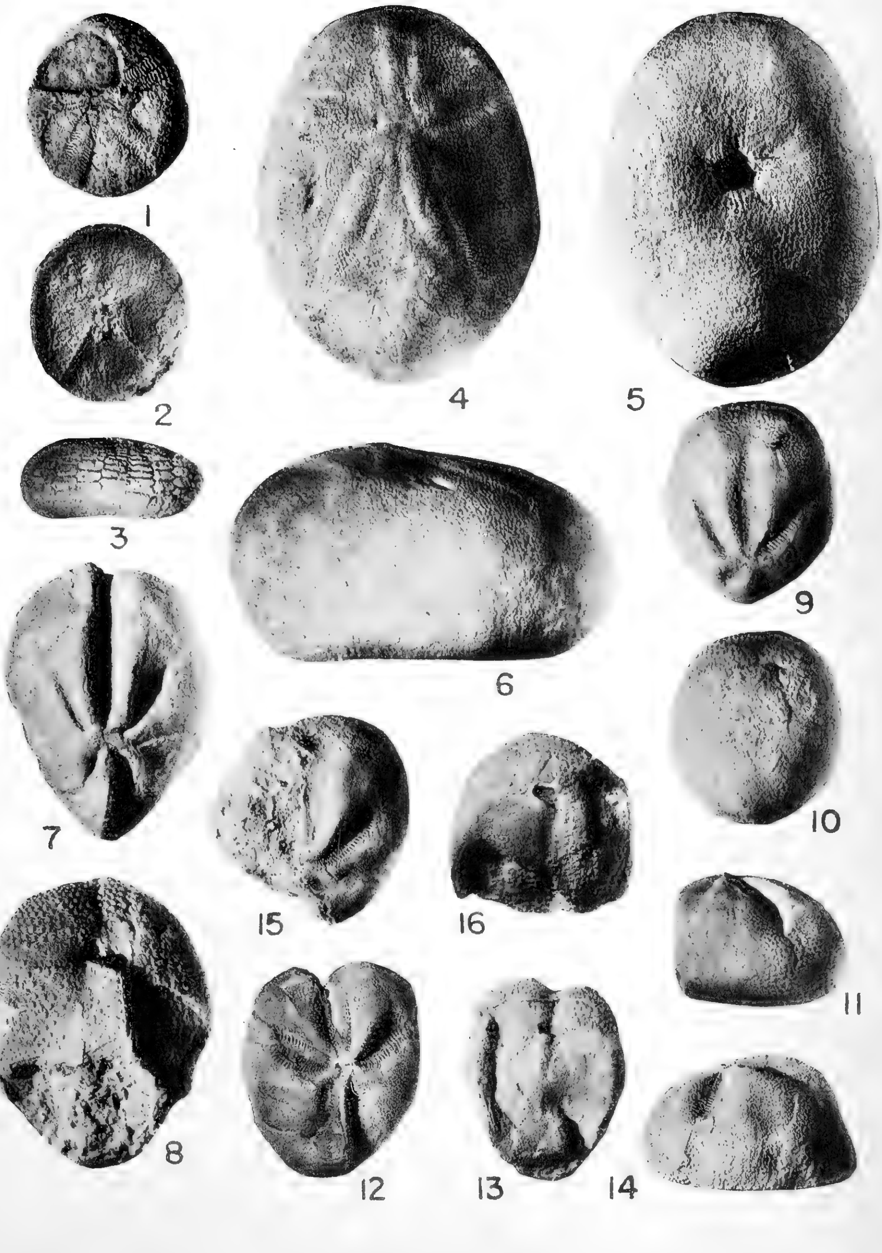

EXPLANATION OF PLATE 8

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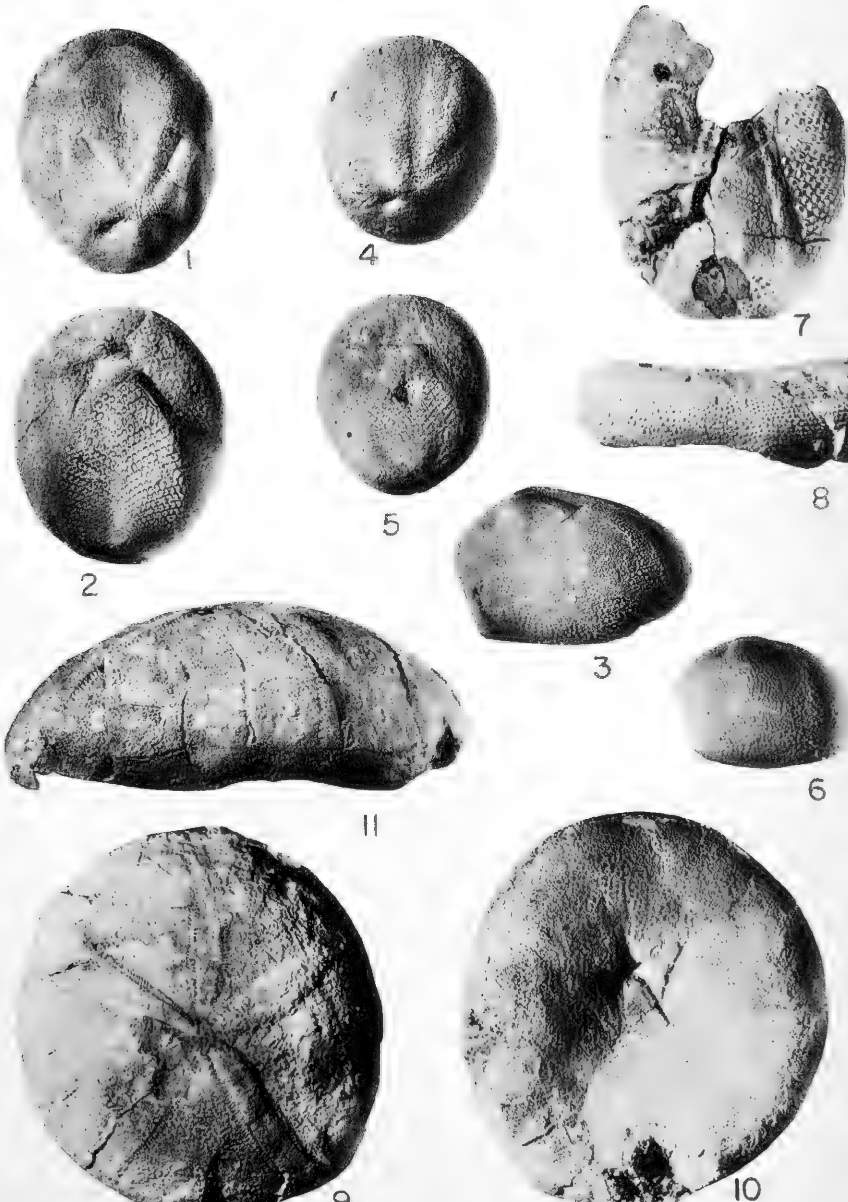
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Explanation of Plate 9

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| | **Brissus camagüeyensis** Weisbord, n. sp. | 76 |
| 1. | Dorsal surface of a partial specimen, about natural size. Holotype | |
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### Oligocene Species

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| | **Agassizia camagüeyana** Weisbord, n. sp. | 83 |
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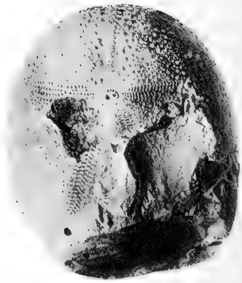

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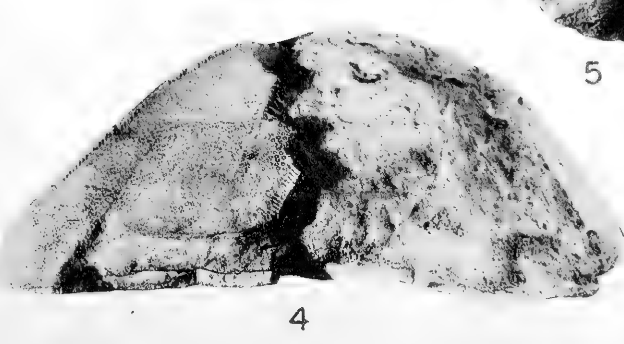

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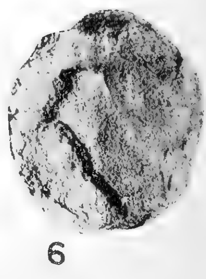

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**Note.**—Light-face figures refer to the paging of the volume, not to the separate Bulletins; heavy face figures refer to the volume plate numbering.