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RUDISTS OF JAMAICA

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RUDISTS OF JAMAICA

L. J. CHUBB

ABSTRACT

All species of rudists known to occur in Jamaica are described and figured. Of the 71 species, 37 were already known; these are re-described on the basis of a re-examination of the original material and, in most cases, of new material. Of the remainder, five forms are new to Jamaica but are referred to species which occur elsewhere; another five which are imperfectly preserved are described as far as possible; they are unnamed, but three of them are compared with known species. The remaining 24 species, which include one new genus and eight other genera new to Jamaica, have been briefly described elsewhere and are here fully described and figured for the first time.

INTRODUCTION

Rudists, though not the commonest, are the most characteristic fossils of the Jamaican Cretaceous rocks. The group receives scant treatment in most text books with the result that many students, even professional palaeontologists, have little basic knowledge of it. In early days there were differences of opinion as to their systematic position, various species having been assigned to the Brachiopoda, Cephalopoda, Cirripedia, and Coelenterata but, since the beginning of this century, it has been generally recognised that they were highly aberrant bivalved mollusks, *i.e.* Pelecypoda or Lamellibranchiata.

Lucas Barrett (1860) first recorded the presence of "Rudistes" in the island. Since then Jamaican rudists have been described by Woodward (1862), Whitfield (1897a and b), Trechmann (1922, 1924b, 1927, 1929), and Chubb (1955a, 1956a and b, 1967). The descriptions are scattered through several periodicals and the collections also are scattered, Woodward's and Trechmann's types being in the British Museum (Natural History), Whitfield's in the American Museum of Natural History, and Chubb's formerly in the museums of the Geological Survey of Jamaica and the Department of Geology of the University of the West Indies, Kingston, have been transferred to the Smithsonian Institution, Washington, D.C. There is a collection in the Museum of the Institute of Jamaica, Kingston; one made by G. P. Wall in the British Museum (Nat. Hist.), London, which has also acquired the Trechmann Bequest, including some hundreds of Jamaican rudists; a collection made by C. A. Matley is in the United States National Museum, Washington, D.C., and one made by P. W. Jarvis is in the Naturhistorisches Museum, Basle, Switzerland. All these collections have been studied by the writer.

In recent years several previously unknown rudistiferous horizons have been discovered and a number of new species or species new to Jamaica have come to light. New work on the stratigraphy and palaeontology of the Cretaceous has made possible a more accurate zonal subdivision and correlation with the standard succession than could previously be attempted. The older publications on

the Jamaican rudists have long been out of print and are today almost unobtainable, and many of their descriptions are inadequate or inaccurate. The time seems ripe, therefore, for a new monograph in which every known Jamaican species of rudist, both old and new, will be described and figured, and placed in its correct stratigraphic and taxonomic context.

ACKNOWLEDGMENTS

This work is based upon 14 years study of Jamaican Cretaceous palaeontology and stratigraphy carried out while the author was a member of the island's Geological Survey. Many of the specimens here described were collected by past and present members of the Department, whose help and cooperation is gratefully acknowledged. Much of the writing was done between September, 1963, and June, 1964, at the University of the West Indies, Mona, and it was continued in England chiefly in the British Museum (Natural History). My gratitude is due to these institutions for the facilities they afforded me and especially for allowing me access to their collections. The Trechmann Bequest was received by the British Museum (Nat. Hist.) while I was working there; it included several new species and many specimens of known species in a better state of preservation than any previously seen.

I am indebted to the American Museum of Natural History for certain photographs, for the loan of several type specimens, and for permission to reproduce a number of illustrations from Whitfield's articles in their Bulletin; to Dr. H. G. Kugler and the Naturhistorisches Museum, Basle, for the loan of their collections; and to Professor M. G. Rutten of Utrecht University for the loan of certain Cuban specimens. Some of the figures have previously appeared in *Palaeontographica Americana*, volume IV, numbers 26, 27. Thanks are due to the editors of the Geological Magazine for permission to reproduce one of Woodward's figures in the Geologist for 1862 and to the Société géologique de France for permission to reproduce a figure from Douvillé's *Revision des principales espèces d'hippurites*. The majority of the photographs are new, some having been made by Dr. Tom Goreau, others by Mr. Owen Jackson, both of the University of the West Indies, and many by Mr. A. Rowe of the British Museum (Natural History).

Finally I gratefully acknowledge my debt to the late Dr. L. R. Cox for help and advice while I was working at the British Museum, (Nat. Hist.) and to the late Dr. C. T. Trechmann who first introduced me to the study of Jamaican rudists and whose criticisms kept me on the alert and compelled me to confirm every observation and reconsider every conclusion during my work in Jamaica.

GEOGRAPHIC AND STRATIGRAPHIC CONSIDERATIONS

The rudists originated late in the Jurassic Period, but were especially characteristic of the Cretaceous, reaching their acme in numbers and variety in Upper Cretaceous times, and becoming extinct at the end of that period. Their distribution was determined partly by geographic and partly by climatic factors. Their zone of maximum concentration coincides closely with that of the Tethys; they were essentially benthonic animals, able to live only in fairly clear water in the shallower parts of the geosyncline and in the seas connected with it. They could develop a full and abundant life only in the tropical seas of their time.

The rudist belt of maximum concentration runs from southern Mexico through the Greater Antilles; it is continued northeastwards in Portugal and the Pyrenees, thence eastwards across south Europe and Turkey and southeastwards through Iraq and Persia, beyond which it passes into the Indian Ocean. According to Douvillé (1900b, p. 235) the middle line of the belt departs little from a circle which would cross the equator at an angle precisely equal to the inclination of the ecliptic. Northwards and southwards of the belt rudists become scarcer and eventually disappear, their northern limit extending beyond 50°N in south Saskatchewan, southern England and Sweden, Esthonia and Moscow, to little more than 30°N in Tibet and to 17°N in the west Pacific. Their southern limit extends to 30°S in Chile, though elsewhere in the continental areas it does not reach as far south as the present equator, embracing only northwestern South America as far east as Trinidad and the coastal belt of north and northeast Africa. Only in the area of the Indian Ocean are rudists found again in the Southern Hemisphere.

No Jurassic rocks are known in Jamaica. The greater part of the island consists of Tertiary and Quarternary formations but the Cretaceous appears in many inliers, the largest being the Blue Mountains with an area of about 240 square miles, and the smallest occupying only a few acres. The total area of Cretaceous rocks is some 500 square miles, less than one-eighth of the island's surface. They consist chiefly of waterlaid tuffs and conglomerates, tuffaceous shales and limestones. Rudists occur abundantly in the limestones, rarely in the shales, and occasionally reworked in the conglomerates. An account of the Jamaican Cretaceous was recently published (Chubb, 1962-1963), but this requires modification.

A revised version of the Cretaceous succession is given in Table 1. It has been pieced together from the sequence in several of the inliers, but it is often impossible to corre-

late exactly the rocks in one inlier with those in another, so there may be gaps or overlaps. Twelve limestones are included in the table and every one of them yields rudists. The dating of the various series has been done mainly on the basis of their microfossils, except for the Lower Cretaceous up to and including the Albian, in which only macrofossils have been found.

The rocks of the Benbow Inlier of northeastern St. Catherine are slightly metamorphosed, with the result that the rudists are welded into the limestones and can be studied only on weathered surfaces or in sections. It is now known that the Bonnett Limestone and Copper Limestone, previously regarded as distinct, are one and the same. The Phillipsburg Limestone, formerly thought to be equivalent to the Copper, is now believed to be a local lenticle at a slightly lower horizon. A fauna similar to that of the Seafield Limestone has been found in rocks of Lower and Middle Albian age in Texas, and the fauna of the lower limestones suggests a still earlier age. It is only in this

TABLE 1
Cretaceous Succession in Jamaica

Maestrichtian (<i>Titanosarcolites</i> Series)	Upper Tuffaceous Series Vaughansfield Limestone Shaw Castle Shale Chatsworth Limestone Woodland Shale Maldon Limestone Summerhill Shale Calton Hill Limestone (concealed)	Maldon Inlier St. James
	<i>Præbarrettia</i> Limestone	
Campanian (<i>Barrettia</i> Series)	Shepherds Hall Series Upper <i>Barrettia</i> Limestone Newman Hall Shale Sunderland Shale Johns Hall Conglomerate	Sunderland Inlier St. James
	New Ground Conglomerate <i>Dioxytyxis</i> Shale Lower <i>Barrettia</i> Limestone	St. Anns Great River Inlier St. Ann
Turonian- Coniacian (<i>Inoceramus</i> Series)	Conglomerate <i>Inoceramus</i> Beds	
	Peters Hill Shale	
Albian	Peters Hill Limestone Conglomerate	Eastern part of the Central Inlier NE Clarendon
	Tuff and Conglomerate Seafield Limestone Tuff and Conglomerate Benbow Limestone Magnetic Tuff	
Lower Cretaceous	Jubilee Limestone Tuff and Shale Bonnett-Copper Limestone Metamorphosed Tuff	Benbow Inlier NE St. Catherine

inlier that rocks of Lower Cretaceous age have been recognised in Jamaica.

The Peters Hill group, outcropping in the part of the Central Inlier lying in northeastern Clarendon, includes a shale member characterized by a large species of *Inoceramus*. In this shale Bronnimann found a fauna with a *Globotruncana* of the *Gl. apenninica* group, possibly *Gl. alpina*, indicating an Upper Cenomanian to Lower Turonian age. Hippuritidae have recently been found by Coates (1964, p. 10) in the limestone at the base of the shale and, as it is regarded as axiomatic that this family started in the Turonian, it appears that the possibility of a Cenomanian age must be rejected, and a Lower Turonian age accepted.

In the *Inoceramus* beds of St. Ann, Bronnimann found a fauna including *Globotruncana coronata*, *Gl. helvetica*, and *Gumbelina globulosa*, indicating a Turonian, or possibly a Turonian-Coniacian age. The presence of Coniacian beds is confirmed by the macrofossils, including *Inoceramus* cf. *deformis*, a Lower Coniacian form, and *Nowakites* aff. *paillettei* of the Upper Coniacian.

Slightly higher in the St. Ann succession in the New Ground area, there is a limestone yielding *Barrettia*, followed by a shale containing many gastropods, including *Diozoptyx matleyi* and Foraminifera, among which Bolli recognised *Globotruncana stuarti*, *Gl. fornicata*, and *Gl. lapparenti lapparenti*, indicating a Campanian age. These three species are found also in the Johns Hall Conglomerate and the Sunderland and Newman Hall Shales of the Sunderland Inlier of St. James; here they occur through a thickness of about 4,500 feet of strata which are immediately succeeded by another *Barrettia* Limestone. The *Barrettia* Limestone of St. Ann is therefore assigned to the basal Campanian, and that of St. James, which is correlated with similar formations at Green Island and Rock Spring in western Hanover, to the Upper Campanian.

At the southern end of the Sunderland Inlier, following the almost microfossiliferous Shepherds Hall Series (probably equivalent to the Lower Tuffaceous Series of the Central Inlier), a new limestone fauna appears, including the first *Titanosarcolites*, associated with *Praebarrettia*. Southwards the Cretaceous disappears beneath the overstepping Eocene Yellow Limestone, to reappear in the inliers of Calton Hill and Maldon. The *Titanosarcolites* Series here includes four limestones, all yielding a similar rudist fauna, interbedded with shales. This series is correlated with similar formations in the part of the Central Inlier lying in northern and especially northwestern Clarendon, and its upper part with the rocks of the Marchmont Inlier on the borders of St. James and Westmoreland, and the Jerusalem Mountain Inlier of western Westmoreland. The limestones yield *Orbi-*

toides apiculata Schlumberger and the intervening shales *Kathina jamaicensis* (Cushman and Jarvis) Maestrichtian Foraminifera.

The Cretaceous rocks of the Blue Mountain area of eastern Jamaica are thought to represent a different faunal province from those of the rest of the island (Chubb, 1960b). They are less well known, but it can be assumed that the *Barrettia* Limestones of Back Rio Grande and the Plantain Garden River are Campanian, and that the Blue Mountain Shales of the Peak, the Providence Shales of the West Town River, and the *Titanosarcolites* Limestones of the Rio Grande Valley are Maestrichtian. There are also metamorphosed rocks in which fossils are rarely preserved.

It may be noted that there appears to be no positive evidence of the presence of Cenomanian or Santonian rocks in Jamaica.

THE RUDIST SHELL

Most pelecypods are free to move over the sea floor, but several groups have adopted a sessile habit, the best known being the oysters, which fix themselves by cementing their left valve to a rock or other hard surface. This manner of life involves considerable changes, the animal losing its symmetry, the attached valve becoming larger, thicker, deeper, and in some genera twisted or distorted, while the free valve remains small and flat.

The rudists also were sessile, usually cementing themselves by one of their valves. They were a more advanced group than the oysters with a more elaborate structure, having two adductor muscles, anterior and posterior, to the oyster's one, and a hinge consisting of interlocking teeth and sockets, which the oysters do not have. The remarkable series of evolutionary changes that the rudists underwent were necessitated by their successful attempt to adapt their complex structure to a mode of life which, in the more advanced families, seems more appropriate to corals than to pelecypods.

Most of the earlier and more primitive rudists were attached by their left valves and, since this condition is usual among cemented bivalves, it is regarded as "normal." But the majority of rudists, including all the more advanced forms, fixed themselves by their right valve, a condition described as "inverse." The arrangement of the hinge teeth varies according to which valve was fixed; nearly always the fixed valve, whether left or right, has one tooth between two sockets, and the free valve, whether right or left, has a socket between two teeth.

Almost all rudists had thick and heavy shells. The more primitive forms were twisted, the beaks always curving towards the anterior. In more advanced groups the fixed

valve was often conical or cylindrical; the free valve at first remained coiled or curved, but generally tended to decrease in size and, in the most specialized forms, became a low cone or even a flat or concave lid.

SHELL STRUCTURE

Some authors have described the shells of rudists as having three layers (Trechmann, 1924b, p. 407; Mullerried, 1931, p. 243; Palmer, 1933, p. 96) or have referred to a "middle layer" implying the existence of three in all (Zittel-Eastman, 1913, pp. 479-480). Others have said that the wall of some species consisted of one layer only (Douvill  , 1904, p. 525). It is here suggested that the rudist shell, like that of other pelecypods, consisted always of two calcareous layers. Presumably in life there was a third or cortical layer, the periostracum, but this, being composed of horny conchiolin, is not preserved in fossils.

The cardinal apparatus, including teeth and sockets, and the attachment areas of the adductor muscles belong to the inner layer. The ligament, however, was originally an external element, and for it to become internal required an infolding of the outer layer. The siphons are a local modification of the periphery of the mantle; for them to open through one of the valves, always the left, necessitated infolding of the mantle edge and, since this is the part that secretes the outer layer, infolding of that layer also. This involved both mantle lobes and, therefore, both valves, producing oscules in the left valve and generally pillars in the right.

Except in the more advanced rudists the outer layer is thin and laminar, the laminae forming a kind of coating over the outer surface of the thick inner layer. In the most highly specialized families, however, the outer layer is thick and the laminae forming it diverge from the inner layer to form a series of inverted cones fitting one into another; from their resemblance to funnels these are commonly called funnel plates (Palmer, 1928, p. 76). In the family Radiolitidae these plates are traversed and intersected by vertical radial plates which, in the more advanced genera, by repeated bifurcation and reunion, make a polygonal pattern. The Hippuritidae have funnel plates but no vertical radial plates.

In the Caprinidae the outer layer is thin and the inner thick, the so-called "middle layer" is part of the inner. It is composed of numerous vertical radial plates between which are longitudinal, tubular, often capillary canals, which may be subdivided by horizontal tabulae. There is a superficial resemblance between this structure and that of the Radiolitidae, but it is not correct to say that, if a caprinid had the tabulae in its adjacent canals arranged at the same levels, they would constitute funnel plates and the

form would be a Radiolite (MacGillavry, 1937, p. 57), for the caprinid structure belongs to the inner layer and the Radiolite structure to the outer. The inner layer lines the body cavity and, in most species with cylindrical or elongate conical shells, forms a series of concave tabulae below it.

There has been confusion between the outer and inner layers even within one family, the Hippuritidae. Palmer, having defined the term "funnel plates" and made it clear that they belong to the outer layer (1928, p. 13, figs. 1, 2, p. 76), later applied the term to the tabulae that occupy the lower part of the body cavity and which are part of the inner layer (1933, pp. 97, 99). This has led to misunderstanding (see below: remarks on *Orbignya maldonensis* and *Parastroma trechmanni*).

DEFINITIONS

Tabulae and *septa*.—Two kind of plates are often found within the rudist shell: (a) horizontal or transverse plates which are normal to the long axis of the valve and, in straight conical or cylindrical forms, are parallel to the commissure; such plates are of the nature of diaphragms which cut off the lower part of a cavity; and (b) vertical plates, parallel to the long axis and, in straight shells, perpendicular to the commissure; they are of the nature of walls. Writers have differed in the nomenclature of these plates. Some (e.g. Whitfield, 1897a) used the term *septa* for the horizontal plates; others (e.g. MacGillavry, 1937) reserved this term for vertical plates, and referred to the horizontal plates as *tabulae*.

The lack of uniformity has led to some confusion; for example, in a discussion of Whitfield's description of "septa" in *Antillocaprina occidentalis* (Chubb, 1955a, p. 7), it was remarked that none of his specimens showed them. Earlier Trechmann (1924b, p. 407) stated that this species had no septum in the living chamber. Caldwell and Evans (1963, p. 616) put these two observations together, equating Whitfield's *septa* with Trechmann's *septum*. The two statements have no relevance to each other. Trechmann's *septum* would be a vertical wall standing within the body cavity; Whitfield's *septa* would be horizontal diaphragms below the body cavity. *Antillocaprina* has no vertical wall but does have horizontal diaphragms, even though Whitfield's specimens show none.

MacGillavry's terminology will be adopted here: *septum* will be used for a vertical plate, *tabula* for a horizontal one. This is the nomenclature used for corals.

Valves.—The two valves of the rudist shell have been distinguished by different authors as left and right, lower and upper, fixed and free, or α and β . Many were recumbent and for them the terms *lower* and *upper* are inappropriate.

Some were unattached in which case both valves were *free* and neither can be correctly described as *fixed*. The Greek letters represent the hinge, the single loop of α symbolizing the single socket of a free valve, and the two loops of β the two sockets of a fixed valve. Such expressions as "lower, attached, right (β) valve" and "upper, free, left (α) valve" (Palmer, 1928, pp. 118,120) are tautological. Here in the systematic descriptions the valves will usually be referred to as *left* and *right*.

Orientation of valves.—The dorsal side of a valve can generally be recognised because the ligament and hinge are located there, and if the shell is curved the concave side will usually be dorsal. Normally the opposite side is regarded as ventral and, if it is known whether the valve is right or left, it is easy to deduce which side is anterior and which is posterior.

Because the rudists were sedentary it is not clear what use they could have for an extensible foot; some forms, however, seem to have had one and its presence is shown by a sinus which crosses the commissure. This is always on the anterior side. In many forms the two siphons, exhalant and inhalant, leave evidence of their existence in the form of sinuses across the commissure, below which there may be bands on the outside of the shell, comparable to the slit bands of certain gastropods, or actual infolds of the shell substance which may penetrate the body cavity as pillars.

Many authorities refer to "anterior and posterior siphons." The use of these terms is to be deprecated as in all pelecypods both siphons are on the posterior side of the shell. According to where they happen to be situated on the commissure either may be nearer to the anterior than the other. In *Sauvagesia* the inhalant siphon is usually diametrically opposite to the ligament; it is anterior to the exhalant siphon. In *Vaccinites* or *Pironea* the exhalant siphon is near the ligament and is anterior to the inhalant. Here the siphons will always be distinguished by the terms *exhalant* and *inhalant* or by the symbols S and E (see below).

Accessory cavities.—This term is here used for cavities between the myophores and the shell wall, not for a cavity cut off from the body cavity by a vertical septum; the latter, when present, is interpreted as a muscle cavity.

Hinge line.—A line connecting the centres of the two sockets in the fixed valve or of the two teeth in the free valve.

Height.—The elevation of the apex of a valve above or below the plane of the commissure; not, as in ordinary pelecypods, the dorso-ventral diameter.

Size.—In the systematic descriptions a general indica-

tion of the size of each species will be given according to the following code:

Very small	mean	adult	diameter	below 25 mm
Small	"	"	"	25- 50 mm
Medium	"	"	"	50-100 mm
Large	"	"	"	100-200 mm
Gigantic	"	"	"	200 mm or more

A more exact statement of the dimensions will be given in a separate paragraph following the descriptive section.

Symbols.—In the systematic descriptions and the plates some of the traditional symbols will be used for certain features of the rudist shell:

L	Ligamental grooves, infolds, crests, ridges or pillars
S (sortie)	Bands, furrows, pillars or oscules attributed to the exhalant siphon
E (entree)	Bands, furrows, pillars or oscules attributed to the inhalant siphon
I	Interband between the siphonal bands
N	Single tooth of the fixed valve
B' and B	Anterior and posterior teeth of the free valve
b' and b	Anterior and posterior sockets of the fixed valve
n	Single socket of the free valve
D (droite)	Body cavity of the right valve
G (gauche)	Body cavity of the left valve
ma	Anterior myophore or muscle attachment area
mp	Posterior myophore or muscle attachment area
maO	Anterior accessory cavity
mpO	Posterior accessory cavity
V	A downfold or outfold believed to be pedal
PD	A posterior-dorsal fold
RV	Right valve
LV	Left valve

CLASSIFICATION

The classification of the rudists has been the subject of considerable diversity of opinion. Woodward (1851) included the normal genera and a few of the more primitive inverse genera with *Chama* in the family Chamidae, and all others in the family Hippuritidae. Later workers raised these families to superfamilies, Chamacea and Rudistacea, the former divided into several families, including the Chamidae and the Megalodontidae as well as the Diceratidae, Monopleuridae, Caprotinidae, and Caprinidae, and the latter embracing only the two most advanced families, the Radiolitidae and Hippuritidae. The term Pachydonia was coined by Neumayr to include both groups.

Most modern rudistologists exclude the Chamidae and the Megalodontidae from the group but include all the other families. This system will be adopted here, the Rudistae being regarded as a suborder of the Pelecypoda, divided into six families: Diceratidae, Monopleuridae, Caprotinidae, Caprinidae, Radiolitidae, and Hippuritidae.

Diceratidae.—This family includes all normal rudists, *i.e.* those attached by the left valve, and a few which,

although attached by the right valve, have normal dentition with one tooth in the left valve and two in the right. As no representatives of this family have yet been recognized in Jamaica it will not be further considered.

All other families are inverse, *i.e.* attached by the right valve.

Monopleuridae. — The simplest inverse forms; all have inverse dentition with one tooth in the right valve and two in the left. The muscles were attached either directly to the inner surface of the shell wall or to horizontal platforms in the same plane as the hinge plate.

Caprotinidae. — Resemble the Monopleuridae, but the muscles were attached to myophores which rise from within the shell and are separated from the wall by accessory cavities.

Caprinidae. — The principal character is the development in one or both valves of a system of longitudinal canals in the thick inner layer of the shell wall. The outer layer is thin.

Radiolitidae. — Differentiated from the former families by the great development of the outer layer of the right valve which consists of funnel plates crossed by vertical radial plates. The inner layer is thin. Hinge and muscle equipment specialised to permit vertical rise of the left valve.

Hippuritidae. — The outer layer is composed of funnel plates without vertical radial plates. The distinguishing character is the presence of two, three or more infolds of the outer layer which, in the right valve, project into the body cavity to form pillars while, in the left, the two principal infolds form apertures or oscules corresponding in position with the two principal pillars. Hinge rather similar to that of the Radiolitidae.

SYSTEMATIC DESCRIPTIONS

Family **MONOPLEURIDAE** Munier-Chalmas, 1873

Shell inequivalve, fixed by right valve which is conical or curved and bears a single tooth between two sockets; left valve operculiform or capuloid and slightly curved, having two equal teeth separated by a socket; ligament external, in a groove which runs more or less normal to the commissure; outer layer thin, inner layer thick, shell substance with no canals or accessory cavities. Muscles attached either directly to wall or to horizontal myophores.

Genus **MONOPLEURA** Matheron, 1842

Shell normally conical or only slightly curved; medial tooth in right valve well developed, rising from the inner

edge of the shell wall; both muscles attached directly to the internal surface of the valves.

Monopleura jamaicensis Chubb

Plate 27, figure 1-3

Monopleura jamaicensis Chubb, 1956a, p. 7, pl. 1, figs. 1-3; 1956c, p. 7.

Occurrence. — A rare fossil in the *Titanosarcophiles* Limestone of Ducketts Land Settlement, Westmoreland, and Vaughansfield and Catadupa, St. James.

Description. — Right valve small, broadly conical, antero-dorsal side flattened this being the area of attachment, and only the tip of the umbo being twisted; a narrow ligamental groove runs from umbo to commissure on the dorsal side behind the attachment area; trilobed, owing to two furrows on the ventral side running from umbo to commissure. Surface ornamented with fine radiating striae. The hinge structure is unknown.

Left valve operculiform, with prominent umbo near the centre of the straight dorsal margin; from it three furrows radiate to the margin of the valve, the anterior and median furrows corresponding with the two furrows of the right valve. Ornamented with fine radial striae.

Dimensions of holotype. — Antero-posterior diameter 55 mm; dorso-ventral diameter 36 mm; height of right valve 31 mm; height of left valve 8 mm.

Monopleura diaboli Chubb

Plate 27, figures 4,5

Monopleura sp. Chubb, 1962/1963, p. 16.

Monopleura diaboli Chubb, 1967, p. 24.

Occurrence. — Abundant in the Bonnett-Copper Limestone in the Benbow Inlier of northeast St. Catherine, believed to be the oldest fossiliferous horizon in Jamaica. Being welded into the hard limestone, the fossil can be studied only in sections and on weathered surfaces.

Description. — Right valve small, elongate conical, tapering to a point, straight or curved, with a smooth surface; sections show that the shell is thick on the dorsal and thin on the ventral side, and has no accessory cavities or canals; in transverse sections the tooth is always weathered away, though a few show two sockets in the thickness of the dorsal wall, the posterior socket oblique and near to the ligamental furrow, the anterior socket smaller.

Left valve capuloid with its beak strongly curved towards the anterior. One rock surface shows several left valves face down; their upper surface has been eroded away so that they show both the body cavity and the socket, which is oblique.

Dimensions.—Maximum diameter at the commissure 30 mm, though most are smaller; maximum height of right valve 70 mm; that of left valve uncertain, but probably some 20 mm.

Remarks.—This is the small rudist mentioned by Matley and Raw (1942, p. 246) in the road section south of Guy's Hill. It resembles several species described by Mullerried (1933b, pp. 315-330) from the Barremian and Aptian of the region of Tehuacan, Puebla, Mexico. He referred these to the subgenus *Himeraelites* Di Stefano, but it may be doubted if this attribution is correct. *Himeraelites* has a character which was mentioned by Di Stefano (1888, p. 1-16), by Douvillé (1900a, pp. 215-216) and by Parona (1909, pp. 171-182), and is shown in their figures; this is a septum in the left valve that extends from the anterior tooth to the ventral margin, cutting off the posterior part of the body cavity to accommodate the posterior muscle; this cavity is in open communication with the dental socket. This character, which is seen also in many Caprotinidae and Caprinidae, is not shown in any of the ten species ascribed by Mullerried to this subgenus, nor in the species, *diaboli*, in the Bonnett-Copper Limestone, which is, therefore, ascribed to *Monopleura* s.s. The specific name refers to its abundance where the Bonnett-Copper Limestone crosses the road known as the Devil's Race Course, running between Water Works and Benbow at Mile Post 22.

***Monopleura* sp.**

Plate 27, figure 6

Monopleura sp. Chubb, 1962/1963, p. 19.

Occurrence.—A block of limestone incorporated in a metamorphosed crushbreccia from Whitfield Hall, at an altitude of about 4000 feet on the southwestern slopes of the Blue Mountain Range, among other indeterminable fossils, shows three sections of a simple rudist. The rock is marmorized and contains white flecks of silicate material, chlorite and sericite, which grade into streaks, having been mechanically distributed in the marble during shearing. They are absent from many of the fragments in the breccia.

Description.—The species is a small one. Of the three sections one is transverse and oval, the second is oblique, and the third is a longitudinal conical section. Probably all are right valves, but the conical section contains a large fragment which may be the left valve crushed into it. The lack of accessory cavities, mural canals, funnel plates or infolds shows that it can belong to no family except the Monopleuridae, and the absence of coiling puts it in the genus *Monopleura*. None of the sections show teeth or myophores.

Dimensions.—The conical section is 37 mm long on one side which may be dorsal, and 50 mm on the other; its maximum diameter is 27 mm. The oval section is 31 mm by 24 mm. The thickness of the wall is 5-6 mm.

Remarks.—This is the first reported occurrence of fossils in the metamorphosed series of Jamaica. Its chief interest is that it proves that this series is not pre-Mesozoic or pre-Palaeozoic as believed by De la Beche (1827) and Matley (in Matley and Higham 1929) but is Cretaceous or later as suggested by Trechmann (1936), Zans (1951), and Chubb (1962-1963).

Genus *GYROPLEURA* Douvillé, 1887

Shell coiled, with a large area of attachment; hinge displaced towards the anterior; in the left valve both muscle impressions are superficial and indicated by thickenings of the test; in the right valve the anterior muscle impression is similar, but the posterior is borne on a horizontal plate resembling a cardinal plate, which extends backwards from the posterior socket and covers the umbonal cavity; the tooth rises from the antero-dorsal margin of this plate.

***Gyropleura shaviensis* Chubb**

Plate 27, figures 7-9

Gyropleura shaviensis Chubb, 1956a, pp. 7-8, pl. 1, figs. 4-6; 1956c, p. 7.

Occurrence.—Many horizons in the *Titanosarcolithes* Series in the parish of St. James and neighbouring parts of Westmoreland; especially abundant in the Shaw Castle Shale; this species is found to be commoner and to have a longer range than was formerly thought.

Description.—A small species; complete shell the size and shape of a segment of an orange; hinged on the straight edge. Surface of the right valve divided by a sharp curved carina, extending from the umbo to the ventral corner, into two areas, a flat anterior area and a curved posterior area; shell attached by the umbonal part or the whole of the flat surface; no external ornament except inconspicuous growth lines; hinge consists of a prominent tooth between two sockets, the posterior socket just below the incurved umbo, the hinge line being parallel to the straight anterior margin; tooth grooved on its anterior side, the groove descending into the corresponding socket; anterior muscle attachment a platform-like thickening of the shell wall, running parallel to the straight edge; posterior myophore a horizontal shelf which abuts anteriorly against the tooth and posterior socket, and extends diagonally across the valve to the curved wall.

Left valve a thin, flat, semicircular plate, with faint growth lines, its internal characters not exposed.

Dimensions.—Maximum dorso-ventral diameter 53 mm; antero-posterior diameter 35 mm; height of right valve on posterior side 25 mm; but most specimens are smaller.

Family CAPROTINIDAE Gray, 1848

Resemble conical or cylindrical Monopleuridae, but typically the muscles are attached to myophores which rise almost vertically from the interior of the shell; the chief characteristics of the family is the separation of the myophores from the shell wall by open spaces, shallow or deep, called accessory cavities. Some forms have accessory cavities in only one valve, and some have only posterior cavities. In the left valve of some genera a septum connects the anterior tooth with the ventral wall. The ligamental groove is infolded, the ligament being submerged in the thickness of the wall.

Genus PACHYTRAGA Paquier, 1900

Right valve cylindro-conical, more or less straight or curved, but never coiled; surface smooth, ligamental infold shown by a longitudinal groove which runs on the dorsal side from the umbo to the posterior socket; single tooth robust, upright, high, crescentic; anterior socket large, in the hollow of the crescent, posterior socket small; anterior muscle impression borne on a thickening of the shell wall; posterior myophore separated from the wall by an elongated accessory cavity. Left valve capuloid, curved or slightly coiled; anterior tooth robust and long, posterior tooth small; anterior myophore parallel to the shell margin, from which it may be separated by a shallow accessory cavity; a septum runs from the anterior tooth to the ventro-posterior margin, forming a cavity into which the posterior myophore slopes; the latter may, at its outer edge, be separated from the wall by a small accessory cavity.

Pachytraga jubilensis Chubb

Plate 27, figures 10,11

Pachytraga sp. Chubb, 1962/1963, p. 16.

Pachytraga jubilensis Chubb, 1967, p. 24.

Occurrence.—Locally abundant in the Jubilee Limestone of the Benbow Inlier. It can only be studied in sections on weathered surfaces of the hard limestone.

Description.—A small shell. Wall of the right valve thick, especially on the dorsal side, its surface smooth with a longitudinal ligamental furrow; valve cylindrical, straight or curved, tapering somewhat towards the base. It has only one

accessory cavity, the posterior, which may be seen in most sections; this, and the body cavity, extend down to the base of the shell. Transverse sections in the hinge area show a massive crescentic tooth enclosing a large oval or kidney-shaped anterior socket, with a small posterior socket, near which the ligamental groove ends; this socket is separated from the accessory cavity by a septum.

Left valve small, capuloid, coiled; ligamental groove curves round to the posterior tooth, which is small; anterior tooth large, prominent and robust; the outer edge of the anterior myophore projects 5-6 mm beyond the commissure, and fits within the margin of the right valve; no positive evidence has been found of accessory cavities or of a transverse septum in the left valve.

Dimensions.—Maximum diameter of right valve 30 mm, maximum height 100 mm; probable maximum height of left valve 20 mm.

Remarks.—This species compares most closely with *P. lapparenti* Paquier (1903, pp 65-68), from the upper Urganian (Aptian) of the south of France, which in many cases has no anterior accessory cavity in the right valve, though the posterior cavity is always present. The left valve too generally lacks an anterior cavity, while the posterior myophore, which projects 4 to 6 mm beyond the commissure, is separated from the edge of the valve only by a shallow furrow, a rudimentary accessory cavity. It would appear that *P. jubilensis* is more primitive than *P. lapparenti*.

It may be noted that the infilling of the shells is a black limestone crowded with small siliceous sponge spicules; the matrix, also a black limestone, is devoid of spicules.

Family CAPRINIDAE d'Orbigny, 1850

In this family the right valve is generally conical or cylindrical but may be curved, while the left valve may be small and capuloid, or large, rarely larger than the right, and curved or coiled. The shell is often said to have three layers, a thin outer layer, a thick middle layer characterised by the development within it of thin-walled longitudinal canals, and a thin inner layer. The view here adopted is that this family, like all other pelecypods, has only two calcareous layers. The outer layer is thin and smooth, marked by growth lines, which may be inconspicuous; it is often completely removed by weathering or erosion. The so-called "middle layer", with its canals, is a specialized part of the inner layer; this is proved by the fact that in some genera the tubular structure invades the myophores and hinge teeth, elements which, in all pelecypods, are formed of the material of the inner layer. At the innermost

margin of this layer the walls of the canals coalesce to form a continuous smooth surface, which lines the body cavity and, in cylindrical and elongate conical forms, forms a series of saucer-shaped tabulae, which cut off and subdivide the lower unoccupied part of this cavity.

The longitudinal canals were apparently derived from caprotinid type accessory cavities, which have become subdivided by vertical radial plates. Primitive genera, such as *Amphitricoeles* Harris and Hodson (1922) of Trinidad, may have only a single row of rectangular canals, running part way around the shell, separating the myophores and teeth from the wall; in more specialized forms the vertical plates may bifurcate several times leading to a multiplication of canals, and in the most advanced genera the plates bifurcate and reunite repeatedly with the result that the whole circuit of the shell consists almost entirely of fine capillary tubes. In many genera the development of canals is more advanced in the left valve than in the right. In the left valve of some genera a vertical septum runs from the anterior tooth to the ventral wall, cutting off from the body cavity a space which accommodates the posterior muscle; in many species this muscle cavity is continuous with the neighbouring dental socket. Similarly, in the right valve, the posterior muscle may occupy a cavity opening into the posterior socket, but divided from the body cavity by a thin septum. The ligament is internal, being infolded into the thickness of the wall; generally, the infold is shown externally by a longitudinal furrow.

The Caprinidae are divided into two subfamilies, the Caprininae and the Plagioptychinae.

Subfamily CAPRININAE Douvillé, 1910

Generally both valves are conical. Right valve elongated conical or cylindro-conical, straight or curved or, in some forms, coiled. Left valve curved or coiled; in primitive genera it is shorter than the right, but in many advanced forms it is nearly or quite as long and in some it is longer. Canals are always present in the walls of both valves. While many forms have a posterior muscle cavity cut off by a septum from the body cavity, some of the later and more advanced genera have raised myophores in the form of plate-forms which are nearly at the same level as the commissure; these need no septum.

Genus CAPRINULOIDEA Palmer, 1928

Right valve long, cylindro-conical, curved or straight, left valve horn-shaped, curved or loosely coiled; surface smooth. The walls of both valves have vertical radial plates

with intervening canals; the plates bifurcate two or three times, and branches from contiguous plates ankylose, producing rounded or polygonal canals; the inner canals may be tabulate or not; the outer canals, which are usually pyriform in cross section, are never tabulate. Single tooth in right valve robust, prominent, quadrilateral in cross section, with flanged corners from which septa radiate to the wall, separating the dental sockets and the posterior muscle cavity from the body cavity. Left valve has two strong and prominent teeth, the anterior slightly the larger and triangular in cross section; from it a septum runs to the ventro-posterior wall cutting off the posterior muscular cavity, which is shallower than the body cavity.

Caprinuloidea perfecta Palmer

Plate 27, figures 12-14

Caprinuloidea perfecta Palmer, 1928, pp. 59-60; text fig. 6; pl. 8, fig. 8; pl. 9, figs. 1-2.
Caprinuloidea perfecta Thiadens, 1936b, pp. 1134-1138; text figs. 3,4.
Caprinuloidea cf. *C. perfecta* Chubb, 1962/1963, p. 16.

Occurrence. — Abundant in the Seafeld Limestone, the highest limestone in the Benbow Inlier; it is welded into the rock, and can be studied only in sections on weathered surfaces.

Description. — The shell is small to medium-sized. A section of a right valve (Pl. 27, fig. 14) closely resembles Palmer's figures of *C. perfecta*. In outline it is subquadrilateral, with its anterior side flattened and a ventral angle. It shows the anterior socket, the base of the tooth between the two sockets, and the posterior socket connected by a constricted channel with the posterior muscle cavity; the latter is separated by a thin vertical septum from the body cavity which is rounded in outline. The ligament is infolded; it is shown by an external groove and a small internal cavity, with no visible connection between the two. The walls, though much weathered, show a system of canals separated by radial plates which divide and ankylose at least twice.

A section near the commissure of the left valve (Pl. 27, fig. 13) hardly differs from Palmer's figures of *C. perfecta* (1928, text fig. 6; pl. 9, fig. 1), except that the teeth have been removed by erosion. The outline is quadrilateral, the anterior wall is thin and flattened, and meets the dorsal and ventral walls in rounded angles. The vertical septum, running from the anterior tooth to the ventral wall, and cutting off the posterior muscle cavity from the body cavity, is clearly seen. The canal system in the walls is visible, except on the anterior side, and resembles that shown in Palmer's figures, but other sections (Pl. 27, fig. 12) show this better.

Dimensions.—The right valve illustrated has a dorso-ventral diameter of 56 mm, and an antero-posterior diameter of 46 mm; the corresponding measurements for the left valve shown are 54 mm by 44 mm. These figures are comparable with, though slightly less than those of Palmer's holotype of *C. perfecta*; they are substantially greater than those of his *C. perfecta gracilis*.

Remarks.—Palmer (1928), the author of the generic name *Caprinuloidea* and of the species name *C. perfecta*, collected his material from Soyatlan de Adentro, Jalisco, Mexico. He ascribed the formation in which he found them to the Cenomanian because of the resemblance of their fauna to that of the *Schiosia* Beds of Sicily, which Douvillé believed to be of that age. Thiadens (1936b) found the same species in southern Santa Clara, Cuba, in association with *Tepeyacia* and *Sabinia*. He was inclined to refer his fauna to the Cenomanian with the possibility of a Turonian age. Recently *Caprinuloidea* and *Tepeyacia* have been found in Texas in beds of Lower and Middle Albian age, and not in any higher horizon. It seems probable, therefore, that the Seafield Limestone, the provenance of *Caprinuloidea*, should be ascribed to the Albian.

Genus *SPHAERUCAPRINA* Gemmallaro, 1865

Right valve resembles that of *Caprina*. Left valve has around its posterior, ventral and anterior sides a marginal row of oval canals, within which there are several rows of polygonal canals, the innermost row the largest; several large accessory cavities lie on the dorsal and dorso-anterior sides of the body cavity; the posterior muscle cavity opens into the socket, but is separated from the body cavity by a thin septum; there is a well-marked ligamental groove.

Sphaerucaprina seafieldensis Chubb

Plate 30, figure 5; Text-figure 1

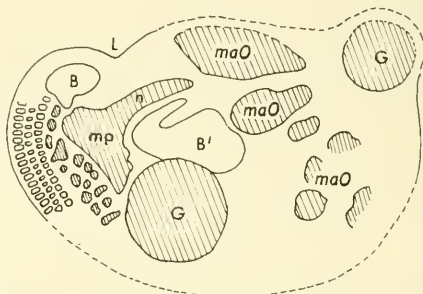
Sphaerucaprina seafieldensis Chubb, 1967, p. 25.

Occurrence.—A single incomplete left valve, considerably recrystallized, was found in a locality described by the collector as N 20°E of Seafield Manse, St. Catherine. It was learnt, however, that the direction was an estimate as a strong local magnetic anomaly rendered a compass bearing impossible. It may be assumed that the site was in a general north-northeasterly direction from the Manse and within sight of it. The shell was associated with *Sabinia totiseptata* and *Tepeyacia multicostata* described below, and near to the horizon of *Caprinuloidea perfecta*. Two transverse sections of the valve have been cut nearly parallel to the commissure.

Description.—A small to medium-sized shell. The

greater part of the outer surface is concealed by tuffaceous matrix, but where exposed it is covered with inconspicuous costae about 1-1.5 mm wide. A well-marked open V-shaped ligamental groove is seen in the sections. The valve is involute with its umbo curved over so that it lies at the dorso-anterior corner of the commissural surface. Body cavity circular and exceptionally small, its diameter at the commissure being only about one quarter of the antero-posterior diameter of the valve; it curves over in a semi-circle in conformity with the umbo, its diameter tapering from 16 mm to 10 mm in a distance of 75 mm; only in its deepest part, near the umbo, are there two or three thin, well-spaced, subconical tabulae. The wall is extremely thick on the dorsal, anterior, and posterior sides; the ventral wall is broken away.

The outer shell layer is thin; the thick inner layer is pierced by many longitudinal canals, a single row around the posterior margin being oval in cross section with their radially directed long axes about 1.5 mm and their short axes 0.5 mm; this band extends some distance round the dorsal side but has not been recognized on the anterior side which



Text-figure 1. *Sphaerucaprina seafieldensis* Chubb. Commissural aspect of left valve reconstructed from several sections; natural size. Compare Plate 30, figure 5.

is much recrystallized, and the ventral side is missing. Within this band on the posterior side there is a zone of irregularly rounded or polygonal canals with an average diameter of 1 mm and within this a narrow, curved, shallow accessory cavity, about 1.5 mm wide and 15 mm long, subdivided in its deeper parts by septa; another band of larger irregular canals separates this cavity from the posterior muscle cavity. Tubular canals exist in other parts of the shell but, except where they are filled with rock matrix, they are difficult to detect owing to crystallization. There are several large and small accessory cavities in the dorsal and anterior regions.

The anterior tooth is large and triangular and stands near the center of the valve on the dorsal side of the body cavity, it is anteriorly grooved. The posterior tooth is much smaller and is apparently conical; it lies close to the dorsal margin. The intervening socket is long and oblique, narrowing towards the dorso-anterior and widening in the opposite direction to open into the posterior muscle cavity, which is separated from the body cavity by a thin septum.

The right valve is unknown.

Dimensions.—Height of left valve 40 mm; diameter, antero-posterior 65 mm, dorso-ventral (estimated) 45-50 mm.

Remarks.—*Sphaerucaprina* differs from *Coalcomana* in its small body cavity, thick walls and the nonbifurcation of the plates separating its marginal canals. It differs from *Schiosia* in having several rows of canals within the marginal row. *Coalcomana* was found by Thiadens (1936b), associated with *Sabinia*, *Caprinuloidea*, and *Tepeyacia* in southern Santa Clara, Cuba, and *Schiosia* by Palmer (1928) in the Maltrata Limestone at Orizaba, Vera Cruz, Mexico. Neither *Coalcomana* nor *Schiosia* has yet been recognized in Jamaica.

Genus *SABINIA* Parona, 1908

Externally resembles *Plagioptychus* but differs from it in that both valves are canaliculate. A cross section shows many small, irregularly polygonal canals, fairly uniformly distributed throughout the whole thickness of the inner layer of the shell, including the part external to the cardinal apparatus. There are no accessory cavities external to the myophoric laminae.

Sabinia totiseptata Palmer

Plate 30, figure 6

Sabinia totiseptata Palmer, pp. 73-74, pl. 14, fig. 5.

Occurrence.—A single fragment of a right valve was found in the locality NNE of Seafield Manse, St. Catherine, which yielded *Sphaerucaprina* and *Tepeyacia*. As found the valve was split longitudinally, and the resulting flat face has been polished and two transverse sections cut.

Description.—A small shell; right valve curved cylindrical, the concave side being dorsal; the surface was probably originally smooth but the greater part is either covered with tuffaceous matrix or weathered away. The body cavity is round to subquadrangular in cross section, its diameter is about half that of the shell and it is without tabulae, being filled with matrix throughout the length of the fragment. Outer layer thin and mostly weathered away. Inner layer thick, its structure is destroyed in places by

crystallization, but elsewhere it consists entirely of round to subpolygonal canals or tubules, with a mean diameter of 1-2 mm; the intervening septa are thick, attaining a maximum of 0.5 mm; even the marginal tubules are rounded, not oval, and all are tabulate, the tabulae being slightly concave and irregularly spaced, the intervals between them varying from less than 1 mm to 2.5 mm. A trace of the hinge structure may be seen at the upper end in the form of two deep rock-filled hollows, the anterior some 4 mm wide and the posterior about 9 mm; there can be little doubt that these are sockets; the wall between them representing the tooth is 6 mm thick.

The left valve is unknown.

Dimensions.—The original length of the fragment was about 90 mm; diameter near the commissure 50 mm tapering to 40 mm at the lower end; diameter of body cavity 25 mm tapering to about 18 mm.

Remarks.—This specimen, imperfect as it is, appears to resemble three Mexican species of *Sabinia* named by Palmer and to be indistinguishable from *S. totiseptata* Palmer, in which the marginal canals are rounded and tabulate.

Genus *ANTILLOCAPRINA* Trechmann, 1924

Trechmann proposed the generic name, *Antillocaprina*, for the species Whitfield named *Caprinella occidentalis*; he gave no description of the genus but only of the specimens that he had collected, which he believed to belong to the same species. He had never seen Whitfield's material and his description differs from it in one important character—the arrangement of the teeth and sockets. It would appear, therefore, that Trechmann's specimens represent a different species, here called *A. suboccidentalis*, which must be regarded as the type species. *C. occidentalis* belongs to the same genus but is less typical.

The genus *Antillocaprina* may be defined as follows; inequivalve, right valve conical, cylindro-conical or pyramidal, straight, undulating or curved, usually but not always larger than left; left valve curved or coiled; surface of both valves sometimes smooth but often longitudinally fluted, the broad shallow grooves being separated by rounded costae, which may be inconspicuous or prominent. Outer layer thin and smooth except for faint growth lines which run across grooves and costae at right angles. Inner layer of both valves thick, forming the main mass of the shell; it is composed of a tightly packed plexus of small tubules, which are polygonal or, in the marginal row, radially oval in section; the tubes invade the myophores and hinge teeth; the polygonal tubes are generally tabulate, the marginal oval tubes nontabulate; typically the myophores are large, sub-

equal, and nearly flush with the hinge plate and the commissure in both valves.

In most species the hinge tooth of the right valve is quadrilateral, and from its inner corners two septa extend anteriorly and posteriorly, dividing the sockets from the body cavity; in the left valve the anterior tooth is conical or pyramidal, the posterior tooth crescentic or sigmoidal, presenting its convex side to the body chamber and the socket. There is no external ligamental groove but there may be a small ligamental pillar, which presumably originated as an infold but which has lost its connection with the outer layer; it is crescentic in section and occupies the hollow of the crescentic posterior tooth in the left valve (Text-figure 2) and the corresponding position relative to the crescentic posterior socket in the right. As MacGillivray observed (1937, p. 63) the ligamental pillar is often dissolved, leaving a cavity which retains its characteristic shape, and in many cases no trace of the ligament can be seen. A comparison of the valves shows that the ligamental pillar, crescentic in both, would face in opposite directions if the two valves were brought together; this seems to be the rule in all species. The innermost part of the inner layer is thin, lining the body cavity and forming a series of saucer-shaped tabulae below it.

There has been some controversy as to the systematic position of *Antillocaprina*. When first defining it Trechmann (1924b, p. 407) remarked that "the structure of the living chamber is quite unlike that of *Caprina*, *Plagioptychus* or *Coralliochama*, and recalls that of *Monopleura* . . . there is no septum in the living chamber, nor any accessory cavities behind the posterior tooth." To compare its body cavity to that of *Monopleura* is not to include it in the Monopleuridae, indeed the resemblance is not obvious, and it would appear from his choice of name, *Antillocaprina*, that Trechmann regarded it as belonging to the Caprinidae; he listed it between *Plagioptychus* and *Coralliochama*, both members of this family; and he described a specimen that he presented to the Institute of Jamaica as a "Caprinid Rudist."

MacGillivray (1937, pp. 26-129) grouped the Antillocaprinae with the Ichthyosarcolitinae, Trechmannellinae, Rousselinae, *Lithocalamus*, *Immanitas*, and the Hippuritinae, not as directly related to each other, but as following the same line of evolution which he called the Trechmannellid type. He stated (p. 67) that "the *Antillocaprina* hinge can be derived directly . . . from that of *Monopleura michaillensis* Pictet-Campeche." This would appear to involve a rotation of the hinge through an angle of 90° for, according to Douvillé's figures (1918, pl. 3, figs. 1-11), the teeth of that species are subparallel to each other and

to the dorsal margin of the shell, like those of *Chama*, and are unlike those of *Antillocaprina*.

Other authorities including Kutassy (1934) and Dechaseaux (1952) recognised the Antillocaprinae and most of the other forms in MacGillivray's trechmannellid group (except the Hippuritinae) as belonging to the Caprinidae. *Antillocaprina* has many typical caprinid characters, the external shape of the valves, the structure of their inner and outer layers, and the invasion of the teeth and myophores by polygonal tubules, which can be matched in some unquestioned Caprinidae, such as *Coralliochama*.

A comparison of Trechmann's types of *A. suboccidentalis* with a plaster cast of Palmer's holotype of *Caprinuloidea perfecta* shows only such differences as could arise naturally in the course of evolution. The hinge structure is almost identical and the ligamental pillar or cavity also is similar, its cross-section being described, in *Caprinuloidea*, as "boot-shaped" by Palmer (1928, p. 56) and in *Antillocaprina* as "comma-shaped" by MacGillivray (1937, p. 63), and as "crescentic" by the writer; all three expressions imply similar shapes. In *Caprinuloidea*, as in *Antillocaprina*, the pillar has lost its connection with the outer layer, but the former genus retains the external ligamental groove which the latter has lost.

Several authors have stressed the absence from the left valve of *Antillocaprina* of a septum which they claim to be an essential character of the Caprinidae. The function of this septum is to divide the cavity occupied by the posterior muscle from the body cavity. But in *Antillocaprina* the muscle attachment areas have risen until they are nearly flush with the commissure, so the septum ceases to be of the nature of a fence between two fields and comes to resemble a retaining wall supporting a raised terrace.

There seems to be no adequate reason for excluding *Antillocaprina* from the Caprinidae.

Antillocaprina suboccidentalis Chubb

Plate 28, figures 3,4

Antillocaprina occidentalis Trechmann, 1924b, p. 407, pl. 25, figs. 1-3.
Antillocaprina suboccidentalis Chubb, 1967, p. 25.

Occurrence.—A common fossil in the *Titanosarcolites* Limestones of Logie Green, Upper Clarendon, and in the Great River Valley on the borders of St. James and Westmoreland.

Description.—This species closely resembles *A. occidentalis*; it tends to be somewhat smaller though still of medium size. The right valve is conical, more or less straight, curved or twisted, with the commissure inclined at an

angle of 110° to its dorsal side; the left valve tends to be low and arched rather than coiled.

Not only the walls but also the large anterior and posterior myophores and the hinge plate in both valves are composed of fine, longitudinal, polygonal tubes, which are generally about 0.5 mm in diameter, and are divided transversely, at distances about equal to their own diameter, by horizontal tabulae, except for the marginal row which are oval and nontabulate. The two myophores and the hinge plate together form a horseshoe-shaped structure which encircles all except the ventral side of the body cavity in both valves. The only important difference between the two species is in the structure of the hinge. In the left valve of *A. suboccidentalis* the two teeth are well separated and between them lies a rectangular socket. The posterior tooth is not especially large or massive, it is a ridge elongated transversely, *i.e.* parallel to the dorsal margin, and is sigmoidal, its anterior end curving up against the socket and its posterior curving down around the dorsal side of the body cavity; the anterior tooth appears to be conical, generally oval in cross section, the long axis of the oval being normal to the shell margin. No ligamental pillar or cavity has yet been recognized in this valve.

In the right valve a rectangular tooth stands between two sockets, the anterior oval and the posterior sigmoidal; these sockets are separated from the body cavity by septa which spring from the ventral angles of the tooth. A crescentic ligamental cavity lies within the concavity of the posterior socket and both present their concave sides towards the dorso-posterior.

Dimensions.—Height of type right valve 85 mm; length of type left valve measured around curve 167 mm, height of left valve above commissure 43 mm; height of largest known right valve about 150 mm; commissure more or less circular, its diameter 55-60 mm; body cavity 30 mm by 20 mm.

Antillocaprina occidentalis (Whitfield)

Plate 28, figures 1,2; Plate 30, figure 8; Text-figure 2

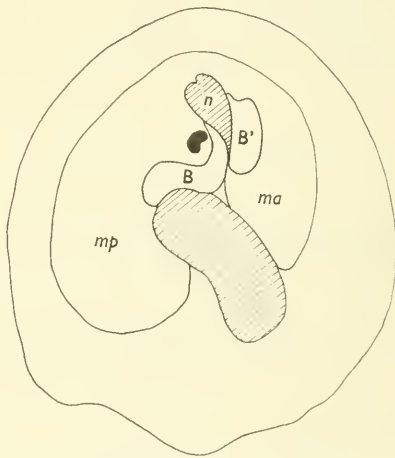
Caprinella occidentalis Whitfield, 1897a, pp. 193-194, pls. 16,17.
Antillocaprina occidentalis Chubb, 1955a, p. 7; 1956c, p. 8.
 not *Antillocaprina occidentalis* Trechmann, 1924b, p. 407, pl. 25, figs. 1-3.

Occurrence.—A common fossil in the *Titanosarcolithes* limestones wherever they occur in Jamaica.

Description.—According to Whitfield "shell of moderate size and very inequivalve, the lower valve long, straight, slightly enroled, twisted or loosely spiral like a corkscrew, smooth, ribbed or slightly channelled on the ex-

terior surface, and gradually expanding from the apex outward. Upper valve coiled and generally more or less involute, often closely so and nearly symmetrical, the exterior surface being nearly smooth or with spiral ridges extending from the apex to the border of the valve; the ridges, from five to ten in number, are elevated and distinct, rounded or sub-obsolete." The body cavity is small and obliquely oval; its deeper parts in both valves are divided off by oblique curved tabulae, those in the left valve being more oblique and more delicate than those in the right.

The structure of the hinge is the distinguishing character of this species. It is clearly seen in one of Whitfield's type left valves, though his figure (1897a, pl. 16, fig. 4) fails to show it; a new photograph of this specimen is given in Plate 28, figure 2, and an interpretative drawing in Text-



Text-figure 2. *Antillocaprina occidentalis* (Whitfield). Commissural aspect of left valve; natural size. Ligament black. Compare Plate 28, figure 2.

figure 2. The posterior tooth is large and crescentic and is in contact with the smaller anterior tooth. The socket is thus occluded and is displaced from its normal position between the teeth towards the dorsal margin; it is shallow and relatively small. A crescentic ligamental pillar stands within the crescent of the posterior tooth; it presents its concave side towards the anterior, whereas the tooth itself is concave towards the dorso-posterior.

Another left valve in the Brit. Mus. (Nat. Hist.) No. L63259, retains both its teeth (Pl. 30, figure 8). The

posterior one is extremely large and massive; its crescent is composed of compact shell substance with its concavity filled in with tubular material; no ligamental pillar is seen. It is in contact with the anterior tooth, which is small and conical and is mainly tubular, though the side facing the suture seems to have a layer of compact material; this tooth has a vertical groove on its dorsal side. The socket is small and oval; its depth is only about 6 mm measured vertically, but it burrows in horizontally below the hinge plate towards the posterior for a distance of 11 mm.

No right valve showing its hinge structure has been seen, but it would probably have a single large socket for the reception of the two teeth of the left valve, perhaps with a septum in its bottom, which would rise dorsally to support a small conical tooth.

Dimensions.—Height of adult right valve about 200 mm, length of left valve measured around the outer curve may be 350 mm, though its height above the commissure may be less than 100 mm owing to coiling; commissural diameter, dorso-ventral 75-80 mm, antero-posterior 60-70 mm; the body cavity may be as little as 30 mm by 10 mm.

Antillocaprina quadrangularis (Whitfield)

Plate 29, figures 1-6

Caprinella quadrangularis Whitfield, 1897a, p. 193, pl. 12, fig. 4; pl. 14, figs. 4, 5.

Antillocaprina quadrangularis (Whitfield), Chubb, 1955a, pp. 6-7.

Antillocaprina quadrangularis (Whitfield), Chubb, 1965a, pp. 12-13, pl. 1, figs. 15, 16; pl. 2, figs. 1, 2; 1956c, p. 8.

Occurrence.—A rare fossil, found in the *Titanosarcotites* Limestone of Catadupa and Shaw Castle, St. James. Whitfield recorded it from "Christianna," Manchester Parish, but there is no Cretaceous at Christiana and his specimens probably came from the Logie Green area, some five or six miles east thereof.

Description.—A medium-sized species. Right valve roughly quadrangular in cross section, owing to the development of four longitudinal flanges; the height is little more than the maximum diameter, so the shape is that of an inverted pyramid; the flanges are respectively dorsal, ventral, anterior, and posterior, and the shell is slightly curved or twisted with its dorsal side concave and ventral convex; the commissure is tilted at a steep angle; the flat faces between the flanges may be smooth or have minor costae of varying widths; the tubes composing the thick inner layer are 1-2 mm in diameter. A section shows the hinge to be essentially of *Antillocaprina* type (Plate 29, figure 6).

The left valve also is quadrangular in outline, capuloid or highly arched with overhanging umbo in the dorsal corner, from which a strong, rounded ridge or flange curves

up and over to the ventral corner; this is flanked by two broad and open furrows, which divide it from two lateral wings or ridges extending outwards to the anterior and posterior corners respectively. The thin outer layer is smooth except for growth lines; decorticated specimens show the capillary tubes which radiate from the umbo. The hinge structure consists of a deep rectangular socket beneath the umbo, flanked by two teeth, the posterior transversely elongate and sigmoidal, the anterior conical; the myophores appear to be arranged like those of *A. occidentalis*, but there is a projecting knob on the anterior myophore; the body cavity is transversely oval.

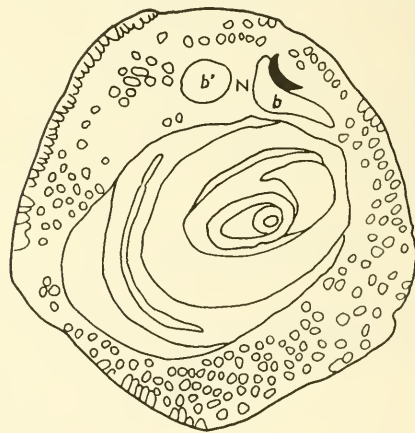
Dimensions.—Whitfield's larger specimen of a right valve is 144 mm high, by 108 mm in maximum diameter; the largest left valve has a dorso-ventral diameter of 93 mm and an antero-posterior diameter of 85 mm; the most highly arched left valve has a height of over 80 mm.

Antillocaprina lowenstami Chubb

Plate 28, figures 5-9; Text-figure 3

*Antillocaprina lowenstami** Chubb, 1967, p. 25.

Occurrence.—In a marly nodular limestone about 80 feet above the *Barrettia* Limestone of Stapleton, St. James. Two specimens were found, one a weathered right valve and the other bivalved. Named for Dr. Heinz Lowenstam, who found the first specimen. The right valve was sectioned



Text-figure 3. *Antillocaprina lowenstami* Chubb. Transverse section of right valve near commissure; × 2. Ligament black. Compare Plate 28, figure 8.

*Spelling emended. Obvious error. Named for H. Lowenstam.

and polished; the bivalve was split apart at the commissure and both surfaces developed.

Description.—A small species, the right valve conical, slightly curved, left valve conical, strongly curved with overhanging umbo, shaped like a Phrygian cap. There is no ligamental groove. Both valves have two shell layers, the outer thin and smooth except for inconspicuous growth lines, it is largely weathered away; the inner layer thick, composed of many longitudinal canals, the outermost row radially elongate and parallel-sided, rather than oval, in cross section; other canals polygonal or rounded; marginal canals 0.5 mm wide by 0.75 to 2.5 mm radially; polygonal canals generally 1 mm in diameter with some larger especially on the posterior side of the right valve, where a few may attain a diameter of 2.5 or even 3 mm. Inner part of this layer forms thin saucer-shaped tabulae at least in the right valve and probably in both.

In the right valve the cellular structure invades only the margins of the hinge area; the polished section (Pl. 28, fig. 8; Text-fig. 3) shows that the hinge is essentially of antillocaprinid type; a rock-filled, crescent-shaped cavity represents the ligamental pillar on the concave side of the equally crescentic posterior socket; in the bivalved specimen the whole hinge area is recrystallized and shows no structure except the ligamental cavity, which is not crescentic but oblique, presumably in an intermediate stage between a crescent concave posteriorly and one concave anteriorly. Anterior muscle attached to the internal surface of the valve; posterior muscle to a surface which slopes down towards the body cavity.

The left valve has a row of large canals on the dorsal side of the hinge plate; elsewhere the canals are as in the right valve, but none are more than 1.5 mm in diameter. Hinge area recrystallized, showing oblique ligamental cavity. Anterior muscle attached to the internal surface of the valve; posterior to a myophore which slopes up to a sharp ridge, with the form of a cuesta, fitting the down sloping muscle area of the right valve.

Dimensions.—Overall length of bivalved specimen 75 mm; height of right valve, dorsal side 44 mm, ventral side 65 mm; left valve, dorsal side 15 mm, ventral side measured around curve 75 mm; diameter at commissure, dorso-ventral 39 mm, antero-posterior 44 mm.

Remarks.—*A. lowenstammi* is a rather primitive member of the genus. The ligament and hinge are typical but the muscle attachments have not developed the characteristic form, though the posterior myophore of the left valve has already risen, so as to render the septum unnecessary.

***Antillocaprina stellata* Chubb**

Plate 30, figures 1-3

Antillocaprina aff. genus B. MacGillivray, 1937, pp. 83-85; pl. 2, figs. 8,9; pl. 8, fig. 11.

Antillocaprina stellata Chubb, 1967, p. 25.

Occurrence.—Fragments are common in the Shaw Castle Shale of the *Titanosarcotites* series of St. James.

Description.—The fragments belong to a species of medium size with a conical right valve, which is often irregularly twisted, and which has a number of prominent longitudinal flanges projecting from the wall. It appears to be similar to, perhaps identical with that described by MacGillivray from Piñar del Rio Province, Cuba, which he regarded as related to *Antillocaprina*, though probably belonging to a different genus. The Jamaican material is more fragmentary than the Cuban, but is better preserved in one respect, that some of the fragments show the thin, smooth outer layer. According to MacGillivray the Cuban forms resemble *Antillocaprina* in the absence of such a layer; the Jamaican forms resemble it by its presence, for there is no doubt that all species of this genus, like other Caprinidae, had a thin outer layer.

In the Cuban material some of the flanges extend out as far as 60 mm. In the Jamaican specimens none of those still attached to the shell project more than a quarter of this distance, but isolated broken flanges attain widths up to 33 mm, with a thickness of about 5 mm. One fragment shows exceptionally regular horizontal growth lines averaging about 18 to a centimeter. The canals forming the shell wall and flanges may be seen, but it has not been possible to ascertain if any show a cross section similar to that illustrated by MacGillivray (1937, pl. 2, fig. 9).

The left valve is unknown.

Dimensions.—Owing to the fragmentary nature of the material the exact dimensions are unknown. The largest fragment is 73 mm high by 39 mm wide.

***Antillocaprina williamsi* Chubb**

Plate 30, figure 7

Antillocaprina sp. Trechmann, 1927, pp. 59-60, pl. 2, fig. 10; pl. 4, fig. 6; 1929, p. +88, pl. 18, fig. 6.

Antillocaprina williamsi Chubb, 1967, p. 25.

Occurrence.—Found in shales about 30 feet below a rudist limestone along the Cambridge-Catadupa railway line; also in a shale at an elevation of about 7,000 feet near the summit of Blue Mountain Peak. Named after Mr. John Williams of the Jamaica Geological Survey.

Description.—A small species. All specimens are somewhat crushed in a dorso-ventral direction. Shell free or lightly attached, nearly equivalve but has the right valve

slightly larger than the left. Both valves short, they may be equally curved with the umbones anteriorly directed, or the right valve may be the straighter. Outer layer very thin and sometimes weathered away; when preserved it is smooth with growth lines which are inconspicuous except near the commissure. Inner layer composed of fine longitudinal tubules, which are about 0.8 mm in diameter and appear to be nontabulate. Internal structures, hinge apparatus, myophores unknown.

Dimensions. — The best preserved bivalved specimen, with both valves arched, has an overall length of 66 mm, each valve being 33 mm high. Measured around the outer curve the right valve has a length of about 80 mm, the left valve about 68 mm. Diameter at commissure: antero-posterior 48 mm, dorso-ventral 23 mm, but the former figure has been increased and the latter reduced by crushing.

***Antillocaprina depressa* Chubb**

Plate 30, figure 4

Antillocaprina (?) sp. Trechmann, 1929, p. 487, pl. 18, figs. 4, 5.

Antillocaprina sp. Chubb, 1961a, pp. 3-4.

Antillocaprina depressa Chubb, 1967, p. 26.

Occurrence. — Internal and external moulds of a single right valve were found by Trechmann in the Cretaceous shale near the top of Blue Mountain Peak.

Description. — The right valve is very small, depressed conical, its height being considerably less than its diameter, transversely oval at the commissure. Outer surface smooth with a few strong foliated growth lines and faint radial striae probably caused by an extremely thin outer layer being moulded onto an inner layer composed of capillaries. Umbo nearly central, slightly twisted. Body cavity apparently nontabulate, deep and acutely conical in the centre, but flaring towards the commissure; deeper part smooth, flaring part marked by strong radial striae, no doubt representing the capillaries. The hinge plate is transverse to the capillaries, being covered with mammillae which are moulds of their ends. The hinge is of *Antillocaprina* type, the two sockets being represented by projections and the tooth by a hollow; the posterior socket is transversely elongated, its anterior end curving up against the tooth, the anterior socket is round triangular, and the tooth more or less square with flanges at each free corner, which extend as septa to divide the sockets from the body cavity. The sides of the sockets are vertically striated. No ligament is seen. The anterior myophore is a ridge encircling that side of the body cavity; the posterior muscle was attached to the wall.

The left valve is unknown.

Dimensions. — Diameter: antero-posterior 25 mm, dorso-ventral 20 mm; height 10 mm.

Remarks. — A depressed conical right valve is not uncommon among medium-sized or large rudists but extremely rare among small ones. Although none of the original shell remains, the mould gives a very good idea of the structure.

Genus *TITANOSARCOLITES* Trechmann, 1924

Generic name proposed by Trechmann for the species described by Whitfield (1897a, pp. 194-196) under the name of *Caprinula gigantea*. It is subequivalve, both valves being nearly cylindrical but tapering distally. It was recumbent on its anterior side, and both valves are curved in one plane, the concave side of the curve being dorsal. Both valves have numerous longitudinal rounded costae, separated by narrow grooves, on their dorsal and anterior sides; the ventral and posterior sides show broad, roundly concave flutings, separated by angular ridges or flanges.

The shell has two layers. The outer, rarely preserved, is thin and smooth, with inconspicuous transverse growth lines, which cross all longitudinal ridges and furrows at right angles. The inner layer is thick, constituting the main mass of the shell; it consists chiefly of fine capillary tubes which are rather closely tabulated; these tubes are mostly polygonal or rounded in section, forming a network, but those in the outermost row on the fluted sides are oval, with their long axes perpendicular to the surface; these are nontabulate; on the costate sides the polygonal mosaic continues to the edge.

The chief structural character of *Titanosarcolithes* is the presence, in both valves, among the polygonal capillaries, of many rounded or oval tubular canals, whose diameter may be more than ten times that of the capillaries. They are nontabulate and are confined to the costate sides. As Trechmann has shown, the tubes are formed by a repeated growing out of the costae, and their spreading "in a roof-like manner" over the intervening furrows, which thus become occluded; each of the tubes is lined with a discrete portion of the outer layer. The tubes were described by MacGillavry (1937, p. 89) as "enclosures of the world outside into the animal's shell."

The commissural surfaces show the ends of the capillaries and tubes. The body cavity, which generally lies ventrally of the centre, is small, its diameter varying between a third and a sixth of the long diameter of the shell; the thin smooth part of the inner layer lines it and forms close-set, deeply concave tabulae below it. The hinge lies between the body cavity and the dorsal zone of tubes; the teeth, which are rounded or oval, are composed of fine polygonal capillaries; the lower unoccupied parts of the sockets are filled with deep funnel-shaped tabulae, fitting into each

other in a cone-in-cone structure. The myophoric areas are often shown by a different pattern in the capillary network. There is no ligamental groove and no ligamental pillar or cavity has been seen in any Jamaican specimen.

There have been differences of opinion as to the orientation of the valves of *Titanosarcotites*. The question was discussed in an earlier publication (Chubb, 1955a, pp. 8-9) and the conclusion was reached that the tubular canals were more or less confined to the dorsal and posterior sides. This view was largely based on a valve described and figured by Trechmann (1924b, p. 400, pl. 23, fig. 2) and now in the British Museum (Natural History). Trechmann stated that it had two teeth which were fused together in the body cavity but divided as they emerged; this interpretation was accepted in 1955 and it was concluded that this was a free or left valve because it had two teeth.

A re-examination of the specimen (Pl. 32, fig. 3) has led to a revision of this view and it is now thought to be a right valve with a single bifid tooth set between two sockets. If it were a left valve with two close-set teeth it would be comparable to *Antillocaprina occidentalis*, illustrated in Plate 28, figure 2 and Plate 30, figure 8, in which the teeth are near together and have occluded the socket, which has moved in a dorsal direction, no such occluded socket is present in the *Titanosarcotites* under discussion. Several specimens of the latter genus have been sectioned and show their hinge apparatus (Pl. 32, figs. 1-2; Pl. 33, fig. 2); in every right valve the two sockets and in every left valve the two teeth are set well apart, usually at a distance of 15-20 mm, not crowded together. In the specimen under discussion the bifid tooth stands between two cavities which appear to be sockets as they occupy the same relative positions as the sockets in the sectioned right valves.

The specimen is, therefore, now believed to be a right valve and the orientation proposed in 1955 is erroneous. The costate side is anterior, and this side and the dorsal have tubular canals; the fluted side with the oval nontabulate capillaries is posterior. This interpretation agrees with that of MacGillavry (1937). The other criteria proposed for the orientation of the valves are valid: the hinge teeth are on the dorsal side of the body cavity, one (which may be bifid) in the right valve, two (well spaced) in the left; both valves taper distally and curve dorsally; and the tabulae below the body cavity of each valve present their concave faces to the other valve.

There has been controversy as to the systematic position of *Titanosarcotites*. Whitfield believed it to be a *Caprinula*, a member of the family Caprinidae. Douvillé (1898, pp. 123-124) compared it with *Ichthyosarcotites* and thought

that in both genera the tests were composed chiefly of *lamæ externæ*, i.e. the plates which are today called funnel plates by many English-speaking rudistologists; the capillaries and canals would be in the outer layer and both genera would belong to the Radiolitidae.

Trechmann (1924b, p. 397) transferred *Caprinula gigantea* to the new genus, *Titanosarcotites*; he believed the tubes to be in the outer layer and expressed conviction that it was one of the Radiolitidae. Though he did not refer to him there is little doubt that his views were influenced by those of Douvillé. Two years later, however, the latter author (1926, p. 132) recognised that the canals of *Titanosarcotites* were in the inner layer.

MacGillavry (1937, p. 91) thought that the cardinal apparatus of *Titanosarcotites* resembled that of *Trechmannella* and *Hippurites*. He was the first to recognise the close relationship of the genus with *Antillocaprina*, from which he believed it to be derived. As explained above he thought that *Antillocaprina* in its turn had developed from a monopleurid ancestor.

Thus *Titanosarcotites* has been believed to have affinities with the Caprinidae, the Monopleuridae, the Radiolitidae, and even with the Hippuritidae. Kutassy (1934) and Dechaseaux (1952) included it among the Caprinidae and this view is here accepted. Its affinities with *Antillocaprina* can hardly be doubted and there seems to be no valid reason for excluding either genus from the family.

Titanosarcotites giganteus (Whitfield)

Plate 31, figures 1,3; Plate 32, figures 1,2; Plate 33, figures 1,2

Caprinula gigantea Whitfield, 1897a, pp. 194-196, pls. 18-22.
Titanosarcotites giganteus (Whitfield), Trechmann, 1924b, *pars*, pp. 397-400, text fig. 1; pl. 23, fig. 1.
Titanosarcotites giganteus (Whitfield), Chubb 1955a, pp. 7-9; 1955b, pp. 178-185; 1956c, p. 8.
 Not *Titanosarcotites giganteus* (Whitfield), MacGillavry, 1937, pp. 85-92, pl. 3, figs. 1-5.

Occurrence.—One of the commonest fossils in the *Titanosarcotites* series wherever it occurs in Jamaica. This is the most widespread of all rudist horizons and is found in the Jerusalem Mountain Inlier, Westmoreland; the Marchmont Inlier on the borders of Westmoreland and St. James; the Maldon Inlier and the south side of the Sunderland Inlier, St. James; the Central Inlier of Upper Clarendon; and in the Rio Grande Valley of Portland, on the east side of the Blue Mountain Inlier.

Description.—As for the genus: the type species *T. giganteus* is characterized by its gigantic size. Both valves are subcylindrical, and oval in cross section, the long diameter being dorso-ventral. The right valve tends to be longer

and broader than the left and may have lateral outgrowths to assist fixation; according to Trechmann its umbo is acutely pointed and bent upwards from the surface of attachment; probably many were unattached and relied on their weight to keep them in position. The left valve may be curved or coiled in a plane spiral. The costae on the dorsal and anterior sides have an average width of 10 mm; the flutings on the other sides are few in number, in adults are generally some 40 to 60 mm wide, and are separated by acute ridges not by projecting flanges.

The capillaries are generally less than 1 mm in diameter, and the tubes, which are rounded, oval or kidney-shaped in cross section, have a maximum diameter rarely exceeding 15 mm; there is a tendency for the larger tubes to be on the dorsal side. All costae, ridges, furrows, flutings and tubular canals are continuous across the commissure from one valve to the other. Young individuals may be difficult to distinguish from *Antillocaprina occidentalis* unless the tubes have been brought to light by weathering or fracture.

Dimensions. — The length of a bivalved specimen, measured around the curve, may be anything up to 2 metres; the maximum diameter at the commissure may exceed 300 mm. The majority are much smaller and it is uncertain whether some of these are the young *T. giganteus* or whether they belong to another species.

Remarks. — It may be doubted if the Cuban specimens attributed to *T. giganteus* (MacGillavry, 1937) actually belong to this species; they should probably be included in the species described below. The Texan species, *T. oddensis* Stephenson (1938), differs from *T. giganteus* in the diameter of its capillaries and tubes, the former being up to 2.5 mm and the latter attaining a maximum of nearly 40 mm. The tubes are more crowded than in the Jamaican form and their zoning is different, the larger being near the myophores and body cavity and the smaller being marginal.

Titanosarcolites alatus Chubb

Plate 31, figure 2; Plate 32, figure 3

Titanosarcolites giganteus Trechmann, 1924b, *pars*, p. 400, pl. 23, fig. 2.

Titanosarcolites giganteus MacGillavry, 1937, pp. 85-92, pl. 2, figs. 1-5; pl. 9, fig. 1.

Titanosarcolites alatus Chubb, 1967, p. 26.

Occurrence. — Apparently a rather rare fossil in Jamaica, occurring in the *Titanosarcolites* Limestone of the Great River Valley on the borders of St. James and Westmoreland, and neighbouring areas, but possibly many specimens that have been thought to be the young of *T. giganteus* may belong to this species.

Description. — This is a medium to large-sized species,

its maximum dimensions being less than half those of *T. giganteus*. The chief characteristic of *T. alatus* is the development of projecting flanges on the posterior and ventral sides; they are considerably more numerous than the ridges on *T. giganteus*. These flanges are flat, parallel-sided, and rounded at the ends; in the specimen illustrated (Pl. 31, fig. 2) there are about seven flanges which project from 25 to 46 mm from the bottoms of the intervening flutings, and they are from 3 to 9 mm thick. A single row of oval capillaries follows the whole periphery of the flanges and flutings with the long axes of the ovals always at right angles to the surface; some of the costae towards the ventral part of the anterior side are lined with suboval capillaries, which are considerably less compressed than those in the flanges. The marginal capillaries on the posterior side are about 1.2 mm by 0.3-0.4 mm; the internal capillaries are generally 0.5-0.7 mm in diameter. The smallest of the tubular canals, which are on the anterior side, have a diameter of 3 mm, the largest, which are dorsal may be as much as 10 mm by 7.5 mm; the specimen illustrated in Plate 31, figure 2 clearly shows the formation of the tubes by the overgrowing of the costae. The interior of this shell is recrystallized so no trace of the hinge structure can be seen, but the right valve shown in Plate 32, figure 3 is the one with the bifid tooth, which is clearly seen between its two sockets.

Dimensions. — The dorso-ventral diameter is about 120 mm, the antero-posterior diameter 83 mm. The length of each valve measured around the curve is likely to be of the order of 250 or 300 mm.

Remarks. — The Cuban specimens described by MacGillavry probably belong to this species. They all appear to be smaller than a typical *T. giganteus* and all have flat, parallel-sided flanges on the posterior and ventral sides, projecting as much as 45 mm. MacGillavry regarded two of the grooves between the flanges as siphonal. Some of the Cuban specimens showed a hinge structure and ligament similar to that of *Antillocaprina*.

Genus *ANTILLOSARCOLITES* Chubb, 1967

Shell of medium size, nearly equivalve, but the right valve possibly rather larger, both strongly curved in a dorsal direction and in the same plane; shell probably recumbent on the anterior side. Both valves are characterized by a few acutely angular longitudinal carinae, separated by broad rounded flutings on the dorsal, anterior, and ventral sides, possibly also on the posterior side, but this is not known.

Outer layer thin, smooth. Inner layer extremely thick on the dorsal side, elsewhere of moderate thickness; it is mainly composed of numerous longitudinal capillary canals,

usually oval in section, and 0.4 to 0.5 mm in diameter, with intervening walls relatively thick. The noncanaliculate innermost part of the inner layer is exceptionally thick, especially on the anterior side.

The body cavity is oval or subquadrilateral in section. The hinge lies in the thick dorsal side of the inner layer. In the right valve the anterior socket is almost central; the posterior socket is connected with the neighbouring myophoric cavity, which is cut off from the body cavity by a septum. The anterior muscle was attached to the thickened lining of the body cavity. The hinge of the left valve is less well known being visible only in section. There appears to be no ligamental furrow, pillar or cavity. The lower part of the body cavity is subdivided by transverse tabulae.

Antillosarcolites macgillavryi Chubb

Plate 30, figures 9-12

Antillocaprina aff. genus *A. MacGillavry*, 1937, pp. 83-84, pl. 1, fig. 10.

Ichthyosarcolites sp. Chubb, 1956c, p. 7.

Antillosarcolites macgillavryi Chubb, 1967, p. 26.

Occurrence.—Two specimens were found in the *Barrettia* beds of Haughton Hall, Green Island, Hanover. They are right and left valves and almost certainly belonged to one individual though they cannot be fitted together as the apertural part of both valves is broken away. Both valves were sectioned and, as far as possible, developed.

Description.—Shell of small to medium size. The two valves are equally curved in the same plane, the left valve shorter than the right; concave side of curve dorsal. Strongly carinate, the carinae being acutely angular and separated by broad, rounded flutings; they match on the two valves, and are respectively dorsal, anterior, ventral, and ventro-posterior; the posterior side is considerably eroded, and its original characters cannot be determined.

Outer layer thin, with faint growth lines, it is largely weathered away. Inner layer thicker, on the dorsal side very thick, its capillary canals rounded or oval in cross section, with an average diameter of 0.5 mm; they are not apparently tabulated. The innermost part of the inner layer, lining the body cavity, is unusually thick, attaining 3 to 4 mm on the anterior side in both valves. The body cavity is oval in the right valve, obliquely subquadrangular in the left; it is crossed by a series of oblique tabulae, which spring from the thickened anterior part of the lining and slope down at an angle of about 120° to the thinner posterior side; these tabulae have the exceptional thickness of 3 to 5 mm, and are from 6 to 9 mm apart.

It has been possible to develop the base of the tooth

and the two sockets of the right valve; the anterior socket is oval and nearly central; the stump of the tooth, which is about 3 mm wide, divides it from the posterior socket; both sockets are about 6 mm dorso-ventrally by 4.5 mm antero-posteriorly, and are separated from the body cavity by a wall 2 mm thick. The posterior socket is partially separated from the neighbouring myophoric cavity by thin vertical buttresses, which bound the posterior side of the socket but fail to meet; the posterior myophoric cavity is divided from the body cavity by a septum 2 mm thick. The anterior muscle appears to have been attached to the thick inner lining of the body cavity; the attachment area is bounded on its inner margin by a slight, nearly horizontal ridge. Cardinal area of left valve seen only in sections.

Dimensions.—Length of right valve 90 mm, probably originally at least 110 mm; length of left valve 65 mm, probably originally 90 mm; approximate diameter at commissure from dorsal to ventral carina 55 mm, from furrow to furrow 42 mm; antero-posterior diameter over 30 mm; body cavity, dorso-ventral diameter 20 mm, antero-posterior about 15 mm.

Remarks.—This form seems to be similar to, probably identical with that collected by Thiadens in southern Santa Clara (Las Villas), Cuba, and described by MacGillavry under the name of *Antillocaprina* aff. genus *A.* He regarded it as occupying a position between *Antillocaprina* and *Titanosarcolites*. The fluted walls and the hinge do indeed resemble those of the latter genus, but in the absence of tubes it must be regarded as an independent genus. MacGillavry's figure shows a dorso-anterior carina which is absent from the Jamaican specimen, and a larger dorsal carina; the Cuban form probably had an anterior carina which is broken off; his section shows the characteristic thickening of the lining of the body cavity, but the sockets appear to be smaller than those of the Jamaican form perhaps because the section is cut lower. MacGillavry described the canals as irregularly tabulated, with the distance between the tabulae generally greater than the canal's diameter. Syntypes of the Cuban material lent by Prof. M. G. Rutten of Utrecht University have some of the canals distantly or not tabulated; others, especially in the flanges, show irregular tabulation.

Subfamily **PLAGIOPTYCHINAE** Douvillé, 1910

The right valve is not greatly elongated; it may be conical but is often cylindrical or low and exograte when its height is less than its diameter. Left valve low, it may be arched with its umbo overhanging the dorsal margin of the right, but in many species it is opercular, gently convex or

nearly flat, without projecting umbo. In some genera canals are present only in the left valve. This valve has a septum which supports the anterior tooth and cuts off the posterior muscle cavity; the anterior muscle was borne on an undercut shelf on the dorsal side of the body cavity.

Genus **PLAGIOPTYCHUS** Matheron, 1843

Right valve variable in form according to the shape of the attachment area, conical or cylindrical, straight or more or less coiled, generally short; it has no canals or accessory cavities and often resembles the right valve of a *Gyropleura*; single tooth prominent, it is near the posterior and from it run ridges delimiting the two sockets and muscle areas; the posterior muscle is raised on a platform. The plane of the commissure is inclined, the dorsal side of the right valve being shorter than the ventral.

The left valve is usually transversely oval, arched but not coiled or twisted, with an umbo on the dorsal side which may be displaced towards the posterior. Its thin outer layer is generally brown in colour and is ornamented only with inconspicuous growth lines; the thick inner layer is penetrated by radial nontabulate canals, separated by plates which bifurcate once or more but do not reunite, with the result that there are more canals near the outer surface than near the inner; these canals are visible in the broad brim which encircles the anterior, ventral, and posterior margins of the valve. The hinge, which is solid and not invaded by the canals, is displaced towards the posterior; it consists of two prominent teeth with intervening socket; from the anterior tooth a vertical septum runs to the ventral margin separating the posterior muscle cavity from the body cavity; this posterior cavity is divided from the socket, if at all, only by a low ridge, which may be oblique; the anterior muscle is set on a deeply undercut myophoric lamina, a horizontal shelf running across the dorsal side of the body cavity. Several species of *Plagioptychus* are known in Jamaica.

Plagioptychus jamaicensis (Whitfield)

Plate 34, figure 1.

Caprina jamaicensis Whitfield, 1897a, p. 192; pl. 15; not pl. 13, figs. 1-2.
Plagioptychus jamaicensis (Whitfield), Chubb, 1955a, p. 6; 1956c, p. 7.
 Not *Plagioptychus jamaicensis* Trechmann, 1924b, pp. 407-408; pl. 25, fig. 4.

Occurrence.—A rare fossil in the *Titanosarcolites* Limestone. Whitfield's specimen was found at Logie Green, Clarendon Parish; the Jamaica Geological Survey found it be-

tween Greenwich and Lambs River, near the northeastern corner of Westmoreland Parish.

Description.—A large, almost a gigantic species. According to Whitfield: shell large and ponderous, having a diameter across the lower valve of eight inches. Lower valve very oblique, broadly spreading and very much curved, shortest on the hinge side; its substance quite thick and strongly marked by irregular concentric ridges or growth lines. Upper valve thin, smooth or with microscopic lines on the exterior; beak large, incurved and overhanging the cardinal side of the lower valve. Within, the shell of this valve is marked by fine, threadlike grooves radiating from the apex.

Both specimens are badly crushed. The wall of the right valve is solid and without canals; inclination of commissure about 130°. In describing the upper (left) valve as thin Whitfield was evidently referring to its outer layer, which is thin and brown, with the horny appearance so characteristic of this genus. Below it is the thick inner layer traversed by nontabulate canals, which are separated by bifurcating plates radiating from the umbo. Whitfield saw these as "thin thread-like grooves".

Dimensions.—Height of Whitfield's right valve 190 mm on ventral side, 60 mm on dorsal; diameter at commissure 200 mm; height of left valve 90 mm. Diameter of Geological Survey specimen at commissure 150 mm; its other measurements without significance owing to crushing and erosion.

Plagioptychus toucasianus Matheron

Plate 34, figures 2-4

Plagioptychus toucasianus Matheron, 1843, p. 117, pl. 6, figs. 1, 2.
Caprina coquandi d'Orbigny, 1847, p. 185.
Plagioptychus coquandi (d'Orbigny), Chaper, 1873, p. 82, pls. 11, 12, text figs. 1-4.
Plagioptychus toucasi Douvillé, 1888, p. 719, text fig. 6.
Plagioptychus sp. Trechmann, 1924b, p. 408.
Plagioptychus toucasi Douvillé, Muellierried, 1933a, p. 9, text figs. 6-9, 11.
Plagioptychus toucasi Douvillé, Chubb, 1956c, p. 7; 1959, p. 45.

Occurrence.—A single left valve was found by the Jamaica Geological Survey in the *Barrettia* Limestone of Haughton Hall, Green Island, Hanover Parish. Trechmann's specimen came to the British Museum (Natural History) with his bequest (No. LL30294); it is from the same locality.

Description.—The Geological Survey specimen has been much rolled, all the outer layer has been lost, and the inner layer with its canals brought to light; the radial plates bifurcate at least twice. Trechmann's specimen is better preserved, retaining part of its brown outer layer, but its interior is filled with hard matrix. The shell is of medium size and highly arched, and the umbo, which is

slightly behind the centre of the hinge line, projects well beyond it. The anterior myophore is prominent, thick, and massive; the base of the anterior tooth is preserved, it is quadrangular, its dorso-anterior side abutting against the myophore, its posterior angle projecting into the socket, and its ventral angle being extended as a septum which cuts off the posterior muscle cavity. The single tooth of the right valve, much eroded, is in the socket; it is large and anteriorly grooved, so that it fits around the posterior angle of the anterior tooth of the left valve. The ventral and lateral margins of the Geological Survey specimen have been eroded away; the Trechmann specimen shows the posterior tooth and part of the brim with its bifurcating plates.

Dimensions.—Geological Survey specimen: dorso-ventral diameter 60 mm; antero-posterior diameter 72 mm. Probably before erosion the dimensions were about 80 by 80 mm. Height 45 mm; originally probably over 50 mm. Trechmann specimen, corresponding figures: 80 mm, 88 mm, 54 mm.

Remarks.—This form is tentatively attributed to the European species *P. toucasianus* from which it shows no significant difference. Mulleried (1933a) described the same species from the Lower Senonian of a locality between La Vega del Paso Real and San Bartolomé de los Llanos in Chiapas, south Mexico, but his specimens were bivalved and did not show the structure of the hinge and myophores; he confirmed his determination by sectioning.

Plagioptychus zansi Chubb

Plate 33, figures 3-5

Caprina jamaicensis Whitfield, 1897a, *pars*, pl. 13, figs. 1,2.

Plagioptychus zansi Chubb, 1956a, pp. 9-10, pl. 1, figs. 7-9; 1956c, p. 8.

Occurrence.—Fairly common in the *Titanosarcolites* Series, chiefly in the more shaly beds of the Maldon Inlier, St. James, and the Marchmont Inlier on the borders of Westmoreland and St. James. Whitfield's specimen came from Logie Green, Upper Clarendon.

Description.—A small species, its right valve variable in form, conical and either straight, curved or twisted, in some cases becoming exogyrate or wedge-shaped; attachment area often large; internal characters unknown; inclination of commissure about 130°.

Left valve gently and evenly arched, without abrupt change of curvature, and the umbo, which is considerably displaced towards the posterior, hardly if at all projecting beyond the cardinal line; it is transversely oval, the antero-posterior diameter being about 25 per cent greater than the dorso-ventral. Outer layer brown, smooth, with fine, close-set growth lines; inner layer shows radial plates which bi-

furcate at least once and often twice; in a distance of 20 mm on the ventral margin there are 21 canals at the inner edge and 46 at the outer. The anterior tooth is a prominent ridge with its long axis directed postero-dorsally at an angle of 45° to the long axis of the valve; the posterior tooth is similarly directed, and both lean slightly towards the posterior; both teeth are supported by septa which converge below the socket and continue as a ridge to the ventral margin. The ligamental groove is short, running a distance of only about 8 mm from the umbo to the posterior tooth, the dorsal side of which it indents. The anterior myophore is a thin, deeply undercut lamina with, on its ventral edge, a raised rim which shows a slight thickening and projection near its middle; the posterior myophore is an oval plate occupying the whole of the cavity behind the two septa, and rising posteriorly to overhang the brim of the valve.

Dimensions.—Height of right valve variable being, in a conical shell about 55 mm on the dorsal side and 75 mm on the ventral, and in a wedge-shaped shell zero on the dorsal and 30 mm on the ventral. Other measurements much less variable, the diameter at the commissure being about 50 mm antero-posteriorly and 40 mm dorso-ventrally; height of left valve about 13 mm.

Plagioptychus trechmanni Chubb

Plate 32, figures 6,7

Plagioptychus jamaicensis (Whitfield), Trechmann, 1924b, pp. 407-408, pl. 25, fig. 4.

Plagioptychus trechmanni Chubb, 1956a, pp. 8-9, text figs. 1,2; 1956c, p. 7.

Occurrence.—Two bivalved specimens and one free left valve were collected by Trechmann from the *Titanosarcolites* Series of Logie Green, Upper Clarendon; now in the British Museum (Natural History). The Institute of Jamaica has some specimens (J67) from the Cambridge-Catadupa railway line.

Description.—Right valve small, short, straight, and cylindrical, ornamented with coarse growth lines, attached by the apex which is broad and flattened, the plane of the commissure is inclined at an angle of about 110°.

Left valve differs from *P. zansi*, in its relative ruggedness, high arching, and overhang of the umbo which is nearly central; the arching is associated with an abrupt change of curvature, the curve being moderate as far as a certain growth line, which is usually slightly dorsal of the middle of the valve, beyond which it steepens abruptly, so that this growth line often forms a carina; other growth lines are strongly developed, especially on the ventral side of the carina, making the valve more rugged than other Jamaican

species of *Plagioptychus*. The anterior myophore is narrower than that of *P. zansi* and lacks the central projection. The anterior tooth is a triangular pyramid supported by a buttress which rises from the bottom of the valve. The posterior tooth is a sharp ridge 11 mm long, parallel to the dorso-posterior margin; it is supported by a low buttress as wide as the tooth at its upper end but narrowing downwards. The socket is not separated from the muscle cavity.

Dimensions.—In the bivalved specimen illustrated (Pl. 32, fig. 7) height of right valve on dorsal side is 11 mm, on ventral side 30 mm; dorso-ventral diameter at commissure 39 mm; at base, i.e. area of attachment, 35 mm. The free left valve has an antero-posterior diameter of 49 mm, a dorso-ventral diameter at the commissure of 29 mm, beyond which the umbo projects 10 mm; height above plane of commissure 22 mm.

***Plagioptychus minor* Chubb**

Plate 34, figures 5-8

Plagioptychus minor Chubb, 1956a, pp. 10-11, pl. 1, figs. 10-13; 1956c, p. 8.

Occurrence.—Probably confined to one horizon near the top of the *Titanosarcolites* Series in the Ducketts Land Settlement on the borders of St. James and Hanover, and perhaps at Logie Green, Clarendon.

Description.—A small and highly gregarious species, the individuals attaching themselves in clusters to shells of *Antillocaprina*, to corals, or to each other; this habit often leads to mutual interference, and distortion of the right valve, but when unencumbered it is curved conical, with ventral side convex, attached by the whole of the antero-dorsal surface, which is flattened, so that the shape comes to resemble the toe of a slipper; inclination of the commissure about 130°. Tooth a four-sided pyramid set obliquely, with low ridges running from its three free corners around the ventral sides of the posterior socket and the two muscle scars; a groove on its antero-dorsal face descends into the adjacent anterior socket. Posterior muscle set on a small raised platform.

Left valve slightly and evenly arched, its umbo projecting little if at all beyond the cardinal margin; outer and inner layers as in *P. zansi*, but the radial plates bifurcate only once, near the inner margin. Anterior tooth grooved dorsally and ventrally; a ridge connects the two teeth, separating the intervening socket from the posterior muscle cavity; the latter is considerably shallower than the body cavity, from which it is separated by the usual septum. Anterior myophore a narrow, parallel-sided, undercut shelf,

with no projection at mid-point, but a raised rim which continues round the ventral side of the body cavity.

Dimensions.—Height of a well-developed right valve on dorsal side 22 mm, on ventral side 33 mm; diameter at commissure, antero-posterior 30 mm, dorso-ventral 22 mm; dorso-ventral diameter is from 68 to 77 percent of antero-posterior. Height of left valve 10 to 12 mm.

***Plagioptychus fragilis* Chubb**

Plate 32, figures 4,5

Plagioptychus fragilis Chubb, 1967, p. 27.

Occurrence.—Not uncommon in the Shaw Castle Shale of the *Titanosarcolites* Series of the Maldon Inlier of St. James. The specific name refers to the delicacy of the shell, especially the left valve.

Description.—A small species, apparently not gregarious. Right valve generally low, twisted and exograte, or possibly sometimes slipper-shaped. Hinge set far back; posterior socket, in extreme corner, is divided by a small ligamental ridge; tooth with an anterior groove descending into the neighbouring socket, which is oblique. Posterior myophore a small platform supported by a buttress rising from the interior; anterior myophore a thickening of the shell wall, running parallel to the dorsal margin.

Left valve only slightly arched, long, delicate, almond-shaped, tending to taper anteriorly; umbo inconspicuous; outer layer extremely thin, smooth; inner layer thin, its radial plates, at least in the postero-ventral area, bifurcate twice or thrice, with the results that the canals near the outer margin outnumber those near the inner by over four to one. Posterior tooth set far back and tilted so that, in extreme cases, it may overhang the posterior margin; it is grooved on the dorsal side by the ligamental furrow; socket triangular in young forms, oblique in adults, bounded by the septa that support the two teeth; anterior tooth peglike and notched in youth, oblique in maturity. Posterior myophore an oblique oval area occupying the cavity behind the septum and sloping up to overhand the postero-ventral brim; anterior myophore a thin, deeply undercut shelf, in the adult widening form 5 mm near the tooth to 11 mm near the anterior end.

Dimensions.—Height of right valve variable between 20 and 30 mm; antero-posterior diameter of an adult 40 to 50 mm; dorso-ventral diameter about 60 percent of antero-posterior; height of left valve 5 to 6 mm; thickness of left valve in base of body cavity 1.5 to 2 mm.

Remarks.—This form differs from previously known Jamaican species of *Plagioptychus* in the relative flatness, narrowness, and thinness of its left valve; it is unusual, in

a small species, for the radial plates to bifurcate more than once.

Genus **MITROCAPRINA** Boehm, 1895

In its shape and many of its characters this genus resembles *Plagioptychus*. The right valve has no canals. In the left valve the hinge and muscle areas are like those of *Plagioptychus*, the chief difference between the two genera being that in *Mitrocaprina* the radial plates separating the canals in the inner layer bifurcate and anastomose again several times, producing a series of polygonal or rounded canals which are seen in the marginal brim.

***Mitrocaprina multicanaliculata* Chubb**

Plate 34, figure 9

Mitrocaprina multicanaliculata Chubb, 1956a, pp. 11-12, pl. 1, fig. 14; 1956c, p. 8.

Occurrence.—A single left valve, considerably weathered, was found in the *Titanosarcophiles* Series of Logie Green, Upper Clarendon. The Basle collection includes a specimen (G13110) from near Catadupa railway station which probably belongs to the same species.

Description.—Valve small, considerably arched, with even curvature. Outer layer thin, brown, of horny appearance, smooth with inconspicuous growth-lines. Inner layer thick, with numerous oval or polygonal canals arranged in six to eight rows; they are well preserved only on the posterior and ventral margins but probably were originally present around the anterior side; the alternate bifurcation and inosculation of the plates continue almost to the periphery. The teeth have been damaged by rainwater solution; posterior tooth quadrilateral, its long axis subparallel to the valve margin; socket large; anterior tooth much damaged, its supporting septum, which is 4 mm thick, runs obliquely in a postero-ventral direction at an angle of 45° to the long axis of the valve, cutting off only a small posterior muscle cavity which opens into the socket. Anterior myophore is much weathered but apparently resembles that of *Plagioptychus*.

Dimensions.—Antero-posterior diameter 42 mm, dorso-ventral from cardinal to ventral margin 30 mm; umbo projects 9 mm beyond cardinal margin; height above plane of commissure 17 mm.

Family **RADIOLITIDAE** Gray, 1848

In this family the right valve is typically straight and conical or cylindrical, and the left valve usually opercular, forming a lid which is flat, depressed conical, or concave, though rarely it is high and coiled. As in other rudists the

shell consists of two layers but, whereas in the families already described the outer layer is normally less than one mm thick and consists merely of a series of superimposed growth rings, in the Radiolitidae this layer forms the main part of the shell-wall, at least in the right valve, and consists of a series of thin, ring-shaped plates. In the more primitive genera these plates take the form of inverted cones fitted one within another which, owing to their resemblance to funnels, are called *funnel plates*. In more advanced forms the funnel plates tend to become horizontal, and in many they are radially frilled or folded.

The funnel plates, although close-set, are usually not in contact. They are separated by vertical radial plates and, according to the pattern made by these, the family is divided into two subfamilies: the Radiolitinae, in which the vertical plates are straight and radial, so that in a section they, together with the funnel plates, make a quadrangular pattern, resembling muslin; and the Sauvagesiinae, in which the vertical plates make a polygonal pattern like a fine honeycomb, which may be seen either on the surfaces of the funnel plates or in a transverse section. The inner layer is thin and serves only to line the body cavity and form concave tabulae below it.

Both subfamilies show various types of external ornament. Many genera have longitudinal costae and, if the funnel plates are frilled, the downfolds usually correspond with the ridges and the upfolds with the intervening furrows. Most genera show, on the posterior side, two vertical bands with ornament different from that of the rest of the shell. These, which may be either ridges or grooves, are the *siphonal bands*, one near the posterior myophore representing the exhalant siphon (S) and a further one the inhalant siphon (E); they are comparable with the slit bands of certain gastropods. A few genera, in which the siphonal bands are considerably infolded, have two orifices, called *oscles*, in the left valve, immediately above the bands; these are evidently siphonal apertures. Oacles are characteristic of gregarious genera.

The structure of the left valve varies; the outer layer is thin and consists of superimposed laminae; the inner layer is thick and in some genera has a structure resembling that of a caprinid, with vertical radial plates, which may bifurcate, separating "canals" within its thickness. In most members of the families previously discussed the left valve opened like the hinged lid of a box, swinging upwards and outwards. The Radiolitidae, however, had a highly specialized hinge apparatus, contrived to allow this valve to rise vertically. The hinge is remarkably symmetrical, the left valve having two long, straight, vertical, parallel and nearly equal teeth, joined at the base by a yoke, which slide into

deep sockets, or merely in channelled grooves in the wall of the body cavity of the right valve. Except in the most primitive genera the latter valve has lost its single tooth.

Anterior and posterior myophores branch from the bases of the two teeth in the left valve, curving around within the body cavity close to its walls. Their outer faces are denticulate for the attachment of the adductor muscles which, in the right valve, were attached directly to the inside of the wall. The gut must have passed close by the end of the posterior muscle (Douvillé, 1910, p. 14) and the long extension of this muscle may cause a shift of the anus, and, therefore, of the S band, towards the venter. This necessitates a shift of the E band which may come to lie diametrically opposite to the hinge area and ligament (if present), though it never lies anterior to the mid ventral point. But, while the anterior myophore is always attached for its whole length to the inside of the left valve, the posterior is commonly pedunculate, being attached only at its dorsal end either to the tooth or to the yoke, so the gut was able to pass over it to the S siphon, which is then sited alongside the muscle and not ventral to it.

The ligament, which was external in the Diceratidae and Monopleuridae, and sunk in a groove in the Caprotinidae and Caprinidae, was in the more primitive Radiolitidae submerged so deeply that it was supported by an infold of the outer layer, which projected into the body cavity to form a vertical ridge or pillar attached to the dorsal wall. The more advanced Radiolitidae have lost this ridge and presumably had no ligament, using some other method to raise the lid.

Subfamily **RADIOLITINAE** Douvillé, 1902

Vertical plates radial and generally unbranched, appearing on the surface of the funnel plates as fine close-set ridges; in section the funnel plates and the radial plates together make a pattern of small squares or quadrangles.

(a) *Radiolitinae with ligament*

Genus **AGRIOPLEURA** Kühn, 1932

This name replaces the preoccupied name of *Agria* Matheron, 1878. It is one of the most primitive genera of the Radiolitidae and some authors refer it to the Monopleuridae. But in the right valve the thin outer layer consists of upturned funnel-plates, crossed by simple radial plates; it has a ligamental ridge and also a tooth. The left valve is flat, with two long, vertical teeth, and myophores only slightly projecting.

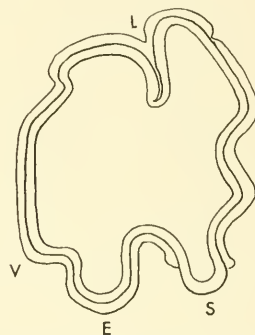
Agriopleura falconi (Chubb)

Plate 35, figure 1; Text-figure 4

Agria falconi Chubb, 1956a, pp. 13-14; pl. 2, fig. 3, text fig. 3; 1956c, p. 8.

Occurrence.—Occurs rarely in the Shaw Castle Shale, Maldon Inlier, St. James.

Description.—A very small species, the right valve elongated conical, tending to become cylindrical, generally slightly curved towards the apex by which it is attached; more or less quadrangular or triangular in cross section. Ornamented with five or six longitudinal costae alternating with furrows, all being actual folds of the wall involving both layers; in the specimen illustrated they may have been somewhat accentuated by crushing. Outer layer generally less than one mm thick, composed of funnel plates and vertical radial plates; inner layer thin. Three of the outfolds are interpreted as the pedal fold (V), the inhalant siphon (E) and the exhalant siphon (S). It is now thought that the published section (Chubb, 1956c, text fig. 3) is inaccurate:



Text-figure 4. *Agriopleura falconi* Chubb. Transverse section of right valve; $\times 2.5$. This corrects the section in Chubb 1956a, p. 13, Text-figure 3, which fails to show the outer layer entering into the ligamental infold.

the outer layer is involved in the ligamental infold, but it is enveloped in an infold of the inner layer (Text-fig. 4). The funnel plates, of which there are about 25 to 1 cm, are inclined upwards at an angle of 45° , they show slight downfolds at the costae and upfolds in the furrows; dorsally they are strongly downfolded at the ligamental furrow. The vertical radial plates are spaced at about 35 or 40 to 1 cm.

The left valve is unknown.

Dimensions.—The largest specimen is 60 mm high; diameter, dorso-ventral 21 mm, antero-posterior 17 mm.

Genus **PRAERADIOLITES** Douvillé, 1902

Outer layer of right valve thick composed of funnel

plates which are smooth and turned up at a steep angle, so that they show a cone-in-cone structure. They are not frilled but have several comparatively slight folds, which affect only the outer layer, not the inner layer. There are three principal costae formed by these folds corresponding to the three openings of the mantle, the two siphonal openings (S and E) and the pedal opening (V); there may also be a postero-dorsal fold. The ligamental ridge is an extremely thin infolding of the outer layer, projecting into the body cavity; it is enveloped in a thicker infold of the inner layer which may be interpreted as a tooth (N). This stands between two sockets which are separated from the body cavity by thin vertical septa. The left valve is of normal radiolite type, with two strong, parallel, vertical teeth, prominent myophores and a ligamental ridge.

Praeradiolites verseyi Chubb

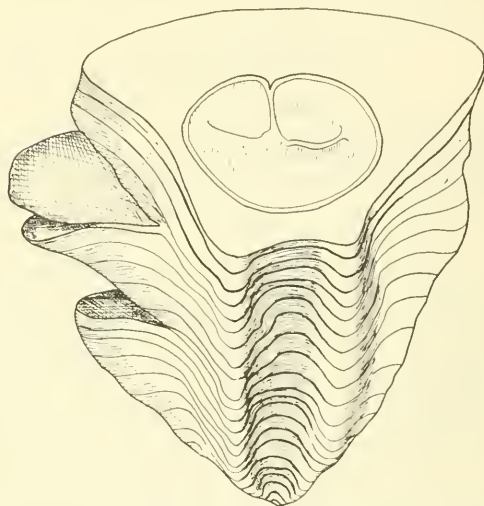
Plate 35, figures 2-4; Text-figure 5

Praeradiolites verseyi Chubb, 1956a, pp. 14-15, pl. 2, figs. 4-6; 1956c, p. 7.

Occurrence.—Not uncommon in the *Barrettia* Limestone at Stapleton, Sunderland Inlier, St. James.

Description.—Shell of medium size. The right valve is conical or pyramidal and slightly curved with the ligament on the convex side, *i.e.* the direction of curvature is ventral and not, as is usual, dorsal. The shell was probably cemented to some solid object when young but was recumbent on its dorsal side in maturity. The ligamental infold forms a barely perceptible groove in the outer surface. The cross section tends to a roundly triangular form and the outer surface has three carinae corresponding with folds of the funnel plates. The outer layer is generally from 10 to 15 mm thick, widening to 20 or 25 mm at the carinae; the funnel plates rise from the inner layer at angles of 90° to 120° , and except at the carinae curve rapidly upwards; they are 0.05 mm thick and at their inner edges are about 1 mm apart, but as they curve upwards they approach each other, in an asymptotic manner, and become nearly tangential, giving a false impression of a cortical layer, at least on the dorsal surface. The folds in the funnel plates should be described as outfolds, rather than downfolds, for they slope upwards, though at a lower angle than the intervening sections. A sharp angular fold at the antero-dorsal corner, only a short distance from the ligamental ridge, is regarded as a pedal fold (V); probably this fold did not form a continuous carina, but a series of spoutlike protuberances; the lowest of these seem to have taken part in the fixation of the valve. A second fold, the so-called postero-dorsal fold (PD) is generally feebly developed; it is the third fold,

representing the exhalant siphon (S), which occupies the postero-dorsal corner; the fourth fold (E) is near the middle of the posterior side. The four folds form radial sinuses in the chalice wall. Owing to the prominence of the V and S carinae the dorsal margin tends to form a nearly straight line. The vertical radial plates generally form a quadrangular pattern, but where the funnel plates are nearly horizontal polygonal cells may be seen, though the radial tendency is still obvious.



Text-figure 5. *Praeradiolites verseyi* Chubb. Right valve reconstructed from several specimens; $\times 0.8$.

The inner layer is about 0.7 mm thick and forms a narrow rim around the inner margin of the chalice. The ligamental ridge is displaced towards the anterior; it consists of an attenuated infold of the outer layer enveloped in an infold of the inner layer; in the adult it projects from 11 to 15 mm into the body cavity, it is 1 mm thick, expanding to form a flange at least 2 mm and perhaps sometimes 5 or 6 mm wide at its inner end. It stands between the two sockets which, below the level of the commissure, are separated from the body cavity by vertical septa running obliquely from the inner flange of the infold to the dorsal wall.

The left valve is unknown.

Dimensions.—Height of right valve about 150 mm;

diameter at commissure, antero-posterior 90 mm, dorso-ventral 70-75 mm; diameter of body cavity 45-50 mm.

(b) *Radiolitinae without ligament*

Genus **DISTEFANELLA** Parona, 1901

This genus includes small, subcylindrical forms, with several acute longitudinal costae and two rather broad, smooth siphonal bands, separated by a single costa. No ligamental infold and no tooth in the right valve, but two sockets which are connected by a vertical transverse plate. Left valve flat or even concave.

Distefanella lombricalis (d'Orbigny)

Plate 35, figures 6,7

Radiolites lombricalis d'Orbigny, 1842, p. 173.

Distefanella lombricalis [sic] (d'Orbigny), Douvillé, 1913, pp. 413-415, fig. 8.

Biradiolites lombricalis (d'Orbigny), Mullerried, 1932, pp. 237-242, fig. 1.

Distefanella lombricalis (d'Orbigny), Chubb, 1959, pp. 742, 748; 1962/1963, p. 18.

Occurrence.—Fragments seen in the weathered surface of a rudist coquina from Bon Hill, near Sunning Hill, St. Thomas Parish; they would probably have been overlooked but for their close resemblance to specimens of *D. lombricalis* collected in 1956 in the Sierra Madre Limestone, Chiapas, Mexico.

Description.—A very small species. Most of the fragments are obliquely transverse sections, showing part of the circumference of a small rudist. The wall is rather thin, its outer layer consisting of funnel plates which turn up at an angle of about 45°; these are traversed by simple radial plates and, in suitable sections, the two sets of plates make a quadrangular pattern. There are about twelve to fifteen acute longitudinal costae separated by rounded furrows; two flat siphonal bands, with a single small sharp costa in the interband. Inner layer thin; hinge and left valve have not been observed in Jamaican material.

Dimensions.—Diameter about 12-15 mm; maximum thickness of outer layer 3 mm, of inner layer 0.4 mm.

Remarks.—The horizon of the Bon Hill Limestone is not known, but *D. lombricalis* is characteristic of the Turonian in south Europe and Mexico.

Distefanella mooretownensis (Trechmann)

Plate 35, figure 5

Biradiolites mooretownensis Trechmann, 1924b, pp. 404-405, pl. 25, fig. 8.

Biradiolites mooretownensis Trechmann, Chubb, 1956c, p. 6.

Distefanella mooretownensis (Trechmann), Chubb, 1962/1963, p. 20.

Occurrence.—A highly gregarious species occurring in the *Titanosarcolites* Limestone in abundance near Moore Town in the Rio Grande Valley, Portland, and rarely in the Catadupa area, St. James, and the Jerusalem Mountain area, Westmoreland.

Description.—This is a smaller species than *D. lombricalis*. The right valve is elongated, cylindrical or tapering gradually, gently curved or somewhat twisted, growing in clusters of many individuals of various sizes. It has 10 to 12 sharp longitudinal costae, separated by shallow sulci; the two slightly wider sulci representing the siphonal bands are not always easy to recognise. The wall, including both layers, is not more than 1 mm thick, except at the costae, where it attains 1.5 mm. The funnel plates turn up at an angle of about 45°, and are crossed by simple vertical radial plates. The hinge structure has not been observed. The left valve is concave, showing fine concentric growth laminae.

Dimensions.—Trechmann gave the diameter of the right valve at the commissure as 15 mm, and of the left valve as 11 mm; these figures are rare, the diameter of the right valve does not generally exceed 10 mm, and a cluster may include hundreds of individuals many of which are less than 5 mm across. He gives the length as 56 mm, but this is often exceeded and probably a length of 100 mm is not uncommon.

Genus **BIRADIOLITES** d'Orbigny, 1847

Shell small or medium-sized, right valve elongate conical with longitudinal costae, and two smooth siphonal bands separated by a costa. Outer layer usually thick, with funnel plates which are more or less horizontal near the body cavity but may be marginally folded, usually with downfolds corresponding with the costae and upfolds with the furrows. No ligament, no tooth and no true sockets in the right valve, but a pair of channelled grooves for the reception of the long, vertical teeth of the left valve. The latter is opercular, flat or slightly convex or concave; springing from the base of the teeth are two projecting myophores which curve around the anterior and posterior sides, and fit closely within the wall of the body cavity of the right valve.

Biradiolites jamaicensis Trechmann

Plate 35, figures 8-12

Biradiolites jamaicensis Trechmann, 1924b, p. 404, pl. 24, figs. 5, 5a, 6, 6a, 7.

Biradiolites jamaicensis Trechmann, Chubb, 1956c, p. 8.

Occurrence.—A common fossil in the *Titanosarcolites* Limestones of the Central Inlier of Upper Clarendon, the

Maldon Inlier of St. James, and the Marchmont Inlier on the borders of St. James and Westmoreland.

Description.—Right valve small, elongated, tapering gradually, straight or slightly curved, growing singly or in clusters of several individuals in contact for their whole length. The valve has eight to eleven sharply angular costae separated by angular furrows which are irregular in depth. Many specimens have a more or less smooth surface, the growth lines, representing the edges of the funnel plates, not being obvious. The funnel plates turn up around the whole circumference, with the result that the costae form spout-like processes at the commissure. On the posterior side the two smooth siphonal bands are separated by a broadly angular costa with a sharp but narrow groove down its middle; the costa limiting the dorsal side of the S band is rounded, that limiting the ventral side of the E band is acutely angular like the normal costae. The body cavity is circular.

The left valve is more or less concave, with subcentral apex, and fine concentric growth lines; in some individuals it nearly covers the right valve, in others it fits well into it and has angular marginal projections to correspond with its costae.

Dimensions.—According to Trechmann the length is up to 140 mm and the diameter at the commissure up to 42 mm. Such dimensions are rare; the length is more often between 50 and 100 mm, and the diameter between 25 and 35 mm, but a cluster in the collection of the Institute of Jamaica (J31) includes shells over 200 mm high.

***Biradiolites robinsoni* Chubb**

Plate 36, figures 1-3

Biradiolites robinsoni Chubb, 1967, p. 27.

Occurrence.—A single right valve was found in the *Titanosarcolithes* beds of Cotton Tree Gully, Lambs River valley, Westmoreland. Named after Dr. Edward Robinson of the University of the West Indies, Jamaica.

Description.—A medium-sized species, curved conical, its maximum diameter near equal to its height. It is attached by the whole of its dorsal side to a right valve of *Biradiolites jamaicensis*, which it enwraps. Its anterior side has about four or five strong, prominent and rather rugged costae, corresponding with sharp downfolds of the funnel plates. On the posterior side the siphonal area is similar to that of *B. jamaicensis*, the two bands being smooth and separated by a broadly angular costa with a narrow groove down its middle; the S band is on the side of a rounded costa, the E band on a sharply angular one. The body cavity is oval, and the two channelled grooves for the reception

of the teeth of the right valve may be seen within it. The downfolds of the funnel plates on the anterior side make grooves across the commissure, and there are similar grooves on the other sides to a total of about ten in all.

The left valve is unknown.

Dimensions.—Height of right valve 67 mm; diameter at commissure: dorso-ventral 63 mm, antero-posterior 48 mm; diameter of body cavity, dorso-ventral 32 mm, antero-posterior 24 mm.

***Biradiolites rudis* (Whitfield)**

Plate 36, figure 4

Radiolites rudis Whitfield, 1897a, p. 189, pl. 11, fig. 4.
"Radiolites" rudis Whitfield, Chubb, 1955a, pp. 3-4.
Biradiolites rudis (Whitfield), Chubb, 1956c, p. 8.

Occurrence.—A single specimen, collected by Nicholas in the *Titanosarcolithes* Series of Logie Green, Upper Clarendon, was described and figured by Whitfield. It must be a rarity as no others have been found by Trechmann, Matley, or the Jamaica Geological Survey, and none have been reported from other Caribbean countries.

Description.—A small shell, the right valve curved elongate conical, but irregular and rugose in appearance. The thin funnel plates spread horizontally and project in irregular folds, which correspond with deep notches in the commissure; it is the uneven development of the funnel plates that gives the shell its rugged shape. The siphonal bands are broadly open concave grooves, each about 9 mm wide, corresponding with rounded upfolds of the funnel plates; they are separated by a strong costa, about 5-6 mm wide, which coincides with a sharp downfold.

The left valve is domed in the centre but flattens towards the margin; it extends to the border of the commissure, its brim is upfolded over the siphonal bands and has a tongue extending down over the interband; elsewhere it fits into the notches and folds of the right valve. According to Whitfield the surface of the left valve is obscured by adhering substances, but when visible is cancellated by two sets of lines, one concentric, the other radial. A re-examination of the specimen showed that this valve is much weathered.

Dimensions.—Height of right valve on dorsal side 73 mm; maximum diameter 45 mm; height of left valve 10 mm.

***Biradiolites rudissimus* Trechmann**

Plate 36, figures 5-8

Biradiolites rudissimus Trechmann, 1924b, p. 402, pl. 26, figs. 4, 4a, 5.
Biradiolites rudissimus Trechmann, Chubb, 1956c, p. 8.

Occurrence.—Fairly common in the *Titanosarcolithes*

Series of Logie Green, the Catadupa area, and the Great River Valley.

Description.—Trechmann described this species as "the most irregularly shaped and clumsily grown Radiolite that I have seen" (in conversation he would describe it as "the rudest rudist I know."). The shell is of medium size, solitary, or occasionally growing in clusters. The right valve is exceedingly irregular in form, and may be more or less conical, cylindrical, or low and spreading. The funnel plates generally spread widely and are unevenly wavy; they show, in addition to the close-set radial striae characteristic of the subfamily, more widely spaced radial vascular impressions some of which bifurcate once or twice. The S band is a longitudinal depression, sometimes with an indefinite raised ridge running up it; the E band is the most definite feature, consisting of a nearly parallel-sided, flat band, crossed by strong horizontal growth laminae representing the edges of the funnel plates; it lies in a depression and is bounded by narrow grooves. The funnel plates are upfolded in both bands, and downfolded in the rugged interband.

The left valve does not quite cover the right; it is thin and more or less convex, with subcentral apex from which low rounded costae radiate towards the margin (Pl. 36, figs. 6, 7).

Dimensions.—According to Trechmann the height is up to 105 mm, and the commissural diameter up to 109 mm. Of the specimens illustrated in Plate 36, the taller (fig. 5) is 85 mm high, maximum diameter 85 mm, diameter of body cavity 40 mm; the shorter (fig. 8) is 50 mm high, maximum diameter 100 mm, diameter of body cavity 24 mm.

Remarks.—This species has considerable resemblance to *Radiolites robusta* Palmer (1928, pp. 80-81, pl. 16, fig. 1) from Huescalapa, Jalisco, Mexico, and to *Bournonia* nov. sect. sp. 4 MacGillivray (1937, pp. 40, 41, text fig., pl. 8, fig. 10) from Camaguey, Cuba. The latter is a *Biradiolites*, not a *Bournonia*.

Biradiolites forbesi Chubb

Plate 37, figures 1, 2

Biradiolites forbesi Chubb, 1956a, pp. 15-16, pl. 3, figs. 1-2; 1956c, p. 8.

Occurrence.—A single right valve with the upper portion of the posterior wall broken away was collected in the higher part of the *Titanosarcolithes* Series in the Ducketts Land Settlement, Lot 184, one mile east of the Lands Department office on the road from Ducketts to Retrieve, St. James Parish. The body cavity is filled with large calcite crystals.

Description.—Shell of medium size, curved cylindro-

conical; wall thick. The outer surface cannot be seen as it is embedded in hard limestone, but it seems to have been irregularly lobed and without definite costae; the posterior wall can only be studied in sections of the lower part of the shell, from which it appears that the E and S bands were broad open furrows separated by a single costa. The funnel plates are thin and close-set, numbering about 100 to 1 cm; they show a circular upfold, about 10 mm wide, which runs around their inner margin; outside this upfold they turn out more or less horizontally and generally dip again towards their periphery. They tend to undulate irregularly but do not have definite radial folds; they are crossed by radial vascular markings which generally bifurcate once or twice. The cellular structure is extremely fine and can be seen in transverse sections, which show the cell pattern to be quadrangular. The inner layer is 0.5 mm thick. The body cavity is circular; there is no ligamental ridge and no visible hinge structure.

The left valve is unknown.

Dimensions.—The height of the specimen is about 120 mm, its maximum diameter 80 mm; thickness of wall 12 to 37 mm, the thickest part being at the anterior and the thinnest representing the E band. The diameter of the body cavity is about 36 mm.

Remarks.—When *B. forbesi* was named it was not known that *B. rudissimus* had vascular markings. It now appears that there is little, except the concentric upfold, to differentiate between the two species, which may be synonymous.

Biradiolites cf. rudissimus Trechmann

Plate 36, figure 9

Occurrence.—Two fragments were found in the *Barrettia* Limestone of St. Anns Great River. Both had been split longitudinally and represented the posterior half of the right valve.

Description.—Shell of medium size, low and broad, the height being half to three-quarters of the diameter. The funnel plates are wide and spreading; they are strongly upfolded at the S band and downfolded in the interband; the E band is missing; they are downfolded on the dorsal side of the S band, in one specimen excessively so, and elsewhere undulate irregularly. They have no vascular markings. Neither specimen has tabulae in its body cavity.

The left valve is unknown.

Dimensions.—First specimen: diameter 70 mm, body cavity 28 mm, height 50 mm; second specimen, diameter 77 mm, body cavity 35 mm, height 38 mm.

Remarks.—This form differs from *B. rudissimus* and

B. forbesi in its lack of radial vascular impressions, and from the latter in its lack of a concentric upfold. It is probably an independent species.

***Biradiolites minhoensis* Trechmann**

Plate 37, figures 3,4

Biradiolites minhoensis Trechmann, 1924b, pp. 402-403, pl. 26, figs. 1, 1a.

Biradiolites minhoensis Trechmann, Chubb, 1956c, p. 8.

Occurrence.—A scarce fossil known only by the type specimens collected by Trechmann in the *Titanosarcolites* Series of Logie Green and Trout Hall in the Rio Minho Valley of Upper Clarendon.

Description.—Shell of medium size. Right valve conical, not strongly costate; funnel plates strong and irregular, directed upwards and outwards, somewhat flaring towards the top, thus making the sides of the valve concave. The type specimen shows a development resembling rejuvenation in corals; after attaining a height of about 50 mm the shell continues its upward growth with a smaller diameter, the pre-existing flaring funnel plates are left behind, forming a ledge around the dorsal side, above which the new funnel plates rise more steeply. The S band is marked by a very sharp and narrow upfolding of the funnel plates, the sides of which rise almost vertically to a peak at the commissure; the E band, which is smooth, 10 mm wide and slightly sunken, is marked by a relatively gentle flat-topped upfolding.

The left valve is thin, nearly circular, sunken, slightly concave, smooth, with fine concentric growth lines and subcentral apex. It has slight, almost imperceptible radial undulations, the sector radiating from the apex to the S band is slightly raised, that to the E band slightly sunken. The diameter of the left valve is considerably less than that of the right; it probably extends very little beyond the limits of the body cavity.

Dimensions.—According to Trechmann the height of the right valve is up to 95 mm; diameter of right valve 65 mm; diameter of left valve 40 mm. These are maximum dimensions; the figured specimen is 60 mm high, originally probably 65 mm; diameter of right valve 57 mm, of left valve 30 mm.

Remarks.—MacGillivray (1937, p. 39) thought that this species was a *Bournonia*. An examination of the type British Museum (Nat. Hist.) leaves no doubt that Trechmann was right in attributing it to *Biradiolites* as both siphonal bands are in grooves.

***Biradiolites novaterrensis* Chubb**

Plate 37, figures 5-8

Biradiolites novaterrensis Chubb, 1967, p. 27.

Occurrence.—A single bivalved shell from the *Bartlettia* Limestone of New Ground, St. Ann's Great River Valley, was included in the Trechmann Bequest. Two imperfect specimens were collected by the Geological Survey in the same locality.

Description.—A small species. Right valve conical, attached by its umbo; the antero-dorsal side, which is the highest, is smooth and flaring, with upturned, tangential funnel plates. Ventrally the smooth face ends at the costa which borders the E band; both bands are broad open grooves, the E band in the figured specimen being 18 mm wide by 9 mm deep, and the S band 11 mm by 6 mm; the interband is a prominent costa and another, nearly as prominent, stands on the dorsal side of the S band. In one of the specimens the latter costa forms the posterior margin of the smooth area, but the figured specimen has three subsidiary costae, appearing later and becoming progressively smaller. All the costae are characterized by strong downfolds of the funnel plates, while in all the grooves, notably the siphonal, these plates stand erect and become tangential; in the three major and the first of the minor costae the amplitude of the downfolds may be as much as 25 mm, but it is only about 7 mm in the two lesser costae.

The central part of the left valve is more or less flat; its outer layer is composed of laminae folded in conformity with the funnel plates; it also has vertical radial plates. It fits in against the high antero-dorsal wall of the right valve, its own margin turning up with it. From its other sides project grooved lappets which fit into the downfolds of the costae.

Dimensions.—Height 54 mm; diameter: dorso-ventral 53 mm, antero-posterior 42 mm.

Remarks.—Of known species of *Biradiolites* this seems to have most resemblance to *B. canaliculatus* d'Orbigny from the Turonian of the south of France.

***Biradiolites riograndensis* Chubb**

Plate 37, figures 9-11

Biradiolites riograndensis Chubb, 1967, p. 27.

Occurrence.—A single bivalved specimen was found in Maestrichtian limestone south-east of Alligator Church in the Rio Grande Valley, Portland. It was associated with *Titanosarcolites* sp., *Antillocaprina* sp., *Distefanella mooretownensis*, and other fossils.

Description.—A small shell. Right valve conical, attached by its apex, which is curved antero-dorsally. A broad, flat flange projects abruptly from the ventral side, its height being about equal to that of the shell and its width to the shell's diameter. The dorsal and anterior sides, including the anterior side of the flange, are smooth, the funnel plates being erect and nearly tangential but slightly separated by vertical radial plates. On the posterior side the S band is flat and slightly sunken, nearly parallel sided, some 10 mm wide, with about five costellae, and coinciding with a broad upfold of the funnel plates; the interband and the E band are both damaged, but the interband appears to have been prominent and was marked by a downfold, as the E band was by an upfold. Between the E band and the flange there is a broad depression with downfolded funnel plates.

The left valve undulates in conformity with the contours of the funnel plates of the right, with upfolds over the bands and a downfold over the interband; a large, saddle-shaped lappet fits into the space between the E band and the flange.

Dimensions.—Height 42 mm; diameter, dorso-ventral excluding the flange 33 mm, including flange 62 mm, antero-posterior 47 mm.

Genus **THYRASTYLON** Chubb, 1956

Shell of medium size, curved cylindro-conical when free to develop, but often distorted by close adherence to foreign bodies; fixation lateral, the whole or a considerable part of the anterior face of the right valve being moulded onto the surface of attachment. The diagnostic character of the genus is in the siphonal areas of both valves. In the right valve the two siphonal bands lie in rather deeply sunken grooves, separated by a rounded interband. The E band, always the wider, is flat and is generally marked by several narrow longitudinal costellae; the S band is smooth and convex. The funnel plates, which have numerous small radial undulations, are more or less horizontal near the body cavity, but turn up sharply at the siphonal bands, forming two peaks which rise above the commissural surface, the S peak usually higher and sharper than the E peak; further out the funnel plates turn upwards on the anterior side and spread over the attachment area, and turn downwards in the dorsal and ventral regions and in the interband. In these regions the funnel plates hang down to form an imbricating series of skirts or aprons; these aprons, bordering the siphonal grooves, tend to spread laterally over them, and may meet in a structure resembling a box pleat, occluding the grooves and converting them into tubes the course of which is indicated by sutures on the surface. Although deeply sunken the siphonal grooves do not form pillars or

pseudo-pillars within the body cavity, which is round or oval, with channelled grooves for the reception of the teeth.

The left valve is shaped like a broad-brimmed hat, its crown, which covers the body cavity, being domed or conical, and its brim fitting closely over the commissural surface. It turns upwards on the anterior side and downwards in the dorsal, ventral, and interband regions, in conformity with the funnel plates; it is sharply upfolded over the siphonal peaks and the sides of the upfolds tend to grow together and may join along sutures, so as to leave open oscules above. The S oscule is vertically oval, with a sharp peak above it, the E oscule is transversely oval. Since they fit closely over the peaks of the right valve, the oscules could inhale or exhale only if the left valve were raised slightly; the expulsion of water from the S oscule would be obliquely upwards at an angle of about 45° to the axis of the shell. The hinge resembles that of *Biradiolites*.

Thyrastylon adhaerens (Whitfield)

Plate 38, figures 1-6

Radiolites adhaerens Whitfield, *pars*, 1897a, pp. 188-189, pl. 10, fig. 1; pl. 12, fig. 1.

Biradiolites adhaerens (Whitfield), Trechmann, 1924b, pp. 400-401.

"*Radiolites*" *adhaerens* Chubb, 1955a, p. 3.

Thyrastylon adhaerens (Whitfield), Chubb, 1956b, pp. 36-37, pl. 6, figs. 1-3; pl. 7, figs. 5-9; 1956c, p. 8.

Occurrence.—One of the commonest fossils in the *Titanosarcoclitus* Series at many localities in the parishes of Westmoreland, St. James, Upper Clarendon, and Portland. Locally it is an important rock-forming organism. It is not certain if specimens from Cuba described by MacGillavry under the name of *Biradiolites adhaerens* (1937) should be assigned to this or to another species of the genus.

Description.—A highly gregarious species of small to medium size, commonly occurring in clusters of 20 or more individuals, the right valves being attached by the whole or nearly the whole of the anterior side. They are moulded onto the surface of attachment, generally primarily the shell of another rudist, and secondarily onto each other; many shells begin growth in a recumbent position but later turn upwards, so that commonly the shells have no regular form, but are rugged and irregular, though the apertural part often becomes free and more or less cylindrical. The S band is about 3-5 mm wide, slightly convex, and smooth except for occasional transverse growth lines; the E band is some 6-8 mm wide, with about four-seven fine longitudinal costae, new ones appearing at the sides or by intercalation; both bands are sunk in grooves and coincide with sharp upfolds of the funnel plates, with the result that at their summits they rise as peaks, well above the general level of

the commissure. The bands are generally overlapped by the downturned funnel plates at their sides but are not always completely occluded. The interband is rounded and is about 16 mm wide. The outer layer is usually 10-15 mm thick, but may be twice this thickness in parts of the anterior side, where it has spread over the surface of attachment, while in the siphonal areas it may be no more than 4-5 mm thick. The funnel plates, of which there are some 25 in 1 cm, are marked by about 30-35 small radial undulations which often bifurcate. The vertical radial plates may sometimes be seen as fine close-set striae on the surface of a well-preserved funnel plate.

The central part of the left valve is a low rounded or conical dome, the brim has fine radial undulations corresponding with those of the underlying funnel plate. In well preserved specimens, if the siphonal bands are occluded, the corresponding peaks of the left valve will bear oscules.

Dimensions. — The height of the right valve is generally between 80 and 160 mm, though in crowded clusters the shells may attain a height of 250 mm or more, no doubt owing to keen competition for access to sea water. The diameter of the shell is usually between 40 and 60 mm, that of the body cavity between 20 and 25 mm; the height of the crown of the left valve is 5 to 8 mm.

Thyrastylon coryi (Trechmann)

Plate 38, figures 7-9; Plate 39, figures 1-3

Radiolites adhaerens Whitfield, *pars*, 1897a, pl. 10, figs. 2,3; pl. 11, figs. 1-3.

Biradiolites coryi Trechmann, 1924b, p. 401, pl. 25, fig. 5.

Biradiolites adhaerens (Whitfield), MacGillivray, 1934, pp. 236-237, pl. 1, fig. 3.

Thyrastylon coryi (Trechmann), Chubb, 1956b, pp. 37-38, pl. 1, figs. 1-3; 1956c, p. 8.

Occurrence. — Locally common in the *Titanosarcolites* Series of Logie Green, Upper Clarendon; at Shaw Castle, St. James; below Catadupa and in the Great River Valley on the borders of St. James and Westmoreland; and in the Ducketts Land Settlement, Westmoreland, where it seems to characterize a definite horizon.

Description. — This species differs from the last chiefly in that normally it grows singly and rarely in groups of two or three individuals, so that it is more free to develop its proper form. The right valve is cylindro-conical, often showing slight longitudinal costae from 5 to 8 mm wide, and is attached by the whole of its anterior side to a foreign object. The shell is shaped in conformity with the surface of attachment and if, as is usual, this is the convex surface of a shell of *Antillocaprina occidentalis*, the anterior surface of *T. coryi* is concave and the whole shell is correspondingly

curved, so that the posterior side, bearing the siphonal bands, is convex (Pl. 38, fig. 7). Specimens from Shaw Castle, however, lie in the base of a shale and are attached to the surface of the underlying limestone; the anterior side is therefore flat, and the umbo curves dorsally as in typical pelecypods (Pl. 39, figs. 1,2). The bands are broader than in *T. adhaerens*, the E band occasionally attaining a width of 12 mm. In some individuals the siphonal grooves are open so that the full width of the bands is visible; in many the margins of the grooves are more or less hidden by lateral overlap of the down-folded funnel plates; occlusion of the S band is common, but the E band is rarely if ever completely occluded. Weathering may reopen grooves which were originally occluded.

The left valve of *T. coryi* differs from that of *T. adhaerens* in that the central part is much more elevated, being high rounded conical or nearly hemispherical, indeed it is sometimes higher than the right valve. The brim has from 30 to 35 radial plications, corresponding with the similar plications of the funnel plates; the siphonal upfolds form deep notches which are rarely occluded. A transverse section cut across the domed crown shows it to be hollow and thin-walled, the mean thickness of the outer layer being about 1 mm, of the inner layer 0.5 mm.

Dimensions. — The dimensions are similar to those of *T. adhaerens* except that the height of the right valve is generally less than 100 mm. The crown of the left valve may be 20 or 25 mm high.

Thyrastylon semiannulosus (Trechmann)

Plate 39, figure 4

Biradiolites semiannulosus Trechmann, 1924b, pp. 401-402, pl. 25, figs. 6,7.

Thyrastylon semiannulosus (Trechmann), Chubb, 1956b, p. 38; 1956c, p. 8.

Occurrence. — A rare fossil in the *Titanosarcolites* Limestone of Logie Green and Catadupa.

Description. — Like *T. coryi* this is a solitary form, but it is small and is attached by only the lower half of its anterior side. The right valve is straight and conical and the siphonal bands are similar to those of the preceding species; as Trechmann observed "both bands are frequently covered by the growth foliations," i.e. they are occluded. In such cases all that can be seen are two open V-shaped furrows with sutures in their bottom. As in other species of *Thyrastylon* the siphonal tubes rise up in peaks. The varix-like annulations shown by some of these specimens are due to the weathering of a surface similar to that of *T. coryi*.

The left valve has more resemblance to that of *T. ad-*

haerens than to that of *T. coryi*, the central part being a low cone, but the brim has only about 20 low radial plications. The figured specimen has the E oscule well developed; the S band is completely occluded but, though the brim of the left valve rises above it in a sharp peak, the two sides of the upfold do not come together, so there is no oscule.

Dimensions.—The height of the right valve is some 50-60 mm and the diameter 30-35 mm. The height of the crown of the left valve is 4-5 mm.

Thyrastylon sp.

Biradiolites sp. Chubb, 1961a, pp. 3-4.

Occurrence.—A single mould of the interior of the body cavity of a right valve was found in the shales at a height of 7,000 ft. near the summit of Blue Mountain Peak. It was associated with *Antillocaprina depressa* and *A. williamsi*.

Description.—A very small shell. The body cavity was conical, there is no tooth or ligamental ridge, but the impressions of the fluted grooves for the reception of the teeth of the left valve are well marked. The impression of the uppermost funnel plate, representing the commissural surface, clearly shows fine, simple, radial ridges, which would make a quadrangular, not a polygonal cell pattern. This funnel plate rises steeply on the anterior side as in *Thyrastylon*; most of it is broken away on the other sides but enough remains to suggest that it was turned down except at two points on the posterior side, where it was sharply turned up; these would be the siphonal upfolds.

Dimensions.—Mean diameter of body cavity 8 mm, depth 8 mm; width of commissural wall on anterior side 8 mm.

Remarks.—The simple radial plates prove that this is a Radiolite, and the sharp upturn of the funnel plate suggests that it was attached by the whole of its anterior side as in *Thyrastylon* or *Bournonia*. The funnel plates do not seem to be sufficiently frilled for the latter genus. The small dimensions of this species and of the associated species of *Antillocaprina* suggest stunting due to an environment unfavourable to rudists.

Genus *BOURNONIA* Fischer, 1887

Bournonia differs from *Biradiolites* in that the siphonal bands take the form of projecting longitudinal costae, separated by a single furrow or by a few minor costae and furrows. The right valve was generally attached by the whole of its anterior or, in species that favoured a muddy environment, lay recumbent, with the result that the anterior side was flattened and the valve typically assumed the form of the toe of a slipper. The dorsal, posterior and ventral sides are costate. The funnel plates turn up steeply

and become nearly tangential on the flat anterior side but on the other sides are radially folded and, as in *Biradiolites*, the downfolds correspond with the costae and the upfolds with the intervening furrows. The commissure is more or less semicircular in outline, with its anterior side straight; the body cavity is oval. The left valve is opercular, usually with its umbo near the middle of the straight side, from which costae radiate to the margin where they coincide with the folds of the right valve. In the previously described species with semicircular commissures, *Praeradiolites verseyi*, *Monopleura jamaicensis*, the straight edge was the hinged side. This is not so with *Bournonia* which has a typical radiolite hinge with two long teeth in the left valve which slide into furrowed grooves inside the body cavity of the right; from near the base of the teeth the two myophores project, running in a ventral direction, respectively within the anterior or flat side and the posterior or curved side; the anterior myophore is attached for nearly or all its length to the inside of the left valve but the posterior myophore is pedunculate, being attached only by a relatively narrow stem to the posterior teeth or to the yoke connecting the teeth. The space thus left between the myophore and the inner surface of the left valve may have served to permit the passage of the S or exhalant siphon. This interpretation would seem to be implicit in Rutten's placing of the S band in his figures of certain species (1936, fig. 3, fig. 4k) in such a position that the corresponding siphon would have to cross the myophore; to pass below would involve piercing the muscle, but the space above it was unimpeded. It is generally difficult to distinguish the siphonal from the other costae, which they closely resemble, though they tend to be somewhat wider and more prominent.

Bournonia cancellata (Whitfield)

Plate 39, figures 5-8

Radiolites cancellatus Whitfield, 1897a, p. 190, pl. 12, fig. 4, pl. 13, figs. 3-7.

Biradiolites cancellatus (Whitfield), Trechmann, 1924b, p. 403; not pl. 24, fig. 4.

Bournonia cancellata (Whitfield), MacGillivray, 1937, p. 39.

Bournonia cancellata (Whitfield), Chubb, 1955a, p. 4; 1956c, pp. 8, 13.

Occurrence.—A common fossil in the more shaly parts of the *Titanosarcolites* Series: at Logie Green and Trout Hall in Upper Clarendon, Catadupa and the Great River Valley on the borders of St. James and Westmoreland, and elsewhere. The specimens collected by Trechmann in the St. Anns Great River Valley are believed to belong to another species described below.

Description.—A small species, the right valve either tapering towards the base or parallel-sided. It was probably

recumbent. The anterior side is flat and is crossed by numerous growth lines representing the edges of the funnel plates; one or sometimes two narrow, shallow grooves run longitudinally. The convex dorsal, posterior and ventral sides have five or six rounded costae alternating with rather shallow, subangular furrows; as usual these correspond with folds in the funnel plates. A broad costa nearly in the middle of the posterior side is probably the S band; it is separated by a narrow costa between two furrows from the E band.

The left valve is moderately convex, with its umbo near the centre of the anterior side. It has low radial costae marked by plications in the thin laminae of the outer layer corresponding with those of the funnel plates; its scalloped edge fits that of the lower valve. Its cardinal apparatus is well shown in the section illustrated (Pl. 39, fig. 7). The two teeth fit into the channelled grooves of the right valve; the anterior myophore runs from the corresponding tooth in a ventral direction within the flattened anterior wall; the pedunculate posterior myophore springs from the yoke connecting the teeth, and at its ventral end there is a slight inflexion of the wall.

Dimensions. — Whitfield's largest specimen was 60 mm high; dorso-ventral diameter 50 mm, antero-posterior diameter 33 mm. The specimen figured in Plate 39 is slightly taller, its height being 70 mm; dorso-ventral diameter 45 mm, antero-posterior diameter 28 mm.

***Bournonia subcancellata* (Trechmann)**

Plate 40, figures 1-3

Biradiolites subcancellatus Trechmann, 1924b, *pars*, p. 403, pl. 26, fig. 3.

Bournonia cancellata Chubb, 1955a, *pars*, p. 4.

Occurrence. — An uncommon fossil found in the *Titanosarcolites* Series of Logie Green, Upper Clarendon.

Description. — The shell is small to medium in size and relatively short, the height being less than the dorso-ventral diameter. From its base the right valve increases rapidly in breadth; its anterior side is flattened with steeply up-turned funnel plates, these have a small sharp downfold in their middle which may express itself as a narrow longitudinal groove or ridge. The other sides are curved and bear about seven strong subangular costae; the funnel plates turn up all round at a low angle and are upfolded at the furrows and relatively downfolded at the costae. The small, simple, radial ridges, characteristic of the subfamily, are seen on the surfaces of the funnel plates. The position of the siphonal bands cannot be definitely determined.

The left valve is slightly convex with its umbo near the anterior margin; it does not appear to have radial undu-

lations; it covered the body cavity but it is uncertain whether it extended out over the folded parts of the funnel plates.

Dimensions. — The largest specimen has a height of 42 mm; diameter, dorso-ventral 65 mm, antero-posterior 45 mm. Trechmann gave the height as 52 mm, but this figure must have been obtained by measuring around the curved posterior side.

Remarks. — In a previous publication (Chubb, 1955a, p. 4) the opinion was expressed that this species was based on short, stumpy individuals of *B. cancellata*. Recently, however, as a result of study of specimens included in the Trechmann Bequest to the British Museum (Nat. Hist.) the conclusion has been reached that it is a distinct species. It is still thought that Trechmann's specimen from St. Ann's Great River should be excluded.

***Bournonia sanctannae* Chubb**

Plate 39, figures 9-12

Biradiolites cancellatus Trechmann, 1924b, p. 403, *pars*; pl. 24, fig. 4.
Biradiolites subcancellatus Trechmann, 1924b, pp. 403-404, *pars*.
Bournonia sanctannae Chubb, 1967, p. 28.

Occurrence. — A fairly common fossil in the *Barrettia* Limestone of St. Ann's Great River Valley.

Description. — A species of medium size. It somewhat resembles *B. cancellata* but is larger, has seven or eight angular costae, and generally no incised line on the anterior side, though a trace of this may occasionally be seen. The right valve is conical and is usually curved, the dorsal side being concave, but it may be straight or even curve ventrally. On the flattened anterior side the funnel plates turn up, becoming tangential; around the dorsal, posterior, and ventral sides the funnel plates are strongly inflected, the acutely angular downfolds corresponding with the costae; the amplitude of the folds may be as much as 10 mm. The two extreme costae, the dorsal and ventral, which bound the anterior face, are usually stronger and more projecting than the others; the ventral may be a pedal fold, but it is impossible to be sure which bands were siphonal.

The left valve is convex with its umbo near the middle of the anterior side. Radial costae are poorly developed; the strong and rather rugged growth lines are only slightly undulose near the umbo, but farther out the inflexions become more marked and, at the commissure, angular projections from the margin of the left valve fit into the grooves formed by the downfolds of the funnel plates of the right. Sections show that the hinge resembles that of *B. cancellata*.

Dimensions. — Maximum height 90-95 mm; diameter: dorso-ventral 65-70 mm, antero-posterior 35-45 mm.

Remarks.—Trechmann did not differentiate between this species and *B. cancellata*, but there are considerable differences between the two species, and also in their horizon, *B. sanctannae* being found in the lowest *Barrettia* Limestone and *B. cancellata* in the *Titanosarcotites* beds.

***Bournonia thiadensi* Vermunt**

Plate 40, figures 6-8

Bournonia sp. Rutten, 1936, p. 138, text fig. 4k.
Bournonia thiadensi Vermunt, 1937, pp. 271-272, pl. 36, figs. 4,5; text figs. 3 e-g.
Bournonia thiadensis [sic] MacGillivray, 1937, p. 39.
Bournonia thiadensi Vermunt, Chubb, 1956c, p. 13; 1961b, p. 421.

Occurrence.—A uncommon fossil in the outcrops of *Titanosarcotites* Limestone at the 14th mile post on the Point-Flamstead road, St. James, and in the Ducketts Land Settlement, Westmoreland, seems to belong to the Cuban species described by Rutten and Vermunt.

Description.—Rutten, who gave a transverse section showing the two teeth fitting into their grooves, their yoke, and the posterior myophore, described it as "a neat little form with strong ribs." According to Vermunt the two siphonal bands are pronounced costae, coinciding with downfolds of the funnel plates, 4 to 6 mm wide, separated by a sharp groove. Dorsally of S there are two sharp costae and ventrally of E there is another one, making five costae in all. The anterior side is flat or moulded onto the attachment surface.

The left valve entirely covers the right, it is depressed, with the apex anterior to the centre and somewhat raised; at its margin the strong ribs correspond with the grooves of the lower valve; the S and E are said to be developed as grooves, but are more probably on two of the costae.

Additionally it may be noted that the costae of the right valve are not necessarily limited to five, as there may be one or two adventitious ones, which are usually small. The shell is generally attached by its antero-dorsal side which tends to be concave as it preferred to fix itself to the convex surface of another rudist; the anterior side is nevertheless flat.

Dimensions.—Vermunt's type specimen has a height of 47 mm, dorso-ventral diameter 37 mm, antero-posterior diameter 25 mm. The largest of the Jamaican specimens illustrated in Plate 40 has a height of 40 mm, dorso-ventral diameter 45 mm, antero-posterior diameter 30 mm.

***Bournonia barretti* Trechmann**

Plate 40, figures 4,5

Bournonia barretti Trechmann, 1924b, p. 405, pl. 26, figs. 2,2a.
Bournonia barretti Trechmann, Chubb, 1956c, p. 8.

Occurrence.—A rare fossil found in the *Titanosarcotites* Limestone of Logie Green, Upper Clarendon, and in the Great River Valley and the railway cuttings near Cata-dupa, St. James.

Description.—Shell of medium size, growing singly; right valve curved conical, its maximum diameter about equal to its height, attached only by the apical portion of its anterior side. It bears 14 or 15 strong angular costae, including two or three less prominent on the anterior side, alternating with angular furrows; the funnel plates are strongly downfolded at the costae and upfolded at the furrows, the downfolds forming grooves across the commissure; the costae may appear as vertical series of spoutlike processes. In some individuals the funnel plates are greatly extended on the anterior side. Body cavity oval or kidney-shaped in outline, the anterior side straight or bulging slightly inwards; dorso-ventral diameter greater than antero-posterior.

Left valve slightly convex with subcentral umbo, concentric growth lines and marginal projections fitting into the grooves in the commissure of the right valve which it nearly covers.

Dimensions.—Height of the figured specimen 60 mm; diameter: dorso-ventral 59 mm, antero-posterior 40 mm; body cavity 35 by 24 mm. The largest specimen known has a diameter at the commissure of 100 by 82 mm; height of the right valve was probably about 90 or 100 mm, of left valve 25 mm.

***Bournonia baileyi* Chubb**

Plate 40, figures 9,10

Bournonia baileyi Chubb, 1967, p. 28.

Occurrence.—Two specimens were found in the *Barrettia* Limestone of Haughton Hall, Green Island by Mr. B. V. Bailey of the Geological Survey of Jamaica, for whom it is named. It has also been found in the *Barrettia* Limestone of St. Anns Great River.

Description.—A small to medium-sized shell, right valve conical, expanding rapidly with the result that the dorso-ventral diameter is greater than the height; it is curved with the dorsal side concave. On the smooth rounded anterior side the funnel plates turn up steeply and become tangential. The apical part of the posterior side also is nearly smooth, the costae becoming prominent nearly half way up; there are about five broadly rounded costae separated by relatively narrow and deep furrows; as might be expected the funnel plates show broad downfolds at the costae and sharp upfolds in the furrows. A characteristic feature is a strong, narrow, nearly parallel-sided ventral outfold, a spoutlike process which projects, as a flange,

about 20 mm, and is only some 3 mm wide; it is separated from the next adjacent costa by a narrow, acutely angular furrow, 5 mm deep. It may be a pedal fold.

The left valve is only slightly convex, its apex seems to be but little displaced towards the anterior. Radial costae are hardly developed, but such as there are can be seen to correspond with the furrows of the right valve, while the intervening grooves extend as lappets over the sinuses in the commissure at the costae. A narrow grooved process fits into the ventral outfold of the right valve.

Dimensions.—Height of right valve 53 mm; dorso-ventral diameter 72 mm, antero-posterior 39 mm; height of left valve 9 mm.

***Bournonia sanctariae* Chubb**

Plate 40, figure 13

Radiolites cf. *cancellatus* Trechmann, 1924a, pp. 9, 19; pl. 1, fig. 3.
Bournonia sanctariae Chubb, 1967, p. 28.

Occurrence.—A conglomerate interbedded in the Richmond Beds or Carbonaceous Shale, near Port Maria, St. Mary, has yielded a number of rudists and Cretaceous gastropods; both the shale and the conglomerate contain an Eocene molluscan and foraminiferal fauna, and it is obvious that the Cretaceous fossils are reworked. Most of the rudists have been reduced to the condition of pebbles by rolling; these include *Thyrastylon* spp., *Bournoni cancellata* and probably other Maestrichtian fossils. But a *Barrettia monolifera* collected by the Geological Survey, and a *Bournonia* sp. collected and figured by Trechmann show little if any rolling, so there is presumptive evidence that these two specimens derive from the same nearby outcrop and are of the same age, i.e. Campanian. Probably the conglomerate was supplied with material from a near Campanian outcrop and a distant Maestrichtian one. The *Bournonia* (BMNH No. L63255) differs somewhat from any known species.

Description.—A small to medium-sized shell, apparently attached by the whole of its anterior side, which is flattened and rough, with its funnel plates vertical and tangential. The dorsal side also is flat with upstanding tangential funnel plates. The posterior and ventral sides have seven longitudinal costae, that nearest the dorsum being small and succeeding ones becoming progressively larger and more prominent; they are separated by narrow angular furrows; the funnel plates are sharply downfolded at the costae, the amplitude of the folds attaining or exceeding 10 mm. The sixth costa divides into two near the commissure and the seventh, which is separated from it by an angular furrow some 15 mm wide by 15 mm deep, is the most prominent and consists of a series of downturned spouts; it is probably a pedal fold.

The marginal parts of the left valve are preserved although the central part has been crushed into the body cavity. It seems to have been more or less flat, its outer layer is laminar, the laminae being folded in conformity with the folding of the funnel plates; as a result of this it has a strong radial costae, the intervening furrows corresponding with the costae of the right valve.

Dimensions.—The height is 60 mm; diameter, dorso-ventral 65 mm, antero-posterior 45 mm.

***Bournonia tetrahedron* Chubb**

Plate 40, figures 11, 12

Bournonia tetrahedron Chubb, 1967, pp. 28-29.

Occurrence.—Three individuals, of which two are immature, are attached to a left valve of *Antilocaprina occidentalis* (Whitfield), from the Maestrichtian of Logie Green, Upper Clarendon, which was included in the Trechmann Bequest.

Description.—A very small shell, tetrahedral, right valve attached by the whole of its triangular anterior face, the dorsal and ventral corners of which are prolonged as narrow, tapering, hornlike processes, closely adherent to the surface of attachment; the umbo curves ventrally. The dorsal and ventral faces are both triangular, their funnel plates turn up parallel to the surface and are mutually tangential, with the result that only the outermost funnel plate is visible and the surface is smooth; each of these faces has a slight downfold at the commissural margin, close to the nearby siphonal band. The bands are represented by two prominent costae, 3 mm wide, and the interband by a slightly broader subangular furrow; the funnel plates rise parallel to the surface in the interband but are downfolded in the bands, where they are rather widely spaced at 14 in 1 cm; here also the vertical radial plates may be seen to the number of about six in a breadth of 3 mm.

The left valve is triangular, nearly flat, not extending over the horns of the right valve, but with grooved lappets covering the siphonal costae. It has a structure similar to that of the right valve of the *Radiolitinae*, with parallel laminae, not in contact, resembling funnel plates, crossed by vertical radial plates, making a pattern of quadrangular cells. The outermost lamina, forming the surface of the valve, is present in the two immature shells, but is largely lost in the adult; however, some is preserved showing a low, nearly flat umbo in the middle and about 5 mm from the anterior margin; it is also preserved in the rounded groove which runs out on the lappet over the E costa; probably the S lappet had a similar groove. The hinge structure and myophores are unknown.

Dimensions.—The adult shell has a height of 23 mm; diameter, antero-posterior 16 mm, dorso-ventral, left valve 29 mm, right valve including horns 44 mm.

***Bournonia coxi* Chubb**

Plate 44, figures 2-4

Bournonia coxi Chubb, 1967, p. 29.

Occurrence.—A single specimen consisting of two mutually adherent bivalve shells was found in the *Barrettia* Limestone of St. Ann's Great River, St. Ann. Named for the late Dr. L. R. Cox of the British Museum (Natural History).

Description.—A small or very small species. Right valve smooth, conical, height considerably greater than diameter, cross-section quadrilateral. The shell is smooth with the funnel plates turned up and becoming tangential except at the siphonal folds where they are downfolded. The bands are two smooth, rounded costae, separated by a narrow, acute furrow. There is a small outfold, probably pedal, near the E band. The siphonal area resembles that of *B. tetrahedron*, but the two right valves are attached to each other, not by their anterior sides as is usual, but by their dorsal sides. Perhaps their relationship is accidental and due to both having originally attached themselves to the same small shell.

The left valves are flat or concave with lappets extending over the siphonal and pedal folds. Their structure is similar to that of *B. tetrahedron*, with horizontal laminae separated by vertical radial plates, making a quadrangular reticulate pattern. Each left valve bears a small adherent *Ostrea* sp.

Dimensions.—The smaller shell is 35 mm high, its antero-posterior diameter is 24 mm, its dorso-ventral 22 mm; the corresponding figures for the larger are 45 mm, 32 mm, 24 mm.

Subfamily **SAUVAGESIINAE** Douvillé, 1910

Radiolitidae in which the vertical radial plates of the outer layer, by repeated bifurcation and inosculation, make a polygonal cell pattern resembling a fine honeycomb; this may be seen either on the surface of the funnel plates or in a transverse section.

(a) *Sauvagesiinae* with ligament

Genus **SAUVAGESIA** Bayle, 1887

Right valve cylindro-conical with numerous longitudinal costae; funnel plates show strong radial plications, the downfolds corresponding with the costae and the upfolds with the intervening furrows. The ligamental infold (L) is well developed in Jamaican species; it is shown externally by a

furrow, not noticeably different from the others, but a transverse section may show a line of crowded cells extending from this furrow across the funnel plates into the infold; the latter projects several millimetres into the body cavity and may have a flange at its inner end. The siphonal bands are represented by two broadly concave sulci, the interband (I) consisting of two costae separated by a narrow furrow; the inhalent band (E) is diametrically opposite to the ligament. The inner layer is thin, lining the body cavity and forming concave tabulae below it. The left valve is depressed conical, with thin outer layer and well-developed inner layer. The hinge is of normal radiolite type.

***Sauvagesia macroplicata* (Whitfield)**

Plate 41, figures 1-4

Radiolites macroplicatus Whitfield, 1897a, pp. 190-191, pl. 13, fig. 8; pl. 14, figs. 1,2; not pl. 12, figs. 2,3.
Sauvagesia macroplicata (Whitfield), Chubb, 1955a, pp. 4-5; 1956a, pp. 16-17, pl. 3, fig. 5; pl. 4, figs. 1,2; 1956c, p. 8.
 Not *Radiolites macroplicatus* Thiadens, 1936a, pp. 1013-1014.

Occurrence.—A rare species in the *Titanosarcolithes* Limestone; Whitfield's and Matley's specimens are from the Logie Green section of Upper Clarendon, and a Jamaican Geological Survey specimen from the Shortwood parochial road, St. James. Whitfield included three species under the name *R. macroplicatus*, so a lectotype was selected (Chubb, 1955a) of which Whitfield's original figure is reproduced in Plate 41, figure 1.

Description.—Shell of medium size. Right valve elongate conical, its maximum diameter being attained some distance below the commissure; above this level the outer layer becomes progressively thinner by decrease in width of the funnel plates, while the body cavity, bounded by the inner layer, continues to increase in diameter to a maximum at the commissure. The outer layer may fail to reach the commissure on the dorsal side, where the uppermost part of the shell wall may consist of inner layer only; on the ventro-posterior side, with its siphonal bands, the outer layer must necessarily reach the commissure. The valve has 14 or 15 sharp longitudinal costae, corresponding to downfolds of the funnel plates. The excessive plication of these plates is the chief specific character; the amplitude of the folds may exceed 25 mm; both the upfolds and the downfolds are sharply angular and the two limbs of a fold may be almost parallel in the middle part of their length and meet in an angle as low as 30°. The siphonal bands are deep rounded grooves and the interband consists of two costae with a relatively shallow furrow between. There are from 35 to 40 funnel plates in 1 cm; the cells forming the polygonal mosaic are between 0.25 and 0.50 mm in diameter. The maximum thick-

ness of the outer layer is at least 25 mm, that of the inner layer only some 0.3 to 0.5 mm. The body cavity is circular; the ligamental ridge, which projects into it about 5 mm, is flat and planklike, being about 1 mm thick; it is formed by an infold of the outer layer covered by a thin envelope of inner layer.

The left valve is a low cone with central apex. The Survey specimen had two young shells of the same species growing upon it and when these were broken away a horizontal section of the left valve was obtained (Pl. 41, fig. 3). It resembles that of a caprinid; its outer layer is laminar, about 2.5 mm thick, and ornamented with concentric growth lines and low radial plications; its inner layer is thick and is penetrated by "canals" separated by a series of thin vertical plates, some of which bifurcate when traced outwards; at their internal edges these plates spread and coalesce to form the smooth inner surface of the valve. The left valve of one of the young individuals has been eroded away showing part of the hinge structure, including the teeth and the myophoric processes with denticulated outer faces, forming a horseshoe within the right valve.

Dimensions.—The lectotype in the American Museum of Natural History has lost the apical part of its right valve, which was probably originally some 90 mm high; it has a maximum diameter, about 35 mm below the commissure, of 64 mm, and a commissural diameter of 45 mm. The Survey specimen also has lost its apical part; it is 115 mm high (perhaps originally 180), and has a diameter at the lowest part preserved of 65 mm, at its widest part at least 85 mm, and at its commissure some 60–65 mm, the widest part being about 60 mm below the commissure; the diameter of the body cavity at the same levels is at lowest point 41 mm, at widest part 46 mm, and at commissure 55 mm. The small Matley specimen in the United States National Museum is 75 mm long, with a maximum diameter of 45 mm, and a commissural diameter of 35 mm.

Sauvagesia mcgrathi Chubb

Plate 42, figures 1-3

Radiolites macroplicatus Whitfield, *pars*, 1897a, pl. 12, fig. 2.
Sauvagesia mcgrathi Chubb, 1956a, pp. 17-18, pl. 3, figs. 3,+; 1956c, p. 8.

Occurrence.—Found in float and river gravel derived from the lowest limestones of the *Titanosarcotites* Series near the southern margin of the Sunderland Inlier, St. James, where it is associated with *Praebarrettia sparcilirata* (Whitfield). Whitfield's specimen came from Logie Green, Upper Clarendon.

Description.—Right valve straight cylindro-conical with nearly circular cross section, ornamented with about 14 longitudinal costae. It is of medium size with its maximum diameter at the commissure. The siphonal bands are broadly concave each attaining a maximum width of about 20–22 mm; they were originally finely costate with seven or eight low rounded longitudinal ridges; the interband is parallel-sided, about 20 mm wide, and consists of two costae separated by an angular furrow. The funnel plates are plicated, the downfolds corresponding with the costae, the amplitude of the folds being about 10 mm, and the angle between the limbs of each fold being 50° to 60°. The thickness of the outer layer varies from a maximum of about 25 mm on the ligamental side to a minimum of some 12 mm in the siphonal bands. The polygonal cell pattern is fine. The inner shell layer is about 0.5 mm thick; the body cavity is nearly circular. In one of the sections illustrated in Plate 42 the ligamental ridge is broken and its end displaced; in the other it is intact, projecting about 6 mm into the body cavity; its breadth is 0.8 mm, expanding abruptly at its inner end to 2.5 mm.

The left valve of Whitfield's specimen is the best preserved; it is depressed conical with eccentric apex, and marked by radial corrugations and concentric growth lines. That of the specimen illustrated in Plate 42, figures 1,2 has been badly eroded, but the section shows within the right valve the posterior myophore of the left valve in position attached to the posterior tooth which has been hollowed by solution; the anterior myophore and tooth are present, but are broken and displaced.

Dimensions.—The specimen illustrated is about 150 mm high, the diameter of the smaller end being about 50 mm and that of the larger or commissural end about 90 mm. The mean diameter of the body cavity is about 50 mm.

Sauvagesia fluminisagni Chubb

Plate 42, figures 4,5

Sauvagesia fluminisagni Chubb, 1956a, p. 18, pl. 4, figs. 3,7; 1956c, p. 8.

Occurrence.—A single right valve considerably eroded on its ventral and anterior sides, and with its upper part crushed, was collected in the *Titanosarcotites* Limestone of Cotton Tree Gully, Lambs River Valley, Westmoreland, near the St. James border.

Description.—This small to medium species is slender and more cylindrical than the two preceding. It has about 16 narrow angular costae corresponding with downfolds of the funnel plates; the amplitude of the folds is generally about 5 mm but in a few places reaches 8 mm.

and the angle between the limbs of the folds is about 60° to 70° . The inhalent siphonal band (E) is not clear owing to erosion, but it is indicated by a broad rounded upfold of the funnel plates which evidently correspond with a sunken band about 10 mm wide, diametrically opposite to the ligament. The interband is about 15 mm wide, and consists of two sharp costae with an angular furrow between. The exhalent band (S) is a flat-bottomed channel about 10 mm wide, with the funnel plates making sharp upfolds in its two corners joined by a slight broad downfold across its floor; there are indications that it had five or six small longitudinal costellae. The thickness of the outer layer is 13-15 mm except at the siphonal bands where it is only 10 mm; the cell pattern is polygonal with traces of radial structure in places. The inner layer is about 0.5 mm thick. The ligamental crest is 0.7 mm wide and projects some 3-4 mm into the body cavity.

Dimensions.—The specimen is about 150 mm high and 50-55 mm in diameter. The mean diameter of the body cavity is about 30 mm.

Sauvagesia annulosa (Whitfield)

Plate 41, figures 5-7

Radiolites annulosus Whitfield, 1897a, pp. 191-192, pl. 14, fig. 3.
Radiolites annulosus Whitfield, Chubb, 1955a, pp. 5-6; 1956c, p. 8.

Occurrence.—Only a single specimen, the holotype, is known. It is stated to have been found in the Cretaceous limestones near "Christianna," Manchester Parish; probably from the Logie Green area, Upper Clarendon Parish.

Description.—Shell of medium size, right valve straight, acutely conical, left valve depressed conical. Right valve has numerous regular varix-like rings, of which there are about seven or eight in 25 mm. The varices, each of which consists of about eight to ten funnel plates, run around the shell almost without inflections, but two broad shallow upfolds occur on the ventral side, separated by a slightly sharper downfold; the funnel plates are grouped into bands of finer and coarser sets to form the varix-like annulations. As Douvillé observed (1898, p. 123) this specimen has been much eroded; the present thickness of the outer layer is only about 1 mm on the dorsal side and 2-3 mm on the ventral, and its original thickness, and whether the funnel plates were marginally frilled or folded cannot be guessed. The cell pattern is not obvious, but a re-examination of the specimen has led to a revision of the opinion that it is radial and quadrangular (Chubb, 1955a, p. 6); it is now thought to be polygonal. A ligamental infold projects about 5 mm into the body cavity, and can be traced down

the outside of the shell to the apex by a slight narrow downfold of the funnel plates.

The umbo of the left valve is near the dorsal side. The valve is much eroded and most, if not all, of the outer layer has disappeared. The inner layer thus revealed resembles that of a caprinid or of *S. macroplicata*, with vertical radial plates which, at their inner edges, spread out and unite to form a smooth lining for the valve. The hinge structure is unknown.

Dimensions.—Height of right valve 95 mm, of left valve 20 mm; maximum diameter at commissure 60 mm.

Remarks.—It is regrettable that a new species was created for such a poorly preserved specimen, and that its specific name was based on a character produced by weathering. It is here transferred from the genus *Radiolites* to *Sauvagesia* because of its apparently polygonal cell pattern.

(b) *Sauvagesiinae* without ligament

Genus *TEPEYACIA* Palmer, 1928

Only the right valve is known. Shell conical, nearly straight, dorso-ventral diameter less than antero-posterior; outer shell layer thin, with numerous strong, acute, longitudinal costae, corresponding with sharp downfolds of the funnel plates. The siphonal bands are smooth and lie in deep grooves which are actual infolds of both outer and inner layers, the latter thinning and bulging into the body cavity to form incipient pseudopillars; the E infold is more pronounced than the S. Inner layer generally thicker than outer; hinge located in the inner layer. Palmer described a ligamental infold but there is no such structure in the Jamaican material. No myophores seen; presumably the muscles were attached directly to the inside of the right valve as in other members of the family.

Tepeyacia multicostata Chubb

Plate 43, figures 1-4

Tepeyacia multicostata Chubb, 1967, p. 29.

Occurrence.—In Cretaceous tuffaceous shaly material, NNE of Seafeld Manse, where it is associated with *Sabinia totiseptata* Palmer and *Sphaerucaprina seafieldensis* Chubb. The matrix attached to and infilling the shells is mainly a finely conglomeratic tuff. One specimen (Pl. 43, fig. 2) shows graded bedding in its interior; evidently when buried it was lying on its posterior side, and it contains coarse tuff on this side which grades into a fine material on its anterior side.

Description.—A small species, obviously closely related to, though not identical with *T. corrugata* Palmer. Right valve conical, the height somewhat greater than the di-

ameter, and the antero-posterior diameter slightly greater than the dorso-ventral. It is ornamented with numerous sharp costae, at least 50, and in the larger shells perhaps as many as 90; these correspond with acutely angular downfolds of the funnel plates comparable with those of *Sauvagesia macroplicata* (Whitfield) though on a much smaller scale. The siphonal bands lie in deep rounded grooves and the interband is marked by several angular costae.

Sections show that the outer layer is relatively thin and the inner thick, in places thicker than the outer. A fine polygonal cellular pattern may be seen in the siphonal areas of the outer layer where the funnel plates are nearly horizontal. There is no ligamental infold but the hinge is well developed, the tooth N, nearly square in section, having flanges at its two free corners; it is flanked by two long transversely oval sockets which, in the higher parts of the body cavity, are mere vertically striated grooves between the tooth and anterior and posterior buttresses which curve inwards from the wall. In the deeper parts these buttresses are connected with the flanged corners of the tooth by extremely thin laminae which separate the sockets from the body cavity. The S and E grooves are sharp infolds of both shell layers, but the inner layer is much attenuated at the infolds, reducing though not eliminating the bulges into the body cavity, which form slight pseudopillars. The E band is diametrically opposite the tooth. The ventro-posterior (*i.e.* the siphonal side) is slightly flattened, with the result that the body cavity is oval. The inner layer forms tabulae only in the deeper parts of the shell, the body cavity being open nearly to the bottom.

The left valve is unknown except that the end of its two teeth may be seen in the deeper parts of the sockets of the right valve; they are transversely oval and fluted on their outer faces to correspond with the flutings of the sockets.

Dimensions.—There are two specimens: (a) antero-posterior diameter 38 mm, dorso-ventral 34 mm, height 35 mm; corresponding figures for (b) 48 mm, 41 mm, 45 mm.

Remarks.—The Jamaican material is superior to the specimens of *Tepeyacia corrugata* found by Palmer (1928, pp. 46-47) in the Tepeyac Mountains, south of Puebla, Mexico, and by Thiadens (1936b, pp. 1133-1134) in the Provincial Limestones of southern Las Villas, Cuba. The latter author found no trace of a ligamental infold and rightly thought that Palmer's figure, which purported to show one, was far from convincing. He, however, believed that he had found traces of myophores, but his own figure fails to carry conviction. Owing to the alleged absence of vertical radial plates Palmer included *Tepeyacia* in the Monopleuridae, but Thiadens, although he did not find such plates, thought

the Cuban form more closely related to the Radiolitidae. Kühn (1932, p. 178) included it in the Radiolitidae. The discovery of a polygonal cellular structure in the Jamaican specimens leaves no doubt that they belong to the family Radiolitidae, subfamily Sauvagesiinae; the difficulty in recognising this structure is due to the intense folding of the funnel plates which, in a cross cut, are seen in almost vertical section except in the siphonal areas.

T. multicostata differs from *T. corrugata* in having twice or thrice as many costae and in being less flattened, though it may be suspected that the flattening of Palmer's specimen has been accentuated by crushing. One of Thiadens' specimens is not much more flattened than the Jamaican material.

Tepeyacia multicostata is one of the earliest and most primitive of the ligamentless Sauvagesiinae. As noted above *Tepeyacia* and *Caprinuloides* have been found by Bob Perkins in Texas rocks of Albian age, so it is probable that the Seafield Series, including limestone and tuff, belongs to this period.

Genus *DURANIA* Douvillé, 1908

Durania typically has a polygonal cell pattern and is generally defined as being essentially like *Sauvagesia* except for the absence of the ligamental ridge. But there seems to be less tendency to plication of the funnel plates, which are often more or less flat and horizontal; this is especially true of Jamaican species. The siphonal bands are represented by two grooves or furrows, which may be sharply angular or broadly concave; in the latter case they may be smooth or finely costate. The interband consists of one or two costae, rounded or angular.

Durania nicholasi (Whitfield)

Plate 43, figure 6; Plate 44, figure 1; Plates 45, 46

Radiolites (Lapcirusia) nicholasi Whitfield, 1897a, pp. 186-188, pls. 6-9.
Lapcirusia nicholasi (Whitfield), Trechmann, 1924b, pp. 405-406.
Durania nicholasi (Whitfield), Kühn, 1932, p. 108.
Durania nicholasi (Whitfield), Chubb, 1955a, pp. 2-3; 1956c, pp. 7-8.
Durania cf. nicholasi Chubb, 1959, pp. 743-746, fig. 10.

Occurrence.—This is the only rudist species that has been found in Jamaica in association with both *Barrettia* and *Titanosarcolites*. It occurs in the limestones of the *Barrettia* Series at New Ground in the St. Ann's Great River Valley, St. Ann; in the Stapleton Limestone of the Sunderland Inlier, St. James; and in the Houghton Hall Limestone of the Green Island Inlier, Hanover. It is found also in the lowest beds of the *Titanosarcolites* Series in the Logie Green area of Upper Clarendon, where it is associated with *Praebar-*

rettia sparcilirata. Right valves, generally incomplete, are common in all these localities, but only one free left valve has been found.

Description.—This is a gigantic species having the largest diameter, though not the greatest height, of any Jamaican rudist, the adult right valve commonly having a diameter of 450 mm or even more. The height may be as great but is usually less the characteristic form being turbinate or depressed conical with a large apical angle. The external surface is rugged with annular ridges running around it, but it is generally badly weathered or eroded and the posterior wall, being the thinnest, is rarely preserved. A specimen figured by Whitfield (1897a, pl. 7, fig. 2) and reproduced here in Plate 43, figure 6, retains this wall, which shows two grooves about 40 mm apart at the base, diverging to 140 mm at the commissure; the intervening area is convex. No doubt these grooves are siphonal.

A specimen in the museum of the Institute of Jamaica, Kingston, figured in Plates 44 and 45, shows a broad rounded furrow extending from the base to the commissure, increasing in width from about 40 mm at the lowest part preserved to 70 mm at the commissure; its depth is a little less than half its width. This is certainly the E band; the S band is broken away.

The diameter of the body cavity is generally about one third of that of the valve, varying between one quarter and two fifths. The wall, except on the posterior side, is extremely thick, usually wider than the body cavity, while that on the siphonal side is much less. Whitfield, who believed this to be the cardinal side, gave its thickness as 25 or 50 mm, but in the Institute specimen the thickness in the E band is only 15 mm, and this band bulges into the body cavity to form an incipient pseudopillar as in *Tepeyacia*. The S band does not form a pseudopillar.

The body cavity is conical extending to the base of the shell. In low broad individuals it is generally open to the bottom, and the inner layer which lines it does not form tabulae. But in the Institute specimen, which is nearly as high as it is broad, the deeper parts of the cavity are filled with vesicular tissue resembling that described below under *Chiapassella radiolitiformis*.

The funnel plates of the outer layer are extremely thin and close set so that there may be as many as 100 in one cm. Usually they are in contact, when no cell pattern is visible, but exceptional specimens show a fine polygonal pattern. The great thickness of the wall is due to the enormous width of the funnel plates which may attain 180 mm or more around the dorsal, anterior, and ventral sides. They show radial vascular grooves which branch dichotomously or laterally several times. The plates are smooth or gently

undulating and have no sharp folds except at the siphonal bands. The downfold at the E band may have an amplitude of 70 mm, steep even precipitous at the sides, but levelling to a gentle curve across the bottom of the groove; there is a sharp upfold at the S band, well shown in Whitfield's figure (see Plate 43, figure 6).

The only known free left valve is that described and figured by Whitfield (1897a, pls. 8,9). It is a thick and massive shell, convex, with a diameter much less than that of the right valve, though somewhat greater than that of the body cavity, which it overlaps by some 12-20 mm. It is transversely oval, its antero-posterior diameter being the greater. The teeth are oblique, relatively short and thick, the anterior the longer, united by a yoke in the form of a vertical plate which is nearly as tall as the posterior tooth. The anterior myophore is a strong vertical process, separated by a notch from the anterior tooth, and curving around within the margin of the right valve; the posterior myophore is a horizontal triangular plate, attached by a relatively narrow neck, and spreading out towards its abutment against the greatly thickened inner layer of the body cavity of the right valve, where it ends in numerous denticulations.

Dimensions.—The principal dimensions are given above; the average diameter of the right valve is some 400 mm and the maximum 600 mm. According to Whitfield the height is "probably somewhat greater"; Trechmann described it as "sometimes two feet in height and over a foot in diameter." In both these estimates the height is exaggerated; it may equal the diameter but is usually less. The body cavity is generally some 120 to 150 mm in diameter. The thickness of the wall, corresponding to the breadth of the funnel plates, on the dorsal, anterior and ventral sides, is from 150 to 200 mm; on the posterior side perhaps about 25 to 50 mm, and in the E band 15 mm. The diameter of the left valve is antero-posteriorly 155 mm, dorso-ventrally 120 mm; height above commissure 50 mm.

Remarks.—Whitfield ascribed this species to Bayle's genus *Lapeirousia*, but it lacks the true pseudopillars in the right valve and the oscules in the left that characterize that genus. He described a plate and ridge, which are attached to the left valve, as a fragment of the right. In an earlier publication (Chubb, 1955a, p. 2) this statement was discredited and the view was expressed that the plate and ridge were an integral part of the left valve. It is now believed that Whitfield was right and the plate and ridge are part of a thickened inner layer of the right valve. The doubt was partly due to the fact that no such thickened inner layer has been seen in any of the many right valves that have been examined. The ridge is a process which penetrates between the posterior tooth and the posterior myo-

phore; such a process is common in the Radiolitidae, it is seen for example in the figured section of *Bournonia cancellata* (Plate 39, fig. 7).

MacGillavry (1937, pp. 40-42) included several species, among them *Radiolites (Lapeirousia) nicholasi*, in a group which he called *Bournonia* new section, "characterized by the nature of the siphonal region. E is a broad, flat-bottomed downfold of the funnel-plates. At the posterior side of E the funnel-plates slope suddenly and dizzily upwards. The highest point is reached at the exhalent siphonal band, S, where they form a flat, narrow, slightly depressed top, to slope downward, but not as steeply again, on the other side of S."

MacGillavry's "new section" appears to be a natural group, but it cannot be ascribed to *Bournonia*, which has a quadrangular cell pattern, a flattened anterior side, and siphonal bands in the form of costae not grooves.

Durania cf. *aguilae* Adkins

Plate 43, figure 5

Durania sp. cf. *D. aguilae* Chubb, 1956a, pp. 18-19, pl. 4, figs. 5, 6; 1956c, p. 7.

Occurrence.—A simple incomplete right valve was found in the *Barrettia* Limestone near mile post 9 on the Kensington-Amity Hall road, St. James. This is a continuation of the Stapleton Limestone outcrop.

Description.—Right valve large, broadly conical at the base with apical angle of about 60°, turning up rather abruptly and becoming more cylindrical, with a mean diameter at the commissure of 160 mm. A slight inward inflection of the wall, some 30 mm wide, resembling one of the rudimentary pseudopillars of *Tepeyacia*, represents the E siphonal band; the part of the wall where the S band would be expected is missing. The maximum thickness of the wall is 25 mm, the minimum thickness is 9 mm at the E band. The funnel plates, of which there are about 40 in 1 cm, are crossed by radial vascular grooves, many of which branch once. The plates turn up slightly from the inner shell layer but soon become horizontal except at the E band, where they continue the upward slope to their outer margin; they are uninflected except at their peripheral edge which is sharply folded, the downfolds being about 5-8 mm wide around most of the circumference, but only 2 mm wide in the E band. The outer surface is nearly everywhere covered with rock material, but where small areas are visible rounded costae may be seen corresponding with the downfolds and rising about 1 mm above the intervening furrows; in the E band the costellae are some 2 mm wide. The cell pattern

is polygonal, the diameter of the cells being 0.3-0.5 mm. The inner layer is 0.7-1 mm thick; it is not known whether it forms tabulae.

The left valve is unknown.

Dimensions.—Height of the specimen 92 mm; diameter at the lowest part preserved 135 by 90 mm; commissural diameter 175 by 140 mm.

Remarks.—This form resembles *D. aguilae* Adkins which, though smaller, has similar proportions and similar slight inward inflexions of the S and E bands. Adkins' species, however, is more strongly ribbed and increases in diameter much more gradually than the Jamaican form.

Genus *CHIAPASELLA* Mullerried, 1931

Shell of medium to large size, right valve conical or cylindro-conical; left valve depressed conical in youth, becoming high conical and arched or coiled, and overhanging the dorsal margin of the right valve in maturity.

The right valve is usually costate, the costae being rounded and intervening furrows angular. The siphonal bands are probably on two of the costae but are difficult to distinguish. The outer layer is thick and is composed of funnel plates which are more or less horizontal, not generally being downfolded at the costae and hardly upfolded at the furrows. Some of the furrows mark the position of infolds which penetrate the outer layer to about the middle of its thickness; they are club-shaped in cross section and the margins of the funnel plates are turned up against them. Inner layer thin, lining the body cavity and filling its lower part with irregular tabulae or vesicular tissue.

The left valve has a smooth surface, sometimes with a few broad, shallow, rounded furrows, separated by low rounded ridges, which converge towards the umbo; this is nearly centrally located on the patelliform valve of young individuals, and arched and overhanging on that of adults. The outer layer is thin and laminar; its commissural edge is turned out and scalloped, with rounded lappets which fit over the costae of the right valve. The inner layer is thick and in youth resembles that of *Sauvagesia macroplicata* (q.v.), being composed of vertical radial plates or septa, some of which bifurcate when traced outwards, separated by empty spaces; at their internal edges these septa spread and unite to form a smooth lining for the valve. In the long curved adult valve these septa extend to the umbo, and the innermost part of the inner layer fills the deeper part of body cavity with vesicular tissue as in the right valve.

The cardinal apparatus is of normal radiolite type, with two externally channelled teeth united by a yoke, sliding

in channelled grooves in the body cavity of the right valve which has no tooth or ligament. The myophores run around within the anterior and posterior margins of the body cavity; the posterior myophore is comparatively short; the anterior is exceptionally long extending at least to the ventral point or even beyond it.

***Chiapasella radiolitiformis* (Trechmann)**

Plate 47, figures 1-4; Plate 48, figures 1-4

Coralliochama radiolitiformis Trechmann, 1924b, pp. 406-407, pl. 24, figs. 1, 2, 2a, 3.

Chiapasella radiolitiformis (Trechmann), Mullerried, 1931, pp. 244-252, figs. 1-11.

Chiapasella radiolitiformis (Trechmann), Chubb, 1956c, p. 8; 1959, p. 746.

Not *Chiapasella radiolitiformis* Boissevain and MacGillavry, 1932, pp. 1308-1312.

Occurrence.—A common fossil in the *Titanosarcolites* beds wherever they occur in Jamaica, especially in the Logie Green area of Upper Clarendon, the Chatsworth, Vaughansfield, and Catadupa areas of St. James, and Lambs River and Ducketts areas of Westmoreland.

Description.—A large species though not, by Jamaican standards, gigantic. It is usually solitary though clusters of half a dozen shells have been found.

An adult right valve is normally cylindro-conical; it has from 16 to 20 low rounded longitudinal costae, separated by angular furrows; in well-preserved specimens fine longitudinal costellae, less than 1 mm wide, are superimposed on the costae. In some individuals the right valve was broadly turbinate in youth but, after attaining a maximum breadth, the walls turned up abruptly and the diameter became somewhat reduced; at the horizon where the direction of growth changed the costae project as "thumb-like outward or downwardly directed prolongations" (Trechmann, 1924b, p. 406). Two of the costae, which have a number of longitudinal grooves, represent the siphonal bands; between them the interband consists of two normal costae. In the outer layer the funnel plates are unfolded except for a small but sharp upturn at the club-shaped infolds. The cellular pattern is sometimes radial close to the body cavity, but is normally polygonal, the mean diameter of the cells being about 1 mm. The inner layer does not form the concave tabulae which are usually found in elongated rudists, but an irregular and complex system of small domed plates, convex towards the body cavity, forming a vesicular tissue, resembling that of certain Palaeozoic corals such as *Michelinia*.

The left valve in young individuals is a low, broad cone, with its umbo eccentric towards the dorsal side; in older forms high and strongly arched with its umbo incurved and

overhanging the dorsal margin of the right valve, so that it resembles the left valve of a caprinid. The smooth outer layer is from 0.5 to 1 mm thick; it is often partly or wholly removed by weathering or erosion, when the underlying vertical septa of the inner layer may be seen. In adults, within the septate zone, the inner layer forms a vesicular tissue of small domed plates convex towards the body cavity, similar to those of the right valve. A section shows that the septate zone merges into the vesicular zone, with no plane of demarcation between them, proving that they belong to the same shell layer. The outer layer is clearly demarcated from the septate zone.

The hinge and myophores have not been seen but there is no reason to suppose that they differ from those of the closely related species *C. pauciplicata* Mullerried which has been described (under the name of *C. radiolitiformis*) by Boissevain and MacGillavry (1932, p. 1311, fig. 6) and *C. cubensis* Rutten, described by its author (1936, p. 140, fig. 4h). See generic description above.

Dimensions.—According to Trechmann his largest specimen was about 206 mm high and 117 mm in maximum diameter; the height of the left valve was generally about half that of the right. The largest specimen shown in Plate 48 is 260 mm high, but before the loss of the apical part of its right valve it was probably well over 300; its commissural diameter is: antero-posterior 150 mm, dorso-ventral 130 mm; the left valve is perhaps half the original height of the right but, measured around the outside of the curve, it would be considerably longer. The outer layer of the right valve is up to 25 mm thick, the inner layer 0.5 mm. The specimens found by Mullerried in Mexico were all considerably smaller.

Remarks.—There has been much confused thinking about this species. It was first described by Trechmann who, misled by the left valve, believed it to be a caprinid and ascribed it to the Mexican and Californian genus *Coralliochama*; he thought that the resemblance of the right valve to a radiolite was deceptive and perpetuated this opinion in the specific name, *radiolitiformis*. Mullerried (1931) found the same species in Mexico, and created the new genus, *Chiapasella*, for it; he believed it to be between the Caprinidae and the Radiolitidae to be related somewhat to the Hipuritidae and to the Chamidae. His description is difficult to follow owing to his unusual use of terms, e.g. anterior and posterior for ventral and dorsal, right and left for posterior and anterior; the siphonal zones are described (p. 250) as concave, and later in the same paragraph as convex; probably he meant to convey that the bands are concave in the left valve and convex in the right, but this is not stated. Mullerried also claimed that there were three layers in each valve; in the right a cortical layer in addition to outer

and inner, while in the left the actual outer layer was regarded as cortical and the septal zone as the outer layer. The so-called "cortical layer" of the left valve was stated to be up to 1 cm thick; in Jamaican material the thickness of this outer layer is generally less than 1 mm.

Mullerried (pp. 252-253) described another Mexican species, *C. pauciplicata*. This and other species have also been found in Cuba (Boissevain and MacGillavry, 1932, pp. 1308-1311; Palmer, 1933, pp. 101-102; Rutten, 1936, p. 140; Vermunt, 1937, pp. 274-275; MacGillavry, 1937, pp. 44-45). The Utrecht geologists discussed the structure of *Chiapasella* and, in his last-mentioned publication, MacGillavry correctly placed the genus in the family Radiolitidae and clarified the problem of the shell layers. He explained that the "cortex" of the right valve is only a compact outer part of the outer shell layer, present in some specimens but not in others; in the left valve the "cortex" is the outer layer, and the canal-bearing zone belongs to the inner layer. It follows that there are only two layers in each valve.

Kühn (1932, p. 97) too, included *Chiapasella* in the Radiolitidae; there can be no question that this is its correct taxonomic position because its hinge is of radiolite type and other members of the family have caprinid-like left valves. Its polygonal cell pattern puts it in the sub-family Sauvagesiinae. Thus there is nothing remarkable about the internal structure of *Chiapasella*. The genus is exceptional, perhaps unique among the Radiolitidae, only in the height and curvature of the left valve. This valve would seem to have been unduly large, clumsy and heavy, although its weight was kept as low as possible by economy in the use of calcareous material. Such a valve seems unsuited to the radiolite hinge with its vertical uplift yet, judging by its abundance, *Chiapasella radiolitiformis* was a highly successful species.

Family HIPPURITIDAE Gray, 1848

The right valve is conical or cylindrical, fixed by its apex and its anterior side, often being in contact with others of the same species for its whole length. Its surface may be ornamented with longitudinal costae or may be smooth. The outer layer consists of funnel plates without vertical radial plates, and the inner layer is smooth, lining the body cavity and forming concave tabulae below it.

There are normally three principal longitudinal furrows indicating infolds of the outer layer. These project into the body cavity where they are enveloped in thin infolds of the inner layer. They form vertical pillars: the first, dorsal in position, evidently supported the ligament; the second, close to the posterior myophore, shows the position of the exhalent siphon(S); and the third that of the inhalent siphon (E).

The left valve is opercular, flat, slightly convex, or rarely concave; its surface is porous. Its margin shows infolds coinciding with the infolds of the right valve. The S and E infolds open up at their inner ends to form round or oval apertures or *oscles*, and it was obviously through these oscles that the animal's siphons communicated with the surrounding water. The withdrawal of the siphons away from the margins seems to have been an adaptation to crowded conditions, for the Hippuritidae might live in clusters of scores or even hundreds of shells.

The hinge structure somewhat resembles that of the Radiolitidae, and uplift of the left valve was vertical. But the right valve retains its single tooth; it rests against the ligamental ridge, is vertically grooved on both sides, and stands between two deep sockets. The two long vertical teeth of the left valve fit into the grooves and occupy the sockets. These two teeth are generally unequal, the anterior is the larger and the corresponding myophore curves around within the anterior side of the body cavity as in the Radiolitidae; the posterior myophore, however, is small, peglike, and fits into a cavity in the right valve between the posterior socket and the S pillar. In some forms the hinge is oblique to the line of the ligamental infold, leaving room for an accessory cavity in front of the anterior socket.

For the purposes of this monograph the Hippuritidae of the Western Hemisphere are divided into two subfamilies: the Hippuritinae¹, with not more than three infolds, and the Barrettiinae, with multiple infolds. This leaves undecided the position of *Pironaea*, an Old World genus with multiple infolds which some regard as an ancestor of the Barrettiinae, but which is probably an independent though parallel development.

Subfamily HIPPURITINAE, n. subfam.

Hippuritidae with only three infolds of which one, the ligamental, may be small or rudimentary. The two siphonal folds are generally well developed, forming pillars in the body cavity. There are always two oscles in the left valve; they were formed by infolds of the margin, starting as notches which, as growth proceeded, became occluded, their development keeping pace with the infolding of the S and E pillars of the right valve. Stages in the process may be seen in immature shells. The pillars of the right valve completely blocked the oscles when the shell was closed making it necessary for the hippurites, like most other pelecypods, to separate their valves slightly to gain access to sea water. The

¹ The term Hippuritinae was used by MacGillavry (1935) to include all the Hippuritidae, which he regarded as a subfamily of his family, Gyropleuridae. This view is unacceptable. Hippuritinae is here used in a new sense and is treated as a new subfamily.

mantle lobes were probably united around the periphery, preventing the inflow or outflow of fluid except through the siphons, like the leather of a bellows.

In this subfamily the left valve is penetrated by a great number of thin-walled, branching canals, which radiate from the umbo in its centre. The pattern is more complex than that seen in the corresponding valve of the Caprinidae and certain of the Radiolitidae, from which it also differs in that the canals open to the exterior by means of a network of small pores, whose shape, whether linear, polygonal or reticulated was used by Douvillé (1890) for classification. But the left valves of the Jamaican Hippuritinae are rarely preserved and here the classification of Toucas (1903), which depends mainly on the development of the ligamental ridge, is adopted. Hippuritinae are rather rare in Jamaica and only three genera are known.

Genus *ORBIGNYA* Woodward, 1862

Hippuritinae in which the ligamental pillar is represented only by a slight angular inflexion of the shell wall, but the two siphonal pillars are well developed. The hinge line is nearly or quite parallel to the dorsal margin, *i.e.* at right angles to the line of the ligamental infold. Most species were gregarious.

Orbignya mullerriedi Vermunt

Plate 49, figures 1,2

Hippurites (*Orbignya*) sp., Trechmann, 1924b, pp. 396-397, pl. 23, fig. 5.

Orbignya mullerriedi Vermunt, 1937, pp. 261-264, pl. 36, figs. 1-2, text figs. 3a-d.

Hippurites mullerriedi (Vermunt), MacGillavry, 1937, p. 110-111, 123, fig. 2.

Hippurites (*Orbignya*) *mullerriedi* (Vermunt), Chubb, 1956a, p. 19, pl. 4, figs. 4,8; 1956c, p. 8.

Occurrence.—A rare fossil in the *Titanosarcolithes* Limestone of the Logie Green section, Upper Clarendon; in the Great River Valley opposite Catadupa, on the borders of St. James and Westmoreland; and in the Ducketts Land Settlement, Westmoreland.

Description.—A small gregarious species, the right valves taper gradually and form clusters by mutual adherence for their whole length. Shell smooth with occasional growth lines, several slight longitudinal folds, and three longitudinal furrows corresponding with the pillars. As MacGillavry (1937, p. 111) showed, the upturned funnel plates have a series of narrow, radial upfolds which extend from one funnel plate to the next. These resemble the radial plates of the Radiolitinae but have a different origin and

structure. The ligamental infold is an open one, forming an inconspicuous pillar triangular in section, broad at the wall and obtusely angular at the inner end; deeper in the cavity it appears to widen and develop a broad open groove on its inner face and relatively deeper and narrower grooves on its two flanks; this extension constitutes the tooth (N), it is part of the inner layer, but is closely moulded onto the L pillar and hardly protrudes beyond it; the hinge line is parallel to the valve margin. In the largest shell the S pillar projects 6 mm into the body cavity. It is 2 mm thick near the base and 3 mm near the end; the E pillar projects 8 mm, with a width of 1.5 mm near the base and 3 mm at the end. The angular distance between L and E is 140° to 150° with S about midway between them.

The left valve is unknown.

Dimensions.—Maximum length of right valve 135 mm; diameter at the commissure 22-37 mm; thickness of wall 2.5 to 4 mm.

Orbignya ceibarum (Chubb)

Plate 49, figure 3; Text-figure 6

Hippurites cf. incisus Mullerriedi, 1930, pp. 165-168, figs. 1,2.

Hippurites mullerriedi MacGillavry, *pars*, 1937, p. 111, lines 35-39, pl. 5, fig. 6.

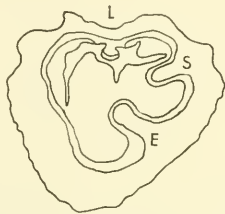
Hippurites (*Orbignya*) *ceibarum* Chubb, 1956a, pp. 19-21, pl. 4, figs. 9,10, text fig. 4; 1956c, p. 8.

Occurrence.—A single specimen from the *Titanosarcolithes* Limestone of Cotton Tree Gull, Lambs River, Westmoreland.

Description.—A very small gregarious species, the specimen including at least ten mutually adherent right valves, some of them showing fragments of the left valve. It is smaller and shorter than *O. mullerriedi*. Right valve subcylindrical, slightly curved or straight, with rounded longitudinal costae about 4 to 5 mm wide, except on the anterior side where there are three or four angular costae separated by broad rounded grooves. The S and E furrows are definite angular infolds, the L furrow a shallow open inflexion. The outer layer, about 2.5 to 3 mm thick, seems to have a structure similar to that of *O. mullerriedi*. Internally the L pillar is low and broad, and rounded rather than angular; the S pillar is hardly if at all constricted and projects about 4 mm with a width of 3 mm; the E pillar is constricted at the base, projects 4 to 6 mm, and widens from 2 to 3 mm. The approximate angular distances between the pillars are L:S 60°, S:E 60°. The inner layer is 0.5 to 0.8 mm thick, but in the depths of the valve it thickens in the recesses between the pillars, reducing their protuberance; it also thickens to form low vertical ridges in the antero-dorsal corner of the body cavity, and between the L and S pillars;

these ridges, presumably forming the outer margins of the sockets, do not appear in sections near the commissure. The inner layer also forms the single tooth (N), which extends inwards from the L pillar a distance of 2.5 mm; it is 2 mm wide and has two vertical lateral grooves and a terminal groove, the three grooves being delimited by four acutely angular vertical flanges; the tooth is less prominent deeper in the valve. The hinge line is parallel to the dorsal margin.

Surviving fragments of the left valve show that the pores were reticulate. The largest shell in the group shows a swastika-like process (Pl. 49, fig. 3) with four bent arms that penetrate between the pillars, and two teeth that fit into the lateral grooves of the tooth N. A section lower down



Text-figure 6. *Orbignya ceibarum* Chubb. Tran verse section of right valve a few mm below the commissure; $\times 2$. Compare with the section at the commissure shown in the right centre of Plate 49, figure 3.

(Text-fig. 6) shows the process somewhat broken and displaced, but the interlocking teeth can be seen and, of the four arms, only two survive; these are the myophores, the posterior fitting between the L and S pillars, and the anterior curving around within the wall, as in other hippurites. The other arms of the swastika were no doubt mere ridges on the under side of the left valve, serving to strengthen it and to help it lock in the correct position when closed.

Dimensions.—Length of right valve 60 to 80 mm; diameter at the commissure 15 to 20 mm; thickness of wall 2.5 to 6 mm.

Orbignya maldonensis (Chubb)

Plate 50, figures 4-6

Parastroma maldonensis Chubb, 1956a, pp. 21-23, pl. 5, figs. 1-6; 1956c, p. 8.

Occurrence.—A single specimen, a fragment of a cluster that included at least three right valves, was found in the *Titanosarcolites* Limestone south of Maldon cross roads, St. James.

Description.—Shell of medium size; it is the largest species of *Orbignya* known in Jamaica, having at least twice

the diameter of *O. mullerriedi*. Right valve cylindrical, tapering gently, its smooth surface showing three furrows, the ligamental furrow hardly perceptible, the S and E furrows narrow, shallow, and sharp angular infolds. In the deep body cavity the L pillar protrudes 3-5 mm, it is broad based and obtusely angular with rounded summit; the S pillar protrudes some 13 mm; it is almost parallel sided and is 5-8 mm wide; the E pillar protrudes 17-18 mm, it is constricted near the wall to 2 mm and widens near the inner end to 6-7 mm. The angular distance between L and E is 150° , with S midway between them. In one of the incomplete shells the E pillar is anomalous, a secondary pillar grows beside it and increases in size while the original pillar becomes thinner and less protuberant; at a higher level the new pillar probably replaced the old.

The outer layer consists of horizontal or slightly upturned funnel plates, which are penetrated by numerous fine vertical capillary tubes, oval, kidney-shaped or vermicular in cross section; the tubes consist of upturned collars, surrounding perforations in the funnel plates, which extend up to the corresponding perforation in the next funnel plate; thus each tube comprises a continuous succession of short tapering rings fitting one into another. The average diameter of the tubes is 0.25 mm and their distance apart about the same; near the inner and outer margins the tubes are radially extended. As a result of this structure a cross section of the outer layer has a superficial resemblance to the corresponding layer of one of the Sauvagesiinae.

The inner layer is about 0.6 mm thick. It forms a series of inverted conical tabulae below the body cavity, with infolds around the pillars and the minor ridges of the outer layer. The hinge tooth is not obvious.

The left valve is unknown.

Dimensions.—Only a fragment 93 mm long is preserved, its original length was probably at least 150-200 mm; maximum diameter 65 mm dorso-ventrally by 85 mm antero-posteriorly; thickness of wall 10-15 mm; depth of body cavity over 75 mm.

Remarks.—This species was originally attributed to *Parastroma*, as it was believed to belong to the same genus as *P. sanchezi* Douvillé (1926, pp. 133-134). This was first recognised as a rudist by Palmer (1933, p. 97), who described it under the name of *Orbignya sanchezi* as "compuesta de placas en forma de embudo (funnel plates) . . . la porcion central de la concha (funnel plates) se encuentra perforada por finos tubos capilares verticales (Lam. 3, fig. 2)." The latter figure shows a structure apparently identical with that of the outer wall of *O. maldonensis*. Subsequently *O. sanchezi* was transferred back to *Parastroma* by MacGillavry (1935, pp. 559-560). Palmer had previously

(1928, p. 13) made it clear that the funnel plates belonged to the outer layer, so it appeared that these were the plates perforated by the fine tubes, especially as, in a paper written in Spanish, he twice inserted the English term (funnel plates) in an apparent attempt at clarification. Actually in *Parastroma sanchezi* it is not the funnel plates but the tabulae below the body cavity that are penetrated by the tubes; *maldonensis* is, therefore, transferred to the genus *Orbignya*.

Genus **VACCINITES** Fischer, 1887

Hippuritinae in which the ligamental ridge is well developed, generally thin and extending far into the body cavity. Siphonal pillars unequal, the S pillar variable, the E pillar always longer and usually constricted near the wall, expanding towards the interior of the body cavity. The hinge line is always inclined at a high angle to the dorsal margin and usually at a lower, sometimes a very low angle to the ligamental ridge; this leaves room for a large anterior accessory cavity. The three pillars are generally relatively nearer together than in *Orbignya*.

Vaccinites eyrei Chubb

Plate 50, figures 1-3

Vaccinites sp. Chubb, 1962/1963, p. 12.

Vaccinites eyrei Chubb, 1967, p. 29.

Occurrence.—Three right valves were collected from the Clifton Limestone, some three miles southeast of Lucea, Hanover, where they were associated with *Barrettia*. Named for Mr. L. A. Eyre, who first found it during a field-class of senior students from Rusea's High School, Lucea, Hanover.

Description.—Two of the shells (a and b) are depressed conical or even discoidal, the height being only one half or one third of the diameter; the umbo is eccentric, towards the dorsal side. The third, incomplete specimen (c) apparently grew in an irregular discoidal form to a diameter of about 80 mm, beyond which its walls turned abruptly upwards diverging somewhat so that the form is a curved, inverted, truncated cone highest on the ventral side. Shell of medium size, smooth or with slight costae about 2 mm wide; the vertical part of the wall has the usual three infolds and irregularly spaced incremental corrugations. Funnel plates show slight, irregular radial wrinkling. The ligamental pillar is thin and tapering, curving gradually and, at its inner end, sharply, to the anterior; it extends up to half way across the body cavity. Both the S and E pillars are constricted near the wall to a width of about 2 mm and expand inwards to 6 or 8 mm; the E pillar of specimen (b) swells to 15 mm. The spacing of the pillars differs in different

specimens; in a depressed conical form (a) with a circumference of 250 mm, the distance L:S is 40 mm, S:E 30 mm; in a discoidal form (b) with circumference 283 mm, L:S is 31 mm, S:E 35 mm; in the third specimen (c) with vertical walls, L:S is 35 mm, S:E 40 mm; the circumference of the last is unknown but was probably about 330 mm. In the first, the distance L:E is some 28 per cent of the circumference, in the second 23.2 per cent, and in the third about 22.7 per cent. The discrepancy is chiefly in the distance L:S which varies between 10.6 and 16 per cent; the distance S:E remains fairly constant at 12 to 12.5 per cent of the circumference. The approximate angular distances between L and E are (a) 90°, (b) 60° and (c) 55°. The discoidal specimen (b) shows the H-shaped tooth N attached to the convex posterior side of the ligamental pillar.

The left valve is unknown except that its cardinal apparatus is preserved in the body cavity of the first specimen (a) mentioned above. The teeth cannot be distinguished as the section seems to be through the yoke which connects the two teeth of the left valve at their upper ends and overlies the single tooth of the right valve. The inclination of the hinge line to the ligamental ridge is about 20° to 30°. The posterior myophore penetrates the space between L and S; the anterior is a thin plate springing from the anterior tooth, curving anteriorly and then ventrally, running parallel to the ventral margin and penetrating the space below E; immediately before entering this space it widens abruptly from less than 1 mm to 9 mm, beyond which it tapers gradually to a point.

Dimensions.—Antero-posterior diameter of (a) 85 mm, dorso-ventral about 73 mm, height about 40 mm; corresponding figures for (b) 95 mm, 83 mm, 30 mm; for (c) antero-posterior diameter unknown, dorso-ventral 110 mm, height over 50 mm on dorsal side, over 110 mm on postero-ventral side.

Remarks.—*Vaccinites eyrei* resembles *V. macgillavryi* (Palmer) of the *Durania* beds of Loma Yucatan, Cuba, in the spacing of its pillars, but differs in the inclination of the hinge line which, in the latter species, is usually between 35° and 50°; it also differs in shape, the Cuban form being elongate conical to cylindrical. It differs from *V. vermunti* MacGillavry, of the *Barrettia* beds of Cuba, in which the pillars are more widely spaced and the inclination of the hinge line is 40° to 50°. In both Cuban species the L pillar is shorter and straighter than in the Jamaican species.

Genus **TORREITES** Palmer, 1933

Generic name created by Palmer for a Cuban species which had been described by Douvillé under the name of

Hippurites (Vaccinites) sanchezi. *Torreites* differs from *Vaccinites* chiefly in the development of its three major infolds. The ligamental ridge is lamelliform, rounded at its end, thick and exceptionally long, extending more than halfway across the body cavity. The S and E pillars are also lamelliform and of uniform thickness, they are neither swollen at their ends nor contracted at their base; the S pillar has a length about 80 percent of that of L; the E pillar has the exceptional character of being shorter than the S, little more than half as long. The outer layer has many short narrow infolds, which do not reach to the inner margin. Palmer described the left valve as having slots through which the three pillars came through to the surface; and as being composed of numerous radial, semicapillary tubes which do not open to the surface; consequently there are no pores.

***Torreites cf. sanchezi* (Douvillé)**

Plate 49, figure 4

Hippurites (Vaccinites) sanchezi Douvillé, 1927, pp. 54-55, pl. 4, fig. 1.
Torreites sanchezi (Douvillé), Palmer, 1933, p. 100, pl. 7, figs. 1,2; pl. 8, figs. 1,2.
Torreites sanchezi (Douvillé), Rutten, 1936, p. 135, text fig. 4g.
Torreites sanchezi (Douvillé), Vermunt, 1937, p. 269.
Torreites sanchezi (Douvillé), MacGillavry, 1937, pp. 128-129, pl. 5, figs. 4e-h.

Occurrence. — A single fragment was found in the Peters Hill Limestone, where it is associated with *Praebarrettia coatesi* Chubb.

Description. — The fragment is a portion of a right valve, welded into a hard limestone. A weathered surface shows the dorso-posterior arc of the shell viewed from below; this has been sectioned. It is not possible to determine the shape of the valve, whether conical or cylindrical. It is large, its diameter being at least 110 mm, or rather more. The outer wall has been largely destroyed by boring organisms, and it is not clear whether it had the typical short narrow infolds, but judging by Douvillé's figure it is possible that these were confined to the antero-ventral margin, which is not preserved in the Jamaican specimen. The three principal infolds are preserved, and they seem to have been indicated by furrows in the outer wall. The ligamental ridge is about 55 mm long, 12 mm wide at the wall, thinning to about 6 mm at its inner end; the S pillar is about 40 mm long by 5 mm wide; the E pillar is some 25 mm long by 8 mm wide. These figures are a little higher but compare reasonably well with those of Douvillé's type. The chief difference is in the spacing of the pillars; in the type these are widely separated, the internal measurement between the base of L and the base of S is 38 mm, between S and E 22

mm. In the weathered surface of the Jamaican specimen the corresponding distances are 30 mm and 15 mm, but the distance from L to S seems to become greater higher in the shell. Palmer's figures also (1933, pls. 7,8) show a wide separation of pillars.

The left valve of the Jamaican form is unknown.

Dimensions. — All known dimensions are given above.

Remarks. — Since the above was written *Torreites sanchezi* has been found by Dr. Peter Jung of the Naturhistorisches Museum, Basel, (1970) in the *Barrettia* Limestone of the Green Island Inlier, Hanover (Jung, 1970).

Subfamily **BARRETTIINAE**, n. subfam.

Hippuritidae whose right valve is characterized by multiple infolds of the outer layer, two of which can be recognised as corresponding to the siphonal infolds of the Hippuritinae. The ligamental infold can generally be distinguished only by its relationship to the tooth N. The latter stands between two deep sockets, and there is a cavity between the posterior socket and the S pillar for the reception of the corresponding myophore of the left valve. The hinge line is parallel to the dorsal margin.

The diameter of the body cavity is about one-third or one-quarter of that of the shell. The wall is extremely thick and both layers enter into its structure. The outer layer is exceptionally thin, usually only one or two millimetres, and its multiple infolds penetrate the wall, the longer reaching almost to the edge of the body cavity, though only the S and E pillars enter into it. The inner layer is greatly developed; its central part is concave, lining the body cavity and forming a series of close set tabulae below it. Each of these tabulae has a broad horizontal brim, which gives it the form of an inverted hat, and these superimposed brims constitute the major part of the wall. The intruding infolds cut the brims into a series of radial strips, each of which has a number of sharp transverse upfolds alternating with rounded downfolds which form cavities between the infolds well shown in Plate 52, figure 1. Thus the outer and inner layers mutually interpenetrate, together forming the wall.

The left valve is flat or slightly convex, often with a central boss over the body cavity. It has infolds corresponding with those of the right valve, the longer of which reach nearly to the boss. It thus consists essentially of a solid boss from which radiate numerous flat bars in lateral contact one with another, the intervening sutures representing the infolds. There are many perforations through the shell along the sutures, and the S infold opens up at its inner end to form an oscule over the corresponding pillar.

The presence of an E oscule has not been proved and it is absent from the best known species.

There are two long, parallel, more or less equal teeth, which slide into the sockets of the right valve, gripping its tooth between them; the posterior myophore is small and peg-shaped, fitting into the cavity provided for it; the anterior myophore is crescentic and, from the corresponding tooth, it runs around within the anterior margin of the body cavity to the ventral side; it is attached to the under side of the left valve for its whole length.

The chief difference between the Barrettiinae of the Caribbean Region and Mexican Region and the *Pironaeae* of the Mediterranean countries and the Near East is seen in the distance between the principal pillars. In *Pironaea* the distance between L and E is generally less than one-fifth of the circumference of the shell; the angular distance is not more than 70°. In the Barrettiinae the distance is at least one-third of the circumference, equivalent to 120°, and is often considerably more.

Genus **BARRETTIA** Woodward, 1862

The distinguishing character of this genus is that the infolds or rays, seen in cross section, are *moniliform* or necklace-like, *i.e.* they resemble a string of beads on a thin thread. Actually each ray is a row of vertical parallel tubes, connected by a thin wall. Though only a small fraction of a millimetre thick, the connecting wall consists of two vertical laminae, and the tubes are formed by these laminae diverging, curving around, and rejoining; thus the tube consists of two hemicylinders, each of which is closely tabulate, the tabulae being dome-shaped, *i.e.* convex upwards; the tabulae in the two hemicylinders are not continuous with each other though, since there is no dividing wall, they are contiguous; they are disjunct portions of the funnel plates which form the outer layer. At the commissure the summits of the tubes project as rounded knobs along the radial walls formed by the infolds; there appears to be no relationship between the position of these knobs and of the upfolds of the intervening strips of the inner layer. The innermost tube of each ray is always the largest and is generally pear-shaped in section. The rays vary in length, some penetrating nearly to the body cavity and others falling far short of it; some of the latter may have only one or two beads. The ligamental infold has no distinguishing features; the S infold has a large cylindrical column at its inner end, which has domed tabulae like the small tubes, and is connected with the outer layer by a moniliform ray; the E infold has a radially elongated, laterally flattened column with flat tabulae, at the end of a relatively short moniliform ray.

A right valve will generally split easily along the median line of any of the infolds, especially S and E; the longitudinal sections thus produced show that the vertical tubes on all sides are parallel to each other and to the vertical axis of the valve for their whole length. The innermost tube of each infold is the first to appear, and young shells not exceeding 25 to 30 mm in diameter have only one tube to each ray; this tube grows vertically upwards and other tubes are inserted, one by one, between it and the outer wall, which grows upwards and outwards; if the valve becomes cylindrical no more tubes are added. Meanwhile, as the shell increases in diameter, so does the body cavity, with the result that the first-formed tubes, except on the dorsal side, are either cut off or else diverted obliquely outwards, in contact with the lining of the body cavity; they coalesce with and absorb the neighbouring tubes. The S and E pillars are not cut off but may be somewhat diverted so that they absorb some of the lesser tubes; the E pillar, which increases greatly in size, usually absorbs several minor tubes.

The radial bars of the left valve overlie the interrays and the sutures overlie the infolds. The bars are laterally notched, the notches being symmetrically arranged on the two sides of each rod, and opposed to the notches on the adjacent rods. Thus each suture opens up to form a row of small apertures which fit over the knobs on the infolds of the right valve as the larger S oscule fits over the S pillar. In view of the absence of an E oscule it seems probable that the function of these apertures was to admit sea water into the mantle cavity, in fact they were all little E oscules.

Barrettia monilifera Woodward

Plate 51, figures 1-3; Plate 52, figures 2,3; Text-figure 7

Hippurites sp. Barrett, 1860, pp. 324-326.

Barrettia monilifera Woodward, 1862, pp. 372-377, pls. 20,21.

Barrettia monilifera Woodward, Douvillé, 1890, pp. 110-112, pl. 17, fig. 6.

Barrettia monilifera Woodward, Chubb, 1956c, p. 6; 1962/1963, p. 19. Not *Barrettia monilifera* Whitfield, 1897b, pp. 233-244, pls. 27-32.

Not *Barrettia* cf. *monilifera* Trechmann, 1922, pp. 510-511, pl. 19, fig. 2; pl. 20, figs. 1,2.

Occurrence.—This species occurs in limestone bands from a few inches to three feet in thickness subordinate to many hundreds of feet of shale, in Back River, a tributary of Rio Grande, about half a mile below the confluence of Catalina River, Portland Parish; also in Clarke's River, a tributary of the Plantain Garden River about one and a half miles southwest of Sunning Hill, St. Thomas Parish. The following description is based on Woodward's types, collected by Lucas Barrett in January, 1861, which are now

in the British Museum (Natural History) and on a number of topotypes collected in Back River by the late V. A. Zans in June, 1958, specimens formerly in the Geology Department of the University of the West Indies, Kingston, Jamaica; now in the Smithsonian Institution, Washington, D.C.

Description. — A large but not gigantic species, tending to be gregarious. Right valve conical; when free to develop it is usually cornute, with a circular cross section; when forming part of a cluster it is generally polygonal; diameter at commissure about one third or one quarter of length. The infolds are indicated by slight longitudinal furrows in the outer surface. Outer wall thin, rarely more than 1 mm thick; this thickness is not exceeded even in the double walls separating the individuals in a cluster, which consist of two walls, each 0.5 mm thick.

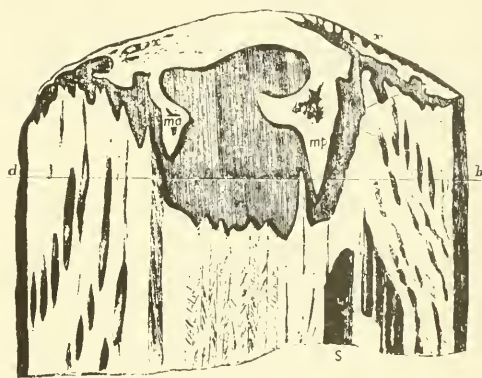
The number of infolds varies according to the size of the shell; Woodward's type specimen, with a diameter of about 120 mm has 65 infolds, the average distance apart, measured around the circumference, being about 5.8 mm. In cross section the L infold is 29 mm long and has eight beads, including the terminal one; between it and the S pillar there are 17 infolds; the latter pillar is 34 mm long, the tabulate column at its inner end is 9 mm in diameter, its stem having six beads; eight infolds lie between it and the E pillar, whose length is 39 mm, its tabulate column 27 mm by 3 mm, and its stem having three beads. The other infolds vary in length, like the septa of a coral; ten of them, the longest, penetrate some 32 mm and have from eight to ten beads; in the sectors between the longer infolds there are other minor infolds, longer and shorter alternating, the shortest having only one or two beads. The individual beads are oval in cross section, averaging 1.5 by 1 mm, and are generally about 1.5 mm apart, though the distance varies somewhat; the innermost bead is larger and may be as much as 4 by 2.5 mm. The angular distance between the L and S pillars is 100° , between S and E about 45° .

A topotype with a diameter of 110 mm has 57 infolds; a pentagonal member of a cluster (Pl. 51) with dorso-ventral diameter 73 mm, and antero-posterior 63 mm has 37; a rounded member of the same cluster with an average diameter of 60 mm has 32. There seems to be a fairly close relationship between the size and the number of infolds, which are set at mean intervals of between 5.8 and 6 mm around the circumference. The angular distances between L, S and E vary little from those given above. The transverse section of Woodward's type specimen (Pl. 51, fig. 3) shows the form of the tooth N, and of the posterior muscle cavity *mp*.

The inner layer shows sharp wrinkling, which appears

to be irregularly concentric, below the body cavity, the structure resembling that of *Parastroma guitarti* (MacGillavry, 1937, pl. 10, figs. 8,9), and the folding of the strips between the infolds also appears to be irregular; in fact this layer may be said to have a vesicular, rather than a tabular structure, resembling that of certain Palaeozoic corals such as *Michelinia* or *Cystiphyllum*.

The left valve is known only from Woodward's type specimens; it is depressed conical in form; its surface features are concealed by hard black matrix. The transverse section (Plate 51, fig. 3) shows its two teeth (B' and B) fitting into the sockets and clasping the tooth (N) between them; the hinge is at right angles to the ligamental infold (L), the posterior myophore (*mp*) is seen fitting into its cavity. The longitudinal section figured by Woodward (Text-figure 7) is cut through the posterior myophore (*mp*) which is



Text-figure 7. *Barretia monilifera* Woodward. Longitudinal section of bivalved specimen after Woodward, 1862; $\times 0.66$. This is the counterpart of the specimen illustrated in Plate 52, figure 2. Courtesy Geological Magazine.

seen to be peglike and to fit into its cavity in the right valve; a similar process, on the other side, is almost certainly the crescentic anterior myophore (*ma*) which appears to be attached for its whole length to the left valve, and which curves around within the anterior margin of the body cavity; part of the S pillar is seen on the right. The original of Woodward's figure is lost, but the counterpart is preserved in the British Museum (Natural History), (Plate 52, fig. 2). It is parallel to Woodward's section but is separated by a distance of some 4 or 5 mm, the thickness of the cut. It shows the continuation of the anterior myophore, but misses the posterior one; the S pillar of the right valve is shown to

a greater height though not to its summit; it seems probable that the corresponding oscule ran obliquely through the thickness of the left valve from the top of the pillar, and opened at a point nearer to the centre. Other smaller but similar perforations run obliquely through the left valve; their inner ends probably fitted onto the knobs at the tops of the vertical tubes.

Dimensions. — Woodward described his type specimen as 5 inches (125 mm) in diameter and probably originally 18 inches to 2 feet (450-600 mm) in length. Another of his illustrated specimens (his pl. 20, fig. 1) which is cornute, has a maximum diameter of 110 mm, and a length of 375 mm, perhaps originally 400 mm. It seems probable that *B. monilifera* does not normally greatly exceed 125 mm in diameter.

Remarks. — Many specimens of *Barrettia* found in Cuba, Puerto Rico, the Virgin Islands, and elsewhere have been determined as *B. monilifera*. It may be doubted whether the determination was correct in every case. Few of them appear to be gregarious. In many the number of rays, relatively to the diameter is fewer than in the true *B. monilifera* and the beads on each ray are fewer and larger. Probably they include one or two new species.

Barrettia gigas Chubb

Plate 52, figure 1; Plate 53, figures 1-3

Barrettia monilifera Whitfield, 1897b, pp. 233-244, pls. 27-32.

Barrettia cf. monilifera Whitfield, Trechmann, 1922, pp. 510-511, pl. 20, figs. 1,2; not pl. 19, figs. 2a,2b.

Barrettia gigas Chubb, 1955a, pp. 9-12; 1956c, p. 7; 1962/1963, pp. 6-15.

Occurrence. — In Cretaceous limestones, which are usually between 10 and 25 feet thick, at Haughton Hall and Rock Spring, Hanover Parish; near Grange, Westmoreland Parish; at Stapleton and Whitechapel Spring, St. James Parish; and at New Ground, St. Ann's Great River Valley, St. Ann Parish.

Description. — The most obvious character of *B. gigas* is its size. It is a gigantic form, the adult commonly having a diameter of 250 or 300 mm. In youth the right valve was generally broadly turbinate or even saucer-shaped and young individuals may have a diameter of twice their height. On attaining the adult diameter the shell continued its upward growth but became cylindrical sometimes with a slight curvature, and usually grew to a height of 300-400 mm. But the form is variable, some individuals continuing a gradual increase in diameter throughout their life so that the shell may be bowl-shaped, broadly turbinate, or even, rarely, cornute.

The outer wall is hardly ever preserved, and it is doubtful if it was more than 2 or 3 mm thick; as might be expected, in view of its greater diameter, *B. gigas* has more moniliform rays than *B. monilifera*. The holotype in the American Museum of Natural History (No. 9665/1) with a diameter of 250 mm has 78 rays, and among other adults the figures are as follows: diameter 250 mm, rays 84; diameter 250 mm, rays 100; diameter 290 mm, rays 102; diameter 300 mm, rays 90; diameter 350 mm, rays 140. Measured around the circumference the distance between rays averages 8-10 mm. They are closer in young individuals.

In cross section the tubes appear as oval beads with a maximum diameter of 2 to 3 mm, and they are separated by a similar distance. The longer rays may have up to 24 beads; the S pillar is a cylinder about 16 mm in diameter, with about 18-20 beads on its stem; the E pillar may be 60 mm by 5 mm, horizontally tabulate, with 8 to 12 beads on its stem. The angular distance L:E is at least 120° and may be as much as 140°; S is variable in position; it is nearer to E than to L.

The diameter of the body cavity is about one-third of the diameter of the shell. The inner layer below it does not show any wrinkling of the tabulae, though the strips extending outwards between the infolds have regular sharp, transverse upfolds, producing a pattern of rectangular cavities over the whole surface of the commissure.

The left valve is not well known except for its cardinal apparatus. One of the specimens believed by Trechmann (1922, p. 510, pl. 19, figs. 2a, 2b) to be a *B. gigas* (his *B. cf. monilifera*), with its upper valve, is a *Parastroma*, described below. Another of his specimens (his pl. 20, fig. 2) is said to show part of its left valve much crushed; it shows nothing but some shells of *Ostrea* sp. adhering to the commissural surface of the right valve. The specimen, illustrated in Plate 52, figure 1, shows the teeth and myophores of the left valve within the body cavity of the right. The posterior myophore *mp* fits snugly into the special cavity provided for it on the dorsal side of the S pillar; it is connected by a yoke with the posterior tooth B. The anterior tooth B' is nearby, and from its springs the anterior myophore *ma*, a crescentic process that lies close within the wall of the body cavity; about halfway along its length there is a slight infold of the inner layer and beyond its end there is a stronger infold; these appear as vertical ridges in the wall of the body cavity. The anterior myophore was seen by Whitfield, who believed it to be a thickening of the inner shell layer of the right valve, and this view was accepted in an earlier publication (Chubb, 1955a, p. 11). But in the specimen illustrated it has been developed and has been found to have no connection with the right valve,

but to be attached to the anterior tooth which is in position in the socket; probably it was also attached by its whole length to the underside of the left valve. A split specimen (Plate 53, figure 1) shows the *mp* cavity beside the deep B socket, which extends nearly to the bottom of the shell.

A right valve was collected in many fragments from Stapleton, St. James, by the late Dr. V. A. Zans. Among the fragments were found the greater part of the two teeth of the left valve, which have been assembled in their correct relative position (Pl. 53, fig. 2). The shell from which they came was a young adult, 300 mm in diameter, but probably not more than 200 mm high. The teeth must have been originally over 150 mm long, penetrating far into the right valve; they are parallel, both about 15 mm in diameter and 12 mm apart; they are curved, the dorsal side being convex, and they are longitudinally striated, at least on the dorsal side.

Dimensions.—The principal dimensions have been mentioned above. The usual adult diameter is 250 to 300 mm; the largest known specimen, found in a road cutting east of Bath Mountain in the Grange Inlier of Westmoreland has a diameter of 350 mm; it was not possible to extract the whole, but it was probably 1,000 mm long. Trechmann (1922, p. 511) recorded that the largest example seen by him was 1 foot (300 mm) in diameter at the top, and 2½ feet (750 mm) in length. A very young individual may be 100 mm or less in diameter and only 50 mm high.

Remarks.—*B. gigas* has so far been reported only from Jamaica, west of the Wagwater fault, but Mullerried (1934) stated that specimens of *B. "monilifera"* found in Chiapas, Mexico, attained a diameter of 33 cm and a height of 1 metre. The writer has also been informed that gigantic forms of *Barrettia*, of comparable size, are found in south-eastern Puerto Rico. All these could be *B. gigas*.

Barrettia multilirata Whitfield

Plate 54, figures 1-4; Plate 55, figure 2; Text-figures 8-10

Barrettia multilirata Whitfield, 1897b, p. 244, pls. 33,34,35.

Barrettia cf. multilirata Whitfield, Trechmann, 1922, pp. 511-512, pl. 18; pl. 19, fig. 1; pl. 20, fig. 3.

Barrettia multilirata Whitfield, Chubb, 1955a, pp. 12-13; 1955b, pp. 180-189; 1956c, p. 7.

Occurrence.—Occurs in abundance in association with *B. gigas* at Haughton Hall, Green Island, Hanover. It has not yet been found elsewhere in Jamaica.

Description.—This species is large, though not gigantic, being approximately the size of *B. monilifera* or a little larger. Typically the form is conical at the base, soon becoming cylindrical, and is often slightly curved. However,

the form is variable and Trechmann (1922, p. 511) erected three varieties: var. *typica*, var. *cylindrica* (*sic cylindrica*), and var. *conica*. It may be doubted if this subdivision is justified; there seems to be little difference between *typica* and *cylindrica*, while *conica* represents young forms. Among adults the diameter is approximately half the height.

The outer layer of the right valve is about 1 mm thick; its surface is marked by longitudinal furrows representing the infolds, at average intervals of 3.5 to 5.0 mm; the intervening ridges may be flattened or rounded, with longitudinal striae separating low rounded costae averaging 1.5 mm wide; the growth lines, representing funnel plates, run straight across all ridges, costae, furrows.

The chief difference between *B. multilirata* and the species described above is in the multiplication of its infolds. For any given diameter this species may have from one and a half times to nearly twice as many rays as either *B. monilifera* or *B. gigas*. Whitfield's type, with a mean diameter of 155 mm, has 125 rays; one of Trechmann's, with a diameter of 127 mm has about 90; a Geological Survey specimen with a diameter of 175 mm has over 100; a conical form with mean diameter 150 mm has 91; another with diameter 130 mm has 87. Cross sections show that the beads on each ray are narrower than in *B. monilifera*, being about 0.75 by 1.5 mm; there are about 14 to 16 beads on the longer rays. The S pillar is cylindrical and some 10 or 11 mm in diameter; the E pillar is laterally flattened and is about 25 by 4 mm; both pillars are connected with the outer wall by moniliform rays. Not only the two siphonal pillars but also several of the longer rays project into the body cavity, about 22 in Whitfield's type and 18 in Trechmann's, the recesses between them serving for the reception of ridges on the under side of the left valve. The angular distances between the three main pillars are large. If Whitfield's interpretation of the figure in his plate 34 is correct the angle L:E would be nearly 180°. But he is probably mistaken in his identification of the teeth and, therefore, of the position of L. The angle L:S is usually 72°, and S:E 72°, the total angular distance L:E averaging 145°.

The body cavity is relatively wider than in *B. monilifera* or *B. gigas*. The inner layer forms close-set concave tabulae which are not wrinkled; they turn up and coalesce on the anterior side, presumably to provide a firm basis for the attachment of the anterior adductor. The parts of the inner layer extending into the interrays form small cavities, quadrangular or sometimes triangular, which are crowded and contracted especially at the points where intercalated rays appear, and towards the outer margin.

Several bivalved specimens of *B. multilirata* were included in the Trechmann Bequest to the British Museum

(Natural History). The left valves are depressed conical or nearly flat, slightly undulating to conform with the shape of the commissure of the right valve. Generally they have a low boss in the centre, though in one of the specimens illustrated (Plate 54, fig. 4), Trechmann's var. *cylindrica*, this is missing, its place being taken by an aperture some 14 by 7 mm, which seems to have been due to an injury inflicted during life. However this specimen has the advantage that, in the dorso-posterior quadrant, the left valve is partly broken away, revealing the commissural surface of the right valve and its relationship to the left.

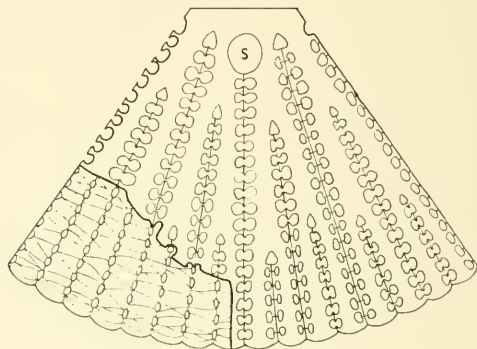
Trechmann (1922, p. 512) thus described the left valve: "the decoration of the top valve . . . consists of irregular rounded ribs radiating from the central apex, often breaking up into two or three divergent ribs, and between these cross ribs arranged parallel with the margin of the valve. Between these again, more smaller ribs diverge, forming a reticulate or honeycomb design . . . the two apertures or foramina of the lid, corresponding to the first and second pillars in the living chamber, are more or less well shown".

The specimens have been re-examined. The left valves are typically some 10 to 15 mm thick in the central boss, thinning to 5 mm halfway to the margin, and 2 mm at the edge. There is no system of branching radial canals opening to the exterior by pores, as in the Hippuritinae. The central boss is from 15 to 25 mm across and is covered with small polygonal cells some 0.5 to 2 mm in diameter. Trechmann's "irregular rounded ribs" which radiate from it and branch dichotomously once or twice are the interrays, and they are separated by sutures representing the infolds.

Along each infold there are numerous perforations which notch the sides of the two adjacent ribs or costae. Between the perforations of each costa little processes extend to abut against those of its neighbour and at the abutment, they spread centripetally and centrifugally, giving the appearance of intercalary radial "smaller ribs" as noted by Trechmann. Thus each perforation consists of two rounded halves partially or completely separated, giving it the form of a figure 8. Trechmann's "cross ribs arranged parallel with the margin" are not continuous, but consist of the processes between the perforations, which are more or less in line from costa to costa.

The radial costae overlie the interrays of the right valve; the infolds with their rows of apertures overlie the moniliform rays. The apertures penetrate right through the valve; they have the figure of 8 only at the upper surface, downwards they become cylindrical and they fit over the knobs at the tops of the moniliform tubes. On the outer surface the infolds of the left valve extend farther in than those of the right; but the apertures in the central and thicker

parts of the left valve slope downwards and outwards at an angle approaching 45° to bring their inner ends into apposition with the moniliform knobs; farther from the centre the slope of the tubes becomes less and near the margin they are vertical. Evidently the boss represents the juvenile left valve; after infolding had begun, as both valves grew larger and the body cavity grew wider, it became neces-



Text-figure 8. *Barrettia multilirata* Whitfield. Diagrammatic sketch of a sector of a left valve resting in position on the right; $\times 1.0$. The left valve is represented as being partly broken away to show the relationship of the two valves. Compare Plate 54, figures 1-4.

sary for the first formed apertures of the left valve to develop into outwardly sloping tubes if they were to retain their connection with the moniliform bodies of the right valve.

Trechmann referred to "the two apertures or foramina of the lid". The S oscule is present; it is oval and overlies the S pillar, but it is smaller, being only 6 by 5 mm while the pillar is 11 by 9 mm. A careful examination of all available left valves has failed to confirm the presence of an E oscule. But the numerous perforations through the valve fit over the little pillars of the moniliform rays exactly as the oscules of any hippurite fit over the S and E pillars. It is, therefore, suggested that they are all little E oscules and served to admit sea water to the mantle cavity.

Whitfield's section (1897b, pl. 34) was cut 50 mm below the commissure, too low to show any of the characters of the underside of the left valve. A section was cut of the specimen shown in Plate 54, figure 4, at about 8 to 15 mm below the commissure (Text-figures 9,10). The underside of the top slice shows the teeth (apparently hollow) connected by a yoke; the posterior myophore fits into its usual place on the dorsal side of the S pillar; a long, narrow,

curved process runs from the anterior tooth around, within the margin of the body cavity for about 180° ; this should be interpreted as a ridge supporting the anterior myophore rather than the myophore itself.

From the outer side of the ridge a number of short branches extend into recesses in the wall of the right valve. There is a small central boss from which three ridges extend towards the posterior, each ridge bifurcates and its branches fit into recesses between the S and E pillars and ventrally to the latter. On its anterior side the central boss is surrounded by a kidney-shaped, radially striated body, resembling that observed by Whitfield in the body cavity of *B. gigas* (his *B. monilifera*), marked d in his plates 27 and 28. Most of the processes described are mere ridges on the underside of the left valve, serving to strengthen it and lock it firmly in position when closed. The counterpart of the slice (Text-figure 10), representing a section a few mm lower, shows only the two myophores, the anterior one considerably wider than the ridge which supports it.

Dimensions.—The maximum diameter recorded is about 175 mm, but the more usual is about 125 to 150 mm. In adults the height is about twice the diameter, though in young conical forms it may be less than half the diameter.

Remarks.—The left valve of *B. multilirata* has been described in considerable detail as it is thought to be typical of the Barrettiinae and no full description has previously been published.

Barrettia ruseae Chubb

Plate 55, figure 1

Barrettia sp. Dixon, 1960, pp. 109-110.

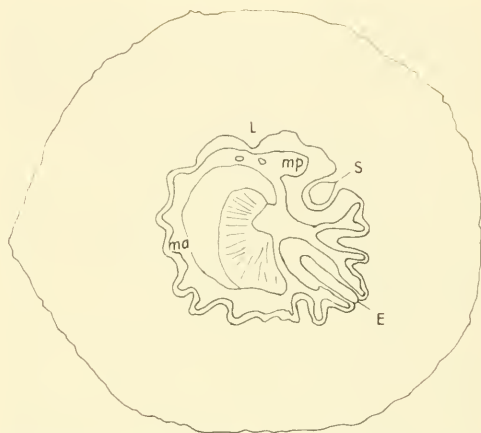
Barrettia sp. Chubb, 1960a, p. 89; 1962/1963, p. 12.

Barrettia ruseae Chubb, 1967, p. 30.

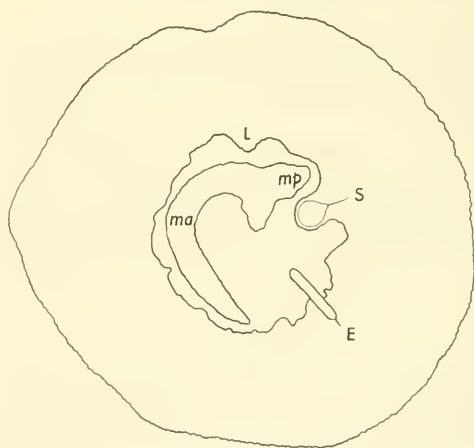
Occurrence.—Common in the Clifton Limestone, about three miles southeast of Lucea, Hanover. Named in honour of Rusea's High School, Lucea, whose 6A Geology Group first found it during a field exercise in July 1960 and recognised it as a species of *Barrettia*.

Description.—The typical form is large, discoidal or saucer-shaped with a flat base; the height is generally less than half the diameter and may be as low as 60 mm for a diameter of 140 mm, though a fragment shows that the height may attain 130 mm. Outer layer about 1 mm thick.

The number of infolds varies according to the diameter, their average distance apart, measured around the circumference, being about 5.5 mm. The following description will be based chiefly on the best specimen from Clifton, which



Text-figure 9. *Barrettia multilirata* Whitfield. Transverse section of right valve about 8 mm below commissure; $\times 0.62$. The structural details of the wall are omitted, being shown in Plate 55, figure 2. The specimen is that illustrated in Plate 54, figure 4. Within the body cavity the processes attached to the under side of the left valve may be seen fitting into the recesses in the wall of the right.



Text-figure 10. *Barrettia multilirata* Whitfield. Transverse section of right valve about 15 mm below commissure; $\times 0.62$. Same specimen as Text-figure 9. At this level only the two myophores of the left valve are seen.

is a low discoidal form but is incomplete having lost part of its ventral side; its mean diameter is 140 mm so its circumference must have been 440 mm, of which 300 mm remain; in this circumference it has 53 infolds; probably it originally had between 75 and 80, of which about 26-28 were long. Even in this depressed, rapidly expanding shell the moniliform tubes are vertical; the infolds are extremely attenuated and in section appear as strings of beads, 0.5 mm wide, 2 mm apart, each bead tapering into the threadlike line connecting them; in some cases the swelling of the beads is so slight as to be almost imperceptible when the infolds are seen as thin lines; the longest infolds penetrate to a distance of 50 or 55 mm, with about 10 or 12 beads.

The body cavity is exceptionally small, its diameter being approximately 30 mm in a shell 140 mm in diameter, i.e. little more than one-fifth. The inner layer forms a vesicular tissue lining the inside of the body cavity, rather than regular tabulae; it forms a similar highly irregular tissue in the interradial areas, showing no trace of the usual quadrangular cells.

Both the S and E pillars penetrate the wall of the body cavity. The former is diamond-shaped in cross section, its dimensions being about 12 mm by 7 mm; it is connected with the outer wall by a moniliform ray. The E pillar is 3 mm wide, and it is seen to a length of 17 mm but its outer part and moniliform ray are broken away. It is not certain which is the L infold, but a probable interpretation would make the angle L:S 75°, S:E 60°.

The left valve is unknown.

Dimensions.—Most of these are given above. The typical form is 140 mm in diameter by 60 mm high, and other less complete specimens appear to have had similar dimensions though, as noted, one appears to have been 130 mm high.

Remarks.—Considering the extreme attenuation of its infolds, it is possible that *B. ruseae* may represent a stage in the evolution from *Barrettia* to *Parastroma*; indeed in the taller specimen mentioned above the rays show a tendency to wander and loose themselves amongst the cells formed by the inner layer.

Genus *PARASTROMA* Douvillé, 1926

Includes large forms which may be conical or cylindrical and externally resemble *Barrettia*, with many longitudinal sulci representing infolds, but a transverse section or a view of the commissural surface shows that internally these infolds are largely or completely effaced, and the concentric wrinklings of the inner layer become much more prominent. The ligamental infold has generally disappeared, and the

moniliform stems of the S and E pillars are lost, although the pillars themselves survive. In some species remnants of the rays are visible near the outer wall, and in some a few can be traced nearly to the body cavity, but they meander among the concentrically elongated cells formed by the foldings of the inner layer. This layer takes an even larger part in the formation of the commissure than in other *Barrettiinae*.

Parastroma trechmanni Chubb

Plate 56, figures 1-3

Barrettia cf. *monilifera* Trechmann, 1922 *pars*, p. 510, lines 27-30, pl. 19, figs. 2a-b.

Parastroma trechmanni Chubb, 1967, p. 30.

Occurrence.—Among the material collected by Trechmann from the *Barrettia* Beds of Green Island, Hanover, was a specimen which he believed to be a *Barrettia gigas* (his *B. cf. monilifera*) with its upper (left) valve. A re-examination of his type (L44200) in the British Museum (Natural History) led to the conclusion that it is a *Parastroma* without the left valve. A young shell from the same locality (L63237) seems to belong to the same species.

Description.—A gigantic species, the right valve broadly conical; the outer surface shows numerous sulci which radiate from the central apex to the commissural margin; as these diverge others are intercalated between them; the intervening costae, which are some 4-6 mm wide, are generally flat and crossed by growth lines representing funnel plates.

The commissural surface closely resembles Palmer's figure of *Orbignya* (*Parastroma*) *guitarti* (1933, pl. 2, fig. 2). The rays are discernible near the outer margin, but most of them become less definite when traced inwards, though they are not so completely effaced as in *P. guitarti*; some, especially round the anterior side, run more or less straight towards the body cavity, but elsewhere they become lost, apparently zigzagging amongst the cavities formed by the concentric wrinkling of the inner shell layer. Measured radially the concentric wrinkles are generally 2-3 mm from crest to crest, rarely 4-5 mm; the cells they form are up to 30 mm long measured tangentially; the radial distances from crest to crest compare closely with those in MacGillavry's thin section (1937, pl. 10, fig. 9) of *P. guitarti*, but in that species the cells are much longer, measured tangentially. In *P. trechmanni*, as in *P. guitarti*, the wrinkles become smaller and closer towards the periphery.

When Trechmann studied the larger specimen its principal features were concealed by matrix; it has been possible to remove this and to clean out the body and posterior myo-

phoric cavities. It can now be seen that the body cavity is small, its diameter being one-quarter of the commissural diameter. The cardinal apparatus and siphonal pillars are essentially like those of *Barrettia*. The tooth is quadrangular, with grooved sides and flanged corners, the flanges extending outwards and obliquely downwards as septa which divide the sockets from the cavity; the teeth of the left valve are still present in the sockets. The posterior myophoric cavity is roundly conical; it is separated from the neighbouring socket by a low septum and is bounded on its ventral side by the stem of the S pillar. This pillar is a cylindrical column, 13 mm in diameter, standing beside the posterior socket; the E pillar is a ridge 8 mm wide, extending 25 mm into the body cavity. The stem of the S pillar, when traced outwards, soon becomes unrecognisable; the E pillar, however, extends almost to the outer wall. The trend of the wrinkling of the commissural surface is not concentric near the E pillar but turns outwards, parallel to the stem of the pillar.

The left valve is unknown.

Dimensions. — Diameter of adult shell: antero-posterior 205 mm, dorso-ventral 195 mm; height 112 mm; diameter of body cavity, antero-posterior 55 mm, dorso-ventral 50 mm; depth of body cavity 35 mm; width of commissure 60-70 mm; diameter of posterior myophoric cavity 20 mm, depth 16 mm. The young shell has a diameter of 85 mm; height 30 mm.

Remarks. — *Parastroma* was first named by Douvillé (1926, pp. 133-134, pl. 8, figs. 1-4) from material collected by Sanchez Roig in the province of Camaguey, Cuba. It consisted of fragments showing a succession of thin parallel plates, more or less close together, united by pillars which penetrated through the plates; the latter rose to form conical projections at their junction with the pillars. Douvillé regarded it as a stromatoporoid, which he called *Parastroma sanchezi*. Palmer (1933, pp. 96-97, pls. 1-3) first recognised that Douvillé's material consisted of rolled fragments of the right valve of two rudist species, which he called *Orbignya guitarti* and *O. sanchezi*. He observed that the so-called pillars were in fact capillary tubes but, as noted above (*Orbignya maldonensis*: Remarks), stated that the tubes perforated the funnel plates, when in fact they perforate the tabulae below the cavity. MacGillavry (1935, pp. 559-560) restored both species to *Parastroma*, which he agreed was a hippurite. It is not known whether the tabulae below the body cavity of *P. trechmanni* are perforated by tubes.

Parastroma seems to be not uncommon in Cuba in both the *Barrettia* and the *Titanosarcolites* Series and it occurs also in Puerto Rico. This is the first record of a true *Parastroma* in Jamaica, because the species formerly described

under the name of *P. maldonensis* (Chubb, 1956a, pp. 21-23) is now ascribed to *Orbignya*. Since the above was written several specimens of *Parastroma* have been found by Dr. Peter Jung in the *Barrettia* beds of the Grange Inlier, Westmoreland.

Genus *PRAEBARRETTIA* Trechmann, 1924

This name was proposed by Trechmann for the species which had been described by Whitfield (1897b, pp. 245-246) under the name of *Barrettia sparcilirata*. Other species have since been referred to it. The right valve is conical or cylindrical and the distinguishing characters of the genus are seen in the infolds. These may be parallel-sided, when they are non-moniliform; or the sides of the rays may undulate and, if the undulations are symmetrically arranged on either side, a ray will show an alternate thickening and thinning, a structure which may be described as submoniliform; if the undulations do not match on the two sides, a swelling on one side being opposed to a sinus on the other, a result is a sinuous or vermicular ray (Boissevain and MacGillavry, 1932, p. 1304).

Praebarrettia sparcilirata (Whitfield)

Plate 57, figures 1,2; Plate 58, figure 1

Barrettia sparcilirata Whitfield, 1897b, pp. 245-246, pls. 36,37.

Barrettia sparcilirata Whitfield, Trechmann, 1922, p. 512.

Praebarrettia sparcilirata (Whitfield), Trechmann, 1924b, pp. 395-396, pl. 23, figs. 3,4.

Praebarrettia sparcilirata (Whitfield), Chubb, 1955a, pp. 13-14; 1956c, p. 8; 1962/1963, pp. 12,14.

Occurrence. — *P. sparcilirata* occurs in the lowest beds of the *Titanosarcolites* Series in the Logie Green area of the Central Inlier of Upper Clarendon, and in the Sunderland Inlier of St. James.

Description. — A large but not gigantic species; it is conical, becoming cylindrical; the height of an adult is probably at least twice the diameter. The outer layer is some 1 or 2 mm thick; its surface shows widely spaced sulci indicating the infolds; between these are low, rounded or nearly flat ridges which, in the best preserved specimens, show horizontal growth lines representing the funnel plates.

The infolds are comparatively few; Whitfield's type has 23, several of which extend inwards hardly enough to be detected on the cut surface. Other specimens show from 20 to 30 rays, and the distances between the infolds measured around the circumference are variable, the maximum being about 25 mm. The internal structure is usually not clear owing to crystallization but it appears that about half the infolds reach the neighbourhood of the body cavity; the L, S and E pillars are often unrecognisable, but in the speci-

men illustrated in Plate 57, fig. 2, the L inflexion extends well into the body cavity and at its end is bent anteriorly, and the three pillars, which resemble those of other Barrettiinae occupy an arc of over a third of the circumference.

The inner layer forms tabulae with interradial extensions which are well shown when the outer layer is weathered away (see Pl. 57, fig. 1); there are about eight in a vertical distance of 50 mm, *i.e.* they come at mean intervals of about 6 mm. They form large quadrangular cells between the rays.

No Jamaican specimen has been found with the left valve well preserved but the right valve shown in Plate 57, figure 2 contains its cardinal apparatus. The section is immediately below the commissure, through the yoke connecting the teeth, so the individual teeth are not seen. However, it is clear that the hinge line is parallel to the dorsal margin of the shell as in *Barrettia*, not inclined as in *Vaccinites* or *Pironea*. The anterior myophore curves around within the margin of the body cavity, and the posterior penetrates between L and S.

Some Cuban specimens of *P. sparcilirata* have their left valve. It is of normal barrettine type with such modifications as might be expected in a form with few infolds. The radial bars broaden towards the periphery to fit over the wide interrays of the right valve, and thus assume a petaloid shape; a longitudinal section shows that they thicken to a maximum of some 16 mm in the middle of their length. Laterally they have numerous grooves separating processes which abut against those of the next radial bar. Where they overlie a submoniliform infold the processes expand at the line of abutment to form minor radial rods between the major ones; where the underlying infold is sinuous they meet in an irregular manner, the processes on one side abutting against the grooves on the other.

Dimensions.—Whitfield's type specimen from Logie Green is about 125 by 150 mm in diameter; its height is not mentioned; he described another specimen as abruptly turbinate, about 200 mm high, with a diameter of 125 by 175 mm. Another from near Shepherd's Hall, St. James, is 110 by 175 mm in diameter; it has a height of some 215 mm and is more or less cylindrical but has lost both ends. The conical specimen illustrated in Plate 57, fig. 1 has a height of 140 mm and a diameter of 130 mm.

Praebarrettia coatesi Chubb

Plate 58, figures 2-4

Praebarrettia sp. Coates, 1964, p. 10.
Praebarrettia coatesi Chubb, 1967, p. 30.

Occurrence.—Abundant in the Peter's Hill Limestone

at the base of the *Inoceramus* shales in the eastern part of the Central Inlier, Clarendon Parish. Many specimens are largely crystallized and interpretation of the structure is difficult. Named after Dr. A. G. Coates who first discovered it.

Description.—The size is small to medium, making this the smallest of the Barrettiinae known as yet in Jamaica. Right valve typically conical, varying from cylindro-conical to turbinate, sometimes slightly curved; the diameter at the commissure may be half or one-third the height, or may be equal to it. There is a tendency to gregariousness and clusters of up to four or five individuals are not uncommon, though many are isolated. The outer layer is usually weathered away but when preserved is about 0.5 mm thick; infolds fairly numerous, spaced at distances of 5 or 6 mm around the circumference; a small shell with a mean diameter of 45 mm has 23 infolds; other specimens show diameter 52 mm, infolds 30; diameter 55 mm, infolds 31; diameter 73, infolds 40. The infolds are generally parallel-sided, straight or slightly vermicular, rarely submoniliform, 0.4 mm wide, expanding at the inner end to 1.5 or 2 mm, but some of the longest rays bend to the right or left just short of the body cavity and expand less; these in section resemble golf clubs.

The L, S, and E infolds can generally be recognised. The L infold may be long or only of moderate length; it is golf-club-shaped, and curves anteriorly; the S and E pillars penetrate to the body cavity; they are of the typical barrettine pattern; the S pillar is connected with the outer layer by a normal infold, it is oval in cross section and varies from 8 by 6 mm in a large shell to 4 by 3 mm in a small one; the E pillar is from 1.5 to 2 mm wide and extends from the body cavity to the outer layer, with only a slight constriction. The angular distance from L to S is about 90°, S to E some 50°. The hinge is essentially similar to that of other Barrettiinae, the hinge line being parallel to the dorsal margin.

The inner layer forms tabulae rather irregularly spaced at an average interval of 0.5 to 1 mm; sometimes they anastomose, making an irregular tissue between the infolds; in some cases the body cavity too is lined with a vesicular tissue. The diameter of the body cavity is about one-third of that of the shell at the commissure.

The left valve is unknown.

Dimensions.—Two of the largest specimens have diameters at the commissure of antero-posterior 80 mm, dorso-ventral 65 mm; one of these has a height on the dorsal side of 75 mm, ventral side 110 mm; the other has a height of about 115 mm but it is considerably eroded and may originally have been 130 mm or more in height. Another

elongate conical specimen has a commissural diameter of 65 by 50 mm and a height of 110 mm. The best preserved is a small one, with a nearly circular commissure, diameter 45 mm, height about 50 mm.

Remarks.—*Praebarrettia coatesi* appears to be the earliest of the Barrettiinae so far found in the Caribbean area. It most closely resembles *P. porosa* Palmer (1933, p. 99, pl. 6, figs. 3-6) from the Maestrichtian of Cuba. The latter species differs in the wider spacing of its tabulae (miscalled funnel plates by Palmer), which are 1 to 2 mm apart, and in the structure of its rays which are described as beaded and similar to those of *Barrettia*; probably they are submoniliform; if truly moniliform the Cuban species should be referred to *Barrettia*.

Affinities of the Barrettiinae.—According to Trechmann (1924b p. 395) *Praebarrettia* "occupies an intermediate position between *Pironaea* and *Barrettia*, and the stages of evolution of the Hippuritidae may be illustrated by the genera *Vaccinites* — *Orbignya* — *Batolites* — *Pironaea* — *Praebarrettia* — *Barrettia*." Of these six genera the first two and the last two are described above; the others are European genera with multiple infolds. *Batolites* closely resembles *Orbignya* but in addition to the three main infolds it has many small ones, affecting only the outer layer. In *Pironaea* the multiple infolds are pronounced, involving both layers and projecting into the body cavity to form pillars; thus it has a superficial resemblance to *Praebarrettia* though its infolds are non-moniliform.

A few New World species have been ascribed to *Pironaea* and Milovanovic (1936, p. 30) regarded one of these, *P. peruviana*, as intermediate between the European forms and *Praebarrettia*. MacGillavry (1937, p. 122), however, noted that the distance L:E is always much greater in the Antillean and American forms with multiple infolds than the European forms, and he suggested that all New World species that have been attributed to *Pironaea* should be removed to *Praebarrettia*. These would include *P. peruviana* Gerth, *P. cf. peruviana* Vermunt, *P. corrali* Palmer, and *P. pacifica* (Olsson).

Until recently the only known Jamaican species of the unhappily named *Praebarrettia* was the post-barrettian form, *P. sparcilirata*. Obviously this could not be accepted as an ancestor of *Barrettia*. Its cardinal apparatus had never been adequately described or illustrated, but a re-examination of one of Trechmann's specimens has thrown light on it (see Plate 57, fig. 2), and it can be seen that this specimen does somewhat resemble *Pironaea polystylus* of south Europe in having a long, curved ligamental pillar, with the tooth N on its convex posterior side.

The newly discovered *Praebarrettia coatesi* occurs in

rocks that are probably Turonian so it could possibly be an ancestor of the Campanian *Barrettia*. It also has a long ligamental ridge, anteriorly bent at its inner end, but both *coatesi* and *sparcilirata* differ from *Pironaea* in that (a) the three principal pillars are widely spaced, the angular distance between L and E being at least 120° and sometimes as much as 160° or more, while in *Pironaea* the distance is 70° or less; (b) the hinge line is at right angles to the proximal, uncurved part of the ligamental ridge and is parallel to the cardinal margin, whereas in *Pironaea* it is inclined.

Thus Trechmann's view of the evolutionary stages leading to *Barrettia* ignores certain important characters, notably (a) the distance between the L, S and E pillars, which is small in *Vaccinites* and *Pironaea* and large in *Orbignya*, *Batolites*, *Praebarrettia*, and *Barrettia*; (b) the ligamental ridge, which is long and anteriorly curved in *Vaccinites*, *Pironaea*, and *Praebarrettia*, and short and straight in *Orbignya*, *Batolites*, and *Barrettia*, and (c) the hinge line, which is inclined in *Vaccinites* and *Pironaea*, but not in *Orbignya*, *Batolites*, *Praebarrettia*, or *Barrettia*.

Pironaea seems to be more closely related to *Vaccinites*, the Barrettiinae to *Orbignya* and *Batolites*, from which they may be descended, though not by way of *Pironaea*. It seems reasonable to accept MacGillavry's suggestion that the Barrettiinae are an independent, parallel group, which developed from a centre of their own.

BANDS, PILLARS, AND OSCULES

In this memoir an hypothesis put forward many years ago (Chubb, 1956b, pp. 39-44) has, with minor modifications, been taken for granted. It was suggested that most of the characters that distinguish the Hippuritidae and to a lesser extent the Radiolitidae were adaptations to life in crowded conditions with a minimum of mutual interference. These characters include the elongate-conical or cylindrical form of the right valve, which made possible the growth of large fasciculate clusters, and the reduction of the left valve to an operculum, without projecting umbo and with vertical uplift, which involved the withdrawal of the hinge teeth, sockets and ligament away from the margin. The problem of water pollution was met by a similar withdrawal of the siphons, with the formation of open oscules in the free valve, which in turn necessitated the development of pillars in the fixed one. Some osculiferous genera, such as *Lapeirousia* and *Barrettia*, had excessively thick walls, and the infolding brought the siphons from the distant shell edge to the margin of the relatively small body of the animal.

The belief that the function of the oscules was to give the siphons access to sea water has been held by nearly all

rudistologists since Douvillé first propounded it in the 1880's. It is not accepted by Dechaseaux (1947) who claims that the oscules are often closed, at least partially, in old individuals. An examination of many hippurites has failed to confirm this. She brought forward evidence that the rudists did not have long siphons but left open the question of whether they had "a mantle widely open, or one closed except in the two regions of entry and exit of water".

An inspection of Plate 51, figure 1, a cluster of *Barrettia monilifera*, may help to decide this question. The left valves of *Barrettia* completely covered the right, so in this cluster they must have fitted closely together like the pieces in a mosaic, with no room between. If the mantles were open each animal would discharge its faeces directly into the mantle cavity of its neighbours, and there would be no possibility of inhaling clean water.

Recently Sir Maurice Yonge (1967) published an important monograph on form, habit, and evolution in the Chamidae with reference to conditions in the rudists. His knowledge of the Chamidae is based on many years study of living animals, but for the rudists he relied on certain publications: Palmer (1928), Cox's (1933) account of a demonstration he gave to the amateurs of the Geologists' Association, Chubb (1956b), and especially Dechaseaux (1947, 1952, 1960), the last two being text books. Yonge also had discussions with the late Dr. L. R. Cox of the British Museum (Natural History), who would no doubt have shown him some specimens.

On Cox's advice Yonge separated the Hippuritacea (including all rudists) from the Chamacea, though he thought their relationship to be "obviously close" (1967, p. 86). Thirty or forty years ago many palaeontologists might have agreed, but few would today. Yet Yonge's analysis of the Chamidae does throw light on at least the more primitive of the rudists, the Diceratidae, the Monopleuridae, even the Caprinidae, for, though not closely related, they have adapted a similar hinged, isomyarian shell to similar living conditions, which has resulted in the development of similar form and habit.

But with the Hippuritidae and the Radiolitidae Yonge is on less certain ground. He did not accept Dechaseaux's view that the mantle cavity may have been open; he supposed two short siphons like those of *Chama* which he placed, not at the oscules, but at the outer margin.

He summarized the writer's 1956 suggestions and continued (p. 94):

The immediate criticism of these ingenious views is that the oscules were *outside* the animal; they could not have communicated with the mantle cavity . . . From consideration of the position of the posterior adductor and so of the anus, the exhalent opening must have

been dorsal to the 'S' pillar and the inhalent aperture *between* the pillars . . . The effect of the mantle foldings which create the pillars is to create a deep canal between them which would lead to the inhalent opening. The corresponding folding of the mantle on the upper valve would produce the oscules. Any attempt to bring siphons upward through these openings would involve an upward and a *sideways* bending. Since the oscules would close down on top of the pillars when the adductors contracted the siphons would be in constant danger of being crushed. In any case there is the fact that oscules often close or greatly diminish with age . . .

Thus Yonge believed that the function of the two infolds was to create a canal. This was for the disposal of waste, silt, and other suspended and inedible material which would accumulate in the mantle cavity, and be conveyed posteriorly by currents to collect as masses of pseudofaeces at the base of the inhalent aperture, as in the Chamidae. From time to time this material would be expelled, by sudden contractions of the adductor muscles, through this aperture, situated not at an oscule but between the two.

Yonge's description of the oscules as being outside the animal recalls MacGillivray's reference to the tubes in *Titanosarcolites* as "enclosures of the outside world into the animal's shell". But the function of the siphons was to communicate with the outside world, and here were two small enclosures of it brought conveniently near to the animal.

For the siting of the exhalent opening and the anus he referred to his Figure 28B. This is a cross section of "*Hippurites*" in which the sockets, the adductors (really the myophores), the mouth, a ctenidium, and the anus are inserted. The anus is placed between the posterior adductor and the 'S' pillar. It is immediately noticeable that only the outer shell layer is shown, the much thicker inner layer being omitted. If it were sketched in there would be no room for the anus where it is placed.

This may be confirmed by an inspection of the figure of *Barrettia gigas* in Plate 52, figure 1. Yonge would put the anus between *mp* and S. These two shelly processes are in contact and in the living animal would move against each other as the upper valve rose and fell. The faeces emitted by this infinitesimal anus would have to travel some 90 mm to reach a siphon at the outer margin. It is hard to understand the objection to the siphon being at the S oscule, a nearby part of the margin. In this respect *Barrettia* is not unusual; in hippurites the S pillar commonly forms the side of the cavity which receives the posterior myophore.

As regards the suggestion that the formation of oscules was an incidental consequence of the formation of pillars, how would he explain *Thyrastylon*, which has oscules but no pillars? It is of course true that any infold in the lower valve would be reflected as an infold in the upper. But the latter would not open up at its inner end to form an oscule unless there were a reason. Most hippurites have a third pillar, the

ligamental, but while this involves infolds in both valves, there is no ligamental oscule.

It is difficult to understand Yonge's objection to a sideways bending of a siphon. Does he expect bilateral symmetry in a hippurite? And why would the contraction of the adductors crush the siphons? It does not crush them in *Chama* whose valves fit together as closely as the hippurite oscules fit onto their pillars. As for the "fact" that oscules close with age, no statement, however often repeated, should be accepted as fact without evidence.

Yonge's figure 25 is a vertical section of "*Hippurites*" based on a woodcut by Woodward (1854, fig. 2). Yonge shows the left valve as raised and has inserted an adductor muscle, the mantle, including the fused fold, and a siphon. The latter projects laterally and would be crushed if another shell grew alongside. Referring again to the illustration of a *Barrettia* cluster (Plate 51, fig. 1.) it is obvious that these animals had no lateral siphons for there is no room for them; their only possible means of access to sea water would be through the oscules.

Many of the above observations on Yonge's views on the hippurites apply also to his views on the radiolites, but here some additional comments are necessary. He wrote (p. 94) "The Radiolitidae possess siphonal bands, in some forming more pronounced pseudopillars symmetrically situated mid-ventrally," and he referred to his figure 28C.

This figure is a cross section of "*Radiolites*." As in 28B only the outer layer is shown but in this case it matters little as the inner layer would be thin. It shows the position of the sockets, the adductors, and the suggested position of some internal organs, the mouth, a ctenidium, and the anus. Also it indicates by arrows the position of the inhalent and exhalent currents. There can be no criticism so far.

But at two points, respectively some 15 mm anterior and 15 mm posterior to the mid-ventral point, the letters PP appear, and the key shows that these stand for pseudopillars. Here two criticisms are called for. The figure shows no trace of pseudopillars; and pseudopillars or bands are never found at the sites indicated.

A pseudopillar is a definite structure. It is found in few genera of which the best known is *Lapeirousia*. No known Jamaican species have them fully developed though

two, *Tepeyacia multicostata* and *Durania nicholasi*, have incipient pseudopillars (Plate 43, figures 2-4; Plate 45, figure 1). The two siphonal bands in the former species and the E band in the latter are so deeply infolded that they bulge slightly into the body cavity. For these to become true pseudopillars it would be necessary for the two sides of each infold to come together in a cicatrix and the inward bulge to become accentuated. Yonge's figure 28C shows no pseudopillars but only a slight flattening at the points indicated, such as might be produced by pressure of neighbouring shells.

The position of the bands or pseudopillars in the Radiolitidae is fixed within definite limits. They are never situated, as Yonge claimed, "symmetrically mid-ventrally" but both always lie on the posterior side, the S band near the posterior myophore and the E band between it and the mid-ventral point. It often lies at the mid-ventral point but never anterior to it. This is shown in many figures in the publications consulted by Yonge such as that of *Thyrastylon adhaerens* (Chubb, 1956b, pl. 7, fig. 6) which shows the two teeth, their connecting yoke, a trace of the myophores, and the S and E bands. This figure is reproduced here on a smaller scale in Plate 38, figure 6. Other figures that show the position of the bands relative to the myophores, hinge or ligament are Plate 35, figure 3; Plate 39, figure 7; Plate 41, figure 2; Plate 42, figure 4; and Plate 43, figure 2.

Perhaps the most interesting point about Yonge's figure 28C is the position of the arrows he drew to indicate the exhalent and inhalent currents, the former by the ventral end of the posterior adductor and the latter mid-ventral. These are precisely the points where the siphonal bands or, if present, the pseudopillars and oscules would be expected. Thus unintentionally Yonge gave strong support to the belief of most rudistologists that these mark the positions of the two siphons.

It must be emphasized that all these criticisms of Sir Maurice Yonge's views apply to only two pages of a valuable memoir of nearly 60 pages. Also that in 1968 he visited Jamaica, when the writer had the benefit of a long discussion with him and was able to show him many specimens including those illustrated here. Perhaps our mutual differences were largely resolved.

STRATIGRAPHIC DISTRIBUTION

Maestrichtian

Monopleura jamaicensis Chubb
 Gyropleura shaviensis Chubb
 Antilocaprina suboccidentalis Chubb
 A. occidentalis (Whit.)
 A. quadrangularis (Whit.)
 A. stellata Chubb
 A. williamsi Chubb
 A. depressa Chubb
 Titanosarcolites giganteus (Whit.)
 T. alatus Chubb
 Plagiptychus jamaicensis (Whit.)
 P. zansi Chubb
 P. trechmanni Chubb
 P. minor Chubb
 P. fragilis Chubb
 Mitrocaprina multicanaliculata Chubb
 Agriopleura falconi (Chubb)
 Distefanella mooretownensis (Trech.)
 Biradiolites jamaicensis Trech.
 B. robinsoni Chubb
 B. rudis (Whit.)

Basal Maestrichtian

Durania nicholasi (Whit.)

Campanian

Antilocaprina lowenstami Chubb
 Antillosarcolites macgillavryi Chubb
 Plagiptychus toucasianus Matheron
 Praeradiolites verseyi Chubb
 Biradiolites cf. rudissimus Trech.
 B. novaterrensis Chubb
 Bournonia sanctannae Chubb
 B. baileyi Chubb
 B. coxi Chubb

Turonian

Torreites cf. sanchezi (Douvillé)

Albian

Caprinuloidea perfecta Palmer
 Sphaerucaprina seafieldensis Chubb

Pre-Albian

Pachytraga jubilensis Chubb

Age uncertain

Monopleura sp
 Distefanella lombricalis (d'Orbigny)
 Bournonia sanctmariae Chubb

Biradiolites rudissimus Trech.
 B. forbesi Chubb
 B. minhoensis Trech.
 B. riograndensis Chubb
 Thyrastylon adhaerens (Whit.)
 T. coryi (Trech.)
 T. semiannulosus (Trech.)
 T. sp.
 Bournonia cancellata (Whit.)
 B. subcancellata (Trech.)
 B. thiadensi Vermunt
 B. barretti Trech.
 B. tetrahedron Chubb
 Sauvagesia macroplacata (Whit.)
 S. mcgrathi Chubb
 S. fluminisagni Chubb
 S. annulosa (Whit.)
 Chiapasella radiolitifomis (Trech.)
 Orbignya mullerriedi Vermunt
 O. cebarum (Chubb)
 O. maldonensis (Chubb)

Praebarrettia sparcilirata (Whit.)

Durania nicholasi (Whit.)
 D. cf. aguila Adkins
 Vaccinites eyrei Chubb
 Barrettia monilifera Woodward
 B. gigas Chubb
 B. multilirata Whit.
 B. ruseae Chubb
 Parastroma trechmanni Chubb

Praebarrettia coatesi Chubb

Sabinia totiseptata Palmer
 Tepeyacia multicostata Chubb

Monopleura diaboli Chubb

Horizon

Whitfield Breccia
 Bon Hill Limestone
 Reworked in Eocene shale

REFERENCES

- Adkins, W. S.
1930. *New rudistids from the Texas and Mexico Cretaceous*. Univ. Texas Bull. 3001, pp. 77-100, pls. 4-9.
- Barrett, Lucas
1860. *On some Cretaceous rocks in the South-Eastern Portion of Jamaica*. Quart. J. Geol. Soc. London, vol. 16, pp. 324-326.
- Boehm, G.
1892. *Ein Beitrag zur Kenntniss der Kreide in den Venetianer Alpen*. Ber. Naturforschenden Gesellschaft, Freiburg, vol. 6, pp. 134-149, pls. 6-9.
- Boissevain, H., and MacGillivray, H. J.
1932. *Some remarks on Barretia sparsilirata Whitfield and Chiapasella radiolitiformis (Trechmann)*. Proc. K. Akad. Wetensch., Amsterdam, vol. 35, pp. 1303-1312.
- Caldwell, W. G. E., and Evans, J. K.
1963. *A Cretaceous rudist from Canada, and a redescription of the holotype of Ichthyosarcosites coralloidea (Hall & Meek)*. Jour. Paleont., vol. 37, pp. 615-620, pl. 75.
- Chaper, M.
1873. *Observations sur une espèce du genre Plagioptychus*. Études faites dans la Coll. de l'École des Mines, . . . , Paris, vol. 2, pp. 82-90, pl. 11,12.
- Chubb, L. J.
1955a. *A revision of Whitfield's type specimens of the rudist mollusks from the Cretaceous of Jamaica, B.W.I.* Amer. Mus. Novitates, No. 1713, pp. 1-15.
1955b. *The Cretaceous succession in Jamaica*. Geol. Mag., vol. 92, pp. 177-195.
1956a. *Some rarer rudists from Jamaica, B.W.I.* Palaeontographica Americana, vol. 4, pp. 1-30, pls. 1-5.
1956b. *Thyrastylon, a new rudist genus from the Upper Cretaceous of Guatemala, the Antilles and Persia, with a discussion of the functions of rudist oscles and pillars*. Ibid., pp. 31-48, pls. 6-7.
1956c. *Rudist assemblages of the Antillean Upper Cretaceous*. Bull. Amer. Paleont., vol. 37, pp. 1-23.
1959. *Upper Cretaceous of Central Chiapas, Mexico*. Bull. Amer. Ass. Petrol. Geol., vol. 43, pp. 725-56.
1960a. *Correlation of the Jamaican Cretaceous*. Geonotes, Jamaica, vol. 3, pp. 85-97.
1960b. *The Antillean Cretaceous geosyncline*. Trans. Second Carib. geol. Conference, Puerto Rico, pp. 17-26.
1961a. *Blue Mountain Shale*. Geonotes, Jamaica, vol. 4, pp. 1-7.
1961b. *Rudist assemblages in Cuba*. Bull. Amer. Paleont., vol. 43, pp. 409-422.
1962/1963. *Cretaceous formations, in Synopsis of the Geology of Jamaica*. Geol. Survey, Jamaica, Bull. 4, pp. 6-20.
1967. *New rudist species from the Cretaceous rocks of Jamaica*. Jour. Geol. Soc. Jamaica, vol. 9, pp. 24-31.
- Coates, A. G.
1964. *Geology of the area around Craxie River, Arthurs Seat, Crofts Hill and British, Clarendon*. Geol. Survey, Jamaica, Annual Rept. for 1962/1963, Appendix A, pp. 6-10.
- Dechaseaux, Colette
1947. *Bandes siphonales, piliers et siphons des Rudistes*. Bull. Soc. Géol. France, ser. 5, vol. 17, pp. 425-435.
1949. *Le genre Bournonia*. Ann. de Paléontologie, vol. 35, pp. 121-138, pls. 14-17.
1952. *Rudistes, in Piveteau, Traité de Paléontologie*, vol. 2, pp. 323-364.
1960. *Bivalves fossiles, in Grassé, Traité de Zoologie*, vol. 5, pp. 2134-2164.
- De la Beche, H. T.
1827. *Remarks on the Geology of Jamaica*. Trans. Geol. Soc. London, ser. 2, vol. 2, pp. 143-194.
- Di Stefano, G.
1888. *Studi stratigrafici e paleontologici sul sistema cretaceo della Sicilia. I Gli Strati con Caprotina de Termini Imerese*. Atti R. Accad. Sci., Lett. ed Arti, Palermo, vol. 10, pp. 1-16, pls. 1-11.
- Dixon, Inez
1960. *Research at Rusea's*. Geonotes, Jamaica, vol. 3, pp. 109-110, text-fig.
- Douvillé, Henri
1887. *Sur quelques formes peu connues de la famille des Chamidés*. Bull. Soc. Géol. France, ser. 3, vol. 15, pp. 756-802, pls. 28-31.
1888. *Études sur les Caprines*. Ibid., vol. 16, pp. 699-730, pls. 22-25.
1890-7. *Revision des principales espèces d'hippurites*. Mem. Soc. Géol. France, No. 6, pp. 1-236, pls. 1-34.
1898. *Les rudistes de la Jamaïque, par R. P. Whitfield*. Rev. Crit. Paléozool., year 1, No. 3, pp. 122-125.
1900a. *Sur quelques rudistes Américains*. Bull. Soc. Géol. France, ser. 3, vol. 28, pp. 205-221.
1900b. *Sur la distribution géographique des Rudistes, des Orbitolines et d'Orbitolites*. Ibid. vol. 1, pp. 222-235.
1902. *Classification des Radiolites*. Ibid., ser. 4, vol. 2, pp. 461-477, pl. 15.
1904. *Sur quelques rudistes à canaux*. Ibid., ser. 4, vol. 4, pp. 519-538, pls. 13-14.
1908. *Sur la classification des Radiolites*. C.R. Soc. Géol. France, No. 12, pp. 114-116.
1910. *Rudistes de Sicile, d'Algérie, d'Égypte, du Liban et de la Perse*. Mem. Soc. Géol. France, Paléontologie, vol. 18, fasc. 1, No. 41, pp. 1-84, pls. 1-7.
1913. *Sur quelques rudistes du Liban et sur l'évolution des Bivalvulites*. Bull. Soc. Géol. France, ser. 4, vol. 13, pp. 409-421, pl. 9.
1918. *Le Barrémien supérieur de Brouzet, Partie III: Les rudistes*. Mem. Soc. Géol. France, Paléontologie, No. 52, pp. 1-20, pls. 1-4.
1926. *Quelques fossiles du Crétacé supérieur de Cuba*. Bull. Soc. Géol. France, ser. 4, vol. 26, pp. 127-138, pls. 7-8.
1927. *Nouveaux rudistes du Crétacé de Cuba*. Ibid., ser. 4, vol. 27, pp. 49-56, pl. 4.
- Fischer, P.
1887. *Manuel de Conchyliologie et de Paléontologie conchyliologique*, pp. 1-1041.
- Harris, G. D., and Hodson, F.
1922. *Rudistids of Trinidad*. Palaeontographica Americana, vol. 1, pp. 119-162, pls. 18-28.
- Jung, P.
1970. *Torreites sanchezii (Douvillé) from Jamaica*. Palaeontographica Americana, vol. 7, No. 42, pp. 1-3, pls. 1-3.
- Kühn, O.
1932. *Rudistae*. Fossilium Catalogus I. Animalia, pars 54, pp. 1-200.
- Kutassy, A.
1934. *Pachydonta mesozoica (Rudistes exclusis)*. Ibid., Pars 68, pp. 1-202.
- MacGillivray, H. J.
1932. *The rudist fauna of the Serot Teintje Limestone (Northern Curaçao)*. Proc. K. Akad. Wetensch., Amsterdam, vol. 35, pp. 381-392, pl. 1,2.
1934. *Some rudists from the Alta Verapaz, Guatemala*. Ibid., vol. 37, pp. 232-238.
1935. *Remarks on rudists*. Ibid., vol. 38, pp. 558-565.
1937. *Geology of the province of Camaguey, Cuba, with revisional studies of rudist paleontology*. Geogr. Geol. Meded., Utrecht, No. 14, pp. 1-168, pls. 1-10.
- Matheron, P.
1843. *Catalogue méthodique et descriptif des corps organisés fossiles du Département des Bouches-du-Rhône et lieux circonvoisins*, Marseilles, pp. 1-269, pls. 1-41.
- Matley, C. A., and Higham, F.
1929. *The Basal Complex of Jamaica with special reference to the Kingston District*. Quart. J. Geol. Soc. London, vol. 85, pp. 440-492, pls. 23-25.
- Matley, C. A., and Raw, F.
1942. *A road section near Guy's Hill, Jamaica*. Geol. Mag., vol. 79, pp. 241-252, pl. 7.
- Milovanovic, B.
1936. *Yvanina maestrichtiensis n. sp. et son importance pour la question de la formation brusque des formes nouvelles*. Ann. Geol. Peninsula Balk., vol. 13, pp. 28-41.

- Mullerried, F. K. G.**
 1930. *Un hippurites de la region de Cardenas*. Ann. Inst. Biol., Mexico, vol. 1, pp. 165-168.
 1931. *Chiapasella, un paquidonto extrañísimo de la America*. Ibid., vol. 2, pp. 243-254.
 1932. *El Biradiolites lombricalis D'Orb sp. de Ejutla, Edo. de Oaxaca*. Ibid., vol. 3, pp. 237-242.
 1933a. *El genero Plagioplychus en Mexico*. Ibid., vol. 4, pp. 1-14.
 1933b. *Estudios paleontologicos y stratigraphicos en la region de Tehuacan, Puebla*. Ibid., vol. 4, pp. 309-330.
 1934. *Sobre el hallazgo de paquidontos gigantes en el Cretácico de Chiapas*. Ibid., vol. 5, pp. 81-82.
- Orbigny, A. d'**
 1842. *Quelques considérations zoologiques et géologiques sur les Rudistes*. Ann. Sci. Nat., ser. 2, vol. 17, pp. 173-192.
 1847. *Paléontologie française*. Terr. Crét., vol. 4, Brachiopodes, pp. 157-373, pls. 528-99.
- Palmer, R. H.**
 1928. *The rudistids of southern Mexico*. California Acad. Sci., Occ. Pap. 14, pp. 1-137, pls. 1-18.
 1933. *Nuevos rudistes de Cuba*. Revista Agricultura, vol. 14, pp. 95-125, pls. 1-10.
- Paquier, V.**
 1903-5. *Les Rudistes urgoniens*. Mem. Soc. Géol. France, Paléontologie, vol. 29, pp. 1-95, pls. 1-12.
- Parona, C. F.**
 1908. *Notizie sulla fauna a Rudiste della pietra di Subiaco nella valle dell'Aniene*. Boll. Soc. Geol. Ital., vol. 27, pp. 299-310, pl. 9.
 1909. *La Fauna coralligena dei Monti d'Ocre nelle Abruzzo Aquilano*. Mem. Carta. Geol. d'Italia, vol. 5, pp. 1-242, pls. 1-28.
- Rutten, M. G.**
 1936. *Rudistids from the Cretaceous of northern Santa Clara Province, Cuba*. Jour. Pal., vol. 10, pp. 134-142.
- Stephenson, L. I. W.**
 1938. *A new Upper Cretaceous rudistid from the Kemp Clay of Texas*. U.S. Geol. Surv. Prof. Paper 193-A, pp. 1-15, pls. 1-5.
- Thiadens, A. A.**
 1936a. *Rudistids from southern Santa Clara, Cuba*. Proc. K. Akad. Wetensch., Amsterdam, vol. 39, pp. 1010-1019.
 1936b. *On some Caprinids and a Monoplcurid from southern Santa Clara, Cuba*. Ibid., pp. 1131-1141.
- Tobler, A.**
 1928. *Demonstration einiger mittelamerikanischer Rudistenfaunen*. Ecl. Geol. Helvet., vol. 21, pp. 216-217.
- Torre, Alfredo de la**
 1960. *Notas sobre rudistas*. Mem. Soc. Cubana de Hist. Nat., vol. 25, pp. 51-64.
- Toucas, A.**
 1903. *Études sur la classification et l'évolution des hippurites*. Mem. Soc. Géol. France, Paléontologie, vol. 30, pp. 1-128, pls. 1-17.
 1909. *Études sur la classification et l'évolution des radiolitides*. Ibid., vol. 36, pp. 1-132, pls. 1-24.
- Trechmann, C. T.**
 1922. *The Barretia beds of Jamaica*. Geol. Mag., vol. 59, pp. 501-514, pls. 18-20.
 1924a. *The Carbonaceous Shale or Richmond Formation of Jamaica*. Ibid., vol. 61, pp. 2-19, pls. 1, 2.
 1924b. *The Cretaceous limestones of Jamaica and their Mollusca*. Ibid., vol. 61, pp. 385-410, pls. 22-26.
 1927. *The Cretaceous shales of Jamaica*. Ibid., vol. 64, pp. 27-42, 49-65, pls. 1-4.
 1929. *Fossils from the Blue Mountains of Jamaica*. Ibid., vol. 66, pp. 481-491, pl. 18.
 1936. *The basal complex in Jamaica*. Ibid., vol. 73, pp. 251-267; 382-3.
- Vermunt, L. W. J.**
 1937. *Cretaceous rudistids of Pinar del Rio Province, Cuba*. Jour. Paleont., vol. 11, pp. 261-275, pls. 36-7.
- Whitfield, R. P.**
 1897a. *Descriptions of species of Rudistae from the Cretaceous rocks of Jamaica, W. I., collected and presented by Mr. F. C. Nicholas*. Bull. Amer. Mus. Nat. Hist., vol. 9, pp. 185-196, pls. 6-22.
 1897b. *Observations on the genus Barretia Woodward, with descriptions of two new species*. Ibid., vol. 9, pp. 233-246, pls. 27-38.
- Woodward, S. P.**
 1851-1856. *Manual of the Mollusca*. Pp. XVI, 486, 25 pls. map.
 1855. *On the structure and affinities of the hippurites*. Quart. Jour. Geol. Soc. London, vol. 11, pp. 40-61, pls. 3-5.
 1862. *Some account of Barretia, a new and remarkable fossil shell from the Hippurite Limestone of Jamaica*. Geologist, vol. 5, pp. 372-377.
- Yonge, C. M.**
 1967. *Form, habit and evolution in the Chamidae (Bivalvia) with reference to conditions in the rudists (Hippuritacea)*. Phil. Trans. Roy. Soc., Ser. B, vol. 252, pp. 49-105.
- Zans, V. A.**
 1951. *Geology and mineral deposits of Jamaica*. Govt. Printer, Jamaica, pp. 1-11.
 ——— (and others)
 1962/1963. *Synopsis of the geology of Jamaica*. Geol. Survey Dept., Jamaica, Bull. 4, pp. 1-72.
- Zittel, K. A. von, and Eastman, C. R.**
 1913. *Text-book of Paleontology*. pp. 476-484.

PLATES

LOCATION OF THE FIGURED SPECIMENS

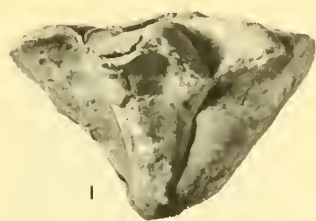
The location and identity of the specimens illustrated in the following plates are indicated by letters and numbers:

- AMNH — American Museum of Natural History, New York. These are Whitfield's types. The Catalogue Numbers are quoted.
- BMNH — British Museum (Natural History), London. These include Woodward's types whose numbers have no prefix, specimens presented by the late Dr. C. T. Trechmann during his lifetime whose numbers are prefixed by the letter L, and those in the Trechmann Bequest which are prefixed by LL.
- Inst — Institute of Jamaica, Kingston. The collection includes, among others, specimens presented by F. C. Nicholas which are topotypes of Whitfield's species; and by C. T. Trechmann, including paratypes of his species.
- Smith — Smithsonian Institution, Washington. Nearly all the types of new species and many older ones have been transferred to the Smithsonian.
- USNM — United States National Museum. Specimens collected by the late Dr. C. A. Matley in 1939-40.
- UWI — University of the West Indies, Department of Geology. Includes specimens collected by the Jamaica Geological Survey. With few exceptions the types formerly at U.W.I. have been transferred to the Smithsonian.

EXPLANATION OF PLATE 27

All illustrations natural size. Figures 1-3 and 7-9 are free specimens; all others are sections on weathered surfaces of limestone.

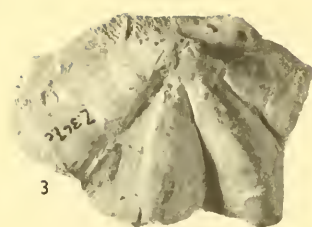
Figure	Page
1-3. <i>Monopleura jamaicensis</i> Chubb	166
Bivalve, ventral view. (Chubb, 1956a, pl. 1, fig. 1). Smith, Maestrichtian, Ducketts, Westmoreland. 2. Same specimen. Anterior view. (Chubb, 1956a, pl. 1, fig. 2). 3. Same specimen. Left valve. (Chubb, 1956a, pl. 1, fig. 3).	
4,5. <i>Monopleura diaboli</i> Chubb	166
Right valve, transverse section near commissure, showing two sockets (b' and b) and body cavity (D) containing a fragment of left valve within its ventral margin. UWI 4161—Bonnets-Copper Limestone, Benbow Inlier, St. Catherine. 5. Same species. Left valve lying with its commissural side down; outer surface weathered away to show socket (n) and body cavity (G). Same number, horizon and locality.	
6. <i>Monopleura</i> sp.	167
Sections. UWI 6176. Whitfield Hall crush-breccia, Blue Mountains.	
7-9. <i>Gyropleura shawiensis</i> Chubb	167
Right valve somewhat broken, showing hinge structure and both myophores (ma and mp). (Chubb, 1956a, pl. 1, fig. 5). Smith. Shaw Castle Shale, Shaw Castle, St. James. 8. Same species. Right valve unbroken, but umbonal area eroded. Smith. Same horizon and locality. 9. Same species. Bivalve. (Chubb, 1956a, pl. 1, fig. 4). Smith. Maestrichtian, Ducketts, Westmoreland.	
10,11. <i>Pachytraga jubilensis</i> Chubb	168
Bivalve, longitudinal section. Right valve showing body cavity, accessory cavity (mp0), and tooth (N) fitting into socket of left valve. Smith. Jubilee Limestone, Benbow Inlier, St. Catherine. 11. Same species. Transverse section of right valve, showing ligamental infold (L), small posterior socket (b), accessory cavity (mp0), large crescentic tooth (N) embracing anterior socket (b') which contains broken off tooth of left valve. Smith. Same horizon and locality.	
12-14. <i>Caprinuloidea perfecta</i> Palmer	169
Left valve, oblique section, showing curvature, ligamental infold (L), longitudinal canals etc. Smith. Seafield Limestone, Benbow Inlier, St. Catherine. 13. Same species. Left valve, transverse section near commissure, showing canaliculate walls, body cavity (G), septum, and posterior muscle cavity (mp). Smith. Same horizon and locality. 14. Same species. Right valve, transverse section near commissure, showing canaliculate walls, ligamental groove (L) and cavity, anterior (b') and posterior (b) sockets the latter connected with muscle cavity (mp), which is divided from body cavity (D) by a septum. Smith. Same horizon and locality.	



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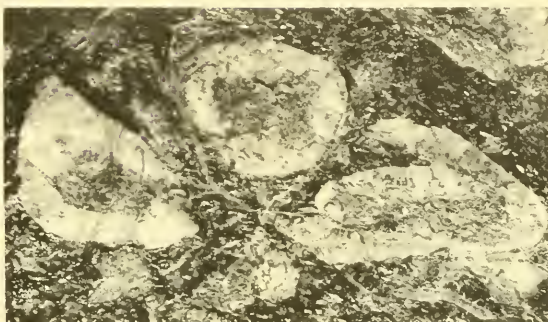
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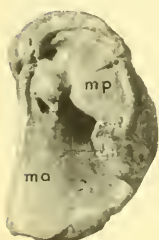
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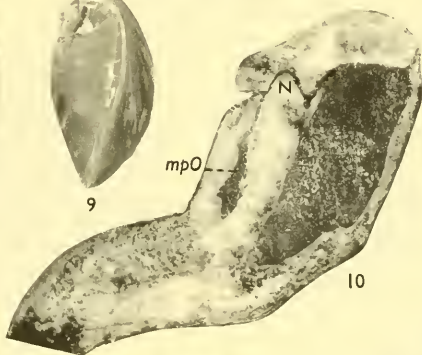
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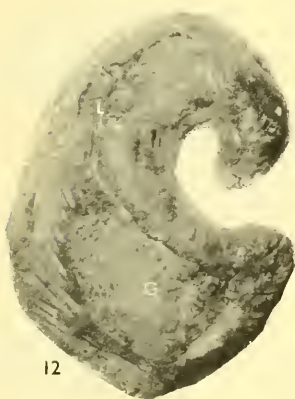
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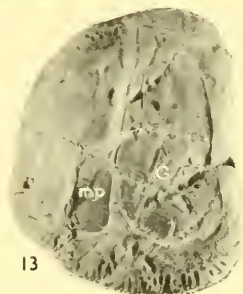
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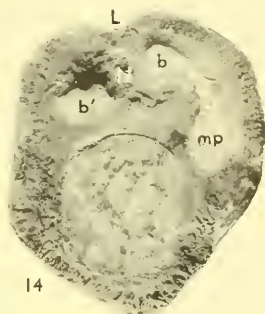
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EXPLANATION OF PLATE 28

All illustrations natural size except figure 2
Figure 1 courtesy American Museum of Natural History

Figure	Page
1,2. <i>Antillocaprina occidentalis</i> (Whitfield)	173
<p>Right valve, reproduced from Whitfield's figure (1897a, pl. 17, fig. 3). A more or less corkscrew-like specimen. AMNH 9673/1. Maestrichtian, Logie Green, Upper Clarendon. 2. Same species. Left valve X 0.67. A new photograph of one of Whitfield's syntypes (1897a, pl. 16, fig. 4). A coiled but not closely involute form, showing body cavity, commissural surface, anterior and posterior myophores, the former (ma) fissured and the latter (mp) having its middle part broken away, anterior tooth (B') abutting against large crescentic posterior tooth (B); the latter embraces a small ligamental pillar which is crescentic in the opposite sense; socket (n) small, occluded; walls, myophores and teeth canalicate. Compare Text figure 2. Same museum number. Same horizon and locality.</p>	
3,4. <i>Antillocaprina suboccidentalis</i> Chubb	172
<p>Left valve. A new photograph of one of Trechmann's types (1924b, pl. 25, fig. 3). A more involute form; both myophores complete and undamaged, showing stump of anterior tooth (B'), socket (n) large and not occluded, and crescentic posterior tooth (B); no ligamental pillar seen. BMNH L63211. Maestrichtian, lower part of Logie Green section. 4. Same species. Right valve. A new photograph of another of Trechmann's types (1924b, pl. 25, fig. 2). It shows both myophores, a single tooth (N) between two sockets, the anterior (b') oval, the posterior (b) transversely sigmoidal, and a ligamental cavity (L) crescentic in the same sense as the socket. BMNH L63210. Maestrichtian, Great River Valley below Catadupa, St. James.</p>	
5-9. <i>Antillocaprina lowenstami</i> Chubb	174
<p>Right valve, showing body cavity (D), canaliculate wall, and smooth down-sloping posterior muscle attachment area (mp); the whole hinge plate recrystallized and showing no structures other than the oblique rock-filled ligament cavity. Smith. Campanian, marly limestone 80 ft. above the <i>Barrettia</i> Limestone, Stapleton, St. James. 6. Same specimen. Left valve; body cavity (G), walls, hinge plate similar to those of right valve; posterior muscle attachment a smooth up-sloping myophore (mp). 7. Same specimen, before separation of the valves, anterior view; on this side nearly all the outer layer has been removed by weathering, revealing the canals in the walls. 8. Same species. Transverse section of the right valve of another specimen, showing canaliculate walls, concave tabulae in body cavity, and hinge plate with narrow tooth between two sockets and crescentic rock-filled ligament cavity. Compare Text figure 3. Smith. Same horizon and locality. 9. Same specimen as figures 5-7. Posterior view of bivalve; on this side most of the smooth outer layer is preserved.</p>	

EXPLANATION OF PLATE 29

All illustrations natural size except Figure 2
 Figure 2 courtesy American Museum of Natural History

Figure	Page
1-6. <i>Antillocaprina quadrangularis</i> (Whitfield)	174
<p>Highly arched left valve, dorsal aspect. Two minor costae are seen between the central flange and the anterior wing. The sigmoidal posterior tooth (B) and the conical anterior one (B') project below the commissure. BMNH LL30298. Maestrichtian, locality unknown. 2. Same species, right valve, ventral aspect X 0.67. A copy of Whitfield's plate 14, figure 4. Anterior flange seen on left, ventral flange in centre, posterior flange on right broken away. AMNH 9681/1. Said to be from Cretaceous limestones at Christianna; perhaps Logie Green, Clarendon. 3. Same species Left valve, commissural aspect; showing central socket (n), long sigmoidal posterior tooth (B), stump of oval anterior tooth (B'). (Chubb, 1956a, pl. 2, fig. 2). BMNH L88064. Maestrichtian, Catadupa, St. James. 4. Same specimen, external aspect. Outer layer weathered away, inner layer shows tubular structure. (Chubb, 1956a, pl. 2, fig. 1). 5. Same species, left valve of a bivalved specimen. Outer layer preserved, showing growth lines (Chubb, 1956a, pl. 1, fig. 16). BMNH L88065. Same horizon and locality. 6. Same specimen, transverse section of right valve near to commissure. Shows single tooth (N), hourglass-shaped in section, slightly displaced, flanked by sockets (b' and b) containing the teeth of the left valve, the anterior one round, the posterior crescentic.</p>	





EXPLANATION OF PLATE 30

All illustrations natural size

Figure	Page
1-3. <i>Antillocaprina stellata</i> Chubb	175
Fragment of right valve showing two flanges. Smith. Shaw Castle Shale, Maestrichtian, Shaw Castle, St. James. 2. Same species. Isolated flange showing close-set horizontal growth-lines crossing longitudinal tubes. Smith. Same horizon and locality. 3. Same species, apical end of a young individual. Smith. Same horizon and locality.	
4. <i>Antillocaprina depressa</i> Chubb	176
Mould of interior of right valve. Shows a clear impression of a hinge of <i>Antillocaprina</i> type with tooth represented by quadrangular hollow, anterior socket by conical projection, and posterior socket by transversely elongated sigmoidal projection. A new photograph of Trechmann's type (1929, pl. 18, figs. 4,5). BMNH LL30290. Maestrichtian, Blue Mountain Shale, Blue Mountain Peak, St. Thomas.	
5. <i>Sphaerucaprina seafieldensis</i> Chubb	170
Left valve, transverse section. Shows small round body cavity (G); long oblique socket (n) opening into posterior muscle cavity (mp); anterior (ma0) accessory cavities etc. Cellular structure not well shown. Compare Text Figure 1. Smith. Probably Albian, near Seafield Manse, St. Catherine.	
6. <i>Sabinia totiseptata</i> Palmer	171
Right valve, longitudinal section. Shows tabulate tubules in walls, nontabulate body cavity, two sockets (b' and b). Smith. Same horizon and locality.	
7. <i>Antillocaprina williamsi</i> Chubb	175
Bivalved specimen, anterior aspect. Figured by Trechmann as <i>Antillocaprina</i> sp. (1927, pl. 2, fig. 10). BMNH L63262. Maestrichtian shale, Cambridge-Catadupa railway cutting, St. James.	
8. <i>Antillocaprina occidentalis</i> (Whitfield)	173
Left valve, commissural aspect. Shows large crescentic posterior tooth (B) abutting against small conical anterior tooth (B'), small socket (n) displaced dorsally. BMNH L63259. Maestrichtian, Great River Valley, below Catadupa, St. James.	
9-12. <i>Antillosarcolites macgillavryi</i> Chubb	179
Left valve broken to show thick oblique tabulae. Smith. Campanian <i>Barrettia</i> Series Haughton Hall, Green Island, Hanover. 10. Same specimen, right valve, commissural aspect. Shows anterior socket (b') separated by base of tooth (N) from posterior socket (b) which opens into posterior muscle cavity (mp); attachment area of anterior muscle (ma) seen in left of body cavity. 11. Same specimen; the two valves seen in anterior aspect, right valve on left, left valve on right. 12. Same specimen; transverse section of left valve.	

EXPLANATION OF PLATE 31

Figures 1 and 3 reduced, figure 2 natural size
Figure 3 courtesy American Museum of Natural History

Figure	Page
1. <i>Titanosarcolites giganteus</i> (Whitfield)	177
Bivalved specimen $\times 0.67$. Anterior aspect with commissure in middle, right valve on left, left valve on right. A new photograph of one of Trechmanns' types (1924b, pl. 23, fig. 1). BMNH L44205. Maestrichtian, Great River Valley, below Catadupa, St. James.	
2. <i>Titanosarcolites alatus</i> Chubb	178
Transverse section of a right valve. BMNH LL30292. Maestrichtian, Great River Valley, borders of St. James and Westmoreland.	
3. <i>Titanosarcolites giganteus</i> (Whitfield)	177
Transverse section of a left valve $\times 0.90$. One of Whitfield's types (1897a, pl. 19, fig. 1; pl. 20), shown also in posterior aspect in Plate 33, figure 1. Compare the angular ridges and few broad flutings on the posterior side with the more numerous projecting flanges and narrow furrows of <i>T. alatus</i> . Crypt of a boring organism seen at \times on left. AMNH 9685/2. Maestrichtian, Logie Green, Clarendon.	





EXPLANATION OF PLATE 32

All illustrations natural size

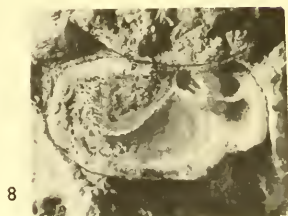
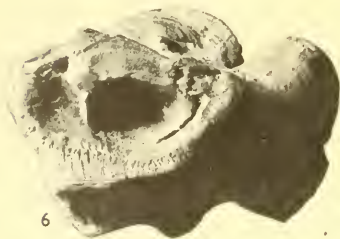
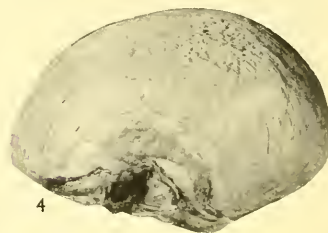
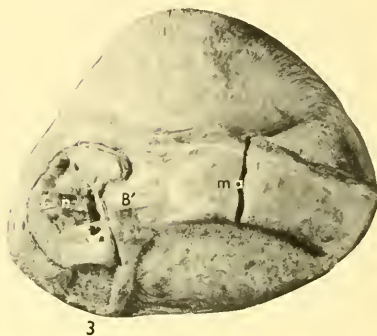
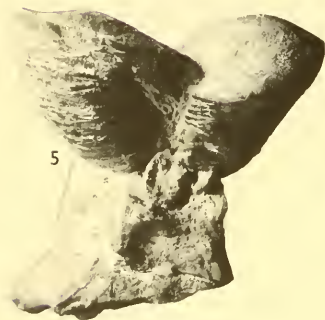
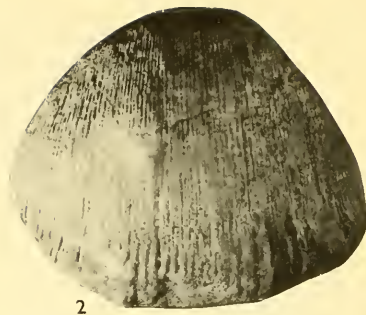
Figure	Page
1, 2. <i>Titanosarcoclitus giganteus</i> (Whitfield)	177
Transverse section of left valve cut about 16 mm from commissure. Anterior on left. Partly crystallized but showing many capillaries and large tubular canals; also, above the rock-filled body cavity (G), the large socket (n) containing the tooth of the right valve. BMNH L63230. Maestrichtian, Catadupa, St. James. 2. Same specimen, transverse section of right valve cut about 16 mm from commissure. Anterior on right. Shows many of the same characters as figure 1. Note that the tubular canals correspond in position, shape and size, indicating that they were continuous from one valve into the other. The two oval sockets (b' and b) contain the teeth of the left valve. Compare Plate 33, figure 2, a similar section of a right valve cut farther from the commissure.	
3. <i>Titanosarcoclitus alatus</i> Chubb	178
Right valve, commissural aspect. A new photograph of one of Trechmann's types (1924b, pl. 23, fig. 2) described by him as <i>T. giganteus</i> . It shows a single bifid tooth (N) between two deep sockets (b' and b). BMNH L63232. Maestrichtian, below Catadupa, St. James.	
4, 5. <i>Plagioptychus fragilis</i> Chubb	182
Left valve, commissural aspect. Smith. Maestrichtian, Shaw Castle Shale, St. James. 5. Same species, right valve. Shows posterior socket divided by ligamental ridge. Smith. Same horizon and locality.	
6, 7. <i>Plagioptychus trechmanni</i> Chubb	181
Left valve, commissural aspect. This and the next figure are new photographs of Trechmann's types (1924b, pl. 25, fig. 4) called by him <i>P. jamaicensis</i> . BMNH L63220. Maestrichtian, Logie Green, Clarendon. 7. Same species, bivalved specimen, posterior aspect. Compare Chubb 1956a, text figure 1. BMNH L 63221. Same horizon and locality.	

EXPLANATION OF PLATE 33

Illustrations natural size except figures 1 and 2
 Figures 1 and 2 courtesy American Museum of Natural History

Figure	Page
1, 2. <i>Titanosarcolites giganteus</i> (Whitfield)	177
<p>Left valve, posterior aspect $\times 0.67$. A copy of Whitfield's plate 20; shown also in transverse section in Plate 31, figure 3. This side shows a few broad, rounded flutings, separated by angular ridges; compare with the anterior side shown in Plate 31, figure 1, AMNH 9685/2. Maestrichtian, Logie Green, Clarendon. 2. Same species, right valve $\times 0.85$. A transverse section of another of Whitfield's types (1897a, pl. 21). Compare with Plate 32, figure 2; this section, being cut farther from the commissure, shows concave tabulae in the body cavity and conical tabulae in the sockets. AMNH 9685/3. Same horizon and locality.</p>	
3-5. <i>Plagioptychus zansi</i> Chubb	181
<p>Left valve, apertural aspect. (Chubb, 1956a, pl. 1, fig. 7). Smith. Maestrichtian, road bank facing Lot 67, Ducketts Land Settlement, Westmoreland. 4. Same species, bivalve, posterior aspect; right valve low and exogyrate (Chubb, 1956a, pl. 1, fig. 8). A <i>Bournonia thiadensi</i> is attached to the left valve (for other views of this specimen see Plate 40, figures 7 and 8). Smith. Maestrichtian, mile post 14 between Point and Flamstead, St. James. 5. Same species, bivalve with conical right valve (Chubb, 1956a, pl. 1, fig. 9). Smith. Same horizon and locality.</p>	





EXPLANATION OF PLATE 34

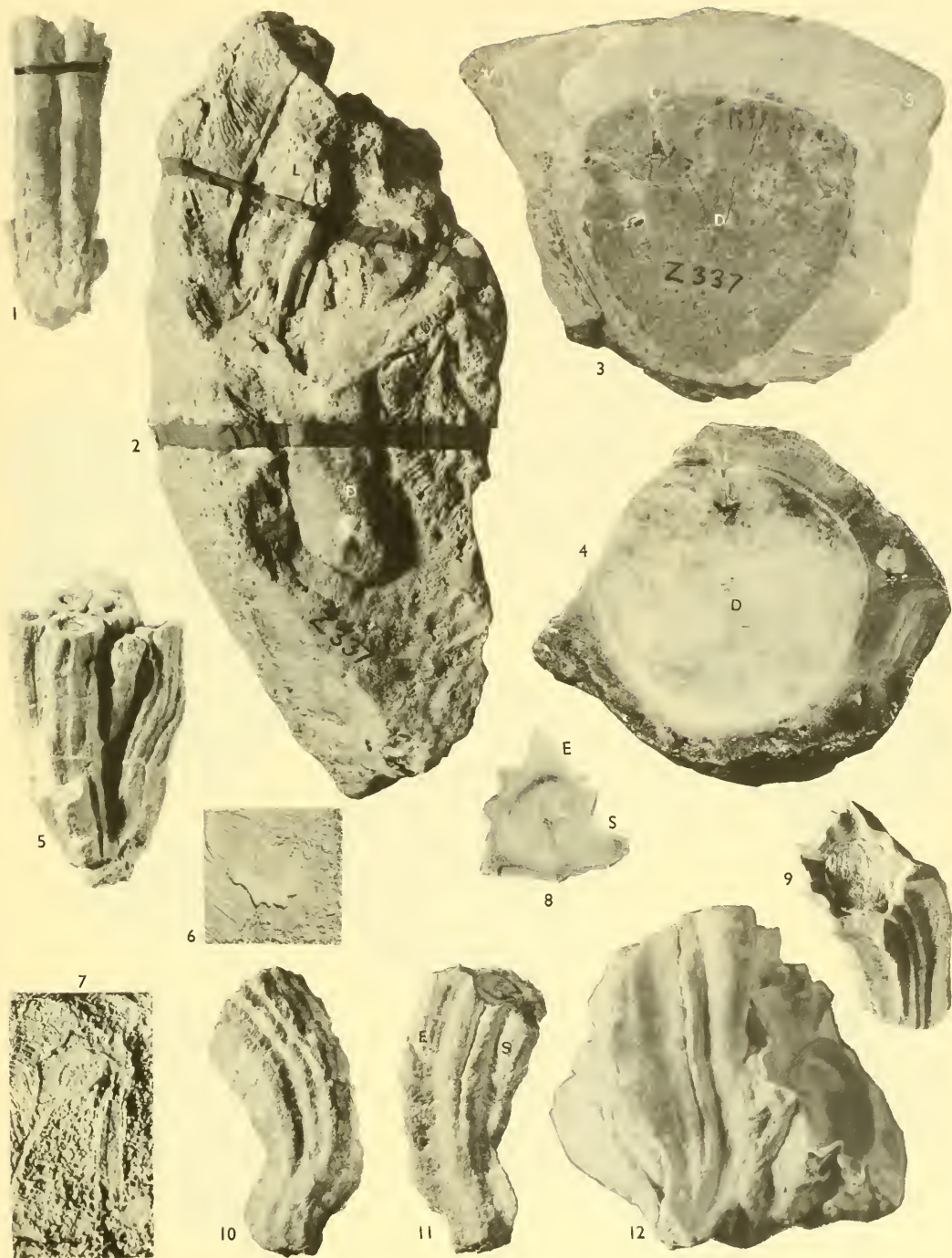
All illustrations natural size except figures 1 and 8
Figure 1 courtesy American Museum of Natural History

Figure	Page
1. <i>Plagioptychus jamaicensis</i> (Whitfield)	180
Bivalve, posterior aspect $\times 0.45$. The diameter of the right valve at the commissure is 200 mm. A copy of Whitfield's plate 15, figure 2. AMNH 9670/1. Maestrichtian, Logie Green, Clarendon.	
2-4. <i>Plagioptychus toucasianus</i> Matheron	180
Left valve, outer aspect. Outer layer removed by weathering to reveal the bifurcating plates of the inner layer. Smith. Campanian, <i>Barrettia</i> bed, Houghton Hall, Green Island, Hanover. 3. Same specimen, commissural aspect. Shows the massive anterior myophore (ma), the anterior tooth (B') and its septum, and the large socket (n) occupied by the tooth of the right valve. 4. Same specimen, posterior aspect, showing the incurving of the umbo.	
5-8. <i>Plagioptychus minor</i> Chubb	182
Cluster of bivalved shells attached to a left valve of the same species (Chubb, 1956a, pl. 1, fig. 10). Smith. Maestrichtian, Ducketts Land Settlement, Westmoreland. 6. Same specimen, viewed from below, showing commissural aspect of the left valve (Chubb, 1956a, pl. 1, fig. 13). 7. Same species. Cluster of right valves attached to a shell of <i>Antillocaprina occidentalis</i> (Chubb, 1956a, pl. 1, fig. 11). Smith. Same horizon and locality. 8. Same specimen. Right valve, commissural aspect $\times 1.8$ (Chubb, 1956a, pl. 1, fig. 12).	
9. <i>Mitrocaprina multicanaliculata</i> Chubb	183
Left valve, commissural aspect (Chubb, 1956a, pl. 1, fig. 14). Smith. Maestrichtian, Logie Green, Clarendon.	

EXPLANATION OF PLATE 35

All illustrations natural size

Figure	Page
1. <i>Agriopleura falconj</i> (Chubb)	184
Right valve, ventral aspect (Chubb, 1956a, pl. 2, fig. 3). Smith. Maestrichtian, Shaw Castle Shale, Shaw Castle, St. James.	
2-4. <i>Praeradiolites verseyi</i> Chubb	185
Right valve, anterior aspect. The anterior side has been broken away revealing, in the upper part, a section of the upturned funnel plates and the side of the ligamental ridge (L) and, in the lower part, the body cavity (D) with funnel plates on both sides, Chubb, 1956a, pl. 2, fig. 4). Smith. Campanian, <i>Barrettia</i> Limestone, Stapleton, St. James. 3. Same species. Transverse section of a right valve, showing the cell pattern and the ligamental ridge (L); the pedal fold (V) is at the top left and the S fold at the top right (Chubb, 1956a, pl. 2, fig. 6). Smith. Same horizon and locality. 4. Same specimen as Figure 2. Transverse section at the lower cut (Chubb, 1956a, pl. 2, fig. 5).	
5. <i>Distefanella mooretownensis</i> (Trechmann)	186
Part of a cluster of right valves. The shell next to the left shows the siphonal bands, that on the right the antisiphonal side. Smith. Maestrichtian, near Moore Town, Rio Grande Valley, Portland.	
6, 7. <i>Distefanella lombricalis</i> (d'Orbigny)	186
Fragment of right valve. Smith. Upper Cretaceous limestone, Bon Hill, near Sunning Hill, St. Thomas. 7. Same species. On the right is a longitudinal section of the wall showing funnel plates tilted at 45°. Smith. Same horizon and locality.	
8-12. <i>Biradiolites jamaicensis</i> Trechmann	186
Transverse section of right valve, showing cell pattern in outer layer and, on the right, the siphonal bands and interband. BMNH LL30301. Maestrichtian, locality unknown. 9. Same species, bivalve, with siphonal area on right, left valve in position. BMNH L63127. Maestrichtian, Great River Valley, opposite Catadupa. 10. Same species. Right valve, antisiphonal side. This and figure 11 are new photographs of one of Trechmann's types (1924b, pl. 24, fig. 6). BMNH L63128. Same horizon and locality. 11. Same specimen, siphonal side. 12. Same species, siphonal side. A <i>Biradiolites robinsoni</i> is attached to the antisiphonal side; its commissure and body cavity may be seen on the right and its umbo on the left. For other views of this specimen see Plate 36, figures 1-3. Smith. Maestrichtian, Cotton Tree Gully, Lambs River, Westmoreland.	





EXPLANATION OF PLATE 36

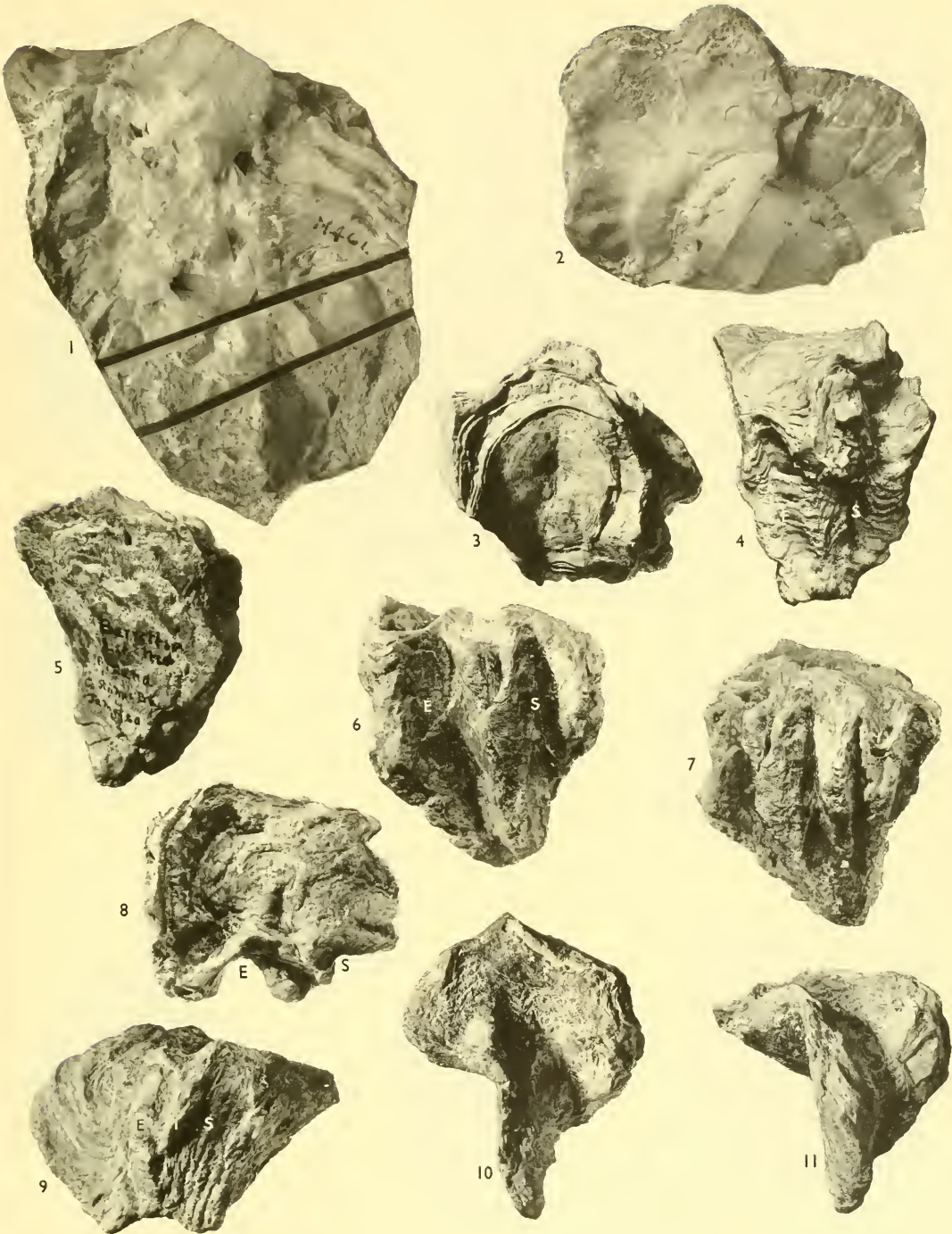
All illustrations natural size
Figure 4 courtesy American Museum of Natural History

Figure		Page
1-3.	<i>Biradiolites robinsoni</i> Chubb 187	187
	Right valve, siphonal side. Same specimen as Plate 35, figure 12. The attached <i>B. jamaicensis</i> is seen on the right. Smith. Maestrichtian, Cotton Tree Gully, Lambs River, Westmoreland. 2. Same specimen, antisiphonal side. <i>B. jamaicensis</i> on left. 3. Same specimen, apertural aspect. In the body cavity may be seen the grooves for the reception of the teeth of the left valve. <i>B. jamaicensis</i> below.	
4.	<i>Biradiolites rudis</i> (Whitfield) 187	187
	Bivalve, showing siphonal bands and interband. A copy of Whitfield's plate 11, figure 4. AMNH 9680/1. Maestrichtian, Logie Green, Clarendon.	
5-8.	<i>Biradiolites rudissimus</i> Trechmann 188	188
	Right valve, a fairly tall individual. Smith. Maestrichtian, St. James. 6. Same species. Bivalve. BMNH L63136. Maestrichtian, Catadupa, St. James. 7. Same species. Part of left valve showing anterior myophore (ma) and tooth (B') BMNH LL30295. Maestrichtian, Logie Green, Clarendon. 8. Same species. Right valve of a low spreading individual. Part of the specimen figured in Plate 38, figure 1. Smith. Maestrichtian, bridge half-a-mile north-west of Catadupa on the Cambridge road, St. James.	
9.	<i>Biradiolites</i> cf. <i>rudissimus</i> Trechmann 188	188
	Part of right valve showing the S band on the left. Smith. Campanian, <i>Barrettia</i> Limestone, St. Ann's Great River, St. Ann.	

EXPLANATION OF PLATE 37

All illustrations natural size

Figure	Page
1, 2. <i>Biradiolites forbesi</i> Chubb	188
Right valve, posterior aspect, showing section of calcite-filled body cavity and funnel plates (Chubb, 1956a, pl. 3, fig. 1). Smith. Maestrichtian, Lot 184, Ducketts Land Settlement, St. James. 2. Same specimen, apertural aspect, showing concentric upfold and radial, bifurcating, vascular marking (Chubb, 1956a, pl. 3, fig. 2).	
3, 4. <i>Biradiolites minhoensis</i> Trechmann	189
Bivalve, commissural view of right valve with left valve in place. This and figure 4 are new photographs of Trechmann's type (1924b, pl. 26, figs. 1-1a). BMNH L63252, Maestrichtian, Logie Green, Clarendon. 4. Same specimen, siphonal aspect.	
5-8. <i>Biradiolites novaterrensis</i> Chubb	189
Bivalve, anterior aspect; the upstanding funnel plates form a smooth concave wall. In this aspect the left valve is not seen. BMNH LL30296. Campanian, <i>Barrettia</i> Limestone, New Ground, St. Ann's Great River, St. Ann. 6. Same specimen, ventral aspect, showing the siphonal grooves (E and S) and interband (I). 7. Same specimen, posterior aspect, showing the subsidiary downfolds. 8. Same specimen, left valve in position on the right.	
9-11. <i>Biradiolites riograndensis</i> Chubb	189
Bivalve, posterior aspect, showing on the left, the flange, in the centre the interband with the E upfold on its left and the costellate S band on its right, and on the extreme right the smooth, concave dorsal side. Smith. Maestrichtian, Alligator Church, Rio Grande Valley, Portland. 10. Same specimen. Left valve in position on right valve. 11. Same specimen. Ventral aspect.	





EXPLANATION OF PLATE 38

All illustrations natural size

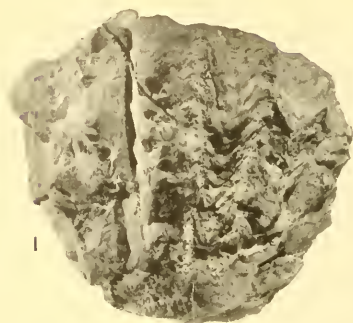
Figure	Page
1-6. <i>Thyrastylon adhaerens</i> (Whitfield)	190
<p>Three shells, two of them bivalved, forming part of a cluster; they are attached to a shell of <i>Biradiolites rudissimus</i> whose aperture may be seen facing downwards at lower right (see Plate 36, fig. 8). The left hand shell shows the peak of the S oscule in silhouette; in the centre shell the S oscule is seen at the top, but the E oscule is displaced from its normal position, which would be on the projection x at the right centre of the valve, to a point about 25 mm away (Chubb, 1956b, pl. 7, fig. 8). Smith. Maestrichtian, bridge half-a-mile northwest of Catadupa on the Cambridge road, St. James. 2. Same specimen. Left hand shell viewed from the posterior; S. band occluded with peaked oscule below; E band occluded below, becoming open above, the oscule not occluded. (Chubb, 1956b, pl. 7, fig. 9). 3. Same species. Right valve, apertural view, showing partial occlusion of the two siphonal bands. (Chubb, 1956b, pl. 6, fig. 2). USNM 18011. Maestrichtian, Logie Green road, Clarendon. 4. Same specimen, posterior view, showing the funnel plates upfolded at the siphonal bands and downfolded and spreading laterally in the inter-band and at the sides (Chubb, 1956b, pl. 6, fig. 3). 5. Same species. Bivalve, posterior view, showing both bands occluded in the right valve and two oscules in the left (Chubb, 1956b, pl. 7, fig. 5). Smith. Maestrichtian, Catadupa, St. James. 6. Same specimen. Section at upper cut seen in Figure 5. Shows cardinal apparatus and S and E bands (Chubb, 1956b, pl. 7, fig. 6).</p>	
7-9. <i>Thyrastylon coryi</i> (Trechmann)	191
<p>Right valve, ventral aspect; it is attached by the whole of its anterior side to a fragment of <i>Antillocaprina occidentalis</i>; it shows curvature and costulate E band (Chubb, 1956b, pl. 7, fig. 2). Smith. Maestrichtian, Ducketts Land Settlement, one mile east of Lands Department office, St. James. 8. Same species. A new photograph of Trechmann's type (1924b, pl. 25, fig. 5). Bivalve, posterior aspect, showing high-crowned left valve, occluded S band, and open, costulate E band, BHHH L63213. Maestrichtian, near Catadupa, St. James. 9. Same species. Bivalve, posterior aspect, shows the same characters as the last, but the crown of the left valve passes smoothly into the brim (Chubb, 1956b, pl. 7, fig. 1). Smith. Maestrichtian, Ducketts Land Settlement, same locality as Fig. 7.</p>	

EXPLANATION OF PLATE 39

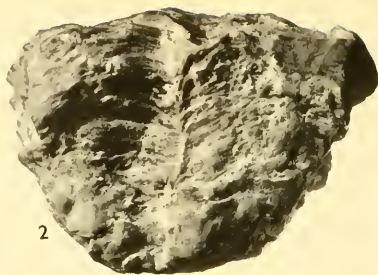
All illustrations natural size

Figure	Page
1-3. <i>Thyrastylon coryi</i> (Trechmann)	191
Right valve, ventral aspect. This shell was found in a shale but was attached to the surface of an underlying limestone; it therefore has an exceptionally flat anterior side. Smith. Maestrichtian, Shaw Castle Shale, Shaw Castle, St. James. 2. Same specimen, posterior aspect. 3. Same species. Posterior aspect, showing S band nearly occluded, E band costulate, unusually wide and partially overlapped by funnel plates (Chubb, 1956b, pl. 7, fig. 3). BMNH L63123. Maestrichtian, Catadupa, St. James.	
4. <i>Thyrastylon semiannulus</i> (Trechmann)	191
Bivalve. A new photograph of one of Trechmann's types (1924b, pl. 25, fig. 6). Both bands are occluded but only the E band has an oscule. BMNH L63247. Maestrichtian, Logie Green, Clarendon.	
5-8. <i>Bournonia cancellata</i> (Whitfield)	192
Bivalve, posterior aspect. Smith. Maestrichtian, Logie Green, Clarendon. 6. Same specimen, left valve. 7. Same specimen, transverse section below commissure, shows cardinal apparatus of left valve including two teeth connected by a yoke and fitting into grooves in the right valve, anterior myophore and pedunculate posterior myophore. 8. Same specimen, anterior aspect, showing longitudinal groove.	
9-12. <i>Bournonia sanctannae</i> Chubb	193
Bivalve, posterior aspect. This specimen was figured by Trechmann (1924b, pl. 24, fig. 4) as <i>Biradiolites</i> (?) <i>cancellatus</i> , BMNH L63244. Campanian, <i>Barrettia</i> Limestone, St. Ann's Great River, St. Ann. 10. Same specimen, left valve. 11. Same specimen, transverse section below commissure. 12. Same specimen, anterior aspect.	

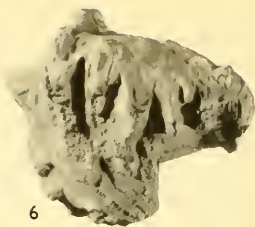




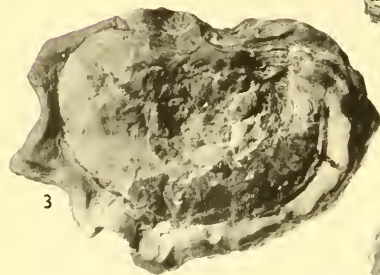
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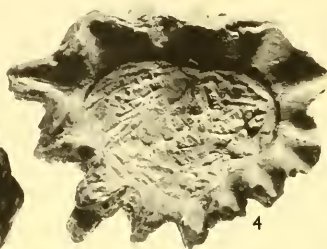
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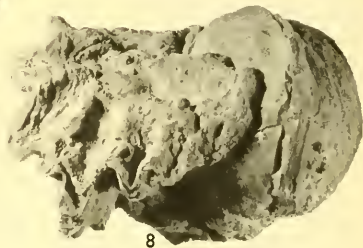
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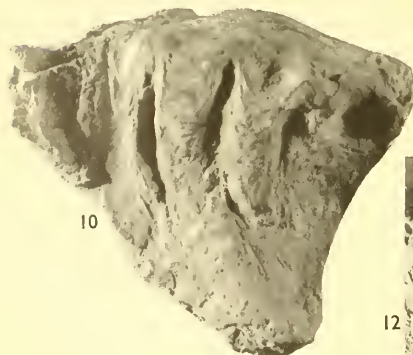
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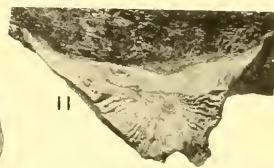
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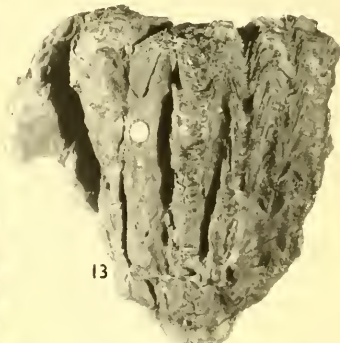
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13

EXPLANATION OF PLATE 40

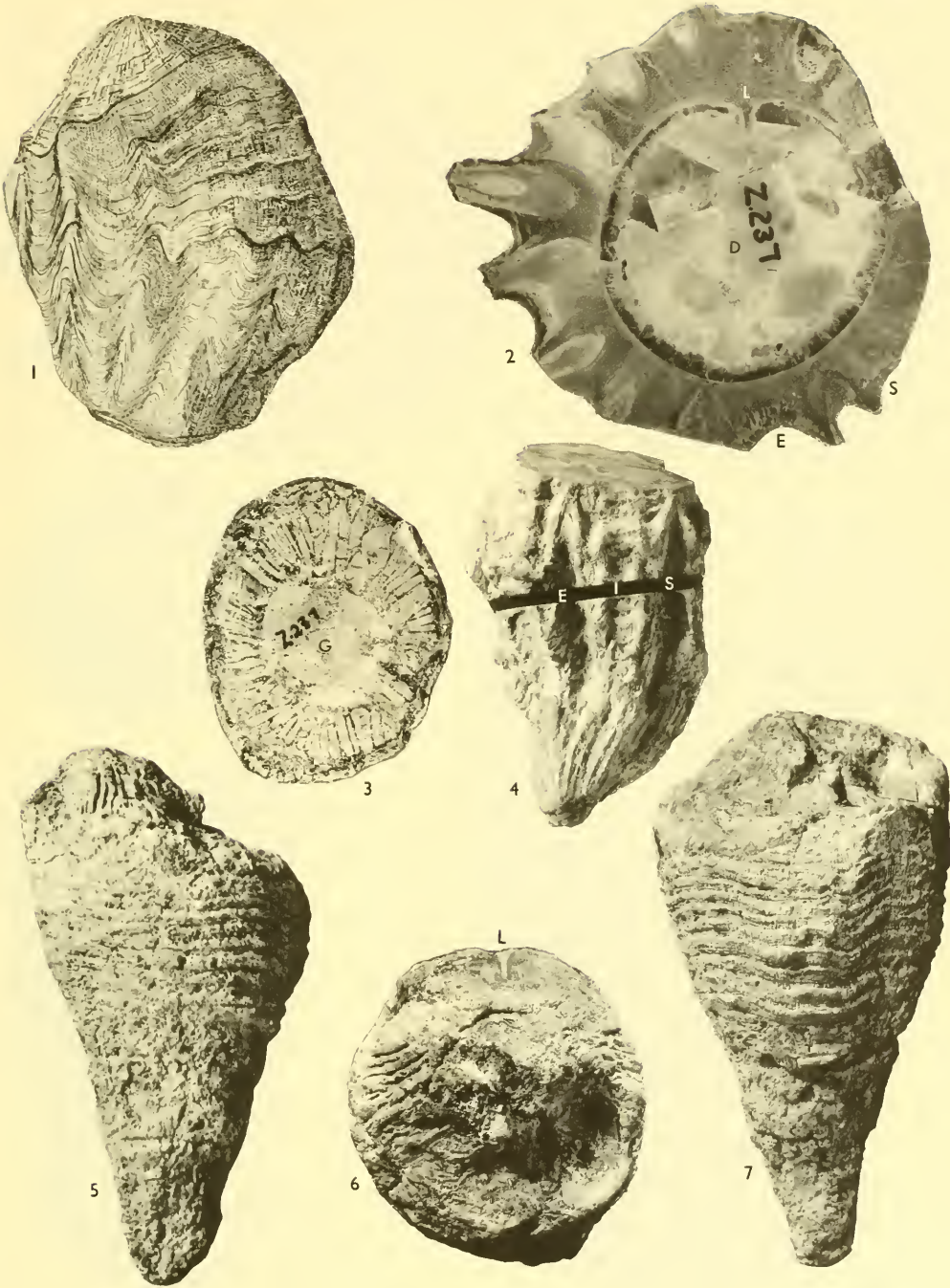
All illustrations natural size

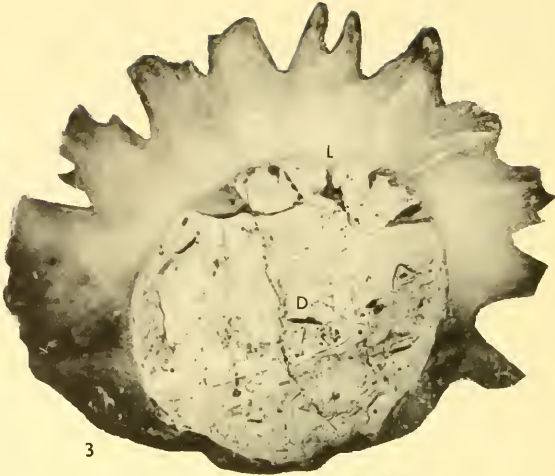
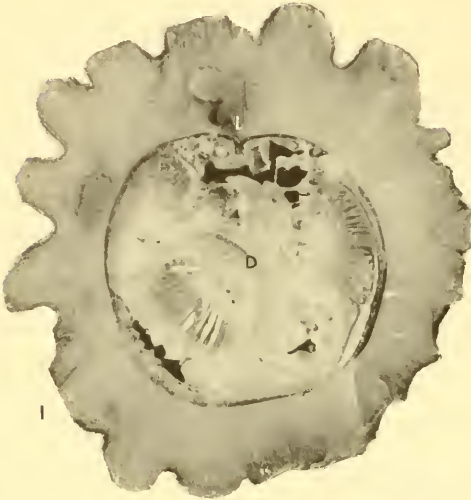
Figure	Page
1-3. <i>Bournonia subcancellata</i> (Trechmann)	193
Bivalve, posterior aspect. BMNH LL30299. Maestrichtian, Logie Green, Clarendon.	
2. Same specimen, anterior aspect. 3. Same specimen, left valve in position on the right.	
4, 5. <i>Bournonia barretti</i> Trechmann	194
Right valve, apertural aspect. This and the next figure are new photographs of Trechmann's type (1924b, pl. 26, figs. 2, 2a). BMNH L63227. Maestrichtian, Great River Valley, opposite Catadupa, St. James. 5. Same specimen, posterior aspect.	
6-8. <i>Bournonia thiadensi</i> Vermunt	194
Posterior aspect. Smith. Maestrichtian, road facing Lot 67, Ducketts Land Settlement, Westmoreland. 7. Same species, posterior aspect. Attached to the left valve of <i>Plagioptychus zansi</i> ; for another view of this specimen see Plate 33, figure 4. Smith. Maestrichtian, mile post 14 between Point and Flamstead, St. James. 8. Same specimen, left valve.	
9, 10. <i>Bournonia baileyi</i> Chubb	194
Left valve. Smith. Campanian, <i>Barrettia</i> Limestone, Haughton Hall, Green Island, Hanover. 10. Same specimen, posterior aspect.	
11, 12. <i>Bournonia tetrahedron</i> Chubb	195
Left valve. BMNH LL30287. Maestrichtian, Logie Green, Clarendon. 12. Same specimen, right valve, posterior aspect.	
13. <i>Bournonia sanctmariae</i> Chubb	195
Right valve, posterior aspect. This specimen was figured by Trechmann as <i>Radolites</i> cf. <i>cancellatus</i> (1924a, pl. 1, fig. 3). BMNH L63255. Reworked in Eocene shale, Port Maria, St. Mary.	

EXPLANATION OF PLATE 41

All illustrations natural size
 Figures 1 and 5 courtesy American Museum of Natural History

Figure	Page
1-4. <i>Sauvagesia macroplacata</i> (Whitfield)	196
<p>Bivalve. A copy of Whitfield's figure of his type (1897a, pl. 13, fig. 8). AMNH 9679/1. Maestrichtian, Logie Green, Clarendon. 2. Same species. Transverse section of a right valve, showing the strong folding of the funnel plates, the polygonal cell pattern and the ligamental infold (Chubb, 1956a, pl. 3, fig. 5). Smith, Maestrichtian, Shortwood Parochial road, St. James. 3. Same specimen. Transverse section of left valve, showing radial plates in the inner layer (Chubb, 1956a, pl. 4, fig. 1). 4. Same species. Young right valve, showing siphonal bands and interband (Chubb, 1956a, pl. 4, fig. 2). USNM 18013. Maestrichtian, Logie Green, Clarendon.</p>	
5-7. <i>Sauvagesia annulosa</i> (Whitfield)	198
<p>Bivalve, anterior aspect. A copy of Whitfield's figure of his type (1897a, pl. 14, fig. 3). The ligament is at the left of the figure and a slight upfold at the right probably represents the E band. The left valve shows radial plates like those of <i>S. macroplacata</i>. AMNH 9676/1. Maestrichtian, said to be from Christianna, probably Logie Green, Clarendon. 6. Same specimen. Left valve showing ligamental infold and radial plates. This and the next figure are new photographs of Whitfield's type. 7. Same specimen, ventral aspect. The slight upfold seen in the centre is thought to be the E band, that on its right the S band.</p>	





EXPLANATION OF PLATE 42

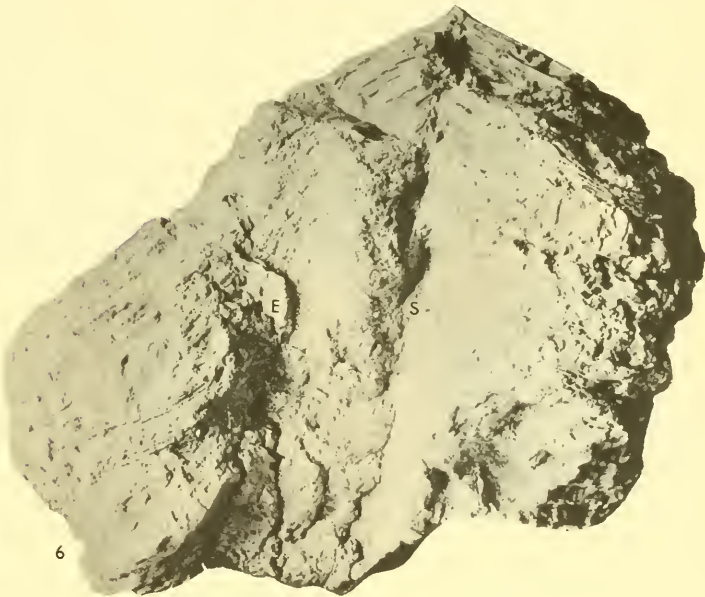
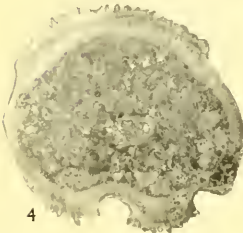
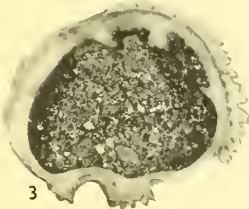
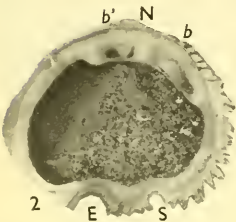
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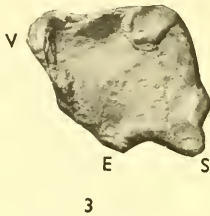
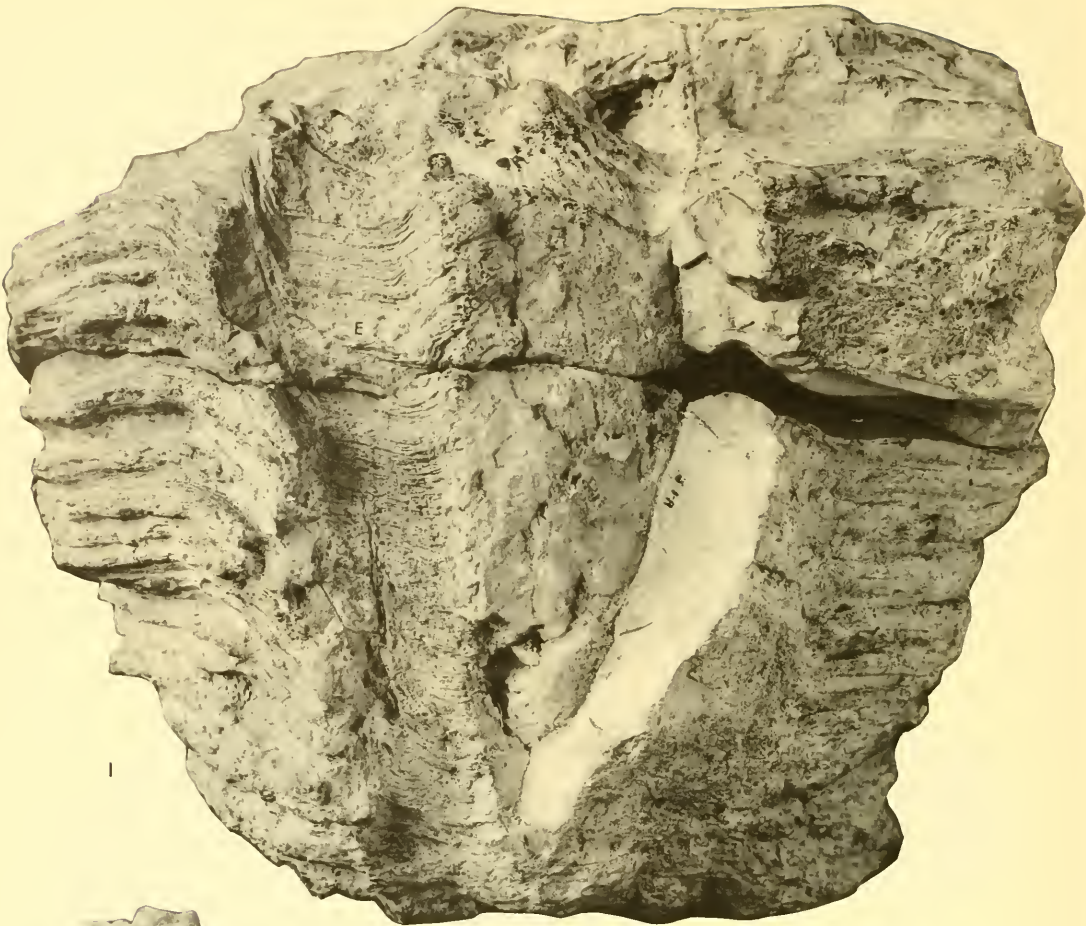
Figure	Page
1-3. <i>Sauvagesia mcgrathi</i> Chubb	197
Transverse section of right valve, showing ligamental ridge broken and dislodged, posterior myophore of left valve in position, anterior myophore displaced (Chubb, 1956a, pl. 3, fig. 4). Smith. River gravel in the Orange River at Stapleton, St. James, derived from Basal Maestrichtian limestone in the headwaters of the river below Kensington. 2. Same specimen, bivalve, much waterworn. Ventro-posterior aspect, showing in the centre the interband consisting of two costae with a furrow between, on its left the E band and on its right the S band, which has costellae (Chubb, 1956a, pl. 3, fig. 3). 3. Same species. Transverse section of right valve clearly showing the ligamental infold. Loose in soil of banana fields at the head of the Orange River, St. James.	
4,5. <i>Sauvagesia fluminisagni</i> Chubb	197
Transverse section of right valve. (Chubb, 1956a, pl. 4, fig. 3). Smith. Maestrichtian, Cotton Tree Gully, Lambs River, Westmoreland. 5. Same specimen. Right valve, posterior aspect. The upper part, which is crushed, is cut away (Chubb, 1956a, pl. 4, fig. 7).	

EXPLANATION OF PLATE 43

All illustrations natural size except figures 5 and 6
Figure 6 courtesy American Museum of Natural History

Figure	Page
1-4. <i>Tepeyacia multicostata</i> Chubb	198
Right valve lateral aspect. Smith. Cretaceous tuffaceous shale, probably Albian, north-north-east of Seafeld Manse, St. Catherine. 2. Same specimen. Transverse section showing tooth (N) between two oval sockets (b' and b) which are separated from the body cavity by thin laminae and are occupied by the ends of the teeth of the left valve; also siphonal infolds (S and E) forming slight pseudopillars. The E infold is diametrically opposite to the tooth N, i.e. it is mid ventral. 3. Same specimen. Transverse section a few millimetres higher than the last. The sockets are not separated from the body cavity but appear as grooves between the tooth and the outer buttresses. 4. Same species. Transverse section of another specimen cut at a higher level; tooth and buttresses have disappeared. Smith. Same horizon and locality.	
5. <i>Durania</i> cf. <i>aguilae</i> Adkins	201
Right valve, apertural aspect $\times 0.7$ (Chubb, 1956a, pl. 4, fig. 6). Smith. Campanian, <i>Barrettia</i> Limestone mile post 9 on the Kensington-Amity Hall road, St. James.	
6. <i>Durania nicholasi</i> (Whitfield)	199
Right valve, posterior aspect $\times 0.28$, the original being about 450 mm in diameter. A reproduction of one of Whitfield's figures (1897a, pl. 7, fig. 2). It shows the two siphonal grooves, the rounded interband, and the angular upfold of the funnel plates at the S band. AMNH 9675/1. Stated to be from the Cretaceous of Orange Cove, Hanover; probably from the Campanian, <i>Barrettia</i> Limestone, Haughton Hall, Green Island, Hanover.	





EXPLANATION OF PLATE 44

Figure 1 reduced; figures 2-4 natural size

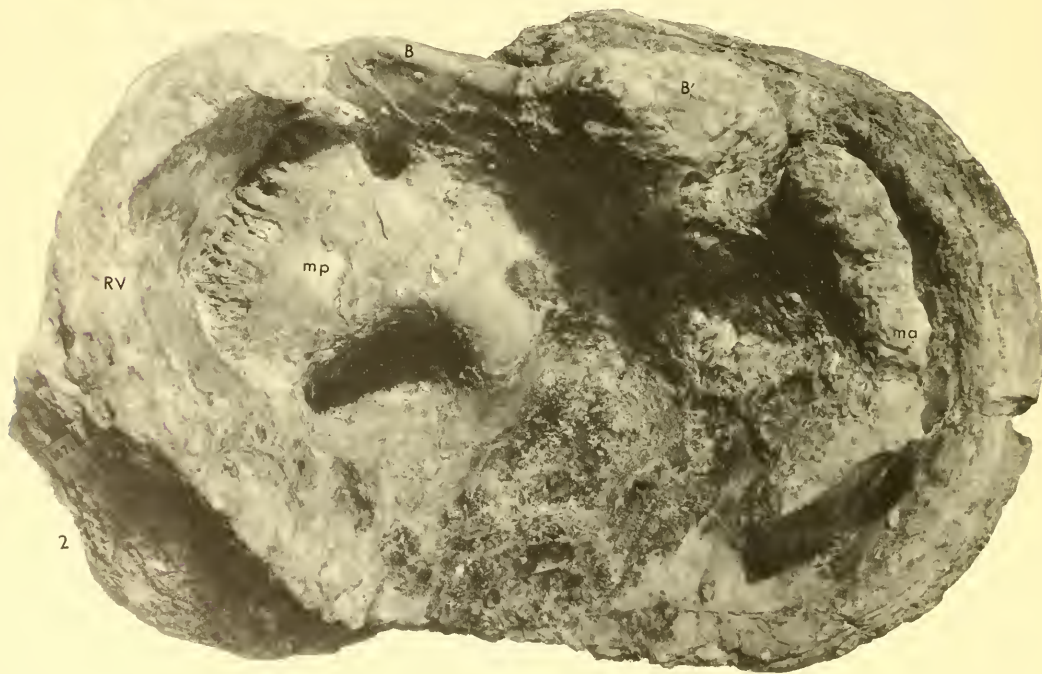
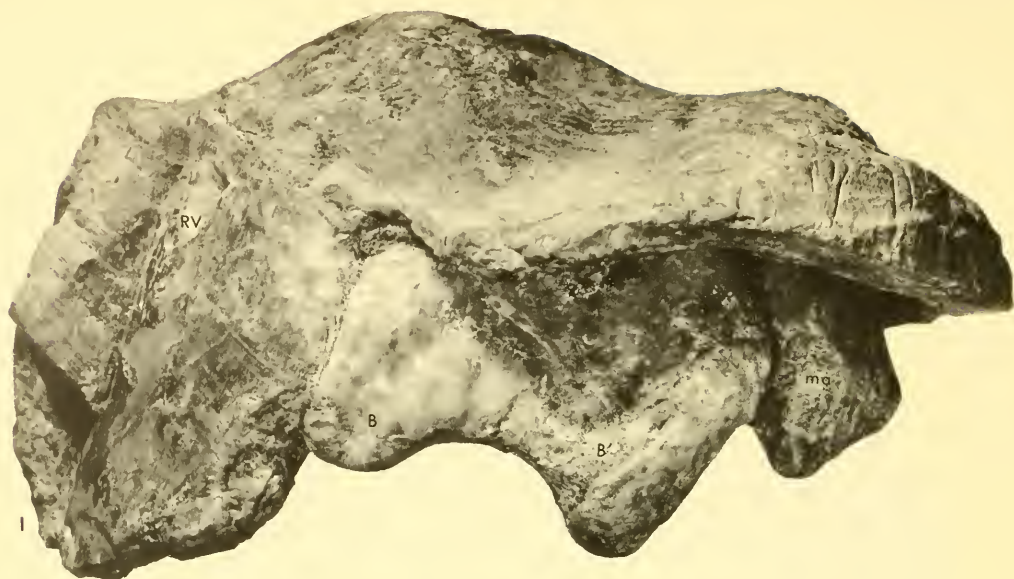
Figure		Page
1.	<i>Durania nicholasi</i> (Whitfield)	199
	Right valve, posterior aspect, $\times 0.4$. The deeply sunken E band and the corresponding downfold of the funnel plates are clearly seen. The outer layer is broken away at the S band. Inst J1A-B. Probably <i>Barrettia</i> Limestone, Haughton Hall, Green Island, Hanover.	
2-4.	<i>Bournonia coxi</i> Chubb	196
	The smaller shell upright with the larger shell lying transversely behind it. The two rounded siphonal bands are well shown. Smith. <i>Barrettia</i> Limestone. New Ground, St. Ann's Great River, St. Ann. 3. Same specimen, left valve of larger shell. The lappet covering the E band is broken off short, but the S lappet is complete. Small <i>Ostrca</i> on dorsal side. 4. Same specimen, the larger shell upright with the smaller lying behind it.	

EXPLANATION OF PLATE 45

The illustration is reduced

Figure	Page
1. <i>Durania nicholasi</i> (Whitfield)	199
Right valve, apertural aspect, $\times 0.5$; the lower part of the specimen figured in Plate 44, figure 1. Shows the broad flat funnel plates crossed by branching vascular impressions. The vesicular structure of the inner layer may be seen in the body cavity. The deeply impressed E band bulges into the cavity to form an incipient pseudopillar. Though the outer layer is broken away at the S band it can be seen that it did not form a pseudopillar. Inst J1A.	





EXPLANATION OF PLATE 46

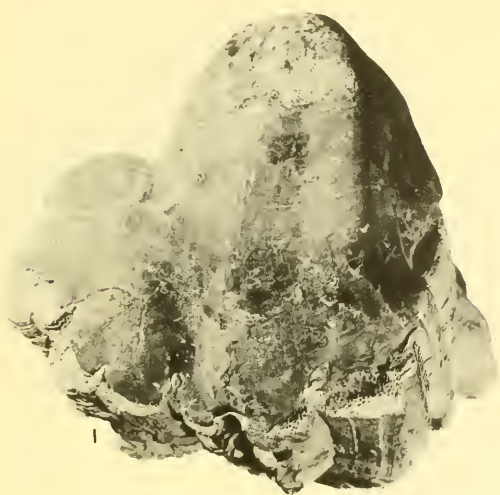
Illustrations natural size

<i>Figure</i>		<i>Page</i>
1,2.	<i>Durania nicholasi</i> (Whitfield)	199
	<p>Left valve, dorsal aspect. The two oblique teeth (B' and B) and their connecting saddle are seen in the centre of the figure, with the anterior myophore (ma) on their right and an attached fragment of the right valve (RV) on their left. This and the next figure are new photographs of Whitfield's type (1897a, pl. 9, figs. 1-2). AMNH 9675/3. Campanian, <i>Barrettia</i> Limestone, Haughton Hall, Green Island, Hanover. 2. Same specimen, internal aspect. On the left the pedunculate posterior myophore (mp) abuts against the attached fragment of the right valve (RV) from which a process projects into the gap between this myophore and the adjacent posterior tooth (B). This tooth is connected by a saddle with the longer anterior tooth (B'), beyond which the anterior myophore (ma) curves around within the margin of the valve; its ventral end is broken away.</p>	

EXPLANATION OF PLATE 47

All illustrations natural size

<i>Figure</i>	<i>Page</i>
1-4. <i>Chiapasella radiolitifformis</i> (Trechmann)	202
Bivalve. A new photograph of one of Trechmann's syntypes (1924b, pl. 24, figs. 2 and 2a). The left valve is seen in position upon the right; lappets from its margin overlie the costae with the invaginations rising between them. In places the polygonal pattern of the right valve may be seen. BMNH L63118. Maestrichtian, Logie Green, Upper Clarendon. 2. Same specimen, posterior view. The surface is unweathered and shows the costellae, also the costae projecting downwards and outwards as thumblike processes. 3. Same species, young individual, somewhat weathered; the left valve is depressed conical. Smith. Same horizon and locality. 4. Same species, adult right valve split longitudinally and showing the vesicular structure formed by the inner layer. Smith. St. James, exact locality unknown.	





EXPLANATION OF PLATE 48

All illustrations natural size except figure 1

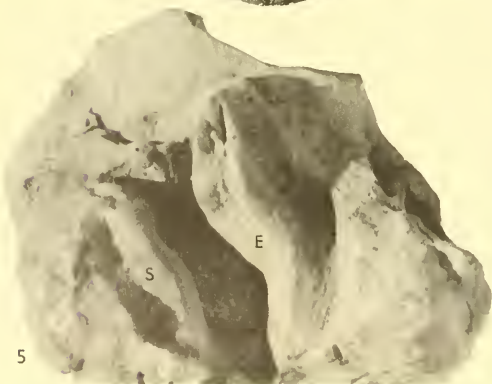
Figure	Page
1-4. <i>Chiapasella radiolitiformis</i> (Trechmann)	202
<p>Adult bivalved specimen $\times 0.67$. Left valve (above) retains most of its outer layer but where this is weathered away the underlying vertical plates can be seen. Right valve shows rounded costae, slight longitudinal costellae and, on the right, the E band; its apical part is broken away. Smith. Maestrichtian, Lambs River bridge, Westmoreland. 2. Same specimen, natural size. Part of broken lower surface of right valve, with a portion of the wall crushed in. It shows the surface of the funnel plates with polygonal cell pattern and invaginations. 3. Same specimen, natural size. Part of left valve. The broken surface shows the extremely thin outer layer; within this the inner layer shows in its marginal part a system of radially elongated "canals" separated by vertical plates; this border merges into the central part which has a vesicular structure, different from the tabular structure shown by most advanced rudists. 4. Same species. Young individual, natural size. The left valve is a low cone which, having lost its outer layer, shows a system of radial vertical plates, most of them bifurcating, similar to those of certain other Radiolitidae. Smith. Maestrichtian, Ducketts Cross Roads, Westmoreland.</p>	

EXPLANATION OF PLATE 49

All illustrations natural size

Figure	Page
1,2. <i>Orbignya mullerriedi</i> Vermont	204
A cluster of right valves closely associated with several species of coral notably <i>Multicolumnastraea cyathiformis</i> Duncan (Chubb, 1956a, pl. 4, fig. 4). Smith, Maestrichtian, at base of a <i>Titanosarcolites</i> limestone near its junction with underlying purple shale, sinkhole on Lot 45, Ducketts Land Settlement, Westmoreland. 2. Same specimen, apertural aspect. (Chubb, 1956a, pl. 4, fig. 8).	
3. <i>Orbignya cibarium</i> Chubb	204
Apertural view of a cluster of shells, the top right-hand one showing part of its left valve, and the middle one showing the tooth of the right valve and the cardinal apparatus of the left (Chubb, 1956a, pl. 4, fig. 10). Compare Text-figure 6. Maestrichtian, Cotton Tree Gully, Lambs River Valley, Westmoreland.	
4. <i>Torreites</i> cf. <i>sanchezi</i> (Douvillé)	207
Part of right valve, transverse section showing the three pillars. Smith. Probably Turonian, Peters Hill Limestone, Peters Hill, northeast Clarendon.	





EXPLANATION OF PLATE 50

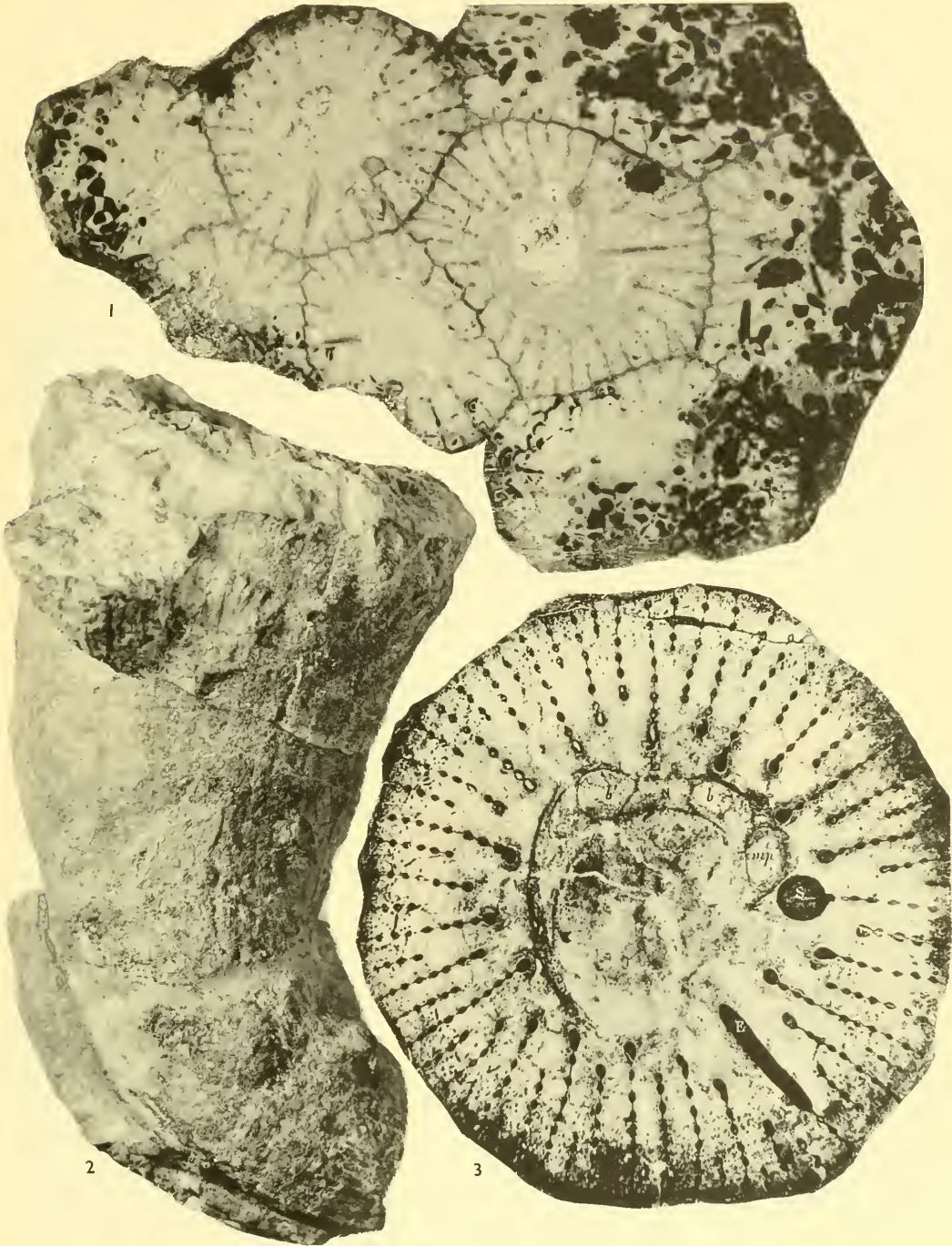
All illustrations natural size except figure 4

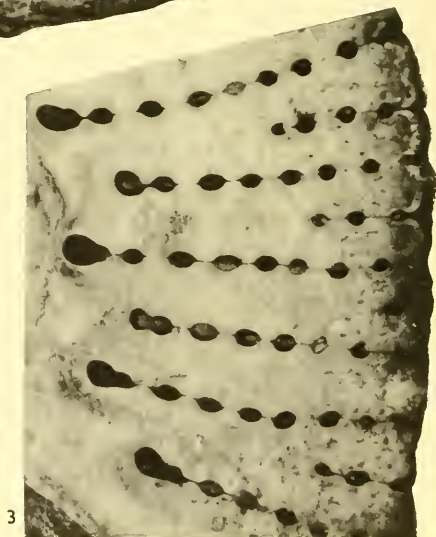
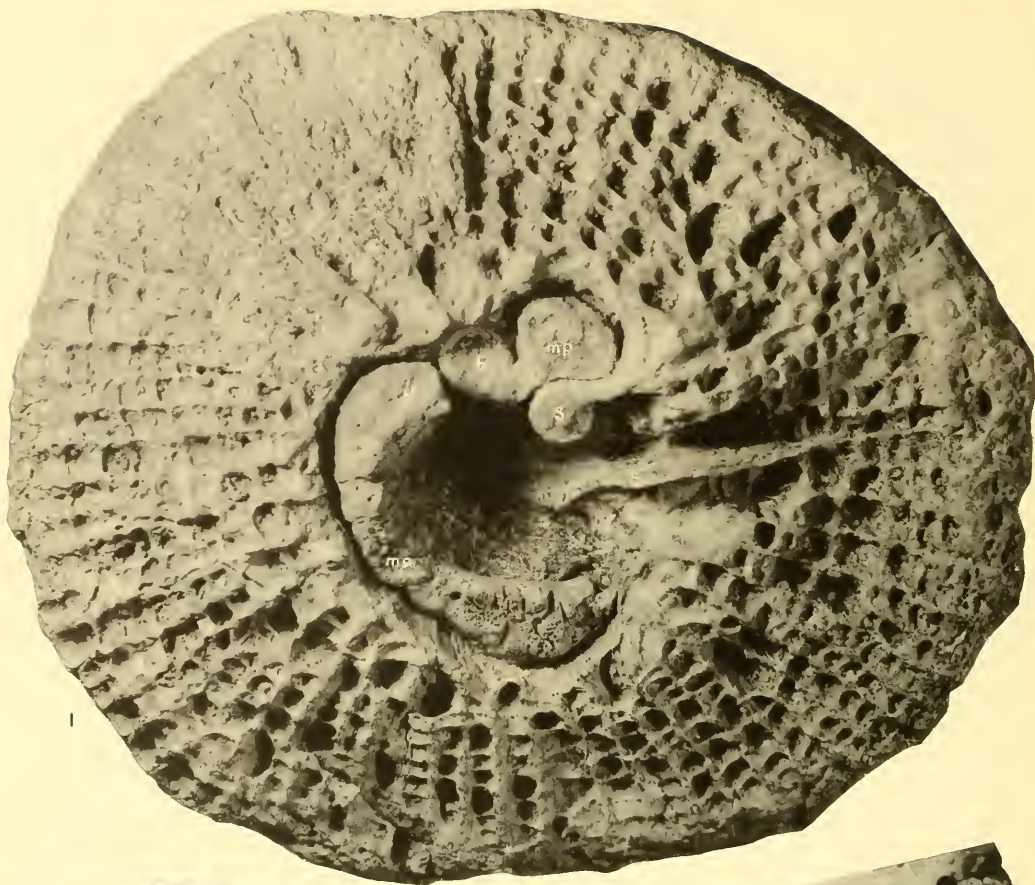
Figure	Page
1-3. <i>Vaccinites cyrci</i> Chubb	206
Right valve (specimen a), apertural aspect, containing the cardinal apparatus of the left valve. Smith. <i>Barrettia</i> Limestone, Clifton, Hanover. 2. Same species (specimen b), showing tooth (N). Smith. Same horizon and locality. 3. Same species (specimen c), posterior aspect; it is split in the ligamental plane and posed so that L is at the right hand margin; the S and E furrows may be seen. Smith. Same horizon and locality.	
4-6. <i>Orbignya maldonensis</i> Chubb	205
Right valve, vertical radial section of the outer layer $\times 20$ (Chubb, 1956a, pl. 5, fig. 5). Smith. Maestrichtian, south of Maldon cross, St. James. 5. Same specimen, interior of the body cavity of an incomplete right valve showing, on the left, the S pillar and in the centre, the E pillar becoming bilobed. The smooth surface of another shell is seen above, showing the S furrow (Chubb 1956a, pl. 5, fig. 3). 6. Same specimen, apertural view of two right valves, the incomplete one showing bilobed E pillar above, the complete normal one below, and a fragment of a third on the right. (Chubb, 1956a, pl. 5, fig. 1).	

EXPLANATION OF PLATE 51

All illustrations natural size except Figure 1
Figure 3 courtesy Société géologique de France

Figure	Page
1-3. <i>Barrettia monilifera</i> Woodward	208
<p>Topotype. Transverse section of a cluster of eight right valves $\times 0.8$, its marginal parts considerably damaged by a boring organism. Since rudists normally attached themselves by their anterior or dorso-anterior, <i>i.e.</i> their antisiphonal sides, no doubt in order to keep their siphons clear, it is obvious that the first member of the group was the rounded shell in the upper row second from the left. This is largely surrounded by a circle of shells which attached themselves by their own anterior sides to its dorsal, posterior and ventral sides; these in turn are partially surrounded by a second circle of shells attached by their anterior sides. Smith. Cretaceous, probably Campanian, Back River, Portland. 2. Same species. Topotype. Cornute specimen with adherent young shells of the same species, natural size. Smith. Same horizon and locality. 3. Same species. One of Woodward's syntypes. A copy of a photograph by Douvillé of a slice of a right valve lent to him by the British Museum (Natural History) (Douvillé, 1890-7, pl. 17, fig. 6). It shows the moniliform infolds, including L, S and E, the tooth N between the sockets <i>b'</i> and <i>b</i>, and the cavity between <i>b</i> and S which accommodates the posterior myophore <i>mp</i> of the left valve. BMNH42861. Same horizon and locality.</p>	





EXPLANATION OF PLATE 52

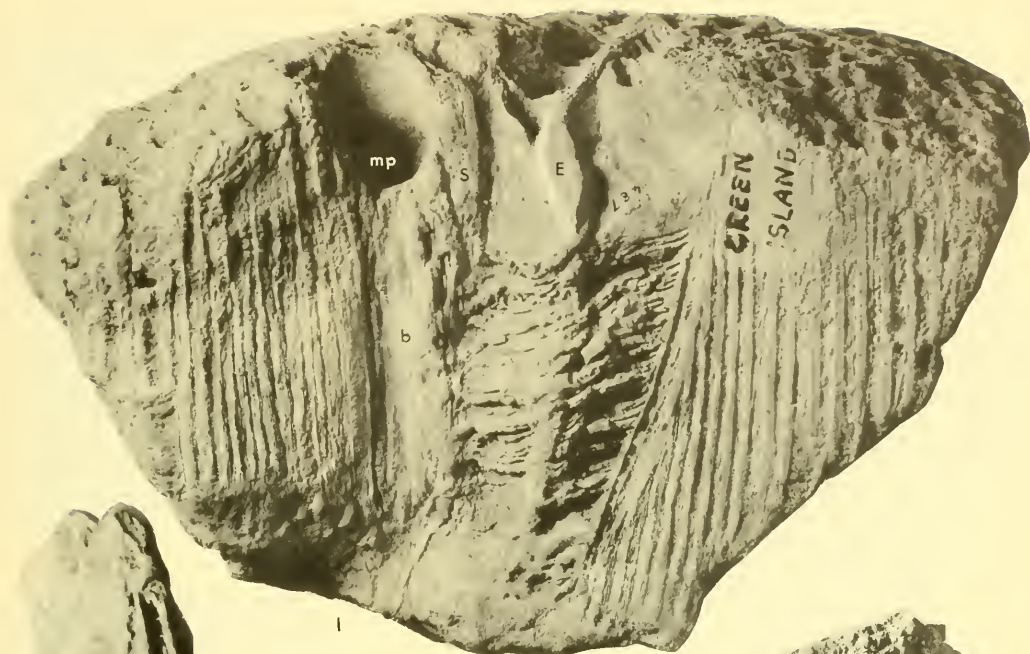
Figures 1 and 2 reduced, figure 3 enlarged

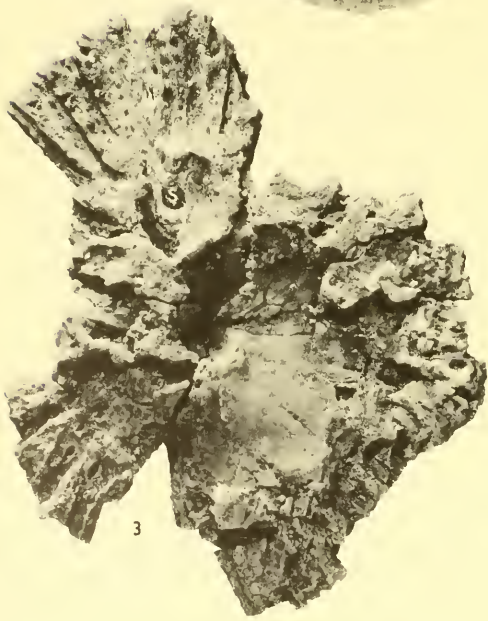
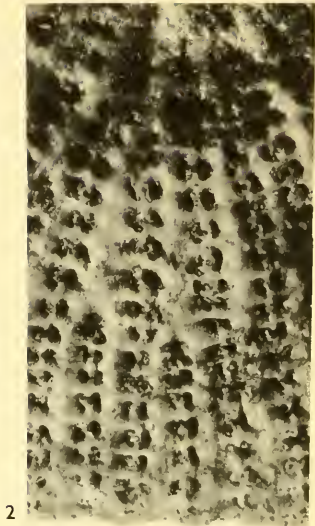
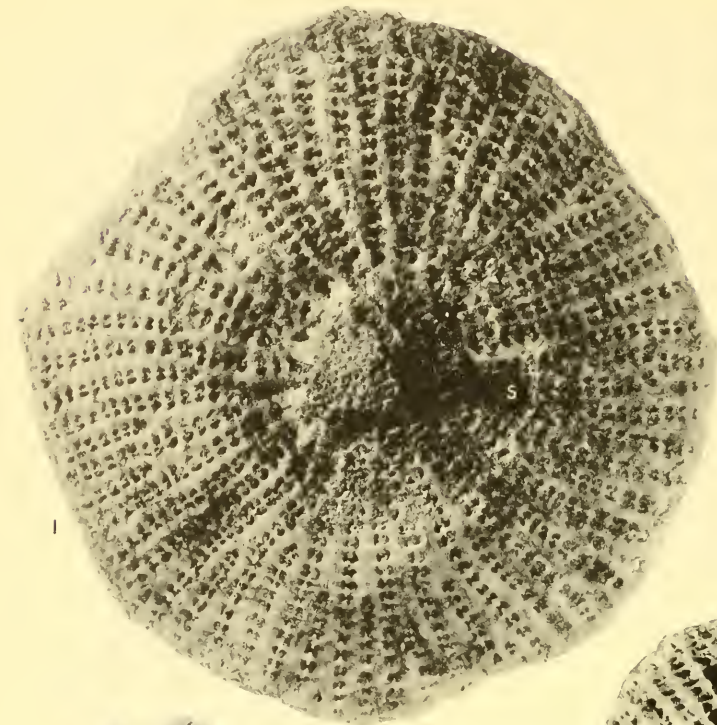
Figure	Page
1 <i>Barrettia gigas</i> Chubb	210
Adult right valve $\times 0.67$. Commissural view showing moniliform infolds with intervening quadrangular cells; L not clear, S with cylindrical column and E with radially extended flat column, its inner end deflected ventrally. Body cavity contains cardinal apparatus of left valve, including crescentic anterior myophore (<i>ma</i>), springing from anterior tooth (<i>B'</i>), and posterior myophore (<i>mp</i>) fitting into its cavity and connected by a yoke with posterior tooth (<i>B</i>). Smith. Campanian, <i>Barrettia</i> limestone, Haughton Hall, Green Island, Hanover.	
2,3. <i>Barrettia monilifera</i> Woodward	203
Longitudinal section of bivalve $\times 0.8$. This is the counterpart of Woodward's section reproduced in Text-figure 7. It shows the corrugated floor of the body cavity, the S pillar on the left and above it an oblique perforation through the left valve, probably the S oscule; the anterior myophore (<i>ma</i>) is suspended from the upper valve on the right. BMNH 42863, <i>Barrettia</i> Limestone, Back River Portland.	
3. Same specimen. Transverse section of part of base $\times 2$, showing details of structure.	

EXPLANATION OF PLATE 53

Figures 1 and 3 reduced; figure 2 natural size

Figure	Page
1-3. <i>Barrettia gigas</i> Chubb	210
<p>Young adult right valve $\times 0.84$ (the original being 215 mm across). It is split in half in the plane of two opposite infolds, that on the left being near to, but not, the ligamental. Dorsum on left, venter on right, conical body cavity in centre, lined with thin inner layer, which also forms concave tabulae that slope down evenly towards the dorsal side; the E pillar, which at its inner end is deflected ventrally, penetrates the body cavity and cuts through the tabulae; further to the left is the S pillar and beyond it the cavity for the reception of the posterior myophore (<i>mp</i>); below the latter is the posterior socket (<i>b</i>), which extends almost to the base of the shell. On the ventral side of the vertical tubes of the infold are deflected or absorbed by the increase in width of the body cavity; on the dorsal side the tubes adjacent to the socket run parallel to it. Smith, <i>Barrettia</i> Limestone, Haughton Hall, Green Island, Hanover. 2. Same species. Parts of the two hinge teeth of a left valve, natural size; the shell was broadly conical, about 300 mm in diameter at the commissure, and not less than 190 mm high. The teeth were at least 150 mm long. The convex side of their curve is dorsal, and this side is fluted to fit the flutings in the socket; the nearer tooth is the posterior one. The direction of curvature may not be typical; obviously the tooth fitting in the socket seen in figure 1, above, was nearly straight. UW16177. <i>Barrettia</i> Limestone, Stapleton, St. James. 3. Same species. Segment of a bowl-shaped valve $\times 0.75$. It is split in the plane of the E infold; it shows the rapid widening of the flattened tabulate pillar, and the deflection and absorption of adjacent tubes. Smith, <i>Barrettia</i> Limestone, Haughton Hall, Green Island, Hanover.</p>	





EXPLANATION OF PLATE 54

All figures natural size except Figure 2

Figure

Page

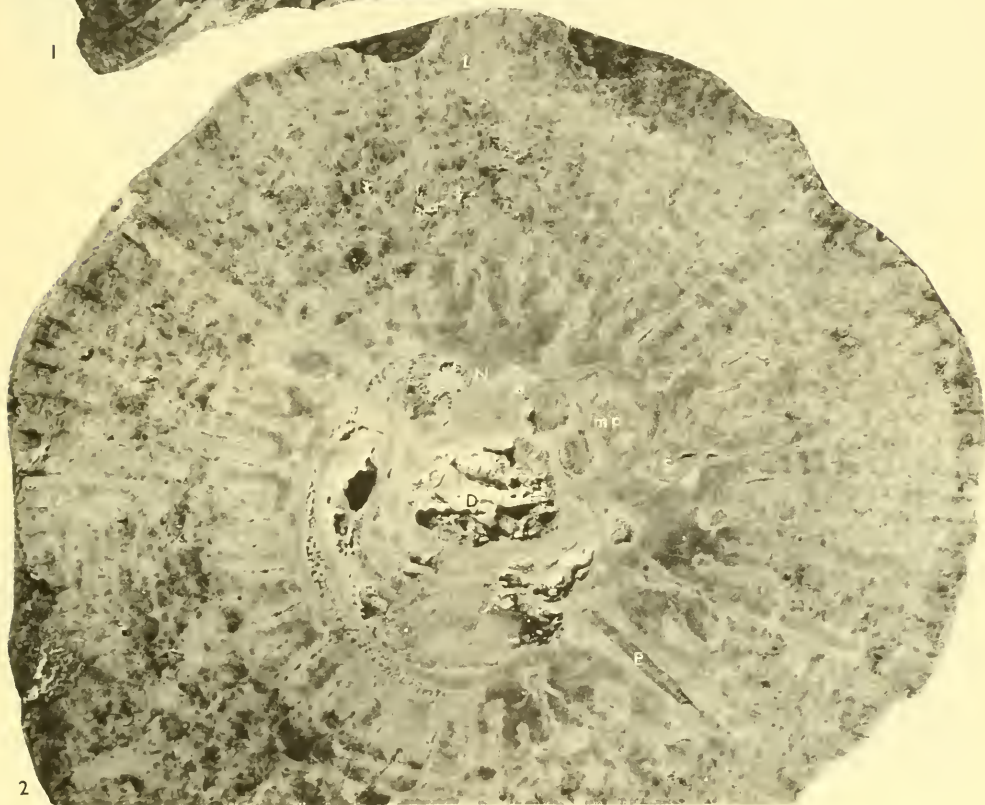
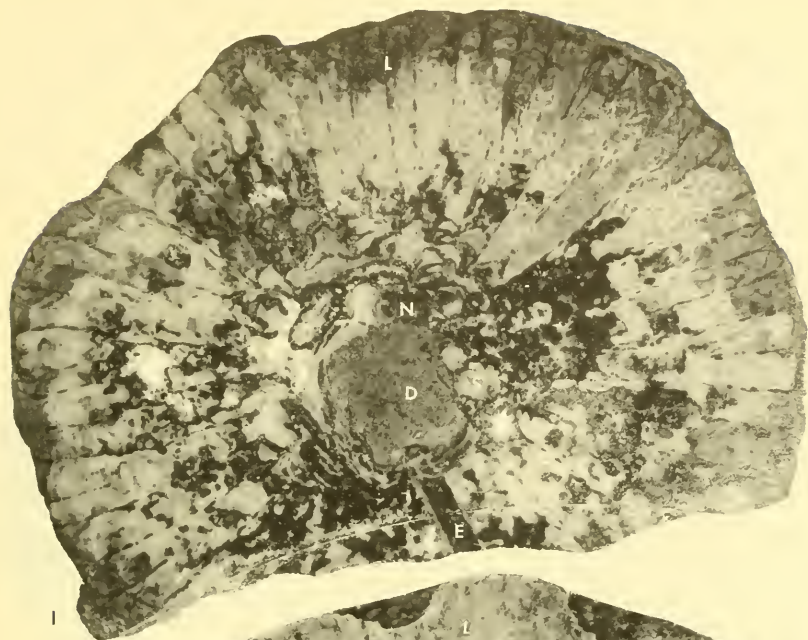
- 1-4. *Barrettia multilirata* Whitfield 211

Left valve, outer aspect. The S oscule may be seen on the right of the central boss; note the absence of an E oscule. BMNH LL30293. *Barrettia* Limestone, Haughton Hall, Green Island, Hanover. 2. Same specimen, a portion of the surface $\times 2$ to show details of structure. Compare with Text-figure 8. 3. Same species. Incomplete left valve, inner aspect. BMNH LL7136. Same horizon and locality. 4. Same species. Bivalve. In the middle quadrant on the left of the figure the left valve is broken away exposing the commissural surface of the right valve. The central boss is missing, its place being taken by an oval aperture, possibly due to an injury sustained during life. The S oscule is seen above and to the left of this aperture. A new photograph of one of Trechmann's types (1922, pl. 20, fig. 3). BMNH L44198. Same horizon and locality.

EXPLANATION OF PLATE 55

Illustrations natural size

Figure	Page
1. <i>Barrettia ruscae</i> Chubb	213
Right valve, incomplete; transverse section. Smith. <i>Barrettia</i> Limestone, Clifton, Hanover.	
2. <i>Barrettia multilirata</i> Whitfield	211
Right valve; transverse section of an exceptionally large shell. Smith. Campanian, <i>Barrettia</i> Limestone, Haughton Hall, Green Island, Hanover.	

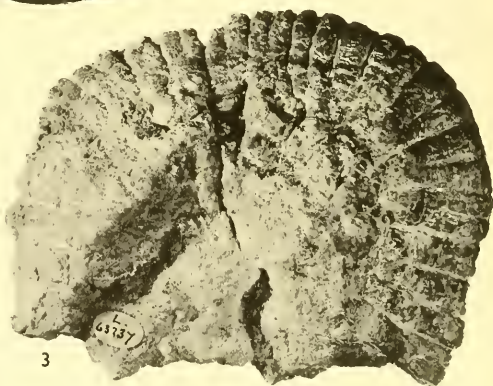




1



2



3

EXPLANATION OF PLATE 56

Figure 1 reduced, others natural size

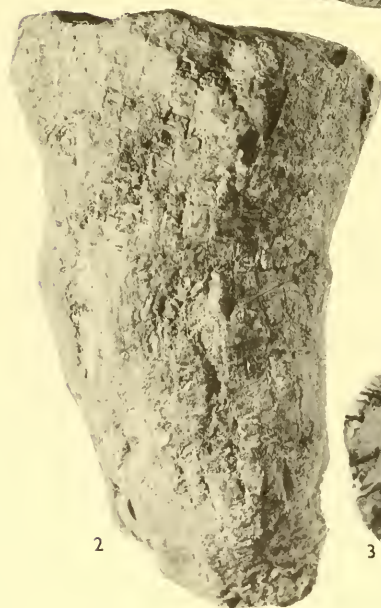
Figure	Page
1-3. <i>Parastroma trechmanni</i> Chubb	214
Commissural surface of young adult valve $\times 0.9$. It shows the body cavity, tooth (N) between the two sockets (b' and b) in which are the broken off teeth of the left valve; the posterior myophoric cavity and the S and E pillars. This specimen was figured by Trechmann as <i>Barrettia</i> cf. <i>monilifera</i> (1922, pl. 19, figs. 2a, 2b). BMNH L44200. <i>Barrettia</i> Limestone, Haughton Hall, Green Island, Hanover. 2. Same species, commissural surface of young right valve. Both the myophores of the left valve may be seen within it. BMNH L63237. Same horizon and locality. 3. Same specimen, lower surface, showing radial sulci between flat costae.	

EXPLANATION OF PLATE 57

Figure 1 natural size, figure 2 reduced

Figure	Page
1,2. <i>Pracbarrettia sparcilirata</i> (Whitfield)	215
Right valve, lateral aspect. Part of the outer layer is preserved; where it is weathered away the outer edges of the infolds and of the tabulae may be seen. Smith. Loose in soil of banana fields at head of Orange River; derived from basal Maestrichtian limestone. 2. Same species, right valve $\times 0.75$. Weathered specimen showing a section of the body cavity near the commissure with the three principal pillars and the cardinal apparatus of the left valve. A new photograph of one of Trechmann's types (1924b, pl. 23, fig. 4). BMNH L44204. Lower part of Logie Green section, i.e. basal Maestrichtian.	





EXPLANATION OF PLATE 58

All illustrations natural size

Figure 1 courtesy American Museum of Natural History

Figure	Page
1. <i>Pracbarrettia sparcilirata</i> (Whitfield)	215
Right valve, transverse section. A reproduction of one of Whitfield's illustrations (1897b, pl. 37). He believed that he had found the S pillar at <i>a</i> and, more doubtfully, the E pillar at <i>b</i> . AMNH 9667. Maestrichtian, Logie Green, Clarendon.	
2-4. <i>Pracbarrettia coatesi</i> Chubb	216
Right valve, posterior lateral aspect. Shows the infolds as faint striae. UWI 4162. Peters Hill Limestone, probably Turonian, Peters Hill, north-east Clarendon. 3. Same species. Transverse section of a right valve, showing the L, S and E pillars. UWI 4163. Same horizon and locality. 4. Same species. A cluster of right valves. UWI 4164. Same horizon and locality.	

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NOTE: Light face type refers to page numbers. Bold face type refers to plate numbers.

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