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THE NEW YORK ACADEMY OF SCIENCES

SCIENTIFIC SURVEY
OF
PORTO RICO and the VIRGIN ISLANDS

VOLUME XVII—Part 1

The Pelecypoda or Bivalve Mollusks of Porto Rico and the
Virgin Islands

Richard A. McLean



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THE PELECYPODA OR BIVALVE MOLLUSKS OF PORTO RICO AND THE VIRGIN ISLANDS

BY RICHARD A. McLEAN

CONTENTS

INTRODUCTION.....	1
CLASSIFICATION OF THE PELECYPODA.....	3
SYSTEMATIC ACCOUNT.....	5
Order Prionodesmacea.....	6
Order Anomalodesmacea.....	46
Order Teleodesmacea.....	51
REMARKS.....	122
GLOSSARY.....	123
PLATES AND EXPLANATION OF PLATES.....	127
INDEX.....	178

INTRODUCTION

The littoral pelecypod fauna of the Greater Antilles and of the West Indian region as a whole is taxonomically well known. It is seldom that collections from this area yield undescribed species. The distribution of these forms, particularly the southern limit of their ranges, still requires considerable study. Exact geographical records for the lower West Indies and the northern Atlantic coast of South America are few and scattered. From the cabinet collector's point of view, a fauna which does not yield new forms is of limited interest. The fact is, however, that a phylum or lesser group of animals must be well founded, taxonomically, before more exact studies of evolution, speciation, and ecological influences can be undertaken. Accordingly, the present work has been written in the nature of a handbook of littoral bivalve mollusks. It may assist students to investigate the dynamic processes which have produced these species and which control them in their present environment.

The collections which have served as source material for this report include those obtained from Porto Rico by The New York Academy of Sciences and the American Museum of Natural History in expeditions during the period from 1914 to 1925. Additional material was furnished by the collections and observations of the author when on an expedition to Porto Rico for Harvard University in the summer of 1937. The Museum of Comparative Zoology at Harvard and the Academy of Natural Sciences of Philadelphia have supplied many further records. Dall and Simpson's¹ report has been a valuable source book. Considerable descriptive and diagnostic

¹ Bull. U. S. Fish Comm. 20. 1901.

material has been derived from monographic works by Dr. W. H. Dall, Dr. W. P. Woodring, and Dr. Julia Gardner.

Specific geographical records have not been identified as to source in the text.

The keys are all original and are applicable to the particular fauna which has been studied.

The author wishes to express his appreciation to Dr. Roy Waldo Miner, editor of the New York Academy of Sciences, for the privilege of studying the collections of the American Museum of Natural History which were made as a part of the Scientific Survey of Porto Rico by The New York Academy of Sciences, and for the opportunity of writing this report. Dr. Henry A. Pilsbry, curator of mollusks at the Academy of Natural Sciences of Philadelphia, has given invaluable advice and encouragement during the preparation of the manuscript. The recommendations of Dr. Francis Harper have been very helpful.

The illustrations were made in the photographic department of the Academy of Natural Sciences of Philadelphia, by Mr. A. D. Warden.

The index and explanation of the plates were prepared by my wife, Virginia M. McLean, who has aided in many ways in bringing the manuscript to completion.

CLASSIFICATION OF THE PELECYPODA

It is remarkable that the primary taxonomic divisions of a group of animals, like the Pelecypoda, which is so numerous in individuals and species and which can be traced back almost to the beginning of the fossil record, still remain in a more or less tentative and uncertain state.

Two fundamental schemes underlie the divergent systems which are in general use today. Pelseneer² proposed a system based on anatomical features, particularly the character of the gills. This scheme is of very great interest to the student of bivalve mollusks, and the value of Pelseneer's work is beyond question. However, there are a number of discrepancies in the taxonomic groups as outlined by him. One of the most notable is the separation of the Ostreidae, Pinnidae, and Limidae from the closely related Pectinidae. This seems to be an artificial break in a continuous evolutionary series. Fundamentally, the gills are a structure which exhibit progressive evolution, that is, they can be traced through lineage and show a definite trend in development. The danger inherent in a classification of this kind is that it may place together members of different lineages at the same grade of evolution, while members of the same lineage at different grades are separated.

Neumayr³ proposed a classification based on hinge characters. These appear to be stable characters which change slowly and may persist through great modifications of life. Taken in conjunction with the relative development of the adductor muscles, and subject always to checking by all other features that are ascertainable, they afford good guidance to natural relationships. A system of this kind has the added advantage of permitting comparisons with fossil forms ranging back through the phylogeny of the recent species.

From Neumayr's classification, which has been subjected to various modifications and changes, two systems have developed which, although based on the same basic concepts, are sufficiently different to be regarded as distinct taxonomic arrangements.

The first of these, and the most widely used, is that of Dall⁴, in which he groups the bivalve mollusks in three orders and gives diagnoses of the superfamilies and families assigned to each. There are anomalies in this system as in the others, but, on the whole, it seems to be the most usable at the present time.

The other system is that proposed by Douvillé⁵. This plan is favored by Davies in his review of the bases of classification of the Lamellibranchia,⁶ and it has a very strong appeal to the present writer. It is certain that Douvillé had a clear, broad concept of evolutionary trends in the bivalve mollusks. He did not propose formal names for his ordinal groups. The

² Pelseneer, Paul, Arch. de Biol. 10. 1891.

³ Neumayr, M. Denkschr. K. K. Akad. Wiss. Wien, math. nat. Cl. 58. 1891.

⁴ Dall, W. H. Trans. Wagner Free Inst. Sci. Philadelphia 3 (3). 1895.

⁵ Douvillé, H. Bull. Soc. Géol. France (4) 7. 1912.

⁶ Davies, A. Morley. Proc. Malac. Soc. London 20 (6). 1933.

three major divisions are based on a mode of life as reflected in the form of the animal. The free-living forms make up one line. Another includes those bivalves which are characteristically attached to the substratum by a strong byssus, and the burrowing genera comprise the third. The chief objection to this classification is that the ecological mechanism which is supposed to have differentiated the orders is seen in evidence, on a minor scale, within these same orders. At present, it seems difficult to reconcile the sporadic occurrence of these three evolutionary trends throughout the orders, each of which is supposedly based on only one of them.

Thiele⁷ has employed a scheme of classification which seems to be a synthesis of those of Neumayr and Pelsener. It will gain some acceptance as part of one of the few general synoptic works on the mollusks.

In the following systematic account of the marine bivalves of Porto Rico and the Virgin Islands, the classification of Dall is employed. It seems to be the most practical one available at this time. It is based upon broad concepts and has fewer unexplained anomalies than any of the others. However, future research may well establish at least some of Douvillé's scheme as an integral part of bivalve evolution and taxonomy.

⁷ Thiele, J. *Handbuch der systematischen Weichtierkunde*. Jena. 1935.

SYSTEMATIC ACCOUNT

Class Pelecypoda

The Pelecypoda are aquatic, bilaterally symmetrical mollusks protected by a pair of shelly valves which are secreted by the lateral portions of the mantle. The valves are united dorsally by a ligament and are moved by muscles which connect their inner surfaces. There is no definite head. Their food consists of minute particles of organic matter and microorganisms which become entangled in mucus while passing over the gills with the circulating water. These mucous strands and the included food are carried along by a system of ciliary currents which run over the gills and forward to the labial palps and thence to the mouth. Respiration is by gills and also through the general surface of the integument. The circulatory system is closed, although there are many large sinuses. The blood is usually nearly colorless, and the respiratory pigment is usually hemocyanin. The heart may have one or two ventricles and two auricles. There is a more or less convoluted intestine, with its oral and anal extremities at opposite ends of the body, and a well-developed stomach near the oral end. There are paired kidneys, connected with the pericardium and discharging independently of the rectum. Reproduction is by eggs and spermatozoa without copulation. The animals may be monoecious or dioecious. Development is external to the genital tract. The postlarval young are protected by a prodissoconch and sometimes exhibit a nepionic stage. The nervous system is usually composed of three principal pairs of ganglia, united by nerves. The Pelecypoda are imperfectly sensitive to light, although occasionally provided with peripheral sense organs and, sometimes, with a light-sensitive pigment in the tissues of the siphons. They have tactile papillae, olfactory organs (osphradia), and auditory and equilibrating organs (otocysts).

There are three major subdivisions or Orders of the Class.

Brief, comparative diagnoses of the three orders follow.

Order PRIONODESMACEA

- (1) Shell substance nacreous and prismatic, rarely porcellaneous.
- (2) Area amphidetic or obscure, rarely divided into lunule and escutcheon; when so divided, having an amphidetic ligament.
- (3) Ligament variable, rarely opisthodetic.
- (4) Hinge plate variable.
- (5) Hinge teeth absent or obscure, taxodont, isodont, dysodont, or amorphous schizodont.
- (6) Byssus present or absent, frequently used for firm fixation by adults.
- (7) Mantle lobes separated or, when caught together, with imperfectly developed siphons.
- (8) Adductor muscles equal, or anterior one reduced, obsolete or absent.

Order ANOMALODESMACEA

- (1) Shell substance nacreous and porcellaneous, rarely prismatic.
- (2) Area amphidetic or obscure, rarely distinctly divided.
- (3) Ligament usually opisthodetic, generally associated with an internal resilium, chondrophores, and a lithodesma.

- (4) Hinge plate not developed.
- (5) Hinge teeth often obsolete or absent, rarely with lateral laminae or well-developed dental processes.
- (6) Byssus present or absent.
- (7) Mantle lobes more or less completely united, with a pedal opening and sometimes an opisthodial opening in addition to the two well-developed siphons.
- (8) Adductor muscles subequal.

Order TELEODESMACEA

- (1) Shell substance porcellaneous or obscurely prismatic, never nacreous.
- (2) Area, if present, always prosodetic, or divided into lunule and escutcheon.
- (3) Ligament opisthodontic, with or without a separate resilium, without a lithodesma, rarely with external accessory shelly pieces.
- (4) Hinge plate usually well developed.
- (5) Hinge teeth differentiated into distinct cardinals and laterals; the posterior laterals, when present, are behind the ligament. Rarely, in boring forms, the hinge is practically edentulous but supplemented by external shelly plates.
- (6) Byssus present or absent, seldom functional in adults.
- (7) Mantle lobes generally more or less connected, forming well-developed siphons.
- (8) Adductor muscles typically subequal.

No key was prepared for the orders, as it is difficult to find a single character, or even two or three, that will separate all members of one major group, without exception, from all members of another. Specialization, convergent evolution or degeneration will often cause members of unlike phylogenies to approximate one another in form or appearance. Subordinal groups and all lower categories have been provided with keys.

Order PRIONODESMACEA

Five subordinate groups of this order seem to have followed definite and distinct trends of evolution and are ranked as suborders.

KEY TO THE SUBORDERS OF PRIONODESMACEA

- (1) Hinge edentulous; periostracum heavy and conspicuous, extending beyond the valve margins. Edentulata
- (1') Hinge not edentulous or, if apparently edentulous, then periostracum not as outlined in (1). (2)
- (2) Hinge teeth numerous, serial, reduplicated along hinge margin; ligament seldom parivincular, but, when so formed, then the teeth are divided into two groups, one on either side of the umbones. Taxodonta
- (2') Hinge teeth and ligament not as described in (2). (3)
- (3) Hinge teeth concentrically arranged. Isodonta
- (3') Hinge teeth not concentrically arranged. (4)
- (4) Hinge teeth schizodont, sometimes obsolete; ligament usually multivincular or alivincular, rarely parivincular; if hinge teeth are obsolete and ligament parivincular, then shell gaping widely behind. Schizodonta
- (4') Hinge teeth dysodont or obsolete; ligament parivincular; shells not widely gaping
Dysodonta

Suborder EDENTULATA

The shell is thin, elongate, practically equivalve, low-beaked, with a conspicuous epidermis, substance prismatic. The hinge is edentulous. Mantle lobes are united ventrally, and anal and branchial openings are not

separated. The gills are foliobranchiate. The pleural ganglion is distinct. Both adductors are present. These animals are not byssiferous.

Family SOLEMYIDAE

The shell is soleniform, gaping, with the anterior end longer and the epidermis conspicuous, extending beyond the valves. The area is obscure or absent. The ligament is amphidetic, parivincular, becoming internal posteriorly. The mantle lobes are attached, in front, to the epidermis and valves by a broad surface, leaving no distinct pallial line. There is a single posterior siphonal and anterior pedal opening in the mantle. The palpi are united laterally above. Adductors are subequal, with a thickened ray in front of the posterior scar. The ventricle embraces the rectum and gives out a single anterior aorta. The foot is elongated, having a pedal gland, but no byssus, with a terminal groove which may be expanded to a stellate disk.

Genus SOLEMYA Lamarck

Solemya Lamarck (1818) Anim. s. Vert. 5: 488.

Solenimya Bowdich (1822) Elem. Conch. 2: 8.

Solenomya Children (1823) Quart. J. Sci. 14: 300.

Solenymia Swainson (1840) Treat. Malacol. 366.

Solenymya Schaufuss (1869) Moll. Syst. Cat. Paetel 21.

TYPE (by subsequent designation, Children 1823), *Solemya mediterranea* Lamarck.

The characters of the genus are the same as given for the family.

There is one species of *Solemya* in this fauna, and it is properly placed in Dall's subgenus *Petrasma*.

Subgenus PETRASMA Dall

Petrasma Dall (1908) Nautilus 22 (1): 2.

TYPE (by original designation), *Solemya borealis* Totten.

Differs from the typical members of the genus in not having the ligament exposed internally in front of the chondrophore.

Solemya (*Petrasma*) *occidentalis* (Deshayes)

PLATE 1, FIGURE 1

Solenomya occidentalis Deshayes (1858) J. Conchyl. 7: 186. Pl. 7, fig. 6.

This species has the chondrophore with an anterior prop or buttress extended as a slender rib in front of the adductor scar. There is no posterior prop. The periostracum is of a light corneous color.

Length 18.5, height 6, width 3 mm.

Porto Rico: One specimen from Porto Rico, without specific locality data, in the collections of the Survey.

Suborder TAXODONTA

The dentition is taxodont, consisting of a repetition of similar teeth along the hinge line. The ligament may be alivincular, multivincular, or parivincular; but, if parivincular, then the teeth are divided into two

separate groups, one before and one behind the umbones. There are two subequal adductors.

There are two distinct groups in this suborder, the superfamily Nuculacea and the superfamily Arcacea.

KEY TO THE SUPERFAMILIES

- (1) Shell substance often nacreous; area obscure or divided into lunule and escutcheon; teeth usually chevron-shaped; not byssiferous. Nuculacea
 (1') Shell substance not nacreous; area amphidetic; teeth rarely chevron-shaped; usually byssiferous. Arcacea

Superfamily NUCULACEA

The Nuculacea have an equivalve shell of varied form. The epidermis is smooth and often greenish in color. Under the epidermis, there is a tubuliferous prismatic layer. The valves may have a pearly or porcellanous lining. The hinge area is usually obscure but, when present, is divided into a lunule and an escutcheon. The ligament extends on either side of the beaks and may be in the form of a single stout band (alivincular) or a short "C" spring (parivincular). The dentition of the hinge consists of a series of similar teeth, alternating on each side of the hinge margin. The pallial line may be simple or sinuate, depending on the absence or presence of siphons. Both adductors are present and subequal. These forms do not have a byssus.

There are two families represented in this fauna.

KEY TO THE FAMILIES OF NUCULACEA

- (1) Ends of the shell tightly closed, no siphons, pallial line simple. Nuculidae
 (1') Ends of the shell usually partly gaping, complete siphons, pallial line usually sinuate. Nuculanidae

Family NUCULIDAE

The shell is compact, closed, with the teeth in two series meeting below the umbones and separated by a chondrophore. The area is represented by an obscure lunule and escutcheon. There is no ligament, but a wholly internal, amphidetic, alivincular resilium. The internal layer of the shell is nacreous. The pallial line is usually simple and the mantle lobes free, without siphons. The ventricle is sub-duplex, dorsal to the rectum, with anterior and posterior aortas.

Genus NUCULA Lamarck

Nucula Lamarck (1799) Mem. Soc. Hist. Nat. Paris -: 87.

TYPE (by monotypy), *Arca nucleus* Linnaeus.

The shell is small, trigonal, inequilateral, with the anterior end longer than the posterior. The interior is nacreous. The area behind the umbo is slightly or strongly depressed. The surface is smooth or sculptured with fine radials or concentric rugae or both. The chondrophore is narrow and oblique. The hinge consists of anterior and posterior series of chevron-

shaped teeth, the anterior one longer. Lower margin of the valve is frequently finely fluted.

Nucula aegeënsis Jeffreys

PLATE 1, FIGURE 4

Nucula aegeënsis Jeffreys (1879) Proc. Zool. Soc. London, -: 581.

The shell is rather small, thin, and nearly regularly ovate. It is slightly oblique, uniformly convex, and has a low, rounded posterior ridge. The straight umbones project but little beyond the rest of the shell. The sculpture is made up of exceedingly fine concentric ridges. The rather broad hinge is armed with few teeth, and the cartilage pit is small. This species is close to *N. tenuis* Montagu.

Length 10.7, height 8, width 4.7 mm.

Family NUCULANIDAE

The shell is similar to the Nuculidae, but with the ligament variable and the resilium sometimes external, or absent. The internal layer is subnacreous or porcellanous. The ends of the shell are partly gaping. The pallial line is usually sinuated, with the mantle lobes more or less united, and with complete, sometimes elongate, siphons. The ventricle embraces the rectum and has both anterior and posterior aortas.

KEY TO THE GENERA OF NUCULANIDAE

- (1) Resilium located in the hinge line dividing the teeth into two series... *Nuculana*
 (1') Resilium above the hinge line, teeth sometimes divided by a blank space but not by a chondrophore..... *Tindaria*

Genus NUCULANA Link

Nuculana Link (1807) Beschr. Nat. Samml. Univ. Rostock 3: 155.

Leda Schumacher (1817) Nouv. Syst. Vers Test -: 55.

TYPE (by monotypy), *Arca rostrata* Chemnitz = *Nuculana rostrata* Link.

The shell is medium-sized, elongate, inequilateral, with the posterior end rostrate and slightly gaping. The rostrum is bicarinate. The lunule is distinct. The sculpture consists of concentric rugae on the dorsal half of the valve, replaced by incrementals on the ventral half. The hinge consists of an anterior and posterior series of chevron-shaped teeth, with the posterior series almost twice as long as the anterior series. The chondrophore is small, deep, and triangular. The pallial sinus is shallow with its apex narrowly U-shaped.

Nuculana acuta (Conrad)

PLATE 1, FIGURE 2

Nucula acuta Conrad (1831) Am. Mar. Conch. -: 32, Pl. 6, f. 3.

Leda cuneata Sowerby (1832) Proc. Zool. Soc. London -: 198.

Leda jamaicensis d'Orbigny (1845) Moll. Cubana 2: 262. Pl. 26, f. 27-29.

Leda unca Gould (1862) Proc. Boston Soc. Nat. Hist. 8: 282.

Leda inornata A. Adams, *vide* Hanley from type.

The sculpture of this species is quite variable. It may be finely concentrically ridged or coarsely waved, but, typically, the concentric ridges are moderate and regular, becoming obsolete towards the ends and base.

Length 9, height 5, width 3.5 mm.

Porto Rico: Mayaguez.

Genus **TINDARIA** Bellardi

Tindaria Bellardi (1875) Monogr. Nuculidi Terr. Terz. Piemonte Liguria -: 28.
Type (by monotypy), *Tindaria arata* Bellardi.

The shell is solid, closed, and concentrically sculptured. The ligament and resilium are amphidetic and outside the hingeplate or line of teeth. The pallial line may be feebly waved or entire.

Subgenus **NEILONELLA** Dall

Neilonella Dall (1881) Bull. Mus. Comp. Zool. 9: 126.
TYPE (by monotypy), *Leda* (*Neilonella*) *corpulenta* Dall.

The shell is attenuate behind with the ligament long; the resilium short, central, and in a socket above the tooth line. The teeth are divided into two series by a space below the resilium. The pallial line is feebly waved.

Tindaria (*Neilonella*) *corpulenta* (Dall)

PLATE 1, FIGURE 3

Leda (*Neilonella*) *corpulenta* Dall (1881) Bull. Mus. Comp. Zool. 9: 125.

The lunule and escutcheon are very faintly defined. There are about 15 teeth on each side of the beaks. The shell substance is porcellaneous with a light olive, polished epidermis.

Length 10, height 6.5, width 4.5 mm.

Porto Rico: Mayaguez.

Superfamily **ARCACEA**

In the Arcacea, the shell is varied in form. There is usually a pilose epidermis. The shell substance is largely porcellaneous, with a tubuliferous, non-prismatic, outer layer and no nacreous layer. The hinge area extends on either side of the beaks. The ligament is external and may consist of one band running from beak to beak across the hinge line (alivincular) or of several similar bands transverse to this line (multivincular). The dentition consists of alternating serial teeth. The pallial line is simple. The adductor muscles are both present and subequal. A byssus is usually developed.

There are two families in this region.

KEY TO THE FAMILIES OF ARCACEA

- (1) Shell circular or very nearly so; teeth in two nearly equal groups; animals free-living, with no byssus.....Glycimeridae
- (1') Shell not usually circular; teeth frequently in unequal groups; animals typically attached by a byssus.....Arcidae

Family **GLYCIMERIDAE**

The shell is circular, equivalve, and practically equilateral. The hinge and ligament are similar to the Arcidae with the two groups of teeth nearly equal on either side of the beaks. The area may be amphidetic or opisthodetic. The principal surface sculpture is radial, although some forms are nearly smooth. The soft parts are similar to the Arcidae. The animals are free-living, without a byssus.

Genus **GLYCIMERIS** da Costa

Glycimeris da Costa (1778) Hist. Nat. Test. Brit. —: 168.
TYPE (by tautonomy), *Arca glycimeris* Linnaeus.

The shell is medium-sized, suborbicular, and equilateral, with the umbones erect or prosogyrous. Sculpture consists of radial striae or radial ribs. The hinge area is moderately wide with the ligament amphidetic or opisthodetic. The hinge consists of two series of heavy teeth, outer teeth of both series almost horizontal, inner teeth chevron-shaped, median teeth obliterated by a downward extension of the hinge area. The inner surface of the margins of the valves are fluted. The byssus is absent in the adult.

KEY TO THE SUBGENERA OF *Glycimeris*

- (1) Umbones erect, ligament amphidetic.....*Glycimeris* s.s.
(1') Umbones prosogyrous, ligament opisthodetic.....*Glycimerella*

Subgenus *Glycimeris* s.s.

The description is as given under the genus with the restrictions of erect umbones and amphidetic ligament.

KEY TO THE SPECIES OF *Glycimeris* s.s.

- (1) Radial ribs rounded, numbering more than thirty; anterior end not attenuate. .
G. pectinatus
(1') Radial ribs flattened, numbering less than thirty; anterior end somewhat attenuate
G. sericatus

Glycimeris (*Glycimeris*) *pectinatus* (Gmelin)

PLATE 1, FIGURE 8

Arca pectinata Gmelin (1792) Syst. Nat., Ed. 13: 1313.

This species is somewhat more regular in outline and more rugose than the following species.

Length 32.5, height 31.5, width 18 mm.

Porto Rico: Mayaguez; Guanica.

Virgin Islands: St. Thomas; St. Croix; Caneel Bay, St. John; Tortola; Virgin Gorda.

Glycimeris (*Glycimeris*) *sericatus* (Reeve)

PLATE 1, FIGURE 6

Pectunculus sericatus Reeve (1843) Proc. Zool. Soc. London —: 190.

This is a broadly ribbed, rather flattened species with a silky epidermis. Length 35.5, height 34.5, width 19 mm.

Porto Rico: Ponce.

Virgin Islands: St. Thomas; Tortola; St. Croix.

Subgenus **GLYCIMERELLA** Woodring

Glycimerella Woodring (1925) Publications Carnegie Inst. Washington 366: 26.

TYPE (by original designation), *Pectunculus pennaceus* Lamarck.

The shell is medium-sized, suborbicular, and slightly inequilateral with the umbones inflated and prosogyrate. The sculpture consists of narrow radial ribs, radial striae, and fine concentric threads. The hinge area is narrow and excavated with the ligament opisthodontic. The hinge is made up of two continuous series of chevron-shaped teeth, the posterior series convex, the anterior series almost straight. The upper edge of inner posterior teeth is obliterated by the ligament. The inner margins of the valves are fluted.

Glycimeris (Glycimerella) pennaceus (Lamarck)

PLATE 1, FIGURE 5

Pectunculus pennaceus Lamarck (1819) Anim. s. Vert. 4: 51.

This is a moderately large species with a characteristic sculpture of fine radial lines. It is variously spotted with chestnut brown. The epidermis is frequently preserved in the interstices of the fine radial sculpture, giving the appearance of colored lines. It bears a very close superficial resemblance to *G. lineatus* Reeve, but the hinge of this species places it in the typical subgenus.

Length 48, height 47, width 30 mm.

Porto Rico: San Juan; Boqueron Bay; Culebra; Vieques.

Virgin Islands: St. Thomas; Tortola; Virgin Gorda.

Family **ARCIDAE**

The shell is trapezoidal or rounded, with the posterior side longer and the ligament usually multivincular. The hinge is typically taxodont, with the teeth in two similar series, meeting below the beaks and approximately vertical to the margin of the valves. The ventricle is more or less double, and dorsal to the rectum. The foot is short, stout, and deeply grooved. The species are generally byssiferous.

Only the typical genus is represented in the material studied for this report. However, several deep-water genera are known from the West Indian region and may, eventually, be found in this area.

Genus **ARCA** Linnaeus

Arca Linnaeus (1758) Syst. Nat. (Ed. 10): 693.

TYPE (by subsequent designation, Gray, 1847), *Arca noae* Linnaeus.

The shell is variable, rounded or quadrate, often strongly inflated, inequilateral, with the anterior end shorter and the sculpture radial. The ribs

are sometimes beaded or cancellate. The area is amphidetic or opisthodontic, with the ligament alivincular or multivincular. The hinge is typically taxodont, in two series, more or less plainly delimited under the umbones. The individual teeth are fundamentally chevron-shaped, but the lower branch of the chevron is frequently absent. The anterior muscle scar is rounded, the posterior scar larger and rectangular. The inner margin is variously crenulate or fluted. The byssus is strong and functional.

There are five subgenera in this region.

KEY TO THE SUBGENERA OF *Arca*

- (1) Ligament opisthodontic.....(2)
- (1') Ligament amphidetic.....(3)
- (2) Hinge teeth in two subequal groups.....*Acar*
- (2') Anterior group of hinge teeth much reduced and irregular.....*Arginarca*
- (3) Margin deeply and regularly fluted.....*Scapharca*
- (3') Margin irregularly fluted or crenulate, sometimes almost smooth.....(4)
- (4) Hinge area wide; beaks high and inflated; teeth relatively regular and very numerous; margin smooth, with crude folds corresponding to the larger ribs.....*Arca* s.s.
- (4') Hinge area moderately narrow; beaks lower and not inflated; teeth reduced beneath the umbones, becoming larger distally, less numerous than in preceding group; margin irregularly fluted or crenulate.....*Barbatia*

Subgenus **ARCA** s.s.

The shell is large, inequilateral, inflated, with the posterior end keeled and the area very broad and flattened. The sculpture is irregular, ribbed or beaded. The ligament is amphidetic. The hinge teeth are small, very numerous and regular, the series scarcely interrupted below the umbones. The margins of the valves are smooth except for crude amorphous folds corresponding to the larger ribs. There is a moderate to large byssal gape.

KEY TO THE SPECIES OF *Arca* s.s.

- (1) Sculpture consisting of strong ribs anteriorly and posteriorly, median area less strongly ribbed; plainly striped with brown.....*A. occidentalis*
- (1') Sculpture consisting of low beaded ribs more or less uniform over the whole shell; irregularly suffused and clouded with brown.....*A. umbonata*

Arca (Arca) occidentalis Philippi

PLATE 1, FIGURE 7

Arca occidentalis Philippi (1847) Abbild. & Besch. 3: 14, Pl. 17, B, figs. 4a-c.

This is a large, plainly marked species. Its ribbing and coloration make it easy to distinguish from all other species of this region.

Length 90, height 40, width 50 mm.

Porto Rico: Mayaguez; Ponce; Guanica; Playa de Humacao; Boca de Cangrejos; San Geronimo; Arroyo; Punta Melones; Parguera; Tallaboa Bay.

Virgin Islands: St. Thomas; Caneel Bay, Flannagans Passage, St. John; Tortola; Virgin Gorda.

Arca (Arca) umbonata Lamarck

PLATE 2, FIGURE 1

Arca umbonata Lamarck (1819) Anim. s. Vert. 6: 37.

The more uniform sculpture and fine beading separate this species from the preceding. It is very irregular in shape, apparently as a result of environmental influences.

Length 50, height 20, width 20 mm.

Porto Rico: San Juan, Mayaguez, Guanica, Boca Prieta; Porto Real; Boca de Cangrejos; N. of Vega Baja; Mona Id.

Virgin Islands: Charlotte Amalie, St. Thomas; Caneel Bay, Flannagans Passage, St. John; St. Croix; Tortola; Virginia Gorda.

Subgenus **BARBATIA** Gray*Barbatia* Gray (1847) Proc. Zool. Soc. London, Pt. 15: 197.TYPE (by original designation), *Arca barbata* Linnaeus.

The shell is medium-sized, inequilateral, equivalve, usually rather compressed laterally, with the posterior end rounded and the area moderately narrow. The sculpture consists of fine radial ribs. The ligament is amphidetic. Hinge teeth are in two series, the anterior group smaller but well developed. The margins of the valves are finely fluted or crenulate. The byssal gape is moderately small.

There are three species of this group in the region.

KEY TO THE SPECIES OF *Barbatia*

- (1) Shell substance white.....(2)
 (1') Shell substance brown.....*Arca barbata*
 (2) Shell flattened, irregular; ribs coarsely beaded.....*Arca candida*
 (2') Shell tumid, trapezoidal, ribs fine and thread-like.....*Arca tenera*

Arca (Barbatia) barbata Linnaeus

PLATE 2, FIGURE 3

Arca barbata Linnaeus (1758) Syst. Nat. (Ed. 10): 693.

This is a smooth rounded species not readily confusable with any other species occurring in the region.

Length 50, height 28, width 17 mm.

Porto Rico: Guanica; Fajardo; San Geronimo; Liaza Vieja; Boca de Cangrejos; Ensenada Honda, Culebra; Caballo Blanco Reef, Vieques.

Virgin Islands: Lindbergh Beach, Charlotte Amalie, St. Thomas; Tortola; Virgin Gorda.

Arca (Barbatia) candida Gmelin

PLATE 2, FIGURES 6 AND 8

Arca candida Gmelin (1792) Syst. Nat. (Ed. 13): 3311.

This is a white species with a heavy brown periostracum. The outline and general form of this species are extremely variable, but the coarse beaded ribs and color serve to distinguish it from the others.

Length 60, height 35, width 28 mm.

Porto Rico: San Juan; Mayaguez; Ponce; Puerto Real.

Virgin Islands: St. Thomas; St. Croix; Caneel Bay, St. John; Tortola; Virgin Gorda.

Arca (Barbatia) tenera C. B. Adams

PLATE 2, FIGURE 2

Arca tenera C. B. Adams (1845) Proc. Boston Soc. Nat. Hist. 2: 9.

Arca (Barbatia) balesi Pilsbry and McLean (1939) Notulae Naturae Acad. Nat. Sci. Phila. 39: 1, text fig.

This fine small species is quite distinct from the others. Its tumid and trapezoidal shape and fine thread-like ribs are good characters. It has somewhat the appearance of an *Acar*, but the hinge is that of *Barbatia*. It was named as new by the author together with Dr. Pilsbry. Some years earlier, the author had segregated this species as unnamed in the collections of the Museum of Comparative Zoology. It was also unnamed in the collections of the Academy of Natural Sciences of Philadelphia. However, Adams' original material came to light when his collection was moved to Harvard University, and *Arca balesi* is without question his unfigured species.

Length 35, height 23.5, width 19 mm.

Virgin Islands: Tortola.

Subgenus ACAR Gray

Acar Gray (1847) Ann. Mag. Nat. Hist. (2) 19: 369.

TYPE (by subsequent designation, Woodring, 1925), *Arca gradata* Brod. and Sowb.

The shell is small, inflated, trapezoidal, equivalve, with the posterior end keeled and the area narrow. The sculpture is reticulate and imbricate. The ligament is opisthodetic. Hinge teeth are in two subequal series, the anterior one somewhat smaller. The margins of the valves are moderately fluted except at the byssal gape, which is small.

KEY TO THE SPECIES OF *Acar*

- (1) Sculpture coarsely reticulate.....*A. reticulata*
- (1') Sculpture very finely cancellate.....*A. adamsi*

Arca (Acar) reticulata Gmelin

PLATE 2, FIGURE 5

Arca reticulata Gmelin (1792) Syst. Nat. (Ed. 13): 3311.

This species is coarsely reticulate. The posterior end is frequently somewhat attenuate, and the shell is quite variable in form.

Length 20, height 11, width 9 mm.

Porto Rico: San Juan; Mayaguez; Ponce; Guanica; Hucare; Boca de Cangrejos; Caballo Blanco Reef, Vieques.

Virgin Islands: Charlotte Amalie, St. Thomas; St. Croix; St. John.

Arca (Acar) adamsi Smith

PLATE 2, FIGURE 4

Arca (Acar) adamsi Smith (1888) J. Linnean Soc., Zool. 20: 499, Pl. 3, figs. 6-6a.

The sculpture is finely cancellate. The shell is trapezoidal, tumid, and quite regular in form.

Length 12, height 7.5, width 7.5 mm.

Porto Rico: San Juan; Mayaguez; Ponce; Aguadilla; Vieques.

Virgin Islands: Charlotte Amalie, St. Thomas; Tortola; Virgin Gorda.

Subgenus **SCAPHARCA** Gray

Scapharca Gray (1847) Proc. Zool. Soc. London, Pt. 15: 198.

TYPE (by original designation), *Arca inaequalivalvis* Bruguière.

The shell is medium-sized to large, inequilateral, sometimes inequivalve, with the posterior end frequently keeled and, usually, strongly inflated. The area is narrow or broad. The sculpture is strongly ribbed and the ligament amphidetic. Hinge teeth are in two functional series, the anterior one smaller than the posterior but regular and vertical to the hinge line. The margins of the valves are deeply fluted and not gaping.

KEY TO THE SPECIES OF *Scapharca*

- (1) Shell length distinctly greater than height. (2)
- (1') Shell length about equal to height. *A. chemnitzii*
- (2) Ribs about thirty in number. (3)
- (2') Ribs about thirty-five in number. *A. secticostata*
- (3) Shell rounded, hinge apparently somewhat curved, posterior slope convex
A. transversa
- (3') Shell auriculate, hinge markedly straight, posterior slope concave. . . *A. auriculata*

Arca (Scapharca) auriculata Lamarck

PLATE 2, FIGURE 9

Arca auriculata Lamarck (1819) Anim. s. Vert. 6: 43.

Arca deshayesi Hanley (1842) Ill. Cat. Bivalve Shells -: 157.

This is a heavy, tumid shell, auriculate both anteriorly and posteriorly. The hinge line is very straight, and the ribs are strong and clearly delimited. The umbones are higher than those in *A. transversa*.

Length 65, height 45, width 45 mm.

Porto Rico: San Juan; Mayaguez; Ponce; Vieques.

Virgin Islands: Lindbergh Beach, Charlotte Amalie, St. Thomas.

Arca (Scapharca) transversa Say

PLATE 3, FIGURE 3

Arca transversa Say (1822) J. Acad. Nat. Sci. Philadelphia 2: 269.

This species is more rounded than the preceding one and gives the impression of being more compressed laterally, although extreme specimens are much the same in general form. The ribbing is less pronounced and the hinge line appears curved. It is sometimes slightly auriculate but not to the extent of *A. auriculata*. It is a smaller species.

Length 30, height 21, width 16 mm.

Virgin Islands: Charlotte Amalie, St. Thomas.

Arca (Scapharca) secticostata Reeve

PLATE 3, FIGURE 2

Arca secticostata Reeve (1844) Conch. Icon. 2, *Arca* fig. 38.

Arca lienosa of authors, not Say.

Anomalocardia floridana Conrad (1869) Am. J. Conch. 5: 108, Pl. 13, fig. 2.

This is a large species not readily confusable with the others. It has more numerous ribs than either of the two preceding ones and is noticeably longer in proportion to its height. The ribbing is strong and distinct.

Length 85, height 52, width 52 mm.

Porto Rico: Mayaguez.

Arca (Scapharca) chemnitzii Philippi

PLATE 2, FIGURE 7

Arca chemnitzii Philippi (1851) Z. f. Mala. 8: 50.

Arca d'orbigny Kobelt (1891) Conch. Cab. 2: 57, Pl. 16, figs. 7-8.

This is a short, tumid species, its height being nearly equal to its length. The umbones are very high and inflated, and the area is correspondingly broad. The ribs are distinct. The anterior ones are always beaded, and sometimes those of the disk and the posterior part as well.

Length 30, height 30, width 30 mm.

Porto Rico: San Juan; Mayaguez; Ponce; Humacao; Boqueron Bay; Culebra; Vieques.

Virgin Islands: Charlotte Amalie, St. Thomas.

Subgenus **ARGINARCA** new name

Argina Gray (1840) Syn. Cont. Brit. Mus. (Ed. 42): 151 (nude name).

Argina Gray (1842) *op. cit.* (Ed. 44): 81 (not Huebner, 1819).

Argina Gray (Adams, 1858) Genera Rec. Moll. 2: 540.

TYPE, *Arca (Arginarca) campechiensis* Gmelin.

The shell is medium-sized to large, rounded and inflated. The area is relatively narrow and the sculpture strongly ribbed. The ligament is opisthodontic. The hinge teeth are in two unequal series, the anterior group much reduced and irregular. The margin of the valves is deeply fluted, not gaping.

Arca (Arginarca) campechiensis Gmelin

PLATE 3, FIGURE 1

Arca campechiensis Gmelin (1792) Syst. Nat. (Ed. 13): 3312.

Arca pexata Say (1822) J. Acad. Nat. Sci. Phila. 2: 268.

Arca americana Wood (1828) Index Test. Suppl., Pl. 2, *Arca* fig. 1.

Arca holmesii Stimpson (1860) Smithson. Inst. Checklist -: 2.

This species is apparently capable of considerable variation under the influence of its environment. It ranges from New England to South America. It may be rounded or elongate, and of a chalky consistency or

porcellaneous, depending on the ecological conditions where it is found. There is a discrepancy in sculpture between the valves: the ribs of the left valve are narrower, flatter, and less prominent than those of the right and are frequently grooved down the middle, while those of the right are not grooved. Some specimens are inequivalve, the left valve overlapping the right. Typical specimens of *campechiensis* are the rounded southern form. *A. holmesii* is also based on this variation. *A. americana* is an elongate, quadrate, porcellaneous form, such as is common on the Carolina coast. Say's *pexata* could be either, but as described by Gould in 1841 it applies to the chalky northern form. The variation in form and sculpture is wide and does not seem to have a geographical correlation, so that it seems inadvisable, at the present time, to give the extreme variants subspecific or varietal names.

Length 36, height 27, width 24 mm.

Porto Rico: San Juan; Mayaguez; Aguadilla.

Virgin Islands: St. Thomas.

Suborder SCHIZODONTA

The shell is of varied form, with the inner layer frequently nacreous or subnacreous and the area amphidetic or opisthodetic. The ligament may be alivincular, multivincular, or parivincular. The hinge is schizodont or edentulous. If the hinge is edentulous and the ligament parivincular, then the shell is gaping widely behind. The adductor muscles may be subequal, or the anterior adductor may be reduced or absent. A byssus is usually present, sometimes only in the larval stages. There is frequently a distinct nepionic stage.

KEY TO THE SUPERFAMILIES OF SCHIZODONTA

- (1) Shell sessile, cemented to the substratum.....Ostracea
 (1') Shell not sessile, frequently attached by a byssus.....Pteriacea

Superfamily PTERIACEA

The shell is of varied form, frequently alate, with a nacreous or subnacreous inner and a prismatic outer layer. The epidermis is seldom conspicuous. The area is amphidetic, with the ligament variable, usually not parivincular. The hinge is schizodont or edentulous; the gills are filibranchiate or reticulate, usually reflected. The mantle lobes are free, without siphons, and the pallial line is simple. The anterior adductor is smaller, or frequently obsolete, in the adult, though present in the young. The species are generally byssiferous. The young sometimes show a distinct nepionic stage.

KEY TO THE FAMILIES OF PTERIACEA

- (1) Shell dimyarian.....Pinnidae
 (1') Shell monomyarian.....(2)
 (2) Ligament alivincular.....Pteriidae
 (2') Ligament multivincular.....Isogomonidae

Family PINNIDAE

The shell is mytiliform, not alate, dimyarian with the anterior adductor smaller. It is equivalve, truncate, and wholly open behind. The hinge is edentulous, the area linear with the ligament parivincular and internal. The shell structure is coarsely prismatic, with a thin, partial, nacreous lining. The ventricle embraces the rectum, with both anterior and posterior aortas. The gills are reticulate and plicate, with direct and reflected laminae, and free distal borders. The foot is conical, elongate, and grooved. There is a profuse, silky byssus. The anal end of the rectum is free and erectile.

KEY TO THE GENERA OF PINNIDAE

- (1) Shell cleft by a median sulcus occupied by cartilage.....*Pinna*
 (1') Shell not cleft by a median sulcus.....*Atrina*

Genus PINNA Linnaeus

Pinna Linnaeus (1758) Syst. Nat. (Ed. 10): 707.

TYPE (by subsequent designation, Gray, 1847), *Pinna rudis* Linnaeus.

The shell is large, thin, elongate, trigonal, and gaping at the posterior end. The umbones are terminal. The exterior bears a longitudinal groove at the angular shoulder. The sculpture consists of longitudinal ridges. The hinge is edentulous. The inner nacreous layer is cleft opposite the shoulder, except near the umbo, where there is a narrow ridge.

Pinna rudis Linnaeus

PLATE 3, FIGURE 5

Pinna rudis Linnaeus (1758) Syst. Nat. (Ed. 10): 707.

Pinna carnea Gmelin (1792) Syst. Nat. (Ed. 13): 3365.

Pinna flabellum Reeve (1858) Conch. Icon., *Pinna* Pl. 10, fig. 18.

The shell is elongate fan-shaped, somewhat keeled down the middle, with a median sulcus and with a variable number of hollow, tubular spines. The shell substance is thin and fragile, ranging in color from almost brick-red to light pink. In some cases, the spines are absent, and it is this smooth form that has received the name *carnea*.

Length 220, height 85, width 29 mm.

Porto Rico: Mayaguez; Caja de Muertos Is.

Virgin Islands: St. Thomas; Tortola.

Genus ATRINA Gray

Atrina Gray (1847) Proc. Zool. Soc. London, Pt. 15: 190.

TYPE (by original designation), *Pinna nigra* Chemnitz.

The shell is large, thin, elongate trigonal to triangular, and gaping at the posterior end. The umbones are terminal. The sculpture consists of longitudinal ridges, smooth or ornamented with spines. The hinge is edentulous.

Atrina rigida (Dillwyn)

PLATE 3, FIGURE 4

Pinna rigida Dillwyn (1817) Catal. 1: 327.*Pinna subviridis* Reeve (1858) *Pinna Pl. 17, fig. 32.*

The shell is similar to the preceding species in general appearance, but ranges in color from light-horn-color to dark brown. There is no keel or sulcus running down the middle of the shell.

Length 150, height 72, width 33 mm.

Porto Rico: Mayaguez.

Virgin Islands: St. Thomas.

Family **PTERIIDAE**

The shell is aviculoid, bialate, monomyarian and inequivalve, with an alivincular ligament. The byssus issues from a notch in the smaller valve. The ventricle is ventral to the rectum, with anterior and posterior aortas. The gills are filamentary or imperfectly reticulate, with direct and reflected laminae attached to the mantle, but the tips behind the adductor floating free. The foot is subcylindrical, small and grooved. The anal end of the rectum is free and erectile. The young are dimyarian and sometimes pass through a distinct nepionic stage.

KEY TO THE GENERA OF PTERIIDAE

- (1) Posterior auricle elongate.....*Pteria*
 (1') Posterior auricle not elongate.....*Pinctada*

Genus **PTERIA** Scopoli*Pteria* Scopoli (1777) *Introduct. Hist. Nat. Lap. Plant. Anim. Naturae*: 397.*Mytilus hirundo* Linnaeus.

The shell is of varying size, nacreous with the posterior and anterior ends auriculate. The posterior auricle is elongate. The anterior margin below the auricle is insinuated by a narrow byssal gape. The sculpture is weak. The hinge area is narrow, almost as long as the dorsal margin of the valves. The right and left valves bear 1 or 2 small denticles fitting into shallow sockets, and a long posterior lateral lamella.

Pteria colymbus (Röding)

PLATE 3, FIGURE 8

Pinctada colymbus Röding (1798) *Museum Boltenianum*, 2: 166.*Avicula atlantica* Lamarck (1819) *Anim. s. Vert.* 6: 148.

The elongate posterior wing and oblique form of the shell characterize this species in the Antillean region. It is often dark brown or almost black in color. The interior is pearly.

Length 89, height 59, width 25 mm.

Porto Rico: Ponce.

Virgin Islands: St. Croix; Tortola; Virgin Gorda.

Genus PINCTADA Röding

Pinctada Röding (1798) Museum Boltenianum 2: 166.

Margaritiphora Megerle (1811) Ges. Nat. Fr. Berlin Mag. 5: 66.

Margaritifera Schumacher (1816) Overs. K. Dansk. Vid. Selsk. Forhandl. 7 (ex. Humphrey).

TYPE (by subsequent designation, Iredale, 1915), *Mytilus margaritiferus* Gmelin.

The shell is of varying size, nacreous with the posterior and anterior ends auriculate. The posterior auricle is not elongate. The byssal gape is on the right valve below the small triangular auricle. The sculpture consists of lamellations of the surface at the growth lines, often forming tongue-like projections which may be arranged in radial rows. The hinge is similar to that in *Pteria*.

Pinctada radiata (Leach)

PLATE 3, FIGURE 7

Avicula radiata Leach (1814) Zool. Miscell. 1:98, Pl. 43.

This is the small pearl oyster of the West Indies. It is often beautifully mottled with yellow and varying shades of brown. Some individuals show a remarkable sculpture of lamellations of the surface at the growth lines. The lamellae curl up and overlap one another, giving a very bizarre appearance to the shell.

Length 75, height 72, width 28 mm.

Porto Rico: Mayaguez; Boca Prieta; Point Brea.

Virgin Islands: St. Thomas; St. Johns; Tortola.

Family ISOGNOMONIDAE

The shell is submytiliform with a broad posterior wing. It is monomyarian, the anterior adductor being absent in the adult. It is also inequivalve and edentulous, with a serial, multivincular ligament. Species usually byssiferous, with a moderate gape or none. The gills are reticulate and united to each other and to the mantle. The anatomy otherwise is generally as in the Pteriidae.

Genus ISOGNOMON Solander

Isognomon Solander (1786) Cat. Portland Mus.: 41.

Melina Retzius (1788) Diss. Nova. Test. Gen.: 22.

Perna Bruguière (1789) Enc. Meth. (Vers), 1 (1): 13 (not Retzius, 1788).

Isognomon Röding (1799), Mus. Bolten. 2: 168.

Isognomon Link (1807) Besch. Nat. Samml. Univ. Rostock, (3): 155.

TYPE (by tautonomy), *Ostrea isognomon* Linnaeus.

The shell reaches a large size and is obliquely subquadrate, with the posterior end auriculate or rounded and the anterior margin insinuated by a narrow byssal gape near the dorsal margin. The ligament area bears numerous parallel grooves perpendicular to the dorsal margin of the valves. The interior is nacreous centrally.

KEY TO THE SPECIES OF *Isognomon*

- (1) Ligament pits relatively widely spaced, color light.....*I. listeri*
 (1') Ligament pits relatively close-set, color dark.....(2)

- (2) Shell smooth internally.....*I. alata*
 (2') Body portion of shell usually distinctly delimited from the marginal portion by a ridge.....*I. vulsella*

Isognomon alata (Gmelin)

PLATE 4, FIGURE 3

Ostrea alata Gmelin (1792) Syst. Nat. (Ed. 13): 3339.*Perna ephippium* Reeve (1858) Conch. Icon. 11: Pl. 2, fig. 8.

This species is large and spatulate and is not easily confused with any other in the region. It is usually dark in color. The units of the multivincular ligament are relatively close-set.

Length 80, height 80, width 8 mm.

Porto Rico: San Juan; Mayaguez; Guanica; Parguera; Puerto Real; Ensenada Honda, Culebra.

Virgin Islands: St. Thomas.

Isognomon listeri (Hanley)

PLATE 3, FIGURE 6

Perna vulsella Lamarck (1818) Anim. s. Vert. 6: 141 (var. b).*Perna listeri* Hanley (1846) Ill. Cat. Biv. Shells: 259.*Perna lamarckiana* d'Orbigny (1846) Moll. Cubana 2: 360.

This species is lighter in color than the other two and is usually characteristically marked with rusty red. The markings are radial fan-shaped rays. The ligamental pits are relatively more widely spaced as well.

Length 25, height 60, width 7 mm.

Porto Rico: Mayaguez; Ponce; Guanica; Hucares; Arroyo; Talleboa; Puerto Real; Ensenada Honda, Culebra.

Virgin Islands: St. Thomas.

Isognomon vulsella (Lamarck)

PLATE 4, FIGURES 1 AND 2

Perna vulsella Lamarck (1818) Anim. s. Vert. 6: 141.*Perna bicolor* C. B. Adams (1845) Proc. Boston Soc. Nat. Hist. 2: 9.*Perna chemnitziana* d'Orbigny (1846) Moll. Cubana 2: 359.

The shell substance is dark, and the ligamental pits are relatively close-set. The most characteristic feature of this species is the raised pallial line which marks off the body portion of the shell from the distal portion.

Length 28, height 18, width 7 mm.

Porto Rico: San Juan; Ponce; Guanica; Caja de Muertos Is.

Virgin Islands: St. Thomas.

Superfamily **OSTRACEA**

In this group, the shell is inequivalve, sessile, and extremely varied in form, even within a single species. It is, apparently, particularly susceptible to ecological conditions in this respect. The valves fit together very closely. The epidermis is inconspicuous. The outer layer of the shell is prismatic, and the inner is subnacreous or porcellaneous. The hinge

area extends on each side of the beaks, with the ligament in the form of a broad band, running from beak to beak. The dentition is obsolete, although some species have a series of small denticles along the margin, especially near the hinge area. The pallial line is simple and often quite obscure. The anterior adductor muscle is absent. There is no byssus.

Family OSTREIDAE

The shell is spatulate or rounded and distorted by early adherence to other objects. It is dimyarian when young, with the anterior adductor absent or very much reduced in the adult. The hinge is edentulous or with obscure, schizodont dentition. The foot is rudimentary or absent. The species are monoecious or dioecious, and the position of the ventricle varies.

Genus OSTREA

Ostrea Linnaeus (1758) Syst. Nat. (Ed. 10): 696.

TYPE (by subsequent designation, Children, 1823), *Ostrea edulis* Linnaeus.

The characters for *Ostrea* are the same as those listed above for the Ostreidae, since this genus alone constitutes the family in the recent fauna.

This genus is subdivided into two groups by the presence or absence of a promyal chamber and the associated position of the adductor muscle scar.

KEY TO THE SUBGENERA OF *Ostrea*

- (1) Promyal chamber absent, muscle scar subcentral.....*Ostrea* s.s.
 (1') Promyal chamber present, muscle scar distally located.....*Crassostrea*

Subgenus OSTREA s.s.

There are two recognized sections of this subgenus in this fauna.

KEY TO THE SECTIONS OF *Ostrea* s.s.

- (1) Valve margins straight or irregularly folded; right valve flatter and smoother than left valve.....*Ostrea* s.s.
 (1') Valves similarly sculptured, with sharp radial plications and corresponding folds in the margins.....*Lopha*

Ostrea (*Ostrea*) *cristata* Born

PLATE 4, FIGURES 8 AND 9

Ostrea cristata Born (1778) Index Mus. Caes. Vind.: 98.

Ostrea equestris Say (1834) Am. Conch. (6), Pl. 58 (in part).

Ostrea spreata d'Orbigny (1846) Voy. Amer. Merid. (Moll.): 672.

Ostrea fundata Holmes (1858) Post Plioc. Foss. S. Carolina 11: Pl. 2, fig. 10.

This is a small, rather circular species, with a centrally located muscle scar. It has an irregularly folded interlocking margin. The beaks are slightly curved. The inner margins of the valves bear a row of denticles on each side of the hinge that extend about one-third of the distance to the opposite side of the valves. The bottom figure on Say's plate is probably a broad specimen of *O. frons*. The others are *O. cristata*.

Length 39, height 36, width 11 mm.

Porto Rico: Gallardo Bank; Ponce.

Section **LOPHA** Röding

- Lopha* Röding (1798) Mus. Bolten. 2: 168.
Alectryonia Fischer (1807) Mus. Demid. 3: 269.
Dendrostraea Swainson (1840) Treat. Malacol.: 389.
Dendrostraea Agassiz (1846) Nomen. Zool. Index Univ.
Rastellum Fischer (1886) Man. de Conchyl.: 926.

Ostrea (*Ostrea*) **frons** (Linnaeus)

PLATE 4, FIGURES 4 AND 7

- Mytilus frons* Linnaeus (1758) Syst. Nat. (Ed. 10): 704.
Ostrea ruballa Lamarck (1819) Anim. s. Vert. 6 (1): 210.
Ostrea limacella Lamarck (1819) Anim. s. Vert. 6 (1): 211.

The radial plicate sculpture and corresponding sharply folded valve margins are typical of this species. The inner margins are closely dotted with minute, pimply denticles for nearly their whole circumference. The muscle scar is located well up toward the hinge. The beaks are somewhat curved. Internally the shell substance is translucent white, while the outside is usually a purplish red. The animal is frequently found attached to the stem of a gorgonian by a series of clasping projections from the shell. Often, too, there is a longitudinal ridge running down the center of the shell in these forms. This ridge has even been given taxonomic importance by some writers. It is nothing more than a reflection of the gorgonian stem to which the animal is attached.

Length 30, height 54, width 19 mm.

Porto Rico: San Juan; Ponce; E. of Cayo Caribe.

Virgin Islands: St. Thomas; St. Croix; St. Johns; Tortola; Virgin Gorda

Subgenus **CRASSOSTREA** Sacco

- Crassostrea* Sacco (1897), [in] Sacco and Bellardi, Moll. Terr. Terz. Piemonte e Liguria 23: 15.
 TYPE (by original designation), *Ostrea virginica* Gmelin.

These species have the right valve decidedly smaller than the left. The beaks are elongate and strongly oblique. The inner margin is smooth. The adductor muscle is located well down toward the distal border, and there is a promyal chamber.

KEY TO THE SPECIES OF SUBGENUS *Crassostrea*

- (1) Attached valve not greatly larger than free valve, margins not heavily shaded with purple, muscle scar frequently purple. *O. virginica*
 (1') Attached valve much larger than free valve, margin with considerable deep purple coloration. *O. rhizophorae*

Ostrea (**Crassostrea**) **virginica** Gmelin

PLATE 4, FIGURE 5

- Ostrea elongata* Solander (1786) Cat. Portland Mus 55, not Born (1780).
Ostrea virginica Gmelin (1792) Syst. Nat. (Ed. 13): 3336.
Ostrea brasiliiana Lamarck (1819) Anim. s. Vert. 6 (1): 205.
Ostrea borealis Lamarck (1819) *ibid.*: 207.
Ostrea canadensis Lamarck (1819) *ibid.*: 207.
Ostrea semicylindrica Say (1822) Jour. Acad. Nat. Sci. Phila. (1) 2: 228.
Ostrea virginiana Sowerby (1822) Genera of Shells, fig. 2.
Ostrea triangularis Holmes (1856) Proc. Elliott Soc. 1: 29.

Ostrea virginiana procyon Holmes (1858) Post. Plioc. Foss. South Carolina: 10, Pl. 2, fig. 9a.
Ostrea floridensis Sowerby (1871) [in] Reeve, Conch. Icon. 18 pl. 29, fig. 76 a-b.

This is an extremely variable form, running from oval to elongate in shape. The margins are straight, or slightly folded, and entirely smooth right up to the hinge. The muscle scar is distally located and usually colored a deep purple. There is a promyal chamber. The beaks are long and quite strongly curved.

Length 66, height 122, width 29 mm.

Porto Rico: Ponce; Mayaguez; Guanica; Puerto Real; Ensenada Honda, Culebra.

Virgin Islands: St. Croix.

Ostrea (*Crassostrea*) *rhizophorae* Guilding

PLATE 4, FIGURE 6

Ostrea rhizophorae Guilding (1828) Zool. J. 3 (12): 542.
Ostrea brasiliiana of authors, not Lamarck.
Ostrea parasitica of authors, not Gmelin.

This is typically a deep-cupped form, with a flat upper valve, very much discrepant in size, and fitting well down into the lower valve. The inner margins are straight and smooth. The beaks are twisted dorsally. The muscle scar is well down toward the margin, indicating that there probably is a promyal chamber.

On first inspection of the left valve, the muscle scar appears to be nearly centrally located, but this is due to the discrepancy in size between the left and right valves. If the right, or free, valve is examined, it will be seen that the scar is distally located, allowing plenty of room for a promyal chamber. There is usually considerable purple coloration, especially around the margin of the left, or attached, valve. The surfaces of both upper and lower valve are typically smoother than in the preceding species.

Length 46, height 70, width 18 mm.

Porto Rico: San Juan; Ponce.

Virgin Islands: St. Thomas; St. Croix.

Suborder ISODONTA

The fundamental dentition is taxodont but this becomes obsolete in the adult, and its function is taken over by modifications of the auricular crura which form interlocking processes. There is an internal resilium. Typically, in the left valve, there is a socket, and then outside of that a tooth on each side of the resilium. There are corresponding teeth and sockets in the right valve. These teeth and sockets are modifications of certain ridges which strengthen the auricles in many species of *Pecten* and which Dall named crura. This type of hinge, then, must be regarded as a remarkable specialization of certain features of the shell, themselves the result of modifications of the valves initiated through influence of external sculpture, but morphologically distinct from the structures which in other bivalves we call teeth.

There are two superfamilies in this suborder.

KEY TO THE SUPERFAMILIES OF ISODONTA

- (1) Shell fan-shaped, with more or less well-developed ears.....Pectinacea
 (1') Shell rounded, without wings or ears.....Anomiacea

Superfamily PECTINACEA

The shell is usually inequivalve and fan-shaped with more or less well developed wings or ears as they are called in the group. The epidermis is generally inconspicuous. The type of shell substance is quite diverse in the different species. It is typically subnacreous internally, but the outer layers may be tubuliferous or more rarely prismatic. The hinge area, when present, extends on both sides of the beaks. The ligament consists of a band, often much thickened, which runs from beak to beak across the hinge line. The normal dentition of the hinge is obsolete, and its functions are performed, if at all, by modifications of the ears, which form interlocking processes. These auricular crura, as they are called, are thickened ridges on the inner surfaces of the ears, which become highly developed and resemble true teeth. They have one very noticeable difference, however, in that they fit together concentrically and not alternately. This concentric dentition is found only in the Pectinacea and their close relatives, the Anomiacea. The pallial line is simple. The anterior adductor muscle is absent. A byssus is sometimes present but is usually poorly developed.

There are three families of the Pectinacea in this region.

KEY TO THE FAMILIES OF PECTINACEA

- (1) Shell sessile, isodont hinge teeth strongly developed.....Spondylidae
 (1') Shell not sessile, or, if so, dentition weak.....(2)
 (2) Shell shape fundamentally subcircular.....Pectinidae
 (2') Shell shape obliquely ovate.....Limidae

Family PECTINIDAE

The shell is inequivalve, inequilateral, auriculate, usually closed, monomyarian, and usually free. The area is amphidetic or obscure. The ligament is obsolete externally, the immersed portion forming an internal resilium. The hinge teeth are taxodont in the very young, obsolete later with the auricular crura sometimes developed into a feeble isodont dentition. The byssus is not strongly developed and frequently absent in the adult. The soft parts are generally similar to those of the Spondylidae.

KEY TO THE GENERA OF PECTINIDAE

- (1) Shell with internal radial lirae.....*Amusium*
 (1') Shell without internal lirae.....(2)
 (2) Ears subequal, one or both valves strongly inflated.....*Pecten*
 (2') Anterior ears larger than posterior ones, both valves moderately inflated.....
Chlamys

Genus PECTEN Müller

Pecten Müller (1776) Zoolog. Danicae Prodr.: 248.

TYPE (by subsequent designation, Schmidt, 1818), *Ostrea maxima* Linnaeus

The shell is subequilateral, inequivalve, the right valve being larger and more inflated. The ears are subequal, the dorsal margin of those of the right valve recurving downward over the hinge line. The pallial line is simple.

KEY TO THE SUBGENERA OF *Pecten*

- (1) Right valve strongly inflated, left valve flat.....*Euvola*
 (1') Both valves strongly inflated.....*Plagioctenium*

Subgenus **EUVOLA** Dall

Euvola Dall, 1898, Trans. Wagner Free Inst. Sci. 3 (4): 694.

TYPE (by original designation), *Ostrea ziczac* Linnaeus.

The right valve is extremely inflated. The surface is polished, the ribs being moderate or obsolete and without radial striation. The concentric sculpture is inconspicuous. The left valve may be with or without conspicuous radial and concentric sculpture; it may be flat or concave.

KEY TO THE SPECIES OF SUBGENUS *Euvola*

- (1) Ribs flattened, interspaces narrow.....*P. ziczac*
 (1') Ribs rounded, interspaces nearly as wide as the ribs.....*P. raveneli*

Pecten (Euvola) ziczac (Linnaeus)

PLATE 5, FIGURE 1

Ostrea ziczac Linnaeus (1758) Syst. Nat. (Ed. 10): 696.

The flat valve is typically reddish or purple in color, sometimes light brown. The lower valve is deeply cupped and light in color. The ribs are flattened, and the surface is polished. Dall's record of *P. laurenti* Gmelin is probably based on a dark specimen of *P. ziczac*.

Length 100, height 90, width 26 mm.

Porto Rico: Mayaguez; Ponce.

Virgin Islands: St. Thomas.

Pecten (Euvola) raveneli Dall

PLATE 5, FIGURE 2

Pecten medius of authors, not Gmelin.

Pecten hemicyclica of authors, not Ravenel.

Pecten raveneli Dall, 1898, Trans. Wagner Free Inst. Sci., 3 (4): 721, Pl. 29, fig. 10.

This species differs from the preceding in having more pronounced ribbing on both upper and lower valves. The coloration is much the same.

Length 50, height 47, width 13 mm.

Porto Rico: Mayaguez.

Virgin Islands: St. Thomas.

Subgenus **PLAGIOCTENIUM** Dall

Plagioctenium Dall (1898) Trans. Wagner Free Inst. 3 (4): 696.

TYPE (by original designation), *Pecten ventricosus* Sowerby, = *Pecten circularis* Sowerby.

Both valves strongly convex; ribbing strong and regular. The right valve is somewhat more inflated than the left. The ctenolium is frequently obsolete in the adult stage.

Pecten (Plagioctenium) gibbus (Linnaeus)

PLATE 5, FIGURE 4

Ostrea gibba Linnaeus (1758) Syst. Nat. (Ed. 10): 698.

This is a common species on the east coast of the United States and is occasionally found in the West Indies. It is a tumid species with strong, rounded ribs. The right valve is frequently light in color, and the left one is variously colored, sometimes brightly colored.

Length 30, height 28, width 19 mm.

Porto Rico: San Juan; Arecibo; Aguadilla.

Virgin Islands: St. Thomas.

Pecten (Plagioctenium) gibbus mayaguezensis Dall and Simpson

PLATE 5, FIGURE 3

Pecten mayaguezensis Dall and Simpson (1901) Bull. U. S. Fish Comm. 20: 465, Pl. 55, figs. 7-9.? *Ostrea nucleus* Born (1780) Text Mus. Caes. Vind.: 107, Pl. 7, fig. 2.

This species is very similar to *P. gibbus* but runs smaller in size. It has much the same color varieties as that species. It ranges from southern Florida to northern South America. Dall regarded it as distinct and it may be a dwarf variety of true *gibbus*. At the present time its status is not definitely established, but it may be that this is the form represented by the name *nucleus* Born.

Length 21, height 19, width 8.5 mm.

Porto Rico: Mayaguez; Ponce.

Virgin Islands: St. Thomas.

Genus **CHLAMYS** Röding*Chlamys* Röding (1798) Mus. Bolten. 2: 161.TYPE (by subsequent designation, Dall, 1898), *Pecten islandicus* Müller.

The shell is inequilateral and nearly equivalve, the right valve being slightly more flattened than the left. The radial ribs are numerous and often increased in number by intercalation. They are usually imbricated by the concentric sculpture. The anterior ears are larger than the posterior ones. The right anterior ear is notched for the passage of a byssus. The margin below this notch is pectinated, often with a well-developed ctenium.

KEY TO THE SUBGENERA OF *Chlamys*

- (1) Sculpture feeble or absent, shells thin and fragile. *Palliolium*
 (1') Sculpture strong, shells relatively solid. (2)
 (2) Ribs numerous and dichotomously branching. *Chlamys* s.s.
 (2') Ribs few in number, large, not branching. *Lyropecten*

Subgenus **CHLAMYS** s.s.

The characters are those of the generic diagnosis but with the limiting features included in the key.

KEY TO THE SPECIES OF *Chlamys* s.s.

- (1) Scales on the ribs very close-set.....(2)
 (1') Scales on the ribs high and widely spaced.....*C. imbricata*
 (2) Valves moderately inflated.....*C. muscosa*
 (2') Valves compressed.....(3)
 (3) Radial ribs moderately heavy, about 20 in number.....*C. ornata*
 (3') Radial ribs very fine, numbering more than forty.....*C. multisquamata*

***Chlamys (Chlamys) imbricata* (Gmelin)**

PLATE 5, FIGURE 7

Ostrea imbricatus Gmelin (1792) Syst. Nat. (Ed. 13): 3318.*Pecten lemniscatus* Reeve: Dall and Simpson (1901) Bull. U. S. Fish Comm., 20: 466.

This beautiful species is not likely to be confounded with any other in the West Indian region. The high vaulted scales are very characteristic. The shell is white and variously mottled and spotted with red or brown.

Length 27, height 31, width 6 mm.

Porto Rico: San Juan.

Virgin Islands: St. Thomas.

***Chlamys (Chlamys) ornata* (Lamarck)**

PLATE 5, FIGURE 6

Pecten ornatus Lamarck (1819) Anim. s. Vert. 6: 176.

The name *ornata* is a good one for this colorful little species. The shell color is white and it is beautifully mottled with dark red. The ribs are close-set and delicately scaled.

Length 20, height 23, width 8 mm.

Porto Rico: Mayaguez; Guanica; Cayo Caribe.

Virgin Islands: St. Thomas.

***Chlamys (Chlamys) muscosa* (Wood)**

PLATE 5, FIGURE 5

Ostrea muscosa Wood (1828) Suppl. Index Test.: 47.*Pecten exasperatus* of authors, not Sowerby.

This species is found in a variety of colors ranging from lemon yellow through many shades of red to light and dark brown. It is variously mottled and clouded. In those specimens which have lived in a sheltered spot or are covered with a growth of sponge the scales on the ribs are often strongly developed, lending a cellular appearance to the surface. Animals from a more exposed place have only the low imbricate bases of these scales left.

Length 37, height 38, width 17 mm.

Porto Rico: San Juan.

Virgin Islands: St. Thomas.

***Chlamys (Chlamys) multisquamata* (Dunker)**

PLATE 6, FIGURE 2

Pecten multisquamatus Dunker (1864) Mala. Blatt. 11: 100.*Pecten multisquamatus* Dunker, Novitates Conchol.: 67, Pl. 24, figs. 1-3.

The many fine threadlike ribs will easily separate this species from the others. The lower valve is light-colored, while the upper one may be rusty red or fawn colored.

Length 49, height 54, width 10 mm.

Virgin Islands: St. Croix.

Subgenus **LYROPECTEN** Conrad

Lyropecten Conrad (1862) Proc. Acad. Nat. Sci. Phila.: 291.

TYPE (by subsequent designation, Dall, 1898), *Lyropecten estrellanus* Conrad.

The shell is equilateral, somewhat inequivalve, and with heavy radial ribs. The left valve is slightly more inflated than the right. The ribs are relatively few in number and do not branch dichotomously. They are ornamented with minute radial striation.

Chlamys (Lyropecten) antillarum (Recluz)

PLATE 6, FIGURE 6

Pecten antillarum Recluz (1853) Jour. de Conchyl., 4: 53, Pl. 5, fig. 1.

This is one of the smallest of the *Lyropectens*. There are about ten large ribs. The fine radial striations are well marked. The lower valve is light-colored. The upper one is light on the umbonal area, becoming orange or red distally. The colored portion is often banded concentrically with white. The submargins are frequently striped diagonally with fine white lines.

Length 23, height 24, width 17 mm.

Porto Rico: San Juan.

Virgin Islands: St. Thomas.

Section **NODIPECTEN** Dall

Nodipecten Dall (1898) Trans. Wagner Free Inst. Sci., 3 (4): 695.

TYPE (by original designation), *Ostrea nodosa* Linnaeus.

The ribs are intermittently nodose, with more or less prominent hollow nodes or bullae. The imbricate surface layer is sometimes very marked.

Chlamys (Lyropecten) nodosa (Linnaeus)

PLATE 6, FIGURE 1

Ostrea nodosa Linnaeus (1758) Syst. Nat., Ed. 10: 697.

The strong ribs with heavy nodes characterize this species. The radial striation is very prominent. Typically the shell is dark red, but an occasional specimen is found that is bright orange.

Length 145, height 140, width 38 mm.

Porto Rico: Mayaguez; Ponce.

Virgin Islands: St. Thomas; Tortola; Caneel Bay and Flannagans Passage, St. John.

Subgenus **PALLIOLUM** Monterosato

Palliolum Monterosato (1884) Nomen. Gen. Spec. Conch. Medit., p. 5.

Pseudamusium of authors not Mörch (1853).

TYPE (by subsequent designation, Cossman and Peyrot, 1912), *Pecten testae* Bivona.

The valves are much compressed, thin, and more or less translucent. The sculpture is feeble or absent. The inner surfaces of the valves are smooth.

***Chlamys (Palliolium) nana* (Verrill and Bush)**

PLATE 6, FIGURE 3

Cyclopecten nanus Verrill and Bush (1897) Trans. Conn. Acad. Sci., 10: 85, 92, Pl. 16, figs. 12-12c.

This is a deep-water form, but specimens were obtained near Mayaguez, and it is included here to avoid confusion in case more specimens are found in relatively shallow water. It is very small, nearly orbicular, and much compressed. The valves appear smooth, but there are some fine concentric striae and minute radial riblets. The interior is smooth. It is semitransparent whitish or horny, often clouded or irregularly rayed with milky white.

Length 5.5, height 5.5, width 1.7 mm.

Porto Rico: Mayaguez.

Genus **AMUSIUM** Röding

Amusium Röding, 1798, Mus. Bolten., 2: 165.

TYPE (by subsequent designation, Herrmannsen, 1846), *Ostrea pleuronectes* Linnaeus.

The valves are subcircular and very thin. In many the outer edge of the right valve is not completely calcified and bends over the left. The outer surface of the valves may have slight radial or concentric sculpture, but the inner surface has radial lirae which are characteristic of the genus. In those species which have color the lower or right valve is frequently white, or sometimes tinted with yellow, while the upper or left valve is red.

KEY TO THE SPECIES OF AMUSIUM

- (1) Left valve with very minute concentric sculpture, ears relatively small, internal lirae not usually reaching beyond the middle of the shell *A. dalli*
- (1') Left valve with well-developed concentric sculpture, ears relatively large, internal lirae reaching almost to margin of shell *A. pourtalesianum*

***Amusium dalli* E. A. Smith**

PLATE 6, FIGURE 4

Amusium dalli E. A. Smith (1886) Challenger Lamell., p. 308, Pl. 22, figs. 7-7c.

The valves are equilateral and nearly equivalve, the right one slightly more convex than the left; they are very thin and fragile. The ears are small and subequal. The right valve is practically smooth, while the left valve has very fine concentric ridges. There are seven to ten, pointed, internal lirae. The color is translucent milky white with sometimes a brownish shading on the disk.

Length 59, height 62, width 6 mm.

Porto Rico: off the south coast.

***Amusium pourtalesianum* Dall**

PLATE 6, FIGURE 5

Amusium pourtalesianum Dall (1886) Bull. Mus. Comp. Zoöl., 12: 211, Pl. 4, fig. 3, Pl. 5, fig. 12.

The valves are small, thin, compressed and subcircular. The right valve is slightly more convex than the left. The ears are small and nearly even, but are larger in proportion than in the preceding species. The right valve appears smooth but has microscopic concentric ridges and radial ribs. The left valve has well-developed concentric ridges. There are nine to eleven somewhat club-shaped internal lirae. The color is translucent milky white, sometimes suffused with brown or rusty red.

Length 13, height 13, width 2.5 mm.

Porto Rico: Mayaguez.

Family SPONDYLIDAE

The shell is inequivalve, nearly equilateral, closed, pectiniform, obscurely auriculated, monomyarian, and sessile. The area is amphidetic and much larger on the attached valve. The ligament is alivincular with the resilium more or less submerged. The byssus is obsolete. The armature of the hinge is originally taxodont but obsolete in the adult and replaced by the typically isodont development of the auricular crura. The gills are fili-branchiate with a reflected limb. The foot is small, subcylindrical, with a terminal funicle. The ventricle embraces the rectum with the auricles intercommunicating below it. There is an anterior and a posterior aorta. The mantle lobes are free, without siphons, usually with an internally projecting lamina or curtain near the margin at right angles to the plane of the valves. The anal end of the rectum is usually free for a short distance.

KEY TO THE GENERA OF SPONDYLIDAE

- (1) Radial ribs few and strong; cardinal area of right valve not very broad. *Plicatula*
 (1') Radial ribs numerous, usually relatively fine; cardinal area of right valve very broad..... *Spondylus*

Genus SPONDYLUS Linnaeus

Spondylus Linnaeus (1758) Syst. Nat., Ed. 10: 690.

TYPE (by subsequent designation, Gray, 1847), *Spondylus gaederopus* Linnaeus.

The shell reaches a large size and is trigonal-suborbicular with the auricles small and subequal. The right valve is higher and more inflated than the left. The sculpture consists of low radial ribs and foliaceous lamellae or spines. The cardinal area is wider on the right valve than on the left. The chondrophore is small, triangular, and median. The hinge of both valves consists of two heavy crural teeth, representing laterals, and two sockets symmetrically placed with respect to the chondrophore; the right valve bears along the lower outer edge of the cardinal area, on both sides, a rude horizontal lamella fitting into the space between the crural tooth and the lower margin of the cardinal area of the left valve. The muscular impressions are suborbicular, posterior.

Spondylus americanus Hermann

PLATE 7, FIGURE 1

Spondylus americanus Hermann (1781) Der Naturforscher, Halle, 16: 51.

Osirea echinatus Martyn (1784) Univ. Conchol., fig. 154 (not binomial).

- Spondylus dominicensis* Röding (1798) Mus. Bolten., p. 193.
Spondylus americanus Hermann: Hedley and Pilsbry (1912) Nautilus 26: 46.
Spondylus dominicensis Röding: Fulton (1937) Nautilus 51: 38.

As far as I have been able to tell, this is the only species of the genus in the West Indian region. It exhibits a very wide range of variation both in color and in sculpture. In his Tertiary Fauna of Florida (1898, p. 759), Dall gives an extensive synonymy. I have checked many of these names, and it seems that there is only one species represented. It seems to be very responsive to environmental conditions and perhaps genetically unstable as well.

Length 80, height 90, width 40 mm.

Porto Rico: Mayaguez; Ponce; Boca Prieta; Punta Melones; Caja de Muertos.

Virgin Islands: St. Thomas; Flannagans Passage, St. John; Tortola; Virgin Gorda.

Genus *PLICATULA* Lamarck

Plicatula Lamarck (1801) Syst. des. Anim. s. Vert., p. 152.

TYPE (by subsequent designation, Gray, 1847), *Plicatula gibbosa* Lamarck.

The shell is small, irregular in outline, and attached by either valve. The sculpture consists of broad radial ribs that may divide near the margin. The cardinal area is very small with the chondrophore narrow, elongate, and flanked on each side by a fluted crural tooth representing a lateral, and also by a socket. The impression of the adductor muscle is ovate and posterior. The margins of the valves are fluted.

Plicatula gibbosa Lamarck

PLATE 6, FIGURE 7

Plicatula gibbosa Lamarck (1801) Syst. des. Anim. s. Vert., p. 132.

Plicatula ramosa Lamarck (1819) Anim. s. Vert., p. 184.

Plicatula vexillata Guppy (1874) Geol. Mag. 1: 444, Pl. 17, fig. 7.

This flat, trigonal species with its heavy radial ribs, sometimes dichotomously branching distally, is not easily confused with any other in the recent fauna. It is usually light-colored and marked with red. Occasional specimens are somewhat shaded with brown.

Length 25, height 25, width 10 mm.

Porto Rico: Aguadilla; Cayo Caribe.

Virgin Islands: St. Thomas.

Family LIMIDAE

The shell is thin, equivalve, auriculate, gaping, pectiniform, and monomyarian. The shell substance is fibrous, with minute tubules, not nacreous or prismatic. The hinge is edentulous or has traces of taxodont armature. The area is amphidetic and equal in both valves. The ligament is alivincular with the resilium subinternal. The gills are filibranchiate, with direct and reflected laminae. The mantle lobes are free with a curtain as found in the Spondylidae. The foot is small, digitiform, and grooved. The

species are usually byssiferous, the byssus passing through the gape of the valves. The anal end of the rectum is free and erectile.

KEY TO THE GENERA OF LIMIDAE

- (1) Valves gaping, shell inequilateral.....*Lima*
 (1') Valves closed, shell equilateral.....*Limatula*

Genus LIMA Cuvier

Lima Cuvier (1798) Tabl. Elem. Hist. Nat. Anim., p. 421.

TYPE (by monotype), *Ostrea lima* Linnaeus.

The shell is medium-sized, moderately inflated, obliquely inequilateral, with the anterior submargin flattened, and the anterior and posterior ends narrowly gaping. The auricles are unequal, the posterior one larger. The sculpture consists of scaly ribs. The cardinal area is wide, triangular, with the chondrophore large and central and the hinge edentulous. The adductor scar is high and posterior. The margins of the valves are fluted.

KEY TO THE SUBGENERA OF LIMA

- (1) Submargins impressed.....(2)
 (1') Submargins not impressed.....*Mantellum*
 (2) Radial sculpture straight.....*Lima* s.s.
 (2') Radial sculpture divaricate.....*Ctenoides*

Subgenus LIMA s.s.

This is the typical group of Limas with strong, straight radial ribs. The ribs are often strongly spinose.

Lima (Lima) lima (Linnaeus)

PLATE 7, FIGURE 3

Ostrea lima Linnaeus (1758) Syst. Nat. Ed. 10: 699.

Lima squamosa Lamarck (1801) Syst. Anim. s. Vert., p. 136.

The shell is broadly fan-shaped with regular rows of vaulted spines. The periostracum is inconspicuous, and the shell substance white.

Length 45, height 55, width 22 mm.

Porto Rico: Mayaguez; Guanica; Mona Island.

Virgin Islands: St. Thomas; St. Johns; Tortola; Virgin Gorda.

Subgenus CTENOIDES Mörch

Ctenoides Mörch (1853) Catal. Yoldi, 2: 56.

TYPE *Lima scabra* Born.

The radial sculpture is divaricate, with a line of divergence running from the umbos more or less centrally to the distal margin. There is a brownish periostracum. The shell substance is white.

KEY TO THE SPECIES OF CTENOIDES

- (1) Radial sculpture coarse.....*L. scabra*
 (1') Radial sculpture fine.....*L. tenera*

Lima (Ctenoides) scabra (Born)

PLATE 7, FIGURE 2

Ostrea scabra Born, 1780, Test. Mus. Vind., p. 110.

The coarse radial sculpture and the brown periostracum will identify this species.

Length 45, height 55, width 17 mm.

Porto Rico: Mayaguez; Ponce; Aguadilla; Guanica; Caja de Muertos Is.; Ensenada Honda, Culebra.

Virgin Islands: St. Thomas; St. Johns; Tortola; Virgin Gorda.

Lima (Ctenoides) tenera Sowerby

PLATE 7, FIGURE 4

Lima tenera Sowerby, 1846, Thes. Conch. p. 84, Pl. 21, figs. 10-11.

The radial sculpture is very fine, and the periostracum is of a light fawn-color.

Length 40, height 54, width 17 mm.

Porto Rico: Mayaguez; Ponce; Parguera, Margarita Pass.

Virgin Islands: St. Thomas; Caneel Bay, St. Johns; Tortola; Virgin Gorda.

Subgenus **MANTELLUM** Röding*Mantellum* Röding, 1798, Mus. Bolten., 2: 160.*Limaria* Link, 1807, Besch. Nat. Samml. Univ. Rostock (3): 157.TYPE (by subsequent designation, Bucquoy, Dautzenberg and Dollfus, 1888), *Ostrea inflata* Gmelin.

The shell is thin, inflated and obliquely inequilateral, the posterior and anterior ends gaping, and the submargins not impressed. The auricles are small and subequal. The sculpture consists of narrow radial ribs, roughened by incrementals. The cardinal area is narrow, the chondrophore very large. Part of the shell under the cardinal area is excavated on the posterior side. The hinge is edentulous. The ventral margins of the valves are weakly fluted.

KEY TO THE SPECIES OF MANTELLUM

- (1) Shell inflated, excavation under posterior cardinal area small *L. inflata*
 (1') Shell relatively compressed, excavation under posterior cardinal area large
L. hians

Lima (Mantellum) inflata (Gmelin)

PLATE 7, FIGURE 5

Ostrea inflata Gmelin (1792) Syst. Nat., Ed. 13: 3321.*Lima inflata* Lamarck (1819) Anim. s. Vert., 6: 156.*Lima fasciata* Sowerby (1872) Icon., 18, Pl. 4, fig. 17.*Lima pellucida* C. B. Adams, 1846, Proc. Boston Soc. Nat. Hist., 2: 102.

Both this species and the following are very fragile, delicately sculptured shells. They are thin and translucent white. The surface is ornamented with fine threadlike radial ribs. *Inflata* is rather tumid and less gaping than *hians*. The excavation under the posterior cardinal area is not so

pronounced as in *hians*. In large specimens the height relative to the length is less than in *hians*.

Length 10, height 16, width 8 mm.

Porto Rico: Mayaguez; Ensenada Honda, Culebra.

Lima (Mantellum) hians (Gmelin)

PLATE 7, FIGURE 6

Ostrea hians Gmelin (1792) Syst. Nat., Ed. 13: 3332.

Lima fragilis Sowerby, 1872, Conch. Icon., 18, Pl. 4, fig. 18.

This species is similar to the preceding but somewhat more slender and spatulate, especially in large specimens. The excavation under the posterior cardinal area is large. It cuts back sharply under the hinge line leaving the posterior part of the hinge projecting like a hook or tooth. The valves are relatively compressed. The sculpture is usually less pronounced than in *inflata*.

Length 12, height 20, width 7 mm.

Porto Rico: Aguadilla.

Virgin Islands: St. Thomas; St. Croix; Tortola.

Genus **LIMATULA** Wood

Limatula Wood (1839) Mag. Nat. Hist. (n.s.) 3: 235.

TYPE (by subsequent designation, Gray, 1847), *Pecten subauriculata* Montagu.

The shell is equivalve and nearly equilateral, valves inflated and not gaping. The sculpture consists of clear-cut nodular radial ribs. The submargins are not impressed. Internally the margins are fluted. The hinge area is nearly symmetrical, and the chondrophore is broad and triangular.

Limatula subauriculata (Montagu)

PLATE 7, FIGURE 7

Pecten subauriculata Montagu (1808) Test. Brit., Suppl., p. 63, Pl. 29, fig. 2.

This symmetrical little species exhibits almost none of the obliquity that is typical of most of the Limidae. The radial ribs are quite straight and are ornamented with regular rounded beading. The shell color is white.

Length 6, height 8.5, width 6 mm.

Porto Rico: Mayaguez.

Superfamily **ANOMIACEA**

Some of the Anomiacea are free-living and some are sessile. As in other groups, the free-living species have the shell much more regular in form than the sessile ones. There are no wings or ears on the shells in this group. The shell is thin, and the epidermis is inconspicuous. Under this, there are traces of a simple prismatic layer, then tubuliferous material, and finally a nacreous lining. The hinge area is obscure, usually small, and extending on both sides of the beaks. The ligament is divided into an obscure outer portion or true ligament, extending on each side of the beaks, and an internal resilium, set down into the hinge plate below the beaks. This condition is

similar to that found in some of the more highly developed Teleodesmacea. The hinge is edentulous or, if teeth are present, they are of the unusual concentric type found in the Pectinacea. The pallial line is obscure. The anterior adductor muscle is absent. There is a byssus which in some forms may become modified to a horny or calcified plug.

Family ANOMIIDAE

The shell is variable. When sessile, it is irregular and inequivalve. The species are byssiferous when young. In most of the genera the byssus becomes modified to a calcified or horny plug passing through a foramen in the attached valve and fastened to other bodies—a condition which may be permanent or transient. The area is small, amphidetic. The ligament is amphidetic, more or less internal, and supplemented by an internal resilium, for which the auricular crura serve as chondrophores. It is alivincular or multivincular. The hinge is usually edentulous, rarely rugose with amorphous interlocking rugosities. The posterior adductor is small, subcentral and in the sessile forms reinforced by the pedo-byssal muscles, which are modified to serve as adductors.

KEY TO THE GENERA OF ANOMIIDAE

- (1) Left valve of shell bearing four muscular impressions *Anomia*
 (1') Left valve of shell bearing two muscular impressions *Pododesmus*

Genus ANOMIA Linnaeus

Anomia Linnaeus (1758) Syst. Nat., Ed. 10: 700.

TYPE (by subsequent designation, Gray, 1847). *Anomia ephippium* Linnaeus.

The right or attached valve is flat with a large sinus on its upper border, through which the pluglike byssus passes. The right valve bears a single muscular impression. The left valve is entire, convex; it has a ligamental fossette below the summit and bears four muscular impressions.

Anomia simplex d'Orbigny

PLATE 8, FIGURE 2

Anomia simplex d'Orbigny (1846) Moll. Cubana, 2: 367, Pl. 38, figs. 31-33.

Anomia ephippium of authors, not Linnaeus.

The shell is irregular, fitting and often imitating the object to which it is attached, suborbicular, thin and semitransparent. The interior of the valves is nacreous and shining. The exterior has concentric scaly ridges. The color is whitish, silvery, greenish straw, or pale brownish.

Length 35, height 35, width 7 mm.

Porto Rico: Mayaguez; Ponce.

Virgin Islands: St. Thomas; Tortola.

Genus PODODESMUS Philippi

Pododesmus Philippi (1837) Arch. f. Naturg., 3 (1): 385.

TYPE (by monotypy), *Pododesmus decipiens* Philippi = *P. rudis* Broderip.

This genus is similar in characteristics to *Anomia*, except that the left valve bears only two muscular impressions.

Pododesmus rudis (Broderip)

PLATE 8, FIGURE 1

Placunanomia rudis Broderip (1834) Proc. Zool. Soc. London, 2 (13): 2.*Pododesmus decipiens* Philippi (1837) Arch. f. Naturg., 3 (1): 386.

The shell is very irregular, compressed, suborbicular, oval, oblong or somewhat elongate, moderately solid. The lower valve is normally flatter than the upper. The byssal opening is round, oval, or closed in old specimens. The surface is ornamented with fine, irregular, broken ridges crossed by scaly or foliaceous growthlines. The interior is shining, the lower valve generally having a brown blotch in its center. The color is whitish or greenish.

Length 40, height 40, width 6 mm.

Porto Rico: San Juan; Aguadilla; Punta Melones.

Virgin Islands: St. Thomas.

Suborder **DYSODONTA**

The shell substance is largely subnacreous, rarely more or less prismatic. The shell is equivalve, very inequilateral; the anterior end is much reduced, and the umbones are strongly prosogyrous. There are no wings. The hinge is edentulous or provided with teeth which are derived from the external sculpture where it impinges on the hinge margin. The curved dental processes or dysodont teeth are fundamentally a continuation of the internal ribs, which alternate with the external ribs in primitive bivalves. The hinge area extends on both sides of the beaks and is often obscure. The ligament is parivincular. There are two adductor muscles, but the anterior one exhibits a varying degree of reduction. The pallial line is usually simple, although in a few rare cases it is sinuate. There is generally a functional byssus in the adult.

Family **MYTILIDAE**

The shell is equivalve, very inequilateral, heteromyarian, and very slightly gaping. It is typically dysodont or edentulous; with the ligament usually external, deep-seated; rarely with an alivincular, internal resilium. The pallial line is simple. The ventricle has an anterior aorta. The gills are attached distally and dorsally, usually with a reflected limb to the filaments. The mantle lobes are united below the anal siphon, otherwise free.

KEY TO THE GENERA OF MYTILIDAE

- (1) Hinge line without teeth or crenulations. 2
- (1') Hinge line with teeth or crenulations. 3
- (2) Umbones anterior but not terminal. *Modiolus*
- (2) Umbones terminal. *Lithophaga*
- (3) Shell mytiliform, pointed anteriorly and broadly spatulate posteriorly
Brachydontes
- (3') Shell not mytiliform, broadly rounded anteriorly. 4
- (4) Shell rounded subquadrate, length usually greater than altitude, radial sculpture interrupted in the middle of the shell by a smooth area showing only growth lines. *Modiolaria*

- (4') Shell ovate, altitude usually greater than length, radial sculpture continuous over surface of shell. *Crenella*

Genus **MODIOLUS** Lamarck

Modiolus Lamarck (1799) Mem. Soc. Hist. Nat. Paris, p. 87.

TYPE (by monotypy), *Mytilus modiolus* Linnaeus.

The shell is oblong or elongate, oblique, generally inflated toward the anterior end and compressed posteriorly. The surface is smooth or concentrically striated, seldom ribbed although in some species feebly striated on the posterior slope. The umbones are obtuse, anterior, but not terminal. The anterior margin is expanded in front of the umbones but quite smooth. The hinge line is without teeth or crenulations. The anterior adductor muscle scar is small. Posterior muscle and byssal scars are united, the former rounded and the latter long and narrow.

KEY TO THE SUBGENERA OF MODIOLUS

- (1) Shells moderate to large in size, not extremely thin, moderately inflated, surface usually with concentric growth lines. *Modiolus* s.s.
 (1') Shells small, very thin, compressed, smooth and polished. *Amygdalum*

Subgenus **MODIOLUS** s.s.

The characters are as listed in the generic description, with the limiting features of the key.

There are two species of this subgenus in this fauna.

KEY TO THE SPECIES OF MODIOLUS S.S.

- (1) Shell large, produced, and rather pointed anteriorly. *M. tulipa*
 (1') Shell small, bluntly rounded anteriorly. *M. castaneus*

Modiolus (Modiolus) tulipa Lamarck

PLATE 8, FIGURE 4

Modiola tulipa Lamarck (1819) Anim. s. Vert., 6: 111.

This species is common throughout the upper Antillean region and is well known. It frequently has rays of red color running out from the umbones to the margin. The periostracum is heavy and characteristically dark chestnut in color.

Length 85, height 40, width 40 mm.

Porto Rico: San Juan; Mayaguez; Playa Humacao; Caja de Muertos Is.; Boca Prieta.

Virgin Islands: St. Thomas; St. Johns; Tortola.

Modiolus (Modiolus) castaneus Say

PLATE 8, FIGURE 6

Modiola castanea Say (1822) Jour. Acad. Nat. Sci. Phila., 2: 266.

Modiola lignea Reeve (1858) Conch. Icon., 10, Pl. 10, fig. 71.

This species has been placed in different genera by various authors. It is frequently found referred to the genus *Botula*. Dall placed it in section

Lioberus under the genus *Modiolaria*. Jukes-Browne has it under *Modiolus* as originally described. On the basis of shell characters there seem to be no grounds for removing it from the genus in which Say placed it. Anatomical studies may provide such grounds, but until they are made and published it would appear necessary to leave it here. The shape is much like that of *tulipa* but it is more quadrate and is more rounded at the anterior end. It is a smaller species, seldom exceeding 28 millimeters in length. The surface shows concentric growth lines, and the epidermis is chestnut-colored and polished. There is frequently an accumulation of byssal threads forming a sort of sheath over the posterior ends of the valves.

Length 28, height 15, width 14 mm.

Virgin Islands: St. Thomas.

Subgenus AMYGDALUM Megerle

Amygdalum Megerle (1811) Mag. Ges. Naturf. Freunde Berlin 5: 69.

TYPE (by monotypy), *Amygdalum dendriticum* Megerle.

The shell is generally similar to *Modiolus* s.s., but more compressed, the surface being smooth and polished and the epidermis glossy and not hirsute.

Modiolus (*Amygdalum*) *dendriticus* (Megerle)

PLATE 8, FIGURE 7

Amygdalum dendriticum Megerle (1811) Mag. Ges. Naturf. Fr. Berlin, 5: 69.

Mytilus arborescens Dillwyn (1817) Cat. Shells, 1: 306.

Modiola papyria Conrad (1846) Proc. Acad. Nat. Sci. Phila., 3 (1): 24.

This species is thin and fragile, compressed, and with a greenish or yellowish, glossy epidermis.

Length 34, height 12, width 7 mm.

Porto Rico: San Juan; Mayaguez.

Genus LITHOPHAGA Röding

Lithophaga Röding (1798) Mus. Bolten., 2: 156.

Lithodomus Cuvier (1817) Regn. Anim., 2: 471.

TYPE (by monotypy), *Lithophaga mytiloides* Röding = *Mytilus lithophagus* Gmelin.

The shell is generally long, narrow, and subcylindrical. The umbones are at the anterior end, which is rounded and inflated. The posterior end is generally wedge-shaped, but sometimes cylindrical and tapering. The surface is smooth or wrinkled. The hinge line is straight without crenulations. The margins are quite smooth. The adductor scars are oval and nearly equal, with the byssal scars oval and small. These animals are typically burrowing forms.

KEY TO THE SUBGENERA OF LITHOPHAGA

- (1) Shell elongate, narrow, subcylindrical, and rounded anteriorly with the umbones not prominent..... *Lithophaga* s.s.
 (1') Shell oblong, subrhomboidal, squared anteriorly with the umbones prominent and spirally curved..... *Botula*

Subgenus **LITHOPHAGA** s.s.

The characters are as given for the genus, with the limiting features of the key. Two sections used by Dall are outlined in the text.

KEY TO THE SPECIES OF **LITHOPHAGA** S.S.

- (1) Epidermis light brown, adult about 90 mm. long. *L. antillarum*
 (1') Epidermis chestnut, adult about 50 mm. long. *L. nigra*

Lithophaga (Lithophaga) antillarum (d'Orbigny)

PLATE 8, FIGURE 9

Lithodomus antillarum d'Orbigny (1846) Moll. Cubana, 2: 332, Pl. 28, figs. 12, 13.

Modiola corrugata Philippi (1846) Abbild. u. Besch., 2: 147, pl. 1, fig. 1.

This large, cigar-shaped species is much lighter in color than the following one. It is light brown. The surface is wrinkled with fine diagonal striae, which are divaricate on the posterior end.

Length 86, height 26, width 20 mm.

Porto Rico: Guanica; Puerto Real; Arroyo.

Virgin Islands: St. Thomas.

Lithophaga (Lithophaga) nigra (d'Orbigny).

PLATE 8, FIGURE 8

Lithodomus niger d'Orbigny (1846) Moll. Cubana, 2: 351, Pl. 28, figs. 10, 11.

Modiola caribaea Philippi (1847) Abbild. u. Besch., 3: 20, Pl. 2, fig. 5.

Modiola antillarum Philippi (1847) *op. cit.*, fig. 4.

This species is smaller and much darker in color than the preceding. The diagonal striae are seldom present on the posterior part of the shell, although some specimens have faint indications of them there. They are well marked on the central part of the shell.

Length 33, height 18, width 17 mm.

Porto Rico: Guanica.

Virgin Islands: St. Thomas; Tortola.

Section **DIBERUS** Dall, 1898

The shell is similar to that of *Lithophaga*, but the animal has the habit of depositing a calcareous crust on the exterior of the valves. This crust bears two or more radial sulci extending backward from the beaks. The incrustation is plumelike, arranged in a distinct pattern on the areas between the sulci, and when projecting beyond the ends of the valves, opposed symmetrically, not alternate and twisted.

Lithophaga (Lithophaga) bisulcata (d'Orbigny)

PLATE 9, FIGURE 3

Lithodomus bisulcata d'Orbigny (1846) Moll. Cubana, 2: 133, Pl. 28, figs. 14-16.

Modiola appendiculata Philippi (1846) Abbild. u. Besch., 2: 150 Pl. 1, fig. 4.

Lithodomus biexcavatus Reeve (1857) Conch. Icon., 10, Pl. 4, fig. 22a-b.

The calcareous crust on this species is characteristic. Superficially it has the appearance of being soft and chalky but it is quite hard. Over

most of the shell it is densely pustulose, but posteriorly, in the area of the sulci, it is laminar and pseudocellular. The dark chestnut color of the shell is visible around the margin or in areas where the crust has broken off.

Length 57, height 17, width 15 mm.

Porto Rico: Guanica; Puerto Real; Arroyo.

Virgin Islands: St. Thomas.

Section MYOFORCEPS Fischer, 1886

Shell as in *Lithophaga*, but the animal deposits a calcareous crust on the exterior surface of the valves. This crust is smooth and projects in a twisted process from the posterior end of each valve.

***Lithophaga (Lithophaga) aristata* (Dillwyn)**

PLATE 9, FIGURE 1

Mytilus aristatus Dillwyn (1817) Cat. Shells, 1: 303.

Modiola caudigera Lamarck (1819) Anim. s. Vert., 6: 116.

Lithodomus forficatus Ravenel (1861) Proc. Acad. Nat. Sci. Phila., p. 44.

This species differs from the preceding in that the calcareous crust is smooth over the whole surface and the extensions beyond the posterior end of the shell are twisted. The process of the right valve overlaps that of the left. The true color of the shell itself is lighter, too, being light brown where it is exposed around the borders of the valves.

Length 43, height 12, width 12 mm.

Virgin Islands: St. Thomas.

Subgenus **BOTULA** Mörch

Botula Mörch, 1853, Cat. Yoldi, 2: 55.

TYPE (by subsequent designation, Dall, 1898), *Modiola cinnamomea* Lamarck.

The shell is oblong, subrhomboid; the umbones are terminal, prominent, and spirally curved.

KEY TO THE SPECIES OF **BOTULA**

- (1) Surface relatively smooth, growth lines not heavily impressed, adult shells about 40 mm. or more in length.....*L. cinnamomea*
 (1') Surface furrowed with heavily impressed periodic growth lines, adult shells about 20 mm. in length.....*L. fusca*

***Lithophaga (Botula) cinnamomea* (Lamarck)**

PLATE 8, FIGURE 5

Modiola cinnamomea Lamarck (1819) Anim. s. Vert., 6: 114.

There has been a certain amount of confusion between this species and the next one. They seem to be distinct. Both were founded on West Indian material. Gmelin cites a figure in Lister which is marked as representing a Jamaican shell. Lamarck gives Mauritius as a locality in his description, but refers to a figure of a West Indian specimen in the Conchylien Cabinet. The relationship between the present species and similar species from the Indo-Pacific region is still uncertain. Many burrowing

species are apparently widespread in their distribution. At present it is not possible to tell whether apparently conspecific populations in different zoological provinces are genetically the same or only morphologically so because of similar habits and environment. *L. cinnamomea* is a larger shell than *fusca*. The surface is relatively smooth. If an area in the umbonal region of *cinnamomea* the size of a full grown *fusca* be compared with a specimen of that species, this difference is clear.

Length 45, height 21, width 20 mm.

Virgin Islands: St. Thomas.

Lithophaga (Botula) fusca (Gmelin)

PLATE 8, FIGURE 3

Mytilus fuscus Gmelin (1792) Syst. Nat., Ed. 13: 3359.

This species is considerably smaller than the preceding and has strongly impressed periodic growth lines, giving the valves a concentrically sulcate appearance. The umbones are relatively more prominent.

Length 19, height 8, width 9 mm.

Virgin Islands: St. Thomas; St. Croix.

Genus **BRACHYDONTES** Swainson

Brachydontes Swainson (1840) Malac., p. 384.

TYPE (by monotypy), *Modiola sulcata* Lamarck (1819) = *Mytilus citrinus* Röding, not *Modiolus sulcatus* Lamarck (1807).

The shell is generally finely ribbed, but sometimes wrinkled, or even smooth. The anterior development of the shell, and consequently the position of the umbones, is variable. The hinge line is generally straight and terminates in an angle posteriorly. The ligament is rather short and marginal or inframarginal. The anterior margin is typically provided with several close-set teeth. The posterior border is crenulated, sometimes throughout its length, above and behind the ligament, sometimes only behind the ligament. The muscle scars are similar to those of *Modiolus*.

KEY TO THE SUBGENERA OF BRACHYDONTES

- | | |
|--|--------------------------|
| (1) Umbones subterminal | <i>Brachydontes</i> s.s. |
| (1') Umbones terminal | 2 |
| (2) Anterior adductor muscle present | <i>Hormomya</i> |
| (2') Anterior adductor muscle absent | <i>Ischadium</i> |

Subgenus **BRACHYDONTES** s.s.

The characters are as given for the genus, with the limiting features of the key.

Brachydontes (Brachydontes) citrinus (Röding)

PLATE 9, FIGURE 2

Mytilus citrinus Röding (1798) Mus. Bolten., p. 157.

Modiola sulcata Lamarck (1819) Anim. s. Vert., 6: 113; not *M. sulcata* Lamarck (1807).

Mytilus cubitus Say (1822) Jour. Acad. Nat. Sci. Phila., 2: 263.

This species is quite distinct. It has a conspicuous yellow epidermis, sometimes tinged with green. The shell substance is often blotched irregularly with reddish or brownish coloration. The crenulations are heavily impressed along the entire hinge margin.

Length 46, height 17, width 13 mm.

Virgin Islands: St. Thomas; St. Johns.

Subgenus **HORMOMYA** Mörch

Hormomya Mörch (1853) Cat. Yoldi, 2: 53.

TYPE (by monotypy), *Mytilus exustus* Linnaeus.

The shell is finely ribbed. The umbones are virtually terminal, possibly just slightly subterminal. The anterior side of the shell is straight or incurved.

Brachydontes (Hormomya) exustus (Linnaeus)

PLATE 9, FIGURE 4

Mytilus exustus Linnaeus (1758) Syst. Nat., Ed. 10: 705.

Mytilus domingensis Lamarck (1819) Anim. s. Vert., 6: 121.

The shell is finely striate, with the striae dichotomously branching. The epidermis is fuscous to dark brown. Internally the shell is shaded with purplish brown. The marginal crenulations are obscure above the ligament, but well marked posterior to it.

Length 37, height 20, width 11 mm.

Porto Rico: San Juan; Mayaguez; Ponce; Guanica; Pt. San Geronimo; Hucares; Puerto Real; Ensenada Honda, Culebra.

Virgin Islands: St. Thomas.

Subgenus **ISCHADIUM** Jukes-Brown

Ischadium Jukes-Brown (1905) Proc. Mal. Soc. London, 6 (4): 223.

TYPE (by monotypy), *Mytilus hamatus* Say, = *Mytilus recurvus* Rafinesque.

The shell is oblong or pyriform in outline, sculptured all over with strong, raised, divaricating ribs. The umbones are slightly divergent. The anterior riblets are well marked and correspond with a variable number of dysodont teeth. The ligament is long and without crenulations behind it in the adult. The anterior adductor scar is absent, and the anterior byssal scar is very small, while the posterior byssal scar is large and broadly united to that of the posterior adductor.

Brachydontes (Ischadium) recurvus (Rafinesque)

PLATE 9, FIGURE 5

Mytilus recurvus Rafinesque (1820) Coq. Biv. Ohio, p. 55.

Mytilus hamatus Say (1822) Jour. Acad. Nat. Sci. Phila., 2: 265.

The epidermis is heavy and dark greenish or brownish color. The shell substance is shaded with blue externally and appears brownish-purple on the interior except for the internal margin which is white.

Length 50, height 25, width 20 mm.

Porto Rico: San Juan; Ensenada Honda, Culebra, and Sail Rock between Culebra and St. Thomas.

Virgin Islands: St. Thomas.

Genus **MODIOLARIA** Beck

Modiolaria Beck (1840) [in] E. Robert, Roy. Recher. Grönl. Pl. 1, figs. 1-4.

TYPE (by subsequent designation, Stoliczka, 1871), *Mytilus discors* Linnaeus.

The shell is rhomboidal and sculptured by two groups of striae, which radiate from the beaks, leaving the middle portion of the shell smooth. The umbones are incurved. The hinge is edentulous or crenulated, and the hinge plate is finely notched.

KEY TO THE SUBGENERA OF MODIOLARIA

- (1) Shell rounded or obtusely angulate posteriorly, epidermis not particularly hirsute
Modiolaria s.s.
- (1') Shell attenuate, acutely angular posteriorly, epidermis hirsute on the dorsal posterior area..... *Gregariella*

Subgenus **MODIOLARIA** s.s.

The characters are those given for the genus, with the limiting features of the key.

Modiolaria lateralis (Say)

PLATE 9, FIGURE 7

Mytilus lateralis Say (1822) Jour. Acad. Nat. Sci. Phila., 2: 264.

The shell is ovate-rhomboidal. About the central one-third of the surface is smooth. The anterior striate area is slightly smaller than the posterior one. The umbones are full and inflated, and umbonal ridge is strong, running obliquely back to the posterior ventral margin. The epidermis is greenish or brownish horn color.

Length 6, height 3.5, width 3 mm.

Porto Rico: San Juan; Mayaguez; Guanica; Pt. Brea; Vieques.

Virgin Islands: St. Thomas.

Subgenus **GREGARIELLA** Monterosato

Gregariella Monterosato (1884) Nom. Conch. Medit., p. 11.

Botulina Dall (1898) Bull. U. S. Nat. Mus., 37: 38.

TYPE (by subsequent designation, Dall, 1898), *Modiolus petagnae* Scacchi.

The shell is attenuate posteriorly and sharply angled at the tip. The umbonal ridge is strongly developed. The smooth unstriated central area is smaller than in typical *Modiolaria* and is located relatively farther forward. The epidermis is hirsute posteriorly.

Modiolaria* (*Gregariella*) *coralliophaga (Gmelin)

PLATE 9, FIGURE 8

Mytilus coralliophagus Gmelin (1792) Syst. Nat., Ed. 13: 3359.

Modiola semen Lamarck (1819) Anim. s. Vert., 6: 115.

Modiola divaricata Philippi (1847) Zeitschr. f. Mala., p. 115.

This species is rather streamlined in appearance, being blunt and rounded anteriorly and tapering off to a point at the posterior end. The epidermis is tan to brown and hirsute, particularly above the sloping umbonal ridge on the posterior dorsal area.

Length 17, height 7, width 7 mm.

Porto Rico: Mayaguez.

Virgin Islands: St. Thomas.

Genus CRENELLA Brown

Crenella Brown (1827) Ill. Conch. Gt. Brit., Pl. 31, figs. 12-14.

TYPE (by monotypy), *Mytilus decussatus* Montagu.

The shell is oval or rhomboidal. The surface is ornamented with longitudinal and concentric striae. The umbones are incurved. The hinge margin is denticulate. The denticles appear as formed where the external sculpture impinges on the margin. When only one denticle is present, it is crenulate.

Crenella divaricata (d'Orbigny)

PLATE 9, FIGURE 6

Nuculocardia divaricata d'Orbigny (1846) Moll. Cubana, 2: 311, Pl. 27, figs. 56-59.

The shell is very small, the height being greater than the length. The surface is sculptured with radial divaricating ribs, which may be very slightly nodular. The shell color is white. The epidermis is inconspicuous. The hinge of this animal presents, superficially, a remarkable analogy to a teleodesmacean hinge. The denticles in the umbonal region are large and grouped in a manner suggesting cardinal teeth, while there is another group posterior to the ligament which is strongly developed. The hinge margin is enlarged in the region of this latter group and gives the impression of a lateral tooth as found typically in the teleodesmacean hinge.

Length 3, height 3.5, width 3 mm.

Porto Rico: Mayaguez.

Order ANOMALODESMACEA

This group is closer to the Teleodesmacea than it is to the preceding order. It is probable that the two groups had a common general origin while the Prionodesmacea followed a separate line of descent. Part of the original stock has produced the perfected types of Pelecypods which have lost all their archaic characters and have become the Teleodesmacea, while another part has come down to us as the Anomalodesmacea retaining indications of their primitive characters, probably on account of the burrowing habit which has shielded them from many vicissitudes and checked in this way the perfecting processes of selection. The group is not unspecialized. Many of their archaic characters are veiled by later adaptations, but they do appear to indicate types which probably were ancestral to some of the modern, more highly developed bivalves.

Major phylogenies which have followed separate lines of descent are not

apparent in this order. For this reason it has not been divided into sub-orders. Groups of families which seem to be closely related have been brought together under the headings of superfamilies. The Porto Rican fauna includes two of these.

KEY TO THE SUPERFAMILIES OF ANOMALODESMACEA

- (1) Gills V-shaped, reticulate.....Laternulacea
 (1') Gills foliobranchiate or lamellar, slightly or not at all reticulate, frequently degenerate or absent.....Poromyacea

Superfamily LATERNULACEA

The gills are reticulate and V-shaped. The ventricle embraces the rectum and usually bears an anterior and a posterior aorta. The animal does not secrete a calcareous tube external to the shell. The ligament may be with or without a lithodesma.

There is only one family of this group represented in the Porto Rican fauna.

Family LYONSIIDAE

The shell is inequivalve, thin, subnacreous and edentulous. The ligament is obsolete and the resilium internal, uniting the edges of a long, mesial lithodesma to a narrow, chondrophoric, submarginal ridge on each valve. The beaks are entire, and the valves are almost closed. The pallial sinus is distinct. The gills are folded, united and septary behind attached to the dome of the mantle and to the siphonal septum. The foot is compressed, grooved, and byssiferous, without an opisthopodium. There is an opisthopodial orifice. The pedal orifice is small. The siphons are short, separate, and papillose. The branchial one has the valve inconspicuous.

Genus LYONSIA Turton

Lyonsia Turton (1822) Conch. Insul. Brit., 17: 34.

Type (by monotypy), *Mya striata* Montagu (1822) = *Mya norvegica* Gmelin (1792).

The description for the genus is much the same as given for the family. There is a fine radial sculpture, and the periostracum often has bits of adherent sand. The length of the shell is greater than the height, and it is truncate behind. The hinge is edentulous with a ligament in a sulcus, and a large lithodesma. The pallial sinus is obscure and angular.

Lyonsia beana d'Orbigny

PLATE 9, FIGURE 9

Lyonsia beana d'Orbigny (1846) Moll. Cubana, 2: 225, Pl. 25, figs. 26-28.

The shell is small, thin and polished. It is very inequilateral, gaping both anteriorly and posteriorly, the anterior end is short and attenuated, and the posterior end laterally compressed.

This species is found living commensally with sponges and compound

ascidians; this indicates one reason for its very irregular shape. The epidermis is often brownish, and the shell sometimes tinted with purple.

Length 27, height 14, width 11 mm.

Porto Rico: Vieques.

Virgin Islands: St. Thomas.

Superfamily **POROMYACEA**

The gills are foliobranchiate or lamellar, slightly or not at all reticulated, and frequently degenerate or even absent. The lamellae when fully developed are attached to one another by interlocking giant cilia, disposed in bands or patches, and by occasional connective fibers which are not of a vascular nature. Often there is a special development of the branchiosiphonal septum. The valves are free. The mantle lobes are united and have developed siphons and a pedal, but not opisthopodial opening. The resilium is reinforced below by a lithodesma.

There are two families represented in this fauna.

KEY TO THE FAMILIES OF POROMYACEA

- (1) Shell rostrate, rarely with surface granulation.....Cuspidariidae
 (1') Shell not rostrate, the surface granulose.....Verticordiidae

Family **CUSPIDARIIDAE**

The shell is subequivalve and rostrate, rarely with surface granulations. The shell substance is earthy or cellulocrystalline. The hinge is edentulous or with subumbonal desmodont tuberculations, and is sometimes buttressed. The ligament is subinternal, anterior to the beaks or obsolete. The resilium is internal, with a mesial or ventral lithodesma. The area is amphidetic or obscure. The valves are closed except at the tip of the rostrum. The pallial line is simple, and the retraction of the siphons usually is effected by the contraction of the septum, which leaves a scar on the valves resembling a pallial sinus. The ventricle is bilobate, embracing the rectum or dorsal to it, with two aortas. The gills are obsolete or absent, represented only by the ciliated foramina in a muscular septum. The palps are degenerate or obsolete. The foot is small, digitiform, and grooved, with a minute byssus but not opisthopodium. The siphons are united, long or short, with a few papillae and an obsolete curtain valve.

Genus **CUSPIDARIA** Nardo

Cuspidaria Nardo (1840) *Revue Zool.*, p. 30.

TYPE (by subsequent designation, Hermannsen (1846) *Tellina cuspidata* Olivi.

The shell is rostrate and concentrically sculptured. The hinge has a small, posteriorly inclined chondrophore in each valve and an elongate ridge behind it. The ligament, when present, is always anterior to the beaks.

KEY TO THE SUBGENERA OF CUSPIDARIA

- (1) Valves smooth or concentrically sculptured.....*Cuspidaria* s.s.
 (1') Valves radially sculptured.....*Cardiomya*

Subgenus **CUSPIDARIA**

The valves are smooth or feebly concentrically sculptured. The fossette of the resilium is posteriorly inclined and attached to the hinge-margin by its posterior edge. There is one posterior lateral tooth in the right valve. The siphons are elongate.

Cuspidaria (Cuspidaria) obesa (Lovèn)

PLATE 10, FIGURE 1

Neaera obesa Lovèn (1846) Ind. Moll. Scand., p. 48.

The surface is rather smooth, with low, concentric sculpture. It is rostrate posteriorly but not so much so as in specimens of *Cardiomya*. The umbones are full, and the shell is tumid.

Length 13 mm.

Porto Rico: Mayaguez.

Subgenus **CARDIOMYA** A. Adams

Cardiomya A. Adams (1846) Ann. Mag. Nat. Hist. (3), 13: 330.

TYPE (by monotypy), *Neaera gouldiana* Hinds

The valves are sculptured radially, and the fossette of the resilium is more vertical and prominent. Otherwise it is similar to *Cuspidaria* s.s.

KEY TO THE SPECIES OF **CARDIOMYA**

- | | |
|---|-----------------------|
| (1) Rostrum long and narrow | <i>C. perrostrata</i> |
| (1') Rostrum short and obtuse | 2 |
| (2) Radial ribs few, prominent | <i>C. ornatissima</i> |
| (2') Radial ribs numerous, less prominent | <i>C. costellata</i> |

Cuspidaria (Cardiomya) perrostrata Dall

PLATE 10, FIGURE 2

Cuspidaria perrostrata Dall (1881) Bull. Mus. Comp. Zool., 9: 296, Pl. 2, figs. 3a 3b.

This is an elegant little species, as are all the members of this subgenus. It has about twenty radial ribs on the disk of the shell and five or six delicate riblets on the rostrate posterior portion. The ribs are very clearly incised. The ribs on the central part of the disk alternate in size, every other one being slightly larger than the intervening one.

Length 5 mm.

Porto Rico: Mayaguez.

Cuspidaria (Cardiomya) costellata (Deshayes)

PLATE 10, FIGURE 3

Corbula costellata Deshayes (1837) Explor. Sci. Morée, Geol., p. 86, Pl. 7, figs. 1-3.

Sphena alternata d'Orbigny (1846) Moll. Cubana, 2: 286, Pl. 27, figs. 17-20.

The rostrum is shorter and more obtuse in this species than in the preceding one. There are about 25 ribs on the main body of the shell which alternate in size on the disk, as in the preceding species. The rostrum has

one well-marked rib, which is probably in the nature of an umbonal ridge, and several very fine riblets.

Length 4 mm.

Porto Rico: Mayaguez.

Cuspidaria (Cardiomya) ornatissima (d'Orbigny)

PLATE 10, FIGURE 4

Sphena ornatissima d'Orbigny (1846) Moll Cubana, 2: 286, Pl. 27, figs. 13-16.

Neaera costata Bush (1885) Trans. Conn. Acad., 6 (2): 472, Pl. 45, fig. 21.

This species is quite distinctive in the presence of seven to nine sharp, prominent ribs with broad concave interspaces. The rostrum is variable, sometimes being short and truncate and in other specimens moderately long. In this species, as in the preceding, the ribs tend to alternate in size.

Length 6 mm.

Porto Rico: Mayaguez.

Virgin Islands: St. Thomas.

Family **VERTICORIIDAE**

The shell is subequivalve, nacreous, and cellulocrystalline. It is granulose externally. The hinge bears a strong tubercle in the right valve before the resilium, and the dorsal margins are modified to overlie and underlie each other. The ligament is obsolete, and the resilium opisthodontic and internal, with a strong ventral lithodesma. The area is obscure or absent, but there is a depressed false lunule before the beaks. The valves are closed, and the pallial sinus is shallow and obscure. The ventricle embraces the rectum and probably has two aortas. The gills are foliobranchiate, simple, and without a lateral reflected extension. They are adnate on the anteriorly extended, fleshy, imperforate siphonal septum. The palps are obsolete. The foot is digitiform, not byssiferous, and without an opisthopodium. The pedal foramen is small, and the siphons short, separate, and papillose. The branchial siphon is without a conspicuous valve.

Genus **VERTICORDIA** J. Sowerby

Verticordia J. Sowerby (1844) Min. Conch. Gt. Britain, 7 (112): 67.

TYPE (by monotypy), *Verticordia cardiiformis* J. Sowerby.

The shell is equivalve, usually small, and suborbicular. Its substance is pearly. The umbones are subcentral or anterior, prominent, prosogyrous, and often strongly involute. There is a deeply impressed false lunule. The sculpture consists of strong radial ribs. The ligament is submarginal. The resilium is supported by a lithodesma. There is usually a strong cardinal tooth in the right valve and sometimes in the left, although the left valve is typically devoid of true teeth. Occasionally a posterior lateral tooth is developed, but more often the valve margins are modified to function as laterals. The adductor muscle scars are small and often obscure. The pallial line is simple or feebly waved. The ventral margins of the valves are deeply fluted.

Verticordia ornata (d'Orbigny)

PLATE 10, FIGURE 5

Trigulina ornata d'Orbigny (1846) Moll. Cubana, 2: 292, Pl. 27, figs. 30-33.

This beautiful little species is quadrate in outline and moderately inflated. It has nine or ten prominent radial ribs with broad, smooth, concave interspaces. The posterior third of the shell is relatively smooth.

Length 3 mm.

Porto Rico: Mayaguez.

ORDER TELEODESMACEA

This order is made up of forms which are presumably the most perfected, although not always the most specialized, of bivalve mollusks. It probably had one general origin with the Anomalodesmacea or sprang from ancient members of that stock. In this order the elaboration of the hinge-plate dentition reaches its highest development. Though many of the members of this order live imbedded in the surface of the sea-bottom, they are more or less migratory and free-living, and only a few extremely specialized forms inhabit permanent burrows of their own excavation. They are sometimes commensal in the burrows of other animals. Similarly, though often byssiferous, especially when young, few of them fix themselves permanently by a byssus.

On the whole it is a rather homogeneous group and does not seem to warrant division into suborders. Several groups of families appear to be closely related, and these have been brought together into superfamilies.

KEY TO THE SUPERFAMILIES OF TELEODESMACEA

- (1) Shell sessile, attached to the substratum..... Chamacea
- (1') Shell not sessile..... 2
- (2) Hinge edentulous, pallial sinus distinct..... 3
- (2') Hinge provided with teeth, or if edentulous, then without a pallial sinus..... 4
- (3) Resilium internal, functional, seated on chondrophores..... Myacea
- (3') Resilium vestigial in the left valve or absent..... Adesmacea
- (4) Hinge scarcely elaborated into a plate, laterals and cardinals more or less conical and seemingly curving up from below the internal hinge margin..... Cardiac a
- (4') Hinge plate and teeth not as described in 4..... 5
- (5) Pallial sinus absent..... 6
- (5') Pallial sinus present, usually well marked, rarely very small..... 8
- (6) Adductor muscle scars subequal and rounded..... 7
- (6') Anterior adductor scar narrow and ventrally produced, posterior scar rounded
Lucinacea
- (7) Cardinal teeth more or less vertical to the hinge line..... Astartacea
- (7') Posterior cardinal extended posteriorly parallel to the hinge line..... Carditacea
- (8) Resilium internal..... Mactracea
- (8') Resilium marginal or submarginal..... 9
- (9) Adductor muscle scars long and thin, dorsally extended..... Solenacea
- (9') Adductor muscle scars rounded..... 10
- (10) Pallial sinus largely free from the pallial line ventrally..... Veneracea
- (10') Pallial sinus largely concrescent with the pallial line ventrally..... Tellinacea

Superfamily **ASTARTACEA**

The hinge plate is well developed. There are two or three cardinals in the right valve and one to three in the left. The laterals are usually obscure. When present, they are distant from the cardinals. The ligament may be external, internal or obsolete. The resilium varies from small and marginal to large and internal. There is no pallial sinus. The adductor muscle scars are rounded and subequal. The gills are not united behind the foot, and the palps are moderate in size. The foot is compressed and grooved but not byssiferous. The mantle lobes are free ventrally. No definite siphons are formed, although the anal orifice is usually complete.

Family **CRASSATELLIDAE**

The outer limb of the gills is smaller and without an appendix. The anal orifice is sometimes incomplete. The branchial orifice is papillose, functional, but incomplete below. The shell substance is cellulo-crystalline, with a pronounced epidermis. The valves are somewhat unequal, and usually more or less rostrate, with the beaks compressed, erect or opisthocelous. The ligament is internal and more or less obsolete. The resilium is large, wholly internal and attached at each end to a chondrophoric pit in the hinge plate. The lateral laminae and sockets usually alternate in the valves. The hinge plate is heavy and flat. The posterior cardinal in the right valve is very small or obsolete, with no distinct socket in the opposite valve. The full cardinal formula is
$$\frac{L\ 1010}{R\ 10101}.$$

Genus **CRASSINELLA** Guppy

Crassinella Guppy (1874) Geol. Mag. (2), 1: 442.

TYPE (by subsequent designation, Woodring, 1925), *Thetis parva* C. B. Adams, which may equal *Crassatella martinicensis* d'Orbigny.

The shell is small, flattened, and rounded-triangular. It is slightly inequilateral, with the posterior dorsal margin excavated. The lunule and escutcheon are flattened, and the umbones are acute. The sculpture consists of concentric lamellae. The ligament and resilium are internal. The chondrophore of the resilium is small. There are two cardinals in each valve. The chondrophore lies between the cardinals in the left valve and behind them in the right. There is an anterior lateral in the right valve and a posterior one in the left. In the left valve a low median ridge separates the chondrophore from the socket in front of it. The inner margins of the valves are smooth.

KEY TO THE SPECIES OF **CRASSINELLA**

- (1) Shell very small, somewhat inflated, nearly triangular. *C. martinicensis*
 (1') Shell small, compressed, slightly rounded anteriorly and attenuate posteriorly
C. guadalupensis

Crassinella martinicensis (d'Orbigny)

PLATE 10, FIGURE 8

Crassatella martinicensis d'Orbigny (1846) Moll. Cubana, 2: 288, Pl. 27, figs. 21-23.

This tiny species is relatively triangular, somewhat inflated, and sculptured with smooth, rounded concentric ridges. It is white or shaded with light brown.

Length 2.4, height 2.2, width 1.3 mm.

Porto Rico: Mayaguez.

Virgin Islands: Magens Bay, St. Thomas.

Crassinella guadalupensis (d'Orbigny)

PLATE 10, FIGURE 6

Crassatella guadalupensis d'Orbigny (1846) Moll. Cubana, 2: 289, Pl. 27. figs. 24-26.

This little shell is slightly larger than the preceding and more irregular in outline. It is rounded anteriorly and more or less attenuate behind. It is relatively more compressed. The sculpture is much the same, although the ridges may be a little sharper. It may be white or variously shaded with red, brown, or purple.

Length 4, height 3, width 1.5 mm.

Porto Rico: Mayaguez.

Virgin Islands: St. Thomas.

Superfamily **CARDITACEA**

The hinge plate is well developed and often quite broad. There are, typically, two cardinals in the left valve and three in the right. The posterior cardinals are prolonged and extended well back under the ligament, appearing almost like lateral teeth. The laterals are usually obsolete or absent. The ligament is usually external, rarely internal. The resilium likewise is usually marginal but rarely internal. There is no pallial sinus. The adductor muscle scars are rounded and subequal. The gills are united behind the foot, and the palps are moderate. The foot is compressed and usually byssiferous. The mantle lobes are free ventrally, and siphons are not developed.

Family **CARDITIDAE**

The anatomy is similar to that of the Crassatellidae, but the gills are united behind the foot and of a very simple reticulate type. The shell usually has radial sculpture. The pedal muscle scar is adjacent to the anterior adductor scar. The ligament is external and parivincular. The resilium usually is included in the ligament, rarely internal. Lateral laminae and sockets alternate in the valves and are usually obsolete. The anterior cardinal is often obsolete, the posterior prolonged parallel with the dorsal margin even below the ligament. The full cardinal formula is
$$\begin{array}{l} \text{L } 01010 \\ \text{R } 1010\bar{1} \end{array}$$

Genus **CARDITA** Lamarck

Cardita Lamarck (1799) Mem. Soc. Hist. Nat. Paris, p. 86.

TYPE (by monotypy), *Chama calyculata* Linnaeus.

The shell is rather mytiliform or elongate-quadrangle and is very inequivalve. The surface is ornamented with strong radial sculpture. There is a

slight ventral byssal gape. The valve margins are fluted internally except in the region of the byssal gape. There are three cardinals in the right valve and two in the left. Laterals may be present or absent.

***Cardita gracilis* Shuttleworth**

PLATE 10, FIGURE 7

Cardita gracilis Shuttleworth (1856) Jour. de Conchyl., 5: 173.

There is a small but distinct anterior lateral in the left valve and a posterior lateral in the right, with corresponding sockets in the opposing hinge margin. The ribs are nodular and sometimes spinose on the posterior slope. The shell substance is white internally and shaded with brown or purple.

Length 24, height 10, width 9.5 mm.

Porto Rico: (A.N.S.P., one lot without specific data).

Virgin Islands: St. Thomas.

Superfamily **CHAMACEA**

These are sessile animals, cemented to the substratum, with the shells spiral and usually very inequivalve. The hinge plate is heavy and curved. There are one or two cardinals in the free valve with two and an intermediate socket in the fixed valve. There is frequently a minute or obsolete posterior lateral. The ligament is external, and the resilium marginal. There is no pallial sinus. The adductor muscle scars are rounded or elongate and subequal. The gills are plicate, united behind to each other and to the siphonal septum, so as to form an anal chamber. The palps are moderate. The foot is small and not byssiferous. The mantle lobes are united to form separate anal, branchial, and pedal orifices. Siphons are not produced.

Family **CHAMIDAE**

The shell substance is three-fold, the inner layer porcellanous and tubular, the middle obscurely prismatic and the external cellulo-crystalline with reticulated tubules and an inconspicuous epidermis. The valves are unequal, irregular, with one of them sessile. They are closed, usually rounded in form, and have conspicuous sculpture, often differing in the opposite valves. The pedal scars are minute, distant. The ligament and resilium are external in a deep groove, parivincular, and opisthodetic. The area is distinct and prosodetic. The beaks are more or less spiral and prosogyrous. The hinge frequently has a minute or obsolete posterior lamina, chiefly in the fixed valve. The anterior cardinal is broad, usually deeply grooved or multifid. The posterior one is simple, long, and curved parallel with the dorsal border. The outer limb of the gills is smaller and appendiculate. The mantle margin is papillose. The siphonal orifices are not produced into tubes. The ovary is extensively distributed in the mantle lobes. The adductors are each composed of two elements.

KEY TO THE GENERA OF CHAMIDAE

- (1) Shell nearly equivalve, the valves strongly convex with a large lunule, sculpture consisting of erect tubular spines on radial ribs. *Echinochama*

- (1') Valves very unequal, the attached one larger, no lunule.....2
 (2) Umbones turning from right to left; attached by the left valve.....*Chama*
 (2') Umbones turning from left to right; attached by the right valve.....*Pseudochama*

Genus **CHAMA** Linnaeus

Chama Linnaeus (1758) Syst. Nat., Ed. 10: 691.

TYPE (by subsequent designation, Gray, 1847), *Chama lazarus* Linnaeus.

The shell is orbicular and very inequivalve. It is attached by the left valve, which is much the larger of the two. The sculpture consists largely of foliaceous concentric lamellae, which are often supplemented by radial threads or riblets. The posterior adductor muscle scar is more elongate than the anterior one.

KEY TO THE SPECIES OF CHAMA

- (1) Pallial line passing around anterior end of adductor muscle scar and joining it anteriorly.....*C. macerophylla*
 (1') Pallial line joining the scar of the anterior adductor muscle at its ventral posterior border.....*C. sarda*

Chama macerophylla Gmelin

PLATE 11, FIGURE 1

Chama macerophylla Gmelin (1792) Syst. Nat., Ed. 13: 3304.

The surface is ornamented with a variable array of foliaceous lamellations. There is a varying amount of radial ridges. The inner margin is crenulate and irregularly shagreened. The coloration shows many combinations of shading and clouding with white, yellow, red, and purple.

Length 75, height 60, width 45 mm.

Porto Rico: Quebradillas.

Virgin Islands: St. Thomas.

Chama sarda Reeve

PLATE 11, FIGURES 2, 3

Chama sarda Reeve (1847) Conch. Icon., 4, Pl. 7, fig. 40.

The color is white with a variable amount of red. The upper valve is often extensively clouded with red, and the lower valve is usually red internally and, to a varying degree, externally as well. The sculpture consists of irregular concentric foliations and slight radial corrugations. The internal margin is crenulate. The attached valve is often very deep-cupped.

Length 27, height 30, width 23 mm.

Porto Rico: San Juan; Mayaguez; San Geronimo; Vieques.

Genus **PSEUDOCHAMA** Odhner

Pseudochama Odhner (1917) Kungl. Svenska Vetensk. Handl. 52 (16): 28.

TYPE (by subsequent designation, Gardner, 1926), *Chama cristella* Lamarck.

The members of this genus are very similar to those of the genus *Chama*, but appear as mirror images of them. They are attached by the right

valve, and the umbones turn from left to right. This close resemblance between species attached by the left or the right valve led conchologists to believe that these animals could attach by either valve. In a study of the two types, however, Obhner investigated the prodissoconch, the hinge teeth of very young specimens, and the anatomical features of each type, and came to the conclusion that two distinct genetic lines were represented. He proposed the genus *Pseudochama* for the so-called inverse species.

***Pseudochama radians* (Lamarck)**

Chama radians Lamarck (1819) Anim. s. Vert., 6 (1): 96.

There are two varieties of *Pseudochama radians* Lamarck in the area under consideration. The species *radians* is a smooth heavy shell, clouded and banded with brown or purple.

KEY TO THE SUBSPECIES OF PSEUDOCHAMA RADIANIS

- (1) Concentric foliations prominent, coloration usually made up of brown shading and clouding. *P. r. ferruginea*
 (1') Concentric sculpture reduced and flattened, often with low spinous projections, coloration typically made up of dark red spotting and striping. *P. r. variegata*

***Pseudochama radians ferruginea* (Reeve)**

PLATE 11, FIGURE 5

Chama ferruginea Reeve (1846) Conch. Icon., 4, Pl. 4, fig. 21.

This species appears almost like a reversed *C. macerophylla*. The foliations are prominent and are variously shaded with brown and occasionally with yellow coloration. The inner margin is crenulate.

Length 39, height 39, width 21 mm.

Virgin Islands: St. Thomas.

***Pseudochama radians variegata* (Reeve)**

PLATE 11, FIGURE 6

Chama variegata Reeve (1847) Proc. Zool. Soc. London, 14 (166): 118.

The sculpture is much reduced in this form and the red spotting or striping is characteristic. The present subspecies also closely resembles one of the members of the typical genus *Chama*. It appears like a mirror image of *C. congregata*.

Length 24, height 30, width 16 mm.

Virgin Islands: St. Thomas.

Genus ECHINOCHAMA Fischer

Echinochama Fischer (1887) Manuel de Conchyliologie, p. 1049.

TYPE (by monotypy), *Chama arcinella* Linnaeus.

The shell is medium-sized and subequivalve. The adult shells are usually found free of attachment to the substratum, although they live cemented to some object during their younger stages. The umbones are strongly prosogyrous, and there is a large deep lunule. The external sculpture consists of

pits and spinose radial ribs. The prodissoconch is large and elongate. It is usually fairly distinct in the left valve. The hinge of the right valve is armed with a heavy, furrowed anterior callosity, a posterior row of denticles paralleling the ligament, and a rudimentary posterior lateral. The left valve bears an anterior row of small denticles, a furrowed socket, and a heavy posterior tooth, which has its upper surface denticulate and its inner surface furrowed. There is a rudimentary left posterior lateral. The margins of the valves are coarsely fluted and internally finely corrugated.

Echinochama arcinella (Linnaeus)

PLATE 11, FIGURE 4

Chama arcinella Linnaeus (1767) Syst. Nat., Ed. 12: 1139.

The pitted surface and strong spinose radial ribs will serve to distinguish this species from all others in the Antillean fauna.

Length 53, height 55, width 40 mm.

Porto Rico: Mayaguez; Ponce.

Virgin Islands: St. Thomas.

Superfamily **LUCINACEA**

The hinge plate is narrow and arched. The cardinals are variable. Typically there are two or three cardinals in each valve but they may be represented by only one in each valve or they may be obsolete or absent. The laterals consist of one anterior and one posterior tooth in the right valve, but these may be obsolete or absent. The ligament is external, set in a groove, with the resilium submarginal. There is no pallial sinus. The anterior muscle scar is usually narrow and produced ventrally, while the posterior one is shorter and rounded. The gills are smooth, usually united behind the foot, forming an anal chamber. Sometimes (in the Thyasiridae) they are free behind the foot. The palps are small, sometimes elongated, and sometimes obsolete. The foot is elongate and club-shaped, not byssiferous except in a few minute forms. The mantle lobes are free ventrally. The anal siphon is complete and sometimes produced into a tube. The branchial siphon is often incomplete although occasionally complete, and, in the Cyrenoididae, it is produced into a tube.

KEY TO THE FAMILIES OF LUCINACEA

- (1) Anterior adductor muscle scar separated ventrally from the pallial line. 2
- (1') Anterior adductor muscle scar contiguous ventrally with the pallial line. 3
- (2) Hinge edentulous or with an obsolete cardinal tooth in the right valve; hepatic and reproductive glands external to the visceral mass, pedunculated and arborescent. Thyasiridae
- (2) Hinge usually with representatives of both cardinals and laterals although rarely edentulous; hepatic and reproductive glands included in the visceral mass
Lucinidae
- (3) Epidermis conspicuous, anal orifice produced into a tube. Cyrenoididae
- (3') Epidermis inconspicuous, anal orifice not tubular. Ungulinidae

Family **THYASIRIDAE**

The shell substance is earthy, with an inconspicuous epidermis. The beaks are prosocoelous. The valves are equal, free and closed, with plain margins. They are smooth or feebly concentrically striated, and usually with a radial posterior flexure. The adductor muscle scars are similar to those of the Lucinidae. The pallial area is often punctate. The ligament and resilium are parivincular, opisthodontic, and subexternal, seated in a groove. The area is impressed. The hinge is feeble, without lateral laminae, and edentulous or with an obsolete cardinal tooth in the right valve. The gills have both internal and external direct and reflected laminae. The external limb of the gills is dorsally directed and they are free behind the foot. The palps are obsolete. The hepatic and reproductive glands are external to the visceral mass, pedunculated and arborescent. The foot is slender and much elongated. The mantle edges are thickened and smooth, free ventrally. The branchial foramen is incomplete and not produced into a tube.

Genus **THYASIRA** Lamarck

Thyasira Lamarck (1818) Anim. s. Vert., 5: 492.

TYPE (by monotypy), *Tellina flexuosa* Montagu.

The description given for the family will apply, for the most part, to the genus as well. The hinge is edentulous. The anterior dorsal area is more or less impressed, and the posterior dorsal area is plicate or radially sulcate.

KEY TO THE SPECIES OF **THYASIRA**

- (1) Posterior slope of shell with two deep, distinct, radial grooves; surface finely concentrically striated. *T. trisinuata*
 (1') Posterior slope with one distinct but rather shallow radial groove; surface finely granular. *T. conia*

Thyasira trisinuata (d'Orbigny)

PLATE 11, FIGURE 7

Lucina trisinuata d'Orbigny (1846) Moll. Cubana, 2: 300, pl. 27, figs. 46-49.

Cryptodon obsus Verrill (1872) Am. Jour. Sci., 3: 287, Pl. 7, fig. 2.

The elevated shape, trisinuate posterior slope, and concentrically sculptured surface will distinguish this species from the next one.

Length 12, height 14, width 10 mm.

Porto Rico: Mayaguez.

Thyasira conia Dall and Simpson

PLATE 11, FIGURE 8

Thyasira conia Dall and Simpson (1901) Bull. U. S. Fish Comm., 20: 490.

The single sinuation of the posterior slope, together with the finely granular surface, characterize this species.

Length 6, height 6, width 3 mm.

Porto Rico: San Juan.

Family LUCINIDAE

The shell substance is porcellaneous or chalky, usually with an inconspicuous or dehiscent epidermis. The shell is rounded, variably sculptured; the valves are equal, free, and closed. There are low, prosocoelous beaks. The adductor and pedal scars may be adjacent or distinct; the latter are small. The anterior adductor scar is elongated and largely within the pallial line, which is not sinuate. The inner surface of valves within the pallial line is often granular or punctate. The cardinal area is small, often deeply impressed. The ligament and resilium are subinternal, set in a deep groove, but usually more or less visible externally. The hinge plate is distinct. The lateral laminae are distant from the cardinals. There are an anterior and a posterior lateral in the right, and corresponding sockets in the left valve. The cardinal teeth are radial; formula $\frac{L\ 1010}{R\ 0101}$. The posterior cardinal tooth is larger and often bifid, but any or all of the teeth may be obsolete or absent. The gills have an internal direct and reflected lamina, without appendix, the external limb absent. The palps are very small. The hepatic glands are contained within the general visceral mass. The foot is not grooved and has a terminal mucous gland. The mantle edges are usually plain and thick. The branchial foramen is papillose, not tubular, incomplete below. The anal foramen is complete, usually with a retractile, tubular siphon.

KEY TO THE GENERA OF LUCINIDAE

- (1) Surface ornamented by conspicuous divaricating sculpture.....*Divaricella*
- (1') Surface sculpture radial or concentric, not divaricating.....2
- (2) Hinge edentulous in the adult.....*Lucina*
- (2') Hinge not edentulous in the adult.....3
- (3) Sculpture reticulate, radial elements as well developed as the concentric elements
Codakia
- (3') Sculpture principally concentric, sometimes with a few radial grooves or ridges or obscure radial threads.....4
- (4) Hinge of right valve bearing two cardinals.....*Phacoides*
- (4') Hinge of right valve with a single cardinal.....*Myrtaea*

Genus CODAKIA Scopoli

Codakia Scopoli (1777) Introd. Hist. Nat. Lap. Plant Anim., p. 398.

TYPE (by monotypy), *Chama codak* Adanson = *Venus punctata* Linnaeus.

The shell is large, suborbicular, and moderately or strongly inflated. The lunule is small and deeply depressed. The sculpture consists of radial grooves and striae, crossed by incrementals. The ligament and resilium are large and deeply inset. The hinge of the right valve bears a prominent anterior lateral, typically, close to the cardinals, an anterior and a middle cardinal, and a small posterior lateral. The hinge of the left valve consists of large double anterior laterals, anterior and middle cardinals, and small double posterior laterals. The inner margins of the valves are slightly wrinkled.

KEY TO THE SUBGENERA OF CODAKIA

- (1) Shell moderately inflated; anterior laterals close to the cardinals. *Codakia* s.s.
 (1') Shell usually strongly inflated; anterior laterals relatively distant from the cardinals. *Jagonia*

Subgenus CODAKIA s.s.

The description is the same as given under the genus, with the limiting features of the key.

***Codakia orbicularis* (Linnaeus)**

PLATE 12, FIGURE 1

Venus orbicularis Linnaeus (1758) Syst. Nat., ed. 10: 688.

Lucina tigrina Linnaeus: Reeve (1850) Conch. Icon., 6, Pl. 1, fig. 3; not Linnaeus (1767).

This large, circular species is easily recognized. It is white and frequently flushed with yellow in the umbonal cavity. The hinge margin is usually characteristically stained with red.

Length 80, height 70, width 30 mm.

Porto Rico: San Juan; Ponce, Mayaguez; Laiza Vieja; Hucares; San Geronimo; Puerto Real; N. of Vega Baja; Playa Humacao.

Virgin Islands: Lindbergh Beach, St. Thomas; St. Croix; Tortola; Caneel Bay, St. John; Virgin Gorda.

Subgenus JAGONIA Recluz

Jagonia Recluz, 1869, Act. Soc. Linn. Bordeaux, 27: 37.

TYPE (by original designation), *Le Jagon* Adanson = *Venus orbiculata* Montagu.

The shell is medium-sized, suborbicular, and strongly inflated. The lunule is small and deeply depressed. The sculpture consists of narrow radial ribs and narrow concentric beads. The ligament is narrow. The hinge resembles that of *Codakia* s.s., but the laterals are more symmetrically situated with regard to the cardinals and the posterior laterals are stronger. The inner margin is weakly frilled.

KEY TO THE SPECIES OF SUBGENUS JAGONIA

- (1) Radial ribs irregular, not strongly delimited, often threadlike; surface not strongly beaded. *C. costata*
 (1') Radial ribs pronounced; surface often distinctly beaded. 2
 (2) Shell circular in outline. *C. orbiculata*
 (2') Shell not circular in outline. 3
 (3) Shell subcircular but with the hinge line flattened. *C. pectinella*
 (3') Shell subcircular but somewhat oblique. *C. portoricensis*

***Codakia (Jagonia) costata* (d'Orbigny)**

PLATE 12, FIGURE 2

Lucina costata d'Orbigny (1846) Moll. Cubana, 2: 296, pl. 27, figs. 40-42.

The irregular, often threadlike, radial ribs are distinctive for this species. They are frequently somewhat prominent in groups, and this is probably the origin of the specific name.

Length 9, height 8, width 5 mm.

Porto Rico: Ponce; Hucares; Arroyo.
 Virgin Islands: St. Thomas; St. Croix; Caneel Bay, St. John; Tortola;
 Virgin Gorda.

Codakia (Jagonia) orbiculata (Montagu)

PLATE 12, FIGURE 3

Venus orbiculata Montagu (1808) Test. Brit. Suppl., p. 42.
Lucina pecten Lamarck (1818) Anim. s. Vert., 5: 543.

This is a circular species, with pronounced beaded radial ribs.
 Length 13, height 12, width 5.5 mm.
 Porto Rico: Ensenada Honda, Culebra.
 Virgin Islands: St. Thomas.

Codakia (Jagonia) pectinella C. B. Adams

PLATE 12, FIGURE 6

Lucina pectinella C. B. Adams (1852) Contrib. Conch., p. 246.

The radial ribs are well marked and are crossed by fine, sharp, concentric sculpture. The shell is subcircular, but the hinge line is straightened, giving the characteristic shape to this species.

Length 7.5, height 8, width 4 mm.
 Porto Rico: San Juan; Mayaguez.

Codakia (Jagonia) portoricana Dall

PLATE 12, FIGURE 4

Codakia (Jagonia) portoricana Dall (1901) Proc. U. S. Nat. Mus., 23 (1237): 822, pl. 39, fig. 6.

The radial ribs are more pronounced than the concentric sculpture, but the most distinctive feature is the oblique shape of the shell.

Length 7.5, height 6.7, width 6 mm.
 Porto Rico: San Juan; Mayaguez.

Genus **LUCINA** Lamarck

Lucina Lamarck (1799) Mem. Soc. Hist. Nat. Paris, p. 84.
 TYPE (by monotypy), *Venus edentula* Linnaeus.

The shell is large, thin, and subspherical. The lunule is small and depressed. There is no escutcheon. The insignificant sculpture is made up of exaggerated incremental growth lines. The ligament and resilium are external but deeply inset. The hinge is edentulous, and the inner margins of the valves are smooth. The anterior adductor muscle scar is long and parallels the pallial line.

KEY TO THE SPECIES OF LUCINA

- (1) Shell tinted with yellow internally, umbones not prominent *L. chrysostoma*
 (1') Shell white, umbones relatively more prominent *L. phenax*

Lucina chrysostoma Philippi

PLATE 12, FIGURE 5

Lucina chrysostoma Philippi (1845) Zeitschr. f. Malakozool., p. 181.
Lucina edentula of authors, not Linnaeus.

This is a moderately large species, thin and globular in outline. It is characteristically tinted with yellow internally.

Length 46, height 41, width 28 mm.

Porto Rico: San Juan; Mayaguez; Ponce; Humacao Playa; E. of Boca de Cangrejos.

Virgin Islands: St. Thomas.

Lucina phenax Dall and Simpson

PLATE 12, FIGURE 8

Lucina phenax Dall and Simpson (1901) Bull. U. S. Fish Comm. 20: 492.

This is a small, thin, white shell with a grayish, papery epidermis. The umbones are somewhat more prominent than in the preceding species. The present species bears a superficial resemblance to a young *Phacoides pensylvanicus*, but has no hinge teeth and much thinner valves.

Length 9, height 8, width 5.5 mm.

Porto Rico: San Juan; Mayaguez.

Genus **MYRTAEA** Turton

Myrtaea Turton (1822) Conch. Insul. Brit., p. 133

TYPE (by monotypy), *Venus spinifera* Montagu.

The shell is ovate or subrectangular and not inflated. The sculpture is chiefly concentric. The lunule and escutcheon are long and narrow. The ligament and resilium are deep-seated but not internal. The anterior adductor muscle scar is relatively short. In the hinge the right anterior cardinal is absent, and the left laterals are frequently obsolete.

Myrtaea pristophora Dall and Simpson

PLATE 12, FIGURE 7

Myrtaea pristophora Dall and Simpson (1901) Bull. U. S. Fish Comm., 20: 493, Pl. 55, figs. 4, 6.

The pronounced concentric sculpture is raised into lamellate projections along the dorsal border of the shell. The color is white. The interior of the disk is punctate. The margins of the valves are finely radially striate or smooth.

Length 7, height 7.5, width 4 mm.

Porto Rico: San Juan; Mayaguez.

Genus **PHACOIDES** Blainville

Phacoides Blainville (1825) Man. Mala. et Conch., p. 550.

Lucina Lamarck (1801) not Lamarck (1799).

TYPE (by monotypy), *Lucina jamaicensis* Lamarck = *Tellina pectinata* Gmelin.

This genus is made up of most of the species commonly included in *Lucina* in the broad sense but not *Lucina* of Lamarck, 1799. Owing to the very numerous modifications of characters shown by members of *Phacoides*, it is divided into a number of subdivisions. Four of them are represented in the Porto Rican fauna.

- (1) Dorsal areas developed.....2
- (1') Dorsal areas obsolete.....*Callucina*
- (2) Cardinal teeth largely effaced or obsolete in the adult.....*Phacoides* s.s.
- (2') Cardinal teeth not obsolete in the adult.....3
- (3) Sculpture concentric.....*Linga*
- (3') Sculpture reticulate or muricate.....*Lucinisca*

Subgenus **PHACOIDES** s.s.

The shell is subcircular and more or less laterally compressed. There are strong dorsal areas and the sculpture is chiefly concentric. The cardinal teeth are obsolete in the adult, but the laterals are well developed.

Phacoides (Phacoides) pectinatus (Gmelin)

PLATE 12, FIGURE 11

Tellina pectinata Gmelin (1792) Syst. Nat., Ed. 13: 3226.
Lucina jamaicensis Lamarck (1818) Anim. s. Vert., 5: 539.

This is a common West Indian shell. It bears a marked resemblance to *Lucina chrysostoma* both in shape and in the internal yellow coloration. It is easily distinguished by the more distinct dorsal areas and the strong lateral teeth.

Length 55, height 50, width 30 mm.

Porto Rico: San Juan; Ponce; Laiza Vieja; Humacao Playa; Quebradillas; San Antonio Bridge; Boca Cangrejos.

Virgin Islands: St. Thomas; St. Croix.

Subgenus **LINGA** de Gregorio

Linga de Gregorio (1884) Bull. Soc. Malac. Italiana, 10: 217.
 TYPE, *Lucina columbella* Lamarck.

The dorsal areas are developed, the lunule often deeply impressed. The right anterior cardinal is often effaced, but the other teeth are usually well developed.

KEY TO THE SPECIES OF SUBGENUS LINGA

- (1) Dorsal areas strongly developed; surface regularly and evenly concentrically sculptured.....*P. pensylvanica*
- (1') Dorsal areas weakly developed; surface finely concentrically ridged, also with three or four deeper concentric sulci.....*P. trisulcata blanda*

Phacoides (Linga) pensylvanica (Linnaeus)

PLATE 12, FIGURE 10

Venus pensylvanica Linnaeus (1758) Syst. Nat., Ed. 10: 688.

This distinct, globular species is a common Antillean bivalve. It exhibits considerable variation in sculpture and shape, but is not easily confused with any other species in the region. Sometimes it has orange coloration internally, and this form has received the varietal name *aurantia*. This condition is probably only a response to ecological factors in the environment.

Length 54, height 53, width 40 mm.

Porto Rico: Mayaguez.

Virgin Islands: Smith's Bay, St. Thomas; St. Croix; Caneel Bay, St. John; Tortola; Virgin Gorda.

Phacoides (Linga) trisulcatus blandus Dall and Simpson

PLATE 12, FIGURE 9

Phacoides (Here) trisulcatus blandus Dall and Simpson, 1901, Bull. U. S. Fish Comm., 20: 493, Pl. 58, fig. 13.

This is a small, obliquely triangular species. The surface is evenly concentrically ridged and characteristically sulcate, with three or four deeper concentric grooves. There are indications of faint radial grooves. The dorsal areas are not so pronounced as in the preceding species. The color is white, sometimes tinged with salmon color. This coloration is probably of a similar nature to that found in *pensylvanica*.

The typical *trisulcatus* Conrad, 1846, (Am. Jour. Sci., 404), is a Miocene fossil. The recent form is so similar that it is treated as a subspecies. There are slight differences in shape and sculpture, but they do not seem to be of sufficient importance to distinguish a separate species.

Length 12, height 13, width 8 mm.

Porto Rico: San Juan.

Virgin Islands: St. Thomas.

Subgenus **LUCINISCA** Dall

Lucinisca Dall (1901) Proc. U. S. Nat. Mus., 23: 805.

TYPE (by original designation), *Lucina nassula* Conrad.

The shell is subcircular and laterally compressed. The dorsal areas are well marked. The sculpture is reticulate and muricate. The right anterior cardinal is obsolete.

Phacoides (Lucinisca) muricatus (Spengler)

PLATE 13, FIGURE 1

Tellina muricata Spengler (1798) Skrift. Nat. Selsk., p. 120.

Lucina scabra Lamarck (1819) Anim. s. Vert., 6: 542.

The beautiful sculpture of this species is distinctive. The spinous processes on the radial ribs are present over the whole external surface of the shell. The color is white.

Length 13, height 12, width 4 mm.

Porto Rico: Mayaguez.

Virgin Islands: St. Thomas.

Subgenus **CALLUCINA** Dall

Callucina Dall, Proc. U. S. Nat. Mus., 23: 806.

TYPE (by original designation), *Lucina radians* Conrad.

The shell is subcircular and inflated. The surface is sculptured with threadlike concentric ridges. Sometimes there are feeble traces of radial sculpture. The dorsal areas are obsolete. There is a very small lunule. There is one cardinal tooth in each valve. The inner margins of the valves are crenulate.

Phacoides (Callucina) radians (Conrad)

PLATE 13, FIGURE 3

Lucina radians Conrad (1841) Am. Jour. Sci., 41: 347.

This little shell has a superficial resemblance to the members of the venerid genus *Dosinia*. The anterior laterals are obscure, and the posterior laterals are virtually absent. The lunule is small and chiefly in one valve, fitting, when closed, into a recess in the other valve. The shell color is white, sometimes tinged with yellow.

Length 18, height 17.5, width 10 mm.

Porto Rico: San Geronimo.

Genus **DIVARICELLA** von Martens*Divaricella* von Martens (1880) Beitrage zur Meersfauna der Insel Mauritius und der Seychellen, p. 321.TYPE (by monotypy), *Lucina (Divaricella) angulifera* von Martens = *Lucina ornate* Reeve.

The shell is medium-sized, orbicular, and strongly inflated. The umbones are low, and the lunule is small although moderately deep. The sculpture consists of oblique grooves angulated along a line extending obliquely downward and forward from the umbones. The ligament and resilium are united and deeply inset. The hinge of the right valve bears a narrow anterior cardinal, a heavy middle cardinal, and an anterior and a posterior cardinal, a heavy middle cardinal, and an anterior and a posterior lateral. In the left valve there is a heavy anterior cardinal, a narrow posterior cardinal, and double anterior and posterior laterals. The posterior laterals are much farther from the cardinals than the anterior ones are. The inner margins of the valves are smooth or finely fluted. The anterior adductor muscle scar is long and parallels the pallial line.

KEY TO THE SPECIES OF DIVARICELLA

- (1) Inner margin smooth.....*D. dentata*
 (1') Inner margins finely fluted or crenulate.....*D. quadrisulcata*

Divaricella dentata (Wood)

PLATE 13, FIGURE 5

Tellina dentata Wood (1815) General Conchol. p. 195.

This species averages a little larger in size than *quadrisulcata*. The inner margin is smooth. The divaricating ridges of the surface sculpture are usually elevated into dentate projections dorsally near the hinge line. The specific name is suggested by this character. Both this species and *quadrisulcata* have the periodic concentric sulcations from which the latter derives its specific name. The shell is pure white.

Length 30, height 29, width 17.5 mm.

Virgin Islands: Lindbergh Beach, St. Thomas; St. Croix; Tortola.

Divaricella quadrisulcata (d'Orbigny)

PLATE 13, FIGURE 8

Lucina quadrisulcata d'Orbigny (1846) Voy. l'Amer. Merid., p. 584.

This is a white, divaricately sculptured species which very closely resembles the preceding one. The inner margins are finely fluted or crenulate, and the dentations of the dorsal margin are lacking. It is also somewhat smaller.

Length 25, height 24, width 14 mm.

Porto Rico: Hucares.

Virgin Islands: St. Thomas; St. Croix; Caneel Bay, St. John; Tortola; Virgin Gorda.

Family UNGULINIDAE

The adductor scars are continuous peripherally with the pallial line. The hinge has the laterals obscure or absent. The valve margins are plain. The shell is orbicular in outline, rarely irregular in nestling forms. The anatomy is like that of the Lucinidae, but with the external limb of the gill developed, reflected, and sometimes appendiculate. The anal foramen is not tubular.

Genus TARAS Risso

Taras Risso (1826) Hist. Nat. Eur. Merid., 4: 344.

Diplodonta Bronn (1831) Ital. Tert.-Gebild. u. Einschl., p. 12.

TYPE (by monotypy), *Taras antiquatus* Risso.

The shell is thin and orbicular, strongly inflated. The surface is finely concentrically striate or pustulose. There are two cardinals in each valve. The left anterior one and the right posterior one are bifid. The laterals are obscure or absent.

KEY TO THE SUBGENERA OF TARAS

- (1) Sculpture consisting of concentric incremental lines. *Taras* s.s.
 (1') Sculpture consisting of incrementals and minute pustules. *Phlyctiderma*

Subgenus TARAS s.s.

The characters are as given for the genus, with the limiting features of the key.

KEY TO THE SPECIES OF TARAS s.s.

- (1) Shell subcircular; very small. *T. nucleiformis*
 (1') Shell subquadrate; relatively large. *T. punctata*

Taras (Taras) punctata (Say)

PLATE 13, FIGURE 4

Amphidesma punctata Say (1822) Jour. Acad. Nat. Sci. Phila., 1: 308.

Lucina janeirensis Reeve (1850) Conch. Icon., Pl. 8, fig. 43.

Mysia pellucida Heilprin (1889) The Bermuda Islands, pp. 179, 190. Pl. 17, fig. 3.

The rounded subquadrate shape and somewhat attenuate anterior end are characteristic for this species. The surface is ornamented with a microscopic sculpture of short radiating striulae, minutely punctate where well developed. This type of ornamentation is apparently peculiar to the species. Dall has suggested that it may bridge the gap between the *Taras*

proper and *Phlyctiderma*. The color is white, although sometimes more or less yellowed.

Length 17.5, height 16, width 12 mm.

Virgin Islands: St. Thomas.

Taras (Taras) nucleiformis (Wagner)

PLATE 13, FIGURE 7

Mysia nucleiformis Wagner (1838) Jour. Acad. Nat. Sci. Phila., 8: 52, Pl. 1, fig. 4.

Cytherea sphaerica H. C. Lea (1845) Trans. Am. Phil. Soc. (2), 9: 241. Pl. 34, fig. 22.

This is a small, subglobose species with very fine concentric sculpture. The hinge is very much concentrated, but the dentition is normal. The shell is moderately heavy, and the altitude is about equal to the length.

Length 6.3, height 6 mm.

Porto Rico: Mayaguez; Culebra.

Virgin Islands: St. Thomas.

Subgenus **PHLYCTIDERMA** Dall

Phlyctiderma Dall (1899) Jour. of Conch., 9: 244.

TYPE (by original designation), *Diplodonta semiaspera* Philippi.

The shell is small, suborbicular, and strongly inflated. The sculpture consists of incremental lines and minute pustules. The ligament and resilium are external. There is a heavy anterior cardinal and a heavy, oblique, bifid posterior cardinal in the right valve. The left valve has a heavy, bifid anterior cardinal and a narrow, elongate posterior cardinal.

KEY TO THE SPECIES OF PHLYCTIDERMA

- (1) Shell relatively coarsely punctate or pustulose.....*T. semiaspera*
 (1') Shell minutely pitted.....2
 (2) Width a little more than one-third the length.....*T. notata*
 (2') Width about two-thirds the length.....*T. gabbi*

Taras (Phlyctiderma) semiaspera (Philippi)

PLATE 13, FIGURE 6

Diplodonta semiaspera Philippi (1836) Arch. f. Naturg., 2 (1): 225.

This is a tumid, robust species with distinct pustulose sculpture. The hinge is typical for the subgenus. The adductor muscle scars in this species are very large. The color is white, sometimes faintly tinted with light straw-color.

Length 14.5, height 13, width 10 mm.

Virgin Islands: Lindbergh Beach, St. Thomas.

Taras (Phlyctiderma) gabbi (Dall)

PLATE 13, FIGURE 9

Mysia subquadrata Gabb (1873) Trans. Am. Phil. Soc., n.s. 15: 252: not *Diplodonta subquadrata* Carpenter, 1855.

D. [iplodonta] gabbi Dall (1900) Trans. Wagner Free Inst. Sci. Philadelphia, 3 (5): 1183, footnote

Diplodonta (Phlyctiderma) puncturella Dall (1900) *op. cit.*, p. 1183, Pl. 45, fig. 26.

This is a small, thin, moderately convex species. The outline is rounded or very slightly subquadrate. The length and height are about equal. The umbones are small but prominent with the hinge line sloping equally on both sides. The surface is very finely pitted. It is white, although sometimes generally tinged with light brown shading.

Length 6.5, height 6.7, width 4 mm.

Porto Rico: San Juan.

Virgin Islands: St. Thomas.

Taras (Phlyctiderma) notata (Dall and Simpson)

PLATE 13, FIGURE 10

Diplodonta notata Dall and Simpson (1901) Bull. U. S. Fish Comm., 20: 495.

This species somewhat resembles the preceding one in general shape and appearance, but is much more compressed laterally. The umbones are nearly central. They are scarcely inflated. The surface punctations are very fine. The color is white.

Length 9, height 8.5, width 3.5 mm.

Porto Rico: Mayaguez.

Family **CYRENOIDIDAE**

The shell is similar to the type found in the Ungulinidae, but has a conspicuous epidermis. The pallial area is smooth. There are no lateral laminae. Typically there are three cardinals in each valve, although two pairs of these may be united dorsally and the anterior left cardinal is usually obsolete. The gills have both inner and outer direct and reflected laminae. The outer limb is smaller and the gills are united behind as in *Lucina*. The palps are elongate. The mantle edges are plain. Both siphons are developed and elongate. They are united to their tips and contractile.

Genus **CYRENOIDA** de Joannis

Cyrenoida de Joannis (1835) Mag. Zool., 5, Pl. 64.

Cyrenella Deshayes (1835) Mag. Zool., 5, Pl. 70.

TYPE (by monotypy), *Cyrenoida dupontia* de Joannis.

The shell is thin and orbicular. The umbones are somewhat inflated, prosogyrous, and located well anterior of the midline. Two cardinals united dorsally in each valve are in the shape of an inverted numeral seven. In the right valve there is a small V-shaped or laminar cardinal below. There are no laterals. The adductor muscle scars resemble those found in the Lucinidae.

Cyrenoida americana (Morelet)

PLATE 13, FIGURE 2

Cyrenoides americanus Morelet, 1851, Test. Nov., 2: 26.

This shell bears a superficial resemblance to that in the members of the genus *Taras*. It differs by the conspicuous epidermis and the very characteristic cardinal teeth united dorsally so as to resemble an inverted

number seven. The anterior cardinal is elongate and produced and appears almost like a lateral but it has its origin beneath the umbo and so is a true cardinal. The sculpture is concentric and fairly conspicuous, recalling some of the fresh-water Corbiculidae.

Length 19, height 18, width 12 mm.

Porto Rico: Arecibo.

Superfamily **CARDIACEA**

Hinge plate arched, very narrow. The margin is scarcely elaborated into a definite hinge plate. Fundamentally there are two simple cardinals in each valve, although one in each valve may be obsolete. The complete hinge includes one anterior and one posterior lateral in the left valve and two anterior and one posterior lateral in the right. The resilium is external and marginal. There is no pallial sinus except in the Adacnidae. The adductor muscle scars are rounded and subequal. The gills are strongly plicate and united behind, forming an anal chamber. The palps are large. The foot is elongate, keeled and geniculate. A byssal gland is present, but no byssus is developed. The mantle lobes are free ventrally. Siphons are formed but not produced into tubes except in the Adacnidae.

Family **CARDIIDAE**

The shell substance is cellulo-crystalline, with the external layer more or less tubular; with a variable epidermis. The valves are equal, free, and gaping slightly behind. The beaks are prosocoelous. The margins are usually serrate or radially striated. The pedal muscle scar is distinct and usually distant from that of the adductor. The ligament and resilium are parivincular, short, external, and set in a groove. The area is obscure. The teeth are simple, smooth, never bifid. One cardinal in each valve is usually persistent, the others inconstant. The gills have a very simple type of reticulation; sometimes the outer limb is much produced dorsally. The siphonal septum is sometimes much produced anteriorly above the gills. The palps are large and not united distally. The foot is grooved and capable of being flattened to serve as a fulcrum. The mantle edges are papillose. The anal foramen has a well-developed valve but no siphons. The branchial foramen is large, usually complete. The perisiphonal area is profusely papillose.

KEY TO THE GENERA OF CARDIIDAE

- | | |
|---|-----------------------|
| (1) Shell distinctly sculptured..... | 2 |
| (1') Shell nearly smooth..... | <i>Laevicardium</i> |
| (2) Shell with two distinctly separated areas of sculpture..... | <i>Microcardium</i> |
| (2') Shell more or less uniformly sculptured..... | 3 |
| (3) Shell very thin; distinctly longer than high..... | <i>Papyridea</i> |
| (3') Shell not particularly thin; subcircular or higher than long..... | 4 |
| (4) Shell with 21 ribs or less, or, if with more than 21 ribs, then shell abruptly flattened posteriorly..... | <i>Trigoniocardia</i> |
| (4') Shell with 22 ribs or more; usually gently rounded or but very slightly flattened posteriorly..... | <i>Cardium</i> |

Genus **CARDIUM** Linnaeus*Cardium* Linnaeus (1758) Syst. Nat., Ed. 10: 678.TYPE (by subsequent designation, Children, 1823), *Cardium costatum* Linnaeus.

The shell is variably sculptured, usually with a predominantly radial ornamentation. It is usually closed or slightly gaping. There is no lunule or escutcheon. The pallial line is simple and rather distant from the margins of the valves.

There are other subgenera represented in the western Atlantic, but all the species recorded from Porto Rico and the Virgin Islands fall into the subgenus *Trachycardium*.

Subgenus **TRACHYCARDIUM** Mörch*Trachycardium* Mörch (1853) Cat. Yoldi, 2: 34.TYPE (by subsequent designation, von Martens, 1870), *Cardium isocardia* Linnaeus.

KEY TO THE SPECIES OF SUBGENUS TRACHYCARDIUM

- (1) Ribs smooth or with slight crenation or tuberculation.....*C. magnum*
 (1') Ribs with sharp scales.....2
 (2) Scales quite short; interior of shell white or slightly colored; shell subcircular in outline.....*C. muricatum*
 (2') Scales long; interior of shell stained with red or purple; shell elongate-ovate in outline.....*C. isocardia*

***Cardium (Trachycardium) isocardia* Linnaeus**

PLATE 14, FIGURE 1

Cardium isocardia Linnaeus (1758) Syst. Nat., Ed. 10: 679.*Cardium eburniferum* Guppy (1875) Ann. Mag. Nat. Hist., 15 (4): 51, Pl. 7 fig. 3.

This is a large, strongly sculptured species with conspicuous scales. They are short and thick anteriorly, and long, flattened, and vaulted posteriorly. The margin is denticulate. The color is yellowish white, tinted here and there with purple-brown. The interior is white, usually deeply stained with red or purple, especially beneath the disk and up under the umbones.

Length 40, height 51, width 35 mm.

Porto Rico: Mayaguez; Humacao; Boca Prieta.

Virgin Islands: St. Thomas; St. Croix; Caneel Bay, St. John; Tortola.

***Cardium (Trachycardium) muricatum* Linnaeus**

PLATE 14, FIGURE 3

Cardium muricatum Linnaeus (1758) Syst. Nat., Ed. 10: 680.

This species is distinguished from the preceding by the much less pronounced sculpture and the subcircular shape. The color is whitish or yellowish, tinted here and there with orange or light brown. The interior is white, sometimes tinted with yellow. There are usually two very characteristic reddish-yellow streaks which have their origin in the cavity of the umbones and fade out a short distance down the shell.

Length 40, height 41.5, width 28 mm.

Papyridea semisulcatum (Gray)

PLATE 15, FIGURE 2

Cardium semisulcatum Gray (1825) Annals of Philosophy, 25: 138.*Cardium ringiculum* Sowerby (1841) Proc. Zool. Soc. London, 8: 106.*Cardium petitanum* d'Orbigny (1846) Moll. Cubana, 2: 337, Pl. 27, figs. 50-52.

This is a very thin and fragile shell. The interstices between the posterior ribs are cut back so as to give the pronounced denticulation of this species. The shell is usually yellowish white, both exterior and interior sometimes stained with orange or rose, especially on the posterior side.

Length 13, height 9, width 7 mm.

Porto Rico: San Juan; Boca Prieta.

Virgin Islands: St. Thomas; Virgin Gorda.

Genus **TRIGONIOCARDIA** Dall*Trigoniocardia* Dall (1900) Trans. Wagner Free Inst. Sci. Philadelphia, 3 (5): 1075.TYPE (by original designation), *Cardium graniferum* Broderip and Sowerby.

The shells are typically small and few-ribbed; the medial ribs are very strong. The posterior end is subtruncate, with smaller, closer ribs. The channels between the ribs are strongly concentrically sculptured.

- (1) Hinge with the anterior laterals relatively close to the cardinals and the posterior laterals more remote. *Trigoniocardia* s.s.
 (1') Hinge with the anterior laterals almost as far removed from the cardinals as the posterior laterals. *Americardia*

Subgenus **TRIGONIOCARDIA** s.s.

The characters for the subgenus are those given under the genus, with the limiting features of the key.

KEY TO THE SPECIES OF **TRIGONIOCARDIA** S.S.

- (1) Shell rounded, usually with 21 radial ribs, the four middle ribs not greatly larger than the others. *T. antillarum*
 (1') Shell more triangular than in the preceding form, usually with 18 radial ribs, the four middle ribs much larger in proportion to the others. *T. ceramidum*

Trigoniocardia (Trigoniocardia) antillarum (d'Orbigny)

PLATE 14, FIGURE 4

Cardium antillarum d'Orbigny (1846) Moll. Cubana, 2: 338, Pl. 27, figs. 53-55.*Cardium guppyi* Thiele (1910) Zool. Jahrb., Suppl. 11: 129, Pl. 9, fig. 25-26.

The shell is rounded and almost subcircular, although it is obliquely truncated posteriorly. There are about 21 ribs, which are not markedly different in size. The color is white.

Length 11, height 10, width 8 mm.

Porto Rico: San Juan; Mayaguez.

Virgin Islands: Caneel Bay, St. John; Tortola; Virgin Gorda.

Trigoniocardia (Trigoniocardia) ceramidum (Dall)

PLATE 14, FIGURE 7

Cardium ceramidum Dall (1886) Bull. Mus. Comp. Zool., 12: 269, Pl. 4, fig. 6.

The shell is subtriangular in this species, and there are usually 18 ribs. The four middle ones are much larger than the rest. The sculpture in the interspaces between the ribs is quite noticeable. The color of the shell is white.

Length 8.2, height 8.2, width 8 mm.

Porto Rico: Mayaguez.

Virgin Islands: St. Thomas.

Subgenus **AMERICARDIA** Stewart

Americardia Stewart (1930) Acad. Nat. Sci. Phila., Special Publ. 3: 267.

TYPE (by original designation), *Cardium medium* Linnaeus.

The shell and hinge plate are fairly heavy. The cardinal teeth are unequal. The anterior laterals are almost as far removed from the cardinals as are the posterior laterals.

Trigoniocardia (Americardia) medium (Linnaeus)

PLATE 14, FIGURE 6

Cardium medium Linnaeus (1758) Syst. Nat., Ed. 10: 678.

The shell is somewhat squarely cordate, rounded anteriorly, and concavely angulated posteriorly. There are about 36 narrow radial ribs. The anterior ribs are covered with short scales. The color is white, variously clouded and spotted with reddish brown. The interior is white. This species is quite variable in the amount of depression of the posterior area and in the elevation of the upper part of the posterior margin projecting from the central part of the depression when the valves are closed.

Length 34, height 40, width 33 mm.

Porto Rico: Mayaguez; Ponce; Vieques.

Virgin Islands: Charlotte Amalie, St. Thomas; St. Croix; Caneel Bay, St. John; Tortola; Virgin Gorda.

Genus **LAEVICARDIUM** Swainson

Laevicardium Swainson (1840) Treat. Malacol., p. 373.

Liocardium Mörch (1853) Cat. Yoldi, 2: 35.

TYPE (by subsequent designation, Stoliczka, 1871), *Cardium oblongum* Gmelin.

The shell is of relatively great altitude, rounded or oval, and not gaping. The middle of the valves is smooth or feebly radially striate, and the ends of the valves have noticeable smooth areas. The anterior laterals arise from the umbonal cavity.

The members of this genus found in the Porto Rican region seem to fall into one variable species.

KEY TO THE SPECIES AND SUBSPECIES OF **LAEVICARDIUM**

- (1) Shell rounded, subcircular, with narrow brown radial lines. *L. l. multilineatum*
- (1') Shell oblique, oblong; color pattern irregular. 2
- (2) Shell small, less than 22 mm. in height; umbones pink with some pink flecks and shading on the disk. *L. l. sybariticum*
- (2') Shell larger, adult greater than 22 mm. in height; variously shaded and marked with pink, yellow, and brown. *L. laevigatum*

Laevicardium laevigatum (Linnaeus)

PLATE 14, FIGURE 8

Cardium laevigatum Linnaeus (1758) Syst. Nat., Ed. 10: 680.*Cardium serratum* of authors not Linnaeus.*Cardium citrinum* Wood (1815) General Conch., p. 223, Pl. 54, fig. 3.

The shell is thin, ovate, and oblique. The surface is smooth; occasionally there are obsolete radial striae. The inner margin is serrate. The exterior is colored with a great variety of pink, yellow, and brown shading and marking. The interior is white, often clouded with pink, yellow, or brown. The epidermis is light straw-colored, often inconspicuous.

Length 38, height 45.5, width 30 mm.

Porto Rico: Mayaguez; Ponce; Loiza Vieja; Vieques; Culebra.

Virgin Islands: Lindbergh Beach, St. Thomas; St. Croix; Caneel Bay, St. John; Tortola; Virgin Gorda.

Laevicardium laevigatum sybariticum (Dall)

PLATE 14, FIGURE 5

Cardium serratum sybariticum Dall (1886) Bull. Mus. Comp. Zool., 12 (6): 270.

This is a small, thin, deep-water subspecies. The shell is ovate, sometimes slightly subquadrate. It is of a translucent white color, with a deep pink flush on the umbones, and pink flecks on the disk of some specimens.

Length 11.5, height 13.5, width 8 mm.

Porto Rico: Mayaguez.

Laevicardium laevigatum multilineatum (Dall and Simpson)

PLATE 15, FIGURE 3

Cardium serratum multilineatum Dall and Simpson (1901) Bull. U.S. Fish Comm., 20: 489.

This large, circular shell, with fine, distinct radial lines, is easy to recognize. It is quite common in the Porto Rican and Virgin Islands area. There are specimens of typical *laevigatum* which approximate it in shape but they do not have the brown radial lines. This subspecies has been synonymized with the typical subspecies but since it occurs in a definite geographical area and seems to represent a distinct population, it is thought better to retain it as a separate entity.

Length 40, height 45, width 32 mm.

Porto Rico: Mayaguez; Ponce.

Virgin Islands: St. Thomas.

Genus **MICROCARDIUM** Thiele*Microcardium* Thiele (1935) Handb. Syst. Weichtierkunde, Pt. 3: 878.TYPE (by subsequent designation, Keen, 1937), *Cardium (Fulvia) permabile* Dall.

The shell is thin and usually small and rounded, sometimes slightly truncated posteriorly. It is equivalve, almost equilateral, and does not gape posteriorly. The surface sculpture is predominantly radial, with an area of reticulate or spinose ornamentation on the posterior slope.

KEY TO THE SPECIES OF MICROCARDIUM

- (1) Shell generally white; about 90 minute ribs. *M. peramabile*
 (1') Shell with color; more than 150 minute ribs. *M. tinctum*

Microcardium peramabile (Dall)

PLATE 15, FIGURE 5

Cardium peramabile Dall (1881) Bull. Mus. Comp. Zool., 9: 132.

The shell is quite tumid. The surface sculpture is divided into two distinct zones. The anterior three-fifths of the shell is provided with fine radiating ribs which are crossed with even finer concentric lines, leaving the surface minutely beaded. At the posterior margin of this area there is a larger rib which marks off this zone of sculpture. Behind this the ribs are finer and more widely spaced. There are occasional scales in this area which have their origin in the interspaces between the ribs.

Length 10, height 11, width 9 mm.

Porto Rico: Mayaguez; Aguadilla.

Virgin Islands: St. Croix.

Microcardium tinctum (Dall)

PLATE 15, FIGURE 6

Cardium peramabile var. *tinctum* Dall (1886) Bull. Mus. Comp. Zool. 12: 270.

This species is much like the preceding, but the areas of sculpture are not quite so distinctly marked off, and the ribs are much finer and more numerous. There are more spines or scales on the ribs in the posterior area of sculpture. The color is white, beautifully tinted and clouded with pink or red.

Length 13, height 12, width 9 mm.

Porto Rico: Mayaguez.

Virgin Islands: St. Croix.

Superfamily **VENERACEA**

The hinge plate is well developed, often broad and strong. Typically there are three cardinals in each valve, of which one or more may be bifid. Occasionally one or more cardinals are obsolete. In specialized forms there are supplemental cardinals or interlocking rugosities on the hinge plate. Usually there is a single obsolete lateral in one valve or the hinge is without laterals. The ligament is external, and the resilium marginal. The pallial sinus is usually well developed, although occasionally very small. It is largely free from the pallial line ventrally. The adductor muscle scars are rounded and subequal. In rare cases the posterior scar is somewhat larger than the anterior one. The gills are slightly plicated and are united behind to form an anal chamber. The palps are moderate in size. The foot is short, compressed, and keeled. There is no byssus. The mantle lobes are free ventrally except in the Glaucomyidae. The siphons are distinct. They may be separate or united and are usually long.

KEY TO THE FAMILIES OF VENERACEA

- (1) Free-living, equivalve forms with the valves regular and closed; a few rare forms are burrowing but these have three cardinal teeth in each valve; external sculpture not modified for burrowing. Veneridae
- (1') Typically burrowing forms, the shell often inequivalve and irregular, frequently somewhat gaping; three cardinals in the left valve and two in the right; external sculpture often spinose and modified for burrowing. Petricolidae

Family VENERIDAE

The valves are equal, free, and closed, with prosogyrous beaks. They are variably sculptured, with the margins more or less dentate, except in the smooth species. The adductor muscle scars are peripheral, with the pedal scar distant. The pallial sinus is more or less sinuated. The area is very distinct. The resilium is usually external, embraced by the ligament. The cardinals are frequently bifid, usually radially disposed and subequal in size except the posterior left one, which is often obsolete or obscure. The outer gill is smaller and frequently has a dorsal appendix. The palps are free behind. In the typical forms the foot is not grooved or byssiferous. The mantle edge is duplex and papillose. The siphons have papillose orifices; the anal one has a distal valve, and the branchial one is larger and has a small curtain valve proximally located.

There have been various schemes proposed for incorporating the genera of this family into subfamilies. However, there is little agreement between the various suggestions along this line, and for the purposes of the present work it seems best to treat them merely as a series of related genera.

KEY TO THE GENERA OF VENERIDAE

- (1) Anterior lateral teeth present, occasionally small. 2
- (1') Anterior lateral teeth absent. 8
- (2) Shell virtually circular. *Dosinia*
- (2') Shell not circular. 3
- (3) Pallial sinus very small, almost vestigial. *Gafrarium*
- (3') Pallial sinus moderate or large. 4
- (4) Lunule and escutcheon clearly delimited. *Antigona*
- (4') Lunule more or less well defined, but escutcheon not defined, or rarely extremely faintly so. 5
- (5) Inner margin sharply tangentially grooved. *Transenella*
- (5') Inner margin not tangentially grooved. 6
- (6) Pallial sinus acutely angular. *Pitar*
- (6') Pallial sinus rounded. 7
- (7) Shell shape triangular. *Tivela*
- (7') Shell shape rounded-oval. *Macrocallista*
- (8) Shell shape circular. *Cyclinella*
- (8') Shell shape not circular. 9
- (9) Valves rostrate posteriorly. *Anomalocardia*
- (9') Valves rounded or somewhat angular posteriorly but not rostrate. *Chione*

Genus DOSINIA Scopoli

Dosinia Scopoli (1777) Intr. Hist. Nat., p. 399.

TYPE (by monotypy), *Chama dosin* Adanson; = *Dosinia africana* Hanley.

The shell is circular and usually much compressed laterally. The surface is sculptured with concentric grooves. The lunule is well defined but the

escutcheon is variable, sometimes distinct and often obsolete. The hinge plate is very broad. There is an anterior lateral tooth in the left valve, though in many species it is much reduced. Typically there are three cardinals in each valve, although one or more may be obsolete. The pallial sinus is angular and ascending.

Dosinia concentrica (Born)

PLATE 15, FIGURE 4

Venus concentrica Born (1780) Test. Mus. Caes. Vind., p. 71, Pl. 5, fig. 5.

Dosinia floridana Conrad (1866) Am. Jour. Conch., 2: 280, Pl. 15, fig. 4.

Dosinia elegans Conrad: Dall and Simpson (1901) Bull. U. S. Fish Comm., 20: 486.

This fine species is similar to the more northern *D. elegans*, but is a more inflated shell, its width being greater in proportion to its other measurements. It is beautifully concentrically sculptured, with about nine ridges to the centimeter on the central portion of the disk. The color is yellowish white.

Length 68, height 66, width 31 mm.

Porto Rico: Ponce.

Virgin Islands: Long Bay, St. Thomas.

Genus **TRANSENNELLA** Dall

Transennella Dall (1883) Proc. U. S. Nat. Mus., 6: 340.

TYPE (by monotypy), *Cytherea* (*Transennella* ?) *conradina* Dall.

The shell is small and elongate-oval, somewhat pointed posteriorly. There are three cardinals in each valve. The middle left cardinal is bifid. There is an elongate left anterior lateral. The lunule is defined, but not the escutcheon. The pallial sinus is obliquely ascending and angular. The inner margins of the valves are sharply tangentially grooved.

KEY TO THE SPECIES OF TRANSENNELLA

- (1) Surface irregularly concentrically ridged; color white, generally with a few brown markings.....*T. cubaniana*
 (1') Surface obsolete, minutely, concentrically undulated; color light yellow-brown
T. culebrana

Transennella cubaniana (d'Orbigny)

PLATE 15, FIGURE 8

Venus cubaniana d'Orbigny (1846) Moll. Cubana, 2, Pl. 26, figs. 44-46.

This species is more ovate in shape than the next one, and the concentric sculpture of the surface is more pronounced. The brown flecking is also of diagnostic value.

Length 8, height 6, width 4 mm.

Porto Rico: Mayaguez.

Transennella culebrana (Dall and Simpson)

PLATE 15, FIGURE 7

Meretrix (*Transennella*) *culebrana* Dall and Simpson (1901) Bull. U. S. Fish Comm., 20: 486, Pl. 55, fig. 5.

This species is subtrigonal, with an obscure surface sculpture. The shell is white internally, but the exterior is a light yellow-brown.

Length 7, height 5.7, width 3.8 mm.

Porto Rico: Culebra.

Genus **TIVELA** Link

Tivela Link (1807) Besch. Nat.-Samml. Univ. Rostock, Pt. 2, p. 152.

TYPE (by subsequent designation, Dall, 1902), *Venus corbicula* Gmelin: = *Venus mactroides* Born.

The shell is solid, trigonal, and subequilateral. The surface is smooth. The beaks are prominent, and the ligament is short. The lunule is large but faintly defined. The escutcheon is not defined. The pallial sinus is small, free, and rounded in front. The hinge bears anterior laterals and from three to six cardinals. Some cardinals may be rugose, and some bifid.

Tivela mactroides (Born)

PLATE 15, FIGURE 9

Venus mactroides Born (1778) Indes Mus. Caes. Vind., p. 53.

Venus corbicula Gmelin (1792) Syst. Nat., Ed. 13: 3278.

This triangular species is not easily mistaken for any other in the region. It is variously rayed and clouded with brown coloration. In some specimens the epidermis is pronounced, but in others it is inconspicuous.

Length 47, height 42.5, width 31 mm.

Porto Rico: Humacao Playa; Guayama; Rio Herrera near Loiza Vieja; E. of Boca de Cangrejos.

Genus **GAFRARIUM** Röding

Gafrarium Röding (1798) Mus. Bolten., 2: 176.

TYPE (by subsequent designation, Dall 1902), *Venus pectinata* Linnaeus.

There are no species of *Gafrarium* s.s. in the western Atlantic.

This genus is represented by the subgenus *Gouldia*, which is characterised as follows.

Subgenus **GOULDIA** C. B. Adams

Gouldia C. B. Adams (1847) Cat. Rec. Shells, p. 29.

TYPE (by subsequent designation, Dall, 1902), *Thetis cerina* C. B. Adams.

The shell is small and trigonal-ovate. The lunule is long, narrow, and slightly depressed. The sculpture is made up of concentric rugae and less distinct radial threads. There are two anterior laterals in the right valve and one in the left. Each valve has three slender cardinals. The pallial sinus scarcely indents the pallial line. The inner ventral margin is not fluted, but the inner dorsal margin is grooved.

KEY TO THE SPECIES OF SUBGENUS GOULDIA

- (1) Shell about 5 mm. in length; rounded-oval in shape. *G. insularis*
 (1') Shell about 10 mm. in length; rounded-triangular in shape. *G. cerina*

Gafrarium (Gouldia) cerina (C. B. Adams)

PLATE 15, FIGURE 11

Thetis cerina C. B. Adams (1845) Proc. Boston Soc. Nat. Hist., p. 9.

Both this species and the following one are small and have both radial and concentric sculpture, which gives the surface a cancellate appearance. Adults of *cerina* are almost twice the length of adult *insularis*. This species is rounded-ovate in shape. The color is white or yellowish white. There usually are brown markings on the dorsal area and often on the disk as well.

Length 11, height 9.5, width 4.6 mm.

Porto Rico: Culebra.

Virgin Islands: St. Thomas.

Gafrarium (Gouldia) insularis (Dall and Simpson)

PLATE 15, FIGURE 10

Circe (Gouldia) insularis Dall and Simpson (1901) Bull. U. S. Fish Comm., 20: 487, Pl. 55, fig. 2.

This species is smaller than *cerina* and much more rounded in outline. The color is white. Many specimens have a fine sulcus parallel with the inner margin of the valves.

Length 5.5, height 5, width 3 mm.

Porto Rico: San Juan; Mayaguez.

Genus **MACROCALLISTA** Meek*Macrocallista* Meek (1876) Rept. U. S. Geol. Surv. Terr., 9: 179.TYPE (by monotypy), *Venus gigantea* Gmelin: = *Venus nimbose* Solander.

The shell is solid, transversely ovate in outline, and polished. The lunule is well defined, but the escutcheon is indistinct. The pallial sinus is large and rounded, with a small point in front. It is almost parallel to the hinge margin. A prominent left anterior lateral tooth is received in a deep socket in the right valve. There are three cardinals in each valve. They are smooth and entire except for the right posterior one, which is bifid.

Macrocallista maculata (Linnaeus)

PLATE 16, FIGURE 1

Venus maculata Linnaeus (1758) Syst. Nat., Ed. 10: 686.

This smooth, rounded-ovate species is very characteristically colored. The shell substance is white. It is mottled in a vague checkered pattern with reddish brown. There are two more or less interrupted rays of this color running obliquely across the disk of the shell from the umbones to the margin. The epidermis is light straw-colored, giving a yellowish cast to the exterior.

Length 67, height 50, width 30.5 mm.

Porto Rico: Quebradillas.

Virgin Islands: St. Thomas; Caneel Bay, St. John; Tortola.

Pitar (Pitar) fulminata (Menke)

PLATE 16, FIGURE 4

Cytherea fulminata Menke (1830) Syn. Moll. Mus. Menk., Ed. 2, p. 150.
Cytherea hebraea of authors, not Lamarck.

This species is similar to the preceding one, but has a distinct surface sculpture of concentric sulci. This sculpture does not always cover the entire shell, but is present on some parts of the surface. The pallial sinus is acute, and the shell, as a whole, is more trigonal than that of *albida*. The color is white, with radial or zigzag painting of brown coloration.

Length 46, height 38, width 26 mm.

Porto Rico: San Juan.

Virgin Islands: St. Thomas.

Subgenus **HYSTEROCONCHA** Fischer

Hysteroconcha Fischer (1887) Man. de Conchyl., p. 1079.
 TYPE (by monotypy), *Venus dione* Linnaeus.

The surface is sculptured with concentric laminae, which frequently became spinose on the posterior slope of the shell. The pallial sinus is much wider than in *Pitar* s.s., and the pallial line is closer to the margin of the shell. The shell has tinted coloration, not distinct color patterns.

KEY TO THE SPECIES OF SUBGENUS HYSTEROCONCHA

- (1) Concentric laminae elevated into spines on the posterior slope of the shell . . . *P. dione*
 (1') Concentric laminae not elevated into spines *P. circinata*

Pitar (Hysteroconcha) dione (Linnaeus)

PLATE 16, FIGURE 6

Venus dione Linnaeus (1758) Syst. Nat., Ed. 10: 684.
Dione veneris Reeve (1863) Conch. Icon., 15, Pl. 6, fig. 24.

The lamellae are thin and sharp over most of the surface of the shell. On account of their thin construction they are frequently broken or chipped, giving them an irregular appearance. On the anterior slope they are elevated into high fragile laminae, and on the posterior slope they are produced into spines. The basic color is white, largely shaded with pink or purple coloration.

Length 39, height 32, width 22 mm.

Porto Rico: Humacao Playa; Fajardo; Loiza Vieja.

Pitar (Hysteroconcha) circinata (Born)

PLATE 16, FIGURE 8

Venus circinata Born (1780) Test. Mus. Vind., p. 61, Pl. 4, fig. 8.

This species is quite similar to the preceding, but the laminae are not elevated or produced into spines. It is more lightly shaded with pink and sometimes with an orange coloration.

Length 40, height 33, width 24 mm.

Porto Rico: Mayaguez.
Virgin Islands: St. John.

Genus *ANTIGONA* Schumacher

Antigona Schumacher (1817) Essai Nouv. Syst. Vers Test., p. 154.
TYPE (by monotypy), *Antigona lamellaris* Schumacher.

The shell is medium-sized, elongate ovate, with strong, predominantly concentric sculpture. The lunule is wide, limited by a deep groove. The escutcheon is long and excavated. It is unequally divided between the two valves, being larger in the left valve. The umbones are plump. The ligament is deep-seated. The cardinals are large and partly bifid. There is a smaller anterior lateral. The inner margins are crenate. The pallial sinus is small and blunt.

The subgenera represented in the Porto Rican fauna differ in external sculpture and hinge dentition.

KEY TO THE SUBGENERA OF *ANTIGONA*

- (1) External sculpture made up of concentric lamellae crossed by distinct radial riblets; right anterior cardinal nearly parallel to the hinge line; right middle cardinal laminar, deeply bifid..... *Antigona* s.s.
(1') External sculpture with little or no radial component; right anterior cardinal nearly perpendicular to the hinge line; right middle cardinal conical, scarcely bifid..... *Ventricola*

Subgenus *ANTIGONA* s.s.

The cancellate sculpture is one character of this subgenus. There are several minor differences in the hinge teeth between this and the following subgenus. In *Antigona* s.s. the laterals are very small and indistinct. The cardinals are in the form of triangular laminae. In the left valve the anterior cardinal is grooved on the dorsal edge but not deeply bifid. The middle cardinal is distinctly bifid. The posterior one is thin and entire. The right valve has the anterior cardinal entire and the middle and posterior ones bifid.

Antigona (Antigona) listeri (Gray)

PLATE 16, FIGURE 5

Dosina listeri Gray (1838) The Analyst, 8 (24): 308.

This large, cancellate species is very distinct. The concentric elements of the sculpture are raised into thin lamellae. The lunule is elongate heart-shaped. There is sometimes a small amount of purplish brown coloration under the nymphs or around the posterior muscle scar.

Length 82, height 64, width 49 mm.

Porto Rico: Mayaguez; Ponce.

Virgin Islands; St. Thomas; Tortola; Virgin Gorda.

Subgenus *VENTRICOLA* Römer

Ventricola Römer (1867) Mala. Blät., 14: 115.

TYPE (by subsequent designation, Dall, 1902), *Venus rugosa* Gmelin. = *Venus rigida* Dillwyn.

The surface sculpture in this subgenus is predominantly concentric. The radial element is confined to crenulations of the concentric ribs. The laterals are small but somewhat larger than in *Antigona* s.s. The cardinals are more conical than in that subgenus. In the left valve the anterior cardinal is heavy, conical, and somewhat sinuated. The middle cardinal is heavy and bifid, and the posterior cardinal is long, narrow, and practically parallel with the hinge margin. The right valve has the anterior cardinal lamellar, rather thin and curved, and almost perpendicular to the hinge margin. The middle one is large, conical, and vaguely bifid. The posterior cardinal is long, strong, and bifid.

KEY TO THE SPECIES OF SUBGENUS VENTRICOLA

- (1) Large concentric ridges close-set, with one or two fine concentric threads between them. *A. rigida*
 (1') Large concentric ridges widely spaced, with four or five fine concentric threads between them. *A. rugatina*

Antigona (Ventricola) rigida (Dillwyn)

PLATE 17, FIGURE 1

Venus rugosa Gmelin (1792) Syst. Nat., Ed. 13: 3276; not Linnaeus (1758).

Venus rigida Dillwyn (1817) Cat. Shells, 1: 164.

This species is rounded and very tumid. The concentric ribs are very prominent and close together. There are one or two concentric threads in each major rib interval. The lunule is deeply sunk and kidney-shaped.

Length 76, height 67, width 59 mm.

Porto Rico: San Juan; Mayaguez.

Virgin Islands: St. Thomas; Tortola.

Antigona (Ventricola) rugatina (Heilprin)

PLATE 16, FIGURE 7

Venus rugatina Heilprin (1887) Trans. Wagner Free Inst. Sci. Phila., 1: 92, Pl. 2, fig. 24.

This species also is rounded and very tumid. The concentric ribs are widely spaced, and there are four or five concentric threads between them. The lunule is broadly heart-shaped.

Length 27, height 25, width 18 mm.

Porto Rico: Mayaguez.

Genus CYCLINELLA Dall

Cyclinella Dall (1902) Nautilus, 16: 44.

TYPE (by subsequent designation. Dall 1902); *Dosinia tenuis* Recluz.

The shell is medium-sized, thin, and suborbicular. There is no lunule and no escutcheon. The surface sculpture consists of growth lines. No lateral teeth are present. There are three slender cardinals in each valve. The posterior one is deeply bifid. The pallial sinus is moderately wide and deep, steeply ascending, the apex narrowly u-shaped.

Cyclinella tenuis (Recluz)

PLATE 17, FIGURE 3

Dosinia (Artemis) tenuis Recluz (1853) Jour. de Conchyl., 3: 250, Pl. 10, fig. 1.

This fine, circular species is easily recognized. The anterior muscle scar is located more ventrally than in many species, being some distance from the anterior termination of the hinge line. The shell is a beautiful translucent white.

Length 42, height 41, width 21 mm.

Porto Rico: Ponce; Mayaguez.

Virgin Islands: St. Thomas.

Genus **CHIONE** Megerle

Chione Megerle (1811) Ges. naturf. Freunde Berlin, Mag., 5: 51.

TYPE (by subsequent designation, Gray, 1847), *Venus dysera* Chemnitz = *Venus cancellata* Linnaeus.

There are no lateral teeth. Each valve has three cardinal teeth. Concentric sculpture is dominant, although many species have radial elements as well. The lunule and escutcheon are defined. The pallial sinus is short and angular. The inner margins of the valves are crenate.

KEY TO THE SUBGENERA OF CHIONE

- (1) Sculpture cancellate *Chione* s.s.
 (1') Sculpture made up of broad concentric waves *Lirophora*

Subgenus **CHIONE** s.s.

The characters are those given for the genus, with the limiting features of the key.

KEY TO THE SPECIES OF CHIONE s.s.

- (1) Shell small, adult specimens seldom exceeding 15 mm; elongate-oval in shape
C. pygmaea
 (1') Shell not small; not elongate-oval 2
 (2) Concentric ribs widely spaced, elevated, and frilled over most of the shell; sculpture cancellate *C. cancellata*
 (2') Concentric ribs not prominent; sculpture beaded over most of the shell
C. granulata

Chione (Chione) cancellata (Linnaeus)

PLATE 17, FIGURE 4

Venus cancellata Linnaeus (1767) Syst. Nat., Ed. 12: 1130.

This is one of the most typical bivalve mollusks of the West Indian fauna. The cancellate surface is very noticeable. The interior is variously shaded with pink, red, or purple.

Length 38, height 30, width 25 mm.

Porto Rico: San Juan; Mayaguez; Ponce; Puerto Real; Boqueron Bay; Boca de Cangrejos; Loiza Vieja; Vieques.

Chione (Chione) granulata (Gmelin)

PLATE 17, FIGURE 5

Venus granulata Gmelin (1792) Syst. Nat., Ed. 13: 3277.

This shell, also, is a typical member of the West Indian fauna. It has a characteristic beaded surface. The concentric and radial elements of the sculpture are about equal, which accounts for the granular or beaded appearance. The color is light yellowish to brown. It is variously shaded and marked with brown or purple coloration. The interior is shaded and clouded with pink and purple.

Length 33, height 28, width 20 mm.

Porto Rico: San Juan; Ponce; Guanica; San Antonio Bridge.

Virgin Islands: Lindbergh Beach, Charlotte Amalie, St. Thomas; St. John.

Chione (Chione) pygmaea (Lamarck)

PLATE 17, FIGURE 2

Venus pygmaea Lamarck (1818) Anim. s. Vert., 5: 585.

This small species is elongate-oval in shape. The sculpture is cancellate. The radial ribs are single on the disk. The color is white, variously flecked and spotted with brown. The dorsal border in the area of the escutcheon has characteristic transverse stripes of purplish-brown color.

Length 15, height 10.5, width 7 mm.

Porto Rico: Quebradillas.

Virgin Islands: St. Thomas; St. John; Tortola.

Subgenus **LIROPHORA** Conrad*Lirophora* Conrad (1863) Proc. Acad. Nat. Sci. Phila. for 1862, pp. 575, 586.TYPE (by subsequent designation, Dall, 1902), *Circomphalus (Lirophora) athleta* Conrad, = *Venus latilirata* Conrad.

The sculpture is of broad concentric waves, attenuated and often conspicuously lamellose distally. There are radial striae. The edges of the right nymph and the posterior left cardinal tooth have interlocking rugosities.

KEY TO THE SPECIES OF SUBGENUS LIROPHORA

- (1) Concentric rugae few, very large, not lamellose on the posterior slope
C. latilirata
- (1') Concentric rugae numerous, not as large as in the preceding species, lamellose on the posterior slope. *C. paphia*

Chione (Lirophora) latilirata (Conrad)

PLATE 17, FIGURE 7

Venus latilirata Conrad (1841) Proc. Aca. Nat. Sci. Phila., 1: 28.*Venus varicosa* Sowerby (1853) Thes. Conch., 2: 723, Pl. 155, fig. 67.

The tremendously developed concentric waves of sculpture are char-

acteristic of this species, and no other species in the West Indian region can be confused with it.

Length 33, height 29, width 22 mm.

Porto Rico: Mayaguez.

Chione (Lirophora) paphia (Linnaeus)

PLATE 17, FIGURE 9

Venus paphia Linnaeus (1767) Syst. Nat., Ed. 12: 1129.

The concentric waves are strongly developed in this species. They are somewhat lamellose on the anterior border and very much attenuate and lamellose posteriorly. The color is white, more or less mottled and shaded with reddish brown.

Length 45, height 37, width 26 mm.

Porto Rico: Mayaguez; Vieques.

Virgin Islands: St. Thomas; St. Croix; Caneel Bay, St. John; Tortola; Virgin Gorda.

Genus **ANOMALOCARDIA** Schumacher

Anomalocardia Schumacher (1817) Essai Nouv. Syst. Vers Test., pp. 44, 134.

TYPE (by monotypy), *Anomalocardia rugosa* Schumacher, = *Venus flexuosa* Linnaeus.

The valves are rostrate. Their inner margins are crenulate. The ligament is exposed, and the lunule and escutcheon are impressed. There are three simple cardinal teeth in each valve. They diverge rather widely from their common center beneath the umbones. The anterior right cardinal is feeble and sometimes nearly obsolete. The pallial sinus is small, angular, and sometimes nearly obsolete.

This group is not very markedly different from *Chione*. However, the species which are placed here are all rather uniform and similar, and it is generally regarded as a separate genus.

KEY TO THE SPECIES OF ANOMALOCARDIA

- | | |
|---|-----------------------|
| (1) Shell large and heavy | <i>A. brasiliiana</i> |
| (1') Shell small and thin | 2 |
| (2) Concentric ridges moderately wide and moderately spaced, 13 to 18 in number | <i>A. puella</i> |
| (2') Concentric ridges narrow and close together, 23 or more in number | <i>A. membranula</i> |

Anomalocardia brasiliiana (Gmelin)

PLATE 17, FIGURE 10

Venus flexuosa Born (1780) Test. Mus. Caes. Vind., p. 62, pl. 4, fig. 10; not Linnaeus (1767).

Venus brasiliiana Gmelin (1792) Syst. Nat., Ed. 13: 3289.

Cytherea macrodon Lamarck (1818) Anim. s. Vert., 5: 580.

This heavy, corrugated species is of a yellowish-white color, variously shaded and spotted with purple or brown. The inner margins of the valves are crenulated. The concentric ridges are sometimes obscured on the disk.

Length 33, height 28, width 20 mm.

Porto Rico: San Juan; Mayaguez; Ponce; Guanica; Humacao Playa; Boca de Cangrejos; Loiza Vieja.

Anomalocardia puella (Pfeiffer)

PLATE 17, FIGURE 6

Venus puella Pfeiffer (1846) [in] Philippi, Abb. Conch., 2 (4): 108.

Venus auferiana d'Orbigny, 1846, Moll. Cubana, 2: 319, Pl. 26, figs. 35-37.

This species, and the following one as well, may prove to be ecological variants of *A. cuneimeris* Conrad, which is common in the southeastern United States. At this time it seems best to regard them as separate. The ranges do not overlap.

The shell is small and fragile, with 13 to 18 narrow concentric ridges. It may be white, brown, or blue, and is variously marked or spotted with brown.

Length 17, height 11.5, width 7.5 mm.

Virgin Islands: St. Thomas; St. Croix.

Anomalocardia membranula Römer

PLATE 17, FIGURE 8

Anomalocardia membranula Römer (1860) Malac. Blätt., 7: 163.

This species is characterized by the numerous fine ridges. They number 23 or more and are very closely spaced. The shell is markedly elongate and attenuate posteriorly. The color is variable. It may be white, reddish, or bluish, and may be shaded or marked with reddish brown.

Length 14.5, height 9, width 7 mm.

Virgin Islands: St. Thomas.

Family **PETRICOLIDAE**

The valves, when not distorted, are equal, free, and somewhat gaping behind. They are radially sculptured with plain margins and inconspicuous beaks. The posterior adductor scar is larger than the anterior one. The pallial line is sinuated. The ligament and resilium are external. The area is obscure or not defined. The hinge is without lateral laminae. There are two or three small, usually bifid, radial cardinal teeth in each valve. The siphons are long, united only near the base. The outer reflected limb of the gill has an appendix.

KEY TO THE GENERA OF PETRICOLIDAE

- (1) Sculpture divaricate or zigzag *Narario*
 (1') Sculpture not divaricate or zigzag 2
 (2) Cardinal teeth closely grouped; radial sculpture predominant *Petricola*
 (2') Posterior cardinal extended along the hinge line, resembling a lateral; sculpture having radial threads and periodic concentric ridges *Coralliophaga*

Genus **PETRICOLA**

Petricola Lamarck (1801) Syst. Anim. s. Vert., p. 121.

TYPE (by subsequent designation, Gray, 1847), *Venus lithophagus* Retzius.

The shell is inflated and rounded in front, attenuated and compressed behind. The sculpture is chiefly radial and is stronger on the posterior end.

Petricola typica (Jonas)

PLATE 18, FIGURE 2

Choristodon typicum Jonas (1844) Zeitschr. Mal., 1: 185.

This species has the shell rounded in front and more or less compressed and attenuate behind. The numerous radial ribs are sharp and clearly marked off, with relatively broad interspaces. Like many burrowing species, it is variable in shell shape. The shell color is grayish white, stained internally with buff or brown.

Length 33, height 22, width 16 mm.

Virgin Islands: St. Thomas.

Genus **NARANIO** Gray

Narano Gray (1853) Ann. Mag. Nat. Hist. (2), 11: 38.

TYPE (by subsequent designation, Dall, 1900), *Narano costata* [Lamarck] Gray: = *Venus lapicida* Gmelin,

The shell is ovate. There is a short, moderately wide pallial sinus. The sculpture is radial and more or less divaricate or zigzag.

Narano lapicida (Gmelin)

PLATE 18, FIGURES 3, 4

Venus lapicida Gmelin (1792) Syst. Nat., Ed. 13: 3269.

Petricola costata Lamarck (1801) Syst. Anim. s. Vert., p. 121.

Petricola divaricata d'Orbigny (1846) Moll. Cubana, 2: 311.

In this species the shell is tumid and rounded-oval, and the umbones are well forward. The divaricating sculpture is very fine and quite distinct. At first glance there may appear to be a pronounced radial ribbing, particularly on the posterior slope of the shell. Upon careful examination it will be seen that this is not sculpture on the true surface of the shell, but is part of a calcareous coating which has been deposited on the shell and elaborated to simulate shell sculpture.

Length 29.5, height 22, width 16 mm.

Porto Rico: San Juan.

Virgin Islands: St. Thomas.

Genus **CORALLIOPHAGA** Blainville

Coralliophaga Blainville (1824) Dict. Sci. Nat., 32: 343.

TYPE (by monotypy), *Coralliophaga carditoidea* Blainville = *Chama coralliophaga* Gmelin.

The shell is elongate, rounded-rectangular, and the umbones are at the anterior end. There are three teeth in each valve. The posterior one is extended along the hinge line like a lateral. The posterior muscle scar is considerably larger than the anterior one. The pallial sinus is short and angular.

This genus is tentatively included under the Petricolidae, where it was

placed by Johnson.⁸ Its systematic position is uncertain. The hinge bears three teeth in each valve. These have been regarded as three cardinals by some authors, while others considered them as two cardinals and a lateral. Dall held the latter view and placed the genus in his family Pleurophoridae. There is disagreement in the interpretations of the anatomical features of this group. The present work does not attempt to resolve them but follows Johnson's placement of the genus.

Coralliophaga coralliophaga (Gmelin)

PLATE 18, FIGURE 1

Chama coralliophaga Gmelin (1792) Syst. Nat., Ed 13: 3305.

The shell is variable in this species, depending on the habitat of the individual. It is fundamentally elongate rounded-rectangular, but may be narrow and elongate or quite short and rounded. The radial elements of the sculpture are fine and threadlike. There are periodic concentric elevated ridges with rather wide interspaces.

These animals are sometimes found in burrows which were apparently excavated by other species. Such animals are apt to be deformed to a greater or less degree. Others are found in holes which seem to be of their own excavation.

Length 52, height 23, width 20 mm.

Porto Rico: Puerto Real.

Virgin Islands: St. Thomas.

Superfamily **TELLINACEA**

The hinge plate is narrow to moderate in thickness. There are two cardinals in each valve. The anterior cardinal is often bifid and somewhat pedunculate. The posterior one is frequently obsolete. Typically there is an anterior and a posterior lateral in each valve but one or both sets may be obsolete. The ligament is external, and the resilium is marginal or submarginal. The pallial sinus is well marked. It is largely contiguous with the pallial line ventrally. The adductor muscle scars are rounded. The anterior scar is somewhat larger than the posterior one. The gills are small or medium-sized and smooth or plicate. They are united behind the foot. The palps are moderate to large in size. The foot is compressed and not grooved, often short. There is no byssus. The lobes of the mantle are free ventrally. The siphons are produced, usually long and separate.

KEY TO THE FAMILIES OF TELLINACEA

- (1) Resilium marginal or submarginal, not internal 2
- (1') Resilium internal, seated on oblique chondrophores Semelidae
- (2) Valves equal and subtrigonal, usually closed and solid; hinge plate moderately developed Donacidae
- (2') Valves slightly unequal, thin and compressed, hinge plate very narrow 3
- (3) Valves slightly unequal, twisted posteriorly; epidermis inconspicuous; gills small and palps very large Tellinidae

⁸ Johnson, C. W., Proc. Boston Soc. Nat. Hist. 40 (1): 50. 1934.

- (3') Valves more equal and less twisted than in 3; the epidermis relatively more conspicuous; gills larger in proportion, and palps relatively smaller

Sanguinolariidae

Family TELLINIDAE

The shell substance is cellulose-crystalline with an inconspicuous epidermis. The valves are compressed and slightly unequal. They are rounded in front, more or less rostrate, oblique, and gaping behind. The valve margins are usually smooth. The beaks are low and variable in position. The sculpture is chiefly concentric. The anterior adductor scar is larger than the posterior one and frequently irregular. The pedal scar is distinct. The resilium is submarginal and embraced in the ligament. The area is narrow or obsolete. The hinge plate is narrow, with the anterior lateral close to the cardinals and the posterior one more distant. Both laterals may be obsolete. The cardinal teeth are small. The gills are very small and have the outer limb dorsally directed. It is sometimes without a reflected lamina and may be obsolete. The palps are very large and are united behind. Anteriorly they sometimes have an antennalike projection. The foot is sometimes capable of being flattened for use as a fulcrum. The mantle margins are duplex, with papillose edges. The siphons are long, unequal, and naked. They are retractile and have papillose orifices. There is no curtain valve in the branchial siphon. The pallial sinus is deep and discrepant in the opposite valves.

KEY TO THE GENERA OF TELLINIDAE

- (1) Hinge with lateral teeth 2
 (1') Hinge without lateral teeth 3
 (2) Shell without oblique sculpture, or, if oblique lines are present, then shell shape elongate *Tellina*
 (2') Shell subcircular, with finely incised oblique sculpture crossing the concentric growth lines *Strigilla*
 (3) Shell with a posterior flexure but no sulcus *Macoma*
 (3') Shell with a posterior flexure and a large sulcus *A polymetis*

Genus TELLINA Linnaeus

Tellina Linnaeus (1758) Syst. Nat., Ed. 10: 674.

TYPE (by subsequent designation, Children, 1823), *Tellina radiata* Linnaeus.

The shell is subequivalve, rather compressed, suborbicular or transversely elongate, and obliquely flexed behind. The umbones are subcentral. The hinge has two cardinals and generally two laterals in each valve. There is one anterior and one posterior lateral, most distinct in the right valve and often obsolete or absent in the left. The pallial sinus is wide and deep. The ligament is external and prominent.

KEY TO THE SUBGENERA OF TELLINA

- (1) Hinge with two lateral laminae in each valve *Tellina* s.s.
 (1') Hinge with less than two lateral laminae per valve 2
 (2) Hinge with two lateral laminae in the right valve, the laminae of the left valve more or less obsolete or absent 3

- (2') Hinge with a strong right anterior lateral, closely adjacent to the cardinals, the other laterals absent. *Angulus*
 (3) Shell greater than 10 mm. in length. *Arco pagia*
 (3') Shell less than 10 mm. in length. *Moerella*

Subgenus **TELLINA** s.s.

The characters of the subgenus are those given for the genus, with the limiting features of the key.

KEY TO THE SPECIES OF **TELLINA** s.s.

- (1) Shell elongate. 2
 (1') Shell rather bluntly oval. 3
 (2) Shell highly polished. *T. radiata*
 (2') Shell with rough concentric sculpture. *T. alternata*
 (3) Shell large; rounded. *T. laevigata*
 (3') Shell small; oval. *T. lineata*

Tellina (Tellina) radiata Linnaeus

PLATE 18, FIGURE 5

Tellina radiata Linnaeus (1758) Syst. Nat., Ed. 10: 675.

Tellina unimaculata Lamarck (1818) Anim. s. Vert., 5: 521.

This large, elongate, highly polished species is very striking in appearance. The shell is a pure milky white. There is some yellow shading and it is variously rayed with pink or red coloration. The color form described by Lamarck as *unimaculata* is entirely white and yellow except for a red ray which covers the umbones and extends a short distance toward the ventral border.

Length 114, height 53, width 27.5 mm.

Porto Rico: San Juan; Aguadilla.

Virgin Islands: Bird Key, St. Thomas; St. Croix; Caneel Bay, St. John; Tortola; Virgin Gorda.

Tellina (Tellina) interrupta Wood

PLATE 18, FIGURE 7

Tellina interrupta Wood (1815) Gen. Conch., p. 146.

Tellina antonii Philippi (1844) Abb. Conch., 1 (5): 124.

The shell is elongate and somewhat attenuate behind. The concentric ridges are clear-cut and prominent. The color is yellowish white, variously flecked and rayed with brown or brownish purple coloration.

Length 90, height 46, width 22 mm.

Virgin Islands: St. Thomas; St. Croix; Tortola; Virgin Gorda.

Tellina (Tellina) laevigata Linnaeus

PLATE 18, FIGURE 9

Tellina laevigata Linnaeus (1758) Syst. Nat., Ed. 10: 675.

This large rounded species is white, with variable shading of yellow or salmon color. The coloration is principally in the form of bands which are concentrically arranged and irregularly spaced. Frequently the color is

confined to the marginal part of the shell. The surface is smooth or has inconspicuous growth lines.

Length 74, height 58, width 20 mm.

Virgin Islands: St. Thomas; St. Croix.

Tellina (Tellina) lineata Turton

PLATE 18, FIGURE 6

Tellina lineata Turton (1819) Conch. Dict., p. 168, Pl. 4, fig. 16.

This is a smaller species than the three preceding ones. The surface has an indistinct concentric sculpture. The shell is more or less elongate-oval, somewhat attenuate behind. The color is white, often with a red flush on the umbones which extends part of the way down onto the disk.

Length 30, height 20, width 7 mm.

Porto Rico: Mayaguez.

Virgin Islands: St. Thomas.

Subgenus **ARCOPAGIA** Brown

Arcopagia Brown (1827) III. Conch. Great Britain and Ireland, Pl. 16, species 8.

TYPE (by subsequent designation, Herrmannsen, 1846), *Tellina crassa* Pennant.

The shell is compressed. It may be elongate or short and rounded. In some sections the pallial sinus is confluent with the pallial line, while in others it is partly free and ascending. Most of the sections have either internal strengthening rays or a left anterior lateral tooth. There are two cardinals in each valve.

The systematics of the Tellinidae as a whole and of this group in particular are somewhat unsatisfactory at the present time. The lines of demarcation between the groups are very tenuous. A careful analysis of the morphological features was made by Dall, but the uncertainty was not entirely eliminated. Experimental investigation of the nature of the diagnostic characters will probably have to be made before the species can be properly grouped and correlated.

KEY TO THE SPECIES OF SUBGENUS **ARCOPAGIA**

- | | |
|--|----------------------|
| (1) Shell short and rounded | 2 |
| (1') Shell elongate | 3 |
| (2) Shell large; surface sculptured with growth lines | <i>T. fausta</i> |
| (2') Shell small; surface with distinct concentric ridges | <i>T. lintea</i> |
| (3) Length greater than 30 mm. | 4 |
| (3') Length less than 30 mm. | 5 |
| (4) Concentric sculpture distinct and regular | <i>T. alternata</i> |
| (4') Concentric sculpture indistinct and irregular | <i>T. angulosa</i> |
| (5) Shell about 10 mm. in length | <i>T. vespuciana</i> |
| (5') Shell about 20 mm. in length | 6 |
| (6) Posterior end of shell relatively short; shell suffused with apricot-yellow coloration | <i>T. persica</i> |
| (6') Posterior end of shell relatively elongate; shell tinted and faintly rayed with pink | <i>T. guildingii</i> |

Tellina (Arcopagia) fausta Donovan

PLATE 18, FIGURE 10

Tellina fausta Donovan (1804) Nat. Hist. British Shells, p. 10, Pl. 25, figs. 13, 14.

This large, round, smooth species is quite distinct. It is white, somewhat tinted with yellow, especially on the inside of the shell.

Length 77, height 64, width 31 mm.

Porto Rico: San Juan; Mayaguez; Ponce.

Virgin Islands: St. Thomas; St. Croix; Tortola.

Tellina (Arcopagia) lintea Conrad

PLATE 18, FIGURE 8

Tellina lintea Conrad (1837) Jour. Acad. Nat. Sci. Phila., 7: 259, Pl. 2, fig. 3.

This fine little species is distinctly concentrically sculptured. The shell is rounded anteriorly, somewhat attenuate and strongly flexed posteriorly. The color is white.

Length 20, height 13, width 5 mm.

Porto Rico: Mayaguez.

Tellina (Arcopagia) alternata Say

PLATE 19, FIGURE 1

Tellina alternata Say (1822) Jour. Acad. Nat. Sci. Phila., 4: 275.*Tellina tayloriana* Sowerby (1867) Conch. Icon., 17, Pl. 30, fig. 68.

This large, elongate species has distinct and regular concentric sculpture. It occurs in a white phase and a pink phase. The latter one has received the name *tayloriana*. It is apparently just a color form, but does not occur throughout the entire range of the species. It is close to the following species, but differs in the more regular sculpture. It is also a larger species, and the posterior end of the shell is a little more elongate.

Length 65, height 35, width 12 mm.

Porto Rico: Mayaguez.

Virgin Islands: St. Thomas.

Tellina (Arcopagia) angulosa Gmelin

PLATE 19, FIGURE 2

Tellina angulosa Gmelin (1792) Syst. Nat., Ed. 13: 3244.

This species resembles the preceding one, but the sculpture is indistinct and irregular and the posterior end of the shell is shorter. The height is slightly greater in proportion to the length than in *alternata*, and the shell is somewhat smaller. It almost always has some degree of pink coloration.

Length 56, height 29, width 10.5 mm.

Virgin Islands: Magens Bay, St. Thomas.

Tellina (Arcopagia) vespuciana d'Orbigny

PLATE 19, FIGURE 5

Tellina vespuciana d'Orbigny (1846) Moll. Cubana, 2: 254, Pl. 26, figs. 12-14.

This small, elongate species has a flexure of the posterior ends of the valves. It is finely, regularly, concentrically sculptured. It was described by d'Orbigny as a white shell, but Dall reports a red color phase.

Length 11, height 6.5, width 3 mm.

Porto Rico: Mayaguez.

Tellina (Arcopagia) guildingii Hanley

PLATE 19, FIGURE 7

Tellina guildingii Hanley (1844) Proc. Zool. Soc. London, 12: 60.

Tellina (Eurytellina) georgiana Dall (1900) Proc. U. S. Nat. Mus., 23 (1210): 310, Pl. 2, fig. 3; not *Tellina georgiana* Gabb.

This species has the posterior end of the shell relatively elongate. The surface is covered with a fine, regular, concentric sculpture. It is white, shaded and rayed with pink, and sometimes tinged with yellow.

Length 17, height 10, width 4 mm.

Porto Rico: Mayaguez; Aguadilla.

Virgin Islands: St. Thomas.

Tellina (Arcopagia) persica Dall and Simpson

PLATE 19, FIGURE 3

Tellina persica Dall and Simpson (1901) Bull. U. S. Fish Comm. 20: 479, Pl. 55, fig. 1.

This species is of a very characteristic color. It is white but largely shaded with apricot-yellow on the outside and on the inside as well. It is somewhat less elongated posteriorly than the preceding species. The concentric sculpture is more prominent on the posterior slope.

Length 20.5, height 13, width 5.5 mm.

Porto Rico: Mayaguez.

Subgenus **MOERELLA** Fischer

Moerella Fischer (1887) Man. Conch., p. 1147.

TYPE (by monotypy), *Tellina donacina* Linnaeus.

The shell is elongate-ovate, inequilateral, with the posterior end obscurely rostrate. The sculpture consists of concentric rugae. The right anterior cardinal and the left posterior cardinal are very small. The right laterals are strong, and the anterior one is closer to the cardinals than the posterior one. The left laterals are weak, the anterior one being still weaker than the posterior one. The pallial sinus almost touches the anterior adductor muscle scar and is confluent with the pallial line below. Its apex is U-shaped.

Tellina (Moerella) martinicensis d'Orbigny

PLATE 19, FIGURE 10

Tellina martinicensis d'Orbigny (1846) Moll. Cubana, 2: 253, P. 26, figs. 6, 8.

This little species is quite tumid. It is more or less rostrate behind. The surface is marked with a pronounced concentric sculpture. The shell is white.

Length 10, height 8, width 4 mm.
 Porto Rico: San Juan; Puerto Real.
 Virgin Islands: Charlotte Amalie, St. Thomas.

Subgenus **ANGULUS** Megerle

Angulus Megerle (1811) Ges. Nat. Fr. Berlin Mag., 5 (1): 47.
 TYPE (by subsequent designation, Gray, 1847), *Tellina lanceolata* Gmelin.

The shell is elongated, variable in size, but chiefly small and compressed. The posterior end is angularly pointed but not twisted. The surface is smooth or finely concentrically sculptured. There are two cardinal teeth in each valve. There is a strong right anterior lateral closely adjacent to the cardinals. The left laterals are absent, and the posterior right lateral is obsolete. The valves are occasionally strengthened with thickened internal rays.

KEY TO THE SPECIES OF SUBGENUS ANGULUS

- (1) Surface smooth or with fine concentric striation 2
- (1') Surface having fine oblique grooves crossing the concentric sculpture at an angle 8
- (2) Shell very large *T. magna*
- (2') Shell small 3
- (3) Shell short, rounded *T. promera*
- (3') Shell elongate 4
- (4) Ventral border more or less straight 5
- (4') Ventral border smoothly rounded *T. viurea*
- (5) Posterior end of shell rather blunt 6
- (5') Posterior end of shell relatively angular 7
- (6) Posterior end of shell somewhat more elongate than the next species; shell faintly rayed with red *T. consobrina*
- (6') Posterior end of shell very short and obtuse; shell color white *T. pauperata*
- (7) Posterior end of shell produced but rounded at the tip; shell color white *T. simplex*
- (7') Posterior end of shell produced but truncate squarely at the tip; shell red, coloration intensified in concentric waves *T. sybaritica*
- (8) Posterior end of shell nearly as long as anterior end *T. caribaea*
- (8') Posterior end of shell very short *T. candeana*

Tellina (Angulus) magna Spengler

PLATE 19, FIGURE 12

Tellina magna Spengler (1798) Skr. Nat. Selsk. Copenhagen, 4 (2): 76.

This large, oval, compressed species is smooth except for some indistinct radial striation near the margin. It is white or concentrically shaded with pink or orange. It is quite distinct.

Length 108, height 63, width 19 mm.
 Virgin Islands: St. Croix.

Tellina (Angulus) promera Dall

PLATE 19, FIGURE 11

Tellina (Angulus) promera Dall (1900) Proc. U. S. Nat. Mus., 23 (1210): 312, Pl. 2, fig. 11.

This is a rather short species, rounded in front and bluntly angular

behind. The surface has low, irregular, concentric sculpture. The shell is white.

Length 22, height 16.5, width 7 mm.

Virgin Islands: Lindbergh Beach, St. Thomas.

***Tellina (Angulus) vitrea* d'Orbigny**

PLATE 19, FIGURE 8

Tellina vitrea d'Orbigny (1846) Moll. Cubana, 2: 253, Pl. 26, figs. 4, 5.

This thin, glassy little species has a rather distinctive shape. The ventral border of the valves is smoothly curved, causing the shell to appear more or less pointed at each end. The surface is smooth with very fine concentric lines. The color is translucent white.

Length 33, height 18, width 6 mm.

Porto Rico: Mayaguez; Boqueron Bay.

***Tellina (Angulus) consobrina* d'Orbigny**

PLATE 19, FIGURE 9

Tellina consobrina d'Orbigny (1846) Moll. Cubana, 2: 254, Pl. 26, figs. 9-11.

This shell was mentioned by d'Orbigny as having certain resemblances to the much larger *T. radiata*. It is elongate-oval in shape and sculptured with fine concentric lines. The shell is thin. It is white with yellow tinting and rays of pink coloration.

Length 15, height 8, width 4 mm.

Porto Rico: Mayaguez.

Virgin Islands: St. Thomas.

***Tellina (Angulus) pauperata* d'Orbigny**

PLATE 19, FIGURE 6

Tellina pauperata d'Orbigny (1846) Moll. Cubana, 2: 306, Pl. 26, figs. 18-20.

This little white species is nearly smooth on the surface. There are fine concentric growth lines. The posterior end is characteristically short and truncated in appearance.

***Tellina (Angulus) simplex* d'Orbigny**

PLATE 19, FIGURE 4

Tellina simplex d'Orbigny (1846) Moll. Cubana, 2: 305, Pl. 26, figs. 15-17.

This little, smooth, white species resembles the preceding one and the following one as well. It may be distinguished from the former by its more attenuate posterior end, and from the latter by the absence of strong pink coloration.

Length 10.5, height 6, width 3 mm.

Virgin Islands: St. Thomas.

***Tellina (Anbulus) sybaritica* Dall**

PLATE 20, FIGURE 1

Tellina sybaritica Dall (1881) Bull. Mus. Comp. Zool., 9: 134.

This small species is somewhat like a number of the preceding ones. It differs on two salient points. One is the red coloration, which is intensified over the disk in concentric waves. The other is the squared tip on the angular posterior end of the shell.

Length 6.5, height 3.5, width 2 mm.

Porto Rico: San Juan; Mayaguez.

Tellina (Anbulus) caribaea d'Orbigny

PLATE 20, FIGURE 3

Tellina caribaea d'Orbigny (1846) Moll. Cubana, 2: 303, Pl. 25, figs. 47-49.

This shell is rounded-rectangular in shape. The surface is quite smooth except for low concentric growth lines and the fine oblique grooves which cross the concentric sculpture at an angle. It may be white, pink, or more or less tinted with pink or orange.

Length 22, height 13, width 6 mm.

Virgin Islands: St. Thomas.

Tellina (Anbulus) candeana d'Orbigny

PLATE 20, FIGURE 2

Tellina candeana d'Orbigny (1846) Moll. Cubana, 2: 303, Pl. 25, figs. 50-52.

The surface of the shell in this species is much the same as in the preceding one. The anterior end is rounded in about the same way in both. In *candeana*, however, the posterior end of the shell is very much reduced. The color is white. In some specimens there may be traces of pink coloration.

Length 11, height 7.5, width 3.5 mm.

Virgin Islands: St. Thomas.

Genus **STRIGILLA** Turton

Strigilla Turton (1822) Conch. Insul. Britannicarum, p. 117.

TYPE (by subsequent designation, Gray, 1847), *Tellina carnaria* Linnaeus.

The shell is thin, rounded-oval, and rather inflated. The surface is sculptured in a very characteristic way. The inconspicuous concentric growth lines are crossed by oblique fine lines which are clearly and beautifully incised into the shell. Both anterior and posterior laterals are well developed in each valve. There is a slender anterior cardinal and a heavy, bifid cardinal in the right valve. The left valve bears a slender, bifid anterior cardinal and a simple, slender posterior cardinal. The pallial sinus is largely confluent with the pallial line below. It may approach the anterior adductor scar or unite with it.

KEY TO THE SPECIES OF STRIGILLA

- (1) Shell relatively large, somewhat laterally compressed; surface of the shell white but generally tinted with pink coloration both inside and outside. 2
- (1') Shell smaller and more tumid; without pink color or having it more or less limited to the umbones outside and to the deeper part of the shell within. 3

- (2) Pallial sinus joined to the anterior adductor scar.....*S. carnaria*
 (2') Pallial sinus not reaching the anterior adductor scar.....*S. rombergi*
 (3) Shell white.....*S. flexuosa*
 (3') Shell white, the umbones and the deeper part of the interior tinted with red
S. pisiformis

Strigilla carnaria (Linnaeus)

PLATE 20, FIGURE 4

Tellina carnaria Linnaeus (1758) Syst. Nat., Ed. 10: 676.

The basic color is white, but the shell is tinted and clouded with red within and often on the outside as well. The shell is somewhat laterally compressed. The pallial sinus is discrepant in the two valves above and is confluent with the pallial line below. It is joined to the anterior adductor muscle scar.

Length 20, height 17, width 9 mm.

Porto Rico: Mayaguez; Aguadilla; Arroyo; Humacao; Quebradillas.
 Virgin Islands: St. Thomas.

Strigilla rombergi Mörch

PLATE 20, FIGURE 5

Strigilla rombergi Mörch (1853) Yoldi Cat., 2: 15.

This species bears a close resemblance to the preceding one. In *rombergi*, however, the pallial sinus is alike in both valves and does not reach the anterior adductor muscle. It is confluent with the pallial line below in both species.

Length 28, height 23, width 12 mm.

Porto Rico: San Juan; Arroyo.
 Virgin Islands: St. Thomas.

Strigilla flexuosa (Say)

PLATE 20, FIGURE 6

Tellina flexuosa Say (1822) Jour. Acad. Nat. Sci. Phila., 2: 303.

This small, tumid, white species is not to be confused with any other in the region.

Length 11, height 10, width 6.5 mm.

Porto Rico: San Juan.
 Virgin Islands: St. Thomas; St. Croix.

Strigilla pisiformis (Linnaeus)

PLATE 20, FIGURE 7

Tellina pisiformis Linnaeus (1758) Syst. Nat., Ed. 10: 677.

The small size, tumid shape, and pink umbones and interior are characteristic features of this shell.

Length 8, height 9, width 5 mm.

Porto Rico: San Juan; Mayaguez; Aguadilla.
 Virgin Islands: St. Thomas.

Genus **APOLYMETIS** Salisbury

Metis Adams (1856) Gen. Moll., 2: 399, (not Philippi, 1843).

Polymetis Salisbury (1929) Proc. Mal. Soc. London, 18: 255, (not Walsingham, 1903).

Apolymetis Salisbury (1929) *loc. cit.* 18: 258.

TYPE (by original designation), *Tellina meyeri* Philippi.

The shell is large and thin. It is irregularly quadrate. The posterior end is flexed, and there is a large radial sulcus on the posterior slope. The surface sculpture is composed of concentric growth lines. The hinge is almost without teeth. There are no laterals, and the cardinals are very much reduced. There are two vestigial cardinals in the right valve. The left valve bears a small bifid anterior cardinal and a very small posterior cardinal. The pallial sinus is very large and confluent with the pallial line for about two-thirds of its length ventrally.

Apolymetis intastriata (Say)

PLATE 20, FIGURE 8

Tellina intastriata Say (1827) Jour. Acad. Nat. Sci. Phila., 5: 218.

Tellina grüneri Philippi (1845) Zeitschr. f. Mal., 2: 150.

The shell is rather irregular in shape, rounded or subquadrate. It is thin and fragile and of a white or yellowish white color. The flexed posterior end with the pronounced sulcation on the posterior slope is distinctive.

Length 57, height 43, width 22 mm.

Virgin Islands: St. Thomas.

Genus **MACOMA** Leach

Macoma Leach (1819) in Ross, Voy. Discov. Baffins Bay, App. 2, Pl. 12.

TYPE (by monotypy), *Macoma tenera* Leach, = *Tellina calcarea* Gmelin.

The shell is elongate-ovate and inequilateral. The sculpture consists of concentric growth lines. There are no lateral teeth. The right valve has a slender anterior cardinal and a widely and deeply bifid posterior cardinal. In the left valve there is a widely and deeply bifid anterior cardinal and a slender posterior cardinal. The pallial sinus is deep and partly confluent with the pallial line below. Its apex is U-shaped.

KEY TO THE SPECIES OF **MACOMA**

- (1) Shell oval.....2
- (1') Shell elongate-oval.....3
- (2) Shell large and thin; pallial sinus largely confluent with the pallial line below
M. constricta
- (2') Shell small and relatively heavy; pallial sinus scarcely confluent with the pallial line.....*M. pseudomera*
- (3) Length 40 mm. or more.....*M. tageliformis*
- (3') Length 25 mm. or less.....4
- (4) Shell fairly solid; posterior end rather truncate in appearance; color white with orange color internally.....*M. brevifrons*
- (4') Shell thin and fragile; posterior end somewhat attenuate; color white, with a brownish epidermis marginally.....*M. souleyetiana*

Macoma constricta (Bruguière)

PLATE 20, FIGURE 12

Solen constricta Bruguière (1799) Mém. Soc. Hist. Nat. Paris, 1: 126.

Tellina cayennensis Hanley (1846) Thes. Conch., p. 312, Pl. 62, fig. 190.

This large white shell with no lateral teeth and a posterior flexure is quite distinct in the Antillean fauna. The pallial sinus is confluent with the pallial line along most of the ventral border. A light brown epidermis is sometimes present.

Length 54, height 38, width 19 mm.

Porto Rico: San Juan; Quebradillas.

Macoma pseudomera Dall and Simpson

PLATE 20, FIGURE 11

Macoma pseudomera Dall and Simpson (1901) Bull. U. S. Fish Comm., 20: 481, Pl. 56, fig. 5.

The posterior end is short and rather squarely truncate. The shell is especially heavy for a member of this genus. It is sculptured with rather prominent growth lines. The pallial sinus is short, ascending, and scarcely confluent with the pallial line below.

Length 16, height 12, width 6 mm.

Porto Rico: San Juan; Mayaguez.

Macoma tageliformis Dall

PLATE 20, FIGURE 13

Macoma tageliformis Dall (1900) Proc. U. S. Nat. Mus., 23: 300.

This large white species has somewhat the appearance of a *Tellina*, but there are no lateral teeth. The pallial sinus is confluent with the pallial line for about a third of its length and then is ascending.

Length 46, height 28, width 13 mm.

Porto Rico: Mayaguez.

Macoma souleyetiana (Recluz)

PLATE 20, FIGURE 9

Tellina souleyetiana Recluz (1852) Jour. de Conchyl., 3: 253, Pl. 10, figs. 5, 5'.

This small, fragile species looks almost like a miniature of the preceding one. The posterior end of the shell is somewhat attenuate and has the appearance of constriction just back of the umbones. It is often listed as a subspecies of the boreal *Macoma tenta* Say, but is regarded here as distinct.

Length 18, height 10, width 6 mm.

Porto Rico: Mayaguez.

Virgin Islands: St. Thomas.

Macoma brevifrons (Say)

PLATE 20, FIGURE 10

Tellina brevifrons Say (1834) Am. Conch., 7: 227, Pl. 64, fig. 7.

In this polished species the posterior end of the shell is rather short and truncate. The shell is white, with a characteristic orange flush on the umbones and in the interior of the shell.

Length 35, height 18, width 10 mm.

Porto Rico: San Juan; Ponce; Aguadilla.

Family SANGUINOLARIIDAE

The members of this family are very similar to those of the Tellinidae. The shell is more equivalve and less twisted, and the epidermis is more conspicuous. The hinge plate is broader and the shells gape posteriorly. There are no laterals except in rare specimens of *Heterodonax*, but sometimes as many as three cardinals in one valve. The external ligament and marginal resilium are conspicuous. There is no defined area. The gills are plicate and have the outer direct and reflected limb ventrally directed. The palps are smaller in proportion to the gills.

KEY TO THE GENERA OF SANGUINOLARIIDAE

- (1) Shell telliniform.....2
- (1') Shell other than telliniform.....4
- (2) Shell smooth or with low concentric sculpture.....3
- (2') Shell with rough radial sculpture.....*Asaphis*
- (3) Posterior end of shell attenuate.....*Sanguinolaria*
- (3') Posterior end of shell truncate.....*Psammobia*
- (4) Shell donaciform.....*Heterodonax*
- (4') Shell soleniform.....*Tagelus*

Genus SANGUINOLARIA Lamarck

Sanguinolaria Lamarck (1799) Mém. Soc. Hist. Nat. Paris, 1: 84.

TYPE (by monotypy), *Solen sanguinolentus* Gmelin.

The shell is thin, ovate, and somewhat attenuate behind. The sculpture is made up of low concentric growth lines. There are no lateral teeth. In the right valve there is a prominent anterior cardinal and a thin lamellar posterior cardinal. The left valve bears a strong anterior cardinal and a well-developed prominent posterior cardinal. The pallial sinus is entirely confluent with the pallial line below. It is somewhat irregular above, perhaps because of the position of the posterior adductor muscle. The scar of this muscle is located well in from the border of the shell.

Sanguinolaria sanguinolenta (Gmelin)

PLATE 21, FIGURE 1

Solen sanguinolentus Gmelin (1792) Syst. Nat., Ed. 13: 3227.

The smooth surface and rather pointed posterior end are distinctive. The shell is white, with a pink flush on the umbones and the upper part of the shell. The interior is tinted with pink.

Length 62, height 42, width 20 mm.

Porto Rico: Rio Herrera; Loiza Vieja.

Virgin Islands: St. Thomas.

Genus **PSAMMOBIA** Lamarck

Psammobia Lamarck (1818) Anim. s. Vert., 5: 511.

TYPE (by subsequent designation, Children, 1823), *Tellina feroensis* Gmelin.

The shell is moderately large and transversely elongated. It is slightly gaping. The umbones are subcentral and the dorsal margins are gently sloping. The anterior end is broadly rounded and the posterior end is more or less truncate. The surface sculpture is feeble and irregular on the anterior and middle portions of the shell but is stronger and more uniform on the posterior slope. The ligament is external, prominent, and opisthodontic. The hinge teeth are variable. Most species have two sub-umbonal cardinals in each valve. The posterior cardinal of the right valve and the anterior cardinal of the left valve are often feebly sulcate. The pallial line is distant from the margin and the pallial sinus is deep. The sinus is confluent with the pallial line for all or a part of its ventral border.

Psammobia circe Mörch

PLATE 21, FIGURE 2

Psammobia circe Mörch (1876) Jour. de Conchyl., 24: 373.

The rounded-rectangular outline of this species is rather characteristic. The sculpture is made up of inconspicuous concentric growth lines. The surface of the shell is more or less polished except near the borders of the valves where a brownish epidermis is noticeable. The shell color is white. Some specimens have a variable pattern of purple flecking and tinting.

Length 43, height 24, width 12 mm.

Virgin Islands: St. Thomas; Tortola.

Genus **HETERODONAX** Mörch

Heterodonax Mörch (1853) Cat. Yoldi, 2: 17.

TYPE (by monotypy), *Tellina bimaculata* Linnaeus.

The shell is bluntly ovate, rounded anteriorly, and more or less truncate posteriorly. The surface is sculptured with concentric growth lines and very fine radial grooves. Some specimens have small anterior and posterior laterals in the right valve; in others, such laterals are obsolete or absent. They are obsolete or absent in the left valve. The right valve has two cardinals, well developed and widely divergent. In the left valve there is a large anterior cardinal and a thin lamellar posterior cardinal. The pallial sinus is rounded and ascending.

Heterodonax bimaculatus (Linnaeus)

PLATE 21, FIGURE 3

Tellina bimaculata Linnaeus (1758) Syst. Nat., Ed. 10: 677.

This species occurs in a variety of colors. It may be white, blue, purple, red, orange, or nearly any combination of these. The color pattern may consist of rays of coloration or irregular clouding or flecking. Its shape is distinctive, however, and it is not easily confused with any other species in the region.

Length 17, height 15, width 6.5 mm.

Porto Rico: San Juan.

Virgin Islands: St. Thomas; St. John; Tortola; Virgin Gorda.

Genus **ASAPHIS** Modeer

Asaphis Modeer (1793) K. Vetensk. Acad. Nya Handl., 14: 176, 182.

TYPE (by monotypy), *Venus deflorata* Linnaeus.

The shell is elongate-ovate, with a rough surface sculpture. The radial elements of the sculpture predominate but are crossed by concentric lines which give a roughened effect. There are no laterals. The right valve has a small anterior cardinal and a large, slightly bifid, posterior cardinal. In the left valve there is a prominent anterior cardinal, also slightly bifid, and a small posterior cardinal. The pallial sinus is U-shaped and ascending.

Asaphis deflorata (Linnaeus)

PLATE 21, FIGURE 4

Venus deflorata Linnaeus (1758) Syst. Nat., Ed. 10: 687.

This species has a long synonymy. For present purposes it is enough to state that this is the only species of *Asaphis* in the West Indian region. The status of the Pacific forms remains in question. *A. deflorata* is yellowish white, variously tinted and shaded with yellow, red, or blue. The interior is often brightly colored, and there is usually a purple patch inside under the posterior slope of the shell.

Length 70, height 45, width 32 mm.

Porto Rico: Ponce; Fajardo; Ensenada Honda, Culebra.

Virgin Islands: St. Thomas; St. John; Tortola.

Genus **TAGELUS** Gray

Tagelus Gray (1847) Proc. Zool. Soc. London, Pt. 15, p. 189.

TYPE (by original designation), *Solen guineensis* Gray.

The shell is elongate-rectangular; the umbones are central or slightly posterior to the center. There are no laterals. Each valve bears two simple pedunculate cardinal teeth. The pallial sinus is horizontal and deep. It extends forward as far as or slightly beyond the umbones and is coalescent ventrally with the pallial line for a part of its length.

KEY TO THE SPECIES OF TAGELUS

- (1) Shell without an internal median rib *T. gibbus*
 (1') Shell with an internal median rib directed from the subumbonal cavity and usually associated with a streak of purple coloration in the shell substance. *T. divisus*

Tagelus gibbus (Spengler)

PLATE 21, FIGURE 6

Solen gibbus Spengler (1794) Skrift. Nat. Selsk., Copenhagen 3: 104.

Solecortus caribaeus Sowerby (1874) Conch. Icon., 19, Pl. 4, fig. 21.

This is much the larger of the two species. It usually has a conspicuous

brownish epidermis. The shell color is white. The surface sculpture is composed of coarse concentric growth lines.

Length 56, height 21, width 15 mm.

Porto Rico: San Juan; Mayaguez; Loiza Vieja; Humacao Playa; Arecibo. Virgin Islands: St. Thomas.

Tagelus divisus (Spengler)

PLATE 21, FIGURE 5

Solen divisus Spengler (1794) Skrift. Nat. Selsk. Copenhagen, 3: 96.

The shell is similar to that of the preceding species, but much smaller. The internal median rib directed from the subumbonal cavity is a conspicuous feature. There is usually a radial streak of purple color in the shell substance over this rib.

Length 38, height 13, width 7 mm.

Virgin Islands: St. Thomas; St. John.

Family DONACIDAE

The valves are equal and subtrigonal, usually closed and solid. The outer surface and inner margins of the valves are smooth or radially sculptured. The posterior end is usually shorter and obliquely subtruncate. The pallial sinus is similar in both valves. The ligament is short, opisthodontic, external, but seated in a deep groove. The resilium is chiefly opisthodontic and subinternal, but some of the large species have a small segment of the resilium separate from the rest, wholly internal and in front of the beaks. Dall regarded this character as a secondary modification and not an archaic retention. The hinge plate is moderately developed. There are usually a posterior and an anterior lateral in the right valve with corresponding sockets in the left. There are typically two cardinals in each valve and the strongest one is often bifid. The anatomy is similar to that outlined for the family Sanguinolariidae, but the siphons are shorter and stouter. The palps are smaller, and the gills are proportionately larger and are united behind the foot to each other and to the siphonal septum so as to form an anal chamber. The foot is relatively large, compressed, and sharp-edged. There is no byssus.

KEY TO THE GENERA OF DONACIDAE

- (1) Shell small, obliquely truncate behind; epidermis inconspicuous.....*Donax*
 (1') Shell large, pointed behind; epidermis conspicuous.....*Iphigenia*

Genus DONAX Linnaeus

Donax Linnaeus (1758) Syst. Nat., Ed. 10: 682.

TYPE (by subsequent designation, Herrmansenn, 1847), *Donax rugosa* Linnaeus.

The description given for the family will apply in large part to the genus *Donax*. As was pointed out in the key, the members of this genus are usually small and the shell is usually obliquely truncate behind. The ventral margin of the shell is more or less serrate in most species.

Donax denticulata Linnaeus

PLATE 21, FIGURE 7

Donax denticulata Linnaeus (1758) Syst. Nat., Ed. 10: 683.

This is a compact little species, with radial grooves on the surface. These grooves are punctate. The margins of the valves are strongly crenulate. The shell is white, with a variable coloration of blue, purple, red, yellow, or brown. The color is usually in the form of clouded rays.

Length 28, height 19, width 11 mm.

Porto Rico: San Juan; Mayaguez; Aguadilla.

Virgin Islands: Magens Bay, St. Thomas.

Genus **IPHIGENIA** Schumacher

Iphigenia Schumacher (1817) Essai Nouv. Syst. Vers Test., p. 155.

TYPE (by monotypy), *Donax laevigata* Chemnitz, = *Donax laevigata* Gmelin.

The shell is subsolid, subtriangular, and subequilateral. There is no radial sculpture. The inner margins of the valves are smooth. The hinge bears two cardinals in each valve. The posterior in the right valve and the anterior in the left one are bifid. There are two obsolete laterals in the right valve. The pallial sinus is deep and rounded.

Iphigenia brasiliensis (Lamarck)

PLATE 21, FIGURE 8

Capsa brasiliensis Lamarck (1818) Anim. s. Vert., 5: 553.

This large subtriangular species is quite distinct. The epidermis is greenish in color and conspicuous. The shell substance is white with some purple shading.

Length 60, height 40, width 23 mm.

Porto Rico: San Juan; Ponce; Humacao Playa.

Virgin Islands: St. Thomas; St. Croix.

Family **SEMELIDAE**

The members of this family are much the same as those of the family Tellinidae, except that the resilium is internal, often on a distinct chondrophore. The laterals, when present, are stronger and less distant from the cardinals.

KEY TO THE GENERA OF SEMELIDAE

- (1) Resilium supported on a linear chondrophore, which is internal but more or less parallel with the hinge line.....2
- (1') Resilium supported by a spoon-shaped chondrophore, which projects below the hinge plate.....*Cumingia*
- (2) Shell relatively large and having a distinct surface sculpture.....*Semele*
- (2') Shell small; surface smooth.....*Abra*

Genus **SEMELE** Schumacher

Semele Schumacher (1717) Essai Nouv. Syst. Vers Test., p. 165.

TYPE (by monotypy), *Tellina reticulata* Spengler, = *Tellina proficua* Pulteney.

The shell is suborbicular or elliptical and slightly inequivalve. The umbones are small and prosogyrous. There are two cardinal teeth in each valve. The right valve bears two distinct laterals. There are vestigial laterals in the left valve. The ligament is external. The resilium is internal, oblique, and supported on linear chondrophores, which are more or less parallel with the hinge line. The muscle scars are large. The pallial sinus is large, deep, and broadly rounded.

KEY TO THE SPECIES OF SEMELE

- (1) Surface sculpture concentric.....2
 (1') Surface sculpture cancellate.....*S. bellastrata*
 (2) Shell large, 30 mm. or more in length in the adult stage.....3
 (2') Shell very small, about 5 mm. in length.....*S. nuculoides*
 (3) Shell subcircular; principal coloration yellow.....*S. proficua*
 (3') Shell suboval; principal coloration reddish or purple.....*S. purpurascens*

Semele proficua (Pulteney)

PLATE 21, FIGURE 9

Tellina proficua Pulteney (1794) in Hutchinson's Dorset, p. 29, Pl. 5, fig. 4.

The rounded outline and yellowish coloration are typical of this species. The surface is strongly concentrically sculptured.

Length 44, height 40, width 20 mm.

Porto Rico: San Juan.

Virgin Islands: St. Thomas; St. Croix; St. John.

Semele purpurascens (Gmelin)

PLATE 22, FIGURE 1

Venus purpurascens Gmelin (1792) Syst. Nat., Ed. 13: 3288.

Tellina oblique Wood (1815) Gen. Conch., Pl. 41, figs. 1-2.

The oblong shape and red or purple coloration will serve to distinguish this species from the preceding one. It is somewhat less heavily sculptured, although the concentric lines are distinct.

Length 36, height 29, width 14 mm.

Porto Rico: San Juan.

Virgin Islands: St. Thomas; St. John; Tortola.

Semele bellastrata (Conrad)

PLATE 22, FIGURE 2

Amphidesma bellastrata Conrad (1837) Jour. Acad. Nat. Sci. Phila., 7: 239, Pl. 20, fig. 4.

Amphidesma cancellata d'Orbigny (1845) Moll. Cubana, 2: 241, Pl. 25, figs. 42-44.

The oblique internal resilium and cancellate sculpture will serve to distinguish this species from any other in the region.

Length 25, height 20, width 9 mm.

Porto Rico: Mayaguez.

Virgin Islands: St. Thomas; Virgin Gorda.

Semele nuculoides (Conrad)

PLATE 22, FIGURE 3

Amphidesma nuculoides Conrad (1841) Am. Jour. Sci., 41: 347.

In this tiny species the external surface is sculptured with fine, regular concentric lines. The shell is relatively solid, and it is white.

Length 4.5, height 3, width 0.5 mm.

Porto Rico: San Juan; Mayaguez.

Genus ABRA Lamarck*Abra* Lamarck (1818) Anim. s. Vert., 5: 492.TYPE (by monotypy), *Maetra tenuis* Montagu.

The shell is rather compressed, oval, subtriangular or subquadrate. The posterior end of the shell is shorter than the anterior end. The color is white, and the surface is smooth. The resilium is internal and supported on linear chondrophores, which are more or less parallel with the hinge line. The right valve has two cardinals and generally two lamellar laterals. The left valve has one distinct cardinal and, in some species, a vestigial posterior cardinal more or less coalesced with the lower surface of the chondrophore. There is sometimes a rudiment of a posterior lateral in the left valve but no anterior lateral.

KEY TO THE SPECIES OF ABRA

- (1) Shell rounded.....2
 (1') Shell oval.....*A. americana*
 (2) Shell slightly oblique; anterior margin of right valve grooved.....*A. aequalis*
 (2') Shell more oblique than the preceding one; right anterior margin not grooved
A. lioica

Abra aequalis (Say)

PLATE 22, FIGURE 5

Amphidesma aequalis Say (1822) Jour. Acad. Nat. Sci. Phila., 2: 307.

This small white species is somewhat less oblique than the following species, and the right anterior margin is plainly grooved with a broad furrow. The posterior end of the shell is slightly sinuated. The surface is smooth and the color is white.

Length 10, height 8, width 4 mm.

Porto Rico: Mayaguez.

Abra lioica (Dall)

PLATE 22, FIGURE 4

Syndosmya lioica Dall (1881) Bull. Mus. Camp. Zool., 9: 133.

This species is smaller, thinner and more fragile than *aequalis*. It is more oblique in shape, and the right anterior margin is not noticeably grooved. The color is transparent white. The surface is quite smooth, as indicated by the name.

Length 8, height 6.5, width 3.5 mm.
Porto Rico: Mayaguez.

***Abra longicallis americana* Verrill and Bush**

PLATE 22, FIGURE 6

Abra longicallis (Scacchi): Verrill (1884) Trans. Conn. Acad., 6: 224, 278.

Abra longicallis americana Verrill and Bush (1898) Proc. U. S. Nat. Mus., 20 (1139): 778, Pl. 83, figs. 6, 7.

Abra longicallis (Scacchi): Dall and Simpson (1901) Bull. U. S. Fish Comm., 20: 478.

This species has the appearance of a *Tellina*, but is readily distinguished by the oblique, internal resilium. This is set on chondrophores and is long and more or less parallel with the hinge line. The pallial sinus is deep although rather indistinct. The shell is smooth externally and white.

Length 25, height 17, width 8 mm.

Porto Rico: Mayaguez.

Genus **CUMINGIA** Sowerby

Cumingia Sowerby (1833) Proc. Zool. Soc. London, Pt. 1, p. 34.

TYPE (by subsequent designation, Gray, 1847), *Cumingia lamellosa* Sowerby.

The shell is triangular or transversely oval, rounded in front and sub-rostrate and slightly gaping behind. It is often somewhat irregular. The surface is sculptured with concentric lamellae. The resilium is internal and supported by spoon-shaped chondrophores. There are a small cardinal and two elongate laterals in each valve. The pallial sinus is wide.

***Cumingia coarctata* Sowerby**

PLATE 22, FIGURE 7

Cumingia coarctata Sowerby (1833) Proc. Zool. Soc. London, Pt. 15, p. 34.

Lavignon antillarum d'Orbigny (1846) Moll. Cubana, 2: 236, Pl. 25, figs. 36-38.

Lavignon petitiiana d'Orbigny (1846) *op. cit.*, figs. 33-35.

The spoon-shaped chondrophores which support the internal resilium are characteristic of the genus and, together with the lamellose concentric sculpture, will distinguish this species from any other in the region.

Length 21, height 14, width 8 mm.

Porto Rico: San Juan.

Virgin Islands: St. Thomas.

Superfamily **SOLENACEA**

The hinge plate is not strongly developed. The cardinals vary from one to four in each valve. Sometimes one in each valve is placed parallel to the hinge margin so as to simulate a lateral. There are no true laterals. The ligament is external, and the resilium is marginal. The pallial sinus is distinct but usually small. The adductor muscle scars are long, thin, and dorsally extended. The gills are plicate, united behind the foot to the siphonal septum but not to each other. The palps are large. The foot is elongate, cylindrical, and club-shaped. It is often obliquely flattened at the end. There is no byssus. The mantle lobes are united ventrally,

sometimes having a small ventral foramen. The siphons are distinctly formed but variable in length and amount of separation.

Family SOLENIDAE

The shell substance is cellulo-crystalline, with the external layer showing its cellular structure clearly. There is a pronounced epidermis. The valves are equal, usually truncate at both ends, and more or less inequilateral. The beaks are low, and the margins are smooth. The pallial sinus is small in species with anterior umbones, and large in those species which have the umbones well back from the anterior end. The hinge plate is often strengthened by a thickened ray which crosses the valves and serves as a buttress. The cardinal teeth are sometimes more or less pedunculated, rarely bifid. The gills are prolonged with the laminae appendiculate anteriorly and arising between the united palps. The palps are large, united, and produced into points behind, simple in front. The mantle lobes are more or less papillose, and the siphons are usually papillose also.

KEY TO THE GENERA OF SOLENIDAE

- (1) Shell elongate, subcylindrical; umbones anterior.....*Solen*
 (1') Shell relatively short, rounded-rectangular; umbones subcentral...*Psammosolen*

Genus SOLEN Linnaeus

Solen Linnaeus (1758) Syst. Nat., Ed. 10: 672.

TYPE (by subsequent designation, Children, 1823), *Solen vagina* Linnaeus.

The shell is long and approximately straight. The dorsal and ventral margins are parallel, and the umbones are anterior. The valves gape at each end. There is one cardinal tooth in each valve. The pallial sinus is short.

Solen obliquus Spengler

PLATE 22, FIGURE 9

Solen obliquus Spengler (1794) Skrift. Nat. Selsk., 3: 104.

Solen ambiguus Sowerby (1874) Conch. Icon., 19, Pl. 5, fig. 21.

In this species the umbones are anterior but not terminal. They are some distance back from the anterior end. The surface is sculptured with rude concentric growth lines. The epidermis is buff or brownish and rather conspicuous. The shell substance is white.

Length 110, height 22, width 14 mm.

Porto Rico: Mayaguez; Ponce; Loiza Vieja; Cabo Rojo.

Genus PSAMMOSOLEN Risso

Psammosolen Risso (1826) Hist. Nat. Europe, 5: 385.

TYPE (by subsequent designation, Dall, 1900), *Solen strigilatus* Linnaeus.

The shell is transversely oblong and gaping at the ends. The beaks are subcentral. The upper and lower valve margins are nearly parallel. There are one or sometimes two cardinal teeth in each valve. The pallial sinus is large. Some of the species are obliquely sculptured.

Psammosolen sanctae-marthae (d'Orbigny)

PLATE 22, FIGURE 8

Solen sanctae-marthae d'Orbigny (1846) Moll. Cubana, 2: 232, Pl. 25, figs. 31, 32.

There are rude growth lines on the shell which are crossed by oblique sculpture over most of the surface. In the left valve there is one high compressed cardinal tooth just behind the umbo. The right valve bears a similar cardinal under the umbo. There are sometimes vestiges of a second cardinal in each valve. The shell color is white. The light horn-colored epidermis is sometimes apparent, especially around the margins of the valves.

Length 37, height 20, width 12 mm.

Porto Rico: Mayaguez.

Virgin Islands: St. Thomas; Tortola.

Superfamily **MACTRACEA**

The hinge plate is well developed. There is typically one bifid or deltoid cardinal in the left valve, fitting below two cardinals in the right valve which are more or less united dorsally. Normally there is an anterior and a posterior lateral in the left valve, which are received into sockets or paired laminae in the right. The laterals are sometimes obsolete. The ligament is marginal or internal, and the resilium is internal and seated on chondrophores. The pallial sinus is distinct. The adductor muscle scars are subequal and rounded. The gills are plicate and united behind to each other and to the siphonal septum, forming an anal chamber. The palps are large. The foot is large, compressed, and keeled. There is no byssus. The mantle lobes are more or less united ventrally. The siphons are well developed, variably united, and sometimes provided with an epidermal tunic.

KEY TO THE FAMILIES OF MACTRACEA

- (1) Shell relatively thin; umbones prosogyrous.....Mactridae
 (1') Shell solid and heavy, usually donaciform; umbones erect or opisthogyrous....
 Mesodesmatidae

Family **MACTRIDAE**

The shell is porcellaneous, with a pronounced epidermis. It is usually rounded-triangular, with smooth or concentrically sculptured surface. The margins are smooth, and the beaks are prosogyrous. The valves are equal, and there is usually a slight posterior gape. The area is not limited. The ligament is variably external or internal. The resilium is internal and seated on subtriangular chondrophores, which are usually excavated out of the hinge plate and rarely are strengthened with a prop or buttress. A delicate lamella, accessory to the cardinals, is often present in the hinge. The outer reflected lamina of the gills usually has a dorsal extension. The palps are large and partly united behind. The mantle margins are smooth and duplex, more or less united ventrally. There is a sensory lamella

running longitudinally on the inner surface of the mantle. The branchial siphon has an obsolete curtain valve internally.

Genus **MACTRA** Linnaeus

Macra Linnaeus (1767) Syst. Nat., Ed. 12: 1125.

TYPE (by subsequent designation, Gray, 1847), *Macra stultorum* Linnaeus, = *Cardium stultorum* Linnaeus.

The shell is ovate-trigonal, generally almost equilateral. The hinge bears well developed laterals. Sometimes there is a small spur projecting over the chondrophore from the cardinal margin.

KEY TO THE SPECIES OF **MACTRA**

- (1) Posterior slope of shell rounded; umbonal ridge marked with a line but not elevated.....*M. fragilis*
 (1') Posterior slope of shell flattened; umbonal ridge bearing a distinct lamellar carina
M. alata

Macra fragilis Gmelin

PLATE 23, FIGURE 2

Macra fragilis Gmelin (1792) Syst. Nat., Ed. 13: 3261.

Macra brasiliiana Lamarck (1818) Anim. s. Vert., 5: 478.

This species is well named. It is a thin and fragile shell, white and usually covered with a pale epidermis. Its smooth appearance and oblong outline are characteristic.

Length 58, height 38, width 17 mm.

Porto Rico: Mayaguez; Ponce; Loiza Vieja; Humacao Playa.

Virgin Islands: St. Thomas.

Macra alata Spengler

PLATE 23, FIGURE 1

Macra alata Spengler (1802) Skrift. Nat. Selsk. [Copenhagen], 5 (2): 99.

This shell is quite distinct. The flattened posterior slope and the carina on the umbonal ridge are characteristic. It has much the same texture and color as *fragilia*. The anterior end of the shell is frequently somewhat attenuate.

Length 90, height 58, width 33 mm.

Porto Rico: Mayaguez; Arroyo; Humacao; Loiza Vieja.

Family **MESODESMATIDAE**

The shell is solid and heavy, usually donaciform, with erect or opisthogyrous umbones, otherwise similar to the Mactridae. The anatomical features resemble those of the Mactridae also, but the siphons are naked and not united.

Genus **ERVILIA** Turton

Ervilia Turton (1822) Conch. Insul. Brit., p. 55.

TYPE (by monotypy), *Mya nitens* Montagu.

The shell is small, concentrically striate, and sometimes brightly colored. The ligament is obsolete, and the resilium is small and internal. The laterals are small. The dorsal anterior lamina is absent. The ventral lamina is more or less united with the anterior arm of the right cardinal. The left cardinal is large and bifid. The pallial sinus is distinct.

KEY TO THE SPECIES OF ERVILIA

- (1) Umbones not prominent..... *E. nitens*
 (1') Umbones prominent..... *E. concentrica*

Ervilia nitens (Montagu)

PLATE 23, FIGURE 4

Mya nitens Montagu (1806) Test. Brit. Suppl., p. 165.

This species is more regular in outline than the following one. Both are finely, regularly, concentrically striated. The shell of *nitens* is smoothly oval; the umbones are distinct but not strongly elevated. The color is white, usually shaded with pink.

Length 7.5, height 5, width 2.5 mm.

Virgin Islands: St. Thomas.

Ervilia concentrica Gould

PLATE 23, FIGURE 3

Ervilia concentrica Gould (1862) Proc. Boston Soc. Nat. Hist., 8: 280.

This species is smaller than the preceding one, and the umbones are more prominent. It is usually pure white, but may occur in red or purple phases.

Length 5, height 3.5, width 2 mm.

Porto Rico: San Juan; Mayaguez.

Superfamily MYACEA

The hinge plate is degenerate. There are no fully-developed cardinals and no laterals. The ligament may be external or internal. The resilium may be marginal but is usually internal and seated on chondrophores. The chondrophore of the left valve is usually prominent. The pallial sinus is distinct. The adductor muscle scars are rounded and subequal. The gills are plicate and united behind so as to form an anal chamber. The palps are large. The foot is small and grooved, byssiferous in the young but rarely in the adult. The mantle lobes are united ventrally. The siphons are well developed, usually long, united, enclosed in a horny tunic, and not wholly retractile.

KEY TO THE FAMILIES OF MYACEA

- (1) Resilium internal.....2
 (1') Resilium marginal or submarginal.....3
 (2) Prominent chondrophore received under the opposing valve margin in closure
 Myaciidae
 (2') Prominent chondrophore received into a socket in the opposite valve.. Corbulidae
 (3) Shell gaping but the valves usually in contact for a considerable distance along
 the ventral margin.....Saxicavidae

- (3') Shell having a very wide antero-ventral gape, the valves in contact only posteriorly
Gastrochaenidae

Family MYACIDAE

The shell substance is cellulo-crystalline, earthy, and with a conspicuous epidermis. The valves are unequal, more or less elongate, rounded in front and gaping behind. The shell margins are plain. The area is obsolete or absent. The resilium is opisthodontic. It is internal and attached in the left valve to a projecting chondrophore, which merges with the dorsal margin behind; in the right valve it is attached to an inconspicuous, usually subumbonal, chondrophore. The gills are usually not extended into the branchial siphon. The palps are more or less united behind. The mantle edges are smooth, thick and duplex. The anal end of the rectum is free.

Genus SPHENIA Turton

Sphenia Turton (1882) Conch. Insul. Brit., p. 36.

TYPE (by subsequent designation, Gray, 1847), *Sphenia binghami* Turton.

The shell is somewhat inequivalve, but not so much so as is common in the members of this family. The surface is sculptured with concentric ridges, which are quite irregular or effaced on the disk of the shell. The hinge teeth are absent, but there is an elongated flattened chondrophore in the left valve which extends obliquely under the dorsal margin of the right valve. The internal resilium extends from the upper surface of this chondrophore to the lower surface of the margin of the right valve. The pallial sinus is large and bluntly rounded. These species are nestlers, and like many nestling forms, they are often quite irregular in shape.

Sphenia antillensis Dall and Simpson

PLATE 23, FIGURE 10

Sphenia antillensis Dall and Simpson (1901) Bull. U. S. Fish Comm., 20: 474, Pl. 55, fig. 14.

The shell is small, thin, subquadrate, and rather compressed. The surface is sculptured with concentric growth lines, and there is a low, obscure thread running obliquely back from the umbones on the umbonal ridge. The shell color is white, and there is usually a yellowish epidermis.

Length 4, height 2.5, width 1.5 mm.

Porto Rico: Ponce.

Family CORBULIDAE

The shell is fundamentally similar to that of the members of the Myacidae, but it is usually small. The pallial sinus is feeble or obsolete. The ligament is usually subexternal and separated from the resilium, which is internal, alivincular, and amphidetic. The chondrophore is received into a socket in the opposite valve, not merged with the valve margin as in the Myacidae. The hinge has one or two subumbonal projecting teeth, and, rarely, obscure traces of laterals. The posterior gape is inconspicuous. The gills are short and arranged as in the Myacidae. The foot is compressed

and often byssiferous. The mantle margins are papilliferous. The siphons are short, united, and with papilliferous tips. They are naked and wholly retractile. The anal end of the rectum is sessile.

KEY TO THE GENERA OF CORBULIDAE

- (1) Dentiform process of the right valve blunt and triangular.....*Corbula*
 (1') Dentiform process of the right valve long and pointed, more or less conical
Basterotia

Genus CORBULA Bruguière

Corbula Bruguière (1797) Enzy. Meth. (Table. Vers), Pl. 230.

TYPE (by subsequent designation, Children, 1823), *Corbula nucleus* Lamarck, = *Tellina gibba* Olivi.

The valves are unequal. The right one is usually the larger of the two. Both are more or less rostrate posteriorly. There are no teeth in the strict sense. In the right valve there is a large dentiform process below the umbo. It fits into a socket in the left valve. The left valve bears a projecting chondrophore which fits below the margin of the right valve. In some species one margin is grooved at the hinge line to receive the opposing margin of the other valve. This simulates the appearance of laterals. The pallial line is variably sinuate.

KEY TO THE SPECIES OF CORBULA

- (1) Shell relatively high and rounded; without distinct umbonal ridge. *C. disparilis*
 (1') Umbonal ridge distinct..... 2
 (2) Shell nearly equivalve..... *C. aequivalvis*
 (2') Shell markedly inequivalve..... 3
 (3) Shell somewhat squared and more or less distorted, rather rude and heavy in appearance..... *C. dietziana*
 (3') Shell distinctly attenuate behind..... *C. caribaea*

Corbula disparilis d'Orbigny

PLATE 23, FIGURE 11

Corbula disparilis d'Orbigny (1846) Moll. Cubana, 2: 322, Pl. 27, figs. 1-4.

The relatively great altitude and rounded outline of this shell are distinctive. The absence of a distinct umbonal ridge is usually a good character, although some examples do occur which have a semblance of this ridge.

Length 9, height 7, width 5 mm.

Porto Rico: Mayaguez.

Corbula aequivalvis Philippi

PLATE 23, FIGURE 7

Corbula aequivalvis Philippi (1836) Arch. f. Naturg., 2: 227, Pl. 7, fig. 4.

Corbula cubaniana d'Orbigny (1846) Moll. Cubana, 2: 322, Pl. 26, figs. 51-54.

Corbula knoxiana C. B. Adams (1852) Contr. to Conch., p. 238.

The concentric ribbing is more regular and precise than is usual in this genus. The shell is nearly equivalve, this also being an uncommon condition. The color is white.

Length 10, height 7, width 5.5 mm.

Porto Rico: Mayaguez.

***Corbula dietziana* C. B. Adams**

PLATE 23, FIGURE 6

Corbula dietziana C. B. Adams (1852) Contr. to Conch., p. 235.

This shell is rather rude in appearance and squarish in outline; it has heavy, irregular, concentric ridges. It is frequently more or less distorted. The color is white, often rayed or shaded with red or purple coloration.

Length 13, height 9, width 5 mm.

Porto Rico: Mayaguez.

***Corbula caribaea* d'Orbigny**

PLATE 23, FIGURE 8

Corbula caribaea d'Orbigny (1846) Moll. Cuba, 2: 323, Pl. 27, figs. 5-8.

?*Corbula lavalleana* d'Orbigny (1846) *op. cit.*, figs. 9-12.

?*Corbula swiftiana* C. B. Adams (1852) Contr. to Conch., p. 236.

This species is strongly attenuate or rostrate behind. The surface is concentrically ridged with a variable amount of fine radial threads. The synonymy is more or less tentative, but with a large series for examination it has been impossible to separate definitely the three forms.

Length 16, height 10, width 10 mm.

Porto Rico: Mayaguez; Puerto Real.

Virgin Islands: Charlotte Amalie, St. Thomas.

Genus **BASTEROTIA** Hoernes

Basterotia Hoernes (1859) Abb. Geol. Reichsanst. Wien, 4: 40.

TYPE (by monotypy), *Basterotia corbuloides* Hoernes.

The shell is inflated, quadrate, and carinate behind. It is more or less gaping posteriorly. The surface is somewhat granular and sculptured with concentric growth lines. The hinge of the right valve bears a conical subumbonal tooth, which is separated from a prominent nymph by a narrow gap. The left valve has a similar but smaller tooth. There is a gap which receives the tooth of the right valve and then a nymph. The ligament is external, and the resilium is marginal. There is no pallial sinus.

***Basterotia quadrata granatina* (Dall)**

PLATE 23, FIGURE 5

Corbula quadrata Hinds (1843) Proc. Zool. Soc. London, 11 (124): 57.

Poromya(?) *granatina* Dall (1881) Bull. Mus. Comp. Zool., 9: 109.

Basterotia quadrata granatina Dall, 1886, Bull. Mus. Comp. Zool., 12: 316.

The form and granulose surface of this species are characteristic. The umbones are very prominent. The dentiform process of the hinge is long and conical. The shell color is white.

Length 10, height 7, width 3.26 mm.

Virgin Islands: Long Bay, St. Thomas.

Family SAXICAVIDAE

The shell substance is similar to that of the Myacidae, and the epidermis is conspicuous. The valves are equal, more or less elongated and gaping, rude, and often irregular. They do not wholly cover the animal. The adductor muscle scars are often irregular, and the pallial line is discontinuous or irregular, although the sinus is distinct. The shell margins are smooth. The area is obsolete. The ligament is external. The resilium is marginal. There are feeble vestiges of subumbonal cardinal teeth. The gills are similar to those of the Myacidae but are extended into the branchial siphon.

Genus SAXICAVELLA Fischer

Arcinella Philippi (1844) Enum. Moll. Siciliae, 2: 53 (in part); not Oken, 1815; not Schumacher, 1817.
Saxicavella Fischer (1878) Act. Soc. Linn. Bordeaux, (4), 2: 175.
 TYPE (by monotypy), *Mya plicata* Montagu.

The shell is small, thin, and equivalve, but inequilateral. It is subtrapezoidal, obliquely angular behind. There is a small denticle in the right valve fitting into a cavity in the left cardinal margin. The ligament and resilium are short and prominent, set on low nymphs. There is a wide, shallow sinuosity in the pallial line.

Saxicavella sagrinata Dall and Simpson

PLATE 23, FIGURE 9

Saxicavella sagrinata Dall and Simpson (1901) Bull. U. S. Fish Comm., 20: 472, Pl. 55, fig. 16.

The shell is small and rounded-triangular. It is almost modioliform in shape. The surface is irregularly concentrically undulated and is minutely granular. There is no pronounced umbonal ridge. The interior of the shell is polished. The shell substance is translucent.

Length 5.5, height 3.7, width 2 mm.

Porto Rico: Mayaguez.

Family GASTROCHAENIDAE

The shell substance is similar to that of the Myacidae. The valves are equal and widely gaping in front. The posterior adductor scar is larger than the anterior one. The pallial sinus is deep. The margins of the valves are simple. There is no area. The ligament and resilium are external and parivincular. The hinge bears a single obsolete cardinal or is edentulous. The gills, as in the Saxicavidae, are prolonged into the branchial siphon. There is no byssus. The mantle edges are thick, smooth, and united, with a small pedal foramen. The siphons are united, naked, and not wholly retractile. These animals frequently form an external protective tube to supplement their burrows, but they are in no way attached to this tube.

Genus GASTROCHAENA Spengler

Gastrochaena Spengler (1783) Nye Saml. K. Dansk. Vidensk. Selsk. Skrift., 2: 179.
 TYPE (by monotypy), *Gastrochaena mumia* Spengler.

The shell is regular, equivalve, inequilateral, ovoid, and widely gaping. The umbones are anterior. There is a feeble concentric sculpture. These animals form flask-shaped excavations, which are lined with calcareous material. When not protected by a burrow, they form a shelly tube to which extraneous matter is attached.

KEY TO THE SUBGENERA OF GASTROCHAENA

- (1) Posterior end rounded; surface having concentric sculpture only. *Gastrochaena* s.s.
 (1') Posterior end truncate; posterior slope with a raised triangular area which is strongly transversely lamellose in addition to the concentric sculpture.....
Spengleria

Subgenus GASTROCHAENA s.s.

The description of the subgenus is the same as that of the genus, with the limiting characters of the key.

Gastrochaena (*Gastrochaena*) *cuneiformis* Spengler

PLATE 24, FIGURE 2

Gastrochaena cuneiformis Spengler (1788) Nova Act. Soc. Hafn., 2: 179, figs. 8-11.

The valves are rather spatulate, with low but distinct concentric ridges. The shells gape very widely; the whole anteroventral border is open. The shell color is white.

Length 18, height 10, width 8 mm.

Porto Rico: Mayaguez.

Virgin Islands: St. Thomas; St. Croix.

Subgenus SPENGLERIA Tryon

Spengleria Tryon (1861) Proc. Acad. Nat. Sci. Phila., 13: 472.

TYPE (by subsequent designation, Dall, 1898), *Chaena rostrata* Spengler.

The valves are truncate behind, and the umbones are not located so far anterior as in the typical subgenus. There is a very characteristic elevated triangular area which radiates from the umbo to the posterior truncation on each valve. This area is crossed by strong transverse lamellations.

Gastrochaena (*Spengleria*) *rostrata* (Spengler)

PLATE 24, FIGURE 1

Chaena rostrata Spengler (1793) Skr. Nat. Selsk. [Copenhagen], 3 (1): 23.

This species is very distinctive. The lamellose area on the posterior slope of the valves is characteristic. There is no other member of this subgenus in the West Indian region.

Length 36.5, height 15, width 15.5 mm.

Virgin Islands: St. Thomas; St. Croix.

Superfamily ADESMACEA

The hinge plate is very specialized. It may be reflected anteriorly and supplied with external, accessory shelly plates. A prominent myophore is

developed from the subumbonal cavity. There are no cardinals and no laterals. The ligament is obsolete or absent. The resilium is obsolete or absent, although there is in some species a remnant in the left valve. The pallial sinus is distinct. The posterior adductor muscle is normal. The anterior one may be marginal or it may be attached to the reflected part of the anterior shell margin and thus external to the shell. In this case it is covered by the mantle and by the accessory, shelly plates. The gills are united and frequently extended anteriorly into the oral region and posteriorly into the branchial siphon. The palps are large. The foot is large, grooved, and modified for boring, or it may be vestigial and not grooved. There is no byssus. The mantle lobes are united ventrally. There are long, well-developed siphons, united for most of their length and sometimes enclosed in an epidermal tunic. In some groups they are also supplied with complex calcareous valves or pallets.

KEY TO THE FAMILIES OF ADESMACEA

- (1) Boring animals in which the shell valves are often supplemented by accessory shelly plates; they do not line the burrow with calcareous material, and the siphons are without pallets.....Pholadidae
 (1') Boring animals without accessory shelly plates but which do secrete a calcareous lining to their burrows; the siphons are provided with calcareous valves or pallets.....Teredinidae

Family PHOLADIDAE

The shell is cellulo-crystalline, with a thin epidermis. The valves are more or less gaping in front and behind. The beaks are inconspicuous. The external sculpture is reticulate, often spinose. The valves are supplemented by external, accessory shelly plates which are attached to the animal and are not in the nature of a tube, such as is found in the Gastrochaenidae. There is no area. The antero-dorsal margins are more or less extensively reflected. The ligament and resilium are usually absent, although there may be an obsolete remnant of resilium and chondrophore in the left valve. The gills are not fused in the median line, and they extend well forward into the oral region. The palps are large and are partly supported by the styloid myophore. The foot is large and modified anteriorly as a boring organ. Behind it is usually grooved but not byssiferous. The mantle lobes are united except at the pedal orifice. They are smooth or papillose and duplex. The inner fold of the duplex margin is conspicuous. The anterior adductor muscle is covered by the mantle and by accessory, shelly plates. It is attached to the reflected portion of the shell and thus, in a sense, is external to the valves. The siphons are without pallets and are largely retractile.

Genus MARTESIA Leach

Martesia Leach (1824) in Blainville, Man. Mal. et Conch., p. 632.

TYPE (by subsequent designation, Gray, 1847), *Pholas clavata* Lamarck, = *Pholas striata* Linnaeus.

The shell is thin, medium-sized, elongate, wedge-shaped, and inequilateral. It is gaping at the posterior end. There is a shallow radial groove extending from the umbo to the ventral margin. The part of the shell in

front of this groove is sculptured with roughened threads. In back of this groove the threads are replaced by crude incrementals. The lower anterior part of the shell is covered with a callus closing the anterior gape. The edge of the callus extends along the upper anterior margin. The umbones are covered with accessory plates. The ventral margins are connected by an accessory plate for the greater part of the distance behind the groove. Internally there is a long slender myophore.

KEY TO THE SPECIES OF *MARTESIA*

- (1) Shelly plate over the umbo broadly rounded.....*M. striata*
 (1') Shelly plate over the umbo triangular.....*M. cuneiformis*

Martesia striata (Linnaeus)

PLATE 24, FIGURE 4

Pholas striatus Linnaeus (1758) Syst. Nat., Ed. 10: 669.

This species is somewhat larger than the following one, and the accessory shelly plate over the umbo is very different in shape. The shell color is white. These species are both somewhat irregular, particularly in the posterior portion of the shell. This is a common feature of boring species.

Length 26.5, height 13, width 12 mm.

Virgin Islands: St. Thomas.

Martesia cuneiformis (Say)

PLATE 24, FIGURE 3

Pholas cuneiformis Say (1822) Jour. Acad. Nat. Sci. Phila., 2: 322.

This species resembles the preceding one in general. It is smaller and has the accessory shelly plate over the umbo in the shape of an arrowhead. The shell color is white.

Length 15, height 9, width 8 mm.

Porto Rico: Mayaguez.

Virgin Islands: St. Thomas.

Family TEREDINIDAE

The shell is much reduced, equivalve, and auriculate. The valves gape widely and are in contact ventrally only on the surface of a parietal tubercle. The anterior adductor muscle scar is very small and marginal. The pallial line is coincident with the valve margins. A styloid myophore projects from the subumbonal cavity of the valves. There is no area and no accessory shelly plates. The hinge margin is somewhat reflected and edentulous. The ligament and resilium are obsolete or absent. The gills are fused in the median line, with direct but no reflected laminae. The external limb is reduced, situated behind the viscera, and extended into the branchial siphon. The palps are normal and not united behind. The foot is rudimentary, not grooved or byssi erous. The siphons are very greatly prolonged and united nearly to their ends. Distally they bear a set of calcareous valves or pallets, which are variable in form and are moved by a special

group of muscles. The mantle edges are smooth and united except at the pedal foramen. The anterior adductor muscle is degenerate and attached at the anterior edges of the valves. It is covered only by the mantle. The mantle secretes a calcareous lining for the burrow.

KEY TO THE GENERA OF TEREDINIDAE

- (1) Pallets made up of one piece.....*Teredo*
 (1') Pallets made up of a series of cone-like elements.....*Bankia*

Genus **TEREDO** Linnaeus

Teredo Linnaeus (1758) Syst. Nat., Ed. 10: 651.

TYPE (by subsequent designation, Gray, 1847), *Teredo navalis* Linnaeus.

The description of the family applies to this genus except that the pallets are made up of a single piece which is usually spoon-shaped or paddle-shaped.

KEY TO THE SPECIES OF TEREDO

- (1) Pallets paddle-shaped.....*T. dominicensis*
 (1') Pallets spoon-shaped.....*T. thomsonii*

Teredo dominicensis Bartsch

PLATE 24, FIGURES 5, 6

Teredo dominicensis Bartsch (1921) Proc. Biol. Soc. Washington, 34: 30.

The posterior portion of the shell or auricle is much larger in this species than in the following one. The pallets are short-stalked. The expanded blade of the paddle-shaped pallet is hollow throughout its length and divided into two chambers by a median septum.

Shell length 2.3, height 2.2 mm.

Pallet length 2.5, width 1.1 mm.

Virgin Islands: St. Thomas.

Teredo thomsonii Tryon

PLATE 24, FIGURES 7, 8

Teredo thomsonii Tryon (1863) Proc. Acad. Nat. Sci. Phila., 15: 280, Pl. 2, figs. 3-5.

This species is larger than the preceding one, but has a very small posterior portion or auricle. The pallets are spoon-shaped, with a winglike edge on each side. The stalk is subcylindrical.

Shell length 9.7, height 9.8, width 9.9 mm.

Pallet length 9.9, width 4.7 mm.

Virgin Islands: St. Thomas.

Genus **BANKIA** Gray

Bankia Gray (1842) Synopsis Contents British Museum, Ed. 44: 76.

TYPE (by original designation), *Teredo bipalmulata* Lamarck.

The description of the family applies to this genus except that the pallets are made up of a series of cone-in-cone elements which are free at the margins and not fused into a solid structure.

KEY TO THE SPECIES OF BANKIA

- (1) Margins of the cones serrated.....*B. fimbriatula*
 (1') Margins of the cones not serrated.....2
 (2) Cones narrow, projected upward against the cone above.....*B. gouldi*
 (2') Cones broad, projected away from the cone above.....*B. caribbea*

Bankia gouldi (Bartsch)

PLATE 25, FIGURES 3, 4; PLATE 26, FIGURES 1, 2

Xylotrya gouldi Bartsch (1908) Proc. Biol. Soc. Washington, 21: 211.

The narrow cones of the pallets which are projected upward against the cone above will distinguish this species in the Porto Rican region.

Shell length 7.0, height 7.2 mm.

Pallet length 13.6 mm.

Porto Rico: San Juan.

Bankia caribbea Clench and Turner

PLATE 25, FIGURES 1, 2; PLATE 26, FIGURES 5, 6

Bankia (Bankiopsis) caribbea Clench and Turner (1946) *Johnsonia* 2, No. 19, p. 16, Pl. 10.

The nonserrated and broadly spreading cones of the pallets will identify the species in this area.

Shell length 4.9, height 4.5 mm.

Pallet length 10 mm.

Porto Rico: Fajardo.

Bankia fimbriatula Moll and Roch

PLATE 25, FIGURES 5, 6; PLATE 26, FIGURES 3, 4

Teredo fimbriata Jeffreys (1860) Ann. Mag. Nat. Hist., (3) 6: 126, not DeFrance, 1828.*Bankia fimbriatula* Moll and Roch (1931) Proc. Mal. Soc. London, 19: 213.*Bankia (Bankia) canalis* Bartsch (1944) *Smithson. Misc. Coll.*, 104 No. 8: 1.

The serrated edges of the cones of the pallets will separate this species from the two listed above.

Shell length 4.5, height 4.5 mm.

Pallet length 16 mm.

Porto Rico: San Juan.

REMARKS

The pelecypod fauna of Porto Rico and the Virgin Islands has been classified in systematic manner on the foregoing pages. The class as a whole and the gradient subordinate groups have been keyed and described. The order of appearance in the text is based on phylogenetic relationships. The keys are more or less empirical and the order of their subject matter has no natural significance. The families, genera, and species will be found in correct order on the pages following their keys. In speaking of a correct or phylogenetic arrangement it must be borne in mind that a linear scheme such as this cannot be in any sense a graphic representation of an ontogenetic or phylogenetic situation. Pelecypod ontogeny occupies three dimensions while its phylogeny extends through time as well. The most any taxonomic account can do is to arrange its subject matter so as to bring related species together in a sequence which is based on their presumed ancestry. The limitations of such a linear system are great.

In the preceding systematic account the prime emphasis has been placed on generic and family relationships. The species have not been described in detail. All species have been figured. These figures together with the keys and comparative remarks, which appear in the text, should serve to identify the species. A knowledge of the orders and subordinate groups down to the genera and subgenera is essential for a fundamental understanding of pelecypod classification. Therefore, these groups have been stressed and presented in detail.

GLOSSARY

- Adductor muscles. The two muscles which draw the valves together at closure. They leave characteristic scars on the inner surface of the shell.
- Alivincular. Descriptive of the ligament when it is in the form of a band running from beak to beak across the hinge line.
- Amphidetic. Descriptive of the ligament or area when disposed on each side of the umbones.
- Anal siphon. The dorsal or excurrent siphon.
- Anisomyarian. Adductor muscles unequal.
- Area. A dorsal area of the shell which is more or less inscribed or delimited and is associated with the hinge line. It may include both a lunule and an escutcheon.
- Auricles. The expanded portions of the hinge, particularly in the Pteriacea and Pectinacea.
- Beaks. Umbones.
- Branchial siphon. The ventral or incurrent siphon.
- Byssus. A tough horny thread or mass of threads which are produced by a gland in the foot and serve to attach the animal to the substratum.
- Cancellate. Said of the external sculpture when concentric and radial elements cross to form a grid.
- Cardinal teeth. Hinge teeth which are radially disposed and have their origin beneath the umbo.
- Cartilage. Resilium.
- Cartilage pit. A pit in the hinge which receives the resilium.
- Chondrophore. A specialized shell structure which bears the resilium; resilifer.
- Concentric sculpture. The expanding circular pattern which begins at the umbo and progresses to the valve margin, often simply incremental or growth lines.
- Crenation. A regular roughening, folding, or grooving.
- Crenulation. Same as crenation.
- Crura. Raised ridges on the ears of the shell in the Pectinacea.
- Ctenolium. A comb-like structure on the margin which guides the byssal threads.
- Dentate. Toothed.
- Denticulate. Armed with minute teeth or denticles.
- Dichotomous. Branching into two elements.
- Dimyarian. Both anterior and posterior adductor muscles present.
- Divaricate. Sculpture with elements which run in two directions from a common axis.
- Dysodont dentition. Hinge teeth consisting of tubercles or denticles where the external sculpture impinges on the hinge margin.
- Ears. Auricles of the shell.
- Edentulous. Without hinge teeth.
- Entire. Said of the pallial line when there is no sinus.
- Epidermis. The outer horny covering of the shell; periostracum.
- Equilateral. Umbones centrally located, anterior and posterior ends more or less equal.
- Equivalve. Both valves equal.
- Erect umbones. Directed neither forward nor backward but more or less vertically.
- Escutcheon. An oval or spindle-shaped area impressed on the surface of the shell posterior to the umbones.
- Excurrent siphon. The dorsal or anal siphon.
- Geniculate. In the form of an elbow.
- Heteromyarian. Adductor muscles unequal in size.
- Hinge. The dorsal borders of the valves united by a ligament or resilium or both.
- Hinge plate. The dorsal valve margin which bears the ligament and usually some form of interlocking teeth.
- Imbricate. Having produced or extended layers which give a shingled effect.
- Incurrent siphon. The ventral or branchial siphon.

- Inequilateral. Said of a shell when the umbones are located nearer to one end than to the other.
- Inequivalve. One valve larger than the other.
- Isodont dentition. Concentrically disposed teeth which are found in the Pectinacea and Anomiacea. They are thought to be elaborations of the auricular crura.
- Isomyarian. Both adductor muscles equal or nearly so.
- Lateral teeth. Interlocking teeth located on the hinge margin some distance from the umbo. Usually parallel to the margin.
- Ligament. A horny or cartilaginous band which unites the valves across their axis of closure. As generally used the term includes the true ligament and the resilium as well.
- Lithodesma. A calcareous supporting structure incorporated into the resilium.
- Lunule. An oval or heart-shaped area impressed on the outside of the shell forward of the umbones.
- Monomyarian. Having one adductor muscle, the posterior one.
- Multivincular. Applied to the ligament when it is disposed in a series of elements across the hinge line.
- Nacreous. Pearly.
- Nymphs. Raised ridges on the hinge plate which support the ligament or resilium or both.
- Opisthodontic. Descriptive of the ligament or area when located behind the umbones.
- Opisthogyrous. Said of the umbones when they are directed backward.
- Opisthopodial opening. An aperture in the mantle margins behind the pedal opening.
- Pallets. Calcareous valve-like structures associated with the siphons of the Teredinidae.
- Pallial line. A line parallel to the margin and impressed on the inner surface of the shell where the mantle is attached.
- Pallial sinus. An indentation in the pallial line which marks the attachment of the siphonal retractor muscles.
- Parivincular. Descriptive of the ligament when it is disposed along the hinge line in the form of a C-spring.
- Periostracum. Epidermis or horny outside layer of the shell.
- Posterior slope. The portion of the shell posterior to the umbonal ridge.
- Prodissoconch. The embryonic shell.
- Prosocoelous. The meaning is the same as prosogyrous but it refers to the internal cavity of the umbones.
- Prosodontic. Said of the ligament or area when forward of the umbones.
- Prosogyrous. Said of the umbones when they are directed forward.
- Radial sculpture. The sculpture with elements which begin at the umbo and extend in a radial linear pattern to the margin.
- Resilifer. The portion of the shell, often specialized, which bears the resilium.
- Resilium. The cartilage located in the hinge which is compressed on closure of the valves and tends to force them apart.
- Schizodont dentition. Hinge dentition made up of amorphous interlocking rugosities.
- Simple. Said of the pallial line when there is no pallial sinus.
- Sinuate. Applied to pallial line when a sinus is present.
- Siphonal septum. The membrane separating the gill chamber from the anal chamber.
- Siphons. Specialized portions of the mantle margins which are tubular and direct the flow of water into and out of the shell.
- Sulcus. A large fold or groove.
- Taxodont dentition. Hinge dentition consisting of a series of similar teeth repeated along the hinge line.
- Teleodont dentition. Hinge dentition made up of cardinal and lateral elements.
- Umbo. The earliest portion of the shell beginning with the prodissoconch.
- Umbonal ridge. The prominent angle of the shell which begins at the umbo and runs obliquely posteriorly to the ventral border.
- Umbones. The plural of umbo.
- Valves. The paired halves of the calcareous shell.
- Ventricose. Swollen or tumid.

Explanation of Plates

PLATE 1

- FIGURE 1. *Solemya (Petrasma) occidentalis* (Deshayes). Right valve: length 18 mm., p. 7.
- FIGURE 2. *Nuculana acuta* (Conrad). Left valve: length 9.5 mm., p. 9; (after Dall).
- FIGURE 3. *Tindaria (Neilonella) corpulenta* (Dall). Right valve: length 9.5 mm., p. 10; (after Dall).
- FIGURE 4. *Nucula aegeensis* Jeffrey. Left valve: length 2.7 mm., p. 9.
- FIGURE 5. *Glycimeris (Glycimerella) pennaceus* (Lamarck). Left valve: length 48 mm., p. 12.
- FIGURE 6. *Glycimeris (Glycimeris) sericatus* (Reeve). Left valve: length 35.5 mm., p. 11.
- FIGURE 7. *Arca (Arca) occidentalis* Philippi. Right valve: length 85 mm., p. 13.
- FIGURE 8. *Glycimeris (Glycimeris) pectinatus* (Gmelin). Left valve: length 33.5 mm., p. 11.

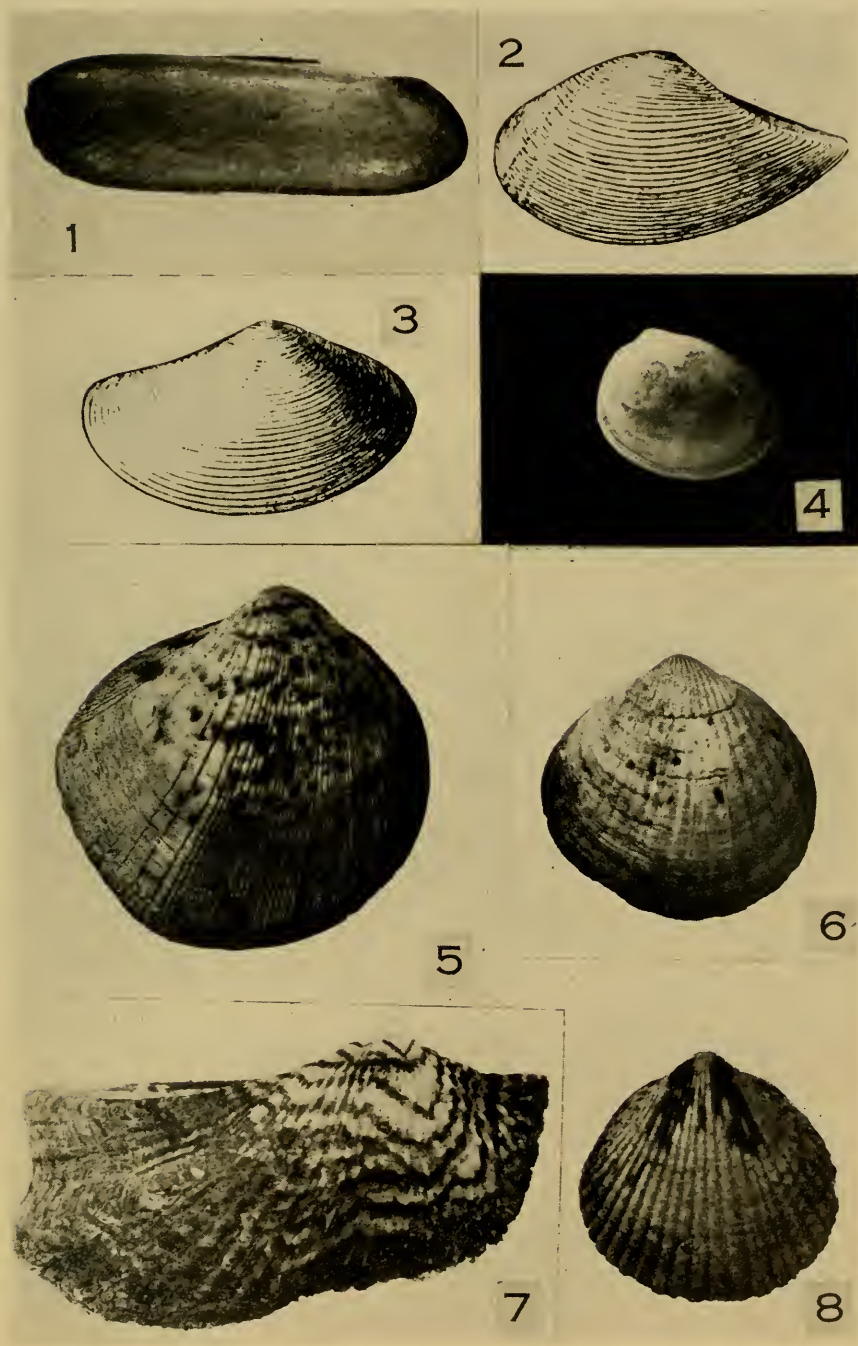


PLATE 1

PLATE 2

- FIGURE 1. *Arca (Arca) umbonata* Lamarck. Right valve: length 46 mm., p. 14.
FIGURE 2. *Arca (Barbatia) tenera* C. B. Adams. Right valve: length 26.5 mm., p. 15.
FIGURE 3. *Arca (Barbatia) barbata* Linnaeus. Right valve: length 40.5 mm., p. 14.
FIGURE 4. *Arca (Acar) adamsi* Smith. Right valve: length 10 mm., p. 16.
FIGURE 5. *Arca (Acar) reticulata* Gmelin. Right valve: length 29.5 mm., p. 15.
FIGURE 6. *Arca (Barbatia) candida* Gmelin. Right valve: length 73 mm., p. 14.
FIGURE 7. *Arca (Scapharca) chemnitzii* Philippi. Right valve: length 27 mm., p. 17.
FIGURE 8. *Arca (Barbatia) candida* Gmelin. Right valve: length 40 mm., p. 14.
FIGURE 9. *Arca (Scapharca) auriculata* Lamarck. Right valve: length 50 mm., p. 16

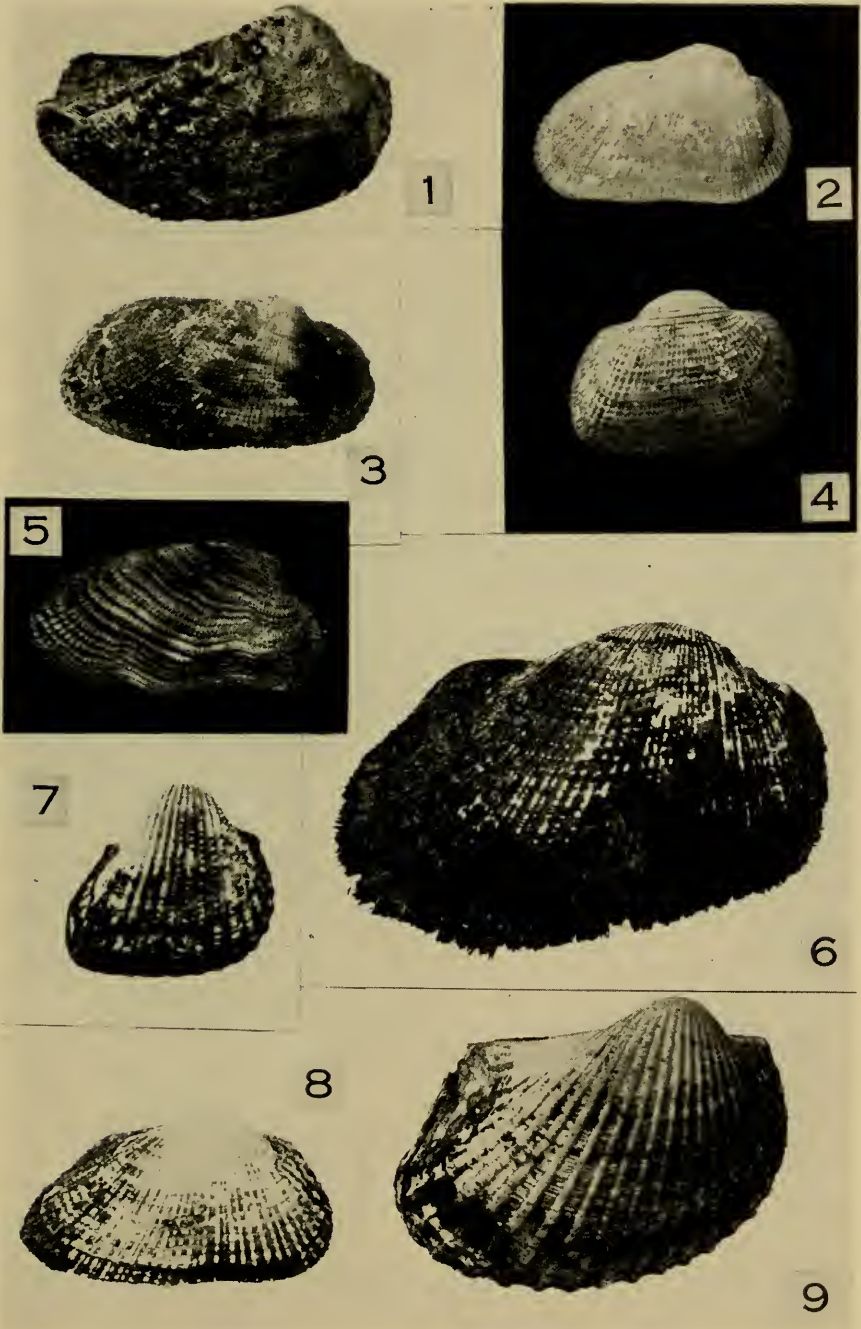
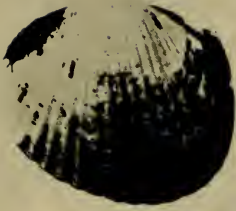


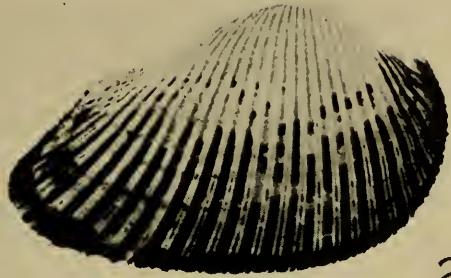
PLATE 2

PLATE 3

- FIGURE 1. *Arca (Arginarca) campechiensis* Gmelin. Left valve: length 31 mm., p. 17.
FIGURE 2. *Arca (Scapharca) secticostata* Reeve. Right valve: length 71.5 mm., p. 17.
FIGURE 3. *Arca (Scapharca) transversa* Say. Left valve: length 28 mm., p. 16.
FIGURE 4. *Atrina rigida* (Dillwyn). Right valve: length 230 mm., p. 20.
FIGURE 5. *Pinna rudis* Linnaeus. Left valve: length 217 mm., p. 19.
FIGURE 6. *Isognomon listeri* (Hanley). Left valve: height 61 mm., p. 22.
FIGURE 7. *Pinctada radiata* (Leach). Right valve: length 56 mm., p. 21.
FIGURE 8. *Pteria colymbus* (Röding). Right valve: length 93 mm., p. 20.



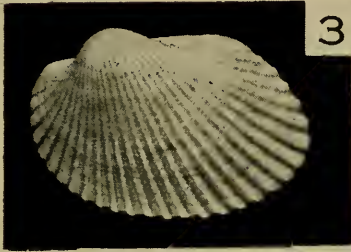
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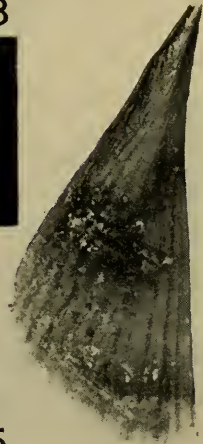
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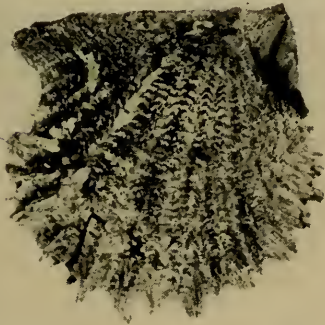
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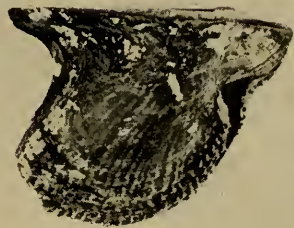
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8

PLATE 3

PLATE 4

- FIGURE 1. *Isognomon vulsella* (Lamarck). Inner side of left valve: height 24 mm., p. 22.
- FIGURE 2. *Isognomon vulsella* (Lamarck). Right valve: height 24 mm., p. 22.
- FIGURE 3. *Isognomon alata* (Gmelin). Right valve: length 86 mm., p. 22.
- FIGURE 4. *Ostrea (Ostrea) frons* Linnaeus. Side view: length 63.5 mm., p. 24.
- FIGURE 5. *Ostrea (Crassostrea) virginica* Gmelin. Left valve: height of shell 81 mm., p. 24.
- FIGURE 6. *Ostrea (Crassostrea) rhizophorae* Guilding. Left valve: height of shell 56 mm., p. 25.
- FIGURE 7. *Ostrea (Ostrea) frons* Linnaeus. Left valve: length 63.5 mm., p. 24.
- FIGURE 8. *Ostrea (Ostrea) cristata* Born. Side view: length 38.5 mm., p. 23.
- FIGURE 9. *Ostrea (Ostrea) cristata* Born. Left valve: length 38.5 mm., p. 23.

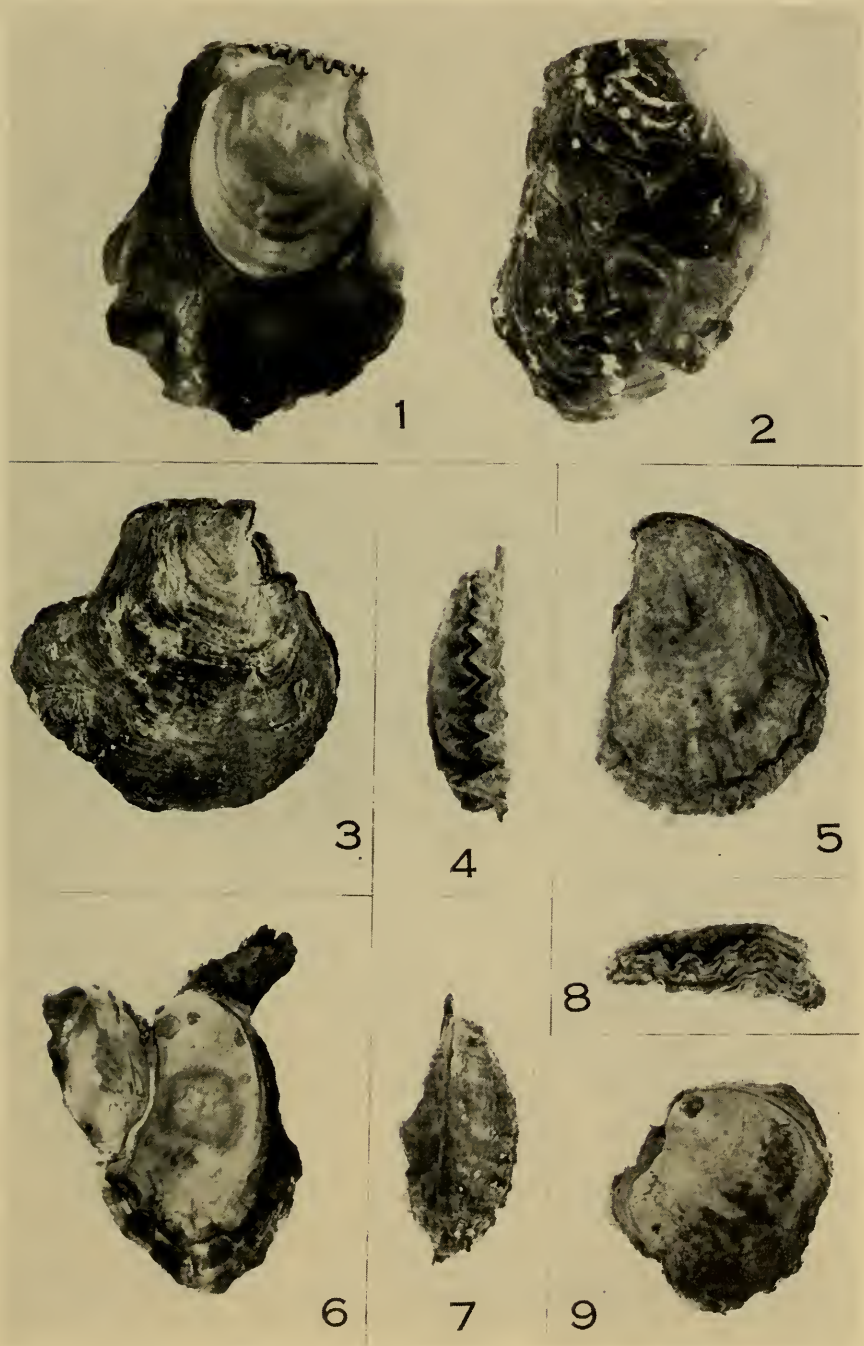
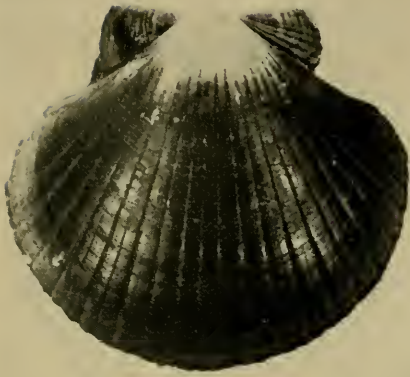


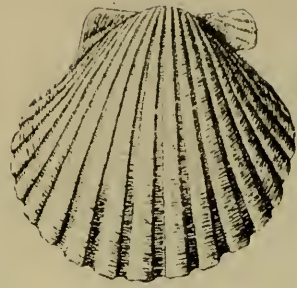
PLATE 4

PLATE 5

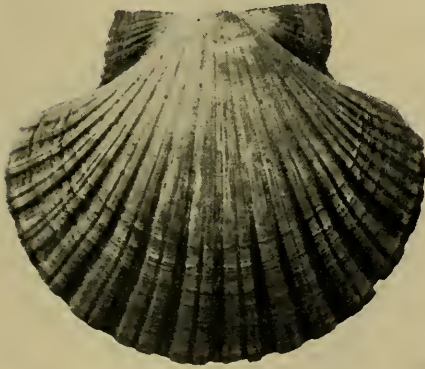
- FIGURE 1. *Pecten (Euvola) siczac* (Linnaeus). Right valve: length 82 mm., p. 27.
FIGURE 2. *Pecten (Euvola) raveneli* Dall. Right valve: length 86 mm., p. 27.
FIGURE 3. *Pecten (Plagioctenium) gibbus mayaguezensis* Dall and Simpson. Right valve: length 18 mm., p. 28; (after Dall and Simpson).
FIGURE 4. *Pecten (Plagioctenium) gibbus* (Linnaeus). Left valve: length 56.5 mm., p. 28.
FIGURE 5. *Chlamys (Chlamys) muscosa* (Wood). Left valve: length 34 mm., p. 29.
FIGURE 6. *Chlamys (Chlamys) ornata* (Lamarck). Left valve: length 31 mm., p. 29.
FIGURE 7. *Chlamys (Chlamys) imbricata* (Gmelin). Left valve: length 34 mm., p. 29.



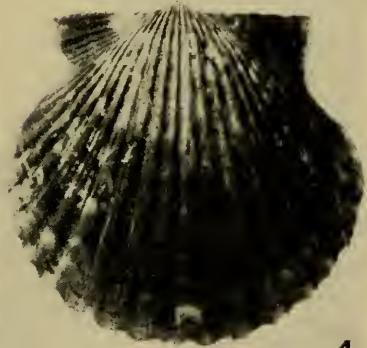
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7



6

PLATE 5

PLATE 6

- FIGURE 1. *Chlamys (Lyropecten) nodosa* (Linnaeus). Right valve: length 138 mm., p. 30.
- FIGURE 2. *Chlamys (Chlamys) multisquamata* (Dunker). Left valve: length 53 mm., p. 29.
- FIGURE 3. *Chlamys (Palliolum) nana* (Verrill and Bush). Left valve: length 5.5 mm., p. 31.
- FIGURE 4. *Amusium dalli* E. A. Smith. Left valve: height 35 mm., p. 31.
- FIGURE 5. *Amusium pourtalesianum* Dall. Left valve: height 4.5 mm., p. 31.
- FIGURE 6. *Chlamys (Lyropecten) antillarum* (Recluz). Left valve: length 24 mm., p. 30.
- FIGURE 7. *Plicatula gibbosa* Lamarck. Left valve: length 24 mm., p. 33.

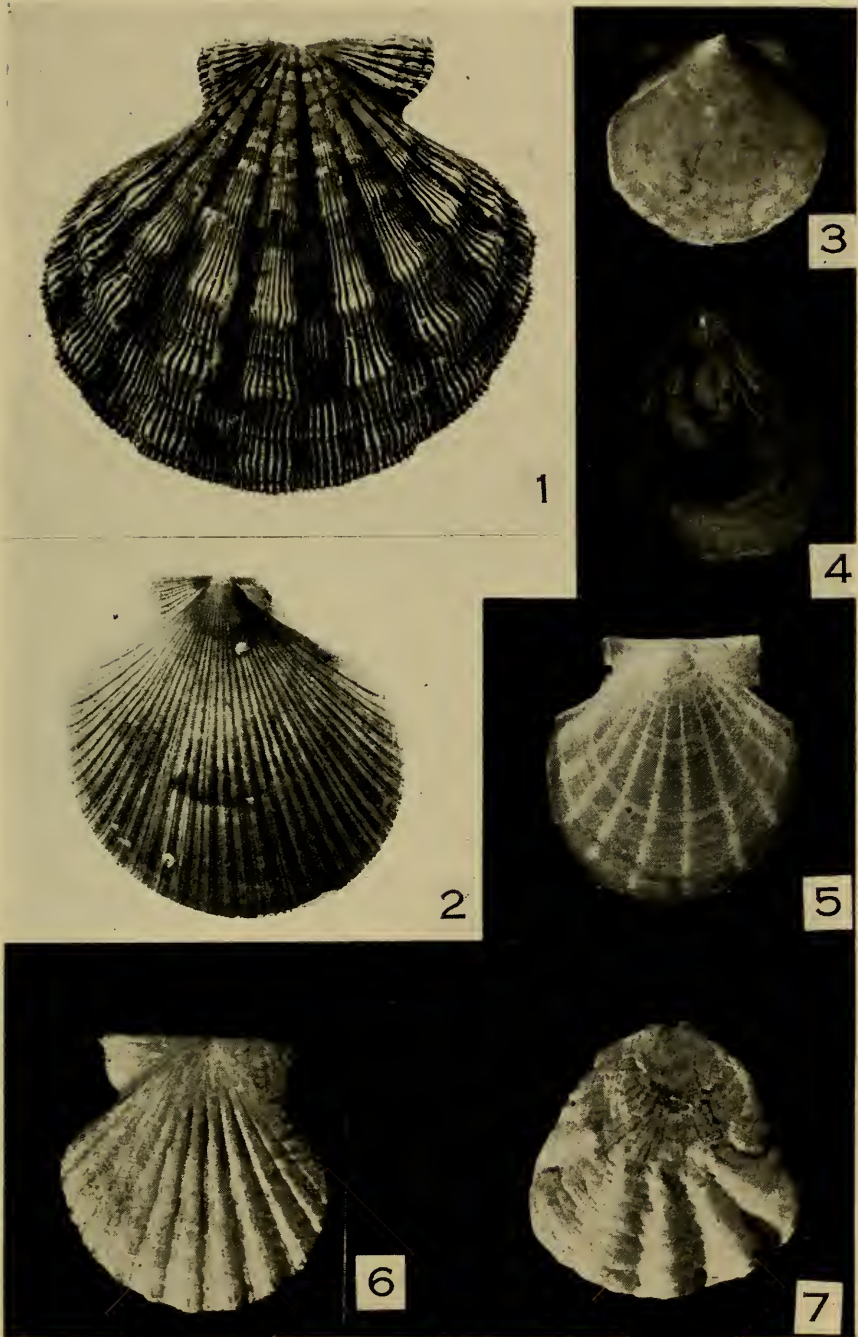


PLATE 6

PLATE 7

- FIGURE 1. *Spondylus americanus* Hermann. Left valve: length 70 mm., p. 32.
FIGURE 2. *Lima (Ctenoides) scabra* (Born). Right valve: height 72.5 mm., p. 35.
FIGURE 3. *Lima (Lima) lima* (Linnaeus). Left valve: height 46 mm., p. 34.
FIGURE 4. *Lima (Ctenoides) tenera* Sowerby. Right valve: height 61 mm., p. 35.
FIGURE 5. *Lima (Mantellum) inflata* (Gmelin). Right valve: height 16 mm., p. 35.
FIGURE 6. *Lima (Mantellum) hians* (Gmelin). Right valve: height 17 mm., p. 36.
FIGURE 7. *Limatula subauriculata* (Montagu). Right valve: height 8.5 mm., p. 36.

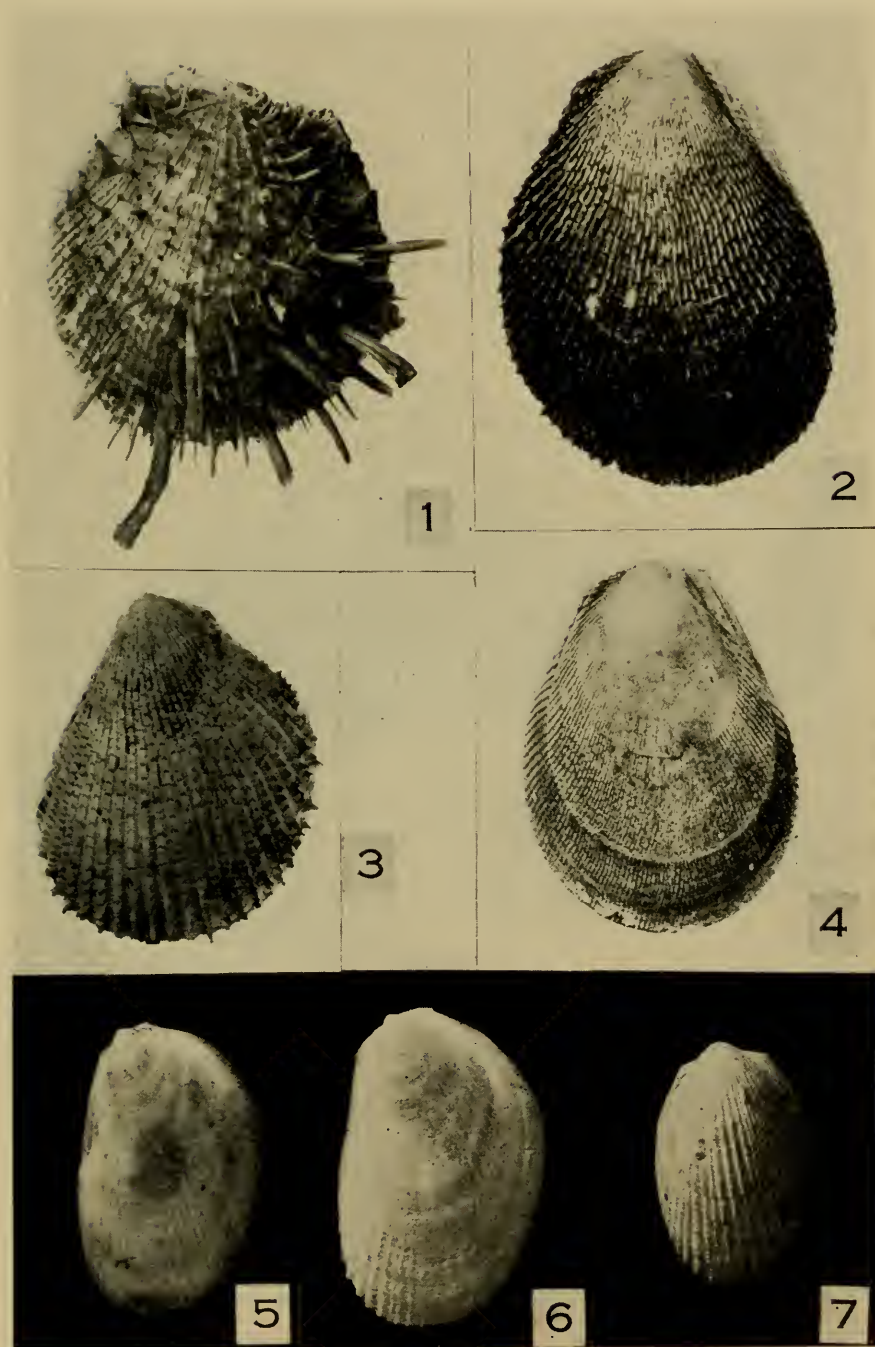


PLATE 7

PLATE 8

- FIGURE 1. *Pododesmus rudis* (Broderip). Left valve: length 43 mm., p. 38.
- FIGURE 2. *Anomia simplex* d'Orbigny. Left valve: length 34 mm., p. 37.
- FIGURE 3. *Lithophaga (Botula) fusca* (Gmelin). Left valve: length 19 mm., p. 43.
- FIGURE 4. *Modiolus (Modiolus) tulipa* Lamarck. Left valve: length 63.5 mm., p. 39.
- FIGURE 5. *Lithophaga (Botula) cinnamomea* (Lamarck). Right valve: length 41 mm., p. 42.
- FIGURE 6. *Modiolus (Modiolus) castaneus* Say. Right valve: length 23 mm., p. 39.
- FIGURE 7. *Modiolus (Amygdalum) dendriticus* (Megerle). Right valve: length 26 mm., p. 40.
- FIGURE 8. *Lithophaga (Lithophaga) nigra* (d'Orbigny). Right valve: length 52 mm., p. 41.
- FIGURE 9. *Lithophaga (Lithophaga) antillarum* (d'Orbigny). Right valve: length 86 mm., p. 41.



PLATE 8

PLATE 9

- FIGURE 1. *Lithophaga (Lithophaga) aristat* (Dillwyn). Right valve: length 42 mm., p. 42.
- FIGURE 2. *Brachydontes (Brachydontes) citrinus* (Röding). Right valve: length 43 mm., p. 43.
- FIGURE 3. *Lithophaga (Lithophaga) bisulcata* (d'Orbigny). Right valve: length 60 mm., p. 41.
- FIGURE 4. *Brachydontes (Hormomya) exustus* (Linnaeus). Right valve: height 39 mm., p. 44.
- FIGURE 5. *Brachydontes (Ischadium) recurvus* (Rafinesque). Right valve: height 39 mm., p. 44.
- FIGURE 6. *Crenella divaricata* (d'Orbigny). Right valve: height 2.5 mm., p. 46.
- FIGURE 7. *Modiolaria lateralis* (Say). Left valve: length 7 mm., p. 45.
- FIGURE 8. *Modiolaria (Gregariella) coralliophaga* (Gmelin). Right valve: length 15.5 mm., p. 45.
- FIGURE 9. *Lyonsia beana* d'Orbigny. Right valve: length 21 mm., p. 47.

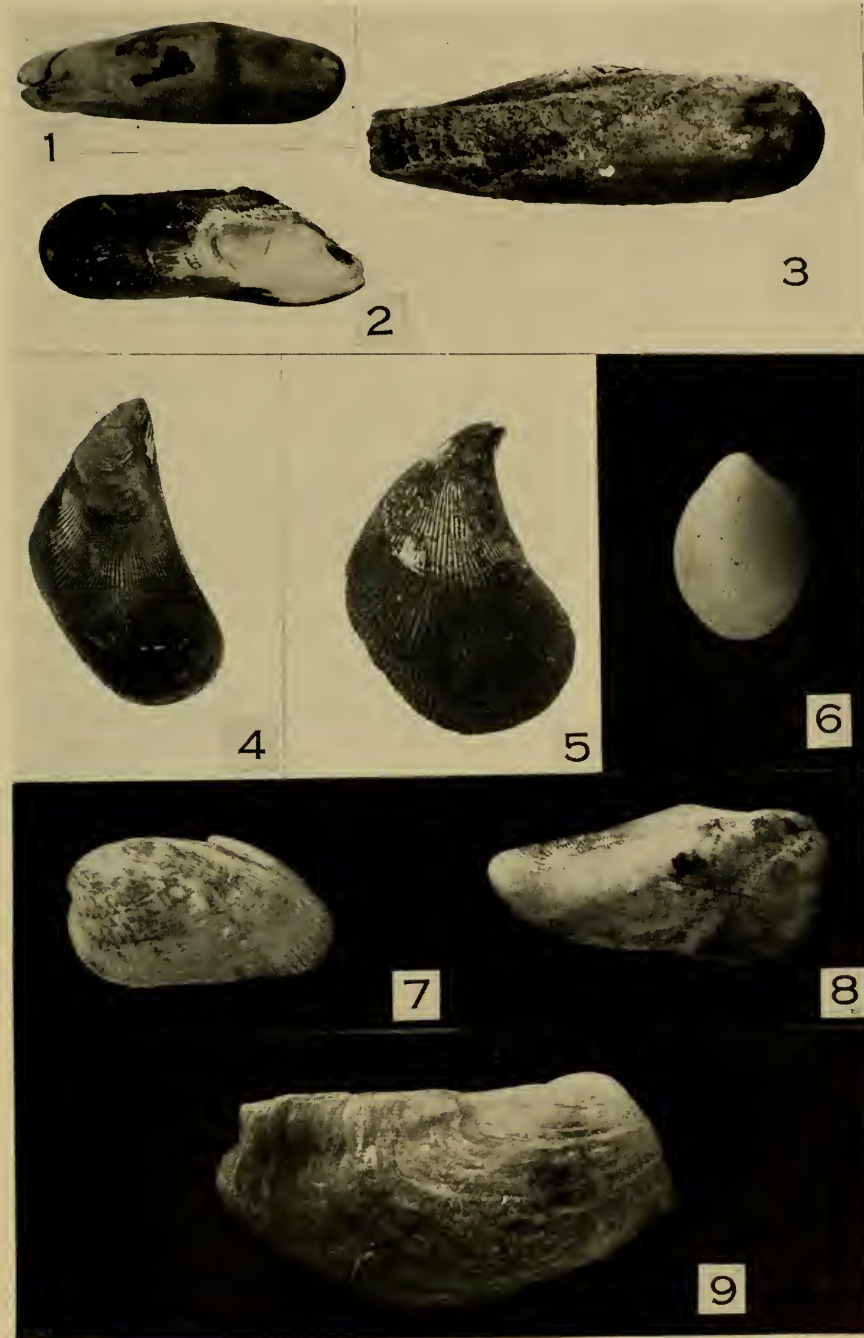


PLATE 9

PLATE 10

FIGURE 1. *Cuspidaria (Cuspidaria) obesa* (Lovèn). Left valve: length 13 mm., p. 49; (after Dall).

FIGURE 2. *Cuspidaria (Cardiomya) perrostrata* Dall. Right valve: length 8 mm., p. 49; (after Dall).

FIGURE 3. *Cuspidaria (Cardiomya) costellata* (Deshayes). Length 4 mm., p. 49; (3 views, after d'Orbigny).

FIGURE 4. *Cuspidaria (Cardiomya) ornatissima* (d'Orbigny). Right valve: length 10 mm., p. 50; (after Bush).

FIGURE 5. *Verticordia ornata* (d'Orbigny). Right valve: length 2 mm., p. 51; (inside and outside view, after Verrill).

FIGURE 6. *Crassinella guadalupensis* (d'Orbigny). Right valve: length 5.5 mm., p. 53

FIGURE 7. *Cardita gracilis* Shuttleworth. Right valve: length 17 mm., p. 54.

FIGURE 8. *Crassinella martinicensis* (d'Orbigny). Right valve: length 3 mm., p. 52.

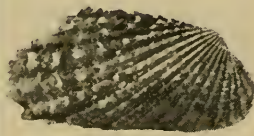
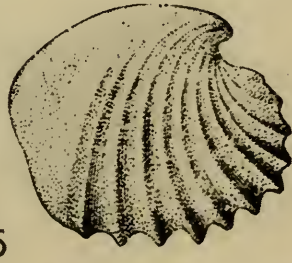
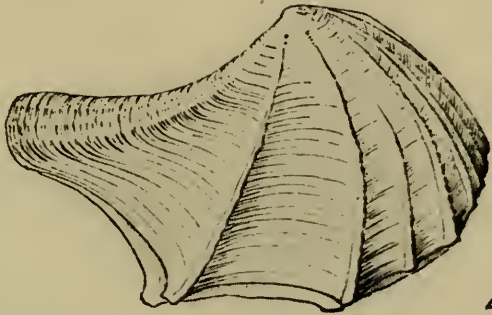
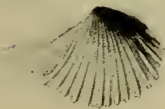
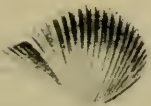
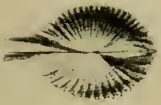
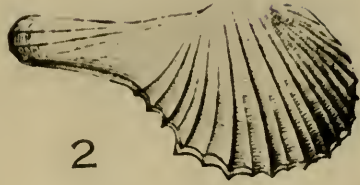
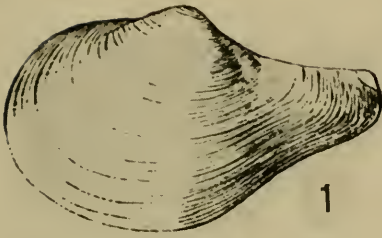


PLATE 10

PLATE 11

- FIGURE 1. *Chama macerophylla* Gmelin. Right valve: length 57 mm., p. 55.
FIGURE 2. *Chama sarda* Reeve. Right valve: length 22 mm., p. 55.
FIGURE 3. *Chama sarda* Reeve. Left valve: length 22 mm., p. 55.
FIGURE 4. *Echinochama arcinella* (Linnaeus). Left valve: length 35 mm., p. 57.
FIGURE 5. *Pseudochama radians ferruginea* (Reeve). Left valve: length 45 mm., p. 56.
FIGURE 6. *Pseudochama radians variegata* (Reeve). Left valve: length 29 mm., p. 56.
FIGURE 7. *Thyasira trisinuata* (d'Orbigny). Left valve: length 4 mm., p. 58.
FIGURE 8. *Thyasira conia* Dall and Simpson. Right valve: height 5.5 mm., p. 58;
(after Dall).

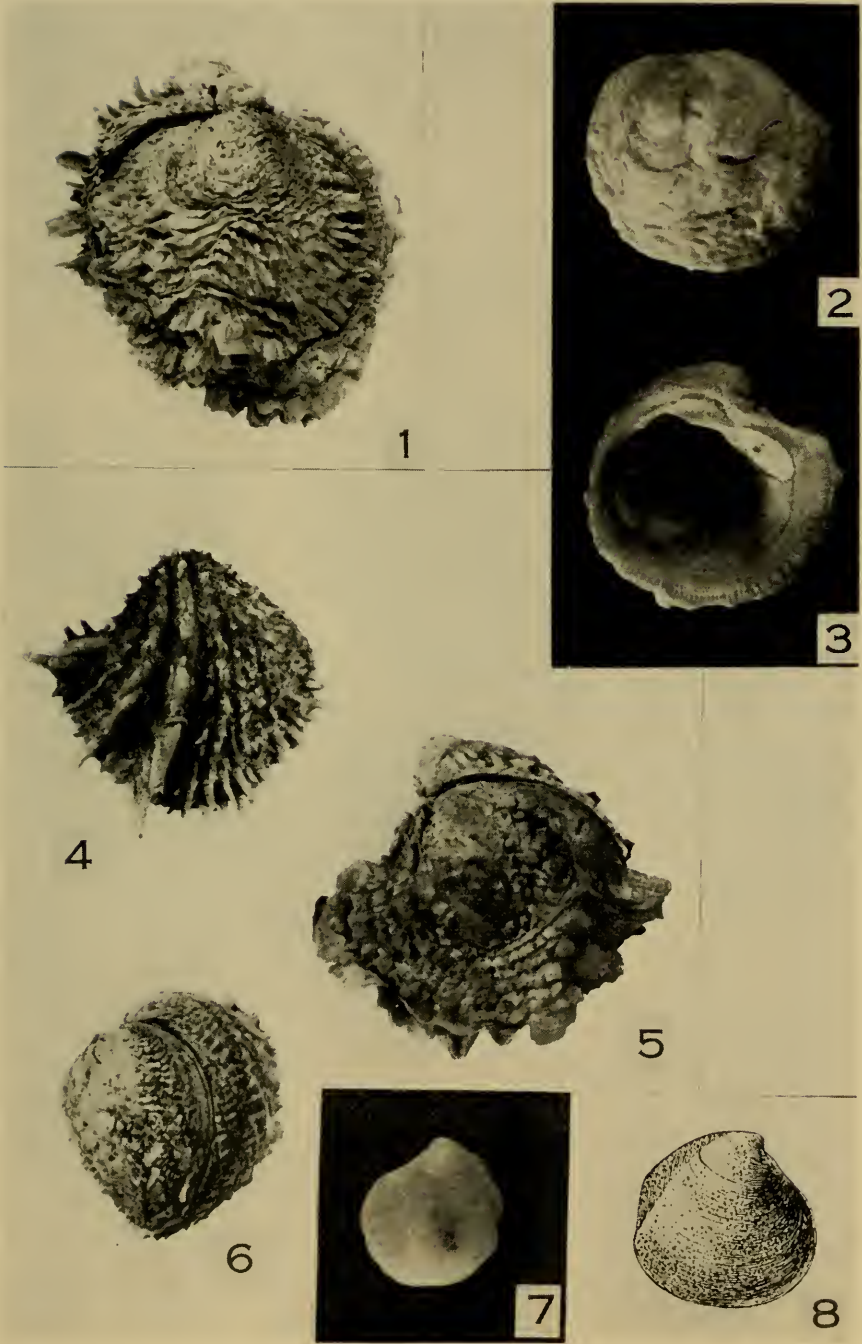


PLATE 11

PLATE 12

FIGURE 1. *Codakia orbicularis* (Linnaeus). Left valve: length 60 mm., p. 60.

FIGURE 2. *Codakia (Jagonia) costata* (d'Orbigny). Left valve: length 14 mm., p. 60.

FIGURE 3. *Codakia (Jagonia) orbiculata* (Montagu). Left valve: length 21.5 mm., p. 61.

FIGURE 4. *Codakia (Jagonia) portoricana* Dall. Right valve: length 7.25 mm., p. 61; (after Dall).

FIGURE 5. *Lucina chrysostoma* Philippi. Left valve: length 52 mm., p. 61.

FIGURE 6. *Codakia (Jagonia) pectinella* (C. B. Adams). Right valve: length 7.7 mm., p. 61; (after Dall and Simpson).

FIGURE 7. *Myrtaea pristophora* Dall and Simpson. Left valve: length 6 mm., p. 62; (after Dall and Simpson).

FIGURE 8. *Lucina phenax* Dall and Simpson. Right valve: height 9 mm., p. 62; (after Dall).

FIGURE 9. *Phacoides (Linga) trisulcatus blandus* Dall and Simpson. Left valve: length 7 mm., p. 64.

FIGURE 10. *Phacoides (Linga) pensylvanica* (Linnaeus). Left valve: length 39 mm., p. 63.

FIGURE 11. *Phacoides (Phacoides) pectinatus* (Gmelin). Left valve: length 51 mm., p. 63.



10

11

PLATE 13

- FIGURE 1. *Phacoides (Lucinisca) muricatus* (Spengler). Left valve: length 17.5 mm. p. 64.
- FIGURE 2. *Cyrenoïda americana* (Morelet). Left valve: length 19 mm., p. 68.
- FIGURE 3. *Phacoides (Callucina) radians* (Conrad). Left valve: length 21.5 mm., p. 65.
- FIGURE 4. *Taras (Taras) punctata* (Say). Left valve: length 17 mm., p. 66.
- FIGURE 5. *Divaricella dentata* (Wood). Right valve: length 29 mm., p. 65.
- FIGURE 6. *Taras (Phlyctiderma) semiaspera* (Philippi). Left valve: length 14 mm., p. 67.
- FIGURE 7. *Taras (Taras) nucleiformis* (Wagner). Right valve: length 4 mm., p. 67.
- FIGURE 8. *Divaricella quadrisulcata* (d'Orbigny). Left valve: length 17.5 mm., p. 65.
- FIGURE 9. *Taras (Phlyctiderma) gabbi* (Dall). Left valve: length 6.5 mm., p. 67.
- FIGURE 10. *Taras (Phlyctiderma) notata* (Dall and Simpson). Left valve: length 8 mm., p. 68.

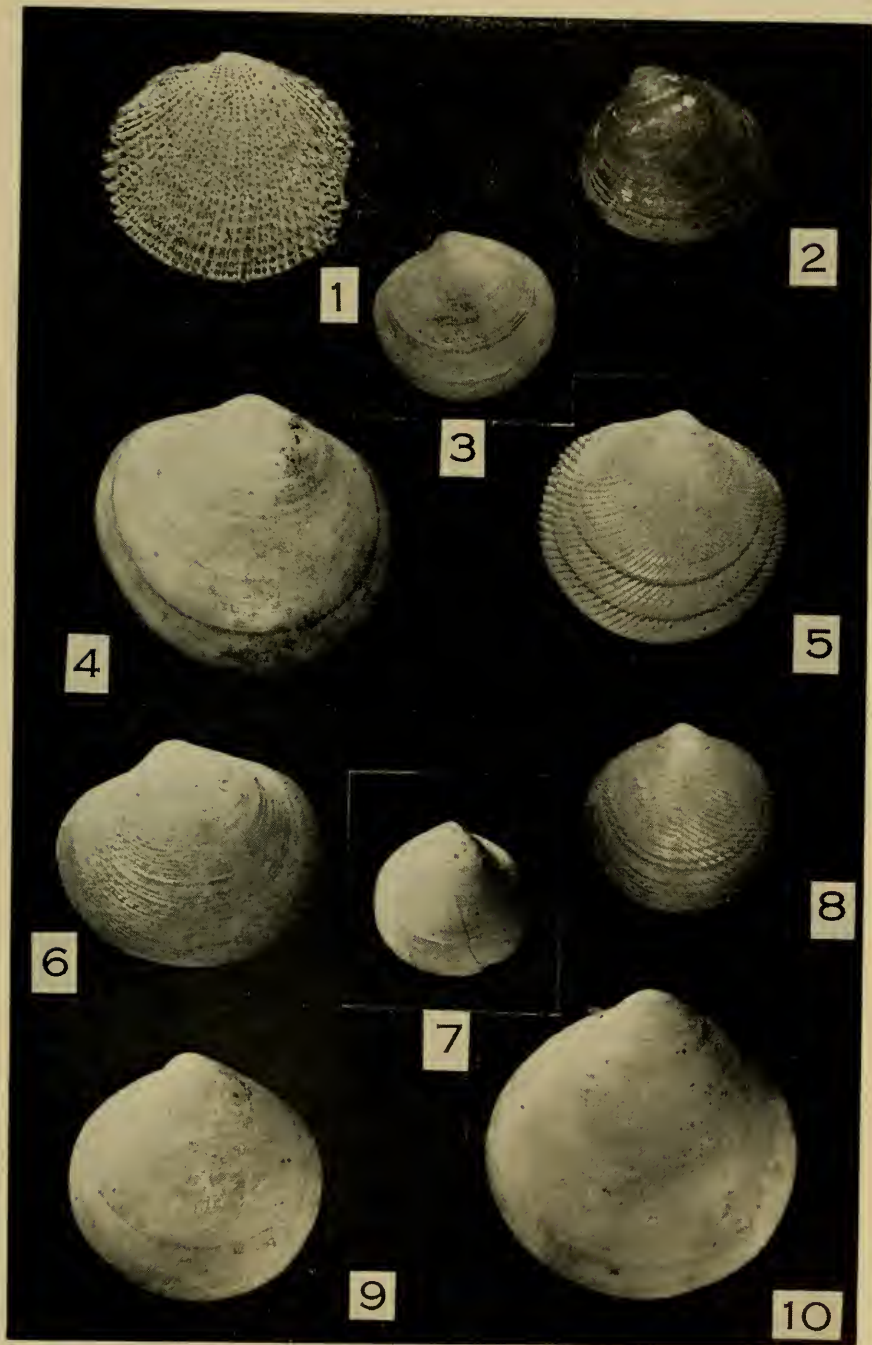


PLATE 13

PLATE 14

FIGURE 1. *Cardium (Trachycardium) isocardia* Linnaeus. Left valve: length 62 mm., p. 70.

FIGURE 2. *Cardium (Trachycardium) magnum* Linnaeus. Left valve: length 57 mm., p. 71.

FIGURE 3. *Cardium (Trachycardium) muricatum* Linnaeus. Right valve: length 40 mm., p. 70.

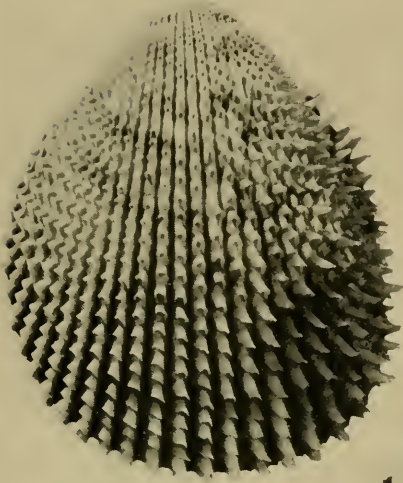
FIGURE 4. *Trigoniocardia (Trigoniocardia) antillarum* (d'Orbigny). Right valve: length 11 mm., p. 72.

FIGURE 5. *Laevicardium laevigatum sybariticum* (Dall). Right valve: length 12 mm., p. 74; (after McLean).

FIGURE 6. *Trigoniocardia (Americardia) medium* (Linnaeus). Right valve: length 30 mm., p. 73.

FIGURE 7. *Trigoniocardia (Trigoniocardia) ceramidum* (Dall). Right valve: length 10 mm., p. 72.

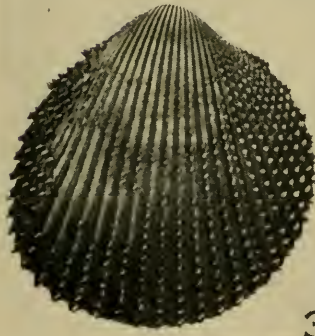
FIGURE 8. *Laevicardium laevigatum* (Linnaeus). Right valve: length 39 mm., p. 74.



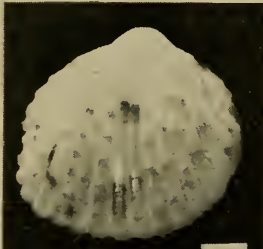
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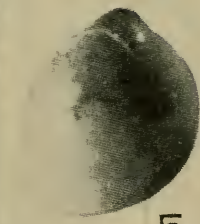
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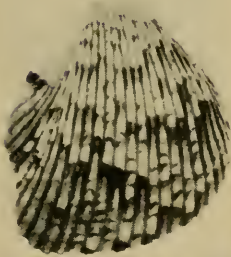
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PLATE 15

- FIGURE 1. *Papyridea hiatus* (Meuschen). Right valve: length 43.5 mm., p. 71.
- FIGURE 2. *Papyridea semisulcatum* (Gray). Right valve: length 12 mm., p. 72.
- FIGURE 3. *Laevicardium laevigatum multilineatum* (Dall and Simpson). Left valve: length 33 mm., p. 74; (after McLean).
- FIGURE 4. *Dosinia concentrica* (Born). Left valve: length 60 mm., p. 77.
- FIGURE 5. *Microcardium peramabile* (Dall). Right valve: length 16 mm., p. 75; (after McLean).
- FIGURE 6. *Microcardium tinctum* (Dall). Right valve: length 9 mm., p. 75; (after McLean).
- FIGURE 7. *Tranzenella culebrana* (Dall and Simpson). Right valve: length 7 mm., p. 77; (internal view, after Dall and Simpson).
- FIGURE 8. *Tranzenella cubaniana* (d'Orbigny). Right valve: length 10 mm., p. 77; (after d'Orbigny).
- FIGURE 9. *Tivela mactroides* (Born). Left valve: length 36 mm., p. 78.
- FIGURE 10. *Gafrarium (Gouldia) insularis* (Dall and Simpson). Left valve: length 6 mm., p. 79; (after Dall and Simpson).
- FIGURE 11. *Gafrarium (Gouldia) cerina* (C. B. Adams). Left valve: length 10 mm., p. 79.

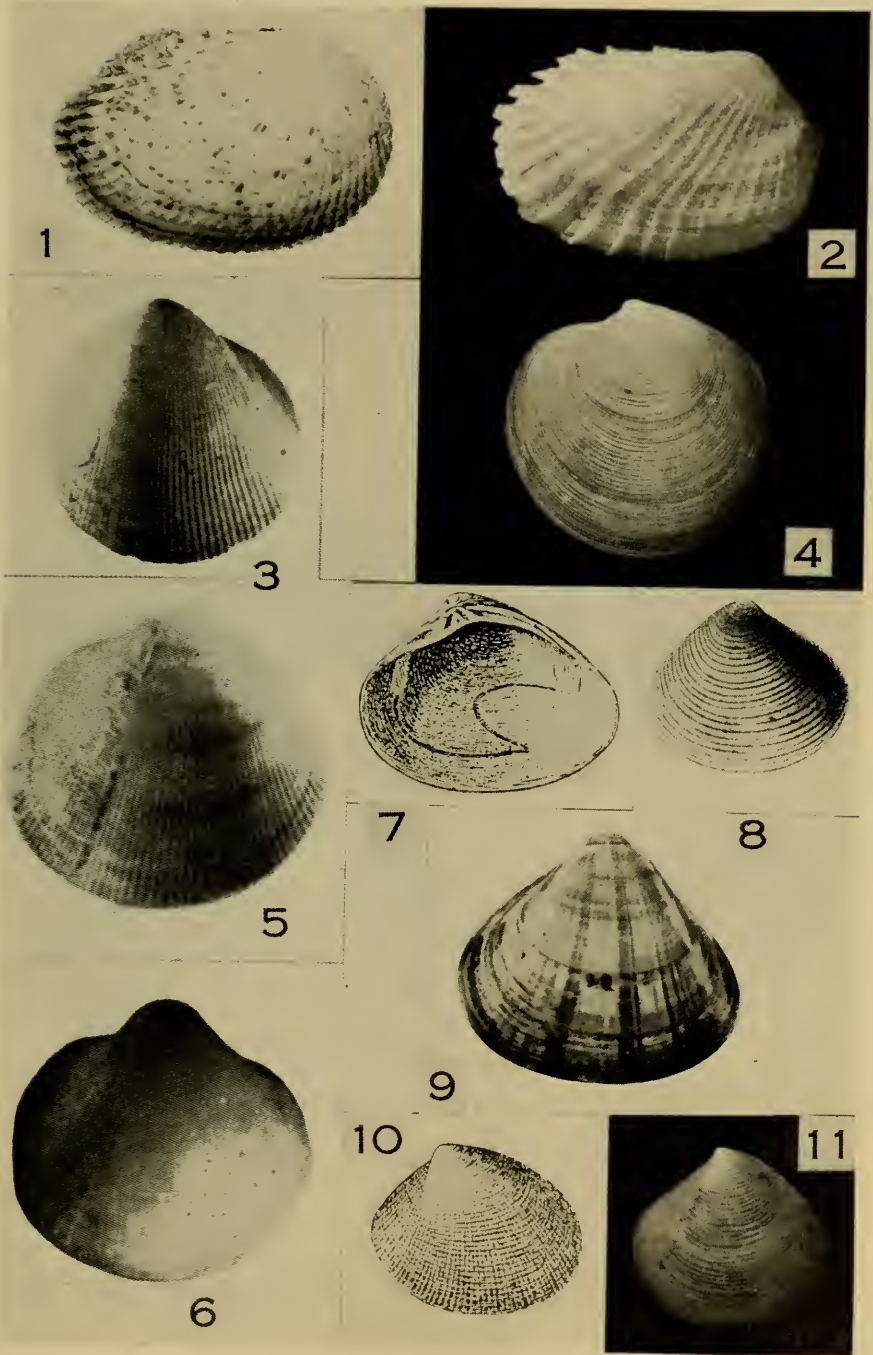


PLATE 15

PLATE 16

- FIGURE 1. *Macrocallista maculata* (Linnaeus). Left valve: length 62 mm., p. 79.
FIGURE 2. *Pitar (Pitar) aresta* (Dall and Simpson). Right valve: length 49 mm., p. 80.
FIGURE 3. *Pitar (Pitar) albida* (Gmelin). Right valve: length 47 mm., p. 80.
FIGURE 4. *Pitar (Pitar) fulminata* (Menke). Right valve: length 46 mm., p. 81.
FIGURE 5. *Antigona (Antigona) listeri* (Gray). Left valve: length 67 mm., p. 82.
FIGURE 6. *Pitar (Hysteroconcha) dione* (Linnaeus). Left valve: length 36 mm., p. 81.
FIGURE 7. *Antigona (Ventricola) rugatina* (Heilprin). Left valve: length 26 mm., p. 83.
FIGURE 8. *Pitar (Hysteroconcha) circinata* (Born). Left valve: length 38 mm., p. 81.

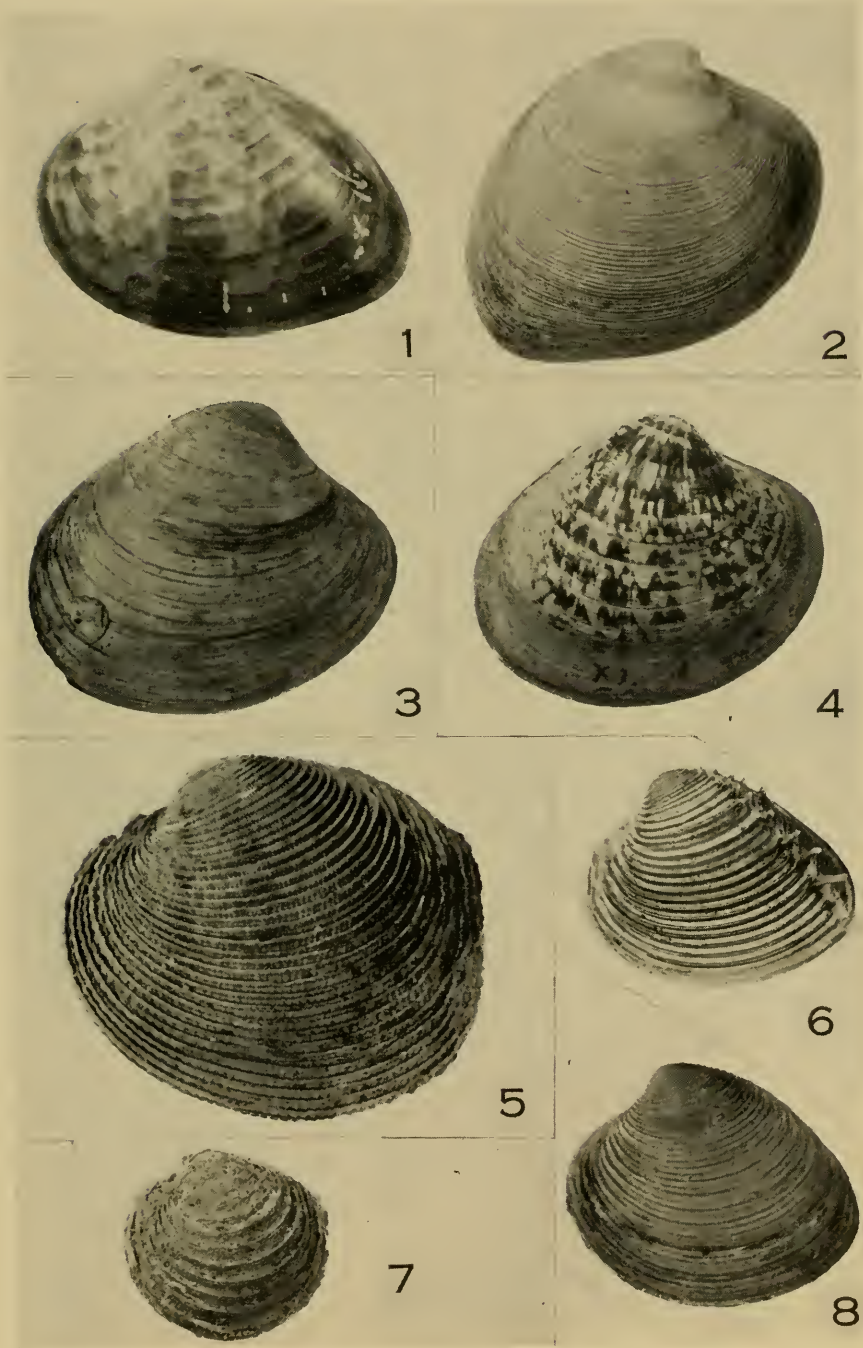


PLATE 16

PLATE 17

- FIGURE 1. *Antigona (Ventricola) rigida* (Dillwyn). Left valve: length 58 mm., p. 83.
FIGURE 2. *Chione (Chione) pygmaea* (Lamarck). Left valve: length 14 mm., p. 85.
FIGURE 3. *Cyclinella tenuis* (Recluz). Left valve: length 27 mm., p. 84.
FIGURE 4. *Chione (Chione) cancellata* (Linnaeus). Left valve: length 30 mm., p. 84.
FIGURE 5. *Chione (Chione) granulata* (Gmelin). Left valve: length 31 mm., p. 85.
FIGURE 6. *Anomalocardia puella* (Pfeiffer). Right valve: length 11 mm., p. 87.
FIGURE 7. *Chione (Lirophora) latilirata* (Conrad). Right valve: length 35 mm., p. 85.
FIGURE 8. *Anomalocardia membranula* Römer. Left valve: length 14.5 mm., p. 87.
FIGURE 9. *Chione (Lirophora) paphia* (Linnaeus). Right valve: length 45 mm., p. 86.
FIGURE 10. *Anomalocardia brasiliana* (Gmelin). Right valve: length 34 mm., p. 86.

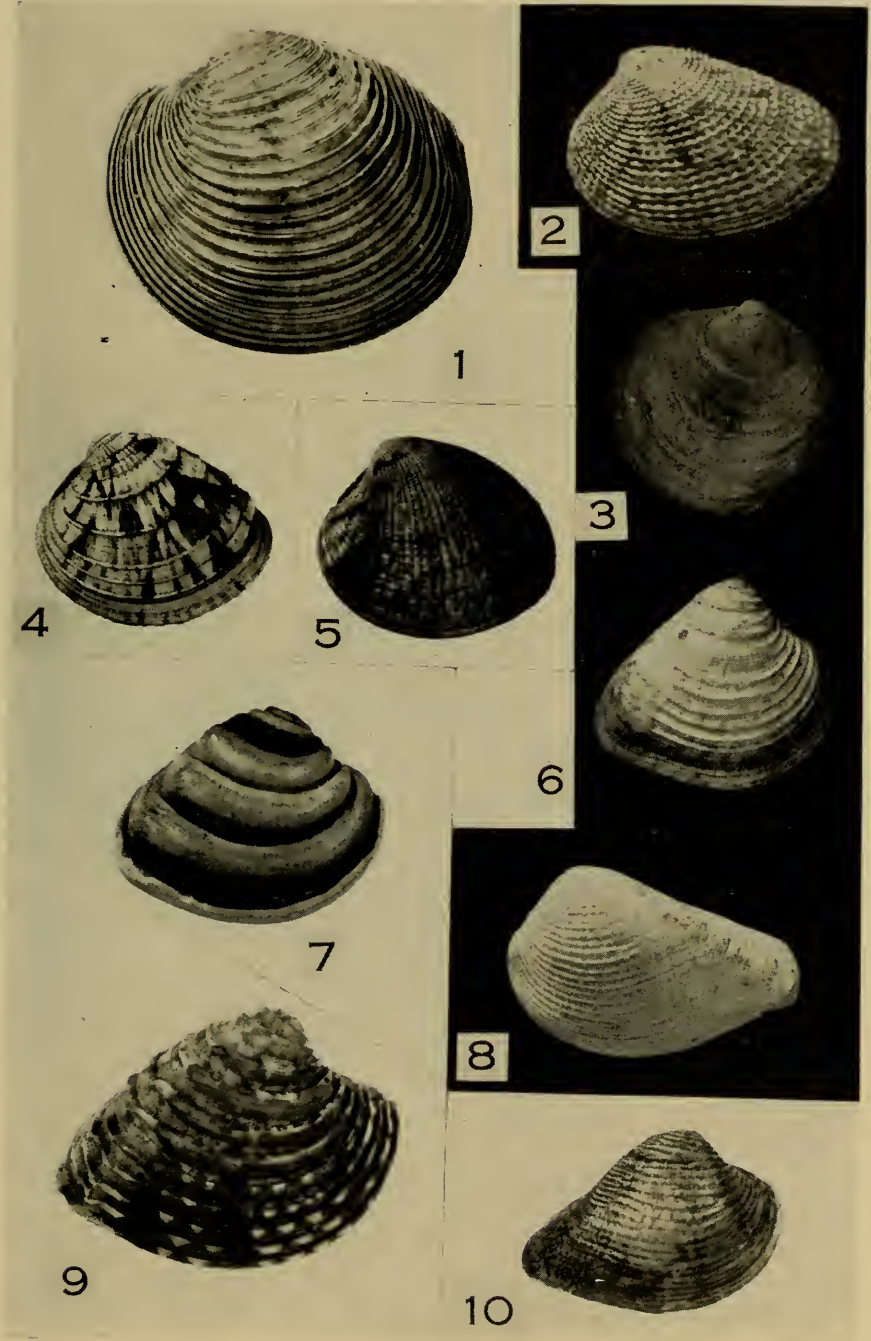


PLATE 17

PLATE 18

- FIGURE 1. *Coralliophaga coralliophaga* (Gmelin). Right valve: length 52 mm., p. 89.
FIGURE 2. *Petricola typica* (Jonas). Left valve: length 33 mm., p. 88.
FIGURE 3. *Narario lapicida* (Gmelin). Right valve: length 30 mm., p. 88. The false sculpture of the calcareous coating is shown.
FIGURE 4. *Narario lapicida* (Gmelin). Left valve: length 30 mm., p. 88. The calcareous coating is partially removed to show the divaricate sculpture beneath.
FIGURE 5. *Tellina (Tellina) radiata* Linnaeus. Right valve: length 76 mm., p. 91.
FIGURE 6. *Tellina (Tellina) lineata* Turton. Right valve: length 30 mm., p. 92.
FIGURE 7. *Tellina (Tellina) interrupta* Wood. Right valve: length 78 mm., p. 91.
FIGURE 8. *Tellina (Arcopagia) lineata* Conrad. Right valve: length 23 mm., p. 93.
FIGURE 9. *Tellina (Tellina) laevigata* Linnaeus. Right valve: length 74 mm., p. 91.
FIGURE 10. *Tellina (Arcopagia) fausta* Donovan. Right valve: length 62 mm., p. 93.

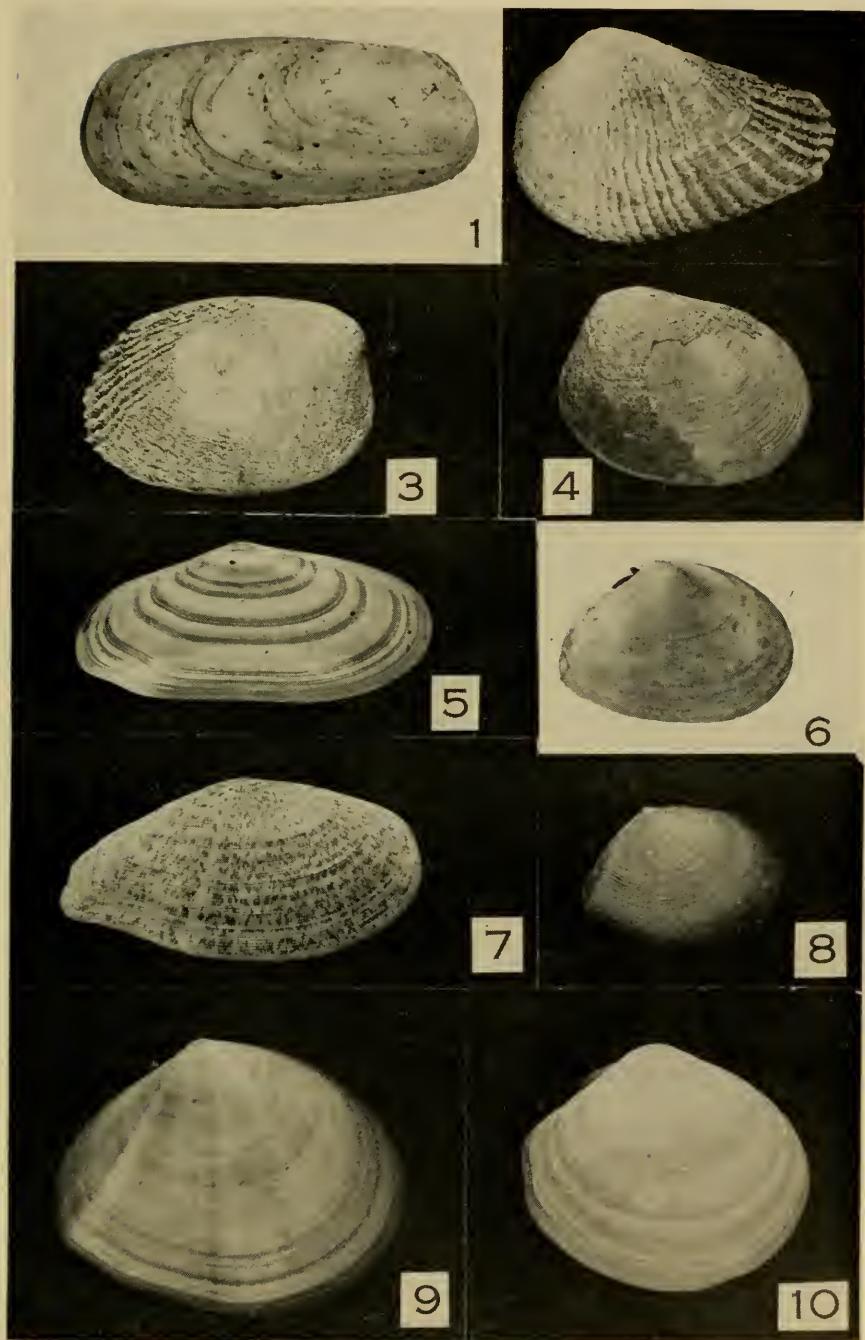


PLATE 18

PLATE 19

- FIGURE 1. *Tellina (Arcopagia) alternata* Say. Left valve: length 52 mm., p. 93.
- FIGURE 2. *Tellina (Arcopagia) angulosa* Gmelin. Right valve: length 46 mm., p. 93.
- FIGURE 3. *Tellina (Arcopagia) persica* Dall and Simpson. Right valve: length 20 mm., p. 94; (after Dall and Simpson).
- FIGURE 4. *Tellina (Angulus) simplex* d'Orbigny. Left valve: length 11 mm., p. 96; (after d'Orbigny).
- FIGURE 5. *Tellina (Arcopagia) vespuciana* d'Orbigny. Right valve: length 7 mm., p. 93; (after d'Orbigny).
- FIGURE 6. *Tellina (Angulus) pauperata* d'Orbigny. Left valve: length 7 mm., p. 96; (after d'Orbigny).
- FIGURE 7. *Tellina (Arcopagia) guildingii* Hanley. Left valve: length 29.5 mm., p. 94.
- FIGURE 8. *Tellina (Angulus) vitrea* d'Orbigny. Right valve: length 21 mm., p. 96; (after d'Orbigny).
- FIGURE 9. *Tellina (Angulus) consobrina* d'Orbigny. Left valve: length 13 mm., p. 96; (after d'Orbigny).
- FIGURE 10. *Tellina (Moerella) martinicensis* d'Orbigny. Right valve: length 10 mm., p. 94.
- FIGURE 11. *Tellina (Angulus) promera* Dall. Right valve: length 22 mm., p. 95.
- FIGURE 12. *Tellina (Angulus) magna* Spengler. Left valve: length 96 mm., p. 95.

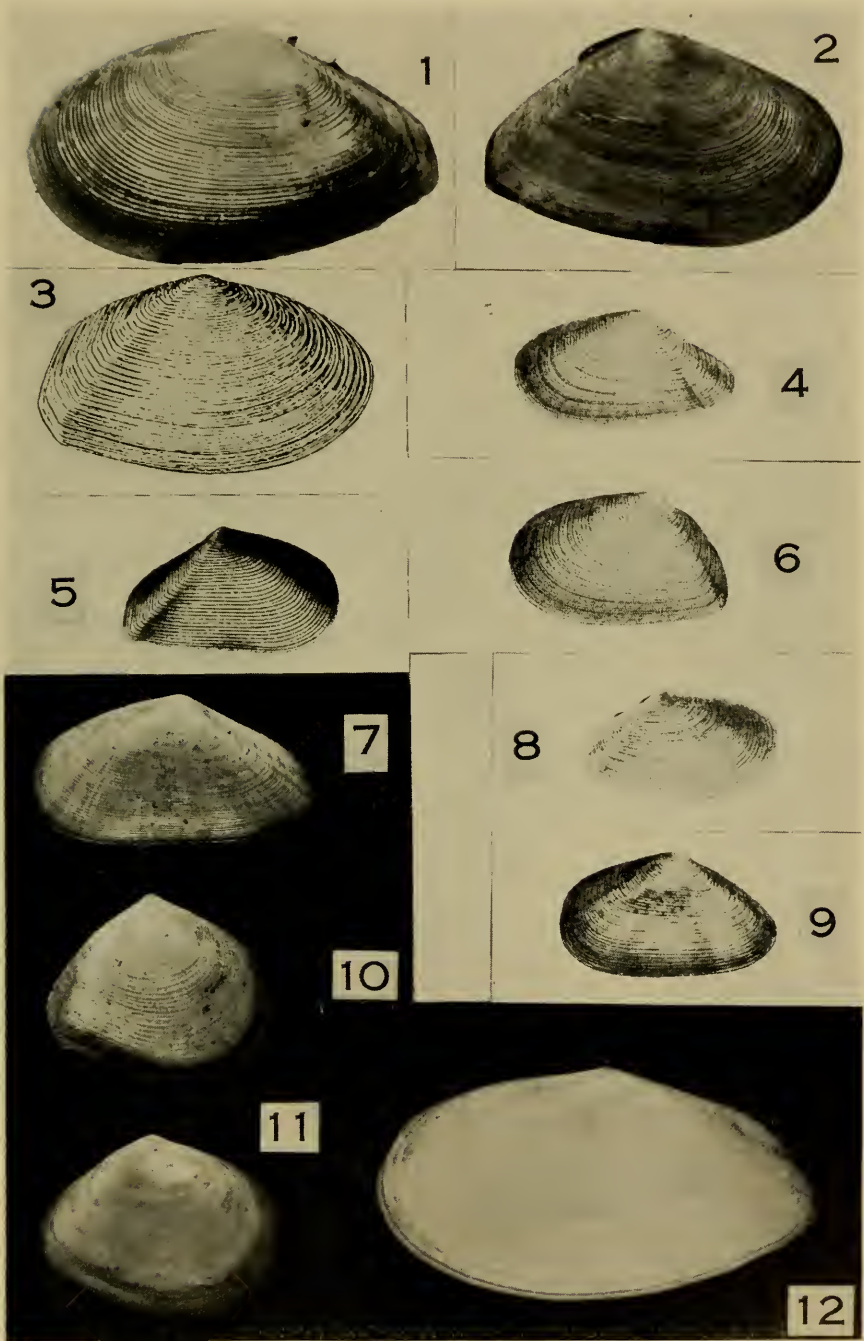


PLATE 19

PLATE 20

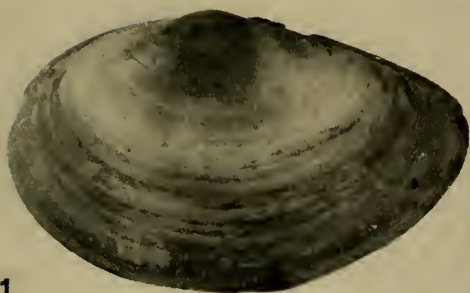
- FIGURE 1. *Tellina (Angulus) sybaritica* Dall. Left valve: length 7 mm., p. 96; (after Dall).
- FIGURE 2. *Tellina (Angulus) candeana* d'Orbigny. Left valve: length 11 mm., p. 97.
- FIGURE 3. *Tellina (Angulus) caribaea* d'Orbigny. Left valve: length 21 mm., p. 97.
- FIGURE 4. *Strigilla carnaria* (Linnaeus). Right valve: length 21.5 mm., p. 98.
- FIGURE 5. *Strigilla rombergi* Mörch. Right valve: length 25.5 mm., p. 98.
- FIGURE 6. *Strigilla flexuosa* (Say). Right valve: length 10.5 mm., p. 98.
- FIGURE 7. *Strigilla pisiformis* (Linnaeus). Right valve: length 10.5 mm., p. 98.
- FIGURE 8. *Apolymetis inlastrata* (Say). Right valve: length 57 mm., p. 99.
- FIGURE 9. *Macoma souleyetiana* (Recluz). Left valve: length 23.5 mm., p. 100.
- FIGURE 10. *Macoma brevisfrons* (Say). Left valve: length 20 mm., p. 100.
- FIGURE 11. *Macoma pseudomera* Dall and Simpson. Right valve: length 25 mm., p. 100.
- FIGURE 12. *Macoma constricta* (Bruguère). Left valve: length 37 mm., p. 100.
- FIGURE 13. *Macoma tageliformis* Dall. Left valve: length 44 mm., p. 100.



PLATE 20

PLATE 21

- FIGURE 1. *Sanguinolaria sanguinolenta* (Gmelin). Left valve: length 59 mm., p. 101.
FIGURE 2. *Psammobia circe* Mörch. Left valve: length 38 mm., p. 102.
FIGURE 3. *Heterodonax bimaculatus* (Linnaeus). Left valve: length 17 mm., p. 102.
FIGURE 4. *Asaphis deflorata* (Linnaeus). Right valve: length 53 mm., p. 103.
FIGURE 5. *Tagelus divisus* (Spengler). Left valve: length 38.5 mm., p. 104.
FIGURE 6. *Tagelus gibbus* (Spengler). Left valve: length 59 mm., p. 103.
FIGURE 7. *Donax denticulata* Linnaeus. Left valve: length 20 mm., p. 105.
FIGURE 8. *Iphigenia brasiliensis* (Lamarck). Left valve: length 56 mm., p. 105.
FIGURE 9. *Semele proficua* (Pulteney). Left valve: length 35 mm., p. 106.



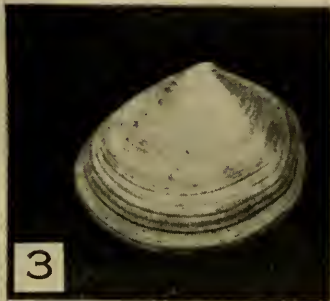
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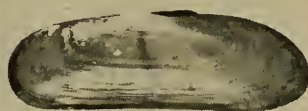
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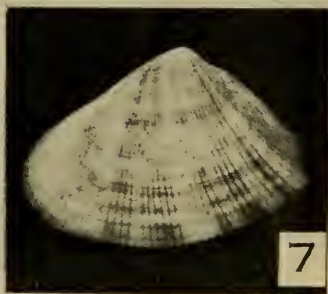
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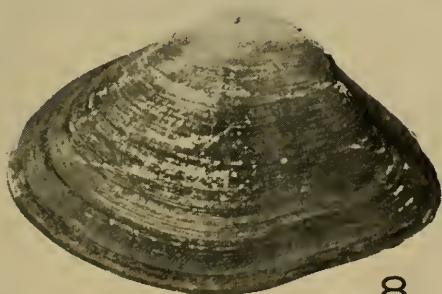
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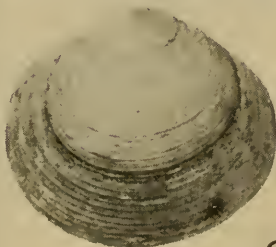
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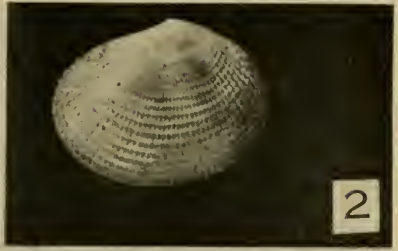
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PLATE 22

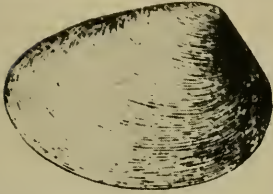
- FIGURE 1. *Semele purpurascens* (Gmelin). Left valve: length 34 mm., p. 106.
FIGURE 2. *Semele bellastrata* (Conrad). Left valve: length 11.5 mm., p. 106.
FIGURE 3. *Semele nuculoides* (Conrad). Left valve: length 5 mm., p. 107; (after Dall).
FIGURE 4. *Abra lioica* (Dall). Left valve: length 8.1 mm., p. 107; (after Dall).
FIGURE 5. *Abra aequalis* (Say). Right valve: length 9.5 mm., p. 107.
FIGURE 6. *Abra longicallis americana* Verrill and Bush. Left valve: length 21 mm., p. 108.
FIGURE 7. *Cumingia coarctata* Sowerby. Right valve: length 7.5 mm., p. 108.
FIGURE 8. *Psammosolen sanctae-marthae* (d'Orbigny). Right valve: length 42.5 mm., p. 110.
FIGURE 9. *Solen obliquus* Spengler. Left valve: length 82 mm., p. 109.



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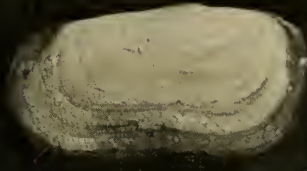
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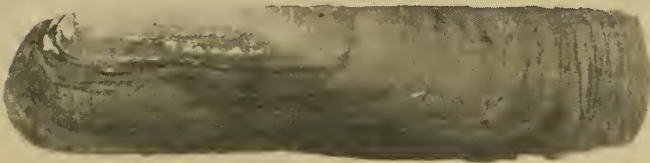
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PLATE 23

- FIGURE 1. *Maetra alata* Spengler. Right valve: length 87 mm., p. 111.
FIGURE 2. *Maetra fragilis* Gmelin. Right valve: length 58 mm., p. 111.
FIGURE 3. *Ervilia concentrica* Gould. Right valve: length 4 mm., p. 112.
FIGURE 4. *Ervilia nitens* (Montagu). Left valve: length 7 mm., p. 112.
FIGURE 5. *Basterotia quadrata granatina* (Dall). Left valve: length 13 mm., p. 115.
FIGURE 6. *Corbula dietziana* C. B. Adams. Left valve: length 10.7 mm., p. 115.
FIGURE 7. *Corbula aequivalvis* Philippi. Left valve: length 12.7 mm., p. 114.
FIGURE 8. *Corbula caribaea* d'Orbigny. Left valve: length 10.4 mm., p. 115.
FIGURE 9. *Saxicavella sagrinata* Dall and Simpson. Right valve: length 6 mm., p. 116; (after Dall and Simpson).
FIGURE 10. *Sphenia antillensis* Dall and Simpson. Left valve: length 4.5 mm., p. 113; (after Dall and Simpson).
FIGURE 11. *Corbula disparilis* d'Orbigny. Left valve: length 9 mm., p. 114.

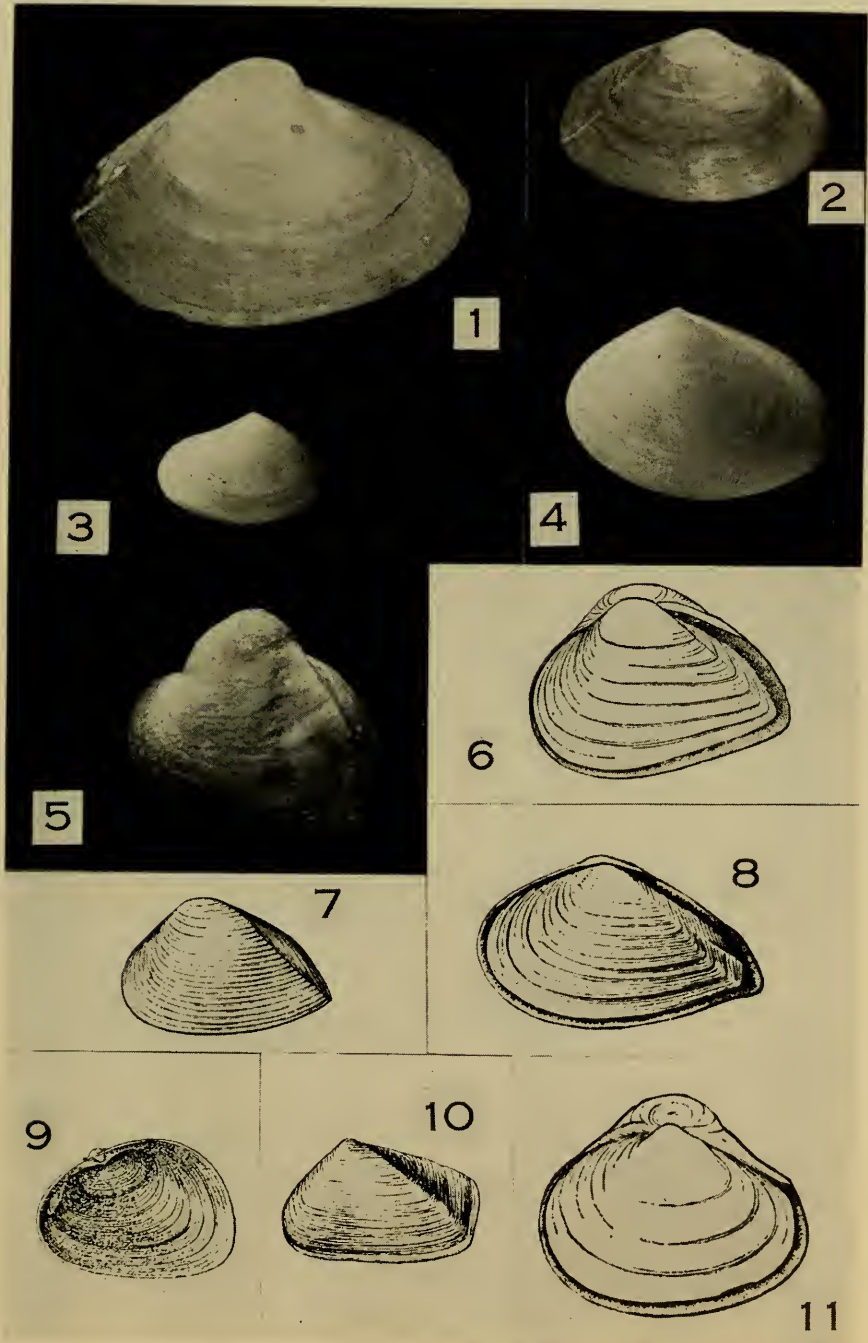


PLATE 23

PLATE 24

- FIGURE 1. *Gastrochaena (Spengleria) rostrata* (Spengler). Right valve: length 33 mm. p. 117.
- FIGURE 2. *Gastrochaena (Gastrochaena) cuneiformis* Spengler. Right valve: length 23 mm., p. 117.
- FIGURE 3. *Martesia cuneiformis* (Say). Dorsal view: length 15 mm., p. 119.
- FIGURE 4. *Martesia striata* (Linnaeus). Dorsal view: length 27 mm., p. 119.
- FIGURE 5. *Teredo dominicensis* Bartsch. Right valve: length 2.3 mm., p. 120; (after Bartsch).
- FIGURE 6. *Teredo dominicensis* Bartsch. Pallets: length 2.5 mm., p. 120; (after Bartsch).
- FIGURE 7. *Teredo thomsonii* Tryon. Right valve: length 9.7 mm., p. 120; (after Bartsch).
- FIGURE 8. *Teredo thomsonii* Tryon. Pallets: length 9.9 mm., p. 120; (after Bartsch).

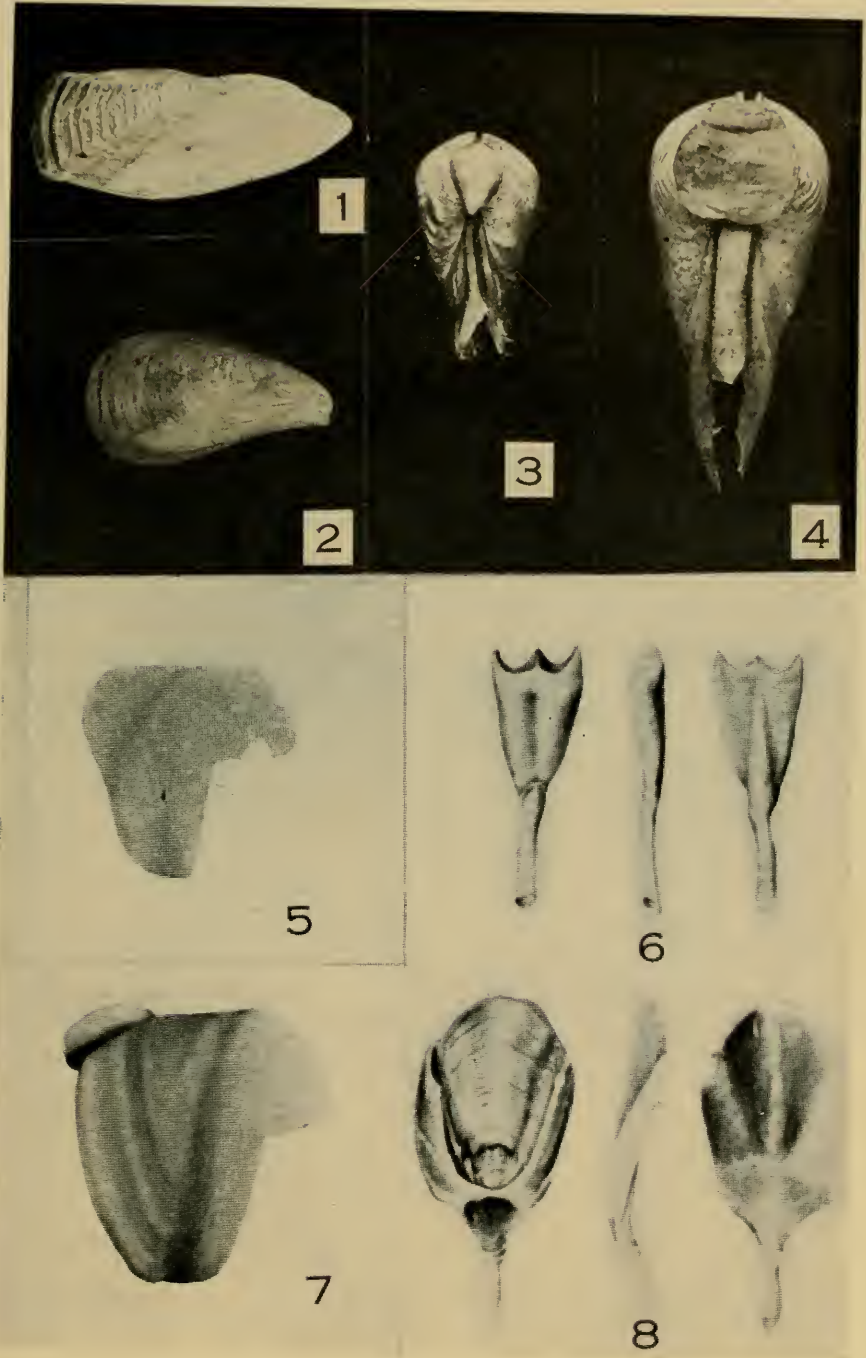


PLATE 24

PLATE 25

FIGURE 1. *Bankia caribbea* Clench and Turner. Outer surface of pallet: length 10 mm., p. 121. (After Clench and Turner).

FIGURE 2. *Bankia caribbea* Clench and Turner. Inner surface of pallet: length 10 mm., p. 121. (After Clench and Turner).

FIGURE 3. *Bankia gouldi* (Bartsch). Outer surface of pallet: length 13.6 mm., p. 121. (After Clench and Turner).

FIGURE 4. *Bankia gouldi* (Bartsch). Inner surface of pallet: length 13.6 mm., p. 121. (After Clench and Turner).

FIGURE 5. *Bankia fimbriatula* Moll and Roch. Inner surface of pallet: length 16 mm., p. 121. (After Clench and Turner).

FIGURE 6. *Bankia fimbriatula* Moll and Roch. Outer surface of pallet: length 16 mm., p. 121. (After Clench and Turner).



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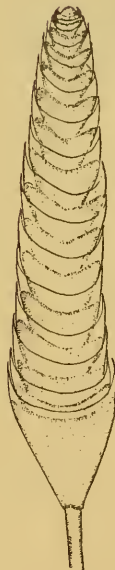
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PLATE 25

PLATE 26

FIGURE 1. *Bankia gouldi* (Bartsch). Internal view, left valve: height 7 mm., p. 121. (After Clench and Turner).

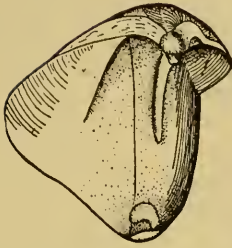
FIGURE 2. *Bankia gouldi* (Bartsch). External view, left valve: height 7 mm., p. 121. (After Clench and Turner).

FIGURE 3. *Bankia fimbriatula* Moll and Roch. External view, left valve: length 16 mm., p. 121. (After Clench and Turner).

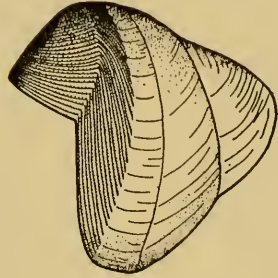
FIGURE 4. *Bankia fimbriatula* Moll and Roch. Internal view, left valve: length 16 mm., p. 121. (After Clench and Turner).

FIGURE 5. *Bankia caribbea* Clench and Turner. External view, left valve: length 10 mm., p. 121. (After Clench and Turner).

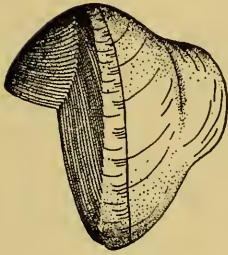
FIGURE 6. *Bankia caribbea* Clench and Turner. Internal view, left valve: length 10 mm., p. 121. (After Clench and Turner).



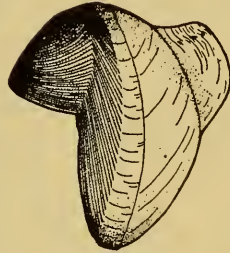
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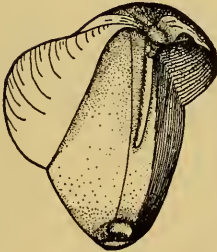
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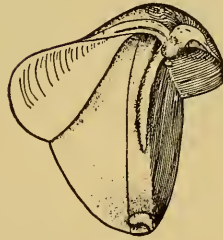
3



5



4



6

PLATE 26

INDEX

A			
Abra.....	107	Asaphis.....	103
Acar.....	15	Astartacea.....	52
acuta, Nucula.....	9	atlantica, Avicula.....	20
acuta, Nuculana.....	9	Atrina.....	19
adamsi, Arca.....	16	auberiana, Venus.....	87
Adesmacea.....	117	auriculata, Arca.....	16
aegeensis, Nucula.....	9	B	
aequalis, Abra.....	107	Bankia.....	120
aequalis, Amphidesma.....	107	balesi, Arca.....	15
aequalis, Corbula.....	114	barbata, Arca.....	14
alata, Isognomon.....	22	Barbatia.....	14
alata, Mactra.....	111	Basterotia.....	115
alata, Ostrea.....	22	beana, Lyonsia.....	47
albida, Pitar.....	80	bellastriata, Amphidesma.....	106
albida, Venus.....	80	bellastriata, Semele.....	106
Alectryonia.....	24	bicolor, Perna.....	22
alternata, Sphena.....	49	biexcavatus, Lithodomus.....	41
alternata, Tellina.....	93	bimaculata, Tellina.....	102
ambiguus, Solen.....	107	bimaculatus, Heterodonax.....	102
americana, Arca.....	17	bisulcata, Lithodomus.....	41
americana, Cyrenoides.....	68	bisulcata, Lithophaga.....	41
americanus, Cyrenoides.....	68	borealis, Ostrea.....	24
americanus, Spondylus.....	32, 33	Botula.....	42
Americardia.....	73	Botulina.....	45
Amusium.....	31	Brachydontes.....	43
Amygdalum.....	40	brasiliانا, Anomalocardia.....	86
angulosa, Tellina.....	93	brasiliانا, Mactra.....	111
Angulus.....	95	brasiliانا, Ostrea.....	24, 25
Anomalocardia.....	86	brasiliانا, Venus.....	86
Anomalodesmacea.....	5, 46	brasiliensis, Capsa.....	105
Anomia.....	37	brasiliensis, Iphigenia.....	105
Anomiacea.....	36	brevifrons, Macoma.....	100
Anomiidae.....	37	brevifrons, Tellina.....	100
Antigona.....	82	bullatum, Cardium.....	71
antillarum, Cardium.....	72	C	
antillarum, Chlamys.....	30	Callucina.....	64
antillarum, Lavignon.....	108	campechiensis, Arca.....	17
antillarum, Lithodomus.....	41	canadensis, Ostrea.....	24
antillarum, Lithophaga.....	41	canalis, Bankia.....	121
antillarum, Modiola.....	41	cancellata, Amphidesma.....	106
antillarum, Pecten.....	30	cancellata, Chione.....	84
antillarum, Trigonocardia.....	72	cancellata, Venus.....	84
antillensis, Sphena.....	113	candeana, Tellina.....	97
antonii, Tellina.....	91	candida, Arca.....	14
Apolymetis.....	99	Cardiacea.....	69
appendiculata, Modiola.....	41	Cardiidae.....	69
arborescens, Mytilus.....	40	Cardiomya.....	49
Arca.....	12	Cardita.....	53
Arcacea.....	10	Carditacea.....	53
Arcidae.....	12	Carditidae.....	53
Arcinella.....	116	Cardium.....	70
arcinella, Chama.....	57	caribaea, Corbula.....	115
arcinella, Echinochama.....	57	caribaea, Modiola.....	41
Arcopagia.....	92	caribaea, Tellina.....	97
aresta, Meretrix.....	80	caribaeus, Solecurtus.....	103
aresta, Pitar.....	80	caribbea, Bankia.....	121
Argina.....	17	carnaria, Strigilla.....	98
Arginarca.....	17	carnaria, Tellina.....	98
aristata, Lithophaga.....	42	carnea, Pinna.....	19
aristata, Mytilus.....	42		

F		hiulcum, Cardium	71
fasciata, Lima	35	holmesii, Arca	17
fausta, Tellina	93	Hormomya	44
ferruginea, Chama	56	Hysteroconcha	81
fimbriata, Teredo	121	I	
fimbriatula, Banki	121	imbricata, Chlamys	29
flabellum, Pinna	19	imbricatus, Ostrea	29
flexuosa, Strigilla	98	inflata, Lima	35
flexuosa, Tellina	98	inflata, Ostrea	35
flexuosa, Venus	86	inornata, Leda	9
floridana, Anomalocardia	17	insularis, Circe	79
floridana, Dosinia	77	insularis, Gafrarium	79
floridensis, Ostrea	25	intastriata, Apolymetis	99
forficatus, Lithodomus	42	intastriata, Tellina	99
fragilis, Lima	36	interrupta, Tellina	91
fragilis, Mactra	111	Iphigenia	105
frons, Mytilus	24	Ischadium	44
frons, Ostrea	24	isocardia, Cardium	70
fulminata, Cytherea	81	Isodonta	25, 26
fulminata, Pitar	81	Isognomon	21
fundata, Ostrea	23	Isognomonidae	21
fusca, Lithophaga	43	J	
fuscus, Mytilus	43	Jagonia	60
G		jamaicensis, Leda	9
gabbi, Diplodonta	67	jamaicensis, Lucina	63
gabbi, Taras	67	janeirensis, Lucina	66
Gafrarium	78	K	
Gastrochaena	116, 117	knoxiana, Corbula	114
Gastrochaenidae	116	L	
georgiana, Tellina	94	Laevicardium	73
gibba, Ostrea	28	laevigata, Tellina	91
gibbosa, Plicatula	33	laevigatum, Cardium	74
gibbus myaguezensis, Pecten	28	laevigatum, Laevicardium	74
gibbus, Pecten	28	laevigatum multilineatum, Laevicardium	74
gibbus, Solen	103	laevigatum sybariticum, Laevicardium	74
gibbus, Tagelus	103	lamarckiana, Perna	22
Glycimerella	11	lapicida, Naranio	88
Glycimeridae	11	lapicida, Venus	88
Glycimeris	11	lateralis, Modiolaria	45
Gouldia	78	lateralis, Mytilus	45
gouldi, Bankia	121	Laternulacea	47
gouldi, Xylotrya	121	latilirata, Chione	85
gracilis, cardita	54	latilirata, Venus	85
granatina, Poromya	115	lavalleana, Corbula	115
granulata, Chione	85	Leda	9
granulata, Venus	85	lemniscatus, Pecten	29
Gregariella	45	leucostomum, Cardium	71
grüneri, Tellina	99	lienesa, Arca	17
guadalupensis, Crassatella	53	lignea, Modiola	39
guadalupensis, Crassinella	53	Lima	34
guildingii, Tellina	94	lima, Lima	34
guppyi, Cardium	72	lima, Ostrea	34
H		limacella, Ostrea	24
hamatus, Mytilus	44	Limaria	35
hebraea, Cytherea	81	Limatula	36
hemicyclica, Pecten	27	Limidae	33
Heterodonax	102	lineata, Tellina	92
hians, Lima	36	Linga	63
hians, Ostrea	36		
hiatus, Cardium	71		
hiatus, Papyridea	71		

lutea, Tellina	93	Myrtaea	62
Liocardium	73	Mytilidae	38
lioica, Abra	107		
lioica, Syndosmya	107	N	
Lirophora	85	nana, Chlamys	31
listeri, Antigona	82	nanus, Cyclopecten	31
listeri, Dosina	82	Narario	88
listeri, Isognomon	22	Neilonella	10
listeri, Perna	22	niger, Lithodomus	41
Lithodomus	40	nigra, Lithophaga	41
Lithophaga	40, 41	nitens, Ervilia	112
longicallis, Abra	108	nitens, Mya	112
longicallis americana, Abra	108	Nodipecten	30
Lopha	24	nodosa, Chlamys	30
Lucina	61, 62	nodosa, Ostrea	30
Lucinacea	57	notata, Diplodonta	68
Lucinidae	59	notata, Taras	68
Lucinisca	64	nucleiformis, Mysia	67
Lyonsia	47	nucleiformis, Taras	67
Lyonsiidae	47	nucleus, Ostrea	28
Lyropecten	30	Nucula	8
		Nuculacea	8
M		Nuculana	9
macerophylla, Chama	55	Nuculanidae	9
Macoma	99	Nuculidae	8
Macrocallista	79	nuculoides, Amphidesma	107
macrodon, Cytherea	86	nuculoides, Semele	107
Mactra	111		
Mactracea	110	O	
Mactridae	110	obesa, Cuspidaria	49
mactroides, Tivela	78	obesa, Neaera	49
mactroides, Venus	78	obliqua, Tellina	106
maculata, Macrocallista	79	obliquus, Solen	109
maculata, Venus	79	obs, Cryptodon	58
magna, Tellina	95	occidentalis, Arca	13
magnum, Cardium	71	occidentalis, Solemya	7
Mantellum	35	occidentalis, Solenomya	7
Margaritifera	21	orbicularis, Codakia	60
Margaritiphora	21	orbicularis, Venus	60
Martesia	118	orbiculata, Codakia	61
martinicensis, Crassinella	52	orbiculata, Venus	61
martinicensis, Tellina	94	d'orbigny, Arca	17
mayaguezensis, Pecten	28	ornata, Chlamys	29
medius, Pecten	27	ornata, Trigonulina	51
medium, Cardium	73	ornata, Verticordia	51
medium, Trigonocardia	73	ornatissima, Cuspidaria	50
Melina	21	ornatissima, Sphena	50
membranula, Anomalocardia	87	ornatus, Pecten	29
Mesodesmatidae	111	Ostracea	22
Metis	99	Ostrea	23
Microcardium	74	Ostreidae	23
Modiolaria	45		
Modiolus	39	P	
Moerella	94	Palliolum	30
multisquamata, Chlamys	29	paphia, Chione	86
multisquamatus, Pecten	29	paphia, Venus	86
muricata, Tellina	64	papyria, Modiola	40
muricatum, Cardium	70	Papyridea	71
muricatus, Phacoides	64	parasitica, Ostrea	25
muscosa, Chlamys	29	pauperata, Tellina	96
muscosa, Ostrea	29	Pecten	26
Myacea	112	pecten, Lucina	61
Myacidae	113		
Myoforceps	42		

semisulcatum, Cardium	72	tenuis, Cyclinella	84
semisulcatum, Papyridea	72	tenuis, Dosinia	84
sericatus, Pectunculus	11	Teredinidae	119
serratum, Cardium	74	Teredo	120
serratum multilineatum, Cardium	74	thomsonii, Teredo	120
serratum sybariticum, Laevicardium	74	Thyasira	58
simplex, Anomia	36	Thyasiridae	58
simplex, Tellina	96	tigerina, Lucina	60
Solemya	7	tinctum, Microcardium	75
Solemyidae	7	Tindaria	10
Solen	109	Tivela	78
Solenacea	108	Trachycardium	70
Solenidae	109	Transennella	77
Solenimya	7	transversa, Arca	16
Solenomya	7	triangularis, Ostrea	24
Solenymia	7	Trigoniocardia	72
Solenymia	7	trisinuata, Lucina	58
souleyetiana, Macoma	100	trisinuata, Thyasira	58
souleyetiana, Tellina	100	trisolcatus blandus, Phacoides	64
Spengleria	117	tulipa, Modiolus	39
sphaerica, Cytherea	67	typica, Petricola	88
Sphenia	113	typicum, Choristodon	88
spinosum, Cardium	71		
Spondylidae	32	U	
Spondylus	32	umbonata, Arca	14
spretta, Ostrea	23	unca, Leda	9
squamosa, Lima	34	Ungulinidae	66
striata, Martesia	119	unimaculata, Tellina	91
striatus, Pholas	119		
Strigilla	97	V	
subauriculata, Limatula	36	varicosa, Venus	85
subauriculata, Pecten	36	variegata, Chama	56
subelongatum, Cardium	71	Veneracea	75
subquadrata, Mysia	67	Veneridae	76
subviridis, Pinna	20	veneris, Dione	81
sulcata, Modiola	43	Ventricola	82
swiftiana, Corbula	115	Verticordia	50
sybaritica, Tellina	96	Verticoriidae	50
		vespuciana, Tellina	93
T		vexillata, Plicatula	33
tageliformis, Macoma	100	virginiana, Ostrea	24
Tagelus	103	virginiana procyon, Ostrea	25
Taras	66	virginica, Ostrea	24
Taxodonta	7	vitrea, Tellina	96
tayloriana, Tellina	93	vulsella, Isognomon	22
Teleodesmacea	51	vulsella, Perna	22
Tellina	90, 91		
Tellinacea	89	Z	
Tellinidae	90	ziczac, Ostrea	27
tenera, Arca	15	ziczac, Pecten	27
tenera, Lima	35		

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OF
PORTO RICO and the VIRGIN ISLANDS

Volume XVII—Part 2

DIGENETIC TREMATODES OF PUERTO RICAN SHORE BIRDS

Raymond M. Cable, Robert S. Connor, Jan W. Balling



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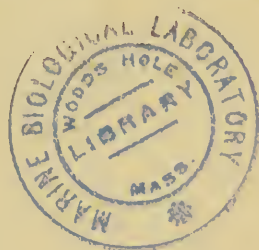
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SCIENTIFIC SURVEY OF PORTO RICO AND THE
VIRGIN ISLANDS

This natural-history survey of Porto Rico and the Virgin Islands, conducted by The New York Academy of Sciences, was established in 1913 and carried out with the cooperation of the Porto Rican government. The results of this survey have appeared from time to time as investigations by specialists have been completed.

FOREWORD

This report is based on adult trematodes found in shore birds during the spring and summer of 1952 under the circumstances and auspices set forth in *Marine Cercariae of Puerto Rico*, an earlier publication in this series. Thanks are due to Felix Iñigo, Director of the Division of Fish and Game, Commonwealth of Puerto Rico, for permits necessary to the collection of hosts and to Virgilio Biaggi for their identification.

An intensive search for cercariae moved in late winter to mud flats, where most of the larvae found seemed certain to have their adult forms in birds. By that time many species had migrated and, of the resident ones, relatively few were examined, and those in small numbers. This study consequently includes only a portion of the trematodes to be found in Puerto Rican shore birds, but it does demonstrate the richness of this trematode fauna.

The analysis of even so limited a collection is time-consuming and still would be unfinished had it not been shared with two of my graduate students, Robert S. Connor and Jan W. Balling, whose theses have been based on the joint study. The Doctor of Philosophy thesis of Connor covered the opisthorchioids and microphallids; the remaining species were the subject of Balling's Master of Science thesis. While engaged in this study Connor was a David E. Ross Fellow of the Purdue Research Foundation, Lafayette, Ind. (1954 to 1956), and Balling was a Purdue University Fellow (1956 to 1957).

RAYMOND M. CABLE

Purdue University, 1960.

CONTENTS

	PAGE		PAGE
FOREWORD.....	187	<i>Retevitellus spinelus</i> n. comb..	213
INTRODUCTION.....	191	<i>Stictodora</i> char. emend.....	214
METHODS.....	191	<i>Stictodora acanthotrema</i>	214
KEY TO SPECIES.....	192	<i>Stictodora</i> sp.....	215
DESCRIPTION AND DISCUSSION OF SPECIES		<i>Opisthometra planicollis</i>	215
Family strigeidae	194	<i>Phocitremonides</i> char. emend.....	217
<i>Cardiocephalus megaloconus</i> n. sp.....	194	<i>Phocitremonides butionis</i> n. sp..	217
<i>Apharyngostrigea cornu</i>	196	<i>Phocitremonides floridae</i> n. sp.	218
Family Cyathocotylidae	197	Family Tetracладиidae n. fam... 219	
<i>Mesostephanus fajardensis</i>	197	<i>Opisthovarium</i> n. g.....	220
<i>Mesostephanus appendiculoides</i>	197	<i>Opisthovarium elongatum</i> n. sp.....	220
Family Notocotylidae	198	Family Microphallidae	221
<i>Paramonostomum actitidis</i> n. sp.....	198	<i>Pseudospetotrema charadrii</i> n. sp.....	223
Family Psilostomatidae	199	<i>Pseudospetotrema nyctanassae</i> n. sp.....	224
<i>Riteiroia ondatrae</i>	199	<i>Maritreminoides patulum</i> n. comb.....	225
Family Echinostomatidae	200	<i>Mecynophallus</i> n. g.....	226
<i>Acanthoparyphium pagollae</i> n. sp.....	200	<i>Mecynophallus glandulosus</i> n. comb.....	226
<i>Microparyphium floridae</i> n. sp..	201	<i>Carneophallus bilobatus</i> n. sp..	228
Family Philophthalmidae	203	<i>Megalophallus</i> n. g.....	229
<i>Parorchis holotestis</i> n. sp.....	203	<i>Megalophallus pentadactylus</i> n. sp.....	229
Family Heterophyidae	204	<i>Microphallus claviformis</i>	230
<i>Galactosomum</i> char. emend.....	207	<i>Levinseniella leptophallus</i>	231
<i>Galactosomum cochleariforme</i>	208	<i>Gynaecotyla adunca</i>	233
<i>Galactosomum cochlear</i>	209	Family Felodistomatidae	234
<i>Galactosomum puffini</i>	210	<i>Parvatrema borinquenae</i>	234
<i>Galactosomoides</i> n. g.....	211	ALPHABETICAL HOST LIST.....	235
<i>Galactosomoides johnsoni</i> n. comb.....	212	REFERENCES.....	235
<i>Retevitellus</i> n. g.....	212	KEY TO LETTERING ON PLATES.....	238
		PLATES I TO IX.....	239

DIGENETIC TREMATODES OF PUERTO RICAN SHORE BIRDS

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INTRODUCTION

Evidently the first investigator to be concerned with the trematode parasites of tropical American shore birds was Johann Natterer, who collected a limited number from Brazilian birds at the beginning of the Nineteenth Century. His specimens were deposited in the Museums of Berlin, Germany, and Vienna, Austria, and received the attention of the pioneer helminthologist C. A. Rudolphi in his *Entozoorum Synopsis* of 1819. In 1902 the collection was redescribed by M. Braun in his comprehensive work *Fascioliden der Vogel*, which dealt with most of the avian trematodes known at that time. The same species have since received limited attention in a series of papers by L. Travassos (1921, 1928, 1931, 1939) in Brazil, Perez Viguera and Alegret in Cuba, and Caballero *et al.* (1954) in Central America. Nevertheless, the trematodes of shore birds in the region remain far less well known than do those of marine fishes.

Doubtless the majority of the species reported here have larval stages that develop in marine mollusks. Several of those larval forms probably are among the cercariae described by Cable (1956), and attention is called to species for which that situation seems likely in the hope that investigators with the opportunity to do so will be encouraged to enter the almost untouched field of marine life history studies in the region. Further knowledge of the avian trematode fauna of Puerto Rico also is much needed and, for that reason, a key to the species reported here is given for their rapid identification and for proceeding directly to the many unknown trematodes that must await the attention of someone who is inclined to look for them.

The collection on which this study is based contains approximately 1600 trematodes, among which we recognize 30 species. Nineteen of these species are almost evenly divided between the families Heterophyidae and Microphallidae and present so varied a representation of those groups as to prompt a comparative study and reexamination of generic concepts. A new family has been proposed for another species that is evidently related to the Heterophyidae but differs in a number of respects from members of that group. Of the 10 remaining species, one belongs to each of the families Notocotylidae, Psilostomatidae, Philophthalmidae, and Fellodistomatidae, and 2 to each of the families Echinostomatidae, Strigeidae, and Cyathocotylidae.

METHODS

Most of the birds examined were taken along the west and southwest coasts of Puerto Rico, but a few were collected at Mona Island. All hosts, except for a brown booby found moribund on the beach, were shot and autopsied as quickly as possible, usually within 2 hours of death. Dead

worms were found in only a few instances and were then accompanied by at least a few living ones, thus ensuring material unaltered by the well-known swelling and other post-mortem changes that could lead to errors of identification. Certain features, especially the shape and extent of the excretory vesicle, were determined from living material.

If plentiful, some specimens were killed under light pressure and others after shaking in saline to obtain relaxation. When only a few worms were available, each one was fixed separately by placing it on a slide in a drop of saline, watching until it became extended, and then quickly adding fixative and a coverglass to prevent curling. After a few minutes such specimens fixed under coverglasses were washed off into a dish of fresh fixative.

Material from Mona Island was fixed in Bouin's fluid, but otherwise corrosive sublimate-acetic acid was used. Fixation in Bouin's fluid yielded poor preparations even though the specimens were washed free of picric acid and preserved in alcohol within 2 weeks after fixation. Superior preparations were obtained after corrosive sublimate-acetic acid fixation for no longer than 24 hours to prevent excessive hardening. Specimens were then washed, transferred through alcohols to 70 per cent, treated with iodine, and stored in vials with closures containing no cork to avoid discoloration by tannins.

Whole mounts were stained with either Harris' hematoxylin or Semichon's carmine, cleared in terpineol, and mounted in damar. Most species were also prepared as serial sections cut at 8 to 10 μ , stained with Harris' hematoxylin, and counterstained with Phloxine B. All figures were drawn to scale with the aid of a microprojector, and all measurements are in millimeters.

Holotypes of new species and examples of others for which accession numbers are given have been deposited in the Helminthological Collection of the United States National Museum, Washington, D. C.

KEY TO SPECIES

- | | |
|---|---|
| (1) Genital pore at posterior end of body | (2) |
| Genital pore at a distance from posterior end of body | (5) |
| (2) Body divided into complex anterior segment and a cylindrical posterior segment containing reproductive organs; cirrus sac absent. (Family Strigeidae) | (3) |
| Body not so divided, with conical posterodorsal appendage; cirrus sac present. (Family Cyathocotyliidae) | (4) |
| (3) Pharynx present, vitellaria in posterior segment only, genital cone over 1.0 long | <i>Cardiocephalus megaloconus</i> p. 194 |
| Pharynx absent, vitellaria in both body segments, genital cone less than 0.5 long | <i>Apharyngostrigea cornu</i> p. 196 |
| (4) Eggs relatively numerous, 0.045 to 0.060 by 0.032 to 0.043 | <i>Mesostephanus fajardensis</i> p. 197 |
| Eggs relatively few, 0.102 to 0.111 by 0.073 to 0.084 | <i>Mesostephanus appendiculatoides</i> p. 197 |
| (5) Ventral sucker absent; testes symmetrically placed at posterior end of body, extracecal, with ovary between; eggs with filaments | <i>Paramonostomum acitidis</i> p. 198 |
| Ventral sucker present; testes not at posterior end of body, but situated between or posterior to ceca; eggs without filaments | (6) |
| (6) In the host's cloaca; gonads closely grouped between ends of ceca in a triangle with ovary at apex; vitellaria a narrow band of follicles along each cecum anterior to ovarian level; uterus throughout most of hindbody; eggs numer- | |

- ous, containing miracidia with conspicuous eye spots. (Family Philophthalmidae)..... *Parorchis hololestis* p. 203
- Intestinal parasites; gonads not closely grouped in a triangle between ends of ceca; vitelline follicles not in narrow bands along ceca anterior to ovary; miracidia if developed, not with conspicuous eye spots (7)
- (7) Eggs over 0.06 long, confined to intercecal region anterior to testis (8)
- Eggs less than 0.04 long, not confined to pretesticular region between the ceca (10)
- (8) Anterior end with collar bearing enlarged spines; esophagus without diverticula. (Family Echinostomatidae) (9)
- Anterior end without collar spines; esophagus with a pair of lateral diverticula. (Family Psilostomatidae) *Ribeiroia ondatrae* p. 199
- (9) Collar with a single row of 23 spines not interrupted dorsally, pre and post oral spines absent; cirrus sac extends posterior to ventral sucker
Acanthoparyphium pagollae p. 200
- Collar spines interrupted dorsally, with 12 spines on each side, 10 in a row and 2 angle spines; pre and post oral spines present but easily lost; cirrus sac not reaching to middle of ventral sucker..... *Microparyphium floridae* p. 201
- (10) Forebody with cercarial eyespot pigment; ceca extend well into hindbody, usually to near posterior end; ventral sucker usually modified and enclosed in a cavity, not modified and opening directly to surface in only a few minute species; seminal receptacle always present and well developed (11)
- Cercarial eyespot pigment absent; ceca usually short and widespread, never reaching beyond midlevel of hindbody; ventral sucker not modified and always opening directly to surface; seminal receptacle rarely if ever present (21)
- (11) Ovary posterior to testes, each cecum with pouchlike extension flanking esophagus and pharynx; ventral sucker with a single blunt process. (Family Tetracladiidae) *Opisthovarium elongatum* p. 220
- Ovary not posterior to testes; ceca without anterior pouchlike extensions; ventral sucker without a blunt process but may be otherwise modified. (Family Heterophyidae) (12)
- (12) With large circumoral spines *Opisthometra planicollis* p. 215
- Without large circumoral spines (13)
- (13) Lining of ventral sucker with patches of spines (14)
- Lining of ventral sucker without patches of spines (18)
- (14) Eggs symmetrical; seminal receptacle posterior to ovary; gonotyl and genital pore directed toward ventral sucker (15)
- Eggs flattened on one side; seminal receptacle anterior to ovary; gonotyl and genital pore directed to left, away from ventral sucker
Galactosomoides johnsoni p. 212
- (15) Forebody wider than hindbody; posterior end not tapered; uterus confined to hindbody from which gonoducts extend directly anteriorly to unite at base of gonotyl; vitelline ducts not forming a conspicuous network in hindbody between ceca (16)
- Body fusiform, hindbody tapering from maximum width at about midlevel of body length; uterus extends into intercecal region of forebody; anterior division of seminal vesicle dorsal to ventral sucker, with pars prostatica and ejaculatory duct arching ventrally and turning posteriorly to join the metaterm at base of gonotyl; vitelline ducts form a conspicuous intercecal network in hindbody *Retevitellus spinetus* p. 213
- (16) A part of seminal vesicle with a conspicuously thick wall (17)
- No part of seminal vesicle with greatly thickened wall
Galactosomum cochlear p. 209
- (17) Forebody greatly expanded, anterior division of seminal vesicle thick-walled
Galactosomum cochleariforme p. 208
- Forebody but slightly expanded, posterior division of seminal vesicle thick-walled *Galactosomum puffini* p. 210
- (18) Testes two, more or less side by side, ventral sucker modified and enclosed in ventrogenital sac; body length over 0.7 (19)
- One testis; ventral sucker not modified or fully enclosed in a ventrogenital sac; body length less than 0.4 (20)
- (19) Uterus confined to hindbody; ventral sucker with 3 fingerlike processes bearing spines; eggs 0.019 to 0.021 long *Sticlodora acanthotrema* p. 214
- Uterus from intestinal bifurcation to posterior end of body; ventral sucker with

- 3 lobes evidently unarmed; eggs 0.024 long.....*Stictodora* sp. p. 215
- (20) Body averages 0.305 long; ceca narrow; ovary anterolateral to testis; uterus from intestinal bifurcation to posterior end of body; eggs numerous
Phocitremonoides butionis p. 217
 Body averages 0.188 long; ceca expanded; gonads between swollen ends of ceca, with testis overlapping ovary; eggs few, confined to hindbody
Phocitremonoides floridæ p. 218
- (21) Cirrus sac absent, genital pore anterior to ventral sucker; excretory vesicle with long arms extending into forebody; vitellaria compact, close to ventral sucker. (Family Fellodistomatidae).....*Parvatrema borinquenæ* p. 234
 Genital pore lateral to ventral sucker, excretory vesicle not extending into forebody; vitelline follicles not grouped close to ventral sucker. (Family Microphallidae)..... (22)
- (22) Cirrus sac present..... (23)
 Cirrus sac absent..... (27)
- (23) With 2 ventral suckers, genital pore at right, male copulatory organ complex
Gynaecotyla adunca p. 233
 With one ventral sucker, genital pore at left..... (24)
- (24) Oral sucker with peculiar internal muscle bands; vitellaria form a ring in forebody; uterus crosses anterior to ventral sucker
Mecynophallus glandulosus p. 226
 Oral sucker with usual musculature; vitellaria and usually uterus confined to hindbody..... (25)
- (25) Genital pore at a distance from ventral sucker; vitellaria a group of follicles on each side with a narrow duct extending medially; ovary lateral, anterior to right testis..... (26)
 Genital pore at left edge of ventral sucker; vitelline follicles form an inverted U joining vitelline reservoir; ovary median to submedian
Maritreminoides patulum p. 225
- (26) Cirrus sac strongly curved, with seminal vesicle posterior to ventral sucker; eggs 0.021 to 0.023 long.....*Pseudospelotrema nyctanassæ* p. 224
 Cirrus sac not strongly curved so that seminal vesicle is posterior to ventral sucker; eggs 0.014 long.....*Pseudospelotrema charadrii* p. 223
- (27) Metraterm simple, tubular..... (28)
 Metraterm a conspicuous pocketed or folded structure..... (29)
- (28) Male copulatory organ a single bulblike structure pierced by the sperm duct
Microphallus daviformis p. 230
 Male organ divided into 2 indistinctly separated fleshy lobes, 1 of which is pierced by the sperm duct.....*Carneophallus bilobatus* p. 228
- (29) Male organ divided into 5 lobes, each with 2 minute papillae at tip; sperm duct opens at base between lobes; modified metraterm posterior to male organ; conspicuous prostatic cells surround ceca
Megalophallus pentadactylus p. 229
 Male organ with 4 unarmed pockets into 1 of which the sperm duct opens; modified metraterm median to male organ; prostatic cells not surrounding ceca
Levinseniella leptophallus p. 231

FAMILY STRIGEIDAE RAILLIET, 1919

Cardiocephalus megaloconus n. sp. (FIGURE 1)

Description based on 4 ovigerous specimens in whole mounts and 3 in serial sections, with the characters of the genus. Total length 6.54 to 8.64; anterior segment cordiform, 1.25 to 1.50 by 1.04 to 1.30; posterior segment elongate, subcylindrical, 5.28 to 7.16 long, 0.93 to 1.21 in maximum width at level of posterior testis, constricted at level of anterior margin of genital cone; ratio of anterior segment to posterior segment, 1:4.19 to 4.83; cuticle thick, pigmented, and unarmed. Oral sucker ovoid, 0.124 to 0.136 by 0.143 to 0.179; ventral sucker elliptical, 0.121 to 0.157 by 0.086 to 0.138, its anterior margin 0.421 to 0.486 from anterior end of body (33.7 to 34.3 per cent of length of anterior segment); tribocytic organ well developed, 2 of

its lobes fingerlike and often protruding well anterior to margin of anterior segment. Esophagus short; pharynx ovoid, 0.098 to 0.183 by 0.107 to 0.192, slightly overlapping oral sucker; ceca slender, bifurcate well anterior to ventral sucker, passing medially through tribocytic organ, then laterally through posterior segment, and flanking the genital cone for about two thirds its length. Testes tandem, slightly separated, deeply cleft, each with 4 main lobes secondarily lobulated; anterior testis 0.378 to 0.500 by 0.521 to 0.707, its anterior margin 2.36 to 3.21 from anterior end of posterior segment (40.5 to 55.5 per cent of length of that segment); posterior testis 0.443 to 0.578 by 0.450 to 0.750, its posterior margin 3.46 to 4.36 from anterior end of posterior segment (59.5 to 75.7 per cent of length of that segment). Seminal reservoir between ovary and anterior testis; seminal vesicle immediately posterior to posterior testis, followed by a convoluted thick-walled duct, narrowed anteriorly as a pars prostatica surrounded by inconspicuous prostatic glands, and then enlarging to become the ejaculatory duct; genital cone conspicuous and partly eversible, 1.43 to 1.79 long by 0.71 to 0.82 wide, its limiting musculature well developed; bursa copulatrix much reduced; genital pore terminal. Ovary entire, pretesticular, 0.228 to 0.278 by 0.236 to 0.300, visible in only 2 of the whole mounts in which its anterior margin is 2.68 to 2.93 from anterior margin of posterior segment (40.5 to 40.9 per cent the length of that segment). Mehlis' gland large, situated with yolk reservoir between testes; Laurer's canal leaves oviduct a short distance from ovary and opens dorsally at the intertesticular level; uterus voluminous, extending anteriorly from Mehlis' gland through middle of posterior segment almost to its anterior end, then turning and extending posteriorly to unite with the ejaculatory duct in the base of the genital cone and form the so-called hermaphroditic canal that traverses the genital cone to the genital pore. Vitellaria confined to posterior segment, in small follicles obscuring the contents of all of that segment except the dorsal region near the gonads and the genital cone, which is overlapped ventrally by a few follicles. Eggs very numerous, oval, measuring 0.107 to 0.131 by 0.070 to 0.075.

Host: *Thalasseus maximus maximus* (royal tern).

Site: duodenum.

Locality: reef off Punta Arenas, Puerto Rico.

Type specimen: Holotype No. 38204.

This species is distinguished by its proportionately very large genital cone and the characteristic shape of the testes. Of the valid species of *Cardiocephalus*, *C. megaloconus* may be readily differentiated from *C. brandesii* by both the size and development of the genital cone and the shape of the testes; from *C. hillii* by the size of the testes; from *C. longicollis* by the size and development of the genital cone; from *C. musculosus* by the size ratio of the anterior and posterior segments; from *C. physalis* by the size of the eggs and the depth of the bursa copulatrix; and from *C. medioconiger* by the body size and development of the genital cone. The species described by Gupta and Dhillon (1954) as *C. halcyonis* belongs elsewhere than in the genus *Cardiocephalus*.

Apharyngostrigea cornu (Zeder, 1800) Ciurea, 1927 (FIGURE 2)

Synonyms:

Distoma cornu Zeder, 1800.

Amphistoma cornu Rudolphi, 1809.

Monostoma cornu Rudolphi, 1819.

Holostomum cornu Dujardin, 1845.

Holostomum variabile (Nitzsch, 1819) Wedl, 1857.

Strigea cornu (Rudolphi, 1819) Braun, 1909.

Apharyngostrigea bilobata Olsen, 1940.

Description based on 2 ovigerous specimens with the characters of the genus. Body 3.57 to 3.78 in length; anterior segment irregular in shape, 0.678 to 0.714 long and 0.607 to 0.664 wide; posterior segment elongate, subcylindrical, 2.89 to 3.07 in length, 0.607 to 0.643 in maximum width at level of anterior testis; ratio of anterior segment to posterior segment, 1:4.2 to 4.3; cuticle thick, unpigmented, and unarmed. Oral sucker 0.129 to 0.150 by 0.100 to 0.107; ventral sucker oval, 0.179 to 0.214 by 0.157, situated in posterior half of anterior segment; tribocytic organ well developed, consisting of 2 lobes; pharynx absent; ceca terminate at level of bursa copulatrix; proteolytic gland 0.185 to 0.228 by 0.143 to 0.171, near junction of body segments and consisting of numerous compact lobes. Testes multilobed; anterior testis 0.443 to 0.521 long, 0.414 to 0.471 wide, its anterior margin 1.46 to 1.50 from anterior end of posterior segment (48.5 to 50.6 per cent of the length of that segment); posterior testis 0.443 to 0.478 long, 0.428 to 0.450 wide, its posterior margin 2.46 to 2.50 from anterior end of posterior segment (80.2 to 88.0 per cent of length of that segment); seminal reservoir lobed, situated between ovary and anterior testis; seminal vesicle somewhat coiled and posterior to posterior testis; ejaculatory duct short; bursa copulatrix well developed, 0.233 to 0.295 in depth; genital cone 0.233 to 0.304 by 0.188 to 0.192; ring muscle present; genital pore terminal. Ovary lobulated, wider than long, 0.143 to 0.214 by 0.164 to 0.304, its anterior margin 1.25 to 1.29 from junction of body segments (40.7 to 43.2 per cent of the length of posterior segment); Mehlis' gland and yolk reservoir situated between testes; Laurer's canal conspicuous, opening dorsally at level between ovary and anterior testis; uterus convoluted, its anterior limit not far from the proteolytic gland. Vitellaria in small follicles through most of hindbody and extending into anterior segment almost to level of the oral sucker and occupying most of the area of the tribocytic organ and the dorsal wall of that segment. Eggs relatively few in number, 0.095 to 0.097 by 0.059 to 0.061.

Host: *Florida caerulea caerulea* (little blue heron).

Site: anterior half of small intestine.

Locality: Boquerón, Puerto Rico.

Deposited specimen: No. 38205.

The above description agrees rather closely with previous accounts of *A. cornu* for which, however, a lobulated ovary has not been mentioned previously. Byrd and Ward (1943) described the species in detail but evidently overlooked Laurer's canal, which is conspicuous in the present material.

FAMILY CYATHOCOTYLIDAE POCHÉ, 1926

Mesostephanus fajardensis (Price, 1934) Lutz, 1935 (FIGURE 3)

Synonyms:

Prohemistomum fajardensis Price, 1934.*Mesostephanus prolificus* Lutz, 1935.

Description based on several hundred specimens, of which 10 representative ones were measured, with the characters of the genus. Body pyriform, 0.86 to 1.64 long, consisting of an expanded anterior segment, 0.76 to 1.11 long by 0.450 to 0.800 wide, and a short posterodorsal appendage, 0.129 to 0.186 long by 0.143 to 0.357 wide at the base. Cuticle spinose. Oral sucker 0.048 to 0.072 by 0.054 to 0.077; ventral sucker 0.045 to 0.090 by 0.075 to 0.125. Tribocytic organ with glandular cells radiating from the irregular slitlike opening. Prepharynx absent; pharynx 0.038 to 0.059 by 0.018 to 0.036; esophagus 0.029 to 0.098 in length; ceca slender, reaching to base of posterior appendage. Anterior testis 0.075 to 0.215 by 0.077 to 0.170; posterior testis 0.098 to 0.286 by 0.079 to 0.197; cirrus sac 0.322 to 0.609 long and 0.095 to 0.150 wide, extending to either left or right of gonads; coiled tubular seminal vesicle in base of cirrus sac, followed by elongate pars prostatica surrounded by numerous prostatic cells. A semicircle of about 8 lamelliform structures lies between end of cirrus sac and vaginal sphincter near their openings into genital atrium; genital pore at tip of posterior appendage; genital atrium large. Ovary globular, 0.075 to 0.143 by 0.070 to 0.161; vaginal sphincter well developed, 0.082 to 0.147 long and 0.093 to 0.166 wide. Vitellaria in large follicles encircling tribocytic organ. Uterus with numerous eggs measuring 0.045 to 0.064 by 0.032 to 0.043.

Host: *Sula leucogaster leucogaster* (brown booby).

Site: anterior half of intestine.

Locality: Lajas (Parguera), Puerto Rico.

Type host and locality: *Sula leucogaster*, Fajardo Roads, between Palominos Island and Fajardo, Puerto Rico, by Price (1934).Other hosts and localities: *Sula brasiliensis* in Brazil by Lutz (1935).

Deposited specimen: No. 38206.

In living material the cirrus was never seen protruded, even under extreme pressure. Accordingly, it may be that this species lacks a protrusible cirrus and that the vaginal sphincter, absent in many cyathocotylids in which a protrusible cirrus has been demonstrated, may here be an accessory copulatory organ that may correspond, at least in part, to the complex genital structures of the strigeids. In that event such cyathocotylids would occupy a phylogenetic position between those that lack a vaginal sphincter and the more specialized strigeids.

Mesostephanus appendiculatoides (Price, 1934) Lutz, 1935. (FIGURE 5)

Synonym:

Prohemistomum appendiculatoides Price, 1934.

Description based on 2 ovigerous specimens with the characters of the genus. Body pyriform, 0.714 to 0.793 long, anterior segment 0.643 to 0.714 in length by 0.386 in 0.400 in maximum width, posterior appendage 0.072 to 0.079 long and 0.166 to 0.203 wide at base; cuticle spinose to level of

anterior testis. Oral sucker 0.045 to 0.052 by 0.047 to 0.048; ventral sucker 0.052 by 0.059 to 0.063; tribocytic organ prominent, with glandular cells radiating from its slitlike opening; prepharynx absent; pharynx 0.045 to 0.050 by 0.029 to 0.030; esophagus 0.036 to 0.054 in length; ceca slender, terminating near base of posterior appendage. Testes subglobular; anterior testis 0.081 to 0.125 by 0.077 to 0.170; posterior testis 0.098 to 0.118 by 0.152 to 0.179; cirrus sac 0.304 to 0.350 by 0.059 to 0.064, extending to either right or left of gonads; lamellae at end of cirrus sac not evident; seminal vesicle slender, coiled; pars prostatica and cirrus long; genital atrium large; genital pore at posterior end of body. Ovary globular, 0.054 to 0.072 by 0.070 to 0.081, between testes or opposite anterior testis; uterus with few eggs; vaginal sphincter inconspicuous. Vitellaria encircle the tribocytic organ. Eggs 0.102 to 0.111 by 0.073 to 0.084.

Host: *Sula leucogaster leucogaster* (brown booby).

Site: anterior half of intestine.

Locality: Lajas (Parguera), Puerto Rico.

Type host and locality: *Pelecanus occidentalis occidentalis*, Samana Bay, Dominican Republic, by Price (1934).

Deposited specimen: No. 38207.

Life history studies have demonstrated that cercariae of the cyathocotylids are of the "Vivax" furcocercous group. Two species of such cercariae described by Cable (1956) may well be the larvae of the above species of *Mesostephanus*. Both cercariae develop in a species of snail common in localities frequented by the brown booby. It is of interest that *Cercaria caribbea* L was much less common than *Cercaria caribbea* LI and that the single brown booby examined harbored but 2 specimens of *M. appendiculatoides* and several hundred of *M. fajardensis*. The infections probably were obtained by eating metacercariae in fish.

FAMILY NOTOCOTYLIDAE LÜHE, 1909

Paramonostomum actilidis n. sp. (FIGURE 6)

Specific diagnosis based on 4 ovigerous specimens with the characters of the genus. Body 0.76 to 0.96 long by 0.29 to 0.33 wide, cuticle finely spinose; cercarial eyespot remnants lateral to esophagus; glandular pits absent on ventral surface. Oral sucker length 0.052 to 0.061, width 0.059 to 0.075; pharynx absent; esophagus 0.072 to 0.084 long; intestinal bifurcation at end of first one seventh of body length; ceca appear to possess short lateral diverticula and terminate at posterior margin of ovary. Excretory pore dorsal, between ovary and posterior end of body. Testes elongate, lateral margins lobed; right testis slightly larger than left, 0.20 to 0.24 long and 0.07 to 0.09 wide; left testis 0.18 to 0.21 by 0.06 to 0.13; cirrus sac elongate, clubshaped, reaching mid-level of body, 0.28 to 0.43 long by 0.059 to 0.068 in maximum width; internal seminal vesicle in basal portion of cirrus sac, followed by convoluted external seminal vesicle; pars prostatica clubshaped and surrounded by numerous prostate cells; cirrus long, unarmed. Genital pore a short distance posterior to intestinal bifurcation. Ovary median, posterior to testes, somewhat oval, irregularly indented, 0.09 to 0.13 by

0.08 to 0.10; Mehlis' gland complex immediately anterior to ovary and of usual notocotyloid type; uterus extends from Mehlis' gland almost to equator of body, with 10 to 12 transverse coils; metraterm conspicuous, a little shorter than cirrus sac. Vitellaria of somewhat elongate, mostly extracecal follicles extending from anterior margin of testes to beginning of posterior one third of body length. Eggs 0.018 to 0.020 by 0.009 to 0.011 exclusive of polar filament 0.025 to 0.030 long at each end of shell.

Hosts: *Actitis macularia* (spotted sandpiper), *Charadrius hiaticula semipalmatus* (semipalmated plover), *Charadrius wilsonia wilsonia* (Wilson's plover).

Sites small intestine and ceca.

Locality: mud flat at Cabo Rojo, Puerto Rico.

Type specimen: Holotype No. 38208 (from *Actitis macularia*).

This species differs from *Paramonostomum alveatum*, *P. pseudalveatum*, *P. parvum*, *P. macrostomum* and *P. brantae* primarily in being elongate rather than oval; from *P. ionorne* in body size, extent of vitellaria, and size of the testes; and from *P. echinum*, *P. bucephalae*, *P. casarcum*, *P. queredulum*, *P. ovatum*, *P. malerischi*, and *P. obtortum* in body size. *P. actitidis* resembles most closely *P. microstomum*, but in *P. actitidis* the eggs and body are smaller.

The larva of this species could well be *Cercaria caribbea I*, a species very similar to monostome cercariae which Rothschild (1941) reported to be larvae of the genus *Paramonostomum*. *Cercaria caribbea I* develops in an abundant snail on the mud flat where hosts of *P. actitidis* were collected. The larva encysts readily on the bottom of the dish, and metacercariae were found attached to the operculum of the snail host, indicating that the life cycle is completed when that host is ingested by birds.

FAMILY PSILOSTOMATIDAE ODHNER, 1913

Ribeiroia ondatrae (Price, 1931) Price, 1942 (FIGURE 7)

Synonyms:

Psilostomum ondatrae Price, 1931.

Ribeiroia insignis Travassos, 1939.

Description based on 2 ovigerous specimens with the characters of the genus. Body 0.78 to 1.03 long, 0.39 to 0.44 wide; cuticle armed with triangular spines in close rows. Oral sucker 0.136 to 0.15 by 0.132 to 0.143; a row of about 8 cephalic gland pores on anterior lip. Ventral sucker transversely oval, 0.153 to 0.168 by 0.158 to 0.179, at midlevel of body. Prepharynx 0.014 to 0.021 long; pharynx oval, 0.073 to 0.075 by 0.054 to 0.064; esophagus 0.036 to 0.054 long, with a pair of conspicuous lateral diverticula 0.081 to 0.117 long; intestinal bifurcation about midway between suckers, ceca extend almost to posterior end of body; excretory pore terminal. Testes tandem, transversely elongate, situated somewhat nearer posterior end of body than ventral sucker; anterior testis 0.096 to 0.109 by 0.273 to 0.279; posterior testis 0.100 to 0.107 by 0.221 to 0.244. Cirrus sac mostly anterior to ventral sucker, overlapping it dorsally and nearly filled by sinuous, tubular seminal vesicle and prostatic cells; cirrus long and unarmed; genital

pore about midway between intestinal bifurcation and ventral sucker. Ovary smooth, situated a short distance anterior to anterior testis and to left of midline, measuring 0.098 by 0.089; uterus occupies intercecal space between anterior testis and ventral sucker; metraterm extends along left side of cirrus sac to enter a shallow genital atrium. Vitelline follicles large, compact, in lateral fields from pharyngeal level to posterior end of body, overlapping ceca, and confluent anterior to cirrus sac and posterior to testes. Eggs oval, 0.084 to 0.090 by 0.041 to 0.052.

Host: *Florida caerulea caerulea* (little blue heron).

Site: Intestine.

Locality: Boquerón, Puerto Rico.

Type host and locality: *Ondatra zibethica*, Canada, by Price (1931), probably an incidental host.

Other hosts and localities: *Larus californicus*, Oregon, by Price (1931); *Gallus domesticus*, Colorado, by Newsom and Stout (1933); *Pandion haliaetus carolinensis*, Pennsylvania, *Accipiter cooperi*, Michigan, and, experimentally, the chicken, duck, pigeon, and canary by Beaver (1939); *Casmerodius egretta*, Brazil, by Travassos (1939); *Butorides virescens*, Puerto Rico, by Riggin (1956).

In a study of the life history, Beaver (1939) emended the original diagnosis of the species by Price (1931), whose material evidently was not in good condition and had been obtained from the liver of a muskrat, a most unusual habitat for a psilostome. Beaver and other investigators have reported *R. ondatrae* from the proventriculus of avian hosts. The occurrence of our specimens in the intestine may have been due to migration of the parasites after death of the host.

Riggin (1956) determined that *Cercaria marini*, which develops in *Australorbis glabratus*, is the larva of *R. ondatrae* in Puerto Rico. The cercaria encysts in the lateral-line canals of fishes or even in the cloaca or other body passages of tadpoles that are eaten by birds, just as Beaver (1939) observed in Michigan. A low degree of host specificity at all stages of the life cycle rather than migratory habits of the definitive host thus seems to be responsible for the occurrence of *R. ondatrae* in widely separated localities of the Western Hemisphere.

FAMILY ECHINOSTOMATIDAE Looss, 1902

Acanthoparyphium pagollae, n. sp. (FIGURES 8 and 9)

Specific diagnosis based on 8 ovigerous specimens with the characters of the genus. Body elongate, 2.6 to 4.5 long, 0.54 to 0.83 wide, slightly constricted at level of ventral sucker; cuticle spinose from anterior end to level of ventral sucker; head collar reniform, 0.116 to 0.321 wide, with 23 spines arranged in a single row uninterrupted dorsally; terminal spine 0.030 to 0.045 by 0.009 to 0.012; other spines 0.045 to 0.060 by 0.013 to 0.014. Oral sucker 0.114 to 0.161 by 0.125 to 0.184; ventral sucker 0.285 to 0.357 by 0.292 to 0.400, within anterior one fourth of body; prepharynx 0.009 to 0.018 long; pharynx subspherical, 0.10 to 0.166 by 0.107 to 0.179, esophagus 0.152 to 0.392 in length; ceca terminate near posterior end of body; excretory

pore terminal. Testes spherical to oval, tandem, and in close proximity; anterior testis 0.249 to 0.399 by 0.278 to 0.385, at or slightly posterior to mid-level of body; posterior testis 0.286 to 0.528 by 0.221 to 0.343; cirrus sac elongate, clubshaped, 0.478 to 0.743 in length, 0.095 to 0.206 in maximum width, with over one half of its length posterior to the ventral sucker and not extending to level of ovary; cirrus unarmed; seminal vesicle oval, contained in expanded posterior portion of cirrus sac; a number of well-developed prostate cells surround the sperm duct anterior to seminal vesicle; pars prostatica not pronounced; genital pore about midway between anterior margin of ventral sucker and intestinal bifurcation. Ovary spherical to oval, 0.0478 to 0.0743 by 0.095 to 0.206, somewhat pre-equatorial, a short distance from anterior testis and slightly to right of midline; Mehlis' gland dorsal, between ovary and anterior testis, somewhat to left of midline; uterine seminal receptacle conspicuous; coils of uterus between testes and ventral sucker, ventral to ovary, and often overlapping ceca laterally. Vitelline follicles begin at ends of ceca and typically extend definitely anterior to ovarian level on right side but barely reaching that level on left; vitelline fields confluent posterior to testes. Eggs 0.086 to 0.111 by 0.060 to 0.072.

Host: *Charadrius wilsonia wilsonia* (Wilson's plover).

Site: small intestine.

Locality: mud flat at Cabo Rojo, Puerto Rico.

Type specimen: Holotype No. 38209.

To our knowledge, a species of *Acanthoparyphium* has not hitherto been reported from the Western Hemisphere. Most of the known ones occur in Asia and Australia, but the type species, *A. phoenicopteri*, is European. *A. pagollae* resembles most closely the Philippine species, *A. ochlodromi* which, however, differs from *A. pagollae* in the extent of the vitellaria, in the presence of lobed testes in mature specimens, and in having the pharynx farther from the oral sucker.

Cercaria caribbea II probably is the larva of *A. pagollae*. The 2 organisms have the same number of collar spines, and the cercaria was found to develop in *Cerithidea costata* on the mud flat where the host of *A. pagollae* was collected. The larva usually encysts in a small lamelibranch (*Gemma purpurea*), but metacercariae were found in the snail host as well. It is of interest to note that Yamaguti (1934) obtained from *Batillaria multiformis*, a snail closely related to *C. costata*, the rediae and cercariae of a species of *Acanthoparyphium*. If one allows for differences in technique, the larval stages found by Yamaguti are very similar to the redia and cercaria of *C. caribbea* II.

Microparyphium floridae n. sp. (FIGURE 10)

Specific diagnosis based on 2 ovigerous specimens with the characters of the genus. Body 2.27 to 2.36 long and 0.943 to 0.964 in maximum width at about level of ovary. Cuticle with large, quincunxially arranged spines, 0.023 to 0.025 by 0.011 to 0.014, extending to level of testes; head collar rudimentary, with 12 spines on each side of a wide dorsal interruption, 10

in line and 2 angle spines. Adoral spines 0.016 by 0.009, variable in number or easily lost; holotype with 7 in preoral row and 8 in postoral semicircle, second specimen with 10 in preoral row and no postoral spines. Oral sucker 0.278 to 0.293 by 0.278 to 0.321; ventral sucker 0.378 to 0.478 in diameter, situated just within anterior half of body length; prepharynx 0.027 to 0.054 long; pharynx subspherical, 0.164 to 0.179 by 0.221 to 0.236; esophagus 0.098 to 0.150 by 0.197 to 0.257, with prominent lateral folds; intestinal bifurcation just within anterior one fourth of body; ceca expanded posteriorly and extending to near posterior end of body; excretory pore terminal. Testes tandem and contiguous, well removed from posterior end of body, with very irregular contour; anterior testis 0.143 to 0.179 by 0.471 to 0.571; posterior testis 0.214 to 0.236 by 0.507 to 0.521. Cirrus sac ovoid, 0.161 to 0.251 by 0.109 to 0.143, diagonally placed immediately posterior to intestinal bifurcation and not overlapping ventral sucker appreciably; seminal vesicle elongate oval, with a shallow constriction; prostate cells well developed; cirrus small and pear-shaped; genital pore median or very slightly to left of midline, between intestinal bifurcation and ventral sucker. Ovary elongate oval, 0.168 to 0.190 by 0.107 to 0.113, immediately pretesticular and slightly to right of midline; Mehlis' gland a conspicuous mass just to left of ovary; uterine seminal receptacle close to ovary; uterus not extensive, confined to region between testes and ventral sucker; metraterm enters genital atrium from left. Vitellaria in small follicles, confined to hindbody or beginning near midlevel of ventral sucker and extending to posterior end of body, their fields intermingling posterior to testes. Eggs 0.063 to 0.098 by 0.048 to 0.063.

Host: *Florida caerulea caerulea* (little blue heron).

Site: posterior half of intestine.

Locality: Boquerón, Puerto Rico.

Type specimen: Holotype No. 38210.

This species may be differentiated from *Microparyphium facetum* by the sizes of the body, suckers, esophagus, pharynx, and testes; from *M. asotum* by the size and shape of the testes and by the size and position of the ovary; from *M. capellae* by the sizes of the suckers and ovary; and from *M. montei* by the sizes of the body, suckers, and ovary. *M. floridae* most closely resembles *M. corvi* but differs from that species in the sizes of the eggs and ventral sucker, in the extent of the vitellaria, and in the number and distribution of the collar spines.

The cercaria of *M. floridae* probably was not among those described by Cable (1956) and, in view of the range and habits of the host, could well develop in fresh-water mollusks. *Cercaria caribbea VI*, which has no collar spines, could conceivably be the larva of *M. floridae*, as instances are known in which development of collar spines is delayed until after the cercarial stage. It is unlikely that *Cercaria caribbea III* with 31 uninterrupted collar spines is the larva of *M. floridae* in view of studies on other echinostomes in which the number and arrangement of collar spines, if present in the cercaria, are known to persist in the adult.

FAMILY PHILOPHTHALMIDAE Looss, 1899

Parorchis holotestis n. sp. (FIGURE 4)

Specific diagnosis based on 3 mature specimens with the characters of the genus. Body pyriform 3.71 to 4.57 long, 2.07 to 2.64 wide; scalelike spines 0.020 to 0.022 by 0.009 to 0.013 on anterior part of body, diminishing in number and size posteriorly; head collar about 0.86 wide, with a poorly defined ventral prominence on each side of oral sucker and bearing a double row of spines that measure 0.013 to 0.020 by 0.009 and are extremely difficult to see; anterior row on ventral side of each prominence with about 8 spines, posterior row with about 12. Oral sucker 0.393 to 0.443 by 0.450 to 0.592; ventral sucker, 0.714 to 0.965 by 0.749 to 0.928, its posterior border at about equator of body; ratio of oral to ventral sucker about 1:1.8; prepharynx 0.071 to 0.072 long; pharynx, 0.214 to 0.251 by 0.179 to 0.257; esophagus, 0.143 to 0.307 in length; intestinal bifurcation just within anterior one fourth of body; ceca extend slightly posterior to testes; excretory vesicle and ascending canals with complex lateral branching; excretory pore terminal. Testes small, spherical, entire, symmetrically placed between ends of ceca; right testis 0.150 to 0.228 by 0.157 to 0.179; left testis 0.179 to 0.228 by 0.157 to 0.214; cirrus sac oval, 0.134 to 0.179 by 0.170 to 0.257, between ventral sucker and intestinal bifurcation; seminal vesicle evidently tubular and not extending beyond posterior margin of ventral sucker; prostatic cells scattered in basal portion of cirrus sac; genital pore between ventral sucker and intestinal bifurcation, its margin with muscle fibers that could be mistaken for spines. Ovary ovoid, 0.186 to 0.236 by 0.179 to 0.243, median and anterior to testes; vitelline reservoir just post-ovarial; uterus occupying most of space between ventral sucker and posterior end of body, its loops extending extracellally almost to lateral margins of hind body; metraterm to left of cirrus sac, opening into genital atrium at side of male aperture. Vitellaria sparse, their fields confined to those of the ceca from slightly anterior to level of the ovary to, or a little beyond, that of the posterior margin of the ventral sucker; from the posterior ends of the vitellaria, the right and left vitelline ducts extend posteromedially and unite to form the reservoir between ovary and testes. Eggs numerous, 0.045 to 0.062 by 0.036 to 0.038, containing miracidia with prominent eye spots.

Hosts: *Charadrius wilsonia wilsonia* (Wilson's plover), *Squatarola squatarola cynosurae* (black-bellied plover).

Site: cloaca.

Locality: mud flat at Cabo Rojo, Puerto Rico.

Type specimen: Holotype No. 38211.

This species differs from *Parorchis pittacium*, *P. acanthus*, *P. proctobium*, *P. asiaticus*, and *P. snipis* chiefly in having small, entire testes about equal to ovary in size and in having a seminal vesicle not extending posterior to the ventral sucker. Of the described species of *Parorchis*, *P. holotestis* resembles most *P. gedoelsti* from northern Europe but differs from that form in the extent of the seminal vesicle and in having a smaller ovary, shorter esophagus, and a much less pronounced head collar.

The difficulty with which it was determined that collar spines were present in *P. holotestis* suggests that such spines have been overlooked in species described as lacking them and supports the reduction of the genus *Proctobium*, erected for such species, to synonymy with *Parorchis*. Because of the collar spines most authorities place *Parorchis* in the family Echinostomatidae but, in other respects, the genus is more in accord with the family Philophthalmidae, a group related to the echinostomes but aberrant in structure and habitat.

From the life history of *P. acanthus*, it seems certain that the larva of *P. holotestis* is *Cercaria caribbea* V, which develops in *Cerithidea costata* on the mud flat where birds harboring the adult worm were collected. In its structure, swimming activity, and encysted stage, that cercaria is almost indistinguishable from the larva of *P. acanthus*.

FAMILY HETEROPHYIDAE ODHNER, 1914

Excluding species that have been assigned to the Cryptogonimidae and Acanthostomatidae, there remain in the family Heterophyidae many digenetic trematodes that infect piscivorous birds, mammals and, rarely, fishes. Before describing species that represent the family, it is necessary to clarify the terminology and homologies of parts in the region of the genital pore, a matter concerning which there is much inconsistency in the literature. Modification in that region seems to compensate for loss of the cirrus sac and a protrusible cirrus. Trematodes lacking those structures often have accessory ones that presumably replace the cirrus as a copulatory organ or otherwise facilitate the exchange of sperms between the worms. Fundamentally different modifications occur in the various families, but in 2 of them, namely, the Heterophyidae and Microphallidae, the genitalia may be so similar in gross appearance that helminthologists have regarded the 2 groups as a single family. Although the basic distinction between adult heterophyids and microphallids was appreciated by Witenberg (1929), it was not until their life histories were found to be very different that their status as distinct families became generally accepted.

In the Heterophyidae these modifications usually include reduction of the ventral sucker and its inclusion in a more-or-less definite cavity that may obscure the sucker. Consequently earlier investigators, including Jägerskiöld (1896), Linton (1901), and Odhner (1910), regarded these trematodes as monostomes.

Cable and Hunninen (1942) interpreted the cavity as a secondary invagination in the region of the genital pore, on evidence from the varying degrees to which this feature occurs in the Cryptogonimidae, a family closely related to the Heterophyidae, and on the histological structure of the cavity in *Siphodera vinalwardsii*. They determined that it is lined with a spinose cuticle similar to and continuous with that of the body surface. Jägerskiöld (1896) also observed such spines in the ventral cavity of "*Monostomum lacteum*," a heterophyid. This cavity has been called a genital sinus, genital atrium, genital sucker, pseudosucker, and genital pit. Witenberg (1929) proposed the term ventrogenital sac for it and its contents. That designation

is the preferred one because it is accurately descriptive of this distinctive feature of the Heterophyidae. The wall of the ventrogenital sac is often thickened more or less throughout, and powerful muscles may radiate from it. When contracted, the sac thus may be deep and suckerlike, and often has its left wall thrown into 1 or more pouchlike folds communicating with the lumen of the sac. When expanded, the ventrogenital sac may be so shallow that its identity is lost with its wall blending into the ventral surface of the body.

Contrary to many accounts, the ventrogenital sac is not homologous with the genital sinus or genital atrium of other trematodes, nor does its opening to the outside correspond to the genital pore which, instead, opens into the ventrogenital sac from a common passage for eggs and sperms. That passage is usually called the hermaphroditic duct but, as Cable and Hunninen (1942) observed, it actually is homologous with the genital atrium of other trematodes and should be designated as such. Its opening into the ventrogenital sac thus corresponds to the genital pore in other families and should be called by that name, while the exit from the sac to the ventral surface of the body is here termed the ventrogenital opening. In this connection it may be pointed out that in the closely related opisthorchiids, which lack the ventrogenital sac, the genital atrium is narrow and inconspicuous, just as it is in the Heterophyidae, and may be very short. In instances in which the ejaculatory duct and metraterm are described as opening separately into the ventrogenital sac it is possible that at least a short genital atrium may have been overlooked. Few descriptions are explicit in this matter.

The ventral sucker usually opens into the ventrogenital sac and may retain its characteristic appearance or become variously modified. In *Monostomum lacteum*, Jägerskiöld called it the *sphäroiden Körper*, and spinose modifications of its free edge the *stacheligen Körper*. In such species the ventral sucker evidently is eversible, and a lumen, if any, is observed only when inverted as in *Stictodora*, in which Looss (1899) incorrectly interpreted the ventral sucker as a thick penis and its lumen as the male gonoduct lined with spines. Braun (1902), however, recognized the ventral sucker as such but erred in his interpretation of the reproductive ducts, mistaking a thickwalled expulsor for a cirrus sac. Ciurea (1933) called such a ventral sucker a weakly muscular spheroidal formation.

In addition to the ventral sucker, the ventrogenital sac usually includes one or more fleshy structures, either pierced by the genital atrium or more closely associated with the genital pore than is the ventral sucker. Much confusion exists concerning the terminology of these structures, which often have the appearance of outgrowths from the wall of the sac and may blend into it. Among other things, they have been called the *zungenformigen Körper* (Jägerskiöld, 1896), *ventouse génitale* (Ciurea, 1924 and 1933), appendix (Ransom, 1920), and atrial pad (Yamaguti, 1934, 1939). Witenberg (1929) proposed for them the term gonotyl, which has become widely accepted but by no means consistently applied to homologous structures. In genera in which both the gonotyl and ventral sucker are well developed their identity should be readily ascertained from their structure and their

position in respect to each other and to the genital pore. Although the gonotyl is sometimes directly anterior or posterior to the ventral sucker, more often it is decidedly to the left of the plane occupied by the sucker. However, when one or the other of these structures is reduced or highly modified the homologies are less obvious and identities may be overlooked or transposed.

Although at least 1 species in each of the genera *Galactosomum* and *Stictodora* has been described as lacking a ventral sucker, and the prominent structure contained in the ventrogenital sac has been interpreted as a gonotyl, we have consistently found in species of both genera a conspicuous body on the right of the sac and, to its left, a smaller structure that is either pierced by the genital atrium or overhangs its opening at the genital pore. In a series of species there is convincing evidence that the structure on the right is always a more or less modified ventral sucker, while the one on the left is the gonotyl that evidently has been overlooked in some species and mistaken for a rudimentary ventral sucker in others. Thus Price (1932), in a general discussion of the genus *Galactosomum* and (1934) in descriptions of *G. darbyi* and *G. johnsoni*, misinterpreted the ventral sucker as a gonotyl, as did Park (1936) in *G. humbargari*, Dollfus (1951) in *G. lacteum*, and Witenberg (1953) in his characterization of the genus. Similar misinterpretation of the ventral sucker and gonotyl in the genus *Stictodora* is given by Martin (1950b) for *Stictodora (Parastictodora) hancocki*; Martin and Kuntz (1955) in *S. tridactyla*, and by Africa *et al.* in species of *Galactosomum* and *Stictodora* from the Philippine Islands. It seems that among the recent workers, only Prudhoe (1949) and Caballero *et al.* (1954) agree with our interpretation of homologies in respect to these structures in *Galactosomum*. However, Yamaguti (1934, 1939) and Johnston (1942) seem to have been more nearly correct than Prudhoe insofar as the genus *Stictodora* is concerned.

The evidence that has led us to the above interpretation is based on a comparative study of the various species of *Galactosomum* and related genera described below. All have been examined critically in both sectioned material and whole mounts. Histologically, the ventral sucker in these genera resembles the unmodified sucker of other trematodes and is separated from the body parenchyma by a distinct muscular septum composed of 2 well-defined muscle layers, an outer layer of circular or transverse fibers and an inner one of longitudinal fibers. In the inner parenchyma are radial muscle fibers with nuclei comparable to those in the suckers of trematodes in general. Similar histology has been described and figured for the "spheroidal body" in *Galactosomum cochleariforme* by Pratt (1911). Although the gonotyl seems to be composed of very fine muscle fibers, nuclei, if present, are extremely few, and hooks and spines are evidently always absent in *Galactosomum*. Although Jägerskiöld figured very minute spines on the gonotyl (*zungensformigen Körper*) of *Monostomum lacteum*, he was of the opinion that what appeared to be spines probably were the insertions of muscle fibers within the limiting membrane of the gonotyl. It thus is desirable that *Galactosomum* and certain other heterophyid genera be redefined before their species are described.

Genus *Galactosomum* Looss, 1899, *char. emend.*

Synonyms:

Microlistrum Braun, 1901.

Cercarioides Witenberg, 1929.

Tubanguia Srivastava, 1935.

Knipowitchetrema Isaichikov, 1927.

Diagnosis: Heterophyidae, Galactosomatinae. Body elongate or tongue-shaped, forebody usually expanded and concave ventrally; hindbody cylindrical. Cuticle spinose over at least anterior half of body; cercarial eyespot pigment present. Oral sucker without spines around mouth; prepharynx relatively long; pharynx well developed, with anterior valves or flaps; prominent muscles extend posterolaterally from pharynx into parenchyma; esophagus shorter than prepharynx, sometimes not evident; Ceca extend to near posterior end of body, with prominent cellular lining. Excretory vesicle elongate sac-shaped or tubular, straight or slightly sigmoid. Ventrogenital sac median, containing on the right a modified ventral sucker with spinose free surface, immediately to its left an inconspicuous, muscular gonotyl directed toward ventral sucker and either pierced by the genital atrium or overhanging the genital pore; left wall of ventrogenital sac thrown into 1 or more thick-walled, pouchlike folds. Testes tandem to slightly oblique; seminal vesicle constricted into 2 or more portions, 1 of which is muscular and may be very thick-walled; vasa efferentia enter posterior division of seminal vesicle at a distinct, inwardly directed papilla. Ovary entire, anterior to testes; Mehlis' gland and Laurer's canal present; seminal receptacle large, posterior to ovary. Vitellaria inter- and extracecal, extending from near posterior end of body for a variable distance anteriorly, usually beyond the testes but not to level of ventrogenital sac. Uterus voluminous throughout hindbody but not overlapping ventrogenital sac; metraterm short, muscular, and joining male duct to form a tubular genital atrium. Eggs numerous, small, symmetrical, often with antopercular knob. Adults in intestine of piscivorous birds, metacercariae probably in fishes. Life history unknown, but cercaria has eyespots and may be magnacercous or even zygoercous (*Rallenkönig*) rather than pleurolophocercous or parapleurolophocercous.

Although the genus *Galactosomum* is attributed to Looss (1899), the latter no more than suggested that perhaps a genus of that name be erected to receive *Monostomum lacteum* Jägerskiöld. The genus received little further attention until it was reviewed by Prudhoe (1949) and by Witenberg (1953). Most helminthologists agree with Poche (1926) that *Galactosomum* belongs in the family Heterophyidae and not in the Cryptogonimidae as proposed by Ciurea (1933). Furthermore, a distinct family, the Galactosomatidae, as proposed by Morozov (1950) and accepted by Timon-David (1955), seems to be unwarranted.

Indeed, species of *Galactosomum* and those of *Stictodora* are so similar that Price (1934) and Yamaguti (1939) have suggested that the 2 genera may be synonymous. However, they differ in certain respects (*see* Prudhoe, 1949), the most suggestive of which is the form of the excretory vesicle: U-, V- or Y-shaped in *Stictodora* and sac-shaped or tubular in *Galactosomum*. Martin

(1950a, b) placed *Euhaplorchis* and *Parastictodora* (= *Stictodora*) in the subfamily Haplorchinae because they have parapleurolophocercous larvae. He also assigned *Galactosomum* to that subfamily, but the type of cercaria has not been established for that genus. It may well be the magnacercous type, 4 species of which Cable (1956) found in marine snails from habitats precisely where larvae of the species of *Galactosomum* reported here would be expected to occur. That possibility is suggested further by the shape of the excretory vesicle which, unlike that of other heterophyids, has no indication of being transversely elongated, U-, V-, or Y-shaped in either the magnacercous larvae or the adults of *Galactosomum* species. It thus is more than likely that further knowledge of life histories would require that species of *Galactosomum* and *Stictodora* be placed in separate subfamilies. For that reason, we recognize the Galactosomatinae as a subfamily distinct from the Haplorchinae.

Galactosomum cochleariforme (Rudolphi, 1819) Pratt, 1911.

(FIGURES 11 to 15)

Synonyms:

Distoma cochleariforme Rudolphi, 1819.

Distomum cochleariforme Diesing, 1850.

Microlistrum cochleariforme Braun, 1901.

Cercarioides cochleariforme Witenberg, 1953.

Description based on 15 mature specimens with the characters of the genus. Cuticle spinose almost to posterior end, with spines gradually decreasing in size and number. Body 3.35 to 4.99 long; forebody 1.44 to 1.64 long, 1.05 to 1.50 wide, expanded, concave ventrally, and with numerous eosinophilic glands, especially in intercecal zone; hindbody cylindrical, 2.05 to 3.56 long, 0.75 to 1.14 wide. Oral sucker 0.19 to 0.27 long, 0.20 to 0.27 wide; prepharynx 0.06 to 0.13 long, pharynx 0.17 to 0.20 long, 0.12 to 0.16 wide, pyriform; esophagus very short, attaining a length of not over 0.05 in well-extended specimens; intestinal bifurcation within first one fourth of body length; ceca extend laterally, then posteriorly in an arch conforming with shape of forebody to enter hindbody and reach almost to its posterior end; ceca with well-defined epithelial lining. Excretory vesicle sac-shaped, reaching only to posterior testis and receiving anterolaterally the pair of main tubules which extend almost to oral sucker and turn posteriorly before dividing; excretory pore terminal, with sphincter. Testes entire, tandem, posterior to ovary and separated by uterine coils; anterior testis 0.21 to 0.31 long, 0.31 to 0.48 wide; posterior testis 0.24 to 0.39 long, 0.31 to 0.45 wide. Seminal vesicle bipartite, posterior division thin-walled, anterior division elongate and with thick wall of circular muscles; pars prostatica a narrow muscular duct surrounded by numerous prostatic cells. Ventral sucker 0.142 to 0.213 long, 0.126 to 0.174 wide, its free surface facing ventrogenital sac with numerous spines 0.008 to 0.012 long; gonotyl immediately to left of ventral sucker, pierced by genital atrium opening at genital pore near tip of gonotyl. Ovary entire, to right of midline, 0.12 to 0.18 long, 0.18 to 0.27 wide; Laurer's canal prominent, Mehlis' gland well

developed; seminal receptacle immediately posterior to and nearly as large as ovary. Vitellaria usually with follicles arranged in rosettes, lateral to and overlapping ceca from near their posterior ends to level of constriction dividing seminal vesicle. Uterus extends from posterior extremity of body almost to ventrogenital sac. Eggs numerous, 0.030 to 0.032 by 0.014 to 0.016, with minute antopercular knob.

Host: *Sula leucogaster leucogaster*, brown booby.

Site: posterior half of intestine.

Locality: Parguera, Puerto Rico.

Other hosts and localities: *Fregeta (Pelecanus) aquila* by Rudolphi (1819), Brazil; Pratt (1911), Florida.

Deposited specimen: No. 38212.

Braun (1901) redescribed this species from material in Rudolphi's collection as type of the new genus *Microlistrum*. Although he misinterpreted the anterior division of the seminal vesicle as a cirrus sac, he did recognize the ventral sucker as such and thus correctly placed the trematode with the distomes. Pratt (1911) reduced *Microlistrum* to synonymy with *Galactosomum*, but repeated Odhner's (1910) error in calling the species a monostome, interpreting the ventral sucker as a "penis-like organ in the genital sinus." Witenberg (1929) described a species very similar to *G. cochleariforme* and erected for it the genus *Cercarioides* to which Nazmi (1930) added a second species. Both Nazmi's and Witenberg's descriptions were based on single specimens, and neither gave a satisfactory account of the ventrogenital sac complex. Although Price (1932) and Prudhoe (1949) have regarded *Cercarioides* as a synonym of *Galactosomum*, Witenberg (1953) has maintained that *Cercarioides* is a valid genus to which he transferred *G. cochleariforme*. We do not accept the expanded, cobralike forebody by which Witenberg distinguished species of *Cercarioides* as a valid generic character because of the gradation in that respect shown by the next 2 species (compare FIGURES 11, 16, and 18).

Galactosomum cochlear (Diesing, 1850) Prudhoe, 1949. (FIGURES 16 and 17)

Synonyms:

Distoma cochleariforme (sternae) Rudolphi, 1819.

Distoma cochlear Diesing, 1950.

Distomum diesingi Cobbold, 1861.

Microlistrum cochlear Braun, 1901.

Description based on 9 ovigerous specimens with the characters of the genus. Body 3.97 to 5.30 long, definitely constricted at level of ventrogenital sac to form a moderately expanded forebody and an elongate, cylindrical hindbody; forebody 1.23 to 1.61 long, 0.65 to 0.77 wide, with glands as in preceding species; hindbody 2.89 to 4.00 long, 0.56 to 0.78 wide. Cuticle spinose to intertesticular level. Oral sucker 0.13 to 0.15 long, 0.11 to 0.13 wide; prepharynx slightly longer than pharynx, which is pyriform, 0.13 to 0.16 long, 0.11 to 0.13 wide; esophagus very short; intestinal bifurcation at about one third length of forebody from anterior end; ceca arch laterally

and extend nearly to posterior end of body. Excretory vesicle elongate sac-shaped, reaching only to posterior testis; excretory pore terminal, sphincter present; main tubules as in preceding species. Testes subspherical, tandem, separated by coils of uterus; anterior testis 0.24 to 0.46 in diameter, posterior testis 0.31 to 0.48; seminal vesicle bipartite with narrow duct between divisions; posterior division thin walled, tubular, sinuous, partly obscured by uterus; anterior division more muscular but not approaching *G. cochlearior me* in that respect; pars prostatica a narrow duct surrounded by prostatic cells. Ventrogenital sac median, its left wall thrown into a single pouchlike fold; ventral sucker 0.13 to 0.15 long, 0.11 to 0.13 wide, its free surface facing ventrogenital sac studded with spines 0.003 to 0.005 long; gonotyl immediately to left of ventral sucker, pierced by genital atrium; genital pore near tip of gonotyl. Ovary entire, oval, 0.14 to 0.20 by 0.18 to 0.25, situated medially in first quarter of hindbody. Mehlis' gland prominent, seminal receptacle large, immediately posterior to ovary. Vitelline follicles usually in definite rosettes scattered from near ends of ceca to level of ovary, interrupted on each side, usually at left of anterior testis and at right of posterior testis. Uterus extends from posterior end of body to near ventrogenital sac. Eggs numerous, 0.0027 to 0.031 by 0.014 to 0.016, with small antopercular knob.

Host: *Thalasseus maximus maximus* (royal tern).

Site: small intestine.

Locality: sand spit off Punta Arenas, Puerto Rico.

Other hosts and localities: *Sterna albifrons (minuta)*, *Sterna (?) sandvicensis (cantiaca)* and *Sterna* sp., Brazil, by Rudolphi (1819) and Braun (1902); *Larus argentatus michahellis*, France, by Timon-David (1934), a host record accepted with reservation by Prudhoe (1949).

Deposited specimen: No. 38213.

Galactosomum puffini Yamaguti, 1941. (FIGURE 18)

Description based on 76 specimens with the characters of the genus. Body shape variable, depending on age and state of contraction; forebody as well developed in immature as in mature specimens, although hindbody is much abbreviated before maturity. Length of ovigerous specimens 1.10 to 1.60, maximum width, which may be either in fore- or hindbody, 0.25 to 0.37; posterior end more pointed than anterior extremity. Cuticle finely spinose from anterior end to level of anterior testis or beyond. Oral sucker 0.056 to 0.087 long, 0.081 to 0.103 wide; prepharynx about as long as pharynx, which is oval, 0.064 to 0.083 long, 0.056 to 0.060 wide; esophagus short, about as wide as long; intestinal bifurcation one fifth to one sixth body length from anterior end; ceca arch laterally, converge, and then separate slightly as they extend posteriorly almost to end of body. Excretory vesicle narrow, sac-shaped, not reaching posterior testis; excretory pore subterminal, opening in a small dorsal depression. Testes round to oval, slightly oblique and separated a short distance by coils of uterus; anterior testis 0.072 to 0.122 in diameter, posterior testis 0.084 to 0.119. Seminal

vesicle bipartite, posterior division elongate, with very thick muscular wall; anterior division rounded, with thinner wall; pars prostatica long, muscular, joined to seminal vesicle by a much narrower, thin-walled duct and surrounded by conspicuous prostatic cells; ejaculatory duct short, joining metraterm to form genital atrium that pierces gonotyl. Ventrogenital sac in first third of body length; ventral sucker well developed, extending anterior and dorsal to gonotyl, reaching the pouchlike folds of the ventrogenital sac; free surface of ventral sucker with 3 separate patches of extremely minute spines. Ovary entire, median, or slightly to right, oval with long diameter parallel to posterior portion of seminal vesicle and measuring 0.052 to 0.068 by 0.071 to 0.114. Seminal receptacle immediately posterior to, and as large as, or larger than, ovary. Vitellaria extend from near posterior extremity to about level of seminal vesicle constriction; follicles in rosettes, a conspicuous one being uniformly ventral to excretory vesicle and consisting of 7 or 8 radiating masses. Uterus extends from near posterior end of body almost to ventrogenital sac to join the short muscular metraterm at left of pars prostatica. Eggs numerous, 0.025 to 0.029 by 0.011 to 0.014.

Hosts: *Thalasseus maximus maximus* (royal tern); *Sterna albifrons antillarum* (least tern); *Sula leucogaster leucogaster* (brown booby).

Site: intestine.

Locality: West Coast of Puerto Rico.

Other hosts and localities: *Puffinus leucomelas*, Japan, by Yamaguti (1941); *Pelecanus occidentalis californicus*, Panama Canal Zone, by Caballero *et al.* (1954).

Deposited specimen: No. 38214.

The next species was described by Price (1934) as *Galactosomum johnsoni*, but it differs from our concept of *Galactosomum* in respects that in our estimation are collectively of generic rank. Accordingly, the following genus is proposed for that species:

Galactosomoides n. g.

Diagnosis: Heterophyidae, Galactosomatinae. Similar to *Galactosomum* but with the following differences: oval to elongate shape, forebody not expanded; testes diagonally placed, ovary to right of midline; seminal receptacle anterior to ovary; vitellaria in scattered follicles not arranged in rosettes; tip of gonotyl and genital pore directed to left, away from ventral sucker; uterus extends to level of ventrogenital sac; eggs flattened on one side; pars prostatica short, prostate cells few; seminal vesicle thin-walled throughout. Type and only species, *Galactosomoides johnsoni* (Price, 1934) n. comb.

The following redescription of the type species is based on our material; measurements differ somewhat from those of Price's specimens which we have seen. These specimens are not in good condition and seem to have been dead when taken from the host.

Galactosomoides johnsoni (Price, 1934) n. comb. (FIGURES
19 and 20)

Synonym:

Galactosomum johnsoni Price, 1934.

Description based on 46 mature specimens with the characters of the genus. Body 0.66 to 0.75 long, 0.31 to 0.36 wide. Cuticle finely spinose to level of testes. Oral sucker 0.046 to 0.064 long, 0.059 to 0.071 wide; pharynx oval, about as long as prepharynx; esophagus up to one half as long as pharynx; intestinal bifurcation about one third body length from anterior end; ceca arch laterally, then extend posteriorly and end near posterior extremity of body; their epithelial lining rather even in height. Excretory vesicle narrow, sac-shaped, extending almost to posterior testis; excretory pore terminal, sphincter present; main excretory tubules divide at level of pharynx. Testes entire, diagonal, with left testis anteriormost; left testis 0.064 to 0.087 long, 0.103 to 0.119 wide, right testis 0.071 to 0.084 long, 0.112 to 0.135 wide; seminal vesicle diagonal, with 2 broadly joined divisions separated by a moderate constriction; pars prostatica short, narrow, with few prostate cells. Ventral sucker to right of midline, its dorsal wall adjacent to ventrogenital sac thickened to form a spiny pad encroaching on lumen of sucker; free ventral wall thinner and with 2 spinose areas. Gonotyl immediately to left of ventral sucker, small, arising from anterodorsal wall of ventrogenital sac; its free end bearing genital pore and directed to left, away from ventral sucker. Left wall of sac with one to 3 thickened folds; ventrogenital opening median or toward left of sac, with sphincterlike muscles. Ovary to right of midline, oval, measuring 0.064 to 0.071 by 0.033 to 0.048; vitellaria posterior to ovary, with follicles scattered among coils of uterus. Seminal receptacle large, in contact with anterior margin of ovary. Uterus voluminous, extending from posterior end of body to level of ventrogenital opening; metraterm long, narrow and almost straight. Eggs asymmetrical, 0.031 to 0.036 by 0.016 to 0.019.

Hosts: *Sula leucogaster leucogaster* (brown booby); *Thalasseus maximus maximus* (royal tern).

Localities: Lajas (Parguera) and Punta Arenas, Puerto Rico.

Type host and locality: a brown booby, Fajardo Roads between Palominos Island and Fajardo, Puerto Rico.

Deposited specimen: No. 38215.

Galactosomum spinetum is another species that differs from our concept of the genus *Galactosomum* in respects that are judged to be of generic rank. Braun (1901, 1902) erected the genus *Microlistrum* for *G. spinetum*, *G. cochleariforme*, and *G. cochlear*. However, *Microlistrum* is unavailable as a generic name for *G. spinetum* because Braun designated *G. cochleariforme* as type species, making *Microlistrum* a synonym of *Galactosomum*. It thus is necessary to propose a new name in erecting the following genus:

Relevitellus n. g.

Diagnosis: Heterophyidae, Galactosomatinae. Similar to *Galactosomum* but with the following differences: body fusiform, tapering toward both

ends without expansion of forebody; vitelline follicles not reaching posterior end of body by a considerable distance; median region of hindbody with a conspicuous network of vitelline ducts; seminal vesicle and uterus extend anterior to ventrogenital sac so that ejaculatory duct and metraterm approach gonotyl from direction of forebody; lobed or indented testes. Type and only species:

Relevitellus spinetus (Braun, 1901) n. comb. (FIGURES 21 to 23)

Synonyms:

Microlistrum spinetum Braun, 1901.

Galactosomum spinetum (Braun, 1901) Pratt, 1911.

Description based on 9 mature specimens with the characters of the genus. Body flattened, widest at ovarian level, tapering toward ends, more pointed posteriorly, 4.74 to 5.72 long, 1.03 to 1.12 in maximum width. Cuticle spinose nearly to posterior end, spines decreasing in number and size posteriorly. Eyespot pigment in forebody; eosinophilic glands with ducts to ventral surface concentrated intercecally in forebody but extending throughout it and into hindbody with a few scattered ones as far as ends of ceca. Oral sucker 0.19 to 0.24 long, 0.22 to 0.24 wide; prepharynx and pharynx subequal in length, pharynx 0.18 to 0.23 long, 0.12 to 0.14 wide; esophagus about one fourth as long as pharynx; ceca extend almost to posterior end of body; epithelial lining distinct. Excretory vesicle extending to posterior testis only, sac-shaped, with large, rather evenly spaced nuclei protruding into lumen; main excretory canals extend to pharyngeal level and turn posteriorly before dividing. Testes tandem, indented, with distinct muscle fibers between indentations that are more conspicuous in anterior testis. Posterior testis 0.68 to 0.79 long, 0.33 to 0.45 wide; anterior testis 0.46 to 0.62 long, 0.34 to 0.37 wide. Seminal vesicle bipartite; posterior division thin walled, sinuous; anterior division moderately thick walled, extending dorsally and then anteriorly to ventral sucker; from it the pars prostatica arches ventrally and then posteriorly to join metraterm; ejaculatory duct short, its termination forming a papilla extending into genital atrium. Gonotyl large, muscular, its base pierced by genital atrium; ventrogenital sac with a large posterolateral communicating pouch; ventrogenital opening median, with thick sphincterlike muscles. Ventral sucker 0.127 to 0.135 long, 0.103 to 0.119 wide, with spinose free surface. Ovary to right of midline, entire, ovoid, 0.24 to 0.30 by 0.17 to 0.24; seminal receptacle large, immediately posterior to ovary; Mehlis' gland and Laurer's canal evident. Vitellaria extend from near level of ventrogenital sac to about midway between posterior testis and end of body, their ducts as in generic diagnosis. Uterus voluminous, mostly intercecal from near posterior end of body to a level anterior to ventrogenital sac. Eggs numerous, 0.022 to 0.027 by 0.014 to 0.016.

Host: *Thalasseus maximus maximus* (royal tern).

Locality: sand spit off Punta Arenas, Puerto Rico.

Type host and locality: *Rhynchops n. nigra* (black skimmer) Brazil, Braun (1901).

Deposited specimen: No. 38216.

The genus *Stictodora* was discussed above in connection with *Galactosomum*. A revised diagnosis is desirable because of errors made by Looss (1899) and some later investigators in interpreting certain features.

Genus *Stictodora* Looss, 1899, char. emend.

Synonyms:

Cornatrium Onji and Nishio, 1924.

Acanthotrema Travassos, 1928.

Parastictodora Martin, 1950.

Diagnosis: small heterophyid trematodes with oval, pyriform, or linguiform bodies. Cuticle spinose nearly to posterior end; eyespot pigment present. Oral sucker without appendage or circumoral spines, pharynx oval, prepharynx usually longer than esophagus, ceca extend well into hindbody, but usually terminate a considerable distance from posterior end. Ventrogenital sac median or submedian; ventral sucker to right within sac, ovoid to pyriform in shape, its free surface bearing pronglike hooks, spines or sclerotized plates; gonotyl small, unarmed, immediately to left of ventral sucker and overhanging genital pore; ventrogenital opening with sphincter. Testes 2, diagonal to almost symmetrical; seminal vesicle relatively thin-walled throughout, more or less distinctly bipartite. Ovary submedian or to right of midline anterior to testes; levels of ovary and anterior testis may overlap; seminal receptacle variable in position, between testes or on either side of, and dorsal to ovary. Vitelline follicles scattered among uterine coils posterior to testes, not arranged in rosettes. Excretory vesicle V- or Y-shaped with short arms. Eggs small, symmetrical, numerous. Type species, *Stictodora sawakinensis* Looss, 1899.

A species of *Stictodora* among our material apparently is the one Travassos (1928) described as *Acanthotrema acanthotrema*. Martin (1950b) suggested that the species belongs in the genus *Stictodora*, and Witenberg (1953) disposed of it in the same way. The following description is based on 18 ovigerous specimens, several of which were dead when removed from the host.

Stictodora acanthotrema (Travassos, 1928) Martin, 1950. (FIGURES 24 and 25)

Synonym:

Acanthotrema acanthotrema Travassos, 1928.

With the characters of the genus. Body flattened, linguiform, widest at level of testes, length 0.78 to 0.86, width 0.19 to 0.28. Eyespot pigment and numerous intercecal glands in forebody; cuticle spinose to level of testes. Oral sucker 0.048 to 0.060 long, 0.054 to 0.071 wide; pharynx 0.044 to 0.057 by 0.032 to 0.040; prepharynx about as long as pharynx, esophagus about one fourth of that length. Intestinal bifurcation at about midlevel of forebody; ceca terminate about one sixth length of body from posterior end; epithelial lining distinct. Ventrogenital sac slightly to left of median, pre-equatorial; ventral sucker oval to subspherical, its free portion with 3 evidently sclerotized pronglike structures 0.032 to 0.039 long and bearing

extremely minute denticles on tips and inner edges; the small gonotyl extends from left wall of sac, ventral to genital pore; ventrogenital opening slightly to left of midline. Testes entire, diagonal to almost symmetrical; left testis 0.047 to 0.090 in diameter, right testis 0.048 to 0.079 long, 0.056 to 0.111 wide. Ovary subspherical, anteromedian to left testis, 0.041 to 0.075 in diameter; seminal receptacle dorsal and to right of ovary. Seminal vesicle with 2 elongate, thin-walled divisions; pars prostatica short, wide, surrounded by well developed prostate gland cells; ejaculatory duct short, joining metraterm to form genital atrium opening at genital pore in posterodorsal wall of ventrogenital sac. Uterus intercecal or overlapping ceca and extending from near posterior end of body to level of pars prostatica. Excretory vesicle V-shaped, sphincter present, pore terminal. Eggs 0.019 to 0.021 by 0.009 to 0.011.

Host: *Thalasseus maximus maximus* (royal tern).

Site: intestine.

Localities: sand spit off Punta Arenas, Puerto Rico, and Brazil by Travassos (1928).

Deposited specimen: No. 38217.

Among our material was another species represented by only 2 individuals, neither of which was fixed well extended; both were crowded with eggs that obscured many internal organs. For that reason the specimens were sectioned after being studied as whole mounts. Below is a description of the species to the extent that its features could be determined from the material available.

Stictodora sp. (FIGURES 26 and 27)

Cuticle spinose to level of testes; eyespot pigment present. Body 0.78 long, 0.52 in maximum width anterior to midlevel. Oral sucker 0.15 by 0.18; esophagus appears to be very short in sectioned material; pharynx 0.071 by 0.66; ceca extend to level of testes. Excretory vesicle Y-shaped, with short arms reaching testes; pore terminal, sphincter present. Ventral sucker lobed, it and gonotyl apparently unarmed. Testes entire, side by side or nearly so, right testis 0.142 by 0.150, left testis 0.126 by 0.166. Seminal vesicle large, its shape not determined. Ovary entire, 0.071 by 0.107, median, ventral to testes and partly covered by them; vitellaria with large, irregular follicles among uterine coils in posterior one third of body. Seminal receptacle large, to right of ovary. Uterus voluminous, evidently extending from posterior end of body to intestinal bifurcation. Eggs small, symmetrical, very numerous, embryonated, 0.023 to 0.025 by 0.010 to 0.012.

Host: *Thalasseus maximus maximus* (royal tern).

Site: intestine.

Locality: sand spit off Punta Arenas, Puerto Rico.

Opisthometra planicollis (Rudolphi, 1819) Poche, 1926. (FIGURES 28 and 29)

Synonyms:

Distoma planicolle Rudolphi, 1819.

Anoicostoma planicolle Braun, 1901.

Lacerdaia lacerdai Travassos, 1931.

Description based on 21 specimens in good condition; with the characters of the genus. Body flattened, elongate pyriform to linguiform, 1.09 to 1.55 long, 0.38 to 0.53 in maximum width at level of posterior testis. Entire cuticle spinose, with spines gradually decreasing in size and number posteriorly. Oral sucker terminal, cup-shaped; mouth surrounded by a single circle of 26 to 36 blunt spines 0.030 to 0.036 long, 0.009 wide; circumoral area bearing spines may be expanded, disklike (FIGURE 29). Pharynx oval, 0.063 to 0.095 long, 0.055 to 0.071 wide; prepharynx about as long as pharynx; esophagus very short, ceca extend slightly posterior to testes. Ventral sucker within ventrogenital sac, unarmed, 0.076 to 0.087 long, 0.087 to 0.102 wide. Ventrogenital opening median, more distinct at anterior margin than elsewhere; fleshy, unarmed gonotyl projects into ventrogenital sac from its left anterior wall. Seminal vesicle large, its long axis transverse, situated between ovary and ventral sucker; slender, recurved duct leads from right end of seminal vesicle to well developed pars prostatica surrounded by conspicuous prostate cells; ejaculatory duct surrounded by gland cells distinct from prostate, joined by long metraterm near ventrogenital sac to form a short genital atrium. Ovary median or slightly to right, subspherical, 0.095 to 0.158 in diameter; vitellaria mostly extracecal, from level of ovary to that about midway between ventral sucker and intestinal bifurcation. Testes posterior to ovary, slightly diagonal, contiguous or overlapping; anterior testis 0.079 to 0.118 long, 0.158 to 0.189 wide, posterior testis 0.079 to 0.118 by 0.158 to 0.215. Seminal receptacle large, between ovary and anterior testis. Uterus voluminous, extending from posterior extremity to level of ventral sucker. Eggs numerous, 0.020 to 0.022 by 0.009 to 0.014. Excretory vesicle Y-shaped, with short arms partly embracing posterior testis, pore terminal, with sphincter; main excretory ducts reach level of pharynx.

Host: *Sula leucogaster leucogaster* (brown booby).

Site: intestine.

Locality: Lajas (Parguera), Puerto Rico.

Type host and locality: *Pelecanus sula* (= *Sula fusca*), Brazil, by Rudolphi (1819) and Travassos (1931).

Deposited specimen: No. 38218.

Braun (1901, 1902) redescribed Rudolphi's material and placed *Opisthometra planicollis* provisionally in the genus *Anoikistoma* Stossich, 1899, the type species of which has characters of the family Acanthostomidae. Poche (1926) and Travassos (1931) correctly placed *O. planicollis* in the Heterophyidae, although more recent workers have assigned it to the Acanthostomidae (= Acanthochasmidae) (Witenberg, 1929) and Cryptogonimidae (Price, 1940). Martin (1951) placed the species in the subfamily Centrocestinae of the Heterophyidae, and his view is probably correct. The acanthostomids and cryptogonimids are parasites of reptiles and fishes and have a very different excretory system from that of heterophyids.

Two species of minute heterophyids are here placed in the genus *Phocitreroides*, erected by Martin (1950c) for the single species *P. ovale*. Martin

gave details of the life history and excretory system but not of the terminal reproductive organs, which are extremely difficult to interpret in such small trematodes. Our material contributes to the following revised diagnosis of the genus and prompts a re-examination of its systematic position:

Genus *Phocitrema* Martin, 1950, char. emend.

Diagnosis: small pyriform to oval trematodes; cuticle with scalelike spines, the free edge of which may be serrated. Suckers well developed; oral sucker slightly larger than ventral sucker, without appendage or enlarged circumoral spines. Prepharynx very short, pharynx well developed, esophagus short; ceca narrow or expanded, extending to, or well within, posterior one fourth of body. Testis single, large, in posterior part of body; seminal vesicle bipartite, thin-walled throughout. Ovary either anterior to testis or overlapped by it dorsally. Laurer's canal present; seminal receptacle well developed, at level of ovary. Ventrogenital sac either with a shallow confluence between portion containing ventral sucker and that associated with genital pore or divided into an anterior genital pit and an inconspicuous posterior ventral pit; genital pit with thickened wall, ringlike in optical section of whole mounts; gonotyl lacking. Ejaculatory duct and metraterm unite to form a tubular genital atrium with pore opening to ventral surface, usually at left edge of genital pit, but *situs inversus* may occur. Vitellaria sparse, confined to hindbody and not reaching its posterior end. Uterus mostly intercecal, from posterior end of body to level of genital pore or intestinal bifurcation. Eggs symmetrical, operculate, few to moderate in number. Excretory vesicle U- or V-shaped with short arms; flame cell formula $2 [(2 + 2 + 2) + (2 + 2 + 2)] = 24$ for both cercaria and adult where known. Cercaria pleurolophocercous, metacercaria in fishes. Contains, in addition to the type species *Phocitrema ovale* Martin, 1950, the 2 new species whose descriptions follow:

Phocitrema butionis n. sp. (FIGURES 30 to 32)

Diagnosis based on 35 specimens with the characters of the genus. Body oval to slightly pyriform, 0.268 to 0.355 long, 0.142 to 0.185 wide. Cuticle armed with scalelike spines laterally, fading at level of ovary and absent on dorsal and ventral surfaces except at anterior end of body. Ventral sucker median, equatorial, subspherical, 0.035 to 0.045 in diameter, contained in shallow ventral pit with posterior border bearing 2 rows of narrow, pointed spines. Ventral pit and genital pit not confluent as in *P. ovale*. Oral sucker subspherical, 0.038 to 0.052 in diameter; prepharynx not over 0.008 long; pharynx oval, 0.020 to 0.022 long, 0.015 to 0.018 wide; esophagus 0.028 to 0.042 long; intestinal bifurcation about midway between suckers; ceca slender, terminating at about mid-level of testis. Excretory vesicle widely V-shaped, arms not reaching anterior margin of testis; excretory pore terminal. Testis within posterior one fourth of body, spherical to oval, 0.046 to 0.071 in diameter. Seminal vesicle extends well anterior to ventral sucker; prostatic cells few, surrounding genital pit with their ducts extending dorsally; ejaculatory duct joins metraterm to form thin-walled genital

atrium opening at genital pore immediately to left of, or perhaps confluent with opening of genital pit. Seminal receptacle overlapping either right or left side of ovary, which is anterior to testis and to either side of midline; diameter of ovary 0.025 to 0.042. Uterus extends from posterior extremity to intestinal bifurcation. Eggs fairly numerous, embryonated, 0.020 to 0.022 by 0.011 to 0.013, with minute antopercular knob.

Host: *Butorides virescens maculatus* (little green heron, *Marlinete*).

Site: intestine.

Locality: Cabo Rojo, Puerto Rico.

Type specimen: Holotype No. 38219.

Phocitrema floridae n. sp. (FIGURE 33)

Diagnosis based on 12 specimens with the characters of the genus. Pyriform 0.158 to 0.221 long, 0.050 to 0.094 wide at level of ovary. Cuticle spinose to that level with spines gradually diminishing in number and size. Ventral sucker median, equatorial or slightly posterior to midlevel, subspherical, 0.027 to 0.035 in diameter; ventral pit shallow, with posterior border bearing minute pointed spines. Ventral pit distinct from genital pit as in *P. butionis*. Oral sucker subspherical, 0.031 to 0.045 in diameter; prepharynx not evident or very short; pharynx oval, 0.017 to 0.021 long, 0.014 wide; esophagus not over 0.014 long; intestinal bifurcation about midway between suckers; ceca extend to posterior edge of ovary, expanded, and compressing ovary, testis, and seminal receptacle into narrow median region between excretory vesicle and ventral sucker. Excretory vesicle widely V- or U-shaped, excretory pore terminal. Testis about 0.028 long by 0.021 wide, median, in posterior one fourth of body, slightly posterior and dorsal to ovary, their zones overlapping. Shape and extent of seminal vesicle not determined. Ovary approximates testis in size with receptacle to its right. Uterus, largely median between levels of ventral sucker and ovary. Vitellaria dorsal to ceca, between ventral sucker and ovary. Eggs 0.021 by 0.012, no more than 12 in 1 worm.

Host: *Florida caerulea caerulea* (little blue heron).

Site: posterior intestine between ceca and cloaca.

Locality: Cabo Rojo, Puerto Rico.

Type specimen: Holotype No. 38220.

Yamaguti (1933) proposed the subfamily Phocitrematinae to contain "an aberrant opisthorchiid," *Phocitrema fusiforme*, but gave no characterization of the subfamily. In addition to *Phocitrema*, the genera *Witenbergia* and *Phocitremaoides* have been assigned to that group. Although Price (1932) included *Phocitrema* in the family Heterophyidae, he later (1940) placed it in the family Opisthorchiidae, but stated that *Phocitrema* apparently differs from the heterophyids only in lacking a gonotyl.

Whether the members of the Phocitrematinae should be placed in the family Heterophyidae or Opisthorchiidae is difficult to decide until life cycles of other members of this subfamily are determined along with precise information concerning their internal anatomy, especially the excretory system. We favor their inclusion in the family Heterophyidae, despite the

apparent lack of a gonotyl in the 2 species just described; indeed, there is a striking resemblance between the terminal genitalia of *P. butionis* as seen in sagittal section and that region in *Haplorchis (Monorchitrema) taihokui*, an accepted heterophyid, as described by Faust and Nishigori (1926). Martin (1950c) cites the common cercarial type of *P. ovale* and *Opisthorchis felineus* as support for placing the Phocitreminae in the family Opisthorchiidae. It should be pointed out, however, that pleurolophocercous cercariae occur in the Heterophyidae as well as in the Opisthorchiidae.

Gupta (1953) regarded *Phocitreminoides* and certain other genera as "a connecting link between Opisthorchiidae and Heterophyidae," but insofar as species of *Phocitreminoides* are concerned it seems as likely that they may be aberrant heterophyids, in at least some species of which the ventrogenital sac has become divided into 2 depressions along with the absence of a gonotyl. Indeed, *P. ovale*, as drawn by Martin (1950c), shows a confluence of the 2 and, were a gonotyl present, would be typically heterophyid in structure. The thickened wall of the genital sac in all species of *Phocitreminoides* is very similar to the wall of the ventrogenital sac in the galactosome group in which the gonotyl is a papillalike outgrowth from, and having the same structure as the wall. Those trematodes are very large as compared to species of *Phocitreminoides* but, even so, the gonotyl in some of them is so inconspicuous as to have been overlooked by some investigators; if those trematodes were reduced to the size of species of *Phocitreminoides* the gonotyl would be scarcely recognizable.

Martin (1950c) reported for *P. ovale* a cercaria that develops in the marine snail *Cerithidea californica* and closely resembles *Cercaria caribbea* XI Cable, 1956, from *Cerithidea costata* in Puerto Rico. Cable observed that snails from mangrove swamps frequented by herons were more often infected with *C. caribbea* XI than were those from more exposed habitats. That cercaria thus may be the larva of 1 of the 2 species of *Phocitreminoides* described above from herons.

Among the trematodes in the collection is a species that evidently is closely related to only one other that is known, namely, *Tetracladium sternaes*, which Kulachkova (1954) placed in the Heterophyidae, and Yamaguti (1958) assigned to a new subfamily. In our opinion the worms differ in respects that make their inclusion in that family doubtful. For that reason it is proposed that the subfamily Tetracladiinae Yamaguti, 1958, be elevated to family rank with the following characterization:

TETRACLADIIDAE N. FAM.

Synonym:

Diplotrematidae Connor, 1957.

Diagnosis: elongate distomes occurring as pairs *in copula*. Cuticle spinose, cercarial eyespot pigment present. Oral sucker subterminal, it and pharynx well developed; ventral sucker reduced; prepharynx and esophagus short; ceca extend to posterior end of body and prolonged anteriorly to form a pair of diverticula flanking pharynx. Testes 2, either preovarian and in tandem or slightly oblique, or with ovary between them; cirrus sac absent,

seminal receptacle present. Genital pore in an invagination ("genital sucker") adjacent to ventral sucker and here termed a genital sac, as it does not contain the sucker. Vitellaria confined to posterior third of body. Uterus voluminous, filling most of hindbody except near posterior end; eggs numerous, rather small, operculate. Excretory vesicle sac-shaped. Intestinal parasites of marine shore birds. Includes the type genus *Tetracladium*, and *Opisthovarium* n. g.

Opisthovarium n. g.

Synonym:

Diplorema Connor, 1957 (preoccupied)

Diagnosis: with the characters of the family Tetracladiidae. Ventral sucker without lumen, bearing a broad, hooklike process used in copulation; genital sac with thickened, overhanging lip which may be a gonotyl. Testes well anterior to ovary, which is a considerable distance from posterior end of body. Seminal receptacle posterolateral to ovary; oötype and Mehlis' gland posterior to ovary. Seminal vesicle bipartite, pars prostatica well developed; male and female ducts unite near ventral sucker to form a tubular, thin-walled genital atrium opening at pore within genital sac. Uterus extends posterior to ovary and then anteriorly in transverse loops overlapping ceca. Eggs thick-shelled. Type and only species:

Opisthovarium elongatum n. sp. (FIGURES 34 to 38)

Synonym:

Diplorema hematophaga Connor, 1957 (nom. nudum)

Diagnosis based on 6 specimens studied alive, then as whole mounts (2 pairs *in copula*) and in serial sections (2 separated individuals) with the characters of the genus. Body broadly rounded anteriorly, posterior end more pointed, 3.70 to 6.57 long, 0.48 to 0.64 in maximum width at pharyngeal level. Oral sucker 0.301 to 0.321 long, 0.287 to 0.294 wide, mouth ventral, elongated; prepharynx much wider than esophagus, about as long as pharynx, which measures 0.198 to 0.219 long, 0.164 to 0.171 wide; esophagus narrow, about as long as pharynx in extended specimens; cecal pouches barely reach level of prepharynx. Ceca usually red in life due to content of host's blood, lined with conspicuous cells and with fine processes on free surface. Ventral sucker pyriform in lateral aspect, 0.095 to 0.110 long, 0.079 to 0.087 wide and with copulatory process 0.047 to 0.055 wide. Excretory pore slightly subterminal dorsally, sphincter present. Testes entire, tandem or slightly oblique, at about midlevel of hindbody, 0.080 to 0.110 long, 0.126 to 0.150 wide. Ovary median, at beginning of posterior fifth of body length, subspherical, 0.181 to 0.202 in diameter. Vitellaria with follicles in rosettes, confined to posttesticular region and extending to posterior end of body. Uterus extends posteriorly from ovary about halfway to end of body and then anteriorly in transverse loops which gradually increase in amplitude and overlap ceca. Eggs uniform in size, measuring 0.027 by 0.017.

Hosts: *Sula leucogaster leucogaster* (brown booby). *Thalasseus maximus maximus* (royal tern).

Site: Intestine.

Localities: Lajas (Parguera) and sand spit off Punta Arenas, Puerto Rico.

Type specimen: Holotype No. 38221 (whole mount of pair *in copula*).

The form of the intestine in combination with rather small eggs, the peculiar modifications used in copulation, and restriction of the vitellaria to the posterior region of the body distinguish the Tetracладиidae from all other families of digenetic trematodes. The intestine is remindful of the Campulidae and Pleorchiidae, but in other respects the family is more like the subfamily Galactosomatinae of the Heterophyidae. Resemblances include general body form, shape of the excretory vesicle, the highly modified ventral sucker, the form of the vitellaria, and common hosts. Furthermore, it is evident that the cercaria of *O. elongatum* is ocellate, as are opisthorchioid larvae. *Cercaria caribbea* XVI differs sufficiently from other magnacercous opisthorchioid larvae described by Cable (1956) to suggest that it may be the cercaria of *O. elongatum*.

The genus *Opisthovarium* is distinguished from *Tetracladium* by the position of the ovary well posterior to the testes and by the uterus extending into the postovarian space. Copulation is not well described in *T. sternaе*, but in *O. elongatum* each worm of the pair hooks the process of the ventral sucker beneath the lip of its partner's genital sac, thus bringing the genital pores into close apposition. Specimens of *O. elongatum* were united so securely that pairs did not separate when strongly flattened and studied for some time alive or when subsequently removed from the slide and fixed.

FAMILY MICROPHALLIDAE TRAVASSOS, 1921

The family Microphallidae is represented by 11 species collected in Puerto Rico, 9 from avian hosts, and 2 from marine fishes. Collectively, they illustrate and extend the range of known modifications of copulatory structures that are peculiar to the group and are not equaled in diversity by any other family of digenetic trematodes. The family Microphallidae was proposed by Travassos (1921) to include species that had been grouped as a subfamily in the Heterophyidae. Witenberg (1929) likewise excluded them from the Heterophyidae on the basis of adult morphology, and since that time his view has been abundantly substantiated by the demonstration of a number of microphallid life cycles that are uniformly and fundamentally different from those of the heterophyids. As the cercaria typically is xiphidiocercous and encysts in arthropods, principally crustaceans, the microphallids are now generally regarded as a distinct family of the superfamily Plagiorchioidea. With the exception of *Maritrema obstipum*, known microphallid cercariae are monostomatous, development of the ventral sucker being delayed until the metacercarial stage, perhaps in adaptation to modifications of the copulatory apparatus adjacent to that sucker. In known life-cycles metacercariae develop to the point that the worms may become fully ovigerous after only a short time in the definitive host, which is usually a bird. This fact probably accounts for the apparent lack of host specificity for certain microphallids at least, and it may be that many of them can develop to full maturity in a variety of definitive hosts before being elimi-

nated from their intestine, as observed by Rausch (1947) for *Microphallus opacus*. However, none of the species found in shore birds in Puerto Rico was recovered from a great variety of fishes, nor were the 2 species that occurred in fishes ever found in avian hosts.

Cable and Kuns (1951) reviewed the family, postulated phylogenetic lines among its genera, and rejected Baer's (1943) proposal separating as a distinct family the Maritremitidae, those microphallids having a cirrus sac from species lacking that structure. Their opinion has been supported by Etges (1953) and by Stunkard (1951).

In most microphallids, principally those lacking a cirrus sac, there is a fleshy structure that may bear a strong superficial resemblance to the gonotyl of the heterophyids. That structure has been variously termed a male copulatory organ, penis, cirrus, and male papilla. The first and last terms are preferable because they do not imply homologies that may not exist. The male papilla is pierced by the sperm duct and protrudes into a more-or-less spacious genital atrium into which the metraterm opens separately. This arrangement is fundamentally different from that in the Heterophyidae as described above. Other differences between adult microphallids and heterophyids include the absence in most microphallids of a true seminal receptacle, which is so prominent and uniformly present in the opisthorchioids. Several investigators have reported small spherical or bilobed seminal receptacles in certain microphallids, and such structures are present in several species described below. In several of them, however, and perhaps all of them, what has been called a seminal receptacle is a small chamber interposed in the path of the oviduct, whereas a true seminal receptacle is a blind sac with its own duct, often part of Laurer's Canal, joining the oviduct. Consequently it seems evident that what has been described as a seminal receptacle for several microphallids is actually a fertilization chamber in which sperms are present and are first encountered by the oocyte as it passes down the oviduct. This interpretation is supported by the fact that some microphallids have a barely perceptible enlargement of the oviduct in place of a well-defined fertilization chamber.

There has been much disagreement as to the separation of genera among microphallids possessing a cirrus sac because of uncertainty as to whether it has a protrusible cirrus or terminates with a more-or-less fixed male papilla in the various species. Furthermore, opinion varies as to the significance of the location and form of the vitellaria. Thus Etges (1953) reduced the genus *Pseudospelotrema* to synonymy with *Maritrema*, which has a male papilla and vitelline follicles in the form of a ring or horseshoe in the hind-body, because Yamaguti (1939) was not explicit in respect to the presence or absence of a protrusible cirrus in erecting the genus *Pseudospelotrema* and because Etges observed the form of the vitellaria to be extremely variable in *Maritrema obstipum*. As to the first point, there is no question that the 2 species here assigned to *Pseudospelotrema* are congeneric with those which Yamaguti (1939) placed in that genus and a large, protruding cirrus was seen in *P. nyctanassae*. Furthermore, Hunter and Vernberg (1953a) reported a cirrus for *P. ammospizae*. Secondly, in the hundreds of

microphallids examined in this study, such variation in the form of the vitellaria as Etges observed in *M. obstepum* did not occur.

To receive those microphallids which do possess a cirrus sac and a protrusible cirrus, Etges (1953) restored the genus *Maritreminoides* Rankin, which had been suppressed as a synonym of *Pseudospelotrema*. From existing descriptions and the present study it is concluded that both *Pseudospelotrema* and *Maritreminoides* should be recognized as distinct genera because the microphallid species that have been assigned to them fall into 2 seemingly natural groups. One, for which the generic name *Maritreminoides* is retained, closely resembles *Maritrema*, has the genital pore close to the ventral sucker, vitelline follicles in the form of an inverted U or closed circle, and a small spherical fertilization chamber. The other, here considered to belong to the genus *Pseudospelotrema*, has the genital pore at a distance from the ventral sucker, a cluster of vitelline follicles on each side, narrow vitelline ducts into which the follicles do not extend, and a saclike fertilization chamber.

Pseudospelotrema charadrii n. sp. (FIGURE 39)

Diagnosis based on 4 specimens, in fair condition, with the characters of the genus. Body linguiform, 0.72 to 0.86 long, 0.21 to 0.27 in maximum width. Cuticle spinose to level of testes. Ventral sucker median, nearly equatorial, spherical, 0.066 to 0.087 in diameter. Oral sucker subspherical, 0.047 to 0.063 long, 0.063 to 0.071 wide; prepharynx slightly longer than pharynx; pharynx oval, 0.039 by 0.030; esophagus 3 to 4 times as long as pharynx; ceca extend to anterior margin of cirrus sac. Testes lateral, symmetrical, approximately midway between intestinal bifurcation and posterior end of body, oval with long axes converging anteriorly; testes 0.063 to 0.071 long, 0.047 to 0.071 wide. Cirrus sac prominent, arcuate, situated transversely anterior to ventral sucker; seminal vesicle occupies basal half of cirrus sac, remainder filled with prostate and what appears to be a protrusible cirrus devoid of spines; genital atrium and pore well to left of ventral sucker. Ovary to right of ventral sucker, rounded, 0.047 to 0.063 in diameter; thin-walled, sperm-filled, saclike fertilization chamber, possibly a true seminal receptacle, between ovary and ventral sucker; uterus occupies entire hindbody posterior to testes and extends anteriorly between testes and vitellaria to posterior margin of ventral sucker; metraterm rather straight, moderately thick-walled, and entering genital atrium dorsally. Excretory bladder V-shaped, its extent not determined. Vitellaria lateral, from midlevel of ventral sucker to that of testes, composed of 9 or 10 large follicles on each side, ventral to and partly overlapping gonads. Eggs numerous, thickshelled, 0.014 by 0.009.

Host: *Charadrius wilsonia wilsonia* (Wilson's plover).

Site: Intestine.

Locality: Cabo Rojo, Puerto Rico.

Type specimen: Holotype No. 38222.

Of the species here considered to belong in the genus *Pseudospelotrema*, *P. charadrii* differs from *P. japonicum*, *P. uriae*, and *P. cincli* in being

significantly smaller in the size of the body, gonads, and eggs, and is much nearer *P. ammospizae* in those respects. However, in *P. charadrii* the body is more slender, the prepharynx is much longer, and the suckers are smaller than in *P. ammospizae*, while the fertilization chamber is situated between the ovary and ventral sucker rather than posterior to the ovary.

Pseudospelotrema nyctanassae n. sp. (FIGURE 40)

Diagnosis based on 14 mature specimens with the characters of the genus. Body broadly oval, with somewhat pointed posterior end, 0.56 to 0.81 long, 0.31 to 0.44 wide. Cuticle spinose to mid-level of hindbody. Ventral sucker median, somewhat pre-equatorial, subspherical, 0.088 to 0.113 by 0.101 to 0.118. Oral sucker 0.071 to 0.087 by 0.082 to 0.102; prepharynx very short but evident in well-extended specimens; pharynx spherical, 0.032 to 0.039 in diameter. Ceca long for a microphallid, extending halfway between ventral sucker and posterior end of body. Excretory vesicle dorsal in position, described in notes on living specimens as being a narrow tube extending to level of ovary, obscured by eggs in whole mounts; excretory pore terminal. Ovary entire, to right of seminal vesicle, subspherical to triangular in shape, 0.055 to 0.079 by 0.071 to 0.087. Fertilization chamber as in preceding species. Uterus nearly fills hindbody posterior to ventral sucker; metraterm simple, to left of sucker, entering genital atrium dorsally. Vitellaria extend posterolaterally from mid-level of ventral sucker to posterior margin of testes, composed of 10 to 14 large follicles on each side. Testes symmetrical, subspherical, 0.063 to 0.103 in diameter. Cirrus sac prominent, strongly recurved, with end containing seminal vesicle directly posterior to ventral sucker; remainder of cirrus sac filled with prostate and gonoduct terminating in a long, protrusible, unspined cirrus; seminal vesicle 0.103 to 0.126 long, 0.032 to 0.047 wide. Genital atrium and pore to left of ventral sucker, about halfway to edge of body. Eggs numerous, 0.021 to 0.023 by 0.011 to 0.013.

Host: *Nyctanassa violacea violacea*, (yellow-crowned night heron).

Site: small intestine.

Locality: Mona Island, Puerto Rico.

Type specimen: Holotype No. 38223.

The strongly curved cirrus sac immediately distinguishes *P. nyctanassae* from all species of *Pseudospelotrema* except *P. cincli*, which, however, is much the larger of the two, and has shorter ceca, smaller eggs, and a less strongly curved cirrus sac, with the seminal vesicle not extending posterior to the ventral sucker.

Far less certain than the distinction between *Pseudospelotrema* and *Maritreminoides* is the matter of separating the genera *Maritrema* and *Maritreminoides*. The only difference between them, if any, is the presence of a protrusible cirrus in *Maritreminoides*, replaced by a small male papilla in *Maritrema*. That a long, spiny cirrus occurs in some species is beyond doubt, but it is by no means certain that what has been termed a male papilla in others may not actually be a cirrus. Because many descriptions are vague on that point, the genus *Maritreminoides* should be retained for

species in which a protrusible cirrus is known to be present, and the genus *Maritrema* for those reported to possess a male papilla instead of a cirrus. Should it eventually be determined that a definite distinction between a cirrus and a male papilla does not exist in these forms, that is, that a more-or-less protrusible cirrus is present in all of them, *Maritreminoides* will then disappear as a synonym of *Maritrema*.

The genus *Maritreminoides*, as thus restricted, is represented in the Puerto Rican material by a single species:

Maritreminoides patulum (Coil, 1955) n. comb. (FIGURE 41)

Synonym:

Maritrema patulus Coil, 1955.

Description based on 204 specimens with the characters of the genus. Body shape broadly oval to pyriform with the posterior end sometimes truncate and usually indented at the excretory pore; length 0.238 to 0.401, width 0.267 to 0.342. Cuticle entirely spinose. Ventral sucker about equatorial, 0.038 to 0.055 in diameter. Oral sucker 0.028 to 0.039 long, 0.039 to 0.047 wide; mouth subterminal; prepharynx about as long as pharynx; pharynx oval, 0.024 to 0.030 long, 0.019 to 0.025 wide; esophagus as long as or longer than pharynx in extended specimens. Ceca end at about level of anterior margin of ventral sucker. Testes 0.039 to 0.063 in diameter, obscured by eggs and usually more nearly spherical than shown in FIGURE 41. Cirrus sac between intestinal crura and ventral sucker, large, arcuate, and not attenuated distally; seminal vesicle 0.082 to 0.125 long, 0.032 to 0.051 wide; prostate granular, massive, and largely anterior to the sperm duct which consists of an indistinct pars prostatica, an ejaculatory duct, and a broad spinose cirrus, often seen protruded across opening of ventral sucker. Genital atrium an inconspicuous cleft very close to ventral sucker; genital pore narrow, slitlike, and directed toward ventral sucker. Ovary somewhat to right of mid-line, slightly posterior to and overlapping ventral sucker, irregular to lobed in outline, diagonally or transversely elongate, 0.071 to 0.107 by 0.047 to 0.071. Fertilization chamber median, between testes, spherical, wall relatively thick and nucleated, 0.016 to 0.028 in diameter. Uterus voluminous, extending from near posterior extremity of body to intestinal bifurcation, often with a transverse loop between cirrus sac and ceca. Metraterum simple, entering left side of genital atrium very close to genital pore. Vitelline follicles and reservoir form an inverted U in hindbody. Excretory vesicle broadly V-shaped; excretory pore at posterior indentation of body. Eggs numerous, 0.017 to 0.020 by 0.011 to 0.013.

Hosts: *Charadrius wilsonia wilsonia*, (Wilson's plover) and an unidentified sandpiper.

Site: intestine.

Locality: Cabo Rojo and Punta Arenas, Puerto Rico.

Type host and locality: *Tringa solitaria*, Oaxaca, Mexico, by Coil (1955).

Deposited specimen: No. 38224.

In placing *Maritreminoides patulum* in the genus *Maritrema*, Coil (1955)

did not observe the protrusible cirrus in the two specimens that he had. Another microphallid, represented by 81 specimens, is identified as the species he described as *Maritrema glandulosa*. The fact that he had but one immature and perhaps excessively flattened specimen makes it desirable to redescribe the species from the abundant material at hand. Before doing so, however, it is necessary to consider the generic status of the species. We do not agree with Coil in allocating the species to the genus *Maritrema*. It possesses not only an oral sucker with a structure reported for no other microphallid but also a very long, protrusible cirrus evidently without spines, and vitellaria in the form of a closed ring invariably in the fore- rather than hindbody as in *Maritrema*. Collectively, these features warrant the erection of a new genus characterized as follows:

Mecynophallus n. g.

Diagnosis: Microphallidae. Modified oral sucker with peculiar musculature. Cirrus sac present, cirrus protrusible, aspinose. Genital pore at left of ventral sucker. Fertilization chamber present. Vitellaria with follicles in a ring in forebody, surrounding ovary, cirrus sac, and ventral sucker and joining vitelline reservoir posteriorly. Uterus in both fore- and hindbody, crossing anterior to cirrus sac. Excretory vesicle V-shaped. Intestinal parasites of shore birds. Type and only species:

Mecynophallus glandulosus (Coil, 1955) n. comb. (FIGURES 42 and 43)

Synonym:

Maritrema glandulosa Coil, 1955.

With the characters of the genus. Body oval, small, 0.274 to 0.363 long, 0.164 to 0.198 wide. Entire cuticle spinose. Ventral sucker equatorial, weakly muscular, 0.038 to 0.056 in diameter. Oral sucker 0.041 to 0.060 by 0.043 to 0.063, rounded posteriorly, contour elsewhere variable, depending on contraction of characteristic longitudinal and horizontal muscle bands but often with a pair of lateral shoulderlike expansions and a broad, papillalike anterior prolongation. Mouth ventral; prepharynx shorter than pharynx; pharynx 0.025 to 0.028 long, 0.017 to 0.021 wide; esophagus longer than prepharynx in well-extended specimens; ceca terminate at about level of anterior margin of ventral sucker. Testes symmetrical at midlevel of hindbody, 0.028 to 0.049 by 0.042 to 0.056. Cirrus sac between intestinal crura and ventral sucker, arcuate, long, basal portion contains seminal vesicle, 0.063 to 0.098 long, 0.021 to 0.028 wide, followed by prostate and sperm duct consisting of an indistinct pars prostatica, ejaculatory duct, and long, thick aspinose cirrus that was observed inserted into metraterm of the same individual in several specimens and extending from genital pore in others, for a distance of 0.084 (to the posterior edge of the left testis) in one specimen. Several rings of muscle fibers encircle cirrus sac. Genital atrium small, near left margin of ventral sucker; genital pore narrow, slitlike and median to genital atrium. Ovary to right of midline, at level of, and usually slightly overlapping, ventral sucker, irregular in outline, 0.046 to 0.056 by 0.056 to 0.077. Fertilization chamber to left of vitelline reservoir, relatively thick-

walled and nucleated, 0.014 to 0.018 in diameter. Uterus in both fore- and hindbody, a loop crossing forebody with the ring of vitelline follicles; metraterm relatively narrow and thick walled, extending anterolaterally dorsal to ventral sucker to enter genital atrium on left. Vitellaria as in generic diagnosis. Excretory vesicle V-shaped, wall with distinct nuclei; excretory pore terminal. Eggs few to moderate in number, 0.024 to 0.027 by 0.014 to 0.015.

Hosts: *Charadrius wilsonia wilsonia* (Wilson's plover). *Squatarola squatarola cynosurae* (black-bellied plover).

Site: intestine.

Locality: Cabo Rojo, Puerto Rico.

Type host and locality: *Florida caerulea caerulea* (little blue heron), Oaxaca, Mexico, Coil (1955).

Deposited specimen: No. 38225.

In the microphallids that lack a cirrus sac, the cirrus is replaced by a male papilla, a copulatory organ that occupies most of the genital atrium and is very diverse in size and form. In most other respects, they are remarkably uniform. Excluding the genus *Levinseniella*, which is discussed later, there remain many species that differ in the size and/or structure of the male papilla, the form of the metraterm and the point at which it joins the genital atrium. To express those differences and group species according to them, various genera have been proposed, among them *Carneophallus* to include species in which the male papilla has 2 or more fleshy lobes, 1 of which is pierced by the male duct. Belopolskaia (1954), however, reduced that genus to synonymy with *Spelotrema*, apparently unaware that Baer (1943) had considered *Spelotrema* to be a synonym of *Microphallus*. Capron *et al.* (1957) combined those views in transferring species of *Carneophallus* to the genus *Microphallus*. They described 2 additional species, *M. chabaudi* and *M. tringae*, the latter from a single specimen and not convincingly distinct from *M. chabaudi*. In both species the male papilla has a large lobe pierced by the male duct and a smaller accessory lobe. In a subsequent paper (Biguet *et al.*, 1958), they described 2 dissimilar forms as species of *Microphallus*. One, *M. canchei*, certainly is congeneric with the next species described below, and the other, *M. debuni*, has a cup-shaped male papilla with marginal ornamentation much as in the genus *Megalophallus* proposed still further below, especially a species to be described in a subsequent monograph on trematodes of marine fishes. In *M. debuni*, however, the genital atrium is described as surrounded by glandular cells, whereas in *Megalophallus* there is a conspicuous and complexly formed metraterm that may overlap the genital atrium. Its true nature was not determined until many specimens, including living ones, were studied. Unless such a metraterm was misinterpreted as the glandular covering of the genital atrium in *M. debuni*, the generic status of that species is uncertain; in our judgment the form of the male papilla and that covering exclude it from the genus *Microphallus*.

The systematic significance of such modifications of the male copulatory organ and metraterm in microphallids is largely a matter of opinion and

probably will remain so until more life histories are known. Although microphallid cercariae are very small and much alike, there are differences such as those that made it possible for one of us (Cable, 1956) to arrange 7 Puerto Rican species in key groups that may correspond to genera of adults. To judge from the diversity of species that Biguet *et al.* (1958) assign to *Microphallus*, they would include in that genus also the species of *Megalophallus* to be described later. However, the life history of the species found in fish was determined, and it was found that its cercaria differed in 2 respects from that larval stage in the 2 known life histories of species of *Microphallus* with simple male papillae: first, the stylet lacked a shaft, instead tapering from the base toward the point and, second, 2 pairs of cephalic glands were well anterior to the others. It thus seems to us that those investigators would assign to *Microphallus* a heterogeneous assortment of species whose subdivision into smaller and more homogeneous groups, that is, genera, may well be substantiated by further life-history studies. Toward that end we propose that the genus *Carneophallus* be recognized for species in which the male papilla is lobed with the male duct piercing one lobe and the metraterm is not modified. As thus restated, the genus includes, in addition to species previously assigned to it, *Carneophallus chabaudi* (Capron *et al.*, 1957) n. comb., *Carneophallus tringae* (Capron *et al.*, 1957) n. comb., *Carneophallus canchei* (Biguet *et al.*, 1958) n. comb., and the following new species, which is represented by 20 specimens in our collection:

Carneophallus bilobatus n. sp. (FIGURE 44)

Specific diagnosis: with the characters of the genus. Body small, pyriform, 0.256 to 0.263 long, 0.171 to 0.253 in maximum width at level of testes. Cuticle spinose to posterior margin of testes. Ventral sucker postequaretorial, 0.032 to 0.047 in diameter. Oral sucker terminal, 0.035 to 0.046 in diameter; prepharynx about 0.011 long, pharynx subspherical, 0.021 to 0.025 by 0.018 to 0.023; esophagus about 3 times length of pharynx; ceca extend to level of ovary but not to ventral sucker. Testes transversely oval, symmetrical, in posterior third of body, 0.024 to 0.035 by 0.039 to 0.060. Seminal vesicle oval to subspherical, its long axis oblique or sometimes parallel to that of body; pars prostatica well developed, surrounded by prostate glands. Male papilla bilobed at a distance from base, dorsal lobe shorter than ventral and pierced by ejaculatory duct; ventral lobe bulbous, sometimes protruding from genital pore; lobes without ornamentation. Genital atrium at left of ventral sucker, its shape conforming with that of male papilla; genital pore oval to slitlike, close to left edge of ventral sucker. Ovary on right, transversely oval, 0.024 to 0.035 by 0.037 to 0.056; spherical fertilization chamber present. Uterus with coils from posterior end of body to ceca but not crossing forebody; metraterm enters genital atrium posterodorsally. Vitellaria consist of a group of follicles on each side, posterior to testes but not reaching posterior end of body. Excretory vesicle broadly V-shaped, excretory pore terminal or subterminal ventrally. Eggs 0.014 to 0.017 by 0.008 to 0.010.

Host: an unidentified sandpiper.

Site: intestine.

Locality: Punta Arenas, Puerto Rico.

Type specimen: Holotype No. 38226.

Of the species of *Carneophallus*, *C. bilobatus* is readily differentiated from all except *C. canchei* by the form of the male papilla which seems to be identical in the 2 species. They may be distinguished, however, by the great difference in their body size, dimensions of suckers and pharynx, length of prepharynx, and size of eggs. Although Biguet *et al.* (1958) give the male papilla in *C. canchei* as simple in their key and conical and asymmetrical in their table of species, they describe and show it (page 407) as having 2 muscular swellings with the ventral the larger, as in *C. bilobatus*. We have reexamined our specimens and found without exception that there is a definite though shallow cleft separating the distal lobes or swellings, and that it is not due to the location of the male opening or to the state of contraction of the papilla.

Megalophallus n. g.

Diagnosis: Microphallidae. Ventral sucker single, genital pore to left. Cirrus sac absent, pars prostatica well developed; prostate cells adjacent to or surrounding ceca. Male papilla large, basically cuplike with sperm duct opening at its bottom; margin either entire and with a circle of small papillae or incised to form fleshy lobes with papillae at tips. Testes as in other microphallids; ovary anterior to right testis. Fertilization chamber represented by a barely perceptible enlargement of oviduct. Uterus mostly in hindbody, may extend somewhat anterior to ventral sucker on each side but not crossing forebody. Metraterm distinctively enlarged and complicated in structure so that it is as conspicuous as the male papilla; it joins genital atrium close to genital pore. Vitellaria a group of follicles on each side posterior to or partly overlapping testes. Excretory vesicle V-shaped, pore terminal. Type species: *Megalophallus pentadactylus* n. sp.

The genus *Megalophallus* differs from *Carneophallus*, which it resembles more than any other, in that the male duct opens into the lumen of the expanded male papilla at its base and, if the papilla is lobed, the duct does not pierce one of the lobes as in *Carneophallus*. Other differences are the complex metraterm, the greatly developed prostate gland and the absence of a distinct fertilization chamber in *Megalophallus*.

Megalophallus pentadactylus n. sp. (FIGURE 45)

Diagnosis based on 10 specimens with the characters of the genus. Body pyriform, 0.356 to 0.465 long, 0.205 to 0.294 wide. Cuticle spinose from anterior end to beginning of hindbody. Ventral sucker postequatorial, 0.046 to 0.057 in diameter. Oral sucker 0.028 to 0.042 in diameter; prepharynx nearly twice as long as pharynx; pharynx oval, 0.017 to 0.021 long, 0.014 to 0.017 wide; esophagus usually longer than prepharynx. Ceca narrow, widespread, obscured by prostate gland. Testes irregular in outline; right testis directly posterior to and in contact with ovary, 0.029 to 0.046

by 0.060 to 0.091; left testis, 0.032 to 0.038 by 0.056 to 0.112, compressed anterolaterally by large metraterm. Seminal vesicle to right, directly anterior to ovary, with narrow, convoluted sperm duct leaving its distal end and entering the expanded pars prostatica; massive prostate gland surrounding intestinal crura; a few deeply staining gland cells, distinct from those of prostate, at junction of pars prostatica and male papilla. Male papilla greatly enlarged, at left of ventral sucker, 0.049 to 0.070 by 0.049 to 0.063, with 5 fleshy lobes, each bearing a small terminal papilla with 2 minute, hooklike spines. Ovary to right of ventral sucker, between and contiguous with seminal vesicle and right testis, irregular or oval in outline, 0.032 to 0.053 by 0.070 to 0.091. Uterus in hindbody, posterior to ovary, not extensive. Metraterm conspicuous, pouchlike, to left of ventral sucker between male papilla and left testis; wall of metraterm thick and complex, the whole a folded mass in whole mounts and measuring 0.098 to 0.0115 long and 0.035 to 0.042 wide. Genital atrium almost filled by male papilla; genital pore near left edge of ventral sucker. Vitellaria in 2 groups of follicles posterior to and overlapping testes ventrally; vitelline ducts usually distinct, at level of testes. Excretory vesicle V-shaped; excretory pore terminal. Eggs malformed, 0.014 to 0.018 by 0.008 to 0.014.

Host: *Tringa solitaria solitaria* (solitary sandpiper).

Site: intestine.

Locality: Cabo Rojo, Puerto Rico.

Type specimen: Holotype No. 38227.

That the sandpiper may not be the natural host of *M. pentadactylus* is suggested by the malformed eggs. The natural host may be a fish, as a second species of *Megalophallus* with an abundance of normal eggs was found in fish (unpublished data).

Another microphallid species, represented by 21 specimens, has been identified as *Microphallus claviformis*, a species that has been reported from a variety of avian hosts including *Calidris alpina*, *Charadrius hiaticula*, *Anthus obscurus*, *Numenius arquata*, *Molacilla flava*, and *Larus ridibundus* from Germany, France, England, and Sweden. Following is a description of the species based on our material:

Microphallus claviformis (Brandes, 1888) Baer, 1943 (FIGURE 46)

Synonyms:

Distomum claviforme Brandes, 1888.

Lecithodendrium claviforme Stossich, 1899.

Levinsenia claviforme Looss, 1899.

Spelotrema claviforme Nicoll, 1907.

With the characters of the genus. Body very small, pyriform, 0.212 to 0.260 long, 0.150 to 0.205 wide. Cuticle spinose to posttesticular level. Ventral sucker slightly postequatorial, subspherical, 0.025 to 0.042 in diameter. Oral sucker 0.025 to 0.042 in diameter; prepharynx short, pharynx oval, 0.017 to 0.020 by 0.012 to 0.017; esophagus more than twice as long as pharynx. Intestinal crura with expanded ends reaching level of ventral sucker. Testes at midlevel of hindbody, symmetrical, transversely oval,

0.022 to 0.039 by 0.042 to 0.063. Seminal vesicle anterodorsal to, and overlapping ventral sucker; distal end of sperm duct surrounded by small prostate. Male papilla directly to left of ventral sucker, 0.011 to 0.014 in diameter; genital pore circular or oval. Ovary to right of midline, dorsal to, and partly overlapping ventral sucker. Uterus not voluminous, confined to hindbody. Vitellaria posterolateral to testes. Eggs relatively few, 0.021 to 0.023 by 0.010 to 0.011.

Hosts: *Squatarola squatarola cynosurae* (black-bellied plover).

Charadrius wilsonia wilsonia (Wilson's plover).

Charadrius hiaticula semipalmatus (semipalmated plover).

An unidentified sandpiper.

Site: intestine.

Localities: Cabo Rojo and Punta Arenas, Puerto Rico.

Seventeen specimens in the collection are identified as *Levinseniella leptophallus*. However, they evidently differ from that species as described by Coil (1956b) in certain respects, including egg size, the structure of the male copulatory organ, and the relative size of that structure and the ventral sucker as determined from Coil's figure; their dimensions were not given. The following description is based on our material.

Levinseniella leptophallus Coil, 1956 (FIGURE 47)

Synonym:

L. caribbea Connor, 1957 *nom. nud.*

With the characters of the genus. Body length 0.684 to 0.909, width at testicular level 0.287 to 0.424. Forebody elongated, hindbody short and broadly rounded posteriorly; cuticle spinose almost to posterior end. Ventral sucker spherical, 0.058 to 0.079 in diameter. Oral sucker 0.079 to 0.102 in diameter; prepharynx shorter than pharynx; pharynx 0.047 to 0.050 long, 0.038 to 0.041 wide; esophagus long and slender; intestinal bifurcation about midway between suckers; ceca terminate at level near posterior margin of ventral sucker. Testes near ends of ceca, 0.047 to 0.090 long, 0.063 to 0.102 wide; seminal vesicle anterior to, and to right of ventral sucker, its left end joined by prominent, thick-walled pars prostatica surrounded by a dense mass of prostatic cells. Male copulatory organ (usually termed the genital atrium; see discussion below) as large or larger than ventral sucker, attaining a size of 0.079 by 0.086 in slightly flattened specimens; its interior folded, with a total of 4 thimblelike pockets without ribs or hooks; ejaculatory duct enters one pocket, the depth of which evidently depends on contraction of the copulatory organ. Genital pore at left edge of ventral sucker, without evident sphincter. Ovary between right testis and ventral sucker, transversely elongate, tapering toward oviduct, and measuring 0.047 to 0.071 by 0.055 to 0.095. Oviduct extends posteriorly a short distance from median end of ovary, enters spherical fertilization chamber dorsally and leaves ventrally. Vitellaria a scanty cluster of follicles on each side posterior to, and partly overlapping testes. Uterus with coils scattered through hindbody, not overlapping ceca laterally; with terminal limb extending anteriorly, following median contour of female pouch and

entering it anteriorly; pouch conspicuous, between and overlapping ventral sucker and male copulatory organ, a narrow passage connecting its lumen with that of the male organ. Eggs 0.024 to 0.025 by 0.011 to 0.013.

Host: *Charadrius wilsonia wilsonia*, Wilson's plover.

Site: ceca.

Locality: Cabo Rojo, Puerto Rico.

Deposited specimen: No. 38228.

Type host and locality: *Crocethia alba*, Oaxaca, Mexico, by Coil (1956b).

Of the species of *Levinseniella* having a male copulatory organ nearly as large as or larger than the ventral sucker, *L. leptophallus* differs from *L. brachysoma*, *L. propinqua*, and *L. pellucida* by lacking ribs or hooks in the pockets of that organ. In that respect, *L. leptophallus* is similar to *L. cruzi*, *L. carcinides*, and *L. amnicolae*, but *L. cruzi* is a smaller species with a male copulatory organ much smaller than the ventral sucker and, *L. amnicolae* evidently lacks a female pouch. In *L. carcinidis* the ceca barely reach the level of the ventral sucker, the ovary is larger than in *L. leptophallus* and the female pouch apparently much less conspicuous, while the genital pore is surrounded by a weakly developed sucker.

As a rule, descriptions are not precise as to the relationship of the ejaculatory duct to the male copulatory organ in species of *Levinseniella*. In several individuals of *L. leptophallus*, the ejaculatory duct was clearly seen to enter 1 of the 4 pockets whereas Coil (1956b) figured the species as having none of the pockets closely associated with that duct; a similar arrangement was shown for *L. carcinidis* by Rankin (1939). One of our specimens shows but 3 pockets and the sperm duct emptying directly into the cavity of the copulatory organ, but none has at that point the protruding cirruslike structure that Etges (1953) described for *L. amnicolae*.

The peculiar male copulatory organ in the genus *Levinseniella* has been interpreted as the highly modified wall of the genital atrium. The question may be raised as to whether it may not instead be homologous with the male papilla of other genera. In opening into one of the similar pockets of the copulatory organ in *L. leptophallus*, the male duct has essentially the same relationship to that organ that it does to the highly modified male papilla of certain other microphallids. The genera *Carneophallus* and especially *Megalophallus* suggest such an interpretation. It could not be determined with certainty in our specimens of *L. leptophallus* whether the copulatory organ is firmly embedded in the parenchyma. A distinct limiting membrane is present and, in some instances a narrow space was seen between it and the parenchyma at points other than that traversed by the gonoduct, but this may have been an artifact due to shrinkage. Even so, it is conceivable that a male papilla, such as that in *Megalophallus* and free except at its base, could either fuse with the wall of the genital atrium or become retracted into the parenchyma and modified to form a copulatory organ of the type occurring in *Levinseniella*.

As a matter of fact, there are several points of resemblance between *Megalophallus* and *Levinseniella* that suggest a close relationship of the 2 genera. For example, the complex metraterm in *Megalophallus* seems certain

to be homologous with the so-called female pouch in most species of *Levinseniella*, the chief difference between those structures being their position (compare FIGURES 45 and 47). Furthermore, such a modification of the metraterm does not occur in other microphallid genera.

The remaining microphallid in the collection has been tentatively identified as *Gynaecotyla adunca* and is represented by 2 nonovigerous specimens. Both trematodes are fully developed, except that eggs are lacking, and are in close agreement with existing accounts of that species. By giving a brief description based on the 2 specimens, this report will include species exemplifying almost the complete range of structural diversity among genera of the family Microphallidae.

Gynaecotyla adunca (Linton, 1905) Yamaguti, 1939 (FIGURE 48)

Synonyms:

Distomum aduncum Linton, 1905.

Levinseniella adunca Linton, 1928.

Cornucopula sippiwissettensis Rankin, 1939.

Cornucopula adunca Rankin, 1939.

Cornucopula nassicola (Cable and Hunninen, 1938) Rankin, 1939.

Gynaecotyla nassicola Yamaguti, 1939.

With the characters of the genus. Body pyriform, 0.44 to 0.48 long, 0.28 wide; cuticle spinose to level of testes. Oral sucker 0.042 to 0.045 in diameter; prepharynx 0.021 long; pharynx oval, 0.028 to 0.032 long by 0.021 to 0.028 wide; esophagus 0.056 to 0.059 long, ceca reach anterior margin of testes. Diameter of right ventral sucker 0.039 to 0.049, of left 0.042 to 0.053. Testes transversely oval, 0.046 to 0.055 by 0.056 to 0.080, situated at beginning of posterior third of body length. Cirrus sac strongly arched, placed transversely anterior to ventral suckers; seminal vesicle apparently empty, cirrus sac occupied largely by prostatic cells; complex copulatory apparatus and genital pore to right of ventral suckers as in other members of the genus; conspicuous muscles extend from genital atrium to basal portion of cirrus sac. Ovary anterior to left testis, pyriform to almost triangular in shape, 0.044 to 0.046 by 0.046 to 0.053; oviduct with a very slightly expanded fertilization chamber; Laurer's canal not observed but probably present; vitellaria a cluster of follicles posterior to each testis; metraterm not modified, extending as an almost straight tube across the body anterior to ventral suckers to enter median side of genital atrium. Excretory vesicle arborescent, wall with numerous, distinct nuclei.

Host: *Florida caerulea caerulea*, (little blue heron).

Site: intestine.

Locality: Boquerón, Puerto Rico.

Other hosts: see Hunter (1952).

Rankin (1940) and Hunter and Vernberg (1953b) gave conflicting accounts of the life cycle of this species, but in a personal communication Hunter has stated that Rankin's observations have been substantiated by further studies. The life cycle thus is typical of the microphallids in general. The cercaria has a stylet of distinctive size and shape, remindful of *Cercaria*

caribbea XXV. However, that larva is sufficiently different from the cercaria of *G. adunca* to indicate that its adult is another species of *Gynaecotyla* or even a species of another genus.

We do not agree with Etges (1953) in reducing *Gynaecotyla* to synonymy with *Microphalloides*, although these 2 genera are unique among microphallids in having the genital pore on the right instead of the left and certain other features that suggest that their species may be sufficiently removed from other microphallids to be placed in a distinct subfamily. From the rather complete descriptions of *Microphalloides japonicus* given by Yoshida (1938) and Miyazaki and Nisimura (1943), it is evident that the copulatory apparatus in *Microphalloides* is quite unlike that of *Gynaecotyla*. Also, the position of the vitellaria is very different in those genera and we have not found in any species reported here the extreme variation that Etges observed in the vitellaria of *Maritrema obstipum*.

FAMILY FELLODISTOMATIDAE NICOLL, 1935

The fellodistomatid trematodes of birds all belong in the subfamily Gymnophallinae that was first assigned to the Heterophyidae and then to the Microphallidae until Cable (1953) placed the group in the Fellodistomatidae. The subfamily is represented here by a single species with the following description taken from his paper, which gives details of the life history and figures of the various stages.

Parvatrema borinqueña Cable, 1953

With characters of the genus. Minute distome with thick, pyriform body broadly rounded anteriorly, more pointed posteriorly, 0.190 to 0.195 long, 0.114 to 0.129 in maximum width well anterior to ventral sucker; entire body with spines in quinunxial pattern. Oral sucker 0.050 to 0.060 long, 0.066 to 0.088 wide, subterminal, with a pair of lateral papillae noticeable only in living specimens. Ventral sucker 0.022 to 0.025 long, 0.026 to 0.030 wide; its anterior margin 0.090 to 0.110 from anterior end of body. Prepharynx absent; pharynx 0.015 long, 0.022 wide; esophagus about as long as pharynx; ceca short, widespread, terminating well anterior to ventral sucker, with thick, sparsely nucleated walls. Testes symmetrical, slightly posterior to ventral sucker, 0.033 to 0.043 long, 0.020 to 0.030 wide; seminal vesicle apparently without constriction although such may be obscured by prostate cells. Genital pore about midway between suckers, wide and pitlike. Ovary 0.038 to 0.048 long, 0.021 to 0.028 wide, anterior to right testis. Vitellaria poorly developed, consisting of an undivided mass of follicles posterodorsal to ventral sucker or displaced to right or left of sucker. Uterus extensive, with loops filling most of hindbody and extending anteriorly to testes, farther on left. Eggs thin-shelled, delicate, 0.014 to 0.016 by 0.006 to 0.008. Excretory vesicle Y-shaped with short stem and long arms reaching oral sucker; flame-cell formula probably $2[(2+2)+(2)]=12$ as in metacercaria. Cercaria minute, furcocercous, developing in the marine bivalve *Gemma purpurea*; metacercaria unencysted, in snail, *Cerithidea costata*.

Host (experimental): *Gallus gallus* (chicken); natural host probably a duck.

Site: intestine.

Locality (larval stages): mud flat at head of Sucia Bay, Cabo Rojo, Puerto Rico.

Type specimen: Holotype No. 47875.

ALPHABETICAL HOST LIST*

<i>Actitis macularia</i> Linnaeus (spotted sandpiper) (1)	<i>Squatarola squatarola cynosurae</i> Thayer and Bangs (black-bellied plover) (1)
<i>Paramonostomum actitidis</i>	<i>Mecynophallus glandulosus</i>
<i>Bulorides virescens maculatus</i> Boddaert (little green heron) (1)	<i>Microphallus claviformis</i>
<i>Phocitremonides butionis</i>	<i>Parorchis holotestis</i>
<i>Charadrius hiaticula semipalmatus</i> Bonaparte (semipalmated plover) (1)	<i>Sterna albifrons antillarum</i> Lesson (least tern) (1)
<i>Microphallus claviformis</i>	<i>Galactosomum puffini</i>
<i>Paramonostomum actitidis</i>	<i>Sula leucogaster leucogaster</i> Boddaert (brown booby) (1)
<i>Charadrius wilsonia wilsonia</i> Ord (Wilson's plover) (5)	<i>Galactosomoides johnsoni</i>
<i>Acanthoparyphium pagollae</i>	<i>Galactosomum cochleariforme</i>
<i>Levinseniella leptophallus</i>	<i>Galactosomum puffini</i>
<i>Maritreminoides patulum</i>	<i>Mesostephanus appendiculatooides</i>
<i>Mecynophallus glandulosus</i>	<i>Mesostephanus fajardensis</i>
<i>Microphallus claviformis</i>	<i>Opisthometra planicollis</i>
<i>Paramonostomum actitidis</i>	<i>Opisthovarium elongatum</i>
<i>Parorchis holotestis</i>	<i>Thalasseus maximus maximus</i> Boddaert (royal tern) (1)
<i>Pseudospelotrema charadrii</i>	<i>Cardiocephalus megaloconus</i>
<i>Florida caerulea caerulea</i> Linnaeus (little blue heron) (5)	<i>Galactosomoides johnsoni</i>
<i>Apharyngostrigea cornu</i>	<i>Galactosomum cochlear</i>
<i>Gynaecotyla adunca</i>	<i>Galactosomum puffini</i>
<i>Micropharyphium floridae</i>	<i>Opisthovarium elongatum</i>
<i>Phocitremonoides floridae</i>	<i>Retevitellus spinetus</i>
<i>Ribeiroia ondatrae</i>	<i>Stictodora acanthotrema</i>
<i>Gallus gallus</i> Linnaeus (chicken—experimental host)	<i>Stictodora</i> sp.
<i>Parvatrema borinquense</i>	<i>Tringa solitaria solitaria</i> Wilson (solitary sandpiper) (2)
<i>Nyctanassa violacea violacea</i> Linnaeus (yellow-crowned night heron) (1)	<i>Megalophallus pentadactylus</i>
<i>Pseudospelotrema nyctanassa</i>	Unidentified sandpiper (1)
	<i>Carneophallus bilobatus</i>
	<i>Microphallus claviformis</i>

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* Number of specimens examined is in parentheses after each host name.

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KEY TO LETTERING ON PLATES

CIR	cirrus	OV	ovary
CS	cirrus sac	PEJ	papilla of ejaculatory duct in genital atrium
ED	esophageal diverticulum	PG	proteolytic gland
EJD	ejaculatory duct	PHA	pharynx
ESO	esophagus	PPH	prepharynx
ESP	eyespot pigment	PPR	pars prostatica
ESV	external seminal vesicle	PRG	prostate gland
EV	excretory vesicle	PVG	pouch of ventrogenital sac
FEC	fertilization chamber	PVS	process of ventral sucker
FPO	female pouch	SE	seminal reservoir
GAT	genital atrium	SR	seminal receptacle
GC	genital cone	SV	seminal vesicle
GON	gonotyl	TE	testis(es)
GPO	genital pore	TO	tribocytic organ
INC	intestinal cecum	UT	uterus
GPT	genital pit	VA	vaginal sphincter
LA	lamellae	VGO	ventrogenital opening
MCO	male copulatory organ	VGS	ventrogenital sac
MET	metraterm	VIT	vitellaria
MG	Mehlis' gland	VPT	ventral pit
MPA	male papilla	VR	vitelline reservoir
OOT	oötype	VS	ventral sucker
OS	oral sucker		

PLATE I

- FIGURE 1. *Cardiocephalus megaloconus*, holotype.
- FIGURE 2. *Apharyngostrigea cornu*.
- FIGURE 3. *Mesostephanus fajardensis* ventral view.
- FIGURE 4. *Parorchis hololestis*, holotype in ventral view.

CABLE ET AL.: DIGENETIC TREMATODES OF SHORE BIRDS

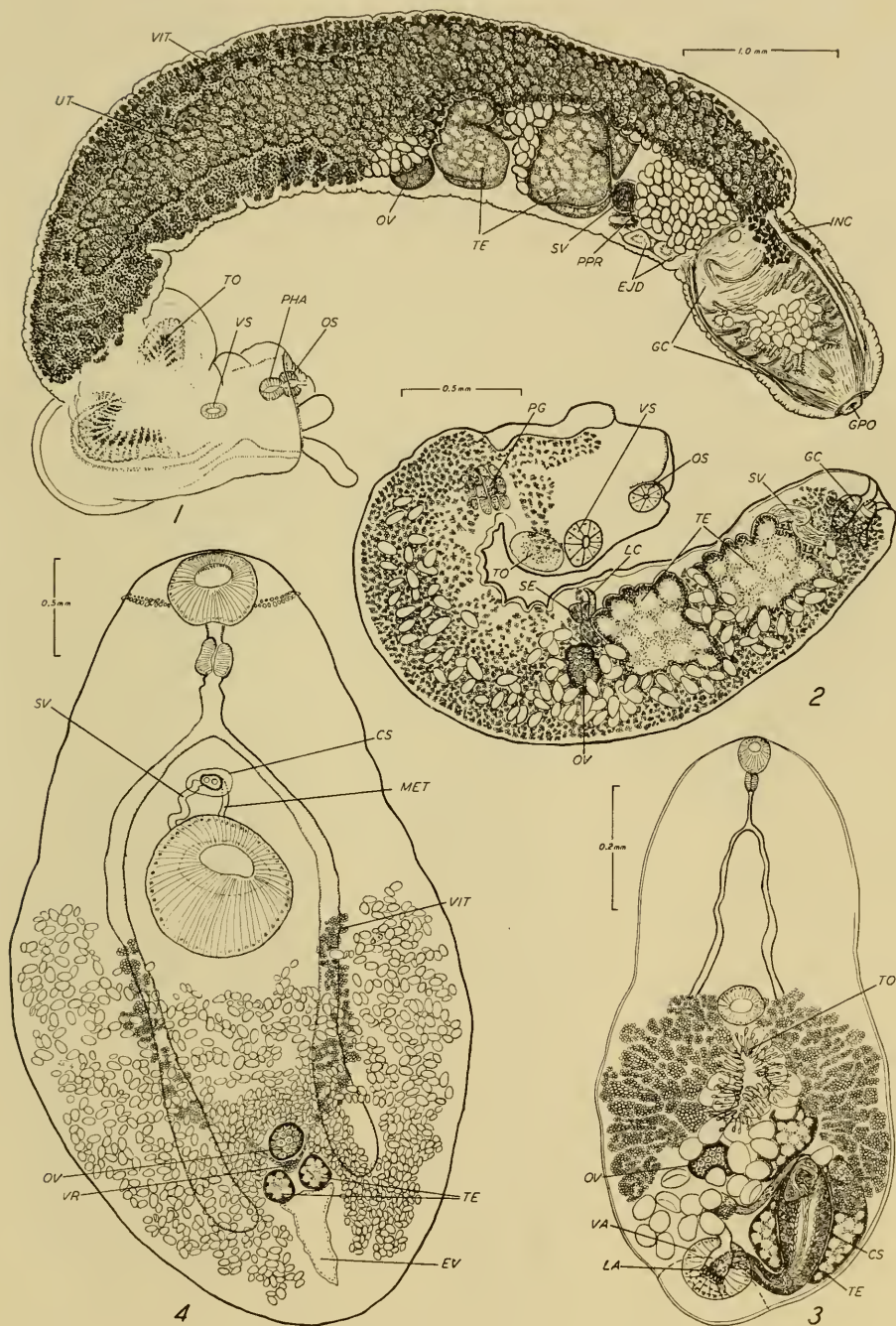


PLATE II

- FIGURE 5. *Mesostephanus appendiculatoides*, ventral view.
FIGURE 6. *Paramonostomum acutididis*, holotype in ventral view.
FIGURE 7. *Ribeiroia ondatrae*, ventral view.
FIGURE 8. *Acanthoparyphium pagollae*, holotype in ventral view.
FIGURE 9. Same as FIGURE 8; anterior end enlarged.
FIGURE 10. *Microparyphium floridae*, holotype in ventral view.

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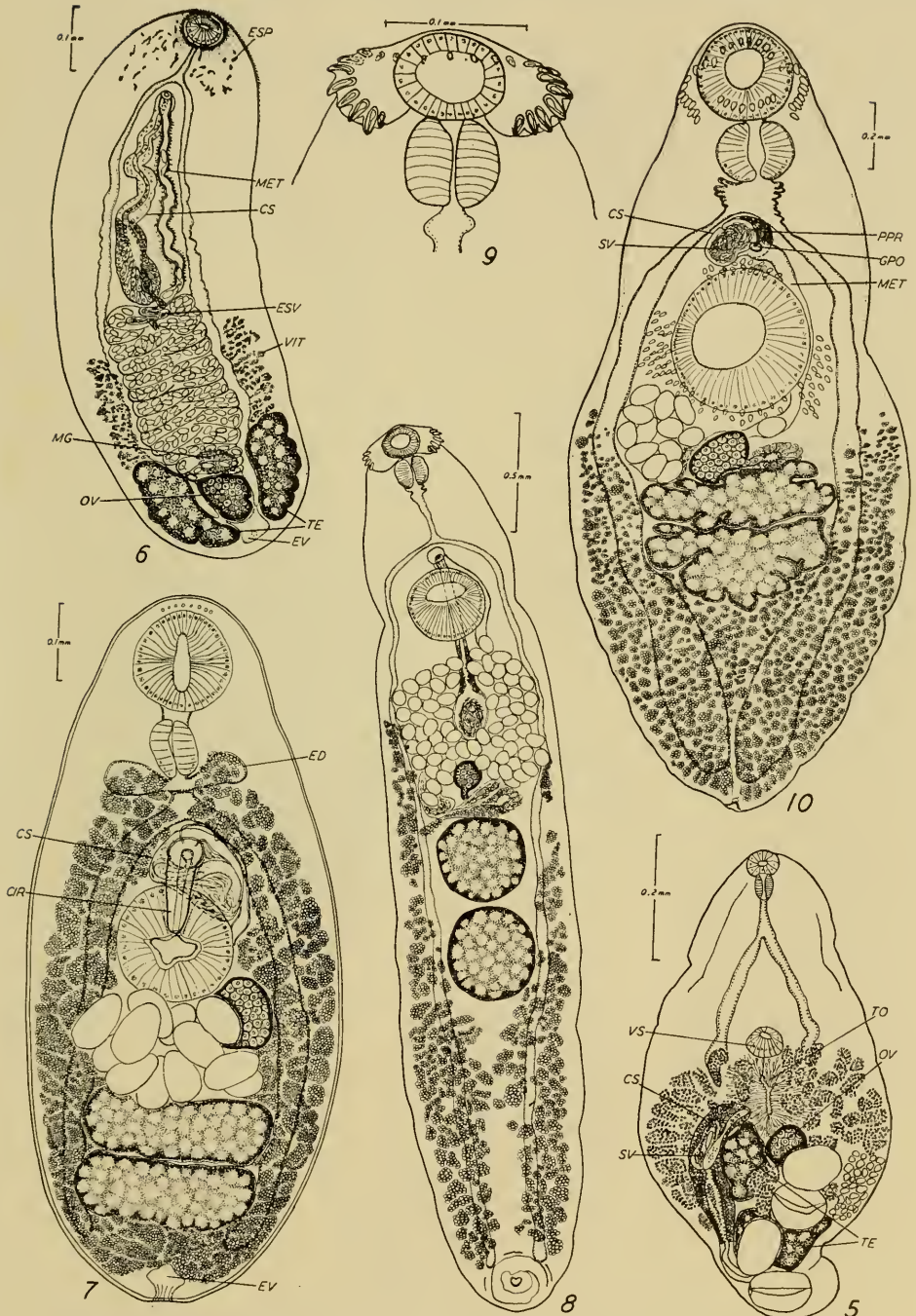


PLATE III

FIGURE 11. *Galactosomum cochleariforme*, ventral view.

FIGURES 12 TO 15. Same as FIGURE 11; consecutive sections through region of ventrogenital sac.

FIGURE 16. *Galactosomum cochlear*, ventral view.

FIGURE 17. Same, region of ventrogenital sac enlarged.

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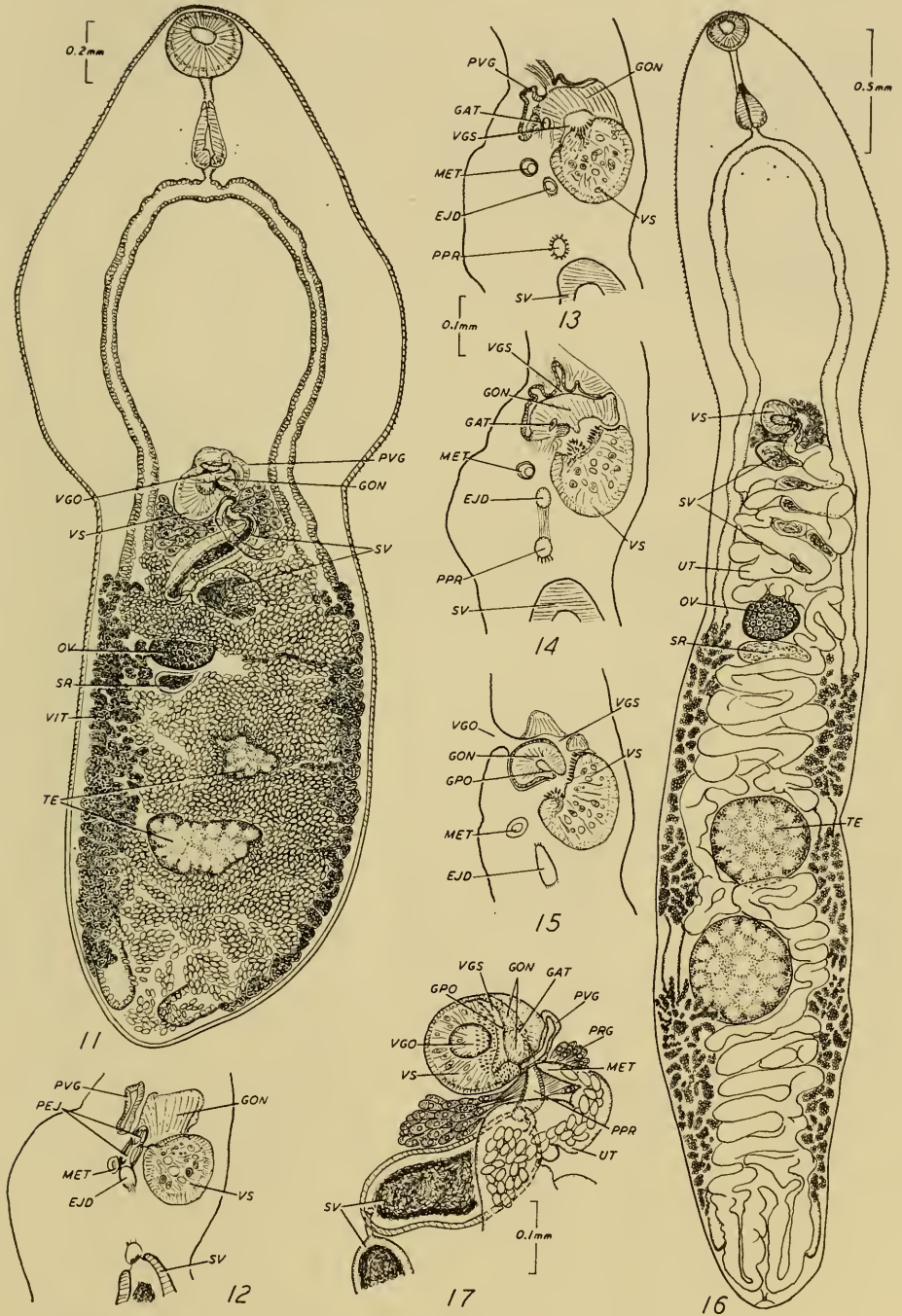


PLATE IV

- FIGURE 18. *Galactosomum puffini*, ventral view.
FIGURE 19. *Galactosomoides johnsoni*, ventral view.
FIGURE 20. Same, region of ventrogenital sac enlarged.

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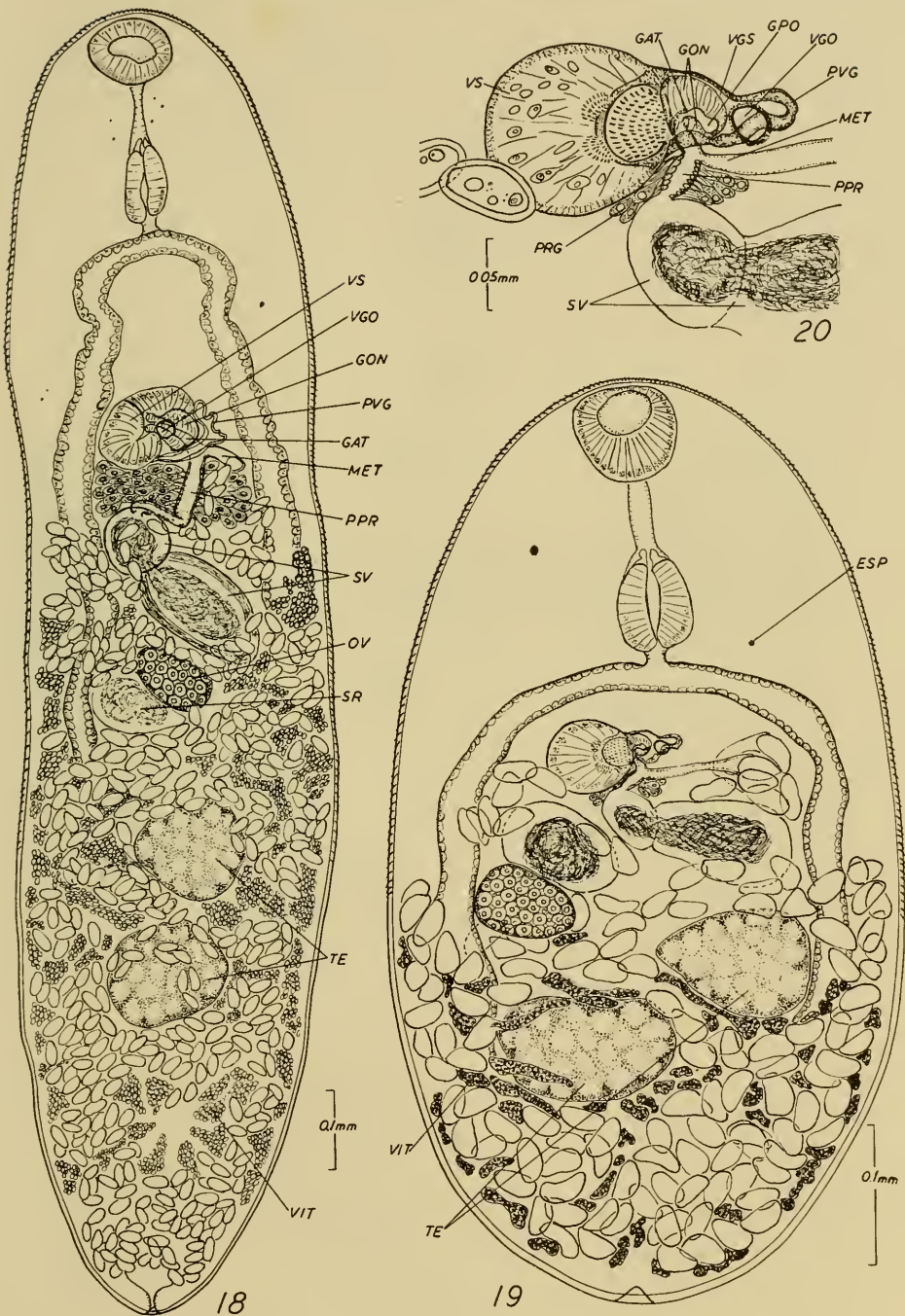


PLATE V

- FIGURE 21. *Retevitellus spinetus*, ventral view.
FIGURE 22. Same, region of ventrogenital sac enlarged.
FIGURE 23. Same, consecutive sections (*a*, *b*, and *c*) through region of ventrogenital sac.
FIGURE 24. *Stictodora acanthotrema*, ventral view.
FIGURE 25. Same as FIGURE 24; region of ventrogenital sac enlarged.

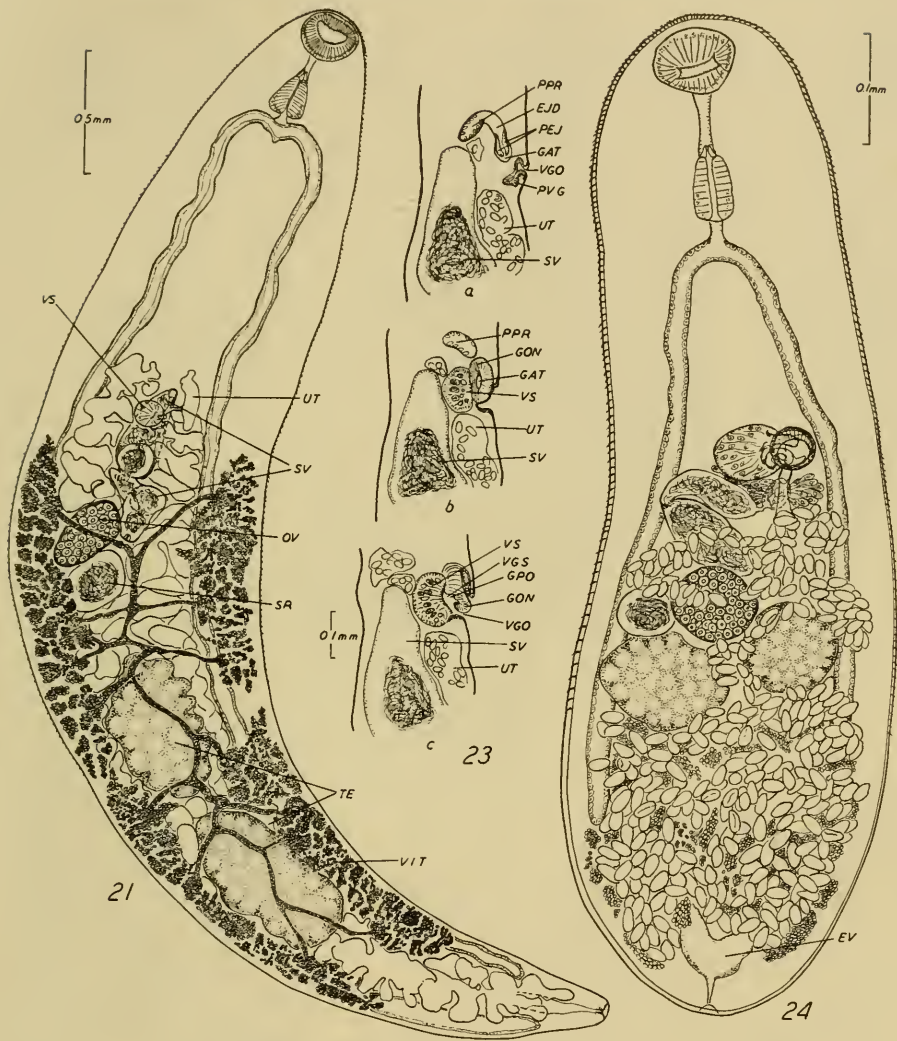


PLATE VI

FIGURE 26. *Stictodora* sp.

FIGURE 27. Same as FIGURE 26; consecutive sections (*a*, *b*, and *c*) through region of ventrogenital sac.

FIGURE 28. *Opisthometra planicollis*, ventral view.

FIGURE 29. Same, anterior end of specimen with oral sucker expanded.

FIGURE 30. *Phocitremoides butionis*, holotype, ventral view.

FIGURE 31. Same as FIGURE 30; region of ventral sucker in another specimen.

FIGURE 32. Same as FIGURES 30 and 31; sagittal section.

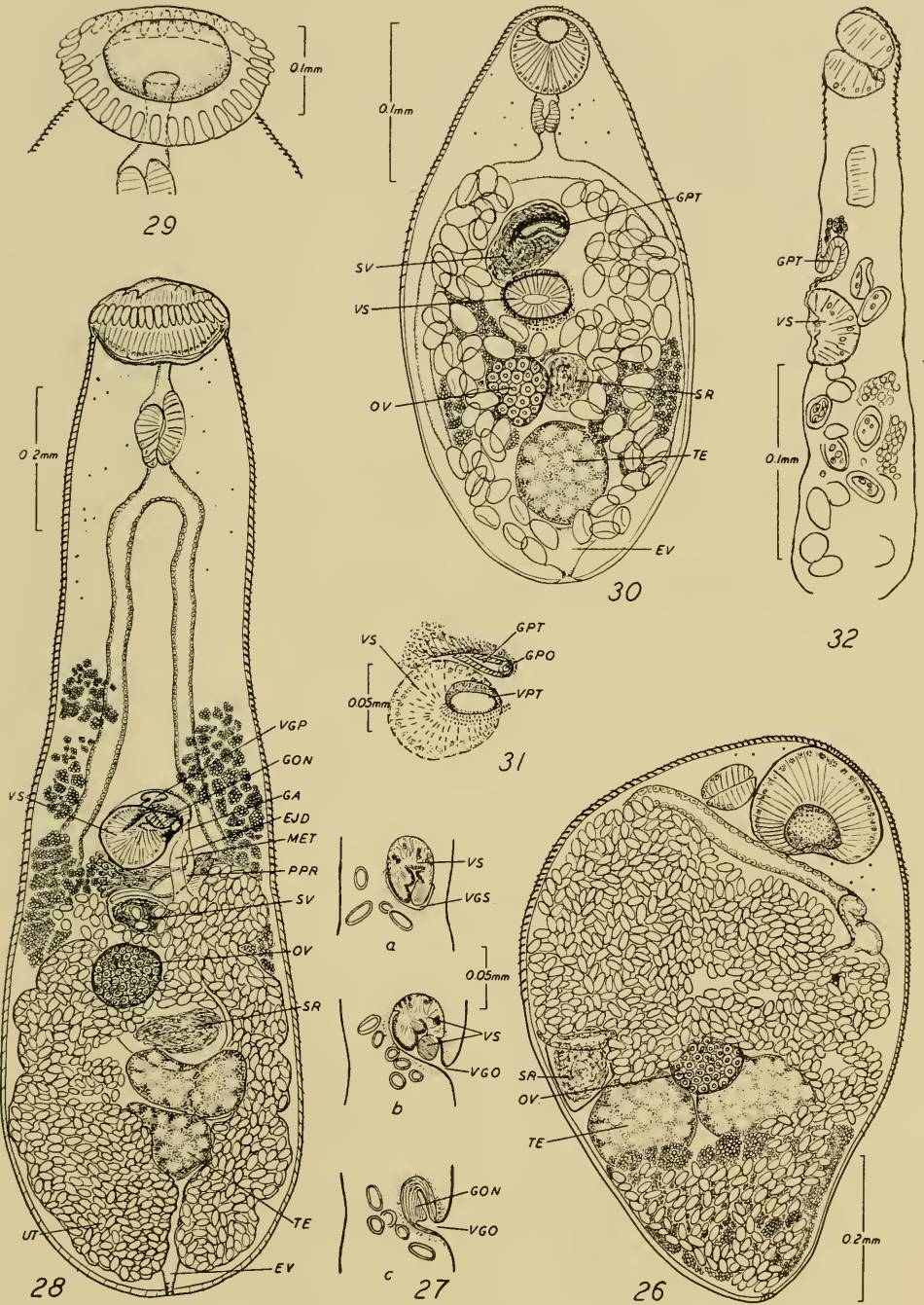


PLATE VII

FIGURE 33. *Phocitremaoides floridæ*, holotype in ventral view.

FIGURE 34. *Opisthovarium elongatum*, copulating pair, holotype on left.

FIGURE 35. Same as FIGURE 34; section through region of ventral sucker.

FIGURE 36. Same as FIGURES 34 and 35; region of copulatory organs in FIGURE 34 enlarged.

FIGURE 37. Same as FIGURES 34, 35, and 36; portion of one of a copulating pair separated after fixation, showing process of partner's ventral sucker hooked beneath gonotyl (?). Its own corresponding process has been broken off.

FIGURE 38. Same as FIGURES 34 to 37; section through wall of intestine.

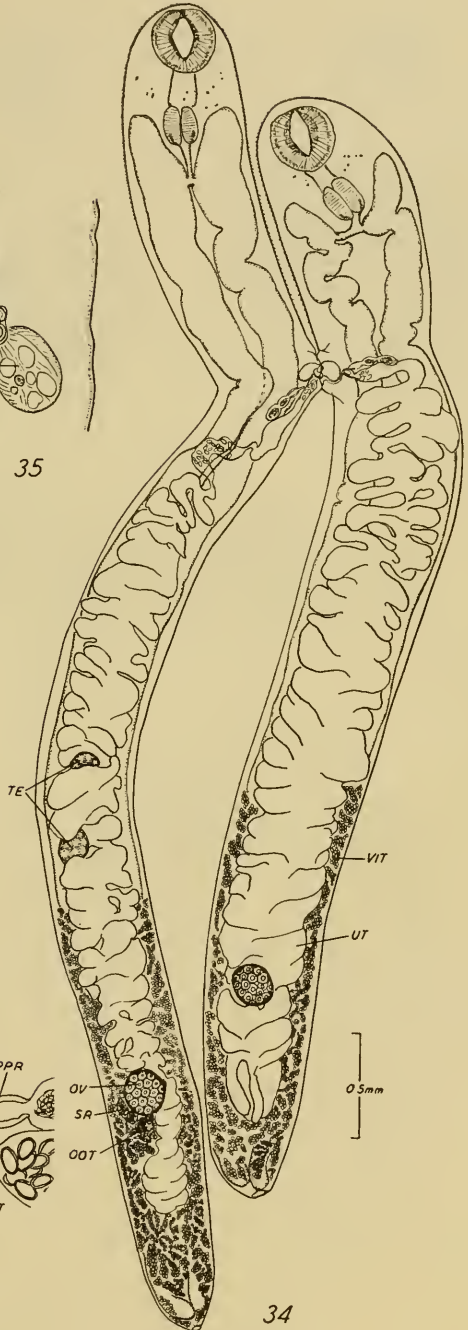
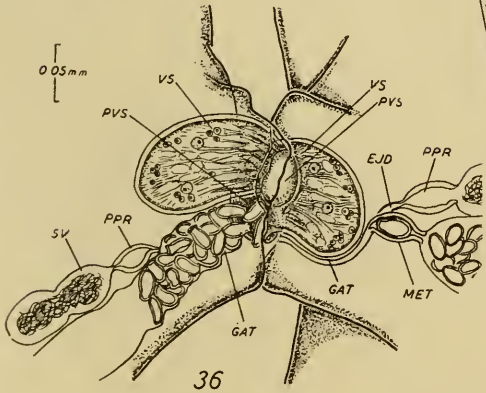
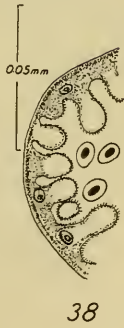
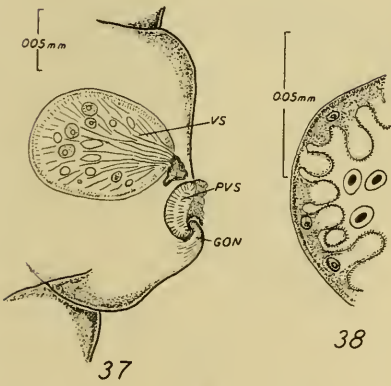
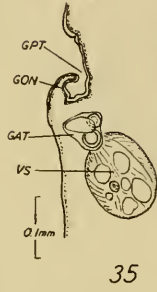
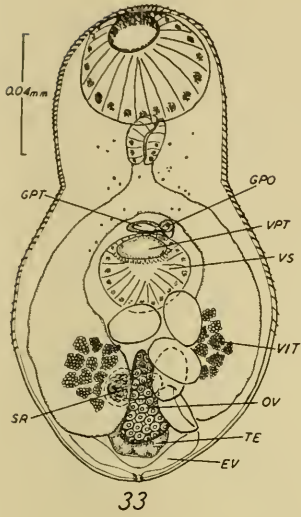


PLATE VIII

- FIGURE 39. *Pseudospelotrema charadrii*, holotype, ventral view.
FIGURE 40. *Pseudospelotrema nyctanassae*, holotype, ventral view.
FIGURE 41. *Maritreminoides patulum*, ventral view.
FIGURE 42. *Mecynophallus glandulosus*, ventral view.
FIGURE 43. Same as FIGURE 42; oral sucker enlarged.

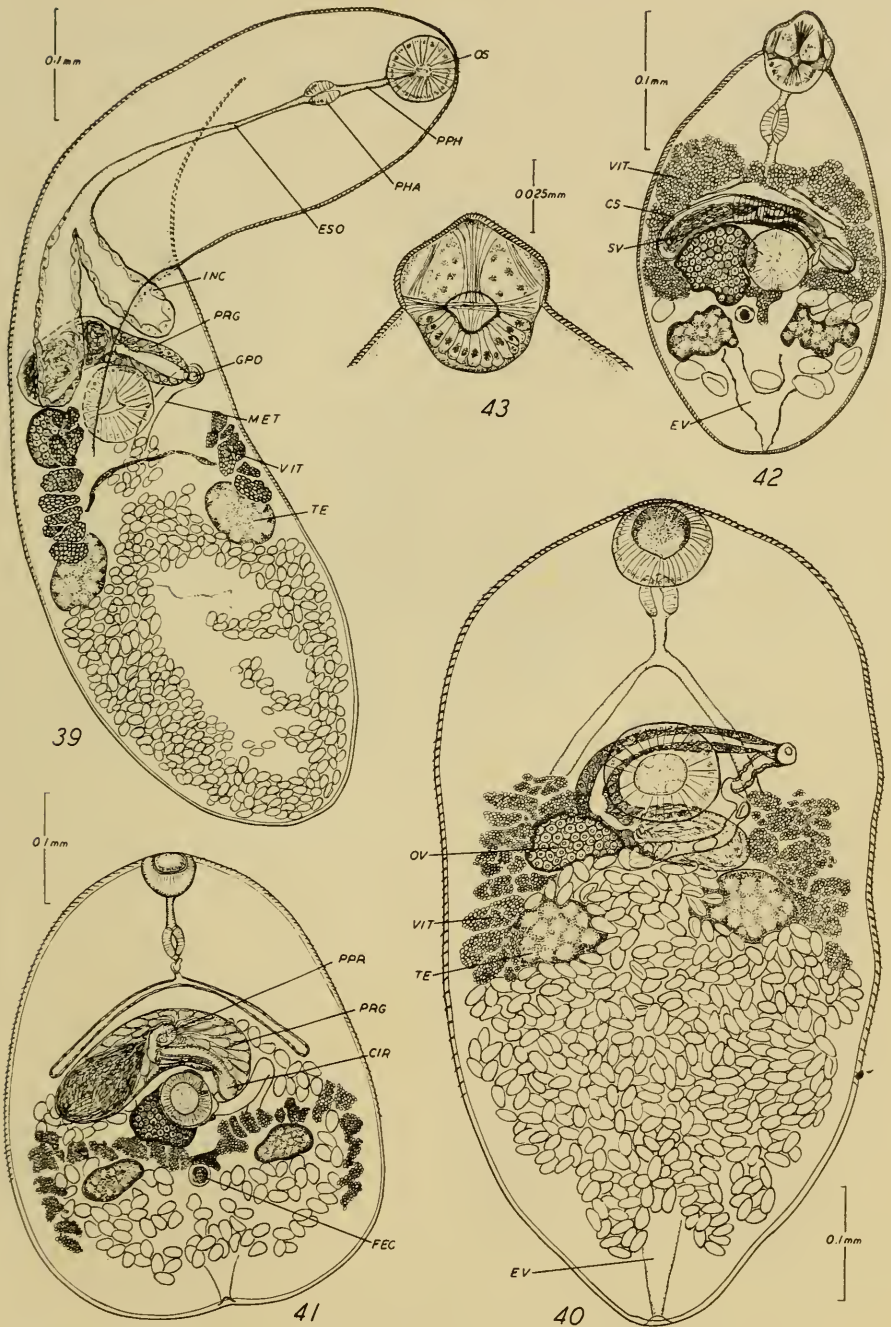
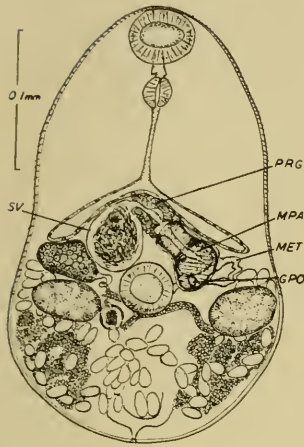
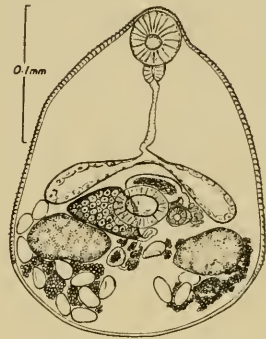


PLATE IX

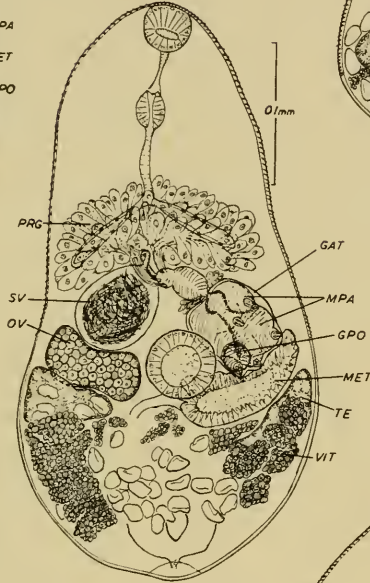
- FIGURE 44. *Carneophallus bilobatus*, holotype, ventral view.
FIGURE 45. *Megalophallus pentadactylus*, holotype in ventral view.
FIGURE 46. *Microphallus claviformis*, ventral view.
FIGURE 47. *Levinseniella leptophallus*, ventral view.
FIGURE 48. *Gynaecotyla adunca*, ventral view.



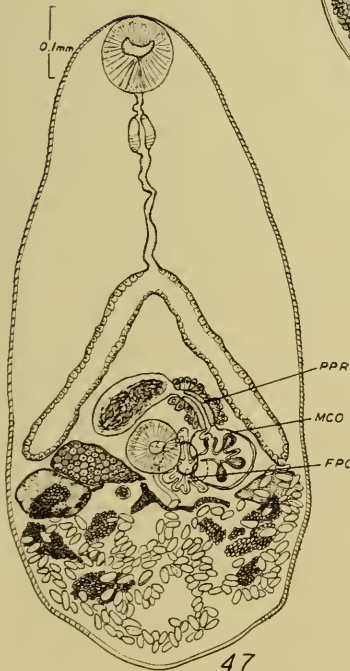
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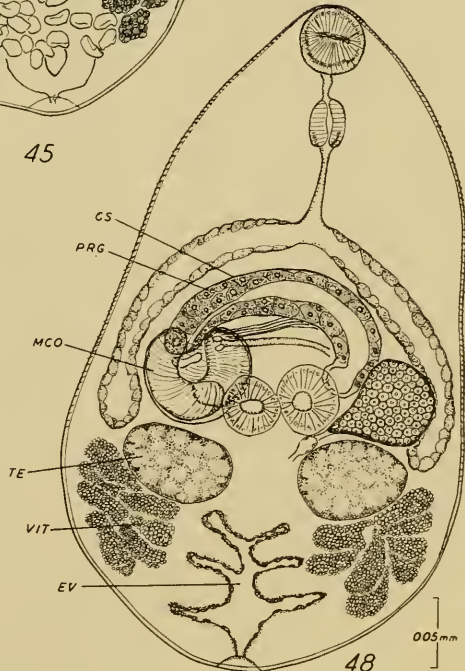
46



45



47



48

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Volume XVII—Part 3

DIGENETIC TREMATODES OF MARINE FISHES OF PUERTO RICO

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SCIENTIFIC SURVEY OF PORTO RICO AND THE
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This natural-history survey of Porto Rico and the Virgin Islands, conducted by The New York Academy of Sciences, was established in 1913 and carried out with the cooperation of the Porto Rican government. The results of this survey have appeared from time to time as investigations by specialists have been completed.

CONTENTS

	PAGE		PAGE
PREFACE	259	<i>Pseudohurleytrema eucinostomi</i>	284
INTRODUCTION	261	<i>Postmonorchis orthopristis</i>	284
METHODS	262	Family Fellodistomatidae	
KEY TO SPECIES	263	<i>Tergestia laticollis</i>	284
DESCRIPTION AND DISCUSSION OF SPECIES	267	<i>Tergestia pectinata</i>	284
Family Aspidogastridae	267	<i>Antorchis holacanthi</i> n. sp.	285
<i>Cotylogaster basiri</i> n. sp.	267	<i>Antorchis urna</i>	285
Family Bucephalidae		<i>Megalomyzon robustum</i>	286
<i>Rhipidocotyle nagati</i>	268	<i>Infundibulostomum spinatum</i> n. g., n. sp.	286
<i>Alcicornis carangis</i>	268	<i>Proctoeces neomagnorus</i> n. sp.	287
<i>Prosorhynchus attenuatus</i> n. sp.	268	<i>Proctoeces lintoni</i> n. sp.	287
<i>Prosorhynchus atlanticus</i>	269	Family Acanthocolpidae	
<i>Prosorhynchus stunkardi</i> n. sp.	269	<i>Stephanostomum coryphaenae</i>	288
<i>Bucephalopsis arcuatus</i>	270	<i>Stephanostomum dentatum</i>	288
Family Pronocephalidae		<i>Stephanostomum casum</i>	288
<i>Glyphicephalus candidulus</i> n. comb.	270	<i>Stephanostomum sentum</i>	289
<i>Glyphicephalus mcintoshi</i> n. sp.	270	<i>Manteria brachydera</i>	289
<i>Barisomium erubescens</i>	271	Family Haploporidae	
<i>Pseudobarisomium holacanthi</i> n. g., n. sp.	271	<i>Allomegasolena spinosa</i> n. g., n. sp.	290
Family Microsaphiidae		<i>Allomegasolena attenuata</i> n. g., n. sp.	290
<i>Hexangitrema breviceca</i> n. sp.	272	<i>Hapladena acanthuri</i> n. sp.	291
<i>Hexangitrema pricei</i> n. sp.	272	<i>Neomegasolena chaetodipteri</i> n. g., n. sp.	292
<i>Hexangitrema pomacanthi</i>	273	Family Megaperidae	
Family Paramphistomatidae		<i>Megapera gyryna</i>	293
<i>Cleptodiscus reticulatus</i>	273	<i>Megapera pseudura</i>	293
Family Haplospianchidae		<i>Thysanopharynx elongatus</i>	293
<i>Schikhobalotrema manteri</i> n. sp.	274	Family Opistholebetidae	
<i>Schikhobalotrema acuta</i>	274	<i>Opistholebes diodontis</i>	294
<i>Schikhobalotrema pomacentri</i>	275	<i>Pachycreadium gastrocotylum</i>	294
<i>Schikhobalotrema obtusa</i>	275	<i>Pachycreadium crassigulum</i>	294
<i>Schikhobalotrema adbrachyura</i> n. sp.	275	Family Opcoelidae	
Family Zoogonidae		<i>Pinguitrema lobata</i> n. g., n. sp.	295
<i>Neozoogonus longicecus</i> n. sp.	276	<i>Hamacreadium lintoni</i> n. sp.	295
<i>Neozoogonus malacanthi</i> n. sp.	276	<i>Hamacreadium longisaccum</i> n. sp.	296
<i>Steganoaderma atherinae</i>	277	<i>Hamacreadium mutabile</i>	297
<i>Diplangus anoplous</i> n. sp.	277	<i>Pseudoplagiaporus brevivittellus</i> n. sp.	297
Family Bivesiculidae		<i>Helicometrina nimia</i>	298
<i>Bivesicula hepsetiae</i>	278	<i>Helicometrina trachinoti</i> n. sp.	298
Family Microphallidae		<i>Helicometrina mirzai</i> n. sp.	299
<i>Megalophallus diodontis</i> n. sp.	278	<i>Helicometra equilata</i> n. comb.	299
<i>Carneophallus lactophrysi</i> n. sp.	279	<i>Helicometra torta</i>	299
Family Cryptogonimidae		<i>Neohelicometra scorpaenae</i> n. g., n. sp.	300
<i>Siphodera vineledwardsii</i>	280	<i>Opcoeloides vitellosus</i>	301
<i>Paracryptogonimus neoamericanus</i> n. sp.	280	<i>Opcoeloides elongatus</i>	301
<i>Paracryptogonimus centropomi</i> n. sp.	281	<i>Opcoeloides</i> sp.	301
<i>Metadena adglobosa</i>	282	<i>Opcoeloides brachyteleus</i>	302
Family Gorgoderidae		<i>Opcoeloides</i> sp.	302
<i>Xystretrum solidum</i>	282	<i>Pseudopcoeloides equesi</i>	302
Family Monorchhiidae		<i>Pseudopcoelus barkeri</i>	303
<i>Genolopa longicaudata</i> n. sp.	283	<i>Pseudopcoelus tortugae</i>	303
<i>Genolopa ampullacea</i>	283	<i>Horatrema crassum</i>	303
<i>Hurleytrematoides chaetodoni</i>	283	<i>Coitocceum</i> sp.	303

	PAGE
Family Lepocreadiidae	
<i>Homalometron elongatum</i>	303
<i>Homalometron foliatum</i> n. sp.	303
<i>Neopocreadium</i> n. g.	304
<i>Neopocreadium angustum</i> n. comb.	305
<i>Neopocreadium coili</i> n. comb.	305
<i>Postporus epinepheli</i>	305
<i>Apocreadium balistes</i>	305
<i>Apocreadium mexicanum</i>	306
<i>Multitestis blennii</i>	306
<i>Multitestis inconstans</i>	306
<i>Lepocreadium trulla</i>	306
<i>Lepocreadium</i> sp.	306
<i>Neolepidapedon trachinoti</i> n. sp.	306
<i>Neolepidapedon epinepheli</i> n. sp.	307
<i>Neolepidapedon equilatatum</i> n. sp.	308
<i>Neolepidapedon mycteropercae</i> n. sp.	309
<i>Lepidapedon holocentri</i> n. sp.	309
<i>Myzoxenus lachnolaimi</i>	310
<i>Dermadena lactophrysi</i>	310
<i>Pseudocreadium</i> sp.	310
<i>Opechona</i> sp.	310
<i>Diploproctodaeum</i> sp.	311
Family Accacoelidae	
<i>Tetrochetus aluterae</i>	311
Family Hemiuridae	
<i>Bilecithaster ovalis</i> n. g., n. sp.	311
<i>Hysterolecitha rosea</i>	312
<i>Leurodera decora</i>	312
<i>Dichadena acuta</i>	312
<i>Theletrium fustiforme</i>	313
<i>Neogenolinea opisthonemae</i> n. g., n. sp.	313
<i>Macradena acanthuri</i> n. sp.	313
<i>Aponurus elongatus</i> n. sp.	314
<i>Aponurus symmetrorchis</i> n. sp.	315
<i>Parectenurus chloroscombri</i> n. sp.	315
<i>Parahemiurus merus</i>	316
<i>Sterrhurus fusiformis</i>	316
<i>Sterrhurus floridensis</i>	316
<i>Sterrhurus monticellii</i>	316
<i>Sterrhurus microcercus</i>	317
<i>Lecithochirium parvum</i>	317
<i>Dinurus breviductus</i>	317
<i>Dinurus barbatus</i>	317
<i>Dinurus tornatus</i>	317
<i>Tubulovesicula lindbergi</i>	317
Family Hirudinellidae	
<i>Hirudinella ventricosa</i>	318
DISCUSSION	318
HOST-PARASITE LIST	323
REFERENCES	326
PLATES	328

PREFACE

This monograph reports the major part of an investigation begun by one of us (R.M.C.) in 1951, when he spent one year at the College of Agriculture and Mechanic Arts, University of Puerto Rico, Mayagüez, Puerto Rico, collecting and studying larval trematodes and the helminth parasites of shore birds and marine fishes. The work there was done under the auspices set forth in the Preface to Part 4, Volume 16, of this series; this part was facilitated especially by Virgilio Biaggi, N. T. Mattox, and Donald Erdman, who rendered invaluable assistance in the collection and identification of fishes. One trip to Mona Island was cut short when a shark attacked and seriously injured Juan Suarez, who took leave of his duties as Librarian of the College so that we could benefit from his skill as a spear-fisherman.

Living material was studied to the extent that time permitted, but this report is based largely on fixed and preserved specimens that were brought back to Purdue University, Lafayette, Ind. There, the first author (A.H.S.) submitted an analysis of over one half of the collection as a thesis for the Ph.D. degree in January, 1959. During 1957 and 1958, he was a David E. Ross Fellow of the Purdue Research Foundation, and completion of the investigation has been supported by Grant No. G-6125 from the National Science Foundation, Washington, D. C. Leave of absence from his position on the staff of Aligarh Muslim University, Aligarh, India, enabled him to participate in this study, and for that opportunity and encouragement in his work he is indebted to M. B. Mirza, Head of the Department of Zoology and to M. A. Basir of that department.
Purdue University, 1960.

ATHER H. SIDDIQI
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DIGENETIC TREMATODES OF MARINE FISHES OF PUERTO RICO

Ather H. Siddiqi and Raymond M. Cable

INTRODUCTION

The digenetic trematodes of marine fishes constitute a large group of parasites that have been studied intensively in only a few regions. The present investigation extends knowledge of that group to the Caribbean Sea, in particular, to the waters adjacent to Puerto Rico and Mona Island, where the trematodes previously have received no attention. During 1951 and 1952 more than 125 species were obtained from about 800 fishes representing more than 140 species in that region. Not included in this report are a few trematodes for which material was unsatisfactory because of immaturity or poor condition. Although this study is one of the more comprehensive of its type, it is certain that many species of digenetic trematodes remain to be found in the fishes of the Caribbean region.

A study of this kind has significance beyond mere knowledge of the parasites themselves. As Manter (1940*a*, 1947, 1955) has stressed, the distribution and host-parasite relationships of the digenetic trematodes have a significant bearing on geology, oceanography and isolation in time and space as a factor in evolution. Manter found, for example, that greater similarity existed between the digenetic trematodes of fishes in the Gulf of Mexico and in the tropical eastern Pacific Ocean than between either of those waters and at Beaufort, N. C., and farther north in the western Atlantic. That observation supports the view that the Gulf of Mexico was at one time confluent with the Pacific Ocean and separated from the Atlantic by a land barrier now represented by the Antilles chain of islands. The present study further supports that view and also provides evidence that deep water between relatively close land masses serves as a barrier to shallow-water fishes and, hence, is an isolating mechanism that has led to a considerable degree of independent speciation among their trematode parasites.

The first digenetic trematodes of marine fishes to be investigated were those of European waters, from which slightly more than 100 species have been reported thus far. Information concerning that group is summarized by Dawes (1956). The principal European investigators were Rudolphi, Stossich, Monticelli, Looss, Odhner, Lebour, and Nicoll. Fish trematodes of the Red Sea, which has its own characteristic fauna, have been investigated almost solely by Nagaty, who has reported about one half the number known for European waters in a series of papers from 1937 to the present.

The studies of Ozaki and Yamaguti chiefly are responsible for the recognition of more than 300 species of digenetic trematodes from marine fishes in Japanese waters. About one fourth that number is known from the Arabian Sea and the Indian Ocean, largely through the efforts of Srivastava, Chauhan, and Gupta.

In a series of papers dating from 1898 to 1940, Linton pioneered the in-

vestigation of marine trematodes in the western Atlantic, reporting about 75 species from the Woods Hole, Mass., region and many additional ones from Bermuda, Beaufort, N. C., and Tortugas, Fla. In that work he was followed by Manter with many publications dating from 1925 until the present and reporting additional species from Maine, the Gulf of Mexico, the Galapagos Islands and, especially, Tortugas, where almost 200 species are known. More recently Manter has extended his studies to the South Pacific so that, with scattered reports by investigators other than those cited above, more than 1000 species of digenetic trematodes have been described from marine fishes.

METHODS

Fishes were collected by all available methods including commercial nets, traps, spear-fishing, and the use of rotenone to obtain species inhabiting reefs and shallow water. In all cases specimens were examined as soon as possible to obtain parasites in good condition; those that were dead and had begun to show the well-known signs of disintegration were discarded. The fellodistomes in herbivorous fishes were especially troublesome in that respect. At the beginning of the study ice was used with the expectation that the parasites would live much longer under refrigeration, but this hope proved to be unfounded; after the death of the host they remained in about as good condition at ambient temperatures as when chilled.

To the extent that time permitted, the worms were studied alive to observe certain features that are difficult to determine in fixed material. That procedure applied especially to the extent of the bladder and other features of the excretory system, the pattern of which was determined more or less completely for a few species and, in part, for several others.

After removal from the host, the trematodes were washed in 0.7 per cent saline and fixed under just sufficient coverglass pressure to prevent curling. Corrosive sublimate-acetic acid was used as a fixative when there was opportunity to process the material further without delay by washing out the fixative, dehydrating to 70 per cent alcohol, and treating with iodine to remove excess mercury. The bulk of the material was handled in that manner, but some specimens, taken from fishes at Mona Island where facilities and time were limited, were fixed and left in Bouin's fluid for less than 2 weeks, after which they were washed free of picric acid and stored in 70 per cent alcohol. Staining following that treatment gave decidedly poorer preparations than did material fixed in corrosive-sublimate acetic acid. Harris' hematoxylin and, to a less extent, Semichon's carmine were used to stain whole mounts that were cleared in terpineol. Serial sections were cut at 8 to 10 μ , stained with Delafield's hematoxylin, and counterstained with eosin.

All drawings with scales indicated were made by microprojection, and all measurements are in millimeters; other figures were drawn freehand. Sucker ratios are given with the oral sucker taken as 1 and were calculated from averages of the length plus width of suckers where those dimensions differed appreciably; otherwise the ratio is based on their diameters.

Examples of most of the species described, including type specimens of all

new ones, are deposited in the Helminthological Collection of the United States National Museum, Washington, D. C. under the accession numbers given. Asterisks indicate new host records.

KEY TO SPECIES

1. Mouth on ventral surface, haptor a rhynchus at anterior end.....	2
Mouth anterior, haptor a ventral disk with 3 rows of alveoli..	<i>Cotylogaster basiri</i>
Mouth at or near anterior end, haptors in the form of suckers.....	6
2. Rhynchus with 7 tentacles.....	<i>Alcicornis carangis</i>
Rhynchus without tentacles.....	3
3. Rhynchus spherical, suckerlike.....	<i>Bucephalopsis arcuatus</i>
Rhynchus not spherical, or if so, very muscular but not suckerlike.....	4
4. Rhynchus with pentagonal cap-like expansion.....	<i>Rhipidocotyle nagatyi</i>
Rhynchus without such an expansion.....	5
5. Rhynchus wedge-shaped, with longitudinal muscle bands	
.....	<i>Prosorhynchus atlanticus</i>
Rhynchus more or less spherical, uterus extends well anterior to mouth	
.....	<i>Prosorhynchus attenuatus</i>
6. Ventral or posterior sucker absent.....	7
Sucker either on ventral surface or at posterior end of body.....	13
7. With one testis.....	<i>Bivesicula hepsetiae</i>
With 2 testes.....	8
8. Testes tandem, median, anterior to ovary; eggs without filaments.....	9
Testes symmetrical, near posterior end; eggs with filaments.....	10
9. Testes entire, ceca reach level of ovary.....	<i>Hexangitrema pricei</i>
Testes lobed, ceca not reaching level of ovary.....	<i>Hexangitrema breviceca</i>
10. Head collar with prominent ridge, ventral fold of body continuous posteriorly..	11
Anterior end without prominent ridge; ventral fold, if present, only in anterior region.....	12
11. Body slender, over 2.0 long, eggs 0.028 to 0.030 long	
.....	<i>Glyphicephalus candidulus</i>
Body stout, less than 2.0 long, eggs 0.040 to 0.043 long	
.....	<i>Glyphicephalus mcintoshi</i>
12. Over 3.0 long, anterior end with fleshy lateral folds; intestine with branching diverticula.....	<i>Barisomum erubescens</i>
Less than 2.0 long, without fleshy folds; intestinal diverticula short, unbranched	
.....	<i>Pseudobarisomum holacanthi</i>
13. Ventral sucker at posterior end of body.....	14
Ventral sucker not at posterior end of body, pharynx present.....	15
Ventral sucker not at posterior end of body, pharynx absent.....	<i>Xystretrum solidum</i>
14. Ventral sucker surrounded by prominent glandular fold, testes symmetrical to slightly oblique, posterior to ovary.....	<i>Opisthoboles diodontis</i>
Ventral sucker without surrounding fold; testes tandem, anterior to ovary	
.....	<i>Cleptodiscus reticulatus</i>
15. Intestine rhabdocoele; with a single testis.....	16
Intestine a pair of ceca; 1, 2 or more testes.....	18
16. Body over 1.4 long; vitelline follicles small, numerous, confined to hindbody	
.....	<i>Schikhhobalotrema manteri</i>
Body less than 1.2 long; vitelline follicles few, large, extending to anterior margin of ventral sucker or into forebody.....	17
17. Sucker ratio 1:1.3, gonads well separated.....	<i>Schikhhobalotrema obtusa</i>
Sucker ratio 1:1.5, gonads contiguous.....	<i>Schikhhobalotrema pomacentri</i>
Sucker ratio 1:1.8, ventral sucker with posterolateral lobes; ovary entire	
.....	<i>Schikhhobalotrema acuta</i>
Sucker ratio 1:1.8, ventral sucker without lobes; ovary lobed	
.....	<i>Schikhhobalotrema adbrachyura</i>
18. Vitelline follicles scanty, not near posterior end of body.....	19
Vitelline follicles extensive, from near posterior end of body well toward ventral sucker or beyond.....	40
19. Genital pore either not median or not close to ventral sucker.....	20
Genital pore near midline and usually close to ventral sucker.....	25

* Number of specimens examined is given at the end of each entry.

20. Ceca short, not extending into hindbody, cirrus sac absent 21
 Ceca extending into hindbody, cirrus sac present 22
21. Male copulatory organ cup-shaped, with corona of papillae; metraterm with conspicuous folds *Megalophallus diodontis*
 Male copulatory organ bilobed, without papillae; metraterm simple, tubular *Carneophallus lactophrysi*
22. Cuticle spinose and vitellaria posterior to ventral sucker or cuticle aspinose and vitellaria in forebody 23
 Cuticle aspinose, vitellaria restricted to hindbody 90
23. Hindbody with angular lateral expansions and scanty vitellaria; cuticle spinose *Steganoderma atherinae*
 Hindbody without such expansions, cuticle aspinose, vitellaria in forebody *Diplangus anoplosus*
 Hindbody without expansions, cuticle spinose, vitellaria in hindbody 24
24. Genital pore near right margin of body, seminal vesicle bipartite *Neozoogonus longicecus*
 Genital pore near left margin of body, seminal vesicle tubular *Neozoogonus malacanthi*
25. Excretory vesicle sac-shaped, confined to hindbody; metraterm conspicuous 26
 Excretory vesicle Y-shaped, with arms extending into forebody; metraterm not conspicuous 30
26. Eggs with filaments 27
 Eggs without filaments 28
27. Vitellaria 2 lateral groups of follicles *Pseudohurleyxtrema eucinostomi*
 Vitelline follicles scattered *Hurleyxtrematoides chaetodoni*
28. Body short, testes near posterior end, uterus reaching level of intestinal bifurcation *Postimonorchis orthopristsis*
 Body more elongate, testes well removed from posterior end, uterus extending into posttesticular space but not to intestinal bifurcation in forebody 29
29. Posttesticular space 3 or 4 times length of testis, metraterm sac reaching well posterior to ventral sucker *Genolopa longicaudata*
 Posttesticular space less than 3 times length of testis, metraterm sac reaching posterior margin of ventral sucker or but slightly beyond *Genolopa ampullacea*
30. Eyespot pigment absent, cirrus sac present 31
 Eyespot pigment present, cirrus sac absent 37
31. Anterior end with tentacles, ceca extend far into hindbody 32
 Anterior end without tentacles, ceca short 33
32. Sucker ratio 1:1 *Tergestia laticollis*
 Sucker ratio 1:2.5 *Tergestia pectinata*
33. Testes 2 34
 A single testis *Infundibulostomum spinatum*
34. Vitellaria in forebody, cirrus sac an inverted U 35
 Vitellaria in hindbody, cirrus sac curved 36
35. Body oval to pyriform, not prolonged posteriorly; uterus not extending to level of ceca *Antorchis holacanthi*
 Body spindle-shaped, with posterior prolongation largely filled by excretory vesicle; uterus to cecal level *Antorchis urna*
36. Oral sucker larger than ventral sucker, ovary well separated from testes *Proctoeces neomagnorus*
 Oral sucker smaller than ventral sucker, ovary close to anterior testis *Proctoeces lintoni*
37. Circumoral spines absent 38
 Circumoral spines present 39
38. Testes 2, pars prostatica inconspicuous *Metadena adglobosa*
 Testes 4 to 6 on each side, pars prostatica prominent, bulblike *Siphodera vinalwardsii*
39. Circumoral spines large, 46 to 51; ovary near midlevel *Paracryptogonimus neoamericanus*
 Circumoral spines small, 64; ovary anterior to midlevel *Paracryptogonimus centropomi*
40. Oral sucker with double row of enlarged spines 41
 Oral sucker without enlarged spines 44
41. Suckers well separated, hindbody less than 6 times length of forebody, corona of spines uninterrupted 42

- Suckers close together, hindbody more than 10 times as long as forebody, corona of spines interrupted ventrally. *Manteria brachydera*
42. Vitelline follicles from mid-level of cirrus sac to posterior end of body
Stephanostomum coryphaenae
 Vitelline follicles from posterior margin of cirrus sac to posterior end of body
Stephanostomum senium
 Vitelline follicles from posterior margin of ventral sucker to posterior end of body 43
43. Circumoral spines 51 to 54 *Stephanostomum dentatum*
 Circumoral spines 36 to 38 *Stephanostomum casum*
44. Testes in forebody, anterior margin of pharynx serrated 45
 Testes in hindbody, anterior margin of pharynx smooth 47
45. Ovary lobed, testes well separated 46
 Ovary entire, testes close together *Thysanopharynx elongatus*
46. Body short, with tail-like projection; vitelline follicles rounded
Megapera pseudura
 Body elongate, vitelline follicles bandlike *Megapera gyrina*
47. Eyespot pigment and cuticular spines present 48
 Eyespot pigment absent, cuticle rarely if ever spinose 52
48. Seminal receptacle absent 49
 Seminal receptacle present 73
49. Hermaphroditic sac present 50
 Hermaphroditic sac absent *Neomegasolena chaetodipteri*
50. Suckerlike structure at genital pore 51
 Genital pore without such structure *Hapladena acanthuri*
51. Sucker ratio 1:1.1, forebody not attenuated *Allomegasolena spinosa*
 Sucker ratio 1:2.3, forebody attenuated *Allomegasolena attenuata*
52. Muscular postoral ring present 53
 Muscular postoral ring absent 54
53. Over 2.0 long, sucker ratio 1:2 *Pachycreadium gastrocotylum*
 Less than 2.0 long, sucker ratio 1:1.4 *Pachycreadium crassigulum*
54. Cirrus sac containing seminal vesicle present 55
 Cirrus sac containing seminal vesicle absent 65
55. Eggs with filaments 56
 Eggs without filaments 61
56. Testes 2 57
 Testes 9 59
57. Oral sucker funnel shaped, ani present *Neohelicometra scorpaenae*
 Oral sucker not funnel-shaped, ani absent 58
58. Cirrus sac extends halfway from ventral sucker to ovary *Helicometra equitata*
 Cirrus sac not extending posterior to ventral sucker *Helicometra torta*
59. Body over 2.5 long *Helicometrina nimia*
 Body less than 2.0 long 60
60. Vitelline follicles interrupted at level of ventral sucker *Helicometrina mirzai*
 Vitelline follicles not interrupted at level of ventral sucker
Helicometrina trachinoti
61. Ventral sucker surrounded by fleshy fold and muscles radiating into parenchyma, testes symmetrical to slightly diagonal *Pinguitrema lobata*
 Ventral sucker without fold, testes oblique 62
62. Vitellaria from posterior end to ventral sucker *Pseudoplagiaporus brexivitellus*
 Vitellaria from posterior end well into forebody 63
63. Cirrus sac extends posterior to ventral sucker *Hamacreadium longisaccum*
 Cirrus sac not extending to ventral sucker 64
64. Vitelline follicles reach intestinal bifurcation, posttesticular space about length of zone occupied by gonads *Hamacreadium mutabile*
 Vitellaria not reaching bifurcation, posttesticular space much longer than zone occupied by gonads *Hamacreadium lintoni*
65. Accessory sucker anterior to ventral sucker present 66
 Accessory sucker absent 70
66. Accessory sucker with a limiting membrane 67
 Accessory sucker without such membrane *Opecoeloides* sp., FIGURE 91
67. Body at least 8 times as long as wide, testes separated 68
 Body less than 6 times as long as wide, testes contiguous 69
68. Body extremely slender, over 2.0 long, ventral sucker with 4 anterior and 4 posterior papillae; vitellaria confluent between, and posterior to testes
Opecoeloides elongatus.

- Body less than 2.0 long, ventral sucker with 3 anterior and 2 posterior papillae; vitellaria not confluent between, or posterior to testes.
69. Accessory sucker 0.093 in diameter; ventral sucker with 3 anterior and 2 posterior papillae. *Opecoeloides vitellosus*
 Accessory sucker 0.042-0.052 in diameter, ventral sucker with 4 anterior and 4 posterior papillae. *Opecoeloides* sp., FIGURE 89
70. Ventral sucker stalked. *Pseudopecoeloides equesi* 71
 Ventral sucker without a stalk. 72
71. Testes tandem. *Horatremia crassum*
 Testes symmetrical. 84
72. Pharynx about as long as oral sucker, ovary to right of midline, vitelline follicles in racemose clusters. *Pseudopecoeloides barkeri*
 Pharynx much shorter than oral sucker, ovary median, vitelline follicles not in racemose clusters. *Pseudopecoeloides tortugae* 84
73. Cirrus sac present. 84
 Cirrus sac absent. 84
74. Testes 11. 75
 Testes 2. 76
75. Testes in one group overlapping ovary. *Multitestis inconstans*
 Testes in 2 groups with ovary between. *Multitestis blennii*
76. Body pyriform, ovary anterior to testes, prostate cells not conspicuously grouped around posterior seminal vesicle, testes oblique or tandem. 77
 Body elongate, ovary anterior to testis, prostate cells in a compact mass surrounding posterior seminal vesicle, testes tandem to slightly oblique. 78
 Body subcircular in outline, prostate cells surrounding neck between internal and external seminal vesicles; testes symmetrical, with ovary between. 83
77. Testes oblique, vitellaria reaching intestinal bifurcation. *Lepocreadium trulla*
 Testes tandem, vitellaria not reaching bifurcation. *Lepocreadium* sp.
78. Ventral sucker with pair of lateral lamellar pads. *Myzoxenus lachnolaimi*
 Ventral sucker not so modified. 79
79. Posterior (external) seminal vesicle and prostate cells not enclosed in a membrane *Lepidapedon holocentri*
 Posterior seminal vesicle and prostate cells enclosed in a membrane. 80
80. Vitellaria from posterior end to level of intestinal bifurcation *Neolepidapedon trachinoti*
 Vitelline follicles not reaching level of ventral sucker. 81
81. Genital pore posterolateral to ventral sucker. *Neolepidapedon myceropercae*
 Genital pore to left of ventral sucker. 82
82. Esophagus long, vitellaria scarcely reaching level of posterior seminal vesicle. *Neolepidapedon epinepheli*
 Esophagus short, vitellaria reach level of cirrus sac. *Neolepidapedon equitatum*
83. Ventral surface without glandular pits. *Pseudocreadium* sp.
 Ventral surface with glandular pits. *Dermadena lactophrysi*
84. Genital pore posterior to ventral sucker. *Postporus epinepheli*
 Genital pore anterior to ventral sucker. 85
85. Lymphatic channels present. 86
 Lymphatic channels absent. 89
86. Mouth a longitudinal, slitlike opening; ceca swollen, vitellaria confluent anterior to ventral sucker. 87
 Mouth subcircular, ceca narrow, vitellaria not confluent in forebody. 88
87. Body over 4.0 long, sucker ratio 1:0.87. *Neopocreadium angustum*
 Body less than 3.0 long, sucker ratio 1:0.65. *Neopocreadium coili*
88. Vitellaria barely reaching level of ventral sucker, sucker ratio 1:1.2 *Apocreadium mexicanum*
 Vitellaria barely reaching level of ovary, sucker ratio 1:1.6 *Apocreadium folistes*
89. Vitellaria not reaching level of ovary, hindbody foliate. *Homalometron foliatum*
 Vitellaria reaching level of seminal vesicle, hindbody cylindrical *Homalometron elongatum*
90. Thick-bodied worms over 75 long when full-grown; hindbody enlarged, occupied mostly by expanded ceca. *Hirudinella ventricosa*
 Less than 25 long, usually much shorter; hindbody cylindrical or but slightly expanded. 91
91. Each cecum with a pouch flanking pharynx. *Tetrochetus aluterae*
 Ceca without such pouches. 92

92. Appendiculate; that is, with posterior end telescoped to form an ecsoma.....	100
Posterior end not telescoped to form an ecsoma.....	93
93. Intestina caeca united posteriorly.....	<i>Dichadena acuta</i>
Ceca end blindly.....	94
94. Vitellaria in 2 clusters, each with 7 lobes.....	<i>Bilecithaster ovalis</i>
Vitellaria not in 2 well-separated clusters.....	95
95. Testes extracecal.....	<i>Leurodera decora</i>
Testes not extracecal.....	96
96. Ridge encircling body just posterior to ventral sucker.....	<i>Theletrium justiforme</i>
Without such a ridge.....	97
97. Pars prostatica long, tubular, extending posterior to ventral sucker	
	<i>Macradena acanthuri</i>
Pars prostatica saclike, its wall with spiral muscles	
	<i>Neogenolinea opisthonemae</i>
Pars prostatica a short tube not extending to ventral sucker.....	98
98. Seminal vesicle tubular, vitellaria in a compact rosette....	<i>Hysterolecitha rosea</i>
Seminal vesicle sacshaped, vitellaria not in a rosette.....	99
99. Testes symmetrical or nearly so, body less than 1.2 long	
	<i>Aponurus symmetrorchis</i>
Testes diagonal, body over 1.2 long.....	<i>Aponurus elongatus</i>
100. Seminal vesicle distinctly tripartite, ecsoma as long as body.....	101
Seminal vesicle indistinctly tripartite, ecsoma very small.....	102
Seminal vesicle unipartite, ecsoma as long as body.....	<i>Tubulovesicula lindbergi</i>
Seminal vesicle bipartite, ecsoma not as long as body.....	103
101. Genital atrium as long as sinus (hermaphroditic) sac which reaches posterior edge of ventral sucker.....	<i>Dinurus tornatus</i>
Genital atrium as long as sinus sac which does not reach posterior edge of ventral sucker.....	<i>Dinurus barbatus</i>
Genital atrium shorter than sinus sac which does not reach posterior edge of ventral sucker.....	<i>Dinurus breviductus</i>
102. Testes symmetrical.....	<i>Sterrhurus microcercus</i>
Testes tandem.....	<i>Lecithochirium parvum</i>
103. Seminal vesicle posterior to ventral sucker.....	104
Seminal vesicle not posterior to ventral sucker.....	105
104. Vitellaria of 7 tubules, sinus sac reaching posterior edge of ventral sucker	
	<i>Parectenurus chloroscombri</i>
Vitellaria of 2 compact masses, sinus sac not reaching posterior edge of ventral sucker.....	<i>Parahemirus merus</i>
105. Vitellaria of 7 short, tubelike lobes.....	<i>Sterrhurus fusiformis</i>
Vitellaria in 2 compact masses.....	106
106. Uterus extends well into long ecsoma.....	<i>Sterrhurus floridensis</i>
Uterus not extending into short ecsoma.....	<i>Sterrhurus monticellii</i>

DESCRIPTIONS AND DISCUSSION OF SPECIES

FAMILY ASPIDOGASTRIDAE POICHE, 1925

Cotylogaster basiri n. sp. (FIGURE 1)

Description based on 3 specimens with characters of the genus. Body 2.428 to 4.965 long, 0.732 to 1.881 wide, divided into narrow forebody or neck and broad hindbody bearing the ventral disk. Cuticle aspinose. Eye spots either compact or diffuse. Buccal funnel prominent, with 5 lobes, 2 lateral, 2 ventrolateral, 1 dorsal bearing a cleft papillalike projection. Prepharynx 0.132 to 0.258 long, pharynx 0.171 to 0.297 by 0.118 to 0.231, esophagus short, intestine rhabdoceol, extending slightly posterior to anterior testis. Ventral disk occupying entire ventral surface of hindbody, encompassed by 57 to 59 suckerlike marginal alveoli, surrounding 20 to 22 median ones that are transversely elongated; with prominent marginal sense organs between adjacent marginal alveoli. Testes 2, entire, oblique, postovarian, postequatorial, 0.290 to 0.396 by 0.264 to 0.363; seminal vesicle unipartite,

tubular, coiled; cirrus sac median, opening into what appears to be a posterior extension of genital atrium, containing pars prostatica, prostate cells, and ejaculatory duct. Ovary smooth, 0.330 to 0.349 by 0.211 to 0.264, slightly to right of midline, anterolateral to right testis. Vitellaria scanty, follicles confined to a narrow band forming an arch well anterior to ovary. Laurer's canal present. Seminal receptacle of uterine type. Uterus voluminous, occupying most of posterior region of body; metraterm tubular, extending anteriorly to left of cirrus sac to join genital atrium. Genital pore median, immediately anterior to ventral disk. Eggs very numerous, colorless, 0.066 to 0.079 by 0.037 to 0.045, containing biocellate miracidia that sometimes hatch in the uterus. Excretory vesicle I-shaped, extending to posterior level of pharynx.

Host: *Calamus calamus*.

Site: posterior intestine.

Locality: Cabo Rojo, P. R.

Type specimen: Holotype No. 39300.

The genus *Cotylogaster* was erected by Monticelli (1892) for *C. michaelis* from a Mediterranean teleost. A second species, *C. occidentalis* Nickerson, 1899, was found in a teleost from the Mississippi River. *C. basiri*, the third species of the genus, resembles most *C. michaelis* but differs from that trematode in the structure of the buccal funnel, number of alveoli, extent of vitellaria and size of eggs.

It is of interest to note that another aspidogastrid reported from the Western Atlantic occurs in the same host species as *C. basiri* but belongs to a different genus, namely, *Lobatostoma* (Manter, 1947).

FAMILY BUCEPHALIDAE POCHÉ, 1907

Rhipidocotyle nagaty Manter, 1940 (FIGURE 2)

Host: *Euthymnus alletteratus*.

Site: intestine.

Locality: Parguera, P. R.

Deposited specimen: No. 39301.

Alcicornis carangis MacCallum, 1917 (FIGURE 3)

Host: *Caranx ruber*.

Site: stomach.

Locality: off Puerto Real, P. R.

Deposited specimen: No. 39302.

MacCallum (1917) gave a very poor and inaccurate description of *A. carangis*, as pointed out by Nagaty (1937), who redefined the genus.

Prosrhynchus attenuatus n. sp. (FIGURE 4)

Description based on 29 specimens with characters of the genus. Body small, slender, about equally wide throughout except at rounded ends, 0.693 to 1.107 long, 0.138 to 0.184 wide. Cuticle with spines becoming less numerous posteriorly. Rhynchus spherical, suckerlike, muscular, 0.090 to

0.105 in diameter. Mouth submedian, posterior to midlevel; pharynx spherical, 0.033 to 0.045 in diameter; intestine saclike, dorsal to pharynx. Gonads to right of midline; testes 2, entire, 0.051 to 0.070 by 0.060 to 0.075, tandem, postovarian, anterior testis contiguous with intestine, sometimes overlapping ovary. Cirrus sac elongate, extending to level of posterior testis, containing small saclike seminal vesicle, tubular pars prostatica and prostate cells. Genital pore ventral, near posterior end of body. Ovary entire, 0.060 to 0.075 by 0.046 to 0.066, pretesticular, overlapping pharynx. Vitellaria in anterior half of body, in 2 lateral groups of diffuse follicles in linear arrangement. Uterus extends from posterior end of body to anterior limit of vitellaria. Eggs numerous, 0.019 to 0.021 by 0.013 to 0.015. Excretory vesicle tubular, extending well anterior to vitellaria; excretory pore terminal.

Host: *Chloroscombrus chrysurus*.

Site: intestine.

Locality: Playa Mani, P. R.

Type specimen: Holotype No. 39303.

This species is similar to *Prosorhynchus tsengi* Tsin, 1933 (= *Gotonius platycephali* = *Prosorhynchus platycephali* Yamaguti, 1934) but differs from that species in smaller size, shape of the rhynchus, topography of gonads, extent of cirrus sac, and much smaller eggs.

Prosorhynchus atlanticus Manter, 1940 (FIGURE 5)

Host: *Mycteroperca* sp.

Site: intestine and ceca.

Locality: Mona Island, P. R.

Deposited specimen: No. 39304

Prosorhynchus stunkardi n. sp. (FIGURE 6)

Description based on 15 specimens with characters of the genus. Body elongate, 1.056 to 1.227 long, 0.171 to 0.264 wide; anterior half spatulate, posterior half cylindrical. Cuticle distinctly spinose from anterior end to about level of pharynx. Rhynchus oval to pyriform, muscular, 0.052 to 0.118 by 0.064 to 0.099, without papillae. Mouth median, posterior to midlevel; pharynx small, spherical, 0.039 to 0.052 in diameter; esophagus not evident, intestine small, oval in shape. Testes 2, entire, 0.078 to 0.082 by 0.064 to 0.067, close together, slightly to left of midline, posterior to ovary. Cirrus sac long, usually extending to posterior testis; with small, rounded seminal vesicle, well-developed tubular pars prostatica and prostate cells. Genital pore ventral, near end of body. Ovary entire, 0.067 to 0.097 by 0.052 to 0.059, to left of midline, pretesticular, near intestine and anterior testis. Vitellaria in 2 short, lateral bands of small follicles immediately anterior to level of pharynx. Uterus spacious, from posterior end of body to level of pharynx. Eggs very numerous, colorless or yellow, 0.016 to 0.018 by 0.011 to 0.015. Excretory system not observed.

Host: *Scomberomorus* sp.

Site: intestine and ceca.

Locality: Puerto Real, P. R.

Type specimen: Holotype No. 39305.

This species is similar to *P. freitasi* Nagaty, 1937, and *P. facilis* Ozaki 1924 in general body shape and disposition of gonads, but differs from *P. freitasi* in the shape of the rhynchus, more anterior location of the vitellaria and size of eggs. It differs from *P. facilis* in size and shape of the rhynchus, size and extent of vitelline follicles, and in egg size.

Bucephalopsis arcuatus (Linton, 1900) Eckman, 1932 (FIGURE 7)

Synonyms:

Gasterostomum arcuatum Linton, 1900.

Gasterostomum sp. Linton, 1910.

Host: *Sphyræna barracuda*.

Site: intestine.

Locality: Mona Island.

Deposited specimen: No. 39306.

FAMILY PRONOCEPHALIDAE Looss, 1902

Glyphicephalus candidulus (Linton, 1910) n. comb. (FIGURE 8)

Synonyms:

Himasomum candidulum Linton, 1910.

Barisomum candidulum (Linton) Price, 1931.

Pleurogonius candibulus (Linton) Manter, 1947.

Host: *Pomacanthus arcuatus*.

Site: small intestine.

Locality: Guaniquilla and Guanica, P. R.

Deposited specimen: No. 39307.

We concur in the opinion of Manter (1947) that this species does not belong in the genus *Barisomum* and transfer it to *Glyphicephalus*, with which it is in closer agreement than *Pleurogonius* in respect to the nonfused excretory canals, prominent dorsal ridge of the head collar, and the greater lateral displacement of the sex openings. Other species of *Glyphicephalus* occur in reptiles, with the exception of the following one.

Glyphicephalus mcintoshi n. sp. (FIGURE 9)

Description based on 3 specimens with characters of the genus. Body short and wide, 1.352 to 1.630 long, 0.567 to 0.627 wide, rounded posteriorly, with prominent marginal fold and muscular head collar. Cuticle and pigment as in preceding species. Oral sucker 0.060 by 0.072 to 0.090, esophagus 0.139 to 0.185 long; ceca narrow, with small diverticula, overlapping median edge of testes to end posterior to them. Testes lobed, 0.132 to 0.138 by 0.118 to 0.145, symmetrical, near posterior extremity. Cirrus sac as in preceding species but more or less sigmoid and apparently lacking internal seminal vesicle; genital pores and external seminal vesicle as in that species. Ovary lobed, 0.072 to 0.100 by 0.069 to 0.118; it and Mehlis' gland as in preceding species; vitellaria as in that species but extending about one third of body length from posterior end. Uterus with transverse coils overlapping ceca; metraterm conspicuous. Eggs numerous, their structure as in

preceding species, 0.040 to 0.043 long, exclusive of filaments, 0.019 to 0.022 wide. Excretory system as in that species.

Host: *Pomacanthus arcuatus*.

Site: small intestine.

Locality: Guaniquilla, P. R.

Type specimen: Holotype No. 39308.

Glyphicephalus mcintoshi is shorter and more compact than *G. candidulus*, the only other species of the genus reported from fishes, and has a more conspicuous dorsal ridge of the head collar and much larger eggs.

Barisomum erubescens Linton, 1910 (FIGURE 10)

Synonyms:

Pleurogonius erubescens (Linton) Prudhoe, 1944.

Monostomum pomacanthi MacCallum, 1916.

Pleurogonius pomacanthi (MacCallum) Price, 1931.

Host: *Pomacanthus arcuatus*.

Site: intestine.

Locality: Parguera, P. R.

Deposited specimen: No. 39309.

Pseudobarisomum n. g.

Diagnosis: Pronocephalidae; lacking head collar and marginal fold, ends rounded, cuticle smooth, eyespot pigment present. Esophagus narrow, relatively long, ceca with short, unbranched diverticula, terminating near posterior end of body. Genital pore extracecal, on left, not far posterior to level of intestinal bifurcation. Testes symmetrical, near posterior extremity, extracecal or slightly overlapped by ceca; cirrus sac cylindrical, its basal half occupied by prostatic complex; external seminal vesicle tubular, sinuous. Ovary pretesticular, to right of midline; vitellaria mostly extracecal, pretesticular; seminal receptacle absent; Mehlis' gland median, intertesticular; uterus in close transverse loops occupying intercecal space between Mehlis' gland and cirrus sac; metraterm well differentiated. Eggs with a single filament at each pole. Excretory vesicle with small unpaired portion and 2 arms crossing ceca and extending anteriorly without branching to end blindly at esophageal level. Type and only species:

Pseudobarisomum holacanthi n. g., n. sp. (FIGURE 11)

Diagnosis based on 2 specimens with the characters of the genus. Body 1.531 to 1.564 long, 0.660 to 0.732 wide; oral sucker 0.079 to 0.085 by 0.102 to 0.112; esophagus 0.217 to 0.237 long; ceca with diverticula anteriorly, almost tubular posteriorly. Testes slightly lobed, 0.145 to 0.191 by 0.132 to 0.165; cirrus sac almost straight to sigmoid, extending from genital pore to right and posteriorly across midregion of worm, evidently without internal seminal vesicle. Ovary anteromedian to right testis, slightly irregular in outline, 0.151 to 0.165 by 0.105 to 0.132; vitellaria with a few follicles overlapping ceca, confined to posterior $\frac{2}{3}$ of body. Eggs numerous, 0.030 to 0.033 long exclusive of filaments, 0.015 to 0.018 wide. Excretory

system as in generic diagnosis, pore dorsal near posterior end of body, with conspicuous sphincter.

Host: *Holacanthus tricolor*.

Site: large intestine.

Locality: Parguera, P. R.

Type specimen: Holotype No. 39310.

The genus *Pseudobarisomum* is distinguished from *Barisomum* by the absence of fleshy lateral folds, a single genital pore, and absence of branched intestinal diverticula. Other differences in their species concern the length of the esophagus, level of the genital pore and position of Mehlis' gland.

FAMILY MICROSCAPHIIDAE TRAVASSOS, 1922

Hexangitrema breviceca n. sp. (FIGURE 12)

Diagnosis based on a single specimen in good condition (others shrivelled badly in clearing) with characters of the genus. Body broadly fusiform, notched posteriorly, 3.755 long, 1.70 wide. Cuticle smooth, eye-spot pigment absent. Oral sucker without evident retrodorsal pockets. Prepharynx 0.334 long; pharynx pyriform, 0.147 to 0.149; esophagus absent; ceca simple, ending blindly near midlevel of posterior testis. Genital pore immediately posterior to oral sucker, cirrus sac absent, seminal vesicle a long sinuous tube beginning near intestinal bifurcation. Pars prostatica and prostate cells indistinct. Testes 2, lobed, tandem, intercecal or slightly overlapping ceca, 0.60 to 0.67 by 0.67 to 0.94. Ovary entire, median, post-testicular, near posterior end of body, 0.207 by 0.140; seminal receptacle absent; Mehlis' gland posterior to ovary. Vitelline follicles subspherical, sparsely confluent posterior to ovary, extending to intertesticular level. Uterus beginning posterior to ovary and extending anteriorly through intercecal region; metraterm simple. Eggs 0.082 to 0.088 by 0.054 to 0.057. Excretory vesicle small, its pore almost terminal.

Host: *Pomacanthus arcuatus*.

Site: intestine.

Locality: Guaniquilla, P. R.

Type specimen: Holotype No. 39311.

Hexangitrema breviceca resembles *H. pomacanthi* more than any other form but differs from that species in having lobed, somewhat separated testes, and short ceca that do not reach the posttesticular region.

Hexangitrema pricei n. sp. (FIGURES 13 and 14)

Description based on 5 specimens with characters of the genus. Body 3.56 to 4.42 long, 1.083 to 1.14 wide, notched posteriorly, rounded anteriorly. Cuticle thick, aspinose, parenchyma vesicular, eye-spot pigment present. Oral sucker 0.187 to 0.225 by 0.204 to 0.315, with inconspicuous retrodorsal pockets seen in living specimens only. Prepharynx 0.847 to 1.32 long; pharynx pyriform, 0.198 to 0.262 by 0.165 to 0.232; esophagus absent, intestinal bifurcation slightly anterior to midlevel of body; ceca wide, with

constrictions and undulations, ending blindly near posterior end of body. Lymph system apparently absent. Genital pore median, a short distance posterior to oral sucker; cirrus sac absent; seminal vesicle long, tubular, with posterior portion coiled within arch of ceca. Gonads well within posterior half of body: testes entire, close together in tandem, preovarian, 0.184 to 0.207 by 0.233 to 0.277; ovary subspherical, submedian, near posterior testis, 0.073 to 0.105 in diameter. Vitellaria confined to posterior half of body but not reaching ends of ceca, mainly extracecal but with a few follicles posterior to ovary. Seminal receptacle absent. Mehlis' gland to left of ovary. Uterus intercecal, may extend posterior to ovary a short distance before turning anteriorly as a sinuous tube as far as intestinal bifurcation, then almost straight, paralleling esophagus and seminal vesicle to open at genital pore; metraterm evidently not differentiated. Eggs few to fairly numerous, 0.069 to 0.073 by 0.046 to 0.049. Excretory vesicle small, with short canal to excretory pore situated subdorsally in notch at posterior end; from vesicle 2 main canals extend anteriorly and bifurcate at level of testes; the resultant canals continue anteriorly and form, by further divisions and anastomoses, the complex shown in FIGURE 13. Right and left halves of system connected by one or more commissures.

Host: *Pomacanthus arcuatus*.

Site: intestine.

Locality: off Puerto Real, P. R.

Type specimen: Holotype No. 39312.

Hexangitrema pricei differs from *H. pomacanthi* and *H. breviceca* in body size and shape, position of the gonads, extent of vitellaria, length of prepharynx, and size of the eggs.

Hexangitrema pomacanthi Price, 1937

Host: *Pomacanthus arcuatus*.

Site: intestine.

Locality: Guaniquilla, P. R.

Because the single specimen obtained was in poor condition the species is not illustrated here. It is readily differentiated from *H. breviceca* by the entire, contiguous testes and the long ceca, that extend well posterior to the testes. Price (1937) did not give explicit dimensions of the egg; we find its length to be 0.088 to 0.091 and width 0.059 to 0.062.

FAMILY PARAMPHISTOMATIDAE FISHOEDER, 1901

Cleptodiscus reticulatus Linton, 1910

Host: *Pomacanthus arcuatus*.

Site: large intestine.

Locality: Guaniquilla, P. R.

Eight amphistomes from one host are tentatively identified as the above species. As in many of our microscophiids, the worms shrivelled badly when cleared, yielding preparations too poor for critical study and description.

FAMILY HAPLOSPLANCHNIDAE POCHÉ, 1925

Schikhobalotrema manteri n. sp. (FIGURE 15)

Description based on 6 specimens with characters of the genus. Body 1.500 to 1.951 long, 0.337 to 0.420 wide, rounded anteriorly, tapering posteriorly. Cuticle aspinose. Eye-spot pigment present. Oral sucker 0.135 to 0.172 by 0.142 to 0.195. Ventral sucker 0.180 to 0.225 by 0.210 to 0.265, about one third body length from anterior end. Sucker ratio 1:1.3. Pharynx 0.082 to 0.112 by 0.090 to 0.105, esophagus short, cecum slender, its extent not observable. Testis elongate, rarely lobulated, 0.202 to 0.390 by 0.075 to 0.112, near posterior end of body. Genital pore ventral, about midway between suckers. Cirrus sac absent; seminal vesicle sinuous, tubular. Ovary entire, 0.075 to 0.157 by 0.068 to 0.082, submedian to left, postequatorial. Vitellaria filling most of available space from posterior margin of ventral sucker to or slightly posterior to testis; follicles small. Seminal receptacle small, spherical, posterior to, and slightly to left of, ovary. Uterus scanty, but extending well posterior to ovary. Eggs few, 0.056 to 0.061 by 0.041 to 0.043. Excretory system not observed.

Host: identified only as a "reef fish with a collar."

Site: intestine.

Locality: Punta Arenas, P. R.

Type specimen: Holotype No. 39313.

Schikhobalotrema manteri differs from all other species of the genus in the distribution of vitellaria, the relative position of the gonads, and the posterior extent of the uterus.

The genus *Schikhobalotrema* was erected by Skrjabin and Guschanskaja (1955) for species of the genus *Haplospplanchnus* which have extensive vitellaria, thereby restricting *Haplospplanchnus* to those which have sparse vitellaria. We have accepted this arrangement, but it would not be surprising to find intermediate species that would invalidate *Schikhobalotrema*.

Schikhobalotrema acuta Linton, 1910, Skrjabin and Guschanskaja, 1955
(FIGURE 16)

Synonyms:

Deradena acuta Linton, 1910.

Haplospplanchnus acutus (Linton) Manter, 1937.

Hosts: *Strongylura* sp., **Hyporhamphus unifasciatus*.

Site: intestine.

Locality: Punta Arenas, P. R.

Deposited specimen: No. 39314.

Our material differs from Manter's description in a few minor details of measurement and relative position of ovary and seminal receptacle. The egg size is slightly smaller.

The species for which Cable (1954a) determined the life history probably was *S. acuta*. On the basis of that study, La Rue (1957) considers the Haplospplanchnidae to be closely related to the echinostomes and fasciolids.

Schikhobalotrema pomacentri Manter, 1937, Skrjabin and Guschanskaja, 1955 (FIGURE 17)

Synonym:

Haplospalanchnus pomacentri Manter, 1937.

Host: **Pomacentrus fuscus*.

Site: intestine.

Locality: Punta Arenas, P. R.

Deposited specimen: No. 39315.

Schikhobalotrema obtusa Linton, 1910, Skrjabin and Guschanskaja, 1955 (FIGURE 18)

Synonyms:

Deradena obtusa Linton, 1910.

Haplospalanchnus obtusa (Linton) Manter, 1937.

Host: **Acanthurus bahianus*, *Sparisoma viride*.

Site: intestine.

Locality: Mona Island, P. R.

Deposited specimen: No. 39316.

Schikhobalotrema adbrachyura n. sp. (FIGURES 19 and 20)

Description based on 10 specimens with characters of the genus. Body 0.675 to 0.682 long, 0.262 to 0.292 in maximum width at level of ventral sucker. Cuticle aspinose. Eye-spot pigment present. Oral sucker 0.086 to 0.129 by 0.108 to 0.120. Ventral sucker 0.172 to 0.240 by 0.165 to 0.195, slightly posterior to midlevel. Sucker ratio 1:1.8. Prepharynx short, pharynx 0.046 to 0.058 by 0.067 to 0.086; cecum long, extending to posterior margin of ovary. Genital pore slightly to left of midline, midway between pharynx and ventral sucker. Seminal vesicle sinuous, tubular, not extending beyond midlevel of ventral sucker. Testis entire, 0.073 to 0.086 by 0.077 to 0.103, near posterior end of body. Ovary with 5 to 6 distinct lobes, closely anterior to testis. Seminal receptacle small, round, adjacent to ovary. Vitelline follicles small, scattered from pharyngeal region almost to posterior end of body. Uterus scanty, preovarian. Eggs very few, 0.079 by 0.068. Excretory vesicle sac-shaped; excretory pore terminal.

Host: *Sparisoma* sp.

Site: intestine.

Locality: Mona Island, P. R.

Type specimen: Holotype No. 39317.

Of the 11 species in the genus *Schikhobalotrema*, *S. adbrachyura* resembles most *S. brachyura* but differs from it in having a strongly lobed ovary and shorter seminal vesicle.

Some haplospalanchnids in addition to those reported above were found in the intestine of the rainbow parrotfish *Pseudoscarus quacamaia* and green parrotfish *Sparisoma viride* but were in too poor condition to be identified positively. In general, haplospalanchnids seem to deteriorate rapidly after the death of the host.

FAMILY ZOOGONIDAE ODHNER, 1911

Neozoogonus longicecus n. sp. (FIGURE 21)

Description based on 5 specimens with characters of the genus. Body flat, rounded at ends, 0.792 to 1.273 long, 0.310 to 0.369 in maximum width at level of ventral sucker. Cuticle spinose anteriorly, spines fading out posterior to ventral sucker. Oral sucker subterminal, 0.066 to 0.082 by 0.090 to 0.105. Ventral sucker 0.075 to 0.105 in diameter, anterior to intestinal bifurcation. Sucker ratio 1:1.2. Prepharynx 0.010 to 0.013 long, pharynx 0.037 to 0.061 in diameter, esophagus 0.260 to 0.330 long; ceca wide, extending to anterior end of excretory vesicle. Genital pore marginal, on right near level of ventral sucker. Cirrus sac large, arching posteromedially from genital pore; seminal vesicle with 2 spherical divisions; prostate well developed; pars prostatica tubular. Testes 2, entire, 0.090 to 0.120 by 0.076 to 0.105, nearly symmetrical, anterior to ovary. Ovary entire, 0.090 to 0.127 by 0.084 to 0.105, median, posterior to left testis. Vitellaria a compact mass posterior or posterolateral to ovary. Seminal receptacle large, on left, posterolateral to ovary. Laurer's canal present. Uterus tubular, its coils filling posterior region of body, with terminal portion passing between testes to join metraterm; metraterm muscular, with accessory seminal receptacle near genital pore. Eggs very numerous, 0.040 to 0.045 by 0.022 to 0.030, with the appearance of membranous sacs containing miracidia in all stages of development. Excretory vesicle short, sac-shaped; excretory pore terminal, without evident sphincter.

Host: *Mulloidichthys martinicus*.

Site: intestine.

Locality: Puerto Real, P. R.

Type specimen: Holotype No. 39318.

Neozoogonus malacanthi n. sp. (FIGURE 22)

Description based on 2 specimens with characters of the genus. Body 0.615 to 0.892 long, 0.232 to 0.262 wide, ends rounded. Cuticle with large, scalelike spines, numerous anteriorly, becoming more scattered towards posterior end. Eye-spot pigment absent. Oral sucker terminal, 0.073 to 0.086 by 0.098 to 0.099. Ventral sucker about one third body length from anterior end, median, 0.077 to 0.092 in diameter. Sucker ratio 1:0.97. Prepharynx short, pharynx 0.046 to 0.058 in diameter, esophagus very long, intestinal bifurcation well posterior to ventral sucker, immediately anterior to left testis; ceca moderately wide, extending into posterior one fourth of body. Genital pore submarginal, on left, posterior to level of ventral sucker. Cirrus sac large, arcuate, extending from genital pore almost to right margin of body; seminal vesicle tubular, pars prostatica spherical, prostate cells well developed. Testes 2, entire, 0.072 to 0.103 by 0.087 to 0.116, at about midlevel, oblique, with left testis anteriormost. Ovary entire, 0.094 to 0.108 by 0.062 to 0.086, submedian, posterior to left testis. Seminal receptacle spherical, posterior to ovary. Vitellaria a compact mass dorsal to, and to right of, ovary. Uterus extensive, tubular, occupying postovarian region,

overlapping ceca; metraterm distinct, muscular, arching anterior to distal end of cirrus sac to approach genital atrium; recurrent segment with distinct accessory seminal receptacle. Eggs numerous, with membranous shells, 0.053 to 0.060 by 0.032 to 0.037. Excretory vesicle sac-shaped, small; excretory pore terminal, without evident sphincter.

Host: *Malacanthus plumieri*.

Site: esophagus and intestine.

Locality: Mona Island, P. R.

Type specimen: Holotype No. 39319.

We have assigned the 2 preceding species to the genus *Neozoogonus* Arai, 1954, because they are in closer agreement with *N. californicus* than other zoogonids. However, generic distinctions in these trematodes are not well defined. The so-called accessory seminal receptacle has been described for some species of both *Zoogonus* and *Zoogonoides* but not for others, and the level of the intestinal bifurcation and length of ceca are features of questionable validity in separating genera. Recognized for the time being, the genus *Neozoogonus* includes *N. californicus* and the 2 species above, which may be differentiated by the shape and position of the oral sucker, course of the metraterm, position of the genital pore, size of eggs, and shape of the seminal vesicle. The extent to which the last feature differs in the 3 is greater than is usually encountered in a single genus as is also the reversed position of the genital pore in *N. longicecus* and *N. malacanthi*.

Steganoderma atherinae (Price, 1934) Manter, 1947 (FIGURE 23)

Synonyms:

Lecilhostaphylus atherinae Price, 1934.

Steganoderma (L.) *atherinae* (Price) Yamaguti, 1953.

Host: **Hepselia stipes*.

Site: intestine.

Locality: Punta Arenas, P. R.

Deposited specimen: No. 39320.

Diplangus anoplosus n. sp. (FIGURE 24)

Description based on a single specimen with characters of the genus. Body rounded anteriorly, tapering posteriorly, 1.427 long, 0.400 wide, ventral surface with a fold. Cuticle smooth, eye-spot pigment absent. Oral sucker almost terminal, 0.153 by 0.167. Ventral sucker at midlevel of body, 0.240 by 0.247. Sucker ratio 1:1.5. Prepharynx very short; pharynx 0.100 by 0.120; esophagus 0.092 long; ceca swollen, ending blindly and extending to midlevel of posterior testis. Genital pore submedian, ventral to pharynx. Cirrus sac very delicate, thin-walled; seminal vesicle bipartite, pars prostatica well developed; prostate cells sparse. Testes 2, contiguous, entire, slightly diagonal, postovarian, 0.116 to 0.139 by 0.112 to 0.131. Ovary entire, contiguous with anterior testis, median, 0.102 by 0.108. Seminal receptacle small, between ventral sucker and ovary. Vitelline follicles numerous, in lateral fields, from base of oral sucker to anterior margin of ventral sucker. Laurer's canal present. Uterus voluminous,

occupying all available space posterior to testes; metraterm simple. Eggs numerous, 0.027 to 0.029 by 0.015 to 0.018. Excretory vesicle I-shaped, extending to ventral sucker; excretory pore almost terminal.

Host: *Ocyurus chrysurus*.

Site: intestine.

Locality: Cabo Rojo, P. R.

Type specimen: Holotype No. 39321.

The above species differs from the 3 others that have been assigned to the genus *Diplangus* Linton, 1910, in having numerous vitelline follicles situated at the sides of the forebody rather than 6 to 13 follicles lateral and posterior to the ventral sucker.

FAMILY BIVESICULIDAE YAMAGUTI, 1939

Bivesicula hepsetiae Manter, 1947 (FIGURE 25)

Host: *Hepsetia stipes*.

Site: intestine.

Locality: Punta Arenas and Parguera, P. R.

There must be other bivesiculids in fishes of the region since 6 species of furcocystocercous cercariae, which are larvae of that group, were found in Puerto Rican snails. The life history apparently is completed by fishes eating the cercariae; immature bivesiculids were found in the intestine of several species of fishes in which the parasites evidently were unable to develop to maturity. From the number of such fishes, it seems that the bivesiculids have a high degree of host specificity.

FAMILY MICROPHALLIDAE TRAVASSOS, 1921

Megalophallus diodontis n. sp. (FIGURE 26)

Description based on 4 specimens with characters of the genus. Body pyriform or oval, 0.990 to 1.128 long, 0.646 to 0.759 wide. Cuticle spinose, with spines fading out posterior to ventral sucker. Oral sucker 0.055 to 0.064 by 0.058 to 0.078. Ventral sucker almost equatorial, 0.085 to 0.138 by 0.099 to 0.151. Sucker ratio 1:1.8. Prepharynx longer than pharynx, pharynx 0.022 to 0.030 in diameter, intestinal bifurcation about midway between pharynx and ventral sucker, ceca very short, extending but little posterior to bifurcation, with epithelial lining. Genital pore to left of ventral sucker. Cirrus sac absent, seminal vesicle a large sac lying transversely anterior to ventral sucker, slightly overlapping it dorsally; prostate cells form a conspicuous mass at left end of vesicle; pars prostatica tubular, ejaculatory duct opens into base of a large cuplike male copulatory organ, the rim of which bears 12 to 19 papillae. Genital atrium spacious to accommodate male organ. Testes entire, 0.125 to 0.184 by 0.178 to 0.264, symmetrically placed at beginning of hindbody. Ovary entire, 0.099 to 0.184 by 0.132 to 0.204, equatorial, anterior to right testis, usually between it and seminal vesicle, and slightly overlapping ventral sucker dorsally. Seminal receptacle absent, oviduct observed in living specimens to have an almost imperceptible enlargement serving as a fertilization chamber. Laurer's canal and Mehlis'

gland present. Vitellaria poorly defined, immediately posterior to testes. Uterus voluminous, occupying almost all available space in the hindbody and extend into forebody on each side but not reaching level of ceca or crossing forebody. Metraterm a very conspicuous, pocketed mass posterolateral to male copulatory organ, folded on itself and joining genital atrium at genital pore. Eggs numerous, 0.019 to 0.024 by 0.012 to 0.013. Excretory vesicle V- to U-shaped, with arms extending almost to testes, each receiving at the tip a main canal, which divides somewhat posterior to level of ventral sucker to form an anterior and posterior secondary tubule. Each secondary tubule with 2 groups of 2 flame cells each, so that the flame cell formula is $2[(2 + 2) + (2 + 2)]$. Excretory pore terminal, without evident sphincter.

Hosts: *Diodon hystrix*, *Spheroides testudineus*.

Site: intestine.

Locality: Punta Arenas, P. R.

Type specimen: Holotype No. 39322.

Life History: *Cercaria caribbea* XXVI developing in sporocysts in *Cerithium variable*; metacercariae in the blue crab, *Callinectes* sp.

The genus *Megalophallus* was erected by Cable *et al.* (in press) for *M. pentadactylus* from shore birds in Puerto Rico. The genus is distinguished from other microphallids by the opening of the ejaculatory duct into the expanded lumen of a male copulatory organ bearing small papillae and by the complex metraterm. *M. diodontis* differs from *M. pentadactylus* in body size and in having the margin of the male copulatory organ entire rather than lobed.

The present study reports for the first time adult microphallids from marine fishes. It is surprising that they have not been found before because of the apparent lack of host specificity among these trematodes. The metacercaria of *M. diodontis* as in other microphallids, has fully formed adult structures and requires but a short time in the definitive host to become ovigerous. In fact, when an infected crab was killed and left at room temperature for several hours it was found that the metacercariae had produced eggs in considerable numbers. For that reason it might be expected that the adult could occur in any vertebrate that ingests the second intermediate host. However, *M. diodontis* was never found in a number of birds collected from Punta Arenas where infected crabs were especially abundant.

Carneophallus lactophrysi n. sp. (FIGURE 27)

Description based on 33 specimens with characters of the genus. Body linguiform, 0.732 to 1.023 long, 0.297 to 0.396 wide. Cuticle spinose to, or slightly posterior to, testes. Oral sucker 0.060 to 0.087 by 0.081 to 0.097. Ventral sucker posterior to midlevel, median, 0.055 to 0.075 in diameter. Sucker ratio 1:0.89. Prepharynx short but distinct, pharynx 0.030 to 0.043 in diameter, esophagus 0.224 to 0.363 long; intestinal bifurcation near midlevel of body, ceca short, with epithelial lining, not extending posterior to midlevel of ventral sucker. Genital pore to left of that sucker. Cirrus sac absent, seminal vesicle large, saclike anterior to ventral sucker, usually overlapping it dorsally; pars prostatica well developed, surrounded by

prostate cells. Male copulatory organ a conspicuous muscular structure filling the spacious genital atrium, with a dorsal and a ventral lobe, not bearing papillae or spines. Ejaculatory duct a narrow, sinuous tube, piercing ventral lobe to open at its tip. Testes 2, 0.066 to 0.105 by 0.090 to 0.135, irregular, symmetrical, or left testis somewhat posterior to right. Ovary entire, 0.061 to 0.077 by 0.070 to 0.104, anterior to right testis, usually overlapping ventral sucker dorsally. Seminal receptacle absent. Laurer's canal and Mehlis' gland present. Vitelline follicles in 2 racemose groups, posterior to or slightly overlapping testes. Uterus scanty, confined to hind-body; metraterm simple, entering genital atrium posterodorsally. Eggs few, 0.019 to 0.021 by 0.012 to 0.013. Excretory vesicle broadly V- to Y-shaped, arms not overreaching testes; excretory pore terminal, without evident sphincter.

Host: *Lactophrys bicaudalis*.

Site: intestine.

Locality: Cabo Rojo, P. R.

Type specimen: Holotype No. 39323.

The genus *Carneophallus* was erected by Cable and Kuns (1951) for *C. trilobatus* from a Mexican insect hawk and *C. pseudogonotylus* Chen, 1944 from the domestic duck in China. There are 3 other species: *C. muellhaupti* Coil, 1956, from a sanderling; *C. turgidus* Leigh, 1958, from a racoon in South Florida; and *C. bilobatus* Cable *et al.* (in press) from a sandpiper in Puerto Rico. *C. lactophrysi* resembles *C. pseudogonotylus* and *C. bilobatus* in having a bilobed male copulatory organ, but differs from both species in the form of that organ and in having the ejaculatory duct pierce the ventral rather than the dorsal lobe.

FAMILY CRYPTOGONIMIDAE CIUREA, 1933

Siphodera vinalwardsii (Linton, 1901) Linton, 1910 (FIGURE 28)

Synonym:

Monostomum vinalwardsii Linton, 1901.

Hosts: **Lulianus synagris*, **L. analis*.

Site: intestine.

Locality: Punta Arenas, P. R.

Siphodera vinalwardsii is an unusual species in that it occurs in shallow-water fishes from the Caribbean to Massachusetts. Our specimens from Puerto Rico were lost but not until they had been prepared as whole mounts and compared with material from Woods Hole, Mass., with no differences being found. In its southern range, the species changes its definitive host from the toadfish to species of *Lulianus* but has a very closely related if not identical molluscan intermediate host if *Cercaria caribbea XIII* Cable, 1956, is its larva. Further comparison of that cercaria with detailed, unpublished notes on the larva of *S. vinalwardsii* in the Woods Hole region shows complete agreement.

Paracryptogonimus neoamericanus n. sp. (FIGURE 29)

Description based on 17 specimens with characters of the genus. Body linguiform, rounded at ends, 0.640 to 0.884 long, 0.349 to 0.488 wide at

level of testes. Cuticle with very fine spines. Eye-spot pigment present. Oral sucker terminal, 0.099 to 0.145 by 0.118 to 0.151, with 46 to 51 circumoral spines 0.018 to 0.020 long. Ventral sucker 0.082 to 0.099 by 0.092 to 0.118, to right of midline, enclosed in ventrogenital sac with diameter of opening about that of sucker. Sucker ratio 1:0.67. Prepharynx short, pharynx 0.045 to 0.059 by 0.060 to 0.085, esophagus short, ceca wide, extending almost to posterior end of body. Genital pore within ventrogenital sac, immediately anterior to ventral sucker; genital atrium very short. Cirrus sac absent, seminal vesicle elongate, bipartite, dorsal to, or deflected to side of, ventral sucker; pars prostatica small, surrounded by inconspicuous prostate cells; ejaculatory duct short; gonotyl absent. Testes 2, 0.112 to 0.138 by 0.099 to 0.151, subspherical to oval, symmetrical, just postequatorial, overlapping ceca. Ovary extensively lobed, about equatorial, slightly pre-testicular. Seminal receptacle large, immediately posterior to seminal vesicle, dorsal to ovary. Laurer's canal present. Vitellaria in 2 lateral groups of follicles at ovarian level, overlapping ceca and, to some extent, testes. Uterus except terminal limb postovarian, between and slightly overlapping ceca, extending almost to posterior end of body. Eggs very numerous, 0.016 to 0.018 by 0.010 to 0.015. Excretory vesicle Y-shaped, with wide stem and long arms reaching pharyngeal region; excretory pore terminal.

Hosts: *Ocyurus chrysurus*, *Lutianus aya*.

Site: intestine.

Locality: Cabo Rojo, P. R.

Type specimen: Holotype No. 39324.

The first species of its genus to be reported outside the Pacific, *Paracryptogonimus neoamericanus*, resembles *P. americanus* Manter, 1940, in sucker ratio, topography of the gonads and vitellaria, and extent of the uterus and form of the ceca, but differs from *P. americanus* in being a much smaller species and in having fewer circumoral spines, a terminal oral sucker and smaller eggs. In certain of these respects, *P. neoamericanus* is more like *P. acanthostomus* Yamaguti, 1934, but that species is still significantly larger than *P. americanus* and has longer eggs, a different arrangement of the gonads, and a more compact ovary.

Paracryptogonimus centropomi n. sp. (FIGURE 30)

Description, based on a single whole mount and notes on 2 additional specimens studied alive but lost during processing, with characters of the genus. Body elongated, spatulate, 0.851 long, 0.343 wide, rather uniformly wide throughout, broadly rounded posteriorly, less so anteriorly. Entire cuticle spinose. Eye-spot pigment present. Oral sucker subterminal, 0.060 by 0.069, retractable into a body fold, circumoral spines 64, very small, when oral sucker retracted appearing in 2 rows that blend into a single one when sucker is protracted. Ventral sucker spherical, 0.052 in diameter, enclosed in ventrogenital sac. Sucker ratio 1:0.78. Prepharynx short, pharynx spherical, 0.035 to 0.039 in diameter; esophagus short, ceca simple, arching widely in forebody and then curving medially in hindbody; their posterior extent obscured by eggs. Genital pore median, within ventrogenital

sac, immediately anterior to ventral sucker. Gonotyl and cirrus sac absent. Seminal vesicle massive, bipartite; prostatic complex poorly developed. Testes 2, oval, 0.147 to 0.173 by 0.107 to 0.127, extracecal, symmetrical, slightly anterior to midlevel. Ovary transversely elongate, strongly lobed, spanning intercecal space immediately anterior to testes. Seminal receptacle anterodorsal to, and to right of ovary; contiguous with seminal vesicle. Vitelline follicles in 2 lateral clusters, 1 anterior to each testis, joined by transverse vitelline duct. Uterus voluminous, nearly filling available space posterior to testes. Eggs numerous, pyriform, opercular end narrowed, 0.018 to 0.019 by 0.010 to 0.012. Excretory vesicle probably as in preceding species.

Host: *Centroponus ensiferus*.

Site: intestine.

Locality: Guanajibo, P. R.

Type specimen: Holotype No. 39325.

Paracryptogonimus centropomi is distinguished from other species of its genus by the large number and small size of circumoral spines, topography of gonads, and the relatively small suckers in comparison with body size. The retraction of the oral sucker with an infolding of the body in this species is suggestive of the genus *Metadena*. It may well be that *Cercaria caribbea* XIV Cable, 1956, which has that distinctive feature, is the larva of *P. centropomi*.

Metadena adglobosa Manter, 1947 (FIGURES 31 to 33)

Hosts: *Lutianus apodus*, *L. griseus*.

Site: intestine.

Locality: Punta Arenas, P. R.

Deposited specimen: No. 39326.

Life history: *Cercaria caribbea* XV Cable, 1956, developing in *Cerithium variable*; metacercariae in tissues of *Gerres cinereus*; no pigmentation response.

FAMILY GORGODERIDAE Looss, 1901

Xystretrum solidum Linton, 1910 (FIGURE 34)

Synonyms:

Catoptroides aluterae MacCallum, 1919.

Catoptroides magnus MacCallum, 1917.

Xystretrum papillosum Linton, 1910.

Macia pulchra Travassos, 1921.

†*Xystretrum pulchrum* (Travassos) Manter, 1947.

Host: **Lactophrys bicaudalis*.

Site: urinary bladder.

Locality: Cabo Rojo, P. R.

Three species of *Xystretrum*, namely, *X. solidum*, *X. pulchrum*, and *X. caballeroi* have been described. Manter (1947) remarked on the difficulty of distinguishing the first 2; the present specimen combines the characters

† New synonymy.

that have been used to separate them. For that reason *X. pulchrum* is here reduced to synonymy with *X. solidum*.

FAMILY MONORCHIIDAE ODHNER, 1911

Genolopa longicaudata n. sp. (FIGURE 35)

Description based on 3 specimens with characters of the genus. Body 0.851 to 0.963 long, 0.136 to 0.264 wide, with broadly rounded ends, forebody with vermiform cutaneous glands. Cuticle spinose, eye-spot pigment absent. Oral sucker 0.040 to 0.052 by 0.054 to 0.067, subterminal. Ventral sucker 0.030 to 0.039 by 0.037 to 0.042, submedian, at about one fifth body length from anterior end. Sucker ratio 1:0.68. Prepharynx very short, pharynx 0.021 to 0.031 in diameter, esophagus short, intestinal bifurcation about midway between suckers, ceca simple, concealed by eggs posteriorly and their extent not observable in whole mounts. Genital pore median, immediately anterior to ventral sucker; genital atrium spinose. Cirrus sac extending posteriorly from genital pore as far as ovarian level, containing seminal vesicle, prostate cells, tubular pars prostatica, and spined cirrus. Testis single, irregular, 0.127 to 0.150 by 0.082 to 0.112, to right of midline, about equatorial, partly concealed by eggs. Ovary entire, 0.076 to 0.109 by 0.075 to 0.082, on right immediately anterior to testis. Seminal receptacle absent. Vitelline follicles large, in 2 lateral groups a little longer than ovary, at or slightly anterior to its level, depending on contraction of the worm. Uterus voluminous, occupying all available space posterior to testis, then with convolutions extending anteriorly in mid-region to enter metraterm sac at junction of its spiny anterior, and vesicular posterior divisions. Metraterm sac large, about two thirds as long as cirrus sac, extending posteriorly to left of ventral sucker. Eggs very numerous, 0.015 to 0.018 by 0.010 to 0.012. Excretory system not observed.

Host: *Odontoscion dentex*.

Site: intestine.

Locality: Punta Arenas, P. R.

Type specimen: Holotype No. 39327.

Genolopa longicaudata resembles *G. pisodontophidis* (Yamaguti, 1938) Skrjabin, 1955, in most respects but differs from that species in length of the hindbody, position of the genital pore, extent of vitellaria, and size of eggs.

Genolopa ampullacea Linton, 1910 (FIGURE 36)

Host: *Haemulon plumieri*.

Site: intestine.

Locality: Boqueron Bay, P. R.

Deposited specimen: No. 39328.

Hurleytrematoides chaetodoni (Manter, 1942) Yamaguti, 1953 (FIGURE 37)

Synonym:

Hurleytrema chaetodoni Manter, 1942.

Host: *Chaetodon capistratus*.

Site: intestine.

Locality: Puerto Real, P. R.

Deposited specimen: No. 39329.

Pseudohurleytrema eucinostomi (Manter, 1942) Yamaguti, 1953
(FIGURE 38)

Synonym:

Hurleytrema eucinostomi Manter, 1942.

Host: **Gerres cinereus*.

Site: intestine.

Localities: Punta Arenas, Boqueron Bay and Cabo Rojo, P. R.

Deposited specimen: No. 39330.

Postmonorchis orthoprists Hopkins, 1941 (FIGURES 39 and 40)

Host: **Haemulon plumieri*.

Site: intestine.

Locality: Boqueron Bay, P. R.

Deposited specimen: No. 39331.

Our specimens of *Postmonorchis orthoprists*, all from a single fish, are much smaller in body size than those described by Hopkins (1941), but otherwise they are in fairly close agreement with his material. Certain ones resemble his specimen more than the one from which FIGURE 39 was drawn.

FAMILY FELLODISTOMATIDAE NICOLL, 1913

Tergestia laticollis (Rudolphi, 1819) Stossich, 1899 (FIGURES
41 and 42)

Synonyms:

Distoma laticolle Rudolphi, 1819.

Pharyngora polonii Molin of Olsson, 1869.

Hosts: *Euthynnus alleletteratus*, **Selene vomer*, **Anchoviella epsetus*.

Site: intestine.

Localities: Parguera, Punta Arenas, Boqueron Bay, and Playa Mani,
P. R.

Deposited specimen: No. 39332.

The flame cell pattern was observed in 2 immature specimens belonging to the genus *Tergestia*. One from *Gerres cinereus* had the pattern described for *T. laticollis* by Hopkins (1940), but in the other, a much smaller specimen from *Selene vomer*, the formula was $2[(1 + 2) + (1 + 2)]$. It is possible that both were *T. laticollis* and that with further development their excretory patterns would agree. However, the presence of 14 cephalic lobes in one and 13 in the other suggests that they may be distinct species, further differentiation of which must await the discovery of mature individuals.

Tergestia pectinata (Linton, 1905) Manter, 1940 (FIGURE 43)

Synonyms:

Distomum pectinatum Linton, 1905.

Theledera pectinata (Linton) Linton, 1910.

Host: *Chloroscombrus chrysurus*.

Site: intestine.

Locality: Playa Mani, P. R.

Deposited specimen: No. 39333.

Antorchis holacanthi n. sp. (FIGURE 44)

Description based on 30 specimens with characters of the genus. Body 0.792 to 0.924 long, 0.316 to 0.468 wide, oval to pyriform or broadly fusiform with anterior end rounded and posterior end more acute; maximum width near level of testes. Entire cuticle with spines, less numerous posteriorly. Eye-spot pigment absent. Oral sucker terminal, 0.151 to 0.158 by 0.138 to 0.151, oval to pyriform. Ventral sucker subspherical, in posterior half of body, 0.105 to 0.138 in diameter. Sucker ratio 1:0.81. Prepharynx absent, pharynx 0.028 to 0.049 by 0.048 to 0.060, esophagus slender, 0.112 to 0.151 long; ceca short, divergent, with ends slightly swollen, not extending posterior to vitellaria. Genital pore very close to, or encroaching on, anterior border of ventral sucker, appearing in some specimens to open into its cavity. Cirrus sac well developed, inverted U-shaped, arching dorsally from genital pore to left or right; its basal portion overlapping level of ventral sucker and containing a bipartite seminal vesicle; remainder of the cirrus sac occupied by conspicuous prostatic complex. Testes 2, smooth, symmetrical, anterolateral to ventral sucker, 0.099 to 0.125 by 0.085 to 0.112. Ovary smooth, to right of midline, 0.079 to 0.099 in diameter, overlapping ventral sucker posterolaterally. Seminal receptacle large, posterolateral to ovary, overlapping it dorsally. Laurer's canal extends posteriorly from female complex to open dorsally near posterior end at a prominent opening. Vitellaria in 2 lateral clusters of follicles in forebody, from pharyngeal level to ends of ceca. Uterus largely in hindbody, but may extend anteriorly on each side to, or slightly beyond, testes; metraterm not differentiated. Eggs numerous, 0.029 to 0.033 by 0.015 to 0.017. Excretory vesicle V-shaped, with long arms extending to level of ceca; excretory pore terminal, without sphincter.

Hosts: *Holacanthus tricolor*, *H. ciliaris*.

Site: ceca.

Locality: Parguera, P. R.

Type specimen: Holotype No. 39334.

Of the previously described species of *Antorchis*, *A. holacanthi* differs from *A. urna* in general shape and size of the body and pharynx, form of vitellaria, position of the testes, extent of uterus, and shape of the oral sucker. It differs from *A. lintoni* Travassos *et al.*, 1928, in sucker ratio, length of esophagus, size of the pharynx, extent of the ceca, and position of the genital pore. Their description of *A. lintoni* does not mention the structure and shape of the cirrus sac, which is a characteristic feature of this genus, nor did they state that a seminal receptacle was present.

Antorchis urna (Linton, 1910) Linton, 1911 (FIGURES 45 and 46)

Synonym:

Mesorchis urna Linton, 1910.

Hosts: *Poamacanthus arcuatus*.

Site: intestine.

Locality: off Puerto Real; Guaniquilla, P. R.

Deposited specimen: No. 39335.

Our material of *A. urna* agrees rather closely with previous descriptions of that species. However, the muscular lining of the genital atrium is reflected over the end of the cirrus sac, giving it an annulated appearance described as a spined cirrus by Manter (1947).

Megalomyzon robustum Manter, 1947

Host: **Diodon hystrix*.

Site: intestine.

Locality: Guánica, P. R.

The single immature specimen found does not permit an adequate figure.

The next trematode has features of the family Monorchidae but is placed in the Fellodistomatidae because it agrees with members of that family in every respect except in having a single testis and because it lacks the highly developed metraterm and structure of the cirrus sac characteristic of monorchids. It thus is necessary to erect for the species a new genus which is defined as follows:

Infundibulostomum n. g.

Diagnosis: Fellodistomatidae. Distomes with spinose cuticle; eye-spot pigment absent. Oral sucker funnel-shaped or pyriform. Prepharynx short; pharynx present; esophagus fairly long; intestinal bifurcation anterior to ventral sucker; ceca not extending far into hindbody, with epithelial lining. Genital pore median or submedian, immediately anterior to ventral sucker. Cirrus sac arcuate, seminal vesicle bipartite, prostatic complex well developed. Testis single, postovarian. Ovary smooth or irregular. Seminal receptacle present. Vitellaria in two groups of follicles near ovarian level. Uterus voluminous, metraterm simple. Eggs small. Excretory vesicle V-shaped. Parasites of marine fishes. Type and only species:

Infundibulostomum spinatum n. g., n. sp. (FIGURE 47)

Description based on 11 specimens with characters of the genus. Body elongate oval, broadly rounded anteriorly, more pointed posteriorly, 0.414 to 0.673 long, 0.213 to 0.293 wide. Oral sucker 0.112 to 0.123 by 0.112 to 0.149. Ventral sucker spherical, near midlevel of body, 0.054 to 0.063 in diameter. Sucker ratio 1:048. Prepharynx short, pharynx subspherical, 0.029 to 0.034 in diameter; ceca simple, terminating at posterior level of vitelline follicles. Cirrus sac large, broad, arching dorsolaterally from genital pore, with base slightly overlapping posterior margin of ventral sucker or not, and containing a massive prostatic complex and small saclike seminal vesicle; some specimens with what appears to be a still smaller external

seminal vesicle. Testis entire, median or submedian, just within posterior half of body, 0.049 to 0.100 by 0.085 to 0.103. Ovary entire to irregular, 0.060 to 0.089 by 0.054 to 0.066, diagonally anterior to, and contiguous with testis. Seminal receptacle small, dorsal, anterior to ovary. Vitelline follicles large, in 2 lateral clusters in dorsal part of body at level of ovary and joined by inconspicuous vitelline duct at or slightly anterior to level of ovary. Laurer's canal not observed. Uterus occupies nearly all available space posterior to gonads. Eggs very numerous, 0.020 to 0.023 by 0.010 to 0.014. Excretory pore subterminal, without evident sphincter.

Host: *Haemulon flavolineatum*.

Site: intestine and stomach.

Locality: Mona Island, P. R.

Type specimen: Holotype No. 39336.

Proctoeces neomagnorus n. sp. (FIGURE 48)

Description based on a single specimen with characters of the genus. Body subcylindrical, 3.40 long, 0.74 wide. Cuticle smooth, eye-spot pigment absent. Oral sucker 0.50 in diameter, ventral sucker 0.394 by 0.414. Prepharynx very short, pharynx 0.152 by 0.146, esophagus 0.116 long, ceca long but not reaching posterior end of body. Genital pore immediately anterior to ventral sucker. Cirrus sac curved, extending slightly posterior to that sucker; cirrus muscular; pars prostatica long, tubular, surrounded by prostatic cells; seminal vesicle subspherical. Testes 2, tandem, entire, near midlevel of hindbody, 0.267 to 0.30 by 0.253 to 0.293. Ovary entire, near posterior edge of ventral sucker, 0.160 by 0.207. Seminal receptacle absent. Vitelline follicles small, scattered in 2 lateral fields from ovary to anterior testis. Uterus fills most available space in hindbody. Eggs thin-shelled, mostly collapsed, 0.033 to 0.049 by 0.013 to 0.022. Excretory system not observed.

Host: *Acanthurus caeruleus*.

Site: intestine.

Locality: Parguera, P. R.

Type specimen: Holotype No. 39337.

Although having the same sucker ratio as *P. magnorus*, *P. neomagnorus* differs from that species in size of the body, suckers, and pharynx and the shape of the seminal vesicle which usually is a constant feature of trematodes. It is a long, coiled tube in *P. magnorus* in contrast to the short, almost spherical, sac in *P. neomagnorus*.

Proctoeces lintoni n. sp. (FIGURE 49)

Description based on 2 specimens with characters of the genus. Body cylindrical, 1.634 to 1.968 long, 0.567 to 0.640 wide. Cuticle smooth, eye-spot pigment absent. Oral sucker terminal, 0.20 to 0.207 by 0.267. Ventral sucker 0.260 to 0.273 by 0.30 to 0.354, in fleshy protuberance about one third body length from anterior end. Sucker ratio 1:1.25. Prepharynx absent, pharynx 0.160 to 0.180 in diameter, esophagus very short; ceca

swollen, extending almost to posterior end of body. Genital pore submedian, about midway between ventral sucker and pharynx. Cirrus sac curved, extending slightly posterior to ventral sucker; cirrus short, muscular; pars prostatica long, tubular, surrounded by prostate cells; seminal vesicle bipartite, anterior division a long coiled tube, posterior division saclike. Testes 2, entire, close together, diagonal to almost tandem, within anterior half of hindbody, 0.153 to 0.233 in diameter. Ovary entire, submedian, near anterior testis, 0.127 to 0.167 by 0.113 to 0.133; seminal receptacle absent. Vitelline follicles sparse, confined to, and confluent in, zone of gonads. Uterus filling space posterior to ovary; metraterm simple. Eggs numerous, 0.054 to 0.057 by 0.015 to 0.018. Excretory vesicle Y-shaped with stem reaching testicular level; pore subterminal dorsally.

Host: *Calamus calamus*.

Site: intestine.

Locality: Cabo Rojo, P. R.

Type specimen: Holotype No. 39338.

Proctoeces lintoni agrees with *P. subtenue* except in having a bipartite seminal vesicle. We have reexamined Linton's material of *P. subtenue*, and Hanson has done the same with her specimens and those collected by Manter. All have found the seminal vesicle to be unipartite in *P. subtenue*.

FAMILY ACANTHOCOLPIDAE LÜHE, 1909

Stephanostomum coryphaenae Manter, 1947 (FIGURES 50 and 51)

Host: *Coryphaena hippurus*.

Site: intestine.

Locality: Mona Passage, P. R.

Deposited specimen: No. 39339.

Stephanostomum dentatum (Linton, 1901) Linton, 1940 (FIGURES 52 and 53)

Synonyms:

Distomum dentatum Linton, 1901.

Stephanochasmus dentatus (Linton) Manter, 1931.

Echinostephanus pagrosomi Yamaguti, 1939.

Stephanostomum pagrosomi (Yamaguti) Manter, 1947.

Host: **Epinephelus striatus*.

Site: intestine.

Locality: Cabo Rojo, P. R.

Deposited specimen: No. 39340.

Stephanostomum casum (Linton, 1910), McFarlane, 1936 (FIGURES 54 and 55)

Synonyms:

Stephanochasmus casum Linton, 1910.

Lechradena edentula Linton, 1910.

Host: **Lutianus analis*.

Site: intestine.

Locality: Parguera, P. R.

Deposited specimen: No. 39341.

Stephanostomum sentum (Linton, 1910) Manter, 1947 (FIGURES 56 and 57)

Synonym:

Stephanochasmus sentus, Linton 1910.

Hosts: **Haemulon flavolineatum*, **Calamus arcifrons*, **Gerres cinereus*.

Site: intestine.

Localities: Cabo Rojo and Mona Island, P. R.

Deposited specimen: No. 39342.

The presence of the uroproct in *S. sentum* was first observed by Manter (1947), but has not been observed for *S. minutum* Looss, 1901, to synonymy with which Caballero (1952) reduced *S. sentum*. That action seems unwarranted because of the much smaller body and eggs of *S. minutum*. Both Manter (1947) and Skrjabin (1954) have accepted *S. sentum* as a valid species.

Manteria brachydera (Manter, 1940) Caballero, 1950 (FIGURES 58 to 61)

Synonym:

Dihemistephanus brachyderus Manter, 1940.

Host: *Oligoplites saurus*.

Site: intestine.

Locality: Guanajibo, P. R.

Deposited specimen: No. 39343.

Our material is identified as *Manteria brachydera*, although it differs from that species, as described by Manter (1940a), in size of pharynx, number of circumoral spines, and extent of vitellaria. He also described the main excretory canal as dividing a short distance from the excretory vesicle but the especially close approach of the recurrent canal to the ascending one at that level (PLATE 9, FIGURE 60) could easily be mistaken for an actual junction of the 2. The system thus is stenostomate, just as Martin (1939) described for *S. tenue*, and apparently is typical of acanthocolpids.

FAMILY HAPLOPORIDAE NICOLL, 1914

Included in the collection are 2 species that have the characters of the genus *Megasolena* except that a suckerlike structure occupies the terminal end of the hermaphroditic sac near the genital pore, and the metraterm and ejaculatory duct remain separate until they approach the genital pore, whereas they unite well back in the sac in *Megasolena estrix*, as described by Manter (1935). To receive the 2 species the following genus is proposed:

Allomegasolena n. g.

Diagnosis: Haploporidae. Distome, with elongated body, cuticle spinose. Eye-spot pigment present. Prepharynx distinct, pharynx massive, larger than oral sucker, esophagus long, intestinal bifurcation immediately posterior to ventral sucker, ceca simple, extending to posterior end of body. Lymph system present. Genital pore median or slightly submedian, between pharynx and ventral sucker. Hermaphroditic sac not extending into hind-body, with muscular, suckerlike structure near genital pore, followed by conspicuous cell mass traversed by male and female ducts that do not unite

before entering suckerlike terminal organ. Male duct with a small internal seminal vesicle and pars prostatica followed by a simple ejaculatory duct. External seminal vesicle a narrow tube extending well into hindbody. Testes 2, entire, median, tandem, removed from posterior end of body. Ovary entire, median, pretesticular. Uterine seminal receptacle present. Vitelline follicles not reaching ventral sucker anteriorly, extending along and overlapping ceca almost to posterior end of body, confluent posterior to testes. Uterus preovarian, not extensive; metraterm simple. Eggs few to moderate in number, medium in size. Parasites of marine fishes. Type species: *Allomegasolena spinosa* n. sp. Includes also: *Allomegasolena attenuata* n. sp.

Allomegasolena spinosa n. g., n. sp. (FIGURES 62 and 63)

Description based on 3 mature and 2 immature specimens with characters of the genus. Body 1.400 to 2.521 long, 0.253 to 0.267 wide, elongate, rather uniformly wide, ends rounded. Anterior half with spinose cuticle. Oral sucker terminal or subterminal, 0.100 to 0.120 by 0.113 to 0.180. Ventral sucker 0.127 to 0.200 in diameter. Sucker ratio 1:1.1. Prepharynx muscular, 0.100 to 0.133 long; pharynx 0.120 to 0.160 by 0.140 to 0.193, esophagus 0.267 to 0.367 long, ceca wide, broadly rounded at blind ends. Lymphatic system consists of 2 longitudinal channels on each side extending from oral sucker to posterior end of body; channels beyond ends of ceca provided with circular muscles and showing peristaltic movements in life. Genital pore about midway between ventral sucker and pharynx. Testes ovoid to slightly irregular, 0.167 to 0.253 by 0.120 to 0.180, somewhat posterior to midlevel. Ovary subspherical, 0.073 to 0.120 in diameter, a short distance from anterior testis. Laurer's canal not observed. Vitelline follicles large, extending from posterior end of seminal vesicle to posterior ends of ceca, overlapping them and confluent posterior to testes. Eggs few, 0.062 to 0.066 by 0.034 to 0.045. Excretory vesicle sac-shaped, extending almost to ovary in adults, to ventral sucker in immature specimens; main canals leave anterior end of vesicle and seem to extend to sides of oral sucker and then turn posteriorly; the system thus would be stenostomate. Excretory pore terminal, without evident sphincter.

Host: *Chaetodipterus faber*.

Site: intestine.

Locality: Puerto Real, P. R.

Type specimen: Holotype No. 39344.

Allomegasolena attenuata n. g., n. sp. (FIGURE 64)

Description based on 1 of 3 specimens found: with characters of the genus. Body 2.145 long, 0.297 wide, forebody narrow, tapering, hindbody cylindrical, ends somewhat pointed. Most of cuticular spines lost, but seen on one side of hindbody to extend to posttesticular level. Oral sucker subterminal, 0.063 to 0.069 in diameter. Ventral sucker in anterior third of body, 0.158 by 0.165. Sucker ratio 1:2.3. Prepharynx 0.217 long, pharynx 0.100 to 0.112 in diameter, esophagus 0.267 long, ceca somewhat expanded. Lymphatic system present, much as in preceding species. Hermaphroditic sac and genital opening immediately anterior to ventral sucker. Testes elongate oval,

0.231 to 0.297 by 0.158 to 0.165, entire, tandem. Seminal vesicle convoluted, extending well posterior to ventral sucker. Ovary a short distance from anterior testis, 0.099 to 0.105 in diameter. Vitelline follicles large, their distribution as in preceding species. Laurer's canal not observed. Uterus scanty; metraterm present. Eggs few, 0.051 to 0.066 by 0.030 to 0.041. Excretory system not observed.

Host: *Lutianus apodus*.

Site: intestine.

Locality: Punta Arenas, P. R.

Type specimen: Holotype No. 39345.

Allomegasolena attenuata differs from *A. spinosa* in body shape, sucker ratio, and size of pharynx.

Hapladena acanthuri n. sp. (FIGURE 65)

Description based on 2 specimens with characters of the genus. Body 2.963 to 4.620 long, 0.785 to 1.254 wide. Anterior half of cuticle spinose. Eye-spot pigment present. Oral sucker terminal, 0.264 to 0.310 by 0.224 to 0.376. Ventral sucker 0.217 to 0.297 in diameter, within anterior one third of body length. Sucker ratio 1:0.92. Prepharynx about 0.100 long, pharynx 0.138 to 0.217 in diameter, esophagus swollen, long; intestinal bifurcation dorsal to ventral sucker, ceca wide, extending almost to posterior end of body, contiguous in posttesticular zone. Lymphatic system with 4 longitudinal channels. Genital pore anterior to ventral sucker. Hermaphroditic sac elongated, extending a short distance posterior to ventral sucker; occupied largely by prostate cells and conspicuous metraterm joined by male duct near base of sac. External seminal vesicle tubular, with constriction at junction with hermaphroditic sac; within sac, male duct parallels metraterm for a short distance as an internal seminal vesicle then forms a small pars prostatica from which the ejaculatory duct crosses metraterm to join it. Testis 0.587 to 0.752 by 0.244 to 0.415, entire, elongate oval, decidedly postequatorial, with two vasa efferentia. Ovary 0.204 to 0.269 by 0.211 to 0.264, median, entire or slightly notched, pretesticular. Seminal receptacle apparently absent. Laurer's canal present. Vitelline follicles dendritic but still appearing more follicular than tubular, extending from level of ventral sucker to posterior end. Uterus preovarian; metraterm and hermaphroditic duct spinose. Eggs 0.054 to 0.057 by 0.036 to 0.041. Excretory system stenostomate, with main tubules reaching sides of oral sucker and returning to level of ventral sucker before branching.

Host: *Acanthurus caeruleus*.

Site: intestine.

Locality: Parguera, P. R.

Type specimen: Holotype No. 39346.

Of the species of *Hapladena* the one most like *H. acanthuri* is *H. varia*, which, however, differs from *H. acanthuri* in size of body and eggs, form of the vitellaria, extent of cuticular spination, and the spiny hermaphroditic duct.

The species shown in PLATE 10, FIGURE 66 cannot be placed in any family or genus as defined previous to this study. It resembles the Acanthocolpidae

and Lepocreadiidae but is closest to the Haploporidae as conceived by Manton (1957), differing from members of that family only in lacking the hermaphroditic sac. As a cirrus sac also is absent, the terminal gonoducts lie free in the parenchyma. Because modifications of these structures have been shown to be of less than family significance in certain other groups, the family Haploporidae is redefined as follows to include the new genus and species:

FAMILY HAPLOPORIDAE NICOLL, 1914 emended

Synonyms:

Megasolenidae.

Waretrematidae.

Diagnosis: Distomes with cuticle spinose or not. Eye-spot pigment usually present. Oral sucker terminal or subterminal, with or without 6 prominent conical papillae; prepharynx present; pharynx well developed; esophagus long; intestinal bifurcation dorsal or posterior to ventral sucker; length of ceca variable. Ventral sucker in anterior half of body. Testes usually one, sometimes 2 in tandem; median, in posterior half of body. Cirrus sac absent. Hermaphroditic sac present or absent; if present, with small internal seminal vesicle followed by an external one, and with prostatic complex, ejaculatory duct, and metraterm, which may join male duct either close to genital pore or at a distance from that opening. If absent, terminal gonoducts the same except that metraterm does not join male duct at a distance from genital pore, and both are free in parenchyma. Genital pore median, or submedian, between pharynx and ventral sucker. Ovary pretesticular. Seminal receptacle present or absent, of the uterine type. Laurer's canal present. Uterus pretesticular and usually preovarian. Vitellaria of follicular or tubular acini, confined to hindbody, extensive or scanty and compact. Excretory vesicle I- or Y-shaped. Lymph channels often present. Parasites of fishes, mostly marine.

Neomegasolena n. g.

Diagnosis: Haploporidae. Distomes with elongated body. Cuticle spinose. Eye-spot pigment present. Prepharynx long, pharynx massive, esophagus long, intestinal bifurcation posterior to ventral sucker. Lymphatic system present. Genital pore median; genital atrium small. Hermaphroditic sac absent. Testes 2, tandem, and in posterior half of body. Seminal vesicle long, coiled, tubular, bipartite with small anterior division followed by prostatic complex. Ovary pretesticular. Uterine seminal receptacle present. Uterus preovarian; metraterm entering genital atrium independently of male duct. Excretory vesicle Y-shaped, with long stem and short arms. Parasitize ceca and intestine of marine fishes. Type and only species:

Neomegasolena chaetodipteri n. g., n. sp. (FIGURE 66)

Description based on 5 specimens with characters of the genus. Body 1.201 to 2.428 long, 0.300 to 0.528 wide, with rounded ends. Cuticular spines fade out posterior to testis. Oral sucker terminal, subspherical, 0.140 to 0.237 in diameter. Ventral sucker 0.092 to 0.151 by 0.126 to 0.178. Sucker ratio 1:0.7. Prepharynx 0.065 to 0.178 long, pharynx 0.131 to 0.231 in diameter,

ceca wide, ending blindly a short distance from posterior end of body. Lymphatic system with 2 channels on each side, paralleling and extending posterior to ends of ceca in hindbody, reaching sides of oral sucker in forebody, enlarging at level of prepharynx. Genital pore median, close to anterior margin of ventral sucker. Seminal vesicle sinuous, posterior division extending to anterior margin of ovary; prostate cells, large, numerous, surrounding small anterior division of seminal vesicle and pars prostatica. Testes 2, entire, 0.184 to 0.270 by 0.165 to 0.184, posterior to midlevel but well removed from posterior end of body. Ovary entire, subspherical, 0.105 to 0.132 in diameter, slightly to right of midline, situated near equatorial level. Vitelline follicles from level of ovary almost to posterior end of body, confluent posterior to testes, dorsal bands of few follicles at intergonadal levels. Uterus preovarian; metraterm small, dorsal to ventral sucker. Laurer's canal not observed. Eggs moderate in number, 0.052 to 0.066 by 0.034 to 0.041. Excretory system stenostomate, excretory vesicle Y-shaped, stem long, extending to posterior margin of ovary, arms short, main excretory tubules extending from them to oral sucker and then turning posteriorly; excretory pore slightly subterminal, dorsal, without evident sphincter.

Host: *Chaetodipterus faber*.

Site: ceca and intestine.

Locality: Isla Ratones, P. R.

Type specimen: Holotype No. 39347.

FAMILY MEGAPERIDAE MANTER, 1947

Megapera gyrina (Linton, 1907) Manter, 1934 (FIGURE 67)

Synonyms:

Distomum gyrinus Linton, 1907.

Eurypera gyrina (Linton) Manter, 1933.

Hosts: *Lactophrys bicaudalis*, *Lactophrys tricornis*.

Site: intestine.

Locality: Cabo Rojo, P. R.

Deposited specimen: No. 34348.

Life history: Cercaria probably *C. caribbea* XXXVII Cable, 1956, which develops in *Crepidula convexa* and encysts in the open (Cable, 1954b).

Megapera pseudura (Manter, 1933) Manter, 1934 (FIGURE 68)

Synonym:

Eurypera pseudura Manter, 1933.

Host: *Lactophrys tricornis*.

Site: intestine.

Locality: off Puerto Real, P. R.

Deposited specimen: No. 39349.

Thysanopharynx elongatus Manter, 1933 (FIGURE 69)

Host: *Lactophrys tricornis*.

Site: intestine.

Locality: off Puerto Real, P. R.

FAMILY OPISTHOLEBETIDAE FUKUI, 1929

Opistholebes diodontis Cable, 1956 (FIGURES 70 to 72)Host: *Diodon hystrix*.

Site: posterior intestine.

Locality: Punta Arenas, Guánica, P. R.

Type specimens: Holotype and paratype No. 37440 deposited by Cable (1956).

Pachycreadium gastrocotylum (Manter, 1940) Manter, 1954 (FIGURE 73)

Synonym:

Plagioporus gastrocotylus Manter, 1940.Host: **Calamus calamus*.

Site: intestine.

Locality: Cabo Rojo, P. R.

Our material agrees with Manter's (1940a), description of *P. gastrocotylum* except in the shape of body and size of the testes to judge from his figure; Manter did not give the measurements of them. From Manter's material, Cable (1956a) verified the presence of a postoral ring in the species.

The genus *Pachycreadium* was erected by Manter (1954) to include *Plagioporus gastrocotylus* Manter, 1940, and *P. crassigulus* (Linton, 1910) Price, 1934. Cable (1956a) emended the family Opistholebetidae and transferred the genus *Pachycreadium* from the Opecoelidae to it.

Pycnadenoides pagrosomi Yamaguti, 1938, and *P. calami* Manter, 1947, show many similarities to species of *Pachycreadium*. If, as seems very likely, a postoral ring is present in the 2 species, *Pachycreadium* should be reduced to synonymy with *Pycnadenoides* if, indeed, both genera are not synonymous with *Pycnadena*, a genus that differs from *Pachycreadium* only in the symmetrical arrangement of the testes. It may be significant that species of all 3 genera have been described from porgies which, with the puffers, include almost all known hosts of the opistholebetids.

Pachycreadium crassigulum (Linton, 1910) Manter, 1954 (FIGURE 74)

Synonyms:

Lebouria crassigula Linton, 1910.*Plagioporus crassigulus* (Linton) Price, 1934.Host: *Calamus calamus*.

Site: intestine.

Locality: Cabo Rojo, P. R.

Deposited specimen: No. 39350.

Our material does not agree with Linton's description in respect to the distribution of the vitelline follicles in the forebody, the position of the genital pore, and the presence of postoral ring which is easily overlooked.

FAMILY OPECOELIDAE OZAKI, 1925

A trematode represented in the collection by 6 specimens resembles *Pycnadena* but differs from species of that genus in having a strongly lobed ovary and definitely lacking a postoral ring, the presence of which in *Pycnadena*

has not been excluded, in our opinion. In possessing a fleshy body fold surrounding the ventral sucker, the species resembles opistholebetids, but its nearest relatives probably are opecoelids of the genus *Hamacreadium*. However, the species differs from members of that genus in body shape, position of the testes and genital pore, presence of the body fold, and extent of the excretory vesicle and uterus. A new genus thus is erected for the species and defined as follows:

Pinguitrema n. g.

Diagnosis: Opecoelidae. Distomes with powerful ventral sucker, surrounded by a fleshy fold; aperture transverse, with muscles radiating from its ends into parenchyma. Postoral ring absent. Cuticle aspinose. Eye-spot pigment absent. Prepharynx, pharynx and esophagus present; intestinal bifurcation anterior to ventral sucker. Genital pore ventral, to left of midline, at esophageal level. Cirrus sac clavate; with coiled, tubular seminal vesicle, prostatic complex and simple, unarmed cirrus. Testes 2, entire, symmetrical to slightly diagonal. Ovary lobed, anterolateral to right testis. Seminal receptacle and Laurer's canal present. Vitellaria in both fore and hindbody. Uterus scanty, metraterm tubular. Excretory vesicle sac-shaped. Parasites of marine fishes. Type and only species:

Pinguitrema lobata n. g., n. sp. (FIGURE 75)

Description based on 6 specimens with characters of the genus. Body pyriform to oval, 1.008 to 1.456 long, 0.588 to 0.896 wide. Oral sucker subspherical, 0.091 to 0.161 in diameter. Ventral sucker 0.182 to 0.259 by 0.203 to 0.273, somewhat anterior to midlevel. Sucker ratio 1:1.9. Prepharynx very short, pharynx 0.056 to 0.105 in diameter, esophagus 0.056 to 0.063 long, ceca but slightly expanded. Cirrus sac reaches ventral sucker, usually overlapping its anterior margin slightly. Seminal vesicle coiled, tubular. Testes 0.161 to 0.224 by 0.112 to 0.154, spherical to oval, symmetrical or slightly diagonal, in posterior third of body. Ovary anterior to, and contiguous with, right testis; with 8 to 10 lobes. Seminal receptacle anterodorsal to ovary, sometimes overlapping it or displaced to its left. Vitelline follicles in lateral fields from pharyngeal level to posterior end of body, confluent posterior to testes, mostly extracecal in anterior half of body, overlapping and concealing ceca posteriorly. Uterus pretesticular, coiling to left of ovary and ascending to left of ventral sucker; metraterm narrow tubular. Eggs few to moderate in number, 0.063 to 0.070 by 0.042. Excretory vesicle sac-shaped, between, and extending to anterior margin of, testes; excretory pore dorsal, near posterior end of body, without evident sphincter.

Host: *Gerres cinereus*.

Site: intestine.

Locality: Cabo Rojo, P. R.

Type specimen: Holotype No. 39351.

Hamacreadium lintoni n. sp. (FIGURE 76)

Description based on 3 specimens with characters of the genus. Body 3.502 to 5.822 long, 0.734 to 1.034 in maximum width at about level of ven-

tral sucker from which body tapers toward both ends. Cuticle aspinose, eye-spot pigment absent. Oral sucker 0.180 to 0.273 by 0.247 to 0.287, subterminal. Ventral sucker 0.380 to 0.474 in diameter, slightly anterior to midlevel. Sucker ratio 1:1.7. Prepharynx short, pharynx 0.147 to 0.200 in diameter, esophagus longer than pharynx, ceca simple, ending blindly near posterior end of body. Genital pore submedian, about midway between intestinal bifurcation and ventral sucker. Cirrus sac clavate, extending to anterior edge of ventral sucker, almost in midline; containing tubular seminal vesicle, small pars prostatica, and short cirrus; seminal vesicle with coiled proximal region swollen with sperms and long, narrow, almost straight distal portion joining pars prostatica (FIGURE 76b). Testes 2, 0.343 to 0.454 by 0.327 to 0.427, lobed, diagonal, posterior to midlevel. Ovary 0.280 to 0.287 by 0.347 to 0.367, strongly lobed, submedian, diagonally to right of anterior testis. Seminal receptacle anterodorsal to ovary. Vitelline follicles in lateral fields from slightly anterior to genital pore to posterior end of body, in more or less distinct bands median and lateral to ceca in posttesticular space. Uterus preovarian, intercecal, moderately extensive; metraterm simple, passing to left of ventral sucker. Eggs numerous, 0.063 to 0.072 by 0.037 to 0.042. Excretory vesicle I-shaped, extending to intestinal bifurcation; excretory pore dorsal, near posterior end of body, with sphincter.

Hosts: *Epinephelus striatus*, *Cephalopholis fulvus*.

Site: intestine and stomach.

Locality: Mona Island, P. R.

Type specimen: Holotype and Paratype No. 39352.

Hamacreadium lintoni differs from *H. lethrini* Yamaguti, 1934; *H. mehsena* and *H. interruptus* Nagaty, 1941; *H. morgani* Baz, 1946; *H. leiperi* and *H. krusadaiensis* Gupta, 1956, in having an almost median genital pore. In distribution of vitellaria it differs from all other species except *H. lethrini*. *Hamacreadium mutabile*, *H. oscitans*, *H. consuetum*, and *H. gulella* Linton, 1910, all have a median genital pore, but *H. lintoni* differs from them in 1 or more of the following features: body shape and size, sucker ratio, extent of cirrus sac, topography of gonads, position of genital pore, posttesticular space, egg size, extent of vitellaria, length of esophagus, and extent of excretory vesicle. In body shape, *H. lintoni* is somewhat similar to *H. epinepheli* Yamaguti, 1934, but differs from that species in the level of genital pore, size of the cirrus sac, and extent of vitellaria. *H. lintoni* is distinguished from *H. lariosi* Caballero, 1946, in having a single, more posterior genital pore, smaller eggs, lobed testes, and a longer posttesticular space.

Hamacreadium longisaccum n. sp. (FIGURE 77)

Description based on 3 specimens with characters of the genus. Body elongate, 2.05 to 2.87 long, 0.490 to 0.812 wide, rounded at either end, rather uniformly wide throughout length. Cuticle aspinose, eye-spot pigment absent. Oral sucker subspherical, 0.154 to 0.196 in diameter, almost terminal. Ventral sucker 0.231 to 0.366 by 0.196 to 0.273, slightly anterior to midlevel. Sucker ratio 1:1.5. Prepharynx short, pharynx subspherical, 0.105 to 0.140 by 0.126 to 0.154, esophagus 0.070 to 0.087 long, ceca simple, extending to

posterior end of body. Genital pore slightly to left of midline, near arch of left cecum. Cirrus sac very long, extending to about midway between ventral sucker and ovary, containing coiled, tubular seminal vesicle, prostatic complex, long ejaculatory duct and cirrus. Testes 2, 0.175 to 0.238 in diameter, slightly lobed, diagonal, in posterior third of body. Ovary 0.091 to 0.161 by 0.098 to 0.231, with 3 to 5 lobes, somewhat to right of midline, near anterior testis. Seminal receptacle small, overlapping ovary anterodorsally. Vitelline follicles small, in lateral fields, from esophageal level to posterior end of body, confluent posterior to testes, and denser in that region than elsewhere. Uterus scanty, preovarian; metraterm a slender muscular tube. Eggs few, 0.054 to 0.069 by 0.033 to 0.048. Excretory vesicle I-shaped, extending to posterior margin of pharynx; excretory pore terminal, with sphincter.

Host: *Epinephelus adscensionis*.

Site: intestine.

Locality: Puerto Real, P. R.

Type specimen: Holotype No. 39353.

Hamacreadium longisaccum is the only species in its genus that has a cirrus sac extending well posterior to the ventral sucker; in others it does not reach the posterior margin of that organ.

Hamacreadium mutabile Linton, 1910 (FIGURE 78)

Hosts: *Lutianus analis*, *Lutianus jocu*, *Lutianus griseus*, *Lutianus apodus*, *Ocyurus chrysurus*.

Site: intestine.

Localities: Parguera, Puerto Real, Punta Arenas, and Mayagüez, P. R.

Deposited specimen: No. 39354.

Pseudoplagioporos brevivitellus n. sp. (FIGURE 79)

Description based on 3 specimens with characters of the genus. Body stout, 0.959 to 1.043 long, 0.525 to 0.546 wide, more rounded posteriorly than anteriorly. Cuticle aspinose, eye-spot pigment absent. Oral sucker 0.133 to 0.154 by 0.154 to 0.175, terminal or slightly subterminal; ventral sucker 0.224 to 0.231 by 0.280 to 0.294, its posterior margin at about midlevel of body. Sucker ratio 1:1.7. Prepharynx very short, pharynx 0.098 to 0.119 in diameter, esophagus very short, intestinal bifurcation anterior to ventral sucker; ceca simple, ending blindly near posterior end of body. Genital pore slightly to left of midline, near anterior border of ventral sucker. Cirrus sac extending to left of ventral sucker, ending at about its midlevel; seminal vesicle coiled, tubular; ejaculatory duct short. Testes 2, 0.103 to 0.175 by 0.120 to 0.136, diagonal, irregular, within posterior section of body. Ovary 0.077 to 0.144 by 0.120 to 0.142, with 2 or 3 lobes, on right, opposite anterior testis. Seminal receptacle anterodorsal to ovary. Vitelline follicles small, from midlevel of ventral sucker to posterior end of body, confluent posterior to testes. Uterus scanty, sometimes slightly overlapping posterior testis; metraterm muscular, dorsal to ventral sucker. Eggs moderate in number, 0.034 to 0.038 by 0.023 to 0.027 (0.034 by 0.028 in living material). Excretory vesicle extends to anterior edge of anterior testis.

Host: *Malacanthus plumieri*.

Site: intestine.

Locality: Mona Island, P. R.

Type specimen: Holotype No. 39355.

The genus *Pseudoplagiopus*, as defined by Yamaguti (1938), agrees with the present species in all respects except extent of vitellaria and position of genital pore. *P. brevitellus* further differs from *P. microrchis* in egg size, sucker ratio, extent of excretory vesicle and topography of gonads; and from *P. lethrini* in most of these respects.

Helicometrina nimia Linton, 1910 (FIGURE 80)

Host: *Scorpaena plumieri*.

Site: intestine.

Locality: Puerto Real, P. R.

Helicometrina trachinoti n. sp. (FIGURE 81)

Description based on 5 specimens with characters of the genus. Body 1.001 to 1.239 long, 0.434 to 0.462 in maximum width somewhat posterior to ventral sucker, rounded posteriorly, tapering anteriorly. Cuticle aspinose, eye-spot pigment absent. Oral sucker terminal, 0.091 to 0.112 by 0.098 to 0.140. Ventral sucker subspherical, 0.140 to 0.224 in diameter, anterior to midbody, with a transverse slitlike aperture. Sucker ratio 1:2.4. Prepharynx short, pharynx 0.040 to 0.054 by 0.056 to 0.084; esophagus longer than pharynx; ceca simple, extending almost to posterior end of body. Testes 9, 0.091 to 0.112 in diameter, entire or slightly irregular, the group almost reaching posterior end of body. Genital pore submedian, ventral to intestinal bifurcation. From pore, cirrus sac extends posteriorly to left of ventral sucker, terminating near its midlevel; containing coiled, tubular seminal vesicle, pars prostatica, long ejaculatory duct and cirrus. Ovary 0.091 to 0.126 by 0.140 to 0.238, irregularly lobed, pretesticular, median or slightly to right, posterior to midlevel of body. Seminal receptacle on right, antero-lateral to ovary. Vitelline follicles in lateral fields from near level of pharynx to posterior end of body, largely concealing ceca. Uterus intercecal, forming a spiral coil between ovary and ventral sucker; metraterm narrow, tubular, dorsal to ventral sucker. Eggs few, each with a unipolar filament; 0.056 to 0.070 long exclusive of filament, 0.024 to 0.028 wide. Excretory vesicle sac-shaped, extending to level of ovary.

Hosts: *Trachinotus* sp., *Mulloidichthys martinicus*.

Site: intestine.

Locality: Punta Arenas, P. R.

Type specimen: Holotype No. 39356.

Helicometrina trachinoti differs from *H. parva* Manter, 1933, and from *H. septorchis* Srivastava, 1936, in the number of testes, and from *H. elongata* Noble and Park, 1937, and *H. orientalis* Srivastava, 1936, in body shape and size, sucker ratio, distribution of vitellaria, and arrangement of gonads. It is distinguished from *H. nimia* Linton, 1910, by body shape, extent of cirrus sac, less lobed ovary, location of testes, and the slitlike aperture of the ventral sucker.

Helicometrina mirzai n. sp. (FIGURE 82)

Description based on 13 specimens with characters of the genus. Body 0.763 to 1.141 long, 0.343 to 0.427 wide, elongate oval to pyriform, more broadly rounded posteriorly than anteriorly. Cuticle aspinose. eye-spot pigment absent. Oral sucker terminal, spherical, 0.077 to 0.112 in diameter. Ventral sucker at midlevel of body, 0.147 to 0.203 in diameter. Sucker ratio 1:1.83. Prepharynx very short, pharynx 0.056 to 0.070 by 0.063 to 0.091, esophagus 0.070 to 0.105 long; ceca simple, ending blindly near posterior end of body. Cirrus sac extending to midlevel of ventral sucker or deflected to its side and reaching only slightly beyond its anterior margin; containing coiled, tubular seminal vesicle, prostatic complex, long ejaculatory duct and unarmed cirrus. Testes 9, 0.042 to 0.084 in diameter, entire, their arrangement variable, in posterior third of body length. Ovary 0.042 to 0.084 by 0.084 to 0.126, lobed, median or submedian, sometimes displaced to one side, contiguous with anterior testes. Seminal receptacle anterior to ovary. Vitelline follicles in lateral fields, from pharyngeal level almost to posterior end of body, with wide interruption at level of ventral sucker. Uterus scanty, in a spiral coil, between ovary and ventral sucker; metraterm a narrow, muscular tube. Eggs few, 0.049 to 0.063 by 0.021 to 0.035 exclusive of uni-polar filament. Excretory vesicle sac-shaped, extending to anterior margin of testes group; excretory pore terminal, with sphincter.

Host: *Lactophrys bicaudalis*.

Site: intestine.

Locality: Cabo Rojo, P. R.

Type specimen: Holotype No. 39357.

Helicometrina mirzai resembles *H. trachinoti* but differs from that species in the position of ventral sucker, sucker ratio, and interrupted vitellaria. The vitellaria are interrupted also in *H. elongata*, but that species differs from *H. mirzai* in the shape and size of body, position of genital pore, and location of gonads.

Helicometra equilata (Manter, 1933) n. comb. (FIGURE 83)

Synonym:

Stenopera equilata Manter, 1933.

Host: *Holocentrus ascensionis*.

Site: intestine.

Locality: Mona Island, P. R.

Deposited specimen: No. 39358.

The genus *Stenopera* Manter, 1933, is here reduced to synonymy with *Helicometra*. In our opinion, the elongated cirrus sac and anterior position of the ventral sucker are of no more than specific value.

Helicometra torta Linton, 1910 (FIGURE 84)

Host: *Epinephelus striatus*.

Site: intestine.

Locality: Cabo Rojo, P. R.

Deposited specimen: No. 39359.

Our material combines features of both *H. torta* of Linton (1910) and *H. pretiosa* Bravo-Hollis and Manter (1957). Egg size is intermediate, and the posterior end of the cirrus sac may be filled with the seminal vesicle as in *H. torta* or not, as in *H. pretiosa*. According to Manter (1933) the gonads of *H. torta* may be either lobed or entire. Thus, *H. pretiosa* probably is not a valid species.

The next species is a new one closely related to opacoelids of the genera *Helicometra*, *Helicometrina*, and *Helicometroides*, but differs from those trematodes in having a funnel-shaped oral sucker and ceca with separate ani. A new genus is proposed for that species and is characterized as follows:

Neohelicometra n. g.

Diagnosis: Opacoelidae. Distome with elongate body, aspinose cuticle, no eye-spot pigment. Oral sucker funnel-shaped; ventral sucker sessile, without papillae; accessory sucker absent. Prepharynx, pharynx, and esophagus present; intestinal bifurcation anterior to ventral sucker; ceca with separate ani at posterior end of body. Genital pore in esophageal region. Cirrus sac with coiled, tubular seminal vesicle, pars prostatica and long ejaculatory duct. Testes 2, tandem. Ovary pretesticular, seminal receptacle present. Vitellaria in both fore- and hindbody. Laurer's canal present. Uterus pretesticular; metraterm simple. Eggs with unipolar filaments. Excretory vesicle sac-shaped. Parasites of marine fishes. Type and only species:

Neohelicometra scorpaenae n. g., n. sp. (FIGURE 85)

Description (based on a single specimen): with characters of the genus. Body 1.732 long, 0.420 wide, rather uniformly wide throughout length, ends rounded. Oral sucker 0.217 by 0.315. Ventral sucker 0.150 by 0.120. Sucker ratio 1:0.5. Prepharynx short, pharynx 0.090 in diameter, ceca tubular, narrowing posteriorly to open at ani. Genital pore submedian, at posterior margin of pharynx; genital atrium small. Cirrus sac somewhat sinuous, extending to midlevel of ventral sucker. Testes irregular, 0.070 to 0.084 in diameter, within posterior third of body, well removed from posterior end. Ovary 0.119 by 0.161, lobed. Seminal receptacle small, antero-lateral to ovary. Vitelline follicles extending from midlevel of esophagus almost to posterior extremity, mostly intercecal, but with intercecal bands in posttesticular region, narrowly confluent at their extreme posterior ends. Uterus fairly extensive. Eggs moderate in number, 0.043 to 0.051 long exclusive of filament, 0.025 to 0.029 wide. Excretory vesicle sac-shaped, extending to anterior margin of ovary; excretory pore dorsal, near posterior end.

Host: *Scorpaena* sp.

Site: intestine.

Locality: Puerto Real, P. R.

Type specimen: Holotype No. 39360.

Opecoeloides vitellosus (Linton, 1900) Von Wicklen, 1946 (FIGURE 86)

Synonyms:

Distomum vitellosum Linton, 1900.

Cymbephallus vitellosus (Linton) Linton, 1934.

Anisoporus manteri Hunninen and Cable, 1940.

Host: *Mulloidichthys martinicus*.

Site: intestine.

Locality: Puerto Real, P. R.

Deposited specimen: No. 39361.

Opecoeloides elongatus Manter, 1947 (FIGURES 87 and 88)

Host: **Mulloidichthys martinicus*.

Site: intestine.

Locality: off Puerto Real, P. R.

Deposited specimen: No. 39362.

Our material differs from Manter's (1947) description in having 4 posterior papillae on the ventral sucker instead of 3 and an accessory sucker with a limiting membrane which, according to Manter, is lacking in his specimens. Our material was dead when taken from the host. The papillae of such trematodes usually retract when living material is fixed, and their exact number is difficult to determine.

Opecoeloides sp. (FIGURE 89)

Description based on a single specimen with characters of the genus. Body 1.141 long, 0.316 wide. Cuticle aspinose, eye-spot pigment absent. Oral sucker subterminal, 0.112 by 0.151. Ventral sucker 0.191 by 0.178, with 3 anterior and 2 posterior papillae. Accessory sucker 0.093 in diameter, with a limiting membrane. Sucker ratio 1:1.4. Prepharynx short, pharynx 0.099 by 0.145, esophagus longer than pharynx, intestinal bifurcation at level of ventral sucker, ceca simple, expanded, joining excretory vesicle to form a wide uroproct in posterior region of body. Genital pore about midway between oral and accessory suckers. Cirrus sac absent; seminal vesicle long, tubular, extending well posterior to ventral sucker; prostatic complex weakly developed. Testes 2, 0.099 to 0.105 by 0.125 to 0.132, smooth, tandem, contiguous, almost in posterior third of body. Ovary 0.059 in diameter, smooth, pretesticular, contiguous with anterior testis. Seminal receptacle absent. Vitelline follicles scattered from slightly anterior to level of ovary to posterior end of body, confluent posterior to testes. Uterus pre-ovarian; metraterm simple. Eggs few, collapsed, 0.054 to 0.056 by 0.028 to 0.030. Excretory vesicle sac-shaped, extending to anterior margin of ovary; excretory pore terminal.

Host: *Trichurus lepturus*.

Site: intestine.

Locality: Joyuda, P. R.

Deposited specimen: No. 39363.

The above species agrees with Manter's (1940a) description of *O. euci-*

nostomi, except that the pharynx and eggs are slightly larger, the accessory sucker has a limiting membrane, and the seminal vesicle extends posterior to the ventral sucker. The species may be new, but judgment is withheld because only a single, excessively flattened mature specimen and 4 immature ones were available.

Opecoeloides brachyteleus Manter, 1947 (FIGURE 90)

Host: *Mulloidichthys martinicus*.

Site: intestine.

Locality: Puerto Real, P. R.

Deposited specimen: No. 39364.

Our material differs from that described by Manter (1947) chiefly in having 4 posterior papillae on the ventral sucker.

Opecoeloides (?) sp. (FIGURE 91)

Description based on 1 immature and 2 mature specimens with characters of the genus. Body 0.665 to 0.735 long, 0.133 to 0.147 wide. Cuticle aspinose, eye-spot pigment absent. Oral sucker 0.061 to 0.079 in diameter. Ventral sucker pedunculate, 0.065 to 0.112 in diameter, with 3 anterior and 2 posterior papillae. Accessory sucker a short distance posterior to pharynx, without a limiting membrane. Sucker ratio 1:1.3. Prepharynx short, pharynx 0.052 to 0.067 in diameter, esophagus longer than pharynx, intestinal bifurcation at level of ventral sucker; ceca simple, extending almost to posterior end of body; their connection with excretory vesicle could not be detected in either living or fixed specimens. Separate ani absent. Genital pore to left of median line, at posterior margin of pharynx. Cirrus sac absent; seminal vesicle long, tubular; prostatic complex not well developed. Testes 2, 0.060 by 0.075, entire, median, within posterior third of body. Ovary entire, 0.039 to 0.042 in diameter, to right, anterolateral to anterior testis. Seminal receptacle absent. Vitelline follicles scattered along ceca from base of seminal vesicle to posterior end of body, not confluent in posttesticular space. Uterus preovarian; metraterm muscular. Eggs few, 0.063 by 0.023. Excretory vesicle sac-shaped.

Host: *Centropomus ensiferus*.

Site: intestine.

Locality: Guanajibo, P. R.

Deposited specimen: No. 39365.

The generic status of this species is questionable because of inability to establish the presence or absence of a uroproct. If such is present, the trematode is a species of *Opecoeloides*; if not, which seems likely, it resembles members of the genus *Genitocotyle*, in which, however, the ventral sucker lacks the characteristics of the present species and of those definitely assigned to the genus *Opecoeloides*.

Pseudopecoeloides equesi Manter, 1947 (FIGURE 92)

Host: *Equus acuminatus*.

Site: intestine.

Locality: Cabo Rojo, P. R.
 Deposited specimen: No. 39366.

Pseudopecoelus barkeri Hanson, 1950 (FIGURE 93)

Hosts: *Holocentrus ascensionis*, **Holocentrus vexillarius*.
 Site: intestine.
 Locality: Mona Island, P. R.
 Deposited specimen: No. 39367.

Except in slightly smaller body size and distribution of vitellaria, the present material is in complete agreement with that described by Hanson (1950).

Pseudopecoelus tortugae Von Wicklen, 1946 (FIGURE 94)

Synonym:

Cymbephallus fimbriatus Linton of Manter, 1934.
 Host: **Apogon maculatus*.
 Site: intestine.
 Locality: Punta Arenas, P. R.
 Deposited specimen: No. 39368.

The present material is in close agreement with Manter's (1934) description of *P. tortugae* except in body size and sucker ratio.

Horatrema crassum Manter, 1947 (FIGURE 95)

Hosts: *Eques acuminatus*, *Odontoscion dentex*.
 Site: intestine.
 Locality: Cabo Rojo, P. R.
 Deposited specimen: No. 39369.

Coitocecum sp.

Hosts: *Labrisomus nuchipinnes*, *Halichoeres bivittata*.
 Site: intestine.

Localities: Mona Island and Isla Ratones, P. R.

A single specimen belonging to the genus *Coitocecum* was found in each of the above hosts. The 2 trematodes are of different species, but the available material is insufficient for adequate descriptions.

FAMILY LEPOCREADIIDAE NICOLL, 1934

Homalometron elongatum Manter, 1947 (FIGURE 96)

Hosts: *Gerres cinereus*, **Chaetodipterus faber*.
 Site: intestine.
 Locality: Cabo Rojo, P. R.
 Deposited specimen: No. 39370.

Homalometron foliatum n. sp. (FIGURE 97)

Description based on 5 specimens with characters of the genus. Body 1.540 to 2.457 long, 0.357 to 0.476 wide, elongate, hindbody foliate, anterior

end bluntly round. Cuticle spinose, eye-spot pigment present. Oral sucker slightly subterminal, subspherical, 0.196 to 0.287 in diameter. Ventral sucker 0.140 to 0.168 by 0.175 to 0.189. Sucker ratio 1:0.76. Prepharynx somewhat longer than pharynx, which measures 0.070 to 0.084 in diameter, esophagus about as long as pharynx, intestinal bifurcation about midway between suckers; ceca simple, slender, ending blindly near posterior end of body. Genital pore median, at anterior margin of ventral sucker. Cirrus sac absent; seminal vesicle sac-shaped, oval, posterior to ventral sucker, to right of midline, ejaculatory duct long and narrow. Testes 2, 0.091 to 0.175 by 0.168 to 0.182, smooth to irregular, tandem, close together, intercecal, near midlevel of body. Ovary 0.084 to 0.126 in diameter, smooth, median or submedian, about midway between ventral sucker and anterior testis. Seminal receptacle small, on right, anterodorsal to ovary. Vitelline follicles from testicular level to posterior end of body, almost filling posttesticular space. Uterus scanty, extending a short distance posterior to ovary before ascending toward genital pore. Eggs few, 0.066 to 0.077 by 0.045 to 0.053. Excretory vesicle sac-shaped, extending to anterior testis; excretory pore dorsal, near posterior end of body, with sphincter.

Host: *Haemulon flavolineatum*.

Site: intestine.

Locality: Mona Island, P. R.

Type specimen: Holotype No. 39371.

Homalometron foliatum differs from *H. pallidum* Stafford, 1904, *H. armatum* MacCallum, 1895, and *H. pearsii* Hunter and Bangham, 1932, in sucker ratio, extent of vitellaria, egg size and location of testes. It differs from *H. elongatum* in the position of the ventral sucker and testes and in the extent of vitellaria.

The next 2 species, represented by 7 and 12 individuals respectively, have been described as new species of *Apocreadium* by Sogandares-Bernal (1959), but they differ from members of that genus in having a longitudinal slitlike mouth, a massive pharynx, wide ceca, and confluent vitelline fields in the forebody. Collectively, these differences are of generic rank and, to receive these 2 species, a new genus is proposed and characterized as follows:

Neopocreadium n. g.

Diagnosis: Lepocreadiidae. Distomes with thick, elongate bodies; cuticle spinose; eye-spot pigment present. Oral sucker subterminal, with longitudinal slitlike opening. Prepharynx present; pharynx massive, with conspicuous anterior muscle ring; esophagus very short or absent; intestinal bifurcation well anterior to ventral sucker, ceca swollen, ending near posterior end of body. Genital pore median, anterior to ventral sucker. Cirrus sac absent; seminal vesicle saclike. Testes 2, intercecal, tandem. Ovary to right of midline, pretesticular. Seminal receptacle present. Vitellaria in both fore- and hindbody; their fields confluent anterior to ventral sucker and in posttesticular space. Uterus pretesticular; metraterm present. Eggs few to numerous. Excretory vesicle sac-shaped or tubular. Lymph system present. Parasites of fishes.

Type species: *Neopocreadium angustum* (Sogandares-Bernal, 1959) n. comb. Other species: *Neopocreadium coili* (Sogandares-Bernal, 1959) n. comb.; *Neopocreadium bravoii* (Sogandares-Bernal, 1959) n. comb.

Neopocreadium angustum n. comb. (FIGURE 98)

Synonym:

Apocreadium angustum Sogandares-Bernal, 1959.

Host: **Lactophrys bicaudalis*.

Site: intestine.

Locality: Cabo Rojo, P. R.

Deposited specimen: No. 39372.

Neopocreadium coili n. comb. (FIGURE 99)

Synonym:

Apocreadium coili Sogandares-Bernal, 1959.

Host: **Balistes vetula*.

Site: intestine.

Locality: off Paraguera, P. R.

Deposited specimen: No. 39373.

Postporus epinepheli (Manter, 1947) Manter, 1949 (FIGURE 100)

Synonyms:

Opisthoporus epinepheli Manter, 1947.

† *Postporus mycteropercae* (Manter) Manter, 1949.

Host: **Epinephelus striatus*.

Site: intestine.

Locality: Mona Island, P. R.

Deposited specimen: No. 39374.

The genus *Postporus* was named for *Opisthoporus* (preoccupied) by Manter (1949), who described 2 species, each represented by 2 specimens from different host species. The present material consisting of 21 specimens from a single host species presents very interesting variations in the characters that he used to distinguish species. Some specimens are similar to *P. epinepheli* in body shape, extent of the excretory vesicle and distribution of vitellaria. Others are like *P. mycteropercae* in those respects or intermediate to that species and *P. epinepheli*, presenting a complete range between them. It is for this reason that *P. mycteropercae* is here reduced to synonymy with *P. epinepheli*, which has page priority.

Apocreadium balistis Manter, 1947 (FIGURE 101)

Host: *Balistes vetula*.

Site: intestine.

Locality: off Parguera, P. R.

Deposited specimen: No. 39375.

The present material agrees in most details with Manter's (1947) descrip-

† New synonymy.

tion based on a single specimen, except that the sucker ratio is slightly different, the pharynx is smaller, and the testes lack equatorial ridges.

Apocreadium mexicanum Manter, 1937 (FIGURE 102)

Host: **Balistes vetula*.

Site: intestine.

Locality: off Parguera, P. R.

Deposited specimen: No. 39376.

The present material agrees with Manter's (1937) description except for slight differences in sucker ratio, width of eggs, and length of posttesticular space.

Multitestis blennii Manter, 1931 (FIGURE 103)

Host: **Chaetodipterus faber*.

Site: intestine.

Locality: Isla Ratones, P. R.

Deposited specimen: No. 39377.

Multitestis inconstans (Linton, 1905) Manter, 1931 (FIGURE 104)

Synonym:

Distomum inconstans Linton, 1905.

Host: *Chaetodipterus faber*.

Site: intestine and ceca.

Locality: Puerto Real, P. R.

Deposited specimen: No. 39378.

Lepocreadium trulla (Linton, 1907) Linton, 1910 (FIGURE 105)

Synonym:

Distomum trulla Linton, 1907.

Hosts: **Rhomboplites aurorubens*, *Ocyurus chrysurus*.

Site: intestine.

Locality: off Puerto Real, P. R.

Deposited specimen: No. 39379.

Lepocreadium sp. (FIGURE 106)

Host: *Ocyurus chrysurus*.

Site: intestine.

Locality: Cabo Rojo, P. R.

This species is neither named nor described because only a single specimen in poor condition was available.

Neolepidapedon trachinoti n. sp. (FIGURE 107)

Description based on a single specimen with characters of the genus. Body 1.491 long, 0.371 wide, rounded posteriorly, tapering anteriorly. Cuticle thick, spinose. Eye-spot pigment present. Oral sucker subterminal, 0.090 by 0.094. Ventral sucker 0.094 by 0.088. Sucker ratio 1:1. Prepharynx

0.069 long, pharynx 0.061 by 0.064, esophagus 0.135 long, ceca simple, extending almost to posterior end of body. Genital pore to left, at anterior margin of ventral sucker. Cirrus sac club-shaped, ending a little short of midway between ventral sucker and ovary; internal seminal vesicle short, concave anteriorly to receive posterior end of conspicuous oval to pyriform pars prostatica; ejaculatory duct long, cirrus simple. External seminal vesicle small and curved. It and posterior end of cirrus sac surrounded by prostate cells; their ducts enter posterior end of cirrus sac around neck of external seminal vesicle, then diverge to pass anteriorly around internal seminal vesicle, and open in pars prostatica. Testes 2, 0.175 to 0.210 by 0.168 to 0.175, more nearly tandem than diagonal, smooth, contiguous, within posterior two fifths of body. Ovary 0.112 by 0.100, somewhat irregular, to right of midline, close to anterior testis, without intervening vitelline follicles. Seminal receptacle submedian, to left of ovary. Vitelline follicles in lateral fields, from level of intestinal bifurcation to posterior end of body, confluent posterior to testes. Laurer's canal present. Uterus with relatively few eggs, not posterior to ovary; metraterm well developed, tubular. Eggs 0.039 to 0.050 by 0.025 to 0.035. Excretory vesicle sac-shaped, extending to posterior margin of anterior testis; excretory pore subterminal, dorsal, with sphincter.

Host: *Trachinotus* sp.

Site: intestine.

Locality: Punta Arenas, P. R.

Type specimen: Holotype No. 39380.

The genus *Neolepidapedon* was erected by Manter (1954) for trematodes that differ from species of *Lepidapedon* only in having a true external seminal vesicle and prostate cells free in the parenchyma, instead of a membrane enclosing those structures and presumably a part of the cirrus sac. Manter allocated 4 species to *Neolepidapedon* and, recently, Montgomery (1957) has added a fifth. *N. trachinoti* differs from all other species in the extent of vitellaria, larger pars prostatica, smaller excretory vesicle, and smaller eggs. It is close to *N. polyprioni* Manter, 1954, but is distinguished from that species by the above features and also by the smaller size of body and pharynx and the shorter esophagus.

Neolepidapedon epinepheli n. sp. (FIGURE 108)

Description (based on 7 specimens): with characters of the genus. Body 1.652 to 3.885 long, 0.679 to 0.777 wide, elongate, hindbody leaflike. Cuticle spinose. Eye-spot pigment present. Oral sucker 0.098 to 0.140 by 0.154 to 0.189, subterminal, ventral sucker subspherical, 0.133 to 0.182 in diameter. Sucker ratio 1:1. Prepharynx very short, pharynx 0.091 to 0.119 by 0.077 to 0.105, esophagus fairly long, intestinal bifurcation about midway between pharynx and ventral sucker; ceca narrow, extending almost to posterior end of body. Genital pore to left, on level with anterior margin of ventral sucker. Cirrus sac with prominent pars prostatica at left of ventral sucker and saclike internal seminal vesicle posterior to that sucker; cirrus small; external seminal vesicle a curved, elongated sac, surrounded by prostate

cells with ducts entering cirrus sac as in preceding species. Testes 2, 0.175 to 0.280 in diameter, smooth, diagonal, in posterior third to quarter of body. Ovary 0.105 to 0.133 by 0.133 to 0.168, smooth to somewhat irregular, median, separated from anterior testis by the large, saclike seminal receptacle. Vitelline follicles in lateral fields from base of external seminal vesicle to ends of ceca, sparsely if at all confluent posterior to testes. Uterus intercecal, from ovarian level to ventral sucker; metraterm slender, tubular, paralleling cirrus sac. Eggs moderate to numerous, 0.057 to 0.065 by 0.035 to 0.041. Excretory vesicle tubular, extending to anterior margin of ventral sucker; excretory pore subterminal, with sphincter.

Hosts: *Epinephelus striatus*, *Epinephelus adscensionis*.

Site: intestine.

Locality: Mona Island and Puerto Real, P. R.

Type specimen: Holotype no. 39381.

Neolepidapedon epinepheli resembles *N. cablei* Manter, 1954, but differs from that species in size of pharynx, length of esophagus, arrangement of gonads, and position of the ventral sucker.

Neolepidapedon equilatum n. sp. (FIGURE 109)

Description based on a single specimen with characters of the genus. Body 2.212 long, 0.441 wide, cylindrical, ends rounded. Entire cuticle spinose. Eye-spot pigment present. Oral sucker subterminal, 0.070 by 0.076. Ventral sucker spherical, 0.105 in diameter. Sucker ratio 1:1.37. Prepharynx apparently absent, pharynx 0.034 by 0.036, intestinal bifurcation near mid-level of forebody; ceca simple, narrow, extending almost to posterior end of body. Genital pore on left, near anterior margin of ventral sucker. Cirrus sac sinuous, extending posterior to ventral sucker about one fourth of the distance to ovary; internal seminal vesicle small, pars prostatica elongated, followed by narrow ejaculatory duct and short cirrus; external seminal vesicle long, tubular, coiled, surrounded by prostate cells as in preceding species. Testes 2, 0.168 to 0.182 by 0.189 to 0.191, smooth, tandem, separated by a few vitelline follicles, in slightly more than posterior third of body. Ovary 0.105 by 0.126, smooth, median, a little posterior to midlevel, separated from anterior testis by a few vitelline follicles and seminal receptacle. Vitelline follicles from base of cirrus sac to posterior end of body, confluent posterior to testes. Uterus with moderate number of eggs, preovarian; metraterm tubular. Eggs 0.057 to 0.060 by 0.030 to 0.033. Excretory vesicle sac-shaped, extending to level of ovary; excretory pore dorsal near posterior end, with sphincter.

Host: *Cephalopholis fulvus*.

Site: intestine.

Locality: Mona Island, P. R.

Type specimen: Holotype No. 39382.

Neolepidapedon equilatum may be differentiated from other species of the genus by position of the genital pore, length of esophagus, absence of prepharynx, size of pharynx, and separation of gonads. It comes closest to *N. cablei* but differs from that species in the slightly greater sucker ratio, relative position of gonads with vitelline follicles between them, and more anterior position of the ventral sucker and intestinal bifurcation.

Neolepidapedon mycteropercae n. sp. (FIGURE 110)

Description based on a single specimen with characters of the genus. Body 3.248 long, 0.315 wide, rather uniformly wide throughout length except near rounded ends. Cuticle spinose. Eye-spot pigment present. Oral sucker 0.052 by 0.063, slightly subterminal. Ventral sucker 0.081 by 0.091, a little less than one quarter body length from anterior end. Sucker ratio 1:1.4. Prepharynx 0.022 long, pharynx 0.028 by 0.039, intestinal bifurcation distinctly nearer oral than ventral sucker; ceca narrow, extending almost to posterior end of body. Genital pore on left, posterolateral to ventral sucker; genital atrium large, muscular. Cirrus sac sigmoid, ending a little less than halfway between ventral sucker and ovary; internal seminal vesicle small, pars prostatica elongated; external seminal vesicle long, tubular, coiled, its distal end surrounded by prostate cells. Gonads median, smooth, tandem, separated, with vitelline follicles between them. Testes 2, 0.168 to 0.210 by 0.113 to 0.147, within posterior third of body. Ovary 0.126 by 0.112, anterior to testes. Seminal receptacle posterior to ovary. Vitelline follicles from base of external seminal vesicle to posterior ends of ceca, confluent posterior to testes. Uterus preovarian; metraterm tubular, wide, Eggs few, 0.048 to 0.057 by 0.035 to 0.038. Excretory vesicle I-shaped, reaching almost to intestinal bifurcation; excretory pore dorsal, near posterior end, with sphincter.

Host: *Mycteroperca* sp.

Site: intestine.

Locality: Mona Island, P. R.

Type specimen: Holotype No. 39383.

Neolepidapedon mycteropercae differs from all other species of the genus in the position of genital pore. In body shape and certain other features, *N. mycteropercae* is much like *N. medialunae* Montgomery, 1957, but differs from that species in the length of the forebody, prepharynx, and esophagus, level of intestinal bifurcation, and spacing of gonads.

Lepidapedon holocentri n. sp. (FIGURE 111)

Description based on 3 specimens with characters of the genus. Body 1.358 to 1.631 long, 0.294 to 0.406 wide, tapering anteriorly, rounded posteriorly. Cuticle spinose almost to posterior end. Eye-spot pigment present. Oral sucker 0.063 to 0.085 in diameter, subterminal. Ventral sucker 0.058 to 0.063 in diameter. Sucker ratio 1:0.78. Prepharynx short, pharynx 0.063 to 0.077 by 0.051 to 0.057, esophagus slender, somewhat longer than pharynx, intestinal bifurcation almost midway between pharynx and ventral sucker; ceca simple, extending almost to posterior end of body. Genital pore to left of ventral sucker; genital atrium large, muscular. Cirrus sac extending halfway from ventral sucker to ovary, of 2 parts separated by a narrow constriction. Anterior part clavate, with small, spherical division of seminal vesicle at base, followed by pyriform pars prostatica and sinuous ejaculatory duct; posterior part massive, thin-walled; filled with sinuous, saclike posterior division of seminal vesicle and prostate cells. Testes 2, 0.119 to 0.147 by 0.073 to 0.077, smooth, diagonal,

in posterior third of body. Ovary 0.084 to 0.091 by 0.066 to 0.080, with 3 or 4 lobes, median, pretesticular, separated from anterior testis by oval seminal receptacle contiguous with those gonads. Vitelline follicles in lateral fields from level of ventral sucker to ends of ceca, a few in median region posterior to testes. Uterus scanty, preovarian; metraterm a long, muscular tube. Eggs 0.046 to 0.056 by 0.032 to 0.033. Excretory vesicle I-shaped, extending to intestinal bifurcation; excretory pore dorsal, near posterior end, with sphincter.

Hosts: *Holocentrus ascensionis*, *Chaetodipterus faber*.

Site: stomach and ceca.

Locality: Cabo Rojo, P. R.

Type specimen: Holotype No. 39384.

According to Hanson's (1950) key to the species of *Lepidapedon*, *L. holocentri* would be identified as *L. nicolli* Manter, 1934. However, it differs from that species in having a distinctly lobed ovary, smaller eggs, subterminal oral sucker, and diagonal testes. Recently Manter (1954) described 2 additional species, *L. congeri* and *L. australis*. *L. holocentri* comes closer to *L. congeri*, but differs from it in sucker ratio, length of prepharynx, position of testes, anterior extent of vitellaria, and size of eggs.

Myzoxenus lachnolaimi Manter, 1947 (FIGURE 112)

Host: *Lachnolaimus maxiumus*.

Site: intestine.

Locality: off Parguera, P. R.

Deposited specimen: No. 39385.

Dermadena lactophrysi Manter, 1945 (FIGURES 113 and 114)

Synonym:

Distomum lamelliforme Linton, 1907, in part.

Hosts: *Lactophrys tricornis*, *Lactophrys triqueter*, **Monacanthus hispidus*.

Site: intestine.

Localities: Mona Island, off Puerto Real, and Cabo Rojo, P. R.

Deposited specimen: No. 39386.

Pseudocreadium sp. (FIGURES 115 and 116)

Host: *Lactophrys tricornis*.

Site: intestine.

Locality: off Puerto Real, P. R.

This species is not described or identified because only a single specimen without eggs was found. It may be *P. scaphosomum* Manter, 1940. The excretory vesicle is much as in *Dermadena*, but the flame cell pattern is simpler, its formula being $2[(2 + 2 + 2) + (2 + 2)]$.

Opechona sp.

Host: *Chloroscombrus chrysurus*.

Site: intestine.

Locality: Playa Mani, P. R.

An immature specimen of *Opechona* species was found but is not figured or described here.

Diploproctodaeum sp.

Hosts: *Myrichthys ocellatus*, *Canthigaster rostratus*.

The species cannot be identified or described adequately because only 2 dead specimens in poor condition were recovered, one from each of the above hosts.

FAMILY ACCACOELIIDAE LOOSS, 1912

Tetrochetus aluterae (Hanson, 1955) Yamaguti, 1958 (FIGURE 117)

Synonym:

Paratetrochetus aluterae Hanson, 1955.

Hosts: *Coryphaena hippurus*, **Acanthocybium solandri*.

Site: intestine and stomach.

Locality: off Puerto Real, Mona Is., P. R.

Deposited specimen: No. 39387.

The genus *Paratetrochetus* Hanson, 1955, was reduced to synonymy with *Tetrochetus* Looss, 1912, by Yamaguti (1958), and we agree, since the 2 species differ only as to whether the conelike elevation at the base of oral sucker is pharyngeal or prepharyngeal. Our specimens are in more or less complete agreement with Hanson's (1955) account of *Tetrochetus aluterae*. Furthermore, they are so similar to *T. proctocolus* Manter, 1950, and *T. coryphaenae* Yamaguti, 1934, as to suggest that the 3 species are identical. They seem to differ but slightly in egg size.

FAMILY HEMIURIDAE LÜHE, 1901

The next species is unique among known hemiurids in having the vitelline follicles in 2 widely separated, 7-lobed groups. To accommodate it, the following genus is proposed:

Bilecithaster n. g.

Diagnosis: Hemiuridae. Small, oval, smooth nonappendiculate distomes. Oral sucker subterminal, prepharynx short, pharynx spherical, esophagus longer than pharynx, ceca short, simple, ending blindly. Genital pore at base of oral sucker. Sinus sac rudimentary. Seminal vesicle with 2 saclike divisions; pars prostatica subspherical. Prostate cells sparse. Testes 2, tandem to diagonal. Ovary in testicular zone, smooth. Seminal receptacle present. Vitellaria in 2 groups each with 7 lobes, in preovarian zone. Uterus extends to near posterior end of body; metraterm simple. Excretory arms uniting dorsal to oral sucker. Parasites of marine fishes. Type and only species:

Bilecithaster ovalis n. g., n. sp. (FIGURE 118)

Description based on 3 specimens with characters of the genus. Body 0.440 to 0.547 long, 0.247 to 0.267 wide. Oral sucker 0.051 to 0.057 by 0.063

to 0.066. Ventral sucker 0.133 to 0.136 by 0.120 to 0.133. Sucker ratio 1:2.2. Pharynx 0.035 to 0.036 by 0.039 to 0.042, esophagus 0.056 long; ceca reach level of anterior testis. Gonads smooth; testes 0.054 to 0.066 in diameter; ovary submedian, on left, 0.042 to 0.049 in diameter. Seminal receptacle anteromedian to ovary. Uterus voluminous. Eggs very numerous, 0.028 to 0.031 by 0.014 to 0.015. Excretory vesicle extends to anterior testis; excretory pore slightly subterminal.

Host: *Haemulon plumieri*.

Site: ceca.

Locality: Puerto Real, P. R.

Type specimen: Holotype No. 39388.

Hysterolecitha rosea Linton, 1910 (FIGURE 119)

Host: *Acanthurus bahianus*.

Site: stomach.

Locality: Mona Island, P. R.

Deposited specimen: No. 39389.

Leurodera decora Linton, 1910 (FIGURE 120)

Host: **Haemulon melanurum*.

Site: intestine.

Locality: off Puerto Real, P.R.

Deposited specimen: No. 39390.

Hyperparasitism of the single specimen by a microsporidian was observed.

Dichadena acuta Linton, 1910 (FIGURE 121)

Synonym:

Lecithaster acutus (Linton) Manter, 1947.

Hosts: *Acanthurus caeruleus*, *A. bahianus*.

Site: intestine and stomach.

Locality: Mona Island; Puerto Real, P.R.

Deposited specimen: No. 39391.

In erecting the genus *Dichadena*, Linton (1910) was unable to see the intestine and described the ovary as being entire in *D. acuta*. Manter (1947) identified as that species a form that had a lobed ovary and, for that reason, transferred *D. acuta* to *Lecithaster* in which, however, the ceca end blindly. He did not observe the cyclocoel intestine, which probably would have been overlooked by us except for 1 excessively flattened specimen. As that feature is of generic significance, we propose that the genus *Dichadena* be restored to include *D. acuta* as the type and only species. Our material is identified as that species but differs from Linton's description in the length and shape of the pars prostatica and seminal vesicle to a degree that may prove to be of specific magnitude. Skrjabin and Guschanskaja (1955) recognized the genus *Dichadena* and transferred *Lecithaster galeatus* Looss, 1907, to it because of the unlobed ovary. However, Looss (1907b) clearly described ceca ending blindly in that species and for that reason it is to be excluded

from *Dichadena* and belongs instead in either *Lecithaster* or *Mordvilkovia* Pigulevsky, 1938.

Theletrum fustiforme Linton, 1910 (FIGURE 122)

Hosts: **Acanthurus caeruleus*, **Pomacanthus arcuatus*.

Site: intestine and stomach.

Locality: Guaniquilla, Parguera, P. R.

Deposited specimen: No. 39392.

The next trematode resembles species of *Genolinea*, but differs from them and other hemiurids in having a large pars prostatica with thick spiral musculature, a saclike seminal vesicle, a narrow, tubular sinus sac, and distinct cuticular striations. To receive that species, the following genus is proposed.

Neogenolinea n. g.

Diagnosis: Hemiuridae. Small distomes without ecsoma. Cuticle with prominent striations. Oral sucker subterminal, pharynx spherical, esophagus short, ceca swollen, ending blindly in posterior region of body. Genital pore ventral, at base of oral sucker. Sinus sac tubular, pars prostatica large, oval, with thick covering of spiral muscle fibers; prostate cells sparse; seminal vesicle large, saclike, posterior to and slightly overlapping ventral sucker, connected with pars prostatica by a narrow duct. Testes 2, diagonal to symmetrical, posterior to ventral sucker. Ovary posttesticular. Seminal receptacle present. Vitellaria of 2 compact indented masses near ovary. Uterus extensive; metraterm simple. Excretory vesicle with arms uniting dorsal to oral sucker. Parasites of marine fishes. Type and only species:

Neogenolinea opisthonemae n. g., n. sp. (FIGURE 123)

Description based on 40 specimens with characters of the genus. Body 0.534 to 0.827 long, 0.153 to 0.193 wide. Oral sucker 0.052 to 0.069 by 0.068 to 0.079. Ventral sucker 0.094 to 0.120 in diameter. Sucker ratio 1:1.6. Pharynx 0.031 to 0.037, testes 0.029 to 0.069, ovary 0.039 to 0.069 in diameter. Gonads entire, ovary median. Seminal receptacle posteromedian to ovary. Eggs 0.029 to 0.032 by 0.012 to 0.015. Excretory pore dorsally subterminal.

Host: *Opisthonema oglinum*.

Site: stomach.

Locality: Playa Mani, P.R.

Type specimen: Holotype No. 39393.

Macradena acanthuri n. sp. (FIGURE 124)

Description based on 3 specimens with characters of the genus. Body nonappending, 1.347 to 2.401 long, 0.300 to 0.480 wide, slightly tapered near both ends. Cuticle smooth, thick. Oral sucker subterminal, 0.100 to 0.140 by 0.147 to 0.173, with muscular preoral lip. Ventral sucker one third from anterior end, 0.207 to 0.260 by 0.180 to 0.253. Sucker ratio 1:1.5.

Prepharynx absent, pharynx 0.069 to 0.100 by 0.086 to 0.120, esophagus very short, ceca swollen, crenate, extending to posterior end of body. Genital pore immediately posterior to intestinal bifurcation. Sinus sac small, hermaphroditic duct very short. Seminal vesicle tubular, appearing as a compact saclike structure at midlevel of body. Pars prostatica a long sinuous tube, surrounded by sparse prostate cells. Gonads almost contiguous; testes 2, entire, 0.065 to 0.111 in diameter, slightly diagonal, just posterior to midbody. Ovary entire, submedian, posttesticular, 0.102 to 0.156 in diameter. Seminal receptacle a large, swollen sac lateral to ovary. Vitellaria of 8 lobes in a rosette, posterior to ovary and overlapping it. Uterus voluminous, occupies all available space in hindbody; metraterm unmodified. Eggs very numerous, 0.023 to 0.026 by 0.012 to 0.015. Excretory pore almost terminal. Excretory crura unite dorsal to pharynx.

Host: *Acanthurus bahianus*.

Site: stomach.

Locality: Puerto Real, P. R.

Type specimen: Holotype No. 39394.

The present species has been assigned to the genus *Macradena* on the basis of its general similarity with that genus. However, the less lobed vitellaria and unlobed ovary are distinctive features of this species. It differs from *M. perfecta* Linton, 1910, in the presence of a preoral lobe, and in sucker ratio in addition to the above-mentioned characters.

Aponorus elongatus n. sp. (FIGURE 125)

Synonym:

Aponurus sp. Linton, 1940.

Description based on 4 specimens with characters of the genus. Body without ecsoma, slightly tapering at each end or truncate posteriorly, 1.277 to 1.908 long, 0.200 to 0.380 wide. Cuticle smooth. Oral sucker subterminal, 0.069 to 0.091 by 0.085 to 0.117. Ventral sucker 0.193 to 0.300 in diameter, almost one third body length from anterior end. Sucker ratio 1:2.5. Prepharynx absent, pharynx 0.039 to 0.062 in diameter, esophagus short, ceca crenate, swollen, extending to posterior end of body. Genital pore slightly submedian, ventral to esophagus. Sinus sac pyriform or oval, hermaphroditic duct thick, muscular, metraterm and ejaculatory duct joining it at base of sac. Seminal vesicle large, sacshaped, anterior to or slightly overlapping ventral sucker; pars prostatica a sinuous tube surrounded by conspicuous prostate cells filling arch of ceca. Testes 2, diagonal, entire 0.069 to 0.095 by 0.088 to 0.100, close together, a short distance posterior to ventral sucker. Ovary posttesticular, submedian, entire, 0.066 to 0.092 in diameter. Seminal receptacle present. Vitellaria of 7 large lobes immediately posterior to ovary. Uterus voluminous, extending into posterior region of body then anteriorly, passing dorsal to ventral sucker; metraterm narrow, long, muscular, ventral to seminal vesicle. Eggs numerous, 0.026 to 0.029 by 0.013 to 0.016. Excretory arms unite dorsal to pharynx.

Host: *Chaetodipterus faber*.

Site: stomach.

Locality: Isla Ratones, P. R.
Type specimen: Holotype No. 39395.

Aponurus symmetrorchis n. sp. (FIGURE 126)

Description based on 3 specimens with characters of the genus. Body without ecsoma, spindle-shaped, rounded at both ends, 0.787 to 1.127 long, 0.273 to 0.347 wide. Cuticle smooth. Oral sucker subterminal, 0.069 to 0.087 by 0.092 to 0.113. Ventral sucker anterior to midlevel, 0.173 to 0.260 in diameter. Sucker ratio 1:2.3. Prepharynx absent, pharynx subspherical, 0.039 to 0.066 in diameter, esophagus very short, ceca simple, inflated, ending blindly near posterior end of body. Genital pore median, ventral to base of pharynx. Sinus sac oval with hermaphroditic duct formed by union of metraterm and male duct at base of sac. Seminal vesicle small, sac-shaped, anterior to ventral sucker, or slightly overlapping it. Pars prostatica a short tube, surrounded by prostate cells. Testes 2, entire, symmetrical, 0.046 to 0.092 in diameter, a short distance posterior to ventral sucker. Ovary to right of midline, entire, 0.046 to 0.068 in diameter, posttesticular. Seminal receptacle a spherical sac, anteromedian to ovary. Vitellaria of 7 lobes, in ovarian and immediately postovarian zone. Uterus not voluminous, extends posterior to vitellaria and anteriorly; metraterm a narrow, muscular tube. Eggs 0.026 to 0.031 by 0.015 to 0.018. Excretory arms unite dorsal to pharynx; excretory pore terminal.

Hosts: *Chaetodon ocellatus*, *Haemulon album*.

Site: stomach.

Locality: off Puerto Real, P. R.

Type specimen: Holotype No. 39396.

Aponurus symmetrorchis resembles most *A. intermedius* Manter, 1934, but differs from that deepwater species in the sucker ratio and general dimensions including egg size.

Parectenurus chloroscombri n. sp. (FIGURE 127)

Description based on a single specimen with characters of the genus. Body appendiculate, total length 1.982, width 0.393, length without ecsoma 1.400. Cuticular plications well developed ventrally from level of ventral sucker almost to posterior end of body proper. Oral sucker terminal, 0.090 by 0.119; ventral sucker 0.249 by 0.295. Sucker ratio 1:2.6. Prepharynx absent, pharynx 0.066 by 0.071, esophagus short; ceca simple, almost straight in hindbody, extending into ecsoma. Genital pore at posterior border of pharynx. Sinus sac 0.386 long, narrow, extending slightly posterior to ventral sucker; at its base, metraterm and male duct unite to form hermaphroditic duct. Seminal vesicle a curved sac between ventral sucker and anterior testis; with shallow constrictions but not divided into distinct divisions; pars prostatica a compactly coiled tube embedded in prostate cells with ducts entering distal portion of tube. Gonads contiguous; testes 2, entire, 0.068 to 0.083 by 0.121 to 0.158, diagonal, immediately posterior to seminal vesicle. Ovary entire, median, posttesticular, 0.098 by 0.174; seminal receptacle absent. Vitellaria of 7 coiled tubules, in 2 groups of 4 and

3, confined to ovarian and postovarian zone. Mehlis' gland posterior to ovary. Uterus moderately extensive, mostly postovarian, not extending into ecsoma; metraterm simple. Eggs 0.012 to 0.014 by 0.006 to 0.009. Excretory arms ending blindly at sides of oral sucker; excretory pore subterminal.

Host: *Chloroscombrus chrysurus*.

Site: intestine.

Locality: Playa Mani, P. R.

Type specimen: Holotype No. 39397.

The above species is assigned to *Parectenurus* but with some reservations as to the validity of separating that genus from *Dinurus*, *Ectenurus*, and *Magnacetabulum* by the form of the seminal vesicle and distribution of prostatic cells along the male duct.

In the length of the sinus sac, *P. chloroscombri* comes closer to *Ectenurus* than *P. americanus* but has an undivided seminal vesicle as in *P. americanus*. *P. chloroscombri* differs from that species in size of body and pharynx, sucker ratio and extent of uterus.

Parahemiurus merus (Linton, 1910) Woolcock, 1935 (FIGURE 128)

Synonyms:

Hemiurus merus Linton, 1910.

Parahemiurus parahemiurus Vaz et Pereira, 1930.

P. platyichthyi Lloyd, 1938.

P. atherinae Yamaguti, 1938.

P. harengulae Yamaguti, 1938.

Host: **Opisthonema oglinum*, **Vomer setapinnis*.

Site: stomach.

Locality: Playa Mani, P. R.

Deposited specimen: No. 39398.

Sterrhurus fusiformis (Lühe, 1901) Looss, 1907 (FIGURE 129)

Synonym:

Lecithochirium fusiforme Lühe, 1901.

Host: *Gymnothorax* sp.

Site: stomach.

Locality: off Puerto Real, P. R.

Deposited specimen: No. 39399.

Sterrhurus floridensis Manter, 1934 (FIGURE 130)

Host: *Paralichthys* sp.

Site: stomach.

Locality: Puerto Real, P. R.

Deposited specimen: No. 39400.

Sterrhurus monticellii (Linton, 1898) Linton, 1910 (FIGURES 131 and 132)

Synonyms:

Distomum monticellii Linton, 1898.

Hemiurus monticellii (Linton) Looss, 1899.

Hosts: * *Bolhus ocellatus*, * *Ocyurus chrysurus*, * *Mulloidichthys martinicus*, * *Trachinotus* sp.

Site: stomach.

Locality: Punta Arenas, P. R.

Deposited specimen: No. 39401.

Sterrhurus microcercus Manter, 1947 (FIGURE 133)

Host: *Fistularia* sp.

Site: stomach.

Locality: Puerto Real, P. R.

Deposited specimen: No. 39402.

Lecithochirium parvum Manter, 1947 (FIGURE 134)

Host: *Euthynnus alletteratus*.

Site: stomach.

Locality: Parguera, P. R.

Deposited specimen: No. 39403.

Dinurus breviductus Looss, 1907 (FIGURE 135)

Host: *Coryphaena hippurus*.

Site: intestine and stomach.

Locality: Mona Island, P. R.

Deposited specimen: No. 39404.

Dinurus barbatus (Cohn, 1903) Looss, 1907 (FIGURE 136)

Synonym:

Lecithocladium barbatum Cohn, 1903.

Host: *Coryphaena hippurus*.

Site: stomach.

Locality: Mona Island, P. R.

Deposited specimen: No. 39405.

Dinurus tornatus (Rudolphi, 1819) Looss, 1907 (FIGURE 137)

Synonyms:

Distomum tornatum Rudolphi, 1819.

Lecithocladium tornatum (Rudolphi) Lühe, 1901.

Host: *Coryphaena hippurus*.

Site: stomach.

Locality: Mona Island, P. R.

Deposited specimen: No. 39406.

Tubulovesicula lindbergi (Layman, 1930) Yamaguti, 1934 (FIGURE 138)

Synonyms:

Lecithaster lindbergi Layman, 1930.

Lecithurus lindbergi (Layman) Pigulevsky, 1938.

Host: *Leptocephalus conger*.

Site: stomach.

Locality: Puerto Real, P. R.

Deposited specimen: No. 39407.

FAMILY HIRUDINELLIDAE DOLLFUS, 1932

Hirudinella ventricosa (Pallas, 1774) Baird, 1853 (FIGURE 139)

Synonym:

Fasciola ventricosa Pallas, 1774.

Host: *Coryphaena hippurus*.

Site: stomach.

Locality: off Mayagüez, P. R.

Deposited specimen: No. 39408.

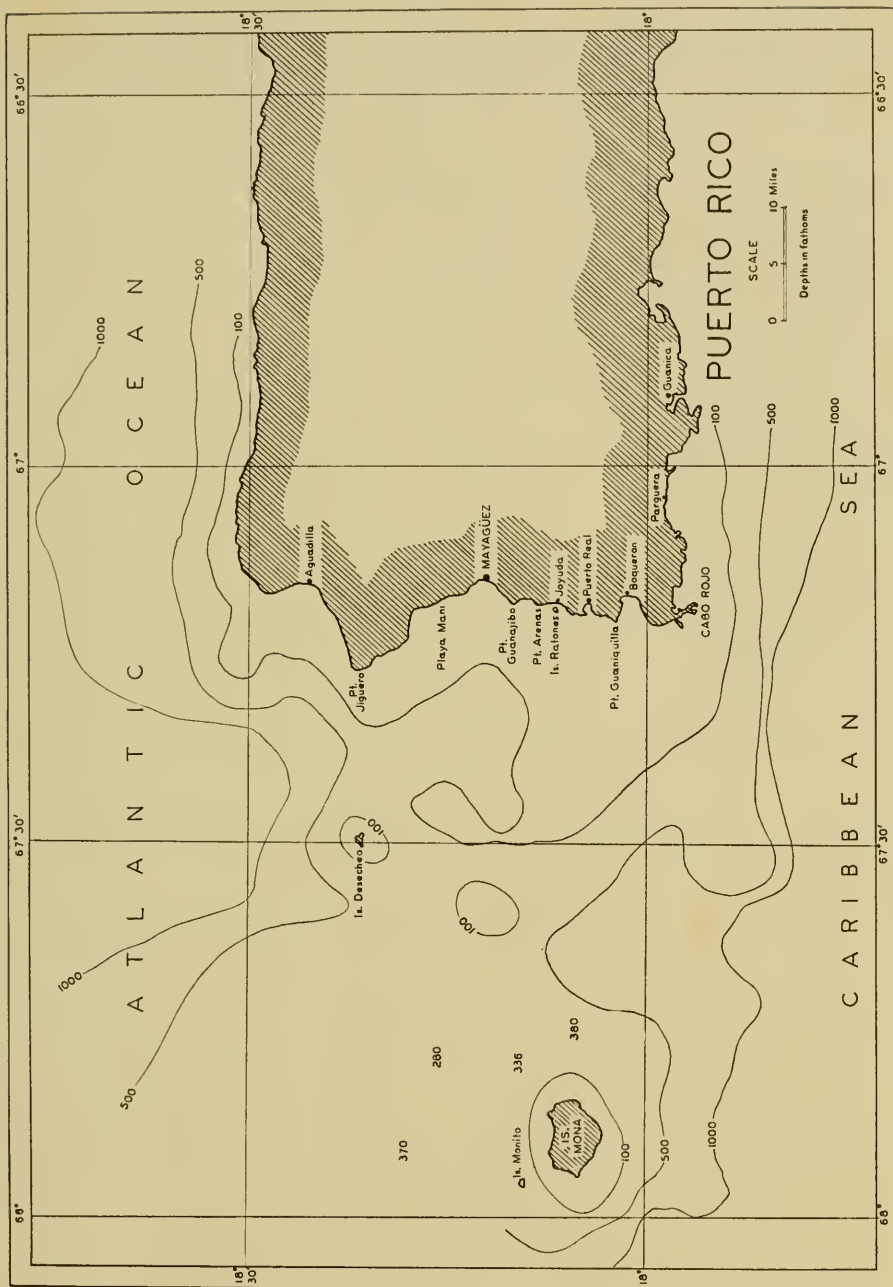
Our material is tentatively assigned to *H. ventricosa* as it appears very similar to that species as described by Manter (1947). In immature specimens, the excretory vesicle was observed as an elongate sac without the median tubular prolongation that receives the main excretory tubes in hemiurids. Instead, the vesicle receives those tubes independently at its anterolateral margins. The system is complex and apparently has 2 commissures anterior to the oral sucker.

DISCUSSION

The geographical distribution of the digenetic trematodes of marine fishes has been summarized by Manter (1947, 1955), who was concerned mostly with rather widely separated localities and the comparison of their trematode faunas. The present study focuses attention on the occurrence of those parasites in fishes from waters adjacent to 2 relatively close land masses, Puerto Rico and Mona Island, which are about 45 miles apart (TEXT FIGURE 1). All fishes examined in Puerto Rico were taken off the western and southwestern coasts, mostly at a depth of less than 100 fathoms. Those at Mona Island came chiefly from depths of less than 200 fathoms to the northwest and north of the island. The deepest continuous channel separating the two is closer to Mona than Puerto Rico and probably is a minimum of 250 fathoms.

Of the total of 123 species of digenetic trematodes found (TABLE 1) 78 were previously described ones. Of that number, 63 were from Puerto Rican waters, 10 from Mona and 5 from both localities. Of the 45 new species, 36 were from Puerto Rico, 8 from Mona, and but 1 from both places. Although the number of host species examined at Mona was but about one tenth that from Puerto Rico, the proportion of new to described trematodes was about the same for the 2 localities. Five of the 8 new species found only at Mona were recovered from host species not examined in Puerto Rico. Thus 2 factors concerned with speciation of these parasites must be considered: host specificity and isolation of host populations.

In general, digenetic trematodes are believed not to exhibit the high degree of host specificity observed for certain other helminth parasites. The 39 new host records reported here for previously described trematodes,



TEXT FIGURE 1. Map of western Puerto Rico and Mona Island.

TABLE I
SPECIES DISTRIBUTION OF DIGENETIC TREMATODES FOUND IN THIS STUDY

Family	Number of Species				Total
	Puerto Rico		Mona Island		
	Old	New	Old	New	
(1) Aspidogastridae	0	1	0	0	1
(2) Bucephalidae	2	2	2	0	6
(3) Paramphistomatidae	1	0	0	0	1
(4) Pronocephalidae	2	2	0	0	4
(5) Microscaphiidae	1	2	0	0	3
(6) Haploplanchnidae	2	1	1	1	5
(7) Zoogonidae	1	2	0	1	4
(8) Bivesiculidae	1	0	0	0	1
(9) Microphallidae	0	2	0	0	2
(10) Cryptogonimidae	2	2	0	0	4
(11) Monorchiiidae	4	1	0	0	5
(12) Fellodistomatidae	4	3	0	1	8
(13) Acanthocolpidae	5	0	1*	0	5
(14) Haploporidae	0	4	0	0	4
(15) Megaperidae	3	0	0	0	3
(16) Opistholebetidae	2	1	0	0	3
(17) Opecoelidae	12	5	3*	2	21
(18) Lepocreadiidae	14	3	2*	4*	21
(19) Accacoeliidae	1	0	1*	0	1
(20) Hemiuridae	10	6	5*	0	20
(21) Hirudinellidae	1	0	0	0	1
Totals	68	37	15	9	123

* One species common to both localities.

and the long host-lists of some of them support that belief. However, exceptions are such that host specificity cannot be ruled out as a significant factor in explaining the small number of trematodes found common to both of the localities investigated.

Food habits of potential hosts undoubtedly play an important role, and other aspects of the trematode life cycle may be equally significant. For example, the ability of a species to attain maturity in a wide range of hosts may depend on the extent to which the parasite develops prior to gaining entry to such hosts. The metacercariae of many trematodes and even the cercaria of a few attain full reproductive maturity through progenetic development, and it may be expected that they could establish themselves in a variety of vertebrates for a sufficiently long period to be found there as ovigerous worms. The best known example of that situation is the family Microphallidae, 2 species of which are here reported from marine fishes for the first time. As described for one of them, *Megalophallus diodontis*, metacercariae became ovigerous when the second intermediate host, a crab, was killed and left in the laboratory for several hours. Conversely, a species whose metacercaria develops but partially toward the adult condition, and especially one that grows a great deal in the definitive host before becoming sexually functional, may be able to do so in but one or a few closely re-

lated host species in which mutual tolerance is possible for the length of time required. However, in certain groups such as the echinostomes and fasciolids, metacercariae grow and acquire adult characters hardly at all before they are infective to a variety of hosts in which they can develop to large, mature adults.

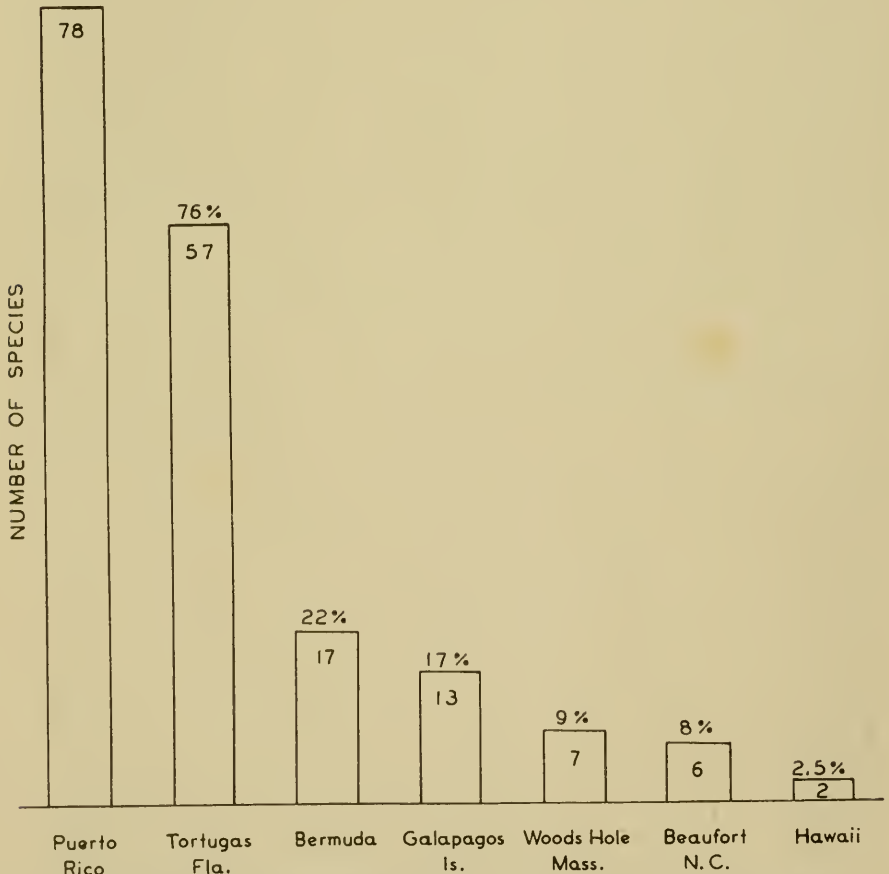
Another factor that may affect host specificity of the digenetic trematodes is the site at which the parasite localizes in the definitive host; that factor may account for the long host lists of certain species, notably many hemiurids which are predominantly stomach parasites of marine fishes. Thus as Manter (1957) stated, ". . . the status of each parasite must be appraised on its own merits" in weighing host specificity against other isolating mechanisms. However, such appraisal is hampered by meager information concerning the habits of hosts and the life histories of their parasites.

As expected, the wide-ranging pelagic fishes examined by us yielded the same species of trematodes reported from those hosts elsewhere. Shallow-water and reef fishes, however, presented quite another picture, harboring nearly all 45 of the new species found. Of that number, 18 occurred in host species examined by Manter (1947) at Tortugas, Fla. Although the remaining 27 were from fishes not collected by him, several occurred in species closely related to those he did examine. Thus host specificity alone is not an adequate explanation of the differences in the trematode faunas of Tortugas and the northeastern Caribbean region. In addition, deep waters and ocean currents may be an important factor through the isolation of host populations and therefore their parasites. Although the number of fishes examined at Mona Island was not large, a degree of their isolation from populations adjacent to Puerto Rico is indicated by finding but one of the 45 new species in both localities and 3 at Mona in host species that were examined in larger numbers in Puerto Rico without finding those parasites.

The distribution of the trematodes according to families is of interest with respect to life history patterns. Excluding families represented by but a few species, 5 contain over one half of the new trematodes: Fellodistomatidae with 4 of 7 new; Opecoelidae and Lepocreadiidae each with 7 of 21; Hemiuridae 6 of 20; and Haploporidae 4 of 4. Of those families, life histories are best known for the Opecoelidae, in which the cercaria is microcercous, unable to swim, and therefore required to utilize as a second intermediate host a bottom-frequenting organism, almost always a crustacean. Although lepecreadiid cercariae are good swimmers at least some of them become photonegative and likewise seek a bottom form as the next host, which may be a mollusk, annelid, or turbellarian. Cercariae of the Fello-distomatidae exhibit all degrees of swimming ability, but to our knowledge utilize only mollusks to reach definitive hosts that feed upon such shellfish. In the Hemiuridae, pelagic invertebrates, mostly copepods, serve as the second intermediate host of certain species and account for their wide distribution. Evidently, some of these cercariae may be obtained by large fish when eating smaller ones that may be a third intermediate or paratenic host that ingests infected copepods; the life histories of such cercariae have not yet been elucidated. However, some hemiurid cercariae cannot swim

and, being unable to penetrate the intermediate host, must be eaten by one necessarily with bottom-feeding habits. As to the Haploporidae, all 4 species of which were new, a life history has not yet been demonstrated for the family, but it seems very likely to parallel that of the leprocreadiids. The definitive hosts of the 4 species are shallow-water and reef-dwelling fishes. On the other hand, no new species were found in the family Acanthocolpidae, whose members are common in wide-ranging fishes, which obtain them by eating smaller fishes.

Factors controlling the distribution of marine organisms are not well understood, but an important one is water depth, which affects both their abundance and variety. Thus fishes depending for food on organisms restricted to waters of shallow and moderate depth, especially bottom-dwelling invertebrates, would likewise be restricted by that factor if not by the habits of the fishes themselves. Deep water therefore would serve to



TEXT FIGURE 2. Similarity of trematode fauna at various localities in American waters.

isolate populations of such fishes and of the parasites that they obtain in feeding. As isolation is generally acknowledged as essential to species formation, it thus is to be expected that the trematodes of fishes of shallow water adjacent to land masses separated by deep water may differ in the species present, and that the difference would increase with the distance between such masses, other factors being equal. At the same time, the number of trematode species common to both regions would be expected to decrease. That relationship for the coastal waters of Puerto Rico (including Mona Island) and certain other regions is shown graphically in TEXT FIGURE 2. Greatest similarity of the Puerto Rican fauna is to that of Tortugas, Fla., and then Bermuda, with ecological conditions more like those of Puerto Rico than of Beaufort, N. C. More than twice as many Puerto Rican species occur in the Galapagos region as at Beaufort, just as Manter (1947) reported in comparing Tortugas with those regions. Manter found, however, fewer Tortugas species at Bermuda than in the Galapagos area. The marine trematode fauna of Cuba is still largely unknown and has not been investigated at all for other islands and island groups in the Caribbean region, some isolated by much deeper water than that separating Puerto Rico and Mona Island. Studies in those regions would contribute much toward the evaluation of factors influencing speciation of the digenetic trematodes of marine fishes and to marine zoology and ecology in general.

HOST-PARASITE LIST

- | | |
|--|--|
| <i>Acanthocybium solandri</i> (Cuvier and Valenciennes), peto | <i>Cotylogaster basiri</i> |
| <i>Tetrochelus aluterae</i> | <i>Pachycreadium crassigulum</i> |
| <i>Acanthurus bahianus</i> Castelnau, ocean surgeonfish | <i>Pachycreadium gastrocotylum</i> |
| <i>Dichadena acuta</i> | <i>Proctoeces lintoni</i> |
| <i>Hysteroleicitha rosea</i> | <i>Canthigaster rostratus</i> (Bloch) sharp-nosed puffer |
| <i>Macradena acanthuri</i> | <i>Diploproctodaemum</i> sp. |
| <i>Schikhalotrema obtusa</i> | <i>Caranx ruber</i> (Bloch), runner |
| <i>Acanthurus caeruleus</i> Bloch and Schneider, blue tang | <i>Alcichornis carangis</i> |
| <i>Dichadena acuta</i> | <i>Centropomus ensiferus</i> Poey, snook |
| <i>Hapladena acanthuri</i> | <i>Opecoeloides</i> (?) sp. |
| <i>Proctoeces neomagnorus</i> | <i>Paracryptogonimus centropomi</i> |
| <i>Theletrum fustiforme</i> | <i>Cephalopholis fulvus</i> (Linnaeus), coney |
| <i>Anchoiella epsetus</i> (Bonnaterre), striped anchovy | <i>Hamacreadium lintoni</i> |
| <i>Tergestia laticollis</i> | <i>Neolepidapedon equilatatum</i> |
| <i>Apogon maculatus</i> (Poey), cardinal fish | <i>Chaetodipterus faber</i> (Broussonet), spadefish |
| <i>Pseudopeoelus tortugae</i> | <i>Allomegasolena spinosa</i> |
| <i>Balistes vetula</i> Linnaeus, queen triggerfish | <i>Aponurus elongatus</i> |
| <i>Apocreadium balistis</i> | <i>Homalometron elongatum</i> |
| <i>Apocreadium mexicanum</i> | <i>Lepidapedon holocentri</i> |
| <i>Neopocreadium coili</i> | <i>Multitestis blennii</i> |
| <i>Bothus ocellatus</i> (Agassiz), flounder | <i>Multitestis inconstans</i> |
| <i>Sterrhurus monticellii</i> | <i>Neomegasolena chaetodipteri</i> |
| <i>Calamus arcifrons</i> Goode and Bean, grass porgy | <i>Chaetodon capistratus</i> Linnaeus, butterfly fish |
| <i>Stephanostomum sentum</i> | <i>Hurleytrematoides chaetodoni</i> |
| <i>Calamus calamus</i> (Cuvier and Valenciennes), saucer-eye porgy | <i>Chaetodon ocellatus</i> Bloch, butterfly fish |
| | <i>Aponurus symmetrorchis</i> |
| | <i>Chloroscombrus chrysurus</i> (Linnaeus), bumper |
| | <i>Opechona</i> sp. |

- Parectenurus chloroscomberi*
Prosorhynchus attenuatus
Tergestia pectinata
Coryphaena hippurus Linnaeus, "dolphin"
Dinurus barbatus
Dinurus breviductus
Dinurus tornatus
Hirudinella ventricosa
Stephanostomum coryphaenae
Tetrochetus aluterae
Diodon hystrix Linnaeus, porcupine fish
Megalomyzon robustum
Megalophallus diodontis
Opisthoteles diodontis
Epinephelus adscensionis (Osbeck), rock hind
Hamacreadium longisaccum
Neolepidapedon epinepheli
Epinephelus striatus (Bloch), Nassau grouper
Hamacreadium lintoni
Helicometra torta
Neolepidapedon epinepheli
Postporus epinepheli
Stephanostomum dentatum
Eques acuminatus (Bloch and Schneider), croaker
Horatrema crassum
Pseudopecoelus equesi
Eathynnus alletteratus (Rafinesque), little tunny
Lecithochirium parvum
Rhipidocotyle nagatyi
Tergestia laticollis
Fistularia sp., cornet fish
Sterrhurus microcerus
Gerres cinereus (Walbaum), white mojarra
Homalometron elongatum
Pinguitrema lobata
Pseudohurleytrema eucinostomi
Stephanostomum sentum
Gymnothorax sp., moray eel
Sterrhurus fusiformis
Haemulon album Cuvier and Valenciennes, margate fish
Aponurus symmetricorichis
Haemulon flavolineatum (Desmarest), French grunt
Homalometron foliatum
Infundibulostomum spinatum
Stephanostomum sentum
Haemulon melanurum (Linnaeus), French margate fish
Leurodera decora
Haemulon plumieri (Lacépède), common grunt
Bilecithaster ovalis
Genolopa ampullacea
Postmonorchis orthopristis
Halichoeres bivittatus (Bloch), slippery dick
Coitoecum sp.
Hepsetia stipes (Müller and Troschel), hardhead
Bivesicula hepsetiae
Steganoderma atherinae
Holacanthus ciliaris (Linnaeus), queen angelfish
Antorchis holacanthi
Holacanthus tricolor (Bloch), rock beauty
Antorchis holacanthi
Pseudobarisomum holacanthi
Holocentrus ascensionis (Osbeck), squirrelfish
Helicometra equilata
Lepidapedon holocentri
Pseudopecoelus barkeri
Holocentrus vexillarius (Poey), squirrelfish
Pseudopecoelus barkeri
Hyporhamphus unifasciatus (Ranzani), halfbeak
Schikhobalotrema actua
Labrisomus nuchipinnis (Quoy and Gaimard), hairy blenny
Coitoecum sp.
Lachnolaimus maximus (Walbaum), hogfish
Myoxenus lachnolaimi
Lactophrys bicaudalis (Linnaeus), trunkfish
Carneophallus lactophrysi
Helicometrina mirzai
Megapera gyrina
Neoapocreadium angustum
Xystretum solidum
Lactophrys tricornis (Linnaeus), common trunkfish
Dermadena lactophrysi
Megapera gyrina
Megapera pseudura
Pseudocreadium sp.
Thysanopharynx elongatus
Lactophrys triquetra (Linnaeus), trunkfish
Dermadena lactophrysi
Leptocephalus conger (Linnaeus), conger eel
Tubulovesicula lindbergi
Lutianus analis (Cuvier and Valenciennes), muttonfish
Hamacreadium mutabile
Siphodera vinalwardsii
Stephanostomum casum
Lutianus apodus (Walbaum), schoolmaster
Allomegasolena attenuata
Hamacreadium mutabile
Metadena adglobosa
Lutianus aya (?)
Paracryptogonimus neoamericanus
Lutianus griseus (Linnaeus), gray snapper
Hamacreadium mutabile
Metadena adglobosa
Lutianus joeu (Bloch and Schneider), dog snapper
Hamacreadium mutabile
Lutianus synagris (Linnaeus), lane snapper
Siphodera vinalwardsii
Malacanthus plumieri (Bloch), blunquillo
Neozoogonus malacanthi
Pseudoplagiopus brevitellus
Monacanthus hispidus (Linnaeus), filefish
Dermadena lactophrysi
Mulloidichthys martimicus (Cuvier and Valenciennes), yellow goatfish
Helicometrina trachinoti

- Neozoogonus longicoccus*
Opecoeloides brachyleleus
Opecoeloides elongatus
Opecoeloides vitellus
Sterrhurus monticellii
Mycteroperca sp.
Neolepidapedon mycteropercae
Prosorhynchus atlanticus
Myrichthys oculatus (Kaup), snake eel
Diploproctodaenum sp.
Ocyurus chrysurus (Bloch), yellowtail
Diplangus anoplosus
Hamacreadium mutabile
Lepocreadium trulla
Lepocreadium sp.
Paracryptogonimus neoamericanus
Sterrhurus monticellii
Odontoscion dentex (Cuvier and Valenciennes), corvina
Genolopa longicaudata
Horatrema crassum
Oligoplites saurus (Bloch and Schneider), leather jacket
Manteria brachydera
Opisthonema oglinum (Le Sueur), thread herring
Neogenolinea opisthonemae
Parahemiurus merus
Paralichthys sp., flounder
Sterrhurus floridensis
Pomacanthus arcuatus (Linnaeus), black angelfish
Antorchis urna
Barisomum erubescens
Cleptodiscus reticulatus
Glyphicephalus caudifidus
Glyphicephalus mcintoshii
Hexangitrema breviceca
Hexangitrema pomacanthi
Hexangitrema pricei
Theletrium justiforme
Pomacentrus adustus (Troschel), maria molle
Schikhobalotrema pomacentri
Pseudoscarus guacamaia (Cuvier), rainbow parrotfish
Schikhobalotrema sp.
Rhomboplites aurorubens (Cuvier and Valenciennes), vermilion snapper
Lepocreadium trulla
Scomberomorus sp.
Prosorhynchus stunkardi
Scorpaena sp., scorpionfish
Neohelicometra scorpaenae
Scorpaena plumieri Bloch, scorpionfish
Helicometrina nimia
Selene vomer (Linnaeus), moonfish
Tergestia laticollis
Sparisoma sp., parrotfish
Schikhobalotrema adbrachyura
Sparisoma viride (Bonnaterre), green parrotfish
Schikhobalotrema sp.
Schikhobalotrema obtusa
Spheroides testudineus (Linnaeus), West Indian puffer
Megalophallus diodontis
Sphyræna barracuda (Walbaum), great barracuda
Bucephalopsis arcuatus
Strongylura sp., houndfish
Schikhobalotrema acuta
Trachinotus sp., pompano
Helicometrina trachinoti
Neolepidapedon trachinoti
Sterrhurus monticellii
Trichurus lepturus Linnaeus, cutlass fish
Opecoeloides sp.
Vomer setapinnis (Mitchill), horsefish or lookdown
Parahemiurus merus
 Unidentified: "collarfish"
Schikhobalotrema manteri
- The following list includes fishes negative for trematodes. The number of each examined is in parenthesis.
- Abudefduf saxatilis* (Linnaeus) (3)
Acanthurus sp. (3)
Anchovia producta (5)
Apogon conklinii (Silvester) (5)
Archosargus unifasciatus (Bloch) (1)
Atherina sp. (1)
Aulostomus maculatus Valenciennes (1)
Bathygobius soporator (Cuvier and Valenciennes) (11)
Bathystoma rimator (Jordan and Swain) (1)
Caranx sp. (2)
Caranx latus Agassiz (3)
Caranx lugubris (Poey) (1)
Carcharias limbatus Muller and Henle (1)
Chaetodon striatus Linn. (2)
Chilomycterus sp. (1)
Cryptopomus auropunctatus (Cuvier and Valenciennes) (1)
Daetyloscopus tridigitatus Gill (4)
Epinephelus guttatus (Linnaeus) (4)
Epinephelus morio (Cuvier and Valenciennes) (1)
Encinostomus californiensis (Gill) (4)
Ilaemulon sciurus (Shaw) (1)
Halichoeres radiatus (Linnaeus) (1)
Harengula macrophthalmia (Ranzani) (3)
Hippichthys brachycephalus (Poey) (1)
Lactophrys trigonus (Linnaeus) (2)
Lutianus buccanella (Cuvier and Valenciennes) (1)
Monacanthus ciliatus (Mitchill) (5)
Monacanthus tokeri Bean (1)
Mugil brasiliensis Agassiz (1)
Mugil curema Cuvier and Valenciennes (8)
Myripristis jacobus Cuvier and Valenciennes (1)
Pomacentrus leucostictus Müller and Troschel (1)
Priacanthus cruentatus (Lacépède) (1)
Pseudupeneus maculatus (Bloch) (1)
Rypticus bistrispinus (Mitchill) (1)
Scarus croicensis Bloch (1)
Scoliodon tærae-novae (Richardson) (1)

- Scomberomorus maculatus* (Mitchill) (6) *Syngnathus* sp. (2)
Sparisoma abildgaardii (Bloch) (4) *Thalassoma bifasciatum* (Bloch) (1)
Sphyræna guachancho Cuvier and Valen- *Trachinotus jalcatus* (Linnaeus) (2)
 ciennes (1) *Trachinotus palometa* Regan (1)

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PLATES

PLATE I

- FIGURE 1. (a) *Cotylogaster basiri* (ventral view); (b) terminal reproductive organs.
FIGURE 2. *Rhipidocotyle nagatyi* (dorsal view).
FIGURE 3. *Alcicornis carangis* (ventral view).
FIGURE 4. *Prosorhynchus attenuatus* (dorsal view).
FIGURE 5. *Prosorhynchus atlanticus* (ventral view).
FIGURE 6. *Prosorhynchus stunkardi* (ventral view).
FIGURE 7. *Bucephalopsis arcuatus* (ventral view).

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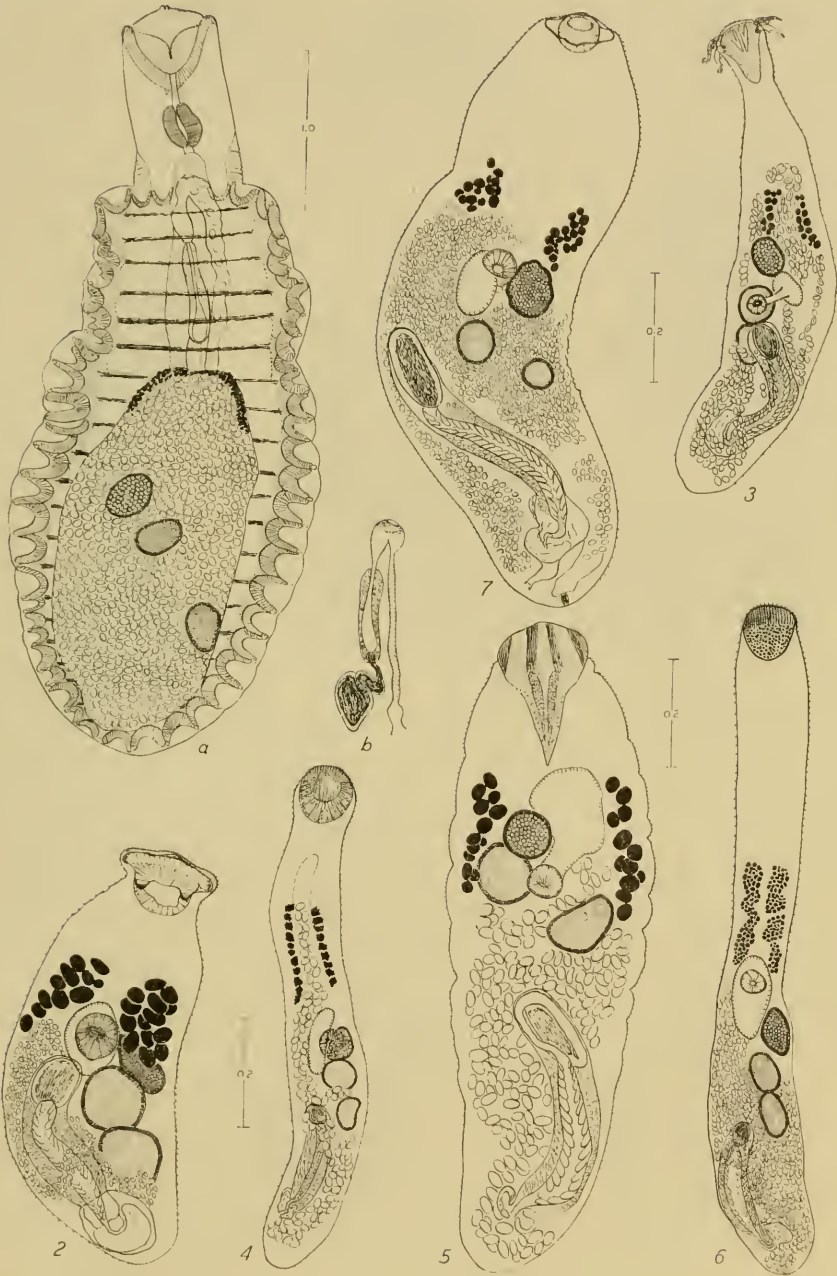


PLATE II

- FIGURE 8. *Glyphicephalus candidulus* (ventral view).
FIGURE 9. *Glyphicephalus mcintoshii* (ventral view).
FIGURE 10. *Barisomum erubescens* (ventral view).
FIGURE 11. *Pseudobarisomum holacanthi* (ventral view).
FIGURE 12. *Hexangitrema breviceca* (ventral view).
FIGURE 13. *Hexangitrema pricei*, excretory system in part.
FIGURE 14. *Hexangitrema pricei* (ventral view).

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PLATE III

- FIGURE 15. *Schikhobalotrema manteri* (ventral view).
FIGURE 16. *Schikhobalotrema acuta* (ventral view).
FIGURE 17. *Schikhobalotrema pomacentri* (ventral view).
FIGURE 18. *Schikhobalotrema obtusa* (ventral view).
FIGURE 19. *Schikhobalotrema adbrachyura* (lateral view).
FIGURE 20. *Schikhobalotrema adbrachyura* (ventral view).
FIGURE 21. *Neozoogonus longicecus* (dorsal view).
FIGURE 22. *Neozoogonus malacanthi* (ventral view).
FIGURE 23. *Steganoderma atherinae* (ventral view).

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PLATE IV

- FIGURE 24. *Diplangus anoplosus* (ventral view).
FIGURE 25. *Bivesicula hepsetiae* (ventral view), redrawn from Le Zotte, 1954.
FIGURE 26. *Megalophallus diodontis* (ventral view).
FIGURE 27. *Carneophallus lactophrysi* (ventral view).
FIGURE 28. *Siphodera vinaledwardsii* (ventral view), redrawn from Cable and Hunninen, 1942.

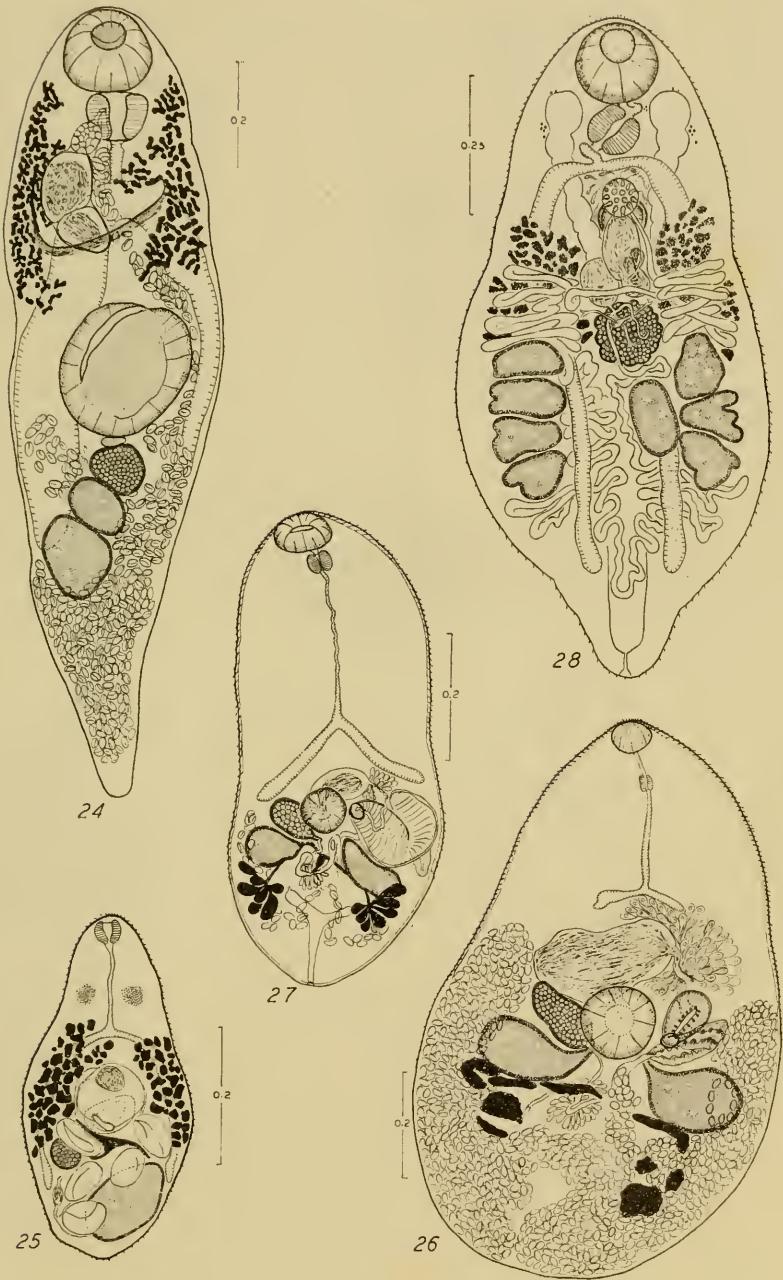


PLATE V

- FIGURE 29. *Paracryptogonimus neoamericanus* (ventral view).
FIGURE 30. *Paracryptogonimus centropomi* (ventral view).
FIGURE 31. *Metadena adglobosa* (ventral view).
FIGURE 32. Female complex of *Metadena adglobosa* (dorsal view).
FIGURE 33. Excretory system of *Metadena adglobosa*.
FIGURE 34. *Xystretrum solidum* (ventral view).

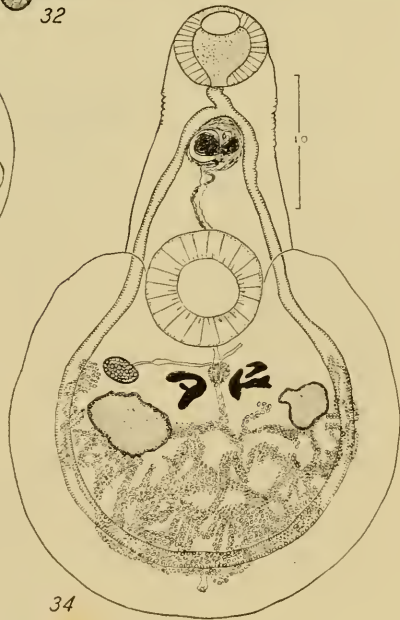
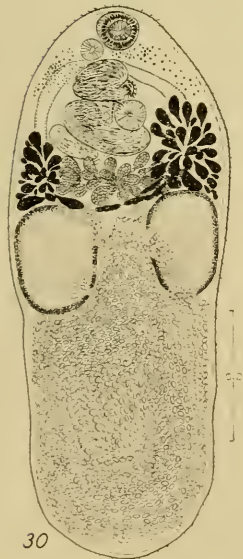
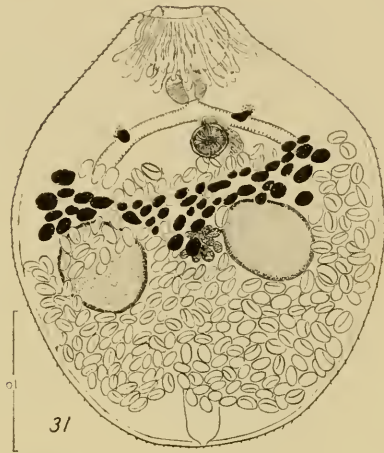
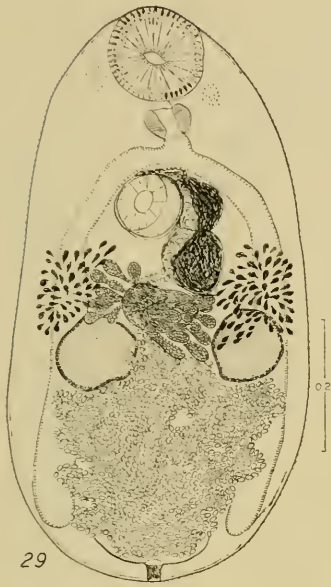


PLATE VI

- FIGURE 35. *Genolopa longicaudata* (ventral view).
FIGURE 36. *Genolopa ampullacea* (ventral view).
FIGURE 37. *Hurleytrematoides chaetodoni* (ventral view).
FIGURE 38. *Pseudohurleytrema eucinostomi* (ventral view).
FIGURE 39. *Postmonorchis orthopristis* (ventral view).
FIGURE 40. Excretory system of *Postmonorchis orthopristis*.
FIGURE 41. *Tergestia laticollis* (ventral view).

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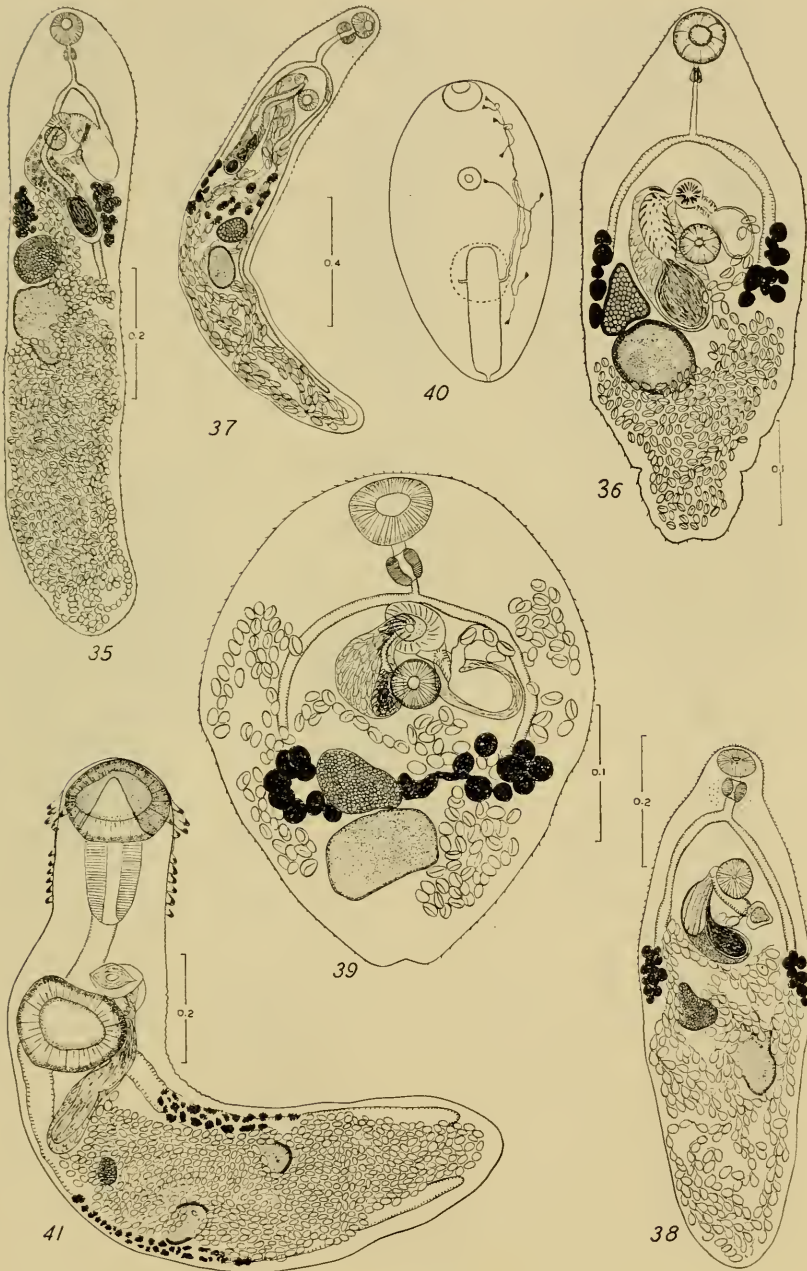


PLATE VII

FIGURE 42. Excretory system of *T. laticollis*: (a) from *Selene vomer*; (b) from *Gerres cinereus*.

FIGURE 43. *Tergestia pectinata* (ventral view).

FIGURE 44. *Antorchis holacanthi* (ventral view).

FIGURE 45. *Antorchis urna* (ventral view).

FIGURE 46. Excretory system of *A. urna*.

FIGURE 47. *Infundibulostomum spinatum* (ventral view).

FIGURE 48. *Proctoeces lintoni* (slightly lateral view).

FIGURE 49. *Proctoeces neomagnorus* (lateral view).

PLATE VIII

- FIGURE 50. *Stephanostomum coryphaenae* (ventral view).
FIGURE 51. Anterior end of *S. coryphaenae*.
FIGURE 52. *Stephanostomum dentatum* (ventral view).
FIGURE 53. Anterior end of *S. dentatum*.
FIGURE 54. *Stephanostomum casum* (ventral view).
FIGURE 55. Anterior end of *S. casum*.
FIGURE 56. *Stephanostomum sentum* (ventral view).
FIGURE 57. Anterior end of *S. sentum*.

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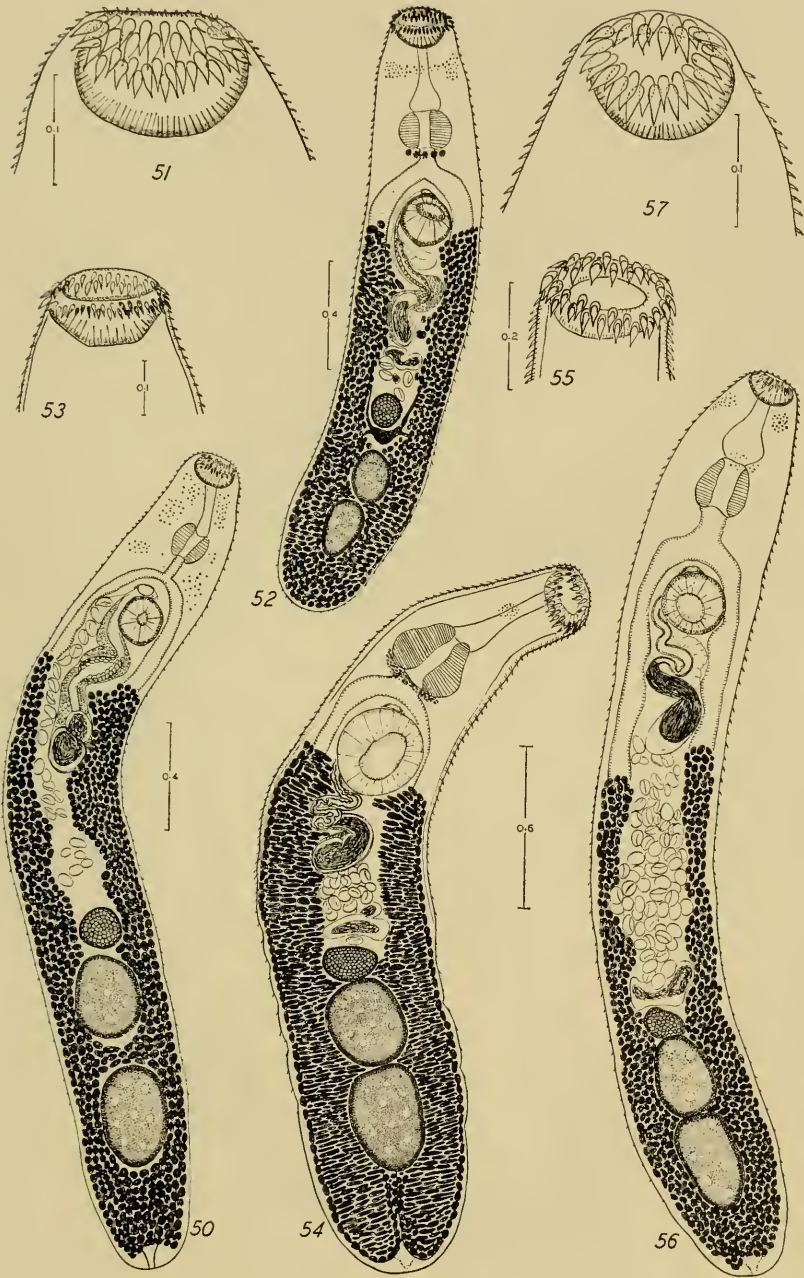


PLATE IX

- FIGURE 58. *Manteria brachydera* (ventral view).
FIGURE 59. Anterior end of *M. brachydera*.
FIGURE 60. Excretory system of *M. brachydera*.
FIGURE 61. Part of excretory pattern of *M. brachydera*.
FIGURE 62. *Allomegasolena spinata* (dorsal view).
FIGURE 63. Hermaphroditic pouch of *A. spinata*.

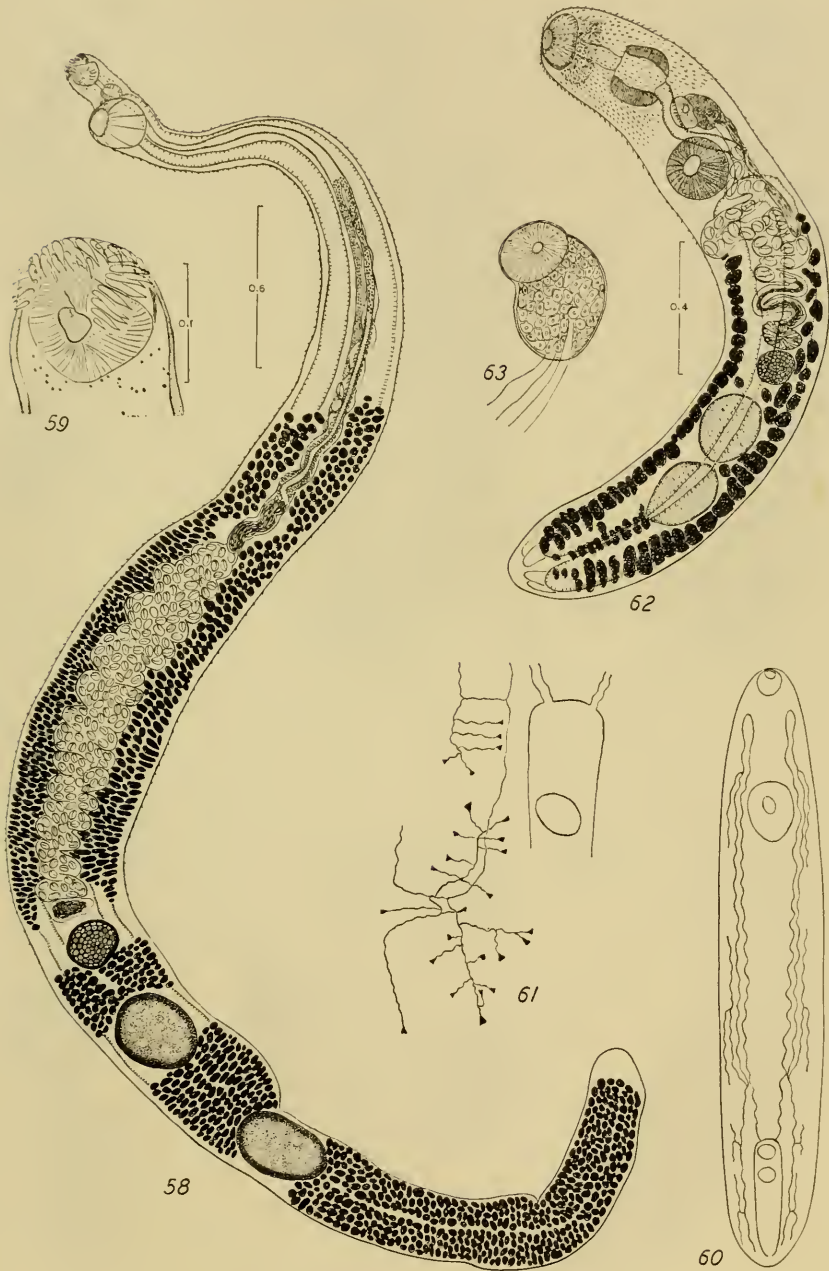
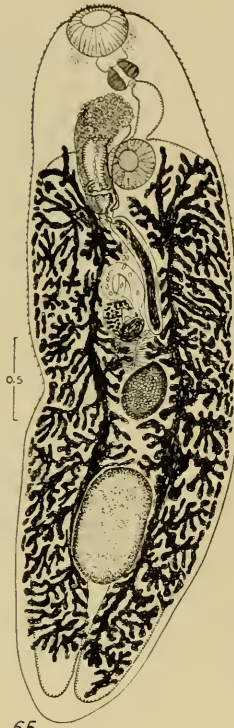


PLATE X

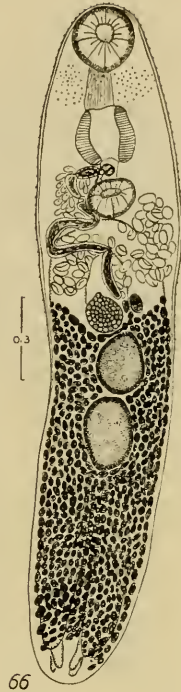
- FIGURE 64. *Allomegasolena attenuata* (ventral view).
FIGURE 65. *Hapladena acanthuri* (dorsal view).
FIGURE 66. *Neomegasolena chaetodipteri* (ventral view).
FIGURE 67. *Megapera gyrina* (ventral view).
FIGURE 68. *Megapera pseudura* (ventral view).
FIGURE 69. *Thysanopharynx elongatus* (ventral view).



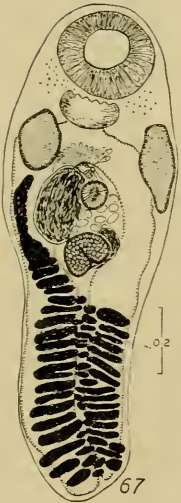
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PLATE XI

FIGURE 70. *Opistholebes diodontis* (ventral view).

FIGURE 71. Excretory system of *O. diodontis*.

FIGURE 72. Giant flame cell of *O. diodontis*.

FIGURE 73. *Pachycreadium gastrocotylum* (ventral view).

FIGURE 74. *Pachycreadium crassigulum* (ventral view).

FIGURE 75. *Pinguitrema lobata* (ventral view).

FIGURE 76. (a) *Hamacreadium lintoni* (ventral view). (b) Cirrus sac of *H. lintoni*.

* Figures 70 to 72 redrawn from original data and figures of Cable, 1956a.

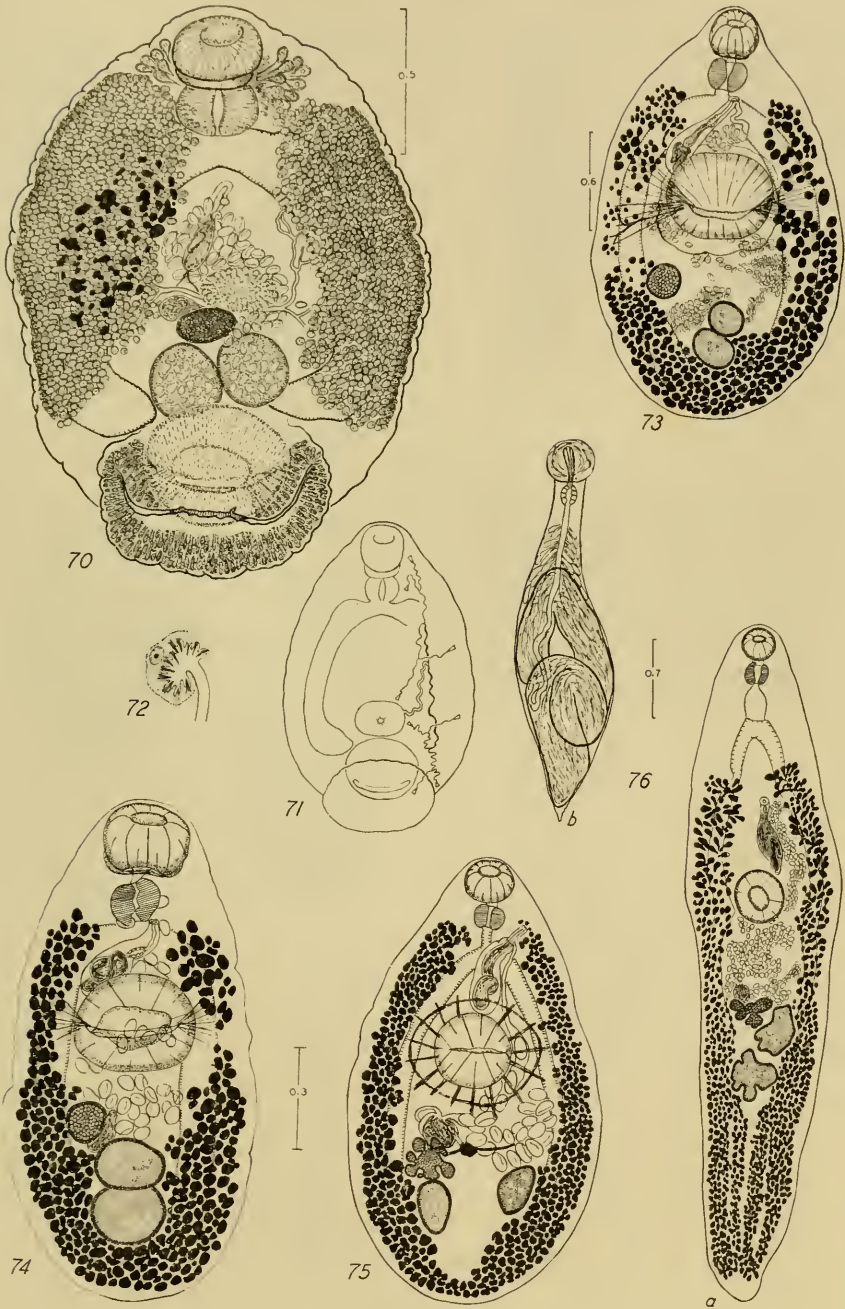


PLATE XII

- FIGURE 77. *Hamacreadium longisaccum* (ventral view).
FIGURE 78. *Hamacreadium mutabile* (ventral view).
FIGURE 79. *Pseudoplagioporus brevitellus* (dorsal view).
FIGURE 80. *Helicometrina nimia* (ventral view).
FIGURE 81. *Helicometrina trachinoti* (ventral view).
FIGURE 82. *Helicometrina mirzai* (ventral view).
FIGURE 83. *Helicometra equilata* (ventral view).
FIGURE 84. *Helicometra torta* (ventral view).
FIGURE 85. *Neohelicometra scorpaenae* (ventral view).
FIGURE 86. *Opecoeloides vitellosus* (ventral view).
FIGURE 87. Ventral sucker of *Opecoeloides elongatus*.

SIDDIQI & CABLE: DIGENETIC TREMATODES OF PUERTO RICO



PLATE XIII

- FIGURE 88. *Opecoeloides elongatus* (ventral view).
FIGURE 89. *Opecoeloides* sp. (ventral view).
FIGURE 90. *Opecoeloides brachyteleus* (ventral view).
FIGURE 91. *Opecoeloides* (?) sp. (ventral view).
FIGURE 92. *Pseudopecoeloides equesi* (ventral view).
FIGURE 93. *Pseudopecoelus barkeri* (ventral view).
FIGURE 94. *Pseudopecoelus tortugae* (ventral view).
FIGURE 95. *Horatrema crassum* (dorsal view).

PLATE XIV

- FIGURE 96. *Homalometron elongatum* (ventral view).
FIGURE 97. *Homalometron foliatum* (ventral view).
FIGURE 98. *Neopocreadium angustum* (ventral view).
FIGURE 99. *Neopocreadium coili* (ventral view).
FIGURE 100. *Postporus epinepheli* (ventral view).
FIGURE 101. *Apocreadium balistis* (ventral view).
FIGURE 102. *Apocreadium mexicanum* (ventral view).
FIGURE 103. *Multitestis blennii* (ventral view).

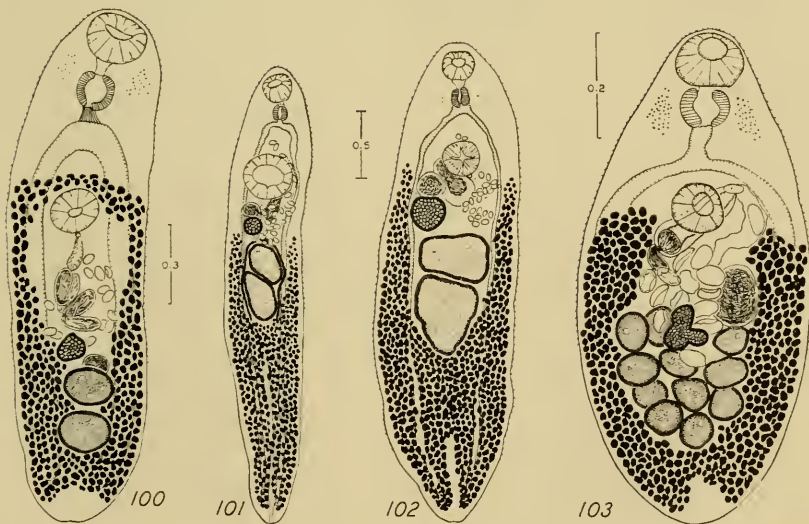
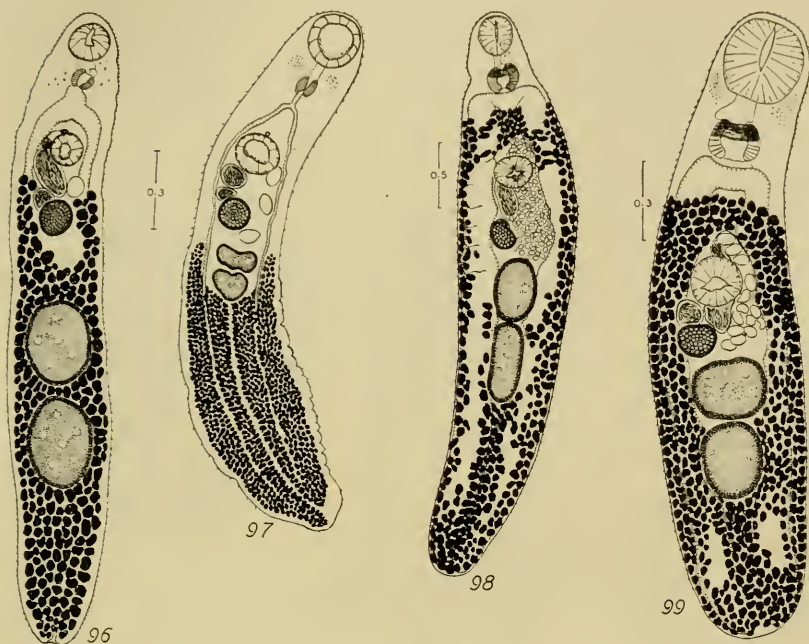


PLATE XV

- FIGURE 104. *Multitestis inconstans* (dorsal view).
FIGURE 105. *Lepocreadium trulla* (ventral view).
FIGURE 106. *Lepocreadium* sp. (ventral view).
FIGURE 107. *Neolepidapedon trachinoti* (dorsal view).
FIGURE 108. *Neolepidapedon epinepheli* (ventral view).

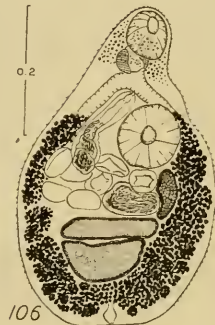
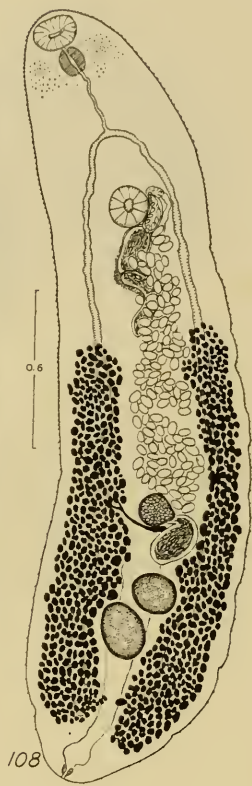
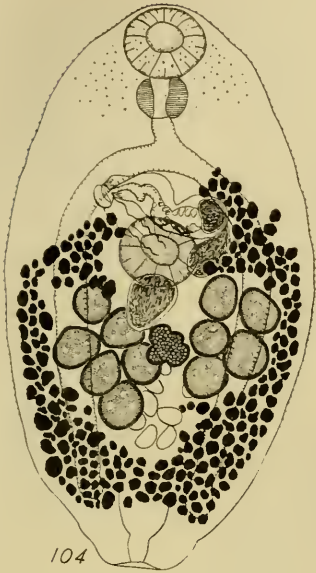


PLATE XVI

- FIGURE 109. *Neolepidapedon equilaterum* (ventral view).
FIGURE 110. *Neolepidapedon myclero-percae* (ventral view).
FIGURE 111. *Lepidapedon holocentri* (ventral view).
FIGURE 112. *Myzoxenous lachnolaimi* (dorsal view).
FIGURE 113. *Dermadena lactophrysi* (ventral view).
FIGURE 114. Excretory system of *D. lactophrysi*.
FIGURE 115. *Pseudocreadium* sp. (ventral view).
FIGURE 116. Excretory system of *Pseudocreadium* sp.



PLATE XVII

- FIGURE 117. *Tetrochetus aluterae* (ventral view).
FIGURE 118. *Bilecithaster ovalis* (ventral view).
FIGURE 119. *Hysterolecitha rosea* (ventral view).
FIGURE 120. *Leurodera decora* (ventral view).
FIGURE 121. *Dichadena acuta* (ventral view).

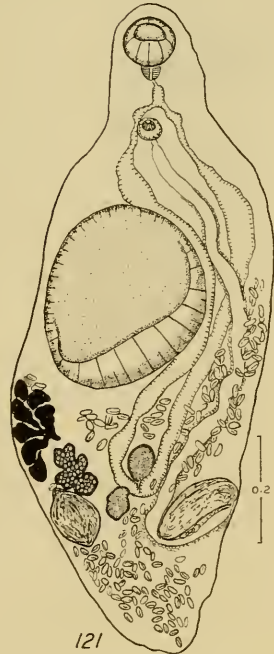
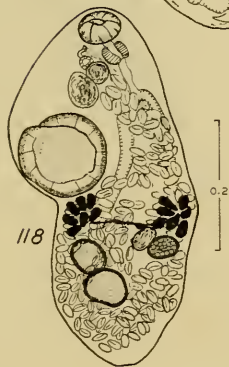
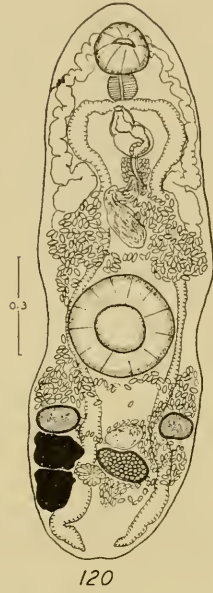
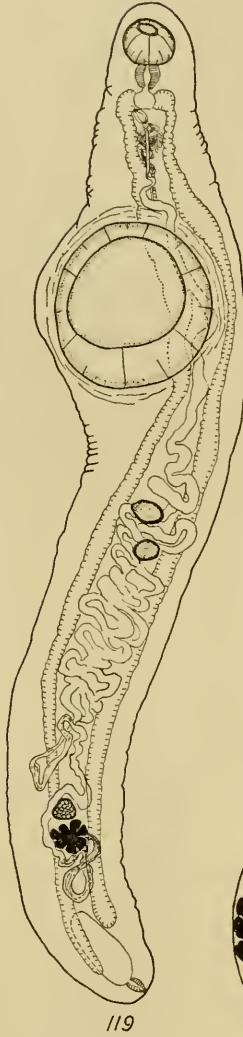
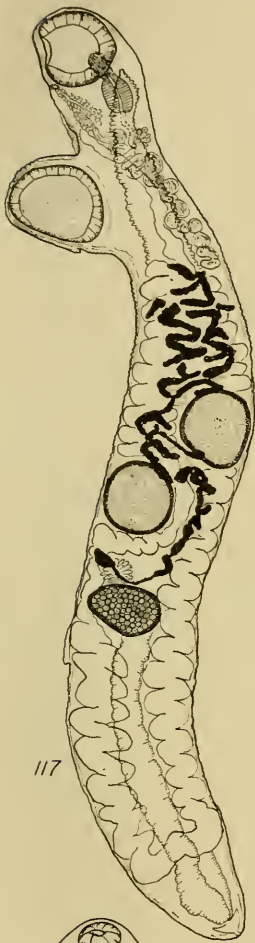


PLATE XVIII

- FIGURE 122. *Theletrum justiforme* (ventral view).
FIGURE 123. *Neogenolinea opisthonemae* (ventral view).
FIGURE 124. *Macradena acanthuri* (ventral view).
FIGURE 125. *Aponurus elongatus* (ventral view).

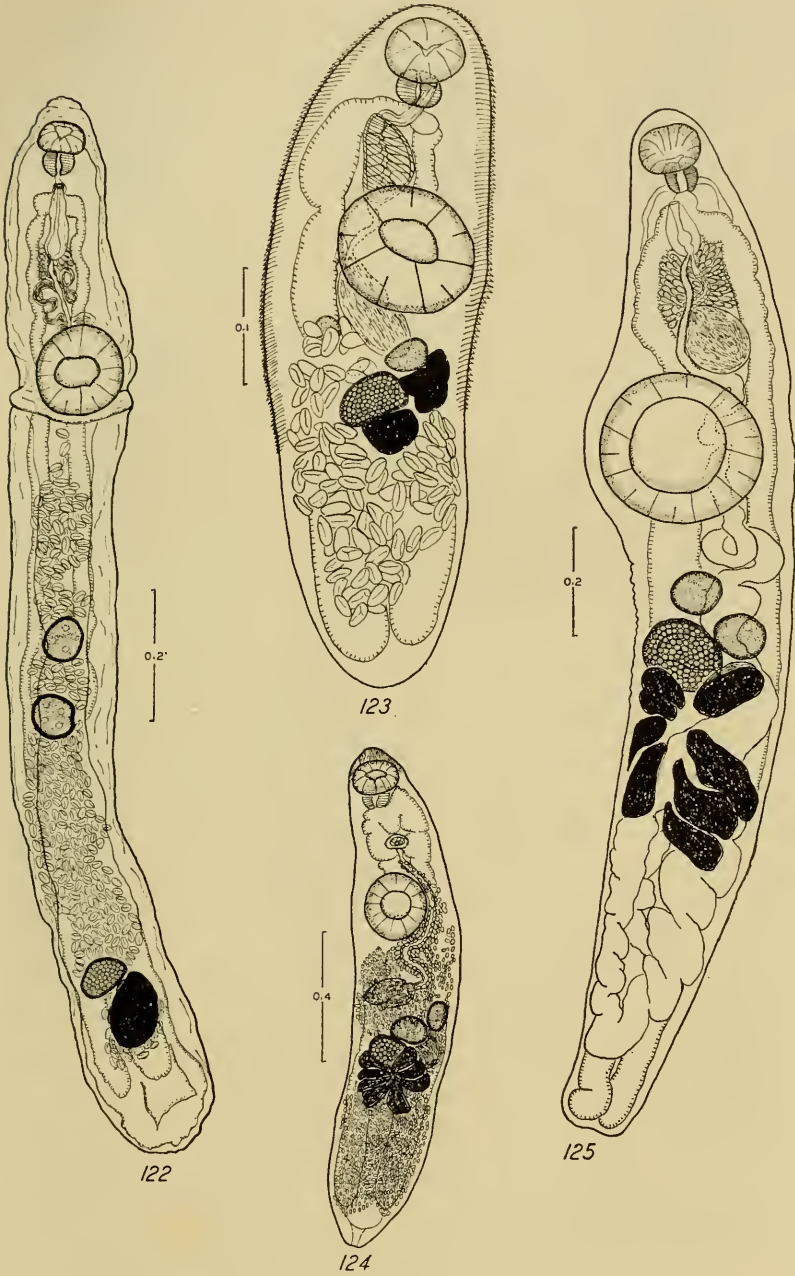


PLATE XIX

- FIGURE 126. *Aponurus symmetrorchis* (ventral view).
FIGURE 127. *Parectenurus chlorosombri* (ventral view).
FIGURE 128. *Parahemiurus merus* (lateral view).
FIGURE 129. *Sterrurus fusiformis* (ventral view).
FIGURE 130. *Sterrurus floridensis* (ventral view).
FIGURE 131. *Sterrurus monticellii* (ventral view).

PLATE XX

FIGURE 132. *Sterrhurus monticellii* (ventral view).

FIGURE 133. *Sterrhurus microcercus* (ventral view).

FIGURE 134. *Lecithochirium parvum* (ventral view).

FIGURE 135. *Dinurus breviductus* (ventral view), complete vitellaria not shown.

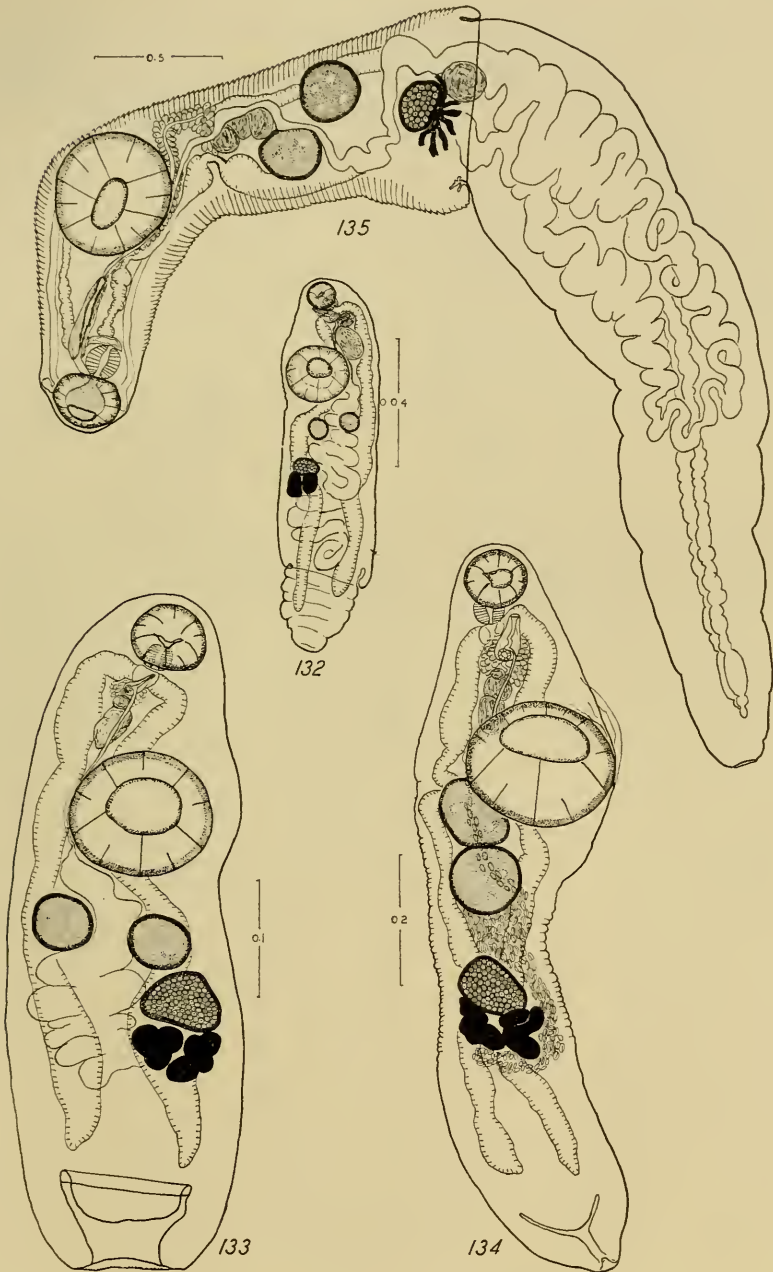


PLATE XXI

FIGURE 136. *Dinurus barbatus* (ventral view).

FIGURE 137. *Dinurus tornatus* (ventral view), complete coils of vitellaria not shown.

FIGURE 138. *Tubulovesicula lindbergi* (ventral view), uterus and vitellaria not shown.

FIGURE 139. *Hirudinella ventricosa*, immature (ventral view).



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