Keys to Marine Invertebrates of the Woods Hole Region

RALPH I. SMITH – EDITOR

K E Y S T O M A R I N E I N V E R T E B R A T E S

o f t h e

W O O D S H O L E R E G I O N

A manual for the identification of the more common marine invertebrates, compiled by Ralph I. Smith with the assistance of many other contributors

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FOREWORD

Cape Cod juts eastward over the continental shelf as the flexed arm of Massachusetts, partly sheltered on its southern side by Monomoy, Nantucket, Martha's Vineyard, and the Elizabeth Islands. The Cape, islands, eastern shores of the state bordering the Cape, Cape Cod Bay, Nantucket Sound, Vineyard Sound, and Buzzards Bay constitute the Cape Cod Region. Glacial in origin, the Region is dotted by myriad small embayments and estuaries, and the clean tidal waters of the North Atlantic wash its shores --- a diverse ecologic setting accounting for the richness of the local marine biota, and for establishment of the Marine Biological Laboratory here in 1888.

On September 1, 1962, the Marine Biological Laboratory inaugurated the Systematics-Ecology Program and embarked on a basic, year-round, long-term program of research and training in marine systematics and ecology. The Program has as one of its major objectives the gradual extension, in a broad sense and at a high level of excellence, of systematic and ecologic knowledge of organisms in the estuarine and marine waters and bottoms of the Cape Cod Region.

Early in the life of the Program we realized the lack of and recognized the urgent necessity for illustrated, referenced, indexed sets of keys and check lists of the commoner plants and animals of the Region for use by non-systematists in the Woods Hole scientific community and neighboring areas. A start on this task was provided in 1960 when Dr. Ralph I. Smith and others of the MBL Invertebrate Zoology Course staff assembled a small loose-leaf collection of keys then existing in the laboratory instructions of that course. These early keys had evolved over a period of years, and the authorship of some could not be determined.

It was a happy occasion for us when Ralph Smith agreed to compile and edit this present publication. He arrived in Woods Hole early in the summer of 1963, worked indefatigably with us during that summer, then returned to Berkeley where he continued his labors, somehow sandwiched among his many duties at the University. Now, some ten months later, the manuscript is ready for publication. We extend to Ralph our hearty thanks! A most sincere word of appreciation is also due collaborators without whose excellent cooperation and zeal the manuscript would never have been completed, and Mrs. San Lineaweaver for her patient and careful typing and correcting of the master copy. The preparation of this publication was made possible by support of the Ford Foundation to the Systematics Division of the Systematics-Ecology Program; it is a pleasure to acknowledge this aid.

The first edition of the Invertebrate Keys is a beginning. We welcome suggestions, and look forward to producing revised editions as the invertebrates of the Region become better known. We are also planning to produce similar keys to other organisms of the Woods Hole Region as this becomes possible.

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Woods Hole, Massachusetts

May, 1964

This handbook of keys is an attempt to fill an obvious need at Woods Hole, the need for a general reference on marine invertebrates for the use of students and investigators who want to know what is here and how to identify it.

Relatively few present day biologists realize the difficulties involved in identifying with certainty the myriad species of marine invertebrates. Some species are readily recognized by distinctive form or color, but in most cases the beginner will experience difficulty in making a positive identification, and in many instances the assistance of a specialist may be necessary. Keys are useful mainly in the identification of common and obvious animals, or in making preliminary identification of less common animals (perhaps to family or genus), or by indicating to the observant non-systematist that he has something out of the ordinary which should be referred to a specialist. The problem is akin to that of medical diagnosis; the alert zoologist, like the general practitioner, need feel no shame if he makes some identifications with confidence, but seeks consultation on others.

The purpose of zoological classification is to arrange animals into groups on the basis of fundamental similarities. The completion of this task will presumably reveal evolutionary relationships, but the immediate objective of a set of keys is more utilitarian, that of identifying and providing the names of the local invertebrate fauna as simply, accurately, and painlessly as possible. It cannot be too strongly emphasized that keys are shortcuts and often very misleading; their function is merely to clear the way to an approximation, and identifications made by keys, if to be of scientific reliability, should be checked by reference to the original description or to recent monographs. A key is made to cover a selected list of species, and any species not one of that group will not "key out" or, worse yet, may key out as something which it is not, hence the need for a cross check in all cases of doubt.

The terminology of systematists may be difficult for the non-systematist to grasp, owing to the independent evolution of descriptive jargon within the groups of specialists on different animal phyla. Therefore each key will when necessary be accompanied by a glossary and illustrations of the descriptive terms and by a brief statement of the characteristics used in the taxonomy of that particular group and how the student may locate and recognize them. The spicules of sponges, the setae of polychaetes, the ossicles of sea cucumbers, are of basic importance to systematists in establishing the degrees of similarity which underlie classification; the problem of the biological role of these structures as functional parts of the animals concerned lies outside the immediate field of classification.

An aspect of identification of animals that commonly proves annoying and frustrating to experimental biologists is the "name-changing" that seems so often to occur in systematics, resulting in the production of synonyms for some of the commonly used experimental animals. In the annotated check lists we have attempted to explain the more conspicuous synonymies. Experimentalists should realize that, in an active field, terminology must change (it is no longer sufficient to speak merely of "Vitamin B", and such terms as muriatic acid, yellow enzyme and even DPN, while understandable in context are considered outdated today). In the same sense it is not good current usage to apply such well-known older names as *Nereis limbata* and *Nassa obsoleta*, although these particular names are perfectly understandable when encountered in the older literature. It is hoped that this manual will provide useful information on the synonymies of local experimentally used animals and contribute to a better understanding of the efforts of systematists to provide a more rational and stable nomenclature. The short discussion of nomenclatorial rules in Hyman's "The Invertebrates", Vol. I, 1940, pages 22-26 will be found useful to those who wish to review this topic briefly, and the more extended discussion in Mayr, Linsley and Usinger's "Methods and Principles of Systematic Zoology", McGraw-Hill (1953) provides a more complete account. In case there are any laboratory biologists who feel that animal classification is outside their proper sphere of interests, we recommend "A Classification of Living Animals", Wiley (1961), by no less an experimentalist than Lord Rothschild. And for those who decide to plunge into serious systematic work, two more references must be mentioned: "International Code of Zoological Nomenclature", published by the International Trust for Zoological Nomenclature, London (1961); and Schenk and McMasters, "Procedure in Taxonomy", third edition, Stanford University Press (1956).

This manual does not pretend to be an exhaustive faunal survey of the Woods Hole Region which, for our purposes, is that area in which one may reasonably collect, using Woods Hole as a base. Hence it includes not only the animals of Buzzards Bay and Vineyard Sound, but also species commonly taken on the northern shore of Cape Cod, as at Barnstable. Only by limiting its scope and content can the manual be kept simple and inexpensive enough to be useful and available to the students and beginning investigators who need it most. There are in existence two old but comprehensive faunal surveys which contain much valuable information for the field worker:

Verrill, A. E. and S. I. Smith, 1873. Report upon the invertebrate animals of Vineyard Sound and the adjacent waters. Rept. U. S. Fish Comm. 1871-1872: 295-778 (also published as a separate volume in 1874).

Sumner, F. B., R. C. Osburn, and L. J. Cole, 1913. A biological survey of the waters of Woods Hole and vicinity. Section III. A catalogue of the marine fauna. Bull. Bur. Fisheries, 31: 545-794.

A work much used at Woods Hole in recent years is Miner's "Field Book of Seashore Life", Putnam (1950). This is illustrated and has much textual material, but since it covers the wide area from Laborador to Cape Hatteras and is not provided with diagnostic keys, it is inadequate for critical identification of many local species and its terminology is not up to date.

The present keys will be found to vary in ease of use and in completeness of coverage, and will naturally become less reliable with increasing distance from Woods Hole. Some groups, e.g. amphipods, are still too incompletely known to permit the construction of specific keys that would be generally useful.

For certain important groups which are intrinsically difficult because of the number of species and small size of individuals, such as Protozoa, nematodes, ostracods, no keys have been attempted. Those wishing to embark upon studies of such groups will need special instruction and more detailed literature than we can provide. Plankton, especially its component of immature stages, will not be treated in these keys, although representatives of certain groups may be identifiable. In other instances, the keys will serve not to provide answers, but to clarify the problem. We regard this edition of the keys as tentative: they will be found inaccurate or incomplete in many respects. We should appreciate receiving criticisms or suggested revisions at any level.

In Woods Hole at the present time the preponderance of experimentalists places a burden of identification upon those who are undertaking systematic problems and who are expected to make reliable identifications. With the aid of proper keys, this load can be more fairly distributed, routine identifications accomplished, nonidentifiable animals more readily detected and referred to specialists, and the exchange of vital information between laboratory and field workers facilitated.

This manual has been made possible only by the generous assistance and cooperation of numerous individuals, actually too numerous to list fully. However, certain ones have given very liberally of help and advice, and are listed here, together with an indication of the areas in which they contributed. It should be noted that there is no clear distinction between those listed as "authors" of chapters and those who contributed heavily to chapters in which a good deal of editorial compilation has taken place. It seems appropriate to acknowledge gratefully this help, and to express the wish that users of this manual will feel free to pass on to editors, and advisors alike, the criticisms and comments that will be inevitable.

Porifera: Willard D. Hartman, Peabody Museum of Natural History, Yale University, New Haven, Connecticut.

Coelenterata (Hydrozoa): Sears Crowell, Department of Zoology, University of Indiana, Bloomington, Indiana.

Coelenterata (Hydrozoa, Stauromedusae): G. F. Gwilliam, Department of Biology, Reed College, Portland, Oregon.

Coelenterata (Hydrozoa, Stauromedusae): Kay Werner Petersen, Systematics-Ecology Program, Marine Biological Laboratory, Woods Hole, Massachusetts.

Coelenterata (Anthozoa): Cadet Hand, Department of Zoology, University of California, Berkeley, California.

Platyhelminthes: Louise Bush, Department of Zoology, Drew University, Madison, New Jersey.

Annelida (Polychaeta): Marian H. Pettibone, Division of Marine Invertebrates, U. S. National Museum, Washington, D. C.

Pycnogonida: Joel W. Hedgpeth, Pacific Marine Station, University of the Pacific, Dillon Beach, Marin County, California.

Crustacea (Cirripedia): Victor A. Zullo, Systematics-Ecology Program Marine Biological Laboratory, Woods Hole, Massachusetts.

Crustacea (Mysidacea, Cumacea, Isopoda): Roland L. Wigley, Biological Laboratory, U. S. Bureau of Commercial Fisheries, Woods Hole, Massachusetts.

Crustacea (Isopoda): Thomas E. Bowman, Division of Marine Invertebrates, U. S. National Museum, Washington, D. C.

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(cover design), and several of the above contributors.

My thanks are due the staff and students of the MBL Invertebrate Zoology Class of 1963, who cooperated extensively in collecting material and critically testing keys. The Supply Department has also been most helpful, and I owe much to Mr. John Valois for his help in the summer of 1963, and especially I am indebted to Mr. Milton Gray, as whose helper in 1939 I learned much that has proved useful in all my work in marine zoology. Above all, the unstinting support given to the preparation of these keys by the Systematics-Ecology Program of the MBL has been the decisive factor in their publication at this time. I wish to record my appreciation for all that Dr. Melbourne R. Carriker and his entire group have done to facilitate this task, and especially am I grateful to Mrs. San Lineaweaver and Mrs. Virginia Smith for their extraordinary efficiency and cheerfulness in the typing involved.

Ralph I. Smith, Editor
May, 1964

PHYLUM PORIFERA

By Willard D. Hartman

There are about ten common sponges in the Woods Hole region. Some are identifiable on sight by form and color; others must be carefully examined before an identification is ventured. Miner's "Field Book" contains inaccuracies and is almost useless for identification of sponges. De Laubenfels (1949) has a selection on methods of handling and observing sponges. Hartman (1958) has given a systematic account of southern New England sponges together with notes on their natural history.

Some knowledge of the terminology of sponge spicules is neccessary if the taxonomic literature on the group is to be read. In the following glossary, terms commonly used are defined to aid those who may go further in this field, as well as to make clear certain expressions used in the key. Most of these terms are illustrated in Plate 1.

GLOSSARY OF SPONGE TERMINOLOGY

Acantho-: prefix meaning spined.
Aniso-: prefix meaning unequal.
Anisochela: a chela with unequal ends.
Chela: a microsclere type resembling a pair of anchor flukes or a shovel with a blade at each end, the ends bent toward each other.
Isochela: a chela with equal ends.
Megascleres: the larger spicule types, comprising the major structural elements of a sponge skeleton.
Microscleres: relatively very small spicules of various form, characteristic of certain sponges.
Monaxon: an unbranched spicule.
Oxea: a monaxon spicule (megasclere) pointed at both ends, often slightly curved.
Sigma: a microsclere of C- or S- shape.
Spiraster: angulate rod-shaped microscleres provided with spines which may be aligned in a spiral course around the rod.
Spongin: proteinaceous horny skeletal material, either alone (as in bath sponges), or binding siliceous spicules together (as in Haliclona or Microciona).
Style: a monaxon spicule with one end pointed, other end blunt.
Subtylostyle: a monaxon spicule with one end pointed and the other with an indistinct swelling or knob (halfway between tylostyle and style).
Toxon: a bow-shaped microsclere (pl. toxa).
Triaene: a spicule with 4 rays, one of which is much longer than the other 3 (known as clads). Anatriaenes have the clads directed backward; protriaenes have the clads directed forward.
Tylo: a prefix meaning a rounded or ball-shaped structure.
Tylote: a monaxon spicule with rounded knobs on both ends (e.g., in Lissodendoryx)
Tylostyle: a style with the blunt end in form of a little swelling or knob (e.g. in Cliona).

A Note on Microtechnique

Detailed studies of sponge anatomy may require the preparation of microscopic sections. For gross preservation 95% alcohol or neutralized formalin followed by 75% alcohol can be used. Neutral formalin is best prepared by adding hexamethylenetetramine (= hexamine) to commercial formalin (37 to 40% formaldehyde) in the proportion of one pound of hexamine to one gallon of formalin. This stock solution is then diluted with water (9 parts water; 1 part neutral formalin) to give 10% formalin or 4% formaldehyde. Formalin that has not been neutralized, or that has been neutralized with borax, should be avoided for preserving sponges since both may cause maceration. When formalin neutralized with hexamine is used, the sponges should be transferred to 75% alcohol after a few days. Fixation of small pieces of each species in standard histological fixatives is desirable, as often histological work must follow. Thin, free-hand sections are readily made with a razor blade if the specimen has been hardened in alcohol. Sections perpendicular to the surface of the colony as well as tangential sections are useful. Such sections can be directly dehydrated, cleared in xylol, and mounted in piccolyte or damar or they can be stained with a saturated solution of basic fuchsin of safranin in 95% alcohol before clearing and mounting. In studying sections, the various types of spicules can be observed as well as their arrangement in the skeleton. Other structures to look for are a cortex, often packed with spicules of one category, subdermal spaces, tracts of spicules, and spongin fibers with or without enclosed spicules. In some cases the shapes and dimensions of the flagellated chambers are important.

In sections, certain spicule categories may be overlooked, and it is usually desirable to make slides which have been freed from the cellular elements of the colony. This can be done by treating a small part of the specimen with sodium hypochlorite (clorox will serve) until the spicules are free. For temporary mounts a piece of the sponge can be placed on a microscope slide with a drop or two of clorox. After disintegration of the cells a cover slip is added and the spicules are ready for examination. If permanent mounts are desired, a piece of sponge can be placed in a centrifuge tube along with a small amount of clorox. After disintegration of the cells, the sample is then washed several times with water, centrifuging between washings to make certain that the minute microscleres have settled. Finally the water can be replaced by 95% alcohol, and the suspension of the spicules poured onto a slide and allowed to dry on a warming plate (or the alcohol can be ignited). A drop of xylene is added to the dry preparation, followed by piccolyte or damar and a cover slip. A slide of clean spicules is now available for study and measurement of spicule types.

KEY TO COMMON SPONGES

(Figure references are to Plate 1)

1. Structure of sponge simple; tubular to urn-shaped; pale tan to whitish; spicules calcareous (test with 10% acetic acid under coverslip) 2
1. Structure massive, fleshy, or spongy; encrusting or branching; color various; spicules siliceous 3

2. Sponges in form of branching, cylindrical, pale tubes (fig. 1) . . . . *Leucosolenia* sp.
2. Sponges in form of little urns or vases, usually clustered, with fringe of spicules around the terminal osculum (fig. 2) . . . . *Scypha* sp.

3. Sponges obviously boring into and sometimes overgrowing shells and other calcareous material; color brilliant sulfur-yellow to pale yellow . . . . *Cliona* 4
3. Sponges not boring; form and color various 7

4. Sponge brilliant sulfur-yellow, boring into calcareous substrate or massive and free-living; external perforations in substrate large (incurrent, 0.8-2.5 mm across; excurrent, 2.0-4.5 mm across); tylostyles only (fig. 3) . . . . *Cliona celata*
4. Sponge light or pale yellow, always boring into calcareous substrate; external perforations small (incurrent, 0.2-0.5 mm across; excurrent, 0.6-1.6 mm across); microscleres present in addition to tylostyles 5

5. Spirasters only as microscleres (fig. 4) . . . . *Cliona lobata*
5. Spined or smooth oxeas present as well as spirasters 6

6. Spirasters usually angulate and larger (6-23μ x 1.0-3.8μ) (fig. 5); external perforations in substrate often arranged in circular patterns . . . . <u>Cliona vastifica</u>
6. Spirasters less distinctly angulate and smaller (6-15μ x 0.5-3.2μ); tends to occur in brackish water . . . . <u>Cliona truitti</u>

7. Megascleres oxeas only 8
7. Megascleres other than oxeas 12

8. Megascleres smaller (<200μ in length) and conspicuously joined together by more or less spongin to form a network or a system of tracts (fig. 6); dermal skeleton absent . . . . <u>Haliclona</u> 9
8. Megascleres larger (mean length>200μ), arranged in loose tracts with little spongin or occurring at random; distinct dermal skeleton present (figs. 9, 10) . . . . <u>Halichondria</u> 11

9. Form branching into rounded or flattened fingers arising from a narrow stalk; oscules distributed along sides of branches; color yellowish to tan, often tinged with violet . . . . <u>Haliclona oculata</u>
9. Form encrusting, often with low tubules arising from a basal encrusting mass 10

10. Sponge a flat encrustation; oscules not raised on tubules; excurrent channels converge on oscules to provide conspicuous stellate patterns beneath surface; gemmules absent; color light buff or tan to brown or gold . . . . <u>Haliclona canaliculata</u>
10. Sponge an encrustation from which arise numerous low tubules often bearing terminal oscules, consistency very soft; white gemmules form at base of sponge in late summer; color dark tan to gold, often tinged with pink or lavender (figs. 6-8) . . . . <u>Haliclona loosanoffi</u>

11. Sponge encrusting and provided with numerous, low, upright tubules each terminating in an oscule; dermal skeleton tends to be a regular network of multispicular tracts (fig. 9); color orange-yellow to greenish . . . . <u>Halichondria panicea</u>
11. Sponge encrusting to massive, usually provided with upright tubules which may bear terminal oscules; some colonies consist of masses of anastomosing branches; dermal skeleton tends to consist of a less regular network of multispicular tracts with larger meshes (fig. 10); color orange-brown to yellow-beige to olive-green . . . . <u>Halichondria bowerbanki</u>

12. Color bright red to orange-brown; sponge encrusting to complexly branched; spicules include styles to subtylostyles with spined or smooth heads, short acanthostyles, toxa, and isochelas (fig. 11) . . . . <u>Microciona prolifera</u>
12. Color never bright red; spiculation otherwise 13

13. Megascleres are tylostyles 14
13. Megascleres are otherwise 16

14. Microscleres absent; sponge a thin encrustation on rocks and algae; basal layer of tylostyles arranged with heads against substrate; color orange-brown, hazel, or olive-brown . . . . <u>Prosuberites epiphytum</u>
14. Microscleres present 15

Plate 1

PORIFERA

Figs. 1,2,3,8 by Bruce Shearer; rest redrawn by Mrs. Emily Reid after Hartman (H); fig. 13 after Wilson. Scales as indicated on plate.

Fig. 1. *Leucosolenia* sp., fragment of a colony.

2. *Scypha* sp., three individuals.

3. *Cliona celata*, colony overgrowing a *Mercenaria* shell.

4. *Cliona lobata*: A. Tylostyles, B. Spirasters with spines (H).

5. *Cliona vastifica*: A. Tylostyles, B. Smooth and microspined oxeas, C. Spirasters and a microspined style.

6. *Haliclona loosanoffi*, spicule tracts joined by spongin (H).

7. *Haliclona loosanoffi*, spicules: oxeas, styles, strongyles (H).

8. *Haliclona loosanoffi*, specimen growing on shell of living *Mytilus*.

9. *Halichondria panicea*, dermis, with spicules and pores (H).

10. *Halichondria bowerbanki*, dermis, with spicules and pores (H).

11. *Microciona prolifera*: A. Megascleres, B. Toxa, C. Isochelas (H).

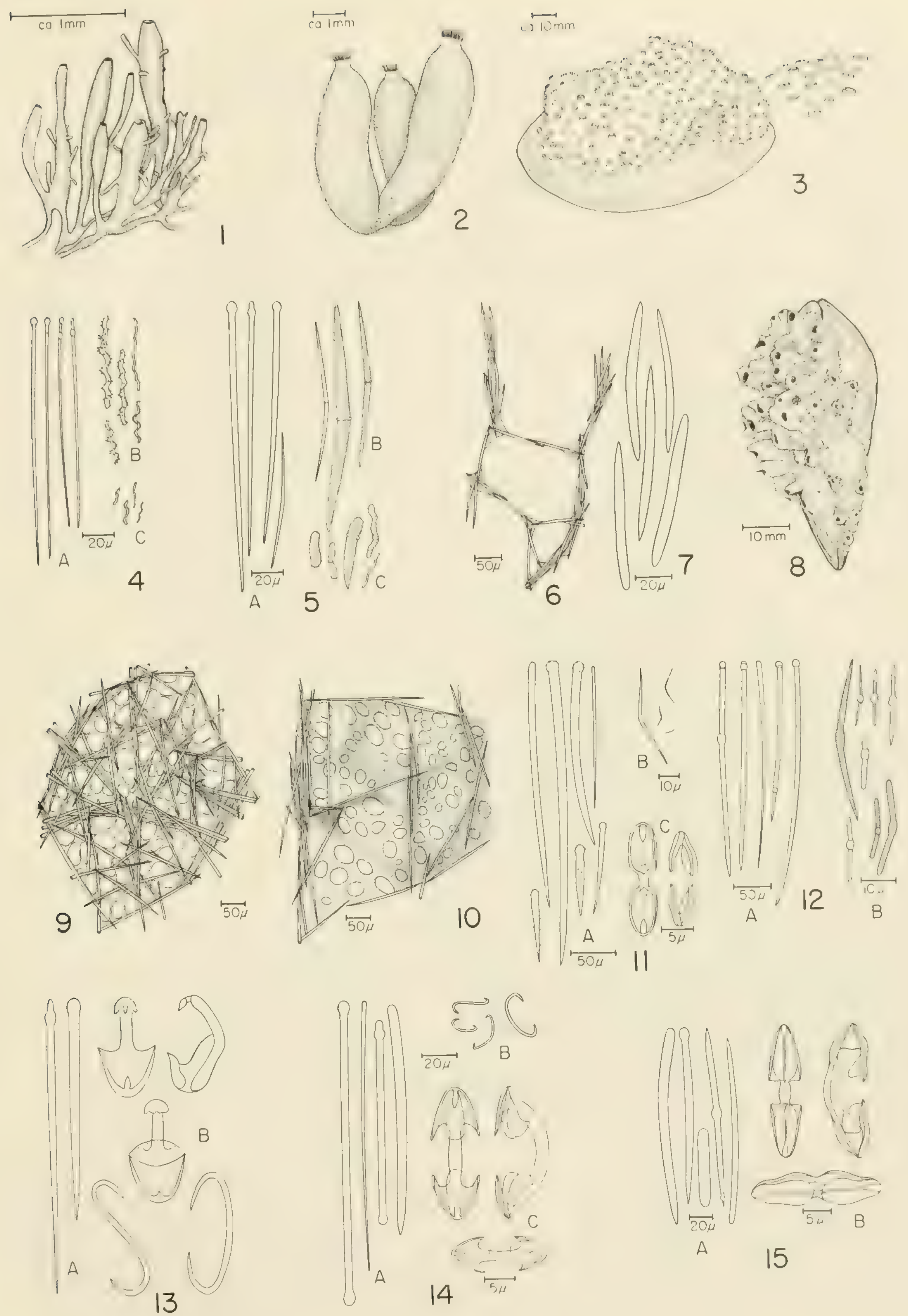
12. *Suberites ficus*: A. Styles and tylostyles, B. Microscleres (H).

13. *Mycale fibrexilis*: A. Megascleres tylostyles, B. Microscleres: sigmas, and anisochelas (after Wilson).

14. *Lissodendoryx isodictyalis*: A. Megascleres: styles and tylates, B. Microscleres: sigmas, C. Microscleres: isochelas (H).

15. *Isodictya deichmannae*: A. Megascleres: styles, strongyle, centrotylote oxea, B. Microscleres: Isochelas (H).

Plate I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15. Sponge massive, lamellate or lobate; microscleres small, rod shaped, with central swelling, spined or smooth, abundant near surface (fig. 12); color yellow to yellowish-gray . . . . *Suberites ficus*
15. Sponge encrusting to massive; microscleres include sigmas, toxa, and anisochelas (fig. 13); color yellow-ochre, hazel-brown, olive-brown ranging to gray-tan, olive-gray to slate-gray . . . . *Mycale fibrexilis*

16. Megascleres are long oxeas and triaenes; microscleres are microspined sigmaspires; sponge biscuit shaped with terminal osculum and flattened base made up of matted oxeas and anatriaenes . . . . *Craniella gravida*
16. Styloid megascleres present 17

17. Sponge encrusting to massive; color buff to olive-tan to gray-brown, slate gray, or bluish-gray; dermal tylotes present; microscleres are sigmas and isochelas (fig. 14) . . . . *Lissodendoryx isodictyalis*
17. Sponge with upright flattened branches; oscules distributed along sides of branches; skeleton a reticulation of tracts of styles; microscleres are isochelas only (fig. 15) . . . . *Isodictya deichmannae*

ANNOTATED LIST OF SPONGES OF THE WOODS HOLE REGION

Class Calcarea

Leucosolenia sp. An "asconoid" calcareous sponge, especially valuable in the laboratory. The specific identity of the common *Leucosolenia* at Woods Hole is at present uncertain.

Scypha sp. A "syconoid" calcareous sponge. Although often called (and sold as) "*Grantia*", it does *not* have the distinct dermal cortex and incurrent canals of *Grantia*. The Woods Hole species is not referable to the species *lingua* described by Haeckel (1872) from Newfoundland and needs a new name. *Scypha* is a prior name for *Sycon*, which is still used by many zoologists.

Class Demospongiae

Order Haplosclerida

Haliclona canaliculata Hartman, 1958. Not yet recorded from the Woods Hole region but to be expected as an encrustation on the lower surface of rocks.

Haliclona loosanoffi Hartman, 1958. Collected in run-out channel under bridge at Barnstable Harbor; records from Nonamesset Island and New Bedford area in the Gray Museum.

Haliclona oculata (Linnaeus, 1759). (= *Chalina oculata* of past authors). Seldom found intertidally; common in offshore waters.

Order Poecilosclerida

Isodictya deichmannae (de Laubenfels, 1949). (= *Neosperiopsis deichmannae* de L.) An offshore species.

Lissodendoryx isodictyalis (Carter, 1882). Fairly common, but in field may be confused with *Halichondria*. Excellent for demonstration of microscleres.

Microciona prolifera (Ellis and Solander, 1786). Common and easily recognized by color; assumes branching form in subtidal waters. Extends into somewhat brackish lagoons.

Mycale fibrexilis (Wilson, 1891). (= *Esperella fibrexilis* Wilson, 1891; = *Carmia fibrexilis*, de Laubenfels, 1949). Common on wharf pilings in the Woods Hole region; often as a thin encrustation that might be confused with *Lissodendoryx*; sometimes massive.

Order Halichondrida

Halichondria bowerbanki Burton, 1930. The common *Halichondria* in the Woods Hole region. Extends into brackish lagoons.

Halichondria panicea (Pallas, 1766). Probably occurs at Woods Hole but difficult to distinguish from the previous species. Common north of Cape Cod. (See discussion in Hartman, 1958).

Order Hadromerida

Cliona celata Grant, 1826. A common boring sponge which assumes a massive, free-living condition as it grows older. Easily distinguished from other local clionids by the large size of the openings in the calcareous substrate excavated for the incurrent and excurrent papillae.

Cliona lobata Hancock, 1849. Of common occurrence on oyster shells and other calcareous materials.

Cliona truitti Old, 1941. Not recorded as yet from Woods Hole, but may occur in brackish waters.

Cliona vastifica Hancock, 1849. Of common occurrence on oyster shells and other calcareous materials.

Prosuberites epiphytum (Lamarck, 1816). Not yet recorded from Woods Hole, but is to be expected as a thin encrustation on the lower surfaces of rocks.

Suberites ficus (Johnston, 1842). A common subtidal species.

Order Choristida

Craniella gravida (Hyatt, 1877). Reported common on mud bottoms in deeper waters of Buzzards Bay. De Laubenfels' synonymy (1949) of this species with the deep-water North Atlantic *C. crania* is in error.

REFERENCES IMPORTANT IN IDENTIFICATION OF WOODS HOLE SPONGES

De Laubenfels, M. W., 1949. The sponges of Woods Hole and adjacent waters. Bull. Mus. Comp. Zool. Harvard, 103(1): 1-55.

Hartman, W. D., 1958. Natural history of the marine sponges of southern New England. Peabody Mus. Nat. Hist., Yale Univ. Bull., 12: 155 pp.

Old, M. C., 1941. The taxonomy and distribution of the boring sponges (Clionidae) along the Atlantic Coast of North America. Chesapeake Biol. Lab. Publ., 44: 30 pp.

A reference for sponges found north of Cape Cod is: Procter, 1933. Porifera. *In*: Biol. Surv. Mt. Desert Region. Part V. Marine Fauna. Philadelphia, Wistar Inst.; 78-115.

PHYLUM CNIDARIA

Introduction and Class Hydrozoa

The phylum Cnidaria is a large and complex group characterized by the production of nematocysts, by a tubular or cup-like body of two layers (ectoderm and endo- or gastroderm) separated by a mesogloeal layer, with the mouth as the sole opening to the digestive cavity, and by enormous diversity of form and life history. The best general account of the group is in Hyman's "The Invertebrates", Vol. 1. This phylum is often called the Coelenterata, but it now seems best to give up the latter term since it is used in some texts to include both Cnidaria and Ctenophora. The latter group is generally considered quite distinct, and is treated as a separate phylum in Chapter V of this manual.

The present chapter deals with the Class Hydrozoa, characterized in many, but not all, of its members by the development of both hydroid (polypoid) and medusoid stages or forms in their life cycles. This class is the most numerous and diverse of the cnidarian classes in the Woods Hole region.

The two other cnidarian classes are the Scyphozoa (Chapter III), most of whose members are large medusae, but which also includes an order (Stauromedusae) of attached forms, and the Anthozoa (Chapter IV). The latter is the largest of the cnidarian classes, but its members are mainly tropical, including corals and a host of related forms. In the Woods Hole region, sea anemones make up the bulk of the representation of anthozoans.

THE SESSILE HYDROZOA

The representation of sessile Hydrozoa in the waters of the Woods Hole Region is extremely good. But, unfortunately, the class Hydrozoa, and in particular the order Hydroida, has been plagued with a curious and troublesome double taxonomy. Students of the benthic fauna have developed one system of families, genera, and species based upon the polypoid or "hydroid" stages, while workers on the planktonic community have tended to develop a system based upon the medusae. Since in numerous instances polyp and medusa of a single species have received different generic and specific names, and since in many cases the life histories are not completely known, the problem of synonymizing these separate stages has been difficult and will continue so. Furthermore, when the attempt is made to bring polyp and medusa together under one name, the rule of priority may require that a less well known prior name replace a familiar later name. This does not bother systematists greatly, but is frustrating and exasperating to the non-specialist. The latter may take comfort, however, in the fact that progress toward a single integrated taxonomy is being made. An excellent example of enlightened systematic work based upon life history studies is to be seen in F. S. Russell's "The Medusae of the British Isles" (1953).

GLOSSARY OF SESSILE HYDROZOA

Adnate: One side of structure growing attached, as the hydrothecae of *Sertularia*.
Annulated: Possessing a ringed appearance.
Athecate: The hydranth is not protected by a chitinous cup or hydrotheca; gymnoblastic hydroids are athecate.
Blastostyle: Modified zooid (gonozooid) from which the medusoids are budded; may be protected by a surrounding theca (gonotheca or gonangium).
Calyptoblastea: The order of thecate hydroids, having each hydranth protected by a hydrotheca.
Capitate tentacle: Short tentacle with a very distinct terminal knob studded with nematocysts, as in *Zanclea* or *Pennaria*.

Colony: The thecate hydroid colony is always a polymorphic system, consisting of at least the gastrozooids (hydranths) or food-securing individuals, and the gonozooids or asexual individuals which produce by budding the sexual free or attached medusoids. The various zooids form a unit arising from a single planula larva and connected by stems and branches; rootlike structures attach the colony to the substrate. In most athecate hydroids the colony is not polymorphic, since all the hydranths alike produce medusa-buds, or else the medusa-buds are produced on certain areas of stolon or stem.

Dactylozooid: A mouthless polyp armed with nematocysts, and serving for protection or to aid in food catching, as in Podocoryne or Hydractinia.

Distal tentacles: The set of tentacles farthest from the stalk of gymnoblasts that possess two or more sets of tentacles.

Fascicled: Hydroids in which several stems of the colony are closely bound together into a bundle or fascicle, as in some species of Eudendrium

Filiform tentacle: Long threadlike tentacle, over which the nematocysts are usually evenly distributed.

Gastrozooid: A nutritive polyp; a hydranth.

Gonangium: The entire asexual reproducing individual of the hydroid colony, in calyptoblasteans composed of the protecting gonotheca, the blastostyle, and the medusoid forms which bud from the blastostyle.

Gonophores: Sexual individuals, which in calyptoblasteans arise asexually by budding from the blastostyle, being either free medusae or reduced to sporosacs; in gymnoblasteans they may arise from the stolons, hydranths, pedicels, or stems. However, Fraser calls the blastostyle, which bears the sexual zooids, a gonophore.

Gonotheca: The peridermal protective structure surrounding the blastostyle and gonophores in calyptoblasteans.

Gonozooid: Another term applied to any individual of the colony which buds off sexual individuals such as free medusae or the various degrees of reduced, attached sporosacs.

Gymnoblastea: The order of athecate hydroids, lacking protective thecae about the hydranths.

Hydranth: The hydranth (gastrozooid) is the feeding member of the colony, having a terminal mouth surrounded by tentacles; may be either sessile or stalked.

Hydrocaulus: The hydrocaulus is the main stem of that type of colony in which the budding of new hydranths can take place on the stalks of the older hydranths. This gives rise to erect, branched colonies. The term hydrocaulus is sometimes used to refer to the type of colony developed in the above way, in contrast to rhizocaulus, in which the new hydranths are developed from the stolons only.

Hydrocladium (-ia): Lateral branch(es) growing from the hydrocaulus.

Hydrorhiza: The rootlike structure, which may be more or less simple or a mass of tangled tubes, attaching the colony to substrate.

Hydrotheca: The peridermal, cuplike structure that surrounds the hydranth, and into which the hydranth may be drawn when disturbed.

Medusoid form: Inclusive term applied to the various types of sexual zooids (gonophores); it includes (1) free medusae with velum, tentacles, radial canals, and manubrium (Bougainvillia, Podocoryne, Obelia); (2) gonophores (eumedusoid) that resemble developing medusae but have no tentacles or other marginal structures, and which in some forms break away but soon die, since they lack a mouth; however, in most cases they remain attached (Tubularia); (3) gonophores (cryptomedusoid) that are still further reduced, lacking radial canals and other obvious medusoid structures (Clava); and (4) the most reduced type, in which the sex cells ripen directly on the sides of the blastostyle (Sertularia). Types 2, 3, and 4 are often called sporosacs. The condition in Hydra is not unlike that in Sertularia, but there is no differentiated blastostyle.

Nematophore: The small, highly modified zooid (dactylozooid) of protective function which is characteristic of the family Plumulariidae (e.g. Schizotricha)

Operculum: A lid closing the hydrotheca or gonotheca when the zooid is drawn in (Calyptoblastea).
Pedicel: The stalk that bears a hydrotheca.
Proximal tentacles: The circlet of tentacles nearer the stalk in gymnoblasts that have two or more whorls of tentacles.
Rhizocaulus: See discussion under hydrocaulus.
Sessile: Hydrotheca or other structure attached directly to stem or branch of colony; lacking a pedicel (*Schizotricha*, *Sertularia*).
Sporosacs: Reduced gonophores that do not develop into free medusae, but remain attached and produce the gametes (*Clava*, *Hydractinia*).
Stolons: Tubular or rootlike processes that extend over the substrate; the stolons are a part of the hydrorhizal system.
Thecate: Hydroids that possess a protective, cuplike hydrotheca which surrounds the hydranth, as in the Calyptoblastea.
Zooid: A general term applied to any of the several types of individuals or "persons" of the hydroid colony.

KEY TO THE MORE COMMON HYDROIDS

Modified after key and check list used by Invertebrate Zoology Course from 1942 through 1946. The assistance of Dr. Sears Crowell, Dr. Frank Gwilliam, Dr. Kay Petersen, and several others in this 1964 revision is gratefully acknowledged. Figure references in this key are to Plate 2.

1. Hydranth naked, lacking a protective cup (hydrotheca) into which it can be retracted (but perisarc may extend to base of tentacles in *Bougainvillia*) (fig. 1) . . . . Suborder GYMNOBLASTEA 2
1. Hydranth with a protective hydrotheca into which it can be withdrawn (but cup much reduced in *Halecium*) (figs. 18, 19) . . . . Suborder CALYPTOBLASTEA 20

2. Hydranths with filiform tentacles only 3
2. Hydranths with distinctly capitate tentacles only 19
2. Hydranths with both filiform and capitate tentacles (distal scattered capitate, basal filiform whorls); bushy colony, dark perisarc, pink hydranths (fig. 2) . . . . *Pennaria tiarella*

3. Filiform tentacles scattered on hydranth (Clavidae) 4
3. Filiform tentacles in distinct whorls 6

4. Very small (2 cm or less) pinkish growths, sparsely branched or with slender hydranths arising from a stolon. Free medusae arise singly on short pedicels with perisarc near bases of hydranths . . . . *Turritopsis nutricula**
4. Gonophores (reduced medusoids or sporosacs) in clusters below tentacles or as ovoid bodies on branching stems 5

5. In very low salinity or fresh water; colony branching, perisarc brownish; gonophores ovoid, borne on stem below hydranths (fig. 11) . . . . *Cordylophora lacustris*
5. In marine or nearly marine salinities, pink hydranths in clusters arising from basal stolons; clustered sporosacs below tentacles . . . . *Clava leptostyla*
5. (Note: a rare species, the large (2-3 cm) solitary *Acaulis primarius* also has scattered filiform tentacles and sporosacs)

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*A form answering this general description but with sporosacs instead of free medusae was taken in 1963, but is as yet unidentified.

6. Hydranths with a single whorl of filiform tentacles 7
6. Hydranths large and showy, with two whorls of filiform tentacles, the proximal longer than distal 15
6. (Note: the minute pelagic hydroid Margelopsis gibbesi consists of a single swimming hydranth , with 2 subequal whorls of tentacles, and bearing medusa-buds).

7. Colonies arising from a basal mat of stolons, and without perisarc around stems of zooids (Hydractiniidae) 8
7. Colonies erect or branching, with perisarc extending out to bases of hydranths, or even to bases of tentacles 10

8. Hydrorhizal spines rough; gonophores are sporosacs, borne on individuals (gonozooids) with reduced tentacles; colonies common on shells occupied by hermit crabs, but also on rocks, piles, etc; color varies from white to salmon (fig. 17) . . . . Hydractinia echinata
8. Hydrorhizal spines smooth; gonophores are free medusae, borne on gonozooids with well developed tentacles (to see released medusae, let colony stand overnight in a small container of cool sea water) 9

9. Medusae with 8 well developed tentacles and unripe when liberated (fig. 15). Colony contains "spiral zooids" (tentacle-less defensive individuals; look for these within the aperture of the snail shell, close to the hermit crab occupant, fig. 16); color white to pink; generally on shells of Nassarius trivittatus occupied by hermit crabs. . . . . Podocoryne carnea
9. Medusae with ripe gonads but rudimentary tentacles at time of release. No spiral zooids in colony. Forms a sparse colony, generally on shells of living Nassarius obsoletus . . . . Stylactis hooperi

10. Perisarc ends below hydranths; hydranths with trumpet shaped hypostomes; gonophores are sporosacs (fig. 12) . . . . Eudendrium 11
10. Perisarc continued as a thin expansion over base of hydranth up to tentacles; hypostome conical; free medusae liberated; at time of liberation medusae show 4 pairs of tentacles (fig. 1) . . . . Bougainvillia 14

11. Main stem fascicled (fig. 12), colonies branched, bushy and fairly large 12
11. Main stems not fascicled; colonies small and sparsely branched 13

12. Tentacles of gonozooids (hydranths bearing gonophores) showing little or no reduction; male gonophores 2- or 3-chambered . . . . Eudendrium ramosum
12. Gonozooids bearing gonophores tend (at least in some to be reduced ("aborted") (fig. 12); male gonophores 4- or 5-chambered . . . . Eudendrium carneum

Plate 2

HYDROZOA

Sources: Fraser (F), from living specimens (S). Scale bars all 1 mm, approximately. Somewhat simplified.

Fig. 1. Bougainvillia carolinensis, with medusae; note perisarc (unstippled) up to tentacles (S).

2. Pennaria tiarella, hydranth with gonophores (medusae with rudimentary tentacles (S).

3. Clytia edwardsi, hydrotheca and gonangium (F).

4. Clytia johnstoni, gonangium (F).

5. Schizotricha tenella, detail of lateral branchlet with hydrotheca and 4 nematophores (S). To scale of fig. 10.

6. Zanclea costata, hydranth (S).

7. Campanularia flexuosa, short internodes, immature and ripe gonangia (S).

8. Campanularia calceolifera, hydranth (tentacles schematic) and male gonangium, long internodes (S).

9. Same, female gonangium.

10. Sertularia pumila, opposite, adnate, hydrothecae (S).

11. Cordylophora lacustris, with young gonangium (S).

12. Eudendrium carneum, fascicled stem, gonophores on gonozooid with "aborted" tentacles (S).

13. Obelia sp., a "bottle-necked" gonangium (F).

14. Calycella syringa, hydrotheca with operculum (S).

15. Liberated medusa of Podocoryne carnea (S).

16. Part of colony of Podocoryne on shell used by hermit crab. Note medusa-buds at left, and spiral zooids at angles of shell aperture (those at right slightly enlarged) (S).

17. Individuals of Hydractinia echinata, among roughened spines. Note that neither the reduced tentacles of dactylozooids and gonozooids nor the feeding tentacles are classed as capitate (S).

18. Halecium halecinium,female gonangium bearing pair of hydranths (F).

19. Same, with gastrozooid and male gonangium (F).

Plate 2

13. Tentacles of gonozooids not completely reduced; male gonophores 2- or 3-chambered; colony small (1/2 inch), whitish . . . . <u>Eudendrium album</u>
13. Male gonophores borne on fully reduced zooids; colony pink, 1/2 to 1 inch high . . . . <u>Eudendrium tenue</u>

14. Stout bushy growths; stems fascicled; greenish perisarc, reddish hydranths; tentacles in extension long, tapering, and seeming to point in all directions; 2-8 inches high; medusae budded singly from branches (fig. 1). This is the <u>Bougainvillia</u> hydroid generally collected . . . . <u>Bougainvillia carolinensis</u>
14. Delicate sparse growth with a single whorl of filiform tentacles (Russell). This species is well known by its medusa, but the status of the hydroid at Woods Hole is not clear . . . . <u>Bougainvillia superciliaris</u>

15. Zooids solitary, not commonly found; liberate free medusae 16
15. Zooids generally in branching form or clustered; medusa-buds not released 17

16. Zooid with perisarc very weak or lacking; large (1-4 inches) . . . . <u>Corymorpha pendula</u>
16. Zooid with obvious brown perisarc; single or slightly branched; about 24 short distal (oral) tentacles, 30 longer proximal tentacles; easily mistaken for <u>Tubularia</u> until medusae seen . . . . <u>Ectopleura dumortieri</u>

17. Colony branching; stems extensively annulated; hydranths bright pink; colonies not large (1 to 1.5 inches) . . . . <u>Tubularia larynx</u>
17. Colonies are clusters of long stems, unbranched or sparsely branched; stem annulated only at intervals 18

18. Grows as a dense cluster of many sparsely or unbranched stems; hydranths rose colored; 3-5 inches high . . . . <u>Tubularia crocea</u>
18. Forms clusters of unbranched stems up to 7 inches tall; hydranths scarlet; up to an inch across tentacles when expanded; generally not found alive in summer . . . . <u>Tubularia couthouyi</u>

19. Colonies of very small, elongated hydranths with perisarc visible only at base; numerous capitate tentacles scattered over hydranths (fig. 6), with an apical whorl of 4-6 tentacles; color pink; height about 1 cm; free medusae budded from hydranths, below tentacles . . . . <u>Zanclea costata</u>
19. Irregularly branching colonies, with shorter bodied hydranths bearing about 16 capitate tentacles; free medusae produced from hydranth body close to tentacles . . . . <u>Sarsia tubulosa</u>

20. Hydrothecae on pedicels or wineglass-like stems (fig. 3, 8) 21
20. Hydrothecae lacking stems ("sessile", "adnate "), closely appressed to stem or branch (fig. 5, 10) 31

21. Hydrotheca, as expected, large enough to enclose hydranth 22
21. Hydrotheca aberrant in being very shallow saucer or funnel-shaped, usually marked by circlet of bright beadlike dots, not covering hydranths (fig. 19); stem fascicled; fanlike branching colony up to 10 inches high; female gonangia in rows on upper side of branches, each surmounted by a pair of hydranths (fig. 18) . . . . <u>Halecium halecinum</u>

22. Hydrotheca tubular, and provided with a conical operculum of toothlike flaps (fig. 14); family Campanulinidae, a difficult group of very small forms, of which the most common local form may be <u>Calycella syringa</u>, a tiny ($^{1}/_{8}$ inch) species found on other hydroids, bryozoans, etc.
22. Hydrotheca bell or wine-glass shaped, with inner diaphragm or annular thickening at base of hydranth, but lacking operculum (closing device): A very numerous family . . . . Campanulariidae 23

Cautionary note: The only basic way to define the genera of Campanulariidae is by their sexual stages. "It appears to be impossible to construct generic characters for the Campanulariidae on the basis of the trophosome. The classification of the group is unnatural and unsatisfactory in the extreme, but this is not the place to attempt its rectification". (Nutting, 1901, p. 344).

a. Produce free medusae having 4-8 tentacles at time of release . . . . <u>Clytia</u> (=<u>Phialidium</u>)
b. Produce tiny free medusae with 12-16 tentacles at time of release . . . . <u>Obelia</u>
c. Medusoids are very reduced and remain in gonotheca; hydrotheca with annular thickening at base . . . . <u>Campanularia</u>
d. Medusoids are extruded from gonotheca in a sac (acrocyst) but are not released; hydrotheca with thin diaphragm at base of hydranth . . . . <u>Gonothyraea</u> (=<u>Laomedea</u>)

23. Colonies consisting of unbranched or not regularly branched growths arising from a more or less extensive hydrorhizal system; hydrothecal margins toothed; gonangia borne on hydrorhiza and ringed (annulated), Japanese lantern fashion (figs. 3, 4); release 4-8 tentacled medusae . . . . <u>Clytia</u> 24
23. Colonies regularly branching (at least in terminal twigs); gonangia not ringed 25

24. Colony of unbranched (or occasionally branched) white growths arising from extensive rootstock; height about $^{1}/_{4}$ inch; hydrothecal rim with ca. 16 rounded teeth; gonangia deeply ringed (fig. 4) . . . . <u>Clytia johnstoni</u>
24. Colony white, profusely branched but without clear main stem; height about 1 inch; hydrothecal rim with 12-14 sharp teeth; gonangia irregularly ringed (fig. 3) . . . . <u>Clytia edwardsi</u>

25. Gonangia liberate small medusae with 12-16 tentacles; several species, of which only 3 are in key . . . . Obelia 26
25. Gonangia contain the reduced medusoids (sporosacs) which are never released; only 4 of the several species are in key . . . . Campanularia 28
25. Gonangia extrude the reduced medusoids inside a sac (acrocyst) . . . . Gonothyraea (=Laomedea) loveni

Note: Of the campanulariid genera occurring at Woods Hole, Laomedea and Obelia can be distinguished by the possession of a thin diaphragm in the hydrotheca at the base of the hydranth. In the others (Clytia and Campanularia) this basal structure has the form of a ring shaped thickening.

26. Main stem simple; hydrothecae smooth, shallow, toothless; gonangia with constricted opening, "bottle necked" (fig. 13) 27
26. Main stem fascicled; hydrothecae deep, longitudinally ribbed, with 14-20 double-pointed teeth on rim; gonangia with opening not constricted; colony may exceed 30 inches . . . . Obelia bicuspidata

27. Colony of stiff, short (1 inch or less) unbranched, zigzag (geniculate) stems with short, stout internodes and hydranths set alternately, in one plane; gonangia about 5 times length of hydrothecae . . . . Obelia geniculata
27. Colony much branched, with long slender internodes; gonangia about 3 times length of hydrothecae; height of colony 6-8 inches . . . . Obelia commissuralis

28. Main stem with many branches, which rebranch; gonothecae with very small apertures; colony in absence of gonangia closely resembles Obelia commissuralis; height about 6 inches . . . . Campanularia amphora
28. Stem bearing only pedicels, or a few branches 29

29. Stem brownish and stout, with short internodes (4-5 times as long as thick, fig. 7); height about 1.5 inches; gonothecae of tubular form with apertures not constricted . . . . Campanularia flexuosa
29. Main stems slender with longish internodes (7-8 times as long as thick, fig. 8); gonangia with specialized apertures 30

30. Stem strongly zigzag (geniculate); height about 3/4 inch; gonangia irregularly wrinkled, bottle-necked . . . . Campanularia angulata
30. Stem flexuose (weakly zigzag); height up to 1.5 inch; female gonangia with a distinctive folded-over tip (fig. 9); male gonangia bluntly fusiform and irregularly bulging (fig. 8) . . . . Campanularia calceolifera

31. Hydrothecae adnate on one side only of stem or branches (family Plumulariidae); the species commonly taken has a white, delicate feathery colony, 1-3 inches high; tiny special zooids (nematophores) form small spout-like extensions set along branches between hydrothecae (fig. 5); gonangia curved, set among branches . . . . Schizotricha tenella
31. Hydrothecae arranged on both sides of stem or branches (Sertulariidae) 32

32. Hydrothecae set as opposite pairs (genus Sertularia); in the commonest local species, the members of each pair of hydrothecae not in contact (fig. 10); gonotheca bottle-necked, not annulated; dark brown, stiff growths, usually on seaweeds; 0.5-1.5 inches high . . . . Sertularia pumila
32. Hydrothecae set in alternating fashion 33

33. Pinnately-branching brown colony, up to 12 inches tall; hydrothecae with tubular necks, smooth-rimmed . . . . Abietinaria abietina
33. Colony dichotomously branching; a handsome bushy form ("squirrel-tail hydroid") with silvery branches, up to 12 inches tall; hydrothecal rims elevated into two opposite teeth . . . . Thuiaria argentea

ANNOTATED LIST OF HYDROIDS IN THIS KEY

In view of the large number of species alleged by Nutting and Fraser for this region, it would be premature to attempt a complete list. The experimentalist should be aware that species not on this list may be expected to turn up, that a given genus, e.g. Tubularia, might be represented in Supply Department collections by different species at different seasons, and that some species and even genera in certain families, notably Campanulariidae, are impossible to identify without sexually mature ("fruiting") material.

Abietinaria abietina (Linnaeus, 1758). Dredged.

Acaulis primarius Stimpson, 1854. Rare, in dredgings north of Cape.

Bougainvillia carolinensis (McCrady, 1858). On rocks, pilings, algae; common.

Bougainvillia superciliaris (L. Agassiz, 1849). Status unclear. According to Russell (1953), hydroid is tiny, with ca. 6 filiform tentacles in a whorl, hydranths arising singly from stolon. Nutting (1901), following Agassiz, described hydroid as up to 2 inches high with 15-20 tentacles, but did not see it himself. If this species occurs here, it may occur chiefly as the medusa.

Calycella syringa (Linnaeus, 1767). Common on other hydroids, bryozoans, algae, but inconspicuous because of small size.

Clava leptostyla L. Agassiz, 1862. Most commonly in small clusters on Ascophyllum nodosum in low intertidal; of rather local, sporadic occurrence.

Campanularia amphora (L. Agassiz, 1862). Common in shallow water. Easily confused with Obelia commissuralis.

Campanularia angulata (Hincks, 1861). Reported on Zostera.

Campanularia calceolifera Hincks, 1871. Common on Mytilus, seaweeds, and pilings. The unique folded-over tip of female gonangium makes identification certain.

Campanularia flexuosa (Alder, 1856). On pilings, rocks, algae. Very common.

Clytia edwardsi (Nutting, 1901). On pilings, etc.

Clytia johnstoni (Alder, 1857). (=Clytia bicophora Nutting, 1901). The medusae produced by the hydroid genus Clytia are known as Phialidium and Russell refers Clytia johnstoni in British waters to Phialidium hemisphericum Linnaeus. The disposition of the local Clytia johnstoni should await proper study. The hydroid is found locally on intertidal brown algae and on rocks.
Note: Clytia differs from Campanularia essentially only in the degree of development of its medusa. It is possible that future practice will be to include Clytia within the genus Campanularia.

Cordylophora lacustris Allman, 1844. An important experimental animal and the only typical colonial hydroid found in fresh water. On pilings, under floats, and in culverts in ponds and passages in areas of low salinity.

Corynitis agassizi, see Zanclea costata.

Corymorpha pendula L. Agassiz, 1862. Dredged quite rarely, from soft bottoms.

Ectopleura dumortieri (Van Beneden, 1844). (=*Ectopleura ochracea* L. Agassiz, 1862). This is generally seen as the medusa. The hydroid is a solitary form resembling *Tubularia*, but producing free-swimming medusae.

Eudendrium album Nutting, 1898. Small, inconspicuous; on rocks, piles, algae.

Eudendrium carneum Clarke, 1882. A conspicuous species, with red hydranths and gonophores. This and the next species are common laboratory examples of hydroids with greatly reduced medusoids. On piles and algae.

Eudendrium ramosum Linnaeus, 1758. Also conspicuous. One of the commonest shallow water forms on rocks and piles, and in deeper water.

Eudendrium tenue A. Agassiz, 1865. Shallow water, on piles.

Gonothyraea (=*Laomedea*) *loveni* (Allman, 1859). On shells, stones, pilings, floats, in shallow water.

Halecium halecinum (Linnaeus, 1767). Common in shallow water on shells, stones, etc.

Hydractinia echinata (Fleming, 1828). Very common on shells of *Littorina* (see Crowell, 1945) and other snails occupied by hermit crabs, and also on rocks and piles. Seems quite variable, both in roughness of spines and in color, which varies from pure white to a rich salmon.

Laomedea, see *Gonothyraea*.

Obelia bicuspidata Clark, 1876. As with other campanulariids, generic identification of *Obelia* may be impossible without mature material. On *Zostera*, piles, and in deeper water.

Obelia commissuralis McCrady, 1858. Widespread in shallow water on various substrates.

Obelia geniculata (Linnaeus, 1758). Grows profusely on floats, piles, and *Laminaria*; on the latter the extensive stolon system is conspicuous.

Pennaria tiarella (Ayres, 1854). A common and conspicuous species in clear shallow water under rock ledges, etc. A favorite laboratory animal. Bears reduced medusae with 4 rudiments of tentacles. Medusae may be released, or may discharge gametes while still attached. In laboratory this is usually seen between 7 and 9 P.M.

Podocoryne carnea Sars, 1846. Generally collected on shells of *Nassarius trivittatus* used by hermit crabs (see Crowell, 1945), although not confined to this shell. Color pink to pure white. An important experimental animal in recent years. Since *Podocoryne* differs from *Hydractinia* mainly in the development of a free medusae, it is possible that future practice will be to include both in the genus *Hydractinia.*

Sarsia tubulosa (Sars, 1835). This species is probably not to be found at Woods Hole in summer. Sumner *et al.* cite records of its abundance in March and April, with the medusae most common in April and May. The hydroid has not been included in the keys and lists of the Invertebrate Zoology Course for at least 25 years. The free medusa is one of a difficult group and Russell includes *Syncoryne mirabilis* (L. Agassiz, 1849) as a synonym of *Sarsia tubulosa*.

Schizotricha tenella (Verrill, 1874). The delicate feathery form is easily recognized. Common on pilings.

Sertularia pumila Linnaeus, 1758. Common on intertidal brown algae in protected waters.

Stylactis hooperi Sigerfoos, 1899. Occurs on shells of living mud snails (*Nassarius obsoletus*). Since *Stylactis*, like *Podocoryne*, differs from *Hydractinia* mainly in the degree of development of its medusa, it is possible that future practice will be to include all three within the genus *Hydractinia.*

Syncoryne mirabilis, see *Sarsia tubulosa*.

Thuiaria argentea (Linnaeus, 1758). Dredged, but usually dead and empty when taken in summer.

Tubularia: A difficult genus, but very important in experimental work. Specific identification is often inadequate, an unfortunate situation when results of different authors have to be compared. Experimentalists using *Tubularia* would do well to record date, water temperature, and place of collection of laboratory material. Nutting lists five species; this key, three:

Tubularia couthouyi L. Agassiz, 1862. On sandy or stony bottom. This large and beautiful species has generally died off by summer.
Tubularia crocea (L. Agassiz, 1862). Subtidal, on pilings, sometimes in brackish water. The same species is thought to occur in the Oakland Estuary (San Francisco Bay). This is the species most used experimentally.
Tubularia larynx Ellis and Solander, 1786. On rocks, piles, and algae.
Turritopsis nutricula (McCrady, 1856). This is generally seen as the medusa. The hydroids are small and inconspicuous.
Zanclea costata Gegenbaur, 1856. The work of Russell makes it seem probable that the hydroid "Corynitis agassizi" and the medusa Gemmaria gemmosa as recorded from Woods Hole should be referred to Zanclea costata. This is found abundantly on the red bryozoan nodules obtained by dredging.

HYDROMEDUSAE

Numerous small medusae occur seasonally in the plankton of Woods Hole and adjacent waters, but their identification is a matter of considerable difficulty. One may identify a good many simply by reference to the illustrations in Hargitt (1905), but there remain problems of synonymy because life histories of medusae were not well worked out at that time, and indeed are still very incompletely known. Reference should be made to Mayer's "Medusae of the World" (1910). A useful guide to the generic identification is the "Pictorial key to species of British Medusae", pp. 42-45 in the excellent volume by Russell (1953). In the present manual, no key has been attempted.

1. Order HYDROIDA (includes most of the local hydromedusans):

   a. Suborder ANTHOMEDUSAE: These are the medusae of the gymnoblastic or athecate hydroids, and are characterized by a deep, bell shaped form, lacking statocysts, and with the gonads born on the manubrium. The medusae of Bougainvillia and Podocoryne are typical examples (Plate 2, figs. 1 and 15).
   b. Suborder LEPTOMEDUSAE: These are the medusae of such of the calyptoblastic or thecate hydroids as produce medusae (most do not). They are of flattened form with gonads born on the radial canals, and ectodermal statocysts. Obelia and Phialidium (=Clytia) are examples.
   c. Suborder LIMNOMEDUSAE: This group is not recognized as such by Hyman (1940) and is given ordinal rank by Russell (1953). It includes the well known Craspedacusta sowerbii, of sporadic occurrence in fresh waters; its polyp stage is the minute, tentacle-less "Microhydra". Another very famous representative, and the subject of much experimental work at Woods Hole, is Gonionemus vertens A. Agassiz, 1862. This was once very abundant in the Eel Pond, but it became very scarce in the Woods Hole region with the dying off of the eel grass (Zostera) about 1930, and, despite the general return of the grass, is now of rather sporadic and unpredictable occurrence. In some summers thousands may be seen in shallow, protected bays on Martha's Vineyard; in other years very few may be taken. Most of the Woods Hole papers on this species refer to it as Gonionemus murbachi, which Kramp (1959) regards as a synonym of G. vertens.

2. Order TRACHYLINA (Suborders TRACHYMEDUSAE and NARCOMEDUSAE): Trachyline medusae are generally oceanic and seldom taken in the inshore waters near Woods Hole. They lack a true hydroid stage, or may have a parasitic larval development; adults may have a distinctive scalloped bell margin, or tentacles inserted above the margin. Russell's pictorial key may be helpful if members of this group are encountered.

The last two groups to be mentioned are commonly called "siphonophores". These (sensu lato) are floating or swimming colonies containing both polypoid and medusoid individuals. The recent trend in classification is to split this group into two orders:

3. Order CHONDROPHORA, allied to the tubularian hydroids, and represented in this region only by rare examples of the "purple sailor", Velella velella (Linnaeus), which has an oval float with diagonal vertical sail, and the somewhat similar Porpita porpita (Linnaeus), which lacks a sail.

4. Order SIPHONOPHORA proper, represented locally by the "Portuguese man-of-war", Physalia physalia (Linnaeus), which is well known and easily recognized by its large purple and rose irridescent float. Physalia may be quite common in Vineyard Sound in certain summers, especially after long periods of southeast storms. However, experimentalists are advised that in occasional summers it is virtually not to be found. The sting is severe and, although they may be picked up by the float, they should be handled with caution and avoided by swimmers. Other siphonophores are of rare or occasional occurrence.

REFERENCES ON HYDROZOA

Crowell, S., 1945. A comparison of the shells utilized by Hydractinia and Podocoryne. Ecology, 26:207.

Fraser, C. M., 1944. Hydroids of the Atlantic Coast of North America, Univ. of Toronto Press, 451 pp., 94 pl.

Hargitt, C. W., 1905. The Medusae of the Woods Hole region. Bull. U. S. Bur. Fish., 1904, 24: 21-79, pl. 1-7.

Hyman, L. H., 1940. The Invertebrates, vol. I, Protozoa through Ctenophora, 726 pp., McGraw-Hill.

Kramp, P. L., 1959. The Hydromedusae of the Atlantic Ocean and adjacent waters. Dana Rept. 46: 1-283, Pl. I-II.

Mayer, A. G., 1901. The Medusae of the World. Vols. I and II, The Hydromedusae. Carnegie Inst. of Wash. Publ. 109.

Nutting, C. C., 1899. The hydroids of the Woods Hole region. Bull. U. S. Bur. Fish., 1899, 19: 325-386.

Russell, F. S., 1953. The Medusae of the British Isles, Cambridge Univ. Press, 530 pp., 35 pl.

Totton, A. K., and G. O. Mackie, 1960. Studies on Physalia physalis (L.). Part I., Natural history and morphology. Part II. Behavior and histology. Discovery Repts, 30: 301-408.

PHYLUM CNIDARIA, CLASS SCYPHOZOA

The commonly encountered members of the Class Scyphozoa are well known to the general public as "jellyfishes", and are often feared unreasonably. And it is fair to advise that any large medusa should be handled with due respect, for its stinging powers despite exaggerations in popular literature, may be formidable (cf. Hedgpeth, 1945).

Scyphozoan jellyfish are commonly large and conspicuous, with scalloped bell-margins and usually with long tentacles and/or mouth lobes. The attached or polypoid stages are absent or inconspicuous; these "scyphistoma" stages (Plate 3, fig. 3) may occasionally be found on eelgrass, rocks, or timbers, or can be reared from larvae shed by medusae in the laboratory.

Members of the order Stauromedusae are easily distinguishable from other members of the Class in that they are sessile throughout their life cycle except for a brief period during development when a creeping, vermiform, nonciliated planula larva is produced. Two families have been designated, the Eleutherocarpidae, represented locally by *Haliclystus*, and the Cleistocarpidae, represented by *Craterolophus*. The latter group possesses "claustra", or membranes, which divide the gastric pockets (see figs. 162B, p. 502, and 165J, p. 510 in Hyman, *The Invertebrates*, Vol. I, for the distinction between the two families). Two stauromedusans are found locally early in the season (to the end of June) attached to *Fucus* at Nobska Point.

The synonymy of Scyphozoa is extensive, and most of the names used by Hargitt and by Mayer have been modified. In the keys below, the names in Kramp's synopsis (1961) have been used. For the key to attached scyphozoans we are indebted to Drs. G. F. Gwilliam and Kay Werner Petersen; the key to scyphomedusae has been derived from Mayer (1910). Figure references are to Plate 3.

KEY TO ATTACHED SCYPHOZOA OF THE VICINITY OF WOODS HOLE

1. Small (under 10 mm) soft individuals connected by stolons (fig. 3); up to 16 or more very long filiform tentacles; gastric cavity with 4 small radial septa . . . . "Scyphistoma" stages of various scyphozoan medusae
1. Larger (up to 30 mm); broadly bell shaped single individuals; 8 marginal clusters of short knobbed tentacles . . Order STAUROMEDUSAE 2

2. Stalk comparable in length to depth of bell; with conspicuous marginal anchors (fig. 2) between tentacle-bearing arms . . . . *Haliclystus auricula* (Rathke, 1806)
2. Stalk much shorter than depth of bell; no marginal anchors (fig. 1) . . . . *Craterolophus convolvulus* (Johnston, 1835)

Note: If the stauromedusan was collected north of Cape Cod, consult the paper of Berrill (1961) before concluding an identification.

KEY TO LARGE AND COMMON FREE-SWIMMING SCYPHOMEDUSAE

1. Bell flat, translucent grayish, with 4 horeshoe shaped gonads; marginal tentacles very short and numerous . . . . *Aurelia aurita* (Linnaeus, 1758)
1. Bell deep and usually colored; marginal tentacles long 2

2. Marginal tentacles long and numerous, arranged in 8 clusters, each of several rows . . . . *Cyanea capillata* (Linnaeus, 1758)
2. Marginal tentacles single 3

Plate 3

SCYPHOZOA AND ANTHOZOA

Fig. 1. *Craterolophus convolulus*, from a preserved specimen; bar is 1 cm.

2. *Haliclystus auricula*, from a preserved specimen; bar is 1 cm.

3. Scyphistoma stage of *Aurelia aurita*, grown in laboratory and sketched from life by Dr. Louise Bush. Scale is about 1 millimeter.

4. *Astrangia danae*, a small section of living colony, sketched from life by Bruce Shearer. Scale is 5 mm.

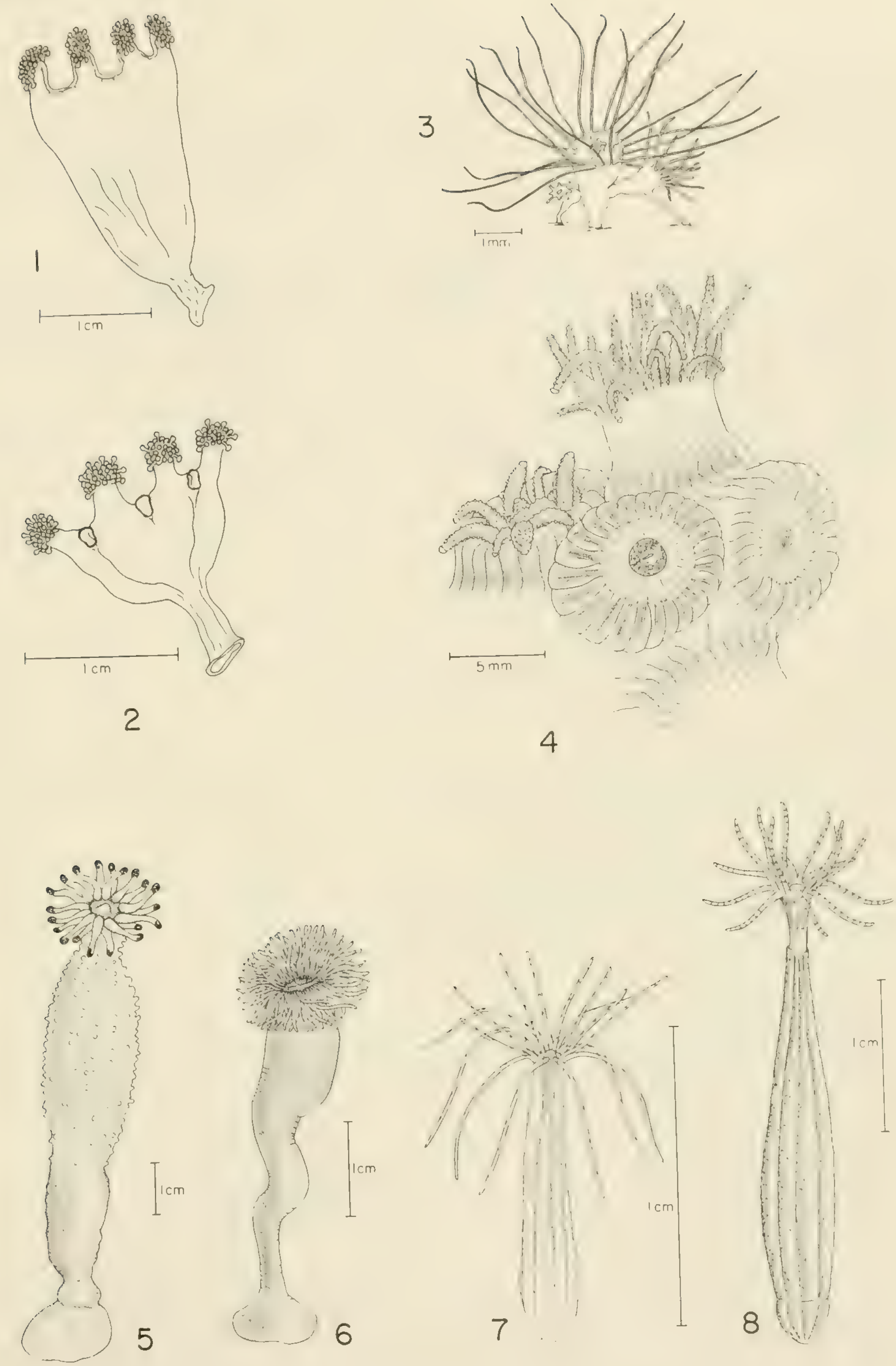
5. *Haloclava producta*, after Hargitt; this and following 3 figures redrawn by Mrs. Emily Reid. Scale bars of figures 5-8 approximately 1 cm long.

6. *Sagartia modesta*, after Hargitt.

7. *Nematostella vectensis*, after Crowell.

8. *Edwardsia elegans*, after Hargitt.

Plate 3



3. Eight marginal tentacles; 16 marginal lappets; bell with numerous nematocyst bearing warts . . . . <u>Pelagia</u> <u>noctiluca</u> (Forskål, 1775)
3. Up to 40 marginal tentacles; about 48 marginal lappets . . . . <u>Chrysaora</u> <u>quinquecirrha</u> (Desor, 1848)

REFERENCES ON SCYPHOZOA

Berrill, M., 1962. The biology of three New England Stauromedusae, with a description of a new species. Canad. J. Zool., <u>41</u>: 1249-1262.

Hargitt, C. W., 1905. The medusae of the Woods Hole Region. Bull. U. S. Bur. Fish. 1904, <u>24</u>: 21-79.

Hedgpeth, J. W., 1945. Re-examination of the Adventure of the Lion's Mane. Sci. Monthly, <u>60</u>: 227-232.

Kramp, P. L., 1961. Synopsis of the medusae of the world. J. Mar. Biol. Assoc. U. K., <u>40</u>: 7-469.

Mayer, A. G., 1910. Medusae of the World. Vol III, The Scyphomedusae. Carnegie Inst. of Washington, Publ. no. 109.

PHYLUM CNIDARIA, CLASS ANTHOZOA

By Cadet Hand

This, the largest class of the Cnidaria, has but a modest representation at Woods Hole, chiefly in the group of sea anemones.

A. Subclass ALCYONARIA (=OCTOCORALLIA):

Members of this subclass are at once identifiable by the possession of 8 pinnate tentacles. The group contains several orders, mostly of warmer waters, such as sea pens, sea fans, gorgonians, "organ-pipe coral", the sea pansy (Renilla), well known in experimental work, and the precious red coral of jewelry. In the Woods Hole region, dredging off Martha's Vineyard and in the Sound may yield two species.

1. Order ALCYONACEA ("soft corals"): Alcyonium carneum Agassiz, 1850. Grows as fleshy, finger-like lobes attached to rocks and shells at depths of 20-60 meters; the color varies from bright salmon to pink or flesh-colored. The tissue contains calcareous spicules, but there is no firm skeleton. At collection the polyps are retracted and the general appearance is describable by the common name of "dead men's fingers". In the relaxed condition the delicate polyps reveal the 8 pinnate tentacles characteristic of the subclass. It survives only moderately well under laboratory aquarium conditions.

2. Order PENNATULACEA: Pennatula aculeata Danielson and Koren, 1858. This "sea pen" has the form of a feather, with a bulbous base on which it stands in soft muddy bottoms. The local species, which is taken only occasionally, is 10-25 cm in height and of a purplish-red color.

B. Subclass ZOANTHARIA:

Here are placed the great assemblages of stony corals (Madreporaria), sea anemones (Actinaria), and some other orders, examples of which are rare or lacking in the Woods Hole region.

1. Order MADREPORARIA ("true" or stony corals): Astrangia danae Agassiz, 1847 is the sole local representative. It is a typical coral in form (Plate 3, fig. 4) forming irregular encrustations or low branching growths almost everywhere on rocks, shells and pilings from low-water mark to 30-40 meters. It is hardy, and lives well in laboratory sea-water aquaria.

2. Order CERIANTHARIA: Cerianthus americanus Verrill, 1866. A southern form, this has been taken only very rarely at Woods Hole. It has the form of an elongated (up to 20 cm) burrowing sea anemone with 2 whorls of tentacles, living in a distinct mucoid tube. McMurrich (1890, J. Morph., 4: 131-150) gives a good colored illustration. See Field (1949) for additional information.

3. Order ZOANTHIDEA: Members of this order resemble small sea anemones but are generally colonial. Epizoanthus americanus (Verrill, 1864) is barely includable in the Woods Hole region, being common only at depths of 50 or more meters, off Martha's Vineyard and Nantucket. It generally occurs on shells occupied by hermit crabs, and also on rocks.

4. Order ACTINIARIA (sea anemones): These are familiar animals, generally recognizable as such. Several local species are readily identifiable from the key by form, color, and habitat, but critical identification of the rest is made difficult by the fact that classification is based upon the assemblage of nematocyst types ("cnidome") and upon internal anatomy such as mesenterial arrangement, musculature, and other details requiring microscopical sections. The student who wishes to go beyond the following key would do well to consult the works of Stephenson (1928, 1935) and Carlgren (1949).

KEY TO SEA ANEMONES
(Figure references are to Plate 3)

1. Burrowing or buried in sand, gravel, or mud with only the tentacles exposed; body elongate, even worm-like 2
1. Attached on hard surfaces with most of body well exposed 5

2. Upper part of body with 20 rows of papillae (fig. 5); tentacles 20 in number, blunt and tending to be swollen at tips; up to 10-15 cm body length . . . . Haloclava producta
2. Tentacles pointed and body without papillae 3

3. Acontia* present; flattened base attached to pebbles or shells (fig. 6) . . . . Sagartia modesta
3. No acontia; aboral end rounded or pointed; no flattened base; normally 16 tentacles 4

4. Small, not over 2 cm long; transparent when extended and without adherent sand (fig. 7) . . . . Nematostella vectensis
4. With middle portion of body covered by a rough brown cuticle to which sand adheres; 8 longitudinal grooves (fig. 8); body up to 3.5 cm long . . . . Edwardsia elegans

5. Column green to grayish black, with or without orange, yellow, or white lines . . . . Haliplanella luciae
5. Column white to salmon or brown, not green or black, sometimes mottled with brown 6

6. Large individuals with lobed or frilled tentacular crown. Tentacles very numerous and short. In extension the column is usually less than twice as long as its diameter . . . . Metridium senile
6. Column elongated when extended and usually 3 or more times longer than its diameter. Tentacles elongate. Color white to pinkish, sometimes showing a greenish tinge in the tentacles and upper column. Some specimens may show one or more larger and more opaque inner tentacles known as "catch tentacles", of uncertain function . . . . Diadumene leucolena

*) Acontia are ciliated, thread-like structures which arise from the free edges of the mesenteries and project into the gastric cavity. When acontiate anemones are roughly handled the acontia may be extruded through the mouth or through special pores (cinclides) in the body wall.

ANNOTATED LIST OF WOODS HOLE SEA ANEMONES

With some exceptions the sea anemones of Woods Hole are not well known, and a restudy of local species is needed. The original descriptions, based largely on form and color, are inadequate by modern standards.

Anemonia sargassensis Hargitt, 1908. Not in key; an occasional visitor upon drifting Sargassum.

Bicidium parasitica, see Peachia parasitica.

Diadumene leucolena (Verrill, 1866). Listed as Cylista in Hargitt (1914). Most commonly found under stones on rocky beaches. See Hand (1955) for synonymy.

Edwardsia elegans Verrill, 1869. Reported burrowing in intertidal sand flats (Hargitt); apparently not common.

Edwardsia leidyi Verrill, 1898. This name applies to a larval stage found parasitic in the ctenophore Mnemiopsis leidyi. The adult has not been determined. Length 2-3 cm, color pink.

Eloactis producta, see Haloclava producta.

Halcampa duodecimcirrata (Sars, 1851). One specimen, reported by Verrill dredged in mud off Gay Head, had 10 tentacles. Species was described as having 12 tentacles, from Maine specimens. On present evidence, rare, not in key.

Halcampa farinacea, see Halcampa duodecimcirrata.

Haliplanella luciae (Verrill, 1898). This common and well known species has a very discouraging synonymy, having been assigned to the genera Sagartia, Chrysoela, Diadumene, Aipaisiomorpha, and Haliplanella, without there being much question of its specific name luciae (after Verrill's daughter Lucy) since Verrill's description. H. luciae is thought to be of Japanese origin; it appeared near New Haven in 1892 and has since become one of the commonest anemones of New England; the first British record was in 1896, and it has also become widespread on the California coast. The color is variable: dark brown, olive or green, with or without lines of orange, yellow, or white. The orange lines when present, are diagnostic, but the unlined individuals are more difficult to identify. Very common, on pilings, among mussels, in salt marshes, often in brackish water. See Hand (1955) for synonymy.

Haloclava producta (Stimpson, 1856). A burrowing form on intertidal sand flats.

Metridium dianthus, fimbriatum, marginatum, see Metridium senile.

Metridium senile (Linnaeus). In systematic work this is referred to as M. senile senile, while the Pacific coast subspecies is M. senile fimbriatum. The species at Woods Hole has also been variously called M. dianthus, M. marginatum, and M. fimbriatum, a not unusual situation when a very widespread and variable form is concerned. See Hand (1955) for synonymy.

Nematostella vectensis Stephenson, 1935 (=N. pellucida Crowell, 1946). A small delicate form found in the Mill Pond, Woods Hole, where salinity may fluctuate greatly. Up to 20 mm long and 2-4 mm in diameter when extended. Lives in soft mud with disc and tentacles exposed. Crowell's account of anatomy is excellent. See Hand (1957) for synonymy.

Peachia parasitica (L. Agassiz, 1859). Young stage reported parasitic in the jellyfish Cyanea. Adults not yet recorded south of Eastport, Maine. Not in key.

Sagartia leucolena, see Diadumene leucolena.

Sagartia luciae, see Haliplanella luciae.

Sagartia modesta Verrill, 1866. There is some doubt as to the proper generic name for this species; see Carlgren (1950) for discussion of this problem.

REFERENCES ON SEA ANEMONES

Carlgren, O., 1949. A survey of the Ptychodactaria, Corallimorpharia, and Actiniaria. K. Svenska Veten. Handl. 4th ser., 1(1): 1-121.

Carlgren, O., 1950. A revision of some Actiniaria described by A. E. Verrill. J. Wash. Acad. Sci., 40(1): 22-28.

Crowell, S., 1946. A new sea anemone from Woods Hole, Massachusetts. J. Wash. Acad. Sci., 36: 57-60. (good account of Nematostella).

Field, L. R., 1949. Sea anemones and corals of Beaufort, North Carolina. Duke Univ. Mar. Sta. Bull. 5, 39 pp, 10 pl. (useful for Cerianthus but otherwise not much help in the Woods Hole region).

Hand, C., 1955. The sea anemones of central California. Part 111. The acontiarian anemones. Wasmann J. Biol., 13: 189-251. (synonymies and redescriptions of several Woods Hole species).

Hand, C., 1957. Another sea anemone from California. J. Wash. Acad. Sci., 47: 411-14. (Nematostella).

Hargitt, C. W., 1914. The Anthozoa of the Woods Hole region. Bull. U. S. Bur. Fish., 32 (for 1912): 223-54. Pl. 41-44.
Stephenson, T. A, 1928. The British Sea Anemones. Vol. I, 148 pp. (Ray Soc. Vol. 113) London.
Stephenson, T. A., 1935. The British Sea Anemones. Vol. II, 426 pp. (Ray Soc. Vol. 121). London.

Admonitory note: Generic name changes may occasionally lead the experimentalist using this manual to give way to Frustration and Despair. Let him remember, however, that systematists are professional gentlemen who are doing the best they can, supported by such declarations as the following:

OPINIONS AND DECLARATIONS RENDERED
BY THE INTERNATIONAL COMMISSION
ON ZOOLOGICAL NOMENCLATURE

VOLUME I. Part 4. Pp. 23-30.
1943
DECLARATION 4
On the need for avoiding intemperate language
in discussions on zoological nomenclature

DECLARATION.--In the opinion of the Commission the tendency to enter into public polemics over matters which educated and refined professional gentlemen might so easily settle in refined and diplomatic correspondence is distinctly unfavorable to a settlement of the nomenclatorial cases for which a solution is sought. It may be assumed that the vast majority of zoologists agree with the Commission in desiring results rather than polemics, and the Commission ventures to suggest that results may be obtained more easily by the utmost consideration for the usual rules of courtesy when discussing the views of others.

The dangers attending the use of sarcasm and intemperate language in discussions on zoological nomenclature were specially considered by the International Commission on Zoological Nomenclature at their Session held at Monaco in March 1913 during the Ninth International Congress of Zoology. The Commission considered that this question was sufficiently pressing to require special treatment in their report to the Congress. In framing that report the Commission accordingly devoted paragraphs (68) and (69) to this subject.

2. Paragraph (68) of that report reads as follows:--

(68) Intemperate Language.--Whether or not it be an actual fact, appearances to that effect exist that if one author changes or corrects the names used by another writer, the latter seems inclined to take the change as a personal offense. The explanation of this fact (or appearance, as the case may be) is not entirely clear. If one person corrects the grammar of another, this action seems to be interpreted as a criticism upon the good breeding or education of the latter person. Nomenclature has been called "the grammar of science" and possibly there is some inborn feeling that changes in nomenclature involve a reflection upon one's education, culture and breeding. Too frequently there follows a discussion in which one or the other author so far departs from the paths of diplomatic discussion, that he seems to give more of less foundation to the view that there is something in his culture subject to criticism. It is with distinct regret that the Commission notices the tendency to sarcasm and intemperate language so noticeable in discussions which should be not only of the most friendly nature, especially since a thorough mutual understanding is so valuable to an agreement, but which are complicated and rendered more difficult of results by every little departure from those methods adopted by professional gentlemen.

PHYLUM CTENOPHORA

The "comb jellies", although classified as coelenterates, are now generally regarded as a phylum distinct from the proper coelenterates or Cnidaria. Ctenophores possess biradial symmetry, an aboral sensory area, and 8 meridional rows of fused cilia (paddle-plates); they lack the circumoral tentacles and nematocysts characteristic of the Cnidaria, and show none of the polymorphism and attached "polypoid" stages so characteristic of the latter phylum. They are essentially marine, although some are common in brackish waters as well.

KEY TO COMMON WOODS HOLE CTENOPHORA

1. Possessing a pair of tentacles, each with small side branches . . . . Class TENTACULATA 2
1. Without tentacles; body in the form of a flattened sac with wide mouth . . . . Class NUDA, Order Beroida 4

2. Body of simple outline, without oral lobes; tentacles long but retractile into sheaths; gastric branches end blindly . . . . . . Order Cydippida 3
2. Body with 2 large oral lobes, and 4 smaller lobes (auricles), body somewhat triangular in outline; tentacles inconspicuous, without sheaths; gastric branches fuse to form loops in oral lobes; . . . . Order Lobata, *Mnemiopsis leidyi*

3. Body firm, egg shaped to nearly spherical; up to 20 mm long; not flattened; tentacles long, with many side branches . . . . *Pleurobrachia pileus*

3. Body of oval outline but compressed, resembling a flattened *Pleurobrachia*; rare . . . . *Mertensia ovum*

4. The side branches of the 8 meridional gastric canals beneath the comb rows do not anastomose; generally north of Cape Cod . . . . *Beroe cucumis*
4. Side branches of the 8 meridional gastric canals anastomose . . . . *Beroe ovata*

ANNOTATED LIST OF CTENOPHORA

Beroe cucumis Fabricius, 1780. A common species on the northern New England coast; rare or occasional south of Cape Cod.

Beroe ovata Chamisso and Eysenhardt, 1821. A southern species, irregular in occurrence north of Delaware Bay.

Mertensia ovum (Fabricius, 1780). An arctic species, the young of which occur occasionally as far south as New Jersey.

Mnemiopsis leidyi A. Agassiz , 1865. This is the commonest ctenophore of Woods Hole waters, especially in late summer and fall. Brilliantly luminescent when disturbed. Often found to contain wormlike pink, immature stages of the sea anemone *Edwardsia* sp.

Pleurobrachia pileus (Fabricius, 1780). An arctic species, found at Woods Hole in winter and spring; usually not seen in July and August.

REFERENCES

Hyman, L. H., Chapter VIII, Ctenophora, *in* "The Invertebrates", Vol. I, Protozoa through Ctenophora, 1940.

Mayer, A. G., 1911. Ctenophores of the Atlantic Coast of North America. Carnegie Inst. of Washington, Publ. no. 162: 1-58, 17 pl.

PHYLUM PLATYHELMINTHES

Class Turbellaria

The Platyhelminthes comprise three classes of which two, the Trematoda (flukes) and Cestoda (tapeworms), are parasitic and although well represented in the Woods Hole region are not treated in this manual. Of the mostly free living class Turbellaria, a few species of the orders Tricladida and Polycladida are well known to investigators at the MBL, but there are a great many small forms belonging to the orders Aceola, Rhabdocoela, and Alloeocoela which are not well known, and which merit much further investigation. The work of Dr. Louise Bush in preparing the preliminary key, check list, and illustrations of these smaller forms is gratefully acknowledged.

METHODS OF COLLECTING AND HANDLING TURBELLARIANS

by Dr. Louise Bush

Turbellarians may be collected in several ways. Many of the larger forms will come to the top of the water or crawl to the surface of mud or debris which has been allowed to stand in containers in the laboratory for several hours or days. This is the time honored method and works well for large marine species and for many fresh water forms, but the smaller marine species do not survive crowding or standing in containers with other plants and animals for more than a few hours; to obtain these, materials must be examined as soon after collection as possible. Stones, algae, debris, and especially hydroids and other materials from pile scrapings should be washed or stirred up thoroughly in sea water and the water poured off and examined under a dissecting binocular. Turbellaria may be found in such washings swimming about, moving beneath the surface film, or crawling about on the bottom or sides of the container. Hand sorting of debris under a dissecting microscope may also be resorted to, but does not seem to be more effective than washing and is much more time consuming.

Examination of the animals should first be made as they swim or crawl about. A familiar species may often be recognized by color, shape, and type of movement, but for exact determination, careful study of compressed specimens, of permanent mounts, and often of serial sections is necessary. The general student may make a tentative determination and learn something of the structure of these animals by mounting them on a slide so that they are slightly flattened by the coverslip. This may be accomplished by judicious control of the amount of water on the slide or by ringing the coverslip with vaseline and compressing the material while observing it under the microscope.

The following key uses characters which may be easily seen, and should enable the student to identify some of the commoner species found at Woods Hole, but in cases where examination of permanent mounts or sections is mandatory for specific identification the key will lead only to some of the higher categories. Figure references are to Plate 4.

PRELIMINARY KEY TO COMMON TURBELLARIANS

by Dr. Louise Bush

1. Large: over 5 mm in length. Body flattened and leaflike and usually showing the pattern produced by the ramifications of the gut (other color patterns may also be present):
   . . . . Order TRICLADIDA, see annotated list on page 32.
   . . . . Order POLYCLADIDA, see keys to species on page 36.
1. Small: under 5 mm and often from 1-2 mm in length. Body shape varies from oval and flattened to cylindrical to almost globular or egg shaped 2

2. Without a clearly defined gut; food lies in center of body more or less irregularly surrounded by parenchyma cells. Statocyst present but eyes absent
. . . . Order ACOELA 3
2. With a true gut which can be distinguished by its clearly defined outer wall. Eyes may be lacking or one or two pairs present. Statocysts only occasionally present
. . . . Orders RHABDOCOELA and ALLOEOCOELA 7

3. Posterior end of body with indentation in which are found 1-5 small tail-like appendages (fig. 1a, b, c). Color reddish-orange to orange
. . . . _Polychoerus caudatus_
3. No tail-like appendage present 4

4. Yellowish area at anterior end of body with dark reddish-purple to black pigment scattered in the middle of body. Under higher magnification this pigment is seen to be in violet to purple individual cells (fig.2)
. . . . _Aphanostoma diversicolor_
4. Color otherwise 5

5. Penis doubled and appearing as two distinct structures side by side at the very posterior end of body (fig. 3). There may be more than one species of this genus in our area but at least one has elongated hairs or spines over the surface of the body and a yellow color from pigmented cells in the parenchyma
. . . . _Childia groenlandica_
5. Penis single and this, with accessory structures, may be seen in posterior third of the body 6

6. Color orange to dark orange or reddish-brown, the pigment occurring in irregularly shaped little nodules over the surface of the body. Found creeping on the surface of mud below low tide (fig. 4)
. . . . _Anaperus gardineri_
6. Color pale tan to transparent. Sperm masses and eggs easily seen scattered at posterior end of body: several species of small acoels, mostly belonging to the family
. . . . Proporidae

7. Asexual reproduction evident as transverse partitions formed or partly formed at intervals along the rather transparent body (fig. 5). Sexual reproduction rare. Eyes lacking . . . . _Microstomum davenporti_
7. Sexual reproduction only; no transverse divisions 8

8. Statocyst present. Body elongated with a squarish posterior end containing adhesive papillae, the whole being used for attachment (fig. 6). See check list for comment on this form . . . . _Monocelis_ sp.
8. Statocyst absent 9

9. Body chalky white, with or without pigmented areas. Form "chunky", almost circular in cross section 10
9. Body more or less transparent or otherwise colored but not chalky white. Form usually somewhat flattened or more or less elongated 11

10. One pair of eyes with a network of black pigment between and around them so that the animal appears to have a distinct black spot on the anterior end. Pharynx just behind eyes. Penis without cuticular stylet at posterior end of body (fig. 7) . . . . Plagiostomum sp.
10. Two pairs of eyes. A ciliated groove extends across body just behind the eyes. Pharynx in posterior half of body (fig. 8) . . . . Monoophorum sp.
10. One pair of eyes without associated black pigment. Ciliated groove lacking . . . . young of Plagiostomum sp. or other alloeocoels

11. Proboscis at anterior end of body, protruded through a pore at the apex in catching prey. Pharynx is separate and located near the middle of the body 12
11. Tongue-like process lying in front of the eyes in the cavity with the pharynx, may be protruded through the subapical mouth (fig. 9) . . . . Woodsholia lilliei
11. No protrusible proboscis or tongue-like process present 13

12. A straight penis stylet appearing like a conspicuous needle at posterior end of body (fig. 10) . . . . Gyratris sp.
12. Penis stylet otherwise; may be curved or coiled . . . . other species of the KALYPTORHYNCHIA

13. Pharynx simple, that is, not conspicuously muscular. Mouth appears as a more or less oval opening just back of eyes. Penis stylet curved, needle-like, at posterior end of body. Adhesive papillae on rounded posterior end of body (fig. 11) . . . . Macrostomum sp.
13. Pharynx doliiform, that is, appears as a bulbous muscular organ just posterior to the eyes (fig. 12) . . . . one of the species of DALYELLIOIDA
13. Pharynx rosulate, that is, round and closing as if by a purse string. Mostly fresh water species . . . . various species of the TYPHLOPLANOIDA

ANNOTATED LIST OF ACOELA, RHABDOCOELA, and ALLOEOCOELA

by Dr. Louise Bush

Order Acoela

Anaperus gardineri Graff, 1911. This species has been taken since 1953 for use in the Invertebrate Zoology Course from mud brought in from below low tide mark in Great Harbor. Many of these worms come to the surface after the mud has stood for two or three days in the laboratory. They do not seem to be present in the Eel Pond.

Aphanostoma diversicolor Oersted, 1845. This species occurs on both sides of the North Atlantic, and is common at Woods Hole on algae. It is easily recognized by its coloration and by the more pointed ends of the body as compared to other common acoels.

Childia groenlandica (Levinsen, 1879). Hyman (1959) considers the Childia spinosa described by Graff (1911) from Woods Hole to be a synonym of the widespread C. groenlandica.

Polychoerus caudatus Mark, 1892. Formerly common in the Woods Hole region and regularly taken both in dredgings and on Ulva from pilings and rocks. Recently it has not been reported. Its use in embryological studies is described in Costello *et al.* (1957).

Order Rhabdocoela

Suborder Opisthandropora

Macrostomum spp. Species of this genus in the Woods Hole fauna are probably most easily recognized by the characteristic curved penis stylet and the simple pharynx located at the anterior end of the gut close behind the eyes. Specimens common on *Fucus* at Nobska Point have adhesive papillae at the caudal end and conspicuous hairlike setae scattered among their cilia.

Microstomum davenporti Graff, 1911. These animals have a characteristic appearance and are easily recognized, since they are one of the few marine flatworms (the only ones seen at Woods Hole) which regularly reproduce by transverse fission. The cylindrical transparent body with the gut as a straight tube inside shows clearly the development of transverse walls and new pharynges as division proceeds. When handled, those individuals in which division is nearly completed usually break in two, so that one often gets only very short specimens on a slide.

Suborder Lecithophora

Section Dalyellioida: Members of the family Dalyelliidae itself are mostly fresh water forms, but the section includes a number of marine genera and species, many of which are in the family Umagillidae and are endocommensal with marine invertebrates, especially echinoderms. The group is poorly known at Woods Hole.

Section Kalyptorhynchia: Includes *Gyratrix* sp., characterized by having a proboscis in a separate pocket opening anteriorly (fig. 10), and easily seen in the living animal.

Section Typhloplanoida: This group probably includes *Woodsholia lilliei* Graff, 1911, of which a few specimens are believed to have been taken in 1963. These have a tongue-like process, difficult to see, in the pharynx. The penis sheath is characteristic, and best seen in whole-mounts.

Order Alloeocoela

Suborder Cumulata: Species of this group seen at Woods Hole are thick and more or less cylindrical in body form, chalky white in color, sometimes with black or brown spots, stripes, bands, or reticulations.

Monoophorum sp. Common on *Ulva*; resembles a chalky white lump until disturbed, when it swims slowly away as a short cylindrical animal with two pairs of eyes and a stumpy tail.

Plagiostomum sp. Longer than *Monoophorum*, and with only one pair of eyes, which are so surrounded with black pigment that the head appears to have a single large dorsal spot.

Suborder Seriata

Monocelis sp. In 1911, Graff described from the Eel Pond a monocelid which he placed in a new genus, *Myrmeciplana*, distinguished from *Monocelis* by having sensory hairs born on sensory papillae on the rostral end of the body; his species was reported as being eyeless. Animals collected from the Eel Pond in 1963 resemble *Myrmeciplana*, but have a pair of eyes in most cases, and also have the anterior

Plate 4

TURBELLARIA (except for polyclads)

Figures 1b, 1c, and 15 are redrawn from Verrill (1892); rest redrawn from sources as cited or from life by Dr. Louise Bush. Scale bars on all figures equal 1 mm.

Figure 1. *Polychoerus caudatus*, with one "tail", after Graff.

1b and 1c. Rear of *Polychoerus caudatus* with 5 and 3 "tails", after Verrill.

2. *Aphanostoma diversicolor*, after Graff.

3. *Childia groenlandica*, from life. Actual size under one mm long.

4. *Anaperus gardineri*, from life.

5. *Microstomum davenporti*, from life.

6. *Monocelis* sp., from life.

7. *Plagiostomum* sp., from life.

8. *Monoophorum* sp., from life.

9. *Woodsholia lilliei* (?), from life.

10. *Gyratrix* sp., with proboscis shown extended at right, from life.

11. *Macrostomum* sp., from life.

12. Unidentified dalyellioid, from life.

13. *Bdelloura* sp., probably *candida*, from life.

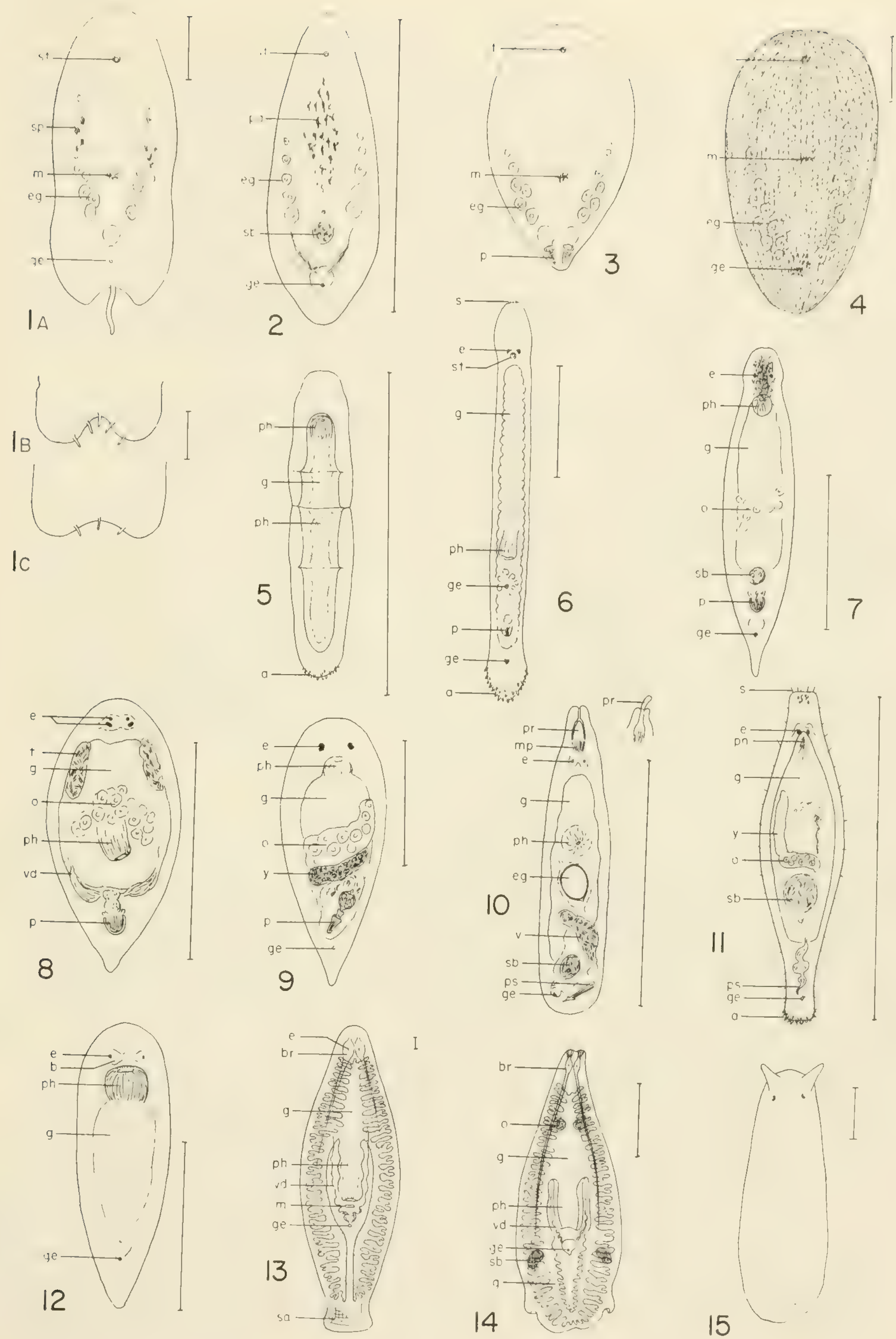
14. *Syncoelidium pellucidum*, from life, showing the diagnostic fusion of the hinder branches of the triclad gut.

15. *Procerodes wheatlandi*, reconstructed outline from figures in Verrill.

Abbreviations:

a - adhesive papillae
br - brain
e - eyes
eg - egg
ge - genital pore
m - mouth
mp - muscles of proboscis
o - ovary
p - penis
ph - pharynx
pr - proboscis
ps - penis stylet
pu - purple cells
s- sensory hairs
sb - seminal bursa
sp - sperm
st - statocyst
su - sucker
v - seminal vesicle
vd - vas deference
y - yolk gland

Plate 4



1A
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sensory hairs set in a thin area of epidermis and not on papillae. The worms from the Eel Pond should be good class material: they are large (up to 4 mm long), can be reared in the laboratory, and regenerate readily. When kept in Syracuse dishes and fed small bits of annelid worms, they laid eggs which developed in about one week into small worms, like the adults except for undeveloped reproductive structures.

Order Tricladida

Although marine triclads are in general uncommon, Woods Hole has several species. Bdelloura spp. (fig. 13) and Syncoelidium (fig. 14) are very easily found as commensals on the gill-books and around the leg bases of Limulus. The following annotated list may aid in the identification of the more common local triclads (figure references are to Plate 4):

Bdelloura candida (Girard, 1850). Abundant on Limulus; the name is usually applied to any Bdelloura collected, although another species is also present. B. candida reaches a length of 15 mm, and has 60-100 testicular sacs on each side of body.

Bdelloura propinqua Wheeler, 1894. This is described by William Morton Wheeler in his paper on Syncoelidium. B. propinqua reaches a length of 8 mm, and has about 170 testicular sacs on each side.

Syncoelidium pellucidum Wheeler, 1894. Also found on Limulus but much less numerous than Bdelloura spp. Length 3 mm with about 15 testicular sacs on each side. The distinguishing feature of Syncoelidium is the fusion of the two posterior branches of the gut, and the lack of a distinct posterior sucker.

Procerodes wheatlandi (Girard, 1850) is considered by Hyman (1944) "to be at best a geographic variant of P. littoralis" (Ström, 1768) which extends from Newfoundland to Scandinavia. P. littoralis in turn may or may not be conspecific with Procerodes (Gunda) ulvae, which tolerates low and variable salinities and is well known as an experimental animal in European studies of osmoregulation. It is reported to be a small (5 mm long) dark animal with a pair of anterolateral tentacles and 2 eyes (fig. 15).

Order Polycladida

Several species of polyclads are common at Woods Hole, and others occur less frequently. The key that follows is restricted to the commoner forms plus a couple that were easily included; consult the annotated list for forms that do not "key out" readily. Polyclads are in some cases very difficult to identify alive, and well cleared whole mounts or even sagittal sections are needed for serious work. In the key, only superficially visible chacteristics are employed; while this facilitates an approximation to an identification, anyone doing experimental work on polyclads should be sure to fix material for determination by a qualified systematist before publication.

For fixation, Hyman recommends hot seawater saturated with mercuric chloride, followed by thorough washing, dehydration in alcohol, and clearing in oil of wintergreen. (For details consult Bull. Amer. Mus. Nat. Hist., 100: 269 et seq.)

KEY TO SOME OF THE POLYCLADS OF WOODS HOLE

(Figure references on polyclads are to Plate 5)

1. Tentacles absent 7
1. Tentacles present (either "marginal" at front edge, or arising dorsally near the brain) 2

2. Tentacles formed by upfolded anterior margin; thin undulated margin; tentacles brownish on pale flesh colored ground; body 10-12 mm long (fig. 1) . . . . Prostheceraeus maculosus
2. Tentacles dorsal, in region of brain (not always obvious when one looks directly down on living animal (figs. 2-4) 3

3. Marginal eyes present on edge of body in addition to more centrally placed eyes 4
3. Marginal eyes absent (but others may be present) 5

4. Body somewhat elongated, with distinct pattern of white or yellowish and brown cross-bars . . . . Stylochus zebra
4. Body broadly elliptical, of various shades of cream, yellow, gray, or brown (figs. 3, 4) . . . . Stylochus ellipticus

5. Body oval, tentacles do not contain scattered eyes 6
5. Body elongated, widened anteriorly, pointed posteriorly; 6-8 mm long; tentacles contain scattered eyes (fig. 2); body yellowish to pellucid with brownish spots . . . . . Gnesioceros floridana

6. Generally found in mantle cavity of Busycon; color white . . . . Hoploplana inquilina
6. Occasionally drifts in on Sargassum weed; color pattern of white reticulation on a brown ground . . . . Hoploplana grubei

7. Body yellowish to gray-brown; 8-12 mm long; slender, resembling a fresh-water planarian; eyes near brain, typically 4-5 on each side in a lengthwise row, and 2 set closely together a little to rear of each row (fig. 5) . . . . Euplana gracilis
7. Eyes in 4 conspicuous clusters in area of brain (fig. 6); to be expected only north of the Cape . . . . Notoplana atomata

ANNOTATED LIST OF POLYCLADS OF THE WOODS HOLE REGION

Acerotisa baiae Hyman, 1940. Taken (Goodchild) at Lagoon Pond bridge (Hyman, 1952). The genus Acerotisa lacks tentacles and has 2 eye clusters. A. baiae is small (3 mm), translucent whitish. Not in key.

Acerotisa notulata (Bosc, 1801). A minute species that might occasionally drift into Woods Hole on Sargassum (Hyman, 1952). Not in key.

Coronadena mutabilis (Verrill, 1873). A rare southern form; status at Woods Hole uncertain. C. mutabilis lacks tentacles and has marginal eyes around anterior half of body; gray to yellowish brown; 18 by 5 mm. Not in key.

Euplana gracilis (Girard, 1850). Reported abundant in Eel Pond and among masses of sponges and hydroids on pilings.

Eurylepta maculosa, see Prostheceraeus maculosus.

Gnesioceros floridana (Pearse, 1938). A southern species, but recorded from eel grass in Woods Hole and Quissett Harbors, also on sandy bottoms at 8-10 meters (Hyman, 1939, 1940). There has been confusion about the name; it was once wrongly referred to Imogine oculifera, and in Hyman's good description (1939) it is called Gnesioceros verrilli.

Gnesioceros sargassicola (Mertens, 1833). Has been taken from Sargassum in Vineyard Sound (Hyman, 1939). Color pellucid with brownish spots; shape characteristic of genus, widened anteriorly, tapering to a pointed posterior end.

Gnesiceros verrilli, see G. floridana.

Hoploplana grubei (Graff, 1892). Has been collected (Hadley) from Sargassum in Vineyard Sound (Hyman, 1939).

Hoploplana inquilina (Wheeler, 1894). Described by William Morton Wheeler as Planocera inquilina, under which name its embryology was described by Surface in a well known study. Occurs locally in the mantle cavity of Busycon canaliculatum but further south has been reported from Thais and Urosalpinx (Hyman, 1944).

Imogine oculifera, see Gnesioceros floridana.

"Leptoplana", used by E. B. Wilson (1894) in an often cited cell lineage study, is not a Woods Hole flatworm, but an unidentified species from Puget Sound, whose actual genus cannot be determined.

Leptoplana variabilis, see Notoplana atomata.

Notoplana atomata (O. F. Müller, 1776). Hyman (1939) calls this the commonest polyclad of the North Atlantic shores, from northern Massachusetts to Scandinavia, but there is doubt that it extends south into inshore waters of Woods Hole. It has been reported from Nantucket.

Planocera elliptica, see Stylochus ellipticus.

Planocera inquilina, see Hoploplana ellipticus.

Planocera nebulosa; considered by Hyman (1944) a synonym of Stylochus ellipticus. P. nebulosa was used in the Invertebrate Zoology Course Keys during the 1940's to refer to a greenish polyclad without marginal eyes, apparently following the usage in Pratt's Manual (p. 188). Verrill (1892, p. 472) points out that"P. nebulosa" has eyes that are difficult to see in the deeply colored living animals. It is probably a color variant of S. ellipticus.

Prosthecereaus maculosus (Verrill, 1892). Reported "in some abundance" on pilings of Lagoon Pond bridge (Hyman, 1952). This has been known as Eurylepta maculosa up until 1952, when an anatomical restudy by Hyman necessitated its transfer to Prosthecereaus.

Stylochus ellipticus (Girard, 1850). Under stones in shallow water and in tide pools. Feeds on oysters and barnacles (Hyman, 1940).

Stylochus zebra (Verrill, 1882). Easily recognized by color pattern. Usually collected from shells of Busycon occupied by the large hermit crab Pagurus pollicarus, but also found free living on rocks and pilings.

REFERENCES ON WOODS HOLE TURBELLARIA

Bresslau, E., 1933. Turbellaria, in Kukenthal and Krumbach (eds.) Handbuch der Zoologie , vol. II, Pt. 1.(Very complete general account with bibliography and most complete outline available of classification, including lists of genera).

Costello, D. P., et al., 1957. Methods of Obtaining and Handling Marine Eggs and Embryos , MBL, Woods Hole (for Polychoerus and Hoploplana embryology and references).

Graff, L. von. 1882. Monographie der Turbellarian I. Rhabdocoelida - 2 vols. Leipzig. (Many changes have made this classification out of date but the second volume of plates is worth looking over).

Graff, L. von, 1911. Acoela, Rhabdocoela and Allocoela des Ostens der Vereinigten Staaten von Amerika. Arbeiten aus den Zoologischen Institut zu Graz. IX Band, no. 8: 321-428, 6 pl. (Of interest because of descriptions and drawings of Anaperus, Childia and Woodsholia). Same title, 1911, Z. wiss. Zool., 99: 1-108.

Hyman, L. H., 1939. Some polyclads of the New England coast, especially of the Woods Hole region. Biol. Bull. 76: 127-52.

____________, 1940. The polyclad flatworms of the Atlantic coast of the United States and Canada. Proc. U. S. Nat. Mus. 89: 449-95.

____________, 1944. Marine Turbellaria from the Atlantic coast of North America. Amer. Mus. Novitates, no. 1266: 1-15.

____________, 1951. The Invertebrates, Vol. II. Platyhelminthes and Rhynchocoela. McGraw Hill, N. Y. (The most useful general reference on Turbellaria).

____________, 1952. Further notes on the turbellarian fauna of the Atlantic coast of the United States. Biol. Bull. 103: 195-200.

____________, 1959. Some turbellarians from the coast of California. Amer. Mus. Novitates, no. 1943: 1-17 (Synonymy of Childia).

Meixner, J., 1938. Turbellaria, in Die Tierwelt der Nord- und Ostsee . Leipzig part IV: 1-146. (Mostly on biology and ecology of the turbellaria but includes

an outline of classification which differs from that of Bresslau and has some advantages as a system).
Verrill, A. E., 1892. Marine planarians of New England. Trans. Conn. Acad. Arts & Sci., 8: 459-520, Pl. 40-44.
Wheeler, W. M., 1894. Syncoelidium pellucidum, a new marine triclad. J. Morph., 9: 167-94, Pl. VIII. (Contains also the description of Bdelloura propinqua).

PHYLUM NEMERTEA (RHYNCHOCOELA)

Nemertean worms are almost always easily recognized as such by their soft, elongated, narrow, highly contractile, unsegmented bodies, lacking setae and covered by cilia. A few species are common in the Woods Hole region, but about 30 may occur. The group is excellently discussed in Coe's "Biology of the Nemerteans of the Atlantic Coast of North America" (1943), which anyone making a serious study of the group must have at hand. However, identification by the beginner attempting to use the extensive keys in Coe's work is made difficult by the fact that the division of nemerteans into orders is based in part upon such internal features as the arrangement of muscle layers in the body wall. The general descriptive features below may be useful in deciding the probable order in which to place an unknown specimen. Figure references on nemerteans are to Plate 5.

Class ANOPLA: Mouth posterior to brain; proboscis not armed with stylets.

Order Paleonemertea. In general, paleonemerteans are slender, soft, and extensile, heads somewhat blunt, bodies not much flattened; ocelli and longitudinal cephalic slits are lacking.

Order Heteronemertea. Heads characteristically rather snakelike, with marked lateral slits (figs. 7, 12), but *Parapolia* and *Zygeupolia* are exceptions. A small caudal cirrus (fig. 12) is found in *Cerebratulus*, *Micrura*, and *Zygeupolia*.

Class ENOPLA: Mouth anterior to brain; proboscis armed with one or more stylets (figs. 8-10) except in Bdellonemertea.

Order Hoplonemertea. The stylets are diagnostic (flatten animals cautiously beneath cover slip or between microscope slides and examine by transmitted light).

Order Bdellonemertea. One species, commensal in mantle cavities of bivalve molluscs. Does not much resemble a nemertean, but has a leech-like form with posterior sucker (fig. 11).

KEY TO THE MORE COMMON NEMERTEANS OF THE WOODS HOLE REGION

1. Free-living 3
1. In mantle cavity of bivalves or in egg mass or gills of crabs 2

2. In mantle cavity of bivalves; intestine convoluted and without diverticula; stylet apparatus absent; mouth and proboscis opening united; posterior sucking disk present (fig. 11); uncommon: Order BDELLONEMERTEA . . . . *Malacobdella grossa*
2. Among eggs or gills of crabs; proboscis rudimentary, with no accessory stylets . . . . *Carcinonemertes carcinophila*

3. In marine or brackish waters 4
3. In fresh water; with 4 or 6 ocelli; color reddish or pinkish; length up to 20 mm . . . . *Prostoma rubrum*

4. Generally small worms, with blunt, flattened heads; usually oblique cephalic grooves mark rear corners of head; ocelli usually obvious (4 or numerous); presence of proboscis stylets diagnostic . . . . Order HOPLONEMERTEA 5
(Note: *Prostoma* and *Carcinonemertes*, keyed out above, are also in this order)
4. Not referable to Hoplonemertea 15

5. Ocelli 4, set as corners of a square; small worm, often colorful 6
5. Ocelli otherwise 11

6. Body of slender cylindrical form; of firmer consistency than other nemerteans of similar small size (10-20 mm); color varies; head not demarcated from body; 4 ocelli in a square . . . . *Oerstedia dorsalis*
6. Body of short, flattened form; head demarcated by inconspicuous transverse grooves; 4 large, occasionally fragmented, ocelli; worms small and variously colored. . . . . *Tetrastemma* 7

7. Body usually with more or less conspicuous longitudinal stripes 8
7. Body lacking well defined longitudinal stripes 9

8. Body rather slender, yellow, with 2 broad longitudinal brown stripes . . . . *Tetrastemma elegans*
8. Body short and broad; usually green, with one or 2 longitudinal yellow stripes and 6 green stripes near tip of head . . . . *Tetrastemma vittatum*

9. White or translucent with superficial flecks of white . . *Tetrastemma wilsoni*
9. Yellow, rosy, red, or green 10

10. Pale green or yellowish, head white or cream colored . . . *Tetrastemma candidum*
10. Yellow or rosy, often spotted with brown; with band of dark pigment connecting the 2 ocelli on the same side of the head . . . . *Tetrastemma vermiculus*

11. Ocelli extend posteriorly along lateral nerve cords beyond brain; basis of central stylet cylindrical and sharply truncated or concave at posterior end (fig. 9) . . . . *Zygonemertes virescens*
11. Ocelli do not extend posteriorly beyond brain; basis of central stylet truncate-conical or pear shaped and usually rounded at posterior end 12

12. Only one pair of ocelli, situated near tip of head; color of body orange-red . . . . *Amphiporus bioculatus*
12. Ocelli 6 to 12 on each side of head 13

13. Ocelli in a single row along each side of head (fig. 10); blood vessels bright red, and conspicuous in life; color of body usually pale yellow or rosy . . . . *Amphiporus cruentatus*
13. Ocelli in an irregular double row on each side or scattered 14

14. Epidermis very thick and soft, secreting much viscid mucus when stimulated; movements of body often leech-like . . . . *Amphiporus griseus*
14. Epidermis thin and firm, secreting but little mucus when stimulated; moves by creeping . . . . *Amphiporus ochraceus*

Note: The following dichotomy involves separating the orders PALEONEMERTEA and HETERONEMERTEA. The mouth in both is posterior to brain; proboscis stylets are absent.

15. Not possessing ocelli, or longitudinal cephalic grooves, or caudal cirrus; worms slender and not over 150 mm long . . . . probably Order PALEONEMERTEA 16
15. Any *large* local nemerteans; any nemerteans with deep longitudinal cephalic slits, *or* with a caudal cirrus (but this is often broken off), *or* with ocelli but without stylets . . . . probably Order HETERONEMERTEA 18

16. Bodies filiform (lengths up to 150 mm, diameter up to one mm 17
16. Body much flattened in posterior region (width 2-5 mm); head changeable in shape, broader than adjacent body, flat, rounded or emarginate anteriorly; color pale reddish or yellowish . . . . Carinoma tremephoros

17. Very slender, filiform body; head broad; mature worms up to 25 mm long; color whitish; forms delicate mucoid tubes . . . . Tubulanus pellucidus
17. Very slender, filiform body; head long, pointed; mouth far back of brain; length up to 100 mm; characteristically coils body into a close spiral . . . . Procephalothrix spiralis

(Note: A worm of similar appearance, but not tending to contract into a spiral, is Cephalothrix linearis, not reported south of Cape Cod).

18. Without longitudinal cephalic grooves 19
18. With longitudinal cephalic grooves 20

19. Caudal cirrus present; head narrow, without oblique cephalic grooves . . . . Zygeupolia rubens
19. Caudal cirrus absent; head broad; with oblique cephalic grooves . . . . Parapolia aurantiaca

20. Caudal cirrus absent; body long and slender, filiform in some species, rounded or flattened in others, very contractile; ocelli present in most species . . . . Lineus 21
20. Caudal cirrus present; body not very slender, ocelli present or absent 23

21. With conspicuous median dorsal stripe, but without transverse markings; reddish brown or olive, with median dorsal stripe of white or yellow extending whole length of body and head (fig. 7) . . . . Lineus bicolor
21. Without conspicuous median dorsal stripe 22

22. Head rather broad, cephalic grooves short; body contracts by shortening and thickening -- not by coiling in spiral . . . . Lineus ruber
22. Head narrow, cephalic grooves long; body contracts by coiling in spiral . . . . Lineus socialis

23. Body firm, long and ribbon-like, sometimes very large; much flattened in intestinal region, with thin lateral margins and well adapted for swimming; body less contractile than in other genera; mouth large and elongated, ocelli absent (fig. 12) . . . . Cerebratulus lacteus
23. Body slender, flattened in intestinal region, but with lateral margins not thin; incapable of swimming; mouth small and round; ocelli present or absent . . . . Micrura 24

24. Head with a row of 4-6 ocelli on each side . . . . Micrura affinis
24. Head without ocelli 25

25. Color of body red or reddish 26
25. Color of body whitish or pale yellowish; may show a tinge of red or orange anteriorly . . . . Micrura albida

26. Deep red or purplish red; common . . . . Micrura leidyi
26. Pale red, yellowish-red, or brownish-red . . . . Micrura caeca

ANNOTATED LIST OF NEMERTEANS

CLASS ANOPLA

Order Paleonemertea

Carinoma tremaphoros Thompson, 1900. Common in sand, clay, mud, or under stones.
Cephalothrix linearis (Rathke, 1799). Not reported south of Cape Cod.
Procephalothrix spiralis (Coe, 1930). Common.
Tubulanus pellucidus (Coe, 1895). Not very common.

Order Heteronemertea

Cerebratulus lacteus (Leidy, 1851). The commonest large nemertean; classical embryological material.
Lineus bicolor Verrill, 1892. Common; usually subtidal.
Lineus ruber (O. F. Müller, 1771). Often in low or variable salinity; color varies.
Lineus socialis (Leidy, 1855). Common; often gregarious.
Micrura affinis (Girard, 1853). A northern species; below 10 m off Martha's Vineyard.
Micrura albida Verrill, 1879. Not reported south of Cape Cod.
Micrura caeca Verrill, 1895. Under stones or in sand.
Micrura leidyi (Verrill, 1892). Common in protected bays.
Parapolia aurantiaca Coe, 1895.
Zygeupolia rubens (Coe, 1895). Abundant in sand in bays and estuaries.

CLASS ENOPLA

Order Hoplonemertea

Amphiporus bioculatus McIntosh, 1873. Common, subtidally in Vineyard Sound.
Amphiporus cruentatus Verrill, 1879. Common locally in Woods Hole area.
Amphiporus griseus (Stimpson, 1857). Occasional at Woods Hole.
Amphiporus ochraceus (Verrill, 1873). Common in Woods Hole area.
Carinonemertes carcinophila (Kolliker, 1845).
Oerstedia dorsalis (Abildgaard,1806). Locally abundant, among growth on rocks and pilings.
Ototyphlonemertes pellucida Coe, 1943. A minute form. Not in key. The genus is unique in possessing statocysts.
Prostoma rubrum (Leidy, 1850). In fresh water swamps and ponds. Coe reports a green variety in a cedar swamp near Woods Hole.
Tetrastemma candidum (Müller, 1874). Common.
Tetrastemma elegans (Girard, 1852). Occasional.
Tetrastemma vermiculus (Quatrefages, 1846). Common.
Tetrastemma vittatum Verrill, 1874. Occasional, in protected muddy situations.
Tetrastemma wilsoni Coe, 1943. Among Bryozoa, sponges, etc. on pilings.
Zygonemertes virescens (Verrill, 1879). Common.

Order Bdellonemertea

Malacobdella grossa (O. F. Müller, 1776). In mantle cavity of Mya, Mercenaria, Ostrea and other bivalves. Not common around Woods Hole. M. obesa and M. mercenaria of Verrill are synonyms.

REFERENCES

Coe, W. R., 1943. Biology of the Nemerteans of the Atlantic Coast of North America. Trans. Conn. Acad. Arts & Sci., 35: 129-328.
Verrill, A. E., 1892. The marine nemerteans of New England and adjacent waters. Trans. Conn. Acad. Arts & Sci., 8: 328-456, pl. 33-39.
McCaul, W. E., 1963. Rhynchocoela: Nemerteans from marine and estuarine waters of Virginia. J. Elisha Mitchell Sci. Soc., 79: 111-124.

Plate 5

VARIOUS UNSEGMENTED WORMS

Polycladida (figs. 1-6), Nemertea (figs. 7-12), Sipunculoidea (figs. 13, 14), Nematomorpha (figs. 15-18). Figs. 11, 12, 15 by Mrs. Emily Reid; figs. 13, 14, 16-18 by Bruce Shearer. Scales various.

Fig. 1. Prostheceraeus maculosus, outline to show marginal tentacles; note cerebral and tentacular eyes.

2. Gnesioceros floridana, simplified after Hyman (1939) to show body outline, cerebral and tentacular eyes.

3. Stylochus ellipticus, simplified, showing tentacles and eyes.

4. Stylochus ellipticus, viewed from side to show dorsal tentacles, and marginal, tentacular, and cerebral eyes.

5. Euplana gracilis, from life, showing pattern of cerebral and "tentacular" eyes. Note that actual tentacles are absent.

6. Notoplana atomata, outline of body and pattern of eyes, simplified after Hyman (1939).

7. Lineus bicolor (Heteronemertea), head in dorsal view, from life, showing left cephalic slit and eyes.

8. Amphiporus ochraceus (Hoplonemertea), proboscis stylets as seen in a worm flattened on a slide; central stylet on pear shaped basis and accessory stylets in 2 lateral pouches. Drawn from a photo taken by Dr. W. E. McCaul.

9. Zygonemertes virescens, head of older animal with many eyes, stylet with truncated basis. After Coe.

10. Amphiporus cruentatus, head and stylet. After Coe.

11. Malacobdella grossa. After Verrill.

12. Cerebratulus lacteus (Heteronemertea), whole animal with head in ventral view, showing mouth, left cephalic slit, proboscis pore anteriorly, and caudal cirrus. After Verrill.

13. Golfingia gouldi, from life; one with extended introvert showing tentacles, other with introvert withdrawn; about half natural size.

14. Phascolion strombi, with extended introvert; much enlarged (scale bar equals one mm).

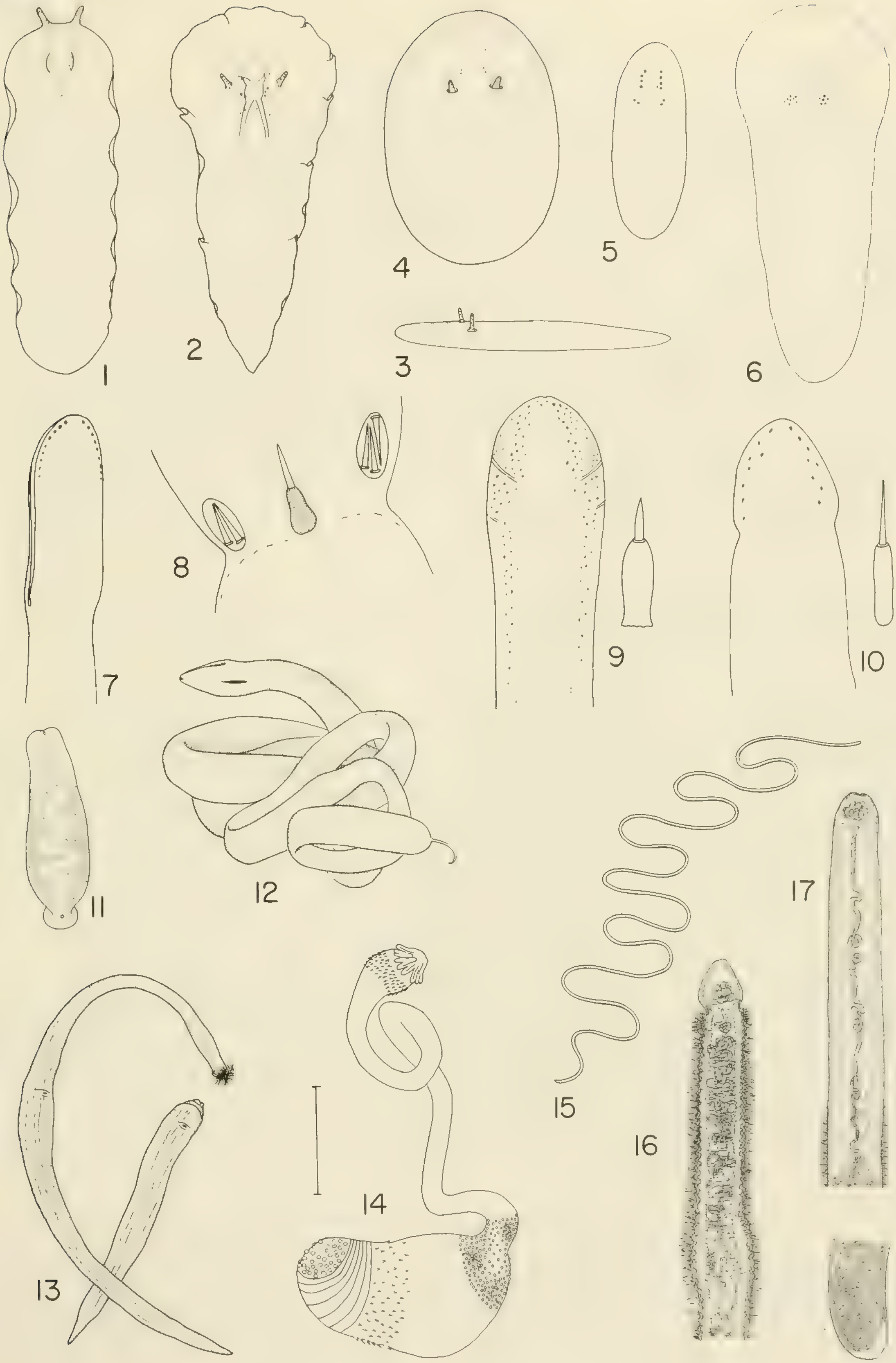
15. Nectonema agilis, impression of the worm as seen swimming. About natural size.

16. Nectonema agilis, anterior end of living specimen much contracted after shedding eggs. Note 2 rows of natatory bristles.

17. Nectonema agilis, anterior end of relaxed, living specimen, prior to shedding of eggs.

18. Nectonema agilis, posterior end of the above specimen.

Plate 5



OTHER UNSEGMENTED WORMS

1. PHYLUM ASCHELMINTHES

Here are included a number of classes (sometimes regarded as phyla) of pseudocoelomate types, most of which are either absent from the local marine fauna (Priapulida) or of such small size, diversity, and great number of species as to make their inclusion in these keys impractical (Rotifera, Gastrotricha, Kinorhyncha, Nematoda). The best general reference on aschelminth groups, and the first source of information when one encounters an unfamiliar member of them, is Hyman's "The Invertebrates", Vol. III: "Acanthocephala, Aschelminthes, and Entoprocta", 1951.

The remaining class, Nematomorpha or Gordiacea, has one marine order, Nectonematoidea, represented by the single genus *Nectonema*. *N. agilis* Verrill, 1879 can be taken at a night light near the breakwater at the U. S. Fish and Wildlife laboratory in Woods Hole. It resembles a whitish "horsehair snake" provided with a double row of fine natatory bristles (Plate 5, figs. 15-18) with a body up to one mm in diameter and 20 cm long, and swims with a remarkable rapid, undulatory motion. The young stages are reported to be parasitic in several species of true crabs and hermit crabs on the coast of France, but the life cycle at Woods Hole has never been observed. Hyman (*loc. cit*) provides the most helpful general account of *Nectonema*.

2. PHYLUM SIPUNCULOIDEA

The unsegmented wormlike creatures formerly lumped as "Gephyreans" include three groups now commonly accorded phylum status: Priapulida, Sipunculoidea, and Echiuroidea (the last, however, is again joined to the annelids by Hyman). At Woods Hole, only the Sipunculoidea are represented, intertidally and in shallow water, by *Golfingia gouldi* (Pourtalès, 1851) (Plate 5, fig. 13), and by *Phascolion strombi* (Montagu, 1804) (fig. 14), a very small worm from 10 meters and deeper off the Elizabeth Islands near Woods Hole, living in deserted gastropod shells or in tubes of *Hydroides*, *Pectinaria*, *Hyalinoecia*, or other worms.

Golfingia gouldi has long been known as *Phascolosoma gouldi* and since there is no question about the species, experimental biologists should be careful to use the specific name to avoid confusion with certain common sipunculids to which the generic name *Phascolosoma* has now been transferred (e.g. *Phascolosoma agassizi*, formerly *Physcosoma*, of the West Coast, a species far less euryhaline than the Woods Hole *Golfingia gouldi*). The reasons for the unfortunate shift of names are, in brief: *Phascolosoma* was established as a genus in 1828 by Leuckhart, with type species *Phascolosoma granulatum* of the Mediterranean. Later, in 1866, Quatrefages broke Leuckhart's genus into subgenera and used *P. granulatum* as the type of a new subgenus *Phymosomum*. This was amended to *Phymosoma* by Salenka, and raised to generic rank in 1883. *Phymosoma*, being found preoccupied, was changed in 1897 to *Physcosoma*. This whole procedure was in clear violation of nomenclatorial rules, according to which the type species of *Phascolosoma* should have retained its name. In 1952, Fisher put *Physcosoma* back into its proper category of *Phascolosoma*, but this left the group long known as *Phascolosoma* without a name. The "next available" name for *Phascolosoma gouldi* was *Golfingia*, and this solution seems to have been generally accepted.

REFERENCES ON SIPUNCULIDS

Fisher, W. K., 1952. The Sipunculid Worms of California ... , Proc. U. S. Nat. Mus., 102: 371-450.

Gerould, J. M., 1913. The sipunculids of the eastern coast of North America. Proc. U. S. Nat. Mus., 44: 373-437.

PHYLUM ANNELIDA

The Annelida or segmented worms have, as a phylum, shown remarkable evolutionary success in adapting to the marine, fresh water, and terrestrial habitats. Among the classes of Annelida, the Polychaeta are the typical marine representatives, although members of the other classes are to be found as well.

Class Hirudinea (Leeches)

Leeches are far less common in the sea than in fresh water, except for one family, Ichthyobdellidae. In the Woods Hole region the following may be encountered attached to fishes; the group, however, needs restudy in this area:

Branchellion raveneli (Girard, 1851). On the sting ray, *Myliobatis fremmviller*. Easily recognized by the leaflike gills along the sides of its body.
Ichthyobdella funduli Verrill, 1872. Reported on *Fundulus heteroclitus*. Body smooth, annulated, greenish; 2 large and 2 small eyes.
Ichthyobdella rapax (Verrill, 1873). On the summer flounder, *Paralichthys dentatus*. Body in extension long, slender, rounded, 3-4 cm, long, dark olive with row of rectangular white spots along each side.
Trachelobdella vividus (Verrill, 1872). Body with two distinct regions; narrow anteriorly and wide posteriorly; brown to purplish; about 2.5 cm long. On skates and rays; apparently not common.

Reference: Knight-Jones, E. W., 1962. The systematics of marine leeches. App. B. *in* "Leeches (Hirudinea) Their Structure, Physiology, etc.", K. H. Mann, Pergamon Press.

Class Oligochaeta

Oligochaete annelids are characteristically fresh water or terrestrial; however there are some 10 species reported from marine or brackish waters of the New England coast, and some are very commonly encountered in shore collecting in the region of Woods Hole. Identification requires study of the internal anatomy, and no key is at present available other than that given by Moore:

Moore, J. P., 1905. Some marine Oligochaeta of New England. Proc. Acad. Nat. Sci. Phila., 57: 373-399, pl. 32-33.

Class Archiannelida

Archiannelids have, as the name implies, been regarded as possibly primitive forms, although many zoologists now prefer to regard them as secondarily simplified and very small derivatives of various polychaete families. They are characteristically tiny marine worms, in sand, mud, or among algae, with few setae, parapodia reduced or lacking, and often with external ciliation persisting in the adult. Because of their very small size, archiannelids may be more common than is generally supposed; however, only one species of *Dinophilus* is collected regularly at Woods Hole. The morphology of *Dinophilus* (although not of a species reported from Woods Hole) is described by Nelson (1907).

The species of archiannelids reported from the Woods Hole region include:

Dinophilus gardineri A. Moore, 1899. Reddish in color; 6 segments; body with ciliated rings but with no setae; occurs in brackish water such as Lillie's Ditch and the Eel Pond at Woods Hole. Figure 49 (Plate 8) is probably of this species.
Dinophilus pygmaeus Verrill, 1892. Described as whitish, of 5 body segments, about 0.7 mm long, and occurring on pilings at Woods Hole.
Chaetogordius canaliculatus J. P. Moore, 1904. Slender, filiform, 30 mm long, with a pair of small tentacles; posterior 10-12 segments with setae.

REFERENCE

Nelson, A. J., 1907. The morphology of Dinophilus conklini n. sp. Proc. Acad. Nat. Sci. Phila., 59: 82-143, Pl. 12-13.

Class Polychaeta

Polychaetes of the Woods Hole area are extremely numerous and diverse. Their treatment in a key is rendered difficult by the fact that, although the polychaetes can be divided into a large number of families, there is no real agreement as to how these families may be grouped into orders. The concept of a Family in the Polychaeta is important and practical for the student to grasp, for the reason that the basic structural features that determine a family also determine a way of life. With a little practice, most families may be readily recognized on sight, and many problems of keying are thus reduced to the level of genera and species, where even the specialist may have to make a close examination. The problem of identifying certain families is simplified by attention to the very characteristic tubes formed by some.

There is still no completed monograph of the polychaetes of the Woods Hole region, but this need will be met by the publication of Pettibone's "Marine Polychaete Worms of the New England Region", of which Part 2 is now in preparation. Until this appears, the most useful complete work is the two volumes by Fauvel; these deal with the polychaetes of France, but are exceedingly useful in identifying families and genera, as well as some of our local species. There also exist Dr. Pettibone's mimeographed preliminary check list and key to Polychaeta of New England; copies of this are available in the invertebrate class laboratory, and should be consulted for forms which do not clearly "fit" in the simpler key presented below for general use. This key is not intended to satisfy the specialist, but rather to bridge the gap between the general biologist and the polychaete systematist. It will probably satisfy neither group, and as a result of this irritation, it is hoped that improved versions will arise.

Much remains to be learned. Polychaete families are of convenient dimensions for individual student projects, and offer much of interest to the comparative physiologist and ecologist. The following key is frankly a preliminary attempt, and will need much revision in the future. We are grateful to Dr. Marian Pettibone for much help and advice in the preparation of the key and check list.

A Note on Polychaete Terminology

There is no generally accepted scheme for dividing the Polychaeta into orders. One method has been to recognize one order of more or less sedentary forms (Polychaeta Sedentaria) and another of free living types (Polychaeta Errantia). Actually, such a division is arbitrary, since the families of polychaetes present a spectrum of adaptions, ranging from free swimming types, through crawlers, burrowers and temporary tube builders, to those which construct fixed tubes which they never leave. In practice it is more useful to recognize the principal family types, such as nereid, polynoid, spionid, syllid, sabellid, serpulid, etc.

A typical free living polychaete such as Nereis (which will serve as an example, although members of other families differ greatly in detail) has paired locomotor appendages or parapodia (sing., parapodium) (Pl. 7 , figs. 12-15), each composed of an upper lobe, the notopodium, and a lower, neuropodium. Each lobe typically contains a bundle of slender chitinous setae (sing. seta) which project from the parapodium, together with a larger dark spine known as the aciculum (pl . acicula). The shape, size, number, and position of the setae are of importance in classification. Arising from the base of the notopodium above and the neuropodium below, there are often slender flexible outgrowths, the dorsal cirrus (pl. cirri) and ventral cirrus, respectively. The notopodium consists of a dorsal lobe or ligule and a middle lobe, between which are the aciculum and the setae; the neuropodium consists of a neuroacicular lobe provided with setae and an aciculum, and a ventral lobe. In many polychaetes, gills or branchiae, made conspicuous by the red or green blood within, arise from or near the parapodia in certain parts of the body.

Setae vary widely in form, and furnish very precise characters for the determination of species. The use of such characters has been avoided where possible in the key but is necessary in some cases. Common types and their names should be recognized. Plate 6 gives some idea of the wide variety of types. First we may distinguish simple setae (figs. 1-20, 29-42) from composite or jointed setae (figs. 21-28). Long slender simple setae are spoken of as capillary setae (fig. 6). The tips of setae, whether simple or composite, may be entire, bifid (fig. 8), or trifid. If bent like a sickle they are termed falcate (fig. 11); if flattened like an oar blade, limbate (fig. 10). Some simple setae have stubby, bent, usually bifid ends. These are spoken of as hooks or crochets (figs. 29-32). These are usually relatively stout setae and grade into short, broadened types known as uncini (figs. 33-42), usually set in close rows, which are especially characteristic of the Sedentaria.

Composite setae may be multiarticulate, as in the long bristles of some flabelligerids (fig. 21), but are characteristically two-jointed, composed of a shaft and a blade (figs. 22-28). This blade in turn may have various shapes and may itself be a crochet (fig. 28). The blade rests in a notch in the end of the shaft. If the two sides of the notch are equal, it is spoken of as homogomph (fig. 27); if unequal, as heterogomph (fig. 26). Finally setae, either simple or compound, may be embedded at their tips in a clear matrix and are then spoken of as hooded. Thus, we may have simple hooded crochets (figs. 20, 29), or composite hooded crochets (fig. 28).

The heads of polychaetes are exceedingly diverse. As an example of the head of an errant polychaete we may take the head of Nereis (Plate 7 , figs. 8-11). This consists of a preoral prostomium, provided at its anterior margin with a pair of small antennae, and at its sides with paired, fleshy, biarticulated palps (palpi). The segment just behind the prostomium is the peristomium (in Nereis it represents a fusion of two segments). It bears, in Nereis, four pairs of peristomial cirri (tentacular cirri) on short stalks at its anterior margin. The usage of the terms palp, antenna , and cirrus varies greatly. Antennae, unless otherwise specified, are usually dorsal or marginal on the prostomium (the term tentacle may also be used). Palpi are usually associated with the mouth and tend to be lateral or ventral to the prostomium and bordering the anterior margin of the mouth. However, certain dorsal structures, especially if these are large, elongated, grooved, or prehensile (as in the spionids) are frequently called palps. The term cirrus is usually applied to structures arising dorsally or ventrally on the parapodia, whereas comparable structures on the anterior part of the body, if elongated, may be designated tentacular cirri (or peristomial tentacles). Tentacle is a very general term and is used to signify any of a variety of elongated sensory or feeding structures, usually on the head.

The prostomium of Nereis bears two pairs of eyes; other polychaetes may have one pair or none, and in some there are numerous eyespots scattered on the peristomium or even on the tentacles or sides of the body.

The first parapodia of Nereis are borne on the segment behind the peristomium. The first two pairs of parapodia are uniramous, that is, each contains a single aciculum and setal fascicle (bundle). All succeeding parapodia are biramous. In other polychaetes the parapodia vary, some having only uniramous, others only biramous parapodia, some with both types, some with parapodia greatly reduced.

In most free living polychaetes the pharyngeal region may be everted (pushed forward and turned inside out) to form a proboscis, which often bears stout jaws and small horny teeth (paragnaths). A study of the arrangement of paragnaths is a necessary step in the identification of nereids; in other families the pattern is less complex, but may be referred to.

The sedentary polychaetes depart widely from the body form which characterizes free living types. Prostomium and eyes are often reduced, proboscis and jaws may be absent, and the anterior end, especially in types dwelling in fixed tubes, greatly elaborated for feeding and respiration. In sabellids and serpulids the peristomial cirri (or tentacles) form a "branchial crown" of feather-like "gills", which serves both for feeding and respiration. Cilia pass water between the branches of the plumes and transport food, entangled in mucus, down to the mouth. In other forms such as terebellids, the peristomial tentacles are long, filamentous, and extensile, serving to bring in food by ciliary action in a groove running along each filament; just behind the head there arise blood-filled branchiae which serve in respiration. Parapodia in tubicolous (tube dwelling) polychaetes tend to be small and are provided with rows of hooklike setae (uncini) for gripping the sides of the tube. Uncini may be set on a low mound or uncinigerous torus. Special glands may secrete tube-forming material. One or more peristomial cirri may, in serpulids, which form a rigid calcareous tube, be modified to a pluglike operculum that can block the tube entrance. The body in tube dwelling forms is often divisible into a more anterior and specialized thorax and a less specialized posterior abdomen. The thorax may bear anteriorly a collar, and this may be extended rearward to the posterior end of the thorax as a pair of folds, the thoracic membranes. The preceeding accounts are of extreme types, free living and tubiculous respectively, and can convey but a poor idea of the actual diversity of pattern that characterizes the numerous annelid families.

The key that follows begins as a key to separate families, and a study of it will give an impression of the characteristics of each family type. Since the ability to recognize families in the field is of great practical value to the zoologist, the student should early learn the family types commonly encountered. Generic and specific identification requires more careful study. (For setal types see Plate 6; other figure references are to Plates 7-10).

KEY TO COMMONER FAMILIES OF POLYCHAETES

I. Instead of presenting only a pair of choices, this key presents several choices at certain steps. Figure references in Keys are to Plates 7-10.

II. Effective use of this key requires practice. We suggest that the beginner, with the advice of the instructor, run an assortment of well known species through the key step by step, in order to acquaint himself with the terminology. The tendency of beginners to skip steps when the worm at hand is known interferes with learning to use the key.

III. In most families only those species are keyed out which are commonly collected. The student is referred to the more detailed key of Dr. Pettibone for the rarer species, or those in which identification must be based upon more details than given here.

IV. The keys to members of families having more than one common or readily identifiable species will be found under the separate families, together with annotated lists of species reported from this region. No attempt has been made to key out all the rare or deeper water species.

V. Unidentifiable and otherwise "interesting" polychaetes may be sent to Dr. Marian Pettibone, Division of Marine Invertebrates, U. S. National Museum, Washington 25, D. C.

1. Dorsal surface with overlapping scales (elytra, fig. 1), flattened setae (paleae, fig. 22), or overlain by a thick felty layer 2
1. Dorsal surface not with elytra, paleae, or felt 4

(Key continued on page 60)

Plate 6

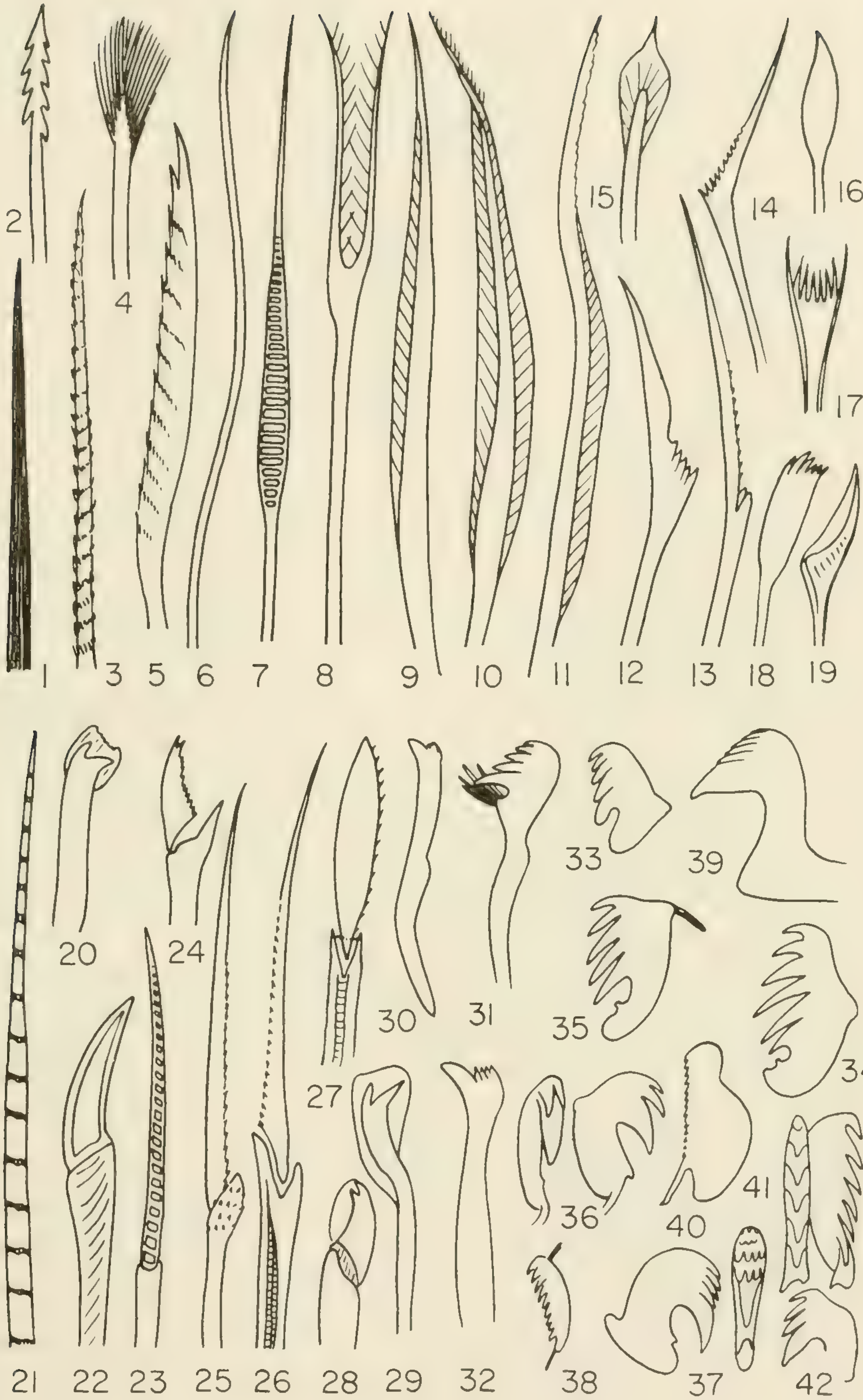


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Plate 7

POLYCHAETA

Polynoidae, Euphrosinidae, Spintheridae, Ampharetidae, Flabelligeridae, Nereidae, Onuphidae, Eunicidae, Scalibregmidae, Dorvilleidae, Spionidae.

Note: In this and in Plates 8, 9, and 10, objects are not to any scale size. Figure sources are: (F) Fauvel, (B) Berkeley and Berkeley, (P) Pettibone, (S) from specimens.

Fig. 1. Lepidonotus squamatus, Polynoidae, showing 12 pairs of elytra (singular is elytron) (S).

2. Head of Harmothoe imbricata (F).

3. Euphrosine borealis, dorsal view of anterior end (P).

4. Spinther citrinus, dorsal view of anterior end (P).

5. Hypaniola grayi, Ampharetidae (S).

6. Anterior end of Polydora sp. (Spionidae), showing modified fifth setiger (after Verrill).

7. Pherusa affinis, Flabelligeridae, anterior end in lateral view (S).

8. Nereis (Neanthes) succinea, head and everted proboscis in dorsal view (S).

9. Platerynereis megalops, proboscis of male in ventral view (S).

10. Nereis (Neanthes) arenaceodonta, proboscis, ventral view (S).

11. Head and proboscis of same, dorsal view (S).

12. Parapodium from posterior part of body of N. succinea (S). In this and figs. 13-15, parapodia are from left side, viewed from front. Acicula are shown in black; omitted in figs. 13-15.

13. Parapodium from mid-body of Nereis (Nereis) pelagica, showing 2 ligules in notopodium (S).

14. Same, from N. (Neanthes) virens, showing 3 ligules in notopodium (S).

15. Same, from N. (Neanthes) arenaceodonta (S).

16. Head of generalized onuphid, showing pair of nuchal tentacles on peristome (P).

17. Eunice pennata, Eunicidae. diagram of head (P).

18. Marphysa sanquinea, same (S).

19. Marphysa belli, same (P).

20. Scalibregma inflatum, Scalibregmidae, same (P).

21. Stauronereis rudolphi, Dorvilleidae (F).

Plate 7

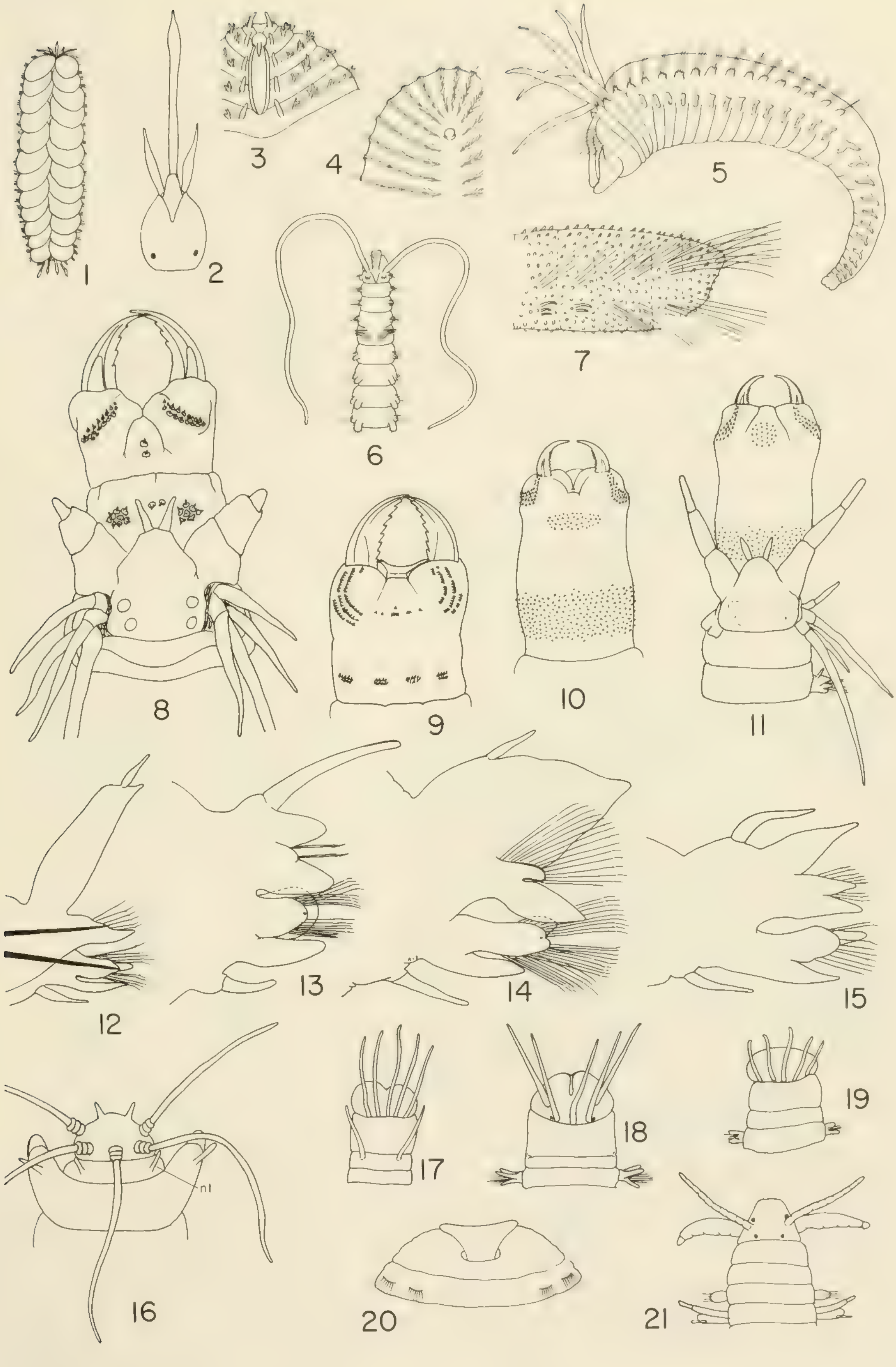

Plate 8

POLYCHAETA AND ARCHIANNELIDA

Chrysopetalidae, Syllidae, Terebellidae, Cirratulidae

Fig. 22. Dysponetus pygmaeus (Chrysopetalidae), dorsal view of whole animal showing dorsal fans of setae (P).

23. Syllis gracilis, head (P).

24. Same, parapodium (F).

25. Same, compound setae.

26. Same, heavy bifurcated simple setae (P).

27. Amblyosyllis formosa (European) to show nuchal epaulettes (F).

28. Odontosyllis fulgurans, head showing nuchal hood (F).

29. Same, armature of proboscis (F).

30. Streptosyllis, diagram of parapodium with knobbed aciculum (P).

31. Eusyllis lamelligera, head (F).

32. Same, armature of proboscis (F).

33. Brania clavata, head (P).

34. Exogone hebes, head (P).

35. Exogone dispar, head (P).

36. Sphaerosyllis erinaceus, head (P).

37. Autolytus prismaticus, head (P).

38. Arborescent (branching) gill of a terebellid (S).

39. A terebellid gill of unbranched filaments (B).

40. Head of adult Nicolea venustula, simplified (P).

41. Head of Pista maculata, simplified (P).

42. Head of Pista cristata, simplified (B).

43. Head of Terebellides stroemi, simplified (B).

44. Gill-like branching parapodium of Enoplobranchus sanguinea (note setae) (P).

45. Dodecaceria coralii, Cirratulidae, whole animal (S).

46. Cirratulus cirratus, anterior end (P).

47. Tharyx, sp., anterior end (F).

48. Chaetozona setosa, head (P).

49. Dinophilus sp., Archiannelida, drawn from life by Dr. Louise Bush.

Plate 8

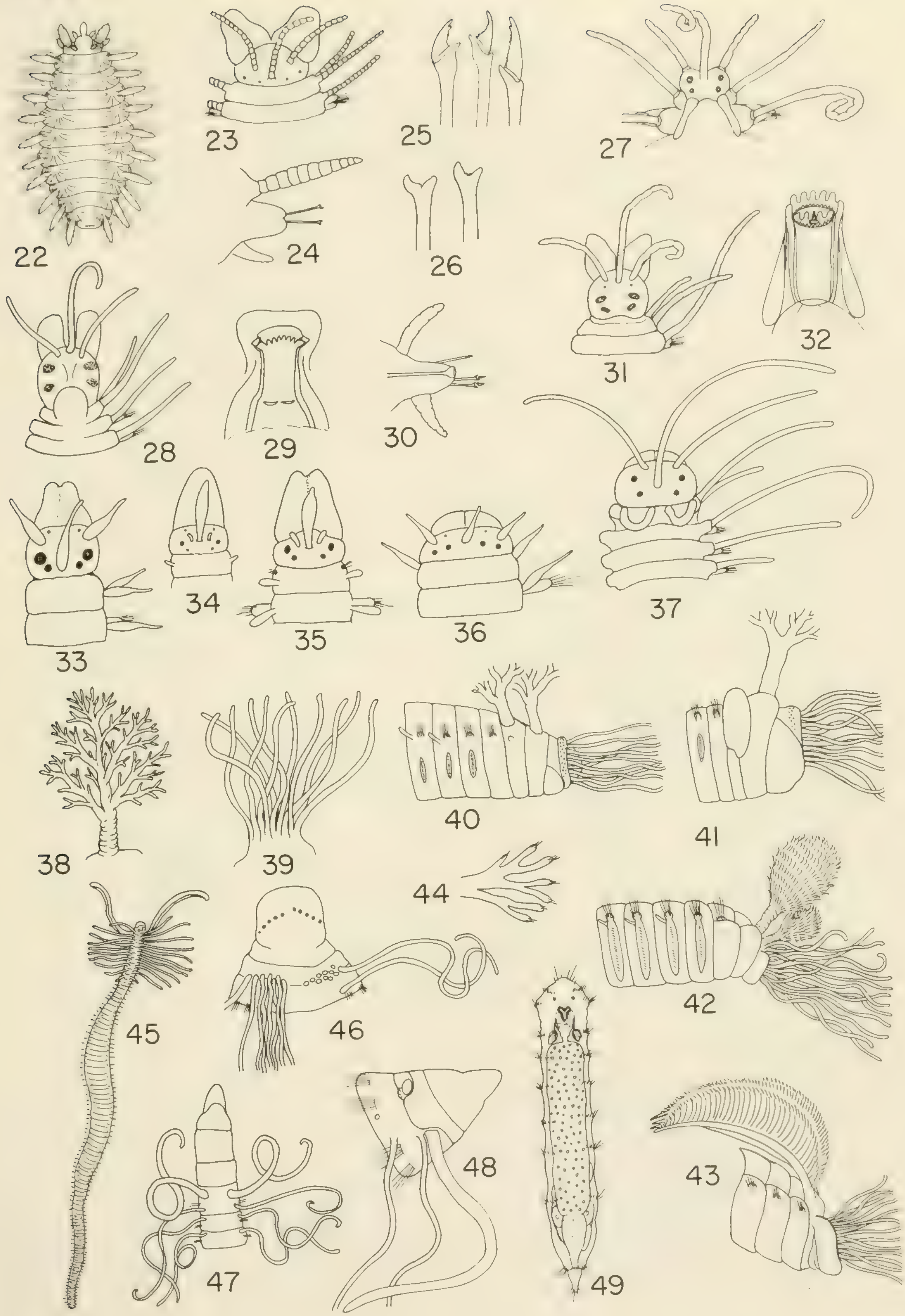
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Plate 9

POLYCHAETA

Sabellidae, Phyllodocidae, Serpulidae, Maldanidae, Hesionidae, Paraonidae

Fig. 50. Fabricia sabella, whole worm, dorsal view (F).

51. Chone infundibuliformis, simplified, anterior end, view of mid-dorsal slit in collar (F).

52. Sabella crassicornis, anterior end viewed from left; note 4-lobed collar (P).

53. Sabella microphthalma, collar region dorsal view; irregular rows of eyes (S).

54. Same, ventral view; note absence of lateral slits (S).

55. Potamilla reniformis, dorsal view of collar region, showing mid-dorsal and lateral notches; "compound eyes" on branchial filaments (S).

56. Eteone sp., anterior end (P).

57. Phyllodoce sp., anterior end (S).

58. Notophyllum americanum, anterior end (P). Note nuchal lappets at rear of prostomium, and large imbricated dorsal cirri.

59. Eulalia viridis, anterior end (P).

60. Eumida sanguinea, anterior end (P).

61. Paranaitis speciosa, anterior end (P).

62. Spirorbis (Dexiospira) spirillum, dextrally coiled tube with end elevated (F).

63. Same, dextral, flat coil (P).

64. Spirorbis (Paradexiospira) violaceus, dextral tube (F).

65. Spirorbis (Laeospira) borealis, sinistral tube (F).

66. Operculum of above (P).

67. Spirorbis (Laeospira) granulatus, sinistral tube (P).

68. Operculum of 67 (P).

69. Operculum of Filograna implexa (P).

70. Operculum of Hydroides (Eupomatus) uncinata (P).

71. Clymenella torquata, anterior end viewed from right, showing collarette on 4th setiger (P).

72. Posterior end of same, showing anal funnel (P).

73. Posterior end of Maldanopsis elongata (P).

74. Posterior end of Maldane sarsi (P).

75. Nephtys incisa, head end (P).

76. Nephtys bucera, head end (P).

77. Aglaophamus circinata, parapodium with branchia curved inwards (P).

78. Nephtys caeca, parapodium from middle region, posterior view, showing branchia curved outward (P).

79. Podarke obscura, head (S).

80. Aricidea jeffreysii, head (B).

Plate 9

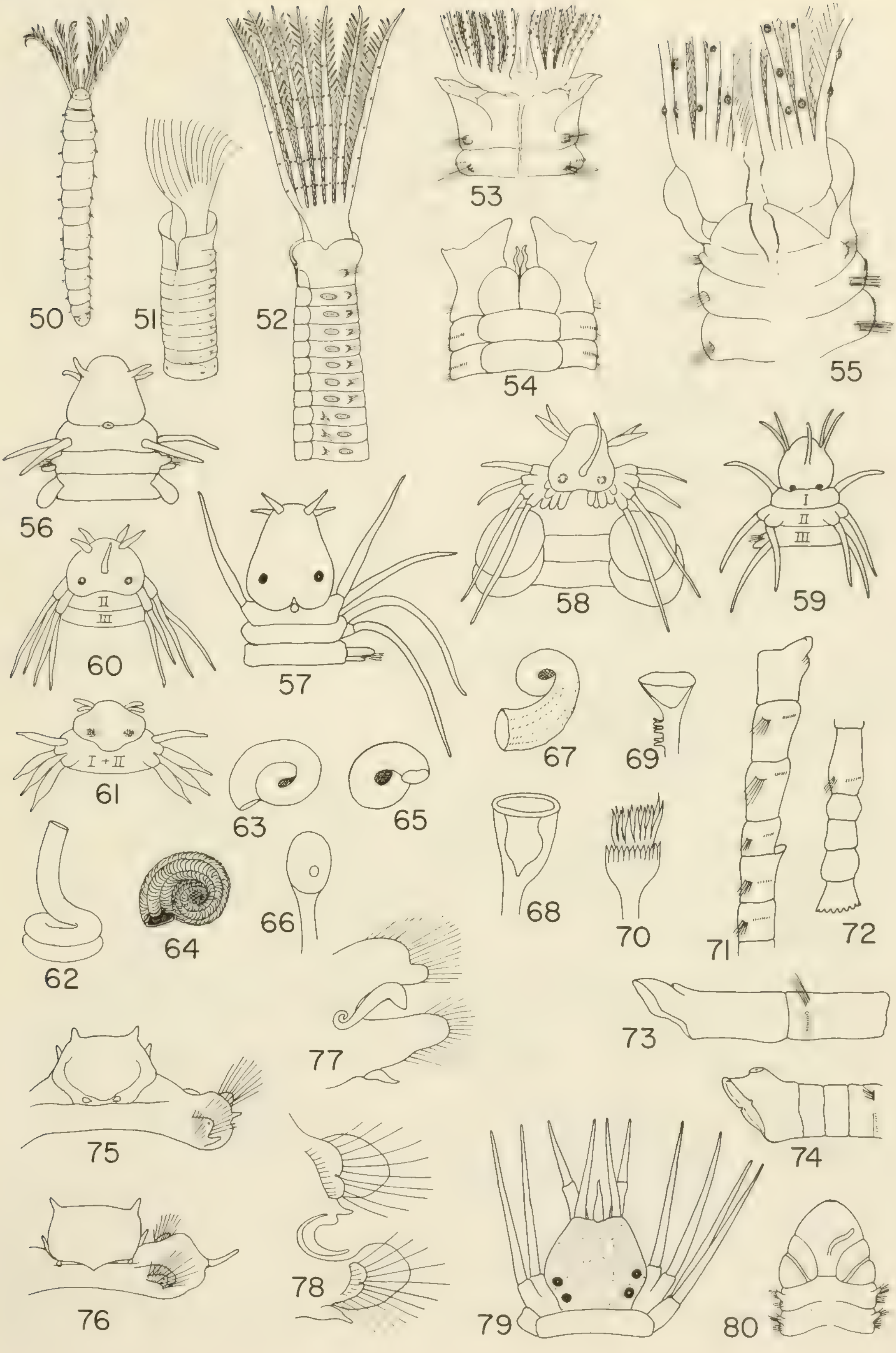
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Plate 10

POLYCHAETA

Spionidae, Goniadidae, Glyceridae, Arabellidae, Lumbrineridae, Orbiniidae, Oweniidae, Pectinariidae, Sabellariidae.

Fig. 81. Polydora ligni, head with occipital antenna (P).

82. Spiophanes bombyx, prostomium (P).

83. Scolecolepides viridis, head (P).

84. Dispio uncinata, head (P).

85. Scolelepis squamata, head (P).

86. Spio filicornis, head (P).

87. Hooded neuropodial crochet of Spio filicornis (P).

88. Goniada maculata, head with extended proboscis, showing chevrons (McIntosh).

89. Glycera capitata, anterior parapodium seen from rear, showing single postsetal lobe (P).

90. Glycera dibranchiata, parapodium seen from rear, showing 2 postsetal lobes and 2 branchiae (P).

91. Glycera americana, parapodium from middle body, seen from rear, showing the branchiae extended (P).

92. Ophioglycera gigantea (Goniadidae), anterior uniramous parapodium seen from front, showing presetal lobe (P).

93. Same, posterior biramous parapodium, seen from front, also with bilobed presetal lobe (P).

94. Lumbrineris fragilis, capillary limbate setae (P).

95. Same, hooded seta (P).

96. Ninoe nigripes, hooded seta (S).

97. Same, branchia bearing parapodium seen from front (P).

98. Lumbrineris acuta, head (P).

99. Lumbrineris tenuis, head (P).

100. L. tenuis, posterior parapodium (P).

101. Arabella iricolor, head (P).

102. Driloneris longa, anterior parapodium (P).

103. Same, posterior parapodium (P).

104. Orbinia ornata, right hand parapodium in thoracic region, seen from rear, showing palisaded neurosetae and postsetal row of papillae (P).

105. Scoloplos robustus, abdominal parapodium, showing undulate subpodial flange (P).

106. Scoloplos fragilis, abdominal parapodium showing incised subpodial lobe (P).

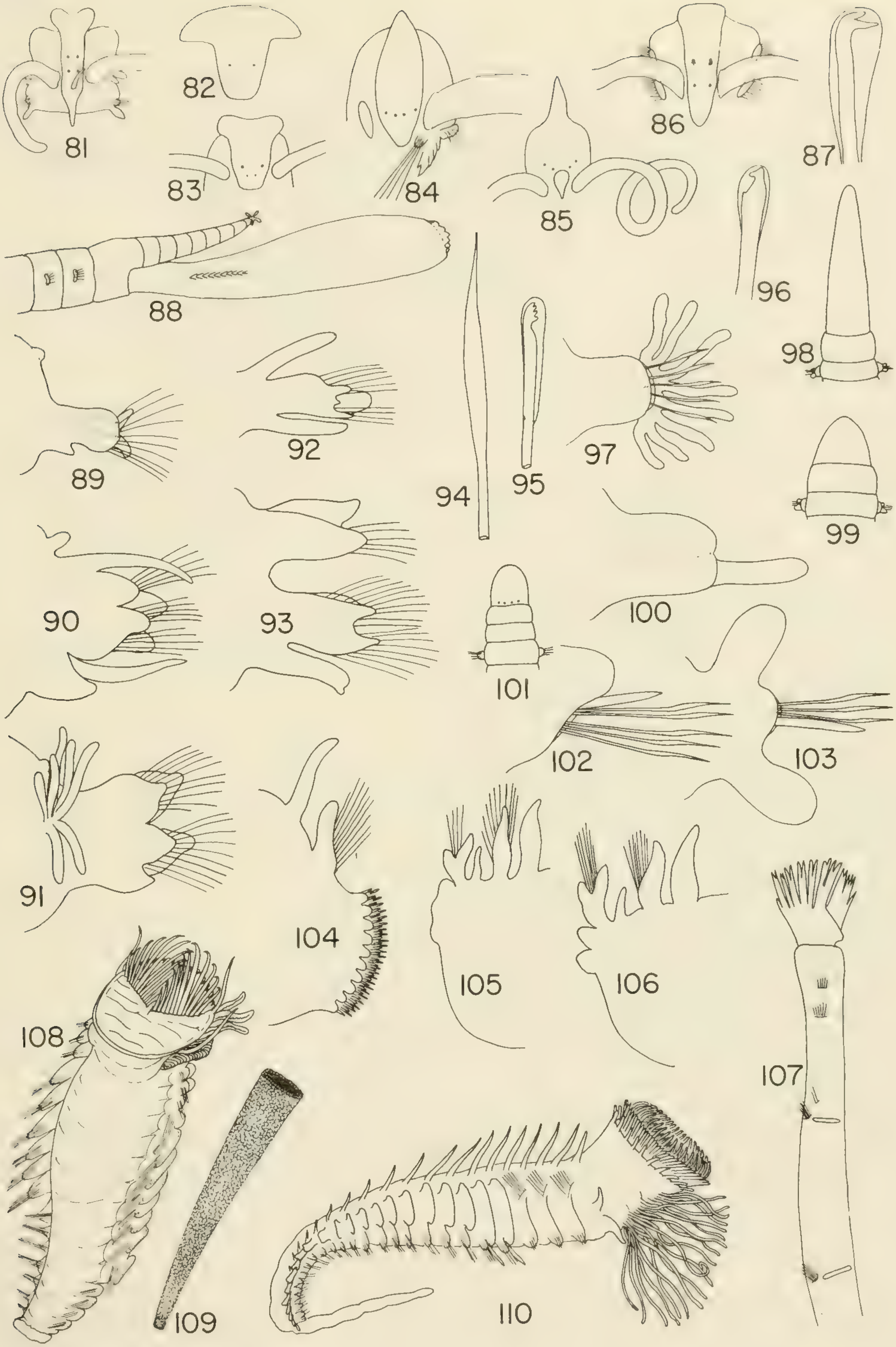
107. Owenia fusiformis, anterior end seen from side, showing slashed branchial membrane (P).

108. Pectinaria gouldii, seen in dorsolateral aspect; note operculum of golden paleae (S).

109. Sand tube of Pectinaria, about natural size (S).

110. Sabellaria vulgaris, living specimen removed from tube (S).

Plate 10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2. Dorsal surface with a felty layer over elytra; "sea mice" . . . . APHRODITIDAE (p.64)
2. Dorsal surface with simple, exposed elytra; "scale worms". 3
2. Dorsal surface more or less concealed by notosetae in fan-shaped groups or transverse rows; minute worms . . . . CHRYSOPETALIDAE
The only species reported locally is Dysponetus pygmaeus Levinsen, 1879; dredged; up to 3 mm long (fig. 22).

3. With filiform dorsal cirri on non-elytra bearing segments . . . . POLYNOIDAE (p.75)
3. Without filiform dorsal cirri on non-elytra bearing segments . . . . SIGALIONIDAE (p. 78)
The only common species is Sthenelais boa, easily told from other common scale worms by its elongated body and 100 or more pairs of scales.

4. Dorsal surface convex, bristly; elongated setigerous dorsal lobes covering the dorsum 5
4. Dorsal surface otherwise 6

5. Notopodium a wide transverse ridge with 2 dorsal cirri and forked notosetae in transverse rows; with a dorsal crestlike "caruncle" on head (fig. 3) . . . . EUPHROSINIDAE (p.67)
With 6-7 branchiae on each notopodium, each with 1-4 branches: Euphrosine borealis.
5. Notopodia with transverse membranous ridges supported by numerous spinelike setae (fig. 4); small, flattened, ellipsoidal . . . . SPINTHERIDAE
The only reported species is Spinther citrinus (Stimpson, 1854), a small dredged form, lemon yellow, resembling in color the sponges with which it is associated.

6. Anterior end bearing conspicuous filaments, or feathery tentacles, or conspicuous bristles, or golden setae (paleae), so that prostomium is usually more or less concealed 7
6. Anterior end with prostomium not concealed by such special outgrowths as may be present 12

7. Anterior tentacles (branchial crown) are pinnate (feather-like); worms almost always form tubes 8
7. Anterior end with flattened golden setae (paleae) forming an operculum (figs. 108, 110); tubes are of cemented sand grains, stiff and brittle 9
7. Anterior end bearing many long filamentous (threadlike) outgrowths; tubes of some are distictive, but lacking in others 10
7. Anterior end somewhat concealed by a cage of long setae directed forward; body heavily papillated . . . . FLABELLIGERIDAE (p. 67)

8. Tubes calcareous; one of tentacles modified to a pluglike stalked operculum . . . . SERPULIDAE (p. 77)
8. Tubes flexible, leathery, parchment-like, sandy, or mucoid (except in the tiny Fabricia); no operculum . . . . SABELLIDAE (p. 76)

9. Tubes of sand, of regular conical form, open at both ends . . . . .PECTINARIIDAE (p.74)
The commonly taken species is Pectinaria gouldii (figs. 109, 110).
9. Tubes of sand, convoluted and solidly cemented onto stones, shells, or into masses; common . . . . SABELLARIIDAE (p. 76)

10. Filamentous outgrowths much concentrated on the head end; the body is divisible into two distinct regions ("thorax" and "abdomen"); branching gills may be present in addition to filaments 11
10. Filamentous outgrowths start back of the head (actual prostomium is bare) and are also borne on several to many segments of the body; never branching gills near anterior end; body not divisible into two distinct regions . . . . CIRRATULIDAE (p.66)

11. Anterior filaments not retractile into mouth, but tend to creep out radially if worms are undisturbed; prostomium seen only by lifting aside filaments; branchiae often present on dorsum behind filaments; well represented locally . . . . TEREBELLIDAE (p.81)
11. Anterior tentacles retractile into mouth, leaving pointed branchiae exposed and extending over anterior end; tapering at rear; not common in most collecting . . . . AMPHARETIDAE (p.63)

12. Anterior end with pair of long, coiling tentacular processes (often referred to as "palps") which may, however, be missing if specimen has been handled roughly 13
12. Prostomium with obvious antennae (not minute relative to size of prostomium); with or without fleshy oral palps 15
12. Prostomium with minute antennae; without fleshy oral palps 21
12. Prostomium without antennae, or with a single median antenna; without tentacular cirri; or prostomium is indistinct 23

13. Body segments similar in size and setae (except that the 5th may be much modified in <u>Polydora</u>); body, although showing gradual transition, is not sharply divisible into distinct regions . . . . SPIONIDAE (p.78)
13. Body divisible into 2 or 3 distinct regions with dissimilar segments 14

14. Small, slender worms with spatulate prostomium; coiling tentacles bear a fringe of papillae or short branches on one side; no tube . . . . MAGELONIDAE (p.69)
14. Larger worms in distinctive leathery or chitinous tubes; parapodia are complexly lobed . . . . CHAETOPTERIDAE (p.65)

15. Dorsal cirri flattened, leaflike, often overlapping; prostomium with 2 eyes and 4-5 antennae; lacking oral palps; smallish, elongate worms of delicate build . . . . PHYLLODOCIDAE (p.74)
15. Dorsal cirri of typical tentacular or slender tapered form 16

16. (With one rare exception) always with parapodial ligules (rounded, leaflike, or straplike dorsal lobes of parapodia) bearing dorsal cirri; prostomium with 4 eyes and 2 antennae; 2 biarticulated oral palps . . . . NEREIDAE (p.70)
16. Lacking parapodial ligules 17

17. With 1-8 lateral pairs of tentacular cirri on peristomial segment; small worms 18
17. Without such peristomial cirri, <u>or</u> with a pair of short dorsal tentacles on nuchal region (fig. 16); dark complex jaw apparatus 19

18. Prostomium with biarticulate oral palps; 2-3 antennae, 4 eyes, 2-8 pairs of peristomial cirri . . . . HESIONIDAE (p.68)
Several species present locally, some of which are commensal. The most common species is the small, dark, short-bodied Podarke obscura (fig. 79).

18. Prostomium with 2 oral palps (sometimes reduced or fused), 3 antennae, and 4-6 eyes; 1-2 pairs of peristomial cirri; the dorsal parapodial cirri often long, moniliform (beaded), and conspicuous; a large and difficult family of small and beautiful worms . . . . SYLLIDAE (p.79)

19. Prostomium with 2 articulated antennae and 2 elongated palps; without branchiae . . . . DORVILLEIDAE (p.66)

19. Prostomium with 1-7 antennae, 2 low globular palps, best seen ventrally; branchiae simple, spiral, pectinate, or lacking 20

20. With 5 occipital antennae (seem to be borne at rear of prostomium, but without frontal antennae; sometimes a pair of short nuchal tentacles (figs. 17-19) . . . . EUNICIDAE (p.66)

20. With 5 occipital antennae plus 2 frontal antennae on prostomium; occipital antennae with distinctly ringed bases (fig. 16) . . . . ONUPHIDAE (p.71)

21. Prostomium subquadrate, 1 pair of small pointed antennae at front corners, a second concealed at sides; parapodia biramous with lamellae well developed; body flattened, with distinctive "shimmying" motion . . . . NEPHTYIDAE (p.70)

21. Prostomium conical, long and tapering, with 4 minute antennae set in a cross at tip; parapodia small and lack lamellae; bodies pink, cylindrical, and pointed at both ends, coiling 22

22. Segments bi- or triannulate; parapodia either uni- or biramous, but of one form for whole length of body; common . . . . GLYCERIDAE (p.67)

22. Segments uni-annulate; parapodia of front part of body uniramous, biramous in rear . . . . GONIADIDAE (p.68)

23. Some of body segments much longer than wide 24

23. Segments shorter than, or not much longer than, wide 25

24. Segments remarkably long; anal segment with a funnel, or a flattened plate, or spatulate (spoon-like); prostomium hood-like or with flattened plate; "bamboo worms" . . . . MALDANIDAE (p.69)

24. Anal segment otherwise; prostomium with or without a slashed branchial membrane (fig. 107) . . . . OWENIIDAE (p.73)

25. Body very long and with small parapodia, somewhat resembling elongated earthworms; proboscis has dark jaw-pieces (not visible unless everted); 2 superficially very similar families 26

25. Form various; proboscis without dark jaw-pieces 27

26. Setae consisting of (1) simple, pointed, "limbate" setae (flattened back of tips) and (2) "hooded" setae (hooked setae with tips encased in a transparent drop of material) . . . . LUMBRINERIDAE (p.68)

26. Setae limbate, with or without stout aciculum-like setae; without hooded setae . . . . ARABELLIDAE (p.64)

27. Parapodia of at least some segments bear typical uncinigerous tori (a torus is a simple raised area representing a low parapodial ramus; uncini are short embedded hooklike setae set in rows). 28
27. Parapodia with capillary (simple, pointed) setae; typical uncinigerous tori absent, but palisaded rows of crochets (elongate hooked setae) on low mounds may be present anteriorly 29
27. Parapodia with filiform postsetal notopodial lobes, with straplike branchiae dorsal to notopodia on some segments; prostomium subconical, with or without a median antenna; small, threadlike worms, living in mucous tubes in mud or sand . . . . PARAONIDAE (p.73)

28. Without branchiae, or when present, only in posterior region; body extremely long, slender, and fragile; characteristically purplish-red, found in mud . . . . CAPITELLIDAE (p. 65)
28. With 11-13 pairs of dorsal branchiae in middle part of body; heavy-bodied; "lug worms" . . . . ARENICOLIDAE (p.64)

29. Prostomium bilobed or T-shaped; branchiae usually 4 pairs limited to anterior few segments, arborescent; integument checkered . . . . SCALIBREGMIDAE (p.77)
29. Prostomium pointed; branchiae are either numerous pairs or lacking altogether 30

30. More or less short bodied, pointed at both ends; parapodia reduced to bundles of setae, all simple, capillary; a ventral groove present in some; branchiae along sides of body or lacking . . . . OPHELIIDAE (p.72)
30. Elongate worms with pointed, actively inquiring heads; anterior thoracic part of body often with flattened dorsum with parapodia lateral; posterior abdominal segments with parapodia dorsal; with paired branchiae dorsal to parapodia, the parapodia and branchiae covering the back like a furry coat . . . . ORBINIIDAE (p.72)

KEYS TO SPECIES AND ANNOTATED CHECK LIST OF THE MORE COMMON POLYCHAETES, ARRANGED BY FAMILIES

1. Family Ampharetidae
List of Species

Amage auricula Malmgren, 1866. Dredged.
Ampharete arctica Malmgren, 1866. Dredged.
Ampharete acutifrons (Grube, 1860). Dredged.
Amphicteis gunneri (Sars, 1835). Dredged.
Asabellides oculata (Webster, 1879). Dredged.
Hypaniola grayi Pettibone, 1953. In shallow ponds of low salinity. Figure 5.
Melinna cristata (Sars, 1851). Dredged.
Samytha sexcirrata (Sars, 1856). Dredged.
Samythella elongata Verrill, 1873. Dredged.

2. Family Amphinomidae (not in key; rare)
List of Species

Amphinome rostrata (Pallas, 1766). Gulf Stream fauna, on floating weed, etc.
Hipponoe gaudichaudi Audouin and Milne Edwards, 1830. On floating objects, barnacles, etc.
Paramphinome pulchella Sars, 1872. Dredged.
Pareurythoe borealis (Sars, 1862). Dredged.

3. Family Aphroditidae
Key

1. Thick felty layer completely covers elytra; dredged in mud . . . . Aphrodita hastata Moore, 1905.
1. Loose felty layer, not completely concealing elytra; dredged in sand . . . . Laetmatonice filicornis Kinberg, 1855.

4. Family Arabellidae
Key

1. Parapodia without heavy projecting acicular setae; prostomium with four eyes in row on posterior margin (may be overlooked under fold of peristomium) (fig. 101) . . . . Arabella iricolor
1. Parapodia provided with stout projecting aciculum-like setae (fig. 102) 2

2. Prostomium conical, with four eyes in row on posterior margin . . . . Notocirrus spiniferus
2. Prostomium spatulate, flattened dorsoventrally, without eyes . . . . Drilonereis 3

3. Parapodia small, inconspicuous on anterior segments (fig. 102); in far posterior region, parapodia distinctly bilabiate (fig. 103) . . . . Drilonereis longa
3. Parapodia prominent from first setiger on, similar throughout length of body . . . . Drilonereis magna

List of Species

Arabella iricolor (Montagu, 1804). Formerly called A. opalina. Common in sandy mud.

Drilonereis longa Webster, 1879. Common in sandy mud.

Drilonereis magna Webster and Benedict, 1887. Rare, dredged.

Notocirrus spiniferus (Moore, 1906). Low water and dredged. Young stages are thought to live parasitically in body cavity of Diopatra cuprea (Pettibone, M., 1957. Endoparasitic polychaetous annelids of the family Arabellidae with descriptions of new species . Biol. Bull., 113: 170-187).

5. Family Arenicolidae
Key

1. 19 setigerous segments; 12-13 pairs of gills; found north of Cape Cod . . . . Arenicola marina
1. 17 setigerous segments; 11 pairs of gills 2

2. Firm, stout, dark blackish-green; commonly 15-30 cm long; castings formless; egg mass a gelatinous streamer up to a meter long . . . . Arenicola cristata
2. Soft and limp; color pale pinkish-tan; length rarely exceeds 15 cm; castings cylindrical, coiled; gelatinous egg mass firm and egg shaped . . . . Arenicola brasiliensis

List of Species

Arenicola brasiliensis Nonato, 1958 (= A. caroledna Wells, 1961). This species prior to 1961 was not formally recognized as distinct from A. cristata, although the difference had been noted years previously by the MBL's distinguished former Collector, Mr. Milton "Sam" Gray. "Caroledna" is generally found in sand.

Arenicola cristata Stimpson, 1856. See above. This large Arenicola is the form traditionally used for dissection in the MBL Invertebrate Zoology Course. It prefers quieter waters and muddier sand than does A. brasiliensis, and is becoming increasingly scarce, in part because of dredging of harbors.

Arenicola marina (Linnaeus, 1758). Occurs north of Cape Cod.

6. Family Capitellidae
Key

1. Capillary (slender, pointed) setae on first 5 setigers; body very slender . . . . Heteromastus filiformis
1. Capillary setae on first 7 setigers . . . . Capitella capitata
1. Capillary setae on first 11 setigers . . . . Notomastus 2

2. Capillary setae in both noto- and neuropodia of first setiger; body blood-red anteriorly, light yellowish posteriorly . . . . Notomastus latericeus
2. Setae only in notopodium of first setiger; body dark purplish-brown with bluish iridescence anteriorly . . . . Notomastus luridus

Note: Capitellids, because of their extreme length and thinness, are difficult to collect entire, and hence to identify.

List of Species

Capitella capitata (Fabricius, 1780). Common, in sandy mud.
Heteromastus filiformis (Claparède, 1864). Common, in mud.
Notomastus latereus Sars, 1851. In muddy sand.
Notomastus luridus Verrill, 1873. In muddy sand.

7. Family Chaetopteridae
Key

1. Tube U-shaped, parchment-like, with both ends open to surface; worm large, thick, well known . . . . Chaetopterus variopedatus
1. Tube long, slender, transparent, annulated; buried vertically in sand; worm long and slender . . . . Spiochaetopterus oculatus

List of Species

Chaetopterus variopedatus (Renier, 1804). Formerly C. pergamentaceus. Is fairly common, but not entirely dependable for experimental work because it may become very scarce in certain years. The distinctive tube may have led to overcollecting.

Spiochaetopterus oculatus Webster, 1879. Uncommon; dredged in mud in Buzzards Bay and has been found by Mr. Gray on certain flats both north and south of the Cape.

8. Family Cirratulidae
Key

1. With 2 elongate grooved tentacles ("palps") arising from forward of the first setiger, in addition to the other filamentous outgrowths 3
1. With numerous filaments, but without the differentiated grooved palps . . . . *Cirratulus*

2. Prostomium bluntly conical with 2-9 eyes on each side in a transverse row or united in an arc (fig. 46) . . . . *Cirratulus cirratus*
2. Prostomium conical, slightly acute; without eyes . . . . *Cirratulus grandis*

3. Only 4-6 pairs of rather short filaments in addition to palps (fig. 45); dark, almost black; forms a calcareous tube mass; in calcareous shell or coral matrix . . . . *Dodecaceria coralii*
3. With numerous filaments in addition to 2 tentacular palps (figs. 47, 48) 4

4. With capillary (simple, pointed) setae exclusively in both rami of parapodia (fig. 47) . . . . *Tharyx acutus*
4. With acicular setae or unidentate crochets in addition to capillary setae; crochets in rows almost encircling the body in posterior region (fig. 48) . . . . *Chaetozone setosa*

List of Species

Chaetozone setosa Malmgren, 1867. Dredged.
Cirratulus cirratus (O. F. Müller, 1776). Dredged.
Cirratulus grandis Verrill, 1873. Common.
Dodecaceria coralii (Leidy, 1855). Dredged.
Tharyx acutus Webster and Benedict, 1887. Dredged.

9. Family Dorvilleidae
Key

1. Prostomium without eyes; in sand . . . . *Stauronereis caecus* (Webster and Benedict, 1884)
1. Prostomium with 4 eyes (fig. 21); in sandy mud and in "weed" in Lagoon Pond (Martha's Vineyard) . . . . *Stauronereis rudolphi* (Delle Chiaje, 1828)

10. Family Eunicidae
Key

1. With 2 short nuchal tentacles on the dorsal side of second segment (fig. 17) . . . . *Eunice* 3
1. Without such nuchal tentacles . . . . *Marphysa* 2

2. Prostomium bilobed (fig. 18); branchiae start on about segment 20 (19-40) and continue nearly to end of body with 1-8 filaments per branchia . . . . *Marphysa sanguinea*
2. Prostomium rounded (fig. 19); branchiae start on segments 12-15, relatively few in number (12-21 pairs) with 7-19 filaments per branchia . . . . *Marphysa bellii*

3. Acicula and subacicular hooks black; branchiae begin on setigers 7-9, and continue nearly to rear of body; tube papery . . . . *Eunice norvegica*
3. Acicula and subacicular hooks yellow; branchiae begin on third setiger, and continue on to setigers 40-50, leaving middle and rear of body without branchiae; tubes thin, rough with debris . . . . *Eunice pennata*

List of Species

Eunice norvegica (Linnaeus, 1767). Includes *E. floridana* Ehlers. Dredged.
Eunice pennata (O. F. Müller, 1776). Dredged.
Marphysa bellii (Audouin and M. Edwards, 1833). Rare, in muddy sand.
Marphysa sanguinea (Montagu, 1815). Common, in muddy sand.

11. Family Euphrosinidae

List of Species

Euphrosine cirrata Sars, 1862. Dredged.
Euphrosine borealis Oersted, 1843. Dredged; fig. 3.
Euphrosine armadillo Sars, 1851. Dredged.

12. Family Flabelligeridae

Key

1. Body covered with thick mucous mantle containing long, *stalked* papillae; neurosetae are compound hooks . . . . *Flabelligera affinis*
1. Body without mucous mantle, covered with simple (not stalked) papillae; neurosetae are simple 2

2. Both neuro- and notosetae are long, capillary; papillae numerous and remarkably long . . . . *Diplocirrus hirsutus*
2. Neurosetae are stout simple hooks 3

3. Hooked neurosetae begin on fourth setiger; body covered with elongate papillae, agglutinated with sand and mud . . . . *Pherusa plumosa*
3. Hooked neurosetae begin on fifth setiger; body covered with short papillae (fig. 7) . . . . *Pherusa affinis*

List of Species

Brada granosa Stimpson, 1854. Dredged.
Brada villosa (Rathke, 1843). Dredged.
Diplocirrus hirsutus (Hansen, 1879). Dredged.
Flabelligera affinis Sars, 1829. Dredged.
Pherusa affinis (Leidy, 1855). Formerly *Trophonia affinis*; in mud, shallow water, and has been taken at night light at WHOI dock.
Pherusa plumosa (Müller, 1776). Dredged.

13. Family Glyceridae

Key

1. Without branchiae; parapodia with single postsetal lobe and two unequal presetal lobes (fig. 89) . . . . *Glycera capitata*
1. Branchiae present (but may be retracted); parapodia with two presetal and two postsetal lobes (figs. 90, 91) 2

2. Branchiae non-retractile at upper and lower edges of parapodia (fig. 90) . . . . Glycera dibranchiata
2. Branchiae completely retractile, many lobed (fig. 91), arising from grooves on posterior side of base of notopodia (opening visible when branchia is retracted) . . . . Glycera americana

List of Species

Glycera americana Leidy, 1855. Common in muddy sand.
Glycera capitata Oersted, 1843. Dredged, in muddy sand.
Glycera dibranchiata Ehlers, 1868. Common, in muddy sand.

14. Family Goniadidae
Key

1. Presetal lobes of neuropodia bilobed (may be simple on some 18 of anterior segments) (figs. 92, 93) 2
1. Presetal lobes of neuropodia simple, not bilobed; proboscis with about 28 chitinous, V-shaped, black chevrons . . . . Goniadella gracilis

2. Proboscis without chevrons . . . . Ophioglycera gigantea
2. Proboscis with 7-11 chevrons (fig. 88) . . . . Goniada maculata

List of Species

Goniada maculata Oersted, 1843. Dredged in mud.
Goniadella gracilis (Verrill, 1873). Small, usually escapes notice; in fine sand.
Ophioglycera gigantea Verrill, 1885. Rare, in mud flats.

15. Family Hesionidae
List of Species

Gyptis vittata Webster and Benedict, 1887. Rare; under rocks.
Microphthalmus aberrans (Webster and Benedict, 1887). In sand; associated with terebellids Lysilla alba and Enoplobranchus sanguineus.
Microphthalmus sczelkowii Mecznikow, 1865. In sand.
Nereimyra punctata (O. F. Müller, 1776). Dredged.
Parahesione luteola (Webster, 1880). In sands, mud, commensal with Upogebia affinis.
Podarke obscura Verrill, 1873. Common in muddy sand and eel grass; may swarm at surface or to night light. Easily recognized by its very dark brown color.

16. Family Lumbrineridae
Key

1. With palmately branched branchiae on some parapodia (figs. 96, 97) . . . . Ninoe nigripes
1. Without branchiae . . . . Lumbrineris 2

2. Prostomium extremely elongated, 2 to 3 times as long as wide (fig. 98) . . . . Lumbrineris acuta
2. Prostomium short, conical (fig. 99) 3

3. Body long, slender, small; acicula yellow; posterior parapodia with elongated fingerlike process (Fig. 100) . . . . *Lumbrineris tenuis*
3. Body stouter; acicula black; parapodia without especially elongated process . . . . *Lumbrineris fragilis*

List of Species

Lumbrineris acuta (Verrill, 1875). Rare. In muddy sand.
Lumbrineris fragilis (O. F. Müller, 1776). Common in muddy sand.
Lumbrineris tenuis (Verrill, 1873). Common in muddy sand.
Ninoe nigripes Verrill, 1873. Common. Dredged in mud.

17. Family Magelonidae

Magelona rosea Moore, 1907. Common in muddy sand. The only polychaete genus reported to have haemerythrin as a blood pigment.

18. Family Maldanidae

Key

1. Anus within a funnel shaped structure (fig. 72). 2
1. Anus associated with (dorsal to) an oblique structure (figs. 73, 74) 3

2. With deep membranous collarette (fig. 71) on fourth setigerous segment; 18 setigerous segments; two color phases: pale with red nodes, or green (in mud) . . . . *Clymenella torquata*
2. Without collarette on fourth setiger; setigerous segments variable in number (19-42) . . . . *Clymenella zonalis*

3. Anus dorsal to anal disc; anal segment forms a spatulate lobe dorsally and funnel-like concavity ventrally (fig. 73); anterior end speckled with black or dark purple; mud tube . . . . *Maldanopsis elongata*
3. Pygidium an obliquely truncated flat oval plate (fig. 74) with short lateral marginal incisions . . . . *Maldane sarsi*

List of Species

Asychis biceps (Sars, 1861). Dredged.
Axiothella catenata (Malmgren, 1856). Dredged.
Clymenella torquata (Leidy, 1855). Very common in sand; forms sandy tubes.
Clymenella zonalis (Verrill, 1874).
Leiochone dispar (Verrill, 1873). Dredged.
Maldane sarsi Malmgren, 1865. Common in very muddy sand.
Maldanopsis elongata (Verrill, 1873). Common in mud.
Nicomache lumbricalis (Fabricius, 1780). Dredged.
Petaloproctus tenuis (Théel, 1879). Dredged.
Praxillella gracilis (Sars, 1861). Dredged. One sp. of *Praxillella* reported common in mud below water at Hadley Harbor (Mr. Gray).
Praxillella praetermissa (Malmgren, 1866). Dredged.
Praxillella ornata Verrill, 1880. Dredged.
Rhodine loveni Malmgren, 1865.

19. Family Nephytidae
Key

1. Branchiae (in form of a sickle shaped cirrus between dorsal and ventral ramus of each parapodium) curved inwards (fig. 77); not common . . . . *Aglaophamus circinata*
1. Branchiae (see above) curved outwards (fig. 78); common . . . . *Nephtys* 2

2. Tentacular segment with enlarged neuropodial lobe lateral to the setigerous lobe; dorsal tentacular cirri lacking on notopodium (fig. 76) 3
2. Tentacular segment without enlarged neuropodial lobe; tiny dorsal tentacular cirri present on first notopodium (fig. 75) 4

3. Ventral tentacular cirri anterior to widest part of enlarged tentacular segment . . . . *Nephtys picta*
3. Ventral tentacular cirri lateral and continuous with widest part of enlarged tentacular segment (fig. 76) . . . . *Nephtys bucera*
4. Both anterior and posterior parapodial lamellae about equally well developed, enclosing the conical acicular lobes; setae dark . . . . *Nephtys incisa*
4. Anterior parapodial lamellae rudimentary; posterior lamellae large, foliaceous; setae light . . . . *Nephtys caeca*

List of Species

Aglaophamus circinata (Verrill, 1874). Dredged in mud.
Nephtys bucera Ehlers, 1868. Common, in sand.
Nephtys caeca (Fabricius, 1780). Common, in muddy sand.
Nephtys incisa Malmgren, 1865. Dredged. Common in mud.
Nephtys picta Ehlers, 1868. Common, in muddy sand.
Nephtys ciliata (O. F. Müller, 1789). Dredged in mud.

20. Family Nereidae
Key

1. Parapodia essentially uniramous, without ligules . . . . *Lycastopsis pontica*
1. Parapodia biramous, with ligules (figs. 12-15) 2

2. Paragnaths (denticles) (fig. 9) of proboscis small and pectinate (in comblike rows); peristomial cirri very long, to segments 10 or 15; often seen in heteronereid form at night lights . . . . *Platynereis dumerilii megalops*
2. Paragnaths of proboscis larger, conical (figs. 8, 10, 11) 3

3. Notopodia of anterior parapodia with 2 ligules 4
3. Notopodia of anterior parapodia with 3 ligules, the upper ligule (bearing cirrus) flattened 5

4. Parapodial ligules sharply conical . . . . *Nereis (Nereis) grayi*
4. Parapodial ligules short, thick, evenly rounded (fig. 13); worm may occur as a heteronereid . . . . *Nereis (Nereis) pelagica*

5. Upper ligules of posterior parapodia elongated, strap-like, with cirrus near tip (fig. 12); often seen as the heteronereid at night light
. . . . Nereis (Neanthes) succinea
5. Upper ligule large, broadly leaf-like, with cirrus inserted near base (fig. 14); the most common large local nereid . . . . Nereis (Neanthes) virens
5. Upper ligule triangular, with cirrus inserted near base (fig. 15); a small pale worm; very numerous tiny paragnaths in oral ring (figs. 10, 11)
. . . . Nereis (Neanthes) arenaceodonta

List of Species

Lycastopsis pontica (Bobretzky, 1872). Found in high intertidal. A primitive, aberrant nereid.
Nereis (Neanthes) arenaceodonta Moore, 1903. Small; common in pilings and in algae; occasionally at night light. Includes N. caudata Delle Chiaje.
N. (Neanthes) succinea (Frey and Leuckart, 1847). Well known to embryologists as Nereis limbata. Common in brackish waters and in the peaty banks of estuaries. Usually taken as heteronereids at night light.
N. (Neanthes) virens Sars, 1835. Very common in muddy sand and in more saline conditions than N. succinea.
N. (Nereis) grayi Pettibone, 1956. In mud, in tubes of Maldanopsis elongata.
N. (Nereis) pelagica Linnaeus, 1758. Common. On algae.
Platynereis dumerilii megalops (Verrill, 1874). This form exhibits a unique copulation and internal fertilization well known to Woods Hole embryologists. It is regarded by Pettibone as a subspecies of P. dumerilii, but its method of reproduction is such that it is reproductively isolated from the externally fertilizing typical P. dumerilii of Europe.

21. Family Onuphidae
Key

1. Peristomial segment without a pair of cirri; tube horny, transparent . . . . Hyalinoecia tubicola
1. Peristomial segment with a pair of short tentacular cirri (fig. 16) 2

2. Branchiae large and spiraled; worm large and wonderfully iridescent; forms long stout vertical tube in sand, the projecting end cluttered with attached debris and shells
. . . . Diopatra cuprea
2. Branchiae not spiraled . . . . Onuphis 3

3. Branchiae pectiniform or with 2 or more filaments where best developed . . . . subgenus Onuphis 5
3. Branchiae simple, cirriform . . . . subgenus Nothria 4

4. Branchiae begin on segments 10-13; parapodia of first segment greatly enlarged; tube free, parchment-like, flattened, covered with pebbles and shells
. . . . Onuphis (Nothria) conchylega
4. Branchia begin on first segment; parapodia of first segment not enlarged; muddy tube
. . . . Onuphis (Nothria) opalina

5. Branchiae begin on segments 5-6, with a maximum of 4-5 pectiniform filaments . . . . Onuphis (Onuphis) quadricuspis
5. Branchiae begin on first segment, with a maximum of 5-7 pectiniform filaments . . . . Onuphis (Onuphis) eremita

List of Species

Diopatra cuprea (Bosc, 1802). The prominent tubes, set in sand, are common and easily recognized.
Hyalinoecia tubicola (O. F. Müller, 1776). Dredged in mud.
Onuphis (Nothria) conchylega Sars, 1835. Dredged in mud; tube free, scabbard shaped.
Onuphis (Nothria) opalina (Verrill, 1873). Dredged in mud; tube of mud.
Onuphis (Onuphis) eremita Audouin and M. Edwards, 1833. Dredged in sand and mud; tube of sand or mud.
Onuphis (Onuphis) quadricuspis Sars, 1872. Dredged; tube of mud.

22. Family Opheliidae
Key

1. Body stout, grub like; no ventral groove . . . . Travisia carnea
1. Body Amphioxus shaped, with ventral groove for whole length . . . . Ammotrypane aulogaster
1. Ventral groove only behind segments 10-12 . . . . .Ophelia 2

2. Branchiae 18 pairs, crenulate on sides . . . . Ophelia denticulata
2. Branchiae 11-15 pairs, smooth . . . . Ophelia bicornis

List of Species

Ammotrypane aulogaster Rathke, 1843. Dredged.
Ophelia bicornis Savigny, 1818. Only north of Cape.
Ophelia denticulata Verrill, 1875.
Travisia carnea Verrill, 1873. On sand flats, Naushon Island (Mr. Gray).

23. Family Orbiniidae
Key

1. Thoracic neuropodia with numerous postsetal papillae in vertical rows (fig. 104); branchiae begin on fifth setiger; large and robust worms . . . . Orbinia ornata
1. Thoracic neuropodia without rows of papillae (1-3 postsetal papillae present in some); branchiae start on setigers 9-32 . . . . Scoloplos 2

2. With a cirrus between the dorsal and ventral parapodial rami of anterior abdominal parapodia (figs. 105, 106) 3
2. Without an interramal cirrus . . . . Scoloplos acutus

3. With ventral papillae on some anterior segments (up to 9 in a row on each side of segments 14-24) . . . . Scoloplos riseri
3. Without ventral papillae 4

4. With 2-3 subpodial papillae in transitional region between thoracic and abdominal regions, followed by an entire flattened subpodial flange (may be undulate but not incised; fig. 105) . . . . Scoloplos robustus
4. With 2 subpodial papillae in transitional region, continuing as 2 subpodial lobes (thus a notched or incised subpodial lobe; fig. 106) . . . . Scoloplos fragilis

List of Species

Naineris quadricuspida (Fabricius, 1780). Dredged in mud.
Orbinia ornata (Verrill, 1873). Formerly called Aricia ornata, common in sandy shoals.
Scoloplos acutus (Verrill, 1873). Dredged in soft mud.
Scoloplos fragilis (Verrill, 1873).
Scoloplos riseri Pettibone, 1957.
Scoloplos robustus (Verrill, 1873). Common. In vertical burrows in muddy sand; has been called Haploscoloplos robustus.

24. Family Oweniidae
Key

1. Prostomium rounded, without appendages; dredged . . . . Myriochele heeri Malmgren, 1867.
1. Prostomium with a slashed branchial membrane (fig. 107); tube distinctive, with a dense coating of flattened sand grains and bits of shell set in overlapping fashion like shingles; dredged . . . . Owenia fusiformis Delle Chiaje, 1844.

25. Family Paraonidae
Key

1. Without dorsal antenna . . . . Paraonis 2
1. With dorsal median antenna (fig. 80); branchiae begin on fourth segment . . . . Aricidea

2. Branchiae begin on segments 6-7, 9-14 pairs . . . . Paraonis gracilis
2. Branchiae begin on fourth segment, 16-25 pairs . . . . Paraonis fulgens

3. Median antenna long, filiform, extending to about segments 4-6; branchiae 9-10 pairs . . . . Aricidea quadrilobata
3. Median antenna short (fig. 80), extending to first segment; branchiae 11-18 pairs . . . . Aricidea jeffreysii

List of Species

Aricidea jeffreysii (McIntosh, 1879). Dredged in mud.
Aricidea quadrilobata Webster and Benedict , 1887. Dredged in soft mud.
Paraonis fulgens (Levinsen, 1883). In sandy beaches.
Paraonis gracilis (Tauber, 1879). Dredged in soft mud.

26. Family Pectinariidae
List of Species

Pectinaria (*Cystenides*) *gouldii* (Verrill, 1873)(fig. 108). Intertidal; common. This is often referred to as *Cystenides gouldii*; *Cystenides* is a subgenus of *Pectinaria*. Conical sand tube (fig. 109) is distinctive of family.
Pectinaria granulata (Linnaeus, 1767). Dredged.
Pectinaria hyperborea (Malmgren, 1866). Dredged.

27. Family Phyllodocidae
Key

1. Two pairs (one pair on each side) of peristomial cirri; prostomium triangular with 4 small antennae (fig. 56) . . . . . . *Eteone* 2
1. Four pairs (2 pairs on each side) of peristomial tentacular cirri(figs. 60, 61). 3

2. Elongate, slender; pale or yellow; dorsal cirri of middle region on body asymmetrical . . . . . . *Eteone lactea*
2. Robust, dark green with light green transverse bands between segments; dorsal cirri of middle region symmetrical, almost triangular . . . . . . *Eteone longa*

3. Four prostomial antennae (figs. 57, 61) 4
3. Five prostomial antennae (figs. 58, 59, 60). 6

4. Prostomium cordiform (heart shaped), with an occipital tubercle in the posterior notch (fig. 57) . . . . . . *Phyllodoce* (*Anaitides*) 5
4. Prostomium oval, without an occipital tubercle (fig. 61) . . . . . . *Paranaitis speciosa*

5. Ventral cirri oval, blunt, or only slightly pointed distally, with a pointed ventral projection; body heavily pigmented . . . . . . *Phyllodoce groenlandica*
5. Ventral cirri acutely pointed distally; green, banded with brown, with white marks on dorsum; dorsal cirri spotted . . . . . . *Phyllodoce mucosa*

6. With 4-5 paired nuchal lappets posterior to prostomium; parapodia biramous; dorsal cirri plate-like, imbricated, resembling elytra of scale worms (fig. 58) . . . . . . *Notophyllum americanum*
6. Without nuchal lappets; parapodia uniramous 7

7. Three tentacular segments distinct dorsally (fig. 59) . . . . . . *Eulalia* 8
7. First tentacular segment not distinct dorsally (fig. 60); dorsal cirri cordiform; body greenish and yellowish, banded with grayish-green, reddish-brown, or light brown . . . . . . *Eumida sanguinea*

8. Dorsal cirri elongate-lanceolate; greenish; body rather short . . . . Eulalia viridis
8. Dorsal cirri thick, oval-obtuse; greenish with darker longitudinal lateral bands; very slender, elongate . . . . Eulalia bilineata

List of Species

Eteone lactea Claparède, 1868. Common in sandy mud. Includes E. alba Webster.
Eteone longa (Fabricius, 1780). Includes E. robusta Verrill.
Eulalia bilineata (Johnston, 1840). In algae. May form epitokous sexual form.
Eulalia viridis (Linnaeus, 1767). Common, on pilings.
Eumida sanguinea (Oersted, 1843). Common, on pilings.
Notophyllum americanum Verrill, 1885. Rare. Dredged.
Paranaitis speciosa (Webster, 1880). Rare. In sand.
Phyllodoce (Anaitides) arenae Webster, 1879. In muddy sand. May swarm at surface of water.
Phyllodoce (Anaitides) groenlandica Oersted, 1842. Dredged.
Phyllodoce (Anaitides) maculata (Linnaeus, 1767). Common among rocks and algae.
Phyllodoce (Anaitides) mucosa Oersted, 1843. Common in muddy sand.

28. Family Polynoidae
Key

1. Elytra 12 pairs (fig. 1) 2
1. Elytra, more than 12 pairs 3

2. Elytral tubercles small, widely spaced; commensal in shells occupied by Pagurus pollicaris . . . . Lepidonotus sublevis
2. Elytral tubercles larger, crowded; very common, free living . . . . Lepidonotus squamatus

3. 15 pairs of scales 4
3. 40-50 pairs of scales; commensal in tubes of Amphitrite ornata . . . . Lepidametria commensalis

4. Anterior pair of eyes antero-ventral on prostomium, not visible dorsally (fig. 2) . . . . Harmothoe imbricata
4. Anterior pair of eyes antero-dorsal on prostomium, visible dorsally . . . . Harmothoe extenuata

List of Species

Alentiana aurantiaca (Verrill, 1885). Dredged; commensal with anemone, Bolocera tuediae.
Antinoella angusta (Verrill, 1874). Dredged in mud.
Arcteobia anticostiensis (McIntosh, 1874). Dredged in mud.
Enipo gracilis Verrill, 1874. Dredged in mud; commensal with maldanid, Nicomache lumbricalis.
Gattyana amondseni (Malmgren, 1867). Dredged in mud.
Gattyana cirrosa (Pallas, 1766). Dredged in mud.
Harmothoe (Eunoe) nodosa (Sars, 1860). Dredged.
Harmothoe (Eunoe) oerstedi (Malmgren, 1865). Dredged.
Harmothoe (Eunoe) spinulosa (Verrill, 1870). Dredged.

Harmothoe (Lagisca) extenuata (Grube, 1840). Common; under stones, algae.
Harmothoe imbricata (Linnaeus,1767)Very common. This is the species usually encountered; under stones, algae.
Harmothoe fragilis Moore, 1910. Dredged.
Lepidametria commensalis Webster, 1879. Commensal in tubes of Amphitrite ornata.
Lepidonotus squamatus (Linnaeus, 1758). Very common. Under stones.
Lepidonotus sublevis Verrill, 1873. Dredged. Commensal in snail shells occupied by hermit crab Pagurus pollicaris.

29. Family Sabellariidae

Sabellaria vulgaris Verrill, 1873. Common. Dredged; on shells or in bryozoan nodules (fig. 110).

30. Family Sabellidae
Key

1. Tiny, of 10-12 setigerous segments; eyes on first segment and on rear of body (fig. 50); poorly defined muddy tubes, which worms may leave and move about, tail first . . . . Fabricia sabella
1. Larger, of more than 12 setigerous segments 2

2. Branchial filaments united by membrane for most of length; tube of mucus, transparent and thick . . . . Myxicola infundibulum
2. Branchial filaments united by membrane for at least half their length; tubes inconspicuous, usually buried in sand or mud 3
2. Branchial filaments often with eyes and united only at bases; tubes obvious, leathery, usually coated with sand 4

3. Large ventral groove with flared sides on about 9 posterior segments; collarette bilobed: notched mid-dorsally and with a small ventral slit . . . . Euchone rubrocincta
3. Without ventral groove; collarette entire ventrally, with only a small mid-dorsal slit (fig. 51) . . . . Chone infundibuliformis

4. Branchial filaments without eyes . . . . Potamilla neglecta
4. Branchial filaments with eyes 5

5. Eyes in pairs, 2-6 on each branchial filament, situated in the transverse color bands; collarette 4-lobed by a small lateral notch on each side in addition to the dorsal and ventral slits (fig. 52) . . . . Sabella crassicornis
5. Eyes not paired 6

6. Branchial filaments with 2 irregular rows of many eyespots; collarette bilobed by ventral and dorsal slits; body short and thick (figs. 53, 54) . . . . Sabella microphthalma
6. Branchial filaments with 1-8 large "compound eyes" in a single row; collarette 4-lobed; body long and thin (fig. 55) . . . . Potamilla reniformis

List of Species

Chone infundibuliformis, Krøyer, 1856.
Euchone rubrocincta (Sars, 1861).
Fabricia sabella (Ehrenberg, 1837). This is the only one of our sabellids that can leave its tube and move about.
Myxicola infundibulum (Renier, 1804). Dredged; noted for its giant axon.
Potamilla neglecta (Sars, 1851). Dredged.
Potamilla reniformis (Linnaeus, 1788). Common; dredged on shells.
Sabella crassicornis Sars, 1851. Dredged.
Sabella microphthalma Verrill, 1873.

31. Family Scalibregmidae
Key

1. Prostomium T-shaped, with frontal horns (fig. 20); body inflated anteriorly. In mud; intertidal and dredged . . Scalibregma inflatum Rathke, 1843.
1. Prostomium bilobed; without frontal horns; body short and fusiform . . . . Polyphysia crassa (Oersted, 1843).

32. Family Serpulidae
Key

1. Minute, flat coiled tubes on stones, algae. . . . . Spirorbis 2
1. Irregular tubes up to several inches long, on rocks and shells 5

2. Tubes coiled "dextrally" (figs. 62, 63, 64) 3
2. Tubes coiled "sinistrally" (figs. 65, 67) 4

3. Tube white, opaque, shiny, smooth (figs. 62, 63) . . . . Spirorbis (Dexiospira) spirillum
3. Tube white, opaque, thick and tough with 3 rounded longitudinal ridges produced into blunt teeth at opening (fig. 64); lined with dark layer . . . . Spirorbis (Paradexiospira) violaceus

4. Tube without luster, chalky, without longitudinal ridges (fig. 65); eggs incubated in tube . . . . Spirorbis (Laeospira) borealis
4. Tube with 2-3 longitudinal ridges to almost smooth (fig. 67); eggs incubated in a brood pouch in operculum (fig. 68) . . . . Spirorbis (Laeospira) granulatus

5. Operculum a two-tiered structure on a smooth peduncle (fig. 70); common; tube usually attached for most of length . . . . Hydroides (Eupomatus) dianthus
5. Without an operculum; tube large white, cylindrical; erect and almost straight in its unattached distal portion . . . . . . Protula tubularia
5. Two opercula, each a thin shallow membraneous cup with barbules on peduncle (fig. 69); tubes very slender (ca. 1 mm) in an intertwining mass . . . . Filograna implexa

List of Species

Filograna implexa Berkeley, 1828. Dredged.
Hydroides (Eupomatus) dianthus (Verrill, 1873). This has been called Hydroides hexagonas, Serpula dianthus, Eupomatus dianthus, and Hydroides uncinata.
Protula tubularia (Montagu, 1803). Dredged.
Spirorbis (Dexiospira) spirillum (Linnaeus, 1758). Common.
Spirorbis (Laeospira) borealis Daudin, 1800. Common.
Spirorbis (Laeospira) granulata (Linnaeus, 1767). Dredged.
Spirorbis (Paradexiospira) violaceus Levinsen, 1883. Dredged.

33. Family Sigalionidae
List of Species

Leanira hystricus Ehlers, 1875. Dredged in mud.
Leanira tetragona (Oersted, 1845). Dredged in mud.
Pholoe minuta (Fabricius, 1780). Dredged.
Sigalion arenicola Verrill, 1879. Rare, in sand.
Sthenelais boa (Johnston, 1873). Common, in *Zostera* root masses in certain areas, e.g., Lagoon Pond.
Sthenelais limicola (Ehlers, 1864). Dredged in sand and mud.

34. Family Spionidae
Key

1. Fifth setiger very modified, with large dorsal setae (fig. 6) . . . . *Polydora* 2
1. Fifth setiger like the rest, unmodified 4

2. Branchiae begin on setiger 6, continuing nearly to posterior end of body; color orange; pygidium with many papillae; bores in shells used by hermit crabs . . . . *Polydora commensalis*
2. Branchiae begin on setiger 7, continuing nearly to posterior end; pygidium with an anal cup notched dorsally 3

3. Prostomium clearly bifid anteriorly, and with a median occipital antenna (fig. 81) . . . . *Polydora ligni*
3. Prostomium indistinctly bifid anteriorly; without a median occipital antenna . . . . *Polydora ciliata*

4. Without branchiae; prostomium T-shaped (fig. 82) . . . . *Spiophanes bombyx*
4. With 1 pair of branchiae dorsal to the 2 coiling palps . . . . *Streblcspio benedicti*
4. With 4-5 pairs of branchiae, some pinnate, others smooth . . . . *Prionospio* spp.
4. With numerous branchiae 5

5. Branchiae begin on or about 13th setiger (11-20); about 14 pairs (7-28) . . . . *Pygospio elegans*
5. Branchiae begin on first setiger, absent from last half or third of body; in brackish water (fig. 83) . . . . *Scolecolepides viridis*
5. Branchiae begin on second setiger, continue to rear of body; in sandy beaches (fig. 85) . . . . *Scolelepis squamata*
5. Branchiae begin on first setiger, continue to rear of body 6

6. Prostomium conical; eyes nearly in a transverse line (fig. 84) . . . . *Dispio uncinata*
6. Prostomium inflated anteriorly; eyes set in a square (fig. 86) . . . . *Spio* 7

7. Ventral lamellae greatly reduced; about 16 hooded crochets in each neuropodium; body dull green with red branchiae held erect over dorsum; common in thick fragile sand tubes on beaches . . . . *Spio setosa*
7. Ventral lamellae little reduced; about 6 hooded crochets in each neuropodium (fig. 87) . . . . *Spio filicornis*

List of Species

Dispio uncinata Hartman, 1951. Burrows in sand.
Laonice cirrata (Sars, 1851). Dredged.
Polydora ciliata (Johnston, 1838). In shells.
Polydora commensalis Andrews, 1891. A bright orange-red worm, commensal with hermit crabs in snail shells; penetrates columnella of shell and not seen without breaking shell. Orange eggs attached in clusters in burrow.
Polydora ligni Webster, 1879. Makes vertical burrows in stiff mud or clay, often in estuaries. Eggs laid in capsules in burrows.
Prionospio heterobranchia Moore, 1907. At low water mark and dredged, in mud.
Prionospio steenstrupi Malmgren, 1867. Dredged in mud.
Scolecolepides viridis (Verrill, 1873). Penetrates further up estuaries than any other local polychaete.
Scolelepis squamata (O. F. Müller, 1789). Includes Nerinides agilis (Verrill, 1873). Makes vertical tubes in sandy beaches.
Spio filicornis (O. F. Müller, 1776). Dredged.
Spio setosa Verrill, 1873. The fragile chimney-like sandy tubes are distinctive in beach areas. Common.
Spiophanes bombyx (Claparède, 1870). Slender, branched, sandy tube.
Streblospio benedicti Webster, 1879. Characteristically in estuaries.

35. Family Sternaspidae (not in key)

Sternaspis scutata (Renier, 1807). Distinctive, gray, grub-like worms, with a pair of horny ventral plates. Dredged in soft bottoms.

36. Family Syllidae
Key

1. Without ventral cirri; palps reduced or lacking; often collected at night lights as sexually dimorphic males ("Polybostrichus") and females ("Sacconereis"), the latter bearing sacs of white or brilliantly colored eggs . . . . Subfamily AUTOLYTINAE 4
1. With ventral cirri; palps better developed 2

2. Antennae and cirri moniliform (beaded); oral palps free or fused at base only . . . . Subfamily SYLLINAE 5
2. Antenna and dorsal cirri smooth or indistinctly beaded 3

3. Palps not fused, or fused only at base . . . . Subfamily EUSYLLINAE 7
3. Palps fused for entire length; eggs and larvae attached along dorsal or ventral surfaces of the female . . . . Subfamily EXOGONINAE 11

Subfamily Autolytinae
Key

4. Without long capillary swimming setae: the "stem" or asexually reproducing form of Autolytus (fig. 37); see key in Pettibone (1963).
4. With long capillary swimming setae; in "heterosyllid" form with body in 2 or 3 distinct regions; sexually dimorphic; both males and the females, carrying 1-3 sacs of eggs, are often taken at night-lights. The specific identification of the tiny worms is difficult; consult the more complete treatment by Pettibone (1963).

Subfamily Syllinae
Key

5. Parapodia with simple setae only, few (2-5) in number, with bifid tips; dorsal cirri with ± 60 articles . . . . . *Syllis spongiphila*
5. At least some of parapodia have compound setae 6

6. Dorsal cirri alternately longer and shorter, with 20-40 articles; blades of upper compound setae fringed, appearing bifid . . . . *Syllis cornuta*
6. Dorsal cirri with 7-16 articles (figs. 23, 24); blades of compound setae do not appear bifid (fig. 25), but there may be heavy bifurcated simple setae (fig. 26) in some of the median segments . . . . *Syllis gracilis*

Subfamily Eusyllinae
Key

7. With occipital or nuchal epaulettes; body short, of few segments; proboscis long, sinuous, armed with a complete circle of bicuspid teeth . . . . *Amblyosyllis finmarchica*
7. Without occipital or nuchal epaulettes; proboscis straight 8

8. Occipital flap or nuchal hood covers rear of prostomium (fig. 28); proboscis armed with semicircle of 6-7 large recurved teeth (fig. 29) . . . . *Odontosyllis fulgurans*
8. Without nuchal hood 9

9. Proboscis armed with a large anterior tooth and with numerous denticles (fig. 32); prostomium with 6 eyes (fig. 31) . . . . *Eusyllis lamelligera*
9. Proboscis unarmed 10

10. Antennae and dorsal cirri cylindrical; acicula large, knobbed (fig. 30) . . . . *Streptosyllis* sp.
10. Antennae and dorsal cirri swollen, club shaped; without large knobbed acicula . . . . *Syllides* spp.

Subfamily Exogoninae
Key

11. Two pairs of tentacular (peristomial) cirri; 3 pairs of eyes; antennae and dorsal cirri fusiform (fig. 33) . . . . *Brania clavata*
11. One pair of tentacular cirri 12

12. Tentacular cirri 1 pair, similar to antennae; dorsal cirri swollen at base, tapering to narrow tip (fig. 36) . . . . *Sphaerosyllis erinaceus*
12. Tentacular cirri 1 pair, rudimentary; dorsal and ventral cirri cylindrical or club shaped, not swollen at base, median antenna fusiform, reaching nearly to end of palps (fig. 34) . . . . *Exogone* 13

13. Two pairs of eyes (fig. 35) . . . . Exogone dispar
13. Three pairs of eyes (fig. 34) . . . . Exogone hebes

Subfamily Autolytinae
List of Species

Autolytus alexandri Malmgren, 1867. On algae.
Autolytus cornutus A. Agassiz, 1863. Common on algae.
Autolytus emertoni Verrill, 1881. Taken in plankton.
Autolytus fasciatus (Bosc, 1802). Includes A. ornatus Verrill. Common on pilings.
Autolytus prismaticus (Fabricius, 1780). Dredged; in sponges.
Autolytus prolifer (O. F. Müller, 1788). Common on pilings.

Subfamily Syllinae
List of Species

Syllis cornuta Rathke, 1843. Dredged; in sponges.
Syllis gracilis Grube, 1840. Common, under stones or algae.
Syllis spongiphila Verrill, 1885. Dredged; in muddy sand.

Subfamily Eusyllinae
List of Species

Amblyosyllis finmarchica (Malmgren, 1867). Includes Pterosyllis cincinnata Verrill)
Eusyllis blomstrandi Malmgren, 1867. Dredged.
Eusyllis lamelligera Marion and Bobretsky. Includes E. fragilis Webster. Common; dredged among shells, bryozoans.
Odontosyllis fulgurans Claparède, 1864. Common on pilings. Reproduces by luminescent swarmers at surface.
Streptosyllis sp.
Syllides longocirrata Oersted, 1845. Includes S. convoluta Webster and Benedict. In sand.
Syllides setosa Verrill, 1882. In mussel beds.

Subfamily Exogoninae
List of Species

Brania clavata (Claparède, 1863). Common, in mud, mussel beds.
Brania wellfleetensis Pettibone, 1956.
Exogone dispar (Webster, 1879). Common, in mussel beds.
Exogone hebes (Webster and Benedict, 1884).
Exogone verugera (Claparède, 1868).
Parapionosyllis longicirrata (Webster and Benedict, 1884). Common in muddy sand.
Sphaerosyllis erinaceus Claparède, 1863. In sand or on pilings.

37. Family Terebellidae
Key

1. With dorsally placed gills just behind tentacular filaments (usually contrasting with filaments in color); body usually with pronounced thickening of "thoracic" region 2
1. Lacking dorsal gills (branchiae) on anterior part of body; bodies less stout, and departing more from the fully expressed "typical" terebellid form than the above group 11

2. Gills arborescent or branching in tree-like fashion (fig. 38) 3
2. Gills consisting of one to many unbranched filaments (fig. 39) 8

3. Three pairs of branching branchiae (note: one member of a pair may be very small or lacking) 4
3. Two pairs of branching branchiae (note: as above) 6
3. One pair of branching branchiae; numerous eyespots (fig. 41); 16 thoracic setigerous segments . . . . Pista maculata
3. With a single large branchia formed of 4 branchiae fused into one large trunk bearing 4 pectinate lobes (fig. 43); 18 thoracic setigers . . . . Terebellides stroemi

4. Setae on 40-50 segments; a large and common worm . . . . Amphitrite ornata
4. Setae on 23-45 segments . . . . Amphitrite johnstoni
4. Setae extend to posterior end of body . . . . Terebella lapidaria
4. Setae on 17 segments 5

5. Buccal segment with large lateral lobes, joined ventrally; the first of the three pairs of branchiae with long main stems, much longer than the last two pairs . . . . Loimia medusa
5. Without enlarged lateral lobes on buccal segment; branchiae subequal . . . . Amphitrite affinis

6. Setae on 17 segments (note: first setigerous segment lacks the neuropodial uncini); with lateral lobes on anterior segments 7
6. Setae on 15 segments; numerous eyespots (fig. 40); without lateral lobes on anterior segments . . . . Nicolea venustula

Note: The young of Nicolea are commonly seen as "hydra-worms" in washings of Fucus; they resemble creeping brown hydras with eyespots on cephalic ridge.

7. Branchiae spirally branched, making (when contracted) a compact oval red pompom on a stalk (fig. 42); one branchia usually much larger than rest . . . . Pista cristata
7. Branchiae arborescent, not spirally branched, with large main trunk, usually unequal in size . . . . Pista palmata

8. With 3 pairs of branchiae, each consisting of one simple long filament; numerous eyespots; 15 thoracic setigers . . . . Trichobranchus glacialis
8. With 2-3 pairs of branchiae, each made up of transverse rows of unbranched filaments (fig. 39) 9

9. Two pairs of branchiae; numerous eyespots; notosetae begin on second gill bearing segment and continue to posterior end . . . . Thelepus cincinnatus
9. Three pairs of branchiae; no eyespots 10

10. Notosetae begin on third branchial (gill bearing) segment, continue on 17 segments; uncini begin on second setiger; tube membranous, encrusted . . . . Amphitrite cirrata
10. Notosetae begin on first branchial segment and continue over a large part of body; uncini begin on fourth setiger; tube hard, coiled . . . . Streblosoma spiralis

11. Very soft and fragile; transparent to yellowish; no setae; somewhat resembles a damaged Leptosynapta when collected, but tentacles are terebellid-like . . . . Lysilla alba

11. Fragile, elongate, blood-red body; setae on all segments, but no uncini; branching red parapodia in mid body region: these look like gills, but note setae! (fig. 44) . . . . Enoplobranchus sanguineus

11. Small worms, enveloped in their tentacles, in which red corpuscles circulate, but lack actual branchiae; setae and uncini present in part of body . . . . Polycirrus 12

12. Red; setae on 18-25 segments; common . . . . Polycirrus eximius

12. Red; setae on 11-13 segments . . . . Polycirrus medusa

12. Lemon-yellow; setae on 24-32 segments . . . . Polycirrus phosphoreus

List of Species

Amphitrite affinis Malmgren, 1866. Dredged.

Amphitrite cirrata O. F. Müller, 1771. Dredged.

Amphitrite johnstoni Malmgren, 1866. Dredged.

Amphitrite ornata (Leidy, 1855). Common. Forms muddy mounds on intertidal flats.

Enoplobranchus sanguineus (Verrill, 1873). In mud; easily recognized by the brilliant color.

Loimia medusa (Savigny, 1818). Dredged.

Lysilla alba Webster, 1879. In quite muddy sand, where it makes a surface depression much like that of Leptosynapta.

Nicolea venustula (Montagu, 1818). Usually seen as the tiny (immature) "hydra worms" in washings from algae.

Pista cristata (O. F. Müller, 1776). Occurs in mud, but tube is very rough and encrusted with coarse pebbles. Common.

Pista maculata (Dalyell, 1853). Dredged.

Pista palmata (Verrill, 1873).

Polycirrus eximius (Leidy, 1855). The commonly taken form. Red cells circulate in tentacles.

Polycirrus medusa Grube, 1850. Dredged.

Polycirrus phosphoreus Verrill, 1880.

Streblosoma spiralis (Verrill, 1874). Dredged.

Terebella lapidaria (Linnaeus, 1767).

Terebellides stroemi Sars, 1835. Dredged.

Thelepus cincinnatus (Fabricius, 1780). Dredged.

Trichobranchus glacialis Malmgren, 1866. Dredged.

CRITICAL REFERENCES ON POLYCHAETES

Fauvel, P., 1923. Polychètes Errantes. Faune de France, Paris, 5: 1-488.

Fauvel, P., 1927. Polychètes Sédentaires. Faune de France, Paris, 16: 1-494.

Pettibone, M.H., 1963. Marine Polychaete Worms of the New England Region, Part 1, Families Aphroditidae through Trochochaetidae. Bull. U. S. Nat. Mus., 227: 1-356.

Pettibone, M.H., Ibid. Part 2, in preparation.

Hartman, O., 1951. Literature of the Polychaetous Annelids. Vol. 1. Bibliography.

Hartman, O., 1959. Catalogue of the polychaetous annelids of the world. Allan Hancock Foundation Publ., Occas. Paper 23: 1-628. (For additional bibliography and synonymy).

PHYLUM ARTHROPODA

Subphylum Chelicerata

In the great group of chelicerates are included a variety of "arachnoid" types, most of which are in highly specialized terrestrial groups. Marine representatives include the primitive and ancient Xiphosurida ("horseshoe crabs"), the small and specialized order of Pycnogonida ("sea spiders") of obscure affinities, and the marine mites (Order Acarina, Family Halacaridae). Of the latter, about 20 species have been recorded from southern New England, but the study of these small creatures presents difficulties, and the interested student is referred to the comprehensive work of Newell, I. M., 1947. A systematic and ecological study of the Halacaridae of eastern North America. Bull. Bingham Oceanogr. Coll., 10: 1-232.

Class Xiphosurida

Limulus polyphemus (Linnaeus), the common "horseshoe crab", has been almost universally known as Limulus, except for a brief period in which the name Xiphosura polyphemus was unfortunately used. Briefly: in 1928 the International Commission on Zoological Nomenclature placed Limulus of O. F. Müller 1785 on the "Official List of Generic Names in Zoology" in the mistaken belief that this name was available and valid. However, Xiphosura was later found to have been used by Brünnich in 1771 for this animal, and so had priority. The discovery that the 1928 Opinion was made in error led some workers to consider it "not binding", and in the period around 1950 the authors of several works (including "Selected Invertebrate Types") used Xiphosura. In 1955, the International Commission, acting under its plenary powers (suspension of the rules) invalidated the priority of Xiphosura as a generic name of the American horseshoe crab. Opinion 320, including the letters expressing the views of specialists, makes instructive reading.

Class Pycnogonida

Despite the abundance of pycnogonids (about 50 genera and 500 species) in the seas of the world, the fauna of Woods Hole includes only three common species: Tanystylum orbiculare, Callipallene brevirostris, and Anoplodactylus lentus. This group has received little attention in recent years, although the first good systematic report on them in America was that on New England Pycnogonida by E. B. Wilson, and their embryology was described by T. H. Morgan in his doctoral thesis (1891). Most shore pycnogonids feed upon hydroids and the young stages of many species encyst or form galls in hydroids. Since our information is still incomplete, collectors would do well to note the associated coelenterate in making collections. The following key will separate the common local species, plus one common north of the Cape; for anything that will not key out, consult Hedgpeth (1948).

KEY TO COMMON PYCNOGONIDS
(Figure references are to Plate 11)

1. Chelifores present; palpi lacking (fig. 1) 2
1. Chelifores absent; palpi present, of 4-7 joints (fig. 4); small species (TANYSTYLIDAE) . . . . Tanystylum orbiculare

2. Ovigerous legs 10-jointed and present in both sexes; (fig. 3) (PALLENIDAE) . . . . Callipallene brevirostris
2. Ovigerous legs less than 10-jointed, and lacking in females (fig. 6) . . . . PHOXICHILIDIIDAE 3

3. Cephalic segment extended forward as a short neck, overhanging base of proboscis (fig. 5) . . . . *Anoplodactylus lentus*
3. Cephalic segment not forming a neck (fig. 2) (common north of Cape) . . . . *Phoxichilidium femoratum*

ANNOTATED LIST OF PYCNOGONIDS REPORTED FROM

THE CAPE COD REGION

Anoplodactylus lentus Wilson, 1878. Breeds in August at Woods Hole. Dawson has described the colored blood corpuscles (Biol. Bull., 66: 1934). Rare north of Cape. In Morgan's embryological work, called *Phoxichilidium maxillare*.

Callipallene brevirostris (Johnson, 1837). The smallest of the common pycnogonids at Woods Hole. Found among hydroids and on pilings. Referred to by Morgan as *Pallene empusa*.

Endeis spinosa (Montagu, 1808). Not in key. Occasional at Woods Hole upon drifting *Sargassum*.

Pycnogonum littorale (Ström, 1762). Not in key. No record for Woods Hole, although within the reported range.

Phoxichilidium femoratum (Rathke, 1799). Has been taken abundantly on *Tubularia* north of the Cape.

Tanystylum orbiculare Wilson, 1878. Common but small and easily overlooked; found on pilings and among ascidians and hydroids.

REFERENCES

Hedgpeth, J. W., 1948. The Pycnogonida of the western North Atlantic and the Caribbean. Proc. U. S. Nat. Mus., 97: 157-342.

Morgan, T. H., 1891. A contribution to the embryology and phylogeny of the pycnogonids. Studies from the Biol. Lab., Johns Hopkins Univ., 5: 1-76, pl. I-VIII.

Wilson, E. B., 1878. Synopsis of the Pycnogonida of New England, Trans. Conn. Acad. Arts & Sci., 5: 1-26.

Plate 11

PYCNOGONIDA, CIRRIPEDIA

(1-6) Pycnogonids after Hedgpeth (scale bars = 1 mm); (7-18) barnacles after Zullo; all redrawn by Bruce Shearer.

1. Anatomy of a generalized pycnogonid:
2. *Phoxichilidium femoratum*.
3. *Callipallene brevirostris*.
4. *Tanystylum orbiculare*.
5. *Anoplodactylus lentus*.
6. Ovigerous leg of male *A. lentus*.

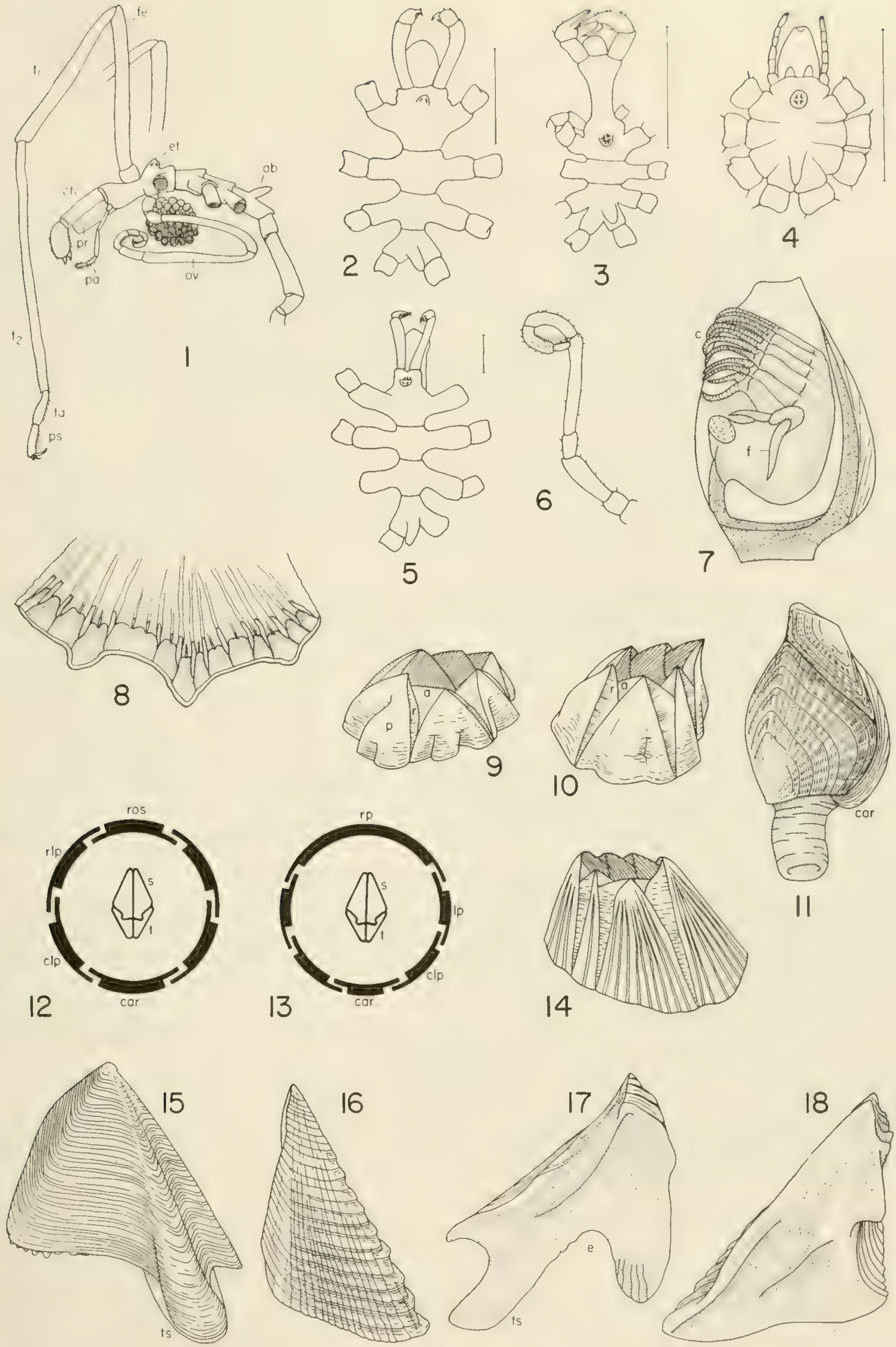
Abdomen (ab)
Eye tubercle (et)
Chelifore (ch)
Palp (pa)
Proboscis (pr)
Ovigerous leg (ov)
Femur (f)
Tarsus (t)
Tibia, first, second (t_1, t_2)
Propodus (p)

7. Generalized lepadomorph barnacle with capitular sheath cut away to show cirri and filamentary appendages.
8. *Balanus balanus*, base of shell wall seen from below, showing internal ribs and septa.
9. *Balanus improvisus*, shell only, showing radius only partly overlapping ala.
10. *Balanus eburneus*, shell only, showing extensive overlap of ala by radius.
11. *Lepas anserifera*, seen from right side.
12. Diagram of plate arrangement in *Chthamalus*.
13. Diagram of plate arrangement in *Balanus*.
14. *Balanus amphitrite niveus*, showing color pattern of longitudinal striae.
15. Exterior of tergum of *Balanus improvisus*, showing tergal spur.

ala (a)
carina (car)
carinolateral plate (clp)
cirri (c)
excavation of tergum (e)
filamentary appendages (f)
lateral plate (lp)
paries (p)
radius (r)
rostral plate (rp)
(rp = fused ros + rlp)
rostrolateral plate (rlp)
rostrum (ros)
scutum (s)
tergal spur (ts)
tergum (t)

16. Exterior of scutum of *B. eburneus*, showing radial striations.
17. Interior of tergum of *B. eburneus*, showing excavation on carinal side of basal margin.
18. Interior of scutum of *B. amphitrite amphitrite*, showing adductor ridge (diagonal line near center).

Plate 11



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PHYLUM ARTHROPODA

Class Crustacea

Lower Crustacea and Cirripedia

Keys are available only for some of the numerous and varied crustacean groups. Branchiopods in general are found in fresh water, and may be worked out with the aid of Ward and Whipple or of Pennak's guide to fresh water life. Copepods and ostracods, because of the number of species and their small size, do not lend themselves to keying at the level of this guide. Cirripedes, amphipods, and isopods will prove difficult. The decapods, on the other hand, are well known and large forms, and, with some exceptions, can be identified with a fair degree of certainty. A key to the subclasses and major orders of crustaceans is not presented; the reader is referred to a basic reference text on invertebrate zoology.

In matters of classification and nomenclature, these keys follow the system outlined by Waterman and Chace in Chapter I, Vol. I, of "The Physiology of Crustacea", edited by T. H. Waterman. The excellent systematic indices of the two volumes are very helpful in respect to the synonymy of experimentally used crustaceans.

Subclass Cephalocarida (no key) Hutchinsoniella macracantha Sanders, 1955 is found in soft sediments at 10-30 meters depth. Not rare but very small (2-3.5 mm). See figure in Sanders, H. L., 1963. Cephalocarida. Functional morphology, larval development, comparative external anatomy. Mem. Conn. Acad. Arts & Sci., 15: 1-80.

Subclass Branchiopoda

Order Anostraca (no local marine representatives)
Order Notostraca (no local marine representatives)
Order Conchostraca (no local marine representatives)
Order Cladocera (no key): The genera Evadne and Podon occur in the marine plankton.

Subclass Ostracoda (no key): Numerous marine representatives.

Subclass Mystacocarida (no key): Derocheilocaris typicus Pennak and Zinn (Smithsonian Misc. Coll., 103(9): 1943) is the type of this subclass. It is minute (0.4-0.5 mm) and lives in the spaces between sand grains on Nobska and Falmouth beaches.

Subclass Copepoda (no key): Extremely numerous in sea, both free living and parasitic. See Wilson, C. B., 1932. The copepods of the Woods Hole Region, Massachusetts. U. S. Nat. Mus. Bull. 158: I-XIX, 1-635.

Subclass Branchiura (no key): "Fish lice"; the genus Argulus occurs on fish in both fresh and salt water. Formerly considered an order (Arguloida) of the Copepoda, but now separated on the basis of their compound eyes and other features. For local species see Wilson (1932; cited above) pp. 11-18.

by Victor A. Zullo

Order Thoracica
(Figure references are to Plate 11)

Classification and identification of thoracic barnacles is based primarily on three sets of criteria: 1) mode of attachment to the substrate, 2) number, morphology and arrangement of the calcareous plates forming the shell wall (compartmental plates) and closing the orifice (opercular valves), and 3) morphology of the mouth parts (trophi) and appendages (cirri). The Thoracica of this region are easily divided into two suborders on the basis of the mode of attachment. Members of the Suborder Lepadomorpha are distinguished by the presence of a conspicuous, fleshy attachment stalk (peduncle) below the distal, expanded end (capitulum) which is more or less completely sheathed by calcareous plates. The shell in members of the Suborder Balanomorpha, on the other hand, is attached directly to the substrate, and it is to this group that most of the common barnacles of the Cape Cod Region belong.

The lepadomorphs included in the key are all of the genus *Lepas*. Specific determination is based 1) on the form and ornamentation of the plates (scutum, tergum, and carina) sheathing the capitulum (fig. 11), and 2) on the number of filamentary appendages present at the base of Cirrus I and on the prosoma. This latter feature can only be observed by removing one side of the capitular sheath to expose the body of the barnacle (fig. 7).

The balanomorphs commonly found in this region (*Chthamalus* and *Balanus*) have a shell wall composed of six compartmental plates and the orifice filled by four opercular valves (2 scuta and 2 terga) (figs. 12-13). Both end plates of the shell wall (rostrum and carina) are overlapped by the adjacent compartmental plates in the genus *Chthamalus* (fig. 12), but in the genus *Balanus*, one of the end plates (rostral plate) overlaps the adjacent plates (fig. 13).

Specific identification of balanomorph species requires a more detailed examination of the opercular valves and shell. In some species, the basal plate sealing the barnacle to the substrate is membranous, but in others a calcareous plate is laid down and often remains attached to the substrate upon removal of the barnacle. The shell wall in many species of *Balanus* is formed of vertical inner and outer laminae separated by longitudinal septa. These septa are usually reflected on the inner shell wall as regularly spaced, longitudinal ribs, which are especially evident near the base of the shell wall. In some instances the number of ribs exceeds the number of septa, and this character is used to differentiate certain species (fig. 8). The development of the articulation between adjacent compartmental plates is also a useful character in the identification of some taxa. In *B. improvisus*, for example, the overlapping section of the plate (radius, plural radii) is narrow and does not cover the overlapped section (ala, plural alae) or extend to the central part of the adjacent plate (paries, plural parieties) (fig. 9).

The removal and examination of opercular valves is necessary for proper identification of most species. The presence or absence on the scutum of an adductor ridge, or external radial striae (figs. 16, 18), and the degree of development of the tergal spur (figs. 15, 17) are characters which are used in the key. However, there are many other features of these valves which are equally significant in specific determination.

KEY TO COMMON BARNACLES OF THE WOODS HOLE REGION

1. Animal enclosed in shell composed of varying numbers of plates 2
1. Animal without shell, found in burrow with comma shaped aperture in the shells of gastropods occupied by hermit crabs . . *Trypetesa lampas*

2. Shell attached directly to substrate . . . . Suborder BALANOMORPHA 3
2. Shell attached to substrate by fleshy stalk or peduncle Suborder LEPADOMORPHA 9

3. Both end plates of shell wall (rostrum and carina) overlapped by adjacent plates (fig. 12); shell dull brown or grey; basis membranous . . . . *Chthamalus fragilis*
3. Only one end plate (carina) overlapped by adjacent compartmental plates, the opposing rostral plate overlapping adjacent plates (fig. 13) . . . . *Balanus* 4

4. Basis membranous . . . . *Balanus balanoides*
4. Basis calcareous 5

5. Exterior of scutum distinctly striate longitudinally (fig.16) 6
5. Exterior of scutum lacking distinct longitudinal striae 7

6. Ribs at base of interior of parieties more numerous than parietal septa (fig. 8); basis solid; basal margin of tergum entire . . . . *Balanus balanus*
6. Ribs at base of interior of parieties a continuation of parietal septa; basis porose; carinal side of basal margin of tergum deeply excavated (fig. 17) . . . . *Balanus eburneus*

7. Adductor ridge of scutum absent . . . . *Balanus crenatus*
7. Adductor ridge of scutum well developed (fig. 18) 8

8. Radii not extending to parieties of adjacent compartmental plates, with oblique summits (fig. 9); tergal spur narrow, less than 1/4 width of basal margin (fig. 15); parieties white . . . . *Balanus improvisus*
8. Radii extending to parieties of adjacent compartmental plates, with slightly sloping summits (fig. 10); tergal spur at least 1/4 width of basal margin; exterior of parieties with regularly arranged gray, purple, or red-purple longitudinal striae (fig. 14) . . . . *Balanus amphitrite niveus*

9. Carina terminating below in an expanded disk, with umbo projecting angularly; valves thin, papery . . . . *Lepas fascicularis*
9. Carina terminating below in a fork; umbo basal; valves well calcified 10

10. Valves radially furrowed or strongly striate (fig. 11) 11
10. Valves smooth or minutely striate 12

11. Occludent margin of scutum arched, protuberant, forming wide shelf between margin and umbonal-apical ridge; 5-6 filamentary appendages on either side of body . . . . *Lepas anserifera*
11. Occludent margin of scutum not arched, nearly parallel with umbonal-apical ridge, leaving comparatively narrow area between margin and ridge; 0-2 filamentary appendages on either side of body at base of Cirrus I . . . . *Lepas pectinata*

12. One or 2 filamentary appendages (fig. 7) on either side of body . . . . *Lepas anatifera*
12. Three filamentary appendages on either side of body . . . . *Lepas hilli*

ANNOTATED LIST OF COMMON BARNACLES

Order Thoracica

Suborder Lepadomorpha

Lepas anatifera Linnaeus, 1758. Common during July and August on floating wood and Sargassum.

Lepas anserifera Linnaeus, 1767. Occasionally associated with L. pectinata on driftwood.

Lepas fascicularis Ellis and Solander, 1786. Found attached to floating Sargassum during the summer months.

Lepas hilli Leach, 1818. Some of the records of this species from the Cape Cod Region may be based on misidentifications of L. anatifera.

Lepas pectinata Spengler, 1793. This species is often associated with L. anatifera on floating wood in Buzzards Bay and Vineyard Sound during the summer months.

Suborder Balanomorpha

Balanus (Balanus) amphitrite niveus Darwin, 1854. (= B. venustus niveus). The most common barnacle in the subtidal waters of Buzzards Bay and Vineyard Sound. Found on stones and shells, especially those of gastropods occupied by hermit crabs. Not known north of Cape Cod nor in Cape Cod Bay.

Balanus (Balanus) balanus (Linnaeus 1758). (= B. porcatus). A large, strongly ribbed barnacle in the lower intertidal zone north of and throughout the Cape Cod Canal. Occasional specimens are found subtidally in Vineyard Sound.

Balanus (Balanus) crenatus Bruguière, 1789. Occasionally associated with B. amphitrite niveus in the subtidal waters of Vineyard Sound, but more common in Cape Cod Bay.

Balanus (Balanus) eburneus Gould, 1841. Common in the lower intertidal of protected inlets and bays, and especially in waters of lower salinity with B. improvisus.

Balanus (Balanus) improvisus Darwin, 1854. Common in waters of low salinity on the southern coast of Cape Cod, and often associated with B. eburneus.

Balanus (Semibalanus) balanoides (Linnaeus, 1767). The most abundant and ubiquitous barnacle in the intertidal zone of the Cape Cod Region, but drops out in brackish waters.

Balanus (Chirona) hameri (Ascanius, 1761). Not in key. Common on the large commercial scallop, Placopecten magellanicus, abundant in deeper water, as on fishing banks. Potentially important to physiologists because it is by far the largest barnacle in this region, over 5 cm in basal diameter.

Chthamalus fragilis Darwin, 1854. Abundant in the upper intertidal zone of Buzzards Bay and Vineyard Sound. Also present in limited numbers along the southern shore of Cape Cod Bay, but not known to occur north of this area.

Order Acrothoracica

Trypetesa lampas (Hancock, 1849). (= Alcippe lampas). Found only in the floor and side of the interior of the body whorl of gastropod shells such as Lunatia heros and Neverita duplicata occupied by hermit crabs.

REFERENCES

Darwin, C., 1851. A monograph on the sub-class Cirripedia, Lepadidae. Ray Society, London, i-xi, 1-400, pls. 1-10.

Darwin, C., 1854. A monograph on the sub-class Cirripedia, Balanidae, Verrucidae. Ray Society, London, i-viii, 1-684, text figs. 1-11, pls. 1-30.

Genthe, K. W., 1905. Some notes on Alcippe lampas and its occurence on the American Atlantic shore. Zool. Jahrb. (Anat.), 21: 181-200.

Pilsbry, H. A., 1907. The barnacles (Cirripedia) contained in the collections of the U. S. National Museum, Bull. U. S. Nat. Mus. 60: i-x, 1-122, text figs. 1-36, pls. 1-11.

Pilsbry, H. A., 1916. The sessile barnacles (Cirripedia) contained in the collections of the U. S. National Museum; uncluding a monograph of the American species. Ibid., 93: i-xi, 1-366, text figs. 1-99, pls. 1-76.

Zullo, V. A., 1963. A preliminary report on systematics and distribution of barnacles (Cirripedia) of the Cape Cod region. Systematics-Ecology Program, Marine Biological Laboratory, Woods Hole, Mass., 33 pp.

Order Rhizocephala

The Rhizocephala are parasitic cirripeds which infest decapod crustaceans and isopods. The adult rhizocephalan is highly modified in body form and bears no resemblance to other cirripeds. The affinities of this group are exhibited only by the larval stages which include a nauplius with characteristic frontal horns (although lacking an alimentary canal) and a cypris.

The life history of the common European species Sacculina carcini (Thompson) was worked out by G. Smith in 1907. The fertilized eggs mature and develop into cirripedan nauplii within the "mantle cavity" of the parent. The nauplii are released and swim actively for four days during which they pass through four molts. On the fifth day the nauplius undergoes metamorphosis into the cypris stage which is also actively free-swimming and lasts from two to three days. About the third day the cypris attaches itself by the antennules to the base of a seta of the portunid crab Carcinus maenas. The thoracic appendages and musculature are cast off and a new larva, the kentrogen, composed of a mass of mesodermal cells surrounded by an ectodermal chitinous bag is produced under the old cypris shell. A hollow, dart-like ectodermal process pierces the base of the seta to which the kentrogen is attached, and the enclosed mesodermal cells pass through into the haemocoel of the crab and settle near the midgut. The cells rapidly divide and form a tumor about the midgut with numerous divergent roots which eventually extend into the extremities of the crab. The main body mass of Sacculina emerges from the interior after the following molt of the host at a point near the ventral juncture of the thorax and abdomen. Further molting is inhibited by the parasite, whose adult organs (including paired ovaries and testes, and a neural ganglion) now differentiate.

Rhizocephalans have not been reported from the Cape Cod Region, although Sacculina carcini parasitizes the green crab Carcinus maenas, and Peltogaster the hermit crab Pagurus bernhardtus in European waters. The works of Professor Hilbrand Boschma (1925-1963) may be consulted for details on the Rhizocephala. A complete bibliography is given in Zool. Meded. (1964), vol. 39, pp. XLI-XLVI.

PHYLUM ARTHROPODA

Class Crustacea

The Lower Malacostraca (Peracarida)

The successful, abundant, and varied peracaridan crustaceans are most commonly represented in shore collecting by isopods and amphipods, the general features of which are well known to the average zoologist. In their rather specialized morphology these orders depart somewhat from the more generalized and shrimp-like body form which is basic to the Subclass Malacostraca. However, certain other peracaridan orders, the swimming Mysidacea and the small, bottom-dwelling Cumacea, retain an essentially shrimp-like form, with carapace and elongated abdomen. The Key to Orders given below will aid in the separation of these groups. The diverse peracaridan orders share one feature, namely, the brood pouch or "marsupium" formed of plates (oöstegites) borne by the thoracic legs of the female, and used to house the eggs and developing young.

KEY TO THE ORDERS OF PERACARIDA

1. Body having the "caridoid" (shrimplike) form, with a distinct carapace over the thorax and an elongated abdomen 2
1. Body having thorax and abdomen not sharply distinguishable; carapace lacking or very small 3

2. Eyes stalked when present; carapace covering all or most of thorax; swimming forms . . . . MYSIDACEA (p.93)
2. Eyes sessile when present; carapace covering only 3 or 4 thoracic segments and inflated into a branchial chamber on each side; in bottom sediments . . . . CUMACEA (p.98)

3. A small carapace present, covering only 2 thoracic segments; resemble small isopods but have first pair of legs chelate . . . . TANAIDACEA (CHELIFERA) (p.102)
3. Carapace lacking 4

4. Body usually dorsoventrally flattened; thoracic legs (except for maxilliped) essentially alike; abdomen with 5 pairs of pleopods with unsegmented rami, and 1 pair of uropods . . . . . . ISOPODA (p.102)
4. Body usually laterally compressed; thoracic limbs of more than one form, with the 2nd and 3rd pairs usually prehensile; abdominal appendages consist of 3 pairs of pleopods and 3 pairs of uropods . . . . AMPHIPODA (p.107)

PART I. ORDER MYSIDACEA

By Roland L. Wigley

The mysids are the most typically shrimp-like ("caridoid") of the various peracaridan orders. They are adapted for swimming, with elongated bodies and a well developed carapace covering almost the entire thorax. The lightly calcified integument is thin and flexible. The antennules are biramous, having multi-segmented flagella; antennae have an exopod, usually in the form of a flattened scale (antennal scale); the endopod is flagelliform, composed of numerous segments. Eyestalks are cylindrical, well developed, terminating in a prominent brown or black (rarely red) cornea. The eight thoracic segments each bear biramous appendages; branchiae are absent in the species listed here. Females bear a large marsupium (hence the common name Opossum Shrimp) composed of 2-7 pairs of oöstegites attached to the thoracic limbs. The pleopod structure varies, depending on sex and species.

Mysids inhabit a wide variety of benthic and planktonic habitats. They are common in brackish and marine waters, but no freshwater forms are known in this region. Mysids are an important link in littoral and continental shelf food webs, and are particularly valuable as food for small species of fish as well as the young of larger fishes. Seasonal inshore-offshore migrations and other horizontal movements have been observed for a few species. Pronounced vertical migrations in which they swim upward during hours of darkness are characteristic of this group.

KEY TO MYSIDACEA OF THE CAPE COD REGION
(Figure references are to Plate 12)

1. Telson with posterior end cleft (figs. 4, 8, 9, 11) 2
1. Telson with posterior end entire (figs. 5-7, 10) 5

2. Antennal scale with setae present on both inner and outer margins (fig. 2) 3
2. Antennal scale with outer margin devoid of setae and terminating in an articulated spine (fig. 4) . . . . Praunus flexuosus

3. Telson with the entire lateral margins armed with spines. Antennal scale elongate, width 9 to 12 times length, produced into an acute apex (figs. 8, 9) 4
3. Telson with basal one-half of the lateral margins devoid of spines; antennal scale elliptical, apex blunt, 3.5 times as long as broad (figs. 3, 11) . . . . Heteromysis formosa

4. Antennal scale approximately 9 times as long as broad, outer margin nearly straight, telson lateral margin spines more than 30, extending posteriorly to apex (fig. 8) . . . . Mysis mixta
4. Antennal scale approximately 12 times as long as broad, outer margin concave in outline; telson lateral margin spines 25, extending posteriorly as far as the cleft (fig. 9) . . . . Mysis stenolepis

5. Antennal scale with setae present on both inner and outer margins; telson lateral margins armed with numerous spines (figs. 7, 10) 6
5. Antennal scale with setae absent on outer margin, terminating in a strong spine; telson without spines on lateral margins (figs. 5, 6) 7

6. Antennal scale about 10 times as long as broad (fig. 10); telson subequal in length to endopod of the uropod . . . . Neomysis americana
6. Antennal scale about 5 times as long as broad (fig. 7); endopod of the uropod 1.5 times as long as the telson . . . . Mysidopsis bigelowi

7. Eyes dorso-ventrally flattened, cornea kidney-shaped, red color; telson length subequal to its greatest width (fig. 5) . . . . Erythrops erythrophthalma
7. Eyes globular not dorso-ventrally flattened, cornea black; telson elongate, length 2 times its greatest width (fig. 6) . . . . Meterythrops robusta

ANNOTATED LIST OF MYSIDS

Erythrops erythrophthalma (Göes, 1863). Occasionally referred to as Erythrops goesii. Inhabits deeper waters, 40-275 meters, from Cape Cod to the Arctic. One of the most beautifully colored New England mysids. Eyes brilliant carmine red; opaque white pigment spots scattered over the body; an orange-red dorsal patch on the carapace and clear bright yellow pigment spots on the ventral body surface. Adult length 9-11 mm.

Heteromysis formosa S. I. Smith, 1873. A common species from New Jersey to Canada. Frequently in small swarms inside dead bivalve shells such as Spisula. Intertidal to 248 meters. Males semi-translucent, but parts of the females are a rose color. Adult length 6-9 mm.

Meterythrops robusta S. I. Smith, 1879. Uncommon; in the western Atlantic, occurs from Cape Cod to Greenland. 66-300 meters. Adult length 14-16 mm.

Mysidopsis bigelowi Tattersall, 1926. A warm water species, from Louisiana to Cape Cod. Most common at shallow shelf depths, 16-50 meters, but has been found to 196 meters. Adult length 7.5 mm or somewhat more.

Mysis mixta Lilljeborg, 1852. Occasionally referred to as Michtheimysis mixta. A common species of the east coast from Woods Hole to Canada. Closely related to Mysis stenolepis; however, in contrast, M. mixta inhabits areas where algae and Zostera are absent. Intertidal to 200 meters. Adult length 20-25 mm.

Mysis stenolepis S. I. Smith, 1873. Sometimes referred to as Michtheimysis stenolepis and Mysis spinulosus. Inhabits intertidal and shallow shelf waters from New Jersey to Gulf of St. Lawrence. Closely related to M. mixta (see above), but is a more strictly littoral weed inhabiting species. Adult length 25-30 mm.

Neomysis americana (S. I. Smith, 1873). Mysis americana is a synonym. Very common, from Virginia to the Gulf of St. Lawrence. Intertidal to 214 meters. Adult length 10-12 mm.

Praunus flexuosus (Müller, 1776). A European species of relatively large size, first found in American waters in 1960. Has been reported only in the harbor at Barnstable, Mass. In Europe is one of the commonest species in brackish waters and tidal zones along the coast. Adult length 24-25 mm.

REFERENCES ON MYSIDS

Lochhead, J. H., 1950. Heteromysis formosa. In: Selected Invertebrate Types. Frank A. Brown, Jr., ed. John Wiley and Sons, Inc., N. Y.

Smith, S. I., 1879. The stalk-eyed crustaceans of the Atlantic coast of North America north of Cape Cod. Trans. Conn. Acad. Arts and Sci., 5: 27-138, pls. 7-12.

Tattersall, W. M., 1951. A review of the Mysidacea of the United States National Museum. U. S. Nat. Mus. Bull. 201,: I-X, 1-292.

Tattersall, W. M., and Olive S. Tattersall, 1951. The British Mysidacea. Ray Society, London.

Verrill, A. E., S. I. Smith, and O. Harger, 1873. Catalogue of the marine invertebrate animals of the southern coast of New England, and adjacent waters. Section D. In: Report upon the invertebrate animals of Vineyard Sound and adjacent waters, with an account of the physical characters of the region. By A. E. Verrill. Rept. U. S. Comm. Fish and Fisheries, 1871-72: 537-749, pls. 1-38.

Plate 12

MYSIDACEA

Figures mainly from Tattersall (1951) and
Tattersall and Tattersall (1951), redrawn
by Ruth L. von Arx.

Fig. 1. Side view of a typical mysid, ovigerous female, thoracic legs 1-7 omitted.

2. Antennal scale and basal portion of antenna of a typical mysid.

3. Heteromysis formosa, dorsal view.

4-11. Upper row shows telsons, lower row shows antennal scales, both in dorsal view, of the following species:

4. Praunus flexuosus.

5. Erythrops erythrophathalma.

6. Meterythrops robusta.

7. Mysidopsis bigelowi.

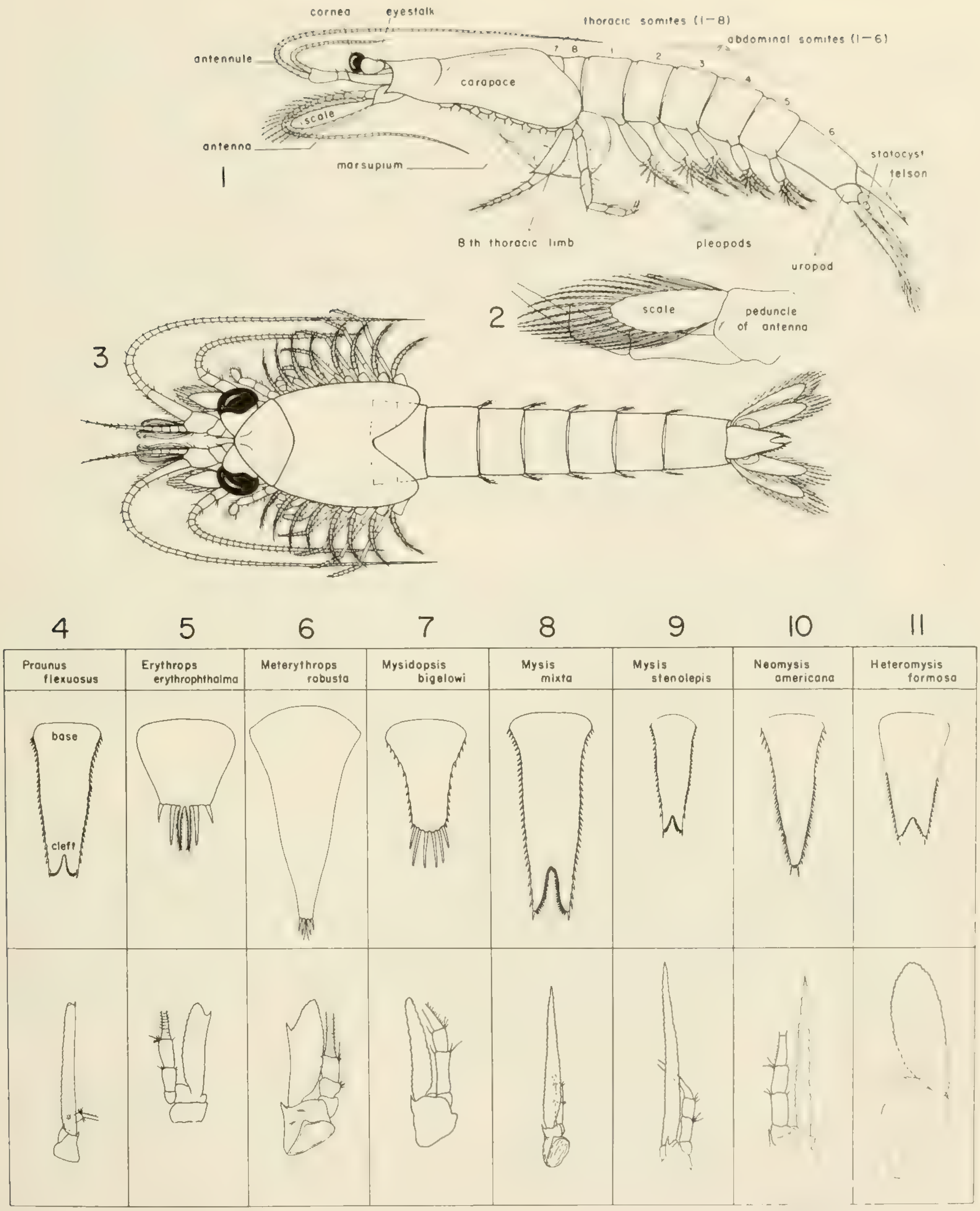
8. Mysis mixta.

9. Mysis stenolepis.

10. Neomysis americana.

11. Heteromysis formosa.

Plate 12


1
cornea
eyestalk
thoracic somites (1–8)
abdominal somites (1–6)
antennule
carapace
scale
antenna
marsupium
statocyst
telson
8 th thoracic limb
pleopods
uropod
2
scale
peduncle of antenna
3
4
5
6
7
8
9
10
11
Praunus flexuosus
Erythrops erythrophthalma
Meterythrops robusta
Mysidopsis bigelowi
Mysis mixta
Mysis stenolepis
Neomysis americana
Heteromysis formosa
base
cleft

PART 2. ORDER CUMACEA

By Roland L. Wigley

Cumaceans, although widespread in marine situations and with some species in brackish waters, are not well known to the average zoologist because of their small size and habit of living buried in sand or mud. The general body form is distinctive, characterized by an inflated cephalothorax and a slender, cylindrical abdomen. The carapace is moderately large, covering the anterior half of the cephalothorax. The integument in many species is rather heavily calcified and brittle. The first thoracic limb (maxilliped) bears a membranous epipodite, usually furnished with respiratory lamellae. A pseudorostrum is present in many species, formed by carapace lateral plates coming together above and in front of the head. Eyes are present in some species, sessile and usually coalesced to form a single organ on a lobe located mid-dorsally on anterior portion of carapace. First antenna with inner flagellum usually reduced or absent; second antenna vestigial in females, well developed in males. First 3 thoracic appendages modified as maxillipeds; remaining 5 as peraeopods. One pair of large styliform uropods present. Telson is distinct, or coalesced with last abdominal somite. Adults in this region generally range from 3 to 15 mm in length.

There is pronounced sexual dimorphism; pleopods are absent in all females and in males of some species, but males generally have from 1 to 5 pairs. Eggs are incubated in a marsupium, and hatch as postlarvae in which the past pair of peraeopods is undeveloped.

Cumaceans are primarilv marine, but a few species occur in brackish waters. They are widely distributed in all oceans from intertidal zone to great depths in mid-ocean, most common subtidally. Basically benthic in habit, they commonly burrow in mud or sand. They occasionally undertake pelagic excursions, chieflv at night, at which time males greatly outnumber females.

KEY TO CUMACEANS OF THE CAPE COD REGION
(Figure references are to Plate 13)

1. Independent telson present (figs. 23-26) 2
1. Without independent telson (figs. 15-22) 7

2. Uropod inner ramus 1-jointed; telson without spines (figs. 13, 23) . . . . *Petalosarsia declivis*
2. Uropod inner ramus 2- or 3-jointed; telson with lateral and apical spines (figs. 24-26) 3

3. Telson with 5 apical spines; male without pleopods . . . *Lamprops quadriplicata*
3. Telson with 0 or 2 apical spines; male with 2 pairs of pleopods . . . . Family Diastylidae 4

4. Telson apex upturned, without apical spines (figs. 11, 26) . . . . *Oxyurostylis smithi*
4. Telson apex not upturned, 2 apical spines (figs. 24, 25) . . . . *Diastylis* 5

5. Carapace with 4 large spines on dorsal surface (figs. 1, 24) . . . . *Diastylis quadrispinosa*
5. Carapace without dorsal spines (figs. 6, 7) 6

6. Carapace with 3 oblique lateral ridges; horizontal ridge on postero-lateral section of carapace in male (fig. 6) . . . . . *Diastylis polita*
6. Carapace with 4 oblique lateral ridges; without horizontal ridge on postero-lateral section of carapace in male (figs. 7, 25) . . . . *Diastylis sculpta*

7. Mandibles broadly truncate at base (fig. 14); male with 2 pairs of pleopods . . . . Family Leuconidae 8
7. Mandibles narrow or acuminate at base (fig. 13); male with 0, 3, or 5 pairs of pleopods 12

8. Pseudorostrum well developed . . . . Leucon americanus
8. Carapace truncate anteriorly without pseudorostrum 9

9. Uropods with outer ramus longer than inner ramus (fig. 18) . . . . Eudorellopsis deformis
9. Uropods with outer ramus shorter than inner ramus (figs. 15, 16) . . . . Eudorella 10

10. Body setose; approximately 14-18 teeth on carapace ventral margin (figs. 8, 15) . . . . Eudorella hispida
10. Body not setose; less than 14 teeth on carapace ventral margin 11

11. Anterior margin of carapace deeply emarginate in female, slightly emarginate in male (figs. 2, 3, 20) . . . . . . Eudorella emarginata
11. Anterior margin of carapace slightly emarginate in female, serrate or entire in male (figs. 9, 16) . . . . Eudorella truncatula

12. Endopod of uropod 2-jointed; 3 pairs of pleopods in male (figs. 10, 17) . . . . Leptocuma minor
12. Endopod of uropod 1-jointed; 0 or 5 pairs of pleopods in male (figs. 19, 22) 13

13. Male has no pleopods and a rudimentary second antenna; in female, uropod peduncle length about equal to maximum width of last abdominal somite (figs. 4, 22) . . . . Almyracuma proximoculi
13. Male has 5 pleopods and well developed second antenna; in female, uropod peduncle length greater than 2 times maximum width of last abdominal somite (figs. 5, 19) . . . . Cyclaspis varians

ANNOTATED LIST OF CUMACEANS

Almyracuma proximoculi Jones, 1959. Brackish water species, known only from Pocasset River. Adult size 3-4 mm.

*Campylaspis affinis G. O. Sars, 1869. Not yet reported from Cape Cod waters, but expected to occur in deeper portions of this area.

*Campylaspis rubicunda (Lilljeborg, 1855). Not yet reported from Cape Cod waters, but expected to occur in the deeper portions of this area.

Cyclaspis varians Calman, 1912. Brackish water species found in surface waters of Woods Hole Harbor and Vineyard Sound. Adult size 3-4 mm.

*Diastylis abbreviata G. O. Sars, 1871. Not yet reported from Cape Cod waters, but expected to occur in deeper portions of this area.

Diastylis polita S. I. Smith, 1879. Found at depths less than ca. 35 meters from Nova Scotia to Block Island Sound. Adult size 12-14 mm.

Diastylis quadrispinosa G. O. Sars, 1871. Occurs from the Gulf of St. Lawrence to New Jersey in depths of 4-400 meters. Adult size 11 mm.

Diastylis sculpta G. O. Sars, 1871. In American waters occurs from Gulf of St. Lawrence to Long Island; low water to ca. 400 meters. Adult size 9-10 mm.

Eudorella emarginata (Krøyer, 1846). In American waters occurs from the Arctic to Martha's Vineyard in depths from 2-130 meters. Adult size 10-12 mm.

Eudorella hispida G. O. Sars, 1871. Occurs from the Arctic to Martha's Vineyard, in depths from 30-130 meters. Adult size 5-6 mm.

Eudorella truncatula (Bate, 1856). On U. S. coast reported from Massachusetts Bay to Block Island Sound, in depths of 30-100 meters. Adult size 4-5 mm.

Plate 13

CUMACEA

Figures mainly from Sars (1900) and Calman (1912), redrawn by Ruth L. von Arx.

Fig. 1. Diastylis quadrispinosa, female, dorsal view.

2. Eudorella emarginata, female, lateral view.

3. Eudorella emarginata, male, lateral view.

4-12. Carapace in lateral view of the following species:

4. Almyracuma proximoculi, male.

5. Cyclaspis varians, female.

6. Diastylis polita, male.

7. Diastylis sculpta, male.

8. Eudorella hispida, female.

9. Eudorella truncatula, female.

10. Leptocuma minor, male.

11. Oxyurostylis smithi, male.

12. Petalosarsia declivis, male.

13. Petalosarsia declivis, mandible.

14. Eudorellopsis deformis, mandible.

15-26. Dorsal view of last abdominal somite, uropod, and telson of the following species:

15. Eudorella hispida, female.

16. Eudorella truncatula, female.

17. Leptocuma minor, female.

18. Eudorellopsis deformis, female.

19. Cyclaspis varians, male.

20. Eudorella emarginata, female.

21. Leucon americanus, male.

22. Almyracuma proximoculi, male.

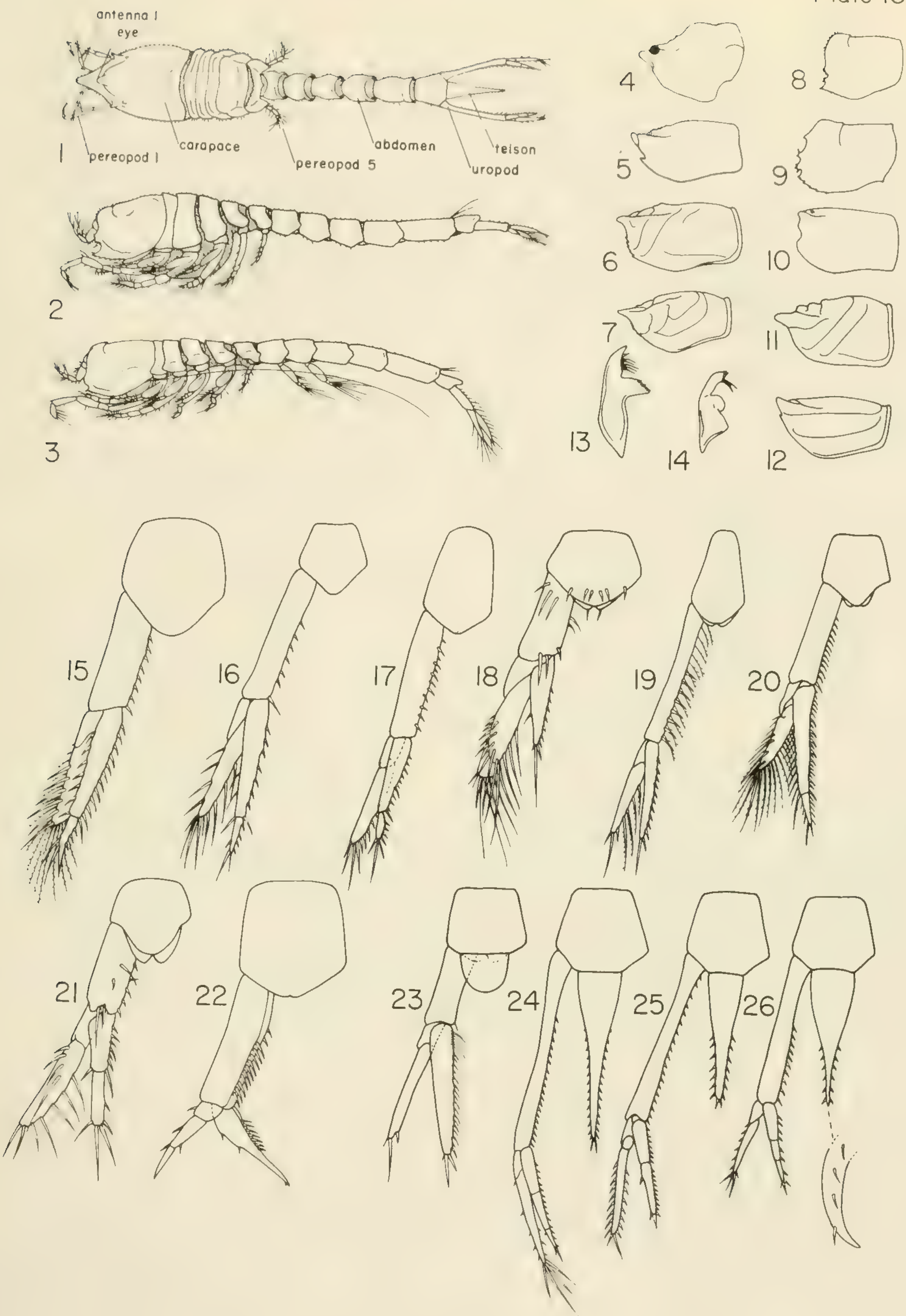
23. Petalosarsia declivis, female

24. Diastylis quadrispinosa, female.

25. Diastylis sculpta, female.

26. Oxyurostylis smithi, female; (inset: telson tip in side view).

Plate 13



antenna I
eye
pereopod I
carapace
pereopod 5
abdomen
telson
uropod
1
2
3
4
5
6
7
8
9
10
11
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25
26

Eudorellopsis deformis (Kroyer, 1846). In American waters reported from the Arctic to Long Island in depths of ca. 2-100 meters. Adult size 4-5 mm.

Lamprops quadriplicata S. I. Smith, 1879. Occurs from Newfoundland to southern New England, in depths from ca. 2-150 meters. Adult size 8-9 mm.

Leptocuma minor Calman, 1912. Occurs from Gloucester, Mass. to Woods Hole, in depths of ca. 2-100 meters. Adult size 6-7 mm.

Leucon americanus Zimmer, 1943. A brackish water species reported from Woods Hole and Chesapeake Bay. Adult size 4-5 mm.

Oxyurostylis smithi Calman, 1912. A euryhaline species, Maine to Louisiana, from surface to 20 meters. Adult size 6-7 mm.

Petalosarsia declivis (G. O. Sars, 1864). In American waters occurs from the Arctic to Buzzards Bay, in 20-200 meters.

*Not in key.

REFERENCES ON CUMACEANS

Calman, W. T., 1912. The Crustacea of the order Cumacea in the collection of the United States National Museum. Proc. U. S. Nat. Mus. 41: 603-676, text figs. 1-112.

Jones, N. S. and W. D. Burbanck, 1959. Almyracuma proximoculi gen. et sp. nov. (Crustacea, Cumacea) from brackish water of Cape Cod, Massachusetts. Biol. Bull. 116: 115-124.

Sars, G. O., 1900. An account of the Crustacea of Norway. vol. 3, Cumacea, pp. I-X, 1-115, pls. 1-72.

Smith, S. I., 1879. The stalk-eyed crustaceans of the Atlantic coast of North America north of Cape Cod. Trans. Conn. Acad. Arts and Sci. 5: 28-138, pls. 8-12.

PART 3. ORDERS ISOPODA AND TANAIDACEA (CHELIFERA)

Isopods are readily recognizable in most instances, except for the grossly modified parasitic forms. Since isopods are so common they are of great ecological significance, and certain species have been widely used in experimental work, hence their identification is a practical matter of much importance. Fortunately, the group is reasonably well known in the Woods Hole region, and specific identification does not offer such difficulties to the average zoologist as does the identification of amphipods. Tanaidaceans, because of their small size, are less frequently noticed. Since they have often been classified as a group within the Isopoda, and since they are so similar in general form, the two orders are combined in the following key. The advice of Thomas E. Bowman and of Roland L. Wigley in the preparation of the following key and check-list is gratefully acknowledged. Figure references on isopods and tanaidaceans are to Plates 14 and 15.

KEY TO THE MORE COMMON TANAIDACEA AND MARINE ISOPODA

1. First pair of legs chelate (figs. 1-3); 6 free thoracic segments; tiny creatures . . . . Order TANAIDACEA (CHELIFERA)
   Not well known locally; possibly species include:

   a) 3 pairs of pleopods . . . . Tanais cavolinii
   b) 5 pairs of pleopods . . . . Leptochelia savignyi

1. First pair of legs simple or subchelate; 7 free thoracic segments . . . . Order ISOPODA 2

2. Parasitic on crustacea; body may be grossly modified; males tiny . . . . Suborder Epicaridea (Bopyroidea) 26
2. Not parasitic on crustacea (a few are ectocommensal); body easily recognizable as that of an isopod 3

3. Uropods terminal, set at rear (figs. 17-19, 29, 30). 22
3. Uropods set laterally or ventrally (figs. 4-16, 26-28) 4

4. Uropods lateral, visible from above, flattened, forming with telson a caudal fan in most instances 5
4. Uropods ventral, not visible dorsally, turned inwards to form the cover of a chamber encasing the pleopods (fig. 11) . . .Suborder Valvifera 14

5. Thorax with only 5 pairs of normal walking legs; not reported locally . . . . Suborder Gnathiidea
5. Thorax with 7 pairs of more or less normal walking legs 6

6. Exopodal part of uropod arched over telson; body very long (7 times the width): Suborder Anthuridea; one species common locally in brackish situations (fig. 4) . . . . <u>Cyathura</u> <u>polita</u>
6. Uropodal exopods lateral; body length seldom if ever more than 5 times width . . . . Suborder Flabellifera

7. Pleotelson (abdomen and telson) shows 6 segments (figs. 6-9) 10
7. Pleotelson with segments fused so as to have only two complete segments, the terminal one of which is large and conspicuous 8

8. Uropods each with two flattened branches; all legs simple; animals able to roll themselves into a complete ball 9
8. Uropods each a single slender pointed process, lacking outer branches (exopods); terminal segment of abdomen triangular, with truncated apex (fig. 26); first and second pairs of legs subchelate . . . . <u>Ancinus</u> <u>depressus</u>

9. Terminal segment of abdomen rounded at rear; exopods of uropods with outer serrated margin (fig. 27) . . . . . <u>Sphaeroma</u> <u>quadridentatum</u>
9. Terminal segment bluntly triangular; exopods of uropods with smooth outer margin (fig. 28) . . . . <u>Exosphaeroma</u> <u>papillae</u>

10. Exopod of uropod flattened (not clawlike) and comparable to endopod in size, forming a normal caudal fan 12
10. Exopod of uropod clawlike and much smaller than endopod (fig. 7); uropods very small relative to telson; animals burrow in wood ("gribbles") . . . . <u>Limnoria</u> 11

11. Telson lacking tubercles and with a Y-shaped ridge (fig. 7) . . . . <u>Limnoria</u> <u>lignorum</u>
11. Telson with tubercles on posterior margin and with three tubercles on dorsal surface (fig. 8) . . . . <u>Limnoria</u> <u>tripunctata</u>

12. Bases of antennae seem to meet in front of the head as seen from above (fig. 5); head terminating in a small point; front 3 legs with slightly hooked tips; endopod of uropod notched laterally . . . . <u>Cirolana</u> <u>concharum</u>
12. Bases of antenna not meeting in midline (figs. 6, 9); all thoracic legs end in hooked dactyls; animals usually found clinging to fish or around fish-landing docks 13

13. Form regular and oval; 2 longitudinal light stripes run length of body; head subquadrate with trilobed rear margin and distinct eyes; abdomen and uropods well developed; body to 13 mm long (fig. 9) . . . . *Nerocila munda*
13. Form oval but with a slight asymmetry; head relatively small with eyes indistinct; abdomen with relatively small uropods; body stout, to 25 mm long (fig. 6) . . . . *Lironeca ovalis*

14. Sides of head entire (figs. 10, 12); eyes lateral 18
14. Sides of head notched or incised (figs. 23-25); eyes dorsal; body broad, with pointed telson . . . . *Chiridotea* 15

(Note: see Bowman (1955) and Wigley (1961) for additional details on identification of *Chiridotea* species).

15. Second (more ventrally placed) antennae decidedly longer than the first pair (figs. 23, 24) 16
15. Second antennae nearly equaling in length the first pair (fig. 25) 17

16. Sides of telson curved; finger of first large gnathopod with a single spine back of the terminal claw (fig. 23 A-C); animal occurs in brackish water . . . . *Chiridotea almyra*
16. Sides of telson straight, telson wedge shaped; finger of first gnathopod with several spines along the inner margin (fig. 24 A-C); animal marine . . . . *Chiridotea tuftsi*

17. Clefts in sides of head deep (fig. 25A); antero-lateral margins of head with numerous bristles; body color light . . . . . *Chiridotea coeca*
17. Clefts in sides of head shallow; antero-lateral margins of head only sparsely provided with bristles; body color dark; occurs in brackish waters . . . . *Chiridotea nigrescens*

18. Pleotelson seems to consist of 3 parts (plus grooves showing a 4th partly coalesced segment); common . . . . *Idotea* 19
18. Pleotelson seems to consist of one part (plus grooves suggesting one partly coalesced segment) 20

19. Rear of telson bracket-shaped, with a central point (fig. 10) . . . . *Idotea baltica*
19. Rear of telson truncated (cut square across) (fig. 12) . . *Idotea metallica*
19. Rear of telson pointed (fig. 13) . . . . *Idotea phosphorea*

20. Pleotelson sides tapering to a point; in side view shows 2 rounded elevations separated by a depression (fig. 14); second antennae short, reaching back only to second thoracic segment . . . . *Edotea triloba*
20. Pleotelson with more or less parallel sides cut off to a triangular point at rear; second antennae long, reaching to 5th thoracic segment . . . . *Erichsonella* 21

21. Pleotelson with a pronounced tubercle on either side (fig. 15) . . . . *Erichsonella filiformis*
21. Pleotelson with only a suggestion of a tubercle on either side (fig. 16) . . . . *Erichsonella attenuata*

22. Aquatic forms; pleotelson consisting of 2 sections . . . . Suborder Asellota 25
22. Terrestrial or high-beach forms; pleotelson showing 6 sections . . . . Suborder Oniscoidea 23

(Most terrestrial forms are not in this key; members of the fully terrestrial genera Porcellio, Armadillidium, etc., may often be washed into bays and estuaries, to confuse the collector).

23. Less than 1 cm long; uropods decidedly shorter than pleotelson 24
23. Length may exceed 2 cm; uropods as long as pleotelson, each with 2 slender terminal articles (fig. 29); animals may be very active, running about like young cockroaches near high tide marks . . . . Ligia oceanica

24. Under boards, rubbish, etc. above high tide marks; small (up to 6.5 mm long); body surface smooth (fig. 19) . . . . Philoscia vittata
24. In beach sand; very small (up to 4.5 mm long); body surface thickly covered with small, spine-tipped tubercles (fig. 30) . . . . Scyphacella arenicola

25. Uropods very small (fig. 18), in a posterior notch of telson; all thoracic legs simple; very small (to 5 mm long); in marine situations . . . . Jaera marina
25. Uropods at least as long as telson (fig. 17); first legs subchelate; up to 15 mm long; in fresh water or water of quite low salinity . . . . Asellus sp.

26. On Callianassa; female with six pairs of jointed branching abdominal processes; small male with elongated appendages at sides of abdomen (fig. 20) . . . . Ione thompsoni
26. On Palaemonetes, forming a bulge in wall of gill chamber; female and male with short abdominal processes (fig. 21) . . . . Probopyrus pandalicola
26. On Pagurus longicarpus; female with pleopods and with 6th thoracic segment longer than others; male with unsegmented abdomen (fig. 22) . . . . Stegophryxus hyptius

LIST OF MORE COMMON SHALLOW WATER ISOPODA AND TANAIDACEA

Order Tanaidacea (Chelifera)

Leptochelia savignyi (Kröyer, 1842).
Tanais cavolinii Milne-Edwards, 1829.

Order Isopoda

Suborder Anthuridea

Calathura branchiata (Stimpson, 1853). Rare south of Cape. Not in key.
Cyathura polita (Stimpson, 1855). Common in areas of low or very low salinity, as in the tidal drainages from ponds. Until recently has been called C. carinata Kröyer (see Miller and Burbanck, 1961).
Ptilanthura tenuis Harger, 1879. Rare. Not in key.

Suborder Flabellifera

Ancinus depressus (Say, 1818). Reported from Woods Hole (see Richardson, 1909).

Exosphaeroma papillae Bayliff, 1938. A brackish water species, reported from Long Island, and from Sandwich, on Cape Cod.

Cirolana concharum (Stimpson, 1853). A scavenger, often very common around fish landing docks.

Cirolana polita (Stimpson, 1853). Not in key. Reported north of Cape.

Limnoria lignorum (Rathke, 1799). Found burrowing into surface layers of submerged, untreated wood.

Limnoria tripunctata Menzies, 1951.

Lironeca ovalis (Say, 1818). An ectoparasite on fish; uncommon.

Livoneca, see *Lironeca*. The commonly used name *Livoneca* is the result of a typographical error; the group of names including *Lironeca*, *Cirolana*, and *Nerocila* was intended as a series of anagrams on Caroline and Carolina.

Nerocila munda Harger, 1873. Uncommon; an ectoparasite on various fish.

Sphaeroma quadridentatum Say, 1818. Along shores, under stones, among algae, on peat banks.

Suborder Valvifera

Chiridotea almyra Bowman, 1955. In water of low salinity, as in the Pocasset River, along with *Cyathura polita*.

Chiridotea coeca (Say, 1818). Burrows like a little mole beneath the surface of intertidal sand flats. Common.

Chiridotea nigrescens Wigley, 1961. Recently described from brackish waters of tidal marshes, North Falmouth to Chatham, on the southern side of the Cape. Resembles the more common *C. coeca*, which is more marine in its habitat.

Chiridotea tuftsi (Stimpson, 1883). On subtidal sand and mud bottoms in marine situations; sometimes concealed by mud adhering to rough back.

Edotea triloba (Say, 1818). On muddy shores, usually with adherent dirt. *Edotea montosa* (Stimpson, 1853) is probably a synonym (Wallace, N. A., 1919. Univ. Toronto Studies, Biol. Ser. no. 18: 42 pp.)

Erichsonella attenuata (Harger, 1873). Apparently uncommon.

Erichsonella filiformis (Say, 1818). Among eelgrass and algae. Common.

Idotea balthica (Pallas, 1772). Ubiquitous.

Idotea metallica Bosc, 1802. Common, swimming or clinging to vegetation.

Idotea phosphorea Harger, 1873. Among weeds and on gravelly bottoms.

Suborder Asellota

Asellus sp. or spp.. *Asellus* is characteristic of fresh waters or of very low salinities. Although the name *Asellus communis* Say, 1818, has been the most widely used in the past (see, for example, Van Name, 1939) it now seems that *Asellus militaris* is the most common eastern American species (Van Name, 1942). For specific determination, the assistance of a specialist is advised.

Jaera marina (Fabricius, 1780). Very common if looked for among weeds, mussels.

Suborder Oniscoidea

Ligia oceanica (Linnaeus, 1767). Has been reported in numbers near high tide mark on rocky shores and under boards north of Boston. Its reported occurrence at Woods Hole needs confirmation.

Philoscia vittata Say, 1818. Found along the shore near high water mark, under boards and rubbish.

Scyphacella arenicola Smith, 1873. Found in the sand of beaches

Note: See Van Name, 1936, for other terrestrial as well as fresh water isopods.

Suborder Epicaridea (Bopyroidea)

Ione thompsoni Richardson, 1904. On Callianassa; the type locality is North Falmouth.

Probopyrus pandalicola (Packard, 1879). On Palaemonetes, in the gill chamber.

Stegophryxus hyptius Thompson, 1902. Thompson reported 3-4% of hermit crabs Pagurus longicarpus at Hadley Harbor infested, and 1.5% at Woods Hole. Parasite occurs on the abdomen of its host.

REFERENCES ON ISOPODA AND TANAIDACEA

Bayliff, W. H., 1938. A new isopod crustacean (Sphaeromidae) from Cold Spring Harbor, Long Island. Trans. Amer. Micr. Soc., 57: 213-217.

Bowman, T. E., 1955. The isopod genus Chiridotea Harger, with a description of a new species from brackish waters. J. Wash. Acad. Sci., 45: 224-229.

Menzies, R. J., 1957. The marine borer family Limnoriidae (Crustacea, Isopoda). Part I. Northern and Central America: systematics, distribution, and ecology. Bull. Marine Sci. Gulf and Caribbean, 7: 101-200.

Miller, M. A. amd W. D. Burbanck, 1961. Systematics and distribution of an estuarine isopod crustacean, Cyathura polita. Biol. Bull., 120: 62-84.

Richardson, H., 1905. A monograph on the Isopods of North America. Bull. U. S. Nat. Mus., No. 54: 1-727.

Richardson, H., 1909. The isopod crustacean, Ancinus depressus (Say). Proc. U.S. Nat. Mus., 36: 173-177.

Swan, E. F., 1956. Isopods of the genus Ligia on the New England coast. Ecology, 37: 204-206.

Van Name, W. G., 1939. The American land and fresh-water isopod Crustacea. Bull. Amer. Mus. Nat. Hist., 71: 1-535.

Van Name, W. G., 1942. A second supplement to the American land and fresh-water isopod Crustacea. Ibid., 80: 299-329.

Wallace, N. A., 1919. The Isopoda of the Bay of Fundy. Univ. Toronto Studies, Biol. Ser. no. 18: 42 pp.

Wigley, R. L., 1961. A new isopod, Chiridotea nigrescens, from Cape Cod, Massachusetts. Crustaceana, 2: 286-292.

PART 4. ORDER AMPHIPODA

By Eric L. Mills

Amphipods are a widespread and important group of crustaceans. That they are poorly known is mostly due to their wide limits of morphological variation, making taxonomy difficult, and partly due to lack of patience in investigators, since long and careful scrutiny is sometimes necessary. Since members of the group are found in a wide variety of ecological niches, they are of interest to students of taxonomy, ecology, physiology, genetics, and behavior.

GENERAL MORPHOLOGY

Amphipods have the basic malacostracan body plan of 6 head, 8 thoracic, and 6 abdominal segments, but there appear to be only 7 free thoracic segments because of the fusion of the first thoracic segment with the head capsule. This first thoracic segment bears the maxillipeds, and each of the 7 free thoracic segments bears a pair of limbs. The abdomen is divided into a pleon of 3 segments, each bearing a pair of pleopods and a urosome of three segments, each with a pair of uropods. A terminal telson projects from the rear of the urosome. The appendages are as follows:

Plate 14

ISOPODA AND TANAIDACEA

Sources in Plates 14 and 15: Redrawn from Richardson (R), from Kunkel (K), from specimens (S), or as noted.

Fig. 1. *Tanais cavolini*, with chela at greater scale (R).

2. *Leptochelia savignyi*, male (R).

3. *L. savignyi*, female (R).

4. *Cyathura polita* (R).

5. *Cirolana concharum* (S).

6. *Lironeca ovalis* (K).

7. *Limnoria lignorum*, with details of pleotelson, after Menzies.

8. *Limnoria tripunctata*, details of pleotelson, after Menzies.

9. *Nerocila munda* (R).

10. *Idotea baltica* (S).

11. Same, ventral view of pleotelson with valve-like left uropod raised, exposing pleopods.

12. *Idotea metallica* (R).

13. Telson of *Idotea phosphorea* (R).

14. *Edotea triloba* (R).

15. *Erichsonella filiformis* (R).

16. Telson of *E. attenuata* (R).

17. *Asellus militaris* (R).

18. *Jaera marina* (R).

19. *Philoscia vittata* (R).

20. *Ione thompsoni*, female in dorsal view at left, male enlarged at right (S).

21. *Probopyrus thompsoni*, female at left with male beside it to same scale; male enlarged at right (R).

22. *Stegophryxus hyptius*, female in dorsal view at left, in ventral view at right with male indicated at same scale, male enlarged in center (R).

Plate 14

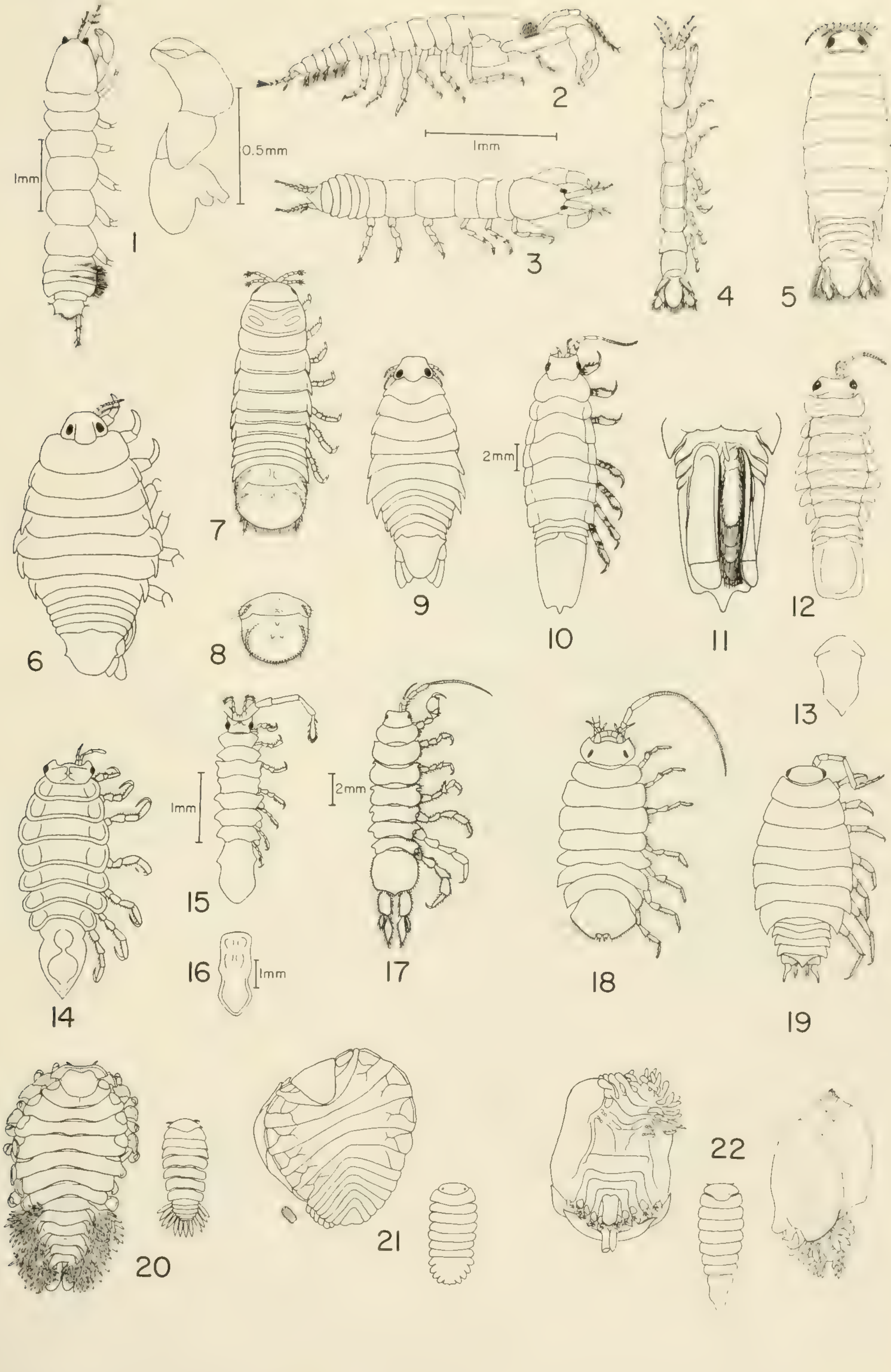

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Plate 15

ISOPODA (cont.), HYPERIIDEA, CAPRELLIDEA

Fig. 23, *Chiridotea almyra*; A. head, B. first pereipod of male, C. pleotelson; redrawn after Bowman.

24. *Chiridotea tuftsi*: A, B, C, as above.

25. *Chiridotea coeca*: A, B, C, as above.

26. *Ancinus depressus* (R).

27. *Sphaeroma quadridentatum* (R).

28. *Exosphaeroma papillae*, redrawn after Bayliff.

29. *Ligia oceanica* (R).

30. *Scyphacella arenicola* (R).

31. *Hyperia galba*, hyperiid amphipod (K).

32. *Aeginella longicornis*, caprellid amphipod (K).

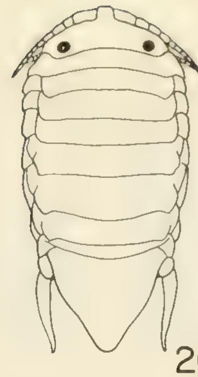
33. *Caprella geometrica*, caprellid amphipod (K).

Plate 15


23A


24A


25A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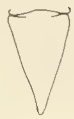
23B


24B


25B


23C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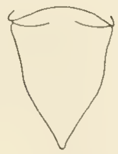
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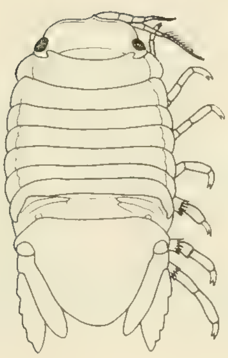
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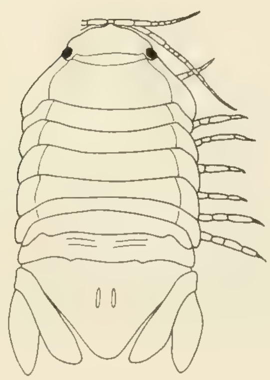
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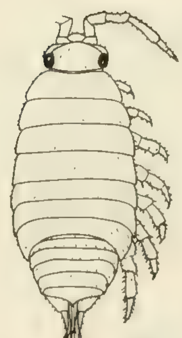
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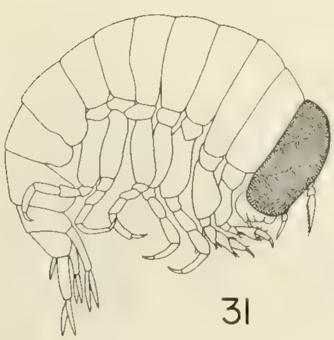
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32


33

1-2: Antennae - (two pairs) - both with peduncles and flagella, first antenna often with accessory flagellum.
3: Mandibles - with molar and incisor surfaces and a palp.
4: First maxillae - with inner and outer lobes and a 2-segmented palp.
5: Second maxillae - simple, of inner and outer lobes.
6: Maxillipeds - with inner and outer plates and a 4-segmented palp.
7-13: Seven peraeopods, each 7-segmented, including flattened coxal plates which contribute to the sides of the body. The first 2 pairs of peraeopods are often called gnathopods and are subchelate, with the 6th segment expanded as a hand. When this "gnathopod 1 and 2" terminology is used, the remaining peraeopods are numbered from 1-5.
14-16: Pleopods (3 pairs) - with a basal peduncle and 2 many jointed setose rami.
17-19: Uropods (3 pairs) - with a basal peduncle and 2 more or less spinose single segmented rami.

For illustrations, see Chevreux and Fage (1925, figs. 1 and 2).

KEY TO THE SUBORDERS OF AMPHIPODA
(After Kunkel, 1918)

1. Eyes absent, but articulated eye lobes present . . . . INGOLFIELLIDEA
1. Eyes present, sessile 2

2. Eyes large, covering side of head; uropods with laminate rami, forming a tail fan with telson . . . . HYPERIIDEA
2. Eyes not covering whole side of head 3

3. Abdomen well developed . . . . GAMMARIDEA
3. Abdomen rudimentary; body very slender (typical caprellids) or very much flattened ("whale-lice") . . . . CAPRELLIDEA

The Hyperiidea are mostly pelagic; some are commensals with scyphozoan jellyfish (Plate 15, fig. 31). Caprellidea (figs. 32, 33) are common inhabitants of weedy areas in littoral and sub-littoral zones. See Chevreux and Fage (1925) for common families and genera of these two suborders. Ingolfiellidea are rare, highly aberrant, mostly abyssal forms, unfamiliar to most taxonomists. Gammaridean amphipods are abundant and obvious members of all aquatic communities, but at present it seems advisable to present only a key to families. For figures, the references must be consulted.

KEY TO COMMON FAMILIES OF GAMMARIDEAN AMPHIPODA
(Based on Stebbing, 1906)

1. Antenna 1, first joint stout, with accessory flagellum; mandible cutting edge almost smooth; gnathopod 2 with 3rd joint elongated . . . . LYSIANASSIDAE
1. These characters not combined 2

2. Head tapering, truncate; eyes simple, usually 4; antennae 1 without accessory flagellum; telson cleft . . . . AMPELISCIDAE
2. These characters not combined 3

3. Peraeopods 3-5 with heavy armature of spines and setae, joints greatly expanded 4
3. Peraeopods 3-5 less setose, joints not greatly expanded 5

4. Peraeopod 4 not greatly longer than peraeopod 5 . . . . HAUSTORIIDAE
4. Peraeopod 4 greatly longer than peraeopod 5. . . . . PHOXOCEPHALIDAE

5. Antenna 1 without accessory flagellum; maxillipeds abnormal; telson entire; fourth coxal plates greatly enlarged . . . . STENOTHOIDAE
5. These characters not combined 6

6. Mandible with molar weak or wanting; telson divided; maxilliped inner plate small . . . . LILJEBORGIIDAE
6. These characters not combined 7

7. Eyes dorsally continuous or confluent; pronounced rostrum; peraeopod 5 elongated . . . . OEDICEROTIDAE
7. Eyes lateral, rostrum not well developed, peraeopod 5 not greatly elongated 8

8. Side plate 4 excavate behind; peraeopods 1 & 2 not glandular; animal not tube dwelling 9
8. Side plate 4 usually not excavate behind; peraeopods 1 & 2 glandular; animal often tube dwelling 13

9. Mandible with palp 10
9. Mandible without palp 12

10. Telson entire . . . . CALLIOPIIDAE
10. Telson usually cleft, antenna 1 with accessory flagellum, urosome with patches of dorsal spines . . . . GAMMARIDAE
10. Telson cleft; other features unlike previous combination 11

11. Gnathopod 1 without hand . . . . BATEIDAE
11. Gnathopods 1 & 2 without hands, telson cleft, antennae of male with calceoli . . . . PONTOGENEIIDAE

12. Uropod 3, both rami well developed . . . . DEXAMINIDAE
12. Uropod 3, one ramus small or wanting . . . . TALITRIDAE

13. Pleon compressed 14
13. Pleon usually depressed; tubicolous animals, often banded with color . . . . COROPHIIDAE

14. Uropod 3 uncinate, i.e. with short hooks 15
14. Uropod 3 not uncinate . . . . PHOTIDAE

15. Inter-antennal lobes small; gnathopod 2 palm usually simple, hand not expanded . . . . AMPITHOIDAE
15. Inter-antennal lobes prominent; gnathopod 2 palm often complex, hand expanded . . . . ISCHYROCERIDAE

Animals may be most readily placed at least to genus by using the keys in Stebbing (1906) and by reference to Sars (1895), Holmes (1905), Kunkel (1918) and Chevreux and Fage (1925). Kunkel is particularly useful for local species. The following list of local genera and species is by no means complete but may aid in narrowing the search, and is presented merely as an aid to those starting a study. The development of keys to the species of amphipods in the Woods Hole region must await further studies. We are indebted to Dr. E. L. Bousfield for assistance in the compilation of the following list.

A PRELIMINARY LIST OF THE COMMONER LOCAL AMPHIPODS

Lysianassidae

Lysianopsis alba Holmes, 1903. In sand, gravel or mud in shallow subtidal.
Orchomenella pinguis (Boeck, 1861).
Tmetonyx nobilis Stimpson, 1853.

Ampeliscidae

Ampelisca macrocephala Liljeborg, 1852.
Ampelisca vadorum Mills, 1963.
Byblis serrata Smith, 1873.

Haustoriidae

Found burrowing in sandy beaches. A complex family of several genera, currently being revised.

Phoxocephalidae

Paraphoxus epistoma (Shoemaker, 1938).
Paraphoxus spinosus Holmes, 1903.
Phoxocephalus holbolli (Kröyer, 1842).

Stenothoidae

Stenothoe spp.

Liljeborgiidae

Listriella clymenellae (Mills, 1961). Commensal in tubes of *Clymenella torquata*.

Oedicerotidae

Monoculodes edwardsi Holmes, 1903.

Calliopiidae

Calliopius laeviusculus (Kröyer, 1838). Commonly taken swimming at night lights.

Gammaridae

Carinogammarus mucronatus (Say, 1818). In both marine and brackish waters.
Crangonyx spp. In fresh water.
Elasmopus laevis (Smith, 1873).
Gammarus annulatus Smith, 1873. Marine.
Gammarus fasciatus Say, 1818. In fresh water.
Gammarus oceanicus Segerstråle, 1947. Marine and brackish water.
Gammarus tigrinus Sexton, 1939. Brackish waters.
Melita nitida Smith, 1873.

Bateidae

Batea catharinensis Fr. Müller, 1865.

Pontogeneiidae

Pontogeneia inermis (Kröyer, 1838).

Dexaminidae

Dexamine thea Boeck, 1861.

Talitridae

Allorchestes littoralis Stimpson, 1853. Intertidal.
Hyale spp. Intertidal.
Hyalella azteca (Sausseure, 1818). In fresh water.
Orchestia spp. Rather small, dark, beach hoppers.
Talorchestia longicornis (Say, 1818). The common, large whitish beach hopper.
Talorchestia megalophthalma (Bate, 1862). A beach hopper similar to the above but smaller and less common.

Corophiidae (a family of tube dwellers)

Cerapus tubularis Say, 1818. Among masses of *Amaroucium*, and among eelgrass. Said to carry tubes about.
Corophium spp. In soft tubes.
Ericthonius spp.
Unciola irrorata Say, 1818. Often found in tubes of polychaetes or other amphipods.

Photidae

Leptocheirus pinguis (Stimpson, 1853).
Leptocheirus plumulosus Shoemaker, 1932.
Photis spp.

Ampithoidae

Ampithoe longimana Smith, 1873.
Ampithoe rubricata (Montagu, 1808).
Cymadusa compta (Smith, 1873).

Ischyroceridae

Ischyrocerus spp.
Jassa falcata (Montagu, 1808).

Cheluridae

Chelura terebrans Philippi, 1839. A wood borer.

Pleustidae

Sympleustes glaber (Boeck, 1861).

Aoridae

Lembos smithi (Holmes, 1905).
Microdeutopus damnoniensis (Bate,1856).
Microdeutopus gryllotalpa Costa, 1853.

REFERENCES ON AMPHIPODS

Barnard, J. L., Index to the families, genera and species of Gammaridean Amphipoda (Crustacea). Allan Hancock Publications, Occas. Papers 19: 1-145. Very useful in literature searches.

Bousfield, E. L., 1963. Studies on amphipod crustaceans of the Cape Cod region. Preliminary report, Systematics-Ecology Program, MBL, Woods Hole (unpublished).

Chevreux, E., & L. Fage, 1925. Amphipodes, in Faune de France, Paris, 9: 1-488; 438 text figures. Very useful for fauna of this region. Includes Hyperiidea and Caprellidea.

Holmes, S. J., 1905. The Amphipoda of southern New England. Bull. Bur. Fisheries for 1904: 457-529, pl. 1-8.

Kunkel, B. W., 1918. The Arthostraca of Connecticut. Conn. Geol. and Nat. Hist. Survey 26: 1-261. Standard work on Amphipoda of New England.

Mills, E. L., 1962. A new species of Liljeborgiid amphipod with notes on its biology. Crustaceana, 4: 158-162.

__________, 1963. A new species of Ampelisca (Crustacea: Amphipoda) from eastern North America, with notes on other species of the genus. Canad. J. Zool., 41: 971-989.

Sars, G. O., 1895. The Crustacea of Norway. Christiania & Copenhagen, 1: 1-711; 240 pls. A standard reference, illustrations excellent.

Stebbing, T. R. R., 1906. Amphipoda 1. Gammaridea. Das Tierreich (Berlin) 21: 1-806; 127 text figures. The basic reference work in amphipod taxonomy.

PHYLUM ARTHROPODA

Class Crustacea

The Higher Malacostraca (Decapoda and Stomatopoda)

The great majority of the well known crustaceans collected and studied at Woods Hole are in the order Decapoda, although the group also includes some little known forms and presents problems of identification in certain families, such as in the Xanthidae and Pinnotheridae. The "mantis shrimps" of the order Hoplocarida or Stomatopoda (see page 127) are represented only by two species, not commonly collected.

Figure references in this chapter are to Plates 16 and 17.

KEY TO THE MORE COMMON DECAPOD CRUSTACEANS

I. Small animals of shrimp-like form; abdomen well developed, with tail fan; pleopods used for swimming; pleura (side plates) of 2nd abdominal segment overlapping those of first segment; the typical shrimps and prawns (fig. 41). . . . . Section CARIDEA 1

II. Animals of heavier form, with well developed abdomen; pleopods not used for swimming; thoracic legs adapted for walking; chelipeds large and strong.

A. Abdomen not much (if at all) wider or longer than cephalothorax; body firm, well armored and well pigmented; the familiar fresh water crayfishes and, as the only local marine representative, the lobster Homarus americanus . . . . Subsection ASTACURA or NEPHROPSIDA

B. Abdomen markedly wider and/or longer than cephalothorax; bodies soft, seemingly weak; burrowing forms with tendency to reduced eyes and pigmentation; sometimes placed with Anomura . . . . Subsection THALASSINIDEA 4

III. Animals of typically crablike form, with 5th (last) pair of thoracic legs not markedly reduced; abdomen reduced, lacking uropods, and folded under body; antennae short and set medial to eyes; the "true crabs" . . . . Section BRACHYURA 5

IV. Fifth pair of thoracic legs very reduced and folded up above bases of 4th pair; form varies from quite crablike to not very crablike; abdomen in some is asymmetrical or twisted, or reduced, but with uropods . . . . Section ANOMURA 27

I. Caridea

1. Carpus (the segment next to the claw or hand) of 2nd pair of legs not annulated (fig. 40) 2
1. Carpus of 2nd pair of legs annulated into 3 parts (fig. 39); with humped abdomen (Family HIPPOLYTIDAE) . . . . Hippolyte zostericola

2. Rostrum short, not compressed; first pair of legs subchelate (fig. 31); 2nd pair of legs chelate (as in fig. 41); eyes set close together (Family CRANGONIDAE) . . . . Crangon septemspinosus
2. Rostrum long and laterally compressed; first and 2nd pair of legs chelate; eyes set widely apart (Family PALAEMONIDAE) . . . . Palaemonetes

There are three local species, of which P. vulgaris is much the most common; the tabulation below should separate the three:

	P. vulgaris (figs. 33, 34)	*P. intermedius* (figs. 35, 36)	*P. pugio* (figs. 37, 38)
Dorsal rostral teeth	to tip	to tip	tip naked
Ventral rostral teeth	4-5	4-5	2-3
Dorsal rostral teeth lying posterior to orbits	2	1	1
Teeth of chelae of second legs: movable finger / fixed finger	2/1	1/0	0/0

II. Thalassinidea

3. Chelipeds unequal in size; body very pale . . . . *Callianassa atlantica*
3. Chelipeds of equal size 4

4. Chelipeds with fingers not deflexed (fig. 30); fairly common and of good size (ca. 100 mm long) . . . . *Upogebia affinis*
4. Chelipeds with fingers deflexed (subchelate, fig. 29); a rare animal of small size (to ca. 35 mm) . . . . *Naushonia crangonoides*

Note: The Hoplocarida (Stomatopoda) or "mantis shrimps" have somewhat the same habitat and body build as the above 3 species, but are at once distinguished by their formidable mantis-like claws, large eyes, and by the short carapace which does not cover the last 4 thoracic segments (see page 127 and fig. 32).

III. Brachyura

5. Carapace triangular or globose, with apex projecting forward to form a rostrum; "spider crabs" 6
5. Carapace usually broader than long; rostrum small or wanting 9

6. Carapace triangular, resembling small chip of stone (fig. 3); walking legs very small but chelipeds relatively huge (Family PARTHENOPIDAE) . . . . *Heterocrypta granulata*
6. Walking legs long and conspicuous . . . . (Family MAIIDAE or INACHIDAE) 7

7. Carapace with medial dorsal spines 8
7. Carapace surface smooth, without median dorsal spines; splotched with red . . . . *Pelia mutica*

8. With 6 spines in the median dorsal row; few dorsal tubercles (fig. 1) . . . . *Libinia dubia*
8. With 9 spines in median dorsal row; many dorsal tubercles (fig. 2) . . . . *Libinia emarginata*

9. Free living crabs, well pigmented, with eyes not reduced 10
9. Small crabs with reduced eyes; commonly but not always with reduced body pigmentation; usually commensal in worm tubes or bivalves, but some may wander free; carapaces either subcircular or markedly widened from side to side; small, rarely reaching 2.5 cm across carapace 19

10. Carapace outline varies, but characteristically front margin is curved, and bears a series of teeth between the eye and the (antero) lateral corner on each side; size varies, but several over 5 cm across carapace belong here; "cancroid" crabs 11
10. Carapace outline squarish, with a more or less straight front margin; most are active, semi-terrestrial crabs, rarely over 4 cm across carapace; free living "grapsoid" crabs 23

11. First antennae (antennules) folded longitudinally or nearly so (fig. 4) . . . . Family CANCRIDAE 12
11. First antennae folded transversely or obliquely (fig. 5) 13

12. Edges of antero-lateral teeth entire; chelipeds granulate, not denticulate (fig. 6) . . . . *Cancer irroratus*
12. Edges of antero-lateral teeth denticulate; upper margin of palm denticulate (fig. 7) . . . . *Cancer borealis*

13. Last pair of walking legs not markedly adapted for swimming; tips sharp, for walking (fig. 10) 14
13. Last pair of legs flattened and paddle-like; tips rounded, for swimming (figs. 8, 9) 18

14. Front (region between eyes) produced into 3 low teeth; 5 very prominent sharp anterolateral teeth (fig. 10); hind pair of legs slightly flattened; an active long legged crab commonly 5-7.5 cm across carapace; the common "green crab" but color varies from greenish-black to orange . . . . *Carcinus maenas*
14. Front not produced into teeth; generally small crabs, but more heavily built and less active than *Carcinus*, with shorter legs and heavier chelae; tips of chelae dark in some species; a group in which specific identification requires care . . . . Family XANTHIDAE 15

15. Frontal margin (between eyes) with a single edge, not seeming double; fingers of chelae dark 16
15. Frontal margin transversely grooved so as to appear double; fingers of chelae whitish; carapace with 4 and 3 distinct transverse lines of granules on anterior half . . . . *Rhithropanopeus harrisi*

16. Movable finger of major cheliped with a heavy blunt tooth near base (fig. 26); carapace width often exceeds 2.5 cm (fig. 25) . . . . *Panopeus herbsti*
16. Movable finger of major cheliped without such a tooth 17

17. With an elongated dark red spot on the inner (concealed) surface of each maxilliped (note: *Panopeus herbsti* sometimes but not always has a comparable spot, but it is small, circular, and located near base of maxilliped); fingers of minor chela "spooned" (fig. 28); carapace rather flattened and oval in outline (fig. 27); uncommon . . . . *Eurypanopeus depressus*
17. Without such red spot on maxillipeds; fingers of minor chela not "spooned" (Fig. 24); carapace outline nore angular (fig. 23) not oval; very common . . . . *Neopanope texana*

18. Antero-lateral teeth on carapace 3 to 5 in number (fig. 9); carapace not usually broad; color cream to tan with red markings ("lady crab") . . . . Ovalipes ocellatus
18. Antero-lateral teeth 9 in number (fig. 8); carapace extremely broad; outermost lateral tooth especially long and sharp; with some blue coloration, particularly on chelipeds ("blue crab") . . . . Callinectes sapidus

19. Fifth (last) pair of thoracic legs very small and tucked up under carapace; you are in the wrong part of key; animal is a brachyurous anomuran; go on to no. 30.
19. Fifth (last) pair of thoracic legs is not especially reduced, useful in locomotion. This is a difficult family with marked sexual dimorphism . . . . Family PINNOTHERIDAE 20

20. Carapace thin and shiny; body almost circular (fig. 12); commensal in mantle cavity of bivalves or in Chaetopterus tubes . . . . Pinnotheres maculatus
20. Carapace much wider than long, generally commensal . . . . Pinnixa 21

21. Propodus (2nd segment from tip) of 3rd walking leg slender, twice as long as wide (figs. 13, 14) . . . . Pinnixa sayana
21. Propodus of 3rd walking leg not slender; less than twice as long as wide 22

22. Body and legs smooth, not especially hairy; propodus of 3rd leg only slightly if at all longer than wide (figs. 15, 16) . . . . Pinnixa cylindrica
22. Body and legs distinctly hairy; propodus of 3rd leg clearly longer than wide, and with edge granular or serrated (figs. 17, 18) . . . . Pinnixa chaetopterana

23. A gap is left between the 3rd maxillipeds when they are held at rest; front very or moderately broad; eyestalks short . . . . Family GRAPSIDAE 24
23. The 3rd maxillipeds almost or quite close over the mouth region when held at rest; front moderately or very narrow; eyestalks long; one cheliped of male very large; local representatives are the typical "fiddler crabs" . . . . Family OCYPODIDAE

24. Carapace very square (fig. 19); dark plum colored to bluish black (the "square backed fiddler"); found burrowing in salt marshes . . . . Sesarma reticulatum
24. Carapace with corners rounded off (fig. 20); color variably blotched olive-green; drifts in on Sargassum ("Columbus crab", "Gulf-weed crab") . . . . Planes minutus

25. Inner surface of large claw of male with an oblique ridge (fig. 22) 26
25. Inner surface of large claw of male without such oblique ridge (fig. 21); carapace mottled in grays and purple ("calico back") . . . . Uca pugilator

26. Carapace uniformly dark, almost black; not exceeding as a rule 22 mm in width; very numerous (the "black fiddler crab") . . . . Uca pugnax
26. Carapace grayish, lighter at front, with central brown mark; size very much larger than in the common fiddler crabs; carapace commonly over 23 mm, even 36 mm wide; reddish spots at joints of chelipeds, especially in males ("big fiddler crab", "red-jointed fiddler crab") . . . . Uca minax

IV. Anomura

27. Animals inhabit gastropod shells; abdomen soft and twisted ("hermit crabs") 28
27. Abdomen symmetrical and tucked under thorax 30

28. Chelipeds slender; hands subcylindrical 29
28. Hands broad, flat, tuberculate . . . . Pagurus pollicaris

29. Chelae with 4 or 5 distinct purplish bands on whitish background . . . . Pagurus annulipes
29. Chelae without such distinct banding . . . . Pagurus longicarpus

30. Form essentially crablike, except for having 5th (last) thoracic legs reduced and hidden under carapace (fig. 11); small, rounded; chelipeds directed forward in resting position (not transversely as in Brachyura); antennae long and set lateral to eyes (Family PORCELLANIDAE) . . . . Polyonyx macrocheles
30. Body egg shaped; carapace gray and shining; telson forms a long triangular white ventral shield; burrows in wave-swept sandy beaches (Family HIPPIDAE; "mole crabs", "sand bugs") . . . . Emerita talpoida

ANNOTATED LIST OF DECAPOD CRUSTACEANS

I. Caridea (shrimps)

Crago, see Crangon. The re-establishment of the old (1798) generic name Crangon for the common shrimps is the result of the suppression in 1955 of the name Crago by the International Commission on Zoological Nomenclature (Opinions and Declarations, 10(1): 1-44). This action terminated a most confusing situation, briefly: In 1904 Rathbun (Proc. Biol. Soc. Wash. 17: 170) reported that the name Crangon had first been used in an obscure work by Weber (1795) for the "snapping shrimps" known since 1798 as Alpheus, and in consequence she redesignated Alpheus as Crangon. This left the common shrimps without a name, so she adopted for them the "next available" name, Crago. The remarkable 3-way confusion included the use of the family name Crangonidae for the snapping shrimps and Cragonidae for the common shrimps. Under the 1955 ruling our common shrimp is secure under the generic name Crangon (Family Crangonidae), and the snapping shrimps (which do not occur at Woods Hole) are Alpheus, and restored to the arms of their family Alpheidae.

Crangon septemspinosus Say, 1818. Found in sand, in which it buries itself, below tide marks. Common, the name Crangon vulgaris Fabricius, 1798 has been used by those who believe the local form to be conspecific with the common European shrimp.

Hippolyte zostericola (Smith, 1874). Particularly common among eel grass (Zostera), its green body color rendering the shrimp inconspicuous.

Palaemonetes intermedius Holthius, 1949. Prior to 1949 this species and the next were confused with and included in P. vulgaris. Found in brackish water, and mainly southern.

Plate 16

DECAPOD CRUSTACEA

Sources: Redrawn from Rathbun (R), from Ryan (Ry), from specimens (S), all but nos. 13-14 by Bruce Shearer.

Fig. 1. Libinia dubia, young male, carapace (R).

2. Libinia emarginata, young male, carapace (R).

3. Heterocrypta granulata (R).

4. Lower side of front of Cancer irroratus to show first antennae folded longitudinally or obliquely (S).

5. Same region of Carcinus maenas to show first antennae folded transversely (S).

6. Carapace of Cancer irroratus, to show smooth edged anterolateral teeth (S).

7. Anterolateral margin only of Cancer borealis, showing denticulate anterolateral teeth (S).

8. Callinectes sapidus, carapace and fifth leg (S).

9. Ovalipes ocellatus, carapace and fifth leg (S).

10. Carcinus maenas, carapace and fifth leg (S).

11. Polyonyx macrocheles (S).

12. Pinnotheres maculatus, male (S).

13. Pinnixa sayana, male, ventral (S).

14. Same, female (S).

15. Pinnixa cylindrica, male (S).

16. Same, female (S).

17. Pinnixa chaetopterana, male (S).

18. Same, female (S).

19. Sesarma reticulatum (S).

20. Planes minutus (S).

21. Inside of large claw of male Uca pugilator, lacking oblique ridge (S).

22. Same, but of Uca pugnax, with oblique ridge (S).

23. Carapace of Neopanope texana (S).

24. Major chela of same, with area of black outlined extending onto palm (S).

25. Carapace of Panopeus herbsti (points exaggerated) (S).

26. Major chela of same, to show blunt tooth on movable finger (S).

27. Carapace of Eurypanopeus depressus, to show oval outline (Ry).

28. Minor chela of same, to illustrate "spooned" condition (Ry).

Plate 16

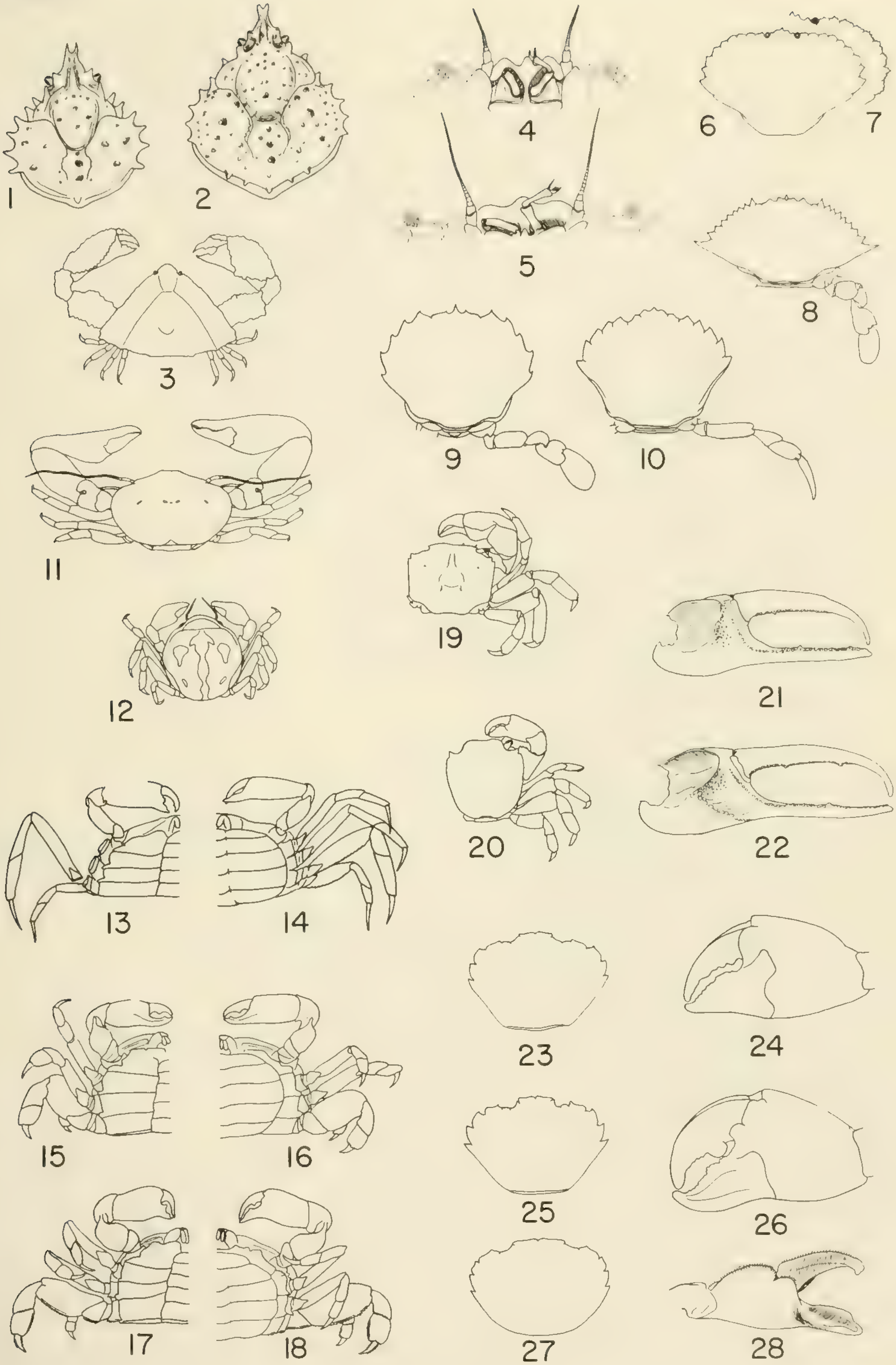


Plate 17

DECAPOD CRUSTACEA (cont.); STOMATOPODA

Figs. 29-40: Redrawn from Kingsley (K), Holthius (H), specimens (S), by Bruce Shearer.

Fig. 29. _Naushonia crangonoides_, carapace and left chela (K).

30. _Upogebia affinis_ (S), left cheliped only.

31. _Crangon septemspinosus_, "subchelate" first chela (S).

32. _Squilla empusa_ (order Stomatopoda, _not_ Decapoda) (S).

33. Second chela of _Palaemonetes vulgaris_ (H).

34. Rostrum of same (S).

35. Second chela of _Palaemonetes intermedius_ (H).

36. Rostrum of same (H).

37. Second chela of _Palaemonetes pugio_ (H).

38. Rostrum of same (S).

39. Second leg of _Hippolyte_ to show annulated carpus (S).

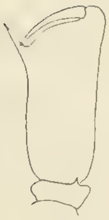
40. Second leg of _Palaemonetes_; carpus not annulated (S).

41. Lateral view of a generalized decapod, redrawn after Schmitt, showing the typical shrimp-like ("caridoid") form and appendages.

Plate 17

29

30



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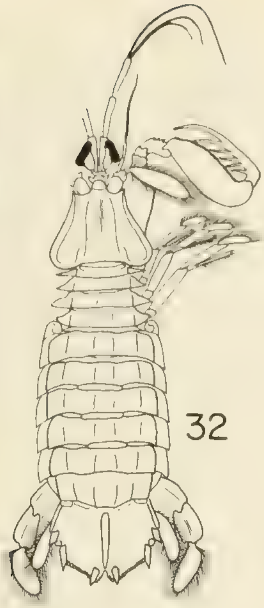

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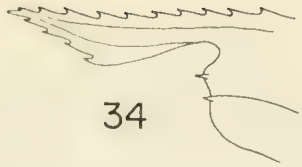

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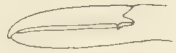

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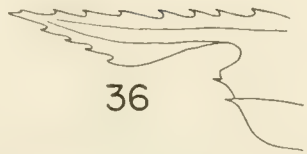

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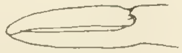

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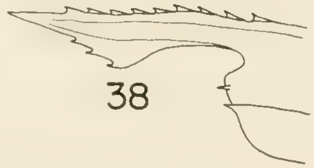

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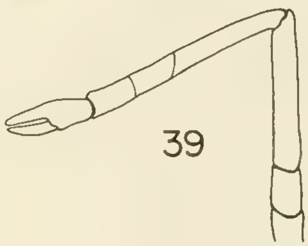

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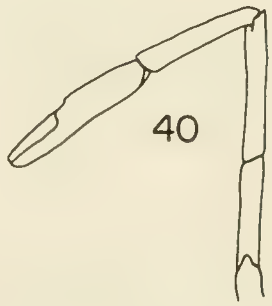

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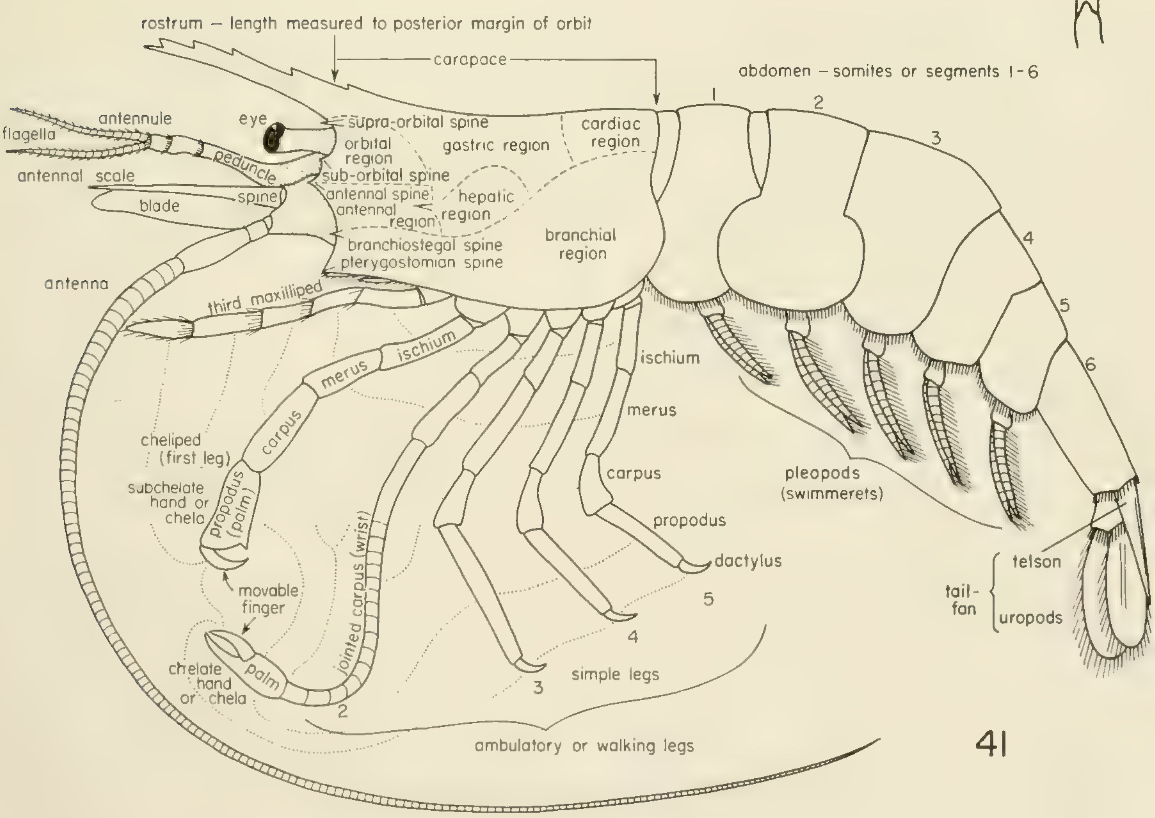


41

Palaemonetes pugio Holthius, 1949. In brackish to almost fresh water.
Palaemonetes vulgaris (Say, 1818). This is the species usually collected and used at Woods Hole. Tends to occur in more saline water than the two less common species above.

II A. Astacura or Nephropsidea

(Crayfish and lobsters)

Homarus americanus Milne-Edwards, 1837. The familiar lobster, generally taken commercially in subtidal water; uncommon locally because of fishing. A point for comparative physiologists to bear in mind is that the lobster is more closely related to the fresh water crayfishes than to any other of the local marine crustaceans.

II B. Thalassinidea

(Mud shrimps)

Callianassa atlantica (Smith, 1874). A burrower in muddy sand, intertidal and in shallow water. The name C. atlantica replaces the name C. stimpsoni, which has prior application to a Pacific coast fossil species (see Schmitt, 1935).
Naushonia crangonoides Kingsley, 1895. Rare; has been found in intertidal or shallow subtidal, in muddy sand.
Upogebia affinis (Say, 1817). Habitat similar to that of Callianassa, but muddier.

III. Brachyura

(True crabs)

Callinectes sapidus Rathbun, 1895. The blue crab. Common in grassy bays and salt water ponds. An important commercial and experimental animal, whose wide range on our east coast has been extended by accidental introduction into France, Holland, Denmark, and Israel. Penetrates into waters of very low salinity, especially in the warmer parts of its range.
Cancer borealis Stimpson, 1859. Northern rock crab, Jonah crab. Despite name, is not confined to rocky areas but is often found in sand.
Cancer irroratus Say, 1817. Rock crab. Similar to the above, but perhaps more characteristic of rocky areas.
Carcinides, see Carcinus. "Carcinides" is now a rejected synonym of Carcinus. The facts are briefly: in 1897 Rathbun (Proc. Biol. Soc. Wash., 11: 164) substituted Carcinides for the well known name, Carcinus, of the common green crab on the grounds that the name Carcinus had been given prior use by Latreille in 1796 for an essentially unrecognizable genus of amphipods. However, Latreille described no species under Carcinus, and the term in his sense was never subsequently used. In Opinion 330 (Opinions and Declarations, ... 9(24): 321-338, 1955) the International Commission on Zoological Nomenclature suppressed Carcinus of Latreille 1796 and validated the Carcinus of Leach 1814 as applied to the green crab.
Carcinus maenas (Linnaeus). The green crab. The commonest crab of this area, in marine and brackish water.
Eurypanopeus depressus (Smith, 1869). Apparently uncommon or of doubtful occurrence in Woods Hole region; reported by Verrill and Smith but not taken by Sumner survey (1913) nor in the summer of 1963. It is extremely common further south (e.g. Delaware Bay), and is often associated with oysters or oyster shells in muddy areas where salinity may be lowered.
Heterocrypta granulata (Gibbes, 1849). Dredged on bottoms of shingles or pebbles, which the animal much resembles.
Libinia dubia Milne Edwards, 1834. On muddy shores and flats. Stenohaline.
Libinia emarginata Leach, 1815. Common on muddy shores and flats. This is the species more commonly used at Woods Hole. Stenohaline.

Neopanope texana sayi (Smith, 1869). Extremely common. This subspecies ranges from Canada to Florida, where it merges and is confused with N. texana texana.
Ovalipes ocellatus (Herbst, 1799). Found in sand at low water mark and subtidally. Buries itself with only the eyes showing. Ranges from Cape Cod to South Carolina.
Panopeus herbsti Milne-Edwards, 1834. The species (as several "forms") ranges from Boston to Brazil.
Pelia mutica (Gibbes, 1850). Dredged, on gravelly and shelly bottom.
Pinnixa chaetopterana Stimpson, 1859. Commensal in tubes of Chaetopterus, Amphitrite, and probably other worms.
Pinnixa cylindrica (Say, 1818). Said to occur in burrows of Arenicola cristata. Young found free on low intertidal muddy shores.
Pinnixa sayana Stimpson, 1860. Reported to be dug out of mud, but probably actually in worm or other burrows.
Pinnotheres maculatus Say, 1818. Commensal in Mytilus, Modiolus, and several other bivalves, as well as in Chaetopterus tubes.
Planes minutus (Linnaeus). A visitor that drifts into Woods Hole on Sargassum; may be found on shore occasionally.
Rhithropanopeus harrissi (Gould, 1841). This has never been reported from Woods Hole, but has probably been overlooked since its range is from Mexico to Maine and New Brunswick. It is found in waters of very low salinity, even fresh water, and has been introduced and become common in other regions, where it has been used in physiological research (e.g. San Francisco Bay, Holland, Germany).
Sesarma reticulatum (Say, 1817). A southern form, of spotty ocurrence in certain fiddler crab marshes, rather to landward. May be looked for in or near Uca minax habitats.
Uca minax (LeConte 1855). A southern species, in this area near the extreme of its range and found only in a few localities. May occur in very low salinities.
Uca pugilator (Bosc, 1801-02). In salt marshes; tends to make burrows in sand and in Salicornia areas. Less gregarious than U. pugnax.
Uca pugnax (Smith, 1870). In salt marshes. Tends to make burrows in muddy areas.

IV. Anomura

Emerita talpoida (Say, 1817). Very common on exposed sandy beaches; intertidal.
Pagurus annulipes Say, 1817. Dredged.
Pagurus longicarpus Say, 1817. The commonest shallow water hermit crab; found everywhere.
Pagurus pollicaris Say, 1817. The large hermit crab; common.
Polyonyx macrocheles (Gibbes, 1850). Lives in Chaetopterus tubes.

Order Hoplocarida (Stomatopoda)

(Mantis-shrimps)

Members of this order differ greatly from decapods in structure, having only a short carapace that does not cover the last 3 or 4 segments of the thorax, and having the second maxillipeds modified to remarkable mantis-like, raptorial claws. They burrow in subtidal or low intertidal mud, and are not commonly taken. There are two local species, distinguished as follows:

1. Carapace and abdomen with several longitudinal carinae or keels; size large, up to 25 cm; 6 teeth on finger of raptorial claw; fairly common subtidally, but rare intertidally (fig. 32) . . . . Squilla empusa Say, 1818

2. Carapace and abdomen smooth, without carinae; small, up to 4 cm long; raptorial claw with 11-15 teeth; rare . . . . Nannosquilla grayi (Chace, 1958) (Described as Lysiosquilla grayi; see Manning, 1963)

REFERENCES ON DECAPODS AND STOMATOPODS

Chace, F. A., Jr., 1958. A new stomatopod crustacean of the genus Lysiosquilla from Cape Cod, Massachusetts. Biol. Bull., 114: 141-145.

Hay, W. P. and C. A. Shore, 1918. The decapod crustaceans of Beaufort, N. C., and the surrounding region. Bull. U. S. Bur. Fish. 35(1915-1916): 371-475.

Holthius, L. B., 1952. A general revision of the Palaemonidae (Crustacea, Decapoda, Natantia) of the Americas. II. The subfamily Palaemoninae. Allan Hancock Foundation Occ. Papers no. 12: 1-396.

Kingsley, J. S., 1899. Synopsis of North American Invertebrates. III. The Caridea of North America. Amer. Nat. 33: 709-720.

Manning, R. B., 1963. Preliminary revision of the genera Pseudosquilla and Lysiosquilla . . . Bull. Mar. Sci. Gulf and Caribbean, 13: 308-328.

Rathbun, M. J., 1917. The grapsoid crabs of America. Bull. U. S. Nat. Mus., 97: i-xxii, 1-461.

______________, 1925. The spider crabs of America. Ibid, 129: i-xx, 1-613.

______________, 1930. The cancroid crabs of America of the families Euryalidae, Portunidae, Atelecyclidae, Cancridae, and Xanthidae. Ibid, 152: i-xvi, 1-609.

Schmitt, W. L., 1935. Mud shrimps of the Atlantic coast of North America. Smithson. Misc. Coll., 93: 1-21, 4 pl.

PHYLUM MOLLUSCA

by W. Russell Hunter and Stephen C. Brown

PART 1. INTRODUCTION, CLASSIFICATION, GLOSSARY, AND REFERENCES

INTRODUCTION

(Figure references in this chapter are to Plates 18 and 19)

Among the relatively few patterns of animal construction (Phyla) which have been highly successful, in terms both of numbers and of diversity of habitats, is the molluscan plan. Along with the Chordata and the Nematoda, the Mollusca must rank just after the Arthropoda in terms of evolutionary "success". Most molluscs are readily recognizable -- the soft body within a hard calcareous shell is usually diagnostic (as is the extensive use of ciliary and mucous mechanisms in feeding, locomotion, and reproduction). The basic molluscan plan of structure and function is remarkably uniform throughout the group, but there is no single standard molluscan shape. An extreme diversity in external body form has been based upon this plan -- clam, chiton, snail, and squid are all molluscs. In an evolutionary sense, the molluscan plan has proved plastic, and the adaptive modifications of structure and function to fit particular environmental circumstances provide material for a wide variety of biological studies.

There are probably about 90,000 living species of molluscs, mostly belonging to the three major classes, Gastropoda, Bivalvia, and Cephalopoda. In the molluscan fauna of the Woods Hole area, the majority of orders and superfamilies are represented, but students and visiting investigators should note that certain groups are absent and others represented by a single common species. For example, in the class Gastropoda, no two gilled aspidobranchs (Haliotidae, Fissurellidae, etc.) occur, and of the one gilled aspidobranchs only the limpet *Acmaea testudinalis* is available. There are no shallow water trochaceans (the group including *Margarites* and *Tegula*) such as are common on other coasts. Representatives of the class Scaphopoda ("tusk shells", e.g. *Dentalium*) can only be dredged from deeper water and are not available for experimental studies. Although most bivalve groups are well represented, including three typical genera of the subclass Protobranchia, the subclass Septibranchia is not found locally. Among the Cephalopoda, neither octopods nor sepioids are available locally, though *Octopus* has been dredged from deeper water offshore.

This chapter includes an outline classification of Mollusca, a glossary of terms relating particularly to shelled forms, some general references, a short section on local amphineurans and cephalopods, and detailed keys and annotated lists of species for the two large groups, the shelled gastropods and the bivalves. For nudibranchs and other shell-less ophistobranch gastropods, see Chapter 15.

Much molluscan systematics in the past has been based on shell characteristics, and previously available keys have been almost entirely conchological - the vital soft parts and environmental circumstances being ignored. We have deliberately tried to design the present keys to be used on molluscs collected alive - and therefore they will not be so useful for the identification of stray empty shells found cast up on the beach. We feel, however, that by using such characters as the siphons of bivalves, we have created less artificial keys. We have tried to use criteria of more fundamental biological significance than the detailed dimensions of shells, and attempted to avoid the artificial separation of naturally related genera. In almost all cases, the specific names used follow those of Abbott (1954). Occasionally, where a well known generic name is no longer correctly applied to a particular species, we have given this after an "equals" sign in parentheses, e.g. (= *Venus*). These "former" genera should be clearly distinguished from the few subgenera quoted, which are placed in parentheses following accepted usage.

The outline classification given below is that which has been used in teaching at Woods Hole for three years, and reflects modern reconsideration of phylogeny in the light of functional morphology (see, for example, the classification of the bivalves). Typical genera (local if possible) are given in parentheses, and are marked "*" if species occur in the Cape Cod area, "n" if non-marine.

OUTLINE CLASSIFICATION OF THE MOLLUSCA

A. Class MONOPLACOPHORA . . . . (Neopilina)

B. Class AMPHINEURA

- I. Subclass APLACOPHORA . . . . (*Chaetoderma)
- II. Subclass POLYPLACOPHORA . . . . (*Chaetopleura)

C. Class SCAPHOPODA . . . . (*Dentalium)

D. Class GASTROPODA

- I. Subclass PROSOBRANCHIA
  - a. Order Archaeogastropoda (Diotocardia or Aspidobranchia) . . . . (*Acmaea)
  - b. Order Mesogastropoda (Monotocardia I or Taenioglossa) . . . . (*Littorina, *Lacuna, *Crepidula)
  - c. Order Neogastropoda (Monotocardia II or Stenoglossa) . . . . (*Busycon, *Nassarius, *Urosalpinx)
- II. Subclass OPISTHOBRANCHIA (key to shell-less forms is in Chapter XV)
  - a. Order Cephalaspidea . . . . (*Acteon, *Philine)
  - b. Order Anaspidea . . . . (*Haminoea, *Aplysia)
  - c. Order Thecosomata (Thecosomatous Pteropods). . . . (*Cavolina)
  - d. Order Gymnosomata (Gymnosomatous Pteropods). . . . . (*Clione)
  - e. Order Sacoglossa . . . . (*Elysia)
  - f. Order Acochlidiacea . . . . (Hedylopsis)
  - g. Order Notaspidea . . . . (Pleurobranchus)
  - h. Order Acoela (Nudibranchia). . . . (*Acanthodoris, *Aeolidia)
- III. Subclass PULMONATA
  - a. Order Basommatophora . . . . (*Melampus, n*Lymnaea)
  - b. Order Stylommatophora . . . . (n*Cepaea)

E. Class BIVALVIA (Lamellibranchia or Pelecypoda)

- I. Subclass PROTOBRANCHIA . . . . (*Nucula, *Yoldia, *Solemya)
- II. Subclass LAMELLIBRANCHIA (no longer used to designate whole class)
  - a. Order Taxodonta . . . . (*Anadara)
  - b. Order Anisomyaria. . . . . . (*Mytilus, *Chlamys, *Crassostrea)
  - c. Order Heterodonta . . . . (*Tellina, *Mercenaria)
  - d. Order Schizodonta . . . . (n*Anodonta, n*Unio)
  - e. Order Adapedonta . . . . (*Mya, *Ensis)
  - f. Order Anomalodesmata . . . . (*Lyonsia, *Pandora)

III. Subclass SEPTIBRANCHIA . . . . (*Cuspidaris*)

F. Class CEPHALOPODA

I. Subclass NAUTILOIDEA (TETRABRANCHIA) . . . .(*Nautilus*)

II. Subclass AMMONOIDEA . . . . (entirely extinct)

III. Subclass COLEOIDEA (DIBRANCHIA)

a. Order Decapoda . . . . (**Loligo*)
b. Order Octopoda . . . .(**Octopus*)
c. Order Vampyromorpha . . . .(*Vampyroteuthis*)

GLOSSARY OF MOLLUSCAN TERMINOLOGY

Adductor muscle(s): The major muscles (usually two in number) of the bivalve body, inserting on each valve, the contraction of which closes the shell valves.
Aspidobranch ctenidium: (Gastropods) A "shield" or "feather shaped" gill with leaflets or filaments alternating on either side of the axis (figs. 1, 2)
Body whorl: The last and largest whorl which terminates at the aperture (Gastropods)(fig. 9)
Byssus: (Bivalves) A permanent (or more usually temporary) attachment of tough organic threads secreted from a gland in the foot.
Callus: A local area of shell thickening (a callus may occur near the umbilicus in certain snails).
Cardinal teeth: Hinge teeth immediately below the umbo.
Chondrophore: (Bivalves) An internal shelf near the hinge line, often spoon shaped which bears the "resilium", or internal ligament in certain groups of clams.
Columella: The thickened axis of the shell about which the whorls are developed (Gastropods)(fig. 9).
Concentric sculpture: Centering around the umbo and parallel to the shell margin (Bivalves).
Ctenidia (sing. - ctenidium): The characteristic gills, present and structurally homologous in all major groups of the Mollusca.
Dimyarian: (Bivalves) With two approximately equal adductor muscles (figs. 5, 17).
Exhalent siphon: (Bivalves) The more dorsal (nearer the hinge line) tubular extension of the mantle edge through which water passes out from the mantle cavity, actually from the so-called "suprabranchial chambers" above and within the gill lamellae.
Foot: The muscular locomotory organ in all molluscs. (In Cephalopoda it is represented by the siphon and possibly the tentacles).
Growth lines or rings: (Bivalves) Lines concentric to the umbo on each valve which mark the successive positions of the shell margin during earlier growth.
Heteromyarian: (Bivalves) With two markedly unequal adductor muscles (figs. 7, 16).
Hinge teeth: See cardinal teeth, lateral teeth.
Inhalent siphon: (Bivalves) The more ventral tubular extension of the mantle edge through which food bearing water is drawn into the mantle cavity.
Inhalent siphon: (Gastropods) The gutter shaped extension of the thickened edge of the mantle through which water is drawn into the mantle cavity in some snails.
Labial palps: Paired ciliated triangular flaps on either side of the mouth in bivalves.
Lamellar gills: Enlarged, flattened plate-like gills (ctenidia) which form the feeding organs of most bivalves (figs. 7, 8).
Lateral teeth: Hinge teeth (anterior and posterior to the cardinals).
Ligament: The elastic horny hinge of the bivalve shell.
Longitudinal sculpture: Crossing the direction of growth of the whorls, essentially axial to the spiral (Coiled gastropods).
Lunules: (Bivalves) Heart shaped impressions (fig.28) in the midline of the shell anterior to the umbones (Venerid clams).

Monomyarian: (Bivalves) Apparently with only a single large adductor muscle uniting the valves (fig. 18).
Operculum: A horny or calcareous plate attached dorsally to the posterior end of the foot in gastropods, which forms a trap door closing the aperture of the shell on withdrawal of the animal.
Pallets: Paired flat shelly plates (figs. 25-27) secreted at the distal end of the elongate siphons in the worm-like wood borers (important in species systematics).
Palp proboscides: Long ciliated grooved tentacles extending from the labial palps (found only in protobranchiate bivalves) (fig. 5).
Pectinibranch ctenidium: (Gastropods) A "comb shaped" gill with leaflets or filaments extending from one side of the gill axis only, the axis usually being fused to the "roof" of the mantle cavity (figs. 3, 4).
Radula: A tough chitinous ribbon bearing teeth of various forms, part of the buccal apparatus in all molluscs except bivalves, used to obtain food by a rasping, "licking" action.
Radial sculpture: Radiating from the umbo (Bivalves).
Ribs: (Bivalves) Radial sculpture.
Ribs: (Gastropods) Longitudinal sculpture.
Spiral sculpture: Running from the shell apex to the aperture along the whorls (Coiled gastropods).
Siphonal canal, siphonal notch: A tube-like extension or notch-like infolding of the lip of the aperture in a gastropod shell through which the inhalent siphon is extended in life (figs. 9, 12).
Sculpture: See concentric, longitudinal, radial, ribs, spiral.
Taxodont dentition: A long row of many small uniform teeth in the hinge line (Bivalves) (fig. 17).
Umbilicus: A pit or chink in the shell next to or within the base of the columella, occurring in gastropods in which the largest whorls are not closely wound against each other axially (fig. 10).
Umbo (pl. - umbones): (Bivalves) The apparent "apex" or "beak" of each valve around which "radial" growth has proceeded.

REFERENCES ON MOLLUSCA

Abbott, R. Tucker, 1954. American Seashells 541 pp., Van Nostrand, Princeton.
Abbott, R. Tucker, 1961. How to Know the American Marine Shells, 222 pp. Signet Key Books, New York.
Fretter, V., and Graham, A., 1962. British Prosobranch Molluscs, their Functional Anatomy and Ecology, 755 pp., Ray Society, London.
Gould, A. A., and W. C. Binney, 1870. Report on the Invertebrata of Massachusetts, 2nd Ed., vi + 524 pp., Boston.
Heath, H., 1918. Solenogastres from the eastern coast of North America. Mem. Mus. Comp. Zool. Harvard, 45: 183-261.
Johnson, C. W., 1934. List of marine Mollusca of the Atlantic Coast from Laborador to Texas. Proc. Bost. Soc. Nat. Hist., 40: 1-204.
Miner, Roy Waldo, 1950. Field Book of Seashore Life, 888 pp., G. P. Putnam's Sons, New York.
Morris, P. A., 1947. A Field Guide to the Shells of our Atlantic and Gulf Coasts 236 pp., Houghton Mifflin, Boston.
Morton, J. E., 1958. Molluscs, 232 pp., Hutchinson, London.
Pelseneer, P., 1906. Mollusca, 355 pp. in "A Treatise on Zoology" (ed. E. R. Lankester), A. and C. Black, London.
Thiele, J., 1931-1935. Handbuch der systematischen Weichtierkunde 4 vols., Gustav Fischer, Jena.
Verrill, A. E., 1882. Report on the cephalopods of the northeastern coast of America. Rept. U. S. Fish. Comm, 1879.
Verrill, A. E. and S. I. Smith, 1873. Report upon the Invertebrata of Vineyard Sound and Adjacent Waters, etc. Rept. U. S. Comm. Fish., 1871-72, pt. I: 295-778, Pl. 1-38.

Wilbur, K. M. and Yonge, C. M., 1964. Physiology of Mollusca , 2 vols., Academic Press, New York.
Yonge, C. M., 1947. The pallial organs in the aspidobranch Gastropoda and their evolution throughout the Mollusca. Philos. Trans. Roy. Soc. London. B, 232: 443-518.

PART 2. CLASSES AMPHINEURA AND CEPHALAPODA

Class Amphineura
(Chitons and Solenogastres)

The Polyplacophora (chitons) are more or less flattened animals bearing eight transverse calcareous plates dorsally. They possess a broad creeping foot, a well developed radula, and a variable number of paired ctenidia within the pallial grooves along each side of the foot. Chitons are typically found on hard substrates, such as the larger rocks of exposed shores or on shells in more protected waters.

The Aplacophora (Solenogastres) are small shell-less forms that might not be recognized as molluscs by the general student. They have not been reported from the Woods Hole region proper, but a few species are known from deeper waters off the New England coast, the most common being Chaetoderma nitidulum Lovén, 1845, from 50 meters or greater depths off Martha's Vineyard (Heath, 1918).

In contrast to Solenogastres, chitons are well known to zoologists, and in some regions make up a conspicuous element of the intertidal fauna. The forty genera of Polyplacophora are, however, largely Indo-Pacific, and the only member of the group common at Woods Hole is:

Chaetopleura apiculata (Say). "Common Eastern Chiton". Elongate-ovate; plates with 15-20 rows of raised beads in the central area, with fine diagonal sculpture on the margins; tan or brown in color, girdle with reddish-brown to green mottling and covered with scattered short "hairs"; up to 3 cm in length; very common in shallow waters on stones and shells.

A rarer species which has been reported taken from the gutters of Hadley Harbor is:

Ischnochiton (= Trachydermon) ruber (Linnaeus). "Northern Red Chiton". Elongate-ovate; surface of plates smooth except for growth lines, plates externally buff colored with reddish marblings, internally colored bright pink; girdle reddish-brown with minute elongate scales; up to 2.5 cm long; more common in deeper waters north of the Cape.

Class Cephalopoda

The only local cephalopods are the squids. The common species, regularly available for experimental work is:

Loligo pealei Lesueur. "Common Squid" or "Long-finned Squid". Fins more than half the length of the trunk (fig. 30); without eyelids; color translucent gray with obvious chromatophores (mostly red and black); up to about 60 cm long; common, Cape Cod southward.

Another squid occasionally but not regularly taken near Woods Hole is:

Ilex (= Ommastrephes) illacebrosus (Lesueur). "Northern", "Summer", or "Short-finned Squid". Fins about 1/3 length of the trunk (fig. 31); with eyelids; color deep blue, ranging to red; up to about 45 cm long; common north of Cape Cod, but taken occasionally in Woods Hole waters in summer.

PART 3. SHELLED GASTROPODS

KEY TO SHELLED GASTROPODS OF THE WOODS HOLE REGION

1. Single aspidobranch ctenidium (figs. 1 and 2) and other archaeogastropod characters, simple conical shell without internal shelf or recurved apex, "tortoise-shell"coloring . . . . . <u>Acmaea</u> <u>testudinalis</u>
1. Single pectinibranch ctenidium (figs. 3 and 4), shells of various forms -- coiled, conical, or reduced 3
1. No ctenidium, mantle cavity as a lung, (and other Pulmonate characters), shiny ovoid shells with no operculum, small salt marsh or high littoral snails 2

2. Squat, egg shaped, widest behind aperture, with very short conical spire, translucent brown, adult is about 15 mm long with 5-6 whorls, abundant in salt marshes . . . . <u>Melampus</u> <u>bidentatus</u>
2. Top shaped, widest at aperture, with longer conical spire one-third length of shell, shiny brownish-yellow, adult is about 7.5 mm long with 7-8 whorls and incised suture, less common than <u>Melampus</u> . . . . <u>Ovatella</u> (+<u>Alexia</u>) <u>myosotis</u>

3. Snails with an inhalent pallial siphon and an extensible proboscis bearing a narrow radula, mostly active predaceous carnivores or carrion feeders, turbinate coiled shells with a canal or rudimentary notch next to the columella to accomodate the pallial siphon, (Neogastropoda - "Whelks" and "Drills") 31
3. Snails other than above 4

4. Shells with only apex as regular turbinate spiral shell, continuing to grow as cylindrical tube which may be irregularly worm-like or minute cucumber shaped 7
4. Cap shaped conical shells with internal shelf 5
4. Snails other than above 9

5. Almost circular "limpet" shell with central cup shaped shelf internally . . . . <u>Crucibulum</u> <u>striatum</u>
5. Ovate "slipper limpet" shells with posterior shelf 6

6. Robust "slipper limpet", shell opaque dirty white to tan, often with brownish blotches, shell height about one third of length, concave white shelf occupies about one half of aperture, often found in "stacks"; up to 5 cm long . . . . <u>Crepidula</u> <u>fornicata</u>
6. Very flat "slipper limpet", always pearly white, variably flexed white shelf occludes less than one half of aperture, never forms "stacks", often inside shells or on <u>Limulus</u>; up to 3.3 cm long . . . . <u>Crepidula</u> <u>plana</u>
6. Small, relatively high "slipper limpet", apex obvious and often overhanging posterior margin of shell, oblique brown shelf occluding about one third of aperture; up to 13 mm long . . . . <u>Crepidula</u> <u>convexa</u>

7. Attached tubular shell drawn out distally and irregularly twisted to resemble a large serpulid worm tube, relatively large, up to 7.6 cm long; only one species recorded near Woods Hole . . . . <u>Vermicularia</u> <u>spirata</u>
7. Minute cucumber shaped molluscs with only a tiny spiral apex which may be eroded 8

8. Glossy opaque white, with about 15 longitudinal ribs, about 5 mm in length . . . . <u>Caecum</u> <u>cooperi</u>
8. Translucent tan when alive, chalky white when dead, with about 20-30 circular ribs; about 2 mm in length . . . . <u>Caecum</u> <u>pulchellum</u>

9. Snails with no operculum, and reduced shell which is usually enclosed within expanded pallial or pedal tissues in life, animal usually incapable of withdrawing completely within shell 10
9. Snails with normal operculum and shell, though expanded soft parts appear disproportionately large and may conceal shell almost completely; but animal is capable of total withdrawal into shell 16
9. Snails with normal operculum and shell, soft parts are readily contained within shell 22

10. Shell totally enclosed within animal 11
10. Shell may be partially or largely exposed upon retraction of animal 12
(Note: Pteropods and other pelagic gastropods with reduced shells are omitted from this key.)

11. With internal saucer shaped horny shell, extensible mantle lobes used for swimming, the only species of "sea hare" recorded in this area; up to 20 cm long . . . . *Aplysia willcoxi*
11. With fragile glassy bean shaped turbinate shell within mantle, living animal characteristically exhibiting four fleshy lobes when viewed dorsally; up to 13 mm long . . . . *Philine lima*

12. Shell visible externally, with a prominent spire and ornamented with fine spiral rows of dots at level of aperture, shell up to 8 mm long . . . . *Acteon punctostriatus*
12. Shells not usually visible externally when animals are active, spire low or absent, thin glassy shell lacking ornamentation, "Bubble-shell" Tectibranchs 13

13. Shells with a small but elevated spire 14
13. Shells with spire depressed into pit, that is, body whorl completely encloses the rest of the shell 15

14. Stubby, fragile shell with very low spire, white with yellowish-brown staining, columella smooth; up to 3 mm shell length . . . . *Retusa obtusa*
14. Moderately elongate, stronger shell with more obvious spire except when eroded; white with dark rust-brown staining; columella with strong spiral ridge; up to 6 mm shell length . . . . *Retusa canaliculata*

15. Larger globose shell, fragile bluish-white; relatively large aperture; up to 13 mm shell length . . . . *Haminoea solitaria*
15. Smaller elongate cylindrical shell; white with brown periostracum; relatively narrow aperture; up to 5 mm shell length . . *Cylichna alba*
(Note: Other species of "Bubble-shell" Tectibranchs may occur in this area.)

16. Globose shells (shaped like Helicid land snails), lacking any siphonal canal on shell, with brown horny operculum characteristically D-shaped; in living animal enormous expanded foot partially encloses shell as animal plows along on sandy substrate; proboscis extrusible but not usually visible, short retractible fleshy inhalent pallial siphon; predaceous carnivores (Naticid "Moon-shells") 17
16. Other than above, recheck alternative characters at 3 and at 9.

17. Shell umbilicus clearly open (fig. 10) 18
17. Shell umbilicus totally or nearly occluded by callus (fig. 11) 20

18. With no obvious callus 19
18. With obvious ivory white thickened callus which does encroach on the umbilicus; shell white with yellowish periostracum; up to 1 cm long . . . . <u>Polinices immaculatus</u>

19. Coarse heavy shell, with no callus; brownish-gray; often with attached algal filaments; up to 12 cm shell diameter; common . . . . <u>Lunatia heros</u>
19. Thin clean shell, with inconspicuous white callus on inner lip, light brown or white with three characteristic rows of squarish dark brown spots on last whorl; up to 13 mm shell diameter; less common . . . . <u>Lunatia triseriata</u>

20. Shell considerably wider than high with flat spire; clean bluish-gray, with obvious purple (or more rarely brown or pink) callus almost completely occluding umbilicus; up to 7.5 cm diameter; often abundant intertidally and in shallow water . . . . <u>Polinices duplicatus</u>
20. Shells slightly higher than wide with obvious spire; white with pale brown periostracum; white callus closing or nearly closing umbilicus; opercula more calcified than other Naticids above; smaller species, less common and usually subtidal 21

21. Larger globose shell; polished white flat callus always completely sealing over umbilicus; up to 3.8 cm shell height . . . <u>Natica clausa</u>
21. Smaller ovate shell; white callus usually leaving open chink at umbilicus; shell usually with faint bands of light brown; up to 8 mm shell height . . . . <u>Natica pusilla</u>

22. Elongate turret shells (fig. 15); usually more than 5 obvious whorls; height more than 1.5 times diameter 23
22. Globose shells (fig. 14); height less than 1.5 times diameter 29

23. Shells coiled dextrally 24
23. Shell coiled sinistrally; 10-12 whorls, dark brown with three spiral rows of prominent beads; up to 6 mm long . . . . . <u>Triphora nigrocincta</u>

24. About 11 markedly globose whorls, expanding rapidly to give a conical shell, each whorl bearing about 16 strong longitudinal ribs; circular aperture with thickened lip; up to 2.5 cm long; the only true "Wentletrap" recorded in this area . . . . . <u>Epitonium rupicola</u>
24. Whorls not markedly globose; whole shell awl or spindle shaped; mostly under 15 mm shell length 25

25. Without obvious shell sculpture; about 5 somewhat globose whorls separated by a clear suture; aperture ovate-circular; up to 5 mm in length 26
25. With obvious shell sculpture of various forms; more than 6 somewhat flatter whorls; aperture flattened or rectangular; up to 18 mm long 27

26. Minute; smooth yellow-brown shells with no markings apart from growth lines; up to 5 mm long (several species may occur in this area, including some in brackish waters). . . . . <u>Hydrobia</u> spp.
26. Minute; light yellow to brown shell with microscopic spiral sculpture of incised lines; also tiny riblets near suture; up to 2.5 mm long . . . . <u>Cingula aculeus</u>

27. Shell with rounded aperture with barely perceptible siphonal notch; 6-8 whorls when adult; about 5 mm long; common species which can be abundant intertidally . . . . <u>Bittium alternatum</u>
27. Shells with obvious siphonal notch at anterior of aperture; 10-15 whorls when adult; lengths 3 mm to 15 mm; rarer species, usually subtidal 28

28. Minute species; glossy brown; later whorls bearing 2-3 rows of glassy beads; 10 whorls when adult; about 3 mm long. . <u>Cerithiopsis greeni</u>
28. Larger species; more elongate; chocolate brown; flattish whorls each bearing 3 rows of distinct raised beads which are lighter in color; 14-15 whorls when adult; about 15 mm long . . <u>Cerithiopsis subulata</u>
28. Larger species; more elongate; flattish whorls each bearing 3 strong continuous squarish spiral cords; 10-12 whorls when adult; about 13 mm long (fig. 15) . . . . <u>Seila adamsi</u>

29. Medium sized (up to 3 cm); coarser shells, lacking umbilicus or apertural groove; adults rarely translucent 30
29. Very small, fragile, smooth shell with groove in inner lip extending into chink-like umbilicus; color variable from pink to brown with purple or dark brown markings; up to 8 mm long . <u>Lacuna vincta</u>
(<u>Note</u>: Minute specimens suspected of being spat (juveniles) of <u>Littorina</u> spp. or of <u>Lacuna</u> are best identified by comparing them closely with the apical parts of the shells in known specimens of adults of all four species.)

30. Spire flattened; shell very smooth and shiny; color variable but commonly uniform clear yellow-orange; often banded; up to 1 cm across; in lower littoral associated with fucoid seaweeds . . . . <u>Littorina obtusata</u>
30. Moderate spire, expanding more rapidly after first tiny whorls with raised spiral threads when young; usually black when young; variable but dull as adult; with planktonic larvae (thus apical shell is small and if not eroded in adult is very sharply pointed); up to 3 cm across; the commonest and most abundant "periwinkle" at all tidal levels . . . . <u>Littorina littorea</u>
30. Obvious but variable spire; shell rough with irregular raised lines; color variable but commonly greenish-yellow; viviparous (thus apical shell relatively large); up to 13 mm long; higher littoral (fig. 14). . . . . <u>Littorina saxatilis</u>

31. Snails with protrusible proboscis and inhalent siphon, but with unsculptured globose shells lacking any siphonal canal or notch (almost certainly naticid "moon-shells") see 16
31. Snails with protrusible proboscis and inhalent siphon, but with turreted shells usually with sculpture and with a siphonal canal or notch near the columella 32

32. Minute turreted snails less than 5 mm shell length as adult 33
32. Snails usually larger than 12 mm shell length when adult (most species much larger) 34

33. Smooth glossy shell; gray or yellow-brown with darkened marbling; narrow oval aperture; with siphonal notch; up to 5 mm shell length, common free living species on eel grass and elsewhere in littoral . . . . <u>Mitrella lunata</u>
33. White glossy shells with considerable ornamentation, usually no obvious siphonal notch; up to 5 mm shell length; usually ectoparasites (often on specific invertebrates) . . . . PYRAMIDELLIDACEA
(See note overpage)

Two species have been positively identified in this region:
Odostomia (Menestho) bisuturalis - host unknown
Odostomia (Chrysallida) seminuda - parasitic on Crepidula fornicata

34. Siphonal canal short, forming conspicuous notch in apertural lip (fig. 13) 35
34. Siphonal canal elongate, forming an obvious extension of the apertural lip (fig. 12) 39

35. Larger "whelk"; solid chalky-gray shell, with rough yellowish periostracum; low but obvious sculpture consisting of about 5 spiral cords crossed by about 12 longitudinal ribs in each whorl; flesh of living animal startling white with black blotches; up to 10 cm shell length; common offshore, rarely in littoral . . . . Buccinum undatum
35. Smaller snails with conspicuous siphonal notch; less than 2.5 cm long 36

36. Stout "dirty" shell often eroded, dark brown or black with neither suture nor sculpture obvious; often with adherent debris or organisms; up to 2.5 cm long; often abundant on mud flats intertidally . . . . Nassarius obsoletus
36. Clean shells with obvious sculpture 37

37. Essentially conical shell with 8-9 whorls in adult, bearing about 5 spiral rows of ranked beads giving "waffle-like" pattern; off-white in color; up to 2 cm long (fig. 13); usually living on sand . . . . Nassarius trivittatus
37. Squat solid pear shaped shell with 4-5 whorls in adult, each bearing about 12 pronounced longitudinal folds; off-white in color; up to 13 mm long; less common in this area, living in muddy sand . . . . Nassarius vibex
37. Slimmer spindle shaped shells, with 6-7 whorls in adult, with less complex sculpture; up to 18 mm long 38

38. With about 12 low rounded longitudinal folds on each whorl; usually dark grayish-brown; up to 13 mm long; lower littoral . Anachis avara
38. With about 24 narrow longitudinal folds on each whorl crossed by incised spiral lines; usually drab yellow in color; up to 18 mm long; lower littoral and shallow water . . . . . . Anachis translirata
(Note: Specific identification of minute specimens suspected of being spat (juveniles) of Nassarius spp. or Anachis spp. is aided by comparing them with the apical parts of the shell in known - and not eroded - specimens of all five species).

39. Smaller "drills" etc. under 4 cm shell length as adults (mostly about 2.5 cm long); common in littoral 40
39. Larger "whelks" all over 6 cm length as adults (may be up to 23 cm long); mostly sublittoral and offshore 43

40. Relatively thin shelled with 6-8 globose whorls in adult; gray with greenish periostracum; no obvious shell sculpture; siphonal canal of moderate length bent back from aperture; up to 2.5 cm long . . . . Colus pygmaea
40. Stout shelled "drills" with obvious shell sculpture 41

41. With 5 angular whorls and deep suture, giving sharp "shoulders" to spire, and relatively long siphonal canal which is almost closed over; up to 2.5 cm long (fig. 12) . . . . Eupleura caudata
41. With rounded but ornamented whorls, siphonal canal relatively short and open 42

42. Very thick polished white shell with thickened lip (rarer color variants - clear yellow, orange-brownish or striped); about 5 whorls in adult with rounded spiral ridges giving corrugated appearance; up to 3.5 cm long; less common, on exposed rocky shores . . . . Thais (=Nucella) lapillus

42. Thick duller grayish, yellowish, or brown shell; about 6 whorls in adult, each with 9 to 12 strong longitudinal ribs crossed by spiral grooves giving knobby appearance; up to 2.5 cm long; the commonest local "drill," on all hard substrates . . . . Urosalpinx cinerea (Note: Minute specimens suspected of being spat (juveniles) of Eupleura, Thais, or Urosalpinx can best be separated by the relative lengths of their siphonal canals. Comparison with apical parts of the shells of known adults is less useful here).

43. Combined length of aperture and siphonal canal about one half shell length 44

43. Combined length of aperture and siphonal canal markedly greater than one half shell length 46

44. Heavy grayish shell with 6-7 whorls as adult, bearing up to 10 conspicuous reddish-brown spiral ridges; up to 10 cm long . . . . Neptunea decemcostata

44. Lighter shells with simple globose whorls 45

45. Shells more elongate, sharper spired; 6-7 whorls in adult; siphonal canal straight; thin semi-glossy periostracum; up to 13 cm long . . . . Colus stimpsoni

45. Shells less elongate, blunter spire; 5-6 whorls in adult; siphonal canal usually twisted away from aperture; hairy periostracum; up to 6.5 cm shell length . . . . Colus pubescens

46. Suture channeled giving broad flat "shoulders" to whorls; up to 20 cm long . . . . Busycon canaliculatum

46. Suture not deeply incised; single row of knobby tubercles on inclined "shoulders" of whorls; up to 23 cm long . . . . Busycon carica

ANNOTATED LIST OF SHELLED GASTROPODS OF THE WOODS HOLE REGION

Acmaea testudinalis (Müller). "Tortoise-shell limpet". On hard substrata only, in the lower littoral and immediate sublittoral of exposed shores, the only true limpet in this area, and the single local gastropod species which retains the primitive feather shaped ctenidium of the rchaeogastropods.

Acteon punctostriatus (C. B. Adams). Near low water mark and offshore, preferred substrata not known.

Anachis avara (Say). Lower littoral, common in some places. Both species of Anachis are predaceous carnivores and are more abundant in the south.

Anachis translirata (Ravenel). Lower littoral, but more commonly dredged in shallow water.

Aplysia willcoxi Heilprin. "Sea Hare". Probably rare, this is the only large tectibranch whih has been recorded in this area. The group is better represented on more southern Atlantic coasts.

Bittium alternatum (Say). Common and often extremely abundant on tidal flats and in shallow water offshore, on a variety of substrata but especially organic muds and eelgrass.

Buccinum undatum L. "White helk" or "Buckie". Not uncommon offshore in colder waters, rarely in littoral, on a variety of substrata.

(Note: *= Busycotypus canaliculatus; **= Busycon aruanum; Hollister, S. C., 1958. Paleont. Amer. 4: 59-125)

Busycon canaliculatum (L). "Channeled Whelk". Dredged in shallow water on sandy bottoms, more common than B. carica in this area.
Busycon carica (Gmelin). "Knobbed Whelk". Dredged in shallow water on sandy bottoms, not uncommon.
Caecum cooperi S. Smith, and
Caecum pulchellum Stimpson. Minute cucumber shaped gastropods found interstitially in sand or in dead sponges, detailed ecology unknown, inshore in warmer waters.
Cerithiopsis greeni (C. B. Adams), and
Cerithiopsis subulata (Montagu). Less common in Cape area than in warmer waters to the south, in shallow water, detailed ecology unknown.
Cingula aculeus Gould. In shallow water; other species of the Rissoacea may be discovered in this area.
Colus pubescens (Verrill) and
Colus pygmaea (Gould) and
Colus stimpsoni (Mörch). Dredged subtidally and offshore.
Crepidula convexa Say. Littoral and offshore, the least common of the three local "slipper-limpets", occasionally on eelgrass and more commonly on a variety of shells.
Crepidula fornicata (L.). "Common Slipper-limpet". Littoral and offshore, the commonest and largest local "slipper-limpet", often found in stacks, showing characteristic sex change with size and position.
Crepidula plana Say. Littoral and offshore, never forming stacks, variably flexed to fit their substratum which may be the inside surface of a larger molluscan shell, or the exoskeleton of Limulus.
Crucibulum striatum (Say). Dredged in shallow water, with an enlarged ctenidium like the closely related Crepidula spp., probably also a filter feeder.
Cylichna alba (Brown). Low water mark and shallow water, the detailed ecology of this and other species of "Bubble-shell tectibranchs" is unknown.
Epitonium rupicola Kurtz. "Brown-banded Wentletrap". Near low water mark and further offshore, not uncommon, this is the only local species of a genus more common to the south.
Eupleura caudata (Say). "Thick-lipped Drill". Hard substrata, lower littoral and subtidal, probably more common in warmer waters. This is the least common of the three local species of "drills" which are predaceous carnivores with radula and proboscis modified for boring and an accessory boring organ in the foot.
Haminoea solitaria (Say). Low water mark and shallow water, probably the commonest "Bubble-shell tectibranch" in this area, may occur mainly in muddier inlets with eelgrass, detailed ecology and reproductive behavior unknown.
Hydrobia spp. Several species of this difficult but widespread genus may occur in this area, some in brackish waters.
Lacuna vincta (Montagu). "Chink-shell". Lower littoral and shallow water, often abundant, a cold water species.
Littorina littorea (L.). "Common Periwinkle". Typically at midlevel littoral, in this area the largest, commonest, and most abundant "periwinkle" at all tide levels, with planktonic larvae and less capacity to resist desiccation and to respire in air than L. saxatilis.
Littorina obtusata (L.). "Smooth Periwinkle". At lower levels at the littoral, usually associated with fucoid seaweeds including Ascophyllum. This periwinkle is referred to in modern European physiological literature as L. littoralis (L.) (not to be confused with the distinct species L. littorea which also occurs in Europe), and in early U. S. conchological literature as L. palliata (Say).
Littorina saxatilis (Olivi). "Rough Periwinkle". Typically high level littoral, of variable shell form and color, in this periwinkle females have a brood pouch and give birth to shelled young resembling miniature adults, the gill is reduced and the mantle cavity more lung-like, and all stages have a greater capacity to resist dessication than the other littorinids. L. rudis (Maton) is simply a synonym of L. saxatilis.
Lunatia heros (Say). "Moon-shell". Not uncommon on sand intertidally but more abundant subtidally, this is the largest of the six local species of predaceous

carnivores belonging to the Naticidae. It is less resistant than Polinices duplicata to higher temperatures and lower salinities.

Lunatia triseriata (Say). Less common and usually subtidal, this small naticid occurs, however, intertidally in Lagoon Pond, Martha's Vineyard, and elsewhere in this area.

Melampus bidentatus (Say) (= M. lineatus (Say)). Usually living around the high water mark of spring tides, and abundant in the high levels of Cape Cod salt marshes, Melampus is a pulmonate belonging to the family Ellobiidae and thus probably related to the gastropod stock which gave rise to most land snails and to the freshwater pulmonates like Lymnaea.

Mitrella lunata (Say). Near low water mark and in shallow water on a variety of substrata, often extremely abundant, this minute snail is closely related to Anachis spp. and is a predaceous carnivore using its extensible rasping and sucking proboscis to prey on various small sessile invertebrates such as Botryllus.

Nassarius obsoletus (Say). "Common Mud Snail". In shallow water subtidally, intertidally on mud flats, and even in estuarine conditions, this is often an extremely abundant species congregating in packed masses which can temporarily cover acres. Embryologists have tended to refer to this snail as Ilyanassa obsoleta (using its subgeneric name), and certain older books place it in the genus Nassa.

Nassarius trivittatus (Say). Intertidally and in shallow water, usually on clean sand in sheltered localities, this species is common but less abundant than N. obsoletus.

Nassarius vibex (Say). Occurs on sand and mud flats intertidally, less common in this area than the other two Nassarius spp.

Natica clausa Broderip and Sowerby. Dredged subtidally and offshore in the Cape Cod area, intertidal on some more northern shores.

Natica pusilla Say. Dredged subtidally and offshore.

Neptunea decemcostata (Say). Dredged offshore, shells occasionally washed up.

Odostomia (Menestho) bisuturalis (Say). Identified here, see below.

Odostomia (Chrysallida) seminuda (Say). Identified here, and found by the writers to live as an ectoparasite on Crepidula fornicata.
(Note: Other species of the PYRAMIDELLIDACEA will probably be found in this area: they are usually ectoparasites and often highly specific as regards their host invertebrates.)

Ovatella (=Alexia) myosotis (Draparnaud). Living around the high water mark of spring tides (for example, in crevices of wharfs and docks, and under the "trash line" of high salt marshes), this minute pulmonate snail is related to Melampus.

Philine lima Brown. Not common in this area, dredged in colder waters.

Polinices duplicatus (Say). "Shark Eye" or "Moon-shell". Most abundant intertidally on sand, this is the commonest of the local species of the Naticidae. Unlike Lunatia heros, it survives lowered salinity and high temperatures, and is thus able to colonize estuarine and high littoral habitats. All naticid snails are predaceous carnivores using the radula in the extensible proboscis to drill through the shells of other molluscs.

Polinices immaculatus (Totten). Less common naticid, subtidal in this area, occuring more frequently to the south.

Pteropods (and other pelagic gastropods with reduced shells) are omitted from this list.

Retusa canaliculata (Say). Sand and mud flats intertidally and in shallow water, this minute species plows along the surface like a tiny naticid and is probably the commonest shelled tectibranch in this area.

Retusa obtusa (Montagu). Not uncommon in habitats similar to those of R. canaliculata.

Seila adamsi (H. C. Lea). Not uncommon around low water mark and subtidally; like the related Cerithiopsis spp., this small "turret-shell" is less common in the Cape area than in warmer water to the south.

Plate 18

MOLLUSCA (1)

Figures 1-8: Mantle cavity and ctenidium in representative molluscs. Figures 1-9 by Stephen C. Brown; 10-15 by Ruth L. von Arx.

Fig. 1. The aspidobranch ctenidium as in the limpet, *Acmaea testudinalis*.

2. Face view of ctenidial leaflets in *Acmaea*.

3. The pectinibranch ctenidium as in *Littorina littorea*.

4. Face view of ctenidial leaflet in *Littorina*.

5. The protobranch ctenidium, associated with large labial palps and palp proboscides, as in *Nucula*.

6. Face view of ctenidial leaflets in *Nucula*.

7. The true lamellibranch ctenidium, as in *Mytilus*.

8. Face view of ctenidial filaments in *Mytilus*.

9. Sectional view of the shell of *Buccinum undatum*, showing whorls surrounding central columella from apical whorl at top to largest "body" whorl with prominent siphonal notch.

10. The naticid "Moon-shell", *Lunatia heros*, showing the shell umbilicus clearly open.

11. The naticid "Moon-shell", *Polinices duplicatus*, showing the obvious pigmented callus nearly occluding the umbilicus.

12. *Eupleura caudata*, showing the elongate siphonal canal forming an obvious extension of the apertural lip.

13. *Nassarius trivittatus*, showing the short siphonal canal forming a prominent notch in the apertural lip.

14. *Littorina saxatilis*, showing a typical "globose" shell with height less than 1.5 times diameter.

15. *Seila adamsi*, showing a typical elongate "turret-shell" with height more than 1.5 times diameter.

Plate 18

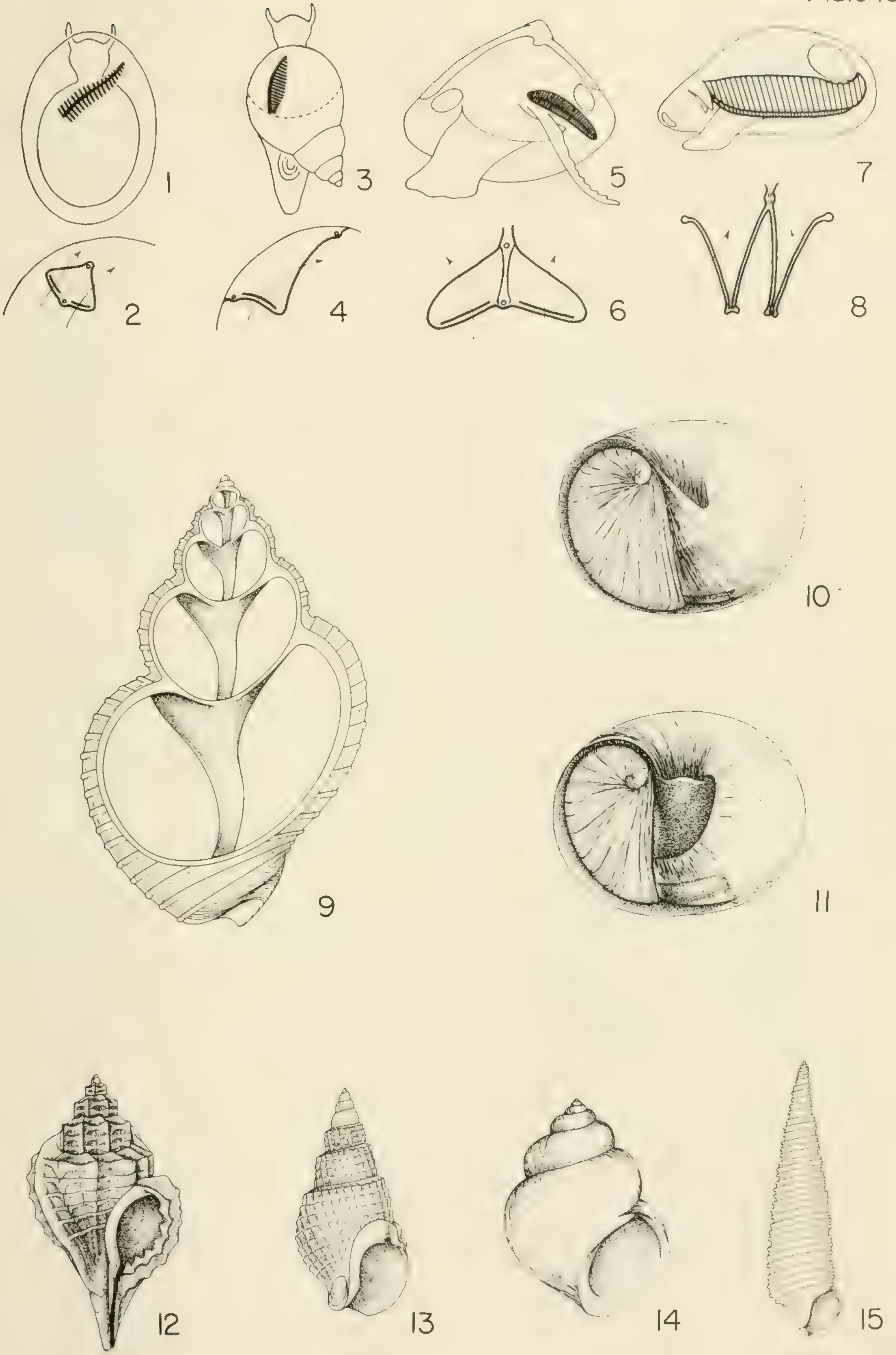


Plate 19

MOLLUSCA (2)

Figures 16-20 and 25-29 by Mrs. R. von Arx; 21-24 by W. Russell Hunter; 30-31 by Bruce Shearer.

Fig. 16. *Modiolus demissus*, shell valve showing the heteromyarian condition of the adductor muscles, and a long external ligament.

17. *Anadara transversa*, shell valve showing dimyarian condition of the adductor muscles, and taxodont dentition in the hinge line.

18. *Aequipecten irradians*, shell valve showing monomyarian condition. of adductor muscle, and internal triangular ligament or "resilium"

19. *Thyasira gouldi*, dorsal view of shell valves with characteristic prominent radial folds running posteriorly from anterior umbones.

20. *Macoma tenta*, dorsal view of shell valves with characteristic posterior twist.

21-24 (following). Siphonal types, and natural posture in substrate, of various bivalves.

21. *Mya arenaria*, a sedentary deep burrowing bivalve with massive fused siphons.

22. *Tellina agilis*, a deposit feeding bivalve with separate extensible siphons.

23. *Mercenaria mercenaria*, an active shallow burrowing bivalve with short fringed siphons and a relatively massive foot.

24. *Ensis directus*, a typical razor clam with short fringed siphons and massive powerful foot emerging terminally like a "mushroom" anchor.

25. *Bankia gouldi*, a typical "Shipworm" bivalve; the elongate body bears reduced valves anteriorly and calcareous pallets at the siphonal openings.

26. *Bankia gouldi*, plume like compound pallet.

27. *Teredo navalis*, simple paddle shaped pallet.

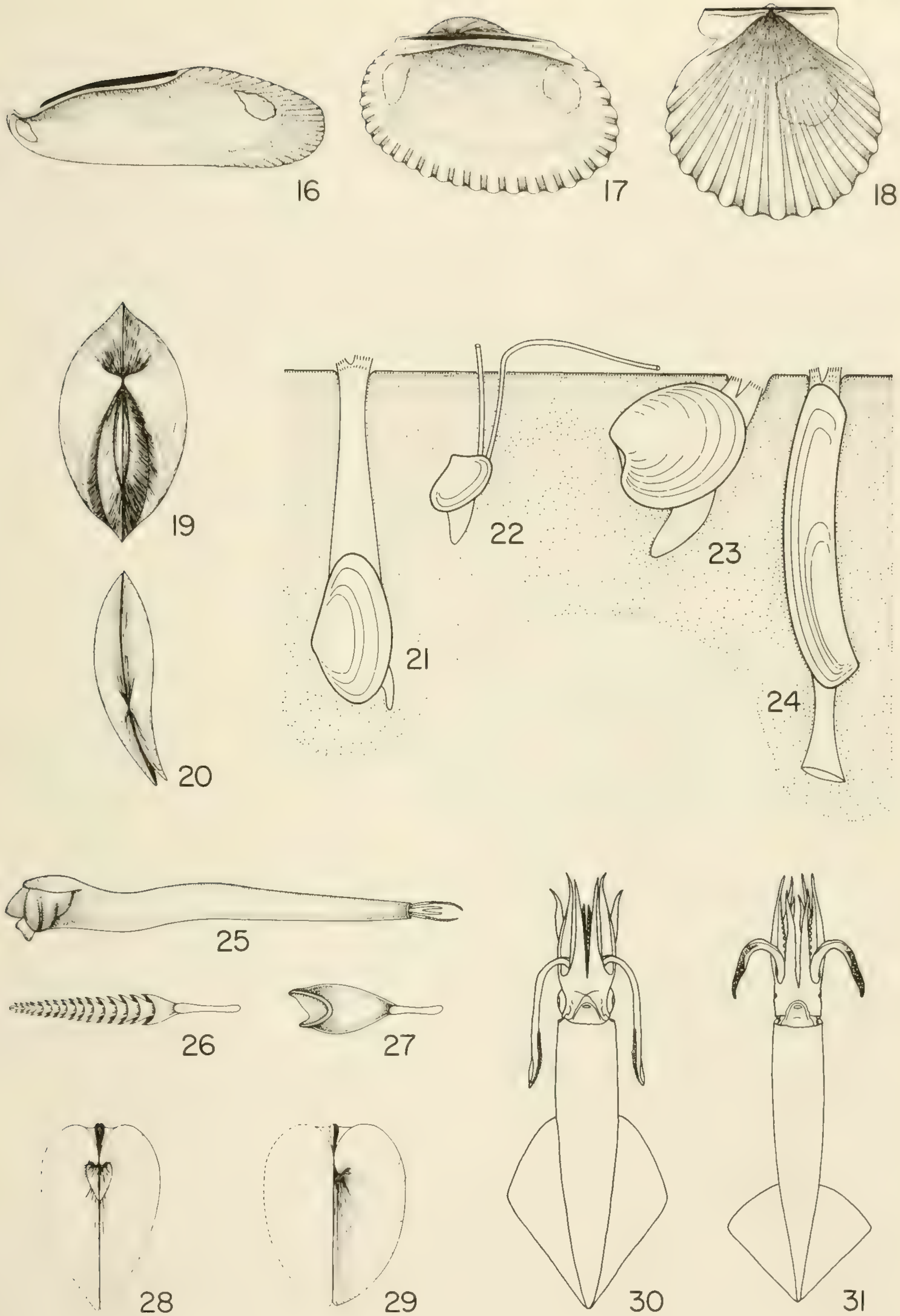
28. *Mercenaria mercenaria*, anterior view of shell showing obvious deeply incised lunules below umbones.

29. *Pitar morrhuana*, anterior view of shell showing large but indistinct lunules below umbones.

30. *Loligo pealei*, showing characteristic lateral fins more than half the length of the trunk and large eyes without eyelids.

31. *Ilex illacebrosus*, showing characteristic short lateral fins and eyes with eyelids.

Plate 19



Thais (=Nucella) lapillus (L.). "Dogwinkle". Hard substrata, lower littoral and subtidal, common only in the Cape area on certain beaches exposed to wave action. This is another carnivorous "drill", feeding on barnacles as well as molluscs.

Triphora nigrocincta (C. B. Adams). Around low water mark on seaweeds, not uncommon, this is the only local gastropod species with a sinistrally coiled shell.

Urosalpinx cinerea (Say). "Oyster-drill". Hard substrata, lower littoral and subtidal, often abundant, this is the commonest of the three local species of drills but, besides using radula, proboscis, and pedal accessory boring organ to bore through the shells of other molluscs, this predaceous carnivore also feeds extensively on barnacles, using muscular action by the proboscis to force apart the plates of the barnacle test without actual boring.

Vermicularia spirata (Philippi). Probably living in shallow water, detailed ecology unknown. "Worm-shells" of this type are rare in this area. Tucker Abbott (1954) records this species only for "Southeast Florida and the West Indies", but shells have been found in the Cape Cod area on several occasions and living specimens found once in 1961 and twice in 1963.

PART 4. CLASS BIVALVIA

KEY TO BIVALVED MOLLUSCS OF THE WOODS HOLE REGION

1. Without lamellar gills, ctenidia resembling those of aspidobranch gastropods (figs. 5 and 6) . . . . Order Protobranchia 2
1. With lamellar gills clearly modified for filter feeding (figs. 7 and 8) 4

2. Protobranchiates feeding by palp proboscides, without lamellar gills, with taxodont dentition (fig. 5) 3
2. Modified protobranchiate with reduced palps, hinge of elongate shell without dentition, with lustrous yellow-brown periostracum, radially marked and extending beyond shell margins. . . . . Solemya velum

3. Obliquely ovate globose shell, usually greenish-gray . . . . . . Nucula proxima
3. Asymmetric elongate shell, narrowing posteriorly, usually greenish-brown . . . . Yoldia limatula

4. With lamellar gills, but retaining taxodont dentition (fig. 17) 5
4. With lamellar gills, with other than taxodont dentition 6

5. Rhomboidal shell (up to 3.8 cm); 30-50 ribs; gray-brown periostracum usually worn, longer stouter ligament clearly distinct, left valve overlapping right valve . . . . Anadara transversa
5. Ovate shell (up to 5.9 cm); 26-35 ribs; hairy black-brown periostracum persistant; narrow ligament less distinct . . . . Anadara ovalis

6. Monomyarian condition of adductor muscle (fig. 18) 7
6. Markedly heteromyarian condition of adductor muscles (fig. 16) 12
6. Dimyarian condition (or nearly so) of adductor muscles (fig. 17) 19

7. Swimming monomyarian bivalves (Scallops) 10
7. Attached monomyarian bivalves (Oysters and Jingle shells) 8

8. Lower bivalve with hole through which passes calcified byssus 9
8. No such hole, lower valve directly cemented to hard substrata (Eastern oyster) . . . . Crassostrea virginica

9. Upper valve translucent and smooth, up to 5.1 cm . . . . Anomia simplex
9. Upper valve drably opaque and rough with small prickles . . . Anomia aculeata

10. Both valves with strong radial sculpture 11
10. Rough, dirty-white, pink or yellowish valves without strong radial sculpture; up to 20 cm diameter . . . . <u>Placopecten magellanicus</u>

11. Approximately equal "wings" (or "ears") at hinge; 17-20 regular ribs forming strong radial corrugations; up to 7.6 cm diameter (fig. 18) . . . . <u>Aequipecten irradians</u>
11. Markedly unequal "wings", about 50 irregular cord-like ribs; up to 10.2 cm diameter . . . . <u>Chlamys islandica</u>

12. "Shipworms" boring in timber, worm-like bodies (fig. 25) bearing reduced valves anteriorly and pallets posteriorly 18
12. Wedge shaped shells, markedly narrow anteriorly with well developed, usually dark periostracum, byssal attachment, lacking siphons (Mussels) 13
12. Markedly elongate shells, active burrowers in sand, with well developed foot and short or medium length separate siphons 16

13. Umbo near but not at anterior tip of each valve (fig. 16) 14
13. Umbo at anterior tip of each valve, no shell sculpture, blue-black with shiny periostracum; common in littoral, often abundant . . . . <u>Mytilus edulis</u>

14. With radial shell sculpture and thin periostracum 15
14. Without radial shell sculpture, with thick hairy periostracum; usually dark brown; up to 15 cm, less common species; lower littoral and subtidally . . . . <u>Modiolus modiolus</u>

15. Hinge without teeth; strong radial ribs which bifurcate usually covering entire shell; up to 10 cm long; salt marshes and upper littoral, often abundant (fig. 16) . . . . <u>Modiolus demissus</u>
15. Hinge finely dentate, ribs on anterior and posterior thirds of shell only; up to 6.4 cm long; rarer species; subtidal in this area . . . . <u>Musculus</u> (=<u>Modiolaria</u>) <u>niger</u>

16. Umbo nearly central, siphons separate and moderately long; powerful foot emerging ventrally 17
16. Umbo at anterior end of dorsal margin; very elongate shell curving dorsally; short siphons; powerful foot emerging terminally; "razor" shape; up to 25 cm long (fig. 24) . . . . . <u>Ensis directus</u>
16. Umbo towards anterior end; elongate ovate shell; short siphons; with strong internal rib running ventrally from umbo; up to 6.4 cm long . . . . <u>Siliqua costata</u>

17. Dull greenish-yellow periostracum often eroded around umbones; thick opaque shell gaping at ends; up to 10 cm long . . . . . <u>Tagelus plebeius</u>
17. Shiny thin periostracum with radial markings; often pale purple, fragile shell; up to 3.8 cm long . . . . <u>Tagelus divisus</u>

18. Pallets as simple paddle shaped blades (fig. 27) . . . . <u>Teredo navalis</u>
18. Pallets each plume-like of many cones (fig. 26) . . . . probably <u>Bankia gouldi</u> (but check other <u>Bankia</u> spp.)

19. Deep burrowing or boring bivalves with massive fused siphons (fig. 21) 20
19. Deposit feeding bivalves with separate extensible siphons (fig. 22) 23
19. Otherwise, usually with short fringed siphons (fig. 23) 29

20. Stout rasping spines externally on anterior of valves, reduced periostracum, borers in peat, clay, or stone 21
20. Thin valves with irregular growth rings but no sculpture; thick periostracum on ventral margin and siphons; up to 15 cm shell length; burrowing in muddy sand . . . . Mya arenaria

21. Elongate shell, umbones nearer anterior, entire shell sculptured with spines; large siphons 22
21. Squat shell; up to 5 cm length; umbones nearer midline; sculpture limited to anterior; shell gaping widely at both ends; disproportionately large siphons . . . . Zirfaea crispata

22. Shell tapering posteriorly, with only slight gape; up to 21 cm long . . . . Cyrtopleura (=Barnea) costata
22. Shell truncate posteriorly, gaping widely at both ends; up to 5 cm in length . . . . Cyrtopleura (=Barnea) truncata

23. Ligament internal, triangular 24
23. Ligament external 25

24. Symmetrical ovate shell; pearly white; up to 3.8 cm length . . . . Periploma (=Cochlodesma) leanum
24. Asymmetrical, shell tapering posteriorly, chalky white; up to 2 cm in length . . . . Cumingia tellinoides

25. Shells markedly elongate 28
25. Shells sub-circular or ovate 26

26. Duller white shells, often with slight posterior twist (fig. 20), and pallial sinus more extensive in right valve 27
26. Glossy white opalescent shell with pallial sinuses similar in both valves; up to 13 mm in length . . . . Tellina agilis

27. Variable dull white shell, never elongate; up to 3.8 cm length . . . . Macoma balthica
27. White, fragile shell moderately elongate-ovate; with slight but obvious posterior twist; up to 2 cm length . . . . Macoma tenta

28. Shell sculptured with rasping spines; reduced periostracum; dull white borer in peat or clay; shell proportions somewhat variable . . . . Petricola pholadiformis
28. Shells not sculptured; well-developed periostracum 17

29. Subglobular shells 30
29. Elongate ovate shell, tapering and becoming compressed posteriorly; periostracum with fine radial lines, often with adherent sand grains; up to 2 cm shell length . . . . Lyonsia hyalina
29. Entire shell compressed; with umbones near anterior corner of nearly rectangular valves; somewhat saddle shaped; up to 3.4 cm across . . . . Pandora gouldiana

30. Shells with concentric sculpture 31
30. Shell with strong radial sculpture . . . . Cardita borealis
30. Shells with no sculpture apart from irregular growth rings 34

31. Ligament external 32
31. Ligament internal, triangular; up to 10 mm across . . . . Crassinella (=Gouldia) mactracea

32. With lunules anterior to umbones (fig. 28) . . . . young Mercenaria (=Venus) mercenaria
32. Without such lunules 33

33. Ovate with strong concentric sculpture; up to 5 cm across . . . . Astarte borealis
33. Trigonal with low concentric sculpture; up to 2.5 cm across . . . . Astarte castanea

34. Ligament external 39
34. Ligament internal, triangular 36
34. Ligament in groove but partly external; characteristic small shells with 2 prominent radial folds (fig. 19) running posteriorly from umbones which are anterior 35

35. Oblong valves, translucent-white; up to 13 mm long . . . Thyasira trisinuata
35. Rounded valves, yellowish periostracum; up to 6.4 mm long . . Thyasira gouldi

36. Mantle almost completely fused; short siphons surrounded by common circlet of tentacles; posterior of right valve slightly overlapping left; up to 6.4 mm long . . . . Corbula contracta
36. Ventral margins of mantle apparently fused, but without tissue union; fourth pallial opening ventral to inhalent siphon with associated groove for waste disposal (mactrid clams) 37

37. Mactrid clams less than 18 mm shell length 38
37. Mactrid clam more than 18 mm shell length; strong, ovate; smooth shell covered by shiny thin yellowish-brown periostracum; spoon-shaped chondrophore in left valve; up to 18 cm shell length . . . . Spisula solidissima

38. Rather globose shell with proportionately small chondrophore; no denticles on hinge teeth; each valve with a single low radial rib near posterior . . . . Mulinia lateralis
38. Slimmer shells, with disproportionately large chondrophore; tiny saw-tooth denticles on anterior and lateral hinge teeth . . . . young of Spisula solidissima

39. Shells under 5 mm shell length 40
39. Shells over 5 mm shell length 42

40. Look out for spat of larger bivalves!
    a) If heteromyarian with wedge shaped shell, specimen is likely to be a juvenile mussel. Go back to 13
    b) If moderately elongate with fused siphons, specimen is likely to be a juvenile of Mya arenaria; see 20
    c) If round or ovate with separate extensible siphons, specimen is likely to be a juvenile deposit feeder like a tellinid clam. Go back to 23
    d) If bearing prominent concentric sculpture and lunules anterior to umbones, specimen is likely to be juvenile of Mercenaria; see. . . . . 32 and 43
40. Shells under 5 mm shell length, seemingly adult and not in above categories 41

41. Minute globose shiny shell, with umbones near mid-line and fine concentric lines; white, often with blue or purple patches (very common and often abundant) . . . . Gemma gemma
41. Minute ovate shell with posterior umbones and shiny nut-brown periostracum (rare and probably commensal) . . . . Mysella (=Rochefortia) planulata
(See note overpage)

(But other minute leptonacean clams may also belong here, check Aligena elevata and Montacuta spp.)

42. Globular smooth "cockle" with variable brown patterning on white exterior of shell; interior always translucent yellow; actively moving through sandy substrates by large very extensible foot; up to 2.5 mm diameter . . . . Laevicardium mortoni
42. Slimmer but still globose clams without above shell coloring; may be up to 15 cm in diameter 43

43. Shell valves with marked, deeply incised lunules anterior to umbones (fig. 28); shell may retain traces of juvenile concentric sculpture, internal free margin of shells crenulated and usually purple; up to 15 cm diameter, "Quahog" . . . . Mercenaria (=Venus) mercenaria
43. Shell valves without such lunules and with shiny dark brown or black periostracum showing many fine incised growth lines; no crenulation on valve margin; up to 13 cm diameter . . . . Arctica (=Cyprina) islandica
43. Shell valves with large but shallow lunules; dull chalky white; without crenulation on ventral margin of valves; up to 5 cm diameter (fig. 29) . . . . Pitar morrhuana

ANNOTATED LIST OF BIVALVES OF THE WOODS HOLE REGION

Aequipecten irradians (Lamarck). "Bay Scallop". The commonest scallop of the area, in most larger harbors and lagoons on flats exposed at lowest tides, also subtidal in shallow water.

Anadara ovalis (Bruguière). "Blood Ark". Formerly known as Arca campechiensis Gmelin, fairly common low water mark to subtidal.

Anadara transversa (Say). "Transverse Ark". Smallest of our "Ark-shells", fairly common in mud, low water mark to subtidal.

Anomia aculeata Gmelin. "Prickly Jingle". Less common, attached to rocks or empty shells, near low water mark.

Anomia simplex Orbigny. "Common Jingle" or "Mermaid's Toenail". More common, attached to logs, docks and boats as well as to rocks; near low water mark.

Arctica (=Cyprina) islandica (L.). "Black Quahog". Dredged in muddy sand, common in certain areas.

Astarte borealis Schumacher and
Astarte castanea (Say). Dredged in shallow water locally, may occur intertidally on exposed sand beaches north of the Cape.

Bankia gouldi Bartsch. A common and very destructive "Shipworm" on the southern Atlantic coast, transported to this area in drifting wood.

Barnea, see Cyrtopleura.

Cardita borealis (Conrad). Dredged in shallow water and on the continental shelf, probably common in some places. This species is listed in most of the textbooks as Venericardia borealis, but Venericardia is apparently a Tertiary genus not surviving today.

Cerastoderma pinnulatum (Conrad). Not in key. Dredged subtidally.

Chlamys islandica Müller. "Iceland Scallop". Common in shallow water and on the continental shelf.

Corbula contracta Say. Dredged in shallow water.

Crassinella (=Gouldia) mactracea Lindsley. Dredged from current swept sand and shell bottom in shallow water.

Crassostrea virginica (Gmelin). "Eastern Oyster". This is the commercially important oyster of the Atlantic seaboard; greatly variable in size and shape; around and below low water mark in estuarine as well as marine conditions, attached to any hard substrata including empty shells, with free swimming larvae, unlike Ostrea spp.

Cumingia tellinoides Conrad. In muds, usually associated with eelgrass, a deposit-feeding bivalve, which, however, does not belong to the family Tellinidae but to the Semelidae, illustrating convergence in functional morphology.

Cyrtodaria siliqua (Spengler). Dredged subtidally. Not in key.

Cyrtopleura (=Barnea) costata (L.). "Angel Wing". Around low water mark in sandy mud, may also be found boring in peat or clay.

Cyrtopleura (=Barnea) truncata (Say). "Truncated Borer". Borers in peat or clay on the Cape, and in softer rocks (e.g. shales) outside of this area.

Ensis directus (Conrad). "Common Razor Clam". Rapid vertical burrower in sand, very common in some areas (including Barnstable).

Gemma gemma (Totten). Very common and particularly abundant on tidal flats.

Hiatella gallicana (Lamarck) and possibly also

Hiatella arctica (L.). Non-boring specimens belonging to this genus have been dredged subtidally and a living specimen of H. gallicana was found in 1963 in shallow water at the Sandwich end of the Cape Cod Canal. Not in key.

Laevicardium mortoni (Conrad). In muddy sand, occasionally with eelgrass, in more sheltered shallow waters.

Lyonsia hyalina (Conrad). Rare at low water mark, more commonly dredged.

Macoma balthica (L.). Common in organic muds, a deposit feeder.

Macoma tenta (Say). In muddy sand, a deposit feeder.

Mercenaria (=Venus) mercenaria (L.). "Quahog" or "Little-neck Clam" or "Hard-shelled Clam". The most important commercial clam, very common, locally abundant.

Modiolus demissus (Dillwyn). "Ribbed Mussel". Salt marshes and upper littoral, often abundant. The nomenclature, and even the systematic position, of this mussel have been obscure. Its shell lacks teeth next to the ligament, and it is certainly erroneous to place it in the genus Brachidontes, the shells of which always have tooth-like crenulations just behind the ligament. Care must be taken to distinguish M. demissus from Brachidontes recurvus Rafinesque ("Hooked Mussel"), common on more southern Atlantic shores, but which may extend into this area. Note that Mytilus (or Modiolus) plicatulus is simply a synonym for M. demissus and that both Volsella and Arcuatula have been suggested as generic names for this species. Volsella has been rejected, but recently Soot-Ryen (1955) has suggested Arcuatula demissa as the best name after setting up several diagnostic characters (including the radial sculpture) to separate Arcuatula from the more characteristic species of the genus Modiolus.

Modiolus modiolus (L.). "Horse Mussel". Cooler waters, usually below low water mark, reaching greatest size subtidally.

Mulinia lateralis (Say). A dwarf mactrid clam, related to Spisula, usually found in shallow water in mud or clay, but occasionally in the same habitat as Spisula in surf stirred sand.

Musculus (=Modiolaria) niger (Gray). A rarer mussel, near low water mark and subtidally,more actively moving than most mussels.

Mya arenaria L. "Soft-shelled Clam" or "Long-neck Clam". The important commercial clam of mud flats, but occurring commonly in a wide variety of substrata (gravel, sand, mud or peat) at all tidal levels and in shallow water. Burrows are probably permanent and adult Mya completely sedentary organisms.

Mysella (=Rochefortia) planulata (Stimpson). A minute leptonacean clam which is probably commensal. This is the only species of this group positively identified recently, but Aligena elevata and Montacuta spp. may occur. Mysella planulata has previously been placed in the genera Kellia and Rochefortia.

Mytilus edulis L. "Common Mussel". Common, often abundant in extensive, packed colonies forming "blankets", between tidemarks, and on the masonry and pilings of docks and other structures.

Nucula proxima (Say). In mud subtidally (several other Nucula spp. may occur in this area). Deposit feeding using palp proboscides, this is probably the most primitive genus of living bivalves.

Pandora gouldiana (Dall). Rare, lower intertidal and shallow water.

Periploma (=Cochlodesma) leanum (Conrad). Rare, dredged.

Petricola pholadiformis Lamarck. "False Angel Wing". The commonest borer in peat and clay in this area. This species, as is clearly revealed by the separate extensible siphons, is a modified deposit feeder derived from a stock like the Tellinidae, which shows secondary convergence in structure and habit with the Pholadidae, e.g. *Cyrtopleura* spp. and *Zirfaea* spp.

Phacoides (*Lucinoma*) *filosus* Stimpson. Subtidally, dredged in Vineyard Sound. Not in key.

Pitar morrhuana (Linsley). Dredged.

Placopecten magellanicus (Gmelin). "Deep-sea Scallop". Common subtidally and on the Continental Shelf.

Siliqua costata (Say). On shallow water and sand flats, another vertically burrowing razor clam, belonging to the Solenidae.

Solemya velum Say. Not uncommon on intertidal mud flats and mud subtidally, a specialized representative of the Protobranchia.

Spisula solidissima (Dillwyn). "Surf Clam" or "Hen Clam". In surf stirred clean sand, common below low water mark on exposed ocean beaches, young specimens occur in the littoral. Called *Mactra solidissima* in much experimental literature.

Tagelus divisus (Spengler) and

Tagelus plebeius (Solander) (=*T. gibbus* (Spengler)). In muddy sand, on intertidal flats and in shallow water, these are deposit feeding bivalves related to the Tellinidae (note the separate extensible siphons). *Tagelus* spp. have secondarily assumed structure and habits like those of the true razor clams.

Tellina agilis Stimpson (=*T. tenera* Say). In fine or muddy sand, on intertidal flats and in shallow water, the only local representative of this important world wide genus of deposit feeding bivalves with separate, very extensible siphons.

Teredo navalis L. "Shipworm". A common and destructive wood borer of world wide distribution, transported to this area in drifting wood from more southern parts of the Atlantic coast.

Thyasira gouldi (Philippi) and

Thyasira trisinuata (Orbigny). Dredged.

Yoldia limatula (Say). Dredged in shallow water just below low water mark, occasionally found intertidally (two other species, *Yoldia sapotilla* (Gould) and *Yoldia thraciaeformis* Storer, may occur in this area. This is one of the three local genera of Protobranchia, deposit feeding by means of palp probocides.

Zirfaea crispata (L.). "Piddock". Borer in peat or clay on the Cape, and in softer rocks (*e.g.* shales) outside this area; more common in colder waters.

Venericardia, see *Cardita*.

PHYLUM MOLLUSCA

Shell-less Opisthobranchia

by George M. Moore

Nudibranchs are the best known of the shell-less opisthobranchiate snails. Thiele (1931) recognized four orders of the subclass Opisthobranchia, placing some of the shell-less forms, along with a few shelled forms, in the order Sacoglossa. Most of the shell-less forms, along with a few shelled forms, were placed in the order Acoela, in two suborders, Notaspidea and Nudibranchia. Odhner (1934, 1936, 1939) recognized seven orders of Opisthobranchia including Notaspidea and Nudibranchia, and the classification adopted in Chapter XIV of this manual gives eight orders. The shell-less opisthobranchs of the Woods Hole fauna belong to three of these orders, with the majority of them in the order Nudibranchia.

Since the time of Alder and Hancock (1845-55) two general types of Nudibranchia have been recognized. One, the Holohepatica (dorids), have the digestive gland (the so-called liver) compact and undivided. The other, the Cladohepatica (eolids), have the digestive gland branched, with the branches extending into special dorsal outgrowths of the mantle (the cerata). Odhner proposed the division of the order Nudibranchia into four suborders, since it appeared to him that the evolution of the branched digestive gland had occurred more than once. Three of the suborders are represented in this key and list.

The suborder Doridacea is characterized principally by a circle of branchial plumes (adaptive or secondary gills) about the anus, which is mid-dorsal on the posterior half of the animal. The digestive gland is compact and does not extend into dorsal extensions of the mantle. In some dorids the mantle is broad and distinct from the foot while in others it is reduced to a ridge or narrow fold. A single pair of tentacles is present, on the dorsal surface a short distance back from the anterior end. These are termed dorsal tentacles or rhinophores, in contrast to the oral tentacles found in certain other nudibranchs. In dorids these dorsal tentacles are delicately sculptured with several diagonal laminae. Typical dorids are represented in the Woods Hole fauna by <u>Palio</u>, <u>Onchidoris</u>, and <u>Acanthodoris</u>. The family Corambidae, although included with the Doridacea, is not typical since its members lack the circlet of branchial plumes. They have a pair of small ctenidia-like gills located one on each side of the anus at the posterior end between mantle and foot.

In the suborder Eolidacea branchial plumes are lacking and the anus is laterally placed on the right side of the body. Typically, in all except the genus <u>Embletonia</u>, there are two pair of tentacles. The branched digestive gland extends into special dorsal processes (cerata; sing. ceras). Many eolids feed on hydroids and sea anemones, and undischarged nematocysts are moved by way of the "liver" canals to the cerata and concentrated in cnidosacs at their tips. A pore connects each cnidosac to the exterior. Eolids are represented in the Woods Hole fauna by nine genera.

The suborder Dendronotacea is represented in the Woods Hole fauna by <u>Dendronotus</u>, <u>Scyllaea</u>, and <u>Idulia</u>. In this suborder the dorsal tentacles are equipped with a basal sheath into which the terminal club can be retracted. Both types of digestive gland organization are found among the genera of this suborder; the holohepatic condition is considered the more primitive.

Nudibranchs, unless carefully anesthetized, contract and distort badly on preservation. Such specimens can be used for radula studies and for certain details of internal anatomy. This key will be of little use when working with such specimens, since it is intended for tentative identification of living specimens and is based entirely on external characteristics. Figure references in this chapter are to Plates 20 to 22.

1. With branchial plumes arranged in circle about the anus; anus located medially on the posterior dorsal half of the body; with single pair of tentacles 2
1. Without circlet of branchial plumes as above; other dorsal processes (pallial outgrowths) present or absent; with one or two pairs of tentacles 5

2. Branchial plumes singly pinnate; mantle distinct from foot 3
2. Branchial plumes doubly pinnate (or imperfectly tripinnate); mantle distinct or reduced to a ridge 4

3. Body white or occasionally slightly yellowish; branchial plumes about 11 and set in circle close to anus; dorsal surface covered with numerous knobbed tubercles of variable size . . . . *Onchidoris aspera*
3. Body dull yellowish-white (sometimes gray) with numerous brown markings; brownish markings form three indistinct interrupted longitudinal bands; branchial plumes up to 20-30 in large specimens, set in elliptical groove around anus, and with an included space covered by several bluntly knobbed tubercles; dorsal surface covered with numerous knobbed tubercles of variable size . . . . *Onchidoris fusca*

4. Mantle distinct from foot; dorsal surface thickly covered with numerous soft, slender, conical papillae of almost uniform size (figs. 3-5) . . . . *Acanthodoris pilosa*
4. Mantle reduced to knobbed ridges extending from sides of head to alongside the circlet of branchiae; body sparsely covered with short, blunt tubercles of variable size . . . . *Palio lessonii*

5. Cerata (dorsal processes which contain as a central core a branch of the digestive gland) absent 6
5. Cerata present 10

6. With distinct mantle; 1 or 2 ctenidia between mantle and foot 7
6. Without distinct mantle; ctenidia absent 8

7. With a single typical gastropod ctenidium on right side between mantle and foot; mantle covers anterior 2/3 of body but not the head (figs. 1, 2) . . . . *Pleurobranchaea tarda*
7. With pair of small ctenidia between mantle and foot at posterior end of body in the midline; mantle covers entire body, including head (figs. 6, 7) . . . . *Corambella* (?) sp.

8. Body compressed; with 2 pairs of strap-like membranous extensions arising from dorso-lateral edges of body; inner surface of dorsolateral folds and surface between them thickly covered with delicately branched filaments (these filaments may be termed cerata by some authors) (fig. 8) . . . . *Scyllaea pelagica*
8. Body depressed; body with lateral extensions which can be folded towards midline over dorsal surface of body to enclose a dorsal canal 9

9. Lateral folds about 2/3 of length of body, not extending to posterior tip of foot, and not quite meeting when folded over back; foot square in front, with rounded corners; length to 1 cm . . . Elysia catula
9. Lateral folds extending to posterior tip of foot, and overlapping each other when folded over the back; anterior angles of foot strongly extended with acutely angled tips; length to 3 cm . . . . *Elysia chlorotica*

10. Cerata branched and tree-like . . . . Dendronotus frondosus
10. Cerata unbranched 11

11. Single pair of tentacles (oral tentacles lacking) 12
11. Two pair of tentacles (both oral and dorsal tentacles present) 13

12. Tentacles arising from trumpet-like sheaths; cerata club shaped and bearing scattered dark colored tubercles . . . . Idulia coronata
12. Tentacles arising directly from head (without basal sheaths); cerata simple and without tubercles . . . . Embletonia fuscata

13. Anterior lateral corners of foot extended and sharply acute angled 14
13. Anterior lateral corners of foot not much extended and either rounded or bluntly angled 18

14. Dorsal tentacles ringed with alternately larger and smaller rings, producing serrate margins (figs. 24, 25) . . Facelina bostoniensis
14. Dorsal tentacles smooth or slightly wrinkled, not annulated 15

15. Body ovate in outline, broad and somewhat depressed; with numerous cerata (up to 400 on each side) . . . . Aeolidia papillosa
15. Body linear, narrow; with fewer cerata (not over 100 on each side) 16

16. Body pale gray with white margins, and with 3 longitudinal reddish to russet interrupted stripes on head and anterior part of body (fig. 23) . . . . Cratena pilata
16. Body transparent white (internal organs may be yellowish or reddish), and without colored stripes on head and anterior part of body 17

17. Anterior lateral extensions of the foot about half as long as width of foot; tips of cerata transparent with an opaque white ring just back of tip; anterior cluster of cerata not as distinct and sharply set off as in the following; central core of cerata scarlet to rose red, varying in some specimens to chocolate (figs. 9-11) . . . . Coryphella rufibranchialis
17. Anterior lateral extensions of the foot about as long as the width of foot; tips of cerata with patch of opaque white; the anterior cluster of cerata distinctly set off from second cluster forming a "ruff about the shoulders"; central core of cerata carmine red; cerata somewhat longer than in above species (figs. 12-14) . . . . Coryphella pellucida

18. Anterior lateral corners of foot bluntly angled (figs. 18, 19) . . . . Cuthona concinna
18. Anterior lateral angles of foot rounded 19

19. Cerata very numerous and crowded, irregularly set; lateral edge of each ceras produced into a wide, strongly undulating membrane (figs. 26, 27) . . . . Fiona pinnata
19. Cerata not so crowded; cerata set in regularly defined rows; cerata circular in cross section and without lateral membrane 20

20. Cerata fairly numerous (at least 30 to 50 on a side) 21
20. Cerata few (4 to 10 or so on a side) 22

Plate 20

SHELL-LESS OPISTHOBRANCHS

Figures 1, 2, 6-8, 18, 24-27 on Plates 20-22 were drawn from Kodachrome transparencies taken by the author. Grateful acknowledgement is made to Miss M. Patricia Morse for inking most of the drawings. Figure 23 is redrawn from Verrill, the others from Alder and Hancock's Monograph. Figures of species that are satisfactorily illustrated in Miner (1950) have not been included in these plates.

Figure 1. Pleurobranchaea tarda. Dorsal view of specimen from Sargassum, Vineyard Sound.

2. P. tarda. Ventro-lateral view of same. Ctenidium visible on right side.

3. Acanthodoris pilosa. Dorso-lateral view.

4. A. pilosa. Branchial plume.

5. A. pilosa. Portion of mantle edge, highly magnified, showing the conical papillae.

6. Corambella (?) sp. Dorsal view of specimen from Sargassum, Vineyard Sound.

7. Corambella (?) sp. Ventral view of same, showing ctenidia-like gills at posterior end.

8. Scyllaea pelagica. Lateral view of right side. Specimen from Sargassum, Vineyard Sound.

All scale bars are 5 mm.

Plate 20

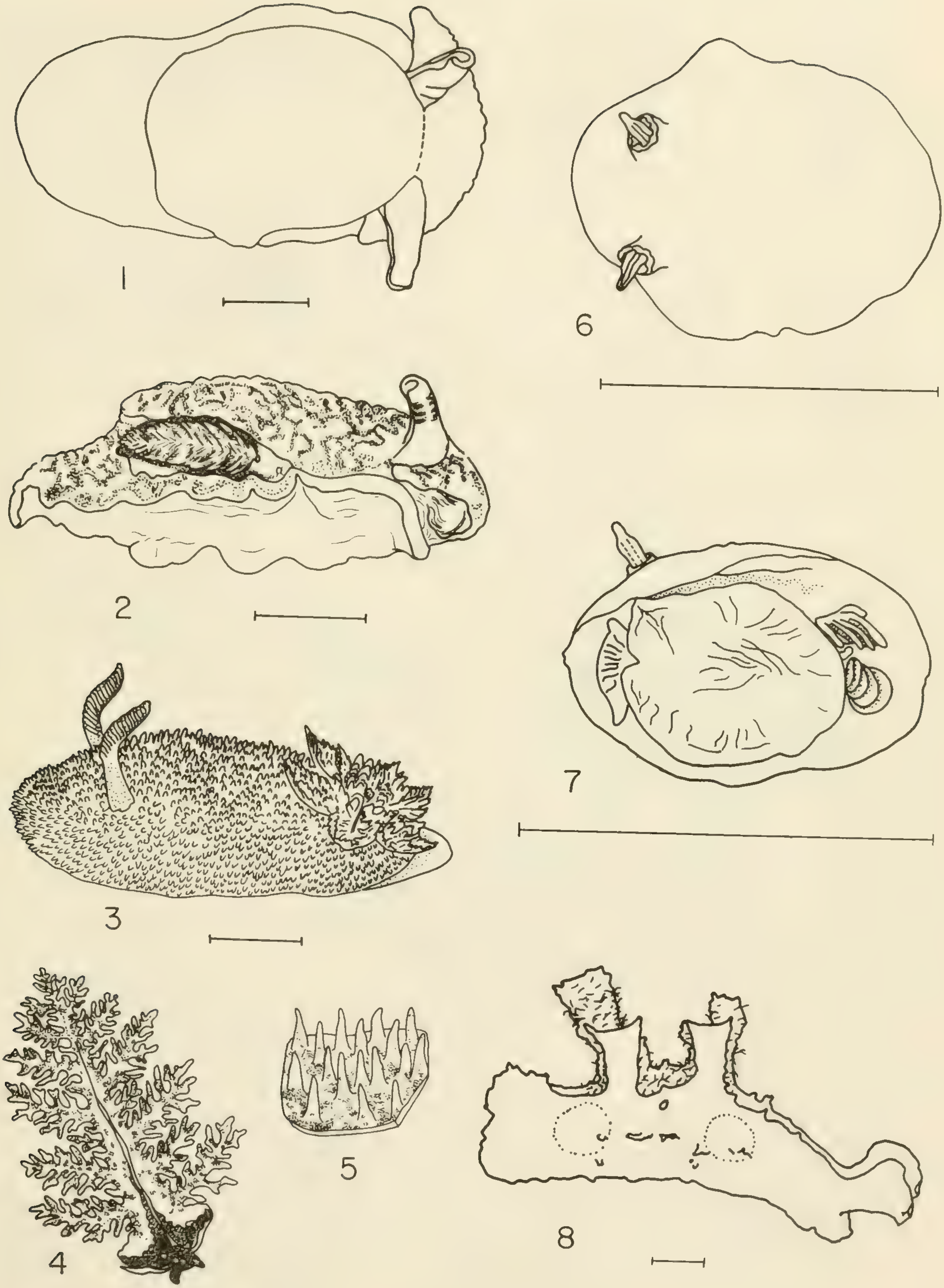


Plate 21

SHELL-LESS OPISTHOBRANCHS (continued)

Figure 9. Coryphella rufibranchialis. Dorso-lateral view.

10. C. rufibranchialis. Ventral view of anterior end.

11. C. rufibranchialis. Two cerata.

12. Coryphella pellucida. Dorso-lateral view.

13. C. pellucida. Ventral view of anterior end.

14. C. pellucida. Two cerata.

15. Eubranchus pallidus. Dorso-lateral view.

16. Eubranchus exiguus. Dorsal view.

17. Tergipes despectus. Dorsal view. Alder and Hancock noted that "The figures in this plate (Fam. 3, Plate 17) have inadvertently been reversed". The figure shown here is not reversed.

18. Cuthona concinna. Dorsal view of specimen from Sakonnet Point, Rhode Island.

19. C. concinna. Ventral view of anterior end.

All scale bars are 5 mm.

Plate 21

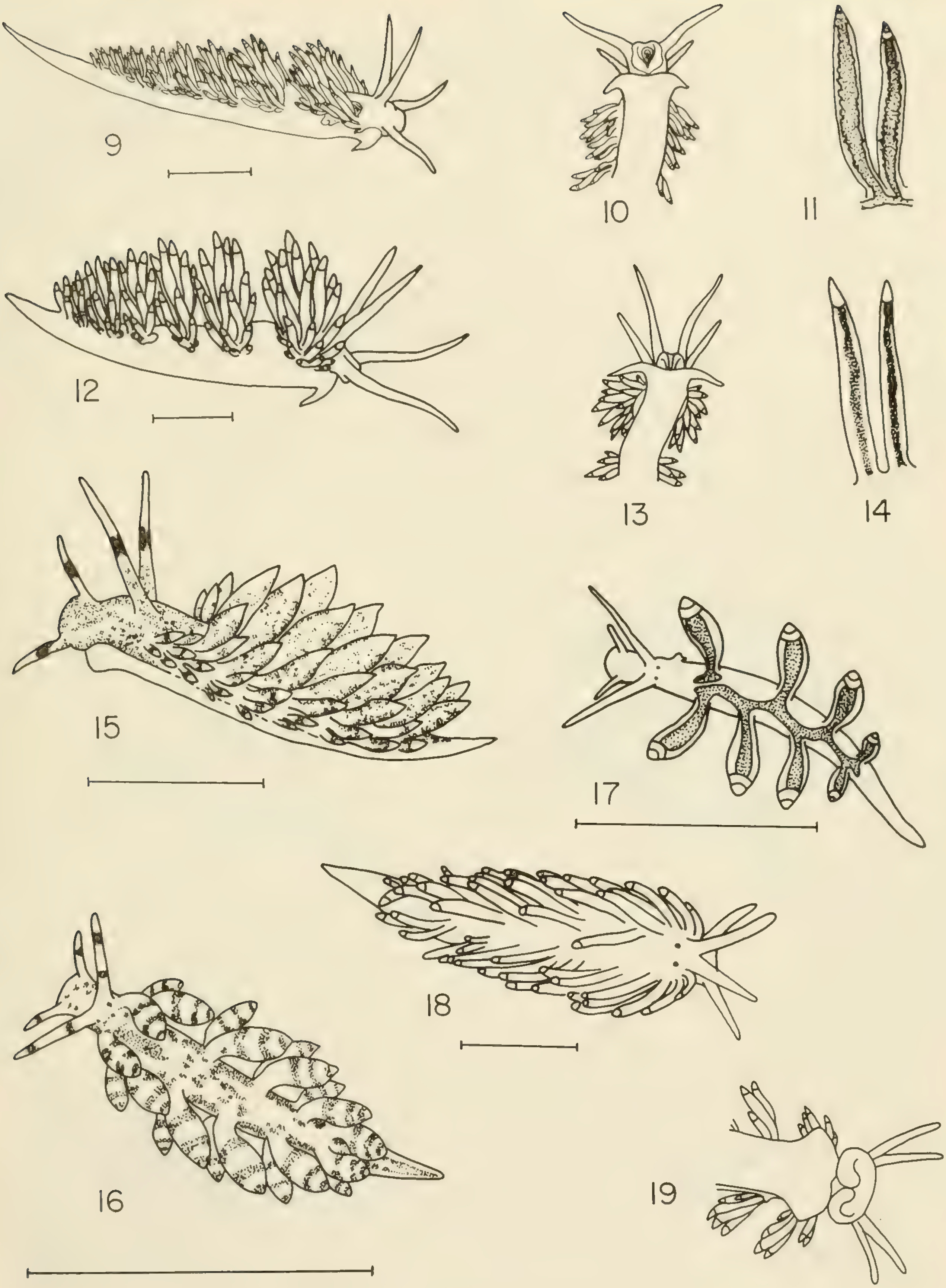


Plate 22

SHELL-LESS OPISTHOBRANCHS (concluded).

Figure 20. *Cratena aurantia*. Dorso-lateral view.

21. *C. aurantia*. Ventral view of anterior end.

22. *C. aurantia*. Two cerata.

23. *Cratena pilata*. Dorsal view.

24. *Facelina bostoniensis*. Dorsal view of specimen from *Tubularia*, Woods Hole.

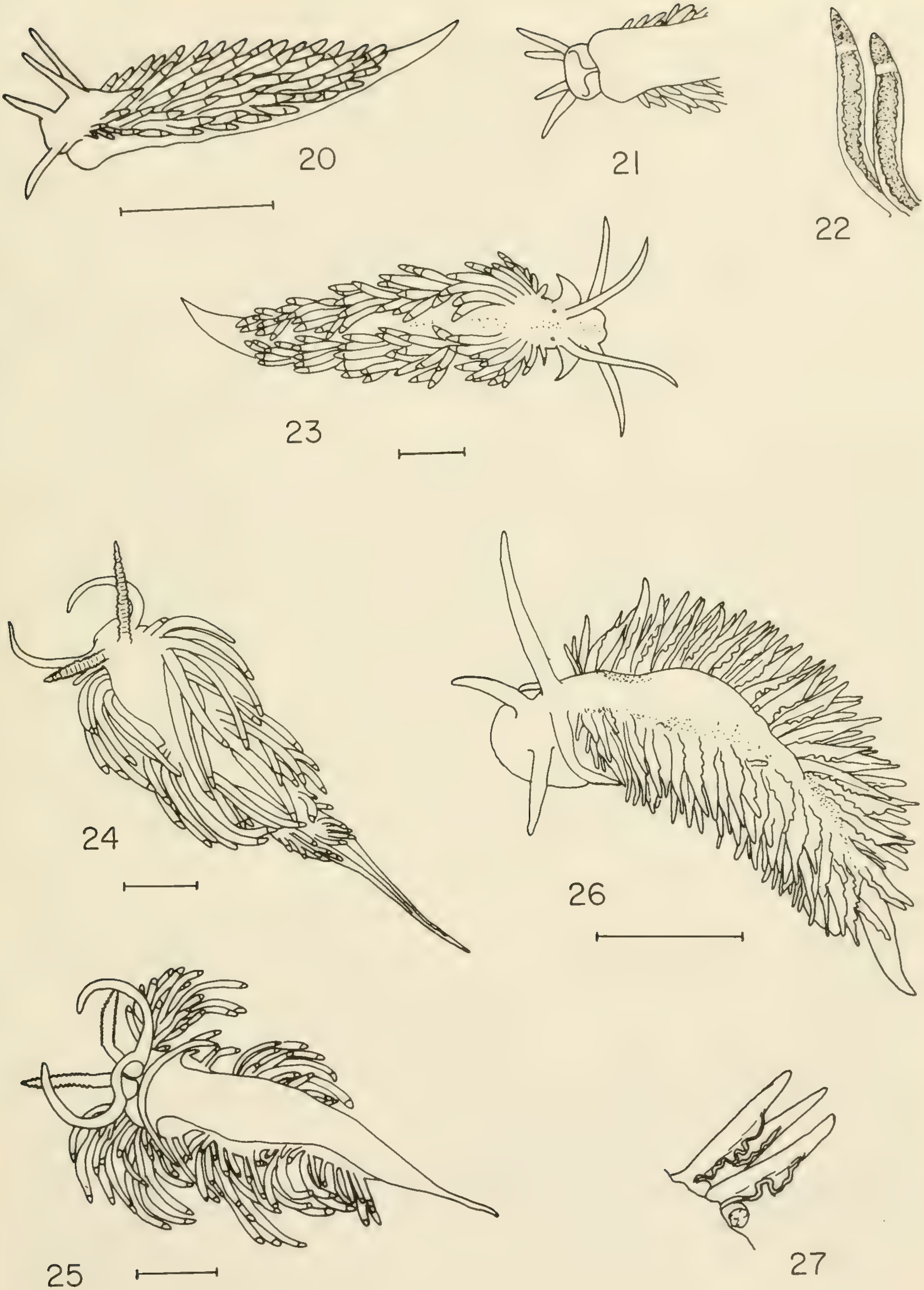
25. *F. bostoniensis*. Ventral view of same specimen.

26. *Fiona pinnata*. Dorso-lateral view of specimen from floating timber, Vineyard Sound.

27. *F. pinnata*. Three cerata showing undulating membranous extensions of same.

All scale bars are 5 mm.

Plate 22



21. Oral tentacles almost as long as dorsal tentacles; cerata long, cylindrical or slightly conical (figs. 20-22) . . . . Cratena aurantia
21. Oral tentacles about half as long as dorsal tentacles; cerata ovoid ovate, much inflated, somewhat compressed (fig. 15) . . . . Eubranchus pallidus

22. Cerata 5 to 10 on a side, clavate, large and inflated, tapering abruptly to a point; body spotted with green or brown; tentacles banded with olive or brown (fig. 16) . . . . . Eubranchus exiguus
22. Cerata 4 (rarely 5) on a side, set in a single longitudinal row on each side; cerata smoothly (i.e. not abruptly) tapering; body transparent white, not spotted, sometimes striped anteriorly with two lateral reddish streaks; tentacles not banded (fig. 17) . . . . Tergipes despectus

ANNOTATED LIST OF SHELL-LESS OPISTHOBRANCHS INCLUDED IN THE KEY

The list presented here includes most of the shallow water species of shell-less opisthobranchs known from the Woods Hole region, and is based both upon published records of Gould (1870), Verrill (1873), and Johnston (1934), and the collections of the author. Since we lack a monographic treatment of the group in this area, and since figures are helpful in identification, page references are made to Miner (1950) in the cases of species not figured in this manual. The synonymies given are not complete (some deletions in the interests of brevity have gone beyond the author's wishes, and for this the editor accepts responsibility). References to Alder and Hancock (1845-55) are given as A & H; Gould and Binney (1870) as G & B; Verrill and Smith (1873) as V & S. Additional synonymy is given by Johnston (1915), and Iredale and O'Donoghue (1923).

CLASS GASTROPODA

Subclass Opisthobranchia

Order Sacoglossa

Elysia catula (Gould, 1870). As Placobranchus catulus in G & B; as Elysiella catulus in V & S; Miner, p. 674.
Elysia chlorotica Gould, 1870. Miner, p. 674. Found in salt and brackish water marshes.

Order Notaspidea

Pleurobranchaea tarda Verrill, 1880. See Verrill, 1882, Trans. Conn. Acad., 5: 546. Dredged, 60-400 meters; also on floating Sargassum in Vineyard Sound.

Order Nudibranchia

Suborder Doridacea

Acanthodoris pilosa (Abildgaard, 1789). As Doris pilosa in A & H; as Doris bifida in V & S. Color various, white to yellow, brown, or even black. Under rocks, midtidal to laminarian zone; abundant sporadically in spring, also taken in summer and fall; throughout New England.
Corambella (?) sp. Animals figured in figures 6 and 7 have been collected at Woods Hole on pilings and from Sargassum in Vineyard Sound.
Onchidoris aspera (Alder and Hancock, 1842). As Doris aspera in A & H; as Doris pallida in G & B; as Onchidoris pallida in V & S; as Onchidorus aspera in Miner, p. 671. The spelling Onchidorus used by Miner and certain other authors is of incorrect gender, and has been emended by Winckworth (1932, J. Conchol. 19: 234, 251). Under rocks, low intertidal to 60 meters. Probably feeds on encrusting bryozoans. All seasons; Bay of Fundy to Rhode Island.

Onchidoris fusca (Muller, 1776). As Doris bilamellata in A & H and G & B; as Lamellidoris bilamellata in Miner, p. 672. Midtidal to 8 meters, on barnacle covered rocks; feeds on barnacles; often gregarious, breeding and laying eggs; all seasons, breeding in spring and fall. Bay of Fundy to Rhode Island.

Palio lessonii (D'Orbigny, 1837). As Polycera lessonii in A & H and V & S; Miner, p. 673. Under stones, low intertidal; New Brunswick to Connecticut.

Suborder Dendronotacea

Dendronotus frondosus (Ascanius, 1774). As D. arborescens in A & H, G & B, and V & S; Miner, p. 671. Often associated with hydroids, especially Tubularia. Large specimens (up to 8 cm) have been collected by the author from pilings at the east end of the Cape Cod Canal; specimens of 2-3 cm from Bay of Fundy to Long Island Sound at all seasons.

Idulia coronata (Gmelin, 1791). As Doto coronata in A & H, G & B, V & S, and Miner, p. 673. Associated with various hydroids, including Sertularia; all seasons; Bay of Fundy to Long Island Sound.

Scyllaea pelagica Linnaeus, 1761. On floating Sargassum in Vineyard Sound.

Suborder Eolidacea

Aeolidia papillosa (Linnaeus, 1761). As Eolis papillosa in A & H; as Aeolis papillosa in G & B, and Miner, p. 670. This largest of New England eolids is sometimes called the "common nudibranch", but it is sporadic in occurence. Found at all seasons, usually associated with sea anemones. Bay of Fundy to Woods Hole.

Coryphella pellucida (Alder and Hancock, 1847). As Eolis pellucida in A & H. Maine and Woods Hole; winter and spring. Not previously reported from New England.

Coryphella rufibranchialis (Johnston, 1832). As Eolis rufibranchialis in A & H; as Aeolis rufibranchialis in G & B. Balch's (1909) C. r. chocolata is but a color variety, intergrading with specimens with red cerata in the same area. The most abundant eolid of New England; among hydroids on rocks, intertidal to 200 meters; winter, spring, and early summer; Bay of Fundy to Massachusetts.

Cratena aurantia (Alder and Hancock, 1842). As Eolis aurantiaca in A & H; as Montagua gouldii in V & S. Associated with Tubularia. Abundant, summer and spring; New Hampshire to Woods Hole.

Cratena pilata (Gould, 1870). As Aeolis pilata in G & B; as Montagua pilata in V & S. Abundant on Pennaria at Woods Hole in July and August. This is the species used by Kepner (1943, J. Morph., 73: 297-311) in his study of the manipulation of nematocysts by nudibranchs.

Cuthona concinna (Alder and Hancock, 1843). As Eolis concinna in A & H. A British species not previously reported from America; the author has taken it in Mass. and Rhode Island; Dr. Henry Russell has reported it from Cape Cod.

Embletonia fuscata Gould, 1870. With red algae; New Hampshire to Woods Hole.

Eubranchus exiguus (Alder and Hancock, 1848). As Eolis exigua in A & H; as Aeolis despecta (in part) in G & B. Gould apparently confused Tergipes despectus and Aeolis exigua (see Verrill, 1882, Trans. Conn. Acad., 5: 553, under Galvinia exigua). On occasion E. exiguus may lose its oral tentacles in the laboratory, and may then be confused with Embletonia fuscata. Associated with hydroids, Bay of Fundy to Woods Hole. Has been found breeding in MBL live cars in May.

Eubranchus pallidus (Alder and Hancock, 1842). As Eolis picta in A & H and Aeolis picta in G & B. Associated with hydroids, winter and spring; Bay of Fundy to Rhode Island.

Facelina bostoniensis Couthouy, 1838. As Aeolis bostoniensis in G & B. Associated with Tubularia; New Hampshire and Woods Hole region.

Fiona pinnata Eschscholz, 1831. As Fiona nobilis in A & H; also F. marina of authors, and F. atlantica Bergh. Taken in August from Sargassum and floating logs in Vineyard Sound.

Terqipes despectus (Johnston, 1835). As Aeolis despecta (in part) in G & B; as Eolis despecta in A & H. Associated with hydroids, spring and summer; Bay of Fundy to Rhode Island.

REFERENCES ON SHELL-LESS OPISTHOBRANCHS

Alder, J. and A. Hancock, 1845-55. Monograph of the British Nudibranchiate Mollusca. Ray Society, London.

Balch, F. N., 1909. Notes on New England Nudibranchs II: A Spring Collecting Trip. Nautilus, 23: 33-55.

Eliot, C., 1910. The British Nudibranchiate Mollusca. Part VIII. (Supplementary to Alder and Hancock). Ray Society, London.

Gould, A. A. and W. C. Binney, 1870. Report on the Invertebrata of Massachusetts, 2nd ed., vi-524 pp. Boston.

Iredale, T. and C. H. O'Donoghue, 1923. List of the British Nudibranchiate Mollusca. Proc. Malacol. Soc. London, 15: 195-223. A useful checklist for synonymy.

Johnston, C. W., 1915. Fauna of New England, Part 13. List of the Mollusca. Occ. Papers, Boston Soc. Nat. Hist., pp. 1-231.

Johnston, C. W., 1934. List of Marine Mollusca of the Atlantic Coast from Labrador to Texas. Proc. Boston Soc. Nat. Hist., 40: 1-204.

Miner, R. W., 1950. Field Book of Seashore Life. xv-888 pp. Putnam, N. Y.

Ohdner, N. H., 1934. The Nudibranchiata. British Antarctic (Terra Nova) Exped. 1910. Zool., 7: 229-310.

Ohdner, N. H., 1936. Nudibranchia Dendronotacea. A Revision of the System. "Melanges Paul Pelseneer". Mèm. Mus. Roy. d'Hist. Nat. Belg., Ser. 2, 3: 1057-1128.

Ohdner, N. H., 1939. Opisthobranchiate Mollusca from the western and northern coasts of Norway. Det Kgl. Norske. Videnskabers Selskabs Skrifter, Nr. 1: 1-92.

Thiele, J., 1929-31, 34, 35. Handbuch der systematischen Weichtierkunde. 2 vols. Gustav Fischer, Jena.

Verrill, A. E. and S. I. Smith, 1873. Report upon the Invertebrate Animals of Vineyard Sound, etc. Rept. U. S. Comm. Fish. for 1871-72, Part 1: 295-778, pl. 1-38. Washington.

PHYLUM ENTOPROCTA

By Mary D. Rogick

Entoprocta and Ectoprocta are zoologically distinct but because they bear superficial resemblance to each other they have been treated together by systematists, as "moss animals", Polyzoa, or Bryozoa (sensu lato).

Entoprocts are minute, less than one centimeter tall. They are usually sessile, pseudocoelomate, and generally of soft texture. Their anus is within the ring of tentacles, which number 8 to 36, depending on the species. Tentacle number and stalk flexibility are important, so should be noted in living specimens wherever possible. The "heads" or calyces of some nod constantly. Some species are solitary, others colonial. Entoprocts may be found attached to rocks, algae, shells, or growing on various organisms as hydroids, sponges, crustacea, ectoprocts and worms.

KEY TO LOCAL ENTOPROCTA (partly after Osburn)
(Figure references are to Plate 23)

1. Individuals solitary, not colonial or stolonate, provided with a contractile stalk and enlarged basal disc (fig. 1); characteristically found on bodies of tube dwelling annelid or sipunculid worms . . . . *Loxosoma* spp. (Consult Prenant and Bobin for species differences).
1. Individuals colonial, arising from creeping stolons, forming low, whitish, simple traceries or sometimes denser tufts 2

2. Stalks of individuals with distinct muscular dilations at bases, near junction with stolons, and sometimes elsewhere along stalk; stalks spineless . . . . *Barentsia* 3
2. Stalks without such muscular dilations, tapering, usually with small spines on stalk and/or calyx (fig. 2) . . . . . . *Pedicellina cernua*

3. Stalk thin walled and muscular, its distal end very flexible, actively curling into a loose spiral (fig. 3). . . . . . . *Barentsia laxa*
3. Stalk heavier walled, straight and rigid 4

4. Stalk wall appears as if punctured by irregularly spaced minute, cone shaped pores. Colony delicate, small . . . . . *Barentsia discreta*
4. Stalk wall without pores . . . . *Barentsia major*

LIST OF LOCAL ENTOPROCTA

Family Loxosomatidae

Loxosoma davenporti Nickerson, 1901. Reported (Nickerson) associated with the polychaete "*Clymene producta*". It is not clear what maldanid is meant, possibly *Maldane*.

Loxosoma minuta Osburn, 1912. May possibly be a *Loxosomella*? Reported on *Phascolion strombi* (Sipunculoidea).

Family Pedicellinidae

Barentsia discreta (Busk, 1886). Inconspicuous but of world wide distribution. Found on algae, stones, hydroids, ectoprocts. See Rogick (1956).

Barentsia laxa Kirkpatrick, 1890. Forms furry patches to half an inch high on *Mercenaria* shells which had been bored by the sponge *Cliona*. See Rogick (1948).

Barentsia major Hincks, 1888. Found on pilings, stones, shells, and around leg bases of spider crabs and *Limulus*.

Pedicellina cernua (Pallas, 1771). On pilings and elsewhere, among bryozoans and other creeping growths.

REFERENCES ON ENTOPROCTA

Atkins, D., 1932. The Loxosomatidae of the Plymouth area, including *L. obesum*, sp. nov. Quart. J. Micr. Sci., 75: 321-391.

Nickerson, W. S., 1901. On *Loxosoma davenporti* sp. nov. an endoproct from the New England coast. J. Morph., 17: 351-380, pl. 33.

Osburn, R. C., 1912. The Bryozoa of the Woods Hole Region. Bull. U. S. Bur. Fish. (for 1910), 30: 203-266, pl. 18-31.

Osburn, R. C., 1944. A survey of the Bryozoa of Chesapeake Bay. Chesapeake Biol. Lab. Publ. no. 63: 1-59.

Prenant, M. et G. Bobin, 1956. Bryozaires, Première Partie. Entoproctes, Phylactolèmes, Ctenostomes. Faune de France, 60: 1-398.

Rogick, M., 1948. Studies on marine Bryozoa. II. *Barentsia laxa* Kirkpatrick 1890. Biol. Bull., 94: 128-142.

Rogick, M., 1956. Bryozoa of the U. S. Navy's 1947-1948 Antarctic Expedition, I-IV. Proc. U. S. Nat. Mus., 105: 221-317.

PHYLUM ECTOPROCTA

By Mary D. Rogick

Ectoprocta, the "true" Bryozoa or "true" Polyzoa are a large and diverse group, composed of animals always individually minute, but organized into colonies of varied form. Since ectoprocts are important as fossils, much of the basic systematic work on the group has been done by paleontologists (see works of Canu and Bassler, particularly); consequently, reliance in taxonomy has been largely upon the external skeletal characters.

In the field, the beginner may confuse ectoprocts with hydroids, sponges, seaweeds, or compound ascidians, because of their growth forms. The colony texture varies from gelatinous, to membranous, to chitinous, to calcareous, depending upon the species.

Identification to genus and species is often a matter of considerable difficulty. Original descriptions of some of the commonest species are too incomplete, too general and do not always include really distinguishing key characters. An original description was sometimes so broad that several species could be included under one specific name and one species could fit with equal justification in more than one genus. Some genera, like Cellepora, Lepralia, Membranipora, and Smittina actually became catch-alls for many diverse and hard-to-identify species.

If possible, bryozoans should be studied alive, with their tentacles extended. Tentacle number is important in distinguishing some species. Use a compound microscope with 100x to 280x magnification and direct (reflected) lighting for the study of calcareous or opaque species and transmitted lighting for transparent forms. Calcareous colonies are sometimes calcined or treated with Eau de Javelle to remove organic matter from the skeleton. Calcining produces beautiful results but is risky and may destroy the specimen, so is recommended only where ample material is available.

GLOSSARY OF TERMS USED IN DESCRIBING ECTOPROCTA

"The study of ectoprocts is burdened by a large and fantastic terminology, much of it dating from a period when the structure of the animals was not understood. Hence the terminology lacks relation to terms employed for other groups of animals. Frequently the ectoproctologists seem to get themselves entangled in their own terminology, using the same word (e.g., aperture) in several different senses". This statement by Dr. Libbie Hyman should be borne in mind when looking up bryozoan literature. The general zoologist will find an illuminating discussion of ectoproct structure and terminology in Vol. 5 of Hyman's "The Invertebrates".

Ancestrula: Primary zoid produced by the metamorphosis of a larva. The rest of the colony develops from it by budding.

Alveolus: Small cavity, pit, or fenced in area between zooecia, chiefly in Cyclostomata.

Aperture: Variously used for any opening, sometimes for the zooecial orifice. Best to avoid its use.

Areolae or areolar pores: One or more rows of pores around the periphery or margin of the zooecial front, often larger than other pores. Remainder of frontal wall, the central part, is usually imperforate if areolae are present.

Autozoid: Normal, "typical", or sometimes asexual individual in a colony, if colony has male and female zoids (as in Hippothoa).

Avicularium: Highly modified zoid, with or without a polypide but with muscles which operate its operculum, called the mandible. It may be adventitious, i.e. attached to some part of the parental zoid's front, or it may be vicarious, i.e. an independent unit, replacing a regular zoid in the colony, or be placed between other zoids in the colony. Many sizes and shapes: larger than autozoids, smaller than autozoids; shaped like a bird's head, like the sole of a shoe, or round, elliptical, spatulate, triangular. May be imbedded in the calcareous wall of parent zooecium or swing freely on a stalk which is sometimes much longer than the whole parent zoid. May even occur on ovicells of some species. Function unknown, although sometimes avicularia ward off other organisms or may keep other larvae from settling on the colony.

Brood chamber: Used especially for cyclostomes. It is an enlarged space, compartment or ovicell in which zygotes develop into larvae.

Brown body: A ball of brownish-orange tissue representing the remains of a degenerating or degenerated polypide. Found either in empty or in inhabited zooecia.

Cardelle: Denticle placed at each side within the orifice for hingement of the operculum; also called condyle. May be peg-like, unicusped, bicusped or even ledge-like.

Communication pore: Opening in zooecial wall between adjacent zoids, for soft tissue connecting the two zoids.

Connate: Firmly united or in close order, as in rows of zoids of Amathia.

Cryptocyst: Shelf-like calcareous lamina extending inward from the front edges of the side walls, beneath the frontal membrane (like inward turned edges of pie crust). In Anasca, especially in the membraniporid group.

Dietellae: Blister-like chambers present in the basal-lateral walls of some Cheilostomes. They contain communication pores and are also called pore chambers.

Distal: Direction of growth away from the ancestrula. That part of the zoid or colony that is farthest away from the ancestrula.

Frontal side: The free or "ventral" side of an attached encrusting ectoproct, or the wall bearing the orifice and other decorations (avicularia, ovicells, pores, sculpturings, etc.) of a zoid.

Gonozoid: Identifiable male or female zoid of a colony. Sometimes differ in size or in orifice from autozoids. Cyclostomes may develop brood chambers for developing young. Cheilostomes develop ovicells of various types.

Gymnocyst: Peripheral calcified portion of frontal membrane in some Cheilostomes, developed especially in proximal region, not covered by membranous ectocyst. See figure 48 (Plate 26).

Heterozoid: Incomplete or highly modified zoid as opposed to autozoid. Includes avicularia, dwarf zoids, vibracula, gonozoids, some types of spines. Preferable to use term heterozooecium, since the zoid or soft parts may be vestigial.

Lophophore: Circular or semicircular fold of tissue which bears the tentacles.

Lyrula: A tooth, commonly anvil-shaped, low, of varying width, placed in the center of the proximal edge of the primary orifice. Characteristic of the "smittinid" orifice. Sometimes it may become very worn down.

Mandible: The operculum closing the beak of an avicularium.

Multiporous: Refers to a sieve-like plate in the lateral or distal walls of calcareous Cheilostomes which serves as an interzoidal connection.

Ooecium: Brood chamber containing the developing zygote or larva in Cheilostomes. Same as ovicell.

Operculum: Membranous, chitinous or very rarely calcareous flap closing the orifice of Cheilostomata. Often works like a drawbridge, after tentacles have been withdrawn into the zooecium.

Opesia: A large uncalcified membrane covered area on the front side of many Anascan Cheilostomes (Membraniporids). It surrounds the orifice and extends proximally. It is bordered by a cryptocyst.

Oral avicularium: An avicularium that is either in the wall of the orifice or next to the orifice. Suboral would be just below or proximal to the orifice. Lateral oral would be to the side of the orifice.

Orifice: The zooecial opening through which tentacles are extruded from the zooecium. In Cheilostomes it is covered by an operculum. In some heavily calcified forms the original orifice (called the primary orifice) may be hidden by a growing calcareous collar (peristome) whose free rim now forms a secondary orifice (peristomice) which may have an entirely different shape or appearance than that of the primary orifice.

Orificial collar: See Peristome and Orifice.

Ovicell: General term for any structure serving to contain bryozoan larvae during their development, according to Bassler. May be of varied shapes and sizes and located conspicuously or inconspicuously on or within zooecia. Often placed at distal end of zoid, like a cap or hood. Sometimes placed in lateral position.

Peristome: An extension of the calcareous rim of the orifice in some Cheilostomes. See also Orifice.

Pleurocyst: The calcareous frontal wall of some Cheilostomes. It is generally granulated and usually not porous over its central area but may have areolar pores around the edge.

Polypide: The protrusible part of the bryozoan individual and that part which is suspended in the body cavity, namely: the tentacles, gut and associated musculature. Early workers on bryozoa thought that the bryozoan individual consisted of a box (zooecium) containing a soft individual (the polypide).

Pore chambers: See Dietellae.

Primary orifice: See Orifice.

Proximal: Direction toward origin of growth, or region nearest the ancestrula. That part of the zoid which is nearest its point of origin.

Rhizoid: Same as radicle, a rootlike structure formed by zooecia for attachment of the colony to the substratum or to various objects. May be calcareous or chitinous.

Scutum: Large flabellate spine or shield in front of opesia; attached laterally.

Secondary orifice: See Orifice.

Septula: Communication pores between neighboring zoids. The pores may be single (uniporous) or grouped together in a sieve-like plate (multiporous) and located in the lateral and distal walls of zoids.

Sinus: A slit or excavation or notch in the proximal part of the orifice. Especially characteristic of the Schizoporellid group but may occur in other Cheilostomes.

Stolon: Tubular strand, usually horizontal or recumbent (upright in Amathia) from which either new zoids or other structures (peduncles or secondary stolons) may be budded. More common in Ctenostomata than in other orders, but sometimes present in the latter.

Tremocyst: Perforated calcareous frontal wall of some Ascophoran Cheilostomes. If the wall is more or less perforated all over it is a tremocyst. If wall is perforated only around the margin and imperforate in center, then it is a pleurocyst.

Vibraculum: Highly modified chitinous or calcareous heterozoid found in Cheilostomes, resembling an avicularium whose mandible has been replaced by a very long bristle or chitinous whip, which may be considerably longer that the zooecium. The vibracular chamber contains powerful muscles for moving the whip.

Zoarium: The entire bryozoan colony, composed of individuals called zoids or bryozoids or bryozoites.

Zooecium: The external skeleton and body wall of the zoid. Originally coined for the compartments in which the polypides are housed. Term especially useful to paleontologists to whom only the hard skeletal structures are available for study.

Zoid: A single individual of the colony. Term includes the zooecium and its contained polypide.

PREPARATION OF SPECIMENS

Preservation of soft or small calcareous specimens. Ryland (1962) suggests preservation of Ctenostomes in 4% sea-water formalin and preservation of calcareous forms in 70% alcohol. If calcareous forms are on large stones or shells, two courses are open to the worker: (1), to store the stones and intact colonies or (2), to burn off (calcine) the colonies and mount them on slides. In either case wash the stone or shell in fresh water and allow them to dry. Store dry.

Calcining. To prepare permanent slide mounts of calcareous Ectoproct skeletons, one often resorts to calcining. To calcine (burn off the organic, membranous tissues), use an alcohol lamp or Bunsen burner and a geologist's blowpipe. Select a dry colony on a suitable rock or shell; blow with the blowpipe so as to direct a narrow jet of flame against the specimen. The colony will first blacken, then turn red hot and finally turn white. Protective glasses should be worn to protect the eyes and face from flying fragments of rock, shell or bryozoan. Caution: Do not burn the colony to a crumbly whiteness, but continue calcining only to the point where some white begins to show and the fine diagnostic pattern is retained. Colony fragments will lift up right off the rock and can be transferred on to the surface of very thick balsam on a slide. No coverslip is needed. If possible, mount a fragment of an uncalcined colony right alongside the calcined fragment for comparison or in case the calcined fragment disintegrates. For further details, consult Rogick, 1945.

Some people prefer to use a bleach like Clorox (sodium hypochlorite) or Javelle water for cleaning and whitening specimens.

KEY TO THE MORE COMMON GENERA OF LOCAL MARINE ECTOPROCTA
(Figure references are to Plates 23-26)

1. Zooecia are white calcareous tubes pitted with pores; orifice terminal, unconstricted in autozoids, i.e. not narrower than the autozoid, but small and constricted in the greatly swollen ovicells or brood chambers; tube tips free but rest of tube is either partly free or else immersed in the common zoarial crust; vibracula, avicularia and opercula absent; colonies may be arborescent, encrusting, or raised into stiff flattened lobes . . Order CYCLOSTOMATA (=STENOLAEMATA Borg, 1926; =STENOSTOMATA Marcus, 1938) 2
1. Zooecia (and gonozoids, if present) otherwise 4

2. Erect, twig-like colonies articulated (having chitinous joints), attached at their origin to a primary calcareous disc; rhizoids present; zooecia slender; inflated vase-like ovicells densely pitted with pores (fig. 4) . . . . Crisia eburnea
2. Colonies compact, discoid, wart-like, encrusting; the tubular zooecia open on the free surface out of the common crust; zooecial tubes arranged in series or fascicles radiating from a free central area; between them are adventitious tubes or incomplete partitions (aveoli or cancelli); brood chambers spread over and among several zoids 3

3. Brood chamber roof overgrown with secondary alveoli, looking reticulated . . . . Lichenopora
3. Brood chamber roof not covered thus, not reticulated (fig. 5) . . . Disporella

4. Zooecia soft, gelatinous, membranous, corneous or leathery but not calcareous; zoids may be distinctly isolated or else closely packed, encrusting, erect, stolonate, or some may burrow into mollusc shells; zooecial orifice terminal, closed by a puckering of the invaginated tentacle sheath usually, or occasionally by special structures (two lips in the Flustrellidae, a setigerous membrane in others (fig. 10), or an operculum in boring Penetrantiidae); true ovicells lacking but gonozoids may occur . . . . Order CTENOSTOMATA 5
4. Colonies usually calcareous, but in some families are corneous or membranous; great variety of growth forms: encrusting, freely lamellate, arborescent, nodulate, stolonate, or reticulate; zooecia are rounded or angular chambers budding distally and/or laterally to form contiguous rows; zooecial orifice terminal or subterminal, more commonly at the distal end of zoid's frontal surface, and closed by a hinged operculum; avicularia and ovicells present in many species . . . . Order CHEILOSTOMATA 13

5. Stolons or stolon-like extensions of zoids absent. Zoids are squat, opaque, their lateral walls fused together. Colony a gelatinous to leathery crust; common on coarse brown algae 6
5. Stolons or stolon-like zoidal extensions present; zoids are membranous or chitinous, separate, tubular, more or less transparent and never leathery 7

6. Colony rubbery, brownish. Closed orifice is a transverse bilabiate slit, purse-like (fig. 6); chitinous spines mounted on small pads (kenozooecia) that appear at edges of frontal wall, oftenest about the orifice . . . . Flustrellidra
6. Colony a gelatinous to rubbery gray or brown crust sometimes arising into sac-like lobes; orifice at tip of a mound-like papilla closed by a puckering of the body wall (fig. 7); spines absent . . . . Alcyonidium

7. Stolon false, non-septate, representing only the drawn out, narrowed, adherent proximal part of the zoid. Only transverse septum present is usually near point of origin of stolon. Remainder of zoid erect, tubular, with orifice squared 8
7. Stolons genuine, divided into one or more segments by transverse septa. Erect zoids bud directly from stolon or from an intermediate peduncle 9

8. Stolons long, zooecia tall (up to 3.8 mm); tentacles number 8 to 22; gut very long (figs. 12, 13) . . . . Nolella
8. Stolons shorter, zooecia very tall (up to 4.85 mm) and close together; new zoids may sprout from the lateral wall of erect zoids; 8 tentacles; funiculus long. In brackish water . . . . Victorella

9. Stolon broad, tubular, often branches dichotomously; gizzard present 10
9. Stolon slender, generally not dichotomous; short or small lateral segments (peduncles) arise from it and give rise to zooecia 11

10. Zooecia very regularly disposed in a parallel series (forming a double row of closely packed, touching, parallel zoids) either in a continuous or an interrupted spiral around the stolon, or in palisade-like groups (fig. 11); colony arborescent . . . . Amathia
10. Zooecia occur in irregularly clumped groups, or singly, along stolon. Zoids soft, flexible, rather transparent. When retracted their tips are squared, with corners reinforced. Membranous or setigerous collar shorter than in Aeverrillia . . . . Bowerbankia

(1) Bowerbankia gracilis, the more common species, has 8 tentacles (fig. 8)
(2) Bowerbankia imbricata, less common, has 10 tentacles (fig. 10)

11. Gizzard present. Zoids yellowish, horny, husk shaped, with membranous frontal area; occur in pairs near end of each internode (fig. 9) . . . . Aeverrillia
11. Gizzard absent 12

12. Zooecia clavate, with long slender stalk which attaches to the stolon peduncles; 12 to 21 tentacles . . . . Triticella
12. Zooecia ovoid to cylindrical, originating from lateral branching sprouts of the stolon. Zooecia sometimes bunched up at nodes; 8 tentacles . . . . Valkeria

13. Colony erect 14
13. Colony recumbent or encrusting 21

14. Avicularia, vibracula and true ovicells completely absent 17
14. One or more of the above (avicularia, or vibracula or true ovicells) may be present 15

15. Ovicells and avicularia may be present but both vibracula and scuta are absent 18
15. Either vibracula or scuta, or both, may occur 16

16. Vibraculum lacking but scutum present . . . . Tricellaria
16. Vibraculum and scutum usually both present (fig. 40) . . . . . Scrupocellaria

17. Zoids tiny, single, erect, isolated, glassy, firm walled, and connected basally by stolonate extensions. Proximal part recumbent, swollen and punctate near where the upright spoon-shaped part diverges from it. Upright stalk reinforced by fine closely wound spiral thread. Colonies diffuse, white, inconspicuous but very common on bases of Bugula, hydroids and other colonial growths (fig. 14) . . . . Aetea
17. Zoids biserial, back to back (fig. 44). New zoids and branches bud from the sides of the zooecia near distal end. Colonies yellowish, bushy. Opesia occupies about half the zooecial front and slants obliquely . . . . Eucratea

18. Zooecia uniserial, budding from distal end and also from frontal wall just below the opesia; ovicell on dwarfed zoid; avicularia absent (figs. 15, 19) . . . . Scruparia
18. Bird's head type avicularia usually present, zooecia biserial or multiserial rather than uniserial 19

19. Colony biserial; zooecia trumpet shaped, divided into three parts; opesia rounded, nearly terminal, at enlarged obliquely truncated end of zooecium. Upward facing orifice surrounded by 4 to 8 extremely long spines. Avicularia and ovicells lateral (fig. 16) . . . . <u>Bicellariella</u>
19. Zooecia not trumpet shaped but more tubular. Opesia very large, occupying from half to nearly the whole of the zooecial frontal surface 20

20. Base of zooecium transverse at its place of origin dorsally and proximally; zooecia multiserial (fig. 52) . . . . <u>Dendrobeania</u>
20. Base of zooecium strongly forked at its place of origin dorsally and proximally. Zoarium biserial to narrowly multiserial (figs. 17, 18) . . . . <u>Bugula</u>

Two species are common at Woods Hole:

(1) <u>Bugula</u> <u>simplex</u> (fig. 17), formerly called <u>B</u>. <u>flabellata</u>, tan in color with flattened, somewhat fan-like fronds. Common in such protected places as the Eel Pond.

(2) <u>Bugula</u> <u>turrita</u> (fig. 18), yellow to orange-brown; colony of conical form with a marked spiral or whorled arrangement of branches. Found in more exposed situations.

21. Colony a fragile calcareous lace; zooecial front has a large uncalcified membranous area (opesia); side walls and their inturning ledges (cryptocyst) calcified 23
21. Zooecial frontal wall more extensively calcified 22

22. Frontal wall covered by two rows of calcareous flattened ribs (costae), more or less fused, with rows of pores or perforations where ribs did not quite meet . . . . <u>Cribrilina</u>

(1) <u>Cribrilina</u> <u>annulata</u> (fig. 28): Frontal costae and rows of pores regular and distinct; avicularia absent; ooecia small.

(2) <u>Cribrilina</u> <u>punctata</u> (fig. 29): Ooecia large; avicularia present at sides of orifice.

22. Frontal wall not costate but well calcified except for the orifice and possible pores 26

23. Ovicells absent; avicularia wanting in most species 24
23. Ovicells and avicularia present; avicularia located proximally or laterally on front wall; opesial spines often present 25

24. Avicularia absent; spines usually present around opesial border (figs. 21, 22, 23). Well developed gymnocyst usually present . . . . <u>Electra</u>
24. Avicularia absent from most species. No calcareous spines on opesial walls but tubercular processes may occur at zooecial corners. Cryptocyst may develop into a proximal shelf under frontal membrane but a regular gymnocyst (calcareous outer front wall) is wanting or greatly reduced (fig. 20) . . . . <u>Membranipora</u> group

The genus <u>Membranipora</u> is a temporary "dumping genus" for hard-to-identify "open-faced" species. Species are shifted from it and its daughter genera <u>Conopeum</u>, <u>Acanthodesia</u>, etc. and then returned to the mother genus. Membraniporan classification is still very fluid.

25. Several large blister-like pore chambers present in basal-lateral walls of zoid; they are punctured by communication pores (fig. 24) . . . . Callopora
25. Pore chambers absent; instead, zooecial walls contain several uniporous or multiporous septules (pore plates) . . . . Tegella

26. Primary orifice without a proximal median tooth, the lyrula 27
26. Primary orifice rounded to subcircular, with median proximal lyrula; cardelles (denticles) usually present 35

27. Orifice semicircular, with straight proximal border, without a cardelle (denticle) in each corner; median suboral ascopore present; frontal wall with many pores; avicularia and/or ovicells on some zoids (fig. 25) . . . . Microporella
27. Orifice otherwise; special ascopore absent 28

28. Proximal border of orifice forms a shallow cradle-like sinus as wide or wider than the rest of the orifice. Frontal wall coarsely perforated all over 29
28. Proximal border of orifice forms a sinus narrower than the rest of the orifice (a "keyhole" orifice); frontal wall either areolate or with pores all over 30

29. Orifice somewhat bell shaped because of sinus width (fig. 30); avicularia and ovicells absent . . . . Cryptosula
29. Orifice rounded; perforate ovicells and occasional avicularia present . . . . Hippodiplosia

30. Orifice with beaded distal vestibular arch separated from the wide proximal sinus by a broad bicusped or bifid cardelle at each side. Ovicell with large uncalcified frontal area
. . . . Hippoporina contracta (fig. 26) but not other Hippoporinae
30. Orifice arch not beaded; ovicells and cardelles not as above 31

31. Avicularia absent; frontal wall non-porous; ovicells with small number of pores; ovicelled zoids of smaller size than autozoids 32
31. Avicularia present; frontal wall variously porous 33

32. Male zoid with rounded notched orifice like that of autozoid, but smaller; cardelles unicusped or bicusped; female gonozoid orifice differently shaped from that of autozoid. Female gonozoid on same face of colony as autozoids. Colony small, vitreous, uniserial to multiserial (fig. 27) . . . . . . Hippothoa
32. Female gonozoid on back surface of autozoids. Colony uniserial or biserial . . . . Haplota

33. Frontal wall a tremocyst, i.e., perforated all over by pores; cardelles small or wanting; ovicells generally with pores 34
33. Frontal wall imperforate except for areolar pores; ovicell evenly perforated by pores; small oral avicularium on asymmetrical suboral umbo; other avicularia elsewhere, of various shapes and sizes (fig. 36)
. . . . Schismopora and some of the other Celleporae

34. Avicularium present in midline proximal to orifice . . . . . . Schizomavella
34. Avicularium not in midline below orifice but located elsewhere about orifice or frontal (figs. 32-35) . . . . Schizoporella

35. Avicularia present 36
35. Avicularia absent; frontal wall imperforate except for areolar pores; ovicell imperforate . . . . Mucronella

36. A median suboral avicularium present 37
36. Avicularium not median nor suboral; frontal wall areolate but not perforated centrally; avicularia may be peripheral (fig. 31) . . . . Parasmittina

37. Suboral avicularium median and longitudinally directed 38
37. Suboral avicularium transverse or obliquely placed on a suboral umbo just in front of or partly obscuring the orifice . . . . Rhamphostomella

38. Frontal wall and ovicell perforated by pores all over the central area; sometimes the median suboral avicularium becomes incorporated into the peristomial collar in old zooecia . . . . Smittina
38. Frontal wall imperforate except for areolar pores 39

39. Ovicell center area perforate . . . . Smittoidea
39. Ovicell usually imperforate, or at most with an occasional pore . . . . Porella

ANNOTATED LIST OF ECTOPROCTA

(Figures of genera mentioned in key are not mentioned here)

CLASS GYMNOLAEMATA Allman, 1856

Order Cyclostomata (= Stenolaemata or Stenostomata)

Crisia cribraria Stimpson, 1853. Rare. At Crab Ledge.

Crisia denticulata (Lamarck, 1836). Doubtful identification.

Crisia eburnea (Linnaeus, 1758). Delicate white brittle upright slender branching sprigs. Common on algae, especially Chondrus crispus, driftweed and holdfasts.

Disporella hispida (Fleming, 1828). Flat rounded white calcareous patches resembling lichens; about 1/8 inch in diameter; edges crinkly, center part with slightly raised tubes or jagged projections. On algae, hydroids, bryozoa and stones.

Lichenopora verrucaria (Fabricius, 1780). On stems of Bugula, Eucratea, hydroids, and on shells and stones. About 1/8 inch in diameter.

Oncousoecia diastoporides (Norman, 1868). Fig. 37; Stomatopora of some authors. Rare, from Crab Ledge.

Tubulipora atlantica (Johnston, 1847). At Crab Ledge, on stones and shells.

Tubulipora flabellaris (Fabricius, 1780). Fig. 43. Uncommon, on shells and stones at Crab Ledge and near Nantucket.

Tubulipora liliacea (Pallas, 1766). Uncommon, on algae, eel grass, shells and stems of hydroids and Bugula, in Vineyard Sound.

Order Ctenostomata Busk, 1852

Aeverrillia armata (Verrill, 1873). On piles and seaweed (Laminaria and Phyllophora).

Aeverrillia setigera (Hincks, 1887). On hydroids and such algae as Chondrus and Ascophyllum. Indistinguishable in field from Aeverrillia armata.
Alcyonidium gelatinosum (Linnaeus, 1767). Questionable.
Alcyonidium hirsutum (Fleming, 1828). Vineyard Sound, on algae.
Alcyonidium parasiticum (Fleming, 1828). Vineyard Sound, Crab Ledge and No Man's Land.
Alcyonidium polyoum (Hassall, 1841). A. mytili of Osburn's 1912 paper. Encrusts piles, barnacles, stones, algae, shells, Libinia crab, and even skate egg cases. Color very variable, from gray to yellow to red to brown.
Alcyonidium verrilli Osburn, 1912. Rare at Vineyard Sound.
Amathia vidovici (Heller, 1867). A. dichotoma of Osburn's 1912 paper. Common, on piles, rocks, oyster shells and algae.
Anguinella palmata Van Beneden, 1845. Rare, mud encrusted. Not in key.
Bowerbankia gracilis var. caudata (Hincks, 1877). On stones, shells, ascidians, and on stems of hydroids, bryozoa and algae.
Bowerbankia gracilis Leidy, 1855. On piles, stones, and about 18 species of seaweeds.
Bowerbankia imbricata (Adams, 1800). The least common Bowerbankia, indistinguishable in field from B. gracilis. Colonies pinkish in breeding season (July and August) because of reddish larvae. Found on algae (Chondrus, Fucus, Ascophyllum, Corallina).
Flustrellidra hispida (Fabricius, 1780). Once known as Flustra or Flustrella. Forms a brown, rubbery crust on such algae as Ascophyllum, Chondrus, Fucus, Ulva.
Nolella blakei Rogick, 1949. On Perophora from Lagoon Pond, Martha's Vineyard.
Triticella elongata (Osburn, 1912). Commensal on legs, shells or branchial chambers of such crabs as Callinectes sapidus, Libinia, and on pinnotherid crabs in Chaetopterus tubes.
Triticella pedicellata (Alder, 1857). Recorded as Vesicularia familiaris in Osburn's 1912 paper. On algae.
Valkeria uva (Linnaeus 1758). From Vineyard Sound, on hydroids and bryozoa.
Victorella pavida Kent, 1870. Membranous, soft, white tracery or tuft; in brackish water.

Order Cheilostomata Busk, 1852

Suborder Anasca Levinsen, 1909

Aetea anguina (Linnaeus, 1758). Tiny but common on stems of algae, and animals, and on stones and shells.
Aetea recta Hincks, 1861. The Aetea sica of Rogick and Croasdale's 1949 paper. On about 18 algal species. Pinkish larvae found in July and August.
Amphiblestrum flemingii (Busk, 1854). Fig. 49; Membranipora flemingii in Osburn, 1912. On shells, stones and algae. Not in key.
Bicellariella ciliata (Linnaeus, 1758). On piles, stones, shells and hydroids. Embryos in ovicells in July and August.
Bugula avicularia (Linnaeus, 1758). Not in key; see fig. 50.
Bugula cucullifera Osburn, 1912. Not in key; see Rogick and Croasdale (1949). On algae (Fucus, Laminaria, Rhodymenia and Phyllophora) along with Aetea and Crisia.
Bugula simplex Hincks, 1886. This has been extensively used experimentally under the name of B. flabellata. Forms thick yellow-orange tufts in protected places such as floats in Eel Pond and piles elsewhere.
Bugula turrita (Desor, 1848). Occurs in more exposed situations than B. simplex, and easily recognized by its spiral growth. Also much used in laboratory studies. Larvae released from late June throughout August. Grows on at least 16 algal species.

Bugulopsis peachii var. beringia Kluge, 1952. Fig. 47. Cellularia peachii in Osburn 1912. Rare; on shells and on Dendrobeania murrayana. Not in key.
Caberea ellisii (Fleming, 1818). Fig. 41; on shells and pebbles. Not in key.
Callopora aurita (Hincks, 1877). Formerly in Membranipora. Small white colonies on rocks and less commonly on such algae as Phyllophora, Phycodrys and holdfasts of Laminaria.
Callopora craticula (Alder, 1857). (= Membranipora formerly). On shells and stones.
Callopora lineata (Linnaeus, 1767). (= Membranipora in Osburn 1912). Rare; on shells, stones and algae.
Cauloramphus cymbaeformis (Hincks, 1877). Fig 38; formerly in Membranipora. Encrusting stalks of hydroids and Dendrobeania murrayana.
Cellaria fistulosa (Linnaeus, 1758). Not in key.
Conopeum reticulum (Linnaeus, 1767). Fig. 39; Membranipora lacroixii of Osburn, 1912, and Rogick and Croasdale, 1949. Delicate encrusting lace on rocks, shells and less frequently on such algae as Ascophyllum, Fucus and Phyllophora; sometimes covers an area of several square inches.
Cribrilina annulata (Fabricius, 1780). Rare; on stones, shells, and algae (Phycodrys and Laminaria).
Cribrilina punctata (Hassall, 1841). Not common, but has been found encrusting shells, pebbles and 7 algal species.
Dendrobeania murrayana (Johnston, 1847). Height 0.5 to 1.5 inches; common in outer waters from dredged shells and pebbles.
Electra crustulenta (Pallas, 1766). As Membranipora monostachys in fig. 29b of Plate XXII, Osburn (1912).
Electra hastingsae Marcus, 1938. As Membranipora monostachys in fig. 29a of Plate XXII, Osburn (1912). Mostly on rocks and shells but occasionally on Fucus, Laminaria, and even on gill chambers of the spider crab Libinia.
Electra pilosa (Linnaeus, 1767). Very common on Laminaria; occurs also on about 16 other algal species, as a fine calcareous lace, one layer thick, sometimes a foot in length.
Eucratea loricata (Linnaeus, 1758). Bushy phytoid colonies up to 10 inches high in outer waters (Crab Ledge, Nantucket, and No Man's Land). Formerly called Gemellaria.
Membranipora tenuis Desor, 1848. Cryptocyst forms a jagged shelf that covers the proximal half of the opesia. Encrusts stones and shells.
Membranipora tuberculata (Bosc, 1802). (= Membranipora tehuelca). Exceedingly abundant on Sargassum, sometimes on Laminaria and driftweeds.
Scruparia ambigua (d'Orbigny, 1841). Fig. 19. Found on Bugula turrita and about 11 algal species (Laminaria, Fucus, etc.).
Scruparia chelata (Linnaeus, 1758). Fig. 15. Not common, but has been reported on bryozoa, hydroids and algae, and also on piles.
Scrupocellaria scabra (Van Beneden, 1848). Rare; on shells, stones and in drift.
Tegella arctica (d'Orbigny, 1851). (= Membranipora). Colonies one inch in diameter, on shells and stones.
Tegella armifera (Hincks, 1880). Membranipora arctica var. armifera of Osburn (1912).
Tegella unicornis (Fleming, 1828). (= Membranipora). Encrusts dredged shells.
Tricellaria gracilis (Smitt, 1867). Menipea ternata in Osburn's 1912 paper. Attaches to shells, stones, hydroids and bryozoans.

Suborder Ascophora Levinsen, 1909

Cellepora avicularis Hincks, 1860. Cellepora americana in Osburn, 1912. On algae and stems of hydroids and bryozoans.
Cellepora canaliculata Busk, 1881. On hydroids and bryozoans.
Cellepora dichotoma Hincks, 1862. On such algae as Chondrus, Gracilaria and Phyllophora. See fig. 36.

Cryptosula pallasiana (Moll, 1803). (= Lepralia). Living colonies an orange color, especially around the periphery. Colonies flat, calcareous, about 2 cm in diameter; common on rocks and shells; also occur on about 11 species of algae such as Laminaria, Fucus, Ascophyllum, Ulva, etc.

Cylindroporella tubulosa (Norman, 1868). Fig. 51. Porina tubulosa in Osburn, 1912. On stones and shells, in outer waters; not common. Not in key.

Haplota clavata (Hincks, 1857). Fig. 42. (= Scruparia). Rare; on Dendrobeania murrayana and Eucratea loricata.

Hippodiplosia americana (Verrill, 1875). (= Lepralia). On shells and stones; colonies white to reddish.

Hippodiplosia pertusa (Esper, 1796). (Formerly Lepralia). White to reddish calcareous colonies of considerable extent on rocks and shells.

Hippoporina contracta (Waters, 1899). Lepralia serrata of Osburn. White to buff-colored calcareous colonies encrusting rocks, shells and some algae (Phyllophora). Zoids small and crowded. The beaded orifice is distinctive.

Hippothoa divaricata Lamouroux, 1821. On stones, shells and occasional algae; rare.

Hippothoa hyalina (Linnaeus, 1767). Exceedingly common and cosmopolitan species, encrusting red and brown algae especially but also found on stones, shells, hydroids and bryozoans. Forms tiny glistening white to irridescent patches about 2 or 3 mm in diameter, usually twining around small algal stems or in protected spots, as on holdfasts. Embryos plentiful in July and August.

Microporella ciliata (Pallas, 1766). On rocks, shells and 5 algal species.

Microporella ciliata var. stellata (Verrill, 1875). On shells.

Mucronella immersa (Fleming, 1828). Mucronella peachii in Osburn, 1912. On stones and shells; occasionally on algae.

Mucronella ventricosa (Hassall, 1842). Rare; on stones and shells.

Parasmittina nitida (Verrill, 1875). Smittina trispinosa var. nitida of Osburn. Colonies very fine grained; form lightweight multilayered porous nodules several inches in diameter; color gray to sulfur yellow. Abundant in dredgings.

Parasmittina trispinosa (Johnston, 1838). On stones, shells, and occasionally on algae. Colonies whitish to yellow.

Porella acutirostris Smitt, 1867. On shells and stones; colonies rounded, pattern often of great regularity. At Crab Ledge.

Porella concinna (Busk, 1852). Common at Crab Ledge on stones and shells.

Porella proboscidea Hincks, 1888. White or yellow frilly bilaminate colonies rising erect from a base that encrusts shells, stones, and the ascidian Boltenia, sometimes several inches high; from Nantucket Shoals, No Man's Land, and Crab Ledge.

Porella propinqua (Smitt, 1867). On shells and hydroid stems.

Rhamphostomella bilaminata (Hincks, 1877). On hydroid stems.

Rhamphostomella costata Lorenz, 1886. Colony encrusts stems of various kinds, rising frill-like to a height of one-half inch; at Crab Ledge and Nantucket Shoals.

Rhamphostomella ovata (Smitt, 1868). Rare, encrusting stones and shells.

Schizomavella auriculata (Hassall, 1842). (= Schizoporella). Colorless to yellow to reddish colonies encrust stones, shells and occasionally hydroid stems; at Crab Ledge and Nantucket Shoals.

Schizoporella biaperta (Michelin, 1841-42). (= Stephanosella). Multilaminate ruffly reddish-orange colonies encrust piles, stones, shells, hydroid stems and 9 algal species (Chondrus, Fucus, Laminaria, etc.).

Schizoporella unicornis (Johnston, 1847). Multilaminate red calcareous colonies encrust shells, stones, piles, worm tubes and 6 algal species (Chondrus, Fucus, Laminaria, etc).

Smittina majuscula Nordgaard, 1905. Smittia porifera of Osburn's 1912 paper. Colony encrusts stones, shells and stems of various kinds; off Nantucket and Crab Ledge.

Stomachetosella sinuosa (Busk, 1860). Fig. 45. (= Schizoporella). Circular red, purple or brown colonies encrust stones and shells at Crab Ledge. Not in key.

Umbonula arctica (Sars, 1851). Fig. 46. Mucronella pavonella of Osburn's 1912 paper. Colony encrusts stones and shells or forms fan shaped expansions on stems of hydroids, etc. Not common. Not in key.

REFERENCES ON ECTOPROCTA

Bassler, R. S., 1953. Bryozoa: 253 pp. Part G of R. C. Moore's "Treatise on Invertebrate Paleontology." Geological Soc. of America, Univ. of Kansas Press. Lawrence, Kans. Exceedingly useful for both recent and fossil genera.

Borg, F., 1944. The Stenolaematous Bryozoa. Further Zool. Results Swedish Antarctic Exped. 1901-1903. III (5): 1-276, 16 plates. Includes many comments and revisions on other than Antarctic species.

Harmer, S. F., 1923. On Cellularine and other Polyzoa. Jour. Linn. Soc. Zool. 35: 293-361; 3 plates. Very important morphological paper settling some taxonomic questions.

Harmer, S. F., 1957. The Polyzoa of the Siboga Expedition, Part IV, Cheilostomata Ascophora...Resultats Siboga-Expedit. XXVIIId (Livr. 145): 641-1147; 33 plates.

Hincks, T, 1880. A history of British Marine Polyzoa, 2 vols., London, England. A classic reference.

Hyman, L. H., 1959. "The Invertebrates", vol V., Smaller Coelomate Groups. McGraw-Hill Book Co., New York, N.Y. Ectoprocta on pp. 275-515. The most comprehensive compilation on the subject.

Kluge, G. A., 1962. Mshanki Severnih Morei SSSR. (Bryozoa of the Northern Seas of the USSR). (In Russian). Fauna USSR #76, Akademia Nauk USSR, Zool. Institute, Leningrad. 584 pp. Very good figures.

Lagaaij, R., 1952. The Pliocene Bryozoa of the Low Countries. Mededelingen van de Geologische Stichting, Ser. C, V(5): 1-233; 26 plates.

Marcus, E., 1940. Mosdyr (Bryozoa eller Polyzoa). Danmark's Fauna, Dansk Naturhistorisk Forening 46, 401 pp.; G. E. C. Gads Forlag, København, Danmark. Excellent handbook for identification.

Osburn, R. C., 1912. The Bryozoa of the Woods Hole Region. Bull. U. S. Bur. Fish. (1910), 30: 205-266; pl. 18-31.

Osburn, R.C., 1950. Bryozoa of the Pacific Coast of America. Part 1. Cheilostomata-Anasca. Allan Hancock Pacific Exped. 14(1): 1-269, pl. 1-29. Univ. of Southern Calif. Press, Los Angeles, Calif.

Osburn, R. C., 1952. Part 2. Cheilostomata-Ascophora Ibid., 14(2): 271-611; pl. 30-64.

Osburn, R. C., 1953. Part 3. Cyclostomata, Ctenostomata, Entoprocta, and Addenda. Ibid., 14(3): 613-841; pl. 65-82.

Prenant, M. et G. Bobin, 1956. Bryozoaires, Ière Partie, Entoproctes, Phylactolames, Ctenostomes. Faune de France, 60: 1-398. Very usable.

Rogick, M., 1940. An ecological effect of the New England hurricane. Ohio Jour. Sci., 40 (3): 163-167.

Rogick, M., 1945. Calcining specimens. Amer. Biol. Teacher, 8: 66-70.

Rogick, M., 1949. Studies on marine Bryozoa, IV. Nolella blakei, n. sp. Biol. Bull., 97: 158-168.

Rogick, M., 1956. Bryozoa of the U. S. Navy's 1947-48 Antarctic Expedition, I-IV, Proc. U. S. Nat. Mus., Smithsonian Inst., 105(3358): 221-317; 35 pl.

Rogick, M. and H. Croasdale, 1949. Studies on marine Bryozoa, III. Woods Hole region Bryozoa associated with algae. Biol. Bull., 96: 32-69.

Ryland, J. S., 1960. The British Species of Bugula (Polyzoa). Proc. Zool. Soc. London, 134(1): 65-105. Exceedingly useful for identification of some troublesome Bugulae.

Ryland, J. S., 1962. Biology and identification of intertidal Polyzoa. Field Studies, I(4): 19 pp.

Silén, L., 1944. On the formation of the interzoidal communications of the Bryozoa. Zooloogiska Bidrag fran Uppsala. Band 22: 433-488. Excellent account of the various types of interzoidal communications, pores, chambers, etc.

Soule, J. D., 1957. Two species of Bryozoa Ctenostomata from the Salton Sea. Bull. So. Calif. Acad. Sci., 56(1): 21-30. Adult Nolella blakei and Victorella pavida.
Zoological Record: Bryozoa (Polyzoa) Section. An annual publication dating from 1864 to the present; indispensable for any worker in the group.

Plate 23

ENTOPROCTA AND ECTOPROCTA

Figures 1, 7, and 11 after Osburn 1912; figs. 2, 4-6, 8-10 after Rogick and Croasdale 1949; figs. 3 and 12-13 after Rogick 1949; all redrawn by Mrs. Emily Reid

Fig. 1. Loxosoma davenporti.

2. Pedicellina cernua.

3. Barentsia laxa.

4. Crisia eburnea: note inflated ovicell and joints or nodes.

5. Disporella hispida, a complete small colony.

6. Flustrellidra hispida, portion of colony; note spines and slit-like closure of orifices.

7. Alcyonidium verrilli, portion of colony; note puckered closure of orifices.

8. Bowerbankia gracilis, zoids with retracted tentacles.

9. Aeverrillia armata, portion of colony; note paired zooecia on short peduncles, and the 4 terminal spines on each zooecium.

10. Single polypide of Bowerbankia imbricata with tentacles extended; note setigerous collar directly below the tentacles, here constricting the tentacle sheath.

11. Amathia vidovici; note close-set spiral bands of zoids.

12. Nolella blakei, retracted individual, very young, with squared orifice.

13. Nolella blakei, very young zoid, with tentacles extended. The four basal extensions are "false" stolons. The bottom right represents the attenuated proximal end of the shown zoid. The other three are cut off by septa from the base of the shown zoid and likewise represent the proximal extensions of their own zoids.

Plate 23

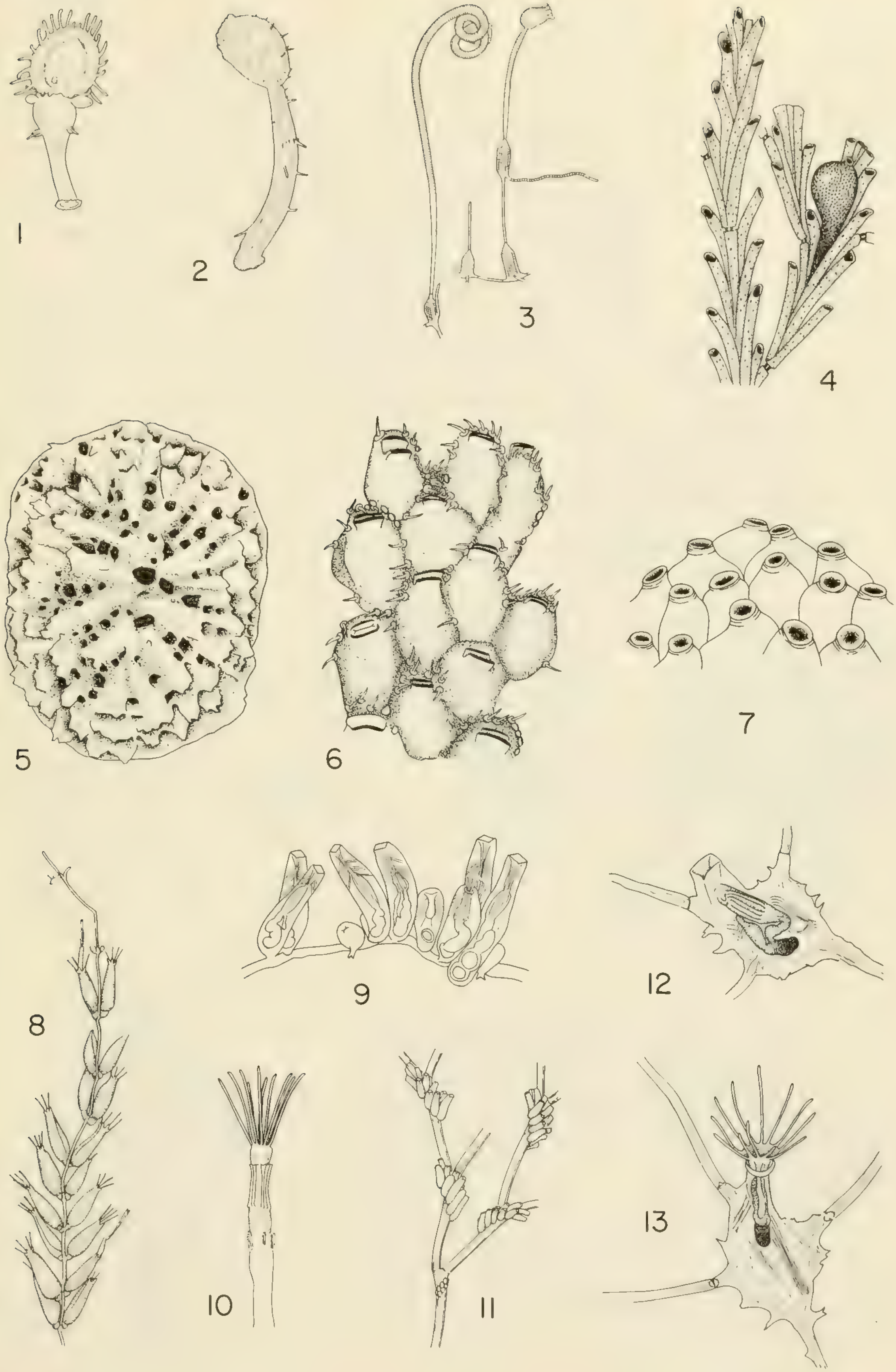


Plate 24

ECTOPROCTA (2)

Figures 15, 16, 20 and 21 after Osburn (1912); rest after Rogick and Croasdale (1949), redrawn by Mrs. Emily Reid

Figure 14A, B. Aetea recta, note proximal recumbent parts of zoids, connected by stolonate extensions.

15. Scruparia chelata; a zoid at left bears ooecium. Opesia oblique and shorter than in S. ambigua.

16. Bicellariella ciliata: A, portion of colony; B, ovicell borne on a zoid; C, avicularium with serrated beak.

17. Bugula simplex: small part of branch, with 3 bird head avicularia and 3 overhanging ovicells.

18. Bugula turrita: small part of branch, shows 4 ovicells and one bird head avicularium. Note spines on zooecia.

19. Scruparia ambigua, portion of colony arising from basal attached row of zooecia. Opesia parallel to back wall and longer than in S. chelata.

20. Membranipora tuberculata: note large opesia and pairs of tubercles.

21. Electra crustulenta, a more or less spineless species.

22. Electra pilosa, a lightly calcified spiny species. Note porous gymnocyst (frontal proximal wall), and spines bordering opesia.

23. Electra hastingsae, a species with delicate spines, sometimes lacking or broken off.

24. Callopora aurita, part of a colony showing 9 zooecia, 10 ovicells (with triangular front area) and 13 avicularia (some smaller than others).

25. Microporella ciliata: note the spine bordered hemispherical orifice under which is a small median crescent shaped ascopore. Four globose ovicells at bottom conceal orifices.

26. Hippoporina contracta: note bifid denticles and beaded arches of the orifices. Ovicells are not pictured but note spatulate avicularia on the two extreme right zoids, and areolar pores.

Plate 24

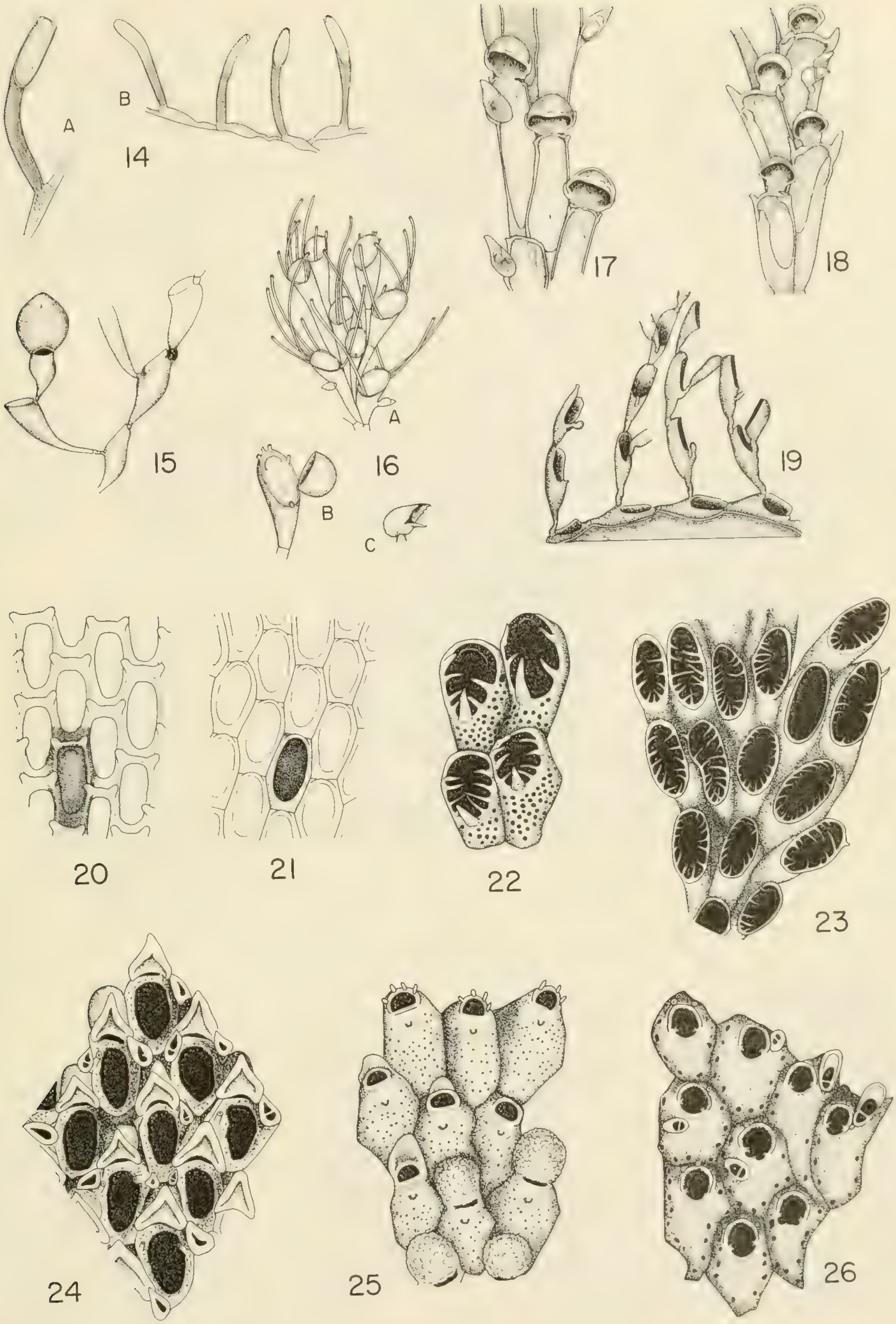


Plate 25

ECTOPROCTA (3)

Figure 30 after Osburn, rest after Rogick
and Croasdale, all redrawn by Mrs. Emily Reid

Fig. 27. Hippothoa hyalina, one ooecium at upper right of group.

28. Cribrilina annulata, no ooecia shown.

29. Cribrilina punctata, three ooecia shown at right in group.

30. Cryptosula pallasiana.

31. Parasmittina trispinosa, portion of colony without ooecia. Note avicularia beside orifices.

32. Schizoporella unicornis, portion of colony without ooecia. Note avicularia beside orifices.

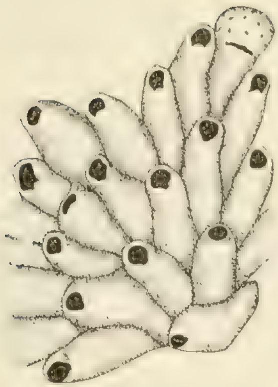
33. Schizoporella unicornis, zooecia with ovicells.

34. Schizoporella biaperta, heavily calcified portion of colony; note avicularia close to orifices.

35. Schizoporella biaperta, portion of less heavily calcified colony, without ovicells.

36. Cellepora dichotoma, portion of colony, with ovicells. Note avicularium borne on umbo on front of each zooecium.

Plate 25



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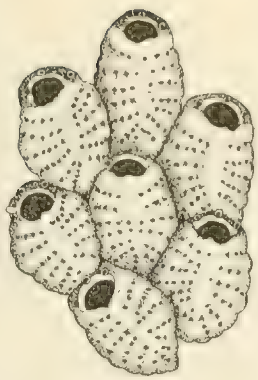

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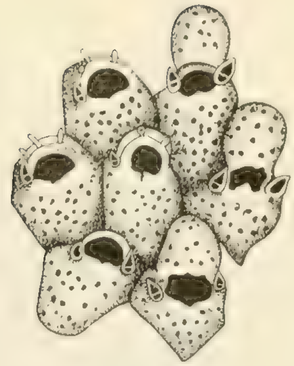

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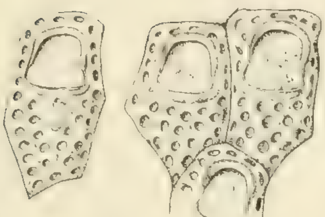

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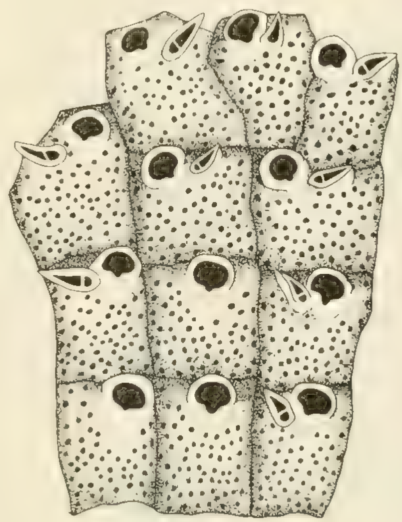

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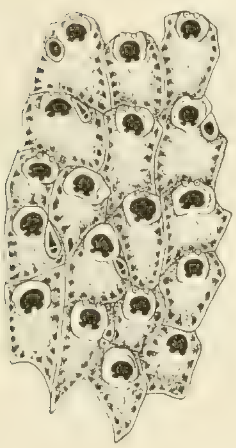

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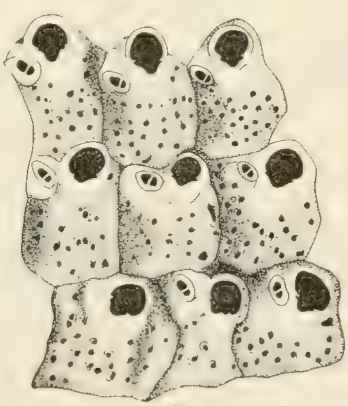

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36

ECTOPROCTA (4)

Figures modified from indicated sources; redrawn by Mary Rogick. Some of the genera figured are not in the key.

Fig. 37. Colony fragment of Oncousoecia diastoporides, after fig. 12A of Osburn, 1912.

38. Five zoids and two pedicellate avicularia of Cauloramphus cymbaeformis, after figs. 36, 36A of Osburn, 1912.

39. Five zoids of Conopeum reticulum, after fig. 9 of Rogick, 1940. The large opesia is here blacked in.

40. Branch of Scrupocellaria scabra, after Plate 6, fig. 7 of Hincks, 1880, showing frontal and lateral avicularia, and scuta (aperture shields).

41. Caberea ellisi from dorsal aspect, showing three long vibracula, after Pl. 8, fig. 7 of Hincks, 1880.

42. Haplota clavata from dorsal aspect, showing ovicell arising from back of zoid on branch at left; from fig. 107 of Marcus, 1940. Detail of aperture (orifice) above at right.

43. Very young colony of Tubulipora flabellaris, showing the "primitive disc" at point of colony origin; after Pl. 64, fig. 2 of Hincks, 1880.

44. Eucratea loricata, showing back-to-back zooecia, from fig. 16 of Osburn, 1912.

45. Three zoids and an ovicell (at bottom) of Stomachetosella sinuosa, from fig. 51 of Osburn, 1912.

46. Umbonula arctica, zoid with 2 adventitious avicularia and the characteristically large orifice; from fig. 16 of Osburn, 1912. Note the areolar pores and small denticle or umbo (not a lyrula).

47. A single internode of Bugulopsis peachii var. beringa after fig. 20 bis of Osburn, 1912. Note dark "joints" at bottom and top.

48. A composite diagram, modified from fig. 116 of Bassler, 1953, showing two membraniporid zoids, and a vicarious (independent) avicularium at right. The lowest zoid shows a pointed adventitious frontal avicularium. This zoid's nonporous frontal surface is an olocystal gymnocyst. The upper zoid has a frontal wall with pores, a tremocystal gymnocyst. The cryptocyst is the shelf immediately framing the opesia. The cap shaped structure overhanging the distal end of the top zoid is an ovicell.

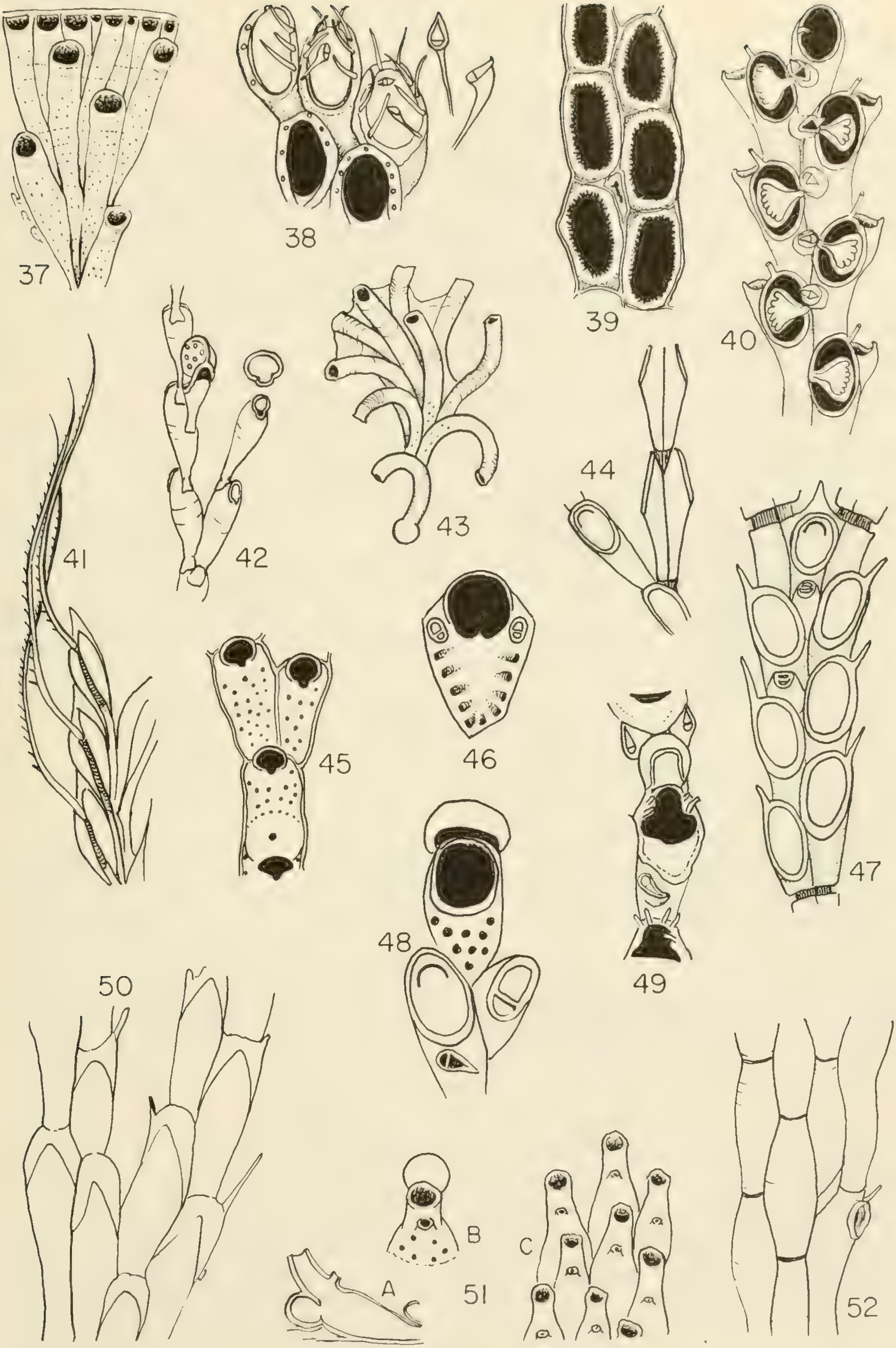
49. An ovicelled zoid of Amphiblestrum flemingii similar to Callopora except for the design on the ovicell; after fig. 38 of Osburn, 1912.

50. Dorsal surface of a Bugula avicularia branch, showing the forked proximal ends of zoids (where zoids originate distally and dorsally), after Pl. 10, fig. 2 of Hincks, 1880.

51 A, 51B, 51C. Cylindroporella tubulosa, after figs. 43, 43A, 43C of Osburn, 1912. Fig. 51A is a side view of an ovicelled zoid; fig. 51B is the frontal view of another ovicelled zoid; 53C shows several bottle shaped autozoids.

52. Dorsal surface showing the transverse proximal ends of Dendrobeania murrayana; after Pl. 14, fig. 6 of Hincks, 1880.

Plate 26



PHYLUM ECHINODERMATA

Keys are provided for the common members of four classes of living echinoderms (the Crinoidea are not represented at Woods Hole). These classes may be recognized as such without difficulty, except in the case of the very worm-like synaptid holothurians. Keys revised with the help and advice of John M. Anderson. Figure references are to Plate 27.

I. Class Asteroidea
(Sea stars or starfishes)

1. Arms bear prominent spines; tube feet in 4 rows . . . . Asterias 2
1. Arms bear only numerous minute spines; tube feet in two rows 3

2. Arms tend to be blunt and cylindrical; skeleton firm; jaws of major pedicellariae (on adambulacral spines) broad and blunt (fig. 1); colors usually dark, brown to greenish black; common . . . . Asterias forbesi
2. Arms pointed and somewhat flattened; skeleton rather soft; usually a line of spines on upper surface of each arm; jaws of major pedicellariae tapering and pointed (fig. 2); colors lighter, yellowish to lavender; rare south of Cape . . . . Asterias vulgaris

3. Five arms; usually crimson above, yellow below; small; more common north of Cape . . . . Henricia sanguinolenta
3. Nine to eleven arms; up to 25 cm across; found north of the Cape . . . . Solaster endeca

II. Class Ophiuroidea
(Brittle stars, serpent stars)

1. Lateral spines on arms short 2
1. Lateral spines on arms prominent 3

2. Disc granulated, with no distinct scales; 2 pairs of slits leading into genital bursae at base of each arm (fig. 3) . . . . Ophioderma brevispina
2. Disc covered with small scales; only one pair of slits leading into genital bursae at base of each arm (fig. 4); found only north of the Cape . . . . Ophiura robusta

3. Three lateral arm spines on each joint (fig. 5); small, gray and white . . . . Amphipholis squamata
3. Five or six lateral arm spines on each joint (fig. 6); color variable, often bright; arms often banded . . . . Ophiopholis aculeata

III. Class Echinoidea
(Sea urchins, sand dollars)

1. Flat and disc-like; very numerous minute spines . . . . . Echinarachnius parma
1. Globular, with prominent spines 2

2. Color purplish, brownish, or blackish, spines long and stout; the common sea urchin about Woods Hole . . . . Arbacia punctulata
2. Color greenish or yellowish; spines short, slender, and more numerous; much more common north of the Cape . . . . Strongylocentrotus drobachiensis

IV. Class Holothuroidea
(Sea cucumbers)

1. Body wall muscular and opaque; typical tube feet present; 10 branching tentacles surround mouth 2
1. Body wall thin, transparent, showing 5 longitudinal ("radial") muscle strands; 12 pinnately branched tentacles about mouth; tube feet absent; worm-like in appearance, tending to adhere to fingers when handled 4

2. Tube feet scattered over body, not confined to five adambulacral rows . . . . Thyone briareus
2. Tube feet mostly in 5 rows . . . . Cucumaria 3

3. Large (up to 30 cm); color some shade of brown; north of Cape . . . . Cucumaria frondosa
3. Small (up to 6 cm); color grayish or pale; south of Cape . . . . Cucumaria pulcherrima

4. Color whitish; tentacular digits 4-6 pairs plus terminal digit (variable); usually in sand (see note in check list) . . . . Leptosynapta tenuis
4. Color pinkish; tentacular digits 2-4 pairs plus terminal digit (variable); usually in gravel or under stones (see note in check list) . . . . Leptosynapta roseola

Note: the two synaptid species can be distinguished by the following internal characteristic: In the calcareous ring of L. tenuis each radial plate contains a hole for the passage of the radial nerve (fig. 7); in L.roseola these plates are not pierced but are notched anteriorly (fig. 8).

ANNOTATED LIST OF ECHINODERMS

I. Class Asteroidea

Asterias austera Verrill, 1895. Found only offshore in deep water. Not in key.
Asterias forbesi (Desor, 1848). "Common starfish" south of the Cape.
Asterias tenera Stimpson, 1862. Not in key. This "slender armed starfish" occurs in deeper water (6-40 meters) both north and south of the Cape, but is not recorded from Vineyard Sound.
Asterias vulgaris Verrill, 1866. "Northern starfish"; South of the Cape this species occurs only in deeper water.
Henricia sanguinolenta (O. F. Müller, 1776). "Blood starfish", formerly known as Cribrella sanguinolenta. The large yolky eggs are brooded beneath the mother; development is direct, without a free larval stage.
Solaster endeca (Retzius, 1783). Does not occur at Woods Hole; found north of the Cape.

II. Class Ophiuroidea

Amphipholis (formerly Amphiura) squamata (Delle Chiaje, 1828). One of the commonest ophiuroids of the region, but small and inconspicuous; generally in gravel, stones, or shell. Development direct, in brood pouches of parent.
Gorgonocephalus agassizi (Stimpson, 1853). Not in key. Remarkable for its dichotomously branching arms, the "basket star" or "spider" occurs in northern waters. Known to the tip of the Cape and Nantucket Shoals. It is occasionally brought into Woods Hole by fishermen.
Ophioderma (formerly Ophiura) brevispina (Say, 1825). Very common in protected, grassy bays such as Lagoon Pond.

Plate 27

ECHINODERMATA

From specimens or redrawn from various sources, all by Bruce Shearer.

Figure 1. <u>Asterias</u> <u>forbesi</u>, outline of a major pedicellaria, showing blunt form (after Coe).

2. <u>Asterias</u> <u>vulgaris</u>, outline of major pedicellaria, showing more elongated form (after Coe).

3. <u>Ophioderma</u> <u>brevispina</u>, underside of junction of arm with disc, to show the two pairs of openings of the genital bursae.

4. <u>Ophiura</u> <u>robusta</u>, underside of junction of arm with disc, showing one pair of openings of genital bursae (after Clark).

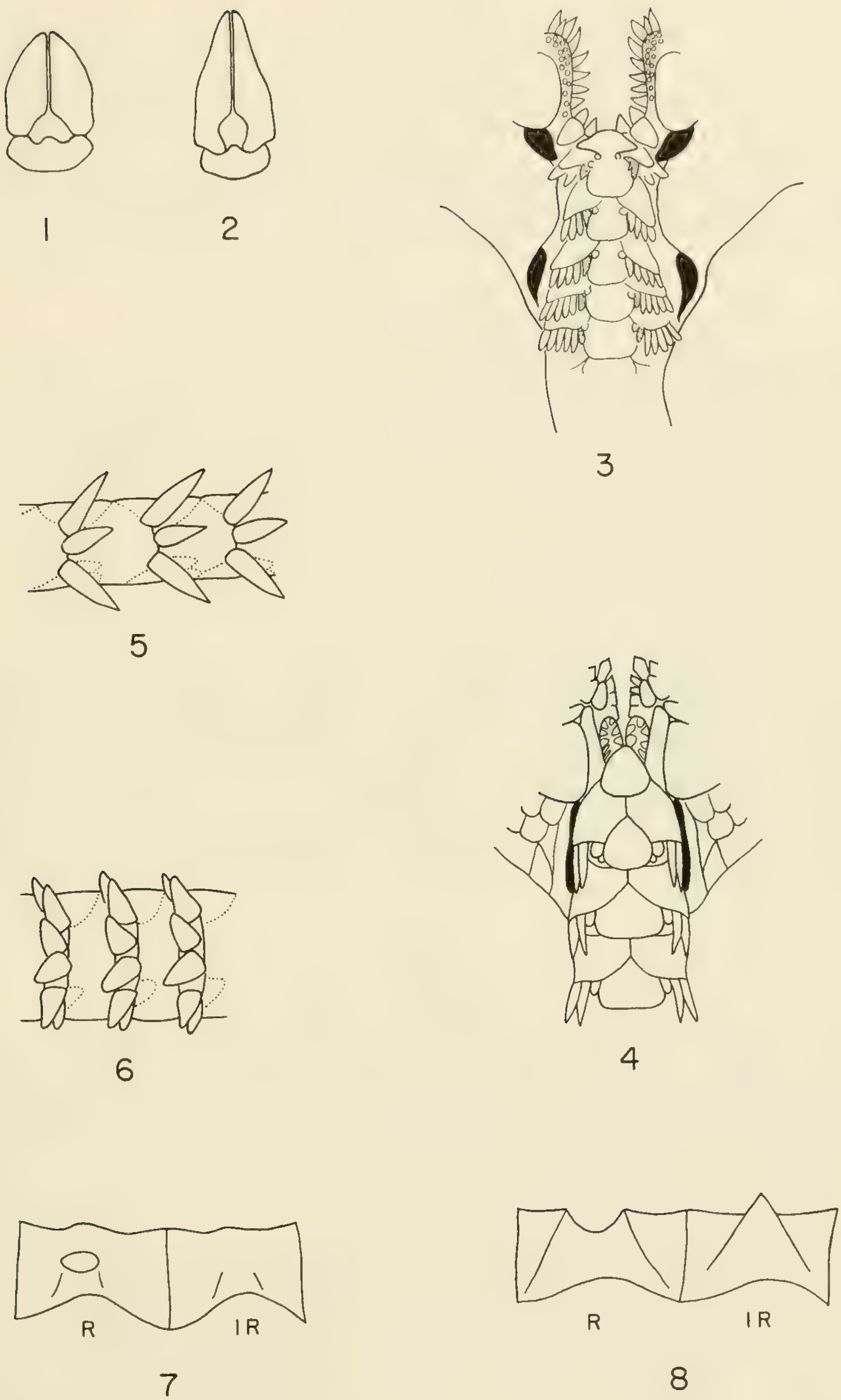
5. <u>Amphipholis</u> <u>squamata</u>, lateral view of a portion of an arm, to show the three lateral arm spines per joint.

6. <u>Ophiopholis</u> <u>aculeata</u>, lateral view of a portion of an arm, showing six lateral arm spines per joint.

7. <u>Leptosynapta</u> <u>tenuis</u>, radial and interradial pieces of calcareous ring, the radial pierced for the passage of the radial nerve (after Heding).

8. <u>Leptosynapta</u> (<u>Epitomapta</u>) <u>roseola</u>, radial and interradial pieces of the calcareous ring, the radial notched anteriorly (after Heding).

Plate 27



Ophiopholis aculeata (Linnaeus, 1767). Uncommon; the "daisy brittle star"; may be found in exposed rocky areas, as at Cuttyhunk.
Ophiura robusta (Ayres, 1851). Found only north of the Cape.

III. Class Echinoidea

Arbacia punctulata (Lamarck, 1816). "Purple" or "common sea urchin". One of the best known sources of embryological material.
Echinarachnius parma (Lamarck, 1816). "Sand dollar"; taken by dredging on sandy bottom.
Strongylocentrotus drobachiensis (O. F. Müller, 1776. "Green sea urchin"; taken rather rarely in Vineyard Sound, but is the common (and only) urchin north of the Cape.

IV. Class Holothuroidea

Caudina arenata (Gould, 1841). Not in key. This apodous (tube-foot-less) holothurian much resembles a smooth skinned sipunculid with one end drawn out into a sort of tail. It is common in sand north of Boston and has been reported off Cuttyhunk.
Cucumaria frondosa (Gunnerus, 1770). This large sea cucumber may be expected only north of the Cape.
Cucumaria pulcherrima (Ayres, 1854). A small gray form; may occasionally be taken, or washed up in numbers, on Nobska and Stony Beaches after severe storms.
Leptosynapta (Epitomapta) roseola (Verrill, 1873). Heding (1928, p. 323) considers this form sufficiently distinct to be given subgeneric or even generic rank as Epitomapta roseola.
Leptosynapta inhaerens, see Leptosynapta tenuis.
Leptosynapta tenuis (Ayres, 1851). This species is almost always referred to at Woods Hole as L. inhaerens (O. F. Müller, 1738). But on the basis of a careful comparison, Heding (1928) concludes that the "L. inhaerens" of Woods Hole is not of the same species as the "L. inhaerens" of Europe and that the next available name, tenuis, should be used. The fact of this difference should be borne in mind if experimental results obtained on L. inhaerens in Europe and America are compared.
Thyone briareus (Lesueur, 1824). A well known experimental animal, collected in very soft mud in shallow bays.
Thyone scabra Verrill, 1873. Rare, dredged. Not in key.
Thyone unisemita (Stimpson, 1851). Rare, dredged. Not in key.

REFERENCES

Clark, H. L, 1904. The Echinoderms of the Woods Hole region. Bull. U. S. Fish. Com. for 1902, 22: 545-576.
Coe, W. R., 1912. Echinoderms of Connecticut. Conn. State Geol. Nat. Hist. Survey, Bull. 19: 1-152.
Deichmann, E., 1930. The holothurians of the western part of the Atlantic Ocean. Bull. Mus. Comp. Zool., Harvard, 71(3): 43-266, pl. 1-24.
Heding, S. G., 1928. Papers from Dr. Th. Mortensen's Pacific Expedition 1914-16, XLVI, Synaptidae. Vidensk. Medd. Dansk Naturhist. Foren., 85: 105-323.

THE "PROTOCHORDATES"

The term "protochordates" today includes the Phylum Hemichordata, and two subphyla of the Chordata, namely:

A. Subphylum Cephalochordata, with Amphioxus and its kin, not represented locally.
B. Subphylum Urochordata (= Tunicata) which includes:

1. Class Ascidiacea, the sessile tunicates, well represented in the Woods Hole fauna and much used in experimental work.
2. Classes Thaliacea and Larvacea, which are pelagic or planktonic, and are not covered in these keys.

PHYLUM HEMICHORDATA

The only common hemichordate of Woods Hole is the well known Saccoglossus kowalewskyi (A. Agassiz, 1873). This occurs intertidally or in shallow water in fine muddy sand where its presence is marked by little piles of fine, stringlike castings. The wormlike body is exceedingly fragile and difficult to collect undamaged. It is easily recognized by the characteristic whitish proboscis, orange collar, and brownish body (plate 28, fig. 1).

The development of S. kowalewskyi is direct, without drastic metamorphosis, from a ciliated larva. Some confusion has resulted from the claim of Agassiz that S. kowalewskyi arose from the metamorphosis of a planktonic "tornaria" larva. The fact that tornaria larvae do appear in local waters indicates that some other species may exist in not too distant, but probably deeper, waters.

Agassiz described our common species as Balanoglossus kowalewskyi; this was reassigned to Dolichoglossus by Spengel in 1893, in his well known work on the Enteropneusta of the Gulf of Naples. However, Van der Horst, in his revision of 1939 (Bronn's "Tierreich", IV:4:2:2) adopted the prior name of Saccoglossus (published by Schimkewitsch in 1892), but long overlooked as a consequence of the paper being in Russian). Since there is no question as to the species kowalewskyi (or the variant spelling kowalevskii), experimentalists should use the specific name and not merely the generic name in reporting work done on Saccoglossus kowalewskyi at Woods Hole, in order to avoid possible confusion to foreign readers.

PHLYUM CHORDATA

SUBPHYLUM UROCHORDATA (= TUNICATA)

Class Ascidiacea

This section has been compiled from material written and contributed by Drs. Donald J. Zinn and Donald P. Abbott, whose assistance is much appreciated. The key is intended only for identification of ascidians in the Woods Hole region. Information about the anatomy and ecology of these animals may be found in Berrill (1950) and further material on their taxonomy in Van Name (1945). Embryological details are discussed at some length by Berrill (1936). Figure references on ascidians are to plate 28.

Ascidians show various degrees of colony formation: "simple" ascidians develop singly from eggs and do not bud; individuals in this group are relatively large. Colonial ascidians can reproduce by budding, and form aggregations of several to many small individuals. In "social" ascidians, such as Perophora, the individuals are distinct from each other and are connected only by stolons at their bases (figs. 2, 3). "Compound" ascidians, such as Botryllus, have minute individuals embedded in a common test or tunic which often has a characteristic growth form (figs. 7, 8).

It is often very difficult to see the anatomical features of fresh, unrelaxed ascidians, since they contract strongly when dissected. For purposes of laboratory study of anatomy, or if necessary for identification, relaxed and properly preserved specimens should be used. Place animals in pans of sea water to which is added Epsom salts ($MgSO_4$), about one heaping teaspoon per liter. After 12-24 hours of anaesthetization, fix for at least an hour before study in 5-10% formalin made up with sea water. This treatment permits easy observation of features nearly impossible to discern in delicate, contractile living forms or in contracted preserved material. Specimens that are kept for more than a couple of weeks should be transferred through 2 changes of 70% alcohol. Large specimens should have slits made in them to facilitate penetration. Fresh specimens will usually be easier to study if hardened a little by previous transfer to strong alcohol for a few days.

In using the following key, note that the branchial or inhalent siphon (morphologically the mouth) is considered anterior. Dorsal is defined by the position of the brain and subneural gland, which lie close to the surface between the siphons. The gonads in solitary ascidians are typically conspicuous structures, each consisting of a sac-like ovary on the surface of which may be located the lobes of the testes.

KEY TO COMMON ASCIDIANS

1. Colonial ascidians (individuals are small and connected by stolons or embedded in common test) 2
1. Simple ascidians (individuals usually of good size, and although they may occur in clusters are not organically connected to each other) 7

2. Colony thin, flat, encrusting; zooids colorful, and arranged in stellate or subcircular clusters or "systems" (figs. 7, 8); zooids of each system with branchial apertures opening independently, atrial apertures directed medially and opening into a common cloacal cavity in the tunic . . . . Botryllus schlosseri
2. Colony not as above 3

3. Colony consisting of numerous tiny (2-4 mm diameter) greenish individuals, connected to one another only by basal stolons (social ascidians) (figs. 2,3) . . . . Perophora viridis
3. Colony not as above; individual zooids completely embedded in matrix of the common test (compound ascidians) 4

4. Forming flat encrusting colonies 2-4 mm thick and up to more than 10 cm in diameter; test smooth on surface, opaque because of large numbers of minute stellate calcareous spicules which are white, yellowish, or reddish in color; no postabdomen present . . . . Didemnum candidum
4. Form of colony otherwise; test not containing stellate calcareous spicules, though sometimes with encrusting or embedded sand grains; postabdomen present, containing the gonads 5

5. Colony in the form of massive "meaty" plates, lumps, or lobes up to several inches long and attached by one edge; tunic very firm; stomachs of zooids bearing about 12 longitudinal ridges (fig. 5) . . . . Amaroucium stellatum
5. Colony not as above; stomachs of zooids bearing 20 or more longitudinal ridges (fig. 4) 6

6. Colonies low, globular, oval or flat topped, attached by a narrow base . . . . Amaroucium constellatum
6. Colonies consisting of globular masses built up of radially arranged, transparent, finger-like lobes, which may contain encrusting and embedded sand . . . . Amaroucium pellucidum

7. Branchial siphon with 8 lobes, atrial siphon with 6; body elongate, up to several inches long; test grayish, gelatinous, transparent enough when expanded to reveal the pharynx with 5-7 longitudinal muscle bands on each side and the main loop of the gut, posterior to the pharynx, basally (fig. 6). . . . . . Ciona intestinalis
7. Branchial siphon with 4 or 6 lobes; body and test not as above 8

8. Branchial aperture (also atrial aperture) square or 4-lobed; dissection shows pharyngeal stigmata straight, elongate, and not arranged in spiral or circular fields; no kidney present . . . . STYELIDAE 9
8. Branchial aperture usually 6-lobed, atrial aperture usually 4-lobed; dissection shows pharyngeal stigmata more or less curved and arranged in circular or spiral fields; kidney present on the right side . . . . MOLGULIDAE 10

9. Test leathery, tough, irregular, yellowish or brownish in color; when collected often feels like a rough lump of gristly consistency; 2 gonads on each side of the body (figs. 9, 10); pharynx with 4 longitudinal folds on each side . . . . Styela partita
9. Test thin, tough, membranous, pinkish to bright red in life, attached by a relatively large area basally; body depressed with long axis usually parallel to the substrate; 1 gonad on the right side (fig. 12), none on the left (fig. 11); pharynx with one longitudinal fold on the right side, none on the left . . . . Dendrodoa carnea

10. Adults live in soft sand or mud substrates, unattached to larger objects 11
10. Adults do not live free in soft sand or mud, but occur attached to larger objects such as gravel, rocks, floats, pilings, marine plants, shells 12

11. Siphons arise close together; body covered with minute fibrous processes which hold a layer of mud about the body; dissection shows only one gonad, this present on the left side (figs. 13, 14); pharynx lacking longitudinal folds but bearing 7 large internal longitudinal vessels on each side . . . . Bostrichobranchus pilularis
11. Siphons separated at bases by a space greater than 1/5 of body circumference (figs. 15, 16); dissection shows 2 gonads, one on each side of the body; pharynx bearing longitudinal folds on each side, each fold marked by a small group of internal longitudinal vessels . . . . Molgula arenata

12. Very common, attached to eel grass, floats, pilings, etc., in bays; long axes of both gonads straight (figs. 17, 18) . . . . Molgula manhattensis
12. Less common; long axes of one or both gonads conspicuously curved 13

13. Gonads on both sides an inverted U-shape, leaving open ends of oviducts pointed away from the base of the atrial siphon (figs. 19, 20) . . . . Molgula complanata

13. Left gonad with an S-shaped or W-shaped curve, right gonad with a straight axis; both gonads with open ends of oviducts curved to point toward the base of the atrial siphon (figs. 21, 22) . . . . Molgula citrina

Plate 28

PROTOCHORDATES

Figures 1, 3, and 9 from life; rest redrawn from Van Name (1945); all by Bruce Shearer.

Fig. 1. Saccoglossus kowalewskii, whole animal, from life.

2. Perophora viridis, individual, seen from left side.

3. Same, colony from life, to show "social" growth habit.

4. Amaroucium constellatum, zooid with larvae in atrial cavity. Note the numerous stomach ridges.

5. Amaroucium stellatum, region of stomach, to show the fewer and simpler ridges.

6. Ciona intestinalis, diagram of body seen from left, to show position of gut and gonads; branchial sac omitted.

7. Botryllus schlosseri, single zooid seen from left side.

8. Same, small colony from life, showing investment in common tunic.

9. Styela partita, diagram of body as seen from left and as if wall transparent, branchial sac omitted, showing gut and gonads.

10. Same, seen from right side, showing gonads.

11. Dendrodoa carnea, view of left side showing gut.

12. Same, view of right side, showing gonad.

13. Bostrichobranchus pilularis, diagram of body seen from left, showing gut and gonad.

14. Same, from right, showing renal sac.

15. Molgula arenata, body from left, showing gut and gonad.

16. Same, body from right, showing renal sac and gonad.

17. Molgula manhattensis, body from left.

18. Same, from right.

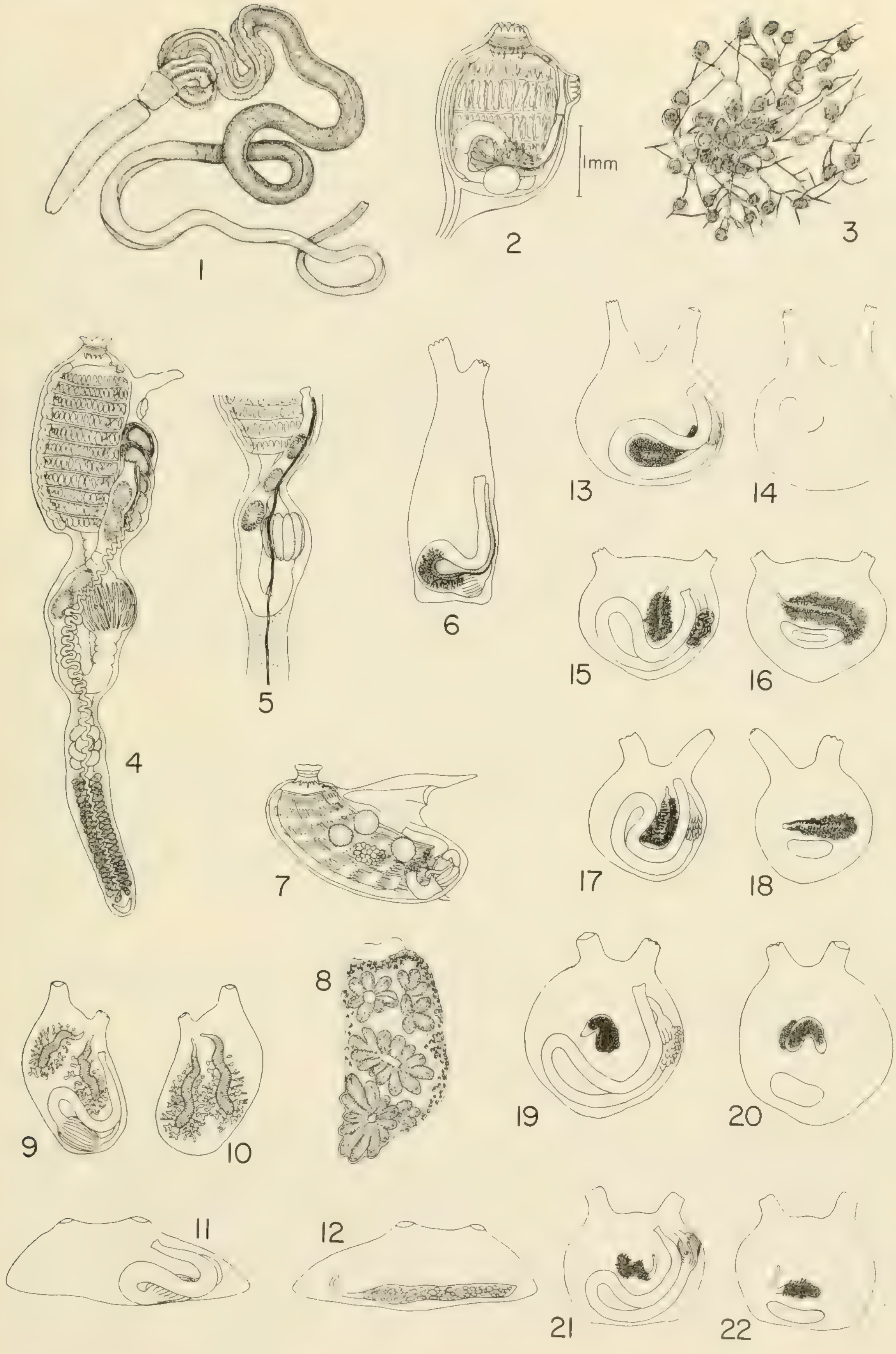
19. Molgula complanata, body from left.

20. Same, from right.

21. Molgula citrina, body from left.

22. Same, from right.

Plate 28



ANNOTATED LIST OF ASCIDIANS

Order Aplousobranchia

Family Synoicidae

Amaroucium stellatum Verrill, 1871, Massachusetts to Florida. "Sea Pork"; viviparous.

Amaroucium constellatum Verrill, 1871. New Hampshire to Florida. Good embryological material. Viviparous.

Amaroucium pellucidum (Leidy, 1855). Massachusetts to Florida. In 10-20 meters on sand, shells, or gravel in tidal currents. Viviparous.

Family Didemnidae

Didemnum candidum lutarium Van Name, 1910. Van Name (1945) considered the form prevalent at Woods Hole, and extending from southern Maine to the south side of Cape Cod, to be a northern geographical race of D. candidum Savigny, 1816. This may prove erroneous (see Millar, 1962. Studies Fauna Curaçao ... 8: pp. 62-66), but the familiar name D. candidum is retained until further investigation shows the necessity of a change.

Order Phlebobranchia

Family Cionidae

Ciona intestinalis (Linnaeus, 1767). One of larger ascidians of the United States, and one of the best known and most widely distributed of all ascidians. Greenland to Rhode Island. Oviparous.

Family Perophoridae

Perophora viridis Verrill, 1871. Although small, its transparent test makes it favorable for observation of heartbeat, etc. Southern Cape Cod to southern Florida. "Sea grape"; viviparous.

Order Stolidobranchia

Family Botryllidae

Botryllus schlosseri (Pallas, 1766). Very common; colonies most often found encrusting in variety of colors on hydroid stems and eel grass leaves. Portland, Maine to West Coast of Florida; viviparous.

Family Styelidae

Styela partita (Stimpson, 1852). Formerly well known as Cynthia partita; the eggs are classical embryological material. Common on wharf pilings, often with other ascidians, from Massachusetts Bay to West Coast of Florida. "Sea peach" (note that the name "sea peach" is also used for the long-stalked ascidian Boltenia, often cast up on beaches north of Cape Cod, and the large solitary Halocynthia aurantium of more northerly waters).

Dendrodoa (Styelopsis) carnea (Agassiz, 1850). Pinkish to bright red body spreads out on surfaces of stones, dead mussel shells, etc., to which animal is attached. Newfoundland to Long Island Sound. Viviparous.

Family Molgulidae

Bostrichobranchus pilularis (Verrill, 1871). Size and transparency of test depend on environment. Found on or in mud or sand from one meter to greater depths. Tadpole larvae not formed. St. Lawrence River to Florida.

Mogula arenata Stimpson, 1852. Commonly unattached; buried; regular, symmetrically circular in profile (except between siphons), disk-like when viewed from above and generally covered with coat of sand grains. South Shore of Cape Cod to Cape May, New Jersey. Tadpole larvae not formed. Oviparous.

Molgula citrina Alder and Hancock, 1848. Usually attached to hard objects or pilings; vary greatly in appearance and shape; are transluscent dull olive. Gulf of St. Lawrence to Narragansett Bay, Rhode Island. Viviparous.

Molgula complanata Alder and Hancock, 1870. Unusually long synonymy (see Van Name); sand and shell encrusted and more or less globular body attached by slender fibrous processes to stones, shells or hard sand from low water to about 300 fathoms. Gulf of St. Lawrence to Martha's Vineyard. Viviparous.

Molgula manhattensis (DeKay, 1843). Commonest ascidian of this area. Nearly globular body with test irregularly hirsute and usually papillated near siphons; attached to others of same species in large groups or to wharves, pilings, ship bottoms, eel-grass in shallow, polluted, brackish or ordinary sea water. Portland, Me. to N. E. Texas (southern Florida?) Oviparous with larvae developing outside of body of parent.

Molgula robusta (Van Name, 1912). Not in key. Differs from M. manhattensis in a) lacking free-swimming larval stage, b) larger average size, c) living at 17-25 meters on compacted mud-sand bottoms in areas of tidal currents, unattached and usually on left side, d) long pointed teeth on margin of posterior part of dorsal lamina, and e) reddish purple eggs. Woods Hole Harbor and Vineyard Sound. Oviparous.

REFERENCES

Berrill, N. J. 1936. Studies in tunicate development. Part V. The evolution and classification of ascidians. Phil. Trans. Roy. Soc., London Ser. B., Vol. 226: 43.

Berrill, N. J. 1950. The Tunicata. London, Ray Society, 354 pp.

Grassé, P. P., Ed. 1948. Traité de Zoologie. Tome XI. Échinoderms, Stomocordés, Procordés. pp. 895-919.

Van Name, W. G. 1945. The North and South American Ascidians. Bull. Amer. Mus. Nat. Hist. 84: pp. 1-476, pl. 1-31.

GLOSSARY OF THE COMMON AND NON-SCIENTIFIC NAMES USED IN THE WOODS HOLE REGION

Among non-scientific or "common" names of invertebrates, a relatively small number are truly vernacular, that is, firmly established in the speech of the region and generally known to natives. Some true vernacular names as "horseshoe crab" and "quohog" may actually be more stable than scientific names, and are quite specific. But other vernacular terms such as "rock crab" or "barnacle" lack precision because each applies to more than one species in the region, not distinguishable by the layman, or because even if only one species is indicated in a particular region, the same name is used for other species elsewhere. Many so-called common names are not vernacular, but may represent anglicized versions of scientific names --- thus we speak of "an ameba", "a hydra", "planarians", or "isopods"; such names are generally learned in school and are better known to the scientific than to the general public. They are useful, but not in referring to particular species. Then there are the sometimes barbarous renditions from scientific specific names, such as "Morton's egg cockle" for "*Laevicardium mortoni*". Names of this sort are characteristic among groups of animals widely studied by amateurs. In the case of birds and fishes, such names have become fairly well standardized. Among invertebrates, such are most commonly used for shell bearing molluscs, and since Abbott's "American Seashells" and similar works provide easy reference, we have included few names of this sort.

The use of synthetic "common" names does nothing to aid the beginning student and is to be discouraged in scientific writing. Likewise, the use of non-specific vernacular names, unless accompanied by the proper scientific name, can lead to great confusion in the literature and should especially be avoided by comparative physiologists and ecologists. Far better to use an "old" but unmistakable scientific name like *Nassa obsoleta*, *Nereis limbata*, or *Mactra solidissima* than a meaningless vernacular term such as "the clam", "the rock crab", or "the sand worm".

In the following glossary, we have attempted to include the common vernacular names characteristic of southern New England, as well as names which have been imported and have taken root among the Woods Hole scientific community. We make no claims of completeness, and would appreciate criticisms. For the great majority of invertebrates, there are no common names, vernacular or otherwise.

"Common name"	Scientific approximation
Acorn barnacles	*Balanus*, *Chthamalus*
Acorn worms	Hemichordata
Bamboo worms	*Clymenella*, Maldanidae
Barnacles	Cirripedia (shelled types)
Beach fleas, hoppers	Amphipoda (various species, esp. of family Talitridae)
Bearded sponges	*Microciona prolifera*
Big fiddler crabs	*Uca minax*
Black fiddler crabs	*Uca pugnax*
Black quohogs	*Arctica islandica*
Blood clams	*Anadara* (various species)
Blood stars	*Henricia sanguinolenta*
Blood worms	*Glycera*
Blue crabs	*Callinectes sapidus*
Boring sponges	*Cliona* (several species)
Bread sponges	*Halichondria*
Brittle stars	Ophiuroidea
Broken back shrimp	*Hippolyte*
Bubble shells	*Haminoea*, etc.
Calico-back fiddler crabs	*Uca pugilator*
Channeled whelks	*Busycon canaliculatum*
Cherrystone clams	young *Mercenaria*
Chitons	Polyplacophora (Amphineura)
Clams	Various Bivalvia (Mollusca) not including the generally recognized mussels, scallops, oysters, etc.
Clam worms	*Nereis*
Columbus's crabs	*Planes minutus*
Comb jellies	Ctenophora
Corals	Madreporaria and some other colonial Anthozoa
Dead-man's fingers	*Alcyonium carneum*
Dog whelks	*Thais lapillus*
Edible mussels	*Mytilus edulis*
Eel grass	*Zostera*
Feather-duster worms	Sabellidae

Fiddler crabs . . . . Uca (3 species)
Finger sponges . . . . . Haliclona oculata
Fish lice . . . . . .Branchiura (Argulus)
Flatworms . . . . Platyhelminthes
Goose barnacles . Lepas (several species)
Grass shrimp . . . . Hippolyte
Green crabs . . . . Carcinus maenas
Green sea urchins
. . . . Strongylocentrotus drobachiensis
Gribbles . . . . Limnoria
Gulf weed . . . . Sargassum
Gulf weed crabs . . . . . . Planes minutus
Hard-shelled clams . . . . Mercenaria
Hermit crabs . . . . Pagurus
Horse conchs . . . . Busycon
Horsehair-snakes . . . . Gordiacea
Horseshoe crabs . . . Limulus polyphemus
Horse mussels . . . . . Modiolus modiolus
Hydra-worms . . . . young of Nicolea
Jack-knife clams . . . . Siliqua, Tagelus
Jellyfishes . Hydromedusae, Scyphomedusae
. . . . Ctenophora
King crabs (British usage) . . . . Limulus
Knobbed whelks . . . . . . Busycon carica
Lady crabs . . . . Ovalipes
Leathery tunicates . . . . Styela
Leeches . . . . Hirudinea
Little-necked clams . . . . . Mercenaria
Limpets . . . . Acmaea testudinalis
Lion's mane (jellyfish) . . . . . Cyanea
Lobsters . . . . Homarus
Long-finned squid . . . . . Loligo pealei
Long-necked clams . . . . . Mya arenaria
Lug worms . . . . . Arenicola (3 species)
Mantis shrimp . Hoplocarida or Stomatopoda
Mermaid's toenail . . . . Anomia
Mites (marine) . . . . Halacaridae
Moon shells Lunatia, Natica,
. . . . Neverita, Polinices
Moss animals Bryozoa (Entoprocta and
. . . . .Ectoprocta)
Mud crabs . . . . Xanthidae
Mud shrimp . . . . . Callianassa, Upogebia
Mud snails . . . . . . Nassarius obsoletus
Mussels . . . . Mytilus, Modiolus
Nassa . . . . Nassarius (several species)
Northern corals . . . . . Astrangia danae
Northern squid . . . . . Ilex illacebrosus
Opossum shrimp . . . . Mysidacea
Oysters . . . . Crassostrea
Oyster crabs . . . . Pinnotheres
Oyster drills . . . . Urosalpinx
Pea crabs . . . . Pinnotheres
Periwinkles . . . . Littorina (3 species)
Portuguese Man-of-War . . . . . Physalia
Prawns . . . . Palaemonetes, etc.
Purple sea urchins . . Arbacia punctulata
Quahogs, quohogs . . . . Mercenaria
Rag worms . . . Nereis (several species)
Razor clams . . . . Ensis
Red-jointed fiddler crabs . Uca minax
Red sponges . . Microciona prolifera
Ribbed mussels . . . Modiolus demissus
Ribbon worms . . . . Nemertea
Rock crabs . . . . Cancer (2 species)
Rock slaters . . . . Ligia
Sand crabs . . . . . Emerita talpoida
Sand dollars . . Echinarachnius parma
Sand moles . . . . . Emerita talpoida
Sand shrimp . . . . Crangon
Scale worms . Polynoidae, Sigalionidae
Scallops . . . . . Aequipecten, Pecten
Scud . . various gammarid Amphipoda
Sea anemones . . . . Actinaria
Sea clams . . . . Spisula solidissima
Sea cucumbers Holothuroidea
Sea egg . . . sea urchins especially
. . Strongylocentrotus drobachiensis
Sea float . . . . . . Velella mutica
Sea gooseberry . . . . . Pleurobrachia
Sea lettuce . . . . Ulva
Sea mice . . . . Aphroditidae
Sea peach . . . . . Boltenia, Styela
Sea pens . . . . Pennatulacea
Sea pork . . . . Amaroucium
Sea slugs . . . (mostly) Nudibranchia
Sea squirts . . . Ascidiacea, Tunicata
Sea stars . . . . Asteroidea
Sea urchins . . (regular) Echinoidea
Sea walnut . . . . Pleurobrachia
Shipworms . . . . Teredo, Bankia
Short-finned squid . Ilex illacebrosus
Skeleton shrimp . . . . . . Caprellidae
Soft corals . . . Alcyonium carneum,
Alcyonaria
Soft-shelled clams . . . Mya arenaria
Soft-shelled crabs
. . . post-moult Callinectes sapidus
Spider crabs . . Libinia (2 species),
Pelia
Sponges . . . . Porifera
Square-backed
fiddler crab . Sesarma reticulatum
Squid, common . . . . . . Loligo pealei
Starfishes . . . . Asteroidea
Stony or true coral . Astrangia danae,
Madreporaria
Striped anemones . Haliplanella luciae
Sulfur sponges . . . . Cliona
Summer squid . . . . Ilex illacebrosus
Surf clams . . . . Spisula solidissima
Tube-worms . . . . . . various sedentary
Polychaeta
Whale lice . . . Cyamidae (Caprellidae)
Whelks . . . . Thais, Busycon
White shrimp . . Callianassa stimpsoni
Winkles . . . . Littorina (3 species)

SYSTEMATIC INDEX

The following index is to genera and higher taxa mentioned in this manual. In general, older synonyms have not been included except for those of experimental animals that have been extensively used at Woods Hole in previous years, and which are widespread in the literature. Specific names of animals, names of plants, localities, authors, and anatomical terms have not been indexed. Underlined page numbers indicate illustrations. For vernacular and non-scientific names, see the glossary starting on page 200.