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) . . . . . Bicellariella

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) . . . . . Dendrobeania

20. Base of zooecium strongly forked at its place of origin dorsally and proximally. Zoarium biserial to narrowly multiserial (figs. 17, 18) . . . . . Bugula

Two species are common at Woods Hole:
(1) Bugula simplex (fig. 17), formerly called B. flabellata, tan in color with flattened, somewhat fan-like fronds. Common in such protected places as the Eel Pond.
(2) Bugula turrita (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 . . . . . Cribrilina

(1) Cribrilina annulata (fig. 28): Frontal costae and rows of pores regular and distinct; avicularia absent; ooecia small.
(2) Cribrilina punctata (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 . . . . . Electra

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) . . . . . Membranipora group

The genus Membranipora is a temporary "dumping genus" for hard-to-identify "open-faced" species. Species are shifted from it and its daughter genera Conopeum, Acanthodesia, 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.

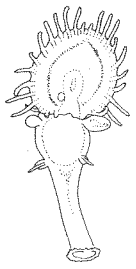
10. Single polypide of Bowerbankia imbricata with tentacles extended; note setigerous collar directly below the tentacles, here constricting the tentacle sheath.

11. Amathia vidovici; note close-set spiral bands of zoids.

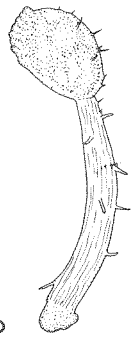
12. Nolella blakei, retracted individual, very young, with squared orifice.

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.

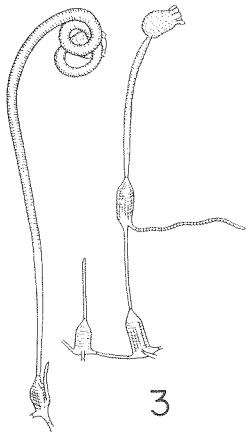
Plate 23



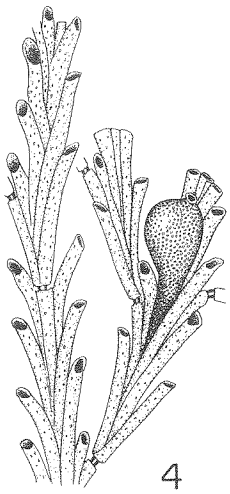
1



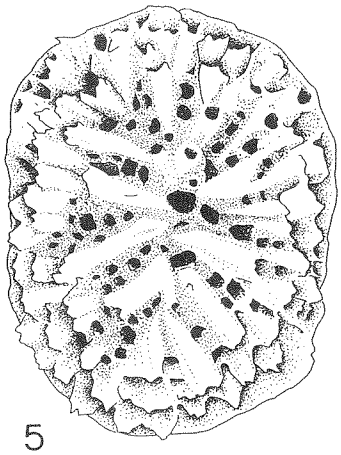
2



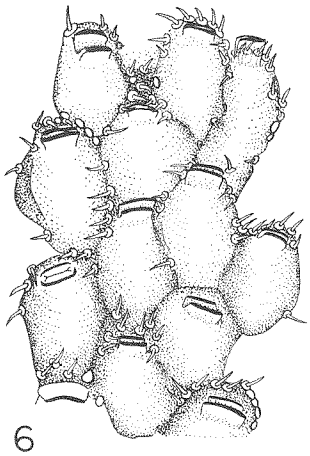
3



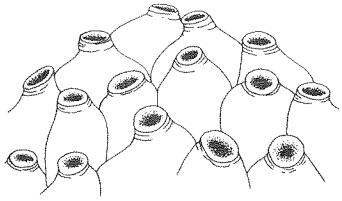
4



5

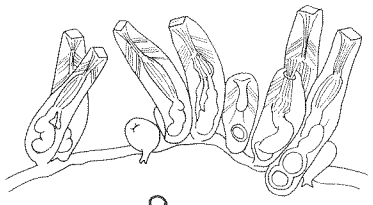


6

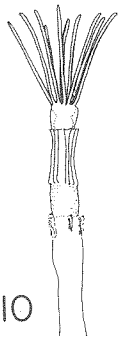


7

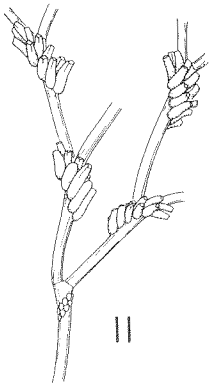
8



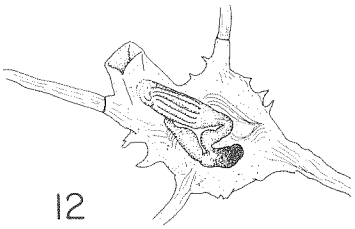
9



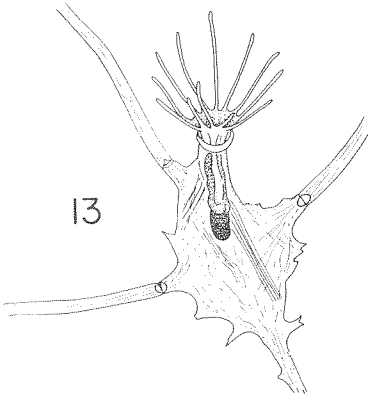
10



11



12



13

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

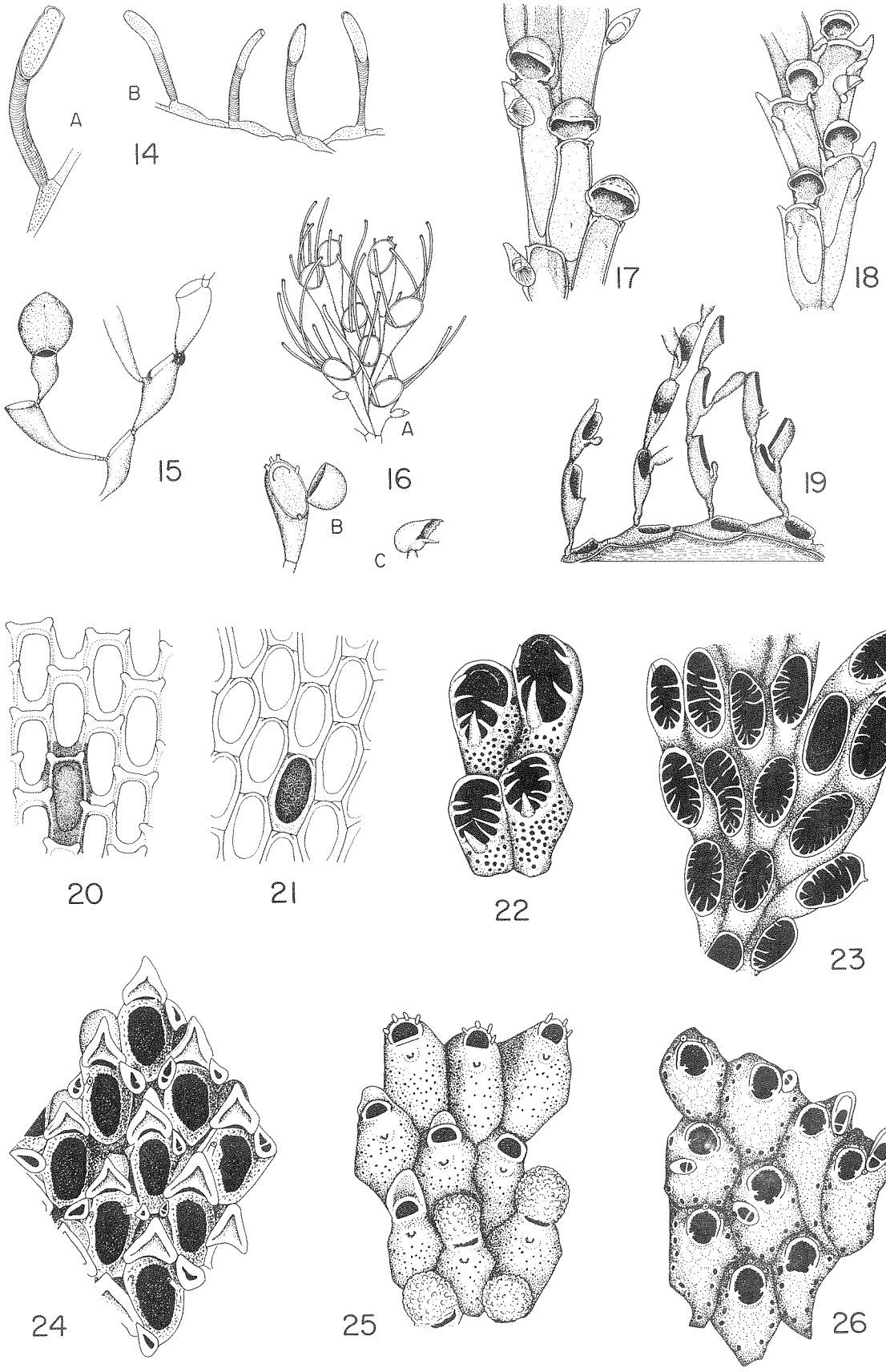


Plate 25

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.

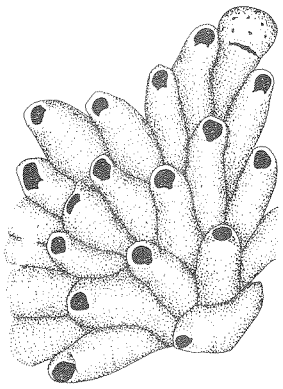
33. Schizoporella unicornis, zooecia with ovicells.

34. Schizoporella biaperta, heavily calcified portion of colony; note avicularia close to orifices.

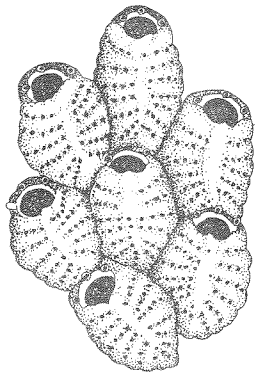
35. Schizoporella biaperta, portion of less heavily calcified colony, without ovicells.

36. Cellepora dichotoma, portion of colony, with ovicells. Note avicularium borne on umbo on front of each zooecium.

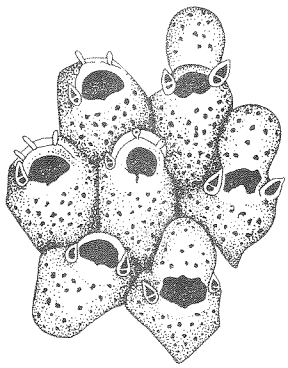
Plate 25



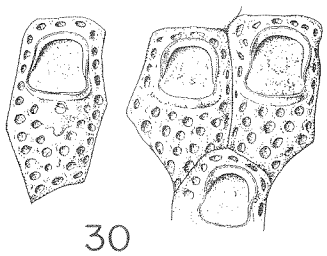
27



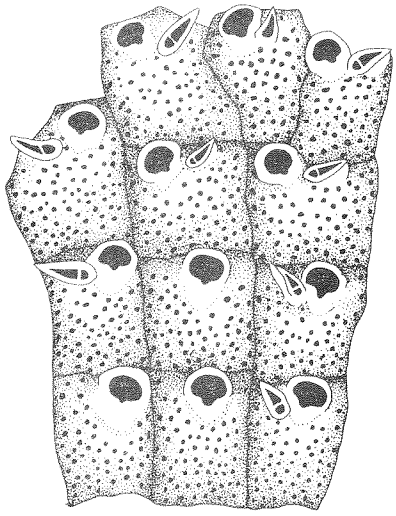
28



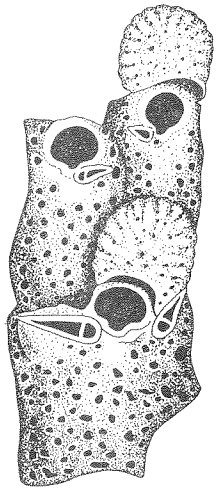
29



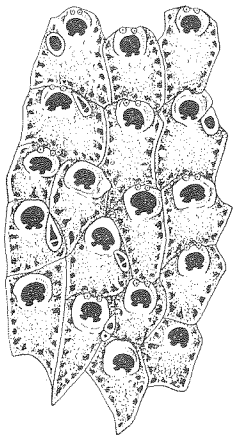
30



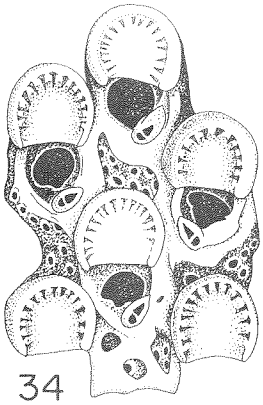
32



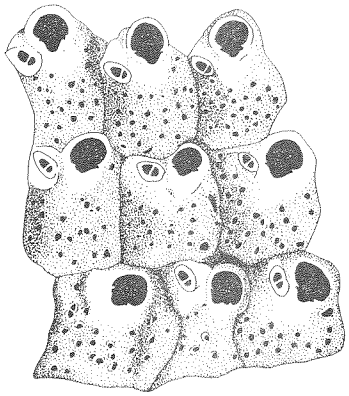
33



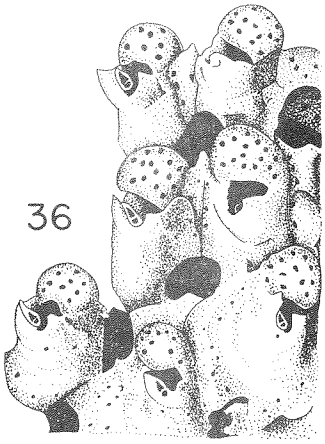
31



34



35



36

Plate 26

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 non-porous 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