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BRYOZOA OF THE PACIFIC COAST OF AMERICA

Part 3, Cyclostomata, Ctenostomata, Entoprocta, and Addenda

(Plates 65-82)

BY

RAYMOND C. OSBURN, Ph.D., D.Sc.

THE UNIVERSITY OF SOUTHERN CALIFORNIA PRESS

REPORTS ON THE COLLECTIONS OBTAINED BY ALLAN HANCOCK PACIFIC EXPEDITIONS OF VELERO III OFF THE COAST OF MEXICO, CENTRAL AMERICA, SOUTH AMERICA, AND GALAPAGOS ISLANDS IN 1932, IN 1933, IN 1934, IN 1935, IN 1936, IN 1937, IN 1938, IN 1939, IN 1940, AND IN 1941, AND VELERO IV IN 1949-1952 OFF THE COAST OF MEXICO AND SOUTHERN CALIFORNIA.

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Plates 65 - 82

A report based chiefly on the Bryozoa collected by the Allan Hancock Expeditions, 1932-1941, in the *Velero III* (see pages 1-2 of Part I) and in the *Velero IV* in 1949-1952.

Additional material received from several sources has greatly enlarged the scope of this study. Especially should be mentioned contributions from the U. S. National Museum, the collections of the Alaska Crab Investigations from southern Alaska, and those from the Point Barrow, Alaska, Arctic Research Laboratory. Also practically every museum and marine laboratory on the Pacific coast of the United States and Canada has contributed some specimens of interest in this extensive survey.

Order Cyclostomata Busk, 1852

Busk in 1852 proposed the name Cyclostomata for this group of Bryozoa, since which time until rather recently it has generally been considered a suborder of the order Ectoprocta. In 1926 Borg pointed out striking anatomical differences between the Cyclostomata and the Cheilostomata-Ctenostomata and gave the former ordinal status under the name Stenolaemata. At the same time Borg (1926:490) included in the Stenolaemata the old fossil order Trepostomata of Ulrich, but did "not wish to give any decided opinion on this point." Later (1944:18-19) Borg definitely made the Trepostomata a suborder of the Stenolaemata, parallel with the Cyclostomata, and included in it the Horneras, Heteropores, Lichenopores and their allies.

While it is now generally recognized that the cyclostomes are sufficiently different from other bryozoans to warrant their separation in a distinct order, the merging of the Trepostomata with this order and the inclusion of the Horneras, Heteropores and Lichenopores in the Trepostomata has not been accepted. The Trepostomes are all Palaeozoic and do not occur above the level of the Permian.

If the Trepostomata are not to be included in the same order with the Cyclostomata, there appears to be no good reason for the use of the new name Stenolaemata and, at least until there is substantial confirmatory evidence on this question, I prefer to continue the use of "Order Cyclostomata." Marcus (1941:12) suggested the name Stenostomata to replace Cyclostomata, which has been used also for a group of vertebrates, but since the rules of priority are not concerned with ordinal names, there seems to be no very good reason for substituting a new term for one which has been well-known and acceptable to zoologists for a century.

Borg's separation of the Cyclostomata (1944:20) into five divisions, based on anatomical studies, follows closely that of older authors and is logical and well-founded, but he seemed to think it necessary to set up a whole new series of divisional names. Since it appears that Borg simply confirmed, by added histological evidence, the distinctions already made in the past, there seems to be no necessity for the discarding of well-known terms and the coinage of a new series of divisional names.

The following table gives a brief digest of the essential characters of the five divisions of the Cyclostomata under the old established names, with those of Borg in parenthesis, to indicate the synonymy.

1. Zoarium adnate, suberect or erect, never jointed, the first few tubules, at least, always adnate. Wall of the zoarium simple; the ovicell a gonozoid varying from simple to broadly expanded and often lobate, its polypide degenerating after first reaching maturity. Tubuliporidae, etc. (Acamptostega Borg, 1926).

   Tubuliporina Hagenow, 1851. 67

2. Zoarium slender, erect from the first zoid, always jointed, branched, rhizoids present. Wall of the zoarium simple; gonozoid simple (somewhat expanded in *Crisulipora*), its polypide degenerating before reaching maturity. Crisiidae. (Camptostega Borg, 1926). 674

   Articulata Busk, 1859.

3. Zoarium erect from the beginning, branched tree-like or wine-glass shaped, never jointed. Wall of zoarium double, increasing in thickness throughout life; gonozoid strongly dilated and usually situated more or less on the dorsal side. Horneridae, etc. (Pachystega Borg, 1926).

   Cancellata Gregory, 1896. 687

4. Zoarium usually erect, sometimes adnate, often cylindrical and branching, composed of autozoids and kenozoids with the apertures of both at the surface. Wall double; brood chamber zoarial formed by the

absorption of kenozoids around a fertile zoid. Heteroporidae, etc. (Heteroporina Borg, 1944).

Cerioporina Hagenow, 1851. 692

5. Zoarium adnate or short stipitate, discoid or semiglobular, sometimes complex by the formation of subcolonies; zoids radiating in all directions from the center and separated by alveoli (cancelli). Brood-chamber zoarial by the fusion of alveoli around a fertile zoid. Lichenoporidae. (Calyptrostega Borg, 1926).

Rectangulata Waters, 1887. 699

In this order the older workers based their descriptions and classification almost solely on zoarial characters, and even Hincks in the 1880s paid little attention to the ovicells. Waters insisted on the importance of the reproductive characters and Harmer, Calvet, Canu and Bassler, Marcus, Borg, Silen and others, including the writer, have accepted this point of view.

The difficulty with zoarial characters is their variability, depending partly on their adaptation to the substratum and other features of the environment, and partly on the stage of growth. In the Crisiidae, the younger stages are so much alike that, in the absence of ovicells, the determination of the species is often impossible.

In the encrusting species the nature of the substratum may determine the size and form of the zoaria, and the environment often modifies the appearance of erect species. Among the Tubuliporidae, encrusting species are usually flat and regular on flat surfaces, but when the same species develops on a small stem the zoarium may be variously contorted. In deeper, quiet water, erect species are usually more slender and more elongate, sometimes giving quite a different zoarial appearance from the same species in the surf area along shore. In protected areas the peristomes are usually much more elongate, and in crowded areas or on rough surfaces the zoaria may be much reduced in size. Numerous "species" have been described on such differences.

By far the most constant characters in this order are found in the ovicells or brood-chambers, either zoidal or zoarial. In the Heteroporidae and Lichenoporidae the brood-chambers are interzoidal or zoarial spaces surrounding a gonozoid and their position in the zoarium and the gonopores and their tubes (ooeciostomes) are fairly constant. In all the others the ovicell is an expanded gonozoid, sometimes only slightly enlarged, or again it may be greatly expanded over a considerable portion of the zoarial surface and may surround some of the autozoid tubules. There may be marked variation in the size and form of these ovicells,

even on different parts of the same colony, but the position and form of the gonopores (ooeciopores) and their tubes (ooeciostomes) are again fairly constant. With most of the species of this order these reproductive organs are essential for exact determination, and even here a certain amount of caution is necessary.

The order is ancient, dating back at least to the Ordovician, and the number of fossil species that have been described far outnumbers those that exist today. How many of these, both fossil and recent, may eventually go into synonymy, no one can even guess, but undoubtedly a very large number of them, described from fragments, young colonies, or without ovicells, may eventually be properly placed.

Glossary

A few terms which are not included in preceding glossaries, or which have a different use in the Cyclostomata.

Alveoli. Pores of various sizes distributed between the zoids (see cancelli).

Autozoid. The functional nutritive individuals of the colony.

Basis rami. A small wedge-shaped base of a branch, characteristic of the crisias.

Brood-chamber. A cavity, usually large, surrounding a gonozoid which opens into it (not an expansion of a gonozoid).

Cancelli. See alveoli.

Capitulum. An expanded "head" at the tip of an erect branch, usually with an ovicell or brood-chamber.

Disc. The frontal area of a zoarium in the lichenopores; in complex colonies there are often numerous discs.

Fascicle. A series or bundle of connate tubules or peristomes.

Gonozoid. A reproductive individual, often greatly expanded to harbor the developing larvae.

Kenozoid. Various types of greatly modified individuals without polypides, which serve other purposes in the colony, e. g., the joints of radicles in the crisias, and the alveoli (cancelli) in the heteropores and lichenopores.

Nannozoid. A much reduced individual similar in appearance to an autozoid.

Ooeciopore. The aperture of an ovicell.

Ooeciostome. The tube surrounding an ooeciopore, the morphological end of a gonozoid (ovicell).

Pellicle. A thin calcareous layer.

Proancestrula. A rounded knob formed by the metamorphosis of the larva, which buds off the first tubule of a colony.

Peristome. The projecting end of a tubule (autozoid). Not homologous with the peristome of Cheilostomata.

Radicle. Root-like or pedunculate structure for attachment.

Radii. Radiating series of tubules, especially in lichenopores.

Rhizoid. See radicle.

Subcolony. Branches or areas similar to the primary zoarium produced by budding of the zoarium, often very numerous in the lichenopores.

Tubule. The main part of a zooecium which contains the polypide, usually embedded and ending in a "peristome."

Zoid. A functional nutritive individual.

Division I. **Tubuliporina** Hagenow, 1851
(Acamptostega Borg, 1926)

This group appears to be the most primitive among recent Bryozoa, as noted by various authors. The zoarium, whether it remains adnate or becomes erect, is always adnate at first, the first tubule arising laterally without a joint from the ancestral disc and attached for most of its length; and at least a few daughter tubules have this position. The resulting zoaria may take almost any form, uniserial or broadly flabellate, flat or contorted, semierect or erect, and sometimes profusely branched. The apertures are always on the frontal side, with the exception of the Entalophoridae, where they are distributed evenly around the erect stem. The ovicells vary from simple pyriform expansions of the middle portion of the gonozoid to very broad, sometimes lobate, expansions which may cover considerable areas of the zoarium; and frequently they surround and enclose the erect portions of neighboring tubules. In *Entalophora* and *Fasciculipora* the ovicells are narrow and greatly elongated.

Key to the Families of Tubuliporina

1. Zoaria adnate or more or less erect, the apertures opening only on the frontal side 2

   Zoaria erect, the zooecial tubes forming cylindrical stems with the apertures opening on all sides . . . . . *Entalophoridae* 166

2. Zoaria adnate, linear or flabellate, ovicells simple 3
   Zoaria adnate or erect, usually flabellate but sometimes with narrow, erect branches; ovicells expanded 4
3. Tubules not seriated nor fasciculate; ovicells slender-pyriform or only slightly expanded . . . . . *Oncousoeciidae* 616
   Tubules single or in small erect fascicles; ovicell short, between fascicles . . . . . *Frondiporidae*
4. Zoaria usually adnate and flabellate, but may be erect and branched; tubules not fasciculate; ovicells expanded laterally, ooeciostome terminal or central . . . . . *Diastoporidae* 627
   Zoaria adnate, with few exceptions, the tubules usually fasciculate or in series; ovicell usually ramifying among the tubules, sometimes more simple . . . . . *Tubuliporidae* 647

Family **Oncousoeciidae** Canu, 1918

"The axis of the ovicell is parallel to that of the tubes. The ovicell is developed at the same time as the adjacent tubes which are not disarranged in their respective positions." (Canu and Bassler, 1920:687).

The ovicell is a simple inflation of the gonozoid, with a terminal or sub-terminal ooeciostome, and is often as primitive as that in the genus *Crisia*. The development of the ovicell has some influence on that of the adjoining tubes, separating them to some extent, and, in the linear species, the tubules at the sides of the ovicell may be increased in number.

Only three genera with recent representatives concern us here, viz.:

1. *Stomatopora*. Zoarium uniserial throughout, except around the ovicell which has tubes on both sides, no doubt for additional nourishment of the developing larvae.
2. *Proboscina*. Zoarium uniserial for only a short distance at the proximal end, then becoming biserial or with additional tubes over most of the length of the linear lobes.
3. *Oncousoecia*. Zoarium rounded, flabellate or with flabellate lobes; the ovicells either narrow or sometimes slightly lobed.

It is evident that this separation is largely based on zoarial characters but the groups present rather distinct facies and it is convenient to treat them separately. In *Oncousoecia* the ovicells are more embedded between the adjacent tubules than in the other genera, where they are usually ventricose. In all cases the ooeciopore is terminal or nearly so.

Genus STOMATOPORA Bronn, 1825

Alecto Lamouroux, 1821, preoccupied.

This genus was described and has generally been considered as uniserial, adnate and branching. Some authors have introduced into it various linear adnate branching species with a biserial or multiserial zoarium, which preferably belong elsewhere. The only part of the *Stomatopora* which is biserial is the expansion about the ovicell. Genotype, *Alecto dichotoma* Lamouroux, 1821.

There has been no description of the ovicells until recently, but Borg, 1926:358, has discovered them in *S. eburnea* (d'Orbigny) and *S. granulata* (Milne-Edwards). They are very simple in nature, differing but little from those of *Crisia* except that they are more or less embedded.

It is true that the zoarium of species of the Tubuliporidae *(sens lat.)* originates in a single zooecium and sometimes the uniserial condition is continued for several generations of zooecia before the biserial or multiserial condition is developed. While the generic distinction is not too sharply defined, it seems better to retain *Stomatopora* for the strictly uniserial species.

The three genera, *Stomatopora, Proboscina* and *Oncousoecia* have so much in common, especially in the nature of the ovicells, that sharp distinctions are difficult. For the purposes of the present treatise they will be considered as genera on the following zoarial basis:

Stomatopora, uniserial, except immediately around the ovicell, which is simple, inflated, and may be slightly lobate, the ooeciostome terminal.

Proboscina, biserial, or the linear branches may have several rows of tubules, the ovicell simple, inflated, sometimes slightly lobate, the ooeciostome terminal or nearly so.

Oncousoecia, broadly multiserial, the zoarium rounded or with fan-shaped lobes, the ovicell simple or slightly lobate, more depressed between the adjoining tubules, the ooeciostome terminal.

Stomatopora granulata (Milne-Edwards), 1836

Plate 65, figs. 1 and 2

Alecto granulata Milne-Edwards, 1838:205.
Alecto granulata, Busk, 1875:24.
Stomatopora granulata, Hincks, 1880:425.
Stomatopora granulata, O'Donoghue, 1923:11; 1926:17.
Stomatopora granulata, Borg, 1926:359.
Stomatopora granulata, Sakakura, 1935:37.

The zoarium is adnate, uniserial except around the ovicell which has a series of tubules on each side of it, branching more or less at right angles. The branches are straight or curved, anastomosing when they come into contact. The peristomes curve up from the adnate tubules, becoming more or less erect, the diameter at the tip 0.15 to 0.18 mm, that of the aperture 0.12 to 0.14 mm; the base of the peristome somewhat broader according to the amount of calcification. The distance from one peristome to the next varies greatly, usually 0.40 to 0.50 mm, but may be as much as 1.0 mm. The tips of younger peristomes are finely reticulate; in older parts the peristomes and adnate tubules are irregularly roughened.

The ovicell, first described and figured by Borg (1926:359), is simple, the proximal end narrow, irregularly pyriform with small lobes extending between the peristomes at the sides. The ooeciostome is an erected tube, shorter than a peristome, its tip free and the aperture circular. In young ovicells the pore is a semicircular slit at the base of the peristome.

It appears to be a widely distributed species in the northern hemisphere, reported from the coasts of Europe from Norway to the Mediterranean Sea; Cape Verde Islands (Norman); British Columbia (O'Donoghue); Japan (Sakakura); and Waters listed it as a fossil from New Zealand.

Hancock Station 1316-41, off Santa Catalina Island, 45 fms; and off San Pedro, southern California, on shells.

Genus **PROBOSCINA** Audouin, 1826

Peristomoecia Canu and Bassler, 1920:692.

"The zoarium consists of multiserial elongate bands, which are simple or branched, and are always flat and adnate. The zooecia are cylindrical and narrow. The peristomes are flush with the surface of the zoarium, or slightly raised; and they are usually distributed irregularly, but are occasionally quincuncial or in transverse linear series." (Canu and Bassler, 1920:658.) Genotype, *Proboscina Boryi* Audouin, 1826:236.

This genus differs but little from *Stomatopora* except in biserial-multiserial disposition of the zooecial tubules. It is true that the zoarium begins with a single series of tubules, but this soon becomes expanded into two or more series, while in *Stomatopora* the expansion is limited to the area immediately around the ovicell. The mode of branching is much the same except that in *Proboscina* the origin of the branch is usually at least biserial while in *Stomatopora* only a single tubule is involved.

Again there is but little difference in the nature of the ovicells. The fertile zooecium arises like any other tubule and is narrow at its proximal end, broadens to various degrees in the different species, and terminates in a slightly elevated and more or less terminal ooeciostome. The terminal expansion of the gonozoid misled Canu and Bassler into believing that the enlargement was a part of the peristome, and on this basis they created a genus *Peristomoecia* which has since been discarded.

The genus also has a close relationship to *Oncousoecia* Canu and Bassler *(q. v.),* which similarly has simple ovicells of much the same nature, but has a flabellate zoarium.

Whatever may be the ultimate disposition of these three groups of species, it seems better for the present to allow them generic status—for convenience in classification if for no better reason!

Large numbers of "species" have been created on incomplete material, probably most often on immature specimens. It is practically useless to attempt to identify such specimens since only the mature ones with the characters of the ovicells show specific characters.

Proboscina major (Johnston), 1847

Plate 65, fig. 5

Alecto major Johnston, 1847:281.
Alecto major, Busk, 1875:24.
Stomatopora major, Hincks, 1880:427; 1884:204.
Stomatopora major, O'Donoghue, 1923:11.
Diaperoecia major, O'Donoghue, 1926:23.
Oncousoecia major, Canu and Bassler, 1930:46.

The zoarium is adnate, strap-shaped, the branches narrow and widening slightly, sometimes a little elevated at the tips on rough substrata. Zooecia in two to four series, the tubules distinct with well-marked grooves, and sometimes in more or less transverse rows; the peristomes moderately high, free, with round apertures. The diameter of the aperture varies greatly, from 0.14 to 0.20 mm and the peristome likewise from 0.20 to 0.26 mm on the same colony.

The ovicells are located near the ends of the branches or just proximal to a bifurcation. The narrow proximal end is comparatively short; the middle portion expanded and rather bulbous; the ooeciostome subterminal, erect, rather short, smaller than the peristome, its aperture about 0.12 mm in diameter. Usually the inflated area is simple in form, but it may be slightly lobed between the surrounding zooecial peristomes, and occasionally a peristome may be surrounded.

It is a widely distributed species in the northern hemisphere, in European waters from Norway to the Mediterranean Sea and the Cape Verde Islands, and in the Pacific from British Columbia to the Galapagos Islands. As a fossil it is known as far back as the Miocene of Italy.

Hancock Stations: 155-34, 324-35 and 450, Albemarle Island, 45 to 70 fms; 183-34, between Albany and James Islands, 50 to 70 fms, and Barrington Island, 52 fms, Galapagos; 328, Cocos Island, Costa Rica, 14 fms; 1150-40, 1187-40 and 1316-41, Santa Catalina Island; 1064, Santa Barbara Island; and 1268-41, Anacapa Island, southern California. Also collected by Miss A. E. Blagg at Monterey Bay, California, and by Dr. John L. Mohr at the San Juan Islands, Puget Sound.

Proboscina sigmata new species

Plate 65, figs. 3 and 4

A very delicate species. The zoarium is encrusting and consists of linear biserial to quadriserial branches with very symmetrical sigmoid lateral curves; the curvature is evidently due neither to the substratum nor to lateral branching, as there is evidence of only one such branch on the outside of a curve. The dorsal side, which is not extended laterally, measures about 0.25 mm in width, and is only slightly wider in the region of the ovicells.

The zooecial tubules are narrow, slightly embedded, the separating grooves distinct. Their peristomes are thin, about 0.10 mm in diameter, very elongate, averaging about 0.65 mm in length but sometimes more than 1.0 mm, semi-erect, their walls thin and the aperture about 0.08 mm in diameter. There is a tendency for the peristomes to arise in alternate pairs; the bases of such a pair may be connate for a short distance but the tips are widely divergent.

The ovicell is an ellipsoid swelling, pointed at the base where it disappears among the tubules and narrowed more roundly at the distal end where it ends in the terminal ooeciopore, near the base of a peristome. In the two ovicells in my material there is no evidence of an ooeciostome, but this may be due to incomplete development. Length of ovicell 0.65 mm, width 0.33 mm.

Type, AHF no. 57.

Type locality, off Rocky Point, southern California, at 45 fms, on the surface of a sunken buoy, Earl Fox, collector, two small colonies, both in reproduction.

Proboscina incrassata (Smitt), 1866

Plate 66, figs. 1 and 2

Proboscina incrassata Smitt, 1866:402 and 458.
Tubulipora (Proboscina) incrassata Smitt, 1871:1119.
Alecto retiformis Hincks, 1871:81.
Stomatopora incrassata, Hincks, 1880:436.
Stomatopora incrassata, O'Donoghue, 1923:11.
Proboscina incrassata, O'Donoghue, 1926:17.

The zoarium is white, adnate, much branched, the branches short, anastomosing to form often a fairly close network; on the basal part the branches are usually two tubules in width, but at the distal ends they may be 4 to 6 tubules wide. The peristomes are very irregular in arrangement, single or 2 or 3 in a transverse line; sometimes a few are clustered but they are never connate except occasionally at the base; sometimes also these clusters are elevated into short fascicles, especially at the ends of branches. The peristomes are usually quite erect, 0.50 to 1.0 mm in height, 0.26 mm in diameter, and aperture about 0.20 mm.

The ovicells, which seem not to have been noticed previously, are simple ventricose expansions near the ends of branches and surrounded by a row of tubules on each side (occasionally a peristome may be enclosed in the expansion); the ooeciostome is a small erect tube much shorter than the peristomes, terminal or nearly so, usually connate with a peristome at its base but the tip always free, the aperture round and about 0.13 mm in diameter.

Described from Spitsbergen and recorded from Norway, Nova Zembla, Kara Sea, and the British Islands from Cornwall to Scotland and the Shetland Islands. On the Pacific coast O'Donoghue listed it for several localities in British Columbia. Point Barrow, Alaska, Arctic Research Laboratory, 328 feet, a common species, especially on stones, G. E. MacGinitie, collector.

Proboscina lamellifera Canu and Bassler, 1930

Plate 66, fig. 3

Proboscina lamellifera Canu and Bassler, 1930:46.

"The zoarium incrusts shells and is formed of sinuous branches joined together by a smooth calcareous lamella. The tubes are indistinct, short, seriated and terminated by a long peristome perpendicular to the zoarial plane. Measurements, — diameter of orifice, 0.12 mm; diameter of peristome, 0.16 mm; internal separation of tubes, 0.20 - 0.30 mm; width of branches 1.5 mm." (Canu and Bassler, 1930:46).

This short description by the above authors and their photographs of the species (Plate 11, figs. 1 and 2) are sufficient for identification, though they did not have the ovicell. In our specimens the lamella, while it extends somewhat from the borders, does not come anywhere near connecting them. This may be due to the fact that our colonies are much smaller and probably younger.

Four ovicells are present in our specimens. They are small, short and very bulbous, raised as high as the peristomes surrounding them, thick-walled and shining; the ooeciostome is a short, round tube, its diameter nearly that of the peristomes, and terminal, which, in this case, is nearly on the top of the semiglobular ovicell. One of the ovicells is slightly enlarged and its border encloses two peristomes.

Described from Albatross Station D. 2813, Galapagos Islands.

Hancock Stations: 143-34, off Wenman Island, 1°23′10″N, 91°48′45″W, at 100-150 fms; 155-34, off Tagus Cove, Albemarle Island, 0°16′45″S, 91°22′52″W, at 50-60 fms; and 453, Gardner Island, 35 fms, Galapagos Islands.

Genus **ONCOUSOECIA** Canu, 1918

The zoarium is adnate, broadly multiserial, rounded or with flabellate lobes; the zooecial tubes are long, distinct on the surface, quincuncially arranged, the peristomes short and more or less erect. The ovicell is simple, often differing only slightly from the zooecial tubules, the proximal end embedded between the neighboring tubules, distally expanding gradually between the adjacent tubules and sometimes extending laterally above them for a short distance. The ooeciostome is terminal, not associated with a peristome, usually short, erect, smaller than the peristomes, round, and not expanded at the tip.

The genotype is *Alecto dilatans* Thompson (Johnston, 1847:281), and not *Tubulipora lobulata* Hincks, 1880, as indicated by Canu, 1918: 325. Hincks confused two species in his Plate 61, and the figure 5, from which Canu evidently drew his description, is that of *Alecto dilatans* Thompson. (For details see Osburn, 1933:9-12).

Oncousoecia diastoporides (Norman), 1868

Plate 66, fig. 4

Alecto diastoporides Norman, 1868:310.
Stomatopora diastoporides, Hincks, 1880:434.
Stomatopora diastoporides, Osburn, 1912:218.
Oncousoecia diastoporides, Osburn, 1933:9.

Zoarium a flat fan-shaped or lobulate incrustation on shells and stones; moderately thick, usually with two rows of incomplete zooecia bordering the outer functional ones. The zooecial tubules are elongate and horizontal for most of their length, about 0.30 mm wide, convex and the separating grooves distinct, finely punctured. The peristomes are short, suberect, quincuncial in arrangement, the aperture about 0.15 mm in diameter.

The ovicells resemble the zooecial tubules, elongate, pointed at the proximal end, only a little swollen and more thickly punctate; they were overlooked for many years, probably because of their resemblance to the tubules, but they are definite enough when one knows what to look for. The ooeciostome is terminal, short, erect, round and about 0.08 mm in diameter, not associated with a peristome.

Described from the Shetland Islands by Norman and recorded also by Hincks from the British Islands. On the west coast of the North Atlantic it ranges from Cape Cod northward to Mount Desert Island, Maine, to the Gulf of St. Lawrence and Baffin's Bay.

Point Barrow, Alaska, Arctic Research Laboratory, G. E. MacGinitie, collector; also at Canoe Bay, southern Alaska, U. S. Alaska Crab Investigation, Sta. 25-40 at 25 fms.

Oncousoecia canadensis Osburn, 1933

Plate 65, figs. 10 and 11

Oncousoecia canadensis Osburn, 1933:12.
Stomatopora diastoporides, Whiteaves, 1901:110.

The zoarium is flabellate or irregularly lobate, entirely adnate on shells and stones, the primary region, 2 or more tubules in width, is usually short; thinner than in *O. diastoporides.* The tubules are comparatively thin-walled, somewhat hyaline and vitreous, conspicuously perforated. They are more slender than those of *diastoporides* (width about 0.18 mm), and never does more than one row of incomplete ones appear at the margin. The peristomes are short, thin-walled, the aperture about 0.10 mm in diameter, and never connate nor seriated.

The ovicells are usually like small thin-walled blisters; the fertile zooecium arises in the same manner as the infertile ones but soon expands both frontally and laterally and the adjacent tubules appear as if separated by the growth of the expansion. Sometimes the expansion extends in very short lobes on either side of the ooeciostome, but occasionally it may be as simple as in *diastoporides.* The ooeciostome is

situated terminally, between but not in contact with the adjacent peristomes; it is rounded or slightly elliptical transversely, short, erect or slightly bent proximally; the aperture 0.06 mm in diameter.

Described from Mount Desert Island, Maine, and recorded by Osburn from the Bay of Fundy and the Gulf of St. Lawrence (for details see Osburn, 1933:13).

Point Barrow, Alaska, Arctic Research Laboratory, to a depth of 50 fms, G. E. MacGinitie, collector, common on shells.

Oncousoecia ovoidea new species

Plate 65, figs. 8 and 9

The zoarium is broadly flabellate; the ancestrula produces a single short tubule; from this two tubules arise, and then four tubules begin the wide expansion. They are arranged in quincunx, the peristomes all well separated. The embedded tubules are about 0.13 mm in diameter, the peristomes 0.11 mm and the apertures 0.08 mm. The tubules are very definitely cross striated, the peristomes smooth and semierect, the longest ones 0.13 mm.

There are two ovicells on one colony, the expanded portion ovate, ventricose, 0.15 to 0.18 mm in width, the distal end rounded, the ooeciostome terminal, short, erect, the aperture rounded and 0.05 mm in diameter. The proximal part of the gonozoid is like the other tubules for about half or two-thirds of the length and the expansion appears suddenly.

Type, AHF no. 58.

Type locality, Hancock Station 276, San Esteban Island, Gulf of California, 28°38′30″N, 112°36′W, at 32 fms. Two colonies encrust smooth shell fragments, while a third is on the rough pebbled surface of an echinoid spine; the largest colony is less than 2 mm in width.

Oncousoecia abrupta new species

Plate 65, figs. 6 and 7

The zoarium is small, delicate and entirely adnate; the proximal portion very slender (0.45 mm at the widest part) for a distance of 5 mm, then abruptly becoming broad and round, about 2.5 mm in either direction. The proximal part, just above the pro-ancestrula, which is wanting, is 2 tubules in width, alternating, and widens to 4 tubules near the expansion; the peristomes moderately short and free. On the expanded area the peristomes are much higher (to 0.50 mm), rather regularly

distributed and not seriated, free with a few exceptions where two are connate at the base, slender with an outside measurement of 0.09 mm. The apertures are round and about 0.07 mm in diameter. The tubules are so much embedded that their measurements cannot be determined, the surface with minute pores and light transverse striae.

There are 3 ovicells side by side, occupying practically the full width of the terminal border, each broadly pyriform and with short lobes between the surrounding peristomes; a little ventricose and cross-striated and the surface with minute pores. The ooeciostome is erect and moderately high, situated beside a peristome with which it is connate at the base and the upper portion free, its base cylindrical and about 0.05 mm in diameter, the tip expanded transversely and its aperture measuring about 0.09 by 0.03 mm.

The basal portion alone would readily be mistaken for a species of *Proboscina,* but the expanded part is similar to that of *Oncousoecia* in the nature of the ovicells and ooeciostomes.

Type, AHF no. 88.

Type locality, off Rocky Point, southern California, about 33°49′N, encrusting a sunken buoy recovered from a depth of 45 fms, one colony by Earl Fox. Also one colony collected at Santa Barbara Island by Dr. H. R. Hill.

Family **Diastoporidae** Gregory, 1899

Diastopora Lamouroux, 1821; *Berenicea* Lamouroux, 1821; *Mesenteripora* Blainville, 1830; *Bidiastopora* d'Orbigny, 1849; *Actinopora* d'Orbigny, 1853; *Microecia* Canu, 1918; *Plagioecia* Canu, 1918; *Diaperoecia* Canu, 1918; *Diplosolen* Canu, 1918.

Diastopora, genotype *D. foliacea* Lamouroux, 1821:42, though it was described from a fossil without ovicells, has rather definite zoarial characters and has been much used for recent as well as fossil species. In the absence of an ovicell, however, it is impossible to place this genus except as a member of the present group. It is useful to the paleontologists when ovicells are wanting, but should not be used when the ooecial characters are present.

Berenicea, genotype *B. prominens* Lamouroux, 1821:80, is so indefinite as to be meaningless. Norman, 1903:569 and 1909:299, and Borg, 1944:61, have maintained that *Berenicea* is not even a cyclostome but a cheilostome form. *Diastopora* and *Berenicea* have been used rather indiscriminately for the same species. If they are synonymous, *Di-*

aperoecia takes precedence by its earlier appearance in Lamouroux's work, but owing to the uncertainty as to its nature *Berenicea* had better be discarded.

Mesenteripora, genotype *M. michelini* Blainville, 1830:397, was proposed for erect contorted forms otherwise similar to *Diastopora.* Here again the genotype is a fossil without ovicells.

Bidiastopora, genotype *Diastopora cervicornis* Michelin, 1846:241, was founded to include erect diastoporas with bilaminate folds, and the genotype is a fossil without ovicells.

Actinopora, genotype *A. regularis* d'Orbigny, 1853:763, was based on the arrangement of the zoids in regular radiating series and like the preceding included only fossil species without ovicells. The ovicelled species which have later been placed in this genus have the ovicells and ooeciostomes definitely of the *Plagioecia* pattern.

The above generic names were all properly founded but only on zoarial characters, so their complete nature is uncertain. They may still be useful when it is necessary to catalog specimens which are incomplete in reproductive characters.

In 1918 Canu attacked the problem of the old *Diastopora* complex with the ovicells as the basis, and proposed a number of additional genera, *Microecia, Plagioecia, Diaperoecia* and *Diplosolen.*

Microecia Canu, 1918:326, was mistakenly founded on *Diastopora Sarniensis* Norman, 1864:89, and is synonymous with *Plagioecia.*

The other three genera agree in the mode of early development in the tubuliporoid manner, in the closure of numerous older peristomes by a calcified porous membrane, and by at least the occasional enclosure of peristomes by the ovicell.

Canu went so far as to propose several new families, Mecynoeciidae, Plagioeciidae and Diaperoeciidae among the diastoporid forms. The first of these, which included *Microecia,* has already been reduced to synonymy by Bassler, 1935:10. While Canu's analysis of the ovicell is of the greatest importance in the separation of species of this group, he apparently was not sufficiently familiar with the intraspecific and interspecific variation in the ooecia and ooeciostomes.

For the purpose of the present work I propose to accept only the old family Diastoporidae with the following genera:

1. *Diastopora* Lamouroux, 1821, reserved for species in which the reproductive characters are unknown.

2. *Plagioecia* Canu, 1918, ovicell usually much broader than long, not proliferated beyond the level of the ooeciopore; ooeciostome terminal, at or near the middle of the distal border; one or more peristomes often surrounded by the lateral prolongation of the ovicell.

3. *Diaperoecia* Canu, 1918, the ovicell completes its development by proliferating distally in advance of the ooeciopore and surrounds few or many distal peristomes in the process; the ooeciostome, which represents the morphological distal end of the gonozoid, is usually located somewhere near the middle or occasionally even near the proximal end of the ovicell.

4. *Diplosolen* Canu, 1918, miniature zooecia (zooeciules) present, scattered among the normal tubules of the zoarium; ooeciostome subterminal at or near the middle; peristomes occasionally surrounded. *Diplosolen* differs from *Plagioecia* in appearance only by the dimorphic nature of the zooecial tubules.

It is sometimes difficult to assign a species to one of the above genera, owing to variation in the size and form of the ovicell and especially in the occasional occurrence of ovicells as simple as those of *Oncousoecia.* When these occur on the same zoarium with more highly developed ovicells, the latter has been accepted as the proper generic association. The simple ovicells usually occur on the older parts of the colony and if only this form of ovicell is present the species would necessarily be assigned not only to another genus but to a different family. A rather exaggerated case of this is found in *Plagioecia ambigua* new species (q. v.), but examples may be found in other species of this genus and also in *Tubulipora.* The enclosure of peristomes by the ovicell, on which Canu (1918) based the genus *Diaperoecia,* is subject to much variation, and this condition is also found to a greater or less extent in *Plagioecia* and several genera of the Tubuliporidae.

In spite of these variations, where a fully developed ovicell is present, the position of the ooeciostome is usually diagnostic, median and terminal or subterminal in *Plagioecia,* more centrally located in *Diaperoecia,* in which genus the ovicell continues to develop distally beyond the ooeciostome. The ooeciostome must be considered the morphological distal end of the gonozoid.

Genus **PLAGIOECIA** Canu, 1918

"The ovicell is a long transverse sack obliterating a certain number of zooecial tubes and developed in the vicinity of the zoarial margins. The ooeciostome is small, equal to or less than the zooecial diameter. The

tubes are isolated from each other. No adventitious tubes." (Canu and Bassler, 1922:26). Genotype, *Tubulipora patina* Lamarck, 1816.

The above description, drawn from *P. patina* and correct for that species, requires some modification as the ovicells are not always much expanded laterally and sometimes in other species may even be longer than broad. The ovicells are symmetrically developed and the ooeciostome is terminal in the midline at or near the distal border and the ooecial expansion is not continued beyond it. The inflation often surrounds one or more, sometimes several, peristomes; even in the same species the shape of the ovicell and the number of the included peristomes may vary considerably due to the amount of lateral expansion. There is much closure of the older peristomes by a calcified membrane which is either perforated by a number of small pores, or provided with a small erect central tubular pore.

The zoarium is usually adnate, but may be erect or semierect and more or less contorted and either unilaminar or bilaminate.

Key to the Species of *Plagioecia*

1. Zoarium more or less free, erect or semierect 2
   Zoarium entirely adnate or sometimes free at the edges . . . 4
2. Zoarium with narrow, bilaminate, contorted branches which form a free reticulum . . . . . *meandrina*
   Zoarium with broad bilaminate lobes, contorted 3
3. Zoarium erect from a rather narrow base, sometimes stipitate, contorted, the folds thicker than in other species . . *grimaldii*
   Zoarium beginning with a broad adnate base from which erect, contorted folds arise, much thinner than in *P. grimaldii* . . . *tortuosa*
4. Except near the center of the zoarium the peristomes are in uniserial, radiating rows, connate only at the base . *anacapensis*
   Peristomes not in radiating series 5
5. Zoarium broad and thin, irregular, with occasional smooth areas containing aborted tubules without apertures; peristomes very short; ovicell low and flat, surrounding a few peristomes, irregularly rounded . . . . . *tubiabortiva*
   Zoarium rounded or with flabellate lobes, ovicell conspicuous and usually transverse 6
6. Ovicell usually several times as broad as long and slightly arcuate to conform to the zoarial border, the lateral ends often enclosing peristomes . . . . . *patina*
   Ovicell narrower, sometimes nearly round 7

7. Zoarium irregularly rounded, peristomes thin, 0.09 mm at their tips; ovicell only moderately broad . . . . . *sarniensis*
   Zoarium lobate, peristomes 0.13 mm at their tips; in the one specimen there are two simple, narrow ovicells and one expanded one, the ooeciostome slightly subterminal . . *ambigua*

Plagioecia patina (Lamarck), 1816

Plate 73, fig. 4

Tubulipora patina Lamarck, 1816:163.
Diastopora patina, Hincks, 1880:458; 1884:206.
Diastopora patina, O'Donoghue, 1923:14.
Plagioecia patina, O'Donoghue, 1926:21.

Zoarium variable in form, rounded or lobate; entirely encrusting, or partially free. The zoids are embedded for most of their length, the free part of the tubules, "peristomes," being semierect and usually short. The apertures are somewhat elliptical or nearly round, measuring about 0.10 by 0.12 mm. The embedded portions of the zoids are slightly convex and are perforated by minute pores. The peristomes show no tendency to be arranged in series, and are not connate even at the base. In older parts of the colony, especially, the apertures become closed by a peculiar calcified membrane which is perforated either by a number of pores or by a single larger tubular pore. The basal lamina often forms a distinct border beyond the functional zoids.

The ovicell is a prominent swelling, moderately large and distinct, the edges usually sharply outlined. Normally it is transversely very elongate, several times as wide as long, but varying considerably in size and form. Usually a number of peristomes are surrounded, 0 to 7 in my specimens. The ooeciostome is terminal and free between the zooecial series, ordinarily occupying a small notch in the middle of the distal side; it is rather short and either erect or flexed slightly toward the proximal part of the zoarium, the aperture rounded and 0.06 to 0.08 mm in diameter.

This well-known Atlantic species resembles *P. sarniensis* in its general appearance, but the zooecia are distinctly larger with shorter peristomes, and the ovicell is much wider transversely. On the Pacific coast it was first noted by Hincks at Cumshewa, and later by O'Donoghue at Bull Passage, British Columbia.

Hancock Stations: 143-34, Wenman Island, 100 fms, 147-34, Albemarle Island, 30 fms, and 352-35, Chatham Island, 35 fms, Galapagos; 299, San Jose del Cabo at the southern tip of Lower California, 82 fms; 72, Guadalupe Island off Lower California, 17 fms; Santa Barbara

and San Miguel Islands and various other places off shore along southern California, 15 to 76 fms. Also collected in Puget Sound, Washington, by Dr. J. L. Mohr, and two colonies from Cleveland Passage, Frederick Sound, southern Alaska.

Plagioecia sarniensis (Norman), 1864

Plate 73, fig. 3

Diastopora Sarniensis Norman, 1864:89.
Diastopora sarniensis, Hincks, 1880:463; 1884:206.
Berenicea sarniensis, Harmer, 1915:114.
Microecia sarniensis, O'Donoghue, 1926:21.
Plagioecia sarniensis, O'Donoghue, 1926:22.

The zoarium is usually encrusting but sometimes the borders are free and slightly contorted; the basal lamina forms a distinct border. There is much resemblance to *P. patina* in the zoarial form, but the smaller size of the zooecia and the form of the ovicell easily distinguish them.

The zooecia are embedded for most of their length. The semierect "peristomes" become suddenly smaller, their diameters only 0.09 mm and their apertures 0.07 mm in diameter. The peristomes are usually longer than those of *patina,* never connate and not in series.

The ovicell varies in form from irregularly rounded to short transverse, occasionally somewhat bilobate, and often one or two peristomes are surrounded. The ooeciostome is terminal or sub-terminal at the distal border, isolated, erect or curved proximally, the ooeciopore round and 0.05 mm in diameter.

Norman and Hincks both figured a small oval or rounded ovicell, though the latter states (1880:463) "Ooecia transversely elongate, subelliptical inflations of the zoarium, of a considerable size." Doubtless it was the small size of the ovicell figured that led Canu (1918:326) to select this species as the genotype of his new genus *Microecia,* which he placed in his new family Mecynoeciidae, now discarded. If there is such a fossil group of species of generic value, the selection of *sarniensis* as the genotype was most unfortunate and the generic name *Microecia* is invalidated, for *sarniensis* is certainly congeneric with *patina.* While the ooecial characters are of the greatest importance in the study of the cyclostomatous species, it is necessary to recognize the fact that these characters, like all others in nature, are subject to variation, and this is especially true of the size and form of the ooecial expansion. I have seen several cases of simple ooecia on the same zoaria with those of larger

size in *sarniensis,* and in *patina* there is much variation in width.

P. sarniensis has now been found in so many parts of the world that its distribution must be considered cosmopolitan. Hincks first listed it for Pacific waters at Cumshewa, British Columbia, and O'Donoghue recorded it from Banks Island and Lowe Inlet, British Columbia, and the San Juan Islands, Puget Sound.

Hancock Stations: 484, Barrington Island, Galapagos, 0°49′S, 90° 06′40″W, 52 fms; 423-35, off Port Utria, Colombia, 5°59′20″N, 77° 21′50″W, at 20 fms; 276, San Esteban Island, Gulf of California, 28°38′50″N, 112°36′W, at 32 fms; 72, Guadalupe Island, off Lower California, 29°N, at 17 fms; Santa Barbara, Anacapa and San Clemente Islands, off southern California; and San Juan Islands, Puget Sound, Washington.

Plagioecia tortuosa new species

Plate 67, figs. 8 and 9

Mesenteripora meandrina, Robertson, 1910:251 (not Wood, 1844:14).

Dr. Alice Robertson has given an excellent description of the zoarium: "Zoarium bilaminate, forming a contorted, convoluted mass . . . beginning as a simple, primitive disk from which there grow tubular zooecia curving in opposite directions, and forming a fan-shaped expansion similar to any young tubuliporidian colony. The two layered condition results from the ridges which occur at irregular intervals over the unilaminar sheet, . . . and which growing upward form the erect, bilaminar layers, the laminae becoming highly convoluted." The encrusting base sometimes covers a considerable area before the bilaminate folds are formed.

The zooecia are alternate, in quincunx, embedded but with the frontal surface convex, with numerous pores and sometimes transversely ribbed. The erect tubules or "peristomes" are usually short but may be as much as 0.50 mm in length, narrowing only slightly, perforated only near the base, about 0.13 mm in outside diameter; the aperture short oval or round and about 0.10 mm in diameter.

The ovicell, partially described by Robertson, is a distinct inflation which is usually considerably broader than long, surrounding 6 to 12 peristomes. The ooeciostome, which Robertson was unable to find, is sub-terminal, median, somewhat removed from the distal border, short, erect and slightly expanded at the tip, the pore round, 0.08 mm in diameter and the tip expanded to 0.13 mm.

In all characters, zoarial and reproductive, except the bilaminate adult zoarium, this species agrees closely with *P. patina* and must be considered congeneric with it.

Robertson recorded it from three localities in southern California, down to a depth of 32 fms.

Type AHF no. 107.

Type locality, Hancock Station 1662-48, off Santa Cruz Island, southern California, 33°55′45″N, 119°31′05″W, at 23 fms. Also taken at 1130-40, off Laguna Beach, southern California at 25 fms; at Cortez Bank, 32°24′N, 119°22′30″W, at 131 fms; and at 1190, Puerto Escondido, Gulf of California, 25°48′04″N, 111°18′53″W, in shallow water. Another fine specimen from Station 275, Raza Island, Gulf of California, 28°48′N, 113°W, at 40 fms has 4 ovicells more or less centrally located and 3 others partially developed near the margins of the zoarium.

Plagioecia grimaldii (Jullien), 1903

Plate 66, fig. 5

Mesenteripora Grimaldii Jullien, 1903:118.
Plagioecia grimaldii, Osburn, 1936:540.
? *Mesenteripora meandrina,* Smitt, 1866:432.

The zoarium consists of erect contorted folds arising from an encrusting base to a height of 1 or 2 cm. The folds are bilamellar, the growing edge showing the basal lamina with the tubules arising on both sides. The colony may be stipitate, as in Jullien's figure, plate 15, fig. 4, but is often broad and irregular. The embedded tubules are convex and quite distinct on the surface of the zoarium, 0.25 to 0.30 mm in width, with moderately deep separating grooves and perforated by numerous small pores. The peristomes are usually very short, often rising scarcely above the zoarial surface, but in protected areas they may rise, semierect, to a length of 0.40 mm. The apertures vary considerably, from 0.14 to 0.18 mm and are often closed by the characteristic diaphragm with a small tubule at the center.

The ovicells, here described from Baffin Bay specimens, are variable in size and form, large enough to surround 5 or 6 peristomes, prominent and sharply outlined; the ooeciostome smaller than a peristome and scarcely elevated above the surface, median and terminal in position. There is a tendency for the ovicells to be slightly broader than long but in one case the length is 50% greater than the width; another much smaller ovicell, which encloses only one peristome, is round. Since so

much attention has been given to the shape of the ovicells by Canu and Bassler it is important to note the amount of variation in form.

Jullien described the species from the Grand Bank of Newfoundland, at 155 meters. The only other positive reference is that in Osburn's report on dredgings by Captain R. A. Bartlett in Baffin Bay, three colonies with ovicells, (previously unknown), at 140 to 210 feet. It is probable that Smitt's *Mesenteripora meandrina* in the Torell collection from Greenland (1866:432) should now be referred to *grimaldii* rather than to the fossil *Diastopora meandrina* of Wood.

Point Barrow, Alaska, Alaska Research Laboratory, at 217 feet, G. E. MacGinitie, collector, several fragments agreeing with Baffin Bay specimens in all other details but without ovicells. The range of distribution is evidently high northern and probably circumpolar.

Plagioecia meandrina (Canu and Bassler), 1930

Plate 66, figs. 6 and 7

Diaperoecia meandrina Canu and Bassler, 1930:51.

The zoarium has a very striking appearance, consisting of a broad encrusting base from which arise at intervals narrower bilaminate branches or fronds which often anastomose to form large quadrangular, pentagonal or hexagonal fenestrae. The branches are usually at right angles to the plane of the zoarium. On the encrusting base the zooecia are arranged in quincunx, but on the erect branches they tend to run in rather regular series more or less transverse to the branch; they are not connate but well separated. The peristomes of the base are short but on the branches, especially near the growing edge, they are moderately elongate and nearly erect. The basal lamina of the base extends rather broadly beyond the functional zooecia and on the branches there is a similar but much narrower lamina projecting from between the two zooecial layers on one edge of the branch. The zooecial tubules are very little inflated and their outlines are often obscure. The peristomial apertures are round and about 0.10 mm in diameter.

The ovicell is a distinct inflation, irregularly elliptical, transverse and parallel to the edge of the branch and surrounding a number of the peristomes, most of which are closed, like those of *P. patina,* with a calcified membrane in the middle of which is a minute tubule. The ooeciostome is small, short, nearly erect, situated near the middle and terminal, free between the peristomes, and measures 0.08 mm.

Canu and Bassler placed the species in their genus *Diaperoecia* because of the peristomes surrounded by the ovicell, but indicated that "It is not yet a true Diaperoecia." As a matter of fact, the ovicell is almost exactly like that of *Plagioecia patina* in form and location as well as the nature of the ooeciostome. The perforation of the ovicell by the peristomes sometimes occurs in its relatives, *patina* and *sarniensis*, and in a specimen of *P. (Microecia) tubiabortiva* (Canu and Bassler, 1930) I have observed as many as 8 such enclosed peristomes. The closure of the peristomial apertures also is exactly like that in *patina,* a porous calcified membrane with a minute short tubule at the middle.

Our best developed specimen measures about 35 mm across the encrusting base and the fenestrate erect portion is about 60 mm high and wide, with 7 complete fenestrae. In most cases the growing edges of the branches are oriented in the same direction.

Described from the Galapagos Islands, Albatross Station D. 2815.

Hancock Stations: 143-34 Wenman Island; 170-34, Chatham Island; 201-34, Hood Island; 450, Albemarle Island; 452, Charles Island, and 453, Gardner Island, all from the Galapagos. Also at 1662-48, Santa Cruz Island, southern California; and collected by Dr. Carl L. Hubbs at Guadalupe Island, off Lower California. The geographic range is wide, from Santa Cruz Island, southern California (33°35′45″N) to Hood Island, (1°21′55″S), and the bathymetric range from 23 to more than 100 fms.

Plagioecia tubiabortiva (Canu and Bassler), 1930

Plate 73, fig. 2

Microecia tubiabortiva Canu and Bassler, 1930:48.

The zoarium is broad and flat, with a very irregular outline; the surface even, with smooth areas free from apertures and consisting of aborted tubules. The zooecial tubes are completely immersed, except for the very short, semierect peristomes which usually project only slightly above the crust. The diameter of the peristomes is 0.12 or 0.13 mm, that of the apertures 0.10 or 0.11 mm. The aperture is rounded to slightly elliptical. The peristomes are irregularly spaced, never connate and not in series. The basal lamina usually forms a distinct border.

The ovicell is a low inflation, rounded, expanded laterally or irregular in outline, usually surrounding a few peristomes (8 in one case). The ooeciostome rises barely above the surface, median and terminal in position, its aperture measuring about 0.06 mm.

This species is evidently congeneric with *patina* and *sarniensis,* judging by the nature of the tubules and especially by the characters of the ovicell.

Described from the Galapagos Islands, Albatross Station D. 2813.

Hancock Stations 143-34, off Wenman Island, Galapagos, 1°23′10″N, 91°48′45″W, at 100 to 150 fms, several colonies on shells.

Plagioecia anacapensis new species

Plate 66, figs. 9 and 10

? *Diastopora catillus* J. Y. Johnson, 1897:61.

The zoarium is round and flat but the margin is more or less turned up to produce small saucer-shaped colonies, which are attached by a comparatively small peduncle. The basal lamina is of moderate width. The zooecia about the center, with short peristomes, are arranged quincuncially, but beyond this area they form uniserial radiating rows which extend to the margin, similar to the fossil *Unitubigera* of d'Orbigny, 1853. Additional shorter series are interpolated toward the margin. The tubules are embedded, convex on the frontal surface, the walls perforated and later often transversely ribbed. The peristomes are semierect and beyond the central area become longer (0.25 mm or more). The central peristomes are always free and isolated, those in the radiating series sometimes connate at the base but the tips always free; diameter at the tip 0.13 mm, the aperture round and 0.10 mm in diameter.

The ovicell is inflated, its outlines distinct, transversely elongate (usually more than twice as wide as long), surrounding one or more peristomes. The ooeciostome is terminal at the middle of the distal border, short, erect, its rim flared like the bell of a cornet, the ooeciopore round and 0.08 mm in diameter, the rim circular and about 0.13 mm across.

When this material was first examined I placed it at once under *Unitubigera* d'Orbigny, 1853, but the large non-seriated central area is different and the nature of the ovicells (unknown in *Unitubigera*) is distinctly like that of *Plagioecia patina.*

There is a possibility that this species may be the *Diastopora catillus* of J. Y. Johnson (1897:61) from Madeira; his description is fairly similar, but he did not give a figure and did not mention the ovicell.

Type, AHF no. 113.

Type locality, Hancock Station 874-38, off Anacapa Island, southern California, 34°01′30″N, 119°21′W, at 45 fms, one colony on a shell. Also two colonies recovered from a sunken buoy off Rocky Point, south-

ern California, 45 fms. One of the latter is almost exactly like the type specimen except that the ovicell encloses three peristomes. The other colony differs only in having the 3 or 4 marginal rows of peristomes suddenly much elevated.

Plagioecia ambigua new species

Plate 66, fig. 8

The zoarium is flat and thin, entirely adnate, encrusting the smooth surface of a shell. The proximal portion is narrowly flabellate, with a very simple ovicell; beyond this the zoarium becomes broadly flabellate with a similar simple ovicell at one side and a very broad ovicell occupying much of the width of the lobe. The zooecial tubes are elongate, moderately distinct on the surface, slightly cross-striated and perforated with small pores, 0.20 mm in width. The peristomes are only suberect and directed strongly forward, the diameter 0.15 and the round aperture 0.13 mm; arranged in quincunx. There is only a single row of incomplete tubules at the margin.

The simple proximal ovicell is about 0.40 mm in width by 0.75 mm long; the simple lateral ovicell 0.30 mm wide by 0.70 mm long and the large ovicell is about 1.60 mm broad by 0.80 mm long. The ooeciostome is terminal in the small ovicells, erect at the proximal side of a peristome; in the large ovicell the ooeciostome is similarly situated, but is somewhat subterminal as the ooecial cavity has extended slightly beyond it; diameter of aperture 0.08 mm.

Type, U. S. Nat. Mus. no. 11049.

Type locality, Point Barrow, Alaska, 130 feet, Arctic Research Laboratory, G. E. MacGinitie, collector, one colony.

This is a very unusual specimen, with characters of several genera. There are two simple ovicells like slightly expanded zooecial tubules and with terminal ooeciostomes, much like *Oncousoecia diastoporides,* except that the ooeciostome is associated with a peristome. There is also a much expanded ovicell, transverse, surrounding several peristomes, with a subterminal ooeciostome and resembling *Plagioecia,* except for the position of the ooeciostome proximal to a peristome. The latter character is more like that of *Tubulipora.* The ovicell surrounds a number of peristomes, which would place the species under *Diaperoecia.*

With such a combination of characters, one is naturally in doubt as to the generic relationship, but I am accepting as the most important character the fullest development of the ovicell, expanded laterally and with a subterminal, median ooeciostome.

I have observed a number of cases of similar ambiguity among the Diastoporidae and Tubuliporidae, but never quite to this extent. Presumably all such cases may be interpreted as examples of the repetition of ancestral characters and therefore useful in tracing the evolution of the group. At the same time they present a problem in identification, for if only the simple ovicell is present the species must necessarily be assigned to a different genus and even a different family than if the expanded ovicell is developed, according to Canu's analysis.

? Plagioecia lactea (Calvet), 1903

Diastopora lactea Calvet, 1903:163; 1907:466.
Plagioecia lactea, Canu and Bassler, 1930:48.

The zoarium is flat and discoidal, with a narrow basal lamina, and is attached by a peduncle. The zooecial tubules are immersed for most of their length, their surfaces rather coarsely cross-striated and punctured. The peristomes are moderately short, semi-erect and well separated. Occasional apertures are closed with a lamella with a central minute tubule. The orifices are round or slightly elliptical and measure about 0.08 mm; the peristomes 0.10 to 0.12 mm in diameter, depending on the amount of calcification.

While no ovicells have been noted in the Hancock specimens, the descriptions and figures given by Calvet and Canu and Bassler, and measurements by the latter are all in agreement.

Recorded by Calvet from the Gulf of Gascony at 300 meters and from Cape Spadel, Morocco, at 717 meters, and by Canu and Bassler from the Galapagos Islands, Albatross Sta. D.2813, at 40 fms.

Hancock Station 143-34, off Wenman Island, Galapagos, 1°23′10″N, 91°48′45″W, at 100 to 150 fms.

Genus DIPLOSOLEN Canu, 1918

Diplopora Jullien, 1903:115 (preoccupied by Gümbel, 1866).

Interspersed among the autozoids are nannozoids or reduced individuals, irregularly distributed, their minute peristomes shorter than those of the normal tubules and often inconspicuous. The ovicell is a prominent swelling, usually surrounding a number of peristomes; the ooeciostome smaller than the peristomes, short, erect and isolated. Genotype, *Tubulipora obelia* Johnston, 1838.

Older authors placed the species under *Tubulipora, Berenicea* and *Diastopora,* but the constant presence of nannozoids, the function of which is unknown, appears sufficient for generic standing.

Diplosolen obelium, (Johnston), 1838

Plate 73, fig. 1

Tubulipora obelia Johnston, 1838:269.
Diastopora obelia, Hincks, 1880:462.
Berenicea obelia, Okada, 1917:352.
Diastopora obelia, O'Donoghue, 1923:14.
Diplosolen obelium, O'Donoghue, 1926:24.

The zoarium is thin and flat, rounded or irregularly lobate. The zooecia are embedded for most of their length, though the semierect peristomes project well above the surface; the aperture is round or slightly elliptical, 0.08 to 0.10 mm in diameter. In Alaska specimens the aperture is noticeably larger, 0.10 to 0.12 mm in diameter (var. *arctica* Waters, 1904a:171) than in southern specimens, but there seem to be no other differences of importance. The nannozoids are similar in form to the autozoids, but are minute in size; their peristomes are much shorter and are only about 0.03 mm in diameter.

The ovicell is considerably inflated, varying in size, oval or arcuate, transverse, and encloses a number of peristomes of both autozoids and nannozoids (as few as 2 and as many as 20 have been counted). The ooeciostome is isolated, short, its aperture rounded and intermediate in size between those of the autozoids and nannozoids, usually more or less central in position.

It is a well-known North Atlantic species, extending into the Arctic, and reported from Japan. On the Pacific coast it has been recorded by O'Donoghue from several places in British Columbia and from the San Juan Islands in Puget Sound.

Hancock Stations: 1194-40, 43 fms, and 1294-41, 34 fms, at Santa Cruz Island, southern California. Also among the collections are specimens from Puget Sound; from Alitak Bay, Alaska (U. S. Fisheries Alaska Crab Investigation); from Nash Harbor, Nunivak Island, Alaska; from the Bering Sea, and from Point Barrow, Alaska (Arctic Research Laboratory, G. E. MacGinitie, collector).

The species is common in Alaska waters, less frequent farther south, and Santa Cruz Island, southern California (34°N. Lat.) is the most southern record.

Genus **DIAPEROECIA** Canu, 1918

The ovicell continues to develop after the calcification of the tubes distal to it and often surrounds a considerable number of peristomes. The ooeciopore is usually not terminal and is often proximal or near

the middle of the ooecial swelling. There are several types of ooeciostomes, which may eventually result in the separation of the genus as suggested by Canu and Bassler (1920:740). (1) In some species the ooeciostome is not associated with a tubule but is quite independent among them; (2) in others it is a high tube at the side of a peristome and more or less connate with it; and (3) in still others it is a transverse or arcuate pore at the base of a peristome and without an ooeciostome.

Pustulopora intricaria Busk, 1875:22, which is the genotype, is an erect, branching species with the ooeciostome isolated and situated a little proximal to the middle of the long ovicell, which surrounds a large number of peristomes.

In my opinion Canu and Bassler have depended too much on a single character, that of the ovicells surrounding peristomes, for this character appears not infrequently to a lesser extent among other genera, even in species of genera that do not ordinarily show it, such as *Tubulipora, Plagioecia, Fasciculipora, Frondipora,* etc. Even in *Plagioecia patina,* the genotype of that genus, a peristome may occasionally be surrounded. It is also true that in *Diplosolen* and *Crisulipora,* which usually have a number of included peristomes, ovicells occasionally occur which have failed to surround any peristomes.

The erect species of our eastern Pacific members of this genus agree in having an elongate ovicell which extends much beyond the isolated and more or less centrally placed ooeciostome. Others, such as those described from the Galapagos Islands by Canu and Bassler, *D. striatula, D. subpapyracea* and *D. meandrina,* with transversely broad ovicells and terminal, median ooeciostomes, more properly belong under *Plagioecia* notwithstanding the inclusion of some peristomes.

It would appear to be true of any species that when the ovicell continues to grow forward around a distal peristome, the walls may come together and coalesce to enclose it. However this may be, there is certainly a group, *Diaperoecia,* with a well-defined facies which shows an extended ovicell enclosing numerous peristomes and with a non-terminal ooeciostome.

The species of the present list show two distinctly different types of ooeciostome; in *D. intermedia, johnstoni* and *claviformis* the ooeciostome is a narrow tube at the side of a peristome and is proximal in position, while in *californica* and *floridana* the tube is wider, broadly flared at the tip, entirely free from the peristomes and situated more medially.

Key to the Species of *Diaperoecia*

1. Slender, erect or semierect, branching species, rising from a small encrusting base, ooeciostome free 2
   Adnate species, with expanded lobes, the lobes sometimes short-erect, ooeciostome at the side of a peristome 3
2. Branches very narrow, seldom as much as 1.0 mm in width, apertures of peristomes about 0.13 mm in width . . *floridana*
   Branches wider, 2 mm or more, apertures of peristomes 0.20 mm or more, the lateral peristomes usually in short connate series . . . . . *californica*
3. Zoarium adnate and branched laterally, with short, erect fertile branches which expand into small capitula containing the ovicell . . . . . *intermedia*
   Fertile lobes adnate 4
4. Fertile lobes flabellate, usually more or less triangular, peristomes projecting high above the ovicell . . . . *johnstoni*
   Fertile lobe rounded, peristomes projecting only slightly above the ovicell . . . . . *claviformis*

Diaperoecia californica (d'Orbigny), 1852

Plate 67, figs. 1 and 2

Idmonea Californica d'Orbigny, 1853:732.
Idmonea Californica, Conrad, 1855:441.
Idmonea californica, Gabb and Horn, 1862:168.
Tubulipora dawsoni, Hincks, 1884:205.
Idmonea californica, Robertson, 1910:253.
Idmonea californica, Canu and Bassler, 1923:199.
Idmonea californica, O'Donoghue, 1923:12; 1926:27.
Idmonea palmata, O'Donoghue, 1923:12.
Diaperoecia intricata, Canu and Bassler, 1928:41.

The zoarium is composed of erect or spreading branches which frequently reach a height of 25 mm and occasionally as much as 50 mm. The branches may anastomose and often form reticulated masses. Usually, in deeper water, the branches are narrow in proportion to their length, 2 to 3 mm in breadth, but in exposed places along shore the zoarium is more consolidated and the branches shorter and wider and less erect (*Idmonea palmata* O'Donoghue); sometimes procumbent and attached to the substratum by the radicles (*Diaperoecia intricata,* Canu and Bassler, 1927:41). Radicles or supporting processes are frequently

present on the dorsal sides of the branches and these may fuse with the substratum or with another branch. The dorsal side is more or less striated transversely.

The zooecia are large, their outlines distinct on the frontal surface; the peristomes curved into an erect position, arranged in fascicles of usually 4 or 5 zoids on either side of the midline, sometimes connate to their tips but often only at their bases. Or they may be entirely free from each other, and there are often isolated peristomes in the midline. The apertures are large, round, averaging about 0.22 mm in diameter.

The ovicell is a large inflation, usually spread across the whole width of the branch below a bifurcation and frequently continuing on one or both branches; it surrounds often a large number of isolated peristomes. The ooeciostome is isolated, sub-terminal, moderately short, usually bent distally but it may be tipped in any direction, large, its base wider than a peristome, its tip flared and compressed, as much as 0.60 mm in diameter in the long direction, the pore long elliptical. There is much variation in the form of the pore, which is sometimes round, and the tip of the ooeciostome may be trumpet-shaped without compression.

This is an extremely common species all along the California coast and I have examined hundreds of specimens, ranging all the way from the short, palmate form to tall, slender branches from sheltered localities and deeper water. It is common in various Pleistocene formations, where it was noted by Conrad, Gabb and Horn, and by Canu and Bassler. I can find no difference between the Pleistocene and recent specimens and I have even found the ooeciostome, which was overlooked by the paleontologists, except by Canu and Bassler, 1923:199, who show it in Plate 43, fig. 6.

The *Diaperoecia intricata* of Canu and Bassler from the Hawaiian Islands is undoubtedly *californica,* as the differential characters by which they distinguish it are exactly those of *californica,* "par ses colonies reticulées, par son grand ooeciostome et par son ovicelle perforée par des tubes écartés les uns des autres."

Hincks' description of *Tubulipora dawsoni* from British Columbia fits the zoarial characters of *californica* perfectly. He made no mention of the ovicell.

Hancock Stations: dredged at more than 100 stations and found at shore stations in abundance. The northern limit of its range, as far as known, is British Columbia, including the records of Hincks *(Tubulipora dawsoni)* and O'Donoghue (both *Idmonea californica* and *I. palmata.)* It is common in the Gulf of California and along the west coast

of Mexico; the most southern record is Hancock Station 460-35, at Playa Blanca, Costa Rica. The bathymetric range is from low tide to about 100 fms.

Diaperoecia floridana Osburn, 1940

Plate 67, fig. 3

Idmonea Milneana, Smitt, 1872:8 (*non* d'Orbigny).
Diaperoecia radicata, Canu and Bassler, 1928:160 (*non* Kirkpatrick).
Diaperoecia floridana Osburn, 1940:331; 1947:5.
? *Diaperoecia rugosa* Osburn, 1940:332.

The zoarium is erect or sprawling, idmoneiform, irregularly branched, the branches slender, 0.60 to 1.0 mm in width, sometimes anastomosing; both dorsal and ventral sides more or less wrinkled; strong unjointed radicles developed on the dorsal side. The tubules are elongate; in younger branches the outlines are definite but the lines disappear with age; 4 or 5 to 6 or 7 tubules make up the width of a branch; the peristomes are curved, sometimes more than 1.0 mm long but usually about 0.40 mm, varying in diameter from 0.16 to 0.20 mm, the aperture varying from 0.13 to 0.17 mm; in older specimens transversely wrinkled nearly to the tips, perforated at the base.

The ovicell is elongate, usually located near the end of a branch and may extend up both branches at a bifurcation, usually surrounding one or more peristomes; but smaller ones may fail to enclose any. The ooeciostome is independent of the peristomes, usually situated near the middle of the ovicell; but when this is branched it is located near the base of the fork. It has the same width as the peristomes, usually bent sharply toward the base but in the forked ovicells it is more or less erect. The tip of the ooeciostome in any case, when fully developed, is broadly flared, irregularly elliptical, and measures from 0.20 to 0.35 mm wide by about 0.16 mm in the shorter dimension.

Pacific specimens have been compared with those from the Atlantic and seem to show no essential differences. Also I am inclined to place *D. rugosa* in synonymy, since in our abundant material there is much variation in the size of the peristomes, the amount of striation, and the form and position of the ooeciostome.

Described from off Beaufort, North Carolina, and recorded also by Osburn from the southern shore of Porto Rico and from several localities on the southern shore of the Caribbean Sea; by Smitt *(Idmonea milneana)* from Florida, and by Canu and Bassler *(D. radicata)* from the Gulf of Mexico and the Straits of Florida.

Hancock Stations: 275, Raza Island, Gulf of California, 40 fms; 305-34, Clarion Island, west of Mexico, 15 fms; 1978-50, Ranger Bank, Lower California, 71 fms; and 1143-40, off Portuguese Point, near San Pedro, 34 fms, 1413-41, San Miguel Island, 34 fms, 1064, Santa Barbara Island, 38 fms, and 1240, off San Diego, all from southern California.

The O'Donoghues have recorded under this genus a number of other species from British Columbia which have not appeared in our material.

D. *(Entalophora) capitata* (Robertson, 1900), 1926:22.
D. *(Entalophora) clavata* (Busk, 1859), 1926:23.
D. *(Stomatopora) expansa* (d'Orbigny, 1851), 1926:23.
D. *(Stomatopora) depressa* (O'Donoghue, 1923), 1926:23.
D. *(Tubulipora) labiata* (O'Donoghue, 1923), 1926:23.
D. *(Tubulipora) striata* (O'Donoghue, 1923), 1926:24.
D. *(Entalophora) vancouverensis* (O'Donoghue, 1923), 1926:23.

Diaperoecia johnstoni (Heller), 1867

Plate 67, fig. 4

Criserpia Johnstoni Heller, 1867:126.
Stomatopora Johnstoni, Hincks, 1880:430.
Stomatopora johnstoni, O'Donoghue, 1923:11.
Diaperoecia johnstoni, O'Donoghue, 1926:23.

Our specimens agree very closely with the *Stomatopora johnstoni* of Hincks from the British Isles, though Hincks did not have the ooeciostome.

The zoarium is encrusting, branching usually dichotomously; the branches short, narrow at the base with 1 or 2 rows of tubules for a short distance, beyond which they suddenly become fan-shaped or triangular with 4 to 6 or 8 tubules in cross-section. The tubules are about 0.26 mm in diameter, convex and conspicuously perforated; the peristomes are moderately high, more or less erect, not connate and not seriate, 0.18 to 0.22 mm in diameter, the aperture about 0.17 mm.

The ovicells are as Hincks described them, "dilated and very ventricose, wedge-shaped," though there is considerable variation in the form; thickly perforated with conspicuous pores; surrounding from 1 to 5 peristomes. The ooeciostome, located near the middle of the ovicell, is as high as the peristomes and about half as large in diameter, the orifice 0.09 mm, situated at the side of a peristome and connate with it for a short distance at the base.

Heller described the species from the Adriatic Sea, Hincks redescribed it from Great Britain, and O'Donoghue listed it from several localities in British Columbia and Puget Sound. It is possible that the species should be placed in the genus *Tubulipora,* but our specimens are incomplete in certain respects which prevent a final judgment. It has much resemblance to *D. intermedia* O'Donoghue but the measurements are larger and the fertile branches are adnate.

Point Barrow, Alaska, 21 fms, Arctic Research Laboratory, G. E. MacGinitie, collector. Also two specimens from Nash Harbor, Nunivak Island, Bering Sea, 8-10 fms, on a shell.

Diaperoecia intermedia (O'Donoghue), 1923

Plate 70, fig. 5

Tubulipora intermedia O'Donoghue, 1923:10.
Diaperoecia intermedia, O'Donoghue, 1926:23.

The zoarium is encrusting and branching, with short erect or semierect branches which form small capitula. The zooecial tubes are all on the ventral side. The stalks of the free branches are about 0.60 to 0.70 mm wide and the capitula may reach a maximum width of 3 mm. The peristomes are all free and moderately long to a maximum of 0.90 mm, width 0.16 mm, the aperture 0.13 mm.

The ovicell has its origin on the ventral side and expands upon the top of the capitulum where it surrounds several peristomes; it is considerably inflated and thickly perforated. The ooeciostome is more or less connected with a peristome at its base, nearly as tall as a peristome, and noticeably smaller, its aperture 0.10 mm in diameter, varying in its position but usually somewhere near the middle of the expansion.

O'Donoghue very properly questioned the generic position of this species, as the adnate portion of the zoarium is similar to that of *Proboscina* and the ovicell bears some resemblance to that of *Tubulipora.* The nature of the ovicell, enclosing a number of tubules, and especially the position of the ooeciostome near the middle of the expansion (occasionally quite proximal to it) suggest *Diaperoecia* where O'Donoghue finally placed it. It may possibly be one of the various northern species which have been described without the ovicell but there is at present no proof of synonymy.

The species was described from Departure Bay, British Columbia.

Our specimens are from Point Barrow, Alaska, 125 to 522 feet, G. E. MacGinitie, collector, common on shells and rocks.

Diaperoecia claviformis new species

Plate 66, fig. 11

Zoarium encrusting on a shell, consisting of a ligulate branch, 0.65 mm wide, which terminates in an asymmetrical rounded expansion 2 mm in width. The tubules are short, their outlines inconspicuous, 2 rows on the basal portion; the peristomes moderately high and unusually close together, not connate and not seriated, 0.16 to 0.18 mm in diameter, the apertures 0.13 mm; the younger tubules have the walls perforated with small pores but these become closed with age.

The ovicell is a conspicuous, ventricose area covering most of the expanded part of the lobe and enclosing 12 peristomes which are quincuncial in arrangement; among these the narrow lobes of the ovicell are evenly distributed around the peristomes. The ooeciostome is near the proximal end, a cylindrical erect tube, connate with a peristome at its base only, the orifice round and 0.10 mm in diameter.

The species has some resemblance to *D. johnstoni,* especially in the narrow ligulate branch and suddenly expanded lobe, but the measurements are smaller, the peristomes much more closely associated, and the meandering branches of the ovicell very narrow.

Type, AHF no. 92.

Type locality, Hancock Station 1624-48, off Santa Catalina Island, southern California, 33°23′48″N, 118°21′05″W, at 36 fms, one colony on a shell.

Family **Tubuliporidae** Johnston, 1838

"Zoarium entirely adherent, or more or less free and erect, multiform, often linear, or flabellate, or lobate, sometimes cylindrical. Zooecia tubular, disposed in contiguous series, or in single lines. Ooecium an inflation of the surface at certain points, or a modified cell." (Hincks, 1880:424).

"Cyclostomata in which the zooecia are restricted to one surface of the colony and are commonly arranged in connate alternating series. Cancelli are absent in the majority of the species. The ovicell is a modified zooecium which is usually much dilated in the region where the embryos undergo their development." (Harmer, 1915:119).

This is a large and difficult family and its analysis is complicated by the great number of fossil forms, often without ovicells, that have been described. As a rule they are adherent to the substratum, more or less lobate, with the zooecial tubes arranged in fascicles, and the ooecium

lobate among the fascicles. The early development is characteristic as they all begin with a few adnate tubules radiating in a flabellate form from one side of the pro-ancestrula; later the zoaria may assume various forms and even become erect and branched. The tubules are usually in connate series or groups but may be single over a large part of the zoarium or its entire surface, and may be biserially arranged or scattered. While the ovicells are usually broad and lobate between the fascicles, examples may be found in which they are almost as simple as in *Crisia* or *Oncousoecia,* and even in species with lobate ooecia, simple ovicells may appear on the same zoarium with lobate ones. Also the ovicells may occasionally surround tubules or fascicles as in *Diaperoecia.* The ooeciostomes are very important in the determination of the species, but in the various genera they may be terminal, subterminal or more centrally located.

Key to the Genera of Tubuliporidae

1. Zoarium adnate with slender lobes; tubules in connate single series, on each side of the midline; ooecium spreading the full width of the lobe between the fascicles, the ooeciostome proximal to the first tubule of a fascicle . . . . . *Platonea* 661
   Ooecium not so arranged 2
2. Ooecium arcuate and much depressed between the fascicles, the ooeciostome terminal at the middle of the arcuate ooecium; zooecial tubes thick-walled . . . . . *Bathysoecia* 658
   Ooecium not arcuate, the surface inflated 3
3. Zoarium composed of extremely high, folded fascicles; ovicell very elongate, simple, like a somewhat enlarged tubule . . . . . *Fasciculipora*
   Zoarium usually flat and adnate, rarely erect and branched; tubules in clusters, radiating series or single; ooecium usually broadly lobed between the tubules or fascicles, sometimes smaller and simple . . . . . *Tubulipora* 654

Genus **TUBULIPORA** Lamarck, 1816

Zoarium variable, encrusting and lobulate, repent and branching, or erect and branching. Zooecia all on the frontal surface, arranged more or less in transverse series or in groups, usually single near the ancestrula and occasionally over the whole zoarium. The ovicell is an inflated gonozoid between the tubules on the frontal surface, simple and pyriform

to broadly lobate with the lobes extending between clusters of tubules; the ooeciostome is usually located at the side of a zooecial tube, sometimes free from it or more or less connate, varying in size, height and form among the different species. Genotype, *T. transversa* Lamarck, 1816 (=*T. liliacea* Pallas, 1766).

Key to Species of *Tubulipora*

1. Zoaria comparatively large and coarse, often irregular in form, the ovicell usually much ramified, ooeciostome tall 2
   Zoaria smaller, often simply lobate, ovicell little ramified, the ooeciostome shorter 5
2. Ooeciostome high, much compressed, the aperture slit-like . . 3
   Ooeciostome high, little compressed, aperture ovate 4
3. Peristomes connate in series or bundles, ooeciostome tall and conspicuous, connate with a tubule at its base, enlarging upward and slightly flared, the aperture compressed (including var. *fasciculifera)* . . . . . *tuba*
   Peristomes sometimes in series, ooeciostome smaller and less conspicuous, its aperture more narrowly slit-like and not flared . . . . . *flabellaris*
4. Peristomes connate, forming high fascicles, the tips free; ooeciostome scarcely compressed, tall, about as wide as a peristome (0.25 mm), slightly expanded at the tip . *admiranda*
   Peristomes not at all connate; ooeciostome slightly smaller than a peristome, not compressed, its tip slightly expanded, not connate with a peristome . . . . . *egregia*
5. Zoarium with erect slender branches, idmoneiform; ovicell small, ooeciostome slightly distal to the first member of a fascicle, short, flared . . . . . *flexuosa*
   Zoarium adnate, small neat-appearing species 6
6. The dorsal side of the zoarium has numerous short attachment processes and near the base these give the edge a serrated appearance . . . . . *pulchra*
   No attachment processes 7
7. Zoarium widely flabellate; ooeciostome comparatively short, connate at base and widely diverging, flared at the tip to a width of 0.18 mm . . . . . *pacifica*
   Zoarium lobate, ooeciostome short erect, connate at base or free, flared at the tip to a width of 0.12 mm . . . . *concinna*

Tubulipora tuba (Gabb and Horn), 1862

Plate 68, fig. 9

Semitubigera tuba Gabb and Horn, 1862:169.
Tubulipora occidentalis Robertson, 1910:249.
Tubulipora occidentalis, O'Donoghue, 1923:8.
Tubulipora tuba, Canu and Bassler, 1923:198.
Tubulipora tuba, O'Donoghue, 1926:24.

The zoarium of this abundant species is always adnate, flat and rather regularly rounded or sometimes lobate on flat surfaces, variously contorted on stems; rather coarse, white, gray or purplish in color. The "peristomes" are nearly erect, 0.12 mm in diameter, varying greatly in length, as much as 2 mm in sheltered locations but usually much less; single near the primary zoid and sometimes over a considerable area, then connate in small fascicles of 2 or more, the marginal fascicles increasing in the number of peristomes to 6, 12 or even as many as 30. The fascicles are usually uniserial or biserial and radiating, but occasionally occur in rounded or irregular clumps; sometimes they are more or less biradial in arrangement, but this is rare.

The ovicell is usually a large lobate inflation extending between several fascicles, but not infrequently it is smaller, and even simple *Crisia*-like ooecia may occur on the same zoarium with the larger normal ones. The ooeciostome is tall, straight, compressed, regularly increasing in size toward the tip, usually a little flared at the top, the pore elongated in the direction of the fascial axis; in typical *tuba* the ooeciostome arises at the side of the first tube of a fascicle and is usually free for most of its length. The variations are discussed under the variety *fasciculifera* (Hincks).

Gabb and Horn described the species from the Pleistocene of Santa Barbara, California, and while their description and figure are incomplete, there can be no doubt. I have compared abundant recent and numerous Pleistocene specimens. Canu and Bassler listed both *tuba* and *fasciculifera* from the Pleistocene of California. Robertson described *occidentalis* (= both *tuba* and *fasciculifera)* and listed it from southern California to Puget Sound, and O'Donoghue recorded both from numerous localities in British Columbia.

In the Hancock Collections it is by far the most abundant species of the genus, taken at shore stations and dredged down to a depth of 117 fms. It is evidently a species of cooler waters as the most southerly record is that of Station 275, Raza Island, Gulf of California, 28°48′N, 113°W.

Tubulipora tuba var. **fasciculifera** (Hincks), 1884

Plate 68, fig. 10

Tubulipora fasciculifera Hincks, 1884:206.
Tubulipora occidentalis Robertson, 1910:249 (in part).
Tubulipora fasciculifera, Canu and Bassler, 1923:197.
Tubulipora fasciculifera, O'Donoghue, 1923:8; 1926:24.

The zoarium is very similar to that of *T. tuba,* presenting the same variations in form. The zooecia are also similar, the free portions of the tubules varying much in length and having the same diameter (0.12 mm). The only zoarial difference is that made use of by Canu and Bassler, the fascicles "never composed of more than 6 tubules," while in *tuba* there may be "from 6 to 20."

The ovicell, like that of *tuba,* is expanded into lobes which extend between the fascicles, and here also there is the occasional occurrence of simpler ooecia. The ooeciostomes are usually situated proximal to the first tubule of a fascicle, connate with it for a short distance, with the flattened ooeciopore transverse to the axis of a fascicle, the top of the ooeciostome sometimes a little flared.

After studying more than a hundred specimens from various localities, I am unable to distinguish sharply between *tuba* and *fasciculifera.* The above diagnoses are for well-marked specimens, but intermediate conditions occur in all of the diagnostic characters. Many colonies have only the smaller fascicles, others mostly small ones with a few larger fascicles, and still others have chiefly the larger numbers. Occasionally the long fascicles arise near the center of the zoarium, while in other specimens they are nearer the edge. The ooeciostomes of *tuba* are usually lateral to a tubule with the pore in line with the fascicle, but may be proximal to a tubule with the pore transverse, and in *fasciculifera* both of these conditions may sometimes be seen on the same zoarium. The form of the ooeciostome is variable though it is always more or less compressed; sometimes it is slightly flared at the tip, or it may be perfectly straight (possibly those in the latter condition have not quite completed their growth). If the size of the fascicles and the position of the ooeciostome were constant they would be considered good specific characters, but I do not find them so.

Hincks described *T. fasciculifera* from British Columbia, the exact locality not stated. Robertson mentions it under her description of *T. occidentalis,* which embodies some of the characters, and lists *occiden-*

talis from Puget Sound to southern California. O'Donoghue recorded it along with *occidentalis* from numerous places in British Columbia and Puget Sound.

The variety, if the varietal distinction is really worthwhile in this case, appears to occur throughout the range of *tuba,* in the same habitat, and they are found together in the Pleistocene at a number of places in southern California.

Tubulipora pacifica Robertson, 1910

Plate 68, fig. 1

Tubulipora pacifica Robertson, 1910:248.
Tubulipora pacifica, O'Donoghue, 1923:8; 1926:25.

The zoarium is encrusting, usually on algae; small (rarely more than 3 mm across), white and rather delicate; fan-shaped to nearly circular, or occasionally with lobes of the same form. The immersed zooecial tubules are long and slender, transversely arched and thickly punctate. The peristomes are moderately high, about 0.12 mm in diameter; near the center of the colony they are single but farther out they are usually fasciculate, with one or two rows of peristomes which are connate with the tips divergent; there is a tendency for them to be distributed biradiately, on either side of the zoarial axis.

The fully developed ovicell appears to be considerably larger than in *T. pulchra,* with as many as 3 or 4 lobes between the fascicles, but frequently they are much simpler, pyriform, and resemble those of *Crisia,* only more immersed, and all the intermediate conditions may be observed. The ooeciostome is comparatively short and is very briefly connate with the succeeding tubule at its base, sharply diverging proximally, or as Robertson expressed it, "It seems to emerge from the side of a zooecium at right angles to it." It is flared outward at the tip, compressed, the ooeciopore elliptical and about 0.18 mm in its greatest diameter.

At first glance the species has much the appearance of *pulchra* but the dorsal side is smooth without attachment processes, there is no serration of the margin at the base, the peristomes are larger, stiffer-looking and in adult colonies there is always some fusion of the peristomes into small fascicles. Robertson described and listed it from various shorewise localities in southern California, and O'Donoghue recorded it from numerous places in British Columbia. It has a wide distribution along the coast to as far south as Colombia; apparently a shallow-water species, but dredged down to 47 fms.

Hancock Collections: numerous shore stations and shallow-water dredgings about the off-shore islands of southern California; Station 225-34, Gorgona, Colombia, 2°58′55″N, the most southern record. Also Albatross collections, 1911 cruise, at San Francisquito Bay and San Esteban Bay, Lower California.

Tubulipora pulchra MacGillivray, 1885

Plate 68, figs. 2, 3, and 4

Tubulipora pulchra MacGillivray, 1885:95.
Tubulipora fimbria forma *pulchra,* Waters, 1887:258.
Tubulipora pulchra, Robertson, 1910:250.
Tubulipora pulchra, O'Donoghue, 1923:8; 1926:25.

A beautiful small, white, delicate species which adheres loosely to the substratum, usually a kelp, but frequently to shells. The zoaria are small, usually only 2 or 3 mm in extent, more or less fan-shaped or ovate, sometimes with lobes of the same size and form. A peculiarity of the dorsal surface is the presence of numerous short attachment processes which support the zoarium "on tiptoe," as Miss Robertson suggests; on the marginal zoids these are larger and project laterally to give the border a serrated appearance, especially near the ancestrula. The tubules are small, elongate and very slender; the peristomes are long and slender (0.08 to 0.09 mm in diameter), not connate and not seriated.

The ovicell or gonozoid is simple and little expanded, its form frequently resembling that of a *Crisia* but more embedded; at its fullest development there are 2 or 3 short lobes extending laterally between the peristomes. The ooeciostome is erect and moderately high; at the base it is about as wide as a peristome and at the tip it flares out into a compressed trumpet shape about twice the width of the base; it is never connate with another tubule.

MacGillivray described the species from Australia, Robertson recorded it from the southern California coast, and O'Donoghue found it at a number of localities in British Columbia.

Hancock Stations: numerous stations along the coast of California and among the Channel Islands; Station 72, Guadalupe Island, and 136-34, Clarion Island, west of Mexico; 468-35, Port Parker, Costa Rica; 462, James Island, Galapagos. Shore to a depth of 35 fms.

Tubulipora flexuosa (Pourtales), 1867

Plate 71, fig. 11

Idmonea flexuosa Pourtales, 1867:111.
Idmonea atlantica var. *flexuosa,* Smitt, 1872:6.
?*Idmonea atlantica* var. *tenuis* Busk, 1875:11.

? *Idmonea atlantica* var. *tenuis,* Hincks, 1880:452.
Tubulipora atlantica var. *flexuosa,* Harmer, 1915:127.
Idmonea atlantica var. *flexuosa,* Osburn, 1940:333.
Idmidronea atlantica var. *flexuosa* Osburn, 1947:5.

Pourtales gave only a brief description, in which the most important points are the slender, flexuous and round branches. Smitt re-worked Pourtales' material and gave a good description and figures. Unfortunately, to the present time, no one has observed the complete ovicell with ooeciostome. It is on the basis of the latter character, chiefly, that I am elevating it once more to full specific standing.

The zoarium presents the same general characters as the well-known *atlantica,* erect and branching from a small base, but the branches are very slender, much flexed and sinuous, and in cross-section they are round instead of being flattened on the dorsal surface. The fascicles are short, the tubules 2 or 3 in series (rarely 1 or 4), while in *atlantica* they are 3 or 4 to as many as 6, and they average a trifle smaller in diameter, connate to the tips and slightly narrowed upward from the base.

The ooecium and the ooeciostome (which is here described for the first time) are quite different from those of *atlantica.* The ooecium is short, usually occupying only two interfascicular areas, into which it spreads more or less, while that of *atlantica* is usually very elongate and is limited to the axis of the branches and not lobed laterally; the perforations of the ovicell wall also appear to be more minute and more numerous. The ooeciostome presents the most striking difference, as it is very short, erect, with a widely flared and rather thick border; it is located just medial to the first tubule of a fascicle and slightly separated from it. In *atlantica* the ooeciostome is about as tall as the tubules, curved distally, expanded gradually, situated on the distal side at about the second tubule of the fascicle, and its base connate with a tubule for a short distance; in the several ooeciostomes I have observed there is no intergradation.

This form was described by Pourtales and by Smitt from north of Cuba and later recovered by Osburn from Porto Rico and the southern shore of the Caribbean Sea. Harmer's reference (1915:127) from the Netherlands East Indies appears undoubtedly to be the same, for, while he did not have a complete ooeciostome, his fig. 1, plate 10, shows the base and pore in the characteristic position. Any attempt at a complete synonymy would be useless, and it will even be uncertain whether Busk's variety *tenuis* is the same as *flexuosa* until the ovicells are carefully studied. Also, there is no certain record of *Tubulipora (Idmonea) atlantica* from the eastern Pacific.

Hancock Stations: Raza Island, Gulf of California, 28°48′N, 113° W, at 40 fms, numerous colonies in reproduction; also one colony from James Island, Galapagos, at 54 fms.

Tubulipora concinna MacGillivray, 1885

Plate 67, fig. 5

Tubulipora concinna MacGillivray, 1885:94.
Tubulipora concinna, Harmer, 1915:123.

The zoarium is entirely encrusting on erect stems and on flat surfaces, the branches narrowly lobate and curved laterally, a small and delicate species. The slender peristomes are very elongate, 0.40 to 0.75 mm, strongly curved and often sinuate, sparsely punctate, about 0.09 mm in diameter and the aperture about 0.07 mm. On flat surfaces the peristomes are usually directed somewhat outward from the midline of the lobes, but on small stems they are very irregular in arrangement; for the most part they are distinct, but on the broader portion of the lobe they are frequently in series of 2 to 4 and connate to the tips.

The ovicells are small, almost as simple as in *Crisia,* narrow proximally and gradually expanded and sometimes slightly lobed between the peristomes, the frontal surface inflated and thickly punctate with very small pores. The ooeciostome is nearly terminal, free or in contact with a peristome, short, the aperture expanded and ovate in form, transverse and about 0.12 mm wide by 0.07 mm long.

Hitherto recorded only from Australia and the East Indies. Our specimens appear to agree in every detail with the description and with Harmer's beautiful illustration (plate 10, fig. 10), except that the ovicells are even simpler and less lobate; the ooeciostome is an exact counterpart.

Hancock Stations: 1924-49, off Guadalupe Island, west of Lower California, 28°54′08″N, 118°15′36″W, 25-30 fms, on algae, several colonies. Also on a sunken buoy brought up from 45 fms at Rocky Point (Earl Fox, collector), several colonies; one colony from "off San Pedro," without other data; and 12 colonies on a kelp stem washed up on shore at Palos Verdes (R. C. Osburn, collector), all from southern California.

Tubulipora egregia new species

Plate 67, figs. 6 and 7

The zoaria are encrusting, surrounding the stems of a coralline alga, in one case spreading across free from one branch to another; usually rough and irregular but one specimen has two flabellate lobes. The most

unusual feature is the size of the peristomes, which reach a length of as much as 0.75 mm (usually 0.40 to 0.60), and a diameter of 0.26 mm (0.30 at the base). The peristomes are entirely free at the tips and only rarely connate at the base, nearly erect, perforated with small pores nearly to the tips and the basal half or more transversely corrugated. The zooecial tubes are correspondingly large, 0.30 to 0.40 mm wide, arched in cross-section, thickly perforated and transversely corrugated.

The ovicell is irregularly lobate, rather flat and its surface thickly punctured, enclosing a few peristomes; the ooeciostome is an erect tube, distant from and smaller than the peristomes, slightly enlarging upward, the aperture ovate in form and its longest dimension about equal to that of the peristomes, finely wrinkled, thin-walled and not punctate.

The large dimensions of the non-connate and non-seriate peristomes, and the nature of the ovicell and ooeciostome easily distinguish this species.

Type, AHF no. 115.

Type locality, Hancock Station 22-33, La Plata Island, Ecuador, 1°16′S, 81°05′10″W, shore collecting, four colonies all with ovicells, Jan. 22, 1933. Another colony, with ovicell, from Hancock Station 136-34, Clarion Island, west of Mexico, at 32 fms.

Tubulipora admiranda new species

Plate 68, figs. 5, 6, and 7

The zoarium is rounded, slightly irregularly lobate, 10 mm broad, attached over most of its dorsal side but with the edges free. The center of the zoarium over a width of 4 mm bears only 5 free peristomes, due to the great length of the embedded tubules; outside of this area the peristomes rise in clusters of varying size, giving the surface a lobate appearance, though there are many free peristomes between the clusters. In the clusters the peristomes are connate for most of their length, but usually free at the tips.

The pro-ancestrula is round and measures 0.40 mm in width; the first tubule, which arises from its side, is 0.26 mm wide and 0.78 mm long, its peristome 0.55 mm in height. The succeeding tubules are remarkable for their length, the embedded portion 1.0 to 2 mm in length and the more or less erect peristomes usually about 1.0 mm but may be as much as 2 mm. The embedded tubules average 0.40 mm in width, slightly arched in cross-section, and are thickly punctate. The peristomes are about 0.25 mm in diameter, the pores extending nearly to the tips, slightly wrinkled, the apertures round and 0.20 mm in diameter.

The ovicells, three of which are complete, vary in size, with lobes extending between the fascicles, their surface rather flat and very thickly punctate. The ooeciostome is a large erect tube, about as wide as a peristome at the base, connate, tall, punctate to its tip, somewhat compressed and broader at the tip, its aperture about 0.30 mm wide by 0.18 mm long, and the edges of the long sides slightly inflexed; arising proximal to the base of a peristome; in one case the ooeciostome curves around the side of the adjacent peristome to open on its distal side.

The nearly free central area, the great length of the large tubules and the semi-erect clustered connate peristomes give this species an unusual appearance. The ooeciostome with its broad base resembles somewhat that of *T. phalangea,* but it is much larger and is not hooded as in that species.

Type, AHF no. 114.

Type locality, Corona del Mar, southern California, 33°36′N, one colony on the broad hold-fast of a kelp, washed up on the beach, R. C. Osburn collector.

Tubulipora flabellaris (Fabricius), 1780

Plate 68, fig. 8

Tubipora flabellaris Fabricius, 1780:430.
Tubulipora flabellaris, Harmer, 1899:99 (synonymy).
Tubulipora flabellaris, Robertson, 1910:247.
Tubulipora flabellaris, O'Donoghue, 1923:8; 1926:24.

The zoarium ranges in form from flabellate in younger colonies to round in older ones, completely adnate and attached to shells, stems, worm tubes, algae, etc., on flat surfaces usually very symmetrical and reaching as much as 8 mm in diameter. The central part of the colony is rather small, the first few peristomes free and often sinuate; beyond this area the peristomes are arranged in linear series (occasionally in small groups) of 2 or 3 or longer, irregularly radiating. The peristomes are high, slender, the apertures about 0.12 mm, connate for most of their length but the tips usually free.

The ovicell is more or less lobate, usually spreading between 3 or 4 fascicles, its surface rather coarsely punctate, and there is rarely any evidence of striation; the ooeciostome is a tall slender tube at the side of and partially connate with a peristome, much compressed toward the top and the aperture slit-like, measuring about 0.13 mm long by 0.04 or 0.05 mm wide.

It is a common species in the northern Atlantic, on the European coast, the American coast as far south as Cape Cod, and in the Arctic area from Spitsbergen west to Icy Cape, Alaska. Robertson recorded it from Puget Sound to southern California, and O'Donoghue from several localities in British Columbia.

Hancock Collections: dredged only once, Station 1122-40, off San Nicolas Island, southern California, 33°18′N, 119°24′10″W, at 30 fms. Also from Point Barrow, Alaska, Arctic Research Laboratory, G. E. MacGinitie, collector.

Genus **BATHYSOECIA** new genus.

Ovicell depressed between the erect tips of the zooecial tubules, irregularly arcuate in form with the ends of the arc prolonged distally into narrow lobes between the fascicles; ooeciostome at the distal border of the arc, median, small, erect and connate to a tubule only at its base. Zoarium rounded or lobate; the ancestrula and first few single tubules tubulipora-like; then the tubules become more or less erect in small groups, connate to their tips. Peristomes are often wanting except in older stages, when they arise around the aperture of the partially closed end of the tubules. Genotype, *Bathysoecia bassleri* Osburn, new species.

In the genotype the erect tubules are so closely connate that there is no exposure of the tubules except at their tips, where they produce a reticulum. In younger zooecia, near the zoarial margin the tubules are thin-walled and wide open; later the walls become thick at the tips and form an infundibular depression with a rounded aperture; still later around the aperture there rises a thin-walled peristome which projects upward from the bottom of the funnel.

The ovicell appears to be different from that of any other form among the Tubuliporidae. It is developed directly on the basal lamina before the tubules distal to it are formed. Later the connate tubules rise high around it on all sides of the ovicell, which appears as a depressed and irregularly arcuate area with a flat thin-walled surface. The ooeciostome is distal, median and connate with a tubule or between two of them, narrow and moderately high.

The only other species with similar tubules and ooecia that has come to my attention is the "? *Tubulipora (Tubularia* by error) *lobulata*" Osburn, 1933:16, from the Atlantic Coast of North America, which

appears to be congeneric; described below as *Bathysoecia hastingsae* new species. The status of *Tubulipora lobulata* Hassall and *T. lobulata* Hincks is also discussed under that species.

Bathysoecia bassleri new species

Plate 69, figs. 4, 5, and 6

Zoarium encrusting on shells, irregularly rounded or with short lobes; a narrow basal lamina; surface reticulated. The zooecial tubules are completely connate to their tips, nearly vertical, so closely set that their exposed ends occupy all of the frontal surface; more or less hexagonal, separated by strong ridges and their apertures widely funnel-shaped over most of the zoarium. The tubules arise from the basal lamina, at first prone but immediately curving upward to become more or less erect. They are completely connate from their origin and are so closely united that no line of separation is visible. As they approach maturity the distal exposed ends become partly closed by a funnel-shaped thickening which leaves a large rounded aperture at the bottom of the funnel. Most of the tubules remain in this condition, but in older areas some of them develop short, cylindrical peristomes inside of the funnel and may project slightly above it. The exposed ends of the zooecia, from ridge to ridge, measure 0.20 to 0.35 mm across, the apertures 0.18 to 0.20 mm, and the cylindrical peristomes of older zooecia 0.13 to 0.15 mm in diameter.

The ovicell is irregularly arcuate in form and so deeply submerged between the high walls formed by the connate tubules that it has none of the usual appearance of an ovicell. The frontal layer is thin in comparison with the wall of the tubules, and is perforated by minute pores (the only pores visible on the whole zoarium). The ooeciostome is located at the distal border in the middle of the arc, compressed and nearly as high as the tubules, connate with a tubule or often between two tubules; the ooeciostome slit-like, its long diameter paralled to the zoarial radius, the pore 0.15 to 0.20 mm long by about 0.06 mm wide.

The species is dedicated to Dr. Ray S. Bassler, whose extensive studies of the Bryozoa have been of great service to the author.

Type, U. S. Nat. Mus. no. 11050; paratype, AHF no. 116.

Type Locality, Lenard Harbor, Alaska, a branch of Cold Bay, Alaska Crab Investigation Sta. 60-40, 55°10′N, 163°30′W, at 25 fms, 4 colonies on shells. Also from Hein Bank, near Friday Harbor, Puget Sound, Washington, one colony, Dr. J. L. Mohr, collector.

Bathysoecia hastingsae new species

Plate 69, fig. 7

Tubulipora (Tubularia by error) *lobulata,* Osburn, 1933:16.
? *Tubulipora lobulata,* Whiteaves, 1874:215; 1901:111.

The zoarium is irregularly fan-shaped or lobed, completely adnate on stones and shells; thick, especially so near the middle, and sloping downward to a narrow basal lamina. The zooecial walls are heavily calcified, the tubules thick and the only exposed areas (near the ancestrula) transversely ribbed. There is no evidence of pores except slightly in the primary zooecial area. The peristomes are moderately high, erect, single, especially near the primary area; farther out they may be single, or connate in short lines or small groups. The erect portion appears to consist partly of the upturned distal end of the tubule, as in *B. bassleri,* new species, but the condition is not so striking; the remaining portion is the peristome, which is considerably smaller than the base on which it arises, diameter 0.16 mm; the peristome is present on most of the tubules (wherein it differs from *B. bassleri,* in which most of the tubules bear no peristomes).

The ovicell is similar to that of the genotype but its surface is less depressed, a flat, white, finely perforated layer; the chamber extends downward to the basal lamina, as it does in *B. bassleri.* The form of the ovicell is like that of *bassleri,* usually beginning with an arcuate portion and extending into narrow lobes which ramify more or less between the fascicles; in one case a fascicle has been completely surrounded. The ooeciostome differs sharply from that of *B. bassleri,* as it is a short erect cylindrical tube, not at all compressed, connate only at its base, and its tip circular and noticeably flared, 0.12 mm across and the pore 0.07 mm in diameter.

Twenty years ago Dr. Anna B. Hastings, after examining a specimen from Mount Desert, Maine, wrote me that "it is likely that it is *T. lobulata* Hassall," (Osburn, 1933:16). Now, with very mature judgment, Dr. Hastings has re-examined the whole problem and writes again (March 8, 1952) in part as follows:

"This time I say with confidence that three species are involved.

1. *T. lobulata* Hincks (not Hassall). Excellently described by Hincks. I need only to add that the ooeciostome is of similar diameter to the zooecial tubes, but shorter, and is attached to the side of one of them. It is widely open, directed upwards or a little obliquely with a slight out-turned rim.

2. *T. lobulata* Hassall. Differs from *T. lobulata* Hincks in having long oblique series of connate zooecia. (Hassall, 1841, pl. X, fig. 2). I think Norman may well have been right (MS. note) in referring it to *T. serpens (T. liliacea* Pallas).

3. *T. lobulata* ? Osburn. Resembles *T. lobulata* Hincks in its stout zooecia with thick transversely striated walls, and in the arrangement of the zooecia in the colony, separately or in small groups, but not in connate series; and in the depressed ooecia. Differs in its less ramified ovicell with the ooeciopore placed more or less symmetrically at the center of the distal border of the ooecium closer to, and behind rather than beside, a zooecial tube; in the small size of the ooeciostome and in the absence of an out-turned rim to the ooeciostome." (The last item must now be corrected as I have a complete ooeciostome with a slightly out-turned rim. R.C.O.)

It is a pleasure to be able at last to solve the long-standing problem of the position of the West Atlantic specimens of *"T. lobulata,"* which could not have been done without the careful analysis by Dr. Hastings, to whom I gratefully dedicate the species.

The species is now known to be distributed on the Atlantic coast from Mount Desert Island, Maine (Osburn, 1933:16); Gaspe (Canada), Hincks Collection (Hastings, in litt., British Museum), and Greenland, "Valorous," 1875, Norman Collection, (Hastings, in litt., British Museum). Now I am able to add the Bering Sea, and the species is certainly high northern and possibly circumpolar in its distribution.

Type, AHF no. 117.

Type Locality, Nunivak Island, Bering Sea (a large island off the west coast of Alaska, about 60°N, and 116° W) at 8 to 10 fms, on shell, 4 colonies. Another specimen is marked merely "Behring Sea," on shell.

Genus **PLATONEA** Canu and Bassler, 1920

Platonea Canu and Bassler, 1920:759; 1929:548.
Reptotubigera d'Orbigny, 1853:751 (in part).
Reptotubigera, Calvet, 1911:4.
Reptotubigera, Harmer, 1915:119.
Reptotubigera, Okada, 1928:492.
Reptotubigera, Borg, 1944:26.

This genus has been accepted by the above authors to include narrow, fasciculate species that are entirely adnate to the substratum, as described by d'Orbigny. But d'Orbigny made no reference to the ovicell, the first

species which he discussed, *R. neocomiensis,* does not appear to belong to the genus, and his fourth species, *R. ramosa* d'Orbigny, 1853:754, has been selected as the genotype of *Reptotubigera.* Since there must always be uncertainty when based only on zoarial characters, Canu and Bassler erected the genus *Platonea* with the description of the ovicell and ooeciostome and with *Reptotubigera philippsae* Harmer as the genotype. The ovicell is broadly lobed between the fascicles and extends to the borders of the zoarium on both sides and the ooeciostome is short, erect, more or less expanded and is located proximal to the first peristome of a fascicle and separated from it.

If we are to accept this type of ovicell as distinctive of the genus, the zoarial description must be modified to include several species which are only partly adnate or semierect, but which have the special characters of a broad ovicell extending between the fascicles and an ooeciostome which is short, isolated and located near a first peristome of a fascicle. This last character, however, is shared by some species of *Tubulipora.* Also the marginal basal lamina, which is characteristic of the adnate species, is wanting in the suberect species.

As with many of the Tubuliporidae it is difficult to draw sharp distinctions in all cases but, dismissing the other characters, the idmoneiform arrangement of the fascicles and the nature of the ovicell and ooeciostome, together present a very characteristic facies sufficient to give this group a distinct place among the genera of the Tubuliporidae.

While it is possible that some of the fossil species included by d'Orbigny under *Reptotubigera* will be found to agree with *Platonea,* there is no indication in his description or figures of an ovicell and all of his figures represent the peristomes as short and non-connate. I am therefore following Canu and Bassler in the use of *Platonea* for species in which the reproductive characters are present.

Platonea veleronis new species

Plate 69, fig. 2

Zoaria adnate, apparently attached to algae; usually consist of a single lobe but occasionally a single branch occurs; maximum length 5 mm, width 1.5 to 2 mm; the dorsal side not expanded beyond the lateral peristomes. The peristomes are arranged in series of 4 to 7, closely connate, except for one or two at the outer ends of the series; the aperture more or less quadrangular, measuring about 0.09 mm wide by 0.12 mm long. At the proximal end the peristomes are single or in short series. The fascicles are high, 0.50 to 0.70 mm, very regular, usually alternating on the opposite sides of the midline, the interspaces

The ovicell usually occupies 3 (sometimes 2, or 2 on one side with 3 on the other) of the interfascicular areas on each side toward the distal end and extends laterally the full width of the lobe, smooth or slightly wrinkled and perforated with very numerous minute pores. The ooeciostome is short, erect, about as wide as a peristome, the aperture suddenly expanded transversely and 0.09 mm long by 0.18 mm wide; located slightly proximal and medial to the first peristome of a fascicle and not connate with it. The ovicell is usually situated near the tip of the lobe, but in two cases there is an additional one situated more proximally, smaller and separated from the distal one by 2 or 3 fascicles.

Type, AHF no. 118.

Type locality, Hancock Station 450, Albemarle Island, Galapagos, 0°55′S, 90°30′W, at 60 fms. Also dredged at stations 190-34, Albemarle Island; 201-34 and 473, Hood Island; 411, Duncan Island; 452, Charles Island; 453, Gardner Island, and 484, Barrington Island, all from the Galapagos, at 25 to 75 fms. It is evidently well distributed among the Galapagos Islands but has not been noted elsewhere.

Platonea expansa new species

Plate 69, fig. 3

The zoarium consists of somewhat clavate lobes about 2 mm in width near the extremity, the tip rounded, loosely attached, apparently always on algae. The fascicles are unusually long, very regular and alternating in arrangement on each side of the midline of the lobe; the fascicles near the proximal end with 4 to 6 tubules, the more distal ones with about 7, closely connate to their tips, except for 1 or 2 at the outer ends which are either connate only at the bases or are entirely free. There is a moderately broad basal lamina. The apertures of the tubules are quadrangular in the connate series, round in the free ones, and measure about 0.14 mm in diameter. Distance between the fascicles averages about 0.24 mm.

The ovicell is very broad, extending to the outer ends of the fascicles, and occupying three interfascicular areas on one side and two on the other, smooth with numerous very small pores. The ooeciostome, proximal to the first peristome of a fascicle, is short, not connate, its diameter at the base noticeably wider than a peristome, directed somewhat proximally, flared widely at the tip, the opening transversely elliptical.

The length and regularity of the high fascicles is the most striking feature of the species.

Type, AHF no. 120.

Type locality, Hancock Station 190-34, Albemarle Island, Galapagos, 0°55′S, 90°30′W, at 58 fms. Also at Station 201-34, Hood Island; and 453, Gardner Island, Galapagos, 35 to 65 fms.

Platonea elongata new species

Plate 69, fig. 1

Zoarium adnate, slender, unbranched; the dorsal lamina narrow, 0.95 mm at its widest part, while the high fascicles project much beyond it to a width of 1.50 mm. The fascicles are regular and alternating on each side of a distinct midline, moderately high (0.40 to 0.50 mm); the peristomes all connate in series of 6 (5 to 7), their apertures rounded or slightly quadrate, 0.09 to 0.10 mm in diameter. There are no free peristomes or vestigial tubules at the lateral margin.

The ovicell is very elongate, its lobes occupying 7 interfascicular areas on each side and extending laterally the width of the lobe. The ooeciopore is located in the usual position beside the first peristome of a fascicle, but unfortunately the ooeciostome is broken away.

The zoarial characters are much like those of *P. veleronis* n. sp., but the lobe is much narrower. The most important character is the great length of the ovicell, covering 7 interfascicular areas on each side, while in the 11 specimens of *veleronis* from the Galapagos Islands there are never more than 3. There are no intermediate conditions presented and, until contradictory evidence is discovered, this must be considered a different species.

Type, AHF no. 119.

Type locality, Hancock Station 1064, off Santa Barbara Island, southern California, 33°30′01″N, 119°02′20″W, at 27 fms, one colony. Also at Station 1143-40, off Portuguese Point, southern California, 33°44′59″N, 118°22′35″W, at 16 fms, one colony.

Genus **FASCICULIPORA** d'Orbigny, 1847

Like most of d'Orbigny's descriptions, this one is very brief, "well characterized by its shell-like (testacés) branches, smooth exteriorly, terminating at the upper extremity in a fascicle of rounded, open cells." (Transl.)

Canu and Bassler, 1920:808, add the following: "This genus differs from *Frondipora* in its long fascicles not arranged on a single side of the zoarium."

Borg, 1926:303 and 382, gives a complete description of the genotype, *F. ramosa,* including the first information about the ovicell, which had not previously been noticed, no doubt for the reason that it is but little differentiated from the zooecial tubules. It is very elongate and slender, slightly expanded on the side of a fascicle, the aperture terminal and directed forward.

Borg is quite justified in removing this genus from the Frondiporidae, as the position and nature of the ovicells are very different. However there is no justification for Borg's resurrection of d'Orbigny's "Family Fascigeridae," since there appears to be no genus *Fascigera,* and the proancestrula and early development, which were hitherto unknown, are similar to those of the Tubuliporidae.

Fasciculipora pacifica new species

Plate 70, figs. 1, 2, 3, and 4

The zoarium is fungiform from a narrow base, the largest colony in my possession (somewhat broken) measures about 25 mm in height by 45 mm in the longest diameter, and the longest fascicles are 30 mm. The base, broken away, is evidently small. The primary branches are comparatively narrow at the base and gradually enlarge, either branching or becoming flabellate or folded into contorted fascicles which frequently coalesce at their tips or are bridged by small flabellate horizontal branches consisting of a few zoids. The surface of the adult colony resembles the meandering contortions of the human cerebrum.

The tubules are excessively elongate, 0.30 to sometimes 0.40 mm in diameter, in cross-section compressed and hexagonal, on the surface of the fascicles rounded and more or less indicated by separating grooves. At the tops of the fascicles the tubes do not project, but on the sides the occasional tubes which appear to be left behind in the elongation of the branch usually show a definite short peristome which is more or less erected and with a round aperture. The walls of the tubules are thickly perforated by small pores, but on the bases of the older fascia these are obscured by a secondary thickening which is more or less ribbed transversely.

The ovicells are little modified and resemble the ordinary tubules so much that they are easily overlooked. As they emerge on the lateral surface of a fascia they take their place among the normal tubules and are only slightly larger. They continue upward on a level with the tubules, becoming gradually wider until they are twice or three times as wide and with a nearly flat frontal surface. The ooeciostome is a

little sub-terminal and consists of a short tube more erect than the lateral peristomes and somewhat larger; the aperture is rounded but modified by irregular folding of the rim. The terminal portion of the ovicell usually extends a short distance beyond the ooeciostome and may be slightly lobate, and in one case it even surrounds the peristome of a neighboring tubule. Borg (1926:383, text figs. 83 and 84) shows the ovicell bifurcating at a branch in *F. ramosa,* with the ooeciostome terminal on one of the branches, but I have not observed this condition in *F. pacifica.*

Fortunately there are several stages in the development of young colonies, two of which show the ancestrula which has not been previously observed in this genus. These are typically tubuliporoid, with the first zoid emerging from the side and the several succeeding generations of zoids encrusting fan-shaped, as in *Tubulipora.* I would undoubtedly have mistaken them for young stages of that genus if I had not had a continuous succession of stages as well as the adult condition, from the same collection (Station 1193-40), for comparison. The tubules of the first few zoids are at first encrusting, then become semierect with elongate peristomes as in *Tubulipora.* After 3 or 4 generations of zoids, the fascicles begin to make their appearance and the zoarium becomes very irregular. D'Orbigny was not far wrong in his belief that this genus should be "partie de la même famille que les Tubulipores" (1847:20).

Type, AHF no. 121.

Type locality, Hancock Station 1193-40, Santa Cruz Island, southern California, 34°N. Lat., shore collection at low tide, numerous young stages encrusting stems, and fragments of the adult stage. Also a large colony from San Felipe, Mexico, 31°N. Lat., near the head of the Gulf of California, shallow water, presented by Dr. A. E. Noble.

Family **Entalophoridae** Reuss, 1869

Zoarium erect, branched, without joints; zooecial tubes elongate, opening on all sides of the rounded stem and branches; gonozoids usually situated near the tip of a branch or below a bifurcation, simple and elongate or swollen and perforated by zooecial tubes. The arrangement of the tubules on all sides of the cylindrical stem is the easiest diagnostic character.

The first stage of development is encrusting and tubuliporoid, and from this small base the erect portion of the zoarium arises. Owing to the mode of development there has been much difference of opinion as

to whether the family Entalophoridae should be maintained or whether *Entalophora* should be considered a genus of the Tubuliporidae. On the basis of the simple ovicell, alone, *Entalophora* would go very nicely under Oncousoeciidae, but *Bientalophora* Borg, with an expanded ovicell surrounding some peristomes, would necessarily be synonymous with *Diaperoecia* Canu. As so few species are known perfectly I am leaving the family to stand on the basis of the special zoarial character of a round, erect stem, with peristomes opening on all sides.

Genus **ENTALOPHORA** Lamouroux, 1821

Zoarium slender, erect, usually only 4 to 8 series of zooecial tubes constitute the stems and branches; the embedded tubes are very elongate, parallel, their peristomes curved sharply outward. Gonozoid simple, elongate, sometimes only a little wider than the zooecial tubes, located usually just below a bifurcation or near the end of a branch; the ooeciopore terminal. Genotype *E. cellarioides* Lamouroux, 1821:81.

Entalophora symmetrica new species

Plate 70, figs. 6 and 7

The zoarium is thick-stemmed, about 1.50 mm in diameter, branched twice dichotomously at about 90 degrees, the branches as thick as the main stem. The secondary branches are at right angles to the primary ones. The tubules are elongate and distinct, with well marked separating grooves, the pores numerous and conspicuous; about 12 tubules surround the stem equally on all sides and arranged more or less in quincunx. The peristomes are moderately high, inclined distally, somewhat tapered toward the tips and porous like the frontal for most of their length; diameter of the aperture 0.15 to 0.17 mm.

The ovicell is simple, pyriform, not extended between the peristomes, moderately inflated, its surface smooth; the ooeciostome is terminal, slightly elevated, more erect than the peristomes and slightly smaller, its aperture rounded and 0.12 mm in diameter.

This species has the zoarial form of a *Bientalophora,* but there are no covering kenozooecia, the tubules are evident throughout their length, and the gonozoid is of the simple type characteristic of *Entalophora.*

Type, AHF no. 122.

Type locality, Hancock Station 170-34, Stephens Bay, Chatham Island, Galapagos, 0°47′30″S, 89°31′W, at 32 fms, one colony without base.

Entalophora proboscideoides Smitt, 1872

Plate 70, figs. 8 and 9

Entalophora proboscideoides Smitt, 1872:11.
Entalophora proboscideoides, Canu and Bassler, 1928:160.
Entalophora proboscideoides, Osburn, 1947:4.

Zoarium erect, slender, branching widely, the stem composed of 6 to 8 very elongate tubules; the embedded tubules about 0.13 mm in diameter and the peristomes, which open on all sides of the stalk, about 0.10 mm. The longest peristomes are about 0.50 mm, perforated and lightly wrinkled like the embedded tubules.

The ovicell is simple, a distinct elliptical swelling of the distal end of a long tubule, 0.55 mm long by 0.35 mm wide, thickly perforated. The peristome is terminal, bent forward sharply, the aperture transversely elliptical, 0.13 by 0.06 mm.

Described by Smitt from west of the Tortugas Islands, Florida, at 68 fms. Recorded by Osburn (1947:4) from 8 stations along the southern shore of the Caribbean Sea (Hancock Atlantic Expedition, 1939), and by Canu and Bassler (1928:160) from the Pliocene of Bocas Island, Panama. Our one ovicelled specimen appears to agree in all details with those from the Caribbean Sea.

Hancock Station 457-35, Secas Islands, Panama, 12 fms.

Entalophora capitata Robertson, 1900

Entalophora capitata Robertson, 1900:328 (Plate 21, fig. 12 only); 1910:257.
Entalophora capitata, O'Donoghue, 1923:13.
Diaperoecia capitata, O'Donoghue, 1926:22.

Dr. Robertson's 1900 description is practically worthless as she confused this form with another species which Borg has since described (1933:325) as *Heteropora pacifica alaskensis.* In 1910 Robertson corrected the error and based her re-description on the specimen from which figure 12 of her former account was taken. O'Donoghue in 1926 placed the species under *Diaperoecia,* where, if only the nature of the ovicell is considered, it would seem to belong. The species has not appeared in the Hancock collections and I am unable to form a definite opinion.

Robertson's 1910 description is as follows:

"Zoarium arising from a flattened or encrusting base and growing from 5 to 8 mm in height. Zooecia tubular, uniting in a short, stout column terminating in a broad somewhat rounded head; distal ends free, usually extending for a considerable distance beyond the surface of the colony,

both of the supporting column and of the head. Ooecium an inflation of the surface of the head. Ooeciostome and ooeciopore slightly compressed, opening beside the zooecial aperture." Orca, Prince William Sound and Sitka, Alaska.

O'Donoghue listed it from several localities in British Columbia.

Entalophora sp.

Zoarium slender, nearly straight, 4 or 6 tubules constituting the stem, width 0.75 to 0.90 mm; the peristomes elongate, nearly at right angles to the stem axis, perforated like the tubules nearly to their tips. On the surface the tubules are more or less distinct, the whole surface transversely wrinkled and perforated with small pores; on the older part of the stem the peristomes also are wrinkled on the basal portion. There is a tendency toward spiral arrangement, though 2 or 3 peristomes may arise at nearly the same level. Width of stem 0.75 to 0.90 mm; width of tubules on the stem 0.30 mm; width of apertures 0.16 to 0.20 mm; longest peristome 0.65 mm but the average about 0.25 mm.

The specimen consists of part of a stem 20 mm in length, both base and tip wanting and without an ovicell. It has some resemblance to *E. proboscideoides* Smitt, 1872:11, but it is much larger, the apertures nearly twice as broad. The large size of the tubules, the width and length of the peristomes and the coarse transverse striation of the stem seem to indicate it as an undescribed species, but in the absence of an ooecium I hesitate to give it a name.

Hancock Station 450, Cartago Bay, Albemarle Island, Galapagos, 0°55′S, 90°30′W, at 70 fms.

Entalophora raripora d'Orbigny is listed by Robertson 1910:256 from Monterey, California, and by O'Donoghue, 1923:13, from several places in British Columbia.

Entalophora clavata Busk is also recorded by O'Donoghue, 1923:13, from several British Columbia localities.

Entalophora vancouverensis O'Donoghue, 1923:13, is described and recorded for Cardale Point, Round Island, British Columbia. From its appearance as judged by figure 7 (plate 1) it may be a species of *Bientalophora,* but O'Donoghue does not mention the presence of kenozoids on the stalk.

The Entalophoras are evidently much in need of a thorough restudy.

Genus **BIENTALOPHORA** Borg, 1944

"Zoarium erect, branching repeatedly, branches originating through forking of the stem; zoarium composed of autozoids, kenozoids and gonozoids. Kenozoids smaller and shorter than autozoids, always closed, numerous, forming greatest part of surface of zoarium. Autozoids protruding through layer of kenozoids, distal portions of their cystids arranged in quincunx or spirally, opening all around the stem. Gonozoids with middle portion large, strongly dilated, traversed by numerous autocystids; distal portion seemingly not terminal." (Borg, 1944:114). Genotype *Entalophora regularis* MacGillivray, 1887:219.

The two striking characters which distinguish this genus are: (1) the greater development of the ovicell which extends over a capitulum or broader area of the stem and surrounds some peristomes, and (2) the presence of a thin layer of completely closed small kenozoids over the zoarium between the peristomes.

The nature of the ovicell, enclosing peristomes, would place the members of this genus in *Diaperoecia* Canu, but as this character appears in a number of other genera which are zoarially quite distinct, I have come to the conclusion that parallel evolution may apply to the development of the ovicell as well as to the zoarium.

Bientalophora cylindrica new species

Plate 70, figs. 10 and 11

The zoaria are erect, with round straight stems and branches 1.50 to 1.60 mm in diameter; dichotomous, the branches diverging at an angle of about 60 degrees, the distance between branches about 1.50 cm; in one case two branches have fused where they came in contact. The branches are very slightly widened toward the tip. The bases of both of our colonies are broken away, but the remaining longest portion measures 17 mm in length. The general appearance is much like that of a *Myriozoum*.

The zooecia are distributed all around the stem, irregularly quincuncial, their tubes not visible on the surface. The peristomes are very short, the longest not more than 0.10 mm high, 0.15 to 0.17 mm in diameter, the apertures 0.12 or 0.13 mm. There are frequent small areas which are free from peristomes. The whole surface between the peristomes, clear up to the growing tips, is covered by a layer of small kenozooecia which are thickly perforated by small pores and their outlines marked by slightly raised lines. These kenozooecia form the

"lamina" which Waters, 1914:842, described under *B. (Entalophora) regularis*. The kenozooecia are smaller than the autozooecia, irregular in size and form but usually somewhat diamond-shaped.

There are no ovicells on our specimens so complete identification is impossible. There is considerable resemblance to *B. regularis* (MacGillivray), the genotype, as figured by Borg (1944, plate 11, figs. 3 and 4), but the diameter of the apertures is distinctly smaller, the diameter of the stems somewhat greater, and the peristomes noticeably shorter. Since *B. regularis* is known only from the Australian area, it seems preferable to give this California form a name.

Type, AHF no. 123.

Type locality, Monterey Bay, California, 36°N, 122°W, at 40 fms, F. P. Shepard, collector, two fragments.

Family **Frondiporidae** Busk, 1875

The zoarium consists of an encrusting, branched, ramifying base from which arise erect cylindrical fascicles which are usually separated by well-marked interfascicular spaces. The ovicell is developed between the fascicles, either simple or lobate, and is sometimes perforated by one or more tubules; the ooeciostome is but little elevated, in *Filifascigera* remote from any of the zoecial tubules, while in *Frondipora* Borg (1926, text fig. 81) shows it as a crescentic pore adjacent to the base of a tubule.

Genus **FILIFASCIGERA** d'Orbigny, 1852

"The colonies are creeping, narrow, linear, or curved. The tubes are grouped in salient, orbicular, or elliptical fascicles, regularly spaced. The orifices are polygonal. The ovicell is a vesicle placed between the fascicles and perforated by closed tubes." (Canu and Bassler, 1929:523). Genotype, *Filifascigera dichotoma* d'Orbigny, 1852.

This genus has been much neglected since d'Orbigny's time and until very recently has been known only as a fossil. Canu and Bassler (1928: 44) described *F. robusta* from Hawaii and found the ovicell for the first time. Later (1929:524) they described two other recent species, *F. pluripora* and *F. parvipora,* from the Philippines.

The above generic description requires a few additions. The orifices are not polygonal except in the fascicle and at its tip where the tubules are compressed together. The free peristomes, which rise as much as 0.40 mm above the tips of the fascicles, are cylindrical with circular apertures, all separated and curving outward. The fascicles are not always evenly

spaced and on a rough background may be quite irregular in distribution, anywhere from 0.20 mm to more than 1.00 mm apart. Apparently the genus is widely distributed over the central area of the Pacific.

Filifascigera clarionensis new species

Plate 69, figs. 8, 9, and 10

The zoarium is encrusting, tortuous, the branches narrow, averaging about 0.60 mm in width between the fascicles. The basal portions of the zooecial tubules are completely embedded with no separating grooves, the distance between the fascicles varying greatly, from 0.26 to 1.10 mm and averaging about 0.60 mm. The fascicles, or bundles of tubules, are nearly erect to a height of 0.40 to 0.50 mm, round or elliptical in cross-section, and consist of 2 to 8 tubules (6 is a characteristic number). The outlines of the tubules are evident only on the upper part of the fascicles. At the top of the fascicles the tubules end in free peristomes which are cylindrical, uniform in diameter or slightly flaring at the tips, and curved outward from the center, the longest being as much as 0.40 mm. The apertures are circular, about 0.11 mm in diameter, and the peristomes 0.14 mm in diameter.

The ovicell is a rather conspicuous non-lobate swelling between the fascicles and extending from one fascicle to the next, the peristomial tubes rising above its level; it measures about 0.55 by 0.80 mm. The ooeciostome is somewhat off-center, a short tube which flares outward at the edges, with a short-elliptical aperture; it is completely dissociated from any of the zooecial tubules.

The description is taken from two colonies from Clarion Island, one on a worm tube, the other on a coralline. Another colony from Santa Barbara Island, southern California, without an ovicell, appears to be the same, as the measurements agree, and it also encrusts a worm tube.

Type, AHF no. 125.

Type locality, Hancock Station 137-34, Clarion Island, 18°19′05″N, 114°44′25″W, at 25 fms. Also at 1067, Santa Barbara Island, southern California, 33°22′30″N, 119°03′45″W, at 55 fms; another at 1624-48, Santa Catalina Island, 36 fms, on a shell, and still another at 1914-49, San Cristobal Bay, Lower California, 27°24′48″N, 114°34′40″W, at 40 fms.

Filifascigera fasciculata (Hincks), 1880

Stomatopora fasciculata Hincks, 1880:441.
Proboscina fasciculata, O'Donoghue, 1926:17.

O'Donoghue gave no description of this species, but his illustration (plate 2, fig. 12) certainly shows a *Filifascigera* and it may well be the *S. fasciculata* of Hincks. The description of the species by Hincks is very complete, showing the erect arrangement of the tubules in bundles, well spaced and elevated, and he also figures the ovicell (plate 59, fig. 4) set between the fascicles with the ooeciostome off center and separated from the tubules. The ovicell has much the same appearance as that of *F. clarionensis* new species, described above, but the ooeciostome is much compressed and its pore almost slit-like.

The only question is whether O'Donoghue's species is that of Hincks, and that cannot be determined here as the species has not appeared in the Hancock material.

O'Donoghue records the species from Northumberland Channel and Gabriola Pass, British Columbia, and the San Juan Islands, Puget Sound.

A specimen from southern Alaska, U. S. Fisheries Alaska Crab Investigation, Sta. 82-40, may belong here, but in the absence of complete ovicells the identification is questionable. It is a much larger species than the preceding, the apertures measuring 0.16 to 0.18 mm in diameter. The one ovicell is properly located for this genus, but is incomplete and lacking the ooeciostome.

? **Filifascigera** sp.

Another species which probably belongs to this genus but may be a *Frondipora* was taken at Hancock Station 1914-49, off Guadalupe Island, west of Lower California, 28°52′N, 118°19′W, at 5-15 fms. The fascicles are larger and higher than those of *F. clarionensis* (the aperture 0.14 mm in diameter), and several fascicles sometimes arise from a single base to form a complex fascicle. The peristomes usually rise free above the top of the connate portion of the fascicle, as they do in *F. clarionensis*. The ovicell lies in the space between the fascicles of a complex fascicle with lobes extending among them. Unfortunately there is no evidence of an ooeciostome.

The material is too imperfect for positive identification but it is certainly different from either of the species mentioned above, especially in the nature of the complex fascicles and the ovicell. The small fascicles, usually of less than 8 tubules, would seem to remove it from *Frondipora*.

Division 2. **Articulata** Busk, 1859
(Camptostega Borg, 1926)
The Crisias

"Primary zoid erect, separated by a chitinous joint from the proancestrula; zoarium jointed; rhizoids present. Body wall a gymnocyst; vestibular sphincter present; brood chamber a gonozoid, moderately dilated in its middle part; polypide of gonozoid degenerating before having been fullgrown." (Borg 1944:133).

This division is clearly distinguished by the jointed zoarium, by the presence of rhizoids, which are formed of jointed series of kenozoids, and by the mode of development from the larva, all of which are different from the other divisions. On attachment the larva forms a dome-like structure, on the top of which the first functional zoid is produced and from which it is separated by a chitinous joint. There is only one family, the Crisiidae, with a number of genera, depending chiefly on the structure of the internodes.

The erect, jointed zoarial form is so strikingly different from any other cyclostome type of growth that the members of this Division are easily placed at once.

Family **Crisiidae** Johnston, 1838

The zoarium is erect and jointed, the zooecia in a single series or alternating in two series, or without definite arrangement in the older branches of *Crisulipora;* the internodes consist of one zooecium to many; attached by jointed radicles, rhizoids, which consist of a series of elongated, tubular kenozooecia. The ovicell is an enlarged zooecium (gonozoid) more or less pyriform in shape, with the ooeciostome (pore) terminal or nearly so. The characters of the ovicell and its ooeciostome are essential for the positive determination of most of the species of this family.

Key to the Genera of Crisiidae

1. Internodes of 1 or 2 zooecia; elongate filiform spines present . . 2
   Internodes with 1 to many zooecia; no filiform spines 3
2. Only one zooecium to an internode . . . . . *Crisidia*
   Two zooecia to an internode, fertile internodes may have 3 to 5; the ovicell is free for much of its length and the ooesciostome is on the dorsal side . . . . . *Bicrisia*

3. Sterile internodes of 1 to 3 zooecia, fertile ones of 3 to 5; ovicell adnate for its whole length and its ooeciostome terminal . . . . . *Filicrisia*
   Internodes of 3 to many zooecia, usually 5 or more except at the base; ovicell adnate for its entire length, the ooeciostome more or less terminal 4
4. Internodes with 2 alternating series of zooecia; ovicell prominent, expanded dorso-ventrally . . . . . *Crisia*
   Internodes with 2 to 8 or more zooecia in cross-section, not regularly arranged; ovicell expanded laterally between the tubules . . . . . *Crisulipora*

Genus **CRISIDIA** Milne-Edwards, 1838

Genotype, *Sertularia cornuta* Linnaeus, 1758.

Crisidia cornuta (Linnaeus), 1758.

Plate 71, fig. 1

Sertularia cornuta Linnaeus 1758:810.
Crisia cornuta, Hincks, 1884:203.
Crisia cornuta, O'Donoghue, 1923:7.
Crisidia cornuta, O'Donoghue, 1926:18.
Crisidia cornuta, Borg, 1926:260 and 349.

The zoarium is delicate, branching dichotomously, each branch consisting of a single series of zooecia, each zooecium constituting an internode. The zooecium is slender, elongate (0.60 to 0.80 mm long), distinctly arcuate; the succeeding zooecium arises on the dorsal side toward the distal end, paired when branching. Long filiform processes (1.0 mm or longer) often arise beside the zooecial base, jointed at the base and usually twice more; from their position and mode of origin these processes would seem to be vestigial zooecia; at any rate they are not homologous with the spines of other bryozoan orders.

The ovicell is a gonozoid, free with a terminal ooeciostome, and represents an internode; it never bears a spinous process.

Hincks and O'Donoghue have listed this species from several localities in British Columbia waters; otherwise it has not been noticed previously on the Pacific coast.

Hancock Stations: 1269-41, off Anacapa Island, at 41 fms; 1279-41, off San Miguel Island, at 40 fms; and 2042-51, off Long Beach Light, at 14 fms; all from southern California. Also off Pescadero Point, outside of Monterey Bay, California, A. E. Blagg, collector.

Genus **BICRISIA** d'Orbigny, 1853

Genotype, *Crisidia edwardsiana* d'Orbigny, 1839.

Bicrisia edwardsiana (d'Orbigny), 1839.

Plate 71, fig. 2

Crisidia edwardsiana d'Orbigny 1839:8.
Crisia cornuta, Robertson, 1900:328.
Crisia edwardsiana, Robertson, 1910:237.
Crisidia edwardsiana, O'Donoghue, 1926:18.
Bicrisia edwardsiana, Borg, 1926:260 and 351.

The zoarium is usually bushy, much branched, reaching a height of 50 to 75 mm, the tips of the branches curved forward. The zooecia are tubular, 0.50 to 0.70 mm long, somewhat arcuated, usually 3 to 5 to an internode (basally 1 or 2). Jointed "spinous processes," 1.0 mm or more in length, similar to those of *Crisidia,* are apparently vestigial zooecia.

The ovicell is somewhat elliptical in form and is free for nearly its entire length; a characteristic feature is the position of the ooeciostome on the dorsal side near the distal end.

Robertson evidently confused this species with *Crisidia cornuta.* Her specimens with "Internodes consisting typically of a single zooecium" must have been *cornuta,* while those of "two, three, four or five zooecia" are undoubtedly *edwardsiana.* Her figure of the ovicell, 1910, plate 19, fig. 10, is definitely *edwardsiana.*

Robertson listed this species (and *cornuta)* from Alaska to San Diego, California. O'Donoghue recorded it from the San Juan Islands, Puget Sound. It appears to be more common than *cornuta* on the California coast and extends farther southward.

Hancock Stations: 1320-41 and 1370-41, off Santa Catalina Island, shore to 18 fms; 1210, at La Jolla, shallow water; San Diego Jetty, shore (Dr. H. R. Hill); Newport Harbor on floats (R. C. Osburn); all from southern California. Also at 843-38, Lobos de Afuera Islands, Peru, 6°53′50″S, 80°43′30″W, at 25 fms. This beautiful but inconspicuous little species is probably more common than the number of stations indicates and possibly extends along the whole Pacific coast.

Genus **FILICRISIA** d'Orbigny, 1853

Genotype, *Crisia geniculata* Milne-Edwards, 1838

In younger stages of growth this genus resembles *Bicrisia* except for the absence of the spinous processes, but older specimens are readily

distinguishable by the conspicuous black joints and by the ovicell, which is more slender, adnate to the internode for its full length, and with a terminal ooeciostome.

Filicrisia geniculata (Milne-Edwards), 1838

Plate 72, fig. 5

? *Crisidia gracilis* Trask, 1857:113.
Crisia geniculata, Robertson, 1910:235.
Crisia geniculata, O'Donoghue, 1923:7; 1926:18.
Filicrisia geniculata, Borg, 1926:263 and 351.

Zoarium bushy, the branches nearly straight, reaching a height of 15 to 25 mm. The zooecia are tubular, straight, 0.60 to 0.90 mm long, 3 to 5 to an internode (except basally). In the older zooecia the joints are black and conspicuous.

The ovicell is long and but little inflated, adnate for its entire length, the ooeciostome situated near the dorsal border with its tube bent forward (sometimes straight). In the absence of the ovicell it is impossible to distinguish positively between this species and *franciscana.* For this reason the *Crisidia gracilis* of Trask must remain in doubt, though it appears to be one of these two species.

Robertson first noted the presence of this species on the Pacific coast and recorded it from Dillon Beach, north of San Francisco, to San Pedro, California. O'Donoghue listed it from numerous localities in British Columbia.

Hancock Stations: Not taken in dredging, but found at numerous shore stations in shallow water about the islands of southern California and along shore from Monterey Bay south to San Pedro, California; well distributed in this area, but never abundant. It appears to be more common farther northward.

Filicrisia franciscana (Robertson), 1910

Plate 72, fig. 4

Crisia franciscana Robertson, 1910:233.
Crisia occidentalis, Robertson, 1903:116.
? *Crisidia gracilis* Trask, 1857:113.
Crisia franciscana, Okada, 1917:338.
Crisia franciscana, O'Donoghue, 1923:7.
Crisidia franciscana, O'Donoghue, 1926:19.

This species resembles *C. geniculata* in practically all respects except for the ovicell. The zoarial form and the number of zooecia to the

internode are the same, and both have the characteristic black joints. The zooecia of *franciscana* are slightly larger and are usually more expanded toward the distal end.

The ovicell is more inflated than in *geniculata* and the ooeciostome is situated on the frontal border with its tube curved backward.

Reported by Robertson from Orca, Alaska, to southern California at numerous places, and by O'Donoghue from British Columbia. It is one of the most common crisias along the California coast from low tide to 25 fms. Okada also found it common in Japanese waters.

Hancock Stations: Numerous stations about the islands and along the coast of southern California from San Francisco southward to San Diego; Dillon Beach, north of San Francisco (R. J. Menzies); Mussel Point, northern California (A. E. Blagg); San Juan Islands, Puget Sound (J. L. Mohr); much more abundant than *C. geniculata,* often occurring in considerable masses on piles and floats; low tide to 50 fms.

Genus **CRISIA** Lamouroux, 1812

Genotype, *Sertularia eburnea* Linnaeus, 1758:810. In this well-known genus the internodes are longer, with 5 to as many as 30 or more zooecia in some of the species. These are arranged very symmetrically in two alternating series, the short projecting peristomes giving the edges a serrated appearance. The ovicells or gonozoids are usually in the midline of the frontal surface, between the rows of zooecia. It is unfortunate that the ovicells, which are often lacking, are necessary for the positive determination of most of the species. Dr. Alice Robertson gave an excellent account (1910:229-245) of the Pacific coast species known to her and her key is used here, with additions and slight modifications.

The little shrub-like colonies of the crisias are often abundant in shallow water, attached to anything that may afford a lodging place and conspicuous because of their chalky whiteness.

Key to the Species of *Crisia*

1. Ooeciostome with a cap-like flap extending forward above the aperture . . . . . *operculata*
   Aperture of ooeciostome without covering flap 2
2. Ovicell very short and wide, ooeciostome almost wanting, pore round; internodes long and slender . . . . . *elongata*
   Ovicell elongate and gradually expanding 3

3. Ooeciostome curved or bent forward 4
   Ooeciostome straight, though the opening may be directed somewhat forward 6
4. Branches of zoarium strongly curved forward; ooeciostome curved forward, its aperture elliptical and its proximal lip somewhat inflected . . . . . *eburnea*
   Branches straight and more divergent 5
5. Ooeciostome long, slender, conspicuously bent forward, its pore round . . . . . *pugeti*
   Ooeciostome short, pore elliptical; internodes long . . *serrulata*
6. Branches of zoarium curved inward or spicate at the tips; ooeciostome short, pore round or short elliptical . . *occidentalis*
   Branches straight and stiff, internodes long 7
7. Ooeciostome distinctly flared at the tip, transversely long-elliptical; a northern species . . . . . *cribraria*
   Ooeciostome not flared, short and inconspicuous, pore round and opening forward . . . . . *maxima*

Crisia serrulata, new name

Plate 72, fig. 2

Crisina serrata Gabb and Horn, 1862:174. (Preoccupied by d'Orbigny, 1853:598).
? *Crisia denticulata,* Hincks, 1884:203.
Crisia pacifica Robertson, 1910:242.
Crisia pacifica, O'Donoghue, 1923:7.
Crisia serrata, Canu and Bassler, 1923:196.
Crisia serrata, O'Donoghue, 1926:18.

Zoarium forming bushy tufts reaching a height of 25 mm. The internodes are long, ranging from 12 to more than 30 zooecia, the longer ones slightly sinuate and not inflected; joints yellow to brownish; *basis rami* of a branch short and wedged in between the zooecia without disturbing their position. The zooecia are connate nearly to their tips which turn forward sharply, the aperture facing frontally; the dorsal lip of the aperture sometimes with a low point. The frontal surface of the branch bears a median keel and the distance between the zooecial apertures is less than the width of the branch.

The ovicell is large, a little flattened, inclined in the axis of the branch and adnate for its whole length; the tube of the ooeciostome is short, opening either ventrally or distally, the aperture more or less elliptical.

Gabb and Horn described the species from the Pleistocene of Santa Barbara, California, overlooking d'Orbigny's previous use of *serrata;* Canu and Bassler listed it from the Pleistocene of Santa Barbara and Santa Monica, and the writer has found it in the Pleistocene of San Pedro and Newport Harbor, California. Robertson described *pacifica* from the "San Diego region only." O'Donoghue recorded it from numerous British Columbia localities, and it is a common species all along the coast from British Columbia southward to Cedros Island (28°N), and less commonly to the Galapagos Islands.

Hancock Stations: Dredged at more than 30 stations and taken at numerous shore stations, most abundant about the island region off southern California. Galapagos Islands, 5 stations: 152-34, Albemarle Island, shallow water; 170-34, Chatham Island, 32 fms; 193-34 and 198-34, Charles Island, 10-65 fms, and 804-38, Onslow Island. Also at 1051-40, Angel de la Guardia Island, Gulf of California, 21 fms.

Crisia occidentalis Trask, 1857

Plate 71, figs. 3, 4, and 5

Crisia occidentalis Trask, 1857:113.
Crisia eburnea, Robertson, 1903:116.
Crisia occidentalis, Robertson, 1910:239.
Crisia occidentalis, O'Donoghue, 1923:7; 1926:18.

Zoaria forming dense tufts reaching a height of 25 mm, the tips of the branches often inflected, especially in ovigerous colonies. The internodes consist of 3 to 5 zooecia near the base, the more terminal ones from 7 to 12; joints white to yellow; *basis rami* not wedged in between the zooecia but extending along the outer side of its mother zooecium, though there is some variation in this respect. The frontal surface of the internode is slightly keeled and the distance between zooecial apertures is about equal to the width of the branch. The zooecia are connate for their entire length, the tips directed forward; frequently there is a short point back of the dorsal lip of the tube, and the tips of the terminal branches often end in spinous points.

The ovicell is moderately large, elongate pyriform, inclined in the axis of the internode; the ooeciostome is situated a little back of the summit of the ovicell, with a short, straight or slightly curved tube, the circular aperture opening more or less upward.

One might conclude from Robertson's discussion that ovigerous colonies have only inflected branches and that only the male colonies have the terminal spinous points. This is not the case, however, as

ovigerous colonies frequently bear the pointed tips and their branches may be perfectly straight. Sex differentiation does not seem to be the answer to these variations.

Trask described the species from San Francisco, very inadequately. Miss Robertson accepted the name and redescribed the species, recording it from Puget Sound, Washington, to San Pedro, California. O'Donoghue listed it from Banks Island and Gabriola Pass, British Columbia. It is a common species along the California coast from low water to 30 fms, and south rarely to the Galapagos Islands.

Hancock Stations: Dredged at 12 stations, mostly about the islands off southern California. Station 470-35, Port Parker, Costa Rica, 5 fms, and 85-33, North Seymour Island, Galapagos, shore collection. The number of the dredging stations does not indicate the abundance of the species, as it is much more common in shallow water near shore.

Crisia operculata Robertson, 1910

Plate 71, figs. 6 and 7

Crisia operculata Robertson, 1910:240.
Crisia operculata, O'Donoghue, 1923:7.

The zoarium is fragile, with irregular tufts reaching a height of about 20 mm; internodes consist of about 10 to 20 zooecia, though the number may reach 30 or more; the frontal surface rounded but not keeled, the *basis rami* exposed for most of its length. The zooecia are very slender, connate for most of their length, though the free tips are longer than in most crisias. The distance between the zooecial apertures is considerably greater than the width of the internode.

Ovicell elongate pyriform, inclined to one side of the internodal axis; "the dorsal wall of the ooecium extending upward and forward covering the ooeciostome as with a lid or cap, the *operculum*" (Robertson). The ooeciopore is a semicircular slit beneath the cap.

The species was described from "one station on the southern California coast, depth not known." O'Donoghue recorded it from Houston Passage, British Columbia, 15 fms.

Hancock Stations: dredged at only 4 stations: 1378-41, Santa Catalina Island, southern California, 2-3 fms; 1049-40, Angel de la Guardia Island, Gulf of California, shore; 675-37, Pulpito Rock, Gulf of California, 55 fms, and San Francisco Island, Gulf of California, 47 fms, 24°47′35″N, 110°35′55″W, the most southern record. Apparently it is not a very common species.

Crisia maxima Robertson, 1910

Plate 72, fig. 3

Crisia maxima Robertson, 1910:243.
Crisia maxima, O'Donoghue, 1923:7, 1926:18.

Zoarium coarse, stiff, with straight, long internodes, resembling *C. serrulata* in its manner of growth, but coarser and larger, occasionally more than 50 mm in height. The internodes are elongate, usually with from 12 to 20 zooecia but may contain more than 40; older joints dark brown; *basis rami* not wedged in between the zooecia. The zooecia are closely connate to their tips, which are turned sharply forward; the distance between their apertures is greater than in *serrulata,* usually distinctly greater than the internodal width. The front of the internode is slightly arcuate in cross-section and not keeled.

The ovicell is large, the frontal surface prominent, the distal end more or less truncate; the tube of the ooeciostome is short, straight, slightly tapered and opens more or less ventrally.

Recorded by Robertson on the southern coast of California from between tide marks at Escondido, Deadmans Island (San Pedro), and White's Point, and dredged from San Pedro to Coronado Island down to 40 fms. O'Donoghue lists it from several British Columbia localities down to 25 fms.

Hancock Stations: 31-33 and 362-35, Hood Island, Galapagos, 1°22′52″S, 89°39′15″W, at 4 to 20 fms (the most southerly record); also at 352-35, Chatham Island, 35 fms; and 810-38, Barrington Island, 48 fms, Galapagos. Station 1051-40, Angel de la Guardia Island, Gulf of California, 21 fms; 870-38, Isabel Island, west of Mexico, 10-15 fms; and 894-38, San Miguel Island, 5-15 fms, 1238-47, San Clemente Island, 14 fms, and 1232-47, off San Pedro, 18 fms, southern California. Also off Pescadero Point, near Monterey Bay, California (A. E. Blagg, collector).

Crisia eburnea (Linnaeus), 1758

Plate 71, fig. 10

Sertularia eburnea Linnaeus, 1758:810.
Crisia eburnea, Hincks, 1880:420; 1884:203.
Crisia eburnea, Osburn, 1912:215; 1923:5D.

Zoarium forming dense bushy tufts, the branches characteristically curved forward. The internodes are short, usually 5 to 7 zooecia, the joints yellow, sometimes dark near the base. Zooecia almost entirely connate, the short free portions nearly at a right angle to the tubules.

Ovicell large, curved forward, usually replacing the second zooecium of an internode; the ooeciostome curved forward, widest at its base, the pore transversely elliptical and the proximal margin somewhat inflected.

This is a very common species on the coasts of Europe and North America (Atlantic coast) and entering the Arctic Ocean, common in Greenland waters. Recorded for Icy Cape and Point Barrow, Alaska by Osburn, 1923:5D. Hincks (1884:203) reported it from Virago Sound, British Columbia, but this record appears to be questionable as the species has not been recovered south of northern Alaska, and he may well have confused it with *C. occidentalis* Trask, which has the same growth form of incurved branches and is common in British Columbia waters.

Point Barrow, Alaska, 18 fms, Arctic Research Laboratory, G. E. MacGinitie, collector.

Crisia cribraria Stimpson, 1853

Plate 72, fig. 1

Crisia cribraria Stimpson, 1853:18.
Crisia eburnea var. *cribraria,* Verrill, 1879:28.
Crisia eburnea var. *cribraria,* Whiteaves, 1901:110.
Crisia cribraria, Osburn, 1912:215; 1912a:276; 1933:8.

The zoarium consists of nearly erect, straight and stiff flabellate branches rising to a height of 20 to 25 mm. The internodes are long, usually about 18 or 20 zooecia, the joints occasionally wanting. The zooecia are almost completely fused, with only a very short peristome which curves abruptly forward and slightly toward the axis of the branch, a sharp projection often present on the outer border of the aperture.

The ovicells are large, elongate, the distal end prominently rounded and more or less obscuring the ooeciostome from a frontal view. The ooeciostome is short and broad, the aperture almost slit-like, the tip somewhat flared outward.

Stimpson described the species from Grand Manan Island, Maine, and it is a fairly common species along the east coast of North America as far south as Cape Cod.

Point Barrow, Alaska, 7 fms, Arctic Research Laboratory, G. E. MacGinitie, collector; two colonies in reproduction.

Crisia elongata Milne-Edwards, 1838

Plate 71, fig. 9

Crisia elongata Milne-Edwards, 1838:203.
Crisia elongata, Harmer, 1915:96 (synonymy).
Crisia elongata, Canu and Bassler, 1928:157.
Crisia elongata, Osburn, 1940:328; 1947:3.

Zoarium with long, slender, sprawling branches; the internodes elongate, usually with about 14 to 16 zoids but ranging from 6 to 30 or more, the joints of both branches and radicles jet black (brownish in younger areas of the colony). The tubules of the zooecia are embedded and their outlines scarcely visible, their peristomes short and turned sharply forward, with usually a small denticle behind the distal border.

The ovicell is situated usually near the middle of an internode, short, suddenly and broadly inflated; the ooeciostome is little or not at all elevated and its pore is a transverse slit.

Our rather scanty material agrees well with Harmer's excellent description (1915:96) and with specimens from the West Indian region. It is my opinion that the *C. eburnea* forma *denticulata* of Smitt (1872: 4), the *C. denticulata* of Osburn (1914:185) and the *C. denticulata* of Canu and Bassler (1928:156), all from the Gulf of Mexico and the West Indian region, should be referred to *C. elongata.*

Hancock Station, 277-34, off Isabel Island, Gulf of California, 21° 51′35″N, 105°30′W, at 10-25 fms. It is apparently a circumtropical species.

Crisia pugeti Robertson, 1910

Plate 71, fig. 8

Crisia pugeti Robertson, 1910:244.
Crisia pugeti, O'Donoghue, 1923:8; 1926:18.

The zoarium is rather stiff and straggling in appearance, the internodes varying greatly from 7 to more than 30 zooecia. The joints are colorless or slightly brownish in older zoaria. The branches are rather numerous, 3 or 4 to an internode, the *basis rami* usually exserted but sometimes short, always a branch immediately above the top of the ovicell.

The ovicell is usually situated low in the internode, most frequently the third member of the internode; elongate, expanding rapidly near the base and maintaining the same width for most of its length; considerably inflated and adnate to the internode for its full length. The

ooeciostome is longer than usual, turned forward sharply, the aperture round or slightly elliptical; when the ooeciostome is fully developed this is the most striking character of the species.

Described from Friday Harbor, Puget Sound. O'Donoghue has also recorded it from a number of localities in British Columbia at 10 to 25 fms.

Hancock Collections: Clayoquot Sound, British Columbia, at low tide, E. F. Ricketts, collector.

Crisia denticulata (Lamarck), 1853

Hincks (1884:203) reported this species from Houston-Stewart Channel, British Columbia, without description. As it has not been noticed since on the Pacific coast it seems probable that he had another species, possibly *C. serrulata* Osburn, which is common in that area and which has some of the characters of *denticulata.*

Crisia californica d'Orbigny, 1853

Crisia californica d'Orbigny, 1853:599.
Crisia californica, Busk, 1875:8.

What this species from "Basse-Californie" may be is altogether problematical, as d'Orbigny's description is so indefinite as to be useless and is without illustration. Busk merely translates d'Orbigny's description and questions whether it may refer to *C. denticulata,* which is not at all likely. The name should be dropped.

Crisia punctata d'Orbigny, 1853

Crisia punctata d'Orbigny, 1853:600.

This species is also entirely unrecognizable from the very short description and lack of figures. It was recorded from the Gulf of California "Ile du Venado, mer Vermeille, en Californie." The name should be dropped.

Genus **CRISULIPORA** Robertson, 1910

"Zoarium erect, dendroid, composed of internodes united by chitinous joints. Zooecia tubular, disposed in several alternate rows. Ooecium an inflation of the surface of an internode." (Robertson, 1910:254). Genotype, *Crisulipora occidentalis* Robertson.

In addition it should be stated that, similar to *Crisia,* there are jointed rhizoids or radicles consisting of tubular kenozooecia; the primary disc is separated from the primary zoid by a joint; the primary zoid arises from the top of the primary disc and not from its side; the lower internodes of the colony and its branches are uniserial or biserial; and the rhizoids, which are exactly like those of *Crisia,* often give rise to branches. For these reasons I agree with Borg (1926:475-6) in placing *Crisulipora* in the family Crisiidae.

On the other hand, the ovicell usually resembles that of the Diaperoeciidae where Canu and Bassler (1920:749) have placed the genus. The gonozoids are more or less embedded between the autozoids and sometimes they are expanded and surround a few peristomes. In narrower branches, however, they are simple, as those of *Crisia,* the only difference being that they are more embedded between the neighboring tubules.

Crisulipora occidentalis Robertson, 1910

Plate 72, fig. 6

Crisulipora occidentalis Robertson, 1910:254.
Crisulipora occidentalis, Okada, 1917:342.
Crisulipora occidentalis, Marcus, 1937:21.

The zoaria form large, stiff, often tangled masses, to a height of 30 mm, attached by jointed radicles; additional zoaria are often produced from creeping radicles. Internodes long, separated by chitinous joints, the terminal ones gently curved backward, the more proximal ones shorter and straight. In the proximal internodes the zooecia number from 1 to 3 or 5, but terminal ones may have 40 or more. The zooecia are not symmetrically arranged as they are in *Crisia,* but are irregularly distributed. Cross sections of fertile internodes may show as few as 4 or 5 zooecia, or as many as 8 to 10 at the widest part. Branching is like that of *Crisia,* with a more or less exserted *basis rami.*

The zooecial tubes are slender and elongate, the frontal surface rounded in cross-section and the separating grooves quite distinct. The peristomes are moderately long, gently curved forward, a little narrower than the tubules, the aperture round and about 0.12 mm in diameter; in the basal internodes the tubules often show a rather regular alternate arrangement.

The ovicells are elongate, narrowly wedge-shaped proximally and widening gradually upward, with much variation in size and form; and

there may be as many as 3 to an internode. In the narrower internodes they may be as simple as those of *Crisia* (though more embedded), with a terminal ooeciostome which is smaller than a peristome and may terminate simply, or the rim may be expanded and slightly bell-shaped, the pore round. On broader internodes the ovicells are more expanded laterally and sometimes extend beyond the ooeciostome, and occasionally a few of the neighboring peristomes are surrounded.

"... at low tide almost anywhere on the coast of Southern California. ... It has been dredged off the coast, from San Pedro to San Diego in depths ranging from 2 to 17 fathoms." (Robertson). Okada has recorded the species from the Bay of Sagami, Japan, and Marcus reports it from Santos Bay, Brazil.

Hancock Stations: Dredged at 28 stations, all the way from Point Conception, California to Peru. Station 844-38, Lobos de Afuera Islands, Peru, 6°55′40″S, 80°43′50″W, shore to 30 fms, the most southerly record; 31-33, Hood Island, Galapagos, 1°22′52″S, 89°39′15″W, at 4 fms; 308, Bahia Honda, Panama; Clarion Island, west of Mexico; 7 stations in the Gulf of California; Dewey Channel west of Lower California; and abundant about the Channel Islands off southern California as well as along shore; from low tide mark to a depth of 47 fms.

Division 3. **Cancellata** Gregory, 1896
(Pachystega Borg, 1926)
The Horneras etc.

The primary zoid is erect but not separated from the ancestral disc by a joint; the zoarium is not jointed, erect, usually branched like a tree. The "wall of zoarium double, consisting of a gymnocyst and cryptocyst, the latter undergoing a process of secondary calcification, by which the zoarium in its older parts becomes very strongly calcified." (Borg, 1944:175). The ovicell or brood-chamber is a much expanded gonozoid, usually situated on the dorsal side or between two branches.

Borg (1944:179) included the families Horneridae and Crisinidae, and erected three new families, Steghorneridae, Pseudidmoneidae and Calvetiidae, but did not discuss the Cytisidae.

The only families we have to deal with are the Horneridae and Cytisidae.

Family **Horneridae** Smitt, 1867

The zoarium is erect, branching like a tree, with rounded stems and branches; the zoids opening on the frontal side only; the inflation of the gonozoid or ovicell on the dorsal side of the zoarium. The family has not hitherto been recorded from the Pacific coast of America.

Genus **HORNERA** Lamouroux, 1821

With the characters of the family. Genotype, *Hornera frondiculata* Lamouroux, 1821. The zoarium with a moderate encrusting base, an erect round stem which branches like a tree with the successive branches diminishing in diameter, and the zooecia all opening on one side, easily distinguish the genus. The species are usually highly colored red or purple.

Hornera pectinata Busk, 1861

Plate 72, figs. 10, 11, and 12

Hornera pectinata Busk, 1861:79; 1875:18.
Hornera pectinata, Johnson, 1897:61.
Hornera pectinata, Norman, 1909:280.

The zoarium is erect, flabellate, the short main stem rising from a slightly expanded base; height 25 mm; the base measures 5 by 7 mm, the main stem 3 mm, the larger branches about 2 mm, the terminal branches just below the tips 0.50 to 0.60 mm. The branching is in one plane, irregular with a tendency toward dichotomy; the main branches are rather regularly tapered from base to tip; all of the branches are round even in the youngest stages. Stunted branches rare. Apparently purple when living.

The zooecia are irregularly arranged in more or less transverse rows of 2 to 4 tubules, connate or separated and often single. All of the peristomes are short, but the outer ones are slightly longer. On older branches the apertures are nearly level with the surface, the apertures round, 0.20 to 0.24 mm in diameter, the rim of the peristome thin, often slightly flared and delicately serrate (never incised), the points being the tips of the parallel ridges or thickenings of the peristome. The longest marginal peristomes are seldom as much as 0.20 mm in height. The sulci are strongly developed on both frontal and dorsal sides and the pores are round or slightly elongate. The ridges between the sulci are very irregular on the frontal surface, but are continuous and more or less parallel on the dorsal side. Complete calcification of the zoarium

extends only about one third of the distance above the base and the peristomes protrude above the level of the front on the whole upper two thirds of the zoarium. Ovicells are not developed on any of our specimens, and in their absence positive identification is impossible. However, the zoarial characters given by Johnson (1897:61) in his amplification of Busk's description of *pectinata* apply very well to our specimens:

"branches terete . . . ultimate branches tapering . . . Anterior surface pierced by numerous oval pores, which are sunk in depressions and have slightly raised borders. Between the pores the surface is irregularly ridged. The pores on the dorsal surface are larger and are partially filled up inside. The peristome is minutely dentate."

Johnson also describes the ovicell, "dorsal, brownish, semiglobular, and the surface is thickly set with warts, each of which has a depression at the top with a perforation therein."

The species has been recorded only from the Madeira Islands.

Hancock Stations: 1397-41, Santa Rosa Island, 33°38′40″N, 119° 58′30″W, at 77 fms; 1299, off Point Firmin, 33°41′45″N, 118°17′50″ W, at 18 fms; and off Santa Catalina Island, 33°24′15″N, 118°13′30″ W, at 228 fms; all from southern California.

Hornera pinnata Canu and Bassler, 1929

Plate 72, figs. 7, 8, and 9

Hornera pinnata Canu and Bassler, 1929:550.

The zoarium is erect from a very small base, the branching dichotomous and irregular, the branches with short pinnules of various sizes. There are usually two rows of peristomes on each side of the midline, sometimes only one row, irregularly alternating, the outer ones the longer. The frontal surface is deeply grooved, the pores conspicuous and 3 to 5 in number on each tubule. The peristomes measure about 0.12 mm in diameter and the aperture about 0.10 mm. The pinnules (dwarfed branches) vary greatly in size and the number of their tubules varies from 3 to 8; sometimes a pinnule ends in a blunt point with a peristome medially placed at the tip. The dorsal side of the zoarium is deeply grooved longitudinally, with conspicuous pores at the bottom of the grooves.

Ovicells are wanting on all of our specimens, so it is impossible to be absolutely certain of the species, but the zoarial characters seem to agree closely with the description of *pinnata*. Also I have for comparison an ovicelled specimen from Hawaii which is undoubtedly *H. pinnata*. The

diameter of the peristomes is only slightly larger, the arrangement and number of the tubules and pores is the same, and the nature of the pinnules corresponds.

It was described from the Philippines, the China Sea and Borneo.

Hancock Stations: 1323-41, off Santa Catalina Island, southern California, 33°14′40″N, 118°12′15″W, at 152 fms; 2158, Ranger Bank off Cedros Island, west of Lower California, 81 fms; and 299, San Jose del Cabo, near the southern tip of Lower California, 22°56′15″N, 109°47′15″W, at 83 fms.

Family **Cytisidae** d'Orbigny, 1854

Genus **DISCOCYTIS** d'Orbigny, 1854

D'Orbigny (1854:1061) gave an unusually careful and full description of this genus, in which he mentioned the attached base upon which rises a narrow peduncle expanding upward into a cupuliform head, the whole zoarium shaped like a wine-glass; the upper surface very concave or infundibuliform at the center and the margin with numerous simple or branched fascicles. He also observed and figured (Plate 798, fig. 8) the unusual position of the ovicell on the under side of the cup above the peduncle. Genotype, *Pelagia eudesii* Michelin, 1844:123.

This genus has been known only as a fossil from the Cretaceous until O'Donoghue (1926:26) described *D. canadensis* as a recent form from British Columbia. In the Hancock Collections there are several zoaria which are similar and which fill all the requirements of *Discocytis*.

Discocytis californica new species

Plate 69, fig. 11

The zoarium is attached by a round thin disc, from the center of which rises a comparatively thin cylindrical peduncle; at the upper end this widens gradually into a funnel-shaped head or capitulum like an inverted cone, the whole structure resembling a minute and moderately short-stemmed wine glass. On its upper surface the capitulum is concave and the whole central area is occupied by rather large cancelli with thick walls and rounded apertures. Around the rim of the cup the functional tubules are arranged in short fascicles, 8 to 10 in number, completely connate, the apertures measuring about 0.10 mm in diameter. The base and stem show no open tubules and appear as if covered by a thin pellicle. The measurements of the various zoarial parts are, on

our largest specimen: height 1.75 mm, width of base 1.20 by 1.30 mm, width of stem 0.53 mm, length of stem 0.60 mm, height of capitulum 1.15 mm, width of capitulum 1.57 by 1.70 mm, height of fascicles 0.25 mm.

The ovicell is very large, conspicuous, rounded and bulbous and is situated on the under (dorsal) side of the capitulum close to the base of the fascicles, its width 0.55 by 0.65 mm. A portion of the wall is broken away and the ooeciostome is wanting. On another, somewhat smaller, specimen there is a smaller ovicell of similar appearance, and it also has been injured.

At first I presumed this to be *D. canadensis* O'Donoghue, 1926:26, but it is much smaller, the ovicell is strikingly different in form, and O'Donoghue describes the capitulum as broad and flattened.

Type, AHF no. 124.

Type locality, off Rocky Point, southern California, about 33°49′N, encrusting on a sunken buoy at a depth of 45 fms, three colonies.

Discocytis canadensis O'Donoghue, 1926

Supercytis digitata, O'Donoghue, 1923:16.
Discocytis canadensis O'Donoghue, 1926:26.

This species has not been found in the Hancock Collections, but the following digest of O'Donoghue's description is here given to indicate the differences. Zoarium cupuliform; base small, flat and circular; stalk short, narrow, expanding into a broad, flattened funnel-shaped capitulum, from the edge of which a number of pinnules radiate outward; each pinnule (fascicle) consists of 12 to 20 tubes closely connate. Largest specimen 4 mm high, the stalk 1.75 mm thick, and the capitulum 7.25 mm across.

Ooecium transversely elongate, sinuous, running up slightly between the bases of the fascicles, its breadth one fifth to one fourth of the circumference. Ooeciostome a circular aperture surrounded by a flattened ring-like margin, sub-terminal near the middle of the ooecium.

Recorded by O'Donoghue from a number of localities on the British Columbia coast and south to the San Juan Islands in Puget Sound.

Division 4. **Cerioporina** Hagenow, 1851
(Heteroporina Borg, 1933)
The Heteropores

"Primary zoid adnate or partially erect; zoarium varying in shape, adnate, suberect or erect, composed of zoids of two kinds, autozoids and kenozoids, the latter at least as numerous as the former, both autozoids and kenozoids opening at about right angles to the surface of the zoarium; wall of the zoarium double, consisting of gymnocyst and cryptocyst; brood chamber a coelomic space, formed by the absorption of the subdistal portions of some autozoids and numerous kenozoids outside the fertile, ovigerous zoid (zoarial brood-chamber)." (Borg, 1944:208).

Family **Heteroporidae** Waters, 1880

"Zoarium erect, pedunculate and capitate, or arborescent; autozoids and kenozoids about equally numerous or the former less in number; apertures of both kinds of zoids scattered over the surface of the zoarium, not forming clusters, circular or polygonal in shape; brood chamber zoarial, not visible from surface except in form of a slight swelling of that part of the zoarium." (Borg, 1944:209).

Two genera are represented in our material, *Heteropora* Blainville, 1830, and *Borgiola* Strand, 1933 *(Canuella* Borg, 1933, preoccupied), the latter having the autozoids often forming small clusters instead of being more regularly distributed. One species of this genus forms a heavy incrustation without any erect branches.

Genus **HETEROPORA** Blainville, 1830

"The zoarium is erect, arborescent, its surface smooth or slightly rugose, honeycomb-like when the cystids are open; the kenozoids much more numerous than the autozoids, located between them and thus separating them, aperture circular or polygonal." (Borg, 1944:210). Genotype, *Ceriopora cryptopora* Goldfuss, 1827.

Robertson (1910:258) gave a very clear statement of certain zoarial details: "If one examines the growing tips of a branch, the tubular openings found there are for the most part those of zooecia in various stages of maturity. Between them, formed by minute triangular spaces where the walls of zooecia do not come into contact, are the interstitial spaces (kenozooecia). As growth proceeds, both zooecia and interstitial canals

curve outwards, and although at the growing tip these tubes are parallel to the axis of the branch, when adult they curve almost at right angles with the axis of the branch and the apertures open laterally, the larger zooecial apertures being surrounded with a circle of small interstitial openings."

Borg (1932, 1933 and 1944) has made a very detailed study of the anatomy, development and the brood-chambers of recent species of *Heteropora* and related genera. He rejects the genus *Tretocycloecia* Canu, 1918a:346, erected to include the species with ovicells and leaving the old genus *Heteropora* for those in which the ovicells are unknown, as "inadmissible."

Heteropora magna O'Donoghue, 1923

Plate 73, fig. 13

Heteropora magna O'Donoghue, 1923:14.
Tretocycloecia magna, O'Donoghue, 1926:29.
Heteropora pelliculata, Robertson, 1910:258 (part).
Heteropora magna, Borg, 1933:326.
Tretocycloecia pelliculata, Canu and Bassler, 1922:110.

"Zoarium stout, densely branched, more or less spherical in outline; distal ends of autozoids not or only slightly protruding; apertures of kenozoids mostly open, but sometimes, in older portions of the zoarium, closed." (From Borg's key, 1933:284).

The encrusting base gives rise to erect cylindrical stems, 3 to 5 mm in diameter, which branch dichotomously while retaining their original thickness, but a little swollen at the tips. The zoarium thus has a more or less spherical form, except when modified by the substratum. There is occasional anastomosis of the branches, "but not so frequently as in *H. pelliculata* (now *H. pacifica* Borg, q.v.) and the colony as a whole has a much more stout and compact appearance . . . and may measure 100 by 70 mm." (After O'Donoghue). Zoarium purplish-brown in color.

Ovicells were not observed by either O'Donoghue or Borg. They are large irregular areas on the sides of the branches near the tips and partially surrounding the branches, only slightly elevated, but conspicuous because of the closure of the kenozoids; appearing as a complete, calcified, thin, whitish cover of the brood-chamber, with the exception of the peristomes of the autozoids which are not displaced. The peristomes are more prominent than elsewhere on the zoarium and are often slightly

flared at the tips and thus appear somewhat larger than the ordinary ones. I have not been able to find any aperture on the four brood-chambers in my material which I can positively identify with ooeciopores, and it is therefore probable that they are similar to the ordinary apertures. On the removal of the roof of the brood-chamber an extensive, broad cavity is revealed, with the bases of the absorbed kenozoids at the bottom. The peristomes of the autozoids usually traverse the cavity without modification, but I have found a few which have become closed, within the chamber, by a membrane with a central raised pore similar to those of *Diastopora.* The apertures of the autozoids average about 0.18 mm in diameter.

This species did not appear in the Hancock dredgings, but I have a fine specimen from Friday Harbor, Puget Sound, 70 mm long by 45 mm wide and 40 mm high, without further data, but evidently dredged locally. The encrusting base is 7 by 9 mm across, and there is a secondary attachment of similar appearance by a branch, 5 mm across. Another portion of a colony, loaned by Dr. R. E. Foerster, Director of the Pacific Biological Station, Nanaimo, British Columbia, and bearing O'Donoghue's identification, is from Gabriola Pass, B. C. This specimen also has a brood-chamber.

Heteropora pacifica Borg, 1933

Heteropora pacifica Borg, 1933:317.
? *Heteropora* sp. Whiteaves, 1882:279.
Heteropora pelliculata, Robertson, 1910:258 (part).
Heteropora pelliculata, O'Donoghue, 1923:14 (part).
Tretocycloecia pelliculata, O'Donoghue, 1925:96; 1926:28 (part).
(The synonymy according to Borg).

Borg separated the more slender, more intricately branched and more highly anastomosed form mentioned by Robertson and O'Donoghue as a distinct species. As I have not had an opportunity to study *H. pacifica,* I can only indicate the essential points of difference given in Borg's description.

The zoarium is erect, branching profusely and dichotomously or in an irregular way. The branches frequently anastomose, giving the whole colony a complexly reticulated appearance which is highly characteristic of the species. The diameter of old stems is about 5 mm, of younger ones 3 mm on an average. Color of dried zoaria grayish, the tips pink. Autozoids with the apertures usually on a level with the surface, but

in more sheltered areas the peristomes are very evident. The apertures are about 0.17 mm in diameter, in older parts of the colony they are usually closed. The kenozoids never project above the surface and are usually closed except toward the growing ends of the branches. Brood-chamber not known.

While this species may have a considerable range along the Pacific coast from Alaska to California, as suggested by O'Donoghue, the only positive records are those of the material studied by Borg, Vancouver Island region to Middleton Island, southern Alaska, down to a depth of 25 meters.

There is in the Hancock collection a very small fragment labelled *Heteropora pelliculata* Waters by Robertson, from "San Diego, Californica," which may belong to *H. pacifica* as the zoids have the same measurement, 0.17 mm. There are also several much worn fragments from Hancock Station 1278-41, off San Miguel Island, southern California, at 35 fms, which present the same zooecial measurements and with stems 2 to 3 mm in diameter, which may belong here. But none of these specimens is in condition for determination beyond the genus.

There are also several much worn fragments from Hancock Stations 143-34, Wenman Island, and 170-34, Chatham Island, Galapagos Islands, which present about the same measurements, but which are not identifiable beyond the genus *Heteropora.*

Heteropora alaskensis (Borg), 1933

Plate 73, figs. 10, 11, and 12

Heteropora pacifica var. *alaskensis* Borg, 1933:325.
Heteropora pelliculata, Robertson, 1910:258 (part).
? *Heteropora pelliculata,* O'Donoghue, 1923:14 (part).

The zoarium is very irregular and much smaller than that of *H. magna* or *H. pacifica.* Our largest colony measures 16 mm in height by 25 mm in width, with 16 branches which average about 2 mm in diameter, but most of the 10 colonies are shorter and more compact; the branches, beyond a bifurcation, are 2 to 4 mm long (in one case 7 mm); only a few cases of anastomosis occur.

The essential characters which differentiate this form from other species of *Heteropora* are: (1) the peristomes of the autozoids project to a marked degree on the branches all the way up to the margins of the cancellated tops, and on older basal branches they still rise slightly above the level of the zoarial surface; diameter of apertures 0.14 (0.13 to 0.17) mm; (2) the kenozoids are covered and closed over the whole

surface of the colony up to the margin of the cancellated tops of the branches. In these characters our specimens agree with Borg's description of *H. pacifica* var. *alaskensis,* and the differences are so striking and constant as to warrant the elevation of the "variety" to specific standing.

On protected areas the peristomes may be as much as 0.25 to 0.30 mm long, though usually they are much shorter. The tips of the branches are sometimes evenly rounded, but more frequently they are somewhat clavate or spatulate, slightly excavated on one side where a brood-chamber is located, and the rim may extend beyond and give off two or three branches, thus leaving the brood-chamber in the broad fork of a branch. Other brood-chambers are found on the sides of branches, as shown in Borg's figure 5 (plate 10).

The brood-chamber is typically that of *Heteropora,* a low, more or less flat swelling, through the roof of which the peristomes of the autozoids penetrate and are slightly elevated above it. On the removal of the calcified membrane, or roof of the chamber, a considerable cavity is exposed, traversed by the autozoid tubules and showing the remains of the partially absorbed kenozoids. I have not been able to find on any of our specimens the large ooeciostome figured by Borg and cannot determine the location and form of the ooeciopore.

This species differs from *H. pelliculata* Waters, 1879, which it somewhat resembles, by the elevation of the peristomes over the whole surface and by the complete closure of the kenozoids over the whole colony up to the level of the margins of the cancellated tops of the branches. The same characters, as well as the smaller size, distinguish it from *H. pacifica* Borg. As the color of our preserved specimens is white, this may be the lemon-colored form recorded by Robertson (1910:259) from "Channel Rock, Puget Sound."

Our specimens are from Bentinck Islands, British Columbia, without further data, loaned by Dr. W. A. Clemens of the University of British Columbia, ten colonies of various forms and sizes. Also 2 fragments, with ovicells, from Clayoquot Wharf, British Columbia, E. F. Ricketts, collector.

Hancock Station 1490-42, off Cape Arago lighthouse, Oregon, 43° 20′26″N, 124°22′24″W, at very low tide, 5 fragments.

Genus **BORGIOLA** Strand, 1933

Canuella Borg, 1933:331, (preoccupied by Scott, 1893).

"Zoarium erect, arborescent, branching sparsely; its surface strongly rugose, showing numerous irregularly shaped elevated areas and between

them well-marked depressions; autozoids frequently forming small clusters; their apertures oblique, prolonged at one side into an erect pointed process; kenozoids much more numerous than the autozoids, thick-walled, mostly with open apertures," Borg, 1933:331. Genotype *Canuella rugosa* Borg, 1933:332.

The genus is certainly close to *Heteropora* and possibly may be found to intergrade. However any means of separating the members of this family, and especially if it is found to apply to the very numerous fossil species, is welcome.

The generic description requires modification to include an encrusting species, without erect branches, *B. pustulosa* new species, which is described below.

Borgiola rugosa (Borg), 1933

Plate 76, fig. 11

Canuella rugosa Borg, 1933:331.

The zoarium of our single specimen measures 25 mm in height and 20 to 25 mm in width, rising from a broad encrusting base 20 by 10 mm across, with numerous irregular branches which are sometimes bifurcate; and there is a single anastomosis. Several small subcolonies arise from the lateral extension of the base. The main stem is about 5 mm in diameter, the branches becoming progressively smaller until the terminal ones measure 2 mm or less. Color pure white.

The autozoids, or functional zooecia, tend to occur in small groups or clusters, sometimes in radiating lines, though single autozoids are also common. The peristomes usually rise slightly above the surface, with the rim higher on one side and often extending into a sharp point; or the rim may be evenly rounded. The zooecial tubes are long, those in the rounded branches have their origin in the center and curve outward as in *Heteropora;* those which form the basal expansion arise on the lamina and curve upward. There is a moderately broad basal lamina surrounding the basal expansion. The apertures of the autozoids are about 0.13 to 0.15 mm in diameter. The kenozoids are much more numerous than the autozoids, always noticeably smaller but varying in size, never rising above the surface and seldom entirely closed. The brood-chamber has not been observed.

A striking feature of the zoarium is the peculiar type of rugosity produced by the irregular elevation of areas with increased numbers of autozoids, while between these are smooth areas of lower level in which there are fewer autozoids.

I presume this to be the same species as that from Japan described by Borg, since the zoarial and zooecial characters appear to agree closely, but in the absence of brood-chambers the identification is necessarily tentative.

The species has hitherto been known only from Sagami Bay, Japan.

Hancock Station, 310-35, off Bindloe Island, Galapagos, 0°18′20″N, 90°31′10″W, at 15 fms, rocky bottom.

Borgiola pustulosa new species

Plate 73, figs. 5, 6, 7, 8, and 9

Zoarium encrusting on rocks and shells, with no evidence of erect branches, the surface with numerous low rounded or elliptical elevations which are rather evenly spaced, the elevated areas about as wide as the lower areas between them. The largest colony (type) measures about 70 mm long by 50 mm wide by 10 mm thick, but is broken and was evidently considerably larger. Another fragment is 50 mm in width, and a third fragment which is on a shell, is 25 mm long by 10 mm wide and appears to have been about twice that width. The color is white to yellowish red.

On the lower, general, surface the apertures of the autozoids are often quite regularly spaced and surrounded by a single row of kenozoids about half as large as the autozoids; on the pustules the autozoids are irregularly disposed and the kenozoids more numerous and irregular in size, and occasionally there are small areas consisting entirely of kenozoids. Over most of the surface the tubes of the autozoids project very slightly above the level of the surrounding kenozoids, the rim round or nearly so; but around the borders of the pustules they are noticeably higher and produced on one side into a pointed process, "giving the aperture a distinctly oblique appearance," as Borg describes them in *C. rugosa* (1933:335). On older areas both autozoids and kenozoids are frequently closed, slightly below the level of the rim. The apertures of the autozoids are about 0.18 mm in diameter but vary considerably. The kenozoids vary excessively, from 0.03 to 0.12 in diameter, but average about 0.08 mm, and they also vary in form.

The autozoids arise on a basal lamina which extends rather narrowly around the margin of the zoarium, at first prone but curving upward at once into an erect position.

The brood-chambers are spacious cavities, as much as 2.50 mm in width and 0.50 mm in depth, resembling those of *Heteropora* with the kenozoid walls absorbed and closed on the floor of the cavity, and most

of the autozoid tubes continued through the chamber and on above it. In the broken walls of old thick zoaria the chambers appear at different levels, some just beneath the surface, but others buried deeply by the regeneration of the zoarium above them. There is little or no surface evidence of the position of the brood-chambers, and the pustules appear to have no relation to them, as shown by dissection. Borg could not be certain as to the brood-chamber in his material of *B. rugosa*, but that of his figure 2 (plate 3) appears to be similar to those of *pustulosa*. I have observed no differentiation of ooeciostomes.

Borgiola is certainly close to *Heteropora* in most of its characters, but the roughened nature of the zoarial surface, the grouping of the autozoids and heterozoids and the pointed processes of the taller zooecial tubes separate it.

The occurrence of this species is of unusual interest, since no member of the Family Heteroporidae has hitherto been recorded from the Arctic Ocean.

Type, U. S. Nat. Mus. no. 11051.

Type locality, Point Barrow, Alaska, Arctic Research Laboratory, 453 feet, encrusting a stone, G. E. MacGinitie, collector. Also on a stone from 295 feet and on a shell at 60 feet.

Division 5. **Rectangulata** Waters, 1887
(Calyptrostega Borg, 1926)
The Lichenopores

"They fool me to the top of my bent." Shakespeare.

"Primary zoid adherent to the substratum, never separated by any joint from the pro-ancestrula; zoarium wart-like, its basal wall adnate, simple; frontal wall double consisting of gymnocyst and cryptocyst; between zoids special coelomic cavities (alveoli) limited by calcareous extrazoidal walls; no vestibular sphincter; brood-chamber zoarial, a coelomic space corresponding to numerous alveoli, outside the fertile zoid; polypide degenerating first after having been functional for some time." (Borg, 1944:211).

The Lichenopores have always been a "thorn in the flesh" to those who have attempted to work with them. Defrance established the genus *Lichenopora* in 1823. Before this time the species were usually referred to *Madrepora* (a coral), or to *Tubulipora* Lamarck. Since then a large number of generic names have been proposed; d'Orbigny was especially lavish in this respect, separating out ten "genera" on trivial

zoarial characters. Some of these have proved to belong in other families and others placed in synonymy until only two genera, *Lichenopora* Defrance, 1823, and *Disporella* Gray, 1848, have survived the research of later authors. Most recent authors have used only *Lichenopora,* but Borg, 1944:234-5 and 249, has given what appear to be good reasons for the retention of *Disporella.* Borg even goes so far as to propose a new family, Disporellidae, to include only this genus, but this appears to me to be unwarranted on the basis of the characters.

A few citations will indicate the difficulty others have had: "One cannot help feeling despair when trying to determine the *Lichenoporae.*" (Waters, 1889:282); "The determination of the species of *Lichenopora* is admittedly very difficult." (Harmer, 1915:160); "The determination of the species, even the recent ones, presents much difficulty." (Canu and Bassler, 1920:812); "The discrimination of the species . . . has scarcely but begun." (Borg, 1944:213).

Family **Lichenoporidae** Smitt, 1866

Zoaria rounded or ovate, occasionally otherwise modified in outline by the nature of the substratum; more or less convex, sometimes dome-shaped; attached the full width of the basal lamina, or the basal lamina free and turned upward at the edge, or, when on small stems, they may be attached by a short central stipe of variable width. The central part of the zoarium, varying in size with the species, is occupied by cancelli (alveoli, Borg), and outside of this area the functional zooecia are arranged in radiating series or more or less in quincunx. The "peristomes" are usually much higher next to the central area and decrease in height regularly to the margin; usually the basal lamina extends in a thin rim around the outer edge. Zoarial budding occurs in some species, either vertically or near the edge, and sometimes very complex zoaria may be formed in this manner. The ovicells are brood-chambers of considerable size, occupying the central area, branching out in lobes between the rays, or located entirely between the rays; covered by a thin calcified layer with minute pores, which may be obscured by the development of secondary cancelli above it.

As stated above, Borg has indicated two families on the following basis:

Lichenoporidae, alveoli soon "roofed in" by a porous calcified layer, with secondary alveoli above them; the one central brood-chamber, which may have lobes extending between the rays; zoarial budding vertical.

Disporellidae, alveoli not roofed in but partially closed "iris-like" with a round hole at the center; brood-chambers between the rays; zoarial budding lateral.

This separation seems to work very well with the few species (55) treated by Borg, but, unfortunately for taxonomic purposes, the three characters used by him to distinguish *Lichenopora* and *Disporella* do not appear to be constant throughout the series. Thus in *Lichenopora buskiana, novae-zelandiae* and *intricata,* which have irregular cancelli closed by a membrane, the budding is lateral with the sub-colonies beyond the margin of the primary disc. The location of the ovicells, in the central area or interradial, shows frequent variations. Also the closure of the cancelli, by a thin porous membrane or by an iris-like diaphragm, is not constant, as both types may occur on the same zoarium. In *L. intricata* Busk, the interradial cancelli and those of the central area of infertile discs have the rounded cancelli, while the fertile discs present the irregular cancelli above the ovicells; in several of the elongated discs of this species both kinds of cancelli are present, the irregular ones covering the ovicell at one end and the rounded cancelli at the opposite infertile end.

Apparently the only character that seems to hold absolutely is the presence of irregular, thin-walled secondary cancelli covering the ovicells in *Lichenopora.*

Genus **LICHENOPORA** DeFrance, 1823

Brood-chambers, one or more, occupy the central area and may extend somewhat into the interradial areas; in older zoaria secondary small brood-chambers may appear between the rays toward the margin. Cancelli (alveoli) of the primary layer thin-walled, irregular in form and size, and closed by a thin, perforated, calcified layer; secondary cancelli above these may be similar to these or may be thicker-walled with large rounded apertures. Marginal zoarial budding sometimes occurs but vertical budding is the rule. The distribution of the functional zoids varies much among the species, in short or longer connate or non-connate rays or in irregular quincunx. Genotype, *L. turbinata* Defrance, 1823: 257.

Key to the Species of *Lichenopora*

1. Radiating rows of tubules biserial . . . . . *buskiana*
   Rays uniserial or more or less in quincunx 2

2. Ooeciostome hooded over the top and opening on the side; tubules distinct, high on proximal border and with one to several sharp points . . . . . *canaliculata*
   Ooeciostome wide open 3
3. Zooecial tubules not connate and, except near the center, they are usually scattered or in quincunx . . . . . *verrucaria*
   Zooecial tubules in series only, connate to the tips 4
4. Cancelli distinctly larger than the zooecial apertures; radii in regular series; pin-head spicules abundant . . *novae-zelandiae*
   Cancelli smaller; radii regular only close to the central area; very complex and intricate colonies formed by lateral budding; pin-head spicules almost wanting . . . . . *intricata*

Lichenopora canaliculata (Busk), 1876

Plate 76, figs. 3 and 4

Discoporella canaliculata Busk, 1876:118; 1879:199.
Lichenopora grignonensis, Ridley, 1881:57.
Lichenopora fimbriata, Borg, 1926:184.
Lichenopora canaliculata, Borg, 1944:235.

Busk's description is very brief, "Zoarium circular, bordered, slightly convex; tubes very irregularly uniserial, with a raised canalicular fillet on one side, interspaces cancellous." Borg, 1944:235, had very rich material from the Swedish Antarctic Expedition and has given an extended discussion of the species.

The zoaria are circular, somewhat elevated at the center and sloping regularly to the basal lamina which is broad and thin; encrusting on shells and attached to stems. The basal lamina is traversed nearly to the edge by the bases of young zooecia. The central area of the zoarium is comparatively small, a little depressed in the young, but later filled in by the flat-topped brood-chamber. The zooecial tubes are irregularly distributed or in short radiating lines and never connate; they are moderately high, usually much elevated on the proximal (central) side and low on the side toward the border, thus forming a channel above the aperture; the proximal side with one to several "fillets" or longitudinal ribs which end in points; aperture rounded and 0.10 to 1.12 mm in diameter. The cancelli are large and irregular in form, often twice as large as the apertures of the zooecia, the walls thin and the whole giving a reticulated appearance.

The brood-chamber covers the central area, with a thin calcareous layer which is very minutely perforated; a coarsely reticulated layer of secondary cancelli later may cover it. The ooeciostome appears to be unique in this genus; it has the short erect cylindrical base but the orifice is on the side, with a peculiar "helmet" or hood-shaped cover which arches widely over the top, closing the orifice entirely from above; also just inside from the rim of the hood there is a transverse row of minute pores, as described by Ridley under *L. grignonensis* (= *L. canaliculata)*.

This species has been recorded only for Antarctic and far southern waters; Kerguelen Island; Strait of Magellan; Kap Adare, Victoria Land; and New South Wales. It is therefore of special interest to discover it in the Arctic region. The nature of the tubules and especially the form of the ooeciostome with its row of perforations seem sufficient for positive identification.

Point Barrow, Alaska, Arctic Research Laboratory, 110 to 522 feet, several colonies, only one of which is mature, G. E. MacGinitie, collector.

Lichenopora verrucaria (Fabricius), 1780

Plate 74, fig. 3

Madrepora verrucaria Fabricius, 1780:430.
Discoporella verrucaria, Busk, 1875:31.
Lichenopora verrucaria, Hincks, 1880:478; 1884:207.
Lichenopora verrucaria, Robertson, 1900:329; 1910:263.
Lichenopora verrucaria, O'Donoghue, 1923:15; 1926:28.
Lichenopora verrucaria, Canu and Bassler, 1923:205.

Zoaria small, rarely more than 3 mm in width; encrusting on algae, stems, stones and shells; high near the center and rounding off gradually to the margin where there is a narrow basal lamina. In younger colonies there is a depressed cancellous central area, but in the sexually mature this area is filled in with one or more brood-chambers. The zooecia are irregularly arranged, often in short radiating series, especially near the central area, but never connate; moderately elevated, carinated on the side toward the center, the keel rising into a point. The cancelli vary greatly in size, sometimes larger than the zooecial apertures but often not half as large.

Usually only one brood chamber fills the central area, but as many as three have been observed, in which case they fuse externally so that the number of ooeciostomes is the only obvious clue to the number of

chambers; they do not extend between the zooecial rays farther than the central ones. The ooecial cover is a thin inflated calcareous plate with numerous minute pores; secondarily the ooecial roof may be covered by a layer of cancelli which form a very irregular reticulum. The ooeciostome is more or less excentric in position, a short erect cylinder with a flaring lip which varies from nearly round to elliptical, the ooeciopore 0.10 to 0.12 mm in diameter.

A common northern and arctic species, extending south to Cape Cod on the Atlantic coast and to California on the Pacific coast; abundant in the Arctic seas.

Hancock Station, 1416-41, San Miguel Island, southern California, 34°02′45″N, the most southern record. Hein Bank, Puget Sound, J. L. Mohr, collector; British Columbia (Hincks and O'Donoghue); southern Alaska (U. S. Crab Investigation); Bering Sea; and abundant at Point Barrow, Alaska, shallow water to 85 fms, G. E. MacGinitie, collector.

Lichenopora buskiana Canu and Bassler, 1928

Plate 74, figs. 1 and 2

Lichenopora buskiana Canu and Bassler, 1928:164.
Not *Unicavea Californica* d'Orbigny, 1853:972.
Lichenopora Californica, Conrad, 1855:441.
Lichenopora californica, Gabb and Horn, 1862:176.
Discoporella californica, Busk, 1875:32.
Lichenopora californica, Canu and Bassler, 1923:203.
Lichenopora buskiana, Borg, 1944:219 and 224.

The misidentification of this species with d'Orbigny's *Unicavea californica* has led to much misunderstanding; *Unicavea* was described as having only uniserial radii, "Toutes les lignees n'ont qu'une seule ligne de cellules" (d'Orbigny, 1853:970).

The zoaria are attached to algae especially, sometimes to shells, worm tubes, etc. The central frontal area is comparatively small and rounded, with large cancellae which are slightly larger than the zooecial apertures. The radiating rows of zooecial tubes are connate and biserial, except that they may begin with a single tube which sometimes is not connate, and also that rarely there may be three series near the outer ends of the radii. Near the center the tubules are unusually high and nearly erect. There are usually 8 to 12 primary radii, with shorter rays originating between these toward the margin. As a rule the rays are very regular

in form, size and arrangement, and separated by 1 or 2 rows of cancellae, often with "pin-head" spicules. The apertures of the tubules are somewhat irregular in form and about 0.06 to 0.08 mm in diameter.

The brood-chamber (ovicell) in smaller zoaria occupies only the central area, with the ooeciostome a little excentric or frequently nearer the border of the area. The ooeciopore is about as large as the zooecial apertures; the ooeciostome is erect with a short cylindrical stalk which flares, trumpet-shaped, slightly ovate, 0.13 to 0.16 mm by 0.16 to 0.20 mm in breadth at the tip. The roof of the brood-chamber is thin and perforated by numerous small pores, and above this are secondary cancellae of irregular size and form. Strong irregular raised lines often give the area a coarsely reticulated appearance.

The zoaria are often complex, with daughter colonies budding off from the sides, and these are frequently very irregular, both in shape and in the arrangement of the uniserial rays. In the daughter colonies the brood-chambers are irregularly situated, often small and situated between the series of tubules, sometimes near the margin. Even in larger simple colonies there may be small secondary brood-chambers near the margin.

The biserial rays with high peristomes, the large and irregular cancelli which frequently bear "pin-head" spicules within their apertures, and the closure of older cancelli by a thin calcified porous membrane, readily distinguish this species from any other of the Pacific coast, even in the absence of an ooeciostome.

It is a common species along the shore and about the islands of southern California, extending southward to Lower California and the Gulf of California; common also in the Pleistocene deposits of the same area; but there are only two dredging records, which indicates that it is definitely a shallow water species.

Hancock Stations: 1378-41, Catalina Island, 2 to 3 fms; 1071-40, San Felipe Bay, Gulf of California at 2½ fms.

Lichenopora novae-zelandiae (Busk), 1875

Plate 74, fig. 4

Discoporella novae-zelandiae Busk, 1875:32.
Lichenopora radiata, Robertson, 1910:262.
Lichenopora novae-zelandiae, Harmer, 1915:155 (references).

Zoarium encrusting on shells and stems; on small stems there is a very short stipe, and the margin of the basal lamina is turned upward, saucer-shaped; zoarial budding rarely occurs at the margin. The tubules

are in radiating uniserial rows, high next to the central area (often 1.0 mm or more in height), and sloping gradually to the edge, which is surrounded by a moderately broad basal lamina. Shorter rays appear between the main ones toward the margin. The tubules are connate to the tips, and slightly compressed, the apertures about 0.08 mm in diameter, the tips prolonged into points on the central side and often also on the outer side. The cancelli are extremely variable in size and form, producing an irregular network; the largest are more than twice the width of the zooecial apertures and the smallest are even less than the apertural width. There is no evidence of closure of the cancelli by an "iris" diaphragm, but instead they often become closed by a thin calcified membrane with numerous small pores like that which covers the ovicell, and this is true for some of the cancelli near the outer border beyond the brood-chambers. "Pinhead" spicules are present within the apertures of the cancelli, often in nearly every one but sometimes more rare; usually they are present slightly above the closing membrane, and it may be that these cancelli are regenerated. Between the rays there are one or two rows of cancelli. In old and more heavily calcified specimens the walls of the cancelli are thicker but not closed by an iris-like diaphragm.

The brood-chambers occupy the central area but often extend for a considerable distance into the interradial spaces; the roof consists of a thin calcified and perforated membrane and soon becomes covered with a secondary layer of cancelli. The ooeciostome is excentric in position, the tube short, the orifice round and about as large as that of a zooecial tube, the lip round or elliptical and slightly flared.

Harmer, 1915:155, includes *L. holdsworthi* under *L. novae-zelandiae;* Waters, 1918:36, reverses this and includes *novae-zelandiae* under *holdsworthi,* though the former has page priority in publication. From Busk's figures of these species, 1875, plate 30, figs. 2 and 4, there appear differences in the height of the peristomes, the mode of closure of the cancelli, and especially in the size of the central area, sufficient to warrant their separation. *L. holdsworthi* has the appearance of a *Discoporella.* The *L. holdsworthi* of Canu and Bassler, 1929, plate 88, fig. 11, has short biserial rays and probably should go elsewhere.

The species was described from New Zealand and later recorded from Australia, Ceylon and Japan. While it has not been listed from the American Pacific, our specimens conform so closely to the descriptions and illustrations of Busk and Harmer that they appear to belong to this species. Also I believe that the *L. radiata* of Robertson from southern California belongs here, and possibly that of O'Donoghue (without description) from British Columbia.

Hancock Stations: 468-35, Charles Island, Galapagos; 1399-41, Santa Catalina Island; 1242, Anacapa Island; 1002, San Clemente Island; Palos Verdes, near San Pedro, all from southern California; Acapulco Harbor, Hubbs Sta. 46-244, west coast of Mexico; and Colombia (without further data); shore to 77 fms.

Lichenopora intricata (Busk), 1856

Plate 76, figs. 5, 6, 7, 8, and 9

Defrancia intricata Busk, 1856:179.

Apparently this species has never been referred to since Busk described it. In December, 1946, Dr. E. Y. Dawson, while collecting algae at Mazatlan, Mexico, the type locality of *D. intricata,* recovered several specimens on algae. Again, in 1949, the "Velero" dredged more than 100 specimens at Magdalena Bay, on the west coast of Lower California.

These specimens conform to Busk's meager description: "Disc very irregular in form, rows of cells radiating irregularly; orifices of cells and interstitial pores of equal size. The small irregular patches appear to be constituted by the confluence of several sets of costae, with their corresponding interstices, each set radiating from a depressed central point."

The form of the encrusting complex zoaria varies to such an extent as to baffle description; adnate on algae, worm tubes, corallines, other bryozoans, etc., the largest colonies 3 cm or more in length, the margins of the zoaria sometimes extending free. The subcolonies are very numerous, more than 70 having been counted on one large zoarium, and vary in form from nearly round to very elongate-elliptical. The radii ("costae," Busk) are high, closely set, and rather regularly arranged about the low central area; in general they are uniserial, but often they are biserial next to the central area and rarely biserial for the whole length of the radii; separated by one or two rows of cancelli. The outer ends of the radii are often extended with short tubules into meandering series which break up into short, separate series or sometimes form small clumps. The subcolonies often arise in the midst of this intricate meandering series, or they may be closely associated, with the low outer ends of their radii in contact.

The central area is flat and low, even when ovicells are present. When an ovicell is present it is covered by a thin lamina and above this the secondary cancelli are large, thin-walled and irregular in form, in true *Lichenopora* fashion. The cancelli between the radii and in the central area, in the absence of ovicells, are rounded and partially closed, sug-

gesting *Disporella.* In some elongate central areas I have observed an ovicell at one end covered by the irregular cancelli, while the other end of the area, free from the ovicell, shows the rounded, partially closed cancelli. This throws some doubt on the complete validity of *Disporella,* as infertile subcolonies would undoubtedly be referred to that genus. On the complex zoaria the fertile discs are easily seen because of their irregular secondary cancelli, and I have not been able to find any evidence of ovicells in discs with the uniformly rounded cancelli.

The ovicells occupy all or a part of the central area and can often be seen through the large irregular cancelli; occasionally two ovicells are present in the same area. The ooeciostome is a short, thin-walled, erect tube, situated near the border of the central area.

Collected by Dr. E. Y. Dawson at Mazatlan, Mexico (the type locality), about 23°11′ N. Lat., shore collection, 4 zoaria, 1 on a shell fragment, the others on algae; the ones on algae are much thinner than those on solid substrata.

Hancock Station 1714-49, two miles east of Entrada Point, Magdalena Bay, west coast of Lower California, 24°32′30″N, 112°01′45″ W, at 17 fms, more than 100 complex zoaria, in a single dredge haul.

Genus **DISPORELLA** Gray, 1848

Brood-chambers, one or more, occupying interradial areas and sometimes extending over parts of the central area; cancelli thick-walled, partially closed by an "iris-like" growth of the rim toward the center but leaving always a small round aperture, never closed by a perforated flat calcified membrane; lateral zoarial budding is common. As in *Lichenopora* the functional zoids may be in radiating series, uniserial, biserial or multiserial and connate or non-connate, or they may be more or less in quincunx. Genotype, *Discopora hispida* Fleming, 1828:530.

Key to Species of *Disporella*

1. Radii uniserial or the tubules in quincunx 2
   Radii with 2 or more (2 to 4) series of tubules, sometimes arranged in short clumps 5
2. Tubules not connate, except sometimes at the base only . . . 3
   Tubules closely connate to their tips, rays longer 4

3. Peristomes slightly expanded at the tips and bearing a number (3 to 5) of long thin spines . . . . . *fimbriata*
   Peristomes not expanded at the tips, sometimes prolonged into a single process, but never fimbriated . . . . . *hispida*
4. Pores of the central cancelli larger than the tubule apertures; pin-head spicules very abundant . . . . . *californica*
   Pores of cancelli small, the walls more heavily calcified; pin-head spicules rare or wanting . . . . . *ovoidea*
5. Radii usually prominent in the form of short fascicles 2 to 4 tubules in width 6
   Radii more elongate and less prominent, with 2 to 4 rows of tubules, zoaria often very complex 8
6. Zoarium high, cylindrical, with a terminal crown of high marginal radii, the encrusting base larger than the erect stem; central, vertical budding . . . . . *astraea*
   Zoarium low, without an erect stem 7
7. Radial fascicles small and low, cancelli of central area nearly closed by a funnel-shaped diaphragm . . . . . *octoradiata*
   Fascicles larger, with more tubules, and higher; cancelli large and nearly wide open . . . . . *alaskensis*
8. Zoarium highly complex, composed of numerous lateral sub-colonies which are separated by rows of cancelli; radii moderately high, 2 to 4 rows of tubules . . . . . *separata*
   Zoarium simple; radii usually forming a low ridge of 2 to 4 series of tubules; central area ovoid and moderately large; sub-colonies superposed vertically . . . . . *stellata pacifica*

Disporella fimbriata (Busk), 1875

Plate 75, figs. 2 and 3

Discoporella fimbriata Busk, 1875:32.
Lichenopora fimbriata, Busk, 1886:26.
Disporella spinulosa Jullien, 1888:83.
Lichenopora fimbriata, Waters, 1904:96; 1905:250.
Lichenopora fimbriata, O'Donoghue, 1923:15.
Disporella fimbriata, Borg, 1944:229.

Busk's original description is as follows: "Zoarium almost conical; cells very indistinctly serial, distant; interstitial pores almost obsolete; mouth expanded, peristome fimbriated."

When the brood-chamber fills the central area the zoarium is "nearly conical," as shown in Busk's illustration (1875, Pl. 27, figs. 1 and 2), but in the absence of the chamber the area is depressed and slightly concave. The "cells" or zoids are often in short radial series of 3 or 4, but frequently are irregularly quincunical. The "interstitial pores" or cancellae are much less numerous than in other species and usually more widely separated; when young they are as large as the apertures but later become partly closed, with a small central pore. The peristomes project strongly and are somewhat flared ("mouth expanded") and fimbriated with 2 to 5 marginal spines. The basal lamina is very broad and turned upward at the edge, as shown in Busk's figure 2.

The brood-chambers, 1 to 3 or 4 in number, are prominent, usually coalesced to more or less fill the central area, but in one of our specimens the 3 chambers are distinct; there are numerous pores in the ooecial cover; the ooeciostomes situated more or less between the inner ends of the rays, the aperture about the size of those of the zoids, the tube short and very slightly flaring but without a distinct lip.

The zoaria are all small, the largest slightly over 4 mm in diameter, the peristome and ooeciostome about 0.10 mm.

Busk described the species from the southern tip of South America, Chonos Archipelago, Tierra del Fuego, Cape Horn and Chiloe, and later added Tristan da Cunha. The *Disporella spinulosa* of Jullien was dredged between the Falkland Islands and the Strait of Magellan. It has also been recorded from Australia, Tasmania, New Zealand, the Azores and Cape Verde Islands; O'Donoghue has recorded it from Round Island, British Columbia. If these identifications are all correct, the species has a very wide distribution.

Hancock collections: not dredged, but taken in low tide collecting by the writer at Palos Verdes near Los Angeles; by Miss A. E. Blagg at Pescadero Point outside of Monterey Bay; and recovered from a sunken buoy brought up from 45 fms, off Rocky Point, near Los Angeles, all from southern California.

Disporella hispida (Fleming), 1828

Plate 75, fig. 1

Discopora hispida Fleming, 1828:530.
Discoporella hispida, Busk, 1875:30.
Lichenopora hispida, Hincks, 1880:473; 1884:207.
Lichenopora hispida, O'Donoghue,1923:15; 1926:28.
Lichenopora hispida, Canu and Bassler, 1923:203.
Lichenopora hispida, Osburn, 1923:5D; 1933:18.
Disporella hispida, Borg, 1944:249.

The zoarium is usually rounded, attached more or less over the whole dorsal surface but sometimes only by a very short stipe, surrounded by a moderate bordering basal lamina which is sometimes turned slightly upward; the central part of the colony in young stages is a little depressed and with rounded cancelli which become partially closed. Adult colonies, with brood-chambers, are usually evenly rounded over the top. The tubules vary much in their arrangement, sometimes occurring in radiating uniserial rows in which, however, the tubes are not connate, or at least are free at their tips; for the most part they are irregularly quincuncial, and they are separated by rounded cancelli about as large as the apertures of the zoids, about 0.08 mm in diameter. The peristomes are a little elevated, rising on the central side into a pointed cusp which is sometimes double or tricuspidate.

The ovicells, or brood-chambers, are located at the edges of the central area and extend outward between the zooecial tubes; occasionally, when more than one is present (I have noted as many as 4) their expanded inner ends may cover the central area. The ooeciostome is situated at the edge of the central area or farther out between the tubules, short, cylindrical, with a round aperture which is somewhat larger than that of the tubules, about 0.10 mm in diameter. The chamber at first is covered by a thin, minutely perforated calcified layer, but later this may secondarily be covered with a cancellous layer.

It is a well known northern and arctic species, extending on the Pacific coast south to Lower California.

Hancock Stations: 1260-41, off San Eugenio Point, Lower California, 27°49′50″N, 115°06′05″W, the southernmost record; off Santa Catalina, Santa Barbara and San Miguel Islands, and Albatross Sta. 2938, all from southern California; from near shore to 34 fms. Also a specimen labelled "Bering Sea," with no other data.

Disporella californica (d'Orbigny), 1853

Plate 74, figs. 7, 8, and 9

Unicavea Californica d'Orbigny, 1853:972.
Not *Lichenopora californica,* Gabb and Horn, 1862:176.
Not *Discoporella californica,* Busk, 1875:32.
Not *Lichenopora californica,* Waters, 1889:282.
Not *Lichenopora californica,* Robertson, 1910:261.
Lichenopora californica, Borg, 1944:219.

D'Orbigny's description, without illustration, reads: "Espèce très-convexe en dessus, ayant le centre excavé, et pourvue de pores intermédiares énormes. Madelaine, Basse-Californie."

The *californica* of d'Orbigny was placed by him in the genus *Unicavea,* which indicates that his species has uniserial rays. On the other hand the *californica* of Busk, Gabb and Horn, Waters, and Robertson is definitely stated to have biserial or triserial rays and has been redescribed as *Lichenopora buskiana* by Canu and Bassler, 1928:164. The description of the zoarial form by d'Orbigny might apply to numerous species, but his final statement of the large size of the cancelli is more definite and is an exact statement of their nature. In older colonies the cancelli become partially closed by an "iris-like" thickening of the internal wall, but the outlines of the large pores are evident in the raised separating ridges. Moreover, the species is common in the area where d'Orbigny obtained his material, Lower California, and we are fortunate to have ten specimens from three stations in Santa Maria Bay and Magdalena (Madelaine) Bay, that is, in the type locality of *californica.* It appears very probable, therefore, that after a century d'Orbigny's species has been resurrected.

The zoaria are round, low dome-shaped with the central area flat or somewhat depressed in the young. The colonies are all small, not over 4 mm in width, the central area one-fourth to one-third as wide as the zoarium; the radiating rows of tubules are all definitely uniserial, about 10 primary rows with shorter ones between them toward the margin. The peristomes are only moderately elevated, slightly higher toward the central area, connate to their tips which usually are truncate but sometimes are extended into short points on their distal borders; the apertures are slightly elongated in the direction of the rays, about 0.10 mm long by 0.08 mm wide. The cancelli of the central area are noticeably larger than the tubules, the apertures round and as much as 0.13 mm in diameter, partially closed by the characteristic "iris" diaphragm; the pin-head spicules are abundant. Between the rays there are two rows of cancelli, occasionally only one, which are somewhat smaller than at the center.

The brood-chambers are interradial or extending somewhat into the central area, the roof a thin calcified membrane with minute pores, later covered by secondary cancelli of the usual type. The ooeciostome is short, round, thin-walled and a little larger than the zooecial apertures.

There is a peculiar type of zoarial budding which I have not seen described and which I have observed in only one other species, *D. alaskensis* new species, described in this report. The sub-colonies arise on the frontal side toward the margin but do not extend beyond it and in the three colonies at hand they are exactly similar in origin. When I

first observed one of these I thought it might be a monstrosity or perhaps due to the attachment of an ancestrula, but the discovery of three similar triple colonies and a very young bud on another proves it to be a normal process. The sub-colonies are short stipitate with their borders and most of the dorsal side entirely free. Thus they have some resemblance to d'Orbigny's "genus" *Tecticavea,* except that the sub-colonies arise near the margin and are not superposed on the central area. In each case the first sub-colony bears another similar to it but smaller. They present the same characters as the primary one, with uniserial radii, large central cancelli, moderately low connate peristomes and inter-radial brood-chambers.

Hancock Stations: 279-34, Santa Maria Bay, Lower California, 24°44′45″N, 112°15′20″W, and 1714-49 and 2180, Magdalena Bay, the type locality of *californica* d'Orbigny, 10 to 18 fms. Also at 1242, Anacapa Island, and 1662-48, Santa Cruz Island, southern California; 1889-49, Cortez Bank at the United States-Mexican boundary; 275, Raza Island, 675-37, Carmen Island, and 1044-40, Tiburon Island, Gulf of California; and 468-35, Port Parker, Costa Rica. Depth 5 to 77 fms. Also 3 colonies from Tobago Island, Panama, each consisting of several sub-colonies, Helen Hoyt, collector.

Disporella ovoidea new species

Plate 75, figs. 4 and 5

Lichenopora radiata, Canu and Bassler, 1928:163; 1930:56.
Lichenopora radiata, Osburn, 1940:334; 1947:6.

Zoarium more or less ovate, in older stages becoming low dome-shaped; the central area large, distinctly elongate, ovoid to elliptical, much depressed in the young but thick and elevated nearly to the tips of the zooecial tubes in older colonies; 3 to 5 mm in the longest dimension. The zoids are in very definite uniserial rays, the longest ray noted having 7 zoids. The tubes are moderately short and are connate to their tips, which are without spinous projections or notches; the apertures elongated in the direction of the rays, averaging 0.07 mm wide by 0.10 mm long, those at the outer ends of the rays usually larger than those near the central area. The cancelli are large, about twice the size of the zooecial apertures, but very soon become partially closed by an iris-like diaphragm so that their apertures are funnel-shaped and surrounded by hexagonal separating ridges. "Pin-head" spicules are sometimes present.

I have not been able to determine the nature of the primary brood-chambers near the central area, but the secondary chambers near the border are covered in the usual manner by a calcified porous membrane; here they lie between the rays, in some cases extending on both sides of a short secondary ray. They are soon covered by secondary cancelli. The ooeciostome is hardly distinguishable from the cancelli in height and size, but the orifice is wide open, rounded and its wall thin.

I must agree with Borg (1944:223) that the *L. radiata* of Canu and Bassler (1928:163 and plate 29, figs. 1-2) from north of Cuba, and those of Osburn (1940:334) from Porto Rico, cannot be identified with *Discoporella radiata* of Waters (1879:276) from the Bay of Naples, nor with the *Melobesia radiata* of Audouin (1826:235). Waters states: "In most specimens the cancelli appear open; but in well-preserved ones a delicate calcareous cover is found covering the aperture: and this is perforated with about 2-10 holes," which is clearly shown in his plate 24, fig. 11a. The figures of *Melobesia radiata* Audouin show a round zoarium with a small round central area; a central brood-chamber covered by a calcareous porous membrane and with lobes extending between radii; the radii high, elongate and uniserial, the tubes connate to the tips and ending in sharp points. Apparently there is no other species recorded from the Mediterranean or Red Seas with which Waters could have confused his *D. radiata,* and we must conclude that it is Audouin's *M. radiata* and is a *Lichenopora* in the strict sense.

On the other hand, the *L. radiata* of Canu and Bassler and of Osburn, from the West Indies, has an ovate or rounded zoarium with a large ovate central area; the cancelli thick-walled and without a covering calcified membrane; the brood-chambers not centrally located; the uniserial connate radii much less elevated. These West Indian specimens appear to conform in every particular with *Disporella ovoidea,* as described above, and it is probable that Canu and Bassler's reference to *L. radiata* from the Galapagos Islands is also to the same species, since Dr. Bassler informs me *(in litt.)* that it has "a large, slightly elongate central area, with the cancelli and rows of tubules as in the Cuban one." How many other references to *radiata* are untenable it is impossible to say, as it has often been recorded without description or figures, but it seems safe to state that it has not been found on the Pacific coast of the Americas.

Our material consists of 4 colonies, 2 from the Galapagos Islands, 1 from Colombia and 1 from southern California, a wide distribution to be sure, but they all agree in the elongate form of the central area, the

short uniserial connate rays, the size and form of the zooecial apertures, and the size, form and nature of the closure of the cancelli. It is very different from any other Eastern Pacific species, but it may represent some of the too numerous lichenoporid species that have been inadequately described from all around the world.

Type, AHF no. 126.

Type locality, Hancock Station 432, Tagus Cove, Albemarle Island, Galapagos, 80 to 100 fms, two colonies, with ovicells. Also 1662-48, Santa Cruz Island, 33°55′45″N, 119°32′30″W, southern California, 23 fms; and one colony from Colombia without further data.

Disporella alaskensis new species

Plate 75, figs. 7 and 8

The zoarium is round, 3 mm in diameter, high at the central area, the broad cancellated thin border turned up all around, shaped like a miniature Mexican straw hat; attached over most of the dorsal surface. The radii are multiserial (2 to 4), consisting of elevated ovoid clumps which are regularly arranged about the central area. The outer ends of the radii descend sharply to the thin bordering lamella. In our two specimens, the smaller has 4 radii with 2 developing between these at the edges, the larger has 8 rays with several smaller incomplete ones. The tubules are completely connate to their tips, which are not extended into points, the apertures rounded or slightly hexagonal and about 0.10 mm in diameter.

The central area is moderate in size, short-ovate in form, with large rounded cancelli (0.13 mm) and the cancelli of the bordering area are of the same size and form (occasional smaller ones are present on the central area and between the radii); there are 2 to 4 rows of cancelli between the radii. Small pinhead spicules are present. There is very little closure of the cancelli of the central area, just enough to suggest an "iris-like" diaphragm, and the bordering cancelli are wide open.

A small sub-colony is present on the front, situated at the outer end of one of the rays and well within from the border; this has the same form, with edge strongly turned up and the tubules and cancelli similar to those of the primary colony.

The ovicell is interradial, extending somewhat into the central area and covered by a thin membrane with minute pores. Unfortunately the ooeciostome is broken away.

Type, U. S. Nat. Mus. no. 11052.

Type locality, Stepovak Island, Alaska, Alaska Crab Investigation, Sta. 84-40, 15 fms. Another colony, the older one, is from Cleveland Passage, Alaska, 10 fms, W. Williams, collector.

The older colony differs from the type specimen only in the larger number and greater prominence of the radii and in the absence of an ovicell.

Disporella stellata var. **pacifica,** new variety

Plate 76, fig. 10

Defrancia stellata Reuss, 1847:37.

Defrancia stellata, Canu and Bassler, 1930:57.

Defrancia Bronn, 1825, is considered synonymous with *Apsendesia* Lamouroux, 1821, by Bassler, 1935:48.

Canu and Bassler, 1930:57 and Plate 14, figs. 7-12, described a specimen of this Miocene form as *Defrancia stellata,* from the Galapagos Islands. As they remark, "It is quite remarkable to rediscover in the recent seas this European fossil." However, the measurements agree with those of the fossils and the specimen photographed (fig. 9) corresponds in a remarkable way to the figures of the fossil specimens shown beside it. It is possible that a species may have continued to live from Miocene time and be distributed half way round the world, but the chances are very much against it. Since we know nothing of the ovicells of *stellata,* it seems better to give the recent form at least a varietal name, pending the discovery of the ovicells of *stellata.*

From the Hancock dredgings at the Galapagos Islands 12 specimens have been recovered from 4 different stations, similar to that discussed by Canu and Bassler, but bearing ovicells which are definitely those of a *Disporella.*

The zoaria are attached to corallines; discoid in form, thick, with a narrowly extending basal lamina; the central area large, nearly flat, round or ovate in form, and the radii on the slope of the zoarium; the colonies are of moderate size, from 2 to 4 mm in diameter. The radii are multiserial with 2 to 4 (usually 3) series of tubules which are closely connate to their tips, and which form elevated ridges separated by 2 to 4 rows of cancelli. The apertures measure 0.08 mm in diameter and the cancelli 0.08 to 0.10 mm, depending on the amount of closure.

Vertical budding appears to be a constant character, as even the smallest colonies have at least one sub-colony superimposed and arising near the center of the frontal area; as many as 3 sub-colonies are present in one specimen, vertically arranged. In one specimen a second bud is present at the edge of the central area, indicating the beginning of a

branched colony. In another case what appears to be lateral budding involves 3 colonies (or sub-colonies); these might have been produced by the fusion of separate colonies, but if so there is no definite line of demarcation.

The ovicells or brood-chambers, shown at or near the surface in two of our specimens, are either at the edge of the central area and extending between the rays or are farther out and entirely interradial or both; they show the calcified bottom layer, which covers the submerged cancelli, and the minutely perforated roofing layer. The roof of the ovicell is again closed by secondary cancelli of the usual type.

The ovicells appear to place this form definitely in *Disporella,* and the character of the cancelli with thick walls (though they are but little closed) also suggests this disposition. At the same time, the normal vertical arrangement of the sub-colonies indicates *Lichenopora* but, as has been shown above, this character does not appear to have positive generic importance.

Recorded by Canu and Bassler at Albatross Station D. 2815, Galapagos Islands.

Type, AHF no. 127.

Type locality, Hancock Station 143-34, Wenman Island, Galapagos, 1°23′10″N, 91°48′45″W, 100-150 fms.

Also at Hancock Stations: Galapagos Islands, 155-34, Albemarle Island; 453, Gardner Island, and 454, Hood Island; 30 to over 100 fms.

Disporella separata new species

Plate 74, figs. 5 and 6

Zoarium a very complex colony of the kind known as *Radiopora* by d'Orbigny, Busk, etc. It consists of about 30 sub-colonies rather regularly arranged over a rounded area about 15 to 20 mm, attached loosely and spreading over the surface of a small dead barnacle and the shell to which the barnacle is attached; most of the basal lamina is free. The sub-colonies are all well separated from each other by a few rows of cancelli and are quite regular in size and form; the discs are short-ovate, about 2.5 by 2 mm in diameter, with the radii varying in number from 8 to 12. The rays consist of small ovate clusters of peristomes, biserial or triserial, which often become uniserial at the outer end; not infrequently uniserial rays are present, and sometimes these may become biserial at the outer ends; while the triserial cluster appears to be the dominant form, all of these variations may be found on a single sub-colony and on any part of the complex zoarium. The peristomes are

moderately high near the center and become gradually shorter outward, connate to their tips, which form a single acuminate spine at the point of junction; the apertures about 0.10 by 0.08 mm.

The central area is concave in younger stages to nearly flat in older sub-colonies, elliptical in outline; the cancelli about as large as the apertures of the tubules, partially closed by an "iris-like" diaphragm with a large central pore. The interradial and intercolonial cancelli do not differ from those of the central area, except that they vary more in size and the amount of closure.

The ovicells are interradial and covered by a layer of secondary cancelli, and the ooeciostome is short, thin-walled, round, without a flaring border, barely elevated above the level of the cancelli, and measures 0.08 mm in diameter.

Young marginal sub-colonies develop near the border along with the proliferation of the lamina after 3 or 4 rows of cancelli are formed. There are several such incomplete discs at the edge of the zoarium, with the first few radii outlined on the side toward the center of the zoarium.

This species belongs to the *"Radiopora"* group in which the sub-colonies are distinct (the discs not confluent) and their discs similar to that of the primary colony (see Waters, 1918, plate 4, figs. 1-4), but appears to be different from any of the recent *"Radiopora"* species described, *Discopora meandrina* Peach, *Radiopora irregularis* J. Y. Johnson, *Discoporella pristis* MacGillivray, and *Lichenopora bullata* and *L. magnifica MacGillivray.*

Type, AHF no. 128.

Type locality, Hancock Station 1889-49, Cortez Bank, west of the United States-Mexican boundary, 32°27′05″N, 119°08′04″W, at 15 to 20 fms.

? Disporella octoradiata (Waters), 1904

Plate 75, fig. 6

Lichenopora octoradiata Waters, 1904:97.

Disporella (?) *octoradiata,* Borg, 1944:257.

Waters' description is as follows: "The zoarium is very solid and much raised, with the base narrower than the disk. There are a number of biserial rays, formed by a few zooecia, and in a well developed colony there are 8 main rays, with indications of the commencement of another series. The rays do not extend to the border of the zoarium, nor are the zooecia around the border of the disk elevated, while in the center of the zoarium the openings are round and vary in size." As far as it goes this is as fairly complete a description of our two young specimens

form around the central area, and vary in size from 2 to 6 tubules, considerably elevated above the central area which is somewhat concave. The zooecial apartures measure 0.10 mm in diameter. The larger cancelli are of about the same size, but most of those in the central area are partially closed, with a smaller rounded central pore; there are usually two rows of cancelli between the radii. The zoids around the border are not at all elevated and in most cases are indistinguishable from the cancelli. There is a narrow basal lamina.

The zoaria are evidently young, as there are no ovicells, and there is a question whether the species is the same as *L. octoradiata* Waters. The nature of the closure of the cancelli appears to relate it to *Disporella* rather than to *Lichenopora.*

Waters described the species from 71°09′ S. Lat., 89°15′ W. Long., and Borg recorded it questionably from 63°57′S, 61°50′W; both of these records are from the area between South America and Antarctica.

Hancock Station 481, Cartago Bay, Albemarle Island, Galapagos, at 12 fms, two colonies.

Disporella astraea, new species

Plate 76, figs. 1 and 2

Zoarium encrusting with a broad base and rising by vertical budding into a short cylindrical stalk which, with the radiating fascicles, gives the appearance of a minute Astraeid coral. The central area is flat with numerous thick-walled and rather wide open round cancelli, which extend between the rays in two or three rows. The flat top is surrounded by a ring of 10 high, short fascicles. The fascicles are groups composed of 4 to about 10 zooecial tubes which are all closely connate, their apertures about 0.07 mm in diameter; the apertures of the cancelli are about the same size, occasionally larger. The encrusting base is 2 mm in width; the primary zoarium arising from it 1.30 mm wide and about 0.60 mm high; the secondary zoarium or vertical bud is 1.10 mm in diameter and about 0.80 mm high.

There is no evidence of an ovicell, and therefore the disposition of the species in *Disporella* is questionable and based merely on zoarial characters.

Type, AHF no. 129.

Type locality, Hancock Station 451, off Post Office Bay, Charles Island, Galapagos, at 100 fms, one colony. Another somewhat smaller colony at Station 461, off Tagus Cove, Albemarle Island, Galapagos, at 80 fms; this specimen has 9 slightly smaller and higher fascicles, but otherwise is similar.

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Order ECTOPROCTA

Suborder CTENOSTOMATA

By RAYMOND C. OSBURN, PH.D., D.Sc. and JOHN D. SOULE, PH.D.

This taxonomic report on the Pacific Coast Ctenostomata was prepared by Dr. Soule under the immediate direction of the senior author. The work was done in connection with a study of postlarval development and histogenesis and the bearing of the results on the classification of this group. The data on which the taxonomic changes are based will be published elsewhere and bear the full approval of the senior author. The new species which have appeared during the progress of the work are all to be credited to the careful work of Dr. Soule.

R. C. O.

Sub-Order CTENOSTOMATA Busk, 1852

The chitinous zoaria may be incrusting, erect, stolonate or burrowing. The zooecial aperture is essentially simple, being closed by the inversion of the tentacle sheath on retraction of the polypide. In some genera specialized apertures are present, including those that are bilabiate, produced or even operculate. The operculum present in one genus of burrowing ctenostomes is analogous to the opercula of the cheilostomes. No avicularia or true external ovicells are present, although specialized gonozoids do occur. Kenozooecia, modified as stolons, are present in the stolonate groups, or as spines in the carnose forms.

Division 1. Carnosa Gray, 1841

Ctenostomata that have in common a comparatively heavy noncalcareous cuticle, giving the zoaria a fleshy or leathery appearance. The colonies included within this group are usually incrusting, but they may rise in thin flabellate or palmate fronds, sac-like expansions, or they may be cylindrical or pedunculate structures.

KEY TO THE FAMILIES OF THE DIVISION CARNOSA

1. Zoaria primarily incrusting 2
   Zoaria erect, clavate, with kenozooecial peduncle . . *Clavoporidae*
2. Zooecia with aperture closed by simple folds . . . *Alcyonidiidae*
   Zooecia with modified apertures 3
3. Aperture bilabiate, zooecia with kenozooecial spines . *Flustrellidae*
   Aperture raised, quadrangular, zooecia with

Family **Alcyonidiidae** Johnston, 1849

Zoaria incrusting or erect in sacculate or cylindrical expansions. Aperture closed by simple folds formed by the invagination of the tentacle sheath when retracted, producing a puckered or drawn appearance.

Genus **ALCYONIDIUM** Lamouroux, 1812

Zoaria incrusting, coriaceous or gelatinous in appearance, forming a soft cover over the substrata, or arising into lobed sac-like, or cylindrical expansions. Zooecia closely united, not stolonate. The aperture may be in the center of raised papillae, or the entire ventral surface of the zooecia may present a smooth surface, a slight puckering at the distal end indicative of the aperture. Genotype: *Alcyonium gelatinosum* Linnaeus, 1767.

Key to the Species of *Alcyonidium*

1. Zoaria primarily incrusting, spreading irregularly 2
   Zoaria primarily erect, or disc-shaped, limited 4
2. Zoaria flat, incrusting, zooecia irregularly hexagonal . . *polyoum*
   Zoaria flat, incrusting, zooecia with raised apertures 3
3. Zoaria argillaceous, zooecia with fine papillate border . *parasiticum*
   Zoaria clear, zooecial aperture mammillate . . . *mammillatum*
4. Zoaria disc-shaped, flattened . . . . . *disciforme*
   Zoaria primarily erect 5
5. Zoaria sacculate, expanded, lobed . . . . . *pedunculatum*
   Zoaria elongate, cylindrical . . . . . *enteromorpha*

Alcyonidium polyoum (Hassall), 1841

Plate 77, fig. 1

Sarcochitum polyoum Hassall, 1841:484.
Alcyonidium mytili, Robertson, 1900:329.
Alcyonidium polyoum, Robertson, 1900:330.
Alcyonidium mytili, O'Donoghue, 1923:191; 1926:54.
Alcyonidium columbianum O'Donoghue, 1926:56.

The zoaria of the specimens in the collection show a great deal of color variation, ranging from transparent to brown or gray. In size the colonies ranged from 1 to 6 cm in breadth depending upon the size and type of subtrate. These zoaria are found incrusting rocks, mollusk shells, algal holdfasts and sometimes on the larger Crustacea.

The zooecia are irregularly hexagonal, but zooecia that are pentagonal, quadrangular and some that are nearly square are not uncommon. This wide variation in shape may account for the differences found in the measurements that have been previously cited in the literature.

The zooecial walls are usually distinct. The apertural openings in some of the zoaria are found on small raised papillae, distally located on the ventral wall, while in other zoaria there are no papillae, the ventral surface being smooth. In the latter case, the openings are either easily discerned, or are very obscure. One recent author (Silen, 1942:9-11) considers *A. polyoum* one of the species with a smooth ventral surface. Other authors (Hincks, 1880:501; Osburn, 1933:61; 1944:16; Marcus, 1941:68) have all noted the presence of a raised oral papilla. It is possible that the presence or absence of the oral papillae may be due to the degree of retraction of the tentacle sheath. If so, a given living zoarium could exhibit no oral papillae at one time, and have them at another.

The tentacle number poses another problem in this species. The vexing question is, does this species have a fixed number of tentacles, a variable number of tentacles, or are there two or possibly three species similar in external appearance being lumped together as *A. polyoum*? The reported tentacle number varies from 12 (Harmer, 1915:38) to 20 (Silen, 1942:11). The original description (Hassall, 1841:484, 485) reports the tentacle number as 20. If then the number to be considered as correct is 20, what is to be the disposition of those with 16 tentacles (Marcus, 1941:68; Rogick, 1949:47), unless *A. polyoum* is considered as having a wide variation in tentacle number. In order to determine the number of tentacles in the specimens from the eastern Pacific found in the Hancock collection, comprising at this time 9 stations (5 from Alaska, 4 from northern California), a sample of each of the best preserved specimens with the external characteristics of *A. polyoum* was sectioned. None of the specimens had 20 tentacles. Two Alaskan specimens, one with raised papillae, and one without, had 17 tentacles. One Californian specimen with definite oral papillae had 17 tentacles. Three others, all from Californian waters, without oral papillae, had 15, rarely 16 tentacles. Until such time as additional material can be obtained of both Pacific and Atlantic origin, the only safe conclusion is that *A. polyoum* does have a variable number of tentacles.

Alcyonidium polyoum is widely distributed in the colder waters of both the Atlantic and the Pacific. In the eastern Pacific it has been

previously reported by Robertson, 1900, and O'Donoghue, 1923, 1926, in the waters off Alaska, British Columbia, and Puget Sound.

The specimens in the Hancock collection are from off Point Barrow, Alaska, Arctic Research Laboratory, G. E. MacGinitie collector; Lenard Harbor, Alaska, Canoe Bay, Alaska, Tomales Bay, California, AHF stations 1607-48 and 1656-48 in depths ranging from intertidal to 40 fathoms. (8 stations.)

Alcyonidium parasiticum (Fleming), 1828

Plate 77, fig. 2

Alcyonium parasiticum Fleming, 1828:518.
Alcyonidium parasiticum, O'Donoghue, 1923:191.

The collection has one large zoarium, thin, incrusting upon an eroded mollusk shell. The individual zooecia may be distinguished with some difficulty, due to the deposit of sand and mud which covers most of the zoarium. The zooecia are small, irregular in morphology, the variation ranging from nearly square zooecia to those that are elongated to nearly diamond-shaped. All of the zooecia that could be examined possessed raised oral papillae on the ventral surface, and minute border papillae. The argillaceous cover upon the cuticle prevented sectioning of a portion of the specimen.

This species is well distributed throughout the colder Atlantic waters and has been reported by O'Donoghue from the Pacific northwest.

The specimen in the Hancock collection came from Tomales Bay, California, at a depth of 5 fathoms, collector R. C. Osburn.

Alcyonidium mammillatum Alder, 1857

Plate 77, fig. 4

Alcyonidium mammillatum Alder, 1857:154.
Alcyonidium mamillatum, O'Donoghue, 1923:191; 1926:54.

The zoaria form dark brown, thin, rough, irregular incrustations upon mollusk shells. The zooecial walls are well defined, except in the portions of the zoaria that are covered by foreign matter. The zooecia vary in shape from an elongated irregular oval to rectangular. Distally the zooecial apertures are raised upon short cylindrical, transversely wrinkled projections.

The literature reveals that this species is moderately well known from the cold waters of the Atlantic. On the Pacific coast of North America, O'Donoghue has reported it from the vicinity of Vancouver Island, 1923, 1926.

Hancock Station 1642-48, off Point Vicente, southern California; also Friday Harbor, Puget Sound, J. L. Mohr, collector; Cold Bay, Alaska, U. S. Alaska Crab Investigation; and off Newport, southern California, which well may be the southern extension for this species. The known depth range is 15 to 70 fms.

Alcyonidium pedunculatum Robertson, 1902

Plate 77, fig. 3

Alcyonidium pedunculatum Robertson, 1902:106.
Alcyonidium pedunculatum, O'Donoghue, 1926:55.

The zoaria of this unusual species are erect, arising from a short "peduncle" into wide flat saccate expansions, the largest of those in the Hancock collection, from Puget Sound, Washington, measuring 6.5 cm high and 4.5 cm wide. The largest from Alaska measures 11 cm long and 3 cm in width. The "peduncles" are wrinkled, rough, coriaceous in appearance, short, stout, cylindrical, and contain a loose reticular connective tissue. The zooecia are not modified as they are in the true peduncle of *Clavopora, i.e.,* for bending and swaying the colony. The expanded portion of the zoarium is sac-like, filled with loose connective tissue, and may have several finger-like projections, or it may be a single foliaceous lobe. These lobes are smooth, light brown in color. The zooecial outlines are well marked, an irregular hexagonal shape. Sectioning disclosed the tentacle number to be 17.

Miss Robertson's specimens were from the Pribilof Islands, Alaska. O'Donoghue (1926) reported the species from the Vancouver Island region.

The specimens in the Hancock collection are from Alaska, Arctic Research Laboratory, G. E. MacGinitie, collector, and Puget Sound, Washington, J. L. Mohr, collector. There are 10 stations ranging in depth from 20 to 35 fathoms.

Alcyonidium disciforme (Smitt), 1871

Plate 77, figs. 5 and 6

Alcyonidium mammillatum var. *disciforme* Smitt, 1871:1122, 1123.
Alcyonidium disciforme, Osburn, 1936:540.

The mature zoaria have a very distinctive, characteristic morphology. Resembling a common wide rubber washer or large coin with a circular hole punched from its center, these zoaria form circular, slightly convex discs, which apparently rest upon soft sandy substrata. Young colonies lack the central hole. Minute, fine root-like extensions from the basal

side help to anchor the colony in place. These kenozooecial filaments are most easily found near the periphery of the zoaria. The zoaria in the collection measured between 2.6 and 3.0 cm in diameter. The zooecia are small, hexagonal, usually bearing the apertures raised on papillae which occupy nearly all of the ventral surface. The tentacle number is 16, determined from sections.

Described by Smitt from Scandinavian waters, and recorded by Osburn from Captain R. A. Bartlett's dredgings in Wakeham Bay, Ungava, Canada.

Hancock collection specimens are from Point Barrow, Alaska, Arctic Research Laboratory, 13 fms, collected by G. E. MacGinitie. The species evidently has a circumpolar distribution.

Alcyonidium enteromorpha Soule, 1951

Plate 77, figs. 7 and 8

Alcyonidium enteromorpha Soule, 1951:367.

The zoaria are elongate without lateral branching, bearing a superficial resemblance to the intestinal tract of a small mammal. Of several zoaria in the collection the longest measured 61 cm in length and from 4 to 6 mm in width. Coiled in several loose folds the zoaria are attached to the substrate without a differentiated "peduncle." The cuticle is firm, mottled light brown to tan in color, and only moderately thick. The zoaria are cylindrical and filled with a loose reticular connective tissue. Within this meshwork of connective tissue may be found numerous brown bodies, the product of degenerated zoids that have entered the central cavity when the thin dorsal zooecial walls were ruptured. From the ventral surface the zooecia are well defined, most easily found in the portions of the zoaria where the cuticle is thin. On the greater part of the zoaria, the lateral zooecial walls can be only faintly discerned, and while not totally obscured, they are rather difficult to trace. The ventral zooecial walls are smooth, with no oral papillae present. As noted before, the dorsal zooecial walls are thin, almost to the point of transparency. In shape the zooecia are varied, ranging from rectangular to irregularly hexagonal, those containing mature polypides measuring between 0.23 and 0.40 mm in length, and from 0.11 to 0.25 mm in width. The tentacle number obtained from serial sections is 17. It differs from *A. pedunculatum* Robertson, by virtue of its cylindrical form, its extreme zoarial length, and its complete lack of a "peduncle."

All of the specimens in the Hancock collection are from Alaska, off Point Barrow, Arctic Research Laboratory, collector G. E. MacGinitie. Collected at depths ranging from 80 to 123 fathoms.

Family **Flustrellidae** Hincks, 1880

Zoaria incrusting or rising in flabellate extensions. The aperture is bilabiate, closed by two lip-like flaps that are supported by chitinous rims. The analogy has been drawn by earlier authors, commenting on the resemblance of the aperture of the Flustrellidae to the opening of an old fashioned clasp purse. Chitinous spines are present.

Genus **FLUSTRELLA** Gray, 1848

Zoaria incrusting, or rising in flattened fan-shaped projections. The zoaria are hispid, with many flexible chitinous spines, which vary in morphology and frequency with the species. The spines originate from kenozooecia. The aperture is bilabiate as described above. Genotype: *Flustra hispida* Fabricius, 1780.

Flustrella corniculata (Smitt), 1871

Plate 77, fig. 9

Alcyonidium corniculatum Smitt, 1871:1123.
Alcyonidium cervicornis Robertson, 1900-330.
Alcyonidium spinifera O'Donoghue, 1923:192.
Alcyonidium cervicorne, O'Donoghue, 1926:56.
Flustrella corniculata, O'Donoghue, 1925:15.

The zoaria are found in various modes of growth, depending upon the types of substrata. The shape varies from small cylindrical clavate colonies to large foliaceous flattened expansions. The color may range from pale tan to dark brown. Macroscopically, the zoaria have a coarse "fuzzy" appearance due to the presence of numerous chitinous spines. These spines arise from modified zooecia scattered abundantly among the functional zooecia. Most commonly the spines have four prongs. However, there are also spines bearing six prongs, and some with but one. The zooecia range in form from an elongated ovoid to hexagonal, usually with distinct lateral walls. The aperture is a narrow transverse slit. Occasionally specimens are found with the apertures slightly raised, at the summits of low papillae. The tentacle number, determined from sections, is 18.

This species, described from cold European waters, has appeared in the Pacific literature under several different names. Robertson found it in the Alaskan collection of the Harriman Expedition, and O'Donoghue described it from the Vancouver Island region and Puget Sound.

Specimens in the Hancock collection are from off Point Barrow, Alaska, Arctic Research Laboratory, collector, G. E. MacGinitie; British Columbia; and Dillon Beach, Tomales Bay, California. Depth range, from intertidal to 36 fathoms.

Flustrella gigantea Silen, 1947

Plate 78, fig. 1

Flustrella gigantea Silen, 1947:134.

The zoaria are incrusting or arise into erect, flattened lobate, bilaminar expansions measuring 3 to 4.5 cm in height, and 0.5 to 1.0 cm in width. Macroscopically all the dark brown zoaria have a hirsute appearance due to the presence of branching chitinous spines. The zooecia are arranged in alternating series, varying in form from an irregular rectangle to an uneven hexagon; in length they range from 0.97 to 1.25 mm, and in width from 0.70 to 0.83 mm. In younger portions of the zoaria the zooecia are distinct, but in the older areas the lateral zooecial walls are obscured by the pigmented cuticle. Each zooecium has a distal raised oral papilla with the bilabiate aperture at its summit. The hollow spines, arising from kenozooecia, are variable in morphology, and have a location pattern that is only moderately uniform. Distally, about the raised oral papilla on each zooecium, are 2 to 4 of the multibranched spines. The number of terminal prongs may vary from 9 to 21, the most frequent range being 11 to 14. Some spines, as well as having the normal numerous prongs, are modified so as to have one large grossly extended, thorn-like spike, giving the spine an over-all length of 1.38 to 2.05 mm. This spectacular form of the spine is scattered at random in generous quantity over the zoaria, from the growing tip to the most mature portions of the zoaria. Sections revealed the tentacle number to be 26.

The specimens described by Silen were from the Bering Sea. The material in the Hancock collection is also from Arctic waters, off Point Barrow, Alaska, G. E. MacGinitie collector. Depth, 36 fathoms.

Family **Pherusellidae** Soule, new family

Zoaria incrusting or arising into flattened flabellate, bilaminar extensions. Aperture square or quadrangular, raised upon a stout tubular process. Prominent compound communication pores (multiporous septulae), supported by heavy chitinous rings, connect adjacent zooecia, piercing the distal as well as the lateral walls. No spines present. Prior to this time the genus *Pherusella* has been placed under the family

Flustrellidae, but the morphological differences in the aperture, the presence of the prominent communication pores, and the lack of kenozooecial spines warrant the separation of this genus into a distinct family.

Genus **PHERUSELLA** Soule, 1951

Zoaria coriaceous, incrusting, or arising from incrustations in branching flabellate, flattened projections. The distal ends of the zooecia rise into prominent tubular processes, which bear the aperture. When the polypide is retracted, the apertures appear square to transversely quadrangular in shape. The lateral walls and the distal walls are pierced by prominent multiporous septulae provided with heavily chitinized rims, apparently a unique character in the Ctenostomata. Genotype: *Flustra tubulosa* (Solander), 1786. The genus *Pherusa* Lamouroux, 1816, is preoccupied by *Pherusa* Oken, 1807. The name *Pherusa* had also been proposed by Leach, 1814, and Rafinesque, 1815.

Pherusella brevituba Soule, 1951

Plate 78, fig. 2

Pherusella brevituba Soule, 1951:368.

The chitinous zoaria are a light brown in color, leathery in appearance, and form prominent incrustations upon the holdfasts and blades of algae. When the zoaria are strictly incrusting, they are unilaminar, or they may form erect fan-like "fronds" that are bilaminar, back to back, where the zoarial growth exceeds the limits of the algae thalli.

The zooecia are elongate with considerable variation in shape, from imperfectly rectangular to hexagonal, averaging about 0.80 mm in length and 0.40 mm in width. Normally the individual zooecia are distinct, clearly defined by the lateral walls. The zooecial walls are perforated by well marked compound interzooecial communication pores having an average diameter of 0.02 mm. The rims of the communication pores are strengthened by heavy chitinous rings. Within this ring are four minute perforations piercing a thin chitinous diaphragm.

The distal portion of each zooecium is raised to form a short but prominent tubular process bearing the aperture. The upper extremity of this tubular process is square to transversely quadrangular in shape. The tentacles number 23.

This species has been taken off Portuguese Bend, California; collected in the intertidal zone at Punta Baja, Rosario, Lower California, by E. Y. Dawson; and found on the holdfast of algae washed ashore near the Santa Barbara-San Luis Obispo county line, southern California. The range in depth is from intertidal to 8 fathoms.

Family **Clavoporidae** Soule, new family

Zoaria erect, arising from a basal plate. Each zoarium is differentiated into two anatomically distinct portions, a capitulum composed of autozoids supported by an annulated peduncle composed of muscular kenozoids. Zoaria may be solitary or in groups but are never compound. The aperture of each zooecium is similar to that found in the family Alcyonidiidae, and is usually located at the center of a small papillate process. The presence of two anatomically distinct regions within a zoarium, a situation not found elsewhere in the carnose families, justifies the proposal of a new family.

Genus **CLAVOPORA** Busk, 1874

Zoaria usually small, erect, coriaceous, clavate, arising from basal discs. As noted above, each zoarium has an annulated peduncle of muscular kenozooecia capable of bending and flexing the erect portion of the colony in any direction, and a capitulum of functional autozooecia capable of feeding and reproduction. The kenozooecia of the annulated peduncle are arranged in a series of rings, the central portion of the peduncle being a hollow fluid-filled tube. This tube forms a communication between each feeding autozoid of the hollow capitulum and the muscular kenozooecia. Fluid containing dissolved nutriments and cellular elements may pass into the kenozooecia by means of minute simple pores (septulae) located in the internal zoid walls. The musculature of the kenozooecia consists of modified parietal muscles that run parallel to the long axis of the peduncle. Contraction of the muscles on one side, with reciprocal relaxation of the musculature of the opposite side, will bend the entire erect portion of the colony. In the capitulum, at the apex of the peduncle, the autozoids are densely packed. On the outer wall of the capitulum the cuticle is comparatively thick and leathery. The lateral walls and the internal walls of the zooecia, submerged within the body of the capitulum, are, in contrast, thin, lightly chitinized, and delicate in appearance. Genotype: *Clavopora hystricis* Busk, 1874.

Clavopora occidentalis (Fewkes), 1889

Plate 78, fig. 3

Ascorhiza occidentalis Fewkes, 1889:1.
Ascorhiza occidentalis, Robertson, 1902:106.
Ascorhiza occidentalis, O'Donoghue, 1923:192.
Clavopora occidentalis, O'Donoghue, 1926:57.

The zoaria are stalked, arising directly from small irregularly cylindrical adherent basal discs. The basal discs are firmly attached to the substrata; rocks, mollusk shells, or, as in the case of some of those in the Hancock collection, attached to colonies of the cheilostome bryozoan *Discoporella umbellata* (Defrance), 1823. The zoaria are a pale brown to light tan in color. The zoarial length is variable, ranging from 8 to 5.8 cm. The zoaria may be solitary, or secondary zoaria may grow attached to the pedunculate portion of an older zoarium, where they have developed from settled larvae.

Anatomically, a zoarium may be divided into two distinct sections, a peduncle composed of muscular kenozooecia, and a capitulum at the apex of the peduncle, composed of functioning autozooecia. The peduncle is cylindrical, stout, and strongly annulated in the older zoaria. According to the figure in Fewkes' original description, the stalk is extremely slender. This is not the case with specimens in the Hancock collection, the peduncular portions of the mature zoaria having a diameter ranging from 0.50 to 0.75 mm. The capitulum, ranging in length from 2 mm to 3.5 cm, is an expanded ovoid structure, bulb-like in appearance with a coriaceous cuticle. It is composed of the functional autozooecia, closely united, somewhat indistinct, with the aperture located within the center of a low papillate process. The tentacle number, determined by means of serial sections, is 18.

The specimens reported by Miss Robertson (1902) were dredged off Santa Catalina Island, California, while those recorded by O'Donoghue came from the vicinity of Vancouver Island. The specimens in the Hancock collection are from Hancock station 924-39, Socorro Island, Mexico; Guadalupe Island, Mexico, collector C. L. Hubbs; and Dillon Beach, California; in depths ranging from 17 to 46 fathoms.

Division 2. **Paludicellea** Allman, 1856

Zooecia connected by stolon-like tubular extensions that may or may not possess internodes separated by septulae. A zooecium may form a daughter zooecium by means of a bud produced near its distal extremity.

Family **Nolellidae** Harmer, 1915

"The Family Nolellidae is characterized by the great development of the peristomial part of the zooecium. This region is typically much elongated and its ectocyst frequently includes muddy particles. The

adnate portion of the zooecium is represented by a delicate stolon-like tube and by the base of the peristome into which it usually passes abruptly, although it more rarely dilates gradually as it approaches this part. The branching is of the cruciform type. Gizzard absent." Harmer, 1915:52.

Genus NOLELLA Gosse, 1855

Zooecia cylindrical, elongate, with considerable variation in size within the same zoarium. The proximal ends of the zooecia are prolonged, narrowed to form connecting tubular extensions. The cuticle may, on occasion, be covered by a very fine argillaceous coat. Genotype: *Nolella stipata* Gosse, 1855.

Nolella stipata Gosse, 1855

Plate 78, fig. 5

Nolella stipata Gosse, 1855:35-36.
Farrella gigantea Busk, 1856:93.
Farrella dilatata, Hincks, 1860:279.
Cylindroecium giganteum, Hincks, 1884:208.
Cylindroecium papuense Busk, 1886:38.
Cylindroecium giganteum, O'Donoghue, 1926:60.

Zoaria with stolonal portion adhering to varied substrata ranging from hydroids and algae to eroded mollusk shells and cheilostomatous bryozoans. The zooecia are chitinous, erect, cylindrical. The cuticle is covered with an extremely fine layer of silt, which does not, however, totally obscure the view of the polypide in alcoholic or wet-mount preparations. The zooecia are extremely variable in length, with mature specimens ranging in length from 0.90 to 3.80 mm, and in width from 0.17 to 0.25 mm. The proximal portion of the zoid, the basal area, is expanded (dilated) forming a junction point for 2, 4, or even 6 of the stolons. The only stolon that is not set off from the basal dilation by a distinct diaphragm is the one from which the zoid arises. The degree of basal dilation seems to be correlated with the type of substratum. The specimens in the collection that are adherent to a soft substrate, such as the algae or the hydroids, have a much less prominent dilation than those adhering to a hard mollusk shell, where the proximal dilation is very great. (See Hincks, 1880:537, pl. 77, figs. 1 & 2, and pl. 79, figs. 1-3).

This species is liberally represented in the cooler waters of the Atlantic on both the European side and the North American. On the Pacific

coast of North America it has previously been reported by Hincks from the Queen Charlotte Islands, and by O'Donoghue from the vicinity of Vancouver Island.

In the Hancock collection specimens are from Puget Sound, Washington, Gulf of California, and the west coast of Lower California. Hancock stations, 650-37, San Francisco Island, Gulf of California, and 1714-49, Magdalena Bay, Lower California. Depth range from 17 to 47 fathoms.

Genus **ANGUINELLA** van Beneden, 1845

Zoaria erect, branching irregularly. Zooecia cylindrical, arising from a small adnate proximal base. Zooecia bud directly from other zooecia. Genotype: *Anguinella palmata* van Beneden, 1844.

Anguinella palmata van Beneden, 1845

Plate 78, fig. 4

Anguinella palmata van Beneden, 1845:34.
Anguinella palmata, Osburn, 1912:253.

Zoaria palmate, chitinous, opaque, brown in color, consisting of erect single stalks with zooecia branching irregularly to all sides. The zoarial length of the specimens in the Hancock collection ranges from 2.0 to 3.1 cm. The zooecia are cylindrical, elongate, rounded distally, the aperture terminal. The cuticle is characteristically covered with a fine coat of silt, rendering examination of the polypide difficult even under optimum conditions of fixation and preservation. The zooecia bud directly from the sides of older mature zooecia. The polypides of the zooecia in the older basal and axial portions of the zoaria are suppressed, and these zooecia serve as support for the younger lateral and distal zooecia that are functional.

No difference could be detected in the morphology of the Pacific specimens when compared with the Atlantic specimens collected at Beaufort, North Carolina, by R. C. Osburn, or those collected at New River, North Carolina, by A. S. Pearse. This is believed to be the first record of this genus and species from the Pacific Coast of North America. According to Hincks, 1880:540, it is moderately abundant in the waters about the British Isles and off the coast of Belgium and France.

Hancock Stations: 277-34, Isabel Island, Mexico; 447-35, Panama City, Panama; 847-38, off Zorritos Light, Peru; 1449-42, Newport Harbor, and 2020-51, Seal Beach, southern California. Depth range, intertidal zone to 25 fathoms.

Division 3. **Vesicularina** Johnston, 1847

The ctenostomes included within the limits of this grouping characteristically have relatively heavy, thickened, usually branching, septate stolons. The zooecia bud directly from the stolon. Polypide usually provided with a gizzard, or as Harmer, 1915:60, stated, "Gizzard present in most of the genera, perhaps in all."

Family **Vesiculariidae** Johnston, 1838

Zoaria erect or creeping, consisting of two types of zooecia, the kenozooecia constituting the stolons, and the autozoids the feeding individuals. From within each internode of a stolon arise several zooecia, the arrangement being characteristic within the genera.

Genus **VESICULARIA** J. V. Thompson, 1830

Zoaria erect, the main stolon or stolons supported on the substrate by a number of kenozooecial rhizoid-like runners. Zooecia ovoid to elongate cylindrical, distinct, arranged within an internode in a single series. Zooecia are contracted at the base, and the polypide is provided with a prominent gizzard. Genotype: *Sertularia spinosa* Linnaeus, 1758.

Vesicularia fasciculata Soule new species

Plate 78, fig. 6

Diagnosis: Zoaria erect, unbranched, arising from a base supported by tubular, root-like, kenozooecial fibers. The main axis of the zoarium is composed of a series of 6 to 8 stout parallel or entwined stolons adherent to each other so as to form an elongated bundle. Zooecia elongate, cylindrical, arising from the stolons in a linear series, containing polypides each bearing 12 short tentacles and a prominent gizzard.

Description: Of the three zoaria representing this species in the Hancock collection, the longest measured 2.80 cm in height, prior to the removal of portions for sectioning and for whole-mounts, while the shortest measured barely 0.6 cm. The remaining zoarium was in a very poor state of preservation.

The zoaria arise in a single, non-branching axis of growth, from a base supported by kenozooecia in the form of tubular radiculate fibers. The main axis mentioned above consists of a series of 6 to 8 or more robust stolons adherent to and twisted about each other to form an

elongate sheaf. Examination of a cross section of a stolonal sheaf from an older portion of the colony revealed stolons of uniform diameter, while cross sections made close to the growing tip of the colony disclosed one larger principal stolon surrounded by 4 to 6 secondary stolons of narrower diameter. An individual stolon does not as a rule traverse the entire length of a zoarium. One stolon will give rise to a second at a point located just below (proximally) a septum terminating an internode. The newly arisen stolon gains mature diameter at once and proceeds distally paralleling its "parent" and the other stolons of the zoarium. The zooecia arise from the stolons, originating in a linear series within an internode in variable numbers. They are deciduous, the stolons characteristically marked with the scars of departed zooecia. The zooecia are constricted slightly at the point of fusion with the stolon. Morphologically they are elongate, cylindrical, ranging in length from 0.94 to 1.10 mm, and in width from 0.24 to 0.28 mm. The polypide contains a prominent gizzard. The tentacles are short, and 12 in number.

Vesicularia fasciculata differs in two major aspects from the other species in the genus, having an unbranched zoarium, as compared to the branched zoaria of *V. spinosa* Linnaeus, *V. papuensis* Busk, and *V. harmeri* Silen, and it has 12 tentacles as compared to 8 tentacles in *V. spinosa* and *V. papuensis.*

Holotype: U. S. N. M. no. 11053; Paratype, AHF no. 134.

Repository: The United States National Museum, Washington, D. C.

Paratype: The Allan Hancock Foundation, The University of Southern California, Los Angeles, California.

Type locality: Off Point Barrow, Alaska, 18 February 1950, depth 162 feet, collector, G. E. MacGinitie. Also Point Barrow, Alaska, August 1, 1949, depth 321 feet, July 1, 1950, depth 118 feet, collector, G. E. MacGinitie.

Genus **AMATHIA** Lamouroux, 1812

Zoaria erect, stolons robust, stiff. Zooecia in biserial arrangement, forming a spiral within an internode. Polypide provided with a gizzard. Genotype: *Sertularia lendigera* Linnaeus, 1758.

Amathia convoluta Lamouroux, 1816

Plate 78, fig. 7

Amathia convoluta Lamouroux, 1816:160.
Amathia convoluta, Harmer, 1915:64.

The zoaria of this well known species are large, erect, prominent, light brown in color. The zooecia are arranged biserially, paired, forming a loose spiral that encircles the stolon within the limits of an internode. An internode is limited to one series of zooecia. The zooecia are completely connate along their entire length when the tentacles are completely retracted. The zooecia are of uniform length, ranging from 0.71 to 0.74 mm. In width, the range is from 0.08 to 0.09 mm. The polypide has a gizzard.

This species appears to be widely distributed, having been previously reported from European waters of the Atlantic and in North and South America from Chesapeake Bay to Santos Bay, Brazil. In the Pacific there have been several reports from the Australian region. This is the first report of its occurrence in the waters of the eastern Pacific.

Hancock Stations: 133-34, Socorro Island, west of Mexico; 253-34, and 257-34, Port Culebra, Costa Rica; 265-34, Petatlan Bay, Mexico, and 486-35, Tenacatita Bay, Mexico. Depth, 5 to 20 fms.

Amathia vidovici (Heller), 1867

Plate 79, fig. 2

Valkeria Vidovici Heller, 1867:128-129.
Amathia vidovici, Osburn, 1940:340.

Zoaria erect, tall, with elongate internodes. The zooecia are small, biserial, forming a spiral in the distal portion of the internode, leaving for the most part the proximal portion of the internode bare. Zooecia connate only at their point of origin and attachment to the stolon. Their length ranges from 0.32 to 0.41 mm.

This species has not appeared in the literature as frequently as some of the other species of the genus *Amathia.* It was originally reported from the Adriatic Sea by Heller. On the Atlantic coast of North America it has been reported by Osburn and by Hutchins. Osburn also reported it from Puerto Rico.

The specimens in the Hancock collection are from about 20 stations, ranging geographically from Santa Rosa Island, southern California (in the northern Channel Islands), to Ecuador and the Galapagos Islands.

Amathia distans Busk, 1886

Plate 79, fig. 1

Amathia distans Busk, 1886:33.
Amathia distans, O'Donoghue, 1925:16.
Amathia distans, Osburn, 1940:339.

The zoaria are comparatively small, low, straggling, with a moderately regular dichotomous mode of branching. The zooecia are found in biserial spirals that may, but usually do not, fill an internode, most frequently occupying only the distal portion. The zooecia are short, ranging in length from 0.35 to 0.46 mm, closely connate, except at the tips. This species differs from *A. convoluta,* whose zooecia are also connate, in its smaller size, its reptant habit, and in having the proximal half of the internode usually devoid of zooecia.

A. distans has been reported previously from the South Atlantic by Busk, 1886:33; from Australian waters by MacGillivray, 1889:30; Java, Harmer, 1915:68; Puerto Rico by Osburn, 1940:339; and Puget Sound, O'Donoghue, 1925.

The specimens in the Hancock collection (20 stations) range geographically from Santa Rosa Island, southern California, to the Gulf of California.

Genus **ZOOBOTRYON** Ehrenberg, 1831

Zoaria loosely spreading, flaccid, not creeping, branching in an irregular fashion. Zooecia ovoid, narrowed at the point of origin and attachment to the stolon. Polypide with a prominent gizzard. Genotype: *Hydra verticillata* delle Chiaje, 1828.

Zoobotryon verticillatum (delle Chiaje), 1828

Plate 79, fig. 3

Hydra verticillata delle Chiaje, 1828:203.
Zoobotryon pellucidus Ehrenberg, 1831: no pagination.
Zoobotryon pellucidum, Osburn, 1940:341.

The zoaria are flaccid, lavishly branching into tangled masses. The stolons are transparent, very flexible, only lightly chitinized, ranging in diameter from 0.40 to 0.70 mm. At intervals both the stolon and the zooecia may be partially obscured due to a deposit of silt. The zooecia are usually found arranged bilaterally along the stolons, but not infrequently they occur in scattered clumps. The zooecia range in length from 0.36 to 0.48 mm, and in width from 0.12 to 0.17 mm; elongated-ovoid, rather narrow at the point of origin and attachment to the stolon, tapering to a bluntly square tip at the distal apertural orifice. The polypide is provided with a prominent gizzard. While this is the first direct description of this species from the Pacific coast of North America, Miss Alice Robertson, 1921:63, mentioned in her paper on the Bryozoa of the Bay of Bengal that she had seen this species in San Diego, California, and had received specimens from Hawaii.

According to Osburn, 1940:342, this species is circumtropical. It has been recovered from the warm waters of the Mediterranean, from Bermuda, Florida, Puerto Rico, Gulf of Mexico, and Brazil.

Specimens in the Hancock collection are from San Diego, California, no further data given.

Genus **BOWERBANKIA** Farre, 1837

"Zooecia arising irregularly from an erect or creeping axis, commonly in definite groups. Tentacles 8-10. Gizzard present." Harmer, 1915:70. Genotype: *Sertularia imbricata* Adams, 1800.

Bowerbankia imbricata (Adams), 1800

Plate 79, fig. 4

Sertularia imbricata Adams, 1800:11.
Bowerbankia imbricata, Robertson, 1900:331.
Bowerbankia imbricata, O'Donoghue, 1925:93.

The zoaria form irregular tangled masses, with reptant stolons having a diameter ranging from 0.06 to 0.09 mm. The stolons are divided into internodes of variable length, separated by a diaphragm perforated by a single pore. The zooecia are elongate-tubular, straight or slightly curved, and have a square distal extremity. The proximal zooecial portion may be extended to form a short caudate process of one or two prongs. The zooecia are constricted at the point of origin on the stolon. The zooecial length of the eastern Pacific specimens ranges from 0.92 to 1.15 mm. A gizzard is present. The tentacle number is 10, as determined from serial sections.

This species appears to be well distributed in the cooler European waters. In the eastern Pacific, it has been previously reported from Alaska and Puget Sound.

In the Hancock collection, the specimens of this species are from British Columbia, E. F. Ricketts, collector, no bathymetric data available.

Bowerbankia gracilis Leidy, 1855

Plate 79, fig. 5

Bowerbankia gracilis Leidy, 1855:142.
Bowerbankia gracilis, O'Donoghue, 1923:192; 1925:93.
Bowerbankia gracilis, Osburn, 1940:341.

The zoaria consist of tangled gray masses of stolons and zooecia, repent, not erect, with extremely irregular branching. The zooecia are tubular, narrow, tapering slightly at both the distal and the proximal ends. The distal extremity is square in most cases. The polypide is provided with a prominent gizzard, measuring between 0.08 and 0.09 mm in diameter. The zooecial length ranges from 1.02 to 1.52 mm. None of the zoaria had specimens of mature zoids with a measurement of less than 1.0 mm. As a rule, the specimens with a caudate appendage proximally were the longest. The zooecia are attached to a creeping stolon with or without a lateral extension. The zooecia may occur single, in pairs, or in dense clusters. The stolonal diameter is variable, ranging from 0.03 to 0.05 mm. The stolons have internodes of variable length, separated by diaphragms which are perforated by a single pore.

In the eastern Pacific specimens in the collection, it was found that both caudate and non-caudate individuals occur within the same zoaria, with the non-caudate form predominant. No zoaria were found in which the caudate individuals occurred solely.

Bowerbankia gracilis is a "cosmopolitan species," having been previously reported from Greenland to Puerto Rico to Brazil.

Specimens in the Hancock collection are from Puget Sound, Washington; Dillon Beach, Tomales Bay, California, R. C. Osburn collector; Los Angeles Harbor; and the Gulf of California. All collections were made in the intertidal range. Hancock station, 510-36, Espiritu Santo Island, Gulf of California.

Bowerbankia gracilis aggregata O'Donoghue, 1926

Plate 79, fig. 6

Bowerbankia gracilis var. *aggregata* O'Donoghue, 1926:58-60.

The zoaria form dense tangled masses which completely obscure the substrata. The stolons, as in *B. gracilis* Leidy, have internodes of variable length, limited by diaphragms perforated by a single pore. The zooecia are very greatly elongated, ranging in length from 1.77 to 2.25 mm. The tentacle number is 8.

This variety was described by O'Donoghue from the Vancouver Island region.

The specimens in the Hancock collection are from Point Barrow, Alaska, Arctic Research Laboratory, G. E. MacGinitie, collector; Puget Sound, Washington, J. L. Mohr, collector; Dillon Beach, Tomales Bay, California, R. C. Osburn collector; and Los Angeles harbor, California. The depths range from intertidal to 9 fathoms.

Division 4. **Stolonifera** Ehlers, 1876

Zoaria with delicate creeping stolons, with occasional points of expansion where a diaphragm occurs and either stolonal branches or zooecia may arise. A gizzard may or may not be present.

Family **Valkeriidae** Hincks, 1877

"Zooecia contracted below, deciduous, destitute of a membranous area." Hincks, 1880:551.

Genus **VALKERIA** Fleming, 1823

Zoaria repent, with creeping stolons. Zooecia ovoid to cylindrical, originating at the distal end of a short internode close to the diaphragm. No gizzard present. Genotype: *Sertularia uva* Linnaeus, 1767.

Valkeria tuberosa Heller, 1867

Plate 79, fig. 7

Valkeria tuberosa Heller, 1867:129.
Valkeria tuberosa, Harmer, 1915:76.

Zoarium stolonate, internodes of variable length, ranging from 0.52 to 0.94 mm in length. At the internodes the stolon is expanded slightly, with lateral branches arising immediately distal to the diaphragm. Here the zooecia arise. The zooecia are small, ranging from 0.43 to 0.55 mm in length, and have a narrow wrinkled base 0.03 to 0.04 mm in width. Tentacles are 8 in number. Polypide lacking a gizzard.

Previously reported from the Adriatic Sea, Red Sea, and Borneo. It has not been previously recorded from the eastern Pacific.

The specimens in the Hancock collection are from Lower California, C. L. Hubbs, collector, no bathymetric data given.

Genus **AEVERRILLIA** Marcus, 1941

Zoaria creeping, minute. Stolons with short lateral peduncles to which the zooecia are attached. Polypide with a prominent gizzard. Genotype: *Buskia setigera* Hincks, 1887.

Aeverrillia setigera (Hincks), 1887

Plate 79, fig. 8

Buskia setigera Hincks, 1887:127.
Buskia setigera, Osburn, 1940:343.
Aeverrillia setigera, Marcus, 1941:74.

The zoaria are adherent to the substrate, minute, delicate, rather difficult to see without the aid of a lens. The zoaria consist of primary and secondary stolons, usually at right angles to each other, with the secondary stolons originating in pairs, one stolon on either side of the primary stolon, adhering closely to the substrate. The primary stolons are septate, divided into internodes. Septa are also found at the junction of the secondary or lateral stolons. The internodes are of variable length. The diameter of the stolons ranges from 0.02 to 0.05 mm. The zooecia arise in pairs from kenozooecia placed at each side of either a primary or secondary stolon. In a number of instances in the eastern Pacific material, the substrate was *Amathia convoluta* and *Amathia vidovici,* and thus did not permit paired zooecia to arise consistently. The zooecia range in length from 0.57 tc 0.62 mm, and in width from 0.16 to 0.20 mm. The basal portion of the zooecia is rounded, somewhat swollen, and usually bears 2 spine-like processes. Distally, the zooecia taper, and each bears upon the oral extremity 4 spine-bearing protuberances that encircle the aperture. A long setigerous collar may or may not project from the aperture. The polypide contains a prominent gizzard. The tentacles number 8.

Aeverrillia setigera, previously unreported from the eastern Pacific, is a semitropical species, having been reported from the warmer waters of the southwest Pacific (Ceylon, New Guinea, Gulf of Bengal, China Sea), from the waters off Puerto Rico, from the Suez Canal, from Brazil, and as far north as Long Island Sound, Connecticut, and New Bedford and Woods Hole, Massachusetts, on the Atlantic Coast of North America.

Hancock Stations: 133-34, Socorro Island, west of Mexico; 445-35, Panama City, Panama; and 847-38, southwest of Zorritos Light, Peru. Depth, intertidal to 35 fms.

Family **Buskiidae** Hincks, 1880

"Zooecia contracted below, not continuous with the creeping stolon, with an aperture on the ventral surface." Hincks, 1880:531. In the light of present knowledge of this family, the above diagnosis must be modified: Zooecia contracted proximally, arising directly from the stolon, aperture terminal.

Genus **BUSKIA** Alder, 1857

Zoaria repent or erect, stolonate. Zooecia arising directly from the stolon. Polypide with a prominent gizzard. Genotype: *Buskia nitens* Alder, 1857.

Buskia nitens Alder, 1857

Plate 80, fig. 1

Buskia nitens Alder, 1857:156.
Buskia nitens, Hincks, 1884:208.
Cylindroecium repens O'Donoghue, 1923:192.
Buskia nitens, O'Donoghue, 1926:60.

Zoaria minute, repent, inconspicuous. Stolons thin, thread-like, subdivided by septa into internodes. Zooecia very small, ranging in length from 0.31 to 0.50 mm. The zooecia arise directly from the stolons and in most cases, but not invariably, the proximal one-third of a zoid is adherent to the stolon and the substrate, with the distal two-thirds free. In some cases the entire zoid arises directly away from the stolon and is free in its entirety. Proximally, some zooecia exhibit one or two pairs of short thorn-like protuberances. Distally, some zooecia show a short setigerous collar projecting from the aperture.

This species is evidently well distributed in both warm and cool marine waters, but because of its minute size is easily overlooked. It has been reported from England, Brazil, Puerto Rico, and British Columbia.

Hancock Stations: 277-34, Isabel Island, Mexico, and 1407-42, Coos County, Oregon, intertidal to 25 fms.

Buskia seriata Soule, new species

Plate 80, fig. 2

Diagnosis: Zoaria erect, branching. Stolons robust, septate, bearing clusters of short stocky zooecia arranged in a paired linear series, alternate, and arising directly from the stolon. Zooecia wrinkled distally and may exhibit a setigerous collar protruding from the aperture. The polypide contains a prominent gizzard. The tentacle number is 8.

Description: The zoaria are large, branching, erect, macroscopically bearing a superficial resemblance to specimens of the genus *Amathia.* The stolons are robust, septate, with internodes of variable length, ranging from 0.90 to 1.30 mm, and in width from 0.07 to 0.09 mm. The zooecia, which are arranged in clusters, arise from the stolon in an irregular alternate, paired linear series. These zooecial clusters may contain from 5 to 14 short, stout zooecia, with 11 occurring most frequently. On the younger stolonal branches only 1 or 2 developing zooecia may be in evidence. Invariably, there is but a single zooecial cluster to each stolonal internode. The zooecia arise directly from the stolon. The proximal portion of the zooecium is constricted, but the body proper rarely adheres to the stolon or substrate for any distance,

although individuals of this type do occur. The zooecia are small, ranging in length from 0.35 to 0.45 mm, and in width from 0.11 to 0.13 mm proximally, and 0.09 to 0.11 mm distally. All of the zooecia have a broad rounded proximal portion, where 1 or 2 small, pointed, spine-like protuberances may appear. The zooecia gradually taper distally, where, shortly beyond the point midway between the two extremities, they become wrinkled transversely. Some of the zooecia exhibit a setigerous collar protruding from the aperture. The polypide is provided with a large and prominent gizzard. The tentacle number is 8, as determined from examination of serial sections.

Although erect, *Buskia seriata* has comparatively short zooecia, differing from *B. socialis* which, according to Marcus, has zooecia measuring 0.75 mm in length. Being erect, it is easily distinguished from the reptant *B. nitens* with its minute creeping zooecia.

Holotype: AHF no. 133.

Repository: Allan Hancock Foundation, The University of Southern California, Los Angeles, California.

Type locality: Galapagos Islands, N. Seymour Island, January 16, 1931, tidepools.

Additional distribution: Hancock station 1111-40, February 14, 1940, San Lorenzo Channel, Gulf of California, west coast, 24°21′55″N, 110°15′15″W, depth 6-13 fathoms, bottom sandy, shells.

Family **Triticellidae** G. O. Sars, 1874

"Stolon delicate without free branches, zooecia erect with a long slender base-like pedicel, with a flattened membranous frontal area and without spines at the distal end around the oral aperture." Osburn, 1944:26.

Genus **TRITICELLA** Dalyell, 1848

Zoaria with creeping stolons. Zooecia pedicellate, erect, attached to the stolon by means of a movable joint. Zooecia are elongate, ovoid, with a membranous frontal area. No gizzard. Genotype: *Triticella flava* Dalyell, 1848.

Triticella pedicellata (Alder), 1857

Plate 80, fig. 4

Farrella pedicillata Alder, 1857:158.
Triticella pedicellata, O'Donoghue, 1923:193, 1926:61.

The zoaria are stolonate, creeping. The zooecia may be clustered, arising from short lateral internodes of the stolon. The pedicel is slender, measuring between 0.03 and 0.04 mm in diameter near the base, becoming slightly enlarged toward the zooecia proper. At the point of junction with the zooecia, the pedicel becomes transversely wrinkled. The zooecia are elongate, elliptical, ranging in length from 0.80 to 1.25 mm, and in width from 0.16 to 0.23 mm. A flattened frontal area extends the full length of the zooecia proper. The polypide does not have a gizzard. The tentacles number 12.

There is some variation in the length of the pedicels, but they are usually about twice the length of the zooecia. The longest measured 2.40 mm, which when combined with its zooecial measurement of 1.19 mm, gave a total height of 3.59 mm.

This species has been previously reported in the cool waters of England and northern Europe. In the eastern Pacific it has been previously reported from the Vancouver Island region.

The specimens in the Hancock collection are from Canoe Bay, Alaska, and Union, Washington. The depth of the Alaskan specimens is unknown; those from Washington were collected at 10 fathoms.

Triticella elongata (Osburn), 1912

Plate 80, fig. 5

Hippuraria elongata Osburn, 1912:256.
Triticella elongata, Osburn, 1944:26.

Zoaria living in the gill chambers of the pea crab, *Scleroplax granulata* Rathbun. The adnate stolons give rise to erect zooecia, which are usually paired in clusters. The zooecia arise from short internodes, rather than directly from the stolons. The zooecia range in length from 0.90 to 1.80 mm, including the pedicel. The length of the zoids proper ranges between 0.50 and 0.90 mm. In width, the zooecia range from 0.18 to 0.24 mm. The polypide has 16 to 18 tentacles.

Osburn, 1944:26, reports this species from Chesapeake Bay, and its geographical distribution on the Atlantic coast of North America from Vineyard Sound, Massachusetts to Beaufort, North Carolina. It has not been previously reported from the eastern Pacific.

Specimens in the Hancock collection are from Elkhorn Slough, California, collector R. I. Smith. No depth data available. Found on *Scleroplax granulata* Rathbun.

Genus **FARRELLA** Ehrenberg, 1838

Zoaria with reptant stolons. Zooecia arising within the internodes along the entire length of the stolon. No gizzard. Genotype: *Lagenella repens* Farre, 1837.

Farrella elongata (P. J. van Beneden), 1845

Plate 80, fig. 3

Laguncula elongata van Beneden, 1845a:26.
Triticella tegeticula O'Donoghue, 1923:193.

The zoaria are comprised of creeping stolons, which may in the older colonies form a dense mat-like network upon the substrate. In the young zoaria the zooecia are seen to arise from the creeping stolons within the internodes, budding forth laterally and vertically without apparent order. In the older colonies, this lack of arrangement packs the pedunculate zooecia closely together. The zooecia are robust, elongate, ovoid to subcylindrical in form, and are situated at the end of a long peduncle that may attain a length of from 0.50 to 0.80 mm. The peduncle is transversely wrinkled and gradually widens into the zooecia proper without a definite joint. The overall length of the zooecia ranges from 1.16 to 1.35 mm, while the width varies from 0.32 to 0.39 mm. The diameter of the primary stolon is about 0.03 mm. The polypide lacks a gizzard. The tentacle number of 16 was determined from serial sections.

A striking feature of this species is the morphology of the zooecial aperture. The aperture deviates from the typical rounded or squared form of the stolonate ctenostomes in that it is bilabiate. Close examination of the apertural area will reveal a pair of lip-like structures, each reinforced by a thin but definite chitinous rim. These "lips" are found only in the zooecia that have reached maturity. Farre, 1837:403, in his work on *Lagenella repens* (Farre), 1837, a very closely related species, considered the labiate structure to be opercula.

Marcus, 1926:50, using *Farrella repens* (which according to Farre, van Beneden, and Hincks, has only 12 tentacles) and experimentally causing unfavorable conditions, produced the "Form" *elongata* and at the same time reduced the tentacle number. Marcus overlooked the fact that van Beneden reported 16 tentacles for *Farrella elongata,* the same number that was found in the Pacific specimens.

Triticella tegeticula O'Donoghue, 1923, is here suggested as a possible synonym of *F. elongata,* because of its habit of growth as well as the morphology of the zooecia. Although O'Donoghue failed to mention

in his description the presence of a bilabiate aperture, the figure of his specimen strongly suggests the bilabiate type of structure.

Farrella elongata appears to be well represented in the cooler European waters in the vicinity of England and the Adriatic Sea.

Hancock Station, 1489-42, Coos County, Oregon; also taken at Tomales Bay, California, by R. J. Menzies. Intertidal.

Division 5. **Terebriporina** Soule, new division

Ctenostomes with stolonate zoaria that are characteristically imbedded within the calcareous shells of living or dead mollusks, brachiopods, or barnacles, their presence marked by the apertural openings of the zoids appearing at the surface of the shell. The stolons are thin, thread-like, septate.

The three families that are placed under the Terebriporina cannot be readily differentiated by the pattern of the tracings that appear upon the surface of the shell in which the zoaria are immersed. The only means of postive identification of the families and the genera is examination of zoaria that have been removed from shells by decalcification. The identification of species involves not only the study of zoid anatomy, but serial sections of the autozoids to determine definitely the tentacle number. The family Penetrantiidae can be anatomically identified by its zoaria with primary and secondary stolons, its typical gonozoids, and the operculated autozoids. Terebriporidae, also with primary and secondary stolons, lacks the operculated autozoids, while Immergentiidae, having autozoids with typical ctenostomatous apertures, has zoaria devoid of true gonozoids, the colonies being composed of a series of zoids joined by stolon-like tubules that are direct extensions of the zoids.

Family **Terebriporidae** d'Orbigny, 1847

Zoaria burrowing, stolonate. The zooecia are connected to the primary or main stolons by means of short secondary stolons emitted from near the distal zooecial extremity.

Genus **TEREBRIPORA** d'Orbigny, 1847

Zoaria stolonate, consisting of primary stolons joined to the zoids by secondary stolons, with the point of union being nearly midway between the distal and proximal extremities, but always closer to the distal end. Polypide provided with a gizzard. Genotype: *Terebripora ramosa* d'Orbigny, 1847.

Terebripora comma Soule, 1950

Plate 80, fig. 6

Terebripora comma Soule, 1950:380.

The zoaria have successive zoids alternately placed to the right and left of the primary stolon at the end of a short secondary stolon. The short lateral stolon has a septum at the junction point where the stolon meets the zoid. The secondary stolons enter the zoids about midway between the distal and proximal extremities of the zoids, but always nearer to the distal end. Two types of zoids are in evidence, the autozoids (feeding individuals) and zoids modified for reproduction that may be termed gonozoids for convenience. Anatomically, the autozoids are typical of the usual ctenostomate type. The polypide bears a prominent globular gizzard. In length the autozoids range from 0.32 to 0.35 mm, and in width from 0.06 to 0.08 mm. The tentacles are short, and are 8 in number. The autozoids are elongate, with the distal aperture bluntly square, and the proximal portion terminating in a tapering rounded point. No brown bodies were seen. The reproductive zooecia or gonozoids have a prominent, large, oval embryo measuring about 0.06 mm in diameter at maturity. In length, the gonozoids range from 0.29 to 0.33 mm, and in width from 0.07 to 0.08 mm.

Hancock Station, 1937-50, Anacapa Island, southern California. Also off Newport, southern California. Depth, 18 to 43 fms.

Family **Immergentiidae** Silen, 1946

Zoaria with only primary stolons, that are not stolons in the strict sense, being prolongations of the zoids. These stolons arise directly from the distal tips of the preceding zoids, and connect one zoid with another in a series.

Genus **IMMERGENTIA** Silen, 1946

Zoaria imbedded in the shells of both living and dead mollusks. The stolonal connections between zoids are slender, thread-like, originating at the distal ends of the zooecia. The zoids are small in size, elongate, narrow. The proximal end may be bluntly rounded or tapered to a narrow point. The distal tip bears a centrally placed square shaped aperture. No zoid specifically modified for reproduction is known to occur. Genotype: *Immergentia californica* Silen, 1946.

Immergentia californica Silen, 1946

Plate 80, fig. 7

Immergentia californica Silen, 1946:6.
Immergentia californica, Soule, 1950:364.

The specimens of *I. californica* in the Hancock collection are identical in all important respects with the paratype material generously donated by Dr. Lars Silen. The zoaria have the zoids arranged in straight rows, with lateral rows branching to the sides at rather irregular intervals. In length the zoids range between 0.32 and 0.34 mm, and in width the range is from 0.08 to 0.09 mm. The tentacle number is 10 as determined by serial sections.

This species was originally described by Silen from material collected at Pacific Grove, California.

Specimens in the Hancock collection are from San Pedro and Portuguese Bend, southern California. All intertidal.

Family **Penetrantiidae** Silen, 1946

Zoaria with septate stolons. Zoids joined to the main stolons by means of short lateral stolons entering the zoids near the distal extremity. Zoids have a double cuticle and are provided with an operculum. The polypide has a gizzard. Reproductive zoids, the gonozoids, have rudimentary polypides and bear large ovoid embryo chambers.

Genus **PENETRANTIA** Silen, 1946

Zoaria are imbedded in the shells of both living and dead mollusks and cirripeds. The zoids are connected by thin septate stolons. From a primary stolon a short thin lateral branch enters the zoid laterally at the distal end. A zoid modified for reproduction, the gonozoid, is present. The zoids are operculated. The polypide is provided with a gizzard. Genotype: *Penetrantia densa* Silen, 1946.

Penetrantia densa Silen, 1946

Plate 80, fig. 8

Penetrantia densa Silen, 1946:2.
Penetrantia densa, Soule, 1950:360.

The zoaria characteristically have the zooecial openings crowded closely together. These openings in the molluscan shells vary in shape from circular to strongly oval. The primary stolons are serrated upon

their upper surfaces. From a primary branch short lateral branches extend to the zoids, entering them at the distal end. The autozoids (feeding individuals) are usually straight, or only slightly curved. In length they range from 0.47 to 0.55 mm, and in width they vary from 0.09 to 0.11 mm. Infrequently, an autozoid with a sharply pointed rather than a bluntly rounded proximal end will be found. The tentacles are 12 in number, determined from serial sections. The reproductive zoid, the gonozoid, is usually as long as but may be slightly shorter than the autozoid. Its proximal portion, extending below the embryo chamber, is long, thin and slightly curved in the direction of the embryo chamber. The embryo chamber is globular, giving the gonozoid a "pot-bellied" appearance. The tentacle number of the gonozoid is 8, but only in immature gonozoids will they be found, where the polypide has not completely degenerated.

The specimens described in the original report by Silen were collected from South Africa and the Cape of Good Hope, and there was one "doubtful" specimen from Panama.

The specimens in the Hancock collection are from numerous localities from San Pedro to La Jolla, southern California, all intertidal.

Penetrantia concharum Silen, 1946

Plate 80, fig. 9

Penetrantia concharum Silen, 1946:5.
Penetrantia concharum, Soule, 1950:360.

The zoids of the colonies are well spaced, without the crowding noted in *P. densa.* The openings in the shell are well defined, reniform in shape. The autozoids are straight, slender, with the proximal extremity tapering to a point. The autozoids range in length from 0.46 to 0.54 mm, and in width from 0.08 to 0.10 mm. The tentacles number 10, as determined from sections. The gonozoids are comparatively rare. The proximal extremity of the gonozoids is straight and visibly thicker than the gonozoid of *P. densa.*

Penetrantia concharum was found by Silen to occur in numerous localities in Sweden and Norway.

The specimens in the Hancock collection are from several localities ranging from San Pedro to La Jolla in southern California and southward to Rosarito, Lower California, Mexico (Hancock station 1597-47). All are intertidal.

Penetrantia sileni Soule, 1950

Plate 80, fig. 10

Penetrantia sileni Soule, 1950:361.

The openings in the scaphopod shell made by this species vary considerably in shape, from a simple circular to a highly exaggerated reniform appearance. The stolon is thin, not serrated on its upper surface, and is in general circular in cross section. The zoids are placed close to each other but are not crowded. The autozoid ranges in length from 0.35 to 0.36 mm, and in width from 0.07 to 0.08 mm. The autozoids may be slightly curved, and they may have a pointed rather than a rounded proximal extremity. The tentacle number, as determined from serial sections, is 11. The mature gonozoid has a very characteristic morphology. It is little more than one-half the length of the autozoid, ranging from 0.19 to 0.20 mm in length. The narrowed proximal portion barely reaches below the swollen embryo chamber.

Specimens in the Hancock collection are from off the San Benito Islands, Mexico, Hancock station 1010-39, 28°12′05″N, 115°33′45″W. The depth range is from 71 to 86 fathoms. It is as yet known only from the eastern Pacific.

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Phylum Entoprocta

By Raymond C. Osburn, Ph.D., D.Sc.

Phylum **ENTOPROCTA** Nitsche, 1869

Subphylum Entoprocta, various authors.
Phylum Entoprocta, Hatschek, 1888.
Phylum Calyssozoa Clark, 1921:19 and 23.
Phylum Kamptozoa Cori, 1929:5.
Phylum Entoprocta, Hyman, 1951:521.

Until recent years this group has generally been considered a subphylum or subclass of the Bryozoa, although Hatschek as early as 1888 (Text-book of Zoology) separated the Phylum Entoprocta. In 1921 Clark recognized the differences and proposed the Phylum Calyssozoa. Again Cori in 1929, though he was familiar with the name Clark had suggested, thought it necessary to rename the group as Phylum Kamptozoa. These writers considered the Entoprocta to be much simpler than the Ectoprocta and separated them widely. Marcus (1939:208-288) raised objections to this wide separation and gave some very cogent reasons for retaining the group as a subphylum of the Bryozoa. Recently Dr. Libbie Hyman, in the third volume of "The Invertebrates" (1951: 521-554) again separates the group as a phylum. She assigns it to a place much lower in the scale and retains the name Entoprocta for the very good reason that it is unnecessary to invent a new name when a perfectly good one already exists. Hyman's discussion is a very satisfactory analysis of the knowledge of the Entoprocta, and it seems unnecessary to argue the matter further at present.

Whether or not the entoprocts are closely allied to the ectoprocts and wherever they may eventually be placed in the taxonomic scale, it happens that the only taxonomists who have paid much attention to them are the bryozoologists, and for this reason the species which are known from the Pacific coast are appended to the Bryozoa. The list is small as the species are not numerous, and the littoral species are rarely found among the dredgings.

The Entoprocta are stalked, with naked heads or calyces (polypides), the tentacles rolled inward instead of being withdrawn into a zooecium, and the anal opening is within the ring of tentacles instead of outside as it is in the Ectoprocta.

The family Loxosomatidae is unique in that the individuals live singly and do not form colonies, and they live as epizoites on other animals, usually on sponges, worms, other Bryozoans, etc. The only other family, Pedicellinidae, is colonial and is represented among our material by 4 genera and 8 species.

Family **Loxosomatidae** Hincks, 1880

The individuals are not colonial but live singly, attached to some other animal by a muscular sucking disc at the base of the stalk. They are unchitinized, flexible and capable of bending in any direction, and some of them, at least, are capable of moving about and re-attaching themselves. They produce buds from the sides of the calyx, but these sever their connections when their growth is complete and live singly thereafter. They are all small, some of them microscopic in size. There are two genera, *Loxosoma* Keferstein and *Loxocalyx* Mortensen, depending on whether the foot-gland disappears after attachment or remains functional.

Genus **LOXOSOMA** Keferstein, 1863

Loxosoma davenporti Nickerson, 1898

Loxosoma Davenportii Nickerson, 1898:220.
Loxosoma Davenporti Nickerson, 1899:368.
Loxosoma davenporti Nickerson, 1901:351.
Loxosoma davenporti, Osburn, 1912:212.

This species has been noted only once on the Pacific coast, by O'Donoghue at low tide in Hammond Bay Lagoon, British Columbia. It is a commensal in worm tubes.

The entire animal is about 2 mm long, somewhat vase-shaped, the pedicel cylindrical and about as long as the calyx into which it merges gradually; foot-gland wanting in the adult; lophophore with 18 to 30 tentacles, the body somewhat narrowed below the lophophore; usually with a pair of flask-shaped glandular organs on the ventral side of the body near the lower end of the stomach. The species was originally obtained by Nickerson and later by Osburn in the Woods Hole region, Massachusetts.

? **Loxosoma** sp.

A small species which was epizoic on an annelid worm at Point Barrow, Alaska, and on account of the preservation is unidentifiable even to the genus. The calyx expands gradually from the pedicel upward; width of calyx at the upper end 0.18 to 0.22 mm, height 0.33 to 0.40 mm, length of pedicel about 0.40 mm. Apparently there is no foot gland, and the tentacles cannot be counted.

Genus **LOXOCALYX** Mortensen, 1911

In this genus the foot-gland is evident and functional throughout life. Genotype *Loxosoma raja* Schmidt, 1876.

Loxocalyx sp.

Three individuals attached to the parapodia of an annelid worm, *Gattyana cirrosa,* from Puget Sound. The calyx expands abruptly, and its base is rounded; width of calyx 0.26 mm, height 0.33 mm, length of pedicel 0.40 mm. The foot-gland is present, but the tentacle number cannot be estimated.

Family **Pedicellinidae** Johnston, 1847

Colonial, the individuals erect from a creeping segmented stolon, the pedicels and stolon more or less chitinized. In the genera *Myosoma* and *Pedicellina* the pedicel is muscular and flexible, without a special muscular enlargement at the base, while in *Barentsia* and *Coriella* the pedicel is more chitinized and bears an enlarged, barrel-shaped muscular enlargement at its base. In *Barentsia* daughter individuals are often produced by budding from joints of the pedicel.

Key to Genera of Pedicellinidae

1. Pedicels not heavily chitinized, muscular and flexible, rising directly from the stolon without a specialized muscular base . 2
   Pedicels usually stiff and inflexible, with an enlarged cylindrical, somewhat barrel-shaped base 3
2. The lophophore (tentacle crown) is diagonally placed on the ventral side; the pedicel thick and with strong diagonal muscles . . . . . *Myosoma*
   The lophophore is terminal, the pedicel narrower and without diagonal muscles . . . . . *Pedicellina*
3. Individuals always arising from short stolon internodes; erect branches formed by the fusion of stolons; pedicels never jointed . . . . . *Coriella*
   Individuals arising from short stolon internodes, or from the sides of the pedicels; erect branches sometimes formed by enlarged pedicels; the stolons do not fuse to form erect branches . . . . . *Barentsia*

Genus **MYOSOMA** Robertson, 1900

"Zoarium with stolon composed partly of successive polypide-bearing segments and partly of alternate non-polypide-bearing segments; both stalk and calyx muscular, the muscle fibers continuous from one into the other; polypide oblique." (Robertson, 1900:324). Genotype, *M. spinosa* Robertson, 1900:324.

The pedicel is unusually thick, flexible, and has a conspicuous set of diagonal muscles in addition to longitudinal ones. The stolon is entirely adnate.

Myosoma spinosa Robertson, 1900

Plate 82, fig. 1

Myosoma spinosa Robertson, 1900:324.

The creeping stolon gives rise to branches which sometimes unite side by side but more frequently ramify and cross each other, forming a rather close mat; all of the internodes are comparatively short, ranging from 0.20 to 0.70 mm, the infertile internodes 0.08 to 0.12 mm in diameter, the fertile ones somewhat thicker, especially near the origin of zooecial buds. The zooecia arise from the internodes without any special differentiation, and even the muscles extend down into the stolon. The pedicels are exceptionally large, as much as 0.26 mm in diameter, narrowing upward to about 0.13 mm below the calyx, varying greatly in height to as much as 2.50 mm. They are highly muscular, with the unique diagonal muscles in addition to the longitudinal ones.

The calyx is moderately large, ovoid in shape, averaging about 0.65 mm long by 0.40 mm in width, the dorsal side more curved; the lophophore is diagonally placed on the shorter ventral side; the tentacle number is apparently 16. Chitinous spines, varying in number, are present on the dorsal side of the calyx and also on the stolon.

Robertson listed the species from Dillon Beach, Tomales Bay, and from Fort Point and San Diego, California.

Hancock collections, numerous specimens from Dillon Beach, California, the type locality, Dr. R. J. Menzies, collector. The writer has also taken it at Newport Bay and at La Jolla, California. It is a littoral species and, as far as known, occurs only on the coast of California.

Genus **PEDICELLINA** M. Sars, 1835

The zoarium is entirely adnate, consisting of fertile and infertile internodes, the latter rather regularly 0.40 mm in length; lateral stolons sometimes cause the zoarium to cover a considerable area. The pedicel

is large, as much as 0.25 mm in diameter at the base and about half as wide as its distal end, as much as 2 mm long but usually much shorter; flexible and with longitudinal muscles only which do not extend into the calyx. The expanded calyx is cup-shaped, with the tentacle crown transverse at the top. Spines present on the stalk and calyx, or wanting on one or both of them. Genotype, *Brachionus cernuus* Pallas, 1771.

Pedicellina cernua (Pallas), 1771

Plate 82, fig. 2

Brachionus cernuus Pallas, 1771:57.
Pedicellina americana Leidy, 1855:143.
Pedicellina nutans, Robertson, 1900:332.
Pedicellina echinata, Robertson, 1900:344.
Pedicellina cernua, O'Donoghue, 1926:7.

The stolon is slender, more or less transparent, branching, consisting of an irregular succession of fertile and infertile internodes, the fertile ones shorter than the others, as a rule, and somewhat swollen. The pedicel is broadest at the base, about 0.25 mm in diameter but often smaller, diminishing in size upward to about half of the basal width; thin walled and flexible, with longitudinal muscles which do not enter the calyx. Usually there is a slight constriction between the pedicel and calyx. The pedicel may be 2 mm or more in length but is usually shorter.

The calyx is cup-shaped with a well-marked gibbosity on the dorsal side, varying greatly in size, in our largest specimens about 0.55 mm long by 0.40 mm in diameter. The lophophore is terminal and transverse, with the tentacle number varying from 14 to 24.

Spines are sometimes present on the stalk and also on the calyx, and this feature has led to the erection of several species names, *P. echinata* M. Sars, 1835:5, *P. glabra* Hincks, 1880:565 and *P. hirsuta* Jullien, 1888:13. However there is so much variation in the presence and distribution of the spines that these must be considered merely nominal varieties. In our material, which extends from British Columbia to southern California, most of the zooecia are without spines, while a few spines occur occasionally even on the same colonies with bare zooecia.

The species is cosmopolitan. Robertson listed it as *P. nutans* (?) from Yakutat, Alaska, and as *echinata* from Tomales Bay, California, and O'Donoghue recorded it from several localities in British Columbia.

Hancock collections: Five Fingers, British Columbia; Tomales Bay and Lime Point, California; and the writer has obtained it at Newport Harbor and La Jolla, southern California. It is a littoral species, usually found on the piles of docks or at low tide.

Genus **BARENTSIA** Hincks, 1880

Pedicellinopsis Hincks, 1884.
Ascopodaria Busk, 1886.
Gonopodaria Ehlers, 1900.
Arthropodaria Ehlers, 1900.

This genus is distinguished by the presence of a large, barrel-shaped, muscular swelling at the base of the pedicel (a character which it also shares with *Coriella* Kluge) and by the adnate stolons which never fuse to form erect branches (as they do in *Coriella*). The pedicel is narrow above the muscular base and is usually well chitinized and stiff; joints occasionally appear in most of the species and in some of them are characteristic. In most of the species the pedicel appears to be more or less perforated, but the outer chitinous layer is complete and there are no pores; the cavities are limited to the internal layer. The calyx is more or less ovoid or vase-shaped, the lophophore terminal and transverse, and at its base the calyx is separated from the chitinized pedicel by a short flexible portion. The muscular base permits swinging back and forth, and the short flexible base of the calyx also permits the head to move freely on the pedicel. In at least one species, *B. laxa* Kirkpatrick, the pedicel is only slightly chitinized, provided with longitudinal muscles, and can be bent or looped in any direction. Genotype, *B. bulbosa* Hincks, 1880a:285.

The differences in the jointing and branching of the pedicel caused the erection of several other generic names, but there is so much variation in this character that it is often not even of specific value. Some species (*e.g. discreta* Busk) very rarely are jointed, some others (*ramosa* Robertson) are very regularly jointed and branched; sometimes the joints are enlarged and muscular, or the muscular enlargement may be wanting. These characters have some value for the determination of species but are scarcely valid for the separation of genera.

Key to Species of *Barentsia*

1. Upper half of the basal internode and the whole of the short second internode thin-walled and flexible; base of the lower internode well chitinized . . . . . *subrigida*
   Stalks with chitinized walls, not flexible 2
2. Stalks never branched, usually without joints 3
   Stalks more or less jointed and branched, the nodes often much enlarged 5

3. Stalk short, basal bulb as long as or longer than the following internode, calyx large . . . . . *robusta*
   Stalk usually much longer than the basal bulb 4
4. Small species, seldom 2 mm in height, the internode little or not at all "perforated," joints simple, rare . . . . . *gracilis*
   Taller species, 2 to 4 mm high, internode very thickly "perforated," joints simple, rare . . . . . *discreta*
5. Zoarium very large, reaching a height of 5 centimeters, profusely branched; muscular bulbs of varying size, sometimes gigantic; high Arctic . . . . . *gorbunovi*
   Branches few, arising from enlarged stem nodes, basal bulbs of one size 6
6. Tall slender species, long internodes, nodes moderately swollen; branching occasionally at the nodes, the basal bulb short and ovate . . . . . *geniculata*
   Stouter species, internodes shorter, the nodes much enlarged, nearly every stalk bears one or more branches; the internodes with a few "perforations" . . . . . *ramosa*

Barentsia gracilis (M. Sars), 1835

Plate 82, fig. 3

Pedicellina gracilis M. Sars, 1835:6.
Pedicellina gracilis, Hincks, 1884:208.
Ascopodaria gracilis, Robertson, 1900:345.
Gonypodaria nodosa, O'Donoghue, 1923:5.
Barentsia gracilis nodosa, O'Donoghue, 1926:7.
Barentsia gracilis, Marcus, 1938:8.

A small, delicate species, usually less than 1.0 mm in height. The stolon is creeping, usually among hydroids and other bryozoans. The basal bulb is of moderate size; the stalk short and lightly chitinized with few or no "perforations." The largest calyx in our specimens measures 0.25 mm high by 0.18 mm wide; the pedicel 0.95 mm high; the basal bulb 0.35 mm high by 0.12 mm in diameter. The pedicel usually bears no "perforations" but a few may be present. The joints, which mark the variety *nodosa* Lomas, 1886, are rare in our material, and they are only slightly enlarged.

Cosmopolitan. Recorded by Hincks and by O'Donoghue from a number of localities in British Columbia, and by Robertson from Lime Point and San Pedro, southern California.

Hancock Stations: 1274-41, Point Hueneme, 30 fms, and 1292-41, Santa Rosa Island, 28 fms, southern California. Also collected by the writer at low tide, Corona del Mar, southern California.

Barentsia discreta (Busk), 1886

Plate 82, fig. 8

Ascopodaria discreta Busk, 1886:44.
Pedicellina australis Jullien, 1888:13.
Barentsia timida Verrill, 1900:594.
Barentsia discreta, Osburn, 1912:214; 1940:327.
Barentsia discreta, Harmer, 1915:29.
Barentsia discreta, Marcus, 1937:15.
Ascopodaria misakiensis Oka, 1890:234.
Barentsia misakiensis, Oka, 1895:76.

The zoarium consists of a slender creeping stolon and erect slender zoids which may reach a total height of 3 mm, but usually range between 1.0 and 2 mm. The variation in height is almost entirely in the length of the slender stalk. The muscular basal bulb is moderately large, averaging about 0.50 mm high by 0.18 mm in width; the slender stalk from less than 1.0 mm to more than 2 mm; the calyx in our largest specimens measures 0.78 mm in height by 0.60 mm in width, but it is often much smaller. The slender stalk is straight, widening slightly and gradually upward, and is especially characterized by the large number of "perforations" of the inner layer of the stalk. The stalk is rarely jointed, but simple joints sometimes occur to the number of 2 or 3. Harmer states that the tentacle number is "about 20-24," but in smaller calyxes the number may be as few as 14.

It is a widely distributed species, occurring around the world in tropical and temperate waters. On the Atlantic coast it occurs from Cape Cod to Brazil, and Jullien described his *Pedicellina australis* from Cape Horn. Oka had it from near Tokyo, Japan, and Harmer from the East Indies. It has not been previously known from the Pacific coast, except for Waters' record at Magellanes, Chili.

Hancock Stations: 391-35, Lobos de Afuera Islands, Peru, 6°55′40″S, shore collection; 401-35, Mantua Bay, Ecuador, 1 fm; 1217-40, Point Fermin, California, shore collection, 33°42′30″N, and 1232-41, off San Pedro Breakwater, 17 fms, California. Also on piles of docks at Corona del Mar (R. C. Osburn) and Upper Newport Bay, shallow water, (J. D. Soule), southern California.

The known range on the Pacific coast is from 33°42′30″N, southern California, to Ecuador, Peru and Cape Horn. It appears to be a species of shallow waters, though Busk described it from Tristan de Cunha Island at a depth of 100-150 fms.

Barentsia ramosa (Robertson), 1900

Plate 82, Figs. 5 and 6

Gonypodaria ramosa Robertson, 1900:337.
Gonypodaria ramosa, O'Donoghue, 1923:6.
Barentsia ramosa, O'Donoghue, 1926:8.

The stolon is creeping and adherent, becoming heavily chitinized and brown, 0.07 mm in width. From this arise erect, jointed, and branched sub-colonies, with 3 or 4 joints in series, and these usually give rise to 1 or 2 branches which in turn may develop secondary branches. The internodes vary much in length, from 0.65 to 2.60 mm; in width they measure 0.06 mm at the base and 0.10 to 0.13 mm near the tips. The muscular nodes vary in length from 0.24 to 0.30 mm and in width from 0.15 to 0.20 mm. The basal bulb is short, 0.30 to 0.35 mm long by 0.20 to 0.26 mm wide. The calyx is short and wide, the height, excluding the tentacles, 0.35 to 0.50 mm and the width 0.40 to 0.55 mm. Tentacle number, 16-20. The total height of the tallest sub-colonies is about 5 mm.

Conspicuous features of the internodes are the heavy chitinization of the wall, the brownish color, and the conspicuous "pores," which are larger than in *B. discreta;* also the sub-colonies appear to be more rigid than in other members of the genus.

The species was described by Robertson from Pacific Grove (Monterey Bay), California, and recorded also from Fort Point and Land's End, California and from Channel Rocks, Puget Sound. O'Donoghue recorded it from several localities in British Columbia.

Hancock Collections: Carmel Cove, south of Monterey Bay, California, on the stems of the hydroid Garveia. It is a littoral species, but O'Donoghue dredged it at 20 fms.

Barentsia gorbunovi Kluge, 1946

Plate 82, figs. 10-12

Barentsia gorbunovi Kluge, 1946:153 and 157.

This is a remarkable species growing in bushy form to a height of 5 cm or more. There is an adherent stolon, 0.10 to 0.20 mm in width, from which arise very complex sub-colonies. At the bases of these there are gigantic muscular bulbs of the usual shape, but with a height of 1.0

to 2 mm and a diameter of as much as 0.80 mm. In other parts of the sub-colony the bulbs are much smaller, from 0.40 to 0.65 mm high and from 0.13 to 0.26 mm in diameter.

The erect branches should be homologous with the stalks of other barentsias, but they differ in bearing a series of zoids throughout their length without joints or septa; they appear like erect stolons, except for the large muscular basal bulb. These erect stems bear branches, all in the same plane, up to the fifth generation of zoids. The unbranched internodes are comparatively short, usually less than 1.0 mm and about 0.08 mm in diameter. The calyx is similar to those of other barentsias, 0.40 to 0.50 mm high by 0.35 to 0.40 mm in width.

The unusual features of this species are the large size and complexity of the colony, the nature of the branching, the absence of nodes, and the variation in the size of the basal bulbs.

Known only from Kluge's record (Drifting Ice Expedition in the central Arctic Ocean in the Ice-breaking Str. "G. Sedov," 1937-40).

Point Barrow, Alaska, Arctic Research Laboratory, 246 feet, G. E. MacGinitie, collector, several colonies.

Barentsia robusta new species

Plate 82, fig. 7

The stolon adnate, ramifying, 0.08 mm wide. The individual zooecia are short-stalked with large calyces, reaching a total height of about 2 mm. The stalks are disproportionate, as the basal bulbs are longer than the narrow internodes. The basal muscular bulbs are unusually long and measure rather regularly 0.90 mm in height by 0.18 mm in diameter. The internode is 0.70 to 0.78 mm long; at the base it varies from 0.06 to 0.08 mm wide and gradually enlarges to 0.11 to 0.13 mm in diameter at the top; the internode wall is moderately chitinized and its inner layer is punctured by scattering conspicuous "pores," similar to those of *B. discreta* but larger and much fewer in number. The calyx is large, the height to the base of the tentacle ring as much as 0.65 mm, and its width varying from 0.52 to 0.65 mm, cup-shaped, widest at the top and the base rounded, the dorsal side curved, the ventral side much straighter. The tentacles cannot be counted accurately but apparently they number about 20 to 24.

The larger calyces all contain embryos in August. The stout appearance of the zooecia, all about the same height, the large calyces (nearly one third of the total height) and the very long and comparatively slender basal bulbs which are consistently longer than the internodes,

distinguish the species. It was collected by the writer in 1902 and has remained unidentified in his collection for the past 50 years awaiting a proper place for publication.

Type, AHF no. 131.

Type locality, near Port Renfrew, Vancouver Island, at the site of the former University of Minnesota Biological Station; from the rocky wall of a deep tide-pool, R. C. Osburn, collector.

Barentsia geniculata Harmer

Plate 82, fig. 4

Barentsia geniculata Harmer, 1915:33.

? *Ascopodaria macropus,* Robertson, 1900:345.

The creeping stolon is thick-walled and brown, 0.06 or 0.07 mm in width; the fertile internodes short, 0.30 to 0.40 mm long, the infertile ones varying greatly in length to as much as 1.30 mm. The zoids are tall, reaching a total length of 5.20 mm, the stalk with 1 to 4 bulbous muscular joints. The stalk internodes are slender, only 0.04 mm at the base and enlarging slightly upward, with a few "pores"; the basal stalk internodes are long, from 1.50 to 1.70 mm, the later ones somewhat graduated in length, the shortest terminal one only 0.45 mm. The stalk nodes are enlarged, muscular and bulbous, the swelling about 0.20 mm long by 0.15 mm in width. The basal bulb is short and wide, about 0.40 mm high by 0.30 mm in diameter, coarsely wrinkled. The calyx is 0.30 mm high by 0.25 mm wide. The tentacle number cannot be determined accurately but they are numerous, at least 20.

One stalk is branched twice, at the first node and again at the first node of a branch. This feature resembles *B. ramosa,* but the nodes are much smaller and the internodes more slender, while the basal bulb is strikingly different.

This is probably the *Ascopodaria macropus* of Robertson, for which she gives no description, but states that it occurs at San Pedro, southern California. I believe it to be the *B. geniculata* of Harmer, as it agrees in the thick wall of the internodes, the form of the joints, the small number of "pores" ("tubercles," Harmer), the form of the muscular base and the size and form of the calyx. It differs in the longer internodes and in the rare formation of branches at the internodes.

Harmer described the species from the East Indies (Siboga Expedition).

Hancock Station 1292-41, near Santa Rosa Island, southern California, 33°53′30″N, 120°W, at 28 fms, two fragments.

Barentsia subrigida new species

Plate 82, fig. 9

A large species, reaching a height of more than 5 mm; it is especially characterized by the stalk which possesses regularly two internodes; the basal one is very elongate, 1.30 to more than 4 mm; the basal half, more or less, has the wall chitinized and rigid while the upper part remains thin-walled, muscular and flexible; this is followed by a somewhat expanded muscular joint, and above this is a short thin-walled and wrinkled flexible internode, only 0.40 to 0.55 mm in length. When completely developed, the top of the basal internode and the base of the terminal internode are both enlarged to about twice the width of the stem with a short muscular section between them; the terminal one has a definite diaphragm just above the node, similar to the one at the base of the first internode. Very old basal internodes may become chitinized for the full length, but I have seen only two such internodes. In any case the short terminal internode is always transparent and flexible. The basal internode usually bears a few "perforations," scattered and generally disappearing entirely on the upper half.

The basal muscular bulb varies greatly in height, from 0.25 to 0.55 mm, probably depending on the nature of contraction, and the width is about 0.15 mm.

The calyx is large, averaging about 0.35 mm high to the base of the tentacle crown, by 0.40 mm in width; the largest calyx measures 0.50 mm high by 0.52 mm wide; the dorsal side is more rounded than the frontal side, and the base is broadly rounded and attached by a rounded bulb to the upper internode. The tentacle number cannot be counted accurately but it appears to be at least 20.

The very regular disparity in the length of the two internodes, the thin-walled flexible upper ends of the basal internodes and the constant thin-walled, muscular, short terminal internodes, together with the large size, apparently mark this as a hitherto unknown species. It is possible that the *Ascopodaria macropus* of Robertson may belong here instead of under *B. geniculata*. The only other known species with flexible internodes is *B. laxa* Kirkpatrick, which has no joints in the stalk, no "perforations," and the stalk is not heavily chitinized basally.

Type, AHF no. 132.

Type locality, Hancock Station 1274-41, three and one-half miles south of Hueneme, southern California, 28°23′20″N, 115°11′52″W, at 55 fms, two colonies. Another specimen in the collection is labeled simply "California."

Genus CORIELLA Kluge, 1946

Stolon adnate and creeping, but giving off clusters of erect stolons which fuse into complex sub-colonies. The zoids arise from the fertile internodes of the erect stolons in large numbers on all sides of the complex branch. The zoids are simple and unbranched, with the usual muscular basal bulbs, and the stalks are provided with scattering "pores" similar to those of some species of *Barentsia.*

Genotype, *C. stolonata* Kluge, 1946:155.

The genus appears to be similar to *Barentsia* in all essential characters except the fusion of erect stolons to form branches.

Coriella stolonata Kluge, 1946

Plate 82, figs. 13 and 14

Coriella stolonata Kluge, 1946:155 and 157.

The complex erect branch varies greatly from 3 to 10 or 12 stolons, to a height of more than 1 cm in our specimens. The calyx is large, reaching 0.80 mm high by 0.65 mm in width; the stalk attains a length of 2 mm and a diameter of 0.06 to 0.08 mm, with rather numerous "pores"; the basal bulb measures 0.40 to 0.45 mm in height by 0.16 to 0.22 mm wide; it arises from a cup-shaped enlargement which is set at an angle on the side of a fertile stolon internode. The total height of the tallest zoid is 3.25 mm, but they are usually much shorter. The tentacle number, according to Kluge, is 22 to 24.

The erect clustered stolons distinguish this species from all members of the Pedicellinidae.

The only record is that by Kluge (Drifting Ice Expedition in the central Arctic Ocean in the Ice-breaking Str. "G. Sedov," 1937-40).

Point Barrow, Alaska, Arctic Research Laboratory, 295 feet, G. E. MacGinitie, collector.

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Addenda

The following species in Ectoprocta-Cheilostomata have come to the author's attention since Parts 1 and 2 were prepared for publication. Also the ovicell of *Pachyegis brunnea* (Hincks), hitherto unknown, is figured (plate 81, fig. 11), and *Cheilopora praelucida* (Hincks), discussed on page 465 of Part 2, is illustrated on plate 81, fig. 12. All but one of these are from the last collections made at Point Barrow, Alaska, by Prof. and Mrs. G. E. MacGinitie. Their persistent efforts for two seasons resulted in 104 species from a very limited area around the Arctic Research Laboratory, which add greatly to our knowledge of circumpolar distribution of the Bryozoa.

No doubt careful collecting all along the American coasts, in special habitats and especially in deeper waters, will add many more species to the long list already recorded.

Cheilostomata

Anasca

Membranipora annae, new name

Acanthodesia serrata (Hincks), Hastings, 1930:707 (not *M. membranacea,* form *serrata* Hincks, 1882:469)

Membranipora hastingsae Osburn, 1950:29 (preoc. by *M. (Electra) hastingsae* Marcus, 1940)

Dr. Anna B. Hastings misidentified this species with the *M. serrata* of Hincks (1882:469, which was already preoccupied by the *M. serrata* of MacGillivray (1868:131). [See under *M. serrilamella,* new name, Part 1, p. 22] The present author renamed it *hastingsae* (Part 1, p. 29), overlooking the fact that Marcus (1940) had already used this name for another species. Dr. Marcus (*in litt.* Aug. 27, 1950) kindly called my attention to the error: "In Danmarks Fauna, 1940, *Electra* is treated as a subgenus of *Membranipora,* and *M. (Electra) hastingsae* is dealt with. So the specific name is preoccupied and your species will have to receive a new name."

I have taken the liberty of using Dr. Hastings' given name for this very attractive little species.

Hincksina gothica new species

Plate 81, fig. 1

Zoarium unilaminar, encrusting on shells, stones and bryozoans, white to light brown. Our largest colony, rounded and about 25 mm in

diameter, spreads across a frond of *Porella compressa*, the edges extending beyond the side of the frond but remaining unilaminar. The zooecia are large, 0.65 to 1.0 mm or more in length by 0.45 to 0.60 mm in width, arranged quincuncially. In the infertile zooecia the opesia occupies practically all of the frontal area; the side walls are very thin and finely granulated. Large interzooecial avicularia are scattered over the zoarium, usually at the beginning of the new series of zooecia. The chamber is nearly as long as the normal zooecia, 0.50 to 0.65 mm, but narrower, about 0.40 mm in width. The mandible, 0.35 to 0.50 mm long by 0.20 to 0.26 mm wide, has the shape of a gothic arch, the sides parallel and the pointed tip strongly decurved to fit inside the recurved tip of the rostrum. Minute avicularia (mandible 0.06 to 0.10 mm long) are situated at the distal zooecial corners and often there are one or two additional ones, with the mandible directed forward instead of backward as in *H. nigrans;* occasionally there are similar small avicularia on the side walls and in these the position of the mandible is reversed, pointing backward. Near the center of the colony there are 5 or 6 short stout spines and one or two of these may be present on the zooecia over the whole zoarium.

The endozooecial ovicells are similar to those of *nigrans,* but the covering transverse ridges are much less developed and there is always a pair of the small avicularia distally placed on either side of the ovicell with the mandible directed forward.

The species is evidently related to *H. nigrans,* but the differences in the avicularia and the cover of the ovicell and the presence of spines appear sufficient to give it specific rank. *H. nigrans* also has large interzooecial avicularia, but they are short with a short triangular mandible.

Type, U. S. Nat. Mus. no. 11048.

Type locality, Point Barrow, Alaska, 453 feet. Numerous colonies were obtained by Prof. G. E. MacGinitie at depths ranging from 216 to 522 feet.

Amphiblestrum trifolium (S. Wood), 1850

Plate 81, fig. 2

Flustra trifolium S. Wood, 1850:20.
Membranipora solida Packard, 1867:272.
Membranipora Flemingii var. *solida,* Verrill, 1879:29.
Membranipora trifolium, Hincks, 1880:167.
Membranipora trifolium, Whiteaves, 1901:97.
Membranipora trifolium, Osburn, 1912:279.
Amphiblestrum trifolium, Osburn, 1923:9; 1932:9; 1933:26.

Zoarium encrusting on stones and shells, the ectocyst sometimes with brown pigment. The zooecia are arranged more or less regularly in quincunx, length 0.60 to 0.80 mm, width 0.35 to 0.60 mm, varying much in form, separated by slightly elevated thin margins which are decorated with coarse granules. The most striking feature is the thick, finely granulated cryptocyst which covers the proximal half or more of the frontal area and extends narrowly around the sides of the trifoliate opesia. Spines are entirely absent from our specimens, though small ones are said to occur occasionally. Avicularia are rare, somewhat elevated, usually located near the proximal end and directed either forward or backward, the mandible short-pointed.

The ovicell is hyperstomial, prominent; in final calcification there is a strong arcuate transverse rib which often rises to a central point, and proximal to this is a semilunar smooth area; width 0.25 to 0.30 mm.

It is a northern and arctic species, evidently circumpolar; in Atlantic waters it extends southward to the British Isles and to the Maine coast of North America, but it has not been recorded from the Pacific coast before.

Point Barrow, Alaska, Arctic Research Laboratory, 262 to 328 feet, G. E. MacGinitie, collector.

Bugula flabellata acuminata new variety.

Plate 81, figs. 3 and 4

The zoarium is erect with broad flabellate branches, the secondary branches biserial but sometimes becoming quadriserial near the tips. The mode of branching is like that of *flabellata* and the origin of the zooecia is also similar, with long prongs extending distally down the dorsal sides of the preceding zooecium. Height of colony about 20 mm.

The zooecia are long and slender, length 0.55 to 0.75 mm, width at base 0.13 mm and widening gradually to 0.15 mm near the tip; the membranous area extends nearly but not quite to the proximal end, narrowing downward; there are no jointed spines, but the distal corners are extended into short, stout processes, sometimes wanting on the inner corner. The avicularia, present on nearly all of the zooecia, are attached by a short stalk more or less above the middle of the zooecium but not near the extremity; moderately large and somewhat compressed, length 0.20 to 0.30 mm, width 0.08 to 0.10 mm, height 0.13 to 0.15 mm; the beak sharply decurved at the tip with a narrow rounded point. The mandible, 0.15 to 0.20 mm long, is unique in my experience as it suddenly becomes constricted near its distal end into a long acuminate recurved process sharply differentiated from the basal part.

The ovicells, on nearly all of the zooecia, are set transversely across the distal end of the zooecia, rounded and prominent, 0.18 mm wide by 0.14 mm long, complete, but the orifice large, the surface not striated, in reproduction in February.

The complete absence of jointed spines, the form of the avicularium and especially the sharply acuminated mandible appear to separate this variety sufficiently from *B. flabellata.*

Type, AHF no. 130.

Type locality, Hancock Station 66-33, Tagus Cove, Albemarle Island, Galapagos, 0°16′17″S, 91°22′41″W, at 10 to 20 fms, several colonies.

Ascophora

Pachyegis brunnea (Hincks)

Plate 81, fig. 11

See Part 2, p. 315.

The ovicells can now be described as I have found them at the margin of a large colony. They resemble those of *P. princeps* (Norman), hyperstomial and prominent but considerably depressed on the base of the succeeding zooecium. With increased calcification they become more submerged but lack the heavy collar which develops across the front of *P. princeps;* width and length about 0.40 mm.

Emballotheca stylifera (Levinsen), 1886

Plate 81, fig. 5

Escharella stylifera Levinsen, 1886:17.
Schizoporella condylata Nordgaard, 1906:18.
Schizoporella (Emballotheca) stylifera, Levinsen, 1916:453.
Schizoporella stylifera, Nordgaard, 1918:57.

Zoarium encrusting shells and stones, unilaminar, and the shining ectocyst with reddish-brown pigment. The zooecia are moderate in size, 0.60 to 0.75 mm long by 0.40 to 0.55 mm wide, elongate-hexagonal in form and rather regularly arranged in quincunx, separated by very thin raised lines. The moderately inflated frontal is a tremocyst with fewer pores than is usual in the genus. Beneath the rather thick ectocyst the frontal is finely granulated, but there are no other surface decorations, and spines and avicularia are both wanting. Dietellae conspicuous on the dorsal surface. The aperture is nearly round, 0.16 to 0.18 mm wide, somewhat transverse proximal to the prominent cardelles, and between these is a shallow arcuate sinus nearly half as wide as the aperture.

There is a narrow vestibular arch. The primary peristome is low and thin and becomes covered on the sides by the encroachment of the frontal wall, which modifies the form of the aperture only slightly.

The ovicell is hyperstomial, considerably depressed and is closed by the operculum; secondary calcification from the three adjacent distal zooecia produces three sutural lines on the surface, and often there is a pore or fenestra at the central junction of the sutures, width 0.26 to 0.30 mm.

The species was described from the Kara Sea and later recorded from northeast Greenland (Levinsen) and the North American Archipelago (Nordgaard).

Point Barrow, Alaska, Arctic Research Laboratory, 217 to 522 feet, G. E. MacGinitie, collector, rather common.

Hippodiplosia cancellata (Smitt), 1867

Plate 81, fig. 6

Escharella porifera forma cancellata Smitt, 1867:9.
Smittina cancellata, Nordgaard, 1906:29.

Apparently this species has not been seen since Smitt described it. Nordgaard placed it under *Smittina,* but without having seen it.

The zoarium is encrusting, spreading over shells, reddish-brown in color. The zooecia are moderately large, 0.65 to 1.0 mm long by 0.40 to 0.65 mm wide; the front a tremocyst with large pores which enlarge upward until the surface is coarsely cancellous or tessellated, with only narrow rims separating the pores. The only exception to this is the smoother area proximal to the aperture which is characteristic of the genus and upon which the secondary layer does not encroach. The aperture is large, 0.18 to 0.20 mm wide, usually a little wider than long, evenly rounded back to the small cardelles; the proximal border broadly arcuate, nearly straight, or often arched forward slightly above the operculum (this last feature gives the aperture somewhat the appearance of a *Smittina,* but it does not appear to be homologous with the lyrula of the Smittinidae). Smitt described the species *"Avicularia desunt,"* but small avicularia are frequently present (though often wanting over large areas), with a rounded mandible and located close to the aperture in the middle on the preoral smooth area. There are no spines or other surface structures.

The ovicells are large, about 0.40 mm wide, hemispherical, hyperstomial but rather deeply embedded, smooth at first but soon becoming covered with a cancellous layer similar to that of the frontal.

The species is related to *H. reticulato-punctata* (Hincks), but the measurements are larger, the aperture shorter and wider, the preoral area shorter and the cancellation of the front much more strongly developed.

Smitt described the species from Spitsbergen and carefully figured it (plate 24, figs. 40 and 41), but I have not been able to find any other record of its occurrence.

Point Barrow, Alaska, Arctic Research Laboratory, 438 feet, G. E. MacGinitie, collector, apparently rare.

Microporella arctica (Norman), 1903

Plate 81, fig. 7

Microporella arctica Norman, 1903:105.
Porina ciliata Smitt, 1867:6 (part).
Microporella ciliata var. *arctica,* Nordgaard, 1918:60.

Zoarium encrusting stones and shells, heavily calcified, and the ectocyst brown in color. The zooecia are much larger than those of *M. ciliata* in all their measurements, 0.65 to 0.80 mm long by 0.40 to 0.65 mm wide; the aperture 0.12 mm long by 0.15 mm wide; the ovicell averaging 0.40 mm in width. The frontal is a thick tremocyst with numerous small pores which often become occluded in complete calcification; inflated with deep separating grooves and smooth, except occasionally there is a minute umbo proximal to the ascopore. The aperture (except for size) and the ascopore are similar to those of *ciliata.* Avicularia, rarely present, are located near the lateral margin proximal to the aperture, the mandibles varying in length, the longer ones noticeably broader (more ligulate) than those of *ciliata.* Spines are usually wanting but I have noted 4 very minute (vestigial) ones on a few young marginal zooecia.

The ovicell is hemispherical, delicately ribbed radiately in the young stage but soon becoming very thick-walled and smooth, with a small umbo distally situated on the top.

Recorded previously by Smitt, Norman and Nordgaard from Spitsbergen and northern Norway. The differences mentioned above indicate that it should be separated from *M. ciliata,* and the following record shows that it is a circumpolar species.

Point Barrow, Alaska, Arctic Research Laboratory, 328 feet, G. E. MacGinitie, collector.

Escharoides jacksoni (Waters), 1900.

Plate 81, fig. 8

Smittia Jacksonii Waters, 1900:87.
Escharoides jacksoni, Nordgaard, 1918:55.
Peristomella (Escharoides) jacksoni, Osburn, 1923:10.

Zoarium encrusting, the ectocyst reddish-brown. The zooecia are large, 0.65 to 1.0 mm long by 0.50 to 0.65 mm wide; the frontal a pleurocyst with numerous large areolar pores between which narrow costal ridges extend upon the front, usually leaving a smoother central area but sometimes extending to the tip of the high lip of the peristome. The zooecia are considerably inflated and elevated toward the distal end, ovate in form and arranged in quincunx. The most striking feature is the form of the peristome which is unusually high above the proximal border of the aperture, where it is more or less pointed, and extends sharply downward on each side to the first spine, resembling an inverted scoop; it lacks the median denticle near the tip which is found in some others of the genus. There are 4 stout oral spines, the proximal pair usually remaining at the corners of the ovicell. The aperture is large, 0.20 to 0.26 mm in either direction, rounded proximally, and broader at the distal end, where it is broadly arcuate or sometimes nearly transverse. There are no condyles and no lyrula. The avicularia are large and conspicuous, situated characteristically at one or both sides of the peristome and directed laterally, but often located more proximally on the front and directed more or less backward, often wanting; the rostrum is elevated, the mandible hooked at its tip and measuring 0.25 to 0.30 mm in length and 0.15 to 0.20 mm wide at the base.

The ovicells are correspondingly large, averaging 0.40 mm in width and length, hyperstomial, hemispherical and conspicuous, perforated but with a small central imperforate area on the top.

It is an arctic species, described from Franz Josef Land and recorded from Greenland and the western part of the American Archipelago. The following record extends its distribution much farther to the west and it is evidently a circumpolar species.

Point Barrow, Alaska, Arctic Research Laboratory, 453 feet, G. E. MacGinitie, collector.

Porella minuta (Norman), 1868

Plate 81, fig. 9

Lepralia minuta Norman, 1868:308.
Porella minuta, Hincks, 1880:326.
Porella alba Nordgaard, 1906:25.
Porella minuta, Nordgaard, 1918:71.

Zoarium small, encrusting on stones and shells, white and glistening. The zooecia are small, 0.40 to 0.50 mm long by 0.25 to 0.30 mm wide; the front considerably inflated and delicately granulated; the areolar pores are few in number and conspicuous only in the younger stages. The zooecia are very distinct, with deep separating grooves which never become filled even in the oldest and most complete stages of calcification. The aperture is semicircular, 0.13 mm wide by 0.10 mm long, the proximal border straight or slightly arcuate and without any indication of a lyrula. The primary peristome is low and thin and there are no spines, even in young marginal zooecia. There is a rounded median avicularium with a prominent bulbous chamber which covers nearly half of the frontal area proximal to the aperture. In advanced calcification, the frontal becomes very thick, extends around the sides of the aperture, and sometimes forms a small umbonate process on the top of the avicularian chamber.

The ovicell at first is prominent, 0.24 mm wide by 0.22 mm long, but soon becomes more or less immersed, thick-walled and granulated like the frontal.

The species resembles *P. concinna* (Busk), but the smaller dimensions, the proportionally larger avicularian chamber, and the distinct separation of the zooecia at all stages clearly distinguish it. It is known from the British Islands (Norman and Hincks), and Nordgaard redescribed it as *P. alba* from the North American Archipelago.

Point Barrow, Alaska, Arctic Research Laboratory, at 216 to 522 feet, G. E. MacGinitie, collector, rather common.

Mucronella microstoma (Norman), 1868

Plate 81, fig. 10

Lepralia microstoma Norman, 1864:87.
Mucronella microstoma, Hincks, 1880:370.
? *Mucronella microstoma,* O'Donoghue, 1923:46.

This species bears much resemblance to *M. labiata,* but it is smaller; the primary aperture 0.13 mm wide by 0.10 long, semicircular, straight on the proximal border with a wide lyrula which is low and without denticles at the corners. The secondary aperture also is much smaller than in *labiata,* wider than long, and the peristome is more or less tubular, rising high on the proximal border and often continued into a central point. The dietellae are small and numerous. There are 2 to 4 short stout oral spines on the distal border of the aperture, the two median ones the largest.

The ovicell is prominent, about 0.40 mm in either direction, the surface finely granulated like the frontal.

The most characteristic feature is the spout-like peristome and the small secondary aperture, about 0.18 mm wide by 0.12 mm long (though there is considerable variation). It has been recorded positively only from the British Isles at depths from 80 to 205 fms. O'Donoghue listed it somewhat doubtfully from Northumberland Channel, British Columbia, at 15 to 18 fms, but as he did not give a full description and mentioned only a few variations this record must remain in doubt until the species is recovered from that area.

Point Barrow, Alaska, Arctic Research Laboratory, 48 to 80 fms, G. E. MacGinitie, collector, rather common.

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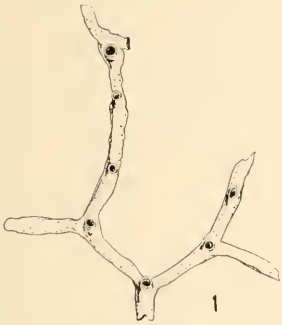
PLATES

Practically all of the illustrations for the following plates, 65 to 82, are the work of Mrs. Virginia Sewell, to whom the author is much indebted for her careful attention to details and interested cooperation.

The scale of enlargement is not indicated on the plates, except in the Ctenostomata, but exact measurements are given for each species in the text.

PLATE 65

Fig. 1. *Stomatopora granulata* (Milne-Edwards), part of zoarium.
Fig. 2. The same, ovicell with ooeciostome.
Fig. 3. *Proboscina sigmata* new species, part of zoarium.
Fig. 4. The same, enlarged to show details of ovicell.
Fig. 5. *Proboscina major* (Johnston), part of zoarium with ovicell.
Fig. 6. *Oncousoecia abrupta* new species, zoarium.
Fig. 7. The same, enlarged to show details of 3 ovicells.
Fig. 8. *Oncousoecia ovoidea* new species, zoarium.
Fig. 9. The same, enlarged to show details of ovicell.
Fig. 10. *Oncousoecia canadensis* Osburn, showing usual type of ovicell.
Fig. 11. The same, at less magnification, with broader ovicell.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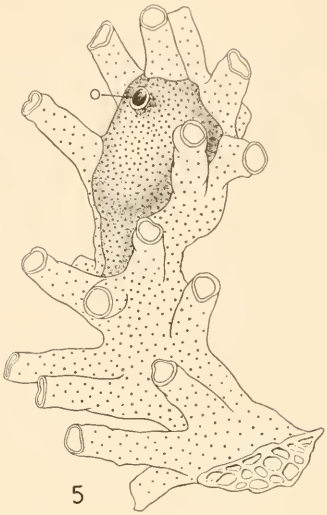
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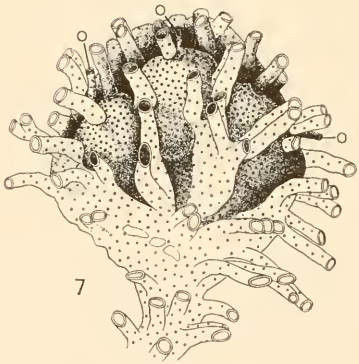
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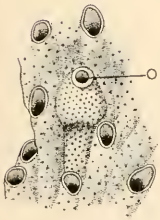
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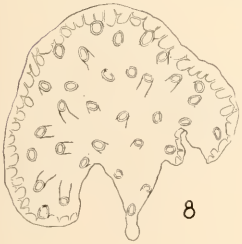
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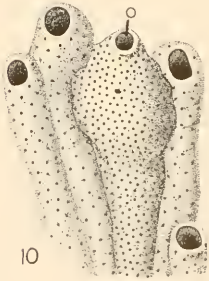
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PLATE 66

Fig. 1. *Proboscina incrassata* (Smitt), zoarium.

Fig. 2. The same, portion of a lobe with ovicell and ooeciostome.

Fig. 3. *Proboscina lamellifera* Canu and Bassler, part of lobe with ovicell and ooeciostome.

Fig. 4. *Oncousoecia diastoporides* (Norman), ovicell and ooeciostome.

Fig. 5. *Plagioecia grimaldii* (Jullien), showing terminal, median position of ooeciostome.

Fig. 6. *Plagioecia meandrina* (Canu and Bassler) showing erect branches and lobes.

Fig. 7. The same, part of a lobe showing position of ovicell and ooeciostome.

Fig. 8. *Plagioecia ambigua* new species, zoarium, with simple and expanded ovicells; note different positions of ooeciostomes.

Fig. 9. *Plagioecia anacapensis* new species, outline of zoarium and linear arrangement of tubules.

Fig. 10. The same, showing ovicell and ooeciostome.

Fig. 11. *Diaperoecia claviformis* new species, part of a lobe showing proximal position of ooeciostome.

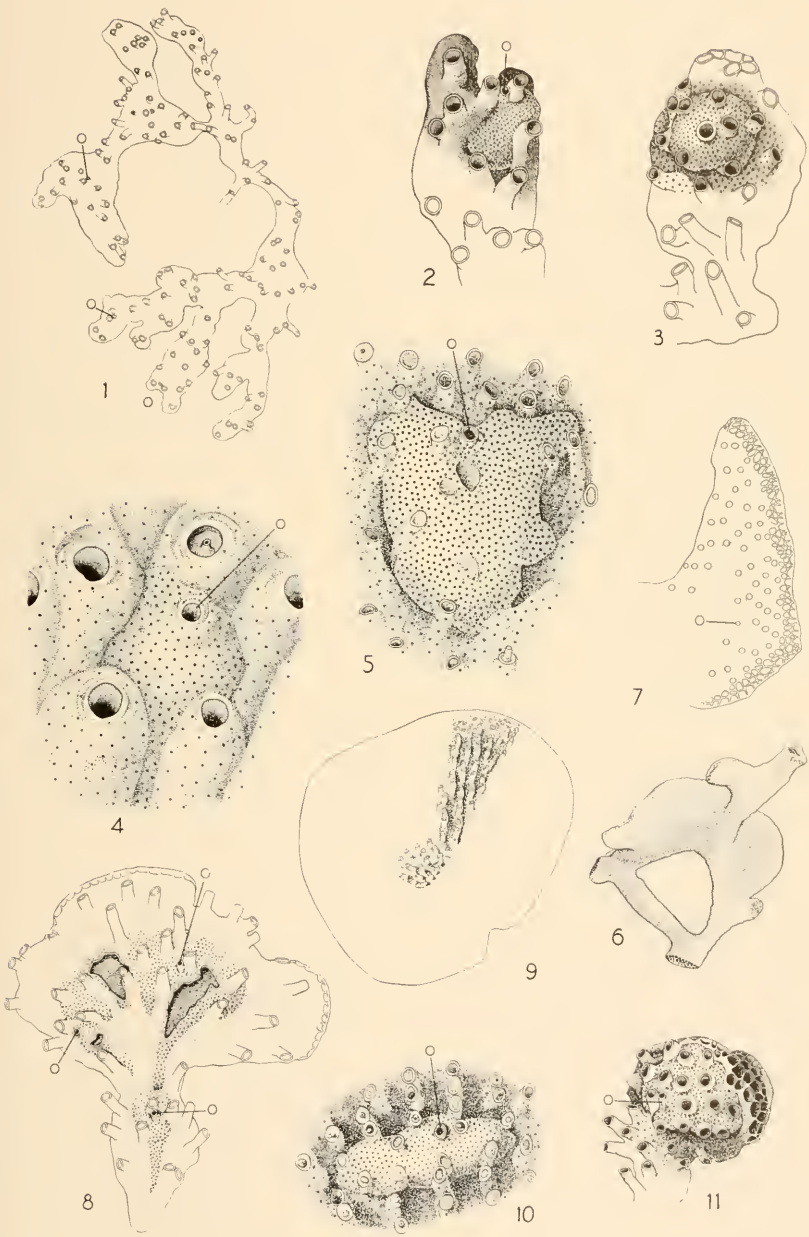
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PLATE 67

Fig. 1. *Diaperoecia californica* (d'Orbigny), showing arrangement of tubules and mode of branching.

Fig. 2. The same, ovicell and large, tall ooeciostome.

Fig. 3. *Diaperoecia floridana* Osburn, part of a branch with elongate ovicell and large, flared, reflected ooeciostome.

Fig. 4. *Diaperoecia johnstoni* (Heller), portion of a lobe with ovicell, and ooeciostome at the side of a peristome.

Fig. 5. *Tubulipora concinna* MacGillivray, ovicell with ooeciostome.

Fig. 6. *Tubulipora egregia* new species, an ovicell with ooeciostome which has an oval and slightly flared lip.

Fig. 7. The same, portion of a zoarium with lobate ovicells.

Fig. 8. *Plagioecia tortuosa* new species, outline of an irregular free lobe, with ovicell and ooeciostome.

Fig. 9. The same, outline of a zoarium, showing the beginning of a vertical bilaminate lobe and the position of four ovicells.


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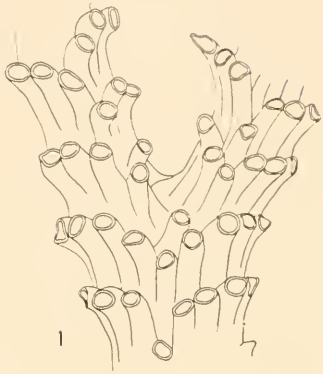
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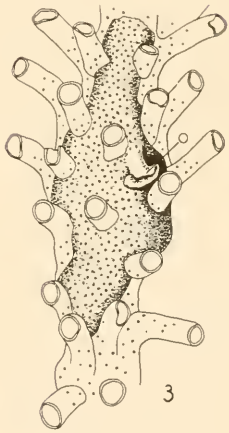
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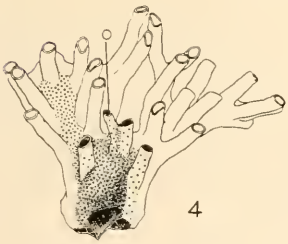
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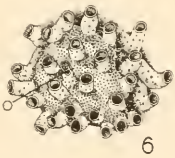
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PLATE 68

Fig. 1. *Tubulipora pacifica* Robertson, with ovicell and ooeciostome.

Fig. 2. *Tubulipora pulchra* MacGillivray, ovicell and ooeciostome.

Fig. 3. The same, base of zoarium with lateral attachment processes.

Fig. 4. The same, portion of dorsal side with attachment processes.

Fig. 5. *Tubulipora admiranda* new species, form of zoarium and distribution of ovicells.

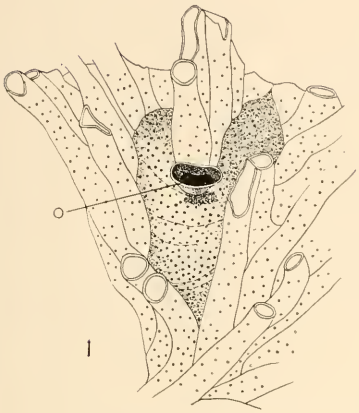
Fig. 6. The same, ovicell with large erect ooeciostome.

Fig. 7. The same, base of zoarium with primary zooecium.

Fig. 8. *Tubulipora flabellaris* (Fabricius), a small ovicell with narrow erect ooeciostome and slit-like aperture.

Fig. 9. *Tubulipora tuba* (Gabb and Horn), showing large fascicles and ovicell with ooeciostome.

Fig. 10. *Tubulipora tuba* var. *fasciculifera* (Hincks), with small fascicles and ovicell with ooeciostome.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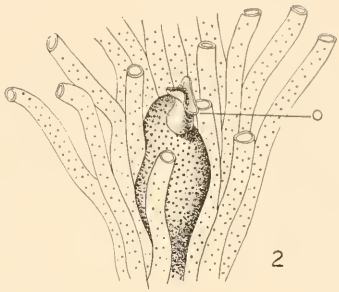
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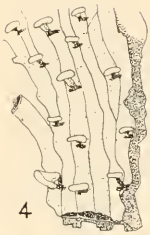
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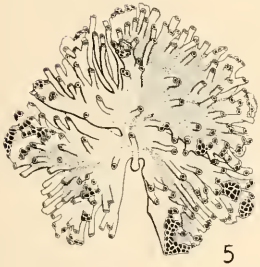
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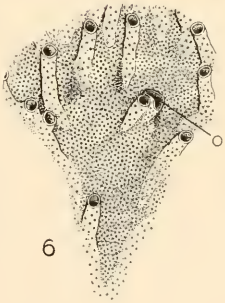
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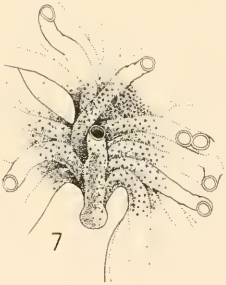
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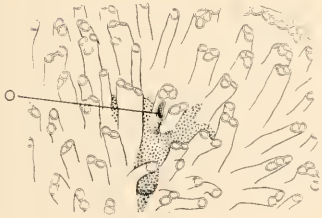
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PLATE 69

Fig. 1. *Platonea elongata* new species, with very elongate ovicell, and position of ooeciopore, ooeciostome broken off.

Fig. 2. *Platonea veleronis* new species, with short ovicell and position and form of ooeciostome.

Fig. 3. *Platonea expansa* new species, with long fascicles, broad marginal lamina and position and form of ooeciostome.

Fig. 4. *Bathysoecia bassleri* new species, outline of zoarium showing position of two ovicells.

Fig. 5. The same, depressed arcuate ovicell with slit-like ooeciostome, the two lobes surrounding peristomes and a fascicle; note the very short peristomes.

Fig. 6. The same, younger part of colony showing partially closed ends of erect tubes before the peristomes are developed.

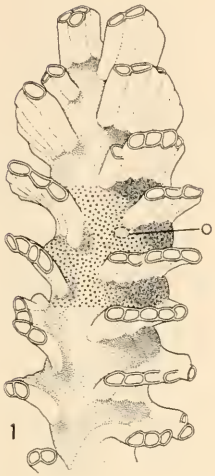
Fig. 7. *Bathysoecia hastingsae* new species, sketch of ovicell, the arcuate ovicell modified by several lobes. Note the position and form of the ooeciostome.

Fig. 8. *Filifascigera clarionensis* new species, portion of zoarium showing mode of branching and position of ovicell.

Fig. 9. The same, enlarged to show the details of the ovicell and ooeciostome.

Fig. 10. The same, a double erect fascicle, enlarged.

Fig. 11. *Discocytis californica* new species, with broad, thin base, short peduncle and the broad capitulum with the large rounded ovicell on its dorsal side.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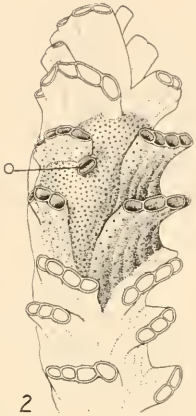
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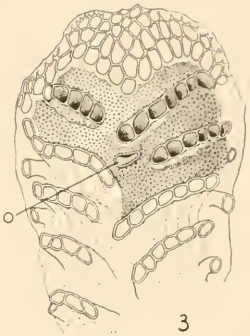
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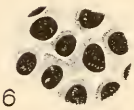
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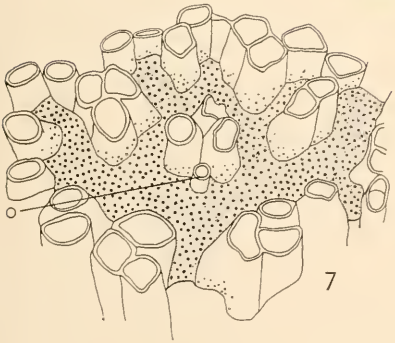
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PLATE 70

Fig. 1. *Fasciculipora pacifica* new species, young colony with about 7 branches beginning to form.

Fig. 2. The same, still younger with the beginning of branches at the right and left borders, more enlarged.

Fig. 3. The same, a very young colony with the proancestrula and first tubule; origin of secondary tubules on the right and the beginning of a branch on the left.

Fig. 4. The same, from an adult zoarium, showing a simple ovicell at the right and a broader one involving two peristomes at the left.

Fig. 5. *Diaperoecia intermedia* (O'Donoghue), an erect branch with ovicell and central ooeciostome. The capitulum here is narrower than usual.

Fig. 6. *Entalophora symmetrica* new species, showing method of branching at right angles and the position of the ovicell at the left.

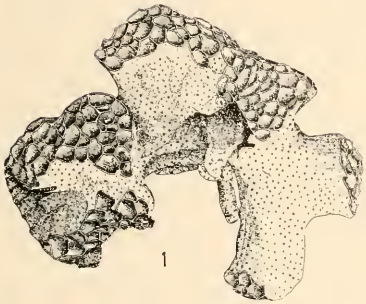
Fig. 7. The same, simple ovicell with terminal ooeciostome.

Fig. 8. *Entalophora proboscideoides* (Smitt), portion of zoarium with simple ovicell.

Fig. 9. The same, side view of ovicell and ooeciostome.

Fig. 10. *Bientalophora cylindrica* new species, outline of zoarium; the left branch is beginning to branch again in the same plane.

Fig. 11. The same, showing arrangement of peristomes and the covering layer of closed kenozoids.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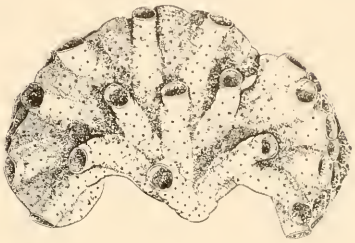
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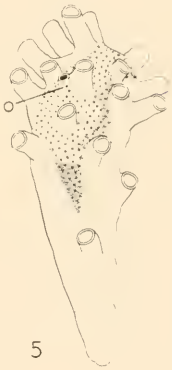
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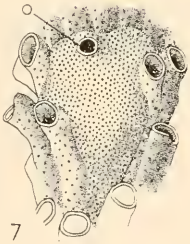
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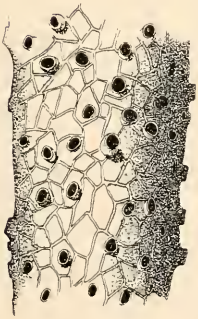
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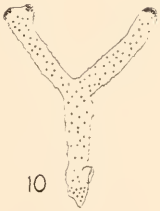
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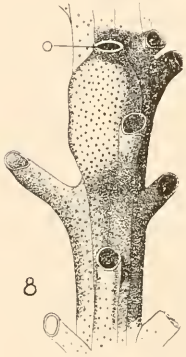
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PLATE 71

Fig. 1. *Crisidia cornuta* (L.), part of zoarium showing mode of branching and position of spine-like processes.

Fig. 2. *Bicrisia edwardsiana* d'Orbigny, with ovicell and spine-like processes.

Fig. 3. *Crisia occidentalis* Trask, showing mode of branching and normal form of ovicell.

Fig. 4. The same, distorted ovicell due to curved internode.

Fig. 5. The same, pointed tip of terminal internode, often present.

Fig. 6. *Crisia operculata* Robertson, frontal view of ovicell and ooeciostome.

Fig. 7. The same, sketch of side view showing the cap or "operculum" above the ooeciopore.

Fig. 8. *Crisia pugeti* Robertson, frontal view of ovicell and, at left, a sketch of the side view with bent ooeciostome.

Fig. 9. *Crisia elongata* Milne-Edwards, frontal view with short, wide expansion of the ovicell.

Fig. 10. *Crisia eburnea* (L.), with short, transverse ooeciostome.

Fig. 11. *Tubulipora flexuosa* (Pourtales), a portion of a branch with short ovicell and ooeciostome distal to a peristome.


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PLATE 72

Fig. 1. *Crisia cribraria* Stimpson, mode of branching and ovicell.

Fig. 2. *Crisia serrulata* new name, ovicell and mode of branching; note at left the usual short inserted *basis rami.*

Fig. 3. *Crisia maxima* Robertson, ovicell and mode of branching; note long free end of the tubules and the small reflected ooeciostome.

Fig. 4. *Filicrisia franciscana* Robertson, mode of branching and frontal position of ooeciostome.

Fig. 5. *Filicrisia geniculata* (Milne-Edwards), infertile internode, ovicell with dorsal position of ooeciostome, and smaller dimensions.

Fig. 6. *Crisulipora occidentalis* Robertson, a fertile internode showing long peristomes and ovicell spreading among peristomes, ooeciostome centrally placed near distal end.

Fig. 7. *Hornera pinnata* Canu and Bassler, sketch of frond and base.

Fig. 8. The same, frontal view of branch with lateral pinnule.

Fig. 9. The same, dorsal view of tip of branch.

Fig. 10. *Hornera pectinata* Busk, sketch of frond and base.

Fig. 11. The same, frontal view of tip of branch, showing the irregular, pectinate tips of the tubules.

Fig. 12. The same, dorsal side of tip of branch.

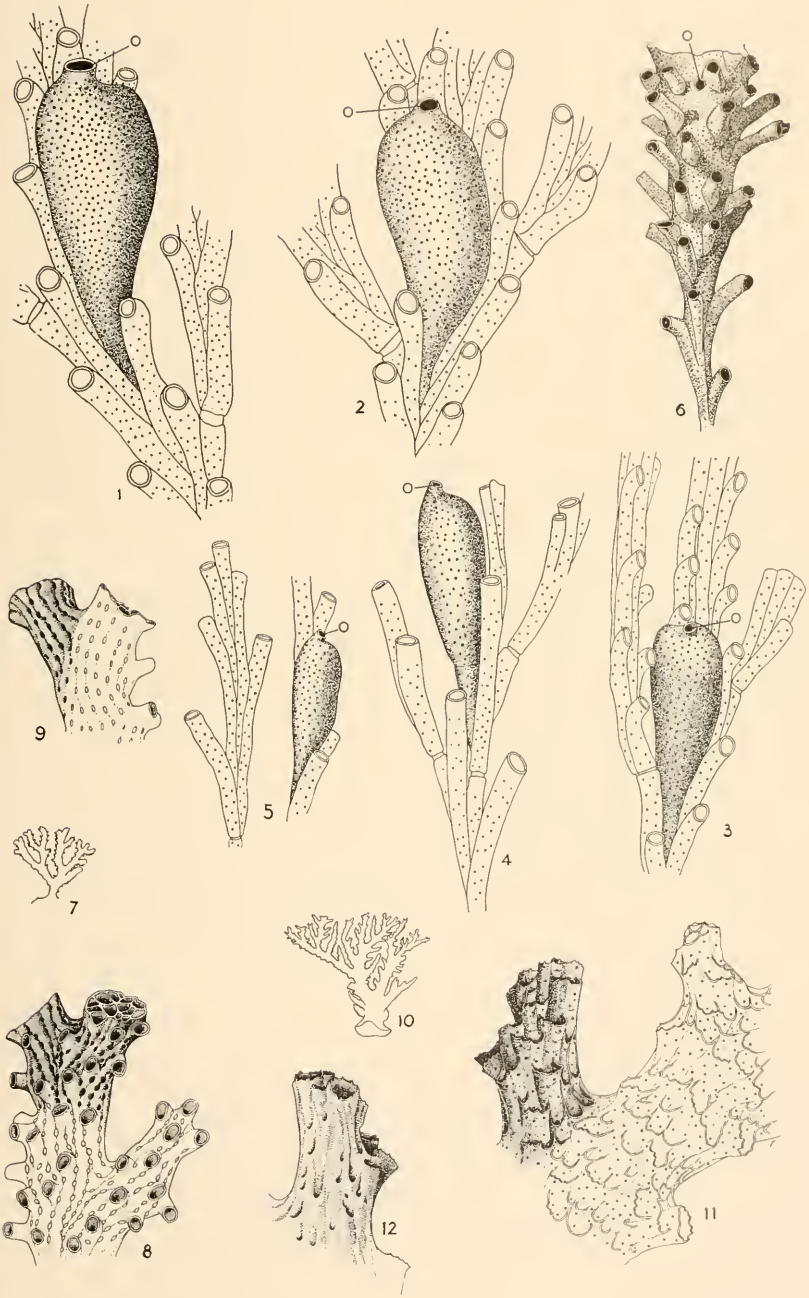
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PLATE 73

Fig. 1. *Diplosolen obelium* (Johnston), ovicell enclosing peristomes of normal and diminutive tubules; ooeciostome near center.

Fig. 2. *Plagioecia tubiabortiva* (Canu and Bassler), ovicell with terminal ooeciostome.

Fig. 3. *Plagioecia sarniensis* (Norman), showing basal tubule and transverse expansion of ovicell and terminal ooeciostome; one peristome enclosed.

Fig. 4. *Plagioecia patina* (Lamarck), basal tubule and usual broad expansion of ovicell, with terminal ooeciostome.

Fig. 5. *Borgiola pustulosa* new species, surface view with "pustules," and broken edge of type specimen.

Fig. 6. The same, at broken edge showing brood-chamber traversed by tubules.

Fig. 7. The same, showing the occasional pointed peristomes at the edge of a pustule.

Fig. 8. The same, margin of zoarium.

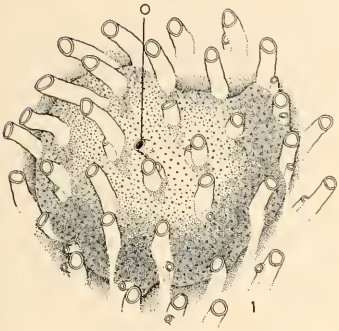
Fig. 9. The same, enlargement of a pustule.

Fig. 10. *Heteropora alaskensis* (Borg), terminal portion of branch with brood-chamber, the roof partly removed to show the cavity traversed by tubules; note also the high peristomes.

Fig. 11. The same, closure and partial closure of peristomes near base of zoarium.

Fig. 12. The same, mode of branching of a young zoarium.

Fig. 13. *Heteropora magna* O'Donoghue, a characteristic zoarium showing mode of branching and anastomosis; the primary base and two secondary attachments.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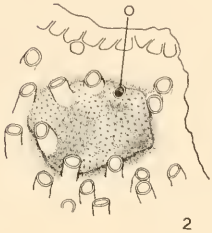
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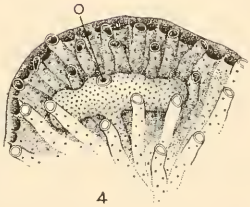
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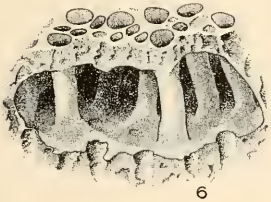
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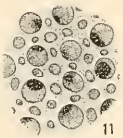
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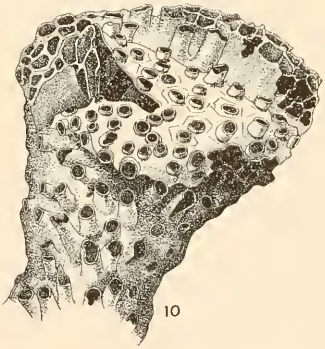
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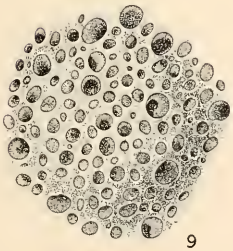
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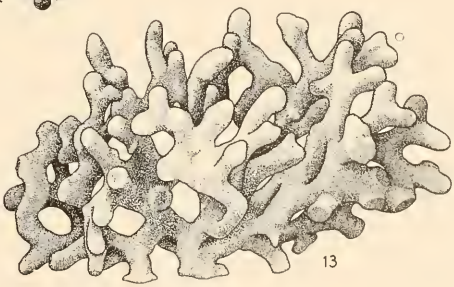
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PLATE 74

Fig. 1. *Lichenopora buskiana* Canu and Bassler, roof of ovicell broken away; the distribution of the radii on the disc is often irregular.

Fig. 2. The same, irregular secondary cancelli above ovicell, position and form of ooeciostome.

Fig. 3. *Lichenopora verrucaria* (Fabricius), showing quincuncial arrangement of peristomes, irregular cancellated cover of ovicell, and position and form of ooeciostome.

Fig. 4. *Lichenopora novae-zelandiae* (Busk), irregular secondary cancelli covering ovicell, position and form of ooeciostome, and occasional extra tubules in the uniserial radii.

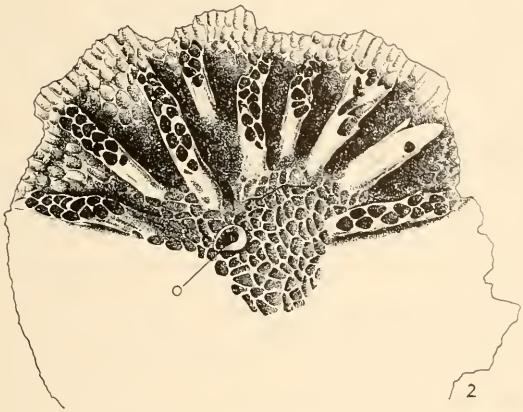
Fig. 5. *Disporella separata* new species, small portion of zoarium showing form and separation of the discs.

Fig. 6. The same, enlarged, showing the irregular nature of the radii and the round partially closed cancelli.

Fig. 7. *Disporella californica* (d'Orbigny), diagram of complex zoarium with two complete discs and three incomplete marginal ones.

Fig. 8. The same, at margin of central area, showing ovicell with perforated cover (seen at left through the rounded secondary cancelli); position and form of ooeciostome.

Fig. 9. The same, enlargement of cancellar pores with pin-head spicules.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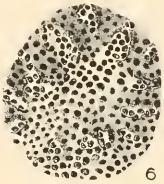
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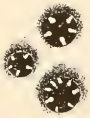
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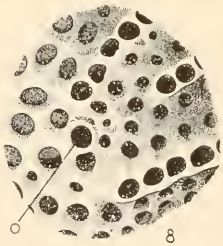
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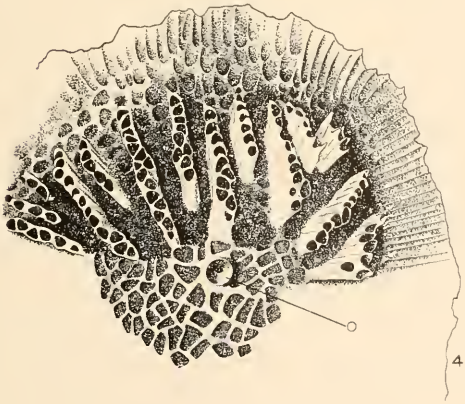
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PLATE 75

Fig. 1. *Disporella hispida* (Fleming), showing form of zoarium, scattered peristomes, small cancellar pores, and two ooeciostomes near the border indicating the presence of interradial ovicells.

Fig. 2. *Disporella fimbriata* (Busk), the ovicell obscured by heavy calcification of the secondary cancelli.

Fig. 3. The same, a younger zoarium with three ovicells occupying most of the central area, the ooeciopores marginal, ooeciostomes not developed.

Fig. 4. *Disporella ovoidea* new species, outline showing ovate form of zoarium and central area, uniserial radii and position of ovicell.

Fig. 5. The same, much enlarged, an interradial ovicell at left covered by rounded secondary cancelli, and interradial ooeciostome; beside this another interradial ovicell dissected away to show the cavity.

Fig. 6. ? *Disporella octoradiata* (Waters), a young zoarium without ovicell.

Fig. 7. *Disporella alaskensis* new species, side view, showing the height of the radii, the upturned margin and the small daughter zoarium.

Fig. 8. The same, frontal view, showing the complex nature of the radii, the position of the ovicell (roof broken away) and the position of the submarginal vertical bud of the daughter zoarium.


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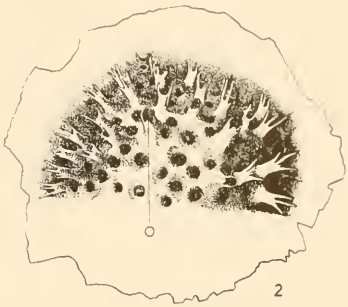
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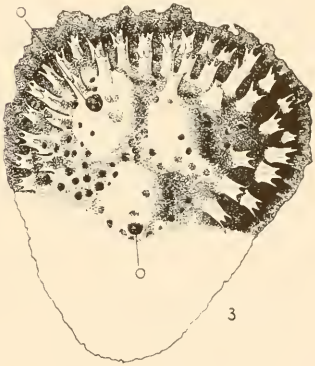
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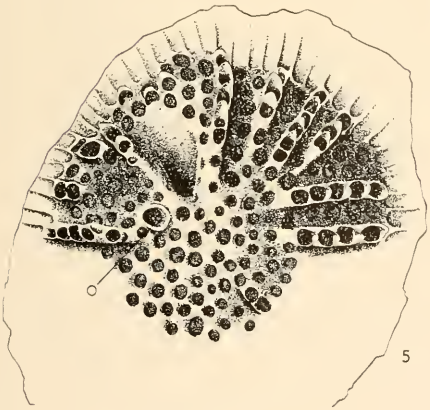
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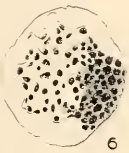
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PLATE 76

Fig. 1. *Disporella astraea* new species, showing attachment, vertical budding and crown from side view.

Fig. 2. The same, top view of crown (disc).

Fig. 3. *Lichenopora canaliculata* (Busk), view of disc with central ovicell and hooded ooeciostome.

Fig. 4. The same, enlargement of ooeciostome.

Fig. 5. *Lichenopora intricata* (Busk), portion of complex zoarium showing irregular distribution of peristomes between discs.

Fig. 6. The same, a fertile disc, with ooeciostome and irregular secondary cancelli covering ovicell.

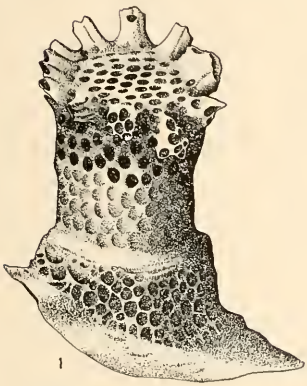
Fig. 7. The same, infertile disc with uniformly round small cancelli.

Fig. 8. The same, one end of a fertile disc with ooeciostome and irregular secondary cancelli covering ovicell.

Fig. 9. The same, the other end of the same disc with irregular cancelli over the end of the ovicell, and smaller rounded cancelli beyond the edge of the ovicell.

Fig. 10 *Disporella stellata pacifica* new variety, disc with large central area, multiserial radii and interradial position of ovicells.

Fig. 11. *Borgiola rugosa* (Borg), side view of zoarium with broad encrusting base and erect irregular branches; a small subcolony from the same base at the right.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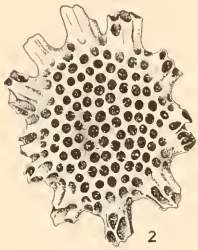
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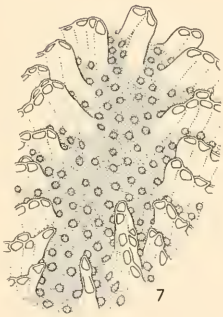
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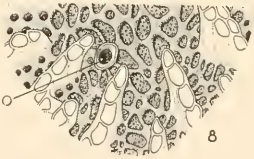
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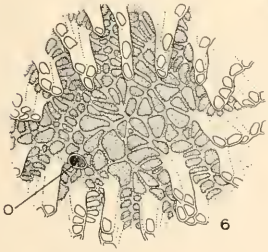
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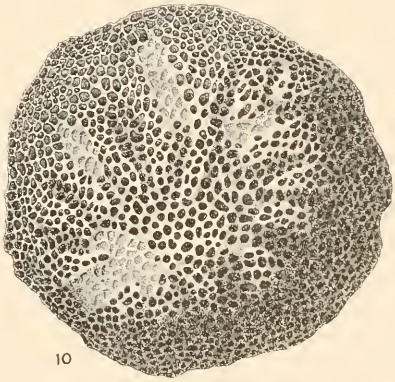
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PLATE 77

Fig. 1. *Alcyonidium polyoum* (Hassall), a portion of a zoarium with a zooecium in detail. X 46.

Fig. 2. *Alcyonidium parasiticum* (Fleming), note minute border papillae on detailed zooecium. X 46.

Fig. 3. *Alcyonidium pedunculatum* Robertson, a portion of a zoarium with one zooecium in detail. X 46.

Fig. 4. *Alcyonidium mammillatum* Alder, note aperture at apex of raised oral protuberance. X 46.

Fig. 5. *Alcyonidium disciforme* (Smitt), a portion of a zoarium with a zooecium in detail. X 46.

Fig. 6. The same, a drawing of a zoarium, ventral aspect, natural size.

Fig. 7. *Alcyonidium enteromorpha* Soule, a portion of a zoarium with one zooecium in detail. X 46.

Fig. 8. The same, dorsal view of dissected zooecium, showing the anatomy of the polypide. X 73.

Fig. 9. *Flustrella corniculata* (Smitt), a portion of a zoarium with a zooecium in detail. X 26.

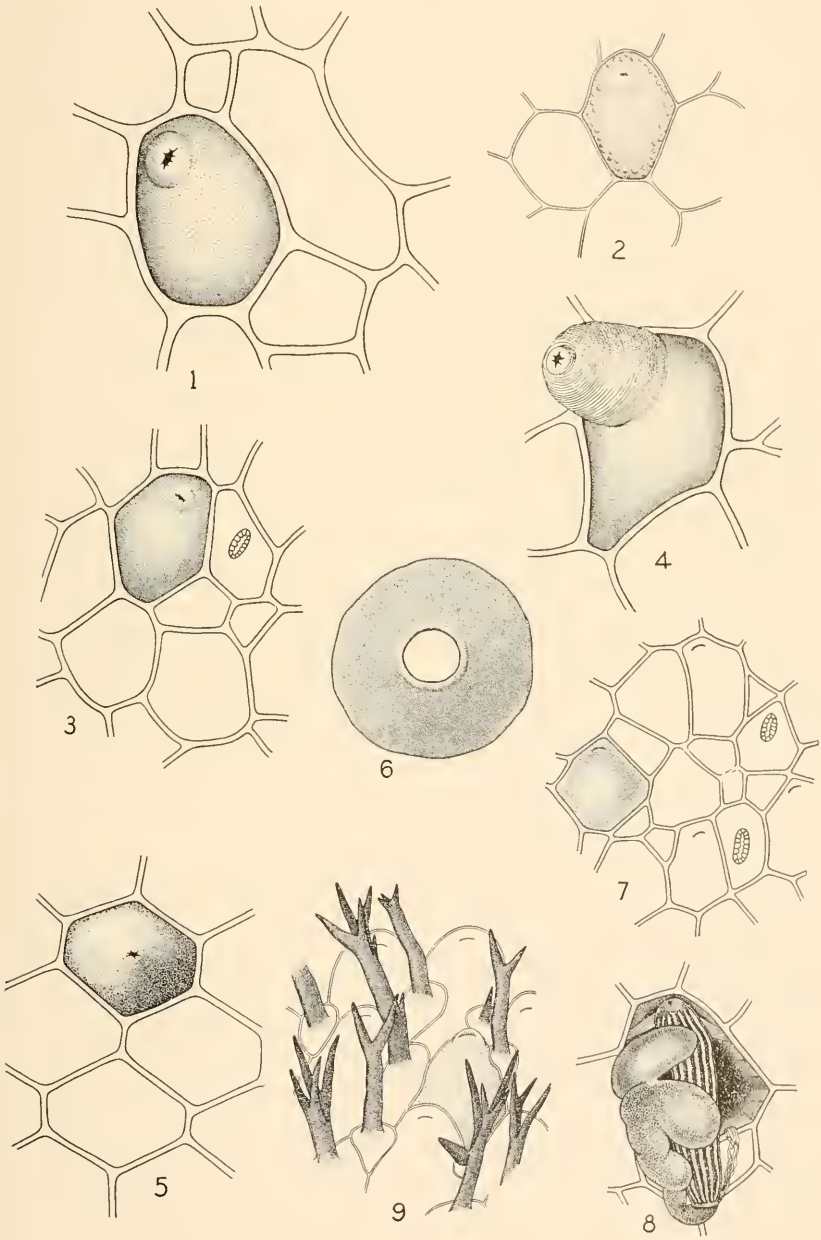
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PLATE 78

Fig. 1. *Flustrella gigantea* Silen, a portion of a zoarium with a zooecium in detail. X 26.

Fig. 2. *Pherusella brevituba* Soule, a portion of a zoarium with a zooecium in detail. X 46.

Fig. 3. *Clavopora occidentalis* (Fewkes), an entire zoarium. X 26.

Fig. 4. *Inguinella palmata* van Beneden, a portion of a zoarium showing the arrangement of the zooecia. X 26.

Fig. 5. *Nolella stipata* Gosse, a portion of a zoarium showing mode of growth, note polypide anatomy. X 26.

Fig. 6. *Vesicularia fasciculata* new species, a portion of a zoarium showing mode of growth, one zooecium with polypide anatomy. X 46.

Fig. 7. *Amathia convoluta* Lamouroux, a portion of a zoarium showing the characteristic spiral pattern of zooecial growth. X 46.


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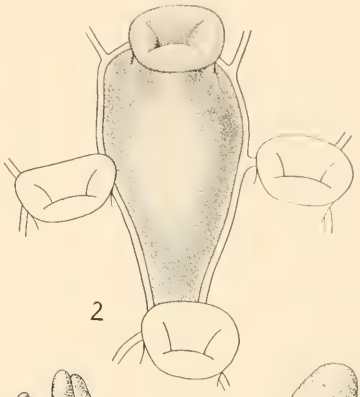
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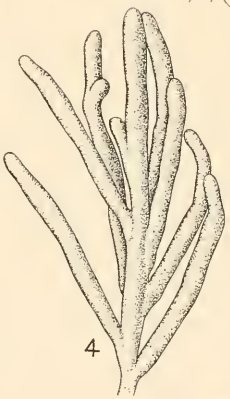
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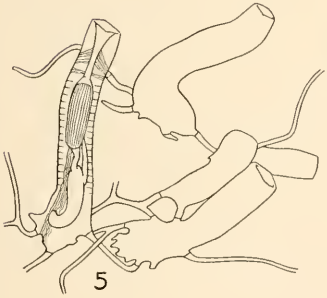
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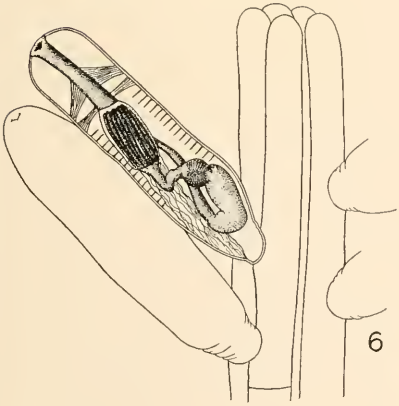
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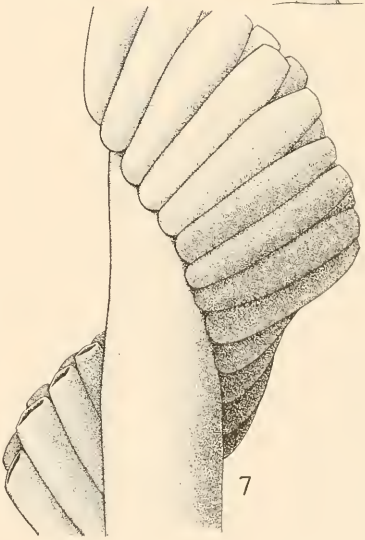
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PLATE 79

Fig. 1. *Amathia distans* Busk, a portion of a zoarium showing the position of the zooecia. X 46.

Fig. 2. *Amathia vidovici* (Heller), a portion of a zoarium showing the position of the zooecia. X 46.

Fig. 3. *Zoobotryon verticillatum* (delle Chiaje), a portion of a zoarium showing the placement of the zooecia. X 26.

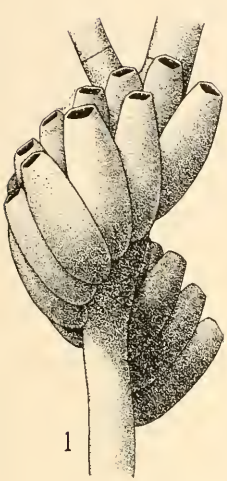
Fig. 4. *Bowerbankia imbricata* (Adams), a portion of a zoarium showing the position of the zooecia; note anatomical details. X 26.

Fig. 5. *Bowerbankia gracilis* Leidy, a portion of a zoarium showing the position of the zooecia. X 26.

Fig. 6. *Bowerbankia gracilis aggregata* O'Donoghue, a portion of a zoarium showing the mode of zooecial growth. X 46.

Fig. 7. *Valkeria tuberosa* Heller, a portion of a zoarium with one zooecium in detail. X 46.

Fig. 8. *Aeverrillia setigera* (Hincks), a pair of zooecia. X 46.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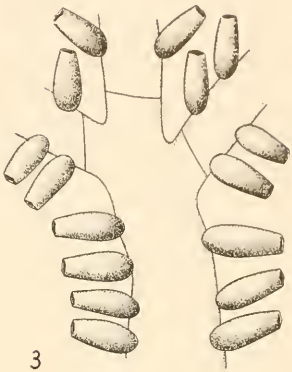
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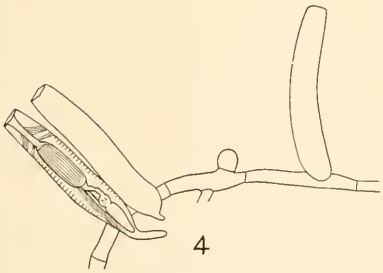
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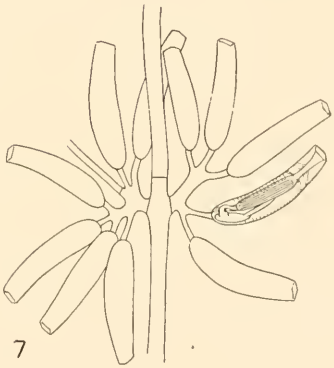
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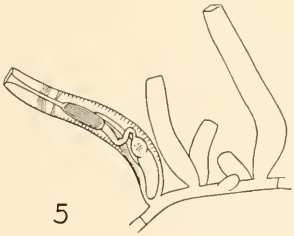
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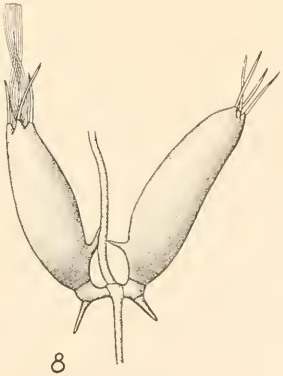
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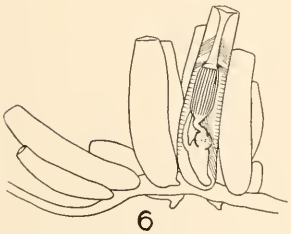
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PLATE 80

Fig. 1. *Buskia nitens* Alder, two zooecia showing mode of growth. X 46.

Fig. 2. *Buskia seriata* new species, a portion of a zoarium showing mode of zoarial growth, one zooecium with polypide anatomy. X 46.

Fig. 3. *Farrella elongata* (van Beneden), a portion of a zoarium, one zooecium showing the anatomy of polypide. X 26.

Fig. 4. *Triticella pedicellata* (Alder), a portion of a zoarium, one zooecium with anatomical details. X 26.

Fig. 5. *Triticella elongata* (Osburn), a portion of a zoarium, one zooecium showing details of polypide anatomy. X 26.

Fig. 6. *Terebripora comma* Soule, a portion of a zoarium removed from a mollusk shell, one zooecium with polypide anatomy. X 46.

Fig. 7. *Immergentia californica* Silen, a portion of a zoarium removed from a mollusk shell, one zooecium with anatomical detail. X 46.

Fig. 8. *Penetrantia densa* Silen, a portion of a zoarium removed from a mollusk shell, one zooecium with polypide anatomy, and also a typical gonozoid. X 46.

Fig. 9. *Penetrantia concharum* Silen, a portion of a zoarium removed from a mollusk shell, one zooecium with anatomical detail, and also a typical gonozoid. X 46.

Fig. 10. *Penetrantia sileni* Soule, a portion of a zoarium removed from a mollusk shell, one zooecium with polypide anatomy, and also a typical gonozoid. X 46.

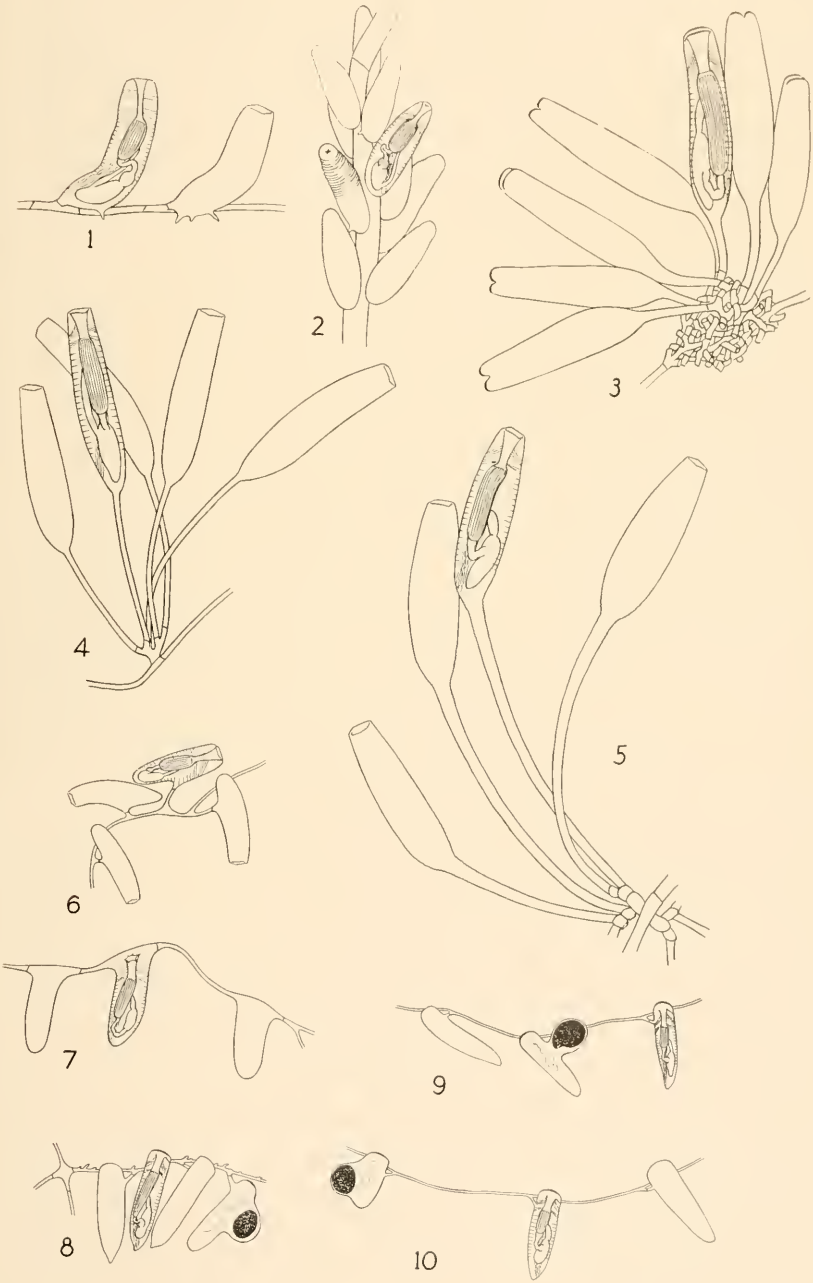
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PLATE 81

Fig. 1. *Hincksina gothica* new species, with zooecium, ovicell and large and small avicularia.

Fig. 2. *Amphiblestrum trifolium* (S. Wood), zooecia with trifoliate opesia and ovicell.

Fig. 3. *Bugula flabellata acuminata* new variety, part of zoarium with different sizes of avicularia.

Fig. 4. The same, large avicularium, partial side view, and front view of mandible with acuminate point.

Fig. 5. *Emballotheca stylifera* (Levinsen), zooecia with ovicell.

Fig. 6. *Hippodiplosia cancellata* (Smitt), zooecia with cancellate frontal wall, minute median suboral avicularium, and ovicell.

Fig. 7. *Microporella arctica* Norman, showing thick-walled frontal, ligulate avicularium, and ovicell.

Fig. 8. *Escharoides jacksoni* (Waters), zooecia with spout-like peristome, spines, avicularia and ovicell.

Fig. 9. *Porella minuta* (Norman), zooecia with suboral avicularium and ovicell.

Fig. 10. *Mucronella microstoma* (Norman), zooecia showing narrow aperture and spines.

Fig. 11. *Pachyegis brunnea* (Hincks), ovicell (for description of species see Part 2, p. 315).

Fig. 12. *Cheilopora praelucida* (Hincks), ovicell (for description of species see Part 2, pp. 464-65).


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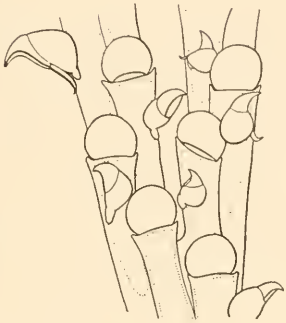
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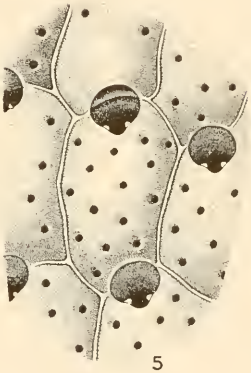
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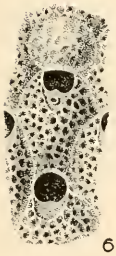
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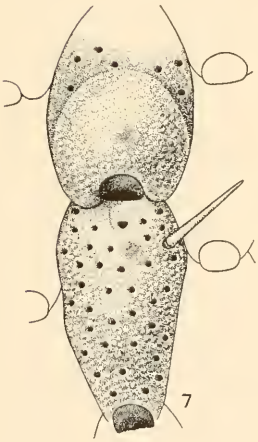
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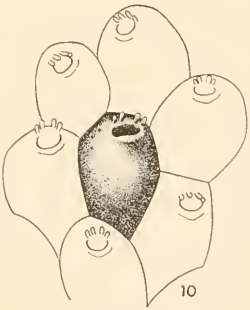
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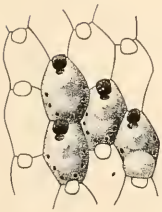
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PLATE 82

Owing to the nature of the material all of the figures are more or less diagrammatic, all to the same scale except figs. 6, 10 and 13.

Fig. 1. *Myosoma spinosa* Robertson, portion of zoarium, zoid, stolon and very young zoid. Note diagonal position of tentacle ring.

Fig. 2. *Pedicellina cernua* (Pallas), a fertile internode with zoid; the spines are irregular in distribution and often wanting.

Fig. 3. *Barentsia gracilis* (M. Sars), fertile internode and zoid; the stalk is often twice as long as that figured.

Fig. 4. *Barentsia geniculata* Harmer, short, wide basal bulb, muscular joints, comparatively small calyx.

Fig. 5. *Barentsia ramosa* (Robertson), details of joints and form of calyx.

Fig. 6. The same, habit sketch to show mode of branching.

Fig. 7. *Barentsia robusta* new species, showing large calyx, tall basal bulb and short internode (often shorter than the basal bulb), and attachment of bulb to stolon.

Fig. 8. *Barentsia discreta* (Busk), large calyx; very elongate internode with "pores" for its entire length.

Fig. 9. *Barentsia subrigida* new species, stalk walls thin and flexible except at the base of the lower internode; the proportions of the two internodes are very constant.

Fig. 10. *Barentsia gorbunovi* Kluge, habit sketch of branch, internodes without septa and three sizes of basal bulbs.

Fig. 11. The same, details of part of branch, with medium and small basal bulbs.

Fig. 12. The same, giant basal bulb at base of large branch, drawn to the same scale as fig. 11.

Fig. 13. *Coriella stolonata* Kluge, habit sketch of erect branch formed of connate stolons.

Fig. 14. The same, details of zoid; note that the basal bulb arises from a cup-shaped process of the fertile internode.


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INDEX

Plate illustrations are in bold face.

INDEX

Index for Orders, Divisions, Families, Genera, and Species