Chapter 9

BRYOZOANS (Phylum BRYOZOA)

by P. E. Bock*

Bryozoans are common components of the littoral and sublittoral benthos. They are usually found attached to solid substrates, such as shells or rocks, or to various algae. They are important as undesirable colonisers of artificial structures, such as boats or cooling water pipes. The waters of southern Australia contain a very diverse bryozoan fauna: over 500 species have been recorded from a limited number of locations. With a little collecting effort, samples of about thirty to 100 species can be obtained from shallow-water locations. The local fauna needs extensive revision, since there have been important advances in the systematics of Bryozoa since the last detailed studies of local collections were made.

Colonies of bryozoans are generally small and inconspicuous, and may escape attention unless samples are examined with a dissecting microscope. Identification usually relies upon the study of skeletal features at magnifications up to 100X. Systematic work, however, requires more detailed study, using thin sections in transmitted light, or electron microscopy. Samples should therefore be fixed and stored in a wet condition. Identification of skeletal features is difficult in wet samples, so a small fraction of the colony can be treated with 5 per cent sodium hypochlorite, or a domestic bleach, for identification. However, this method destroys weakly calcified or non-calcified species, including members of the important genera *Amathia* and *Bugula*. Cleaning in this way also removes articulated spines and rootlets; jointed colonies simply fall apart.

The morphology of bryozoans shows great variation: consequently, the literature contains a large number of special terms for particular features. Recent workers have rationalised the terminology, and many misleading or redundant terms are no longer being used. Recent works by Ryland (1970, 1976) and by Ryland and Hayward (1977) are most useful in gaining an understanding of the group. The glossary in Bassler (1953) is extensive, and is a useful guide to the older terms. A revised edition of the Treatise of Invertebrate Paleontology is in preparation, and should become an important source of information. Important works on anatomy and physiology include Hyman (1959), and Woolacott and Zimmer (1977).

All bryozoans are colonial; most are marine, with the vast majority of these being sessile. All are filter-feeders, so they thrive in waters rich in microplankton. Each colony is made up of functional units called *zooids*. Adjacent zooids are separated by walls constructed of skeletal material and

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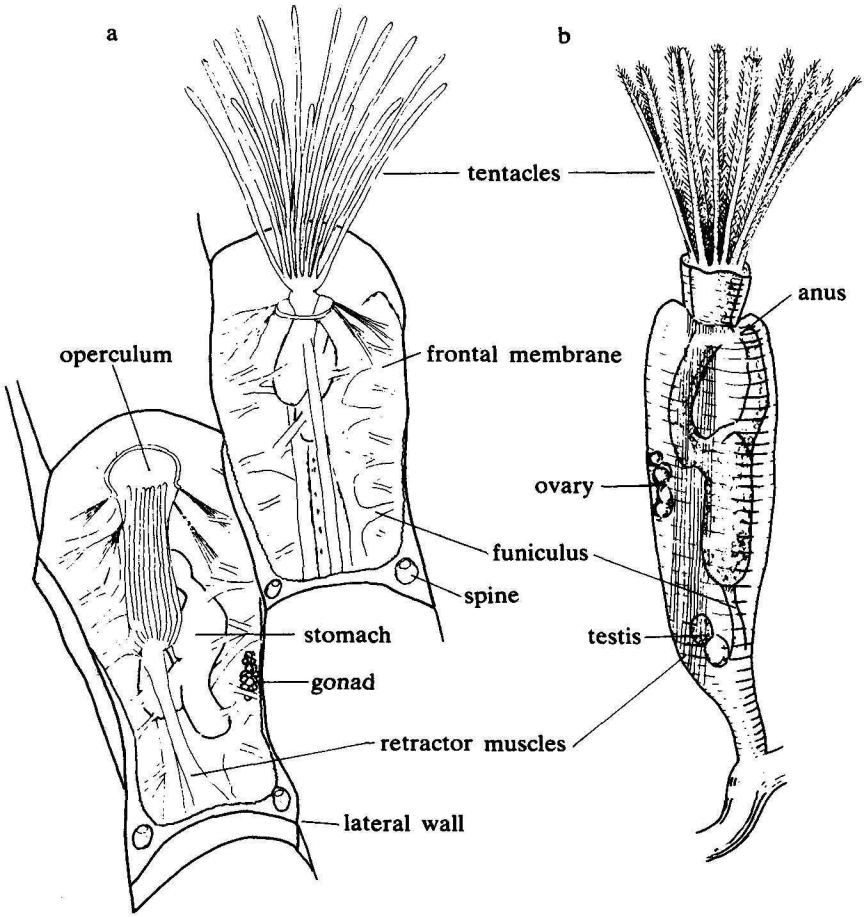


Fig. 9.1. Structure of bryozoans: *(a)* the cheilostome *Membranipora membranacea* showing tentacles of one individual extended and in another retracted; *(b)* A typical ctenostome

organic cuticle. A funicular system allows communication between the zooids of the colony. This system operates between zooids through septular pores in the body walls. These pores are occupied by specialised cells. (Fig. 9.1).

In living specimens the colour and colony form are the most obvious features. Unfortunately, these are not of great use in specific identification. Colour may prove to be useful eventually, but few of the available descriptions include

information on colour. Colony form is notoriously variable in some groups; there are other groups which can be identified immediately by the shape of the colony. Colony form includes such aspects as: the type of attachment to the substrate, the rigidity, the number of layers of zooids, the colony height, the branching pattern, and the shape of branches or of the entire colony.

Bryozoa are significant to human activity only as unwanted pests, when they colonise the surfaces of ship hulls or inlet pipes for cooling water. Some bryozoan species are important components of the fouling population; particularly those types which are resistant to anti-fouling paints. These colonies can subsequently provide a more suitable settlement surface for other types of fouling organisms. Bryozoan settlement can also be a pest in commercial shellfish production. A species of *Alcyonidium* found in the North Sea can cause allergic dermatitis if colonies are handled, but no similar reactions have been recorded for Australian species.

Dinoflagellates are one of the main food sources of bryozoans. Species which contain a gizzard can also make use of diatoms as food. Each feeding zooid has a crown of tentacles, including from eight to about thirty-four ciliated tentacles. Tentacle number is fairly consistent for each species. Food particles are directed into the mouth at the centre of the crown of tentacles. The gut includes a differentiated stomach, and terminates at the anus, located near the base of the crown of tentacles.

Reproductive behaviour varies considerably within the phylum. All forms produce larvae by sexual reproduction; these larvae settle after a short free-swimming period and then commence asexual reproduction, by budding, to form the colony. A few species have differentiated male and female zooids in a colony; many species contain zooids with both male and female gonads. Some types release ova into the sea, so that fertilisation is external; but other forms have internal fertilisation, with the sperm entering the zooid through a special pore. Release of sperm takes place from the tentacles in the species which have been studied. It is difficult to establish whether fertilisation by sperm from other zooids in the same colony is significant, but it is believed that cross-fertilisation is important. Brooding of the fertilised ovum into a larva takes place in a specialised sac or chamber. This may be enclosed within the normal zooid walls, or may be in a chamber called the ooecium, with a skeletal protection called the ovicell. The cyclostomes show polyembryony, in which the fertilised primary embryo buds to produce secondary or tertiary embryos which subsequently develop into larvae. This takes place in an enlarged brood chamber, or gonozooid.

The manner of growth of the colony, or astogeny, and the development of the individual zooid, or ontogeny, are processes which are of great significance in systematic studies. In particular, the skeletal features of early-formed zooids may be different from those formed at a later stage. All zooids of a colony may show ontogenetic changes, including secondary calcification, which alter the appearance of the zooid. Some branching forms may have variations from the main stem out to the peripheral branches, which alter the form of the zooid

considerably. Identification of small samples, or of small fragments of a colony, must therefore be made with great care.

Growth rates of colonies vary, and have not been documented for local species. Some species reach maturity within a few weeks, with a colony surviving for a few months only. Other species produce colonies which can survive for several years. The warm-water fouling bryozoan *Zoobotryon* is deciduous, with the branches decaying before winter, and the formation of new branches taking place from the colony base after winter. The main organs of a zooid (the polypide) may degenerate seasonally, or if conditions are unfavourable. The decay products form a 'brown body' which is retained within the zooid. If conditions are favourable, the zooid may regenerate, forming a fully functional individual again. This process may be repeated several times, so that old zooids may contain several brown bodies. Little work has been done on the reproductive behaviour or colony development of Australian species. A study by Stach (1939), and work by Wass on catenicellids are notable exceptions.

Bryozoans are adapted to a wide variety of sublittoral habitats. Substrate type and competition for space with other organisms appear to be major factors. Examples of substrate types are:

Macrocystis fronds: *Membranipora membranacea.*

Sargassum and similar algae: *Smittina papillifera, Calloporina canaliculata, Chaperia cervicornis, Gigantopora biturrita* and others.

Mollusc shells, such as *Mytilus planulatus: Microporella diademata, Calloporina lunata, Celleporina spatula, Tubulipora pulchra,* and others.

Exposed rockface and jetty pilings: *Celleporaria* spp, *Triphyllozoon* spp, *Bugula dentata, Bugula cucullata.*

Rock face in deeper water or surfaces protected from light in shallow water: catenicellids, *Cellaria* spp.

It is not known whether the variation in habitats of the species selecting solid substrates is controlled by competition with algae of various groups, but this factor appears to be a major one. Depth and current activity are considered to be significant factors of the environment, but there are no detailed local studies. Productivity (the supply of phytoplankton) would appear to be one of the reasons for the variety and abundance of the bryozoan faunas in some locations.

The main collections which have been studied from southern Australia were mainly obtained from Port Phillip and Western Port in Victoria, the Bass Strait Islands south from Wilson Promontory, and Gulf St. Vincent in South Australia. The information is inadequate to comment on the distribution of local species. Many species of bryozoans have a cosmopolitan distribution, including *Membranipora membranacea, Electra pilosa,* and *Aetea anguina.* Further revision may prove, however, that some of the local records of overseas species have been based on incorrect identifications. The wide distribution of certain species which settle on the hulls of ships may be explained by dispersal by shipping.

SYSTEMATICS

In most modern works, the phylum Bryozoa (or Ectoprocta) is defined to exclude the entoprocts. While most references separate these as a distinct phylum, there are some specialists who argue for their inclusion within the Bryozoa (Nielsen, in Woolacott and Zimmer, 1977: 529). A few local species of entoprocts have been described, but these are inconspicuous and are not included in this account.

Key to Orders

1. Non-calcified bryozoans 2
— Calcified bryozoans 3
2. Orifice closed by a hinged flap or operculum on the frontal surface. ..... CHEILOSTOMATA
— Orifice closed by a muscular collar, which contracts to a small opening when the tentacles are retracted ..... CTENOSTOMATA
3. Orifice is circular, at the termination of a tubular zooid; no operculum is present. Bulbous gonozooids may be present, but specialised zooids, such as avicularia, are absent. ..... CYCLOSTOMATA
— Orifice semicircular, elliptical or subcircular, closed by a hinged operculum or a flap of frontal membrane. Ovicells may be present; specialised zooids, such as vibracula or avicularia, may be present. ..... CHEILOSTOMATA

Class STENOLAEMATA

Zooids cylindrical, body wall calcified. The lophophore is pushed out by an internal muscular system acting upon the coelomic pressure.

Order CYCLOSTOMATA

The only order of the class with living representatives. Zooids are interconnected through open pores. Reproduction includes the process of polyembryony, with brooding of several larvae in each gonozooid.

The colonies of cyclostomes may be erect, with few or many branches, with some colonies forming a delicate lacy network; or low-growing, encrusting the surface of shells, rocks, and algae; or lenticular. One group forms bushy branching colonies of rigid sections joined by short flexible internodes. Colony form is highly flexible within some groups. The zooids are tubular internally, but the skeletal material merges between the zooids in a variety of patterns to produce the external form. The calcareous skeleton is punctured by pores in most species. Since these pores do not pass through the outer cuticle to the environment, they are termed pseudopores.

Normal feeding zooids are termed autozooids; gonozooids are specialised for

brooding larvae; nanozooids are dwarf zooids with reduced polypides found in a few forms; and rhizozooids are rootlets for anchorage and support.

The key which follows is designed to discriminate only between the few species which have been selected for inclusion because they are fairly common. The key is based upon the obvious features of colony form, which are usually considered unreliable for detailed study. Discrimination of other species would require more detailed information, particularly on the structure of the gonozooids and their orifices. This information is not available for all local species. The group requires major revision.

Key to Genera of Cyclostomata:

1. Colony flexible at the joints between calcified sections..... *Crisia* (p. 325)
— Colony without uncalcified joints; erect or encrusting 2
2. Colony erect; branching, or forming a fenestrate network..... 3
— Colony low-growing, encrusting shells, algae, rocks 7
3. Colony composed of fenestrate fronds..... *Hornera* (p. 330)
— Colony branching with a bifurcating pattern..... 4
4. Zooids opening radially, on all sides of each branch ... *Diaperoecia* (p. 328)
— Zooids opening on the frontal surface only; zooids arranged in series, radiating distally outwards from midline of branch 5
5. Outer zooids of series longer than inner zooids. Basal surface of branch marked with longitudinal grooves, transverse growth ridges, and small irregular branches used for anchorage ..... *Nevianipora* (p. 325)
— Outer zooids appear shorter than inner zooids in the series 6
6. Basal surface of branch marked with fine longitudinal grooves; four to six zooids in a series; few branches in colony; pseudopores absent ..... *Idmidronea* (p. 325)
— Basal surface of branch grooved, with deep, elongate pseudopores regularly arranged along grooves; one to four zooids in a series; many branches in a colony. Gonozooids form porous, prominent bulges proximal to bifurcations ..... *Mesonea* (p. 328)
7. Colony encircling stems of the seagrass *Amphibolis*, forming a nodule, with regular, sharp ridges on the surface ..... *Densipora* (p. 330)
— Colony spreading over flat or curved surfaces 8
8. Colony spreading in one main direction from ancestrula, growing in a lobate or fan-shaped form. In some cases, several lobes develop..... *Tubulipora* (p. 328)
— Colony spreading radially from ancestrula, growing to a discoid or lenticular form 9

9. Zooids tubular, terminating at circular orifices, which may be produced into a short, very thin tube; gonozooid grows towards the margin of the colony ..... *Plagioecia* (p. 330)
— Zooids with irregular projections at the orifice, often with several fine spines; zooids arranged in series, radiating from the centre of the colony; gonozooids, if present, are central ..... *Lichenopora* (p. 330)

DESCRIPTION OF COMMON SPECIES OF CYCLOSTOMATA

Crisia acropora (Busk) Fig. 9.2a, b

Colonies of cream colour, up to 30 mm diameter, consisting of some tens of branches. Branches composed of internodes about 2 mm long, connected by black flexible tubular nodes. Internode skeletons well-calcified, consisting of nine to thirteen zooids in two rows, opening on frontal surface. Frontal and basal surface contain numerous pseudopores. Zooid orifices circular to slightly elliptical; a short spike usually seen at the outer edge of the orifice. Secondary branches usually arise from between first and third zooids of internode. Rhizozooids (rootlets) may grow from proximal end of basal wall of internode. Gonozooids form bulbous chambers rising from frontal wall; gonozooid surface also pitted with pseudopores.

This is a common shallow-water species, often found attached to algal holdfasts. *Crisia setosa* is less common, and may be identified by the presence of an articulated hollow spine near the distal margin of the orifice.

Idmidronea australis (MacGillivray) Fig. 9.2c

Colonies rigid, erect, up to about 30 mm in diameter, with several branches. Segments of branches between bifurcations about 3 mm long. Branches roughly triangular in cross-section; basal surface marked by grooves. Zooid tubes open on frontal surface, arranged in series of four to six zooids; the inner zooids more prominent than outer zooids of each series. Tubes do not project far beyond the lateral margin of branch.

This species is recorded from Victorian waters; its distribution is not known.

Nevianipora interjuncta (MacGillivray) Fig. 9.2d

Colonies erect, rigid, up to 40 mm in diameter, with many branches in mature colonies. Basal surface of branches marked by longitudinal grooves and by transverse growth ridges; numerous pseudopores present. Zooid tubes open on frontal surface, united into series of about four zooids; outer zooids more prominent than inner zooids in each series, and extend well beyond the lateral margin of the branch. Zooid orifices subcircular or elliptical. Narrow subordinate branches of a few zooid tubes arise from the basal surface. Gonozooids have not been described from available material.

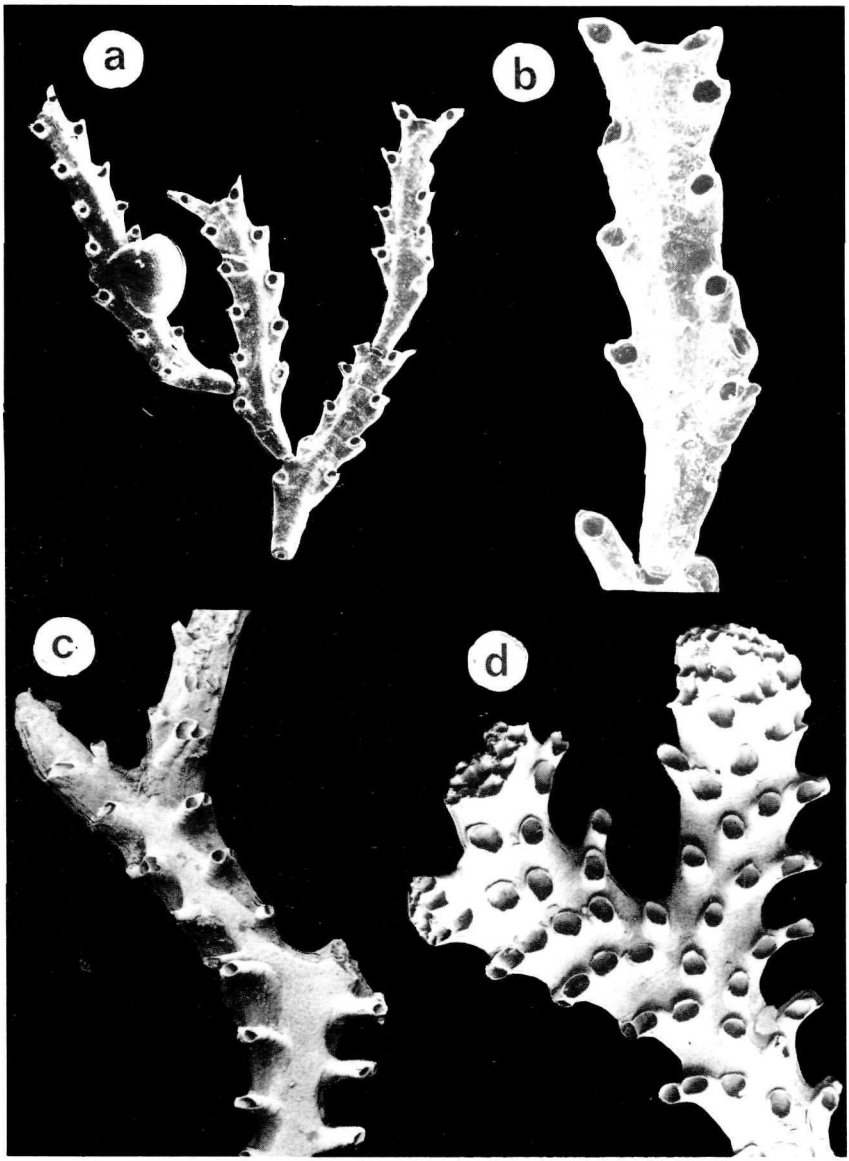


Fig. 9.2 *(a), (b) Crisia acropora: (a)* four internodes, one with gonozooid (23x); *(b)* single internode (48x); *(c) Idmidronea australis:* part of branch, with gonozooid (32x); *(d) Nevianipora interjuncta* (40x).

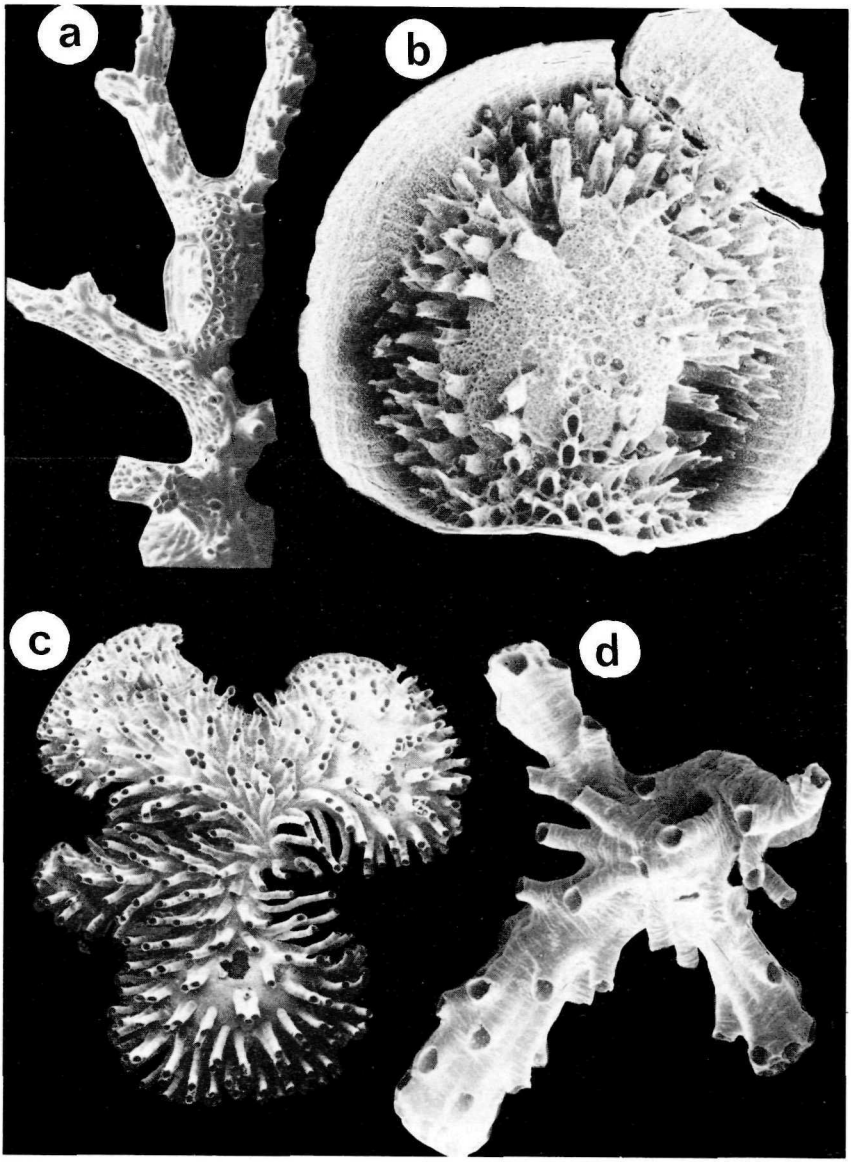


Fig. 9.3 *(a) Mesonea radians:* part of colony, with gonozooid (16x); *(b) Lichenopora echinata* (24x); *(c) Tubulipora pulchra* (11x); *(d) Diaperoecia australis:* small colony (13x).

Mesonea radians (Lamarck) Fig. 9.3a

Rigid, erect, branching colonies attached to substrate by small disc. Colonies fan-shaped, with larger colonies spreading to form an inverted cone, with numerous branches radiating from base. Colonies purple to white, with purple colouration unevenly distributed. Basal surface of branches ornamented with longitudinal grooves, in which are elongate pseudopores. Frontal surface rises to a central ridge consisting of rows of zooid tubes in series of one to four zooids. Series alternate to left and right margins of branch. Inner zooid of each series produced into a tube, rising above the frontal surface, often obscuring less prominent openings of outer zooids. Frontal surface with numerous large pseudopores except on the surface of the central ridge. Gonozooids large, enclosing about four series of zooids on each side of branch; distal extremity of gonozooid located at a bifurcation. Gonozooids ornamented on frontal surface with meandering longitudinal ridges, with intervening large pseudopores. Lateral surface of gonozooids smooth, with numerous fine pseudopores. Ooeciostome a crescentic opening proximal to one of the zooid series.

This species is widely distributed in Australian and New Zealand waters.

Tubulipora pulchra (MacGillivray) Fig. 9.3c

Colonies flat, fan-shaped or of many lobes, about 5 to 10 mm in diameter, encrusting shells or algae. Zooid tubes radiate from ancestrula, horizontal at first, then separating from adjacent zooids and rising as delicate tubes with circular orifices. Pseudopores distributed over zooid surfaces, except at distal extremities. Gonozooids form bulbous chambers surrounding lower parts of several zooid tubes in a lobe. Ooeciostome circular, at the termination of a small erect tube, usually proximal to one of the zooid tubes.

The features which have been used to separate various species of tubuliporids are not diagnostic, and so the group needs revision.

Diaperoecia australis (Busk) Fig. 9.3d

Colonies about 5 to 10 mm in diameter, of from two to six branches about 1.5 mm in diameter. Colour, pale brown. Zooid tubes open radially around branch, so that frontal walls only are visible. Distal part of zooid forms a projecting tube separated from neighbouring zooids. Frontal wall perforated by numerous fine pseudopores. Gonozooids covered by frontal wall which surrounds several zooid tubes. Ooeciostome elliptical, with an expanded flange, at the end of a small raised tube adjacent to a zooid.

The colonies are usually found partly encircling stems of hydroid colonies or flexible bryozoan colonies.

This species is fairly common in Bass Strait, but has not been recorded by many authors since the original description. It was originally described as *Pustulopora australis*; the reference to *Diaperoecia* in this account is tentative only.

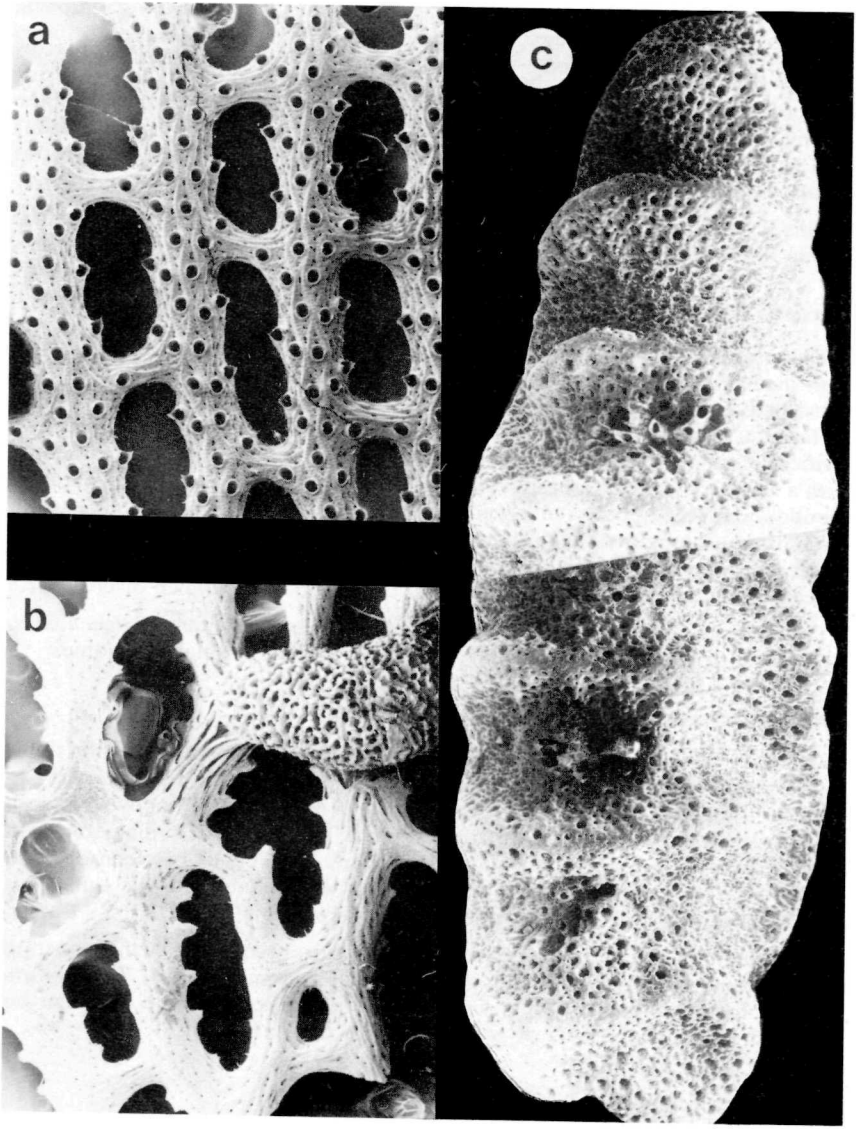


Fig. 9.4 *(a), (b) Hornera foliacea: (a)* frontal surface of part of colony (25x); *(b)* basal surface, with gonozooid (25x); *(c) Densipora corrugata* (16x).

Plagioecia sarniensis (Norman) Fig. 9.5a

Colonies discoid, up to 15 mm diameter, encrusting shells. Zooids grow radially from the ancestrula, becoming separate from each other distally, rising as tubes above the colony surface. Orifice circular, except near the centre of the colony, where some are constricted by a flat plate, with a fine central tube rising to a small secondary orifice. Gonozooids located towards colony margin, as inflations of frontal wall; elongated circumferentially.

This is a cosmopolitan species, which has been placed in several genera since it was first described.

Hornera foliacea (MacGillivray) Fig. 9.4a, b, Plate 23.5

Colonies large and spectacular, formed of numerous delicate fenestrate lace-like sheets, spreading and branching from a cemented base. Each sheet is constructed of a large number of radiating branches; zooids open on the frontal surface. Crossbars connecting adjacent branches with few zooid orifices. Orifices elliptical to circular, surrounded by a short collar, possibly ornamented with a short spine. Spines best developed at lateral margin of branches. Frontal pseudopores large, between zooid orifices; basal pseudopores small, set in discontinuous longitudinal grooves. Gonozooids bulbous chambers on basal surface, extending along a crossbar between two or three branches. Ooeciostome opens laterally, usually obscured by part of branch or crossbar.

Other local species include *H. robusta* and the cosmopolitan *H. lichenoides*. Both these species lack connecting crossbars, and form smaller colonies.

Densipora corrugata (MacGillivray) Fig. 9.4c

Colonies up to 25 mm long and 12 mm in diameter, fusiform, encircling stems of the seagrass *Amphibolis*. Surface raised into regular sharp ridges tending to encircle the colony, but possibly terminating or bifurcating. Hollows between the ridges gently rounded. Zooid orifices round, about 0.1 mm in diameter, with small marginal spines. Numerous smaller openings (alveoli) between orifices. Gonozooids covered by a smooth frontal wall punctured by numerous pseudopores, opening through a large ooeciostome.

This common shallow-water form is almost entirely confined to the substrate of the stems of *Amphibolis antarctica*. A cheilostome species, *Celleporaria cristata*, forms colonies with a similar general shape, and the two can be confused unless the details of zooid structure are examined.

Lichenopora echinata (MacGillivray) Fig. 9.3b

Colonies discoid, about 3 to 5 mm in diameter, cemented by basal surface to shell or algal substrate. Basal layer extends to colony margin, may be flat and adherent, or concave with raised lip. Zooid tube usually terminates inside margin. Centre of colony dome-shaped, with short vertical zooid tubes and

alveoli. Zooids may join in series radiating from the central area. Orifices subcircular, with numerous fine spines. Gonozooid covered by dome-shaped frontal wall with fine pseudopores; ooeciostome near margin.

The lichenoporids need thorough revision; this form is common and fairly consistent in its characters, but may be synonymous with *L. fimbriata* (Busk).

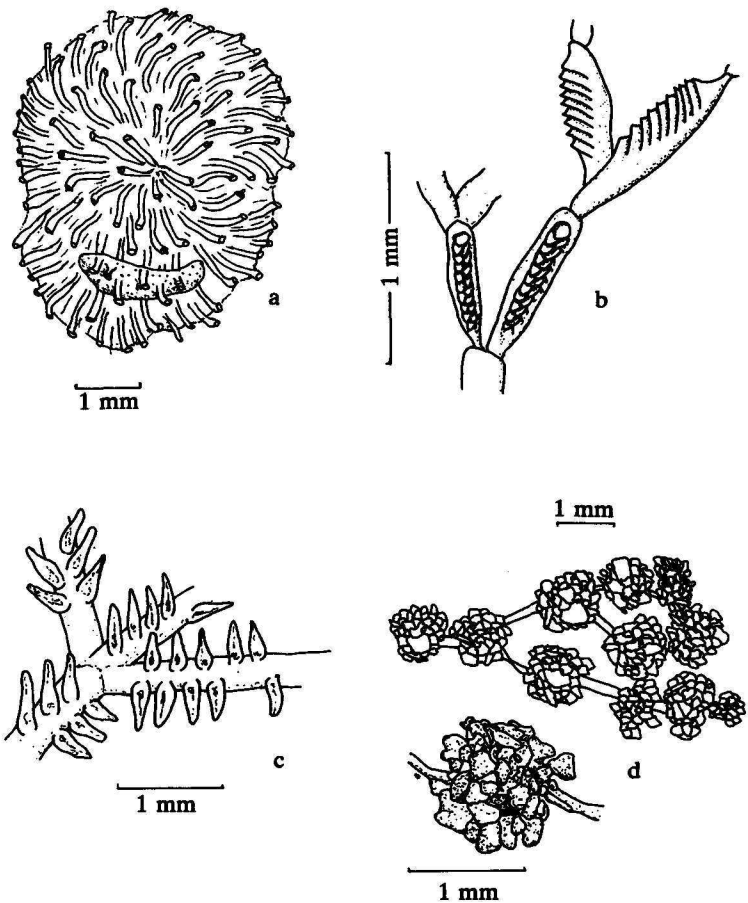


Fig. 9.5 *(a) Plagioecia sarniensis:* colony with gonozooid; *(b) Amathia biseriata; (c) Zoobotryon verticillatum; (d) Cryptopolyzoon wilsoni.*

Class GYMNOLAEMATA

Zooids tubular or flattened; body wall calcified, uncalcified, or partially calcified. The lophophore is pushed out by hydrostatic pressure as muscles deform the external body wall, or by enlarging an internal invagination of the body wall (ascus).

Order CTENOSTOMATA

Zooid body wall uncalcified, with a soft outer cuticle. Zooid orifice closed by a contractile collar. Communication between zooids by a funicular system, which passes through a communication plate by means of a pore plugged with special cells (rosettes). In many genera, zooids bud from a stolon or series of stolons. Brooding of larvae is internal.

Key to Genera of Ctenostomata

1. Colony composed of a number of nodules, covered with an armour of organically cemented sand grains ..... *Cryptopolyzoon* (p. 332)
— Colony organic-walled, bushy 2
2. Zooids separated from each other, with nearly transparent, very soft body walls ..... *Zoobotryon* (p. 333)
— Zooids joined to neighbours in a group, usually forming two rows; zooid walls brown, comparatively rigid ..... *Amathia* (p. 333)

Three genera in addition to those above should be noted as present in the region: *Bowerbankia, Terebripora* (?), and *Alcyonidium*. The former two have apparently not been recorded before. Species of *Bowerbankia* are reported to be found among the fouling fauna, therefore they may have been introduced by shipping. *Terebripora*(?) species are found inhabiting minute bores in shells such as *Neotrigonia*. They have apparently been overlooked in bryozoan studies, and need further work. *Alcyonidium* species forms gelatinous mats encrusting rocks and shells: the colonies are also inconspicuous, and are probably more widely distributed than the present single record would suggest.

DESCRIPTION OF COMMON SPECIES OF CTENOSTOMATA

Cryptopolyzoon wilsoni (Dendy) Fig. 9.5d

Colonies consist of a branching mass of subspherical nodules of aggregated sand grains, about 2 mm in diameter, connected by transparent tube about 1 mm long. Colonies range up to 50 mm in diameter. Individual zooids protrude tentacles from between sand grains, but are inconspicuous.

This unusual bryozoan can easily be overlooked as part of the fauna. The colonies are attached to algae, rocks, or to other bryozoans. The species is widely distributed in water depths up to about 20 m. *C. concretum* is similar, with larger, less regular sand aggregations. The individual sand aggregations of

both species were called 'nodes' aptly in the original description, but they correspond to 'internodes' in modern conventional terminology for bryozoans.

Zoobotryon verticillatum (della Chiaje) Fig. 9.5c

Colonies form large, bushy, branching networks, with branches up to 500 mm long. Numerous branches rise from the main stem, bearing ovoid or subcylindrical zooids arranged in two series along the branch, but not joined to each other. Zooids about 0.5 to 1 mm long, soft-walled, transparent.

This is a cosmopolitan fouling species of warmer waters. It has not been recorded from Victoria, but has been found at Adelaide, S.A. This species is found attached to boats, structures, and cooling-water intake pipes. The colonies are deciduous; the branches fall off during winter, with new branches regenerating from the basal section during the following spring.

Amathia biseriata Krauss Fig. 9.5b, Plate 23.6

Colonies flexible, bushy, up to 100 mm in diameter, light brown colour. Branches bifurcate regularly, with internodes about 2 to 3 mm long. Internode consists of a basal stolon and a group of zooids rising from it in a double series, with about 4 to 9 pairs of zooids. Zooids about 1 to 1.5 mm long; length decreases distally in each internode. The zooid group occupies the entire length of the internode, or a small proximal section of the internode may lack zooids.

Colonies of *Amathia* may be a substrate for a variety of other bryozoans and hydroids. Crustose coralline algae may cover the surface, giving the colony a pink colour. *Amathia biseriata* is often found in exposed shallow water, where current velocities are high. About 14 species of *Amathia* have been recorded from the region; these may be distinguished by branching pattern, length of internodes, number of zooids per internode, and the spiral pattern of growth of zooids in some species.

Order CHEILOSTOMATA

Zooid body wall strongly or weakly calcified; a few species apparently uncalcified. Frontal wall is flat or inflated, containing an orifice which is closed by an operculum or membranous flap. Polymorphism of zooids is normal; specialised zooids include avicularia, vibracula, ovicells, spines and rhizozooids.

The Cheilostomata is the most diverse and abundant bryozoan group, containing the most spectacular species. Colony form is the most obvious feature, but this can vary within a single species in certain groups. Species identification is more reliably made using the following features: zooid shape, shape of the primary orifice and operculum, the manner of calcification of frontal walls, the presence of various types of pore in the frontal wall, the types of specialised heterozooids, and a variety of other features which may be significant within certain groups.

Zooids are usually described as 'box-shaped', but this term masks great variability. The basal wall is usually flat, but may be slightly convex. The lateral, distal, and proximal walls rise vertically from this, forming an outline which may be rectangular, rhombic, hexagonal, oval, or variants with curved walls. The margin between the vertical walls and the frontal wall is usually well-defined, but in some groups the vertical walls curve over to become the frontal wall. The frontal wall may be composed of cuticle or membrane, or may be partially or nearly completely reinforced by calcification. In some forms the frontal wall is membranous and is shielded by a frontal shield or by several overarching spines. Almost without exception, the skeletal frontal wall has a covering of organic cuticle: this may be transparent or variously coloured in living bryozoans.

Eversion of the tentacles is effected by the action of parietal muscles, pulling down the frontal membrane, and increasing the internal pressure of the zooid; or by the muscular expansion of an internal sac, the ascus, which opens to the external environment through a pore in the frontal wall or near the operculum. The presence or absence of an ascus has generally been used to separate two major suborders, Anasca and Ascophora, but the validity of this classification is in doubt. It is probably better to use the words 'anascan' and 'ascophoran' as descriptive terms to indicate grades of organisation. The two suborders are used in this account for convenience, as the suprageneric classification of cheilostomes remains undecided.

In anascans, the uncalcified part of the frontal wall is called the frontal area. This is surrounded by a calcified frontal wall called the gymnocyst. The frontal area may be partly occluded by a calcareous cryptocyst, which develops below the frontal membrane. The opening remaining inside the margins of gymnocyst and cryptocyst is called the opesia (opesium in some references).

Polymorphism of zooids is a major feature of cheilostomes. Avicularia are common among heterozooids: these are zooids in which the operculum is modified into a mandible which can be snapped shut by adductor muscles. Avicularia carry out protective functions, presumably against predators or

settlement by larvae of various organisms. Size, shape, and location of avicularia vary considerably, with some species developing three or more distinct types. Adventitious avicularia are found as small individuals on the surface of a zooid; vicarious avicularia are about the same size as an autozooid, and replace one in the growth pattern; interzooidal avicularia are smaller than the autozooids, and grow between neighbouring zooids. Vibracula are heterozooids with a whip-like seta, which is also a modified operculum. The setae apparently help dislodge foreign particles; they also have a locomotory function in *Selenaria maculata*. Kenozooids are rudimentary zooids, lacking opercula or lophophores; they include several types of spine, anchoring rootlets or rhizoids, and connecting chambers.

Reproductive behaviour varies considerably within the group. Colony growth is by budding, a form of asexual reproduction. Many zooids contain both male and female sex organs; but in some species male and female zooids are differentiated. Biochemical techniques have established that cross-fertilisation between colonies is important, at least in some species. In species which are believed to be more primitive (as in the genera *Membranipora* and *Electra*), the fertilised ova are released at an early stage, and develop externally as bivalved feeding larvae ('cyphonautes'). In other forms, brooding of larvae takes place in a membranous ovisac, or in specialised brood chambers. The ovisacs may be external (as in *Aetea*) or internal (as in *Cryptosula*). The brood chambers, called ovicells, develop on the distal side of the maternal zooids, but several neighbouring zooids may contribute to their construction. The external parts of a zooid may be independent, that is, not attached to the distal zooid, or dependent. Dependent ovicells may be prominent, rising above the frontal surface of the distal zooid, or they may be immersed, or subimmersed in the general structure of the colony. Ovicells may be closed by a flexible inner vesicle, or by an operculum. In some species, the operculum of the maternal zooid closes both the orifice and the ovicell. A few species of cheilostome develop modified zooids for internal brooding of larvae, as in the genus *Adeonellopsis*. These specialised zooids may also be termed gonozooids, as in the Cyclostomata. A thorough treatment of polymorphism in bryozoans may be found in the chapter by Silen, in Woolacott and Zimmer (1977).

Key to the Genera of Cheilostomata

1. Frontal wall of zooid at least partly composed of membrane; operculum not clearly differentiated from frontal membrane along its proximal margin; ascus not present ..... (anascans) 2
— Frontal wall strongly calcified, with a separate cuticular operculum, usually pivoting along an axis which is distal from its proximal margin, ascus present, discharging through an ascopore or close to the proximal lip of the operculum. The features of the orifice and ascus are often obscured by secondary calcification ..... (ascophorans) 29
2. Colony unattached to the substrate, cap-shaped 3
— Colony attached to the substrate 4

3. Frontal surface with large area of cryptocyst; avicularia vicarious, covered by porous frontal wall ..... *Selenaria* (p. 347)
— Frontal surface mainly membranous, with marginal gymnocyst; avicularia narrower than zooids, confined to series radiating from centre of colony, alternating with zooid series ..... *Lunulites* (p. 347)
4. Colony creeping, or mainly adherent to substrate 5
— Colony rising above substrate as erect branches or layers 15
5. Zooids spreading irregularly, connected by a stolon system 6
— Zooids in contact or in close proximity with neighbouring zooids 7
6. Zooids composed of an adherent, elongate or bulbous chamber, from which rises an erect portion, terminating in a spoon-shaped part, with a flat frontal membrane ..... *Aetea* (p. 341)
— Colony composed of a series of horn-shaped zooids, joined by short tubes; oval frontal membrane; short erect branches may bud from the proximal end of the frontal membrane ..... *Scruparia* (p. 341)
7. Zooids not in close contact with neighbours; zooid wall essentially uncalcified ..... *Beania* (p. 353)
— Zooids in close contact with neighbours; at least the vertical walls are partially calcified 8
8. Several pairs of spines grow from margin of frontal membrane 9
— Spines, if present, restricted to two small spines at distal end of frontal membrane 11
9. Spines simple, not jointed, generally poorly calcified 10
— Spines calcified, joined to frontal wall by a flexible joint .. *Chaperia* (p. 346)
10. Gymnocyst extensive, oval frontal membrane. Usually a well-developed unpaired proximal spine which is flexible; ovicells absent . *Electra* (p. 343)
— Gymnocyst poorly developed; extensive oval frontal membrane which is protected by overarching spines. One or two pairs of large distal spines. Bulbous ovicells may be present ..... *Crassimarginatella* (p. 346)
11. Cryptocyst essentially absent 12
— Cryptocyst extensive 13
12. Colonies adherent to *Macrocystis* fronds, frontal surface uncalcified, vertical walls partially calcified, with breaks in calcification which allow flexibility ..... *Membranipora* (p. 341)
— Frontal wall with extensive calcified gymnocyst which is highly convex. Usually growing on stems of *Amphibolis*. ..... *Pyripora* (p. 343)
13. Frontal area with two zones: a distal part which is subcircular (orifice), merging with a proximal part which is wider than long; the area consequently has a trifoliate appearance. Gymnocyst extensive, but may be occluded by dependent subimmersed ovicell .... *Amphiblestrum* (p. 346)
— Frontal area roughly semicircular; gymnocyst poorly developed. Cryptocyst perforated by two pores for passage of parietal muscles 14

14. Cryptocyst flat; articulated spine on each side of frontal area (orifice); ovicells subimmersed; small interzooecial avicularia with triangular mandibles ..... *Micropora* (p. 346)
— Cryptocyst undulating; a grooved boss on each side of the orifice; no ovicells; large vicarious avicularia with triangular mandibles ..... *Thairopora* (p. 349)
15. Colony erect, branching, flexible 16
— Colony composed of rigid, erect, bilaminar sheets 25
16. Colony composed of rigid, calcified internodes articulating at flexible joints 17
— Entire colony flexible due to weak calcification 26
17. Internodes with two or three autozooids only; colony forming a tangled network by growth of rhizoids ..... *Emma* (p. 357)
— Internodes made of more than three zooids 18
18. Internodes rod-shaped, circular in cross-section; zooids opening radially on surface of internode ..... *Cellaria* (p. 349)
— Zooids opening on frontal surface, facing one direction only 19
19. Internodes composed of two series of zooids side by side 21
— Internodes of many series of zooids, forming a wide branch 20
20. Marginal avicularia large; basal surface partly covered by long rhizoids extending proximally from each zooid; rhizoids uniting into bundles along internode margin ..... *Amastigia* (p. 355)
— Marginal avicularia small; marginal vibracula with long setae with fine barbs; basal surface covered by vibracular zooids; no rhizozooids; colony joints internal, obscure ..... *Caberea* (p. 355)
21. Adjacent branches connected by flexible cross-tubes; basal surface with short vibracula extending diagonally from margin of branch ..... *Canda* (p. 357)
— Adjacent branches not connected 22
22. Vibracula present 23
— Vibracula lacking 24
23. Vibracula with large diagonal chambers on basal surface of branch; setae long, with fine barbs, colony joints internal, obscure... *Caberea* (p. 355)
— Vibracula with small chambers at margins and bifurcations of branch; setae short, simple, and usually twisted spirally; joints between internodes are pairs of flexible tubes ..... *Scrupocellaria* (p. 353)
24. Colony of bifurcating branches; internodes with about five to nine zooids; connecting tubes between internodes short ..... *Tricellaria* (p. 359)
— Colony with a cluster of primary branches, attached to substrate by a stem of several long, intertwined rhizoids; secondary branches grow from proximal section of primary branches: many (over 20) zooids in each branch ..... *Rhabdozoum* (p. 357)

25. Operculum thickened, clearly differentiated from frontal membrane, filling about half of frontal area; extensive cryptocyst descending to basal wall from proximal margin; skeletal sheets about 3 mm thick ..... *Steginoporella* (p. 349)
— Operculum a thin flap, not clearly differentiated from frontal membrane; cryptocyst vestigial; skeletal sheets about 1 mm thick ..... *Membranipora* (p. 341)
26. Branches biserial 27
— Branches multiserial 28
27. Zooids trumpet-shaped, tapering proximally; opesia elliptical to subcircular, with a group of three to six long curved spines articulated from the distal margin ..... *Cornucopina* (p. 351)
— Zooids hemicylindrical, not tapering significantly; opesia elongate, roughly rectangular; no operculum differentiated; spines short, attached at distal angles of opesia ..... *Bugula* (p. 351)
28. Branches unilaminar, with the basal surface lacking zooids ..... *Bugularia* (p. 351)
— Branches bilaminar, with zooids opening on both surfaces *Spiralaria* (p. 343)
29. Erect colonies: growing up from substrate as branches or sheets to a greater extent than the base spreads over the substate 30
— Encrusting colonies: spreading over substrate as a single layer or a few superimposed layers, or with extensions raised into comparatively low mounds or lobes 49
30. Colony rigid; either cemented rigidly to substrate, or attached by a flexible stem, or by a series of rhizoids 31
— Colony flexible throughout its extent, by articulation at uncalcified nodes. 41
31. Colony cemented rigidly to substrate 32
— Colony attached to substrate by flexible stem or rhizoids 39
32. Colony of fenestrate, lace-like sheets, with zooids opening on one surface of each sheet only 33
— Colony of non-fenestrate branches or sheets, with zooids opening on both surfaces 36
33. Ovicell with single longitudinal slit or opening on frontal surface 34
— Ovicell with two small notches in the proximal margin of ovicell, or with a T or Y-shaped mark (stigma) on the surface of the ovicell 35
34. Ovicell with a wide longitudinal opening in the proximal margin; avicularia found both on frontal and basal surfaces ..... *Schizoretepora* (p. 381)
— Ovicell with a median longitudinal slit or mark, usually closed proximally; avicularia absent from basal surface ..... *Sertella* (p. 378)
35. Ovicell with two small notches in the proximal margin; colony a bright pink-purple colour, even in dead material ..... *Iodictyum* (p. 380)
— Ovicell with a T or Y-shaped mark on frontal surface; colony white or cream ..... *Triphyllozoon* (p. 381)
36. Colony composed of thick, vertical, multilaminar sheets . *Cigclisula* (p. 372)
— Colony of thin bilaminar sheets or lobes 37

37. Colony small (about 20 mm), composed of one or two rounded lobes about 5 m wide ..... *Porina* (p. 368)
— Colony extensive (up to 200 mm), composed of many branching sheets ... 38
38. Zooid frontal wall with an orifice, one or more avicularia and a depression with one or more stellate pores ..... *Adeonellopsis* (p. 363)
— Zooid frontal wall with an orifice, marginal pores, with rare adventitious avicularia ..... *Parasmittina* (p. 374)
39. Colony a flat, usually discoid sheet, without fenestrae, attached to substrate by a single uncalcified flexible stem ..... *Lanceopora* (p. 383)
— Colony sheets fenestrate, flat, curved, or branching; attached by many rootlets or by partially calcified stem 40
40. Colony curved; zooids opening on concave surface only; attached to substrate by many uncalcified rootlets ..... *Petralia* (p. 361)
— Colony a single flat sheet or many branching sheets; zooids opening on both surfaces; attached by partly calcified stem ..... *Adeona* (p. 361)
41. Internodes of more than three zooids; internodes roughly circular in cross-section; zooids opening radially on surface of internode ..... *Margaretta* (p. 378)
— Internodes of 1,2, or 3 zooids; zooids all face the same direction. 42
42. Frontal or lateral surface of skeleton with a pair of elongate depressions (vittae) proximal from the orifice. 43
— Frontal surface marked with several uncalcified windows, usually elliptical or teardrop-shaped. 44
43. Vittae on frontal surface. ..... *Vittaticella* (p. 391)
— Vittae on lateral walls ..... *Cornuticella* (p. 387)
44. Numerous small windows, with a ring of larger ones of the margin on the frontal wall ..... *Paracribricellina* (p. 388)
— Few windows, mainly confined to central part of frontal wall. 45
45. Windows comparatively small, with a group of radiating ribs (costae) in the centre of the frontal wall ..... *Costaticella* (p. 387)
— Windows comparatively large; costae lacking 46
46. Orifice keyhole-shaped, or with a pronounced sinus 47
— Orifice without sinus, or with an inconspicuous sinus 48
47. Orifice keyhole-shaped. ..... *Calpidium* (p. 385)
— Orifice with a pronounced sinus in the proximal lip .... *Claviporella* (p. 387)
48. Lateral chambers of internodes wide, flattened, and angular in cross-section ..... *Pterocella* (p. 388)
— Lateral chambers narrow, and rounded in cross-section ..... *Orthoscuticella* (p. 388)
49. Colony multilaminar, of many layers of zooids budding from frontal surfaces of earlier layers 50
— Colony generally unilaminar, with two or three layers of zooids in rare cases only. 52
50. Orifice with a straight or slightly curved proximal margin. *Celleporaria* (p. 365)
— Orifice with a sinus indentation in proximal margin 51

51. Ovicell with pores or slits in frontal skeletal wall ..... *Celleporina* (p. 385)
— Ovicell frontal wall without pores or slits ..... *Osthimosia* (p. 385)
52. Ascopore present in frontal wall 53
— Ascopore lacking 55
53. No avicularia in colony ..... *Fenestrulina* (p. 367)
— Avicularia present 54
54. Frontal wall perforate over entire surface ..... *Microporella* (p. 365)
— Frontal wall imperforate in centre, with marginal pores . *Calloporina* (p. 367)
55. Avicularia lacking 56
— Avicularia present 61
56. Frontal wall imperforate, thin, transparent ..... *Hippothoa* (p. 369)
— Frontal wall perforate 57
57. Deep, narrow sinus in proximal margin of orifice ..... *Arthropoma* (p. 372)
— Orifice without sinus 58
58. Broad central tooth (lyrule) in proximal margin of orifice ..... *Parasmittina* (p. 374)
— Proximal margin of orifice smoothly curved, without lyrule 59
59. Small tooth (condyle) on each side of orifice ..... *Watersipora* (p. 383)
— Condyles absent 60
60. Orifices elliptical, elongated transversely ..... *Cyclicopora* (p. 369)
— Orifice elongate longitudinally, broader in proximal part than distal part ... *Cryptosula* (p. 383)
61. A frontal shield, with a transversely elongate secondary orifice and several open pores, arches over the frontal membrane .... *Arachnopusia* (p. 360)
— Frontal shield lacking; frontal wall consists of skeletal wall and overlying cuticle and tissue 62
62. Frontal wall with two large windows proximal to the orifice, and several fairly large perforations with stellate teeth at their base ..... *Didymosella* (p. 374)
— Frontal wall without perforations, or with marginal perforations (areolae), or with uniformly fine perforations 63
63. Frontal wall with uniformly fine perforations 64
— Frontal wall with marginal perforations only, or without visible perforations 68
64. Proximal margin of orifice with sinus 65
— Proximal margin of orifice with broad central tooth (lyrule) 67
65. Avicularium central, proximal to orifice ..... *Schizomavella* (p. 372)
— Acicularium or avicularia lateral to orifice 66
66. Paired avicularia adjacent to orifice, on raised bosses, with triangular mandibles ..... *Gigantopora* (p. 372)
— Avicularium not paired, lateral but not close to orifice, with rounded or spatulate mandible ..... *Hippoporella* (p. 378)
67. Projection or several projections proximal to orifice; base of colony attached to substrate by numerous rootlets ..... *Mucropetraliella* (p. 361)
— Depression in peristome proximal to orifice; base of colony cemented to substrate ..... *Smittina* (p. 374)

68. Broad central tooth (lyrule) in proximal margin of orifice 69
— Lyrule absent; orifice broadly elliptical, but may be obscured by secondary calcification 71
69. Avicularium central, proximal to orifice 70
— Avicularium absent or irregularly placed on frontal wall ..... *Parasmittina* (p. 374)
70. Small tooth (condyle) on each side of orifice ..... *Smittoidea* (p. 377)
— Condyles absent ..... *Porella* (p. 377)
71. Paired lateral avicularia near mid-point of frontal wall; peristome with symmetrical proximal projection with three teeth, or with teeth coalescing to form two pores ..... *Exochella* (p. 360)
— Avicularia placed irregularly on frontal; peristomes with internal anvil-shaped projection proximal to orifice ..... *Rhynchozoon* (p. 380)

DESCRIPTION OF COMMON SPECIES OF CHEILOSTOMATA

Aetea anguina (Linnaeus) Fig. 9.6d-f

Colony spreading over surfaces as series of tubular chambers, with zooid tubes rising vertically, each terminating in spoon-shaped distal chamber with oval, frontal membrane. Tubular part usually bends near junction with distal chamber, so that frontal membrane faces towards substrate. Tubular part marked by rings, distal chamber with finely pitted surface. Erect zooids about 0.6 to 0.8 mm long.

This species is cosmopolitan in distribution, and is usually found creeping over the surface of algae, rocks, or shells. *Aetea dilatata* has a distal chamber which expands rapidly at its junction with the tubular part. *Aetea* species are common, but inconspicuous, members of the fouling fauna.

Scruparia ambigua (d'Orbigny) Fig. 9.6c

Colony forms chains of single zooids, creeping over substrate, or with short erect sections. Zooids elongate, with uncalcified basal wall, oval frontal membrane with opercular flap; tubular connections to other zooids at proximal and distal ends, and buds developing from the proximal margin of frontal membrane. Brood chambers rare: forming a bivalved globular structure distal to a zooid.

This is a cosmopolitan species that is also a minor component of the fouling fauna. Colonies are found encrusting algae, hydroids, other bryozoans, rocks, or shells in water from shallow subtidal down to 50 m or greater.

Membranipora membranacea (Linnaeus) Fig. 9.6a, Plate 25.1

Colonies form thin, extensive, flexible layers; frontal and basal surfaces uncalcified; lateral walls of two layers of calcareous material with an intervening

organic membrane; terminal walls of single-layered calcareous material. Calcification in lateral walls is discontinuous, allowing flexibility of colony. Zooids rectangular, arranged in longitudinal rows, with terminal walls alternating in position in adjacent rows. At each distal corner the wall is raised into low rounded tubercles, formed by kenozooids. Avicularia and ovicells not present. 'Tower zooids' may form from evagination of frontal membrane at some stages of development.

This species is most often seen on the fronds of the kelp *Macrocystis* sp.. Distribution is cosmopolitan; in other regions colonies are found on other kelps or laminarians.

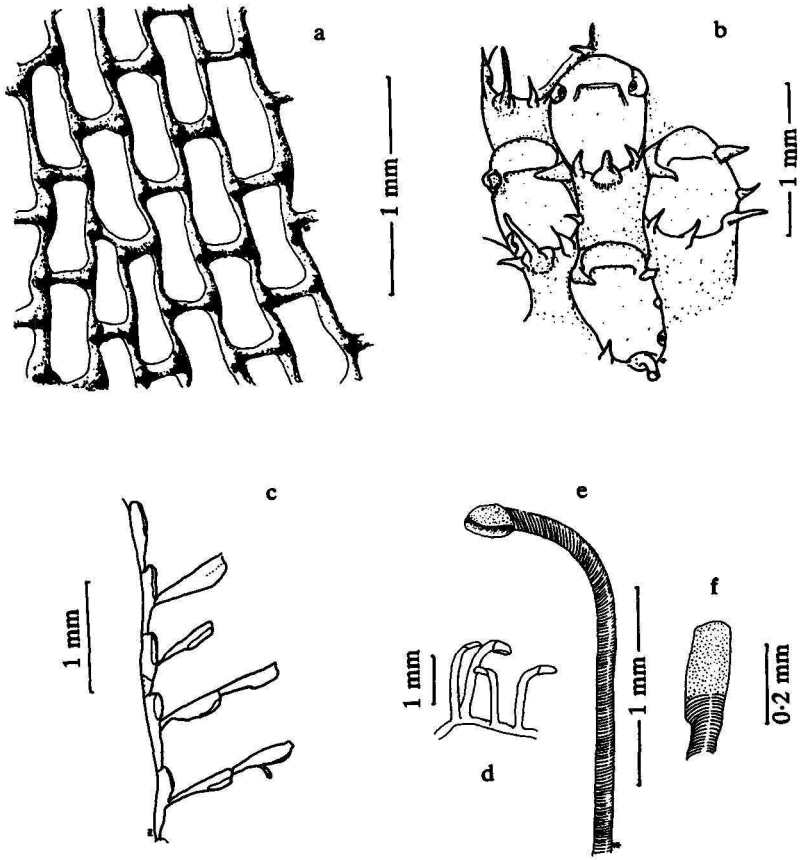


Fig. 9.6 *(a) Membranipora membranacea; (b) Electra pilosa; (c) Scruparia ambigua:* part of colony; *(d-f) Aetea anguina: (d)* part of colony; *(e)* single zooid; *(f)* detail of distal part of zooid.

Membranipora perfragilis (MacGillivray) Fig. 9.7a, Plates 25.2; 27.1

Colonies yellow-orange; of many branching, bilamellar thin sheets with zooids back to back; up to at least 150 mm diameter. Parts of colonies may be encrusting unilamellar. Zooids in longitudinal series, alternating in adjacent rows; lateral walls sinuous, terminal walls curved distally. Cryptocyst slightly developed in proximal part of zooid, leaving a large oval opesia, with an opercular flap at the distal extremity. Slight development of raised tubercles at distal angles of zooid. Vicarious avicularia present, often as one of the pair forming where one zooid row buds to produce two; mandible spatulate, occupying more than half frontal area; pivot structures absent. Ovicells absent. These fragile colonies are found in Victorian and South Australian waters, and have been recorded at Heard Island. Records from the North Pacific are of doubtful validity, as the species has been confused with *Membranipora savartii*.

Electra pilosa (Linnaeus) Fig. 9.6b

Colonies spreading over stems and fronds of algae, forming patches several centimetres in diameter. Zooids elongate, loosely joined to neighbours. Gymnocyst extensive proximally; thinly calcified, with finely porous markings. Up to twelve spines rise from margin of frontal area; proximal spine long and whip-like. Operculum a simple flap with thickened margin in distal part of frontal membrane. Ovicells and avicularia absent.

Overseas accounts of this cosmpolitan species record a wide variety of substrate types, but most local occurrences are on the stems and fronds of brown algae. *Electra pilosa* is a significant fouling species.

Pyripora polita (Hinks) Fig. 9.7c

Colonies unilaminar, encrusting, white, opaque. Zooids bulbous, loosely joined to neighbours, thickly calcified. Gymnocyst extensive, smooth, or raised in a few rounded protrusions. Frontal area elliptical, partly occluded by annular cryptocyst. Ovicells and avicularia absent.

This species is mainly found in shallow water, with the colonies wrapping around stems of the seagrass *Amphibolis antarctica*.

Spiralaria denticulata (Busk) Fig. 9.7d

Colonies erect, branching, up to 50 mm in diameter, of bilamellar flexible strips. Zooid features variable; zooids in longitudinal rows; gymnocyst poorly developed; frontal area rectangular, overarched by short spines from lateral margins. Large hollow spines may project upwards from the distal margin of the frontal area. Hinged operculum at distal end of frontal membrane. Avicularia occupy proximal part of a few zooids scattered over colony. Ovicells bulbous, projecting into the distal zooid (immersed).

This species appears to be common in Bass Strait.

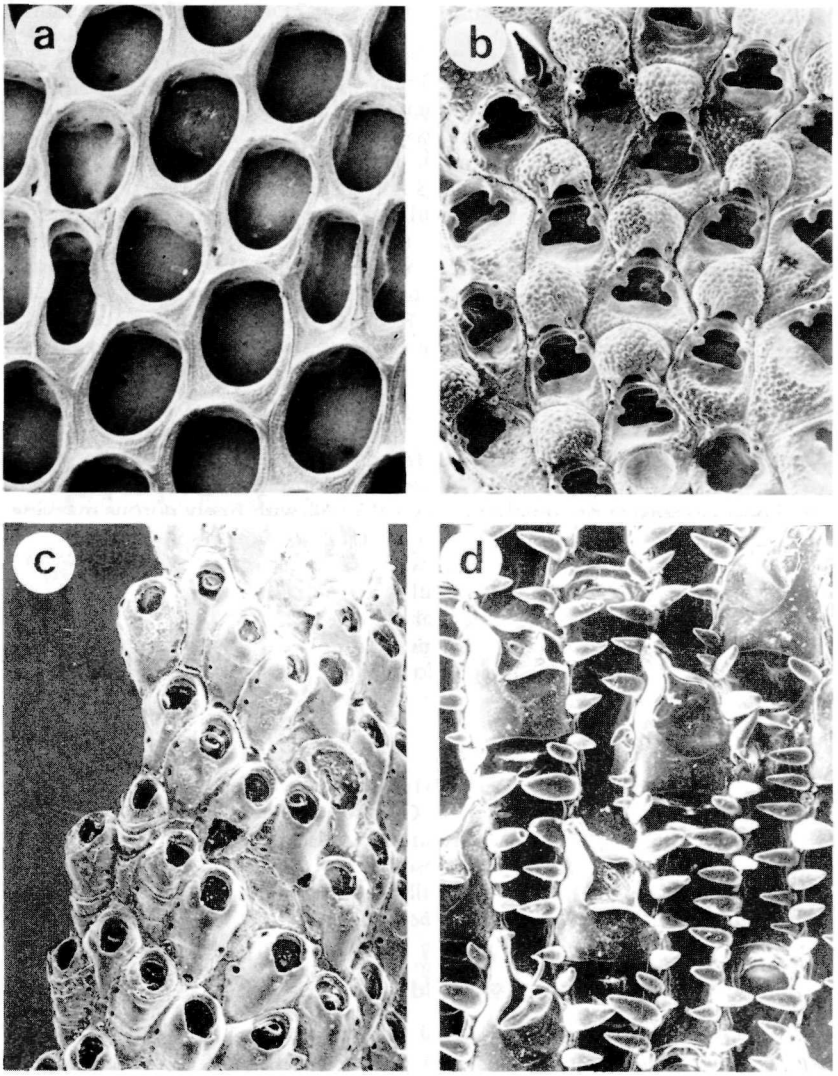


Fig. 9.7 *(a) Membranipora perfragilis:* part of colony with two avicularia (35x); *(b) Amphiblestrum propinquum:* with ovicells and one avicularium (45x); *(c) Pyripora polita* (28x); *(d) Spiralaria denticulata:* with ovicells and avicularia (54x).

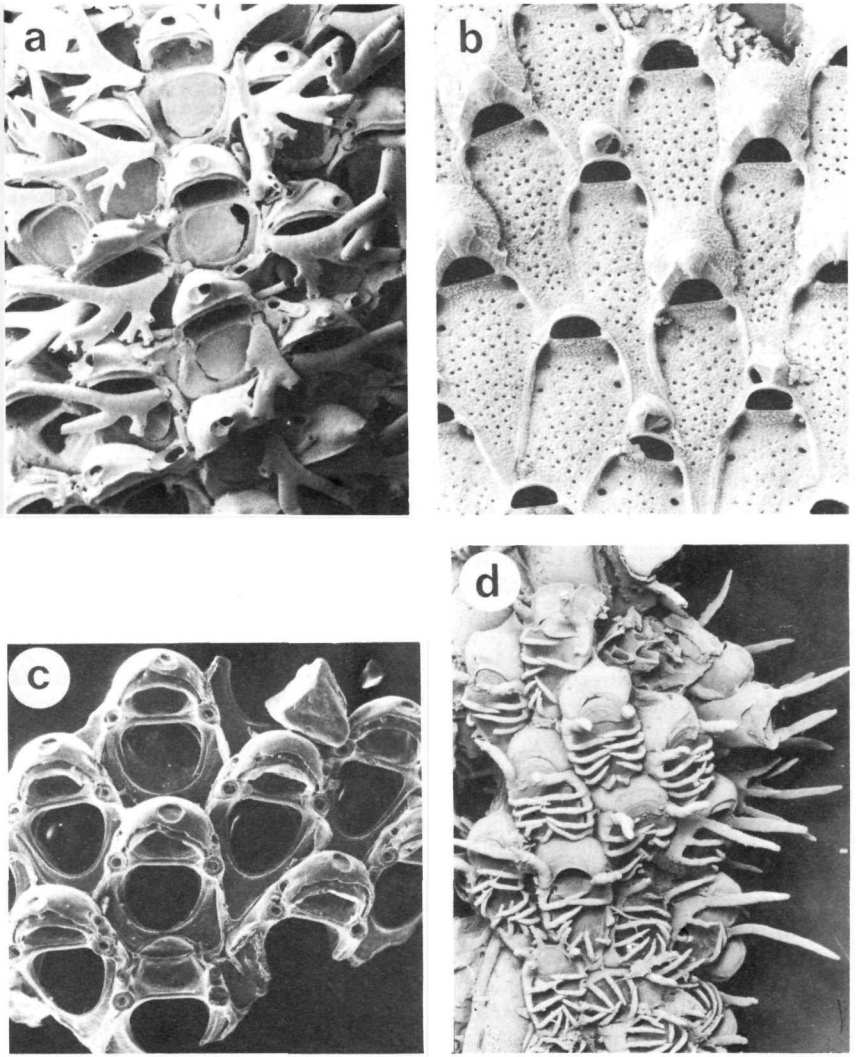


Fig. 9.8 *(a), (b) Chaperia cervicornis: (a)* showing spines and ovicells (21x); *(b)* after cleaning with hypochlorite (21x); *(c) Micropora coriacea:* with ovicells and avicularia (40x); *(d) Crassimarginatella corbula:* with ovicells (40x).

Amphiblestrum propinquum (Waters) Fig. 9.7b

Colony encrusting; zooids roughly hexagonal-elongate; proximal half of frontal a papillate gymnocyst; frontal area subcircular; shelf of cryptocyst surrounding an opesia with a short, wide proximal part, and an elliptical distal part, with lateral constrictions of cryptocyst where the two parts merge. One or two short, articulated spines at each distal angle. Avicularia interzooidal, elongate, with acute mandible. Ooecia bulbous, subimmersed, displacing most of gymnocyst of distal zooid, with papillate frontal wall.

This species usually encrusts shells. It has been confused with *Amphiblestrum trifolium,* which appears to be mainly a European species.

Crassimarginatella corbula (Hincks) Fig. 9.8d

Colony encrusting; zooids in longitudinal rows, loosely united to neighbouring rows; gymnocyst convex, smooth, tapering proximally; frontal area elliptical, bordered by several spines which arch over it; the distal pair or two pairs of spines are longer and wider, and are directed distally from articulations lateral to the orifice. Ooecia globular, subimmersed, with a smooth outer layer which is not calcified near the proximal margin. Avicularia absent.

This species forms small colonies wrapped around the stems of erect flexible bryozoans, such as catenicellids. It has been found in New Zealand and Japan, as well as in southern and eastern Australia. *Crassimarginatella papulifera* is quite different in general appearance, as it lacks spines, and has a rounded boss on the proximal gymnocyst; it usually encrusts solid objects, such as shells.

Chaperia cervicornis (Busk) Fig. 9.8a, b

Colony encrusting, up to 25 mm diameter, white. Zooids roughly elliptical; gymnocyst flat or concave, wide proximally and laterally; frontal area subrounded to triangular with rounded angles; distal margin straight in fertile zooids; raised lip around frontal area. Hollow branching spine like a stag-antler, articulated at each side of distal angle of frontal area; smaller simple spine located distal to each. Ooecium dependent, prominent, with a wide, semicircular opening; a small avicularium located on its crest. Small interzooidal avicularia may be found. Larvae pink.

This common species is found encrusting stems of algae such as *Sargassum,* and other objects such as shells and rocks. In living specimens the zooid features are difficult to distinguish because the prominent branched spines arch over the zooid, and often trap a variety of foreign material. When the colony skeleton is treated with hypochlorite, the spines are lost, and the appearance of the colony is quite different.

Micropora coriacea (Johnston) Fig. 9.8c

Colony encrusting. Zooids approximately rhomboid or subhexagonal, arranged quincuncially. Frontal wall with no clear gymnocyst, the cryptocyst

extending to the proximal margin, where it is nearly level with the colony surface. Cryptocyst finely perforate, with granular surface. A small opesiule on each side of the cryptocyst. Opesia small, semicircular, closed by operculum of the same size. Ooecia subimmersed, convex, smooth, or with a transverse ridge or apical umbo. The opening of the ovicell is closed by the zooidal operculum. Avicularia rare, interzooidal, proximal to a zooid, with a triangular mandible.

Colonies encrust solid objects such as shells. This is a cosmopolitan species, but shows variation in characters. The local form lacks the bosses on each side of the orifice which are seen in specimens from Europe, and may be a distinct subspecies or species.

Micropora stenostoma (Busk) Fig. 9.9a

Colony encrusting. Zooids approximately hexagonal or rectangular, arranged quincuncially. Gymnocyst lacking. Cryptocyst extensive, finely perforate, with lateral opesiules. Orifice semicircular, with a hollow spine articulate at each side. Ovicells subimmersed, bulbous, with granular surface. Interzooidal avicularium of moderate size proximal to zooid, with triangular mandible.

This species encrusts algae such as *Sargassum*. *Micropora perforata* (MacGillivray) is a synonym.

Selenaria maculata (Busk) Fig. 9.9c

Colony free, conical, with concave basal surface lacking zooids, up to 20 mm in diameter. Zooids in radiating rows, arranged quincuncially. Gymnocyst lacking. Cryptocyst extensive; opesia with lateral constrictions, and two small expansions proximally. Operculum semicircular, smaller than opesia. Vibracula vicarious, larger than zooids, distributed regularly over surface, with porous frontal, and long flexible seta.

This species is one of the few bryozoans tolerant of loose sandy substrates. Colonies have been observed to move about slowly by coordinated movement of the lateral vibracular setae. The species has been recorded from Queensland as well as Bass Strait; *Selenaria punctata* is also found in South Australian waters. The latter species has a semicircular opesia, and two small opesiules proximal to it.

Lunulites capulus (Busk) Fig. 9.9d

Colony free, dome-shaped, up to 30 mm in diameter and height. Zooids on frontal (convex) surface only; arranged in radiating rows, alternating with rows of vibracula. Zooids subrectangular, lacking gymnocyst, with narrow marginal cryptocyst, extending as a small projection from the proximal margin. Vibracula elongate, narrower than zooids, with semi-rigid setae ending in three small points.

This species is also found in areas of sandy substrate, including Gulf St. Vincent and Backstairs Passage, and has been recorded down to 35 m depth.

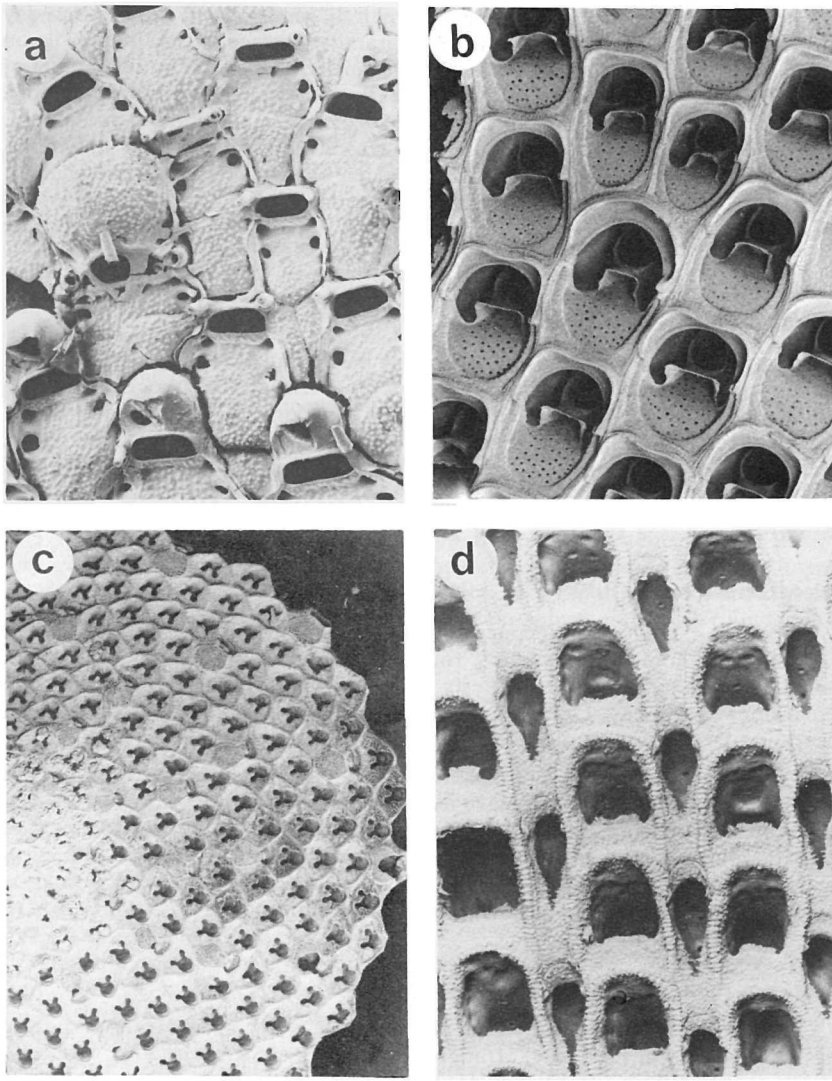


Fig. 9.9 *(a) Micropora stenostoma:* with one ovicell, and avicularia (40x); *(b) Steginoporella truncata:* with one 'B-zooid' (25x); *(c) Selenaria maculata:* part of colony, with avicularia (12x); *(d) Lunulites capulus:* with rows of avicularia (25x).

Steginoporella truncata (Harmer) Fig. 9.9b, Plate 27.2

Colonies of complexly branching bilaminar sheets, up to 500 mm or more in diameter; or encrusting and unilaminar. Zooids up to 1 mm long, rectangular, arranged in longitudinal rows. Gymnocyst lacking. Frontal membrane extends over proximal half of zooid; a thickened operculum, clearly differentiated from frontal membrane, covers distal half of zooid. Two types of zooids are found: 'A-zooids' are more numerous, smaller, with a quadrate operculum having a trapezoidal reinforcing wall internally; 'B-zooids' with a large semicircular operculum having a triangular, thickened zone extending to the distal margin, and about twenty teeth on the distal margin. Cryptocyst complex, descending from proximal and lateral walls and joining the distal wall close to the basal wall. Cryptocyst folded centrally around a tube entering the lower part of the zooid. Ovicells and normal avicularia not present.

The large colonies of this species develop in exposed locations on vertical walls or under overhangs. This species has been confused with *Steginoporella magnilabris*, which has not been positively recorded from southern Australia.

Thairopora cincta (Hutton) Fig. 9.11a

Colony encrusting, purple or brown in colour. Zooids in longitudinal rows, rectangular, with rows bifurcating rarely. Gymnocyst as two small curved projections from sides of zooid. Cryptocyst extensive, undulating, deepest beside gymnocyst projections, where it may be imperfectly developed. Opesia with semicircular distal and arcuate proximal margins. A radially grooved boss or short spine present on each side of opesia; each boss is located just distal or proximal to the corresponding boss in the adjacent zooid. Avicularia interzooidal, with triangular mandible directed distally. Ovicells absent.

This species is found as colonies encircling stems of algae or the seagrass *Amphibolis*; the rows of zooids are arranged circumferentially. It is widely distributed from S.A. to N.S.W. Several other species of this genus are recorded from the region.

Cellaria pilosa (Kirchenpauer) Fig. 9.11b, Plate 26.1

Colony erect, branching, up to 50 mm high, composed of cylindrical internodes about 8 mm long, bifurcating at distal extremity of each internode. Connections between internodes short, flexible, tubular. Zooids in longitudinal rows, subhexagonal. Cryptocyst extensive, depressed. Opesia with semicircular distal margin, arcuate proximal margin projecting distally, with a pair of condyles. Numerous flexible uncalcified spines on colony, each derived from proximal part of a zooid. Avicularia vicarious, with a large semicircular mandible. Ovicells immersed endotoichal, with a lunate opening in the distal part of a zooid. Ovicells developed in a swollen part of an internode.

Colonies are cemented to the substrate by a system of several rhizoids which grow from zooids near the proximal part of an internode. The function of the

uncalcified spines is not known. The synonyms of this species include *Cellaria hirsuta* and *Cellaria setigera*. Other species of the genus in the region include *C. australis*, *C. rigida*, *C. tenuirostris*, and *C. squamosa*.

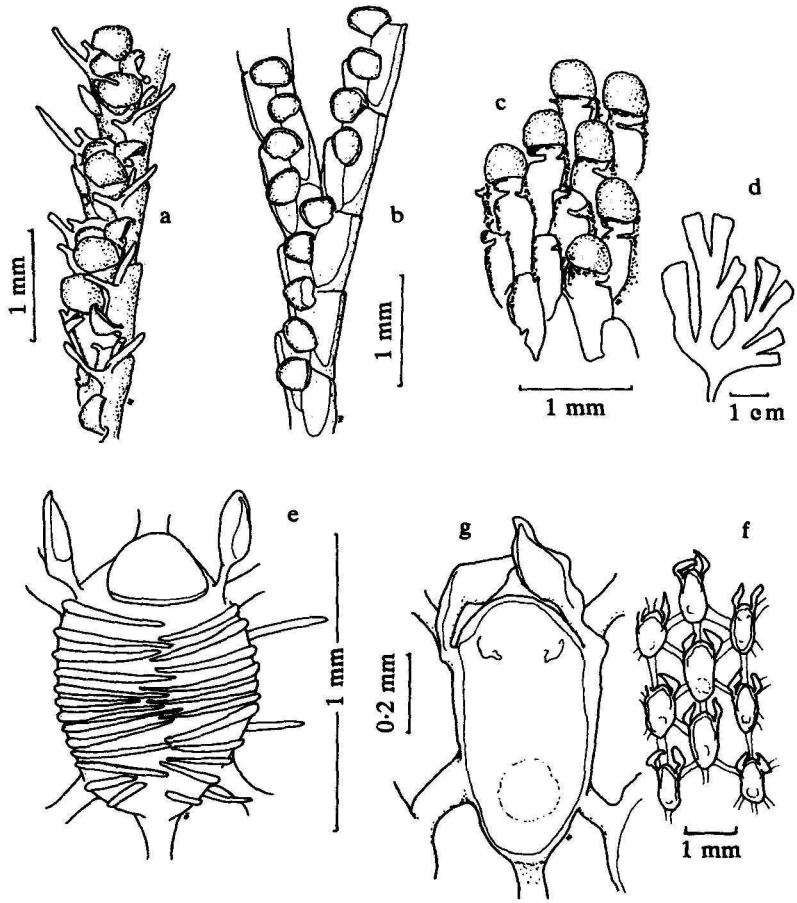


Fig. 9.10 *(a) Bugula dentata:* with ovicells; *(b) Bugula neritina:* with ovicells; *(c), (d) Bugularia dissimilis: (c)* detail, with ovicells; *(d)* part of colony; *(e) Beania discodermiae:* single zooid, with avicularia; *(f), (g) Beania magellanica: (f)* part of colony; *(g)* single zooid.

Bugula dentata (Lamouroux) Fig. 9.10a, Plate 28.1

Colony erect, flexible, bushy, up to 50 mm high, bluish-green. Branches biserial. Zooids subrectangular, with oval frontal membrane, narrowing proximally, occupying about two-thirds of frontal length. No operculum can be distinguished. Short hollow spines articulated at distal angles of frontal area: usually three on outer angle and one small spine (or none) on inner angle. A pedunculate avicularium, shaped like a bird's head, articulated about one-third of length of zooid up from proximal margin, on lateral wall. Ooecia rarely seen; hyperstomial, globular.

This is a widely distributed species found in shallow water, and is often seen on jetty pilings or on vertical rock surfaces.

Bugula neritina (Linnaeus) Fig. 9.10b

Colony erect, flexible, bushy, up to 80 cm high, purplish-brown. Branches biserial. *Zooids rectangular with slight narrowing proximally.* Frontal membrane occupying whole frontal surface; no operculum. Spines absent: the outer distal angle of zooid projecting slightly. Avicularia absent. Ooecia *globular, attached to inner distal angle, white, with concealed opening.*

This species is found worldwide in warm-water ports and harbours, and is a serious and common fouling organism.

Bugularia dissimilis (Busk) Fig. 9.10c, d, Plate 28.2

Colony erect, flexible, bushy, up to 100 cm high, composed of flat multiserial branches about 8 mm wide, orange-brown. Zooids in longitudinal rows, subrectangular, with small area of cryptocyst proximally. Frontal area elliptical, often with a short spine on each of the distal angles. Interzooidal avicularia at the proximal end of a zooid, with small triangular mandible. Ooecia prominent, smooth.

The extent of distribution of this species is incompletely known, but it is moderately common in water depths of about 10-20 m in Victorian and Tasmanian waters.

Cornucopina grandis (Busk) Fig. 9.12a, Plate 26.2

Colony erect, flexible, densely branching, up to 100 mm high, pink, composed of delicate biserial branches. Zooids trumpet-shaped, tapering proximally to a very fine tube, terminating distally in an elliptical frontal membrane facing obliquely distally and towards the midline of the branch. Operculum a flap in the distal margin of the frontal membrane. A group of two to five curved hollow spines rise from the distal end of the zooid; another spine attached near the middle of the inner margin of the zooid. Avicularia and ovicells not recorded.

This species occurs from depths of about 20-80 m.

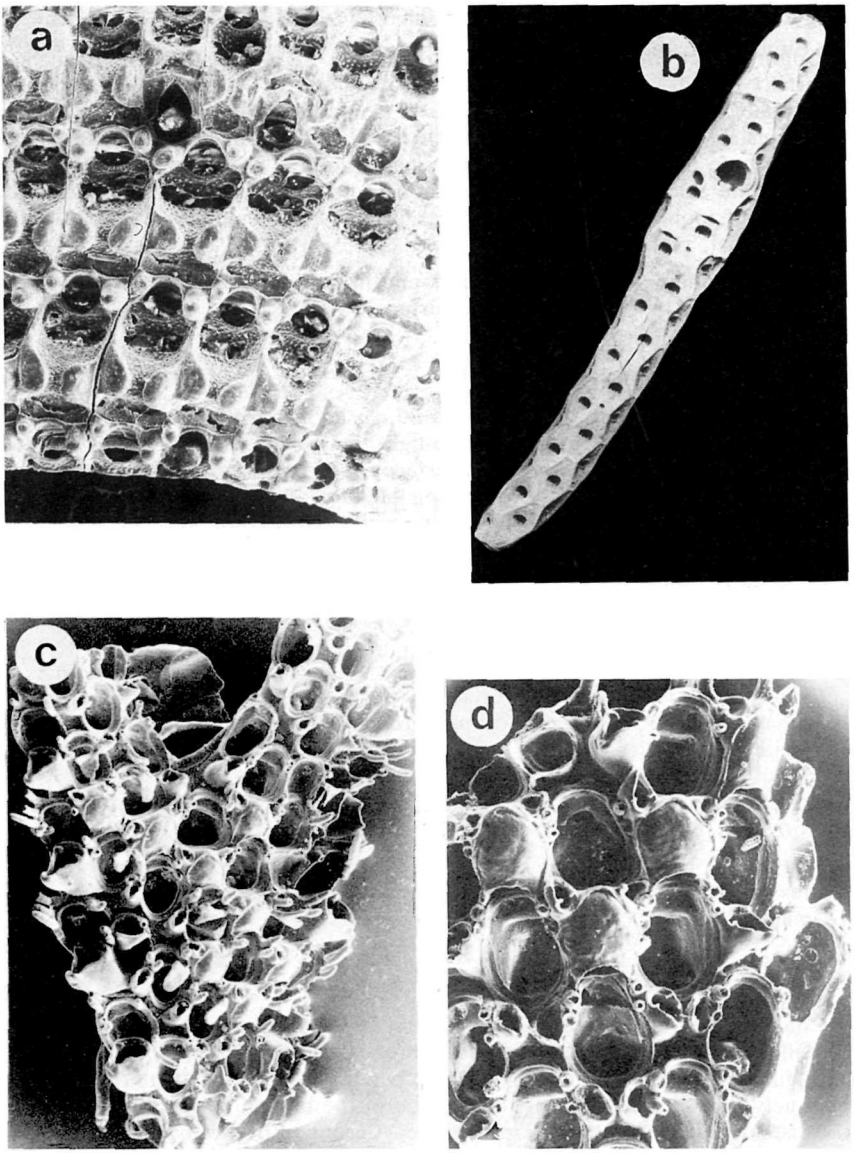


Fig. 9.11. *(a) Thairopora cincta* (26x); *(b) Cellaria pilosa:* single internode (12x); *(c), (d) Amastigia rudis; (c)* part of branch (24x); *(d)* detail showing ovicells (62x).

Beania discordermiae (Ortmann) Fig. 9.10e

Colony encrusting, loosely attached to substrate or partly free; soft-walled, pale brown. Zooids not in contact with each other, connected to the six neighbouring zooids by short connecting tubes. Basal surface smooth. Frontal surface entirely membrane, with a number of fine spines arching over it from both margins; about four to six spines at the distal margin. Orifice a flap in the distal part of frontal membrane. A pedunculate avicularium attached on each side of zooid, proximal to orifice. Ovicells absent.

This species has been recorded as *Beania costata* in records up to 1943. Like other species of *Beania*, it is inconspicuous, and may be mistaken for an alga or some foreign material.

Beania magellanica (Busk) Fig. 9.10f, g

Colony encrusting, loosely attached to substrate or partly free, soft-walled, brown. Zooids not in contact with each other, connected to the six neighbouring zooids by short connecting tubes. Basal surface smooth. Frontal surface entirely membrane; no spines. A pedunculate avicularium attached on each side of zooid, lateral to orifice. Ovicells absent.

This species is widely distributed in southern hemisphere waters.

Scrupocellaria bertholettii (Audouin) Fig. 9.12b

Colony erect, branching, bushy, of biserial internodes connected by flexible uncalcified sections of pairs of zooids, at bifurcations. About five to seven zooids in each internode. Zooids slightly tapering proximally, opesia elliptical, occupying about two-thirds of frontal surface. Spines at distal angles: usually three on outer angle and one or two on inner. A single, forked, rigid spine (scutum) arches over frontal area from inner margin. Vibracula present on basal surface; single vibraculum in axil of bifurcation. Small avicularia lateral to distal outer margin of zooids; globular adventitious avicularia close to midline of branch, with triangular mandible directed proximally. Ooecia subimmersed, with globular frontal surface with a few uncalcified windows on the ectooecium.

A cosmopolitan fouling species of warmer waters; recorded at Adelaide, S.A. by B. Brock. Found in harbour areas.

Scrupocellaria ornithorhynchus Wyville Thomson Fig. 9.12c

Colony erect, branching, flexible at bifurcations, up to 20 mm high, white, attached by rhizoids to substrate. Internodes biserial, with five to twelve zooids opening on frontal surface. Zooids subrectangular, with smooth, convex gymnocyst on proximal half of zooid. Opesia elliptical, shielded by elliptical scutum arching from inner margin of opesia. Two or three spines articulated from outer distal angle. Lateral avicularium projects outwards from outer

margin; small adventitious avicularium proximal to opesia. Vibraculum on outer margin, proximal to opesia; two vibracula in axil of bifurcation. Ovicells globular, with smooth frontal surface.

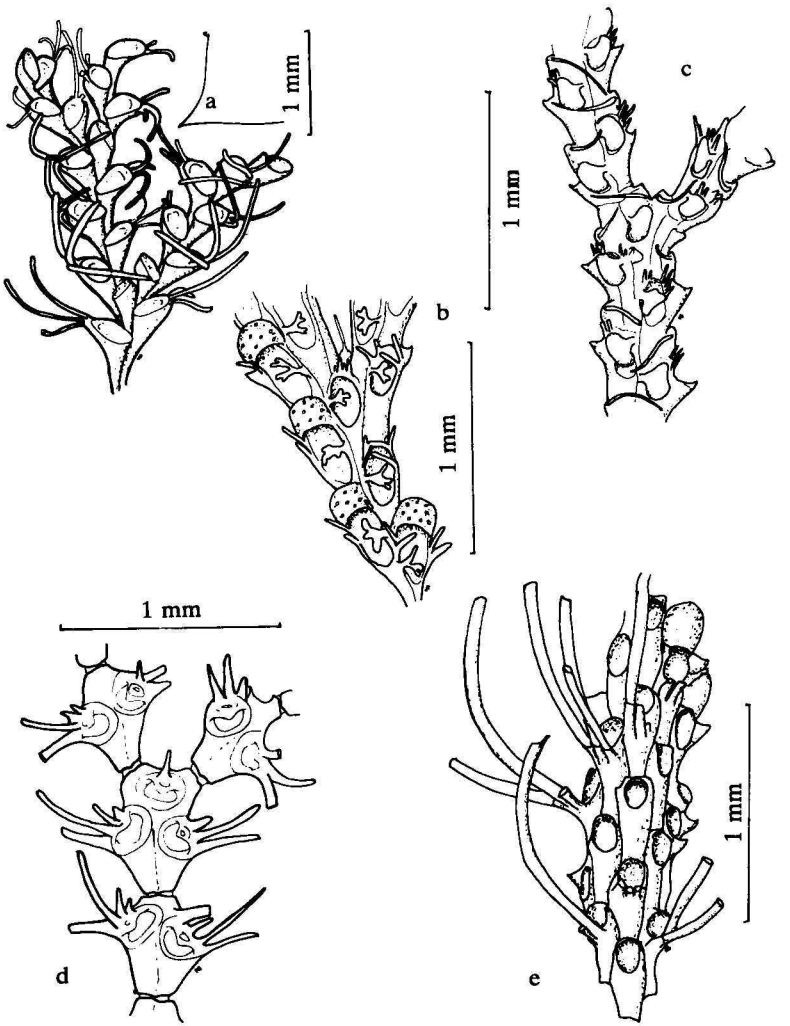


Fig. 9.12 *(a) Cornucopina grandis; (b) Scrupocellaria bertholetii; (c) Scrupocellaria ornithorhynchus; (d) Emma rotunda; (e) Rhabdozoum wilsoni;* with ovicells.

This species is very similar to *Scrupocellaria scrupea:* local records need revision to determine whether the latter occurs in Australian waters.

Amastigia rudis (Busk) Fig. 9.11c, d

Colony erect, branching, up to 25 mm high. Branches biserial near base; multiserial distally, unjointed. Gymnocyst almost entirely obscured by avicularia or ooecia. Opesia elliptical or narrowing distally. Normally two spines on each side of opesia, distally; marginal zooids with four outer spines and one inner. One of the spines may be enlarged as a bilobate scutum over opesia. Central zooids with paired frontal avicularia proximal to opesia or on distal angles of ooecium; marginal zooids with enlarged avicularia projecting marginally. Avicularia basal, on alternate sides of midline of branch, with seta directed obliquely proximally. Ooecia subimmersed, with ectooecium lacking from most of frontal surface, leaving a semicircular area of endooecium exposed.

This species has been recorded widely from the western Pacific and from southern Australia, and also from warmer waters of the north-eastern Pacific.

Caberea glabra MacGillivray Fig. 9.13a

Colony erect, branching, fan-shaped, 10 to 15 mm in diameter; of several biserial branches. Branches flexible; joints internal, not visible. Opesia elliptical; two short spines articulated at outer distal angle; large scutum at inner margin, with long spine articulated near base of scutum. Frontal avicularia of medium size, near mid-line of branch, near base of scutum; lateral avicularia small, beside distal angle of opesia. Marginal vibracula prominent, with fine, flexible, barbed seta. Basal surface of branch with tubular, elongate vibracular chambers extending proximally towards the mid-line; and with rhizoid tubes growing proximally. Ovicells subimmersed, quadrate to rounded, with ectooecium lacking from most of frontal surface.

This species is closely related to the southern species *Caberea darwinii,* which shows considerable variation in characters. *Caberea darwinii* has been recorded from the region, but records have not been confirmed. Other smaller species of *Caberea* recorded from the region include *C. dolabrata, C. helicina,* and the overseas form *C. boryi.*

Caberea grandis Hincks Fig. 9.13b, c, Plate 26.3

Colony erect, of numerous branches radiating from the base, about 50 mm high, orange brown in colour. Branches about 2 to 3 mm wide, multiserial, slightly flexible; joints not visible, internal. Zooids subrectangular, in about three to six longitudinal series. Opesia elliptical, with marginal cryptocyst. Small spines articulated at the distal angles: usually one on each angle of medial zooids, with two spines on the outer and one on the inner angle of marginal

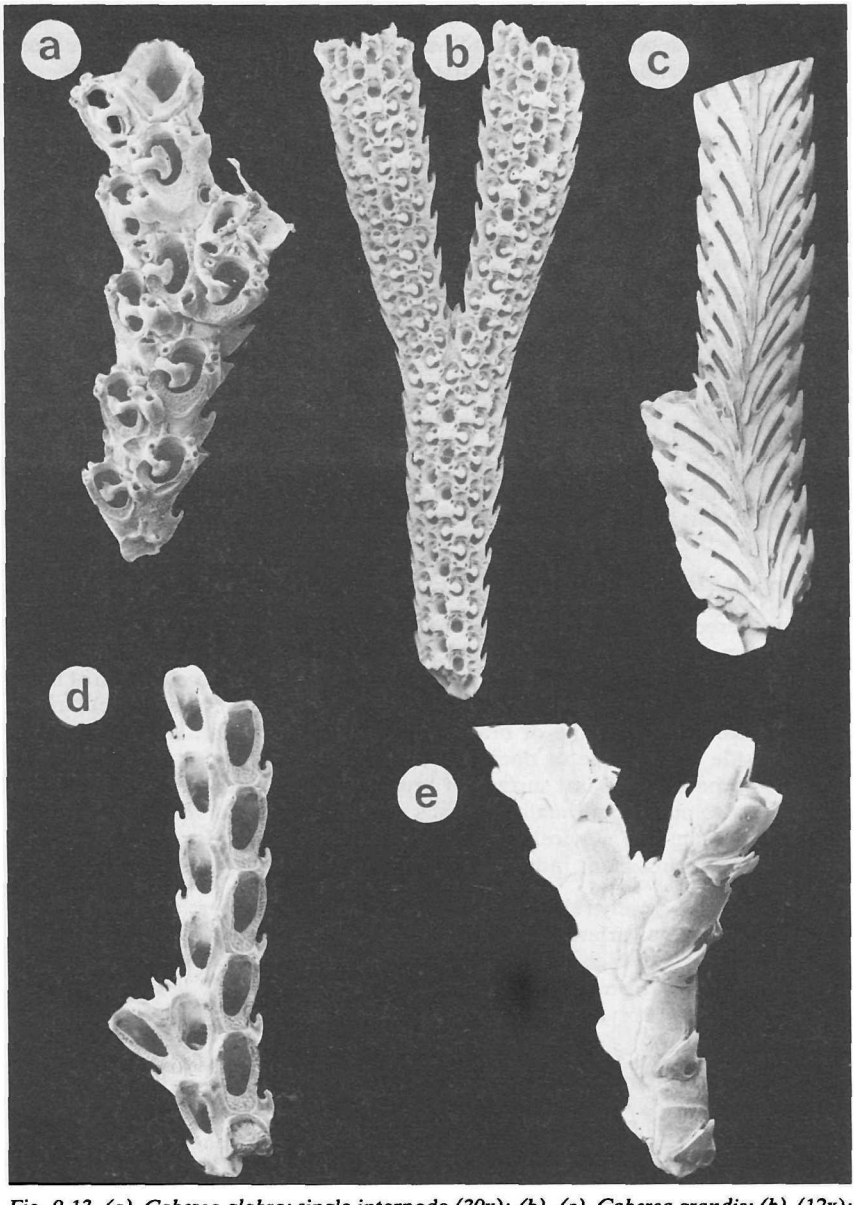


Fig. 9.13 *(a) Caberea glabra:* single internode (30x); *(b), (c) Caberea grandis: (b)* (12x); *(c)* basal surface, treated with hypochlorite (20x); *(d), (e) Canda arachnoides: (d)* frontal surface (20x); *(e)* basal surface (20x).

zooids. A comparatively small scutum arches over opesia from zooid margin. A pair of small frontal avicularia on proximal end of zooid, or on distal angles of ooecium; lateral avicularia on outer edge of marginal zooids small; rare very large frontal avicularia. Marginal vibracula with long barbed setae, and with basal chambers extending obliquely proximally. Ooecia immersed, rounded, with ectooecium lacking from most of frontal surface, and with thickened margin to ectooecium.

This species appears to be fairly common in water depths of about 10 to 20 m in the region.

Canda arachnoides Lamouroux Fig. 9.13d, e, Plate 27.3

Colony erect, flexible, many-branched, orange, up to 100 mm high. Branches biserial, united to neighbouring branches by short tubes to form a flexible sheet of branches. Zooids subrectangular, with narrow frontal gymnocyst, and broad granular proximal cryptocyst. Opesia elliptical, with a short spine at each distal angle. Frontal avicularia along the mid-line of branch, with triangular mandibles. Vibracula extending from lateral margin to midline of basal surface, slightly obliquely, with short simple setae. Ooecia rarely seen, subimmersed, with an avicularium distally, and a frontal area lacking ectooecium.

This species appears to be distributed fairly widely in the region.

Emma rotunda Hastings Fig. 9.12d

Colony erect, flexible, branching, forming a tangled network about 30 mm in diameter. Internodes of two or three zooids, connected by short double tubes; skeleton transparent. Zooids subconical, with narrow proximal part and expanded distal part, flattened frontally. Gymnocyst smooth, covering proximal half of zooid; frontal area circular, with annular, granular cryptocyst around opesia. Opesia subcircular with nearly straight proximal margin. Operculum a simple flap of frontal membrane near distal margin of opesia. About three or four hollow spines articulated from distal margin of frontal area. Marginal avicularium may be present proximal to frontal area. Rhizoids may develop from pore on frontal surface; these usually reunite with another part of colony. Ovicells immersed in the third zooid of internode, with smooth frontal.

This is one of several species of the genus which are fairly common in 'bryozoan thickets', or are attached to algal holdfasts. It has been recorded from Victorian and Tasmanian waters, as well as from N.S.W., New Zealand, and possibly from South America. Another common and widely distributed species is *Emma triangula* Hastings, in which the internodes have two zooids with subtriangular frontal areas and opesiae.

Rhabdozoum wilsoni Hincks Fig. 9.12e

Colony erect, growing as a tuft of slender stems from basal rhizoids, up to about 40 mm high. Branch consists of long thin tubular stem, branching distally

to about three branches with zooids arranged in multiserial rows. Frontal mainly of smooth gymnocyst, with subcircular frontal area. Proximal to frontal area is a small inflated area, bearing either a small frontal avicularium or a group of two

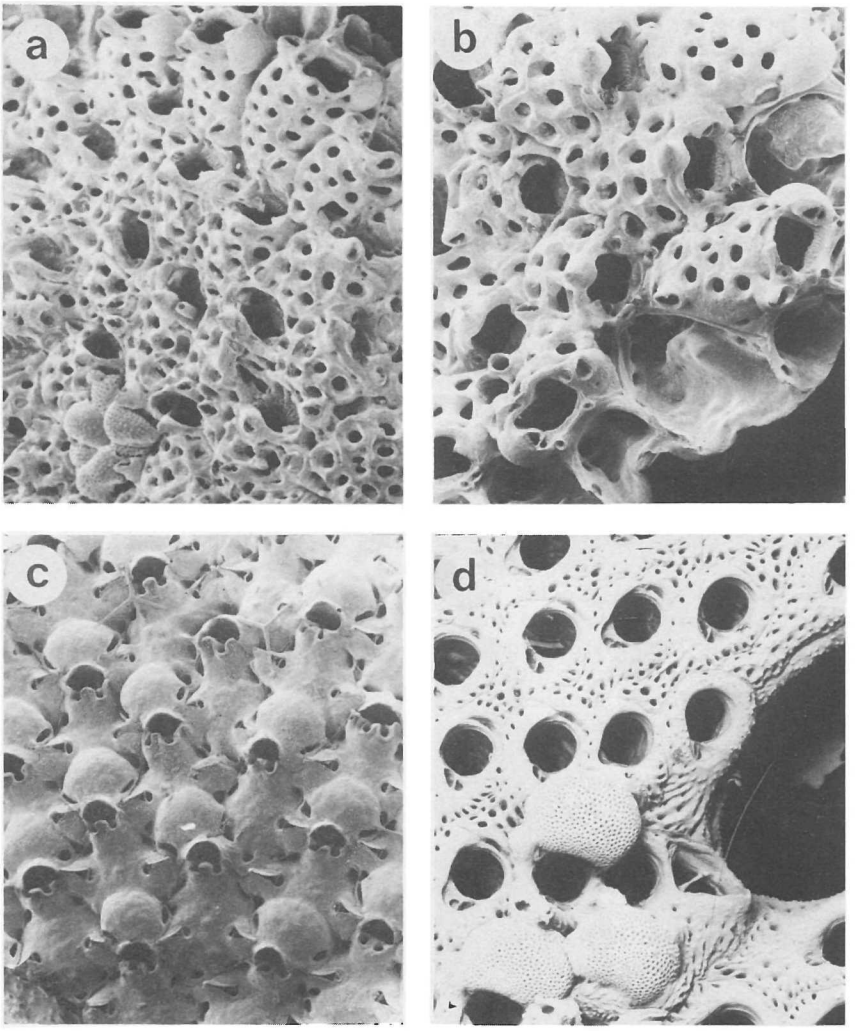


Fig. 9.14. *(a), (b) Arachnopusia unicornis: (a)* (35x); *(b)* (40x); *(c) Exochella tricuspis:* with ovicells (32x); *(d) Petralia undata:* with ovicells and fenestral avicularium (30x).

or three long spines curving distally. Ooecia subimmersed, with smooth rounded frontal surface.

This species is found in waters of about 10 to 20 m depth, usually on vertical faces or in crevices.

Tricellaria monotrypa (Busk) Fig. 9.15a, b

Colony erect, branching, flexible and up to about 30 mm high. Branches biserial, composed of thinly calcified internodes with about five to nine zooids per internode; connections are uncalcified sections of two zooids. Bifurcations at distal end of each internode. Opesia large, elliptical, with narrow marginal

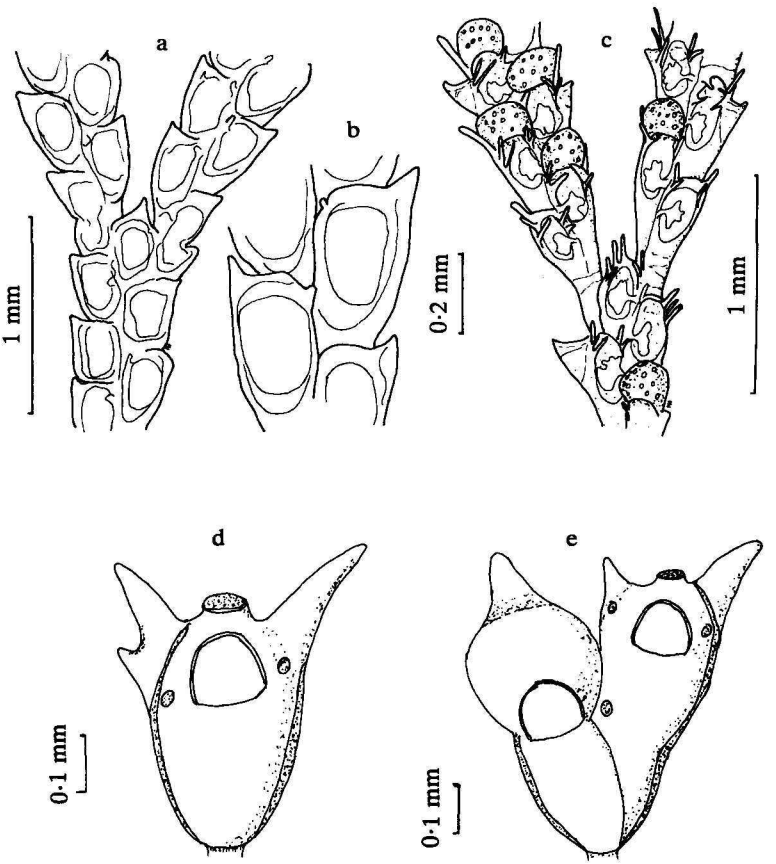


Fig. 9.15. *(a), (b) Tricellaria monotrypa; (c) Tricellaria porteri:* with ovicells; *(d), (e) Cornuticella cornuta: (d)* internode of single zooid; *(e)* fertile internode.

gymnocyst on frontal. Operculum a simple flap at distal end of frontal membrane. The outer distal angle of the zooid is prolonged into a projection or blunt spine; the terminal zooid between the two pairs of internode connections has a similar distal spine. Avicularia absent. Ooecia rare, completely immersed, shallow.

This species is fairly common, attached to other bryozoans by rhizoids. It has been recorded in references before 1943 as *Bugulopsis cuspidata*, or *Cellularia cuspidata*.

Tricellaria porteri (MacGillivray) Fig. 9.15c

Colony erect, branching, bushy, flexible. Branches of biserial internodes with about three to nine zooids, bifurcating at distal end of internode, with connections of uncalcified double tubes. Zooids tapering proximally, with elliptical frontal area occupying about two thirds of frontal surface length. Gymnocyst smooth. About six hollow spines articulated at distal margin or angles. Scutum elliptical, extends over opesia from inner margin. Lateral avicularia located near distal part of opesia, often lacking. Vibracula lacking. Ooecia subimmersed, frontal surface convex, with several small circular windows in the ectooecium. Small bulbous kenozooids on basal surface, with proximal pore from which grows a long flexible rhizoid.

This species appears to be a fairly common fouling species, recorded from Sydney and S.A., and also seen in collections from Port Phillip. Colonies superficially resemble *Scrupocellaria*, but vibracula are lacking in *Tricellaria*.

Arachnopusia unicornis (Hutton) Fig. 9.14a, b

Colony encrusting, or unilaminar, or bilaminar. Frontal membrane covered by a frontal shield with numerous perforations. Orifice elliptical or with a straight distal margin; secondary orifice elliptical, with a spine articulated from proximal angle inside the peristome. Avicularia variable in size and location: one on a raised projection proximal to the secondary orifice; one or two with triangular mandibles on frontal close to proximal angle of secondary orifice. Ovicell deeply immersed in distal zooid, with opening separated from orifice of proximal zooid.

This is a common and widely-distributed species in southern Australia and New Zealand, also recorded as *Arachnopusia monoceros*. There is considerable variation in the features of the frontal shield.

Exochella tricuspis (Hincks) Fig. 9.14c

Colony encrusting. Zooids small, rhombic or hexagonal, arranged in longitudinal rows, indistinctly separated from adjacent zooids. Primary orifice semicircular, usually obscured by growth of secondary orifice. Proximal margin of secondary orifice has two lateral rounded notches, with a central raised tooth-like structure. Three or four spines articulated at distal margin of orifice, seen

only in juvenile zooids near colony's growing margin. Frontal surface smooth, with an avicularium on each side, with acute mandible directed laterally. A few large marginal pores (areolae) present. Ovicells subimmersed, opening into peristome, with smooth convex frontal having a marginal pore on each side.

Colonies are found encrusting shells or other solid objects, including other bryozoans. Distribution is wide in southern Australia, New Zealand and South Africa. Juvenile, marginal zooids differ considerably from older zooids with secondary calcification.

Petralia undata MacGillivray Fig. 9.14d, Plate 25.5

Colony unilaminar, forming an obtuse fan with strong curvature in the proximal-distal direction, convex upwards. Colony rooted to sand substrate by large numbers of soft rhizoids, growing from proximal margin of colony, up to 150 mm wide, dark brown, with lighter coloured growing edge. Elliptical or subcircular fenestrae arranged regularly, pass through colony. Zooids opening on concave surface, rectangular, arranged in longitudinal rows. Frontal wall of skeleton with several perforations in proximal part, and about nine or ten marginal areolae. Orifice subcircular, with proximal avicularium. Vicarious avicularium usually located proximal to fenestra. Basal surface with well-marked grooves at zooid contacts, and with about twenty perforations in skeleton. Ovicells found in a few colonies; dependent, prominent, with fine perforations and adventitious avicularia.

Colonies are recorded from Western Port, Vic. to S.A.

They are particularly abundant near Port Phillip Heads, on areas of stabilised sand substrates.

Mucropetraliella ellerii (MacGillivray) Fig. 9.16a

Colony encrusting, attached to algal stems by several soft rhizoids, bright orange-red, up to about 20 mm diameter. Zooids subhexagonal to irregular in outline, with distinct contacts, possibly obscured by secondary calcification. Frontal wall with numerous perforations. Primary orifice subcircular, with a pair of semicircular indentations in proximal margin, one on each side of wide shallow lyrule. Small avicularium on proximal margin of orifice, directed laterally. Secondary orifice with one or several raised spikes or bosses. Basal surface smooth, with small pit communicating with zooid through a multiporous septula, for development of rhizoid. Ovicell subimmersed, with granular surface.

This is a common shallow-water species distributed widely in the region, and is often found attached to stems of algae such as *Sargassum*. Several other species of this genus have been recorded from the region.

Adeona grisea (Lamouroux) Fig. 9.16b, Plate 28.3

Colony subcircular, bilaminar, with subcircular fenestrae, with strongly

calcified stem, attached to substrate by a bundle of stem joints and organic-walled rhizoids, black, up to 100 mm in diameter. Zooids rhomboid, with shallow groove at zooid contact. Primary orifice lenticular, generally obscured

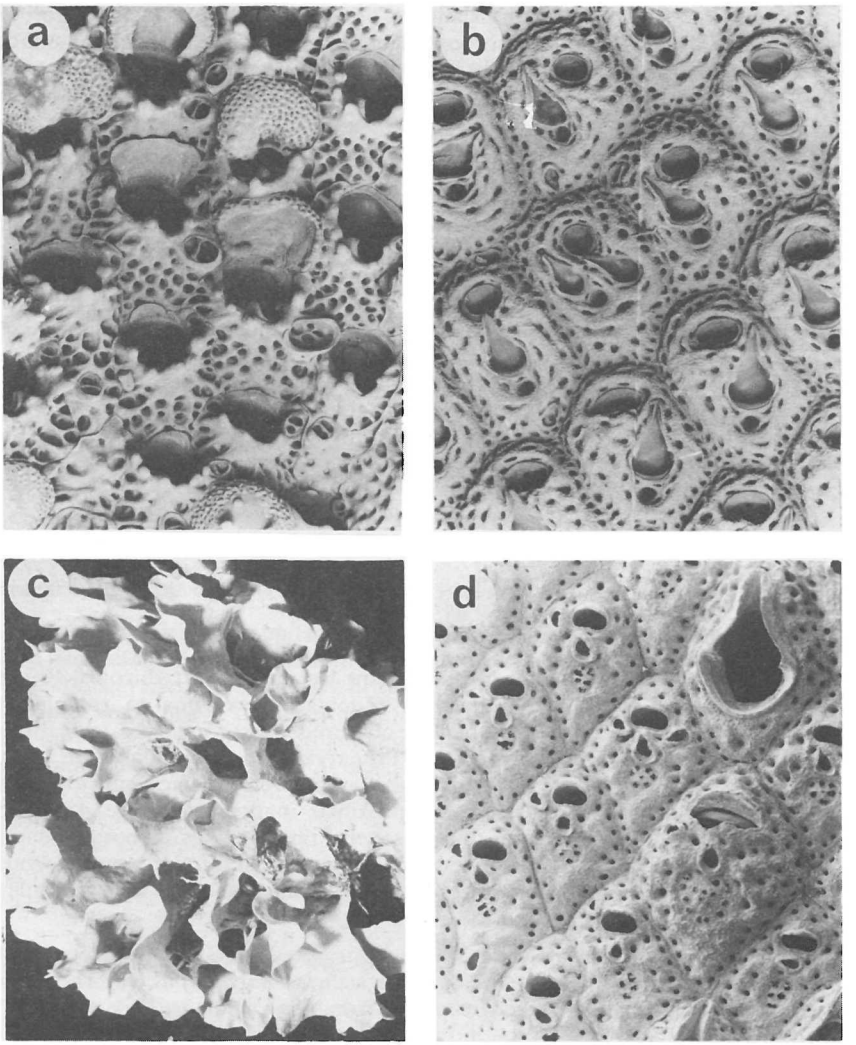


Fig. 9.16 *(a) Mucropetraliella ellerii:* with ovicells (35x); *(b) Adeona grisea:* treated to remove cuticle (40x); *(c), (d) Adeonellopsis foliacea: (c)* colony (0.2x); *(d)* detail, showing gonozooid, and vicarious avicularium (40x).

by secondary calcification. Secondary orifice circular. Large frontal avicularium proximal to orifice, with acute mandible directed obliquely distally, terminating lateral to orifice. Large pore (ascopore) through skeleton and cuticle, located proximal to base of avicularium. Several smaller perforations in frontal skeleton, concentrated near margin of zooid. Vicarious avicularia around margin of fenestrae, with mandibles directed distally. Raised mound lateral to frontal avicularium of zooid. Ovicells not present.

Three other species of the genus are recorded from the region, but details of distribution of each is inadequate.

Adeonellopsis foliacea MacGillivray Fig. 9.16c, d

Colony rigid, cemented to substrate, composed of a complex of branching, fragile, bilaminar sheets, up to 250 mm in diameter, pale coloured. Zooids rhomboid, dimorphic, with distinct grooves at contacts. Primary orifice lenticular, usually obscured by secondary calcification. Secondary orifice semicircular, with rounded proximal angles. Usually two or three frontal avicularia: one proximal to orifice with distally-directed mandible; one or a pair lateral to orifice, with inward-directed mandibles. Frontal skeleton with central depression, with about six stellate perforations. Several simple perforations near zooid margins. Large vicarious avicularia with acute mandibles directed distally are sparsely distributed on colony surface. Fertile zooids are larger than normal zooids; orifice much wider than that of normal zooids; ovicells absent.

This spectacular species appears to be fairly common in South Australian waters; and is also found in Victoria. Colony shape is variable within the genus; zooidal features are more important in identification.

Adeonellopsis sulcata (Milne-Edwards) Fig. 9.17a, b

Colony erect, of branching bilaminar sheets or lobes, up to about 50 mm high, cemented to substrate. Zooids rhomboid, dimorphic, with distinct zooid contacts in young marginal zooids, but becoming obscure in mature zooids. Primary orifice lenticular, obscured. Secondary orifice semicircular with rounded proximal angles. Usually a single frontal avicularium, proximal to orifice, with distally-directed mandible closing on a raised palate which projects slightly into the proximal lip of the secondary orifice. Central depression in frontal skeleton, with about eight to ten stellate pores. Secondary calcification around the central area results in both the avicularium and the porous area becoming set deeply in an elongate depression in more mature zooids. Lateral areolae surround zooid. Fertile zooids much larger than normal zooids, with large arcuate secondary orifice, and several frontal avicularia. Vicarious avicularia with large acute mandibles sparsely distributed.

The species is common in the region, and has been recorded as *Adeonellopsis mucronata* and *A. australis*. *Adeonellopsis foliacea* may yet prove to be another synonym, but at present it is preferable to separate them.

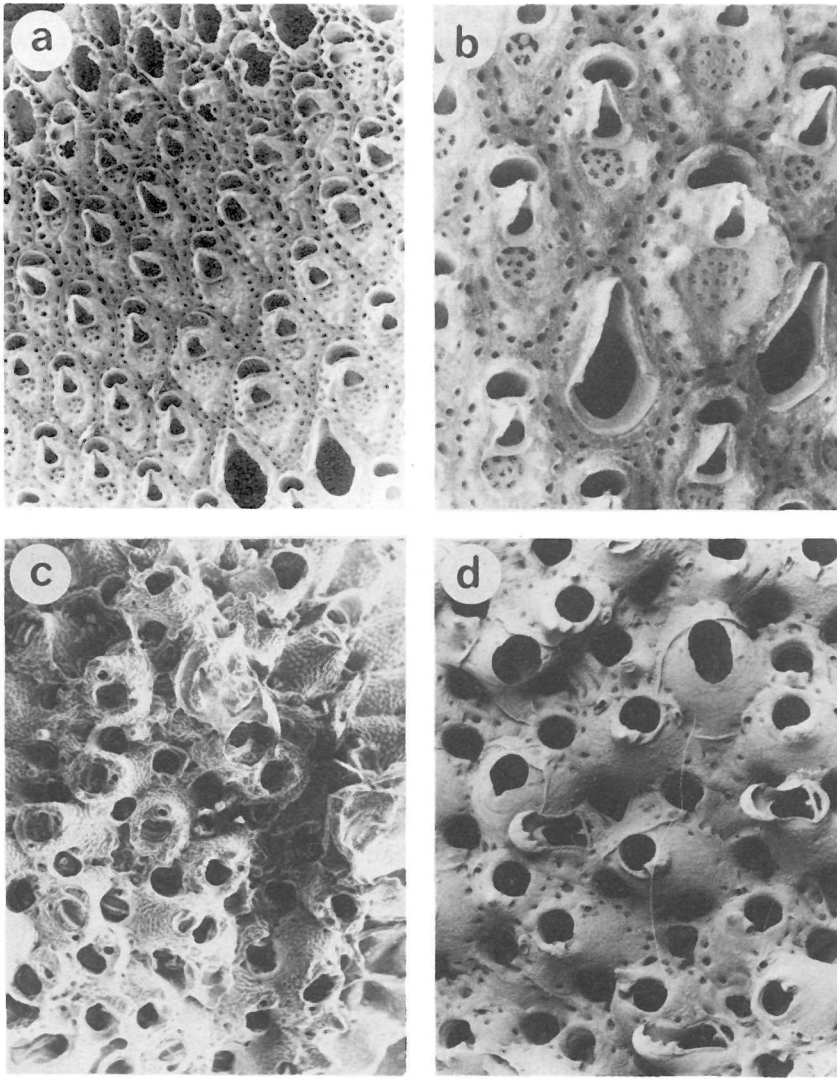


Fig. 9.17. *(a), (b) Adeonellopsis sulcata:* (a) juvenile zooids near growing edge of colony (23x); *(b)* enlarged, with gonozooid and two vicarious avicularia (47x); *(c) Celleporaria bispinata* (26x); *(d) Celleporaria fusca:* with vicarious avicularia (35x).

Celleporaria bispinata (Busk) Fig. 9.17c

Colony encrusting, multilaminar, low-growing, up to about 30 mm in diameter. Zooids elongate at growing edge, rounded near colony centre; contacts between zooids distinct. Frontal wall highly convex, with granular ornament. Orifice semicircular, with very small condyles; two short spines articulated from distal margin. A median sub-oral process (rostrum) may be present with a small avicularium bearing a semi-circular mandible. Large interzooidal avicularia with ligulate mandibles may be present. Lateral pores (areolae) surround zooid. Ovicells located above zooidal orifice (vestibular), prominent, with granular surface.

As with all species of the genus, *Celleporaria bispinata* shows considerable variation, particularly in characters of the colony. Colonies encrust rocks, shells and algae. The species appears to be distributed widely in the region.

Celleporaria fusca (Busk) Fig. 9.17d, Plate 25.4

Colony encrusting, rising to separate cylindrical or flattened multilaminar lobes, up to about 100 mm in diameter and height, usually purple when live. Zooids irregularly arranged except at growing edge of colony; frontal wall smooth, highly convex. Primary orifice semicircular; a short peristome above, forming a subcircular secondary orifice, usually with a notch on the proximal edge, formed by the growth of a suboral rostrum. Suboral avicularium on rostrum small, with semicircular mandible. Vicarious avicularia variable in size, typically on the side of raised conical rostrum, with ligulate mandible, closing on serrated palate. Ovicells small, forming a convex hood over a secondary orifice; larvae dark red.

This is one of a group of related species, all of which need thorough revision to determine which characters are most useful in the discrimination of species. The more obvious features of colony shape, and the degree of development of suboral and vicarious avicularian rostra, are all highly variable and unreliable as diagnostic features. Variation in colour has not been studied; colour of larvae is expected to be reliable, but surface colour of colonies is the result of more than one factor and may not be a useful guide. *Celleporaria fusca* appears to be widely distributed in the south-west Pacific and the Indian Oceans, but not all records may be valid. Species which are closely related to *C. fusca* include *C. hastigera, C. foliata, C. mamillata, C. prolifera, C. verrucosa,* and a form wrongly identified (by MacGillivray) as *C. albirostris* (see Plates 26.4; 27.4; 28.4).

Microporella ciliata (Pallas) Fig. 9.18a

Colony encrusting, unilaminar. Zooids subhexagonal, arranged quincuncially, distinctly separated by grooves. Frontal wall convex, perforate, with granular ornament. Orifice semicircular, with five or six spines articulated from distal margin: the spines often missing from more mature zooids. Ascopore proximal to orifice, lunate, concave distally. One or a pair of frontal avicularia,

proximal from angles of orifice, with very long, thin mandibles directed obliquely distally. Ovicells dependent, prominent, hyperstomial, with granular,

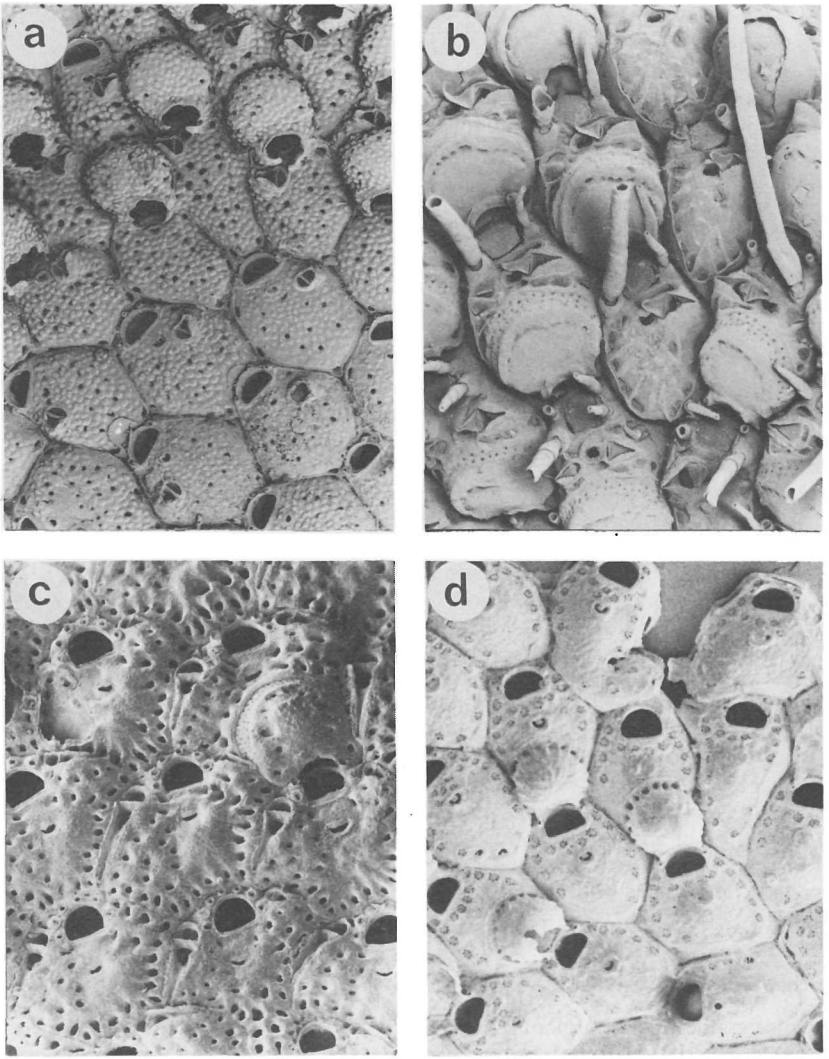


Fig. 9.18. *(a) Microporella ciliata:* with ovicells (25x); *(b) Calloporina canaliculata:* with ovicells (32x); *(c) Calloporina lunata:* with ovicell (42x); *(d) Fenestrulina malusii:* with ovicells (25x).

imperforate frontal. Distal and lateral walls of ovicell with large pores.

This is a cosmopolitan species which reputedly shows great variation in characters. Local specimens frequently show proximal elongations of the ovicell lateral walls, wrapping around the orifice and ascopore, leaving an elliptical secondary orifice. There is a need for the status of this form to be settled, but at present the name *Microporella ciliata* var. *diadematа* (Lamouroux), is preferred to *Microporella orientalis* Harmer, for local material only.

Calloporina canaliculata (MacGillivray) Fig. 9.18b

Colony encrusting. Zooids subhexagonal, rhomboid, or irregular, indistinctly separated from neighbouring zooids. Frontal wall flat to convex, with large areolae extending inward as furrows. Orifice semicircular, with minute pivots at proximal angles; about five distal spines. Ascopore round, often with rampart of secondary calcification. Frontal avicularia single or paired, with acute mandible directed laterally, situated beside ascopore. Ovicell subimmersed, with convex frontal, and numerous large pores around margin.

Typically found encrusting fronds of algae such as *Sargassum*. Records of species of *Calloporina* prior to 1967 should be revised; distribution data for the various species are inadequate.

Calloporina lunata (MacGillivray) Fig. 9.18c

Colony encrusting. Zooids hexagonal, arranged in longitudinal rows. Frontal wall flat, with numerous areolae, and several perforations inside the row of areolae. Orifice semicircular; about six spines articulated at distal margin. Ascopore lunate, concave distally, proximal to orifice. Single frontal avicularia lateral to orifice, with long acute mandible directed obliquely proximally. Ovicell immersed, with marginal band of granular ornament, and semicircular row of pores within ornamented band.

Found encrusting shells or rocks. It appears to be fairly common from Port Phillip towards the east, but records are inadequate.

Fenestrulina malusii (Audouin) Fig. 9.18d

Colony encrusting, small in extent. Zooids subhexagonal to subquadrate. Zooid frontal wall convex, with stellate perforations, often absent from central zone. Orifice semicircular, with three to five distal spines. Ascopore lunate, often with secondary calcification surrounding it. Avicularia lacking, Ovicell subimmersed, with convex imperforate frontal, and with several pores on the distal margin, seen from above as indentations of the margin.

This cosmopolitan species is mainly found encrusting solid objects such as shells, but is also found on algae. It has been recorded from shallow water down to depths of about 300 m.

Porina gracilis (Lamarck) Fig. 9.19a, b

Colony erect, bilaminar, lobate, up to 20 mm long. Zooids arranged quincuncially, contacts obscured by secondary calcification. Primary orifice circular with two small condyles; at the base of long oblique peristome;

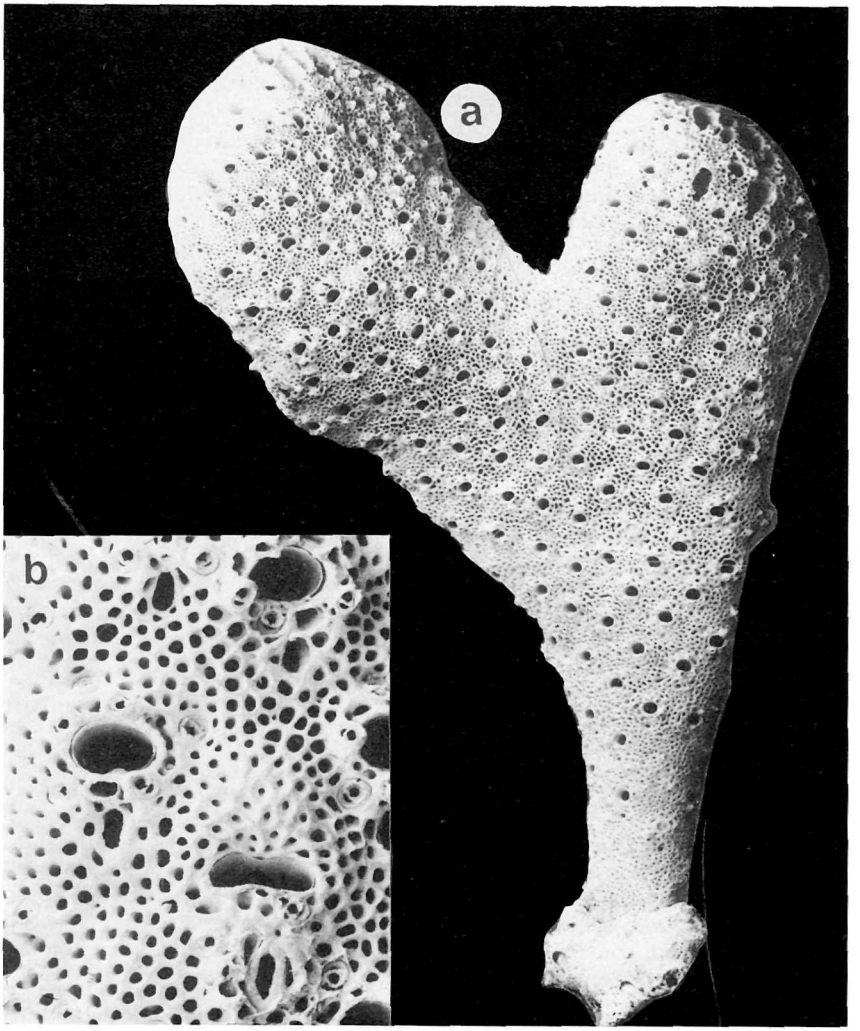


Fig. 9.19. *(a), (b) Porina gracilis: (a)* colony (15x); *(b)* enlarged with ovicell (48x).

secondary orifice circular or elongated laterally. Frontal wall of skeleton a porous network. A special pore opens proximal to secondary orifice; either round or elongate longitudinally. Small frontal avicularia with rounded mandibles scattered over surface, with several around margin of secondary orifice. Ovicell totally immersed, with laterally elongate secondary orifice to zooid, and with increase in density of calcification above ovicell frontal wall.

Typically attached to other bryozoans by a small area of cementation. The taxonomic history of the species is long and confused, and as its status is still uncertain, the name given should be regarded as provisional. The frontal pore has been considered to be an ascopore, but dissection of specimens shows that it communicates with the peristome rather than the zooid. There may be more than one species with similar external form.

Cyclicopora longipora (MacGillivray) Fig. 9.20c

Colony encrusting, unilaminar. Zooids subquadrate, arranged alternately in longitudinal rows, with distinct contacts between zooids. Frontal convex, smooth, with several perforations distributed over surface. Orifice elliptical, elongated transversely, with a thin rim. Ovicell subimmersed, with strongly convex frontal with fine perforations. Avicularia absent.

Found encrusting shells, rocks, and other bryozoans. It appears to be fairly common in Victorian waters, and has also been recorded from the northeast Pacific.

Hippothoa aporosa Levinsen Fig. 9.20a, b

Colony encrusting, up to about 20 mm in diameter. Zooids elongate, thin-walled, trimorphic, distinct from neighbouring zooids, with low connecting chambers. Frontal wall convex, imperforate, smooth or marked with growth lines. Orifice subcircular, with wide deep sinus and pair of condyles. Normal zooids with raised tubular process on each side of orifice; fertile zooids with laterally elongate orifice without sinus, and prominent independent ovicell with a few round perforations in the distal part only; male zooids smaller, with very small orifice with sinus.

The Australian species of *Hippothoa* need revision. *H. aporosa* appears to be common in Victorian waters, encrusting algae such as *Sargassum*. The colonies are small, transparent, and inconspicuous.

Hippothoa distans MacGillivray Fig. 9.20d

Colony encrusting. Zooids small, elongate, not in contact with neighbouring zooids. Connections between zooids are fine calcareous tubes encrusting the substrate, between the distal end of one zooid and the proximal end of the next, or branching from the lateral wall of the proximal zooid. Orifice subcircular, with deep sinus, and pair of condyles in proximal margin. Frontal surface

convex, smooth, or with median keel, Fertile zooids smaller than normal zooids, with similar orifice, and with globular prominent ovicells.

This species usually encrusts solid objects such as shells. *Hippothoa divaricata* spreads similarly, but the connecting tubes are shorter, and the sinus in the orifice is shallow. *Hippothoa distans* is almost cosmopolitan in distribution.

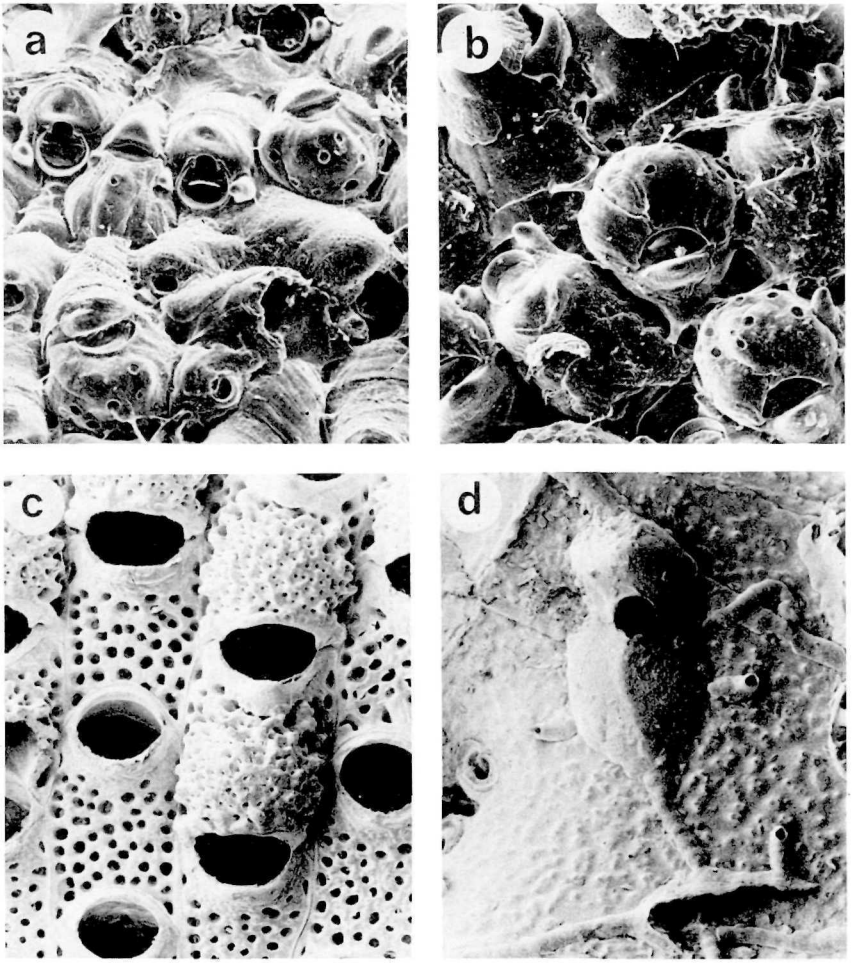


Fig. 9.20. *(a), (b) Hippothoa aporosa: (a)* colony tilted to show form of autozooid aperture (68x); *(b)* female zooids with ovicell (95x); *(c) Cyclicopora longipora:* with ovicells (42x); *(d) Hippothoa distans:* zooids with ovicell (85x).

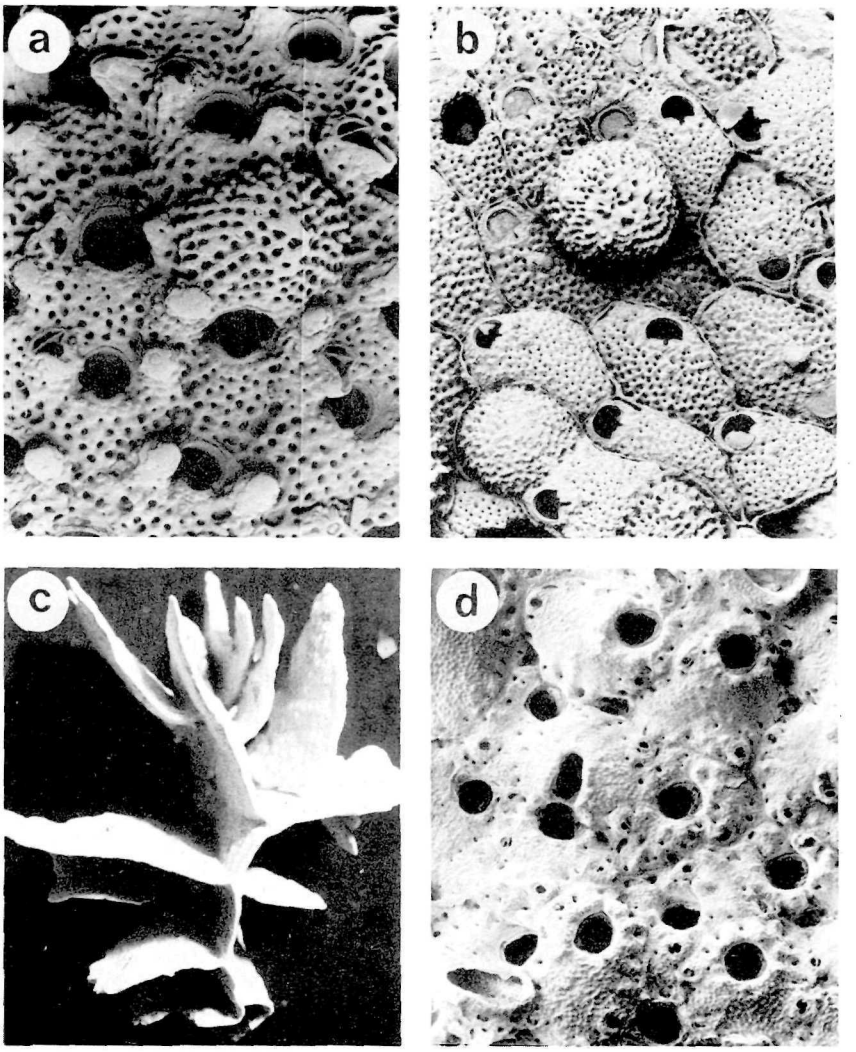


Fig. 9.21. *(a) Gigantopora biturrita:* with ovicell (35x); *(b) Arthropoma cecilii:* with ovicells (30x); *(c), (d) Cigclisula verticalis: (c)* dorsal view of colony (0.25x); *(d)* enlarged with ovicell (23x).

Gigantopora biturrita (Hincks) Fig. 9.21a

Colony encrusting, unilaminar, orange. Zooids irregularly arranged, with indistinct contacts. Frontal surface flat or slightly convex, perforate, with granular ornament. Orifice subcircular, with wide, shallow sinus. A raised process on each side of orifice, bearing an avicularium with triangular mandibles directed towards, and encroaching upon the orifice. Ovicells large, prominent, with perforate, granular frontal surface.

Colonies encrust stems and fronds of algae in shallow water. It is distributed in Victorian and South Australian waters.

Cigclisula verticalis (Maplestone) Fig. 9.21c, d, Plate 26.5

Colony erect, cemented to substrate over large area, growing as branching multilaminar vertically compressed sheets up to 200 mm high. Zooids rhomboid to subhexagonal, arranged quincuncially, with zooidal contacts distinct in juvenile zooids, becoming indistinct by secondary calcification. Frontal rough or granular, with marginal areolae, and a few frontal perforations. Orifice with semicircular distal part, and wider proximal part with arcuate margin; small condyles present at junction of two parts of orifice. Vicarious avicularia with spatulate mandibles, small frontal avicularia with rounded mandibles. Ovicells immersed, with granular frontal surface and longitudinal slit-like opening.

This large and spectacular species has been recorded mainly from S.A.

Arthropoma cecilii (Audouin) Fig. 9.21b

Colony encrusting, unilaminar. Zooids large, subhexagonal, with distinct grooves between zooids. Frontal with numerous fine perforations, possibly absent in central area, convex. Orifice semicircular, with narrow, deep sinus. Operculum with an articulated part covering the sinus. Avicularia generally absent. Ovicells prominent, imperforate, smooth or slightly granular.

This species is usually found encrusting shells or rocks. It has a cosmopolitan distribution.

Schizomavella triangula (Hincks) Fig. 9.22a

Colony encrusting. Zooids subhexagonal to quadrate, arranged in longitudinal rows, with distinct contacts. Frontal uniformly perforate, granular, becoming pustulate by secondary calcification. Orifice elliptical, elongate laterally, with pair of blunt condyles and broad sinus. Frontal avicularium proximal to orifice, with triangular mandible directed proximally. Ovicell large, prominent, constructed from parts of two or three neighbouring zooids, with a pair of conical processes directed over orifice of maternal zooid, surface perforate and granular.

Colonies encrust shells and rocks. The first layer is regularly developed, but in some cases a second layer of zooids develops by frontal budding: these zooids are irregular in arrangement. The species is recorded from shallow water down to about 80 m.

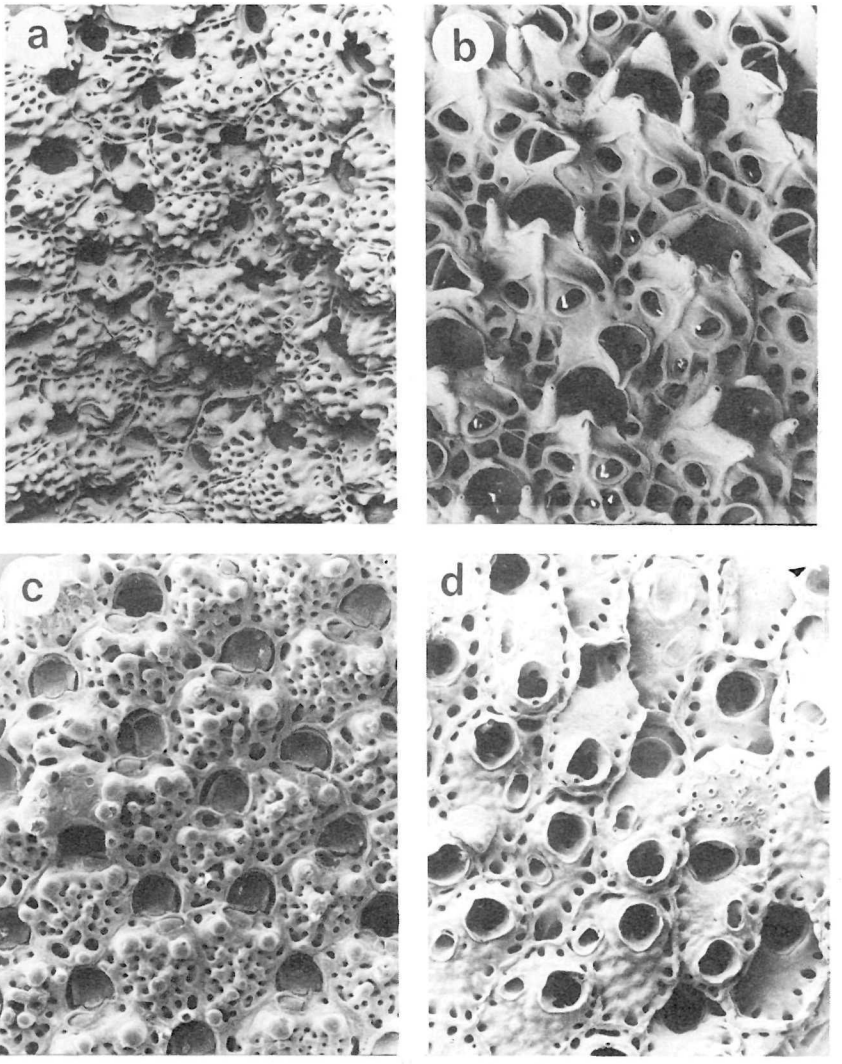


Fig. 9.22. *(a) Schizomavella triangula:* with ovicells (25x); *(b) Didymosella larvalis* (40x): *(c) Smittina maplestonei:* with ovicell (30x); *(d) Parasmittina unispinosa:* with ovicell (30x).

Didymosella larvalis (MacGillivray) Fig. 9.22b

Colony encrusting, or bilaminar-erect, up to about 20 mm diameter. Zooids arranged quincuncially, contacts indistinct. Frontal surface with several perforations, with stellate teeth at the base; two large central pores open into the peristome. Primary orifice elliptical, elongate transversely, obscured by growth of peristome. Secondary orifice with proximal conical process, and with spine bases at one or both proximal angles. Avicularia proximal to a frontal pore, with large triangular mandible on raised palate. Ovicells vestibular, large, globular.

Mainly found encrusting algae. It is recorded from Victorian and South Australian waters.

Smittina maplestonei (MacGillivray) Fig. 9.22c

Colony encrusting, unilaminar. Zooids subhexagonal, arranged quincuncially, contacts indistinct. Frontal surface uniformly perforate. Primary orifice semicircular, with shallow sinus. A raised peristome around the distal and lateral margins of sterile zooids, with proximal continuations in fertile zooids, leaving a narrow notch or pore in the peristome (spiramen). Suboral avicularium beside or proximal to sinus, with rounded mandible directed proximally or tranversely, sometimes lacking. Rarely the avicularium is enlarged, on a chamber covering most of the frontal wall. Ovicells immersed to subimmersed, with convex, perforated frontal wall.

This is a common species encrusting algae, recorded from Vic., S.A., New Zealand and Antarctic waters. The appearance of the colony surface shows considerable variation, depending upon the amount of calcification.

Smittina papillifera (MacGillivray) Fig. 9.23a, b

Colony encrusting, unilaminar. Zooids subhexagonal, distributed quincuncially or irregularly, with distinct contacts. Frontal wall slightly convex, with about four to ten papillae, and with perforations, often obscured by calcification. Aperture subcircular, with prominent narrow central lyrule and marginal acute condyles. Suboral avicularium large, with rounded mandible facing distally and directed proximally and away from substrate. Ovicells develop on zooids with slightly larger orifice; ovicells subimmersed, with convex frontal similar to zooid frontal in ornament.

This species is also a common epizoon on algae such as *Sargassum*. It has been recorded from Victorian waters and from the Outer Harbor at Adelaide.

Parasmittina unispinosa (Waters) Fig. 9.22d, plate 25.6

Colony encrusting, unilaminar or multilaminar; or erect, bilaminar, branching, up to 100 mm diameter. Zooids subquadrate, arranged in longitudinal rows, with distinct contacts. Frontal flat, with numerous areolae,

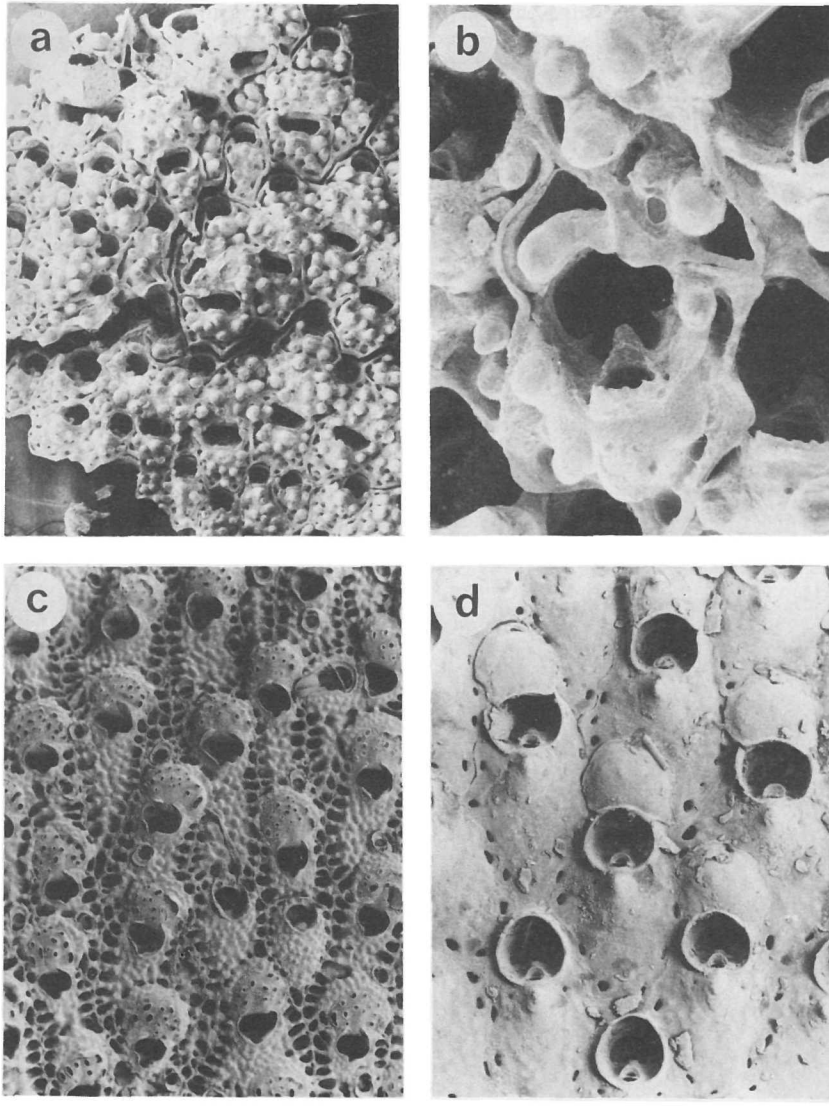


Fig. 9.23. *(a), (b) Smittina papillifera: (a)* (18x); *(b)* orifice (60x); *(c) Parasmittina raigii:* with ovicells (20x); *(d) Porella marsupium:* with ovicells (40x).

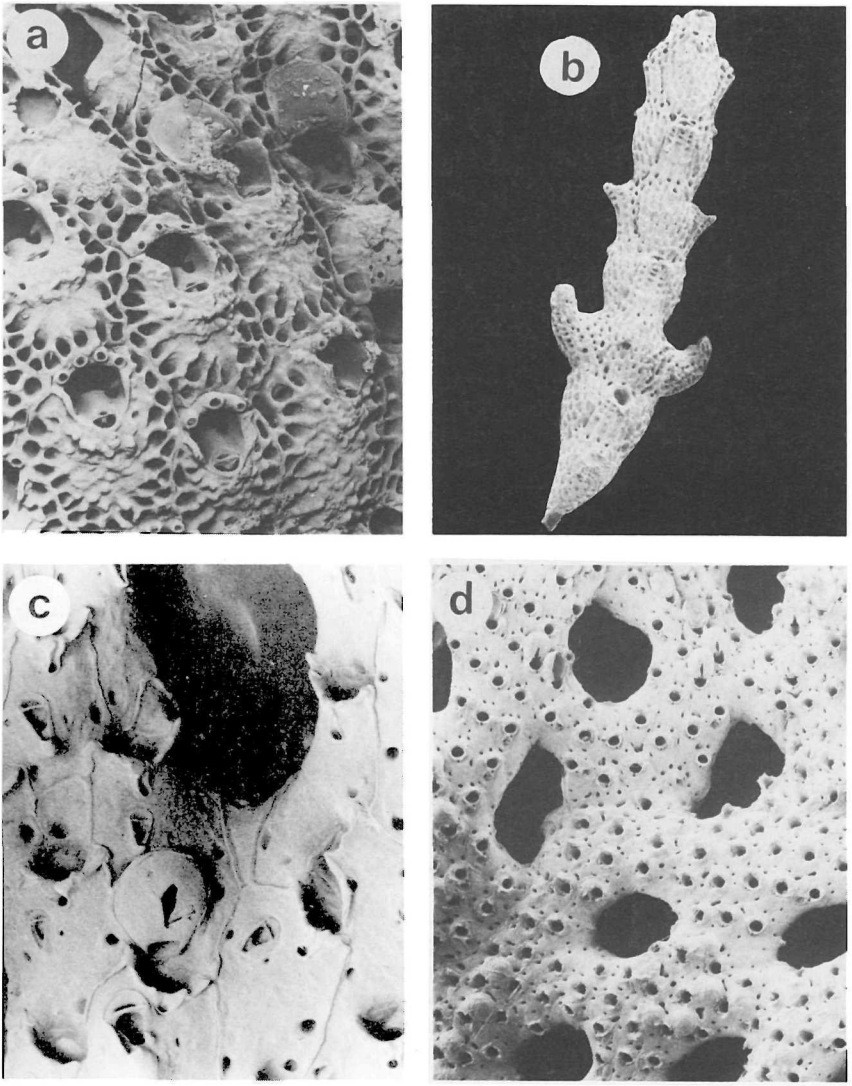


Fig. 9.24. *(a) Smittoidea acaroensis:* with ovicell (45x); *(b) Margaretta hirsuta:* single internode, cleaned (15x); *(c) Sertella fissa:* a part of colony with ovicell, and fenestra (45x); *(d) Iodictyum phoeniceum:* with ovicells (15x).

smooth and imperforate centrally. Primary orifice subcircular, with quadrate lyrule, and projecting acute condyles. Secondary orifice circular, with thickened peristome; proximal channel poorly developed. Adventitious frontal avicularia lateral and proximal to orifice, with spatulate mandibles directed proximally. Scattered vicarious avicularia with large ligulate mandibles. Ovicells prominent, globular, with fine perforations. A single articulated spine from a base at distal end of orifice.

This species is normally found encrusting shells and rocks, and has been recorded from Vic., N.S.W. and New Zealand. The erect form has only been seen in specimens from S.A.

Parasmittina raigii (Audouin) Fig. 9.23c

Colony encrusting. Zooids quadrate, in longitudinal rows, with distinct contacts. Frontal with areolae and small tubercles. Primary orifice subcircular, with lyrule and condyles. Peristome raised laterally into a pair of cusps near the proximal angles; proximal channel well developed. Two or three spines distal to orifice. Avicularia uneven in distribution; often lacking from smaller colonies. Frontal avicularia proximal and lateral to orifice, with acute mandibles directed proximally; larger interzooidal avicularia seen rarely. Ovicells small, subimmersed, with exposed endooecium, minutely perforated.

Colonies encrust shells and rocks. The species is widely distributed on coasts of the Indian and west Pacific Oceans. Neanic colonies are unilaminar, with few avicularia, regularly arranged zooids and usually no ovicells. As colonies mature and develop a second layer by frontal budding, the general appearance changes markedly, with ovicells and avicularia becoming more frequent.

Porella marsupium (MacGillivray) Fig. 9.23d

Colony encrusting, unilaminar. Zooids subhexagonal, arranged in longitudinal rows, with distinct contacts. Frontal wall convex, with marginal areolae, with variable secondary calcification. Primary orifice semicircular with rounded proximal angles, and with small central lyrule in proximal margin. Peristome shallow; secondary orifice subcircular. A small frontal avicularium present on a convex chamber proximal to the orifice; avicularian mandible facing obliquely distally, directed proximally. Ovicells subimmersed, with smooth, convex frontal wall.

This species is recorded from Vic. and New Zealand, encrusting shells. It is superficially similar to *'Schizoporella' ridleyi*, which can be distinguished by the presence of a proximal sinus in the primary orifice.

Smittoidea acaroensis (Levinsen) Fig. 9.24a

Colony encrusting, unilaminar or bilaminar. Zooids quadrate, arranged alternately in longitudinal rows, contacts distinct. Frontal wall granular, with

marginal areolae, and possibly a row of pores inside the row of areolae. Primary orifice elliptical, elongate transversely, with rectangular lyrule and a pair of hooked condyles. Three distal spines, lost from old zooids. Peristome not well-developed. Suboral avicularium with rounded mandible, facing obliquely distally, and directed proximally. A rod-like process (ligula) extends under mandible from cross-bar of avicularium. Ovicells immersed, with flat frontal markings of fine radiating slits or pores.

This species encrusts solid objects, and is recorded from New Zealand, Bass Strait, and the east coast of Australia.

Margaretta hirsuta (Lamouroux) Fig. 9.24b

Colony erect, branching, of cylindrical internodes connected by flexible tubes, up to 80 mm high. Internodes are quadriserial, with zooids in pairs, opening opposite each other, and succeeding zooids opening at right angles to the previous pair. Primary orifice obscured by long oblique peristome; secondary orifice circular, at end of tube. Fertile zooids develop a modified peristome, which curves back towards internode. A long flexible seta rises from a pore on each side of proximal part of peristome; setae grow distally. Small ascopore proximal to peristome. Frontal surface uniformly perforated, zooidal contacts indistinct. Rhizoids develop from near proximal end of internode.

This species is only superficially similar to the anascan *Cellaria pilosa*, which also has elongate setae. Zooidal characters of the two species are quite different. The species is mainly found in Victorian and South Australian waters.

Sertella fissa (MacGillivray) Fig. 9.24c

Colony erect, of branching, fenestrate, lace-like, unilaminar sheets. Zooids subhexagonal or quadrate, separated by fine ridges. Frontal wall smooth, imperforate, convex. Primary orifice semicircular, usually at the base of a long peristome; secondary orifice subcircular, with proximal notch, sometimes closed by calcification, leaving an open spiramen. Frontal avicularium small, with acute mandible, directed generally proximally. Ovicell subimmersed, with convex, smooth frontal surface marked by a central, longitudinal slit or comma-shaped mark. Basal surface with smooth surface between fine ridges (vibices) at zooid contact. Basal avicularia small, infrequent.

This is an example of several species originally included in the genus *Retepora*, which have now been ascribed to a variety of other genera. It is expected that gross colony form varies with habitat, but no work has been done on the variation of local species. As with other reteporids, the amount of secondary calcification can change the appearance of the frontal surface considerably.

Hippoporella orbicularis (Hincks) Fig. 9.25a, b

Colony encrusting, unilaminar or bilaminar. Zooids subhexagonal or

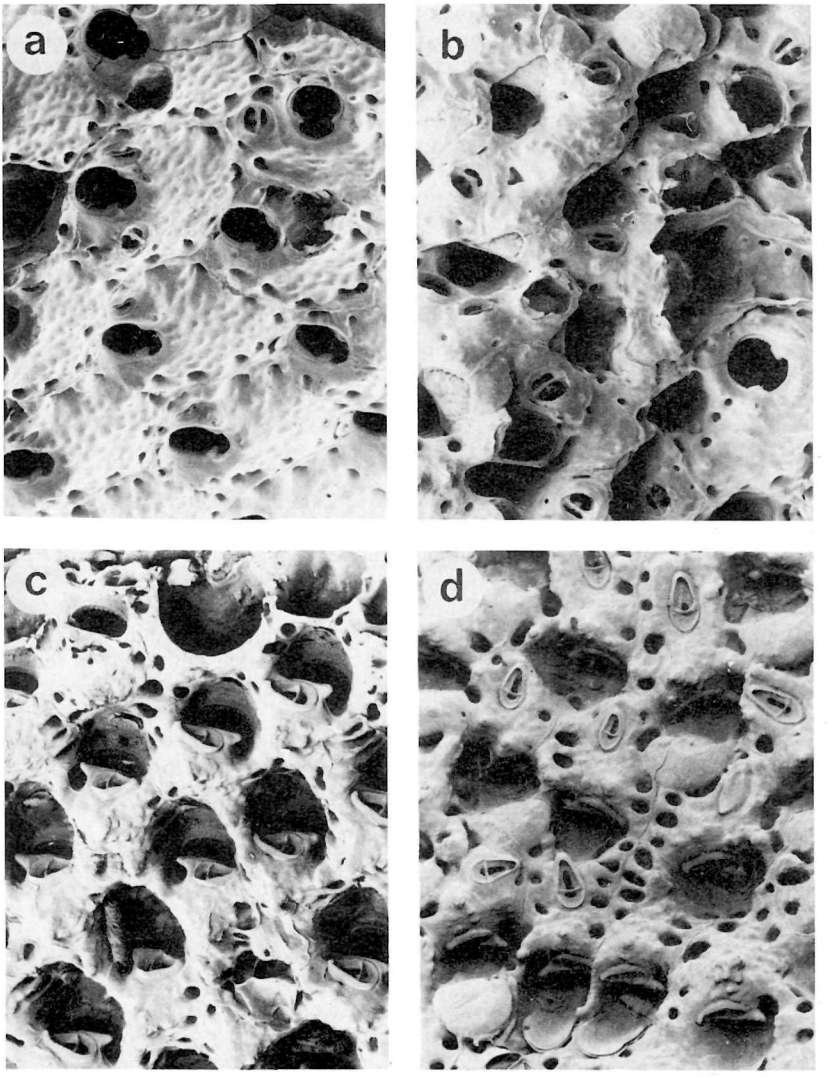


Fig. 9.25. *(a), (b) Hippoporella orbicularis:* (a) juvenile zooids (40x); *(b)* mature zooids with secondary calcification and ovicells (40x); *(c), (d) Rhynchozoon tubulosum: (c)* juvenile zooids, showing characters of orifice and peristome (30x); *(d)* mature zooids with secondary calcification and ovicells (35x).

irregular, zooid contacts distinct in youthful individuals, becoming obscured by secondary calcification. Frontal surface with marginal areolae, imperforate and granular centrally, flat or slightly convex. Primary orifice with circular distal part, with wide shallow proximal sinus, constricted by a pair of robust condyles. Distal margin of orifice serrated. One or rarely two avicularia lateral to orifice, with semicircular mandibles directed obliquely distally; short ligula projecting from crossbar. Avicularia rarely with enlarged spatulate mandible. Ovicell prominent to immersed, with subtriangular area of exposed endoecium proximally.

This species appears to be a synonym of *Hippoporella ligulata* Powell. Colonies are found encrusting solid objects. It is recorded from Vic., Tas. and N.S.W.; the westerly limit is unknown. Appearance of the colony varies depending upon the amount of secondary calcification, and whether the layer of zooids is the first, or a later superposed layer formed by frontal budding.

Iodictyum phoeniceum (Busk) Fig. 9.24d, Plate 28.5

Colony erect, fenestrate, branched, up to 70 mm in diameter, reddish-purple. Zooids subhexagonal or quadrate, separated by fine ridges when juvenile. Frontal surface convex, smooth, imperforate except for a few areolae. Orifice elliptical with a serrated, flared peristome which is obscured in older zooids by calcification around it. Fine pore (spiramen) opens on distal edge of peristome. Frontal avicularia sparsely distributed, with triangular mandible directed obliquely distally. Ovicell prominent in younger zooids; immersed in mature zooids, smooth except for central tubercle with terminal pore. Opening of ovicell with a pair of small comma-shaped notches. In early stages of ovicell development the frontal surface has a median longitudinal slit extending distally from the opening; this is covered by secondary calcification later in development. Basal surface smooth, with fine ridges at zooid contacts, and few small avicularia.

This species is easily recognised by the colour, which remains in preserved or dry specimens. It appears to be distributed widely through the region.

Rhynchozoon tubulosum (Hincks) Fig. 9.25c, d

Colony encrusting. Young, marginal zooids elliptical, distinct, with smooth frontal, and elliptical orifice. In central part of colony, mature zooids not distinctly separate from neighbours, with flat, granular frontal surface. Peristome deep, with internal anvil-shaped or hooked process on proximal side. Small suboral avicularium at base of process. Elongate frontal avicularia common, with mandibles directed proximally. Ovicells subimmersed to immersed, with convex, granular frontal surface.

The species of *Rhynchozoon* are not well known: detailed studies of variation within species are needed before taxonomic revision is possible. Colonies are

usually found encrusting rocks or shells. Distribution of this species appears to be wide in the Indian Ocean, the southwest Pacific, and southern Australia.

Schizoretepora tessellata (Hincks) Fig. 9.26a, b

Colony erect, fenestrate, branching complexly. Zooids subhexagonal or rhomboid, with contacts marked by fine ridges. Primary orifice subcircular with shallow sinus. Frontal surface convex, smooth, imperforate. Frontal avicularium with long, acute mandible directed obliquely proximally. Basal surface divided by fine ridges into areas which each contain a small avicularium with acute mandible. Ovicell prominent to subimmersed, with smooth frontal and a broad notch in the margin of the opening.

This species appears to be fairly common in shallow waters, particularly in S.A. but also in Vic.

Triphyllozoon moniliferum (MacGillivray) Fig. 9.26c, d

Colony erect, fenestrate, complexly branching, often forming tubular projections about 5 mm in diameter, with zooids opening inwards. Colonies up to 160 mm in diameter. Zooids subhexagonal, convex, with smooth or granular frontal surface; contacts of zooids distinct, with fine ridge. Primary orifice semicircular, peristome deep, with circular secondary orifice, proximal median notch or spiramen, and a pair of lateral articulated spines, usually jointed. A small suboral avicularium on peristome beside notch; frontal avicularium with semi-elliptical mandible. Basal surface with scattered small avicularia. Ovicells prominent to subimmersed, with trifoliate ornamented band, extending laterally just distal of ovicell opening, with distal extension to approximate middle of ovicell.

There is some confusion in the records of species of *Triphyllozoon*: several forms or varieties of this species described in the 19th century have been separated as distinct species, but detailed and diagnostic descriptions are not available. The colony form described for this species is distinctive; but it is not known whether this is useful in defining species. The species has been recorded from shallow water down to about 20 m.

Triphyllozoon umbonatum (MacGillivray) Fig. 9.27a, Plate 26.6

Colony erect, fenestrate, simply branched, up to 80 mm in diameter. Branching pattern usually not complex. Zooids subquadrate, arranged quincuncially, with convex, granular frontal surface; zooid contacts a distinct fine ridge. Primary orifice semicircular, usually at base of oblique peristome. Secondary orifice subcircular, usually without proximal notch. Frontal pore (spiramen) opens proximal to secondary orifice. A pair of fine tubular spines articulated at proximal angles of orifice. Avicularia of various types: suboral avicularium small, close to spiramen; suprafenestral avicularium large, convex, with semicircular mandible; fenestral avicularia small, with semicircular mandibles, numerous, also one or two large fenestral avicularia, with elongated

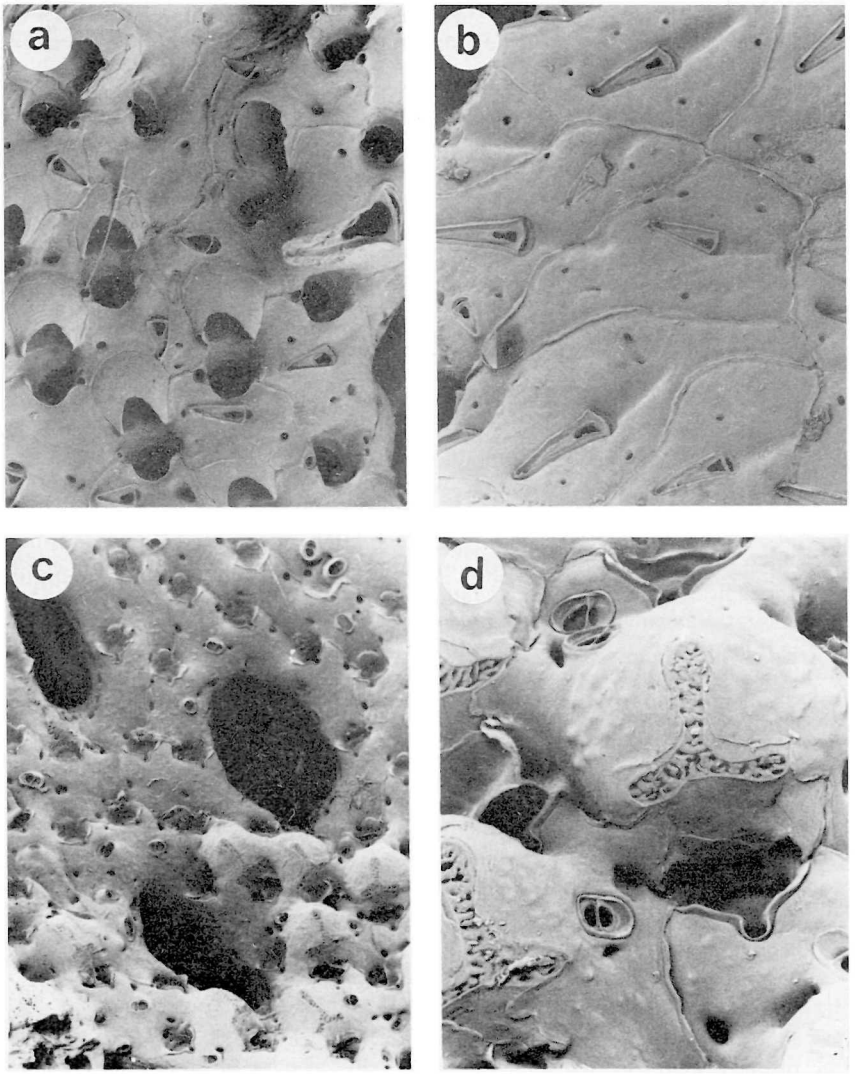


Fig. 9.26. *(a) Schizoretepora tessellata:* frontal surface; with ovicells (30x); *(b)* basal surface with avicularia (45x); *(c), (d) Triphyllozoon moniliferum: (c)* with fenestrae and ovicells (15x); *(d)* enlarged ovicell (85x).

mandible closing on a palate with two raised projections; basal avicularia small, numerous. Ovicell subimmersed, with convex frontal wall raised in a sharp spine or umbo, and with trifoliate ornamented band. Basal surface marked with clearly defined fine ridges.

This species appears to be fairly common, but shows apparently significant variation in characters, and in some cases may be close to *Triphyllozoon munitum*. The genus needs thorough revision, and measurement of intraspecific and interspecific variation of characters.

Cryptosula pallasiana (Moll) Fig. 9.27b

Colony encrusting, unilaminar. Zooids quadrate to subhexagonal, with distinct raised ridges at contacts. Frontal surface with moderately large perforations distributed uniformly. Orifice subquadrate, with rounded distal margin, and with short widened proximal part. Orifice surrounded by low, imperforate rim. Suboral avicularia rare. Ovicells absent.

This cosmopolitan species is a common component of the fouling fauna. It is found encrusting rocks, or other solid objects, usually in shallow water.

Watersipora arcuata Banta Fig. 9.27c

Colony encrusting, unlaminar or multilaminar with dark brown or black cuticle. Zooids subhexagonal, arranged quincuncially in longitudinal rows, with distinct contacts. Frontal wall with perforations uniformly distributed except around orifice; perforations at proximal and distal angles of zooids are specialised communication pores (septulae). Orifice at distal end of zooid, with semicircular distal margin, and proximal margin curved distally (concave); condyles conspicuous. Avicularia and ovicells absent.

The species is distinguished from a complex of closely related members of the genus by the concave proximal margin of the orifice. The genus is under revision. *W. arcuata* is also a significant component of the fouling community, and has mainly been recorded from the Pacific Ocean.

Lanceopora obliqua (MacGillivray) Fig. 9.28a, b, Plate 28.6

Colony bilaminar, discoid to lobate, attached by uncalcified flexible stem, up to 30 mm in diameter. Zooids rhomboid, arranged in arcuate rows oblique to growth axis, with distinct fine ridges at zooid contacts. Orifice terminal, subcircular, with rounded proximal sinus. Frontal wall with numerous perforations, more abundant near zooid margin. Fertile zooids with semicircular orifice about twice as wide as normal orifice. Ovicells immersed, with convex, perforated frontal constructed by the two or three neighbouring distal zooids. Avicularia absent.

This species is common in water deeper than about 20 m, along the southern coast of Australia. The soft stem is attached by rootlets to a soft, sandy substrate.

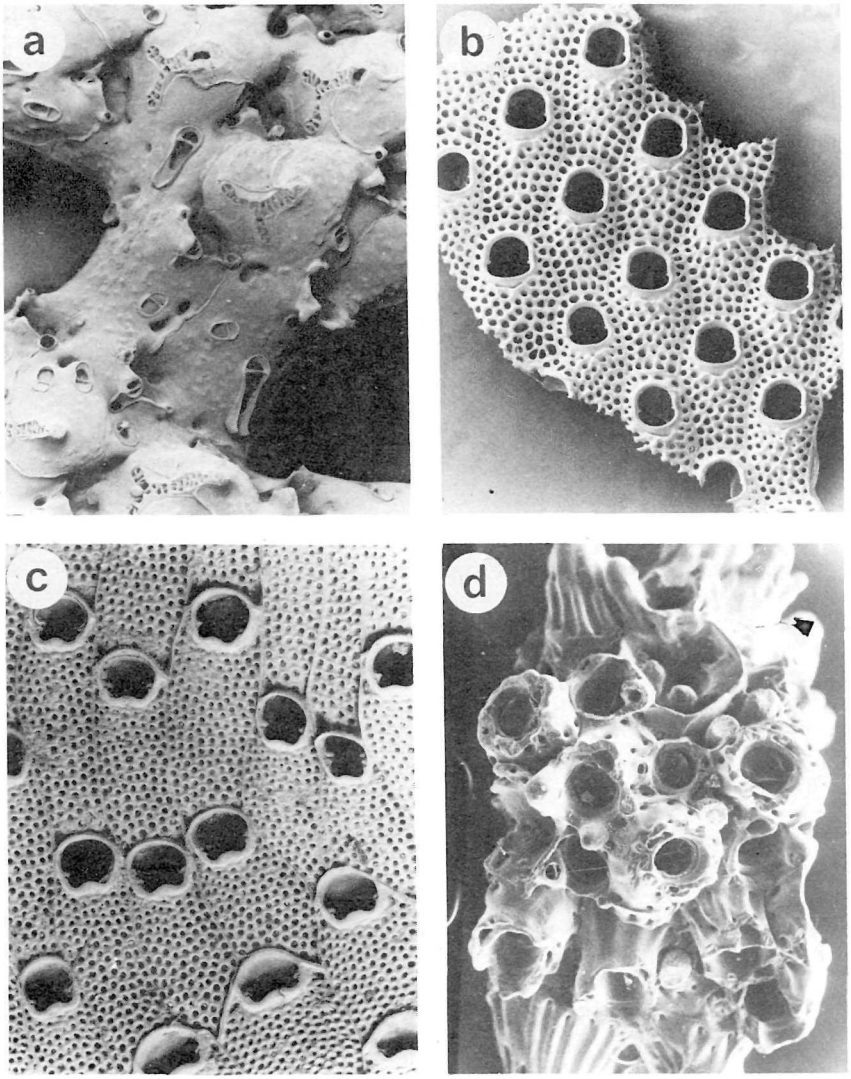


Fig. 9.27. *(a) Triphyllozoon umbonatum:* with ovicells and different types of avicularia (40x); *(b) Cryptosula pallasiana* (20x); *(c) Watersipora arcuata* (35x); *(d) Celleporina costata* (25x).

Celleporina costata (MacGillivray) Fig. 9.27d

Colony encrusting, multilaminar, up to 10 mm in diameter. Zooids irregular in shape and arrangement, rising from colony as erect, ribbed, cylinders with terminal orifices. Orifice subcircular with small proximal sinus. Peristome raised around orifice, produced into projections with small avicularia. Vicarious avicularia rare, elevated, with semicircular mandibles. Ovicells prominent, with smooth, convex frontal with a few perforations.

The colonies of this species are found encrusting stems of algae, hydroids, or bryozoans. The species appears to be widespread, at least in Victorian waters.

Celleporina spatula (MacGillivray) Fig. 9.28c

Colony encrusting, up to 30 mm in diameter, pink. Zooids arranged irregularly, rising above colony surface. Frontal surface often obscured, with a few round tubercles and with marginal areolae. Primary orifice subcircular, with deep proximal sinus. Peristome high, with proximal rounded prominence with suboral avicularium. Suboral avicularium with rounded mandible facing laterally, directed away from colony surface; vicarious avicularia with large spatulate mandibles, horizontally near general surface of colony. Ovicells prominent, with circular or semicircular area of exposed endooecium which is perforated by a row of radiating slits or elongate pores.

This species is mainly found encrusting shells or rocks.

Osthimosia glomerata (MacGillivray) Fig. 9.28d

Colony subspherical, multilaminar, encrusting. Zooids irregularly arranged, erect. Orifice subcircular, with wide, shallow sinus in proximal margin. Frontal surface usually obscured, smooth, with marginal areolae. Suboral avicularium small, with semicircular mandible, on raised prominence proximal or lateral to orifice; vicarious avicularia with small, spatulate mandibles. Ovicells prominent, with convex, smooth frontal wall.

O. glomerata is mainly found encrusting stems of hydroids. Its distribution is poorly known. A species of *Celleporina* has a similar colony form, but appears not to have been described.

Calpidium ponderosum (Goldstein) Fig. 9.30c

Colony erect, branching, about 80 mm high, composed of a large number of calcified internodes connected by flexible tubes. Internodes of one or two autozooids. Orifice approximately keyhole-shaped, constricted by a pair of condyles about one-third up from proximal end. Frontal surface with five tear-drop-shaped windows. Basal and lateral walls marked by several ridges of gymnocyst, separating areas of cryptocyst. Avicularia at both distal angles of internode. Ovicell at termination of branch, forming a large bulbous chamber

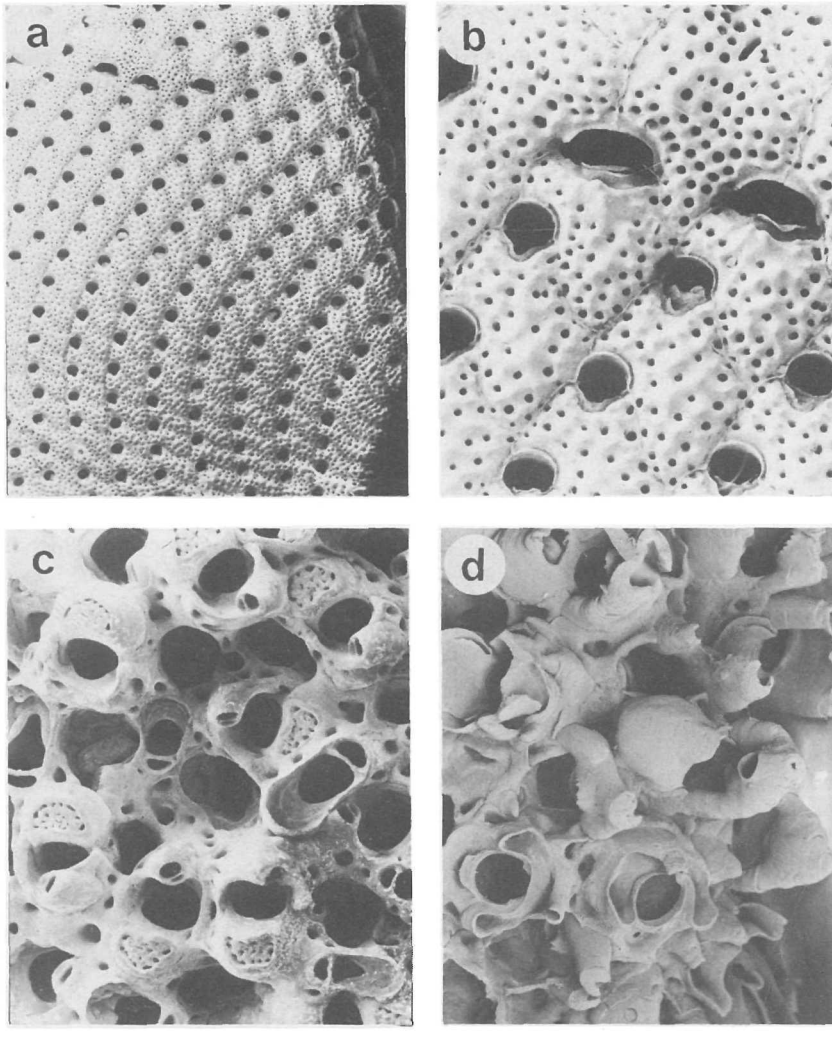


Fig. 9.28. *(a), (b) Lanceopora obliqua:* a proximal part of colony (15x); *(c)* fertile and infertile zooids (45x); *(c) Celleporina spatula:* with ovicells (25x); *(d) Osthimosia glomerata:* with ovicells (40x).

distal to a modified maternal zooid; frontal surface with ectooecium lacking from large area, with perforated endooecium.

The species is distributed fairly widely in the region, in depths from about 10 m down.

Claviporella aurita (Busk) Fig. 9.30b

Colony erect, branching, up to 25 mm high, composed of calcified internodes connected by flexible tubes. Internodes of one or two autozooids with bifurcations from double internodes. Orifice with subcircular distal section and deep, narrow sinus proximally. Frontal wall with central convex area with five small windows surrounding a central ascopore and with four lateral perforations. A pair of short spines lateral to orifice; pair of longer spines lateral to opening for distal communication tube. Lateral avicularia on special compartments forming distal angles of zooid; one of these may be enlarged, appearing like a gaping parrot beak. Ovicell terminal, globular, with small perforations on the ectooecium.

This species is found attached to algae or hydroids, and is widely distributed in South Australian and Victorian waters.

Cornuticella cornuta (Busk) Fig. 9.15d, e

Colony erect, branching, up to 50 mm high, composed of calcified internodes connected by flexible tubes. Internodes of one autozooid, or two autozooids at bifurcations. Orifice with semicircular distal margin, and arcuate proximal margin. Frontal surface smooth, convex centrally, with curved depression (vitta) on each side of internode, extending for entire length. Long spinose processes at distal angles, curved basally, with perforations near proximal end of frontal and basal surface. Lateral process absent from inner angle of proximal zooid of internode at bifurcation; less developed from inner angle of distal zooid. Lateral process may be replaced by avicularian chamber with gaping cavity for mandible. Ovicell from proximal zooid of a doublet; globular , with distal spine: maternal zooid lacking lateral processes. Basal surface smooth, convex.

C. cornuta has been recorded from Victorian and South Australian waters. *Cornuticella perforata* and *C. taurina* have also been recorded in the region.

Costaticella hastata (Busk) Fig. 9.29c

Colony erect, branching, up to 80 mm high, composed of calcified internodes connected by flexible tubes. Internodes of one autozooid, or two autozooids at bifurcations. Orifice semicircular. Frontal surface slightly convex, with a few lateral perforations and a central costal field with and outer row of about five to twelve infracostal windows, with an inner shield of about five to thirteen radiating costal spines. Minute costal windows perforate the surface of spines. Large angular lateral processes at outer distal angles of internode. Basal surface

ornamented with fine longitudinal ribs. Ovicell terminal, with large modified orifice in maternal zooid, perforations in ectooecium, and terminal short projecting process.

This appears to be a very common species in the region. As with other catenicellids, intraspecies and intracolony variation is great, and identifications of particular species should be treated with caution.

Orthoscuticella ventricosa (Busk) Fig. 9.29a, b, Plate 27.5

Colony erect, branching, up to 120 mm high, composed of calcified internodes connected by flexible tubes, yellow. Internodes of one autozooid, with two autozooids at bifurcations. Orifice nearly semicircular, with acute proximal angles. Frontal surface with seven large windows. Vittae lateral, fairly short and wide, with a few perforations in cryptocyst. Lateral processes at outer distal angles acute, with lateral avicularia. An area of cryptocyst on each side of distal opening for connecting tube (distal chambers). Basal surface smooth.

This is a common species in the region, but separation from similar species is difficult because of the amount of variation. Ovicells are either rare or absent: one reference on living bryozoans records 'ova in ordinary cells', which is unusual for catenicellids.

Paracribricellina cribraria (Busk) Fig. 9.30d, e

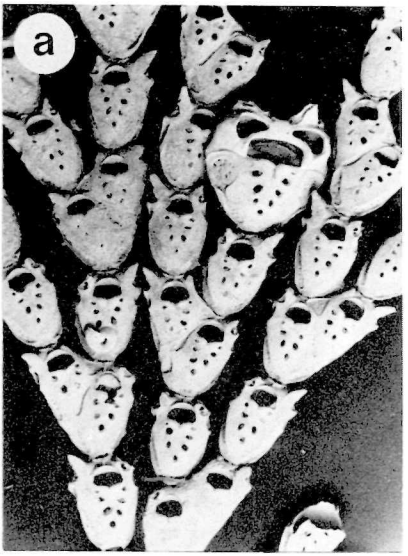
Colony erect, branching, up to 50 mm high, reddish-brown, composed of calcified internodes connected by flexible tubes. Internodes of one autozooid, with two autozooids at bifurcations. Orifice nearly semicircular, with acute proximal angles. Frontal surface perforated by numerous windows, with a row of large windows inside the proximo-lateral margin, and smaller windows on central area. Central lunate ascopore proximal to orifice. Wide lateral processes with gaping avicularia at distal angles of zooid. Basal surface smooth.

This is a common and widely distributed species in the region, also found in N.S.W. and New Zealand.

Pterocella alata (Wyville Thomson) Fig. 9.29d

Colony erect, branching, up to 30 mm high, pink, composed of calcified internodes connected by flexible tubes. Internodes of one autozooid, with two autozooids at bifurcations. Orifice semicircular. Frontal wall with marginal windows, either with narrow band of cryptocyst, or uncalcified. Semicircular costal shield proximal to orifice with about five to seven infracostal windows, and with spines radiating from centre to the infracostal windows. Lateral processes long and thin, with acute distal angles, possibly uncalcified. Basal

Fig. 9.29. *(a), (b) Orthoscuticella ventricosa: (a)* part of colony; with fertile internode (18x); *(b)* single internode, with adhering coralline alga and algal borings (85x); *(c) Costaticella hastata* (90x); *(d) Pterocella alata:* double internode (68x).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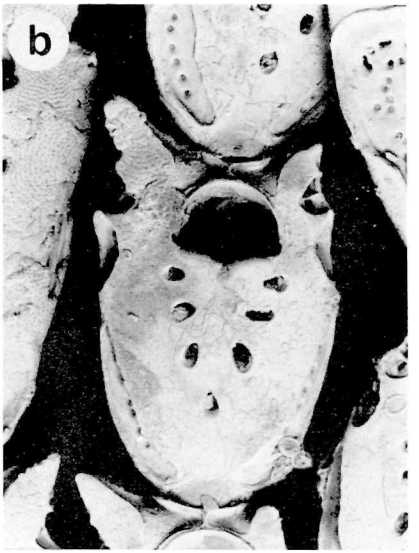
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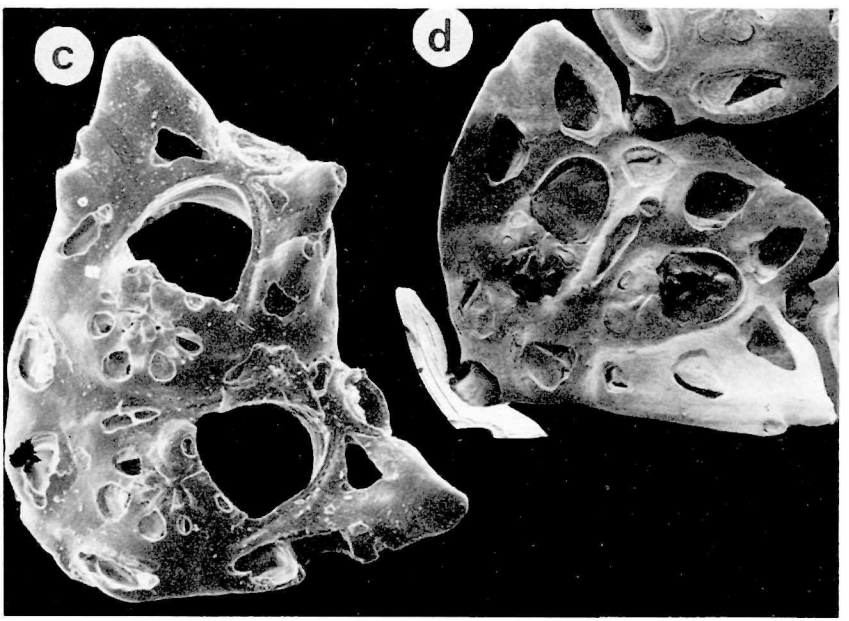
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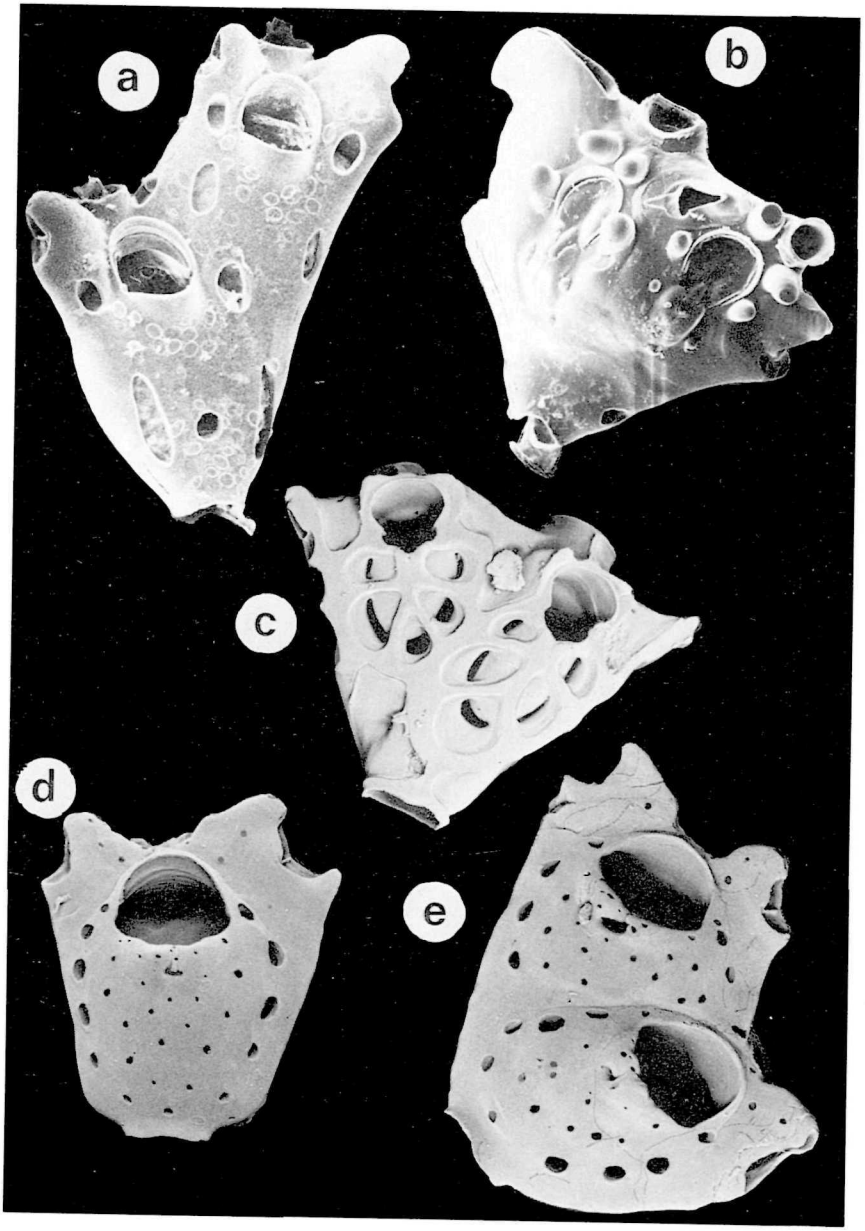
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surface convex, with fine longitudinal ribs. Ovicells are apparently either rare or absent.

This species has been recorded from numerous localities, but may need revision.

Vittaticella elegans (Busk) Fig. 9.30a, Plate 27.6

Colony erect, branching, up to 50 mm high, brownish purple, composed of calcified internodes connected by flexible tubes. Internodes of one autozooid, with two autozooids at bifurcations. Orifice with semicircular distal margin and arcuate proximal margin; proximal angles obtuse. Frontal surface smooth, with vittae near each proximal margin, extending about half the length of the internode or less. A subcircular window lateral to each side of orifice. Avicularian chambers at distal angles, rounded with wide gape containing mandible, directed distally. Ovicell located between two zooids of a doublet which is not a bifurcation, immersed, with few perforations in frontal surface. Basal surface of zooids smooth.

GLOSSARY

Alveolus: small cavity or pit between zooecia in cyclostomes.

Ancestrula: first formed zooid in a colony.

Areola: marginal pore on frontal wall in some cheilostomes connecting endocyst with ectocyst.

Arcuate: arched; bow-shaped.

Ascopore: small opening in frontal wall of some cheilostomes, connecting the ascus to the external environment.

Ascus: hydrostatic organ in some cheilostomes.

Autozooid: a normal feeding zooid.

Avicularium (pl. avicularia): specialised cheilostome zooid with reduced polypide but with strong muscles which operate a mandible-like operculum.

Bifurcate: like a two-pronged fork.

Bilaminar: consisting of two layers of zooecia growing back to back with a double walled median lamina between them.

Bilobate: having two lobes.

Condyle: rounded protuberance on which the operculum is hinged.

Costa: radially arranged ridge forming part of frontal shield.

Cryptocyst: shelflike calcareous lamina under frontal membrane extending in from proximal, mural rim.

Fig. 9.30. *(a) Vittaticella elegans:* double internode; with adhering diatoms (114x); *(b) Claviporella aurita* (90x); *(c) Calpidium ponderosum:* internode of two autozooids (80x); *(d), (e) Paracribricellina cribraria: (d)* single internode (75x); *(e)* double internode (75x).

Distal: away from the ancestrula of the colony.

Ectocyst: anterior layer of wall of zooecium.

Ectooecium: external, calcareous wall of ovicell.

Endooecium: inner calcareous wall of ovicell.

Endotoichal: type of ovicell in some cheilostomes consisting of a hollow formed by resorption of thick, frontal wall and provided with independent opening outwards.

Fenestra (adj. fenestrate): open spaces or meshes in reticulate zoaria of some cheilostomes.

Frontal: pertaining to the exposed or orifice-bearing sides of zooecial chambers.

Funiculus: strand connecting polypide to zooidal wall or with communication pores.

Gonozooid: in cyclostomes, and some cheilostomes, a modified zooid used as a brood chamber for larvae.

Gymnocyst: marginal calcified portion of frontal wall in some cheilostomes.

Heterozooid: a specialised zooid such as an avicularium or a rhizoid.

Hyperstomial: type of external ovicell in cheilostomes resting on or indenting distal wall of associated zooecium.

Internode: segment of jointed colony between surfaces of articulation.

Kenozooid: zooid without polypide and usually without orifice or muscles.

Lenticular: shaped like a double convex lens.

Ligula: calcareous projection from the cross-bar of an avicularium.

Lophophore: circular or horsehoe-shaped ridge around mouth of polypide bearing ciliated tentacles.

Lunate: crescent shaped.

Lyrule: median tooth on proximal edge of orifice.

Neanic: the early stage of colony development (astogeny); opposite of ephebic.

Node: a place of articulation in a jointed colony.

Ooeciostome: peristome surrounding aperture of ovicell for escape of larvae.

Ooecium: ovicell or brood pouch.

Opesia: large opening of anascans, usually equal to entire frontal area of zooecium, bordered by cryptocyst and covered by frontal membrane.

Opesiule: small groove or opening in cryptocyst for passage of depressor muscles attached to ectocyst.

Ovicell: globular brood pouch of cheilostomes.

Parietal pore: perforation in distal wall of zooecium of some cheilostomes serving as passageway for fibres connecting polypides.

Pedunculate: elevated on a stalk (usually referring to avicularia).

Peristome: rim surrounding an orifice.

Polypide: the living material in an individual in a bryozoan colony.

Proximal: directed toward the ancestrula.

Pseudopore: perforation in the skeleton of some cyclostomes, obstructed by organic material.

Quincuncial: arrangement of four objects symmetrically placed around a fifth.

Rhizoid, rhizozooid: rootlike structure—a modified zooid.

Scutum: large fan-shaped spine overhanging an aperture.

Septulum (pl. septula): single or grouped perforations in walls of zooids for communication between zooids or part of a single zooid.

Seta: slender bristle or hair; modified operculum in vibraculum.

Sinus: slit or depression at proximal edge of orifice.

Spatulate: spoon-shaped.

Spiramen: median pore in frontal wall on proximal side of orifice, not communicating directly with the ascus.

Subimmersed: partly buried in the colony.

Vibraculum: modified avicularium with mandible replaced by a bristle-like seta.

Vicarious avicularium: one that replaces an autozooid in a series.

Vitta: depression in the frontal wall of some ascophorans.

Zoarium: a bryozoan colony (obsolete).

Zooecium: the outer skeleton of an individual of a bryozoan colony.

Zooid: single member of a bryozoan colony consisting of polypide and zooecium.

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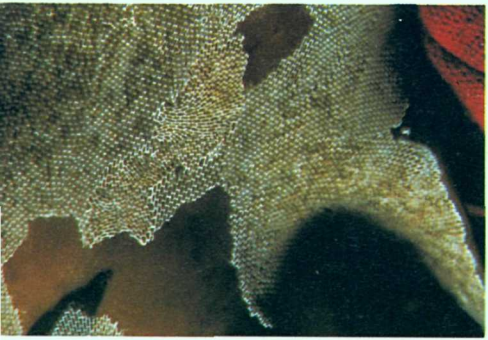
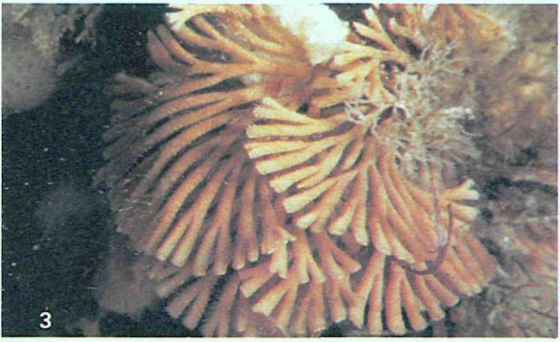
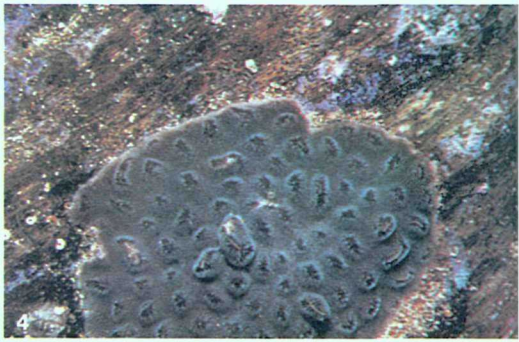


Plate 25. 1. *Membranipora membranacea*, dead colony (J.E.W.), 2. *Membranipora perfragilis* (J.E.W.), 3. *Bugula cucullata* (J.E.W.), 4. *Celleporaria* cf. *fusca* (J.E.W.), 5. *Petralia undata* (J.E.W.), 6. *Parasmittina unispinosa* (N.H.).





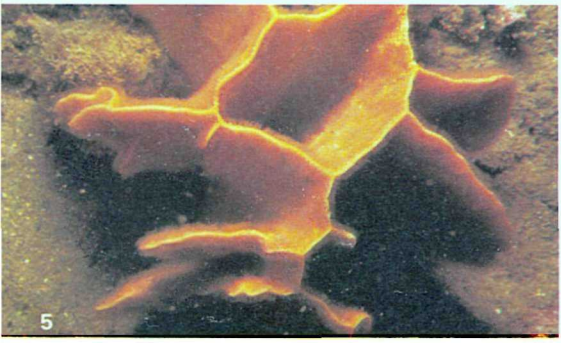
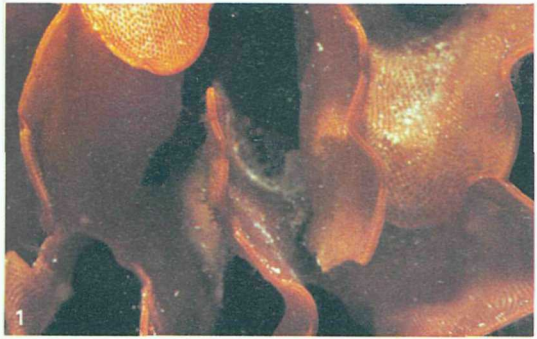
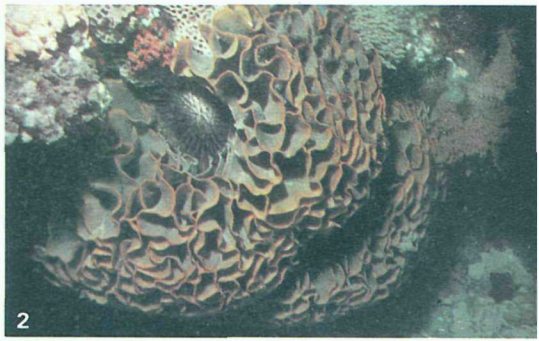


Plate 26. 1. *Cellaria pilosa* (J.E.W.), 2. *Cornucopina grandis* (J.E.W.), 3. *Caberea grandis* (J.E.W.), 4. *Celleporaria* sp., 5. *Cigclisula verticalis* (M.R.), 6. *Triphyllozoon umbonatum* (J.E.W.).





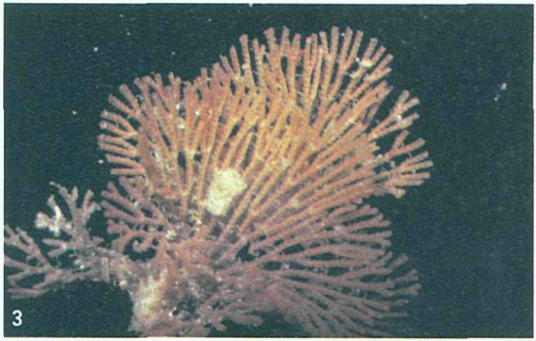
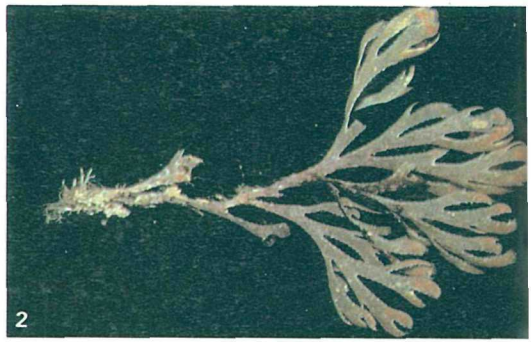
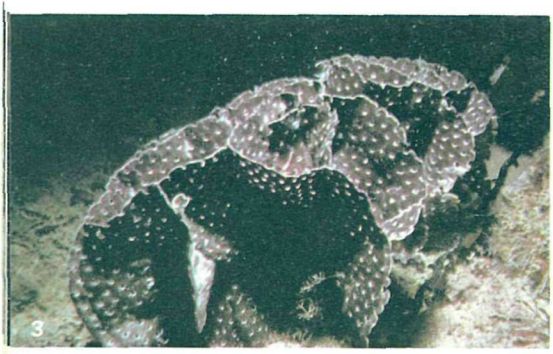
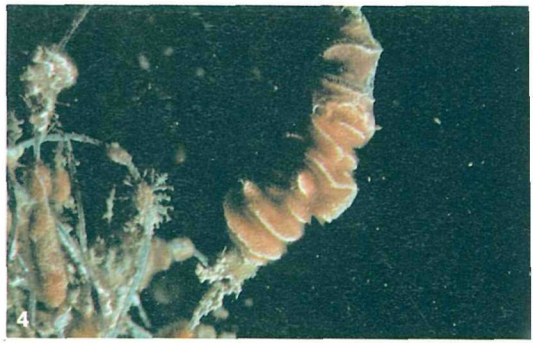


Plate 27. 1. *Membranipora perfragilis* enlarged (J.E.W.), 2. *Steginoporella truncata* (M.S.), 3. *Canda arachnoides* (I.K.), 4. *Celleporaria* sp. (J.C.), 5. *Orthoscuticella ventricosa* (J.E.W.), 6. *Vittaticella* sp. (J.E.W.).







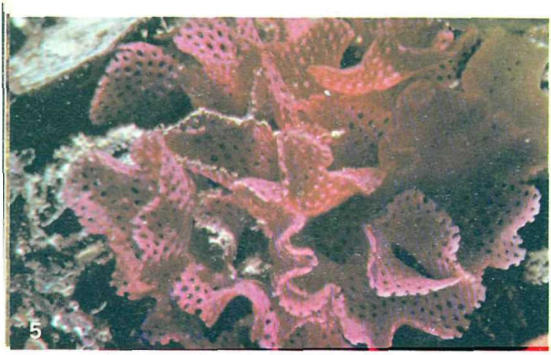


Plate 28. 1. *Bugula dentata* (M.K.), 2. *Bugularia dissimilis* (I.K.), 3. *Adeona cellulosa* (J.E.W.), 4. *Celleporaria cristata* (J.C.), 5. *Iodictyum phoeniceum* (C.A.D.), 6. *Lanceopora obliqua* (J.C.).