Diversity and Zoogeography of South African Bryozoa

Melissa Kay Boonzaaier

UNIVERSITY of the
WESTERN CAPE

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Department of Biodiversity and Conservation Biology
University of the Western Cape
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DECLARATION

I declare that *Diversity and Zoogeography of South African Bryozoa* is my own work, that it has not been submitted for any degree or examination in any other university, and that all the sources I have used or quoted have been indicated and acknowledged by complete references.

Full name: Melissa Kay Boonzaaier

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Research outputs from this dissertation

Accredited Research Outputs:

Manuscript: "Historical review of South African bryozoology: a legacy of European endeavour" (December 2014) Annals of Bryozoology 4: aspects of the history of research on bryozoans, Patrick N. Wyse Jackson and Mary E. Spencer Jones (eds).

M.K. Boonzaaier[1,2], W.K. Florence[1], M.E. Spencer-Jones[3]

[1]Natural History Department, Iziko South African Museum, Cape Town, 8000, South Africa

[2]Biodiversity and Conservation Biology Department, University of the Western Cape, Bellville 7535, South Africa

[3]Department of Life Sciences, Natural History Museum, London SW7 5BD, United Kingdom

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ABSTRACT

The taxonomic history of South African bryozoans is fragmented and outdated, with the majority of published works in the 20th Century. Sampling gaps exist in deep-sea regions and parts of the coastline, while existing collections within museums remain undetermined due to scarcity of specialist taxonomists. This project forms part of a larger project aimed at updating marine invertebrate biodiversity in South Africa. Outcomes of this project include updating bryozoan biodiversity by identifying species from existing collections housed in natural history museums (e.g., Iziko South African Museum, Cape Town and Natural History Museum, London), and analysing current regional bryozoan biogeographical and depth-related species richness patterns. The biogeography and richness of bryozoan species around South Africa was investigated using published distribution records from the literature and museum catalogues as well as examining un-worked bryozoan material from Iziko South African Museum. A total of 368 species of bryozoans were recorded, including twelve new species (*Favosipora epiphyta* sp. nov., *Chaperiopsis* (*Chaperiopsis*) *yinca* sp. nov., *Aspidostoma staghornea* sp. nov., *Micropora erecta* sp. nov., *Trypostega infantaensis* sp. nov., *Khulisa ukhololo* sp. nov., *Adeonella assegai* sp. nov., *Celleporaria umuzi* sp. nov., *Hippomonavella lingulatus* sp. nov., *Microporella lezinyosi* sp. nov., *Phidolopora cyclops* sp. nov. and *Reteporella ilala* sp. nov.) and 70 unidentified species. Distribution data for 286 valid species were separated by depth zones (shallow waters, subphotic zone, shelf edge, bathyal zone and abyss) and four biogeographic regions are recognised a priori around South Africa, namely the west, south, southeast and east coasts. This study revealed that there is a clear biogeographic structure to regional bryozoan fauna of South Africa. Species richness and endemism appear lowest on the west coast (104 species) and highest on the south coast (174 species), while local peaks are observed in the Cape Peninsula/False Bay area, East London, Durban and St. Lucia, which coincide with distinct genetic lineages for some marine taxa (e.g. octocorals, chitons, echinoderms, fishes, seaweeds). Although, the faunal break in Durban does not represent a peak in species richness in this study, but rather very low bryozoan richness, highlighting the undersampled areas north of Durban. The northward-flowing Benguela Current and strong upwelling centres may influence the low diversity on the west coast. On the south coast, the high diversity may be attributed to the Agulhas Current that can carry larvae southwards and eastward-flowing counter currents produce great variability in bryozoan communities in this region. Within any biogeographic region, bryozoan diversity was higher in shallower (< 500 m) than deeper waters, which may be attributed to sampling effort and heterogeneity (e.g. variable substrate and wave action) in shallower waters.

Keywords: Bryozoa, distribution patterns, gradients, species richness, South Africa

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DEDICATION

"What you need, above all else, is a love for your subject, whatever it is. You've got to be so deeply in love with your subject that when curve balls are thrown, when hurdles are put in place, you've got the energy to overcome them." - Neil deGrasse Tyson

I lovingly dedicate my thesis to my beautiful 84-year old grandmother, 'Ouma' Caroline Keet (née Abrahams). She is a pillar of strength and unity in our family, and her unconditional support and love throughout my life has been tremendous. I am so grateful that 'Ouma' was part of this long studious journey of mine. I love you always.

Ouma Caroline's (middle) visits the Iziko South African Museum in Cape Town, with my Mom, Sonia (right), a few months after I started with my doctoral studies.

Photo taken on 9 August 2012, Women's Day.

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CHAPTER 1. AN INTRODUCTION TO SOUTH AFRICAN MARINE BRYOZOAN DIVERSITY

1. Phylum Bryozoa

1.1. Classification of bryozoans

Bryozoans (referred to as “moss animals” or “sea mats”) are aquatic, sessile colonial animals and typically found attached to various substrates such as rocks, shells, algae and even on other bryozoans (Bock 1982; Hayward and Ryland 1999). The phylum Bryozoa is monophyletic and consists of predominantly marine species, with some freshwater and estuarine species (Hayward and Ryland 1999; Fuchs *et al.* 2009). The recent classification given here follows that of Bock and Gordon (2013). Bryozoa can be divided into three monophyletic classes (Table 1.1): Gymnolaemata, Stenolaemata and Phylactolaemata, but it is uncertain as to whether Stenolaemata are more closely related to Phylactolaemata or Gymnolaemata (Wyse Jackson and Spencer Jones 2002; Branch and Hayward 2007; Fuchs *et al.* 2009). Phylactolaemata is exclusively freshwater, while Stenolaemata (Order: Cyclostomata) and Gymnolaemata (Orders: Ctenostomata and Cheilostomata) inhabit marine and/or estuarine environments (Hayward and Ryland 1999; Bock and Gordon 2013).

Within the Gymnolaemata, soft-bodied Ctenostomata and mineralised Cheilostomata are not considered monophyletic, in fact, mineralised skeletons are more likely to have evolved more than once within the early gymnolaemates (Fuchs *et al.* 2009). In a previous study, results suggested that Bryozoa are closely related to lophophorates such as Brachiopoda and Phoronida, in the super-phylum Lophotrochozoa, which also includes the phyla Annelida and Mollusca (Helmkampf *et al.* 2008). This study also concluded that brachiopods and phoronids each formed monophyletic groups, while bryozoans (ectoprocts) formed a monophyletic group with entoprocts (Helmkampf *et al.* 2008), while a study of the mitochondrial DNA sequence suggested that Bryozoa may be related to Chaetognatha, a phylum of predatory marine worms (Shen *et al.* 2012). This confusion seems to be resolved by Nesnidal *et al.* (2013) where phylogenetic analyses strongly support the monophyly of Lophophorata and that Brachiopoda formed a sister group to Phoronida and Bryozoa.

Bryozoans are the only major phylum of exclusively clonal animals and form colonies. A typical bryozoan colony consists of a replicated series of functional units called zooids and grows by continuous asexual budding from a single sexually-produced primary zooid, the ancestrula (Bock 1982; Hayward and Ryland 1999). Colonies may consist entirely of identical autozooids, or include specialised polymorphs, called heterozooids (Hayward and Ryland 1999). Each autozooid has an eversible, bell-shaped or horseshoe-shaped lophophore with ciliated tentacles (Hayward and Ryland 1999). The orifice, through which the lophophore everts, may be closed by hinged flap called the operculum (Hayward and Ryland 1999). The

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mouth is situated at the middle of the lophophore and a U-shaped gut resides in the body cavity of the zooid (Hayward and Ryland 1999). The gut consists of a short, fat pharynx, a slender oesophagus, stomach, a slender intestine passes to a short rectum and opens at a dorsally situated anus (Hayward and Ryland 1999). The lophophore, gut and associated muscles, are collectively termed the polypide and a nerve ganglion is present between the mouth and anus, with nerves radiating to other parts of the zooid (Hayward and Ryland 1999). Therefore, autozooids are functionally independent, while the energy needs of heterozooids are supplied by the autozooids (Hayward and Ryland 1999). Adjacent zooids are separated by walls constructed of skeletal material and organic cuticle, with septular pores that allow for communication between zooids, by a funicular system (Bock 1982).

Cyclostome bryozoans are distinguished by cylindrical zooids with calcified body walls and limited polymorphism, while ctenostomes and cheilostomes include cylindrical or box-shaped zooids, calcified or non-calcified body walls and well-developed polymorphism (Branch and Hayward 2007). Ctenostomes have non-calcified, membranous or gelatinous zooid walls, orifice closed by sphincter, and heterozooids are limited to stolons and spines (Branch and Hayward 2007). In cheilostomes, heterozooids include avicularia (reduced polypide and a modified operculum, now called a mandible), vibracula (an operculum in the form of a long seta), rhizoids (modified rootlets that attach the colony to the substrate), kenozooids (no polypide, and usually without an orifice or muscles), zooeciules (small zooid with an orifice), and some spines (Ryland and Hayward 1977; Bock 2013).

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The skeletal material of cheilostomatous bryozoans consist of calcium carbonate, most specifically in varying ratios of aragonite and calcite, two of three mineral polymorphs calcium carbonate (Taylor *et al.* 2008). The outer cuticular body wall of the autozooid is called the gymnocyst (Hayward and Ryland 1999). In ascophoran bryozoans, the frontal wall or cryptocyst may be smooth or rugose, entire or porous (Branch and Hayward 2007). In addition to having a completely calcified frontal wall, ascophorans possess an ascus, a water-filled sac of frontal membrane opening at or near the orifice (Figure 1.1) (Hayward and Ryland 1999). The ascus allows water into the space below the frontal wall by muscles pulling the frontal membrane inwards when the zooid everts its polypide, functioning as a hydrostatic system (Boardman and Cheetham 1983; Hayward and Ryland 1999). It was previously thought that the infraorder Ascophorina was monophyletic, but recent data demonstrated that the ascus and associated structures involved in lophophore extension evolved multiple times and that Ascophorina is in fact non-monophyletic (Sarah *et al.* 2011; Lidgard *et al.* 2012). Cheilostomes in the suborder Flustrina included those with the frontal wall uncalcified, or part of it, and flexible, however new data suggests that Flustrina is polyphyletic (Branch and Hayward 2007; Ostrovsky 2013).

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Table 1.1. Main characteristics of the three orders of marine bryozoans adapted from Hayward and Ryland (1999) and Ostrovsky (2013).

Class	**Stenolaemata**	**Gymnolaemata**	
Order	Cyclostomata	Ctenostomata	Cheilostomata
Environments	Marine	Mostly marine	Mostly marine
Colony shapes	Erect or encrusting	Erect or encrusting	Erect, encrusting or free-living
Exoskeleton material	Mineralised	Chitin, gelatinous or membranous; unmineralised	Mineralised
Lophophore extension	Compressing membranous sac	Compressing the whole body wall	Pulling inwards of a flexible section of body wall or an internal sac that expands
Types of zooid	Limited heterozooids, mainly kenozooids and gonozooids	Stolons and spines as well as autozooids	Range of types
Reproduction	Embryos brooded in gonozooids	Embryos brooded within parent zooid	Embryos brooded in specialised brooding chambers

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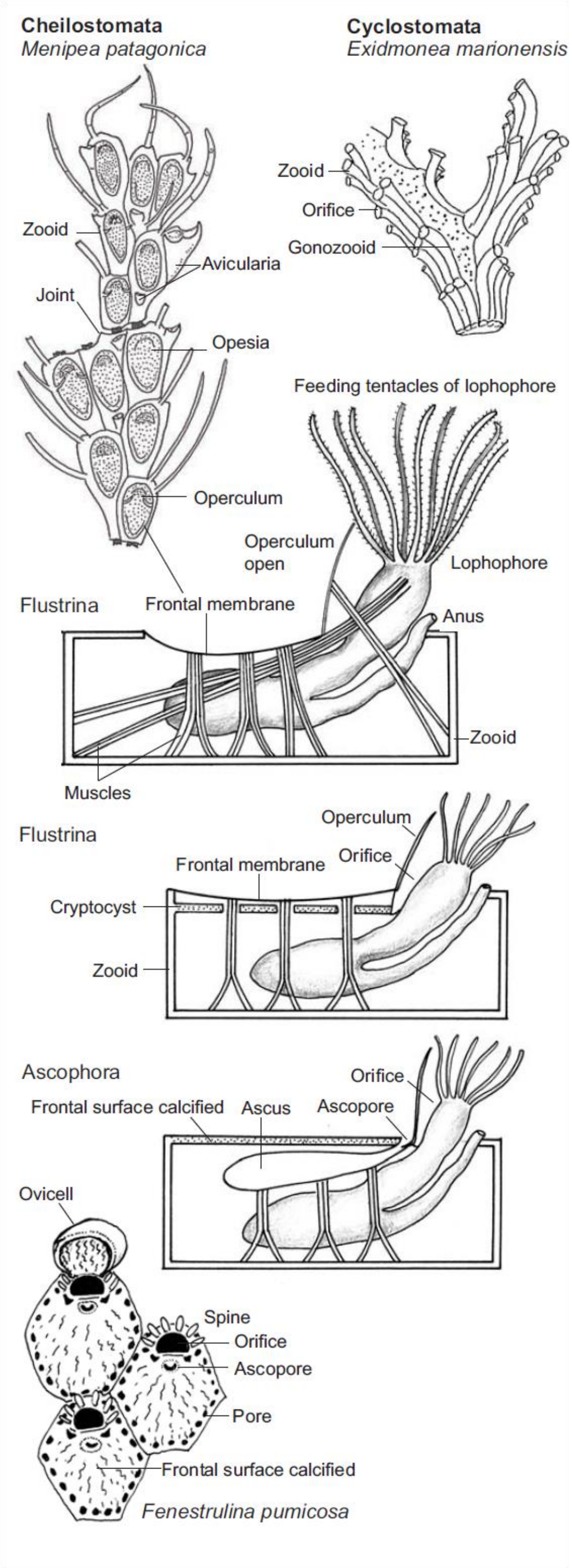

Figure 1.1. Main morphological characteristics of cheilostomes and cyclostomes. Although the suborder Flustrina is not applicable. *Image taken from Branch and Hayward (2007)*

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1.2. Colony morphotypes

Bryozoans naturally occur in a wide range of skeletal morphologies and heavily calcified structures or growth forms are formed by utilizing a wide range of biominerals (Smith *et al.* 2006). They can form thin, flat or thick, circular or irregular encrustations; or form erect tufts or bushy colonies that may resemble hydroids or small seaweeds, while other bryozoans can form rigid coral-like structures, referred to as lace corals (Smith and Gordon 2011).

It has been well-documented that colony morphotypes can be influenced by environmental parameters often related to depth such as substrata, rate of sedimentation and turbulence (e.g. Stach 1936; Lagaaij and Gautier 1965; Harmelin 1976; Hageman *et al.* 1998; Reid 2010). It has also been suggested that increasing temperatures and decreasing pH in global oceans, known as ocean acidification, may negatively effect calcification and growth in bryozoans, but few empirical studies exist to support this hypothesis and different species may react differently to environmental changes (Smith 2014). Ocean acidification is caused by an increase in carbon dioxide (CO_2) in the atmosphere, an acid gas that leads to the reduction of seawater pH when dissolved in seawater (Saderne and Wahl 2013).

In some studies, for example Durrant *et al.* (2013), found that lowered pH levels and higher temperatures significantly reduced the growth rate of *Celleporaria nodulosa* (Busk, 1881). Unlike *C. nodulosa*, high concentrations of atmospheric carbon dioxide (pCO_2) – thus low pH levels – do not effect the growth rate of *Alcyonidium hirsutum* (Fleming, 1828) and *Electra pilosa* (Linnaeus, 1767), and enhanced the growth rate of *E. pilosa* was observed at intermediate levels of pCO_2 (Saderne and Wahl 2013). Therefore, understanding the underlying mechanisms in bryozoan colony growth may offer considerable advantages to study the effects of a changing ocean (Smith *et al.* 2006; Smith 2014; Figuerola *et al.* 2015).

In South Africa, colony growth in bryozoans and its relation to environmental conditions has not received much attention, with one paper on fossil bryozoans from Brood (1976) and a section on extant bryozoans in a monograph from Hayward and Cook (1979). Brood (1976) examined fossil bryozoans from shallow-water reef communities along the East African coast that comprised largely of encrusting cheilostome forms such as *Escharoides*, *Crassimarginatella* and *Microporella* species. The second most common group of bryozoans were tuft-like forms including genera of *Buguloidea* and *Cellarioidea*, that grow on the upper side of corals and rocks in reef areas associated with high energy (turbulent) environments (Brood 1976).

Deep-water environments are less turbulent with low sedimentation rates (Hayward and Cook 1979). The substratum in depths beyond the continental shelf is rather restricted to sediment particles and not suitable for encrusting species, except for minute colonies of *Characodoma protrusum* (Thornely, 1905) that are able to encrust sand grains (Hayward and Cook 1979). Therefore, the majority of species reported from deeper waters generally grows

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as secondary fauna on flexible substrata and comprises of tuft-like (cellulariiform and cellariform) and branching (adeoniform and reteporiform) forms (Hayward and Cook 1979). The primary bryozoan fauna of fine sediments in deep-water environments are the most abundant of bryozoans, containing very few species (e.g. *Batopora* spp., *Notocoryne cervicornis* Hayward and Cook, 1979 and *Conescharellina africana* Cook, 1966) and represents the least common of morphotypes, namely conescharelliniform, lunulitiform and setoselliniform (Hayward and Cook 1979). South Africa has a wide range of microhabitats that may influence colony growth and reproduction in bryozoans that need to be addressed in the future.

1.3. Reproduction and life histories

All bryozoan colonies are hermaphroditic, thus producing male and female gametes (Hayward and Ryland 1999). Autozooids may be dioecious or monoecious and protandrous[1] or protogynous[2] (Hayward and Ryland 1999). Many cheilostomatous bryozoans exhibit protandrous zooids, while in some dioecious[3] species, including all cyclostome species, male and female zooids may be morphologically dissimilar (Hayward and Ryland 1999). Male zooids may be smaller than other zooids, with smaller orifices and modified lophophores (Hayward and Ryland 1999). Female zooids may be larger or smaller than autozooids for internal brooding of embryos, and may be enlarged and specialised, or reduced and serving merely to produce ova and support a brooding ovicell as observed in *Celleporella* with ovicelled dwarf zooids (Hayward and Ryland 1999).

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Bryozoans are unique among invertebrates in possessing placenta-like analogues (for example brooding ovicells) and displaying extraembryonic nutrition in all high-level (class) taxa (Ostrovsky *et al.* 2009). Extant representatives of the classes Stenolaemata and Phylactolaemata are evidently all placental (Ostrovsky *et al.* 2009). Recently, Ostrovsky (2013) studied the various types of brood chambers found in living and fossil Cheilostomata, and suggests that chambers for incubation of the embryo evolved in this group at least seven times – in Aeteidae, "*Carbasea*" *indivisa* , Scrupariidae, Thalamoporellidae, Calloporidae, Tendridae, *Bellulopora* and possibly Alysidiidae – from modified mural spines, kenozooids, outgrowths of the zooid wall and fertilization envelopes. The conclusion was based on the differences in their morphology and the pattern of their distribution in the Cheilostomata and ultimately suggests that the suborder Flustrina (= Neocheilostomina) is polyphyletic.

The considerable modification of some cheilostome brooding structures that evolved independently several times was probably associated with enhancement of their protective

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[1] The male reproductive organs come to maturity before the female reproductive organs.
[2] The female reproductive organs come to maturity before the male reproductive organs.
[3] The male and female reproductive organs in separate individuals.

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function (Ostrovsky 2013). The most common brooding structure in Cheilostomata is the ovicell, a globular structure situated at the distal end of the maternal zooid (Figure 1.2) (Hayward and Ryland 1999). The ovicell develops as a double fold of tissue, enclosing a flat lumen, with the ectooecium (outer layer) usually uncalcified and membranous frontally, exposing the endooecium (inner layer) which may have uncalcified spots or larger lacunae (Hayward and Ryland 1999). In other brooding structures as seen in *Microporella* species, both layers may be completely calcified and the frontal surface of the ovicell may develop ridges or knobs (umbones) (Hayward and Ryland 1999). In cyclostomes, the brooding of polyembryonous larvae occur in large (inflated) polymorphic zooids called gonozooids, but this structure can be seen in a minority of ascophorine cheilostomes, for example *Reptadeonella* (Hayward and Ryland 1999).

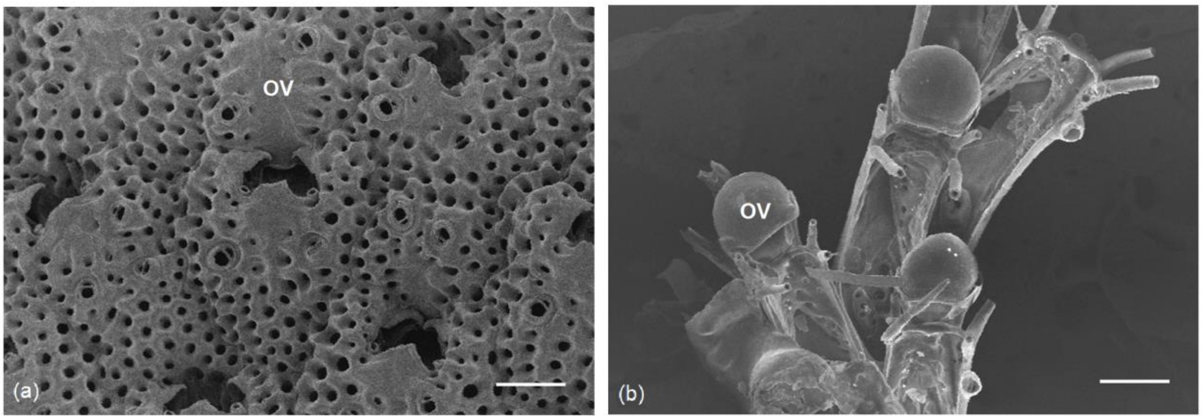

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Figure 1.2. Two different types of ovicells (OV). (a) Dependent, prominent, immersed ovicell of *Escharoides custodis*. (b) Independent, hyperstomial ovicell of *Bugula dentata* Lamouroux, 1816. Scale bars = 0.2 mm; magnified x75.

In cheilostomes, two major larval types exist, namely planktotrophic and lecithotrophic larvae. The majority of species produce lecithotrophic larvae in bulk or non-feeding coronate larvae, which generally settles within a few hours of release (Hayward and Ryland 1999). In other species, for example in the family Membraniporoidea, numerous small eggs are released directly into the sea and develop into shelled planktotrophic larvae, called cyphonautes, which feed and grow for several weeks or months in plankton (Hayward and Ryland 1999). The larvae of all cyclostomes are small spheres with slightly flattened oral poles and a densely ciliated outer cuticle (Hayward and Ryland 1985).

Upon settlement, a larva undergoes metamorphosis to form the primary zooid, the ancestrula, which may be single or twinned; or the larva may differentiate simultaneously into three or six ancestrular zooids (Hayward and Ryland 1999). In cyclostomes though, the larva metamorphose into a simple proancestrula (or primary disc) that calcifies its body wall to develop a tubular distal extension to complete the ancestrula (Hayward and Ryland 1985).

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In both cheilostomes and cyclostomes, budding commences often before the ancestrula has differentiated a functional polypide and the development of a colony from the ancestrula is termed astogeny, while the transitional zone from neanic (juvenile) to ephebic (mature or adult) zooids is referred to as the zone of astogenic change (Fig. 1.3a) (Hayward and Ryland 1999). Subsequently, the colony enters a period of astogenic repetition – identical modules differentiate from each succeeding generation of buds (Hayward and Ryland 1999). The colony periphery is usually marked by a fringe of developing zooids, this is the growth zone (Figure 1.3b), also referred to as the zone of ontogenetic change (Hayward and Ryland 1999).

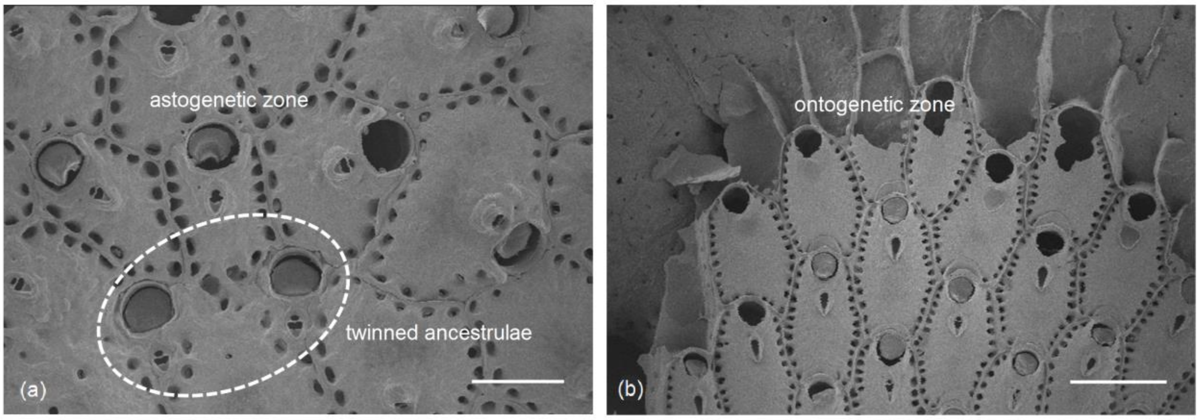

Figure 1.3. *Hippomonavella* cf. *praeclara* (SAMC-A029010) showing (a) twinned ancestrula, overgrown proximally, and the astogenic zone where zooids develop from the ancestrula (scale bar = 0.2 mm, magnified x100), and (b) the colony periphery with developing zooids, called the ontogenetic zone (scale bar = 0.2 mm, magnified x50).

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Cycles of growth and reproduction vary widely among bryozoans. Some species, like *Celleporella hyalina* (Linnaeus, 1767), produce larvae continuously through spring and summer, giving rise to numerous short-lived colonies that grow, reproduce and dies within a few months (Hayward and Ryland 1999). In contrast, perennial species, such as the European *Pentapora fascialis* (Pallas, 1766), may live for more than 10 years and other species such as *Schizoporella unicornis* (Johnston, 1874) that has a limited, annual reproductive period (Hayward and Ryland 1999). The majority of all temperate species' growth and reproduction decline in autumn, and colonies may die at the onset of winter or polypides degenerate, leaving conspicuous brown bodies (Hayward and Ryland 1999).

Unlike freshwater bryozoans, marine bryozoans do not possess statoblasts (dormant stages), but colonies remain dormant during desiccation stress (dry season) or low temperatures (winter season) by reducing metabolic rate (Hughes 1989; Hand 1991; Hengherr and Schill 2011). Bryozoan species are most abundant in the spring and, particularly in the

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summer months, while during winter, colonies largely die off in some bryozoan species and regenerate in spring (Seed *et al.* 1981; Hayward and Ryland 1999).

1.4. Bryozoan diversity

Globally, the number of known fossil bryozoans is 15000 species (Smith and Gordon 2011). Bryozoans are amongst the three dominant groups of Paleozoic fossils and the oldest known species with mineralised skeletons occur in the Early Ordovician, about 485-470 mya (McKinney and Jackson 1991; Taylor *et al.* 2013). It is likely that the first bryozoans were entirely soft-bodied and appeared much earlier, and the Ordovician fossils record the first mineralised skeletons in this phylum (Fuchs *et al.* 2009). All modern orders of Stenolaemata were present by the Early Ordovician, and in the Middle Ordovician (about 465 mya), the ctenostome order of Gymnolaemata appeared (Dewel *et al.* 2002). Other types of filter feeders appeared at more or less the same time, which suggests that changes in the environment may have been favourable for this lifestyle (Rich *et al.* 1997).

Cheilostomes, also in the order Gymnolaemata, first appear in the Mid Jurassic period (about 172 mya), and have been the most abundant order of gymnolaemates from the Cretaceous to present (Rich *et al.* 1997). From the last 100 million years, fossil evidence indicates that cheilostomes have replaced cyclostomes perhaps outcompeting for space, and may explain how cheilostomes became the dominant marine bryozoans (McKinney 1994). Additionally, marine fossils from the Paleozoic period, which ended 251 million years ago, are mainly erect forms, while those form the Mesozoic period are fairly equally divided by erect and encrusting forms and more recent species are predominantly encrusting (Wood 1999). Soft, freshwater fossils of phylactolaemates are very rare, and appear from the Late Permian (about 260 mya), consisting of their durable statoblasts (Rich *et al.* 1997; Massard and Geimer 2008). No known fossils of freshwater members of other classes exist (Massard and Geimer 2008).

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Freshwater bryozoan species (Class: Phylactolaemata) are non-calcified and account for about 94 species globally, of which a small number (≈ 20 species) belong to the essentially marine class Gymnolaemata of the order Ctenostomata (Massard and Geimer 2008; Hartikainen *et al.* 2013). Many phylactomates have a broad distribution and some species are considered as cosmopolitan (Wood 2002). However, even with their wide distributions and often high in abundances, phylactolaemates are generally over-looked, partly because of their sessile growth habit and intertwined colonies in cryptic evironments where they are protected from sedimentation (Wood and Okamura 2005).

The global diversity of extant marine bryozoans is estimated to be 6000 species (Smith and Gordon 2011). Uniform, muddy intertidal areas are uninhabitable for bryozoans, because muddy substrates may clog the filtering apparatus of suspension-feeding organisms (Rhoads and Young 1970). However, subtidal muddy sands and abyssal areas harbour rare species

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that can attach themselves to the smallest of substratum (Hayward and Ryland 1999). In continental shelf seas, abundance and taxonomic diversity of benthic bryozoan faunas are directly correlated to substratum (Hayward and Ryland 1999). Sheltered rocky shores support a large number of bryozoans, some species are primarily found in intertidal areas, while other species may have wider depth distribution ranges (Hayward and Ryland 1999).

The greatest number of marine bryozoan species has been recorded in Australia (987 species), China (671 species) and New Zealand (639 species) (Costello *et al.* 2010). The European Seas (including Atlantic Europe, Mediterranean Sea and Baltic Sea) indicate an overall high bryozoan diversity (> 700 species), and are likely to be the best studied globally, while Australia, Japan and New Zealand may be the best studied in Australasia and the western Pacific (Costello *et al.* 2010; Costello and Wilson 2011). Owing to new levels of taxonomic accuracy, available technology and exploration of previously inaccessible habitats, the rate of discovering new species has increased (Hayward and Ryland 1999).

Hayward and Ryland (1999) stated that a true account for benthic marine bryozoans cannot be achieved unless Scanning Electron Microscopy (SEM) is used for morphological taxonomy. Early bryozoologists relied on light microscopy to identify and describe species, and not all descriptions were accompanied by illustrations (Florence *et al.* 2007). Moreover, the scale of some illustrations are questionable or vague, while SEM can reveal details previously unnoticed (Florence *et al.* 2007).

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However, the state of South Africa’s regional taxonomic richness for marine invertebrate taxa, including bryozoans, is largely incomplete (Gibbons 1999). For South African bryozoans, the number of publications over the years attests to Gibbons’ (1999) statement – the most publications are from the south coast and the least on the west and southeast coasts (Figure 1.4). This also highlights the lack of publications in the 21st Century, mainly attributable to the few trained taxonomists and a lack of general interest in bryozoans.

An estimated 270 valid species of marine bryozoans have been reported from South Africa (Florence *et al.* 2007). This number comprises of an estimated 40 species of cyclostomes (Order Cyclostomata) and seven ctenostome species (Order Ctenostomata), while the remaining species are cheilostomes (Order Cheilostomata). Previous studies have suggested that 64% of marine bryozoan species from South Africa are considered endemic (Griffiths *et al.* 2010), while six are introduced, *Bugula neritina*, *Bugulina flabellata*, *Virididentula dentata*, *Conopeum seurati*, *Cryptosula pallasiana* and *Watersipora subtorquata* (Mead *et al.* 2011b). In South Africa in particular, studies on freshwater bryozoans have been neglected and are still largely unexplored and unknown, with five known freshwater species (*Fredericella browni*, *Lophopodella capensis*, *Plumatella bushnelli*, *Plumatella repens rugosa* and *Plumatella vaihiriae*) from the Western Cape (Hartikainen *et al.* 2013) and some known fossils (Kohring and Hörnig 2002; Wood 2002).

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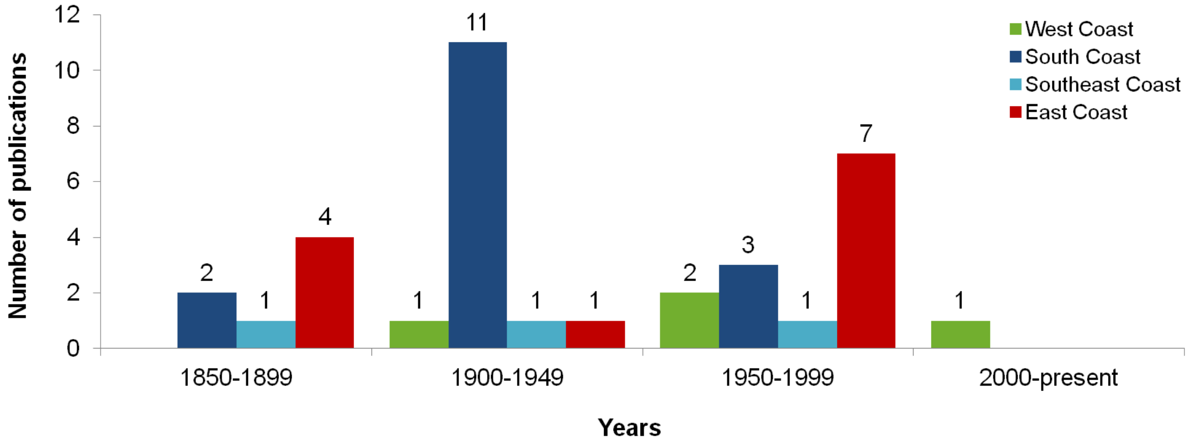

Figure 1.4. Number of publications on South African bryozoans in a 50-year increment until present.

1.5. Ecological importance

Suspension feeding

Unlike on terrestrial environments, the physical properties of aquatic systems such as seawater allow living creatures and particulate matter to remain in suspension, thereby creating a niche for suspension feeding animals (Gili and Coma 1998). Suspension feeders, also known as filter feeders, feed by separating food particles from water that contain such as planktonic organisms. In shallow waters, strong, variable currents transport large concentrations of suspended particles that can also be found at great depth on the continental shelf and slope (Gili and Coma 1998). Filter feeders include a wide range of animals such as bivalves, some snails, sponges, fan worms, barnacles, corals, sea lilies, some fish, and even some birds like Flamingos and baleen whales like the Blue Whale. Because of their abundance, certain benthic suspension feeders, filter feeders and detritivores have been shown to have a major impact in marine ecosystems in carbon recycling and remineralisation (Gili and Coma 1998; Lange 2012). All bryozoans are filter feeders, and use their lophophores to feed in plankton-rich waters (Bock 1982).

Habitat-forming bryozoans

Although zooids are microscopic, sometimes less than 1 mm in height, colonies may range in size from 1 cm to over 1 m across. However, colonies of extant, heavily-calcified species may grow larger, forming three-dimensional structures and attain sizes of over 5 cm referred to as habitat-forming bryozoans (Wood *et al.* 2012). Habitat-forming bryozoans contribute significantly to benthic habitat structure as living colonies (Wood *et al.* 2012). Large bryozoans often provide habitat for diverse associated assemblages, particularly for other bryozoans, molluscs, annelids, arthropods, cnidarians, sponges, echinoderms and macroalgae (Wood *et al.* 2012). Habitat-forming bryozoans occur from ~59°N to 77°S, but are

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particularly abundant and diverse in New Zealand, including Antarctica (Weddell, Lazarev and Ross Seas), the North Pacific around Japan, the northern Mediterranean and Adriatic, and along the southern edge of the North Sea, through the English Channel and around the United Kingdom(Wood *et al.* 2012, 2013). In South Africa, however, there is no known published study on the distribution or extent of habitat-forming bryozoans, although reports of these large bryozoans appear to be abundant and diverse in Port Elizabeth on the East Coast of South Africa (Dr Wayne Florence, pers. comm.).

Biofouling

All surfaces that are submerged in the sea or freshwater bodies rapidly become covered by a biofilm through a process called biofouling (Armstrong et al. 2000). Some freshwater bryozoans, such as *Plumatella vaihiriae* (Hastings, 1929), *P. repens* (Linnaeus, 1758) and *Paludicella articulata* (Ehrenberg, 1831), are known to cause biofouling problems in wastewater treatment plants in the United States (Wood and Marsh 1999; Wood and Okamura 2005) and New Zealand (Smith 2005). Similarly, some marine bryozoans, for example *Amathia verticillata* (delle Chiaje, 1822) are considered problematic marine fouling organisms by growing inside water pipes and on ship hulls (McCann et al. 2015). Consequently, the economic costs associated with biofouling control can be substantial (Fitridge et al. 2012)

A recent study done across 14 harbours in South Africa, found 29 alien species, of which bryozoans accounted for 17% of species recorded, while the most common group was ascidians with 31% (Peters et al. 2017). There are six known introduced bryozoan species in South Africa, namely *Virididentula dentata* (Lamouroux, 1816), *Bugulina flabellata* (Thompson, in Gray, 1848), *Bugula neritina* (Linnaeus, 1758), *Cryptosula pallasiana* (Moll, 1803), *Watersipora subtorquata* (d'Orbigny, 1852) and *Conopeum seurati* Canu, 1908. However, the extent of these bryozoans, in both area and level of invasiveness in South Africa, have not yet been quantified.

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Medicinal research

Tectitethya crypta (de Laubenfels, 1949) is a large shallow-water sponge found in the Caribbean and was first studied for the development of a number of anti-viral and anti-cancer drugs in the 1950s (Bergmann and Feeney 1950, 1951). Researchers isolated two chemicals in the sponge, namely spongothymidine and spongouridine, which were used as models for the HIV drug AZT, anti-viral drugs to treat herpes, and an anti-leukemia drug. The anti-leukemia drug was the first marine-drug approved for cancer treatment in 1969. Consequently, several marine-derived molecules have been approved for anticancer treatment or are under clinical trials during the last past few decades (Petit and Biard 2013). These include some bryozoan species that produce secondary metabolites and the usefulness of these products is being explored for a potential Alzheimer's disease and cancer drug (Sharp et al. 2007). *Bugula*

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neritina Linnaeus, 1758, for example, has received considerable attention for the compound bryostatin-1 used for anti-cancer research (Winston and Woollacott 2008).

1.6. Threats

Known predators that commonly feed on bryozoans include browsers and grazers such as sea urchins, crabs, fish and some prosobranchs. These natural predators often affect sessile community structure by creating patches of substratum for recolonisation, but these effects do not influence at the population level. However, ocean acidification and anthropogenic activities such as trawling and pollution contribute to the degradation of ecosystems and destroy populations, particularly habitat-forming bryozoans (Farby et al. 2008).

At a global level, ocean waters absorb the excess of atmospheric CO_2 and in doing so, alters the water chemistry by decreasing the pH referred to as ‘ocean acidification’. The ability of marine animals, most importantly pteropod molluscs, foraminifera, and some benthic invertebrates such as bryozoans, to produce calcareous skeletal structures is directly affected by seawater CO_2 chemistry (Farby et al. 2008). Elevated CO_2 influences the physiology of marine organisms as well through acid-base imbalance and reduced oxygen transport capacity (Farby et al. 2008).

2. Research project

2.1. Rationale and aims

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To date, no study examined species richness patterns of South African bryozoans in its relation to biogeography. It is evident that large spatial gaps exist and, along with limited bryozoan distribution data from published papers, compiling a regional biodiversity assessment is difficult. In addition to that, historical collections from the 1900’s housed in the Iziko South African Museum, Cape Town (SAMC), and the Natural History Museum, London (NHMUK), that have remained unexamined, can provide an important baseline to assess species richness patterns as well as ecological changes over time.

Approximately 1125 catalogued specimen records, excluding the number of duplicates, in SAMC collection exist, of which 1028 have location data. This study takes advantage of undetermined bryozoan material in the existing marine invertebrate collection in SAMC to increase bryozoan species richness and distribution knowledge. Along with collating South African bryozoan data acquired from the literature and other museum databases, species distribution patterns were analysed to determine whether relationships exist across gradients of latitude and depth along the coastline.

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The aims of this project are to:

- collate published and unpublished information from literature, reports and museum databases;
- examine un-worked collections in SAMC to increase bryozoan distribution data and describe new species;
- describe species richness patterns along longitudinal and depth-related gradients around South Africa;
- examine biogeographical patterns of bryozoans along the South African coastline.

The key research questions proposed for the current study are:

- What is the richness and endemism of South African bryozoans, and how does bryozoan richness compare to other southern latitude regions such as Australia and Brazil?
- Does bryozoan species richness patterns follow a gradient as seen in other South African marine taxa, and which biogeographical features may influence bryozoan community structure along the coastline? Are the results comparable with global marine species richness patterns?
- How rich is shallow-water bryozoans in colony morphotypes?

2.2. Thesis outline

Chapter 1: An introduction to bryozoans or "moss-animals" (Phylum: Bryozoa), classification of bryozoans, reproduction and ecological importance is described in this chapter. South African "bryodiversity" is underestimated considering large spatial gaps and/or undetermined existing museum material, hereby introducing the current research project.

Chapter 2: This chapter is adapted from the published paper by Boonzaaier *et al.* (2014), which reviews the history of South African bryozoology from the onset of European researchers to the present day. A brief history of the South African Museum (today, the Iziko South African Museum) in Cape Town details the growth of animal and plant collections that later led to the establishment of the first museum in sub-Saharan Africa. An increase in marine research in South Africa and immigrant researchers from the 18th Century contributed to the biodiversity and scientific knowledge of marine biota. Brief biographies of some of the major contributors to South African bryozoology are also included.

Chapter 3: The materials and methods used for this study are described in this chapter, detailing the study area and biogeography of the South African coastline.

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Chapter 4: This chapter aims to list the majority of the species from existing bryozoan material in SAMC. It seems appropriate to provide genera descriptions, because no known manuscript contains the descriptions of genera reported from South Africa.

Chapter 5: Spatial richness patterns of South African bryozoans were examined. Latitudinal, depth-related and longitudinal gradients in richness patterns were discussed, although in bryozoans, a longitudinal gradient was observed. Through highlighting areas of overall high species richness may aid in potential marine protected areas. High species richness in False Bay led to examining colony morphotypes that dominate the area.

Chapter 6: This chapter is a synthesis of chapters 4 and 5 with main conclusions drawn from the data collected during this study.

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CHAPTER 2. HISTORICAL OVERVIEW OF THE LAST 135 YEARS OF BRYOZOOLOGY IN SOUTH AFRICA

Abbreviations used in text

BMC : British Museum Collection (today, Natural History Museum in London)
HMS : Her Majesty's Ship
NHMUK : Natural History Museum in London
RV : Research Vessel
SA : South African
SAMC : Iziko South African Museum in Cape Town
SS : Steam Ship
VOC : *Verenigde Oos-Indiese Kompanjie* (Dutch East India Company)
UCT : University of Cape Town

1. Introduction

During the onset of European colonialism in South Africa from the mid-17th Century, the interest in South African biota and for natural resources grew, resulting in the arrival of nature enthusiasts from Europe. For example, Kolb (1727) contributed largely to South African biodiversity knowledge with his work on marine fish, whales, seals, molluscs and crustaceans. A few decades later in 1772-1775, the Swedish naturalist Carl Peter Thunberg, who was a pupil of Carl Linnaeus, completed a fine South African marine collection (Day 1977). In addition to the previous collections, opportunistic sampling by passing ships and visiting biologists such as Charles Darwin, whom visited the Cape on the second voyage of the HMS *Beagle*, Ferdinand Krauss, J.H. Wahlberg and Wilhelm Peters, resulted in extensive marine fauna collections made during the first half of the 19th Century (Brown 1997; Day 2000). However, these collections were sent to European museums and institutions to be described by experts (Brown 1997).

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For the next five decades, local marine collections and biologists were few and sporadic (Day 2000), possibly attributed to the conflict between the Dutch and the British settlers, and with the native tribes, such as the AmaXhosa and AmaZulu, concerning land claims and the slave trade (Anonymous 2011). Then, during 1873-76, the first global marine research expedition, the *Challenger Expedition*, was conducted by the British Royal Navy vessel, HMS *Challenger* (Morris 1986). The HMS *Challenger* visited the Cape in October and November of 1873, and collected marine fish, polychaetes, molluscs and bryozoans from South Africa (Tizard *et al.* 1885; Perry and Fautin 2003). Although, the *Challenger Collection* is housed at

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the Natural History Museum in London (NHMUK), a large amount of other historical collections are housed in the South African Museum in Cape Town.

1.1. *The South African Museum, Cape Town*

Animal collections from South Africa, that would later form part of the museum displays, link to the earliest years of settlement from 1656 and the zoological exploration of southern Africa (Summers 1975). The skins of lions and other wild animals were preserved, often stuffed and mounted for display in the *Fort de Goede Hoop* ("Fort of Good Hope"), commanded by Jan Van Riebeeck (Summers 1975). Van Riebeeck, from the Netherlands, arrived in Cape Town in April 1652 and established the Cape Colony (Summers 1975). The Fort was later replaced by the Castle of Good Hope (as it is today), built during 1666-1679 by the *Verenigde Oos-Indiese Kompanjie* (VOC) (Summers 1975).

The collections of flora and fauna from South Africa continued to grow over the years, consequently led to the establishment of a small zoological museum by the Governor of the Cape Colony, Willem Adriaan van der Stel, during the early 18th Century (Summers 1975). This small museum was an appendage of the Governor's Menagerie and collection of live wild animals and birds near the *Tuynhuys*, or "Garden House" (Summers 1975). Today, the Michaelis School of Art of the University of Cape Town occupies the old Menagerie building, including the museum erected by van der Stel (Summers 1975).

International demand for skins, faunal skeletons and mounted specimens became popular in the 18th Century, but records of where the specimens were stored are not precisely known (Summers 1975). Some specimens were used to decorate the *Tuynhuys*, which was originally used as a tool shed for the Company's Garden established in 1653 by Van Riebeeck, and after numerous renovations later became the Governor's House after British occupation in 1806 (Summers 1975). The need for storage of the growing collections became evident, which led to Lord Charles Henry Somerset, the first British Governor of the Cape Colony from 1814-1826, founded the South African Museum on 11 June 1825 in Cape Town; situated at the bottom of Government Avenue in the Old Supreme Court (Summers 1975; Day 2000; Kennedy 2004).

Lord Somerset appointed Dr Andrew Smith to be the first director of Natural History at the museum (Summers 1975; Day 2000; Kennedy 2004). Smith was a Scottish army medical doctor and naturalist, whom obtained his medical degree in 1816 at Edinburgh University, and joined the British Army Medical Services (Summers 1975; Kennedy 2004). In 1820, Smith was sent to the Cape and Grahamstown to supervise the medical care of European soldiers and soldiers of the Cape Corps (Summers 1975; Kennedy 2004). However, upon his appointed as director in 1825, Smith spent the time to conduct a few expeditions around the Cape and Africa to collect specimens for the Museum (Summers 1975).

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During his appointment, Smith published several reports on zoology and anthropology, including *On the origin and history of the Bushmen* in 1831 and the *Report of the expedition for exploring Central Africa* published in 1836 (Kennedy 2004). In 1832, the Museum was moved to Looyer's Plein (today on the corner of Roeland and Hope street), exhibiting interesting specimens Smith collected during the Cape of Good Hope Association's Expedition to the Interior (Summers 1975). The Museum remained at Looyer's Plein until 1838, and largely influenced the cultural life in Cape Town (Summers 1975).

In May 1836, the second voyage of the HMS *Beagle* came to the Cape, upon its return to England, and here, Smith met Charles Darwin, who was a young geologist graduate student at the time (Day 2000; Kennedy 2004). According to notes, Darwin spent a few days with Smith in and around the Cape and made good use of Smith's valuable observations on large animals recorded during the excursions (Summers 1975). Shortly after Darwin's visit to the Cape, Smith returned to England in 1837 and took most of his collections with him (Summers 1975; Day 2000).

After Smith left, a German researcher, Dr Baron von Ludwig, also sent his collections, including a herbarium, to Europe (Summers 1975). Von Ludwig settled in the Cape since 1805 and was an avid collector of birds and insects that was displayed in the Museum (Summers 1975). For more than a decade, after the greater part of the museum material was lost when Smith and von Ludwig removed their collections, the existing museum material decayed (Summers 1975). The lack of interest and no available funds to maintain the museum collections resulted in moving the collections to the South African College (Summers 1975).

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From 1838-1855, the museum collections were placed on loan to the South African College (today, the *Weeshuis* or "Orphan House" on Long street) on the condition that it be maintained (Summers 1975). The Museum collection still contained important specimens, some were type specimens of great historical interest and unique zoological importance, which became teaching aids at the college (Summers 1975). Sir George Grey, Governor of the Cape Colony from 1854-1861, took interest in museum matters and formed the Board of Trustees on 25 June 1855 to govern the Museum (Summers 1975). Responsibilities of the Board of Trustees, initially consisted of three members, were appointing staff, purchase equipment to maintain specimens and house the collections (Summers 1975). The Museum collections were temporarily moved from the South African College to a building on St. Georges street (today Barclay's Bank on Shortmarket street) (Summers 1975).

The Trustees appointed Edgar Leopold Layard as the curator at the Museum (Summers 1975). The first report compiled by Layard to the Trustees in August 1855, comprised of a small collection of insects, reptiles, birds, mammals and fish of nearly 500 specimens, the majority of which were in poor condition and/or discarded (Summers 1975).

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During Layard's appointment, and succeeding curators during those formative years, accommodating the specimens became increasingly difficult (Summers 1975). Consequently, the Government agreed to erect a building to house both the Museum and Public Library, and the Museum collection was moved from St. Georges street during the summer of 1859/60 (Summers 1975). However, as the collections grew (both of the Museum and Public Library), the need for a proper museum building was apparent and by 1886, the Museum was too small to cope with its rapidly increasing collection (Summers 1975).

The Government decided to build a new museum building in the upper part of the historic Company's Gardens, its present day location since 1897 (Figure 2.1) (Summers 1975). To date, the Museum, now known as the Iziko South African Museum (SAMC), holds some of the largest collections in southern Africa, which include fossils, insects, mammals, birds, fish, marine invertebrates as well as several archaeological artefacts (Summers 1975). A recent inventory of the Natural History collections were estimated at 1.9 million objects, of which 22% are digitised on the *Specify version 6.5.02* database, and dwarfs the figure of nearly 500 specimens reported by Layard in 1855.

Figure 2.1. The South African Museum in 1940's in the Company's Gardens at its present day location since 1897. *Image taken from Summers (1975)*

1.2. Marine invertebrate collections of Iziko South African Museum

Marine researchers, including Prof. John D.F. Gilchrist and Prof. John H. Day from the University of Cape Town, led oceanographic and ecological research in South Africa. A number

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of historical cruises, including international expeditions such as the HMS *Challenger*, contributed to benthic collections housed at Iziko South African Museum (SAMC) (Table 2.1). Although, the majority of the benthic collections were sampled in the 1950's to early 1980's during the University of Cape Town Ecological Survey and RV *Meiring Naude* cruises (Louw 1977, 1980). Benthic and annual surveys implemented by the Department of Environmental Affairs (DEA) and the Department of Agriculture, Forestry and Fisheries (DAFF) have also resulted in large collections housed at SAMC and/or other institutions, but the majority of these collections remain undetermined.

The primary marine collections in SAMC comprise of approximately 129000 records – excluding nearly 17000 catalogued marine invertebrate fossil records – and constitutes a significant coverage of all major marine invertebrate taxa for South Africa (Table 2.2) (Griffiths *et al.* 2010). This is a large collection, but managed by only two curators, which highlights the need for capacity and trained taxonomists in South Africa. Nearly 80% of the marine invertebrate collection contains catalogued molluscs and crustaceans, and a further estimated 6000 unaccessioned specimen lots. Smaller invertebrates have been neglected within the existing collection, for example pycnogonids, poriferans and ascidians, with over 400 catalogued records each.

Similarly, existing bryozoan material, comprising of an estimated 1000 unaccessioned specimen lots, have remained unexamined over the years. There are 1225 catalogued and digitised bryozoan records, of which 1028 records show locality data (Figure 2.2).

Interestingly, a large number of bryozoan fossils are in the collection, but only one catalogued record (Mr. Eugene Bergh, pers. comm.). Bryozoans are considered to be one of the most abundant animal fossils (McKinney and Jackson 1991), but to date, few studies have been conducted on fossil Bryozoa in South Africa. Tate (1867) and Brood (1977) reported on some South African Jurassic and Upper Cretaceous bryozoans, respectively. More recently, Kohring and Hörnig (2002) described rare fossilised statoblasts of freshwater bryozoans from the Triassic of the Molteno Formation of the Karoo Supergroup. This suggests either a lack of interest in fossil and extant Bryozoa, or more probably a lack of specialist taxonomists in the country, which is unfortunate considering southern Africa's rich fossil record and marine biota.

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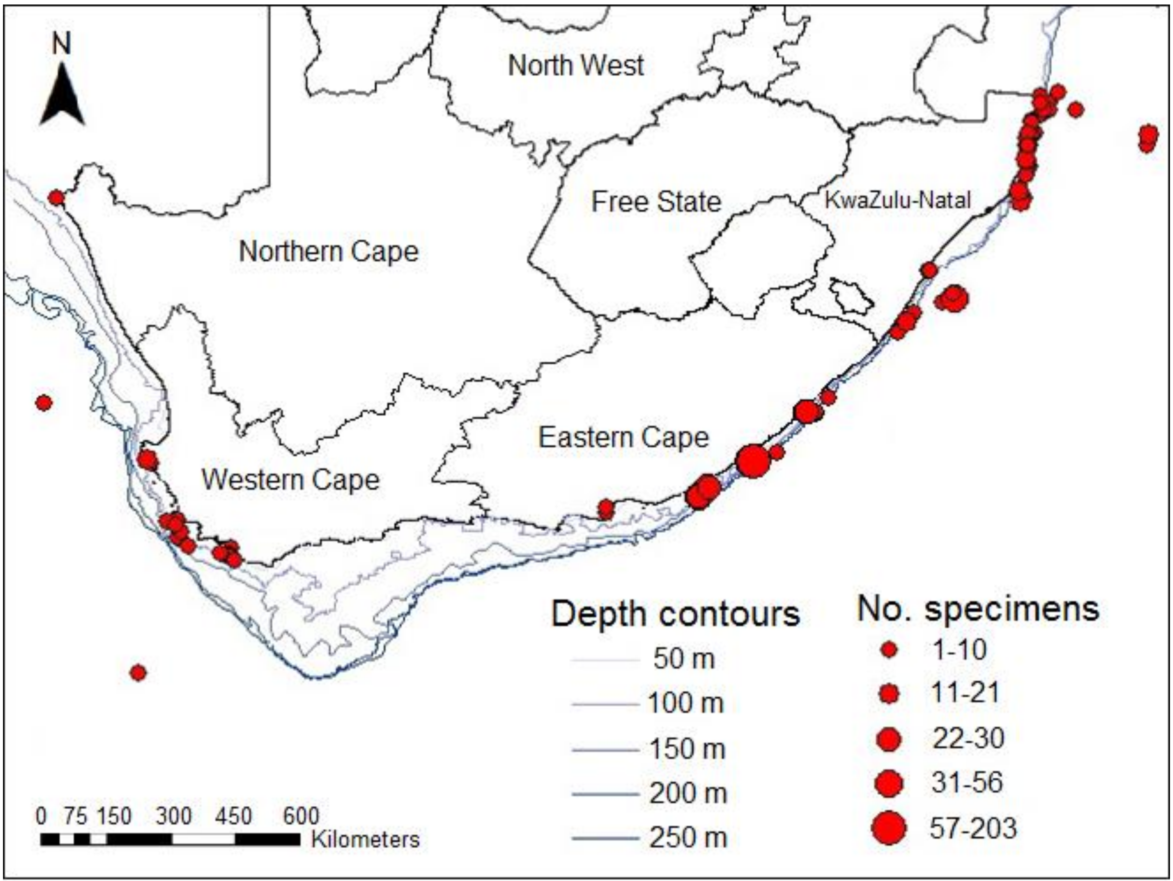

Figure 2.2. An estimated 1028 catalogued bryozoan records with locality data housed at SAMC.

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Table 2.1. Historical cruises that collected various marine invertebrates in South African waters. N.D. = no data. *Adapted from Lange (2012)*

			No. of samples		
Date	**Location/Ship**	**Depth (m)**	**Dredge**	**Grab**	**Trawl**
1873-1876	HMS *Challenger*	179-4525	5		
1874	*Gazelle*	90	2		
1898	*Deutschen Tiefsee* Expedition	70-2750	13		
1898-1906	RV *Pieter Faure*	11-475	44		91
1925-1927	*Discovery* Expedition	47-550	1		3
1934	DANA Expedition	1000-3000			3
1946	Langebaan, UCT	2.5-9	118		
1946-48, 1950-51	False Bay, UCT	9-175	238		
1950-52	RV '*Vema*'	< 1500	N.D.	N.D.	N.D.
1946, 1953, 1959, 1969, 1962-64	Saldanha Bay, UCT	4-56	109	110	
1946-54, 1956-58, 1963	South African coast, non-commercial trawler	5-768	20		106
1947-49	*Africana* II Deep-sea	9-547	71		30
1959-61, 1963-65, 1967	West Coast Dredge, UCT	18-400	16	1	
1975-79	RV *Meiring Naude*	80-1300	26		8
2011	*Africana* Voyage	45-345			18

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Table 2.2. Summary of marine invertebrates in the SAMC collections in decreasing order. An estimated number of unaccessioned specimen lots per phylum are listed. Compiled by using *Specify 6.5.02* digitizing software and personal communication with collections' managers in SAMC.

Taxonomic group	**No. lots accessioned**	**Est. no. lots unaccessioned**
Kingdom Protoctista		
Foraminefera	142	0
Dinoflagellata	33	0
Plankton	0	60000
Kingdom Animalia		
Molluscs	26658	1700
Crustacea	18406	4500
Cnidaria	4830	2400
Echinodermata	2607	600
Annelida	1942	600
Bryozoa	1225	1000
Pycnogonids	391	44
Porifera	245	1000
Ascidiacea	234	50
Helminth worms and Nemertea	157	70
Brachiopoda	138	0
Sub-totals	57008	71964
Total no. specimens	**128972**	

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2. South African bryozoology from the 19th-21st Century

Evidently, the majority of published papers on South African marine bryozoans are from the south and east coasts, while the west and southeast coasts are neglected (Figure 2.3). To date, research on bryozoans in South Africa is taxonomic in nature, with the first few publications on the large number of specimens in the British Museum Collection (BMC) described by Hincks (1880, 1891) and Busk (1852a, 1854, 1875). The following section briefly describes bryozoan taxonomists whom contributed to South African bryozoan diversity.

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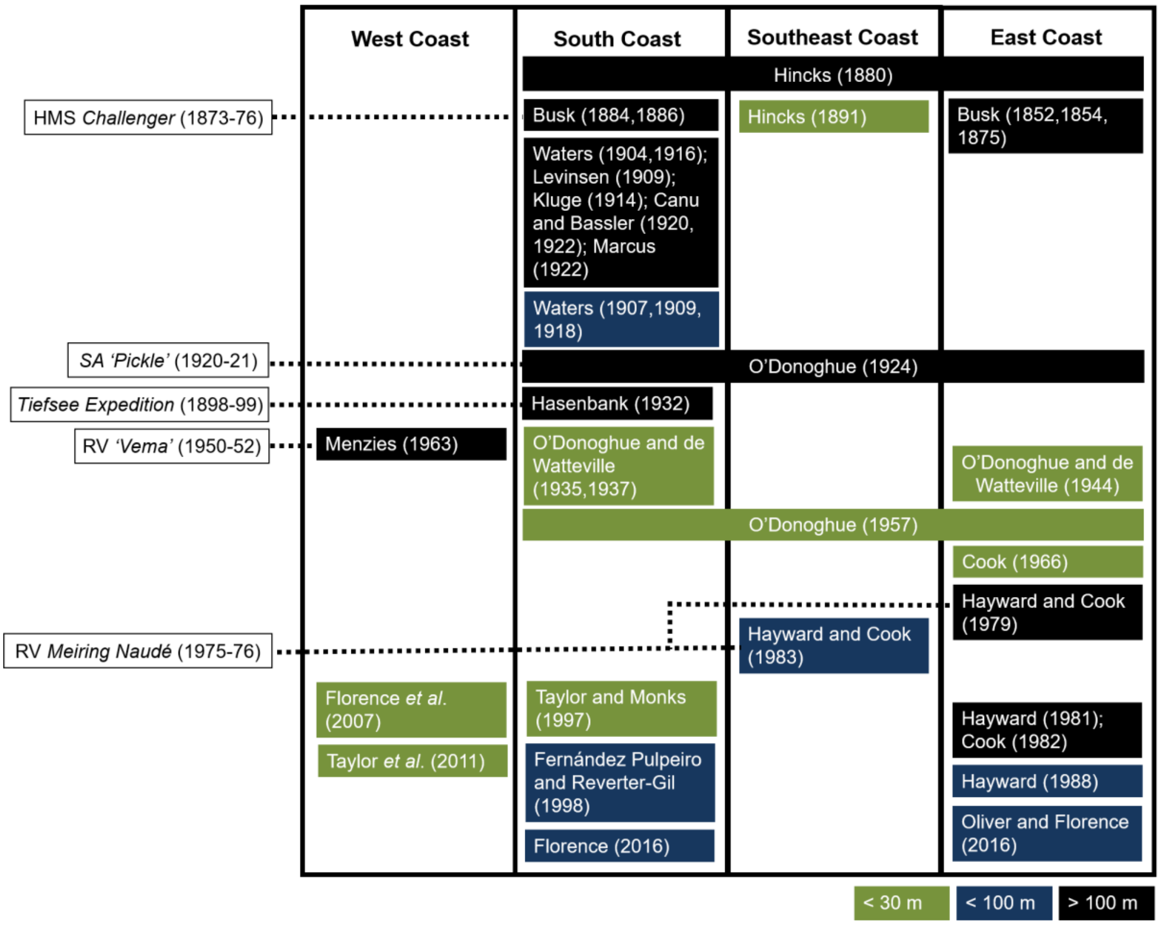

Figure 2.3. A summary of the published works of described South African Bryozoa since the 19th Century, and, if applicable, the expedition cruise is associated with the publication.

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2.1. Nineteenth Century

2.1.1. Thomas Hincks

Thomas Hincks (1818-1899) was born in Exeter, England (Wyse Jackson and Spencer Jones 2002; Calder 2009). He served in Ireland (Cork and Dublin) and later in England as a Unitarian minister, but was also a naturalist and taxonomist (Wyse Jackson and Spencer Jones 2002). Two of his major publications, *A history of the British hydroid zoophytes* (1870) and *A history of the British marine Polyzoa* (1880), described specimens in the British Museum Collection. Hincks (1880) reported thirteen species from South African material, mainly from the south and east coast, collected by W. Oates and Eliza Jelly.

Subsequent reports of some South African material (Hincks 1878, 1881) included *Schizoretepora tessellata*, *Exochella tricuspis* and *Rhynchozoon longirostris*. An additional seven species from Port Elizabeth, collected by Jelly, including *Gregarinidra spinuligera*, *Flustra nobilis*, *Laminopora bimunita*, *Schizoporella (= ?Hippomonavella) inconspicua* and *Lepralia lancifera* (Hincks 1891). Some species previously placed in the genus "*Lepralia*" were

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moved to *Schizoporella*, because a number of species within the genus indicate no selected holotype specimens and is therefore considered invalid (Bock 2013).

2.1.2. George Busk

Born in St Petersburg (Russia), George Busk (1807-1886) was a British Naval surgeon, zoologist and palaeontologist (Woodward 1901; Cook 1997; Foote 2004). He was a Fellow of the Royal Society in 1850, and served as Secretary and Vice-President of the Linnean Society of London (Wyse Jackson and Spencer Jones 2002). Busk made some valuable contributions to the debate on hominid evolution having discovered the skull of Neanderthal Man, although it was another bryozoologist, William King of Galway Ireland, who coined the scientific name *Homo neanderthalensis* (Cook 1997; Wyse Jackson and Spencer Jones 2002).

Between 1849 and 1886, Busk made huge (taxonomic) strides in the field of bryozoology (Wyse Jackson and Spencer Jones 2002). He erected the Orders Ctenostomata, Cyclostomata and Cheilostomata in a paper that examined bryozoans collected during the HMS *Rattlesnake* expedition in Australia (Busk 1852a). Busk also examined a large amount of catalogued material in the British Museum (today, the Natural History Museum of London).

A number of specimens in the BMC appeared to have been sampled from Algoa Bay and Cape of Good Hope (South Africa), and published in a serial monograph, *Catalogue of Marine Polyzoa in the Collection of the British Museum (Parts 1-3)*. The three volumes (Busk 1852b, 1854, 1875) reported on 308 species, of which 25 species were from South Africa. Four cyclostomes were described, namely *Lichenopora ciliata* and *Tennysonia stellata* from Cape of Good Hope, and *Mecynoecia clavaeformis*, *Idmidronea contorta* and *Discoporella algoensis* from Algoa Bay (Busk 1875). Although, the latter species is considered invalid and no other known records exist.

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The *Challenger* Collection, housed at NHMUK, includes various marine calcareous specimens such as ostracods, echinoderms, brachiopods, molluscs (gastropods and bivalves), foraminiferans, corals and bryozoans. The South African bryozoan material, collected in Simon’s Bay and south of Cape of Good Hope, Busk published in the *Report on the Polyzoa collected by H.M.S. Challenger during the years 1873-1876 (Part 1 and 2)*. These reports yielded 28 cheilostome and two cyclostome bryozoans (Busk 1884, 1886).

2.2. Twentieth Century

2.2.1. Post-Busk era

In the early 1900’s, the British bryozoologist, Arthur William Waters FLS (1846-1929), reported on 18 bryozoan species from South Africa in six different publications (Waters 1904, 1907, 1909, 1916, 1918, 1919). Seven of the 18 species have an Antarctic or Sub-Antarctic distribution (Waters 1904). Waters (1909, 1918) examined material from the Cyril Crossland Collection: eight species reported from the Sudanese Red Sea and Cape Verde Islands, also

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occur in South Africa. However, many of these works by Waters, reporting on species found in South Africa, were mainly observational accounts, and may be considered doubtful (Florence *et al.* 2007).

Subsequent papers reported on some South African bryozoan species (Levinsen 1909; Kluge 1914; Canu and Bassler 1920, 1922; Marcus 1922). Georg Marius Reinald Levinsen (1850-1914) was the museum curator at the Zoological Museum of Copenhagen. His work comprised mainly on morphological and systematic studies of cheilostomatous bryozoans. Twelve species from South Africa were listed in Levinsen (1909) and he referred to some of Hincks's and Busk's illustrations.

German (Herman) Avgustovich Kluge (1871-1956) was a Russian zoologist and examined bryozoan material collected during 1901-1903 from the Southern Ocean and South Africa, as part of the German South Polar Expedition (Kluge 1914). Six species were reported, including three new species described *Beania vanhoeffeni*, *Membranipora polystachys* and *Aetea annulata* (= *A. anguina* Linnaeus, 1758).

Ray Smith Bassler (1878-1961) specialised in Ordovician fossils, but included recent bryozoans later, and published the first volume of the *Treatise of Invertebrate Palaeontology* (Cuffey *et al.* 2002; Wyse Jackson and Spencer Jones 2007). Bassler was appointed as an assistant curator in the Department of Geology at the National Museum of Natural History in Washington DC in 1904, and continued his affiliation at the museum until he retired (Wyse Jackson and Spencer Jones 2007). In 1902, Bassler began corresponding with the French palaeontologist Ferdinand Canu (1863-1932), but they only met for the first time in 1926 (Sanner 2002). They developed a productive collaboration that resulted in a large number of important publications (Canu and Bassler 1920, 1922, 1927, 1929, 1930), of which Canu received the Daniel Giraud Elliot Medal in 1923 for his work *North American Later Tertiary and Quaternary Bryozoa* (Sanner 2002). Even though a number of publications were produced, only three species were reported in Canu and Bassler (1920, 1922) from South Africa.

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Ernst Gustav Gotthelf Marcus (1893-1968) was born in Germany and studied zoology in 1912 at the University of Berlin to become a coleopterist (a person who studies or collects beetles) (Winston 2002). Research towards his doctoral studies (on Coleoptora) begun in the Entomology Department at the Berlin Museum and was interrupted in World War I. After the war, he returned to the University and completed his doctorate in 1919 (Winston 2002). Marcus continued working at the museum, but later immersed himself in taxonomic study of bryozoans, working up collections from various European museums and from German, Danish and Swedish expeditions in the Pacific, Australia and South Africa (Winston 2002). Marcus (1922) reported on South African material in Gothenburg Natural History Museum (Sweden), comprising of 21 bryozoan species from the Cape of Good Hope.

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2.2.2. *Charles O'Donoghue and Dora de Watteville*

Another major contributor to early South African bryozoan taxonomy, was Charles Henry O'Donoghue (1885-1961), a Professor of Zoology at the University of Reading from 1939-1952 (Anonymous 1939). He reported on 55 bryozoan species collected by the SS '*Pickle*', commissioned by the Fisheries and Marine Biological Survey during 1920-1921, headed by Dr J.D.F. Gilchrist (O'Donoghue 1924). Additionally, this work also included specimens collected along the shoreline and by trawlers from Table Bay, False Bay, Cape Infanta and as far east as the mouth of the Illovo River (O'Donoghue 1924). In subsequent reports, O'Donoghue, together with Dora de Watteville, attempted to record comprehensively the bryozoan fauna of South Africa (O'Donoghue and de Watteville 1935, 1937, 1944; O'Donoghue 1957). The bryozoan material in the aforementioned works, were collected by Professor T.A. Stephenson during ecological studies at the University of Cape Town, published in a series of reports (Stephenson *et al.* 1937, 1938; Eyre and Stephenson 1938; Eyre *et al.* 1938; Eyre 1939). These reports yielded 68 species reported, of which two are introduced species *Conopeum reticulum* Linnaeus, 1767 and *Cryptosula pallasiana* Moll, 1803.

Despite the efforts by O'Donoghue and Busk to describe South African bryozoans, several taxonomic problems arose. Eurocentric tendencies were frequent where South African bryozoans have been given European species names, but appears improbable considering the known geographic distribution of these species, mostly restricted to the Northern Hemisphere (Hayward and Cook 1983). For example, two European species, *Membranipora membranacea* and *Bicellariella ciliata* previously reported from South Africa, were misidentified resulting in the erection of new species, *Membranacea rustica* and *Bicellariella bonsai* in Florence *et al.* (2007).

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2.2.3. *Patricia Cook and Peter Hayward*

Patricia Lynette Cook (b. 1927) worked as an assistant and later in 1964 became Head of the Bryozoa Section at the British Museum (today, NHMUK). Her published work include descriptions of African bryozoans and studies of larval development in *Membranipora* (Cook 1962; Cook and Hayward 1966). Cook (1966) described material collected by Dr J.D.F. Gilchrist between 1903 and 1904 off Durban on the East Coast of South Africa; and erected four cheilostome species, namely *Conescharellina africana*, *Anoteropora inarmata*, *Batopora murrayi* and *Lacrimula pyriformis*. Some African species in the Adeonellidae family were examined, including detailed discussions on South African *Laminopora* and *Adeonella* species (Cook 1982). Additionally, Cook and Chimonides (1981) examined a few specimens from the RV *Meiring Naudé* collection. Thereafter, Cook decided to examine the *Meiring Naudé* collection from South Africa by collaborating with Peter Hayward – this contributed largely to South African bryozoology.

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Peter Joseph Hayward was first introduced to bryozoans when working as a scientific assistant at NHMUK, at the age 16 (Prof Patrick Wyse-Jackson, pers. comm.). He graduated from University of Reading in 1970 in Zoology and received his Ph.D. in 1974 from the University of Swansea under the supervision of John S. Ryland, with whom he collaborated on the serial monographs of *Synopses of the British Fauna*. Hayward published extensively on the taxonomy, morphology and biology of marine bryozoans from the North Atlantic, Antarctica, Southwest Pacific and deep-sea bryozoans.

Hayward and Cook co-authored two comprehensive taxonomic reports on RV *Meiring Naudé* material (Hayward and Cook 1979, 1983). The first paper reported 51 species, of which 23 species were new, sampled from depths between 376-1300 m along the south and east coasts (Hayward and Cook 1979). The second paper yielded 130 species, of which 44 species were new, also sampled on the south and east, but from shallower depths (< 100 m) (Hayward and Cook 1983). Hayward (1988) reviewed the genus *Adeonella* by examining the material in NHMUK. Globally, 41 *Adeonella* species are known, of which 27 species are considered endemic to South Africa (Hayward 1988). The highest diversity of *Adeonella* species occur on the east coast, but high apparent endemicity (66%) in *Adeonella* from South Africa may warrant molecular research to potentially establish high plasticity in *Adeonella* species (Hayward 1988).

2.3. *Twenty-first Century*

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Bryozoan fauna on the west coast is not well known, albeit a number of harbour areas on the west coast are very well-sampled, for example Langebaan and Saldanha Bay (Griffiths *et al.* 2010). However, these collections have remained unpublished or undetermined. Florence *et al.* (2007) was the first to examine shallow-water (< 30 m) bryozoans from the southwest region around the Cape Peninsula. Here, 63 species were recorded, including 16 new species. A few years later, a molecular study on *Tennysonia stellata* Busk, 1875 revealed high morphological plasticity (Taylor *et al.* 2011). In Florence (2016), bryozoans collected as bycatch on the *Dr Fritjov Nansen*, a demersal trawler, at a depth of 95 m on the south coast revealed twelve species, including one new species *Arthropoma* (= *Rogicka) lioneli* (Florence 2016). Additionally, *Taylorius nyembezi*, Oliver and Florence 2016 was described from specimens collected by the R.V. *Meiring Naudé*; previously reported from South Africa as *Escharina waiparaensis* by Hayward and Cook (1983).

Nearly two decades into the 21st Century only four papers on South African bryozoans were published. The poor publication rate is largely attributed to very few trained bryozoan taxonomists. However, bryozoan projects are currently underway, including a compilation of shallow-water bryozoan species from the south and east coasts, and the first molecular study conducted on known introduced species from South Africa. Additionally, (Wayne K. Florence, unpublished data).

CHAPTER 3. MATERIAL AND METHODS

As mentioned in the thesis outline (in Chapter 1), this chapter is subdivided into four sections and describes the materials and methods used to assess species richness patterns of South African bryozoans. Sections 1 and 2 introduces the biogeographic features of the South African coastline, including ocean currents, topography and habitat types. The taxonomic procedures for Chapter 4 were described in section 3, while section 4 describes the steps taken in preparing the bryozoan dataset to assess species richness patterns for Chapter 5.

1. Study area

The South African coastline stretches from the Namibian border (29°42'S, 17°59'E) on the west coast to the Mozambican border (26°51'S, 32°49'E) on the east coast. The coastline may be roughly divided into four regions, namely cool-temperate west coast, warm temperate south and southeast coast, and tropical east coast (Mead *et al.* 2011). The southeast coast has been roughly defined as the region from Port Elizabeth to East London (Figure 3.1). Two transition zones (i.e. zones lying between two regions) are False Bay, in the Western Cape and East London in the Eastern Cape (Mead *et al.* 2011).

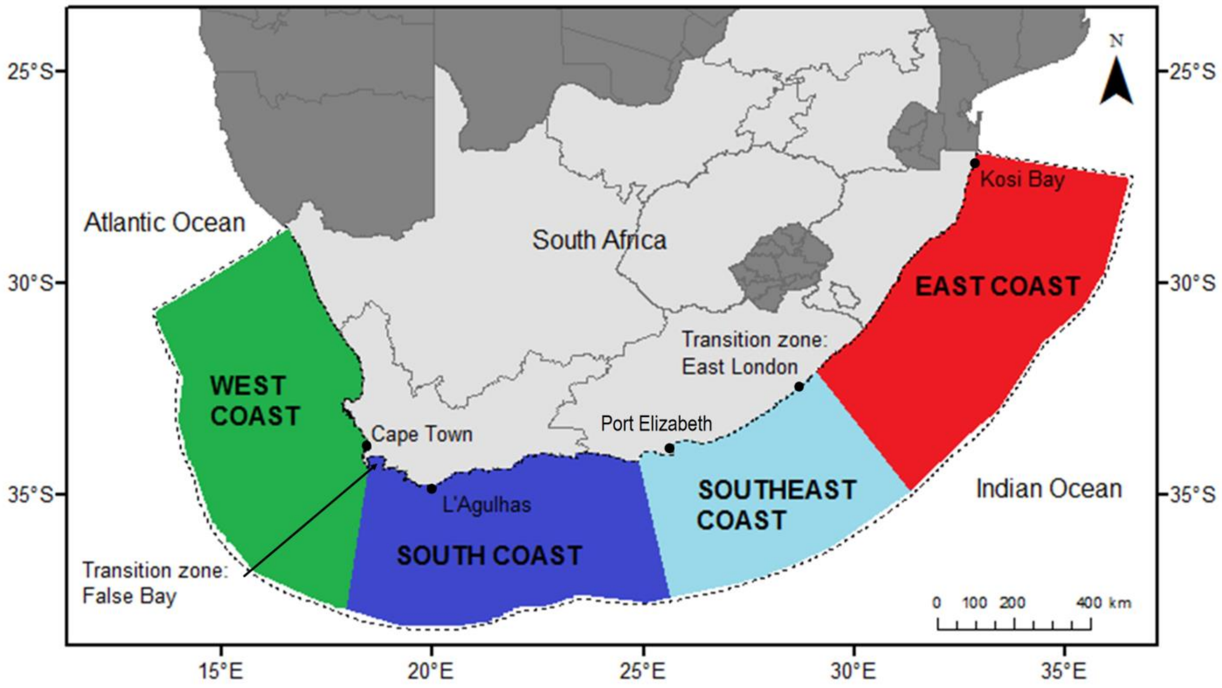

Figure 3.1. The South African coastline roughly divided into four marine bioregions, namely the west coast (green), south coast (blue), southeast coast (light blue) and east coast (red).

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2. Biogeography of South Africa

2.1. Ecoregions

The Offshore Marine Protected Area Project (Sink *et al.* 2011a) and National Spatial Biodiversity Assessments (Lombard *et al.* 2004; Driver *et al.* 2005; Sink *et al.* 2011b) have largely contributed to the understanding of South Africa's threatened and under-protected areas, and identifying priority bioregions for biodiversity conservation. A "bioregion" (or "ecoregion") is a region based on ecological data or characteristics of the natural environment that can be mapped as distinct distribution patterns of plants, animals and habitats (Van Newkirk 1975; McGinnis 1999).

In the South African context, "bioregions" are based on large-scale biological variability and biogeography, as well as large-scale habitat differences related to current systems, temperature- and productivity variability (Lombard *et al.* 2004). In regions where biological data were limited (e.g. abyssal zone), abiotic processes were used as surrogate biological data (Lombard *et al.* 2004). Lombard *et al.* (2004) proposed nine bioregions and 34 biozones, however, these were revised by Sink *et al.* (2011b) which resulted in six ecoregions and 22 finer-scale ecozones (Figure 3.2). Here, Sink *et al.* (2011b) replaced "bioregions" with "ecoregions" to avoid confusion in published literature. Inshore ecoregions (Southern Benguela, Agulhas, Natal and Delagoa) include the coast, continental shelves and the shelf edge with depths ranging from 0-500 m. Offshore ecoregions (Southeast Atlantic and Southwest Indian) are deeper than 500 m and include the bathyal and abyssal zones (Sink *et al.* 2011b).

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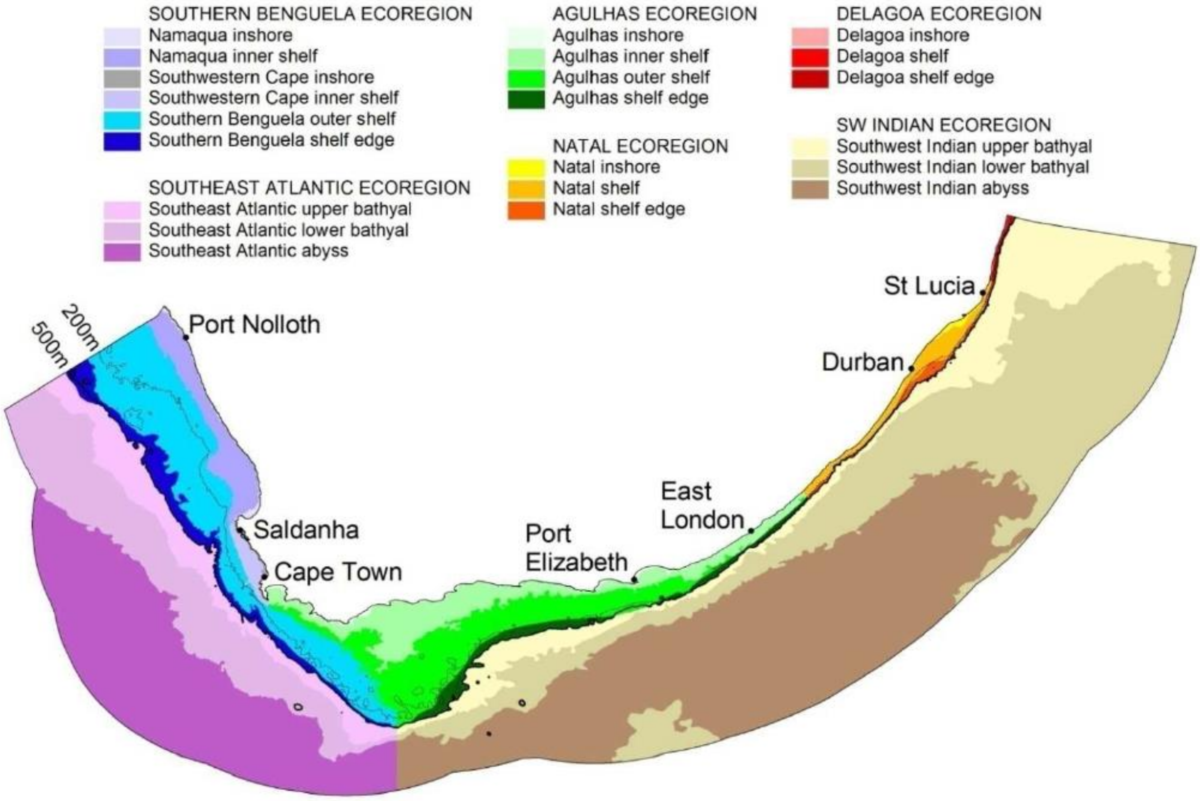

Figure 3.2. Six marine ecoregions with 22 ecozones recognized along the South African coast, as defined by Sink *et al.* 2011b. The 200 m and 500 m depth contours are indicated. *Image taken from Sink et al. (2011b)*.

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2.2. Ocean currents

The limits of these three biogeographic provinces are predominantly influenced by variations in sea water temperature caused by two major currents, the cold slow-flowing Benguela Current on the west coast and the warm, fast-moving Agulhas Current on the east coast (Figure 3.3). The Benguela Current off the west and southwestern coast of Africa, stretches along three countries (Angola, Namibia and South Africa) and is associated with strong wind-driven upwelling that brings cool, nutrient-rich waters to the surface, which moves northwards toward the equator (Hill *et al.* 1998; Shillington 1998; Shillington *et al.* 2006). The Agulhas Current starts roughly halfway between Richard's Bay and Maputo (≈ 28°S) and brings nutrient-poor, warmer waters southward, and exhibits a number of meanders south of Africa (Lutjeharms and Van Ballegooyen 1988; Lutjeharms 2006a). Substantial energy transfer takes place on the surface due to winds from neighbouring basins; contrasting sea surface temperatures lead to high evaporation rates, turbulent latent and heat fluxes (Yu 2007; Rouault *et al.* 2009).

The southern Benguela region is characterised by a pulsed, seasonal, wind-driven upwelling at particular centres and warm Agulhas Current water offshore (Hutchings *et al.* 2009b). Low-oxygen water only occurs close inshore and may markedly affect some resources

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(Hutchings *et al.* 2009b). Low-oxygen levels are prevalent, but variable in a narrow inshore strip over the southern Benguela shelf region, attributed solely to the decay processes of phytoplankton enriched from coastal upwelling, while extreme depletion levels are fairly common in the northern Benguela, which coincide with the Angola Benguela Front (Monteiro and van der Plas 2006; Hutchings *et al.* 2009b). High phytoplankton concentrations are observed usually during summer and autumn in the southern Benguela, particularly around the central northern Namibian shelf (17–23°S), especially near Walvis Bay (23°S) and off the Namaqua shelf (29–33°S), particularly St Helena Bay (32°S). Dense phytoplankton blooms in the vicinity of St. Helena may cause mass mortalities of shellfish and rock lobsters when they collapse (Pitcher and Weeks 2006). The west coast is a nursery ground for a number of fish species that spawn on the Agulhas Bank and are transported to the west coast by alongshore jet currents (Hutchings *et al.* 2009b).

The Agulhas Bank represents the southern boundary of the Benguela system, displaying mixed characteristics of coastal, shelf edge and dynamic upwelling and temperate shallow shelf systems with seasonal stratification (Hutchings *et al.* 2009b). Additionally, the Agulhas Bank exhibits moderate productivity and the shelf is well-oxygenated (Hutchings *et al.* 2009b). During the summer season a large biomass of fish, such as sardine (*Sardinops sagax*) and anchovy (*Engraulis encrasicolus*) populations, occupies the Bank and appears to be linked to coastal upwelling and the Agulhas Current (Hutchings *et al.* 2009b).

Similar to any major currents that carry a large body of 'foreign" water from neighbouring oceans into a particular oceanic region, the Agulhas Current has a marked effect on the distribution of pelagic species in the South West Indian and South Atlantic Oceans (Lutjeharms 2006b). Three potential mechanisms or a combination of these, influence biogeographical breaks within the current. Firstly, the current may transport immotile organisms such as fish larvae, seaweeds and even plastic debris, through advection (Lutjeharms 2006b). Secondly, certain marine fauna have adapted to use the current as a means of transportation during a particular life cycle (Lutjeharms 2006b). This can be seen in marine turtles nesting on the sandy beaches of Maputaland, KwaZulu-Natal: leatherback turtles (*Dermochelys coriacea*) follow the trajectory of the current to minimise the energy required for swimming (Luschi *et al.* 2003; Lutjeharms 2006b). In contrast, loggerhead turtles (*Caretta caretta*) avoid the Agulhas Current and use the inshore currents to aid their trips northward to favourable feeding grounds (Lutjeharms 2006b). The third mechanism involve hydrographic peculiarities of the Agulhas Current, including water temperature, nutrient availability, vertical stability of the water column and advection rate, may affect distribution of organisms that find these characteristics favourable or unfavourable (Lutjeharms 2006b). The Agulhas Current influences the distribution patterns of some species of fish, zooplankton, seaweeds and marine hydrozoans (Barange 1994; Anderson *et al.* 2009; Gibbons *et al.* 2010).

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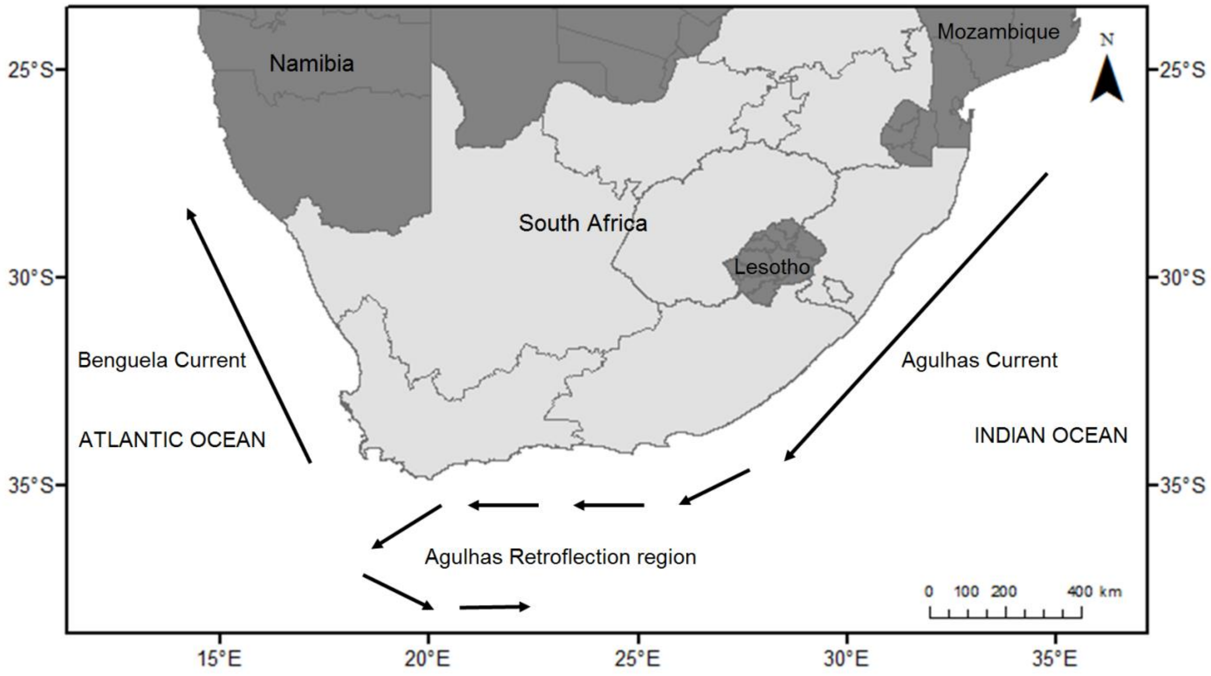

Figure 3.3. Two major currents surrounding South Africa are the Benguela Current dominating on the west coast and the Agulhas Current on the east coast. The retroflection of the Agulhas Current is also indicated.

2.3. *Thermal properties, upwelling and salinity*

The process of upwelling is associated with vertical upward transport of water from deeper to shallower depths of the ocean (Schumann *et al.* 1982). On the west coast of southern Africa, in the region between 15°S and 37°S, surface currents and vigorous, strong coastal upwelling cells near Cape Town (34ºS, 18ºE) and off Lüderitz (28ºS, 15ºE) are usually equatorward, as well as a poleward undercurrent along the shelf edge and bottom (Shillington *et al.* 2006). Intense upwelling result in phytoplankton-enriched waters and directly affect the fishing industries dependent on upwelling events along the west African/Namibian coast and off the Cape west coast (Schumann *et al.* 1982; Hutchings *et al.* 2009a). Upwelling along the Cape south coast does not have the same economic importance compared to the west coast, but localised upwelling events enhance primary productivity that indirectly affects local fishing activities of sole (*Austroglossus pectoralis*) and hake (*Merluccius capensis* and *Merluccius paradoxus*) within capes and bays (Schumann *et al.* 1982). Along the Cape south coast, the “cold current” and associated southeasterly winds is well-documented, but the influence of the Agulhas Current is likely to be minimal (Schumann *et al.* 1982). The main flow of the Agulhas Current generally lies beyond the shelf break; upwelling events occur along the full length of the shelf edge (Schumann *et al.* 1982; Lutjeharms *et al.* 2000). Towards the southeast coast, clear upwelling exists at Port Elizabeth and Port Alfred, generally attributed to winds, except in

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Port Alfred where water is upwelled from central water depths (Lutjeharms *et al.* 2000; Shillington *et al.* 2006).

Around southern Africa, it is suggested that heat and salt exchange is the key link in maintaining the global overturning circulation of the ocean (e.g. Lutjeharms 1996). The salinity of lakes, estuaries and brackish water bodies are normally between 5-30 ppt, while seas and salt lakes are between 30-50 ppt, with the average salinity of sea water 34.7 ppt (Anati 1999). Along the west South African coast, near the Orange River (≈ 30°S), surface water temperatures of coastal waters may range 14-16°C and a salinity of about 33.4 ppt, most likely attributed to some estuarine influence near the vicinity of the Orange River (Wall *et al.* 1977). Towards the southwest, monthly mean surface water temperatures range between 11-14ºC (Mucina *et al.* 2006).

Temperature variations across the shelf along the southeast coast may vary dramatically with upwelling events and season; the most noticeable feature with upwelling systems are the contrasting temperatures with surrounding waters (Schumann *et al.* 1982; Lutjeharms *et al.* 2000). Ambient water temperatures may vary more than 5°C in upwelling regions along the south and southeast coast (Schumann *et al.* 1982). The water on the shelf inshore of the Agulhas Current is characterised by an overlap of surface water of about 22°C and South West Indian Central Water ranging between 12-14°C, and persists as far upstream to north of Durban (Lutjeharms *et al.* 2000).

The Agulhas Current abruptly loops eastward to form a retroflection of the Agulhas Current, characteristically between 10°E and 21°E along the Agulhas Bank, until south of Port Elizabeth, and indicate water temperature of about 17°C, and salinity lower than 34.9 ppt below 100 m (Lutjeharms and Van Ballegooyen 1988; Lutjeharms 2010). Inter-ocean leakage of water masses occur between the South Indian and South Atlantic oceans, mainly through shedding of eddies at the Agulhas Current Retroflection, which may transport organisms and eggs (Lutjeharms 1996, 2006a). The Agulhas Return Current also has very high levels of mesoscale variability with flow characteristics rapidly decrease, from a surface speed of approximately 1.3 m.s^{-1}, as the current progresses eastward and thought to be terminated at a longitude of about 70°E at the Kerguelen Plateau (Lutjeharms 2010).

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2.4. Topography

The (continental) shelf, slope (or shelf break) and abyss are the three main topographic environments that occur offshore (Figure 3.4) (Sink and Attwood 2008). The coastal division includes the shelf, which is divided into depth zones that include the intertidal, shallow sub-photic (to a depth of 10 m) and deep photic zones (10-30 m), also collectively known as the subtidal area, and the sub-photic zone, defined as the area from the 30 m depth contour down to the shelf break (Sink and Attwood 2008). Offshore, the shelf break divides the continental shelf and slope, which occurs at different depths in different areas as defined by the slope

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angle (Sink and Attwood 2008). The shelf break varies from about 400 m in the Namaqua region, to 200 m in the Agulhas bioregion, 100 m off Natal and narrow at 50 m in the Delagoa bioregion (Lombard *et al.* 2004; Sink and Attwood 2008). The shelf break line, correctly defined by the slope angle, ranges between approximately 350 m to 500 m (Sink *et al.* 2011b). The shelf edge includes the shelf break and shelf break line. In the deep sea sections, the bathyal zone consists of the upper- (extends from the shelf edge up to about 1800 m) and lower bathyal zone (extends from about 1800-3500 m depth contour), including a transition zone (≈ 1600-1800 m) as upper- and lower bathyal species occur in this mixed zone (Sink *et al.* 2011b). The abyssal zone extends from 3500 m and deeper regions (Lombard *et al.* 2004; Sink *et al.* 2011b). The abyssal zone covers the bulk of the ocean floor generally comprising of mid-ocean ridge systems and ridges associated with seamount chains and island arcs (Watling *et al.* 2013). Only until recently, has Sink *et al.* (2011a) investigated offshore regions of South Africa, although many knowledge gaps still exist.

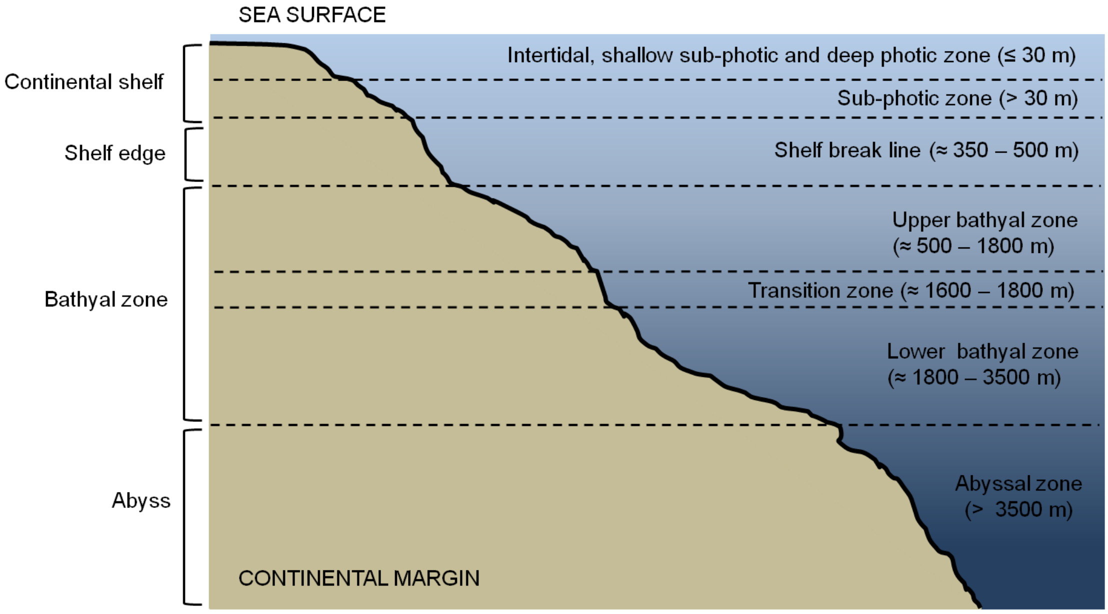

Figure 3.4. Schematic diagram of typical South African topography of the continental margin, showing the main topographic environments as described in Sink *et al.* (2011b).

2.5. Habitat types

In Sink *et al.* (2011b), four coastal habitat types are recognised, namely coast types, inshore habitat types, continental island-associated and lagoon habitat types. Ecoregions and ecozones were classified into one or more habitat types and summarised (Sink *et al.* 2011b: 41). **Coast types**, referring to the area 500 m inland from high water mark to the -5 m depth contour offshore, reflect the connectivity of coastal habitats through complex linkages, for example energy and nutrient flow, sediment dynamics and pathways for biota to move (Sink

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et al. 2011b). The National Beach Classification and Mapping Project (Harris *et al.* 2010, 2011) distinguished between rocky coasts (intertidal area comprises of rock only), sandy coasts (intertidal area comprises of sand only) and mixed coasts (when rock and sand were both present in intertidal area). The west coast is characterised by rocky cliffs, long sandy beaches, extremely sheltered deep bays and highly exposed open beaches, producing a very heterogeneous intertidal environment (Harris *et al.* 2010). Even though the west coast comprise of contrasting beach morphodynamic types, the majority of long dissipative beaches in South Africa are found in this region (Sink *et al.* 2011b). The south and southeast coasts comprise mainly of a series of log spiral bays (such as Mossel Bay, Plettenberg Bay and Port Elizabeth) interspersed with cliffs or long stretches of rocky outcrops (like the Tsitsikamma) (Sink *et al.* 2011b). Dissipative-intermediate beaches almost exclusively dominate the sandy coast type in the Agulhas Bioregion (Sink *et al.* 2011b). The Alexandria dune field presents a unique feature on the southeast coast – considered as one of the largest active coastal dune fields in the world (McLachlan *et al.* 1982). The transition zone within the southeast coast is dominated by cliffs, rocky shores and intermediate estuarine pocket beaches (Sink *et al.* 2011b). In KwaZulu-Natal, rocky shores and reflective or intermediate sandy beaches dominate the south while beaches become more intermediate and dissipative-intermediate in the north (Sink *et al.* 2011b).

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Inshore habitat types include inshore ecosystems from the subtidal coast type boundary (from -5 m depth contour) to the offshore boundary (to a depth of -30 m offshore) (Sink *et al.* 2011b). These inshore habitat types were subdivided according to substratum and geology (Sink *et al.* 2011b). Sandy, gravel and muddy habitat types constitute unconsolidated inshore ecosystems and are poorly studied in South Africa, while inshore reefs and hard grounds constitute the two main inshore rocky ecosystems (Leslie *et al.* 2000; Sink *et al.* 2011b). Sandy habitat types are more prevalent in Agulhas and Natal ecoregions, while the greatest extent of muddy habitat type is the Namaqua Muddy Inshore (Sink *et al.* 2011b). The smallest extent of rocky inshore habitat is the Namaqua Inshore Reef, however, this may be due to a lack of reef data in this region (Sink *et al.* 2011b). Agulhas Inshore Hard Grounds have the greatest extent, but Anderson (2000) concluded that our knowledge on subtidal hard substratum in South Africa is poor, and gaps cannot be quantified as yet.

South Africa has 34 continental islands classified as a “major” or “minor” island based on their conservation importance in terms of the land-breeding predator colonies that they support and also are broadly applicable to their size (Sink *et al.* 2011b). Of these, 20 islands have dense colonies of the Cape fur seal (*Arctocephalus pusillus*) and considered “minor”, because the Cape fur seal is not a conservation priority, categorised as least concern in terms of the IUCN red listing (Sink *et al.* 2011b). Such islands have an area generally less than 0.025 km^2 and may support small numbers of breeding seabirds (Rand 1972; Sink *et al.* 2011b). Major islands are usually larger in size and support a number of threatened seabird colonies

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such as the African Penguin (*Spheniscus demersus*), Cape Gannet (*Morus capensis*) and Bank Cormorant (*Phalacrocorax neglectus*) (Sink *et al.* 2011b). Even though the seal and seabird populations have been well studied, the near-shore island biota and subtidal habitats are less known (Sink *et al.* 2011b). Only three ecoregional groupings constitute **island-associated habitats** (such as rocky shores). One major island (Bird Island in Lambert's Bay) and three minor islands is in the Namaqua region and in the southwestern Cape there are eight major islands (e.g. Jutten, Vondeling, Dassen and Robben Islands) and three minor islands (Sink *et al.* 2011b). Four of the major islands in the southwestern Cape, including Jutten, Malgas and Marcus Islands, are found at the mouth of the Langebaan Lagoon (Sink *et al.* 2011b). In the Agulhas ecoregion there are five major islands (including Dyer Island on the south coast, Bird Island and St. Croix Island groups in Algoa Bay) and four minor islands (Sink *et al.* 2011b).

Only one **lagoon habitat type** exist in South Africa: Langebaan is South Africa's only lagoon because it receives freshwater input via groundwater, not from freshwater surface flow as with estuaries, but shares certain ecological features with estuaries (Whitfield 2010). This unique ecosystem in South Africa is comparable with areas such as Sandwich harhour in Namibia and Baía dos Tigres in Angola in southern Africa (Sink *et al.* 2011b). Consequently, the heterogeneous coastal environments along the South African coastline, encompassing the Economic Exclusive Zone (EEZ), provide a variety of marine bioregions ranging from cool-water kelp forests to tropical coral reefs (Sink and Attwood 2008).

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3. Taxonomic examination procedures

3.1. Specimen sorting

This study takes advantage of 254 unaccessioned specimens of bryozoan material in the existing marine invertebrate collection in the Iziko South African Museum (SAMC). The bryozoan material, examined for this study, was caught as bycatch during the UCT Ecological Surveys, and *Africana* demersal cruises in an effort to increase biodiversity knowledge on South African bryozoans. These samples were collected mainly from localities on the south coast and a few on the west coast, during 1902, 1946-1967, 1998 and 2011 using various gear types (Table 3.1). The majority of examined material in this study was collected at stations during summer and autumn months (February – July), although some stations were sampled in spring (October – November).

Dredges, used in the UCT Ecological Surveys, were about 70 cm wide, with a 1 cm mesh, and usually dragged for about 10 minutes (Christie 1976). Van Veen grabs have a catch area of 0.2 m^2 (Field 1971) and divers used quadrates with a 32 x 32 cm frame (0.1 m^2) (pers. comm. Charlie Griffiths). No additional information was obtained for trawled stations in the UCT Ecological Surveys, during the *Africana* cruises trawls are dragged for 30 minutes (pers. comm. Dr Rob Leslie).

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All gelatinous, non-calcified ctenostome specimens were preserved in alcohol. Calcified cheilostome and cyclostome specimens, including encrusted shells, gravel or stones, are initially placed in 4% formalin and later stored in 70% alcohol for preservation. Bryozoans from 18 samples, in the *Africana* demersal cruises, were preserved dry (in containers) upon collection. Although skeletal features may remain intact, partially calcified colonies may lose its colour and form by shrinking, thus not ideal for specimen preservation.

Examination was conducted using a *Wild Heerbrugg M8* dissecting microscope, with a *LV1000 Macro-Lite* LED ring light as the light source for detailed examination. Samples were sorted into morpho-species, and microscope images were taken of colonies using *ScopeTek ScopePhoto version 3.1.475*. If species validation was necessary, or in case of potentially new species, fragments of specimens were prepared for Scanning Electron Microscopy (SEM) as described in the next section. In some cases, species-level was not possible and specimens are referred to as morpho-species, if the species in question morphologically differs from a closely related species. Morpho-species, identified to genus-level, remain undescribed or undetermined, classified as “sp.”, until further investigation.

3.2. Scanning Electron Microscopy preparation

Scanning electron microscopy (SEM) has been a valuable tool for examination of bryozoan skeletal structures, and is often pivotal in resolving problems in taxonomy (Taylor and Jones 1996). Scanning electron microscopy was conducted by using the high resolution JEOL JSM-5200 SEM and morphological characteristics such as zooidal arrangement, orifice structure, autozooid structure, avicularian structure and ovicell structure were examined. Preparation procedures were followed and adapted from Florence *et al.* (2007).

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Firstly, specimens were bleached in a weak solution of NaOCl for not longer than five minutes, depending on the fragility of the specimens, to remove excess organic material for clearer images of skeletal structures. If needed, a soft brush was used to remove excess organic material from cheilostome skeletons, but care was taken if spines were visible and/or the specimen was fragile. Thereafter, the specimens were placed in an ultrasonic cleaner for 1-3 minutes, and the latter steps were repeated, if needed.

To ensure the quality of the images, undesired and excess moisture was removed by placing specimens in a dry oven at 40°C for three hours. Dried specimens were mounted onto 12.5 mm JEOL SEM stubs by using adhesive or carbon tabs. Lastly, specimen stubs were sputter-coated with a film of gold-paladium mixture to ensure reflectivity. Stubs were stored in Agar storage cabinets, to ensure an airtight, desiccated storage environment and housed at SAMC.

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Table 3.1. Summary of 254 stations sampled, of which bryozoan material in this study are housed in the SAMC collection. These stations are part of the UCT Ecological Surveys, except for two stations in the *Africana* surveys (AFR270 and AFR273). N.D. = no data.

			No. stations sampled				
Year	**Survey/Ship**	**Depth range (m)**	**Dredge**	**Trawl**	**Grab**	**Other**	**Total no. stations**
1947-49, 1961	*Africana* Trawl Survey (AFR)	37-459	17	2		2 (N.D.)	**21**
1947, 1949, 1951-58	Non-commercial Trawler (TRA)	22-480	15	12		2 (N.D.)	**29**
1959-61, 1963-65, 1967	West Coast Dredge (WCD)	18-400	16		2	1 (Dive)	**19**
1946, 1957, 1959-60, 1962	Saldanha Bay Survey (SB)	4.5-35	5		1	3 (N.D.); 6 (Hand collected)	**15**
1946, 1948-51, 1953, 1956	Langebaan Survey (LB)	3-12	4			10 (N.D.); 3 (Hand collected)	**17**
1902, 1952-54, 1959-65, 1967, 1998	False Bay Survey (FAL)	2-147	71	1	17	24 (N.D.); 2 (Coarse Plankton Net); 21 (Dive)	**136**
2011	West Coast Demersal Survey (AFR270)	303-345		2			**2**
2011	South Coast Demersal Survey (AFR273)	45-179		16			**16**
Total no. stations sampled			**128**	**34**	**18**	**74**	

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3.3. *Morphometrics*

Morphometric variation of species was examined using free downloadable software, ImageJ (https://imagej.nih.gov/ij/), to take zooidal measurements. Mean (standard deviations) measurements of up to 20 zooids (depending on the colony size) were tabulated. Measurements taken, where applicable, were: autozooid length and width (Lz, lz); orifice/opesia length and width (Lo, lo); secondary orifice length and width (Lso, lso); gonozooid length and width (Lg, lg); ovicell length and width (Lov, lov); adventitious avicularium length, width and height (Ladav, ladav, hadav); interzooidal avicularium length and width (Lintav, lintav) (see example in Figure 3.5).

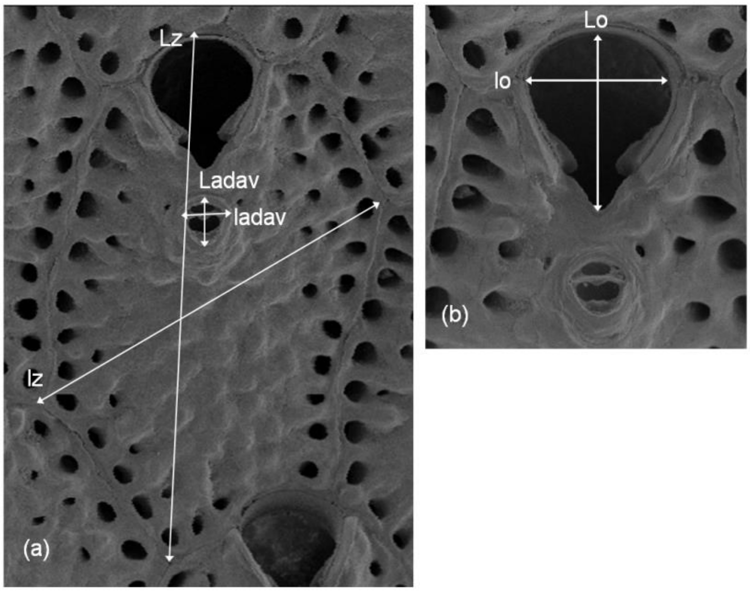

Figure 3.5. An example of morphological measurements taken for species of *Schizoporella (= ?Hippomonavella) inconspicua* (SAMC-A029008). Here, typical measurements of (a) a single zooid (magnified x150): autozooid length and width (Lz and lz), adventitious avicularium length and width (Ladav and ladav); (b) an orifice (magnified x350): orifice length and width (Lo and lo).

3.4. *Classification and outline*

Classification of Bryozoa follows Bock and Gordon (2013) and the World Register of Marine Species (WoRMS). This list constitutes part of the *Zootaxa* series ‘Animal biodiversity: an outline of higher-level classification and survey of taxonomic richness’ (Zhang 2011). As knowledge of bryozoan phylogeny is rapidly evolving and taxonomic revisions of many genera are needed, the classifications in this study should be considered provisional (Bock and Gordon 2013). Known genera from South Africa are described in Chapter 4, using mainly the

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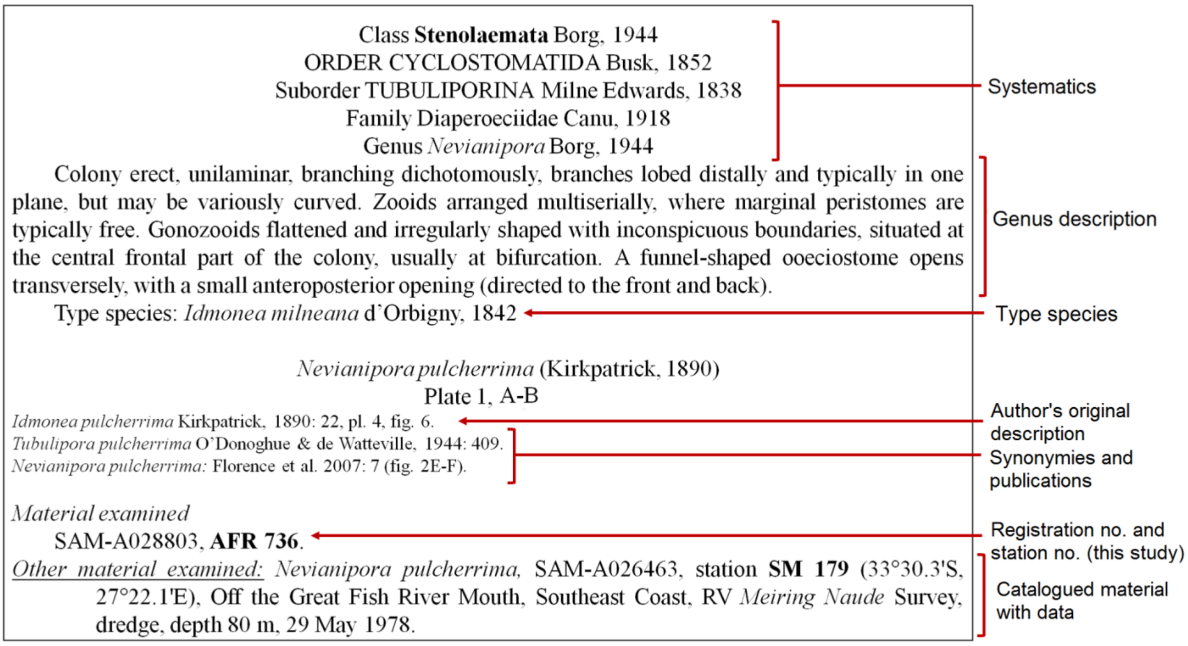
serial synopses of the three Bryozoa orders, Cyclostomata (Hayward and Ryland 1985), Ctenostomata (Hayward 1985) and Cheilostomata (Hayward and Ryland 1998, 1999). Putative "new species" are described in full, while the descriptions of common known species are omitted, unless taxonomic revision was necessary. A typical species description contains the systematic classification (Order, Class, Family, Genus) and details such as synonymies, SAMC registration numbers, taxonomic description, distribution range and the remarks (Figure 3.6).



Class **Stenolaemata** Borg, 1944
ORDER CYCLOSTOMATIDA Busk, 1852
Suborder TUBULIPORINA Milne Edwards, 1838
Family Diaperoeciidae Canu, 1918
Genus *Nevianipora* Borg, 1944

Colony erect, unilaminar, branching dichotomously, branches lobed distally and typically in one plane, but may be variously curved. Zooids arranged multiserially, where marginal peristomes are typically free. Gonozooids flattened and irregularly shaped with inconspicuous boundaries, situated at the central frontal part of the colony, usually at bifurcation. A funnel-shaped ooeciostome opens transversely, with a small anteroposterior opening (directed to the front and back).

Type species: *Idmonea milneana* d'Orbigny, 1842

Nevianipora pulcherrima (Kirkpatrick, 1890)
Plate 1, A-B

Idmonea pulcherrima Kirkpatrick, 1890: 22, pl. 4, fig. 6.
Tubulipora pulcherrima O'Donoghue & de Watteville, 1944: 409.
Nevianipora pulcherrima: Florence et al. 2007: 7 (fig. 2E-F).

Material examined
SAM-A028803, **AFR 736**.

Other material examined: *Nevianipora pulcherrima*, SAM-A026463, station **SM 179** (33°30.3'S, 27°22.1'E), Off the Great Fish River Mouth, Southeast Coast, RV *Meiring Naude* Survey, dredge, depth 80 m, 29 May 1978.

Figure 3.6. An example of a (partial) typical species description.

3.5. *Material deposition*

Primary type material and paratypes are housed in the Natural History Collections Department of Iziko South Africa Museum, Cape Town. Registration numbers and station event (in **bold**) for bryozoan material from the current collection is under "*Material examined*" (see Figure 3.6). If type material is erected, for example in new species with a holotype specimen, extra material of the species are referred to as "*Additional material*", while "*Other material examined*" refers to determined bryozoan species in museum collections (e.g. type material), in SAMC and NHMUK, used for taxonomic comparison.

4. Species richness and biogeography

4.1. *Creating species database*

4.1.1. *Data gathering*

South African Bryozoa have been sparsely sampled and unexamined material has been deposited into a variety of institutions (museums, biodiversity research facilities and universities). However, with few specialist taxonomists able to identify species within these collections, the material has either remained unexamined or has deteriorated from being stored inappropriately.

To date, a species list for Bryozoa in South Africa does not reflect the number of species that exist along the coastline, attributable to few specialist taxonomists and poor sampling. Known fossil bryozoan records from South Africa are few, and not part of the scope of this project, therefore extant bryozoan records were used. In order to compile a database of South African bryozoans, all published and unpublished information on the distribution of marine bryozoans were entered into a data matrix. Three types of records exist:

- Observational records (no specimen, but species observed and recorded)
- Specimen records (catalogued specimens in museums or institutions)
- Literature records (e.g. media, photographs or published research papers)

The papers of Busk (1852, 1854, 1875, 1884, 1886), O'Donoghue along with de Watteville (O'Donoghue 1924, 1957; O'Donoghue and de Watteville 1935, 1937, 1944) and Florence *et al.* (2007), were the main source for compiling literature records for the dataset. Other sources used included Bryozoa.net (Bock 2013) and the World Register of Marine Species (WoRMS) (http://www.marinespecies.org/). O'Donoghue (1924) attempted to collate all preceding taxonomic studies of South African bryozoans, but as this list was compiled nearly a century ago, and taxonomic revisions of problematic genera or species, descriptions of new species and resolved synonymies have taken place since then.

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Digitised catalogues of deposited specimens within collections were made available by museums. About 1225 catalogued specimens, in the Iziko South African Museum (SAMC), were extracted from *Specify 6.5.02 software* – a programme used to digitize catalogued specimens in natural history collections – of which 1028 specimens were used in this study (see Figure 2.2 in Chapter 2). A number of South African bryozoans are housed at the Natural History Museum in London (NHMUK) and approximately 1403 records were acquired from their database. In addition to that, over 1000 individuals were identified to species-level, where possible, and associated locality information (latitude/longitude coordinates and depth) recorded (Chapter 4).

4.1.2. Data cleaning

A "usable" record contained a valid species name, locality and/or locality coordinates (latitude/longitude) and depth. Data cleaning involved three steps, namely updating resolved synonymies, inferring omitted locality data and removing dubious or duplicated records. The WoRMS Taxon Match Tool was used to automatically match the compiled species list with WoRMS. After matching, the tool returned the file with the valid names and authorities,

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therefore, providing an updated list of valid species and its associated synonymies. However, some synonymised species were resolved in this study using the literature.

In most publications from the 19th Century, and early 20th Century, species records had limited locality data. GEOLocate, a software for georeferencing natural history data (http://www.museum.tulane.edu/geolocate/), was used to obtain latitude/longitude coordinates for records with only locality names. In instances where specimens were collected by hand, from the intertidal zone or scraped from a plate in harbours, depth (in m) was inferred as ≤ 10 m. Bryozoans collected from the hulls of ships or beach casts were excluded from the dataset.

The Global Biodiversity Information Facility (GBIF) provides free access to biodiversity data (http://www.gbif.org/). Over 300 bryozoan records from South Africa were acquired from GBIF. These records include fossil (≈ 13 records), observational (≈ 82 records) and specimen (≈ 122 records) records with very limited locality data; the remaining records lack valid species names and/or locality data. Limited locality data associated with species and invalid species names resulted in the latter database to be excluded from this study.

Dubious or doubtful observational records and records not determined by a specialist taxonomist were also omitted from the species list used for analyses. The majority of the specimen records acquired from SAMC and NHMUK databases were used in published papers, while a number of records were duplications and/or without associated locality information. Moreover, locality coordinates of some records were on land, therefore omitted from the dataset. This resulted in a majority of the records in the SAMC (51%) and NHMUK (88%) databases being excluded from the current dataset – highlighting the need for consistency and accuracy in the digitizing museum records for biodiversity research. To avoid confusion, if a record was duplicated in the database and/or used in a publication, it was seen as a single record for the dataset.

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After data cleaning, the > 1700 “usable” records that fall within the South African EEZ borders were used to analyse distribution patterns. Over 800 records were from the literature and the present collections, while the SAMC database yielded 74 records and NHMUK database only three records from over 600 samples. The number of samples are important to assess sampling effort along the coast (Figure 3.7). A “lot” refers to specimens in this study sampled from a single locality or station, and may contain more than one species. Therefore, species recorded as beach cast or in a random collection event was excluded from the dataset, because the depth and locality of cannot be accurately determined.

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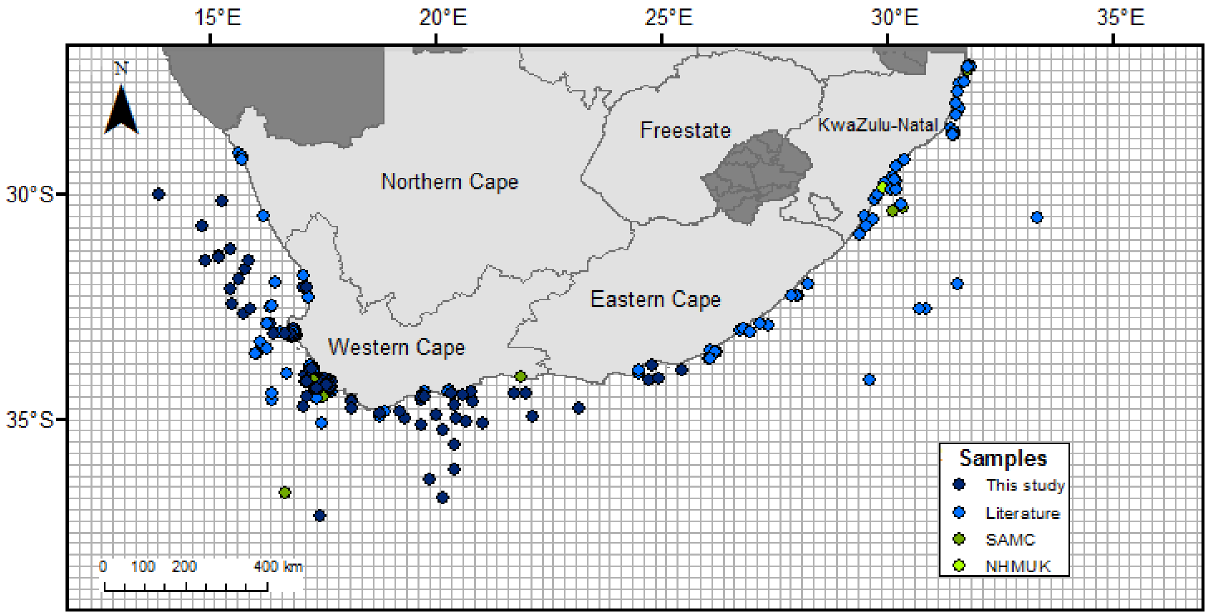

Figure 3.7. A visual representation of samples used from the current collections (this study), the literature and museum records.

4.2. Gridded cell method to assess species richness patterns

4.2.1. Quarter Degree Grid Cells

Preceding studies that have examined the species richness of various South African marine taxa have divided the coastline into contiguous 5° grid sectors (e.g. Millard 1978; Samaai 2006; Gibbons *et al.* 2010) or units of 50 km or 100 km (e.g. Turpie *et al.* 2000; Awad *et al.* 2002; Acuña and Griffiths 2004; Griffiths *et al.* 2010). These methods may limit an explanation of species richness variations in bryozoans, because of sparse distribution data for South African bryozoans.

In this study, Bryozoa species richness patterns are assessed using the Quarter Degree Grid Cells (QDGC) method. Larsen *et al.* (2009) explained that QDGC represents a method of measuring consistently sized squares covering a specific area to represent specific qualities of the covered area. The squares are based on full degree squares (1° latitude x 1° longitude) covering earth (Table 1 in Larsen *et al.* 2009). The number of squares at each level designation is the level designation as an exponent associated with the base of 4 (Larsen *et al.* 2009). Therefore, level 0, $4^0 = 1$ square, level 1, $4^1 = 4$ squares, level 2, $4^2 = 16$ squares (Figure 3.8) and so on, meaning the calculation of an area can be examined at any level (Larsen *et al.* 2009).

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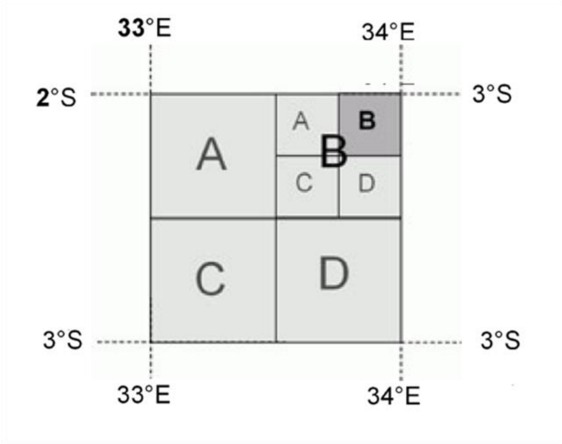

Figure 3.8. An illustration of a standard QDGC based on a full degree at level 1 (4 squares within the degree square), level 2 means dividing each level 1 square into a further 4 squares resulting in 16 squares per degree square. *Image taken from Larsen et al. (2009)*

Instead of a full degree QDGC that would misrepresent the sparsely distributed datapoints of Bryozoa, a level 2 QDGC (0.25 decimal degree per square or 16 squares per degree square) was created using the vector grid tool in QGIS *version 2.2.0*. This resulted in the coastline being divided into 0.25 QDGC's each with its output number. This layer was projected into *ArcGIS 10.2* to be combined with the datapoints layer created from species richness database.

Data from this joint layer (with unique QDGC's and associated datapoints) was extracted and, similar to Samaai (2006), used to create an actual and interpolated (predicted) data matrix of species presence/absence. Species occur at two extreme points (localities) in the dataset, and interpolation of the species distribution takes on the assumption that the species occur between the two points. For example, if a species occur in gridded cell 3 and 9, the predicted distribution is from gridded cells 4-8.

4.2.2. Stratification

The aim of this project was to assess species richness patterns along the coastline, however, overall limited distribution data across depth zones resulted in the dataset being analysed separately. Available literature suggests bryozoan diversity changes with depth, therefore distribution data were stratified into depth bins of 10 m, 50 m and 500 m, and using depth zonation categories from Sink *et al.* (2011b):

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- Shallow water (intertidal to deep-photic) ≤ 30 m
- Subphotic zone 31-300 m
- Shelf edge 301-500 m
- Bathyal zone 501-3500 m
- Abyss > 3500 m

Sections 1 and 2 in this chapter, distinguishes between marine bioregions *a priori*, as defined in the literature (e.g. Sink *et al.* 2011b). Gridded cells or QDGC's were grouped into depth categories and separated into a priori west, south, southeast or east coasts (Figure 3.9), except when two marine bioregions/depth categories overlap in one gridded cell. Here, datapoints within the cell were divided separately into associated marine bioregion and/or depth category. For example, a gridded cell contains datapoints on either side of a west and south coast border, therefore each datapoint was assigned to either west or south coast.

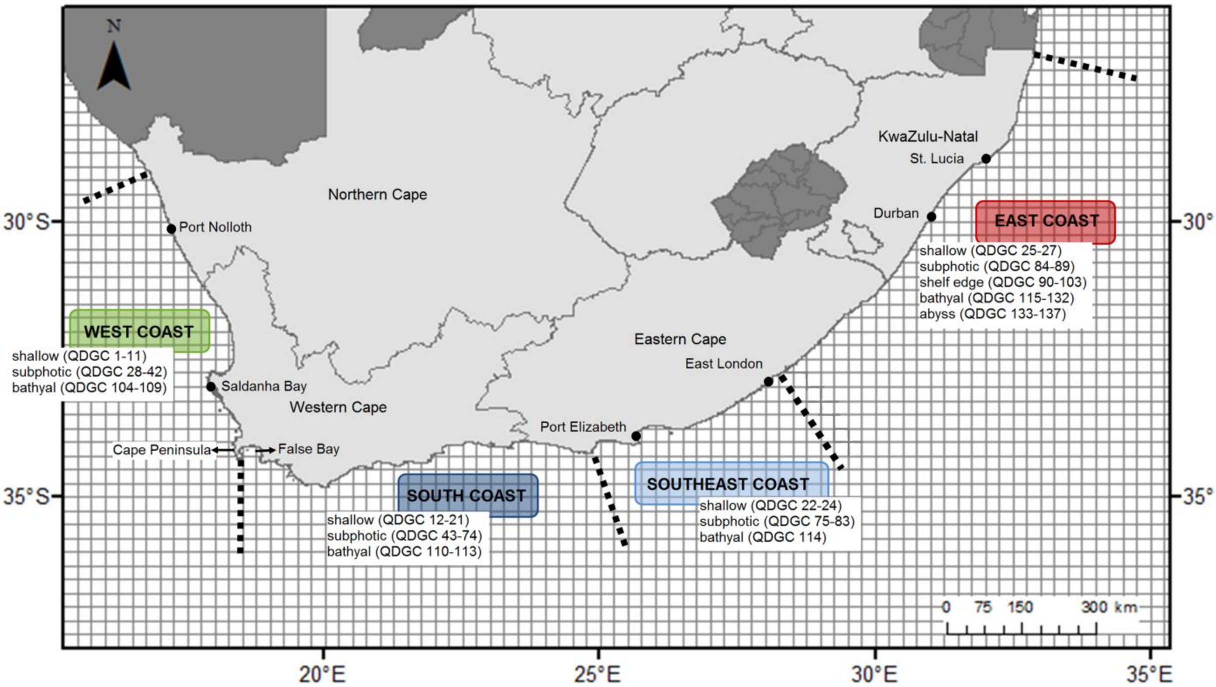

Figure 3.9. Numbered quarter degree grid cells (QDGCs) along the coastline separated into marine bioregions (west, south, southeast and east coasts) and the depth zones within cells.

4.2.3. Global distribution affinities

To analyse faunal components and regional distribution patterns, distribution ranges were acquired from Bryozoa.net, WoRMS and published literature. Each species recorded in South Africa was classified to one of the following zoogeographic categories:

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- *Endemic*: Species (presumably) restricted to South African waters. Species endemism may be referred to as apparent endemism, since taxa outside South African borders are not particularly well known. True endemism remains unknown until bryozoans occurring in neighbouring coasts (Namibia and Mozambique on the west and east coast of Africa) are investigated.
- *Indo-Pacific*: Species known to occur in any portion of the Indian and/or Pacific Oceans, but not known to occur elsewhere.
- *Atlantic*: Species known to occur in any portion of the Atlantic Ocean.
- *Cosmopolitan*: Species known to occur in the Indian-, Pacific- and Atlantic Oceans, including both temperate and tropical waters.
- *Scattered*: Species known to occur in various oceans, but not widespread enough to be regarded as cosmopolitan. Taxa that do not fit in the above categories are also assigned here.
- *Widespread*: Species known to occur over a wide region, or occurring in more than one ocean, but not enough to be regarded as cosmopolitan.

4.2.4. Statistical analyses

The species data matrix used here comprises of valid species names, their associated QDGC numbers, depth (*a priori* in some cases), marine bioregion and depth zone category. If a species was recorded from only one QDGC of the whole grid, the species was removed from the dataset, unless the species was found at either of the coastal extremes of depth zones, or if the species has been recognised as an apparent endemic. For analyses, the data matrix was simplified by only using species name and QDGC number (which was associated with its marine bioregion and depth zone category). All analyses were conducted in PRIMER 6.

To assess dissimilarities (and similarities) between the interpolated species composition of QDGC's, the species data matrix was transformed to a presence/absence matrix in PRIMER. Due to limited data for the shelf edge and abyss, both groups were excluded from detailed analysis. The Bray-Curtis index was used and visualised this by using non-metric multidimensional scaling. This analysis measures the differences in species composition in a single distance statistic between groups (or samples). If the ecological distance is large, then groups have few species in common (Kindt and Coe 2005). Analyses were repeated for two separate gradients (depth and longitude). Firstly, similarity matrices were conducted across depth zones (shallow waters, subphotic and bathyal zones) within assumed marine bioregions. Secondly, similarity matrices were conducted across marine bioregions (west, south, southeast and east coasts) within groups separated by depth zones.

To test hypotheses for spatial differences in bryozoan assemblages (or communities) within and between QDGC's, one-factor analysis of similarity (ANOSIM) was conducted. ANOSIM generates a value of R, scaled to lie between -1 and +1, with a value of zero

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representing the null hypothesis (Chapman and Underwood 1999). PRIMER's similarity percentage (SIMPER) analysis gives the percentage of similarity and dissimilarity of samples, between levels of samples and for specific levels of samples. This analysis identifies the species that explain the differences – higher contribution percentages indicate that the species contribute more to the differences than species with lower contribution percentages.

4.3. Environment and colony morphotypes

i) Study area (False Bay)

The Atlantic seaboard borders the western side of the Cape Peninsula, while False Bay is situated on the eastern side and is part of the Atlantic Ocean, which extends as far as Cape Agulhas. False Bay (34°13'S, 18°38'E) is a very large bay, over 1000 km^2 in area (Day 1970). The stretch of coastline includes the smaller Smitswinkel Bay, Simon's Bay and Kalk Bay to form the western boundary, from Muizenberg towards the east at Gordon's Bay form the northern boundary, and the eastern border is from Gordon's Bay, include Rooi Els and Cape Hangklip (Figure 3.10) (Day 1970; Sink *et al.* 2011b). Water depth is greatest in the mouth of the bay, about 80 m, and steeply slopes up towards the western and eastern coastlines, which are dominated by rocky shores, while gently sloping up towards the northern coastline which consists almost entirely of sandy beach (Clark *et al.* 1996).

The Agulhas ecoregion is oceanographically complex, being subjected to warm water intrusions from the Agulhas Current and wind-induced upwelling from the cold waters of the South Atlantic (Harris 1978). This region has medium productivity with moderate chlorophyll and frequent chlorophyll fronts (Sink *et al.* 2011b). False Bay reefs are considered relatively distinct from other reefs within this ecoregion, probably due to the significant shelter within the bay, and the influence of both the Agulhas Current and seasonal intermediate upwelling (Sink *et al.* 2011b). The complexity of False Bay is reflected in the nature and composition of benthic fauna, where the distribution of cold and warm water species is related to the pattern of water temperatures in summer (Day 1970).

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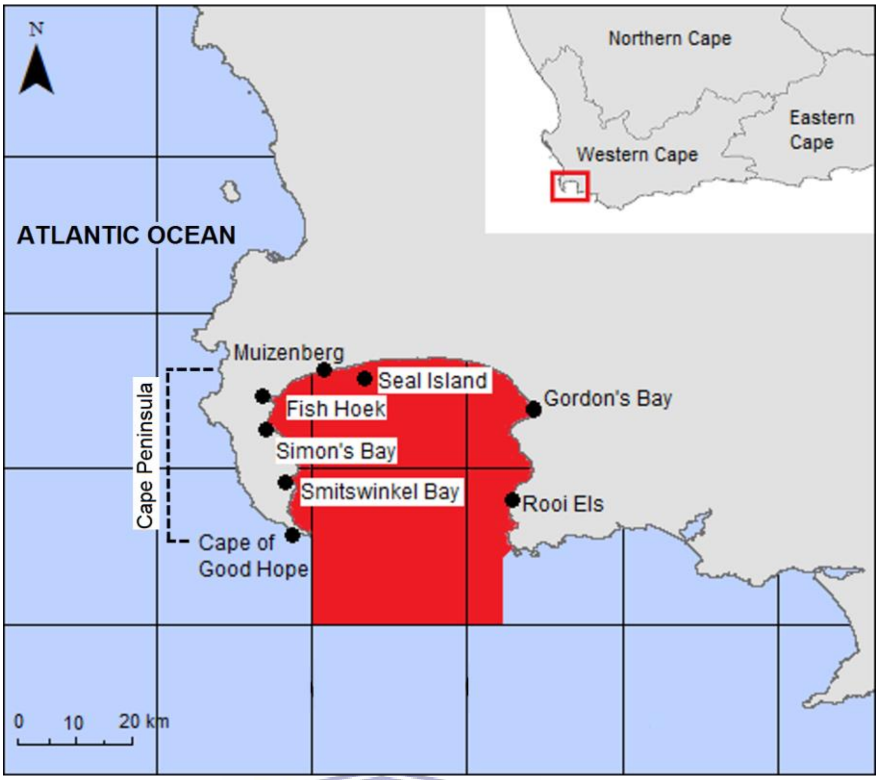

Figure 3.10. A map of False Bay indicating gridded cells (in red) from which bryozoan distribution data was used.

ii) Colony morphotypes

Distribution data for False Bay were collated from the literature, but the majority of samples were examined in the current study. The initial scope of this project did not include colony morphotypes, because of sparsely distributed data. However, owing to the great number of samples within the bay, it seemed fitting to examine colony morphotypes of shallow-water cheilostome bryozoans. Colony morphotypes recognised in this study are summarised in Table 3.2.

4.4. Maps

StatPlanet in StatSilk© 2008-2015, a free interactive mapping software, was used to download shapefiles for southern Africa (StatSilk 2015). The South African Exclusive Economic Zone (EEZ) shapefile was acquired from the South African National Biodiversity Institute (SANBI). All maps were produced in ArcMap in *ArcGIS 10.2*.

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Table 3.2. Summary of 17 bryozoan colony morphotypes recognised in this study. *Sources: [1]Brown (1952); [2]Moyano (1979); [3]Stach (1936); [4]Cook (1968).*

	Orientation	**Attachment**	**Construction**	**Rows of zooecia**	**Layers of zooecia**	**Shape**	**Skeletal thickening**	**Substrate type**
Adeoniform[1]	erect	firmly attached	rigid	few individuals	bilaminar	lobate	calcareous base	solid substrate
Adeonelliform	erect	firmly attached, encrusting base	rigid	numerous individuals	bilaminar	lobate or fenestrate		
Buguliform[2]	erect	rootlets	flexible, unjointed	numerous individuals		tuft-like, branched		variable
Catenicelliform[3]	erect	rootlets	flexible, jointed	few individuals				red algae
Cellulariiform[4]	erect	firmly attached or rootlets	flexible, jointed			tuft-like, branched		
Celleporiform[1]					multilaminar	variable		flexible
Cellariform[3]	erect	rootlets	flexible, jointed	numerous individuals	on all faces	cylindrical		variable
Eschariform[3]	semi-erect	radicles or direct	strongly calcified	macroserial	bilaminar	foliaceous	frontal	
Flustriform[3]	erect		flexible (non-rigid)					
Lunulitiform[3]		free living or rootlets			outer face	discoid or cup-shaped		sandy bottoms
Membraniporiform A[3]	encrusting		completely calcified		unilaminar			solid substrate
Membraniporiform B[3]	encrusting		poorly calcified		unilaminar			flat, flexible substrate
Petraliiform[3]		rootlets			unilaminar			
Pseudovinculariform[3]	erect				unilaminar	hollow cylinder		algal stem
Reteporiform[3]	erect	firmly attached	rigid			fenestrate/reticulate	strongly calcified	solid substrate
Scrupariiform[4]	erect	creeping		uniserial				variable
Vinculariform	erect	firmly attached	rigid		all sides	subcylindrical	calcareous base	solid substrate

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CHAPTER 4. SPECIES ACCOUNT OF PHYLUM BRYOZOA FROM SOUTH AFRICA BASED ON UCT ECOLOGICAL SURVEYS AND *AFRICANA* DEMERSAL CRUISES

This study takes advantage of 254 unaccessioned specimen lots of bryozoan material in the existing marine invertebrate collection in SAMC. Over 1000 specimens were examined for this study and were sampled during the UCT Ecological Survey and *Africana* demersal cruises. The current study yielded 162 species, of which 141 species were listed in this chapter. Twelve new species (*Favosipora epiphyta* sp. nov., *Chaperiopsis* (*Chaperiopsis*) *yinca* sp. nov., *Aspidostoma staghornea* sp. nov., *Micropora erecta* sp. nov., *Trypostega infantaensis* sp. nov., *Khulisa ukhololo* sp. nov., *Adeonella assegai* sp. nov., *Celleporaria umuzi* sp. nov., *Hippomonavella lingulatus* sp. nov., *Microporella lezinyosi* sp. nov., *Phidolopora cyclops* sp. nov.and *Reteporella ilala* sp. nov.) were described. Five species previously assigned to genera *Eurystotos*, *Aetea*, *Schizoporella, Chaperia* and *Arthropoma* are transferred to *Microeciella*, *Callaetea*, *Hippomonavella, Chaperiopsis* and *Rogicka*, respectively (*Microeciella* cf. *planus* comb. nov., *Callaetea* cf. *spiralis* comb. nov., *Hippomonavella inconspicua* comb. nov., *Chaperiopsis familiaris* comb. nov. and *Rogicka lioneli* comb. nov.). Six genera (*Biflustra*, *Callaetea*, *Favosipora, Rogicka, Phidolopora* and *Triphyllozoon*) are newly recorded from South Africa. Annotated notes are provided for five redescribed species and the remaining 121 species.

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Abbreviations used in the text

NHMUK : Natural History Museum, London
SAMC : Iziko South African Museum, Cape Town
WD : working distance
Lz/lz : autozooid length/width
Lo/lo : orifice or opesia length/width
Lso/lso : secondary orifice length/width
Lov/lov : ovicell length/width
Ladav/ladav : adventitious avicularium length/width
hadav : adventitious avicularia height
Lintav/lintav : interzooidal avicularium length/width
N_T : number of characters measured
SD : standard deviation.

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Class **Stenolaemata** Borg, 1944

ORDER CYCLOSTOMATA Busk, 1852

Suborder TUBULIPORINA Milne Edwards, 1838

Family Diaperoeciidae Canu, 1918

Genus *Nevianipora* Borg, 1944

Colony erect, unilaminar, branching dichotomously, branches lobed distally and typically in one plane or variously curved. Zooids arranged multiserially, marginal peristomes typically free. Gonozooids flattened and irregularly shaped with inconspicuous boundaries, situated at central frontal part of the colony, usually at bifurcation. Funnel-shaped ooeciostome opens transversely, with small anteroposterior opening (directed to the front and back).

Type species: *Idmonea milneana* d'Orbigny, 1842

Nevianipora pulcherrima (Kirkpatrick, 1890)

Idmonea pulcherrima Kirkpatrick, 1890: 22 (pl. 4, fig. 6).

Tubulipora pulcherrima: O'Donoghue and de Watteville, 1944: 409.

Nevianipora pulcherrima: Hayward and Ryland, 1995: 534 (fig. 2A) (*cum. syn*.). Florence *et al.*, 2007: 7 (figs. 2E-F).

Material examined

SAMC-A028803, **AFR 736**, SAMC-A077575, **FAL 42**; SAMC-A077631, **FAL 475**; SAMC-A073469, **FAL 504**; SAMC-A077517, SAMC-A077540, SAMC-A077525, **FAL 576**; SAMC-A077358, **FAL 730**; SAMC-A073455, **FAL 775**; SAMC-A077393, **FAL 783**.

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Substratum, depth and ecology

Grows erect, attached to hard rocky substrates in sheltered areas. Previous known depth range was down to 20 m, but in this study the known depth range is extended 4-42 m.

Geographic distribution

Fairly widespread distribution in the Indo-Pacific region, reported in Australia, east Africa (Brood 1976), and also reported from China. In South Africa, this species occurs on the southwest coast from False Bay to Mossel Bay.

Remarks

This species is very well characterised and exhibit high polymorphism (Harmer 1915). In this study, *N. pulcherrima* specimens were more robust in nature, free peristomes in some zooids and usually 4-5 zooids, but in some specimens, wider parts of the colony may consist of up to seven zooids. The latter feature agrees closely with specimens of d'Orbigny and Darwin (during the *Beagle Voyage*) from Falkland Island and Albrohos Island (Harmer 1915). Harmer (1915) and Florence *et al.* (2007) observed that wider parts of the colonies (with 6-7

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zooids) are normally associated with gonozooids, but no gonozooids were observed in the current specimens.

The basal surface of Darwin's specimen, with distinct longitudinal and transverse lines of growth, agrees with some of the colonies in the current collection (Harmer 1915). In some colonies (SAMC-A073455 and SAMC-A077575), the flat basal surface exhibits growth lines and cross-connections (kenozooids) between branches, and coincides with 'Siboga' specimens described in Harmer (1915). Cross-connections were particularly marked in a large reticulated colony (SAMC-A077575), forming a three-dimensional structure, with cross-connections between closely situated branches.

This species is fairly widespread throughout the Indo-Pacific region, but reported from China as well. Additionally, the validity of South African *N. pulcherrima* may be questionable, because of high polymorphism in *N. pulcherrima* and wide distribution range. Molecular research would establish whether South African *N. pulcherrima* is comparable with specimens from other regions.

Family Oncousoeciidae Canu, 1918

Remarks

Cyclostomes assigned to this family are tubuliporine with simple gonozooids, usually pyriform or ovoidal shape, with a terminal, cylindrical ooeciopore (Taylor and Zaton 2008). These include genera both encrusting (e.g. *Oncousoecia*, *Microeciella*) and erect (e.g. *Filisparsa*) (Taylor and Zaton 2008). Complex issues surrounding the taxonomy of the family Oncousoeciidae, including some species in the genus *Eurystrotos* Hayward and Ryland, 1985 that is considered as a subjective junior synonym of *Oncousoecia* Canu, 1918, was discussed in detail in Taylor and Zaton (2008). For example, *Alecto compacta* Norman, 1867, the type species for *Eurystrotos*, is considered a junior synonym for the lectotype *A. dilitans* Johnston, 1847 (Taylor and Zaton 2008).

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Genus *Microeciella* Taylor and Sequeiros, 1982

Remarks

Oncousoecia colonies have ramifying ogliserial branches with kenozooids forming tapered branch edges (Taylor and Zaton 2008). These characters enables it to be distinguished from the subcircular, spot- or sheet-like colony form of *Microeciella* , but both genera share similarities in zooidal and gonozooidal features (Taylor and Zaton 2008). Therefore, based upon colony form that serves to be a distinct feature, some *Eurystrotos* species have been tentatively assigned to the family Oncousoeciidae, while others were placed in Plagioeciidae Canu, 1918 (Bock 2013). Notwithstanding the taxonomic issues within

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this family, the sheet-like colony form of *Eurystrotos planus* Florence *et al.* 2007, previously assigned to Plagioeciidae, is better placed in *Microeciella*, now in the family Oncousoeciidae.

Type species: *Microeciella beliensis* Taylor and Sequeiros, 1982

Microeciella cf. *planus* (Florence, Hayward and Gibbons, 2007) comb. nov.

Plate 1, A-B

Eurystrotos planus Florence, Hayward and Gibbons, 2007: 7 (figs. 2G, H).

Material examined

SAMC-A029005, **TRA 31**.

Substratum, depth and ecology

Attached to mussel shells and other bryozoans – in this study found encrusting on ***Reteporella ilala*** sp. nov. Reported from shallow waters (< 20 m), but in this study found at a depth of 86 m. Extended known depth range 4-86 m.

Geographic distribution

Previously reported only from Saldanha Bay on the west coast, but in this study found off Struisbaai on the south coast.

Remarks

Florence *et al.* (2007) assigned the name *Eurystrotos planus* due to its close resemblance to *E. compacta* (Norman, 1866). However, the minimal peripheral lamina on the growing edge, autozooids arranged in series from the colony origin and short peristome of this small colony agrees with the description of the genus *Microeciella*, therefore placing *E. planus* in *Microeciella*. The gonozooid is described by having an oval, slightly inflated shape with dense perforations, but no gonozooid was observed in this single specimen. This species is tentatively placed in *Microeciella* until more specimens with a wider range of ontogeny are collected.

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Family Plagioeciidae Canu, 1918

Genus *Plagioecia* Canu, 1918

Colony encrusting, lobed or discoid, secondary daughter zooids budding from margin or from more central areas. Autozooids in quincuncial arrangement or irregular; calcified terminal diaphragms develop in later ontogeny. Extensive gonozooid, enveloping peristomes of autozooids, wider than long, often occupying much of the margin of the colony. Ooeciostome forms a cylindrical short tube, siuated distally and partially recurved proximally, but aperture not flared. Ancestrula producing one distal and one disto-lateral bud; while further zooids grow in a fan-shape, later growing proximally and obscuring the ancestrula.

Type species: *Tubulipora patina* Lamarck, 1816

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Plagioecia patina (Lamarck, 1816)

Tubulipora patina Lamarck, 1816: 163.

Plagioecia patina: Hayward and Cook, 1983: 131.

Material examined

SAMC-A029083, **WCD 11**.

Substratum, depth and ecology

Form flattened discoid colonies attached to other bryozoans. Depth range 55-90 m.

Geographic distribution

Temperate Atlantic, Mediterranean and eastern Pacific distribution. In South Africa, *P. patina* was reported from the southeast coast, near East London and the east coast, near Uhmlanga. This is the first report of *P. patina* sampled west of the Cape Peninsula, off Kommetjie, extending its known distribution range.

Remarks

Plagioecia patina is characterised by its small subcolonies and often extended peripheral lamina. Zooids in the growing edge have connate, single radial rows. This agrees well with the one colony (and two subcolonies) found in the current collection, attached to ***Biflustra khoisan*** sp. nov. No clear gonozooids were observed. This species warrants molecular research, since its distribution seem widespread and only a few colonies have been found along the coast of South Africa.

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Plagioecia sp. 1

Material examined

SAMC-A077577, **FAL 42**; SAMC-A077396, **FAL 783**.

Description

Colony discoid and lobed, widening distally, adnate and flat; peripheral lamina well-developed. Calcification opaque white to cream when dead. Autozooids radiating from proximal region of colony, in a more or less quincucial series, mostly adnate, but mostly with distal portion of peristome erect, slightly curved towards the lateral periphery. Developing zooids at growing edge has a circular aperture, later becoming oval, except in erect peristomes, which are nearly cylindrical, deflected either to the right or left. In later ontogeny, zooids develop a terminal diaphragm.

Substratum, depth and ecology

Found encrusting on the basal surface of an algae branch and *Menipea* sp., respectively. Depth range 17-21.5 m.

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Geographic distribution

The specimens were found in Gordon's Bay and south of Smitswinkel Bay in the False Bay area.

Remarks

Only two colonies were found. The discoid and lobed colony, quincuncial series, well-developed periphery or marginal lamina, some freely erect peristomes and terminal diaphragms in older zooids agrees with the diagnostic features of this genus, therefore confidently placed in *Plagioecia*.

Very few *Plagioecia* species have been reported in South Africa. *Plagioecia patina* Lamarck, 1816 was reported in South Africa on the southeast to east coast (Hayward and Cook 1983). The discoid or elliptical colonies and the well-developed lamina of *P. patina* agree with *Plagioecia* sp. 1, but differs from *P. patina* by having circular orifices at growing edge that becomes oval in later ontogeny, and having longer, deflected peristomes near the growing edge. However, the characteristics of the gonozooid and ooeciostome was unclear in these specimens. This species will remain unnamed until more material is acquired for an accurate diagnosis.

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Family Tubuliporidae Johnston, 1838

Genus *Exidmonea* David, Mongereau and Pouyet, 1972

Colony erect, dichotomous branching, developing a narrow two-dimensional form. Connate autozooids in tranverse rows, in groups alternating along the right and left axis of the branch. Gonozooid situated frontally in median position along the branch axis, elongate, pyriform; ooeciostome distal, narrow, cylindrical, recurved, with hooded aperture. Kenozooids absent on basal surface.

Type species: *Exidmonea atlantica* David, Mongereau and Pouyet, 1972 (not *Idmonea atlantica* Forbes in Johnston, 1847)

Remarks

Taylor and Voigt (1993) resolved the problematic authorship of this genus and identity of the type species. Previously, the presence or absence of kenozooidal growth on the basal surface of branches were used to distinguish between the genera *Idmidronea* and *Exidmonea*, respectively (Ostrovsky and Taylor 1996). However, some species, for example *Idmidronea hula* Borg, 1944 was referred to *Exidmonea*, due to the absence of dorsal kenozooids, but later returned to *Idmidronea* since polymorphs were found in some colonies of *I. hula* (Ostrovsky 1998). Even though the presence or absence of basal kenozooids may be artificial in some species, this characteristic is still used to distinguish between the genera (Ostrovsky 1998).

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Exidmonea cf. *atlantica* David, Mongereau and Pouyet, 1972

Idmonea atlantica Forbes in Johnston, 1847: 278. Hincks, 1880: 451. Busk, 1886: 10. Marcus, 1940: 69. Kluge, 1962: 110.

Idmidronea atlantica: Harmelin, 1976: 182. Hayward and Cook, 1979: 116. Buge, 1979: 232 (pl. 7, fig. 4). Hayward and Cook, 1983: 136.

Exidmonea atlantica: Florence *et al.*, 2007:5 (figs. 2A-B, 20E).

Material examined

SAMC-A029039, **AFR273 A31617**.

Substratum, depth and ecology

Colonies grow erect, attached to hard rocky substrate in a depth range of 20-110 m.

Geographic distribution

Widespread distribution as this species has been recorded in Britain, Norway, Shetland, eastern Atlantic to Madeira, Cape Verde, the Gulf of Mexico, Angola and southern Africa. In this study, *E. atlantica* was found on the south coast in False Bay, off Mossel Bay and Port Elizabeth.

Remarks

Idmidronea species are characterised by its erect colony, dichotomous branching and kenozooids present on the basal surface. Brood (1977) examined fossil cyclostomes from South Africa, and the current specimens agree with some features of the fossil bryozoan *Idmidronea langi* Brood, 1977. The triangular stems composed of generally five, and rarely four or six autozooids opened in fascicles either side of axis and the basal surface has fine growth striations, very rarely kenozooids (Brood 1977). Thus, this species is better placed in *Exidmonea* due to growth striations and absence of kenozooids on the basal surface (Florence *et al.* 2007).

The distinguishing features for *E. atlantica* include zooids opening on one plane of the branch in alternating connate series of three to five, with peristomes deflected and gently curved (up to 0.8 mm in length), alternately to the right and left side of axis (Florence *et al.* 2007). However, the length of the peristome in the current specimens are shorter, which warrants further investigation to potential environmental influence.

The general placement of species without kenozooidal overgrowths in the genus *Exidmonea* may be found to be incorrect, as some colonies of *Idmidronea* showed no kenozooidal growth (Ostrovsky and Taylor 1996). The current specimens are tentatively assigned to *E. atlantica* based on the number of zooids in a series and the direction of deflection of the peristomes, but no apparent gonozooids and ooeciostomes were observed for an accurate diagnosis.

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Genus *Tennysonia* Busk, 1867

Taylor *et al.* (2011) revised the genus *Tennysonia* Busk, 1867 in great detail. The description of the type species encompass the genus description (Taylor *et al.* 2011). See “Remarks” section below.

Type species: *Tennysonia stellata* Busk, 1867

Tennysonia stellata Busk, 1867

Plate 1, C-D

Tennysonia stellata Busk, 1867: 242 (pl. 36, figs. 10, 11). Busk, 1875: 34 (pl. 31, fig. 6). Taylor *et al.*, 2011: 61 (figs. 1-4).

Material examined

SAMC-A077482, SAMC-A077484, SAMC-A077495, **FAL 576**; SAMC-A077543, SAMC-A077545, **FAL 577**; SAMC-A077465, **FAL 603**; SAMC-A073432, **FAL 783**; SAMC-A028908, **TRA 37**; SAMC-A028907, **TRA 141**; SAMC-A028927, **TRA 151**; SAMC-A029100, **WCD 11**; SAMC-A029116, **WCD 159**.

Substratum, depth and ecology

Forming erect colonies on hard substrata, some attach on other bryozoans. Depth range 17-75 m.

Geographic distribution

Previously recorded from Cape of Good Hope, Plettenberg Bay, Port Elizabeth, East London and extending eastwards into Kwazulu Natal. In this study, sampled west of the Cape Peninsula.

Remarks

Taylor *et al.* (2011) suggested high plasticity within *Tennysonia* created much confusion, and investigated the variation in skeletal morphology of *T. stellata*. Collections of *T. stellata* from South Africa housed at NHMUK from a few localities and some at SAMC collected in Port Elizabeth were used to examine its phylogenetic position and skeletal morphology (Taylor *et al.* 2011).

The most common morphotype found in the current collections were relatively narrow, bifurcating branches, some develop anastomosing branches as described in Taylor *et al.* (2011). Some colonies (SAMC-A077482, SAMC-A077484, SAMC-A077495, SAMC-A077543, SAMC-A077545, SAMC-A028927) have ‘free-walled’ skeletal organization where autozooids and kenozooids have frontal exterior wall and pseudoporous basal surface. In ‘free-walled’ autozooids, apertures are polygonal and no peristomes. Kenozooids differ from autozooids generally smaller and irregularly polygonal in shape. Brood chambers were found in SAMC-A028927, a ‘free-walled’ colony (Fig. 1D).

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Other colonies developed ‘fixed-walled’ zooids, with subcircular apertures and very short peristomes (SAMC-A077465), but variation in peristome length within colonies were observed. Gonozooids were rarely observed in the current samples, similarly in Taylor *et al.* (2011), and the ooeciostome was not easily distinguished, therefore not described.

Genus *Idmidronea* Canu and Bassler, 1920

Colony erect, dichotomous branching, developing a slender, two-dimensional structure. Autozooids in connate rows, in alternating groups to the left and the right axis of the branch. Gonozooid elongate, pyriform, situated frontally in median position along the axis of the branch; ooeciostome distal, slender, cylindrical, recurved, with hooded aperture. Kenozooids present on the basal surface.

Type species: *Idmonea coronopus* Defrance, 1822

Idmidronea contorta (Busk, 1875)

Idmonea contorta Busk, 1875: 12 (pl. 8).

Tennysonia contorta: Canu and Bassler, 1922: 52 (pl. 11, figs. 11-14); as *Lobosecia semiclausa* in error, on p. 145.

Idmonea contorta: O’Donoghue, 1924: 24.

Idmidronea contorta: Hayward and Cook, 1983: 133 (fig. 32A).

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Material examined

SAMC-A029040, **AFR273 A31605**; SAMC-A029063, **AFR273 A31617**; SAMC-A028805, **AFR 866**; SAMC-A077281, **FAL 42**; SAMC-A077283, SAMC-A077560, **FAL 48**; SAMC-A077620, SAMC-A077628, **FAL 475**; SAMC-A077293, **FAL 570**; SAMC-A028930, **TRA 151**.

Substratum, depth and ecology

Colonies fragmented; sponge and other encrusting bryozoans may grow on branches. Depth range 18-850 m.

Geographic distribution

Previously reported from the Indian Ocean of South Africa, but here also collected from the False Bay area, considered the transition zone of the Indian and Atlantic Ocean.

Remarks

This species is well-characterised by its frequent branching and contorted structure, sometimes anastomosing branches. Additionally, this species can be recognised by the connate series of zooids, usually in groups of 5-7 zooids. These features are congruent with the specimens in the current collections.

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The difficulty in distinguishing between *I. contorta* and *T. stellata*, currently relies merely on the peristome lengths since the nature of the branches and number of zooids are similar. In young branches of *I. contorta*, peristomes seem inconspicuous while older branches have pronounced peristomes. Peristome length in *T. stellata* is short (Taylor *et al.* 2011). The image of a fragmented *I. contorta* in Hayward and Cook (1983: 129) resembles *T. stellata* and may warrant further investigation.

Idmidronea cf. *parvula* (Canu and Bassler, 1929)

Idmonea parvula Canu and Bassler, 1929: 546.
Idmidronea cf. *parvula*: Hayward and Cook, 1983: 134 (fig. 33A).

Material examined

SAMC-A029063, **AFR273 A31617**; SAMC-A028804, SAMC-A028939, **AFR 754**.

Substratum, depth and ecology

Colonies grow erect, attached to hard rocky substrate in a depth range of 90-187 m.

Geographic distribution

Philippines and east Africa; locally, reported from east coast of South Africa and False Bay, but in this study also found near Hondeklip Bay on the northwest coast of South Africa – extending its known distribution range.

Remarks

The current fragments lack gonozooids, but exhibit a flat basal surface and zooids alternating in connate groups of mostly three zooids that distinguish this species from allied species.

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Idmidronea cf. *capensis* Brood, 1977

Tervia gibbera Gregory, 1899 *in* Lang, 1908: 7 (pl. 1, fig. 9).
Idmidronea capensis: Brood, 1977: 76 (figs. 11G, 12).

Material examined

SAMC-A073435, **FAL 302**; SAMC-A077451, **FAL 445**; SAMC-A077250, **FAL 503**.

Substratum, depth and ecology

Attached to hard rocky substrata. Depth range 35-42 m.

Geographic distribution

To date, only fossils of *I. capensis* exist in South Africa.

Remarks

The nature of the branches agree with *I. contorta*, but also closely resembles *I. capensis* described from the Late Cretaceous period (Brood 1977), because of alternating

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series of 3-4 zooids. However, the material is fragmented and lack gonozooids, therefore these specimens were provisionally assigned to *Idmidronea* cf. *capensis* until more material is acquired for an accurate diagnosis.

Suborder ARTICULATA Busk, 1859

Family Crisiidae Johnston, 1847

Genus *Crisia* Lamouroux, 1812

Colonies erect, branched. Each branch composed of internodes connected by non-calcified nodes or joints. Sterile internodes, except in proximal region; number of zooids per internode from three to up to 36. The membranous sac of the gonozooid not subdivided.

Type species: *Sertularia eburnea* Linnaeus, 1758

Crisia holdsworthii Busk, 1875

Crisia holdsworthii Busk, 1875: 7 (pl. 6, fig. 2). Busk, 1886: 6 (pl. 3, fig. 2). Hayward and Cook, 1979: 116.

Material examined

SAMC-A077602, **FAL 21**.

Substratum, depth and ecology

Tuft-like colonies attached with rhizoids. Depth range 11-810 m.

Geographic distribution

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Reported from the Indian Ocean and Sri Lanka. In South Africa, from False Bay on the south coast to as far as the iSimangaliso Wetland Park on the east coast.

Remarks

This species is well characterised and distinguished by its attenuated zooids, in some zooids the orifice has a short tubular projection directed forward, 9-11 zooids per internode and branches usually originate from the third zooid. Gonozooid funnel-shaped, inflated, rounded distally. These features are congruent with the current specimens.

Hayward and Cook (1979) found *C. holdsworthii* in *Meiring Naude* at depths of 800-810 m. In contrast, the current specimens were collected at a depth of 11-12 m. Even though the *Meiring Naude* material have no apparent gonozooids to validate the identification, the current material agrees with descriptions and figures of *C. holdsworthii*.

Crisia sp.

Material examined

SAMC-A077184, **FAL 141**.

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Substratum, depth and ecology

Forms tuft-like colonies. Depth 5 m.

Geographic distribution

False Bay on the south coast.

Remarks

The current specimens resemble *C. eburnea* Linnaeus, 1758 in slightly incurved branches, basis rami short and not wedged between zooids, zooids almost adnate, peristome short and directed forward, sometimes with a small pointed process lateral to orifice and gonozooid pyriform, tapered proximally. These features coincide with Harmer's (1915) description. However, this specimen differs from *C. eburnea*, because of longer internodes (at least 10 zooids as opposed to 3-5 zooids per internode) and branching occurs usually from the fifth zooid (as opposed to the first zooid). The gonozooid in *C. eburnea* normally replace the second zooid in the next internode, but in this single specimen the position of the gonozooid is unclear. Therefore, this specimen will remain unnamed until more material is acquired.

Very few *Crisia* species have been reported from South Africa, namely *C. elegans* Lamouroux, 1821, *C. holdsworthii* Busk, 1875 and *C. elongata* Milne Edwards, 1838. A single known record of *C. elegans* was sampled from the Cape of Good Hope on the south coast (Lamouroux 1821), but the author used the term "lyre-shaped" to describe zooids and creates confusion, because it does not fit the zooidal characteristics of this specimen or genus *Crisia*. This may warrant the re-examination or redescription of *C. elegans* specimens, housed at the Muséum National d'Histoire Naturelle.

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Suborder CANCELLATA Gregory, 1896

Family Horneridae Smitt, 1867

Genus *Hornera* Lamouroux, 1821

Colony erect and branching, continued budding of zooids and secondary calcification produce thickened cylindrical stems. Autozooids budded basally, apertures opening on frontal surface, either in regular or irregular longitudinal series. The distal portion of the brood chamber is inflated and on the basal surface of the colony.

Type species: *Hornera frondiculata* Lamouroux, 1821

Hornera americana d'Orbigny, 1842

Plate 1, E-F

Hornera americana d'Orbigny, 1842: 22 (pl. 10, figs. 7-12).

Hornera caespitosa: Busk, 1875: 17 (pl. 15, figs. 1-3).

Hornera americana: Marcus, 1922: 35 (figs. 21a-c).

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Material examined

SAMC-A029041, **AFR273 A31680**; SAMC-A073440, **FAL 302**; SAMC-A029106, **WCD 11**.

Substratum, depth and ecology

Hard substrates. Depth range 102-103 m.

Geographic distribution

This species has a South Atlantic distribution. Previously recorded in South Africa, in Cape Town and in this study, from False Bay and off Cape Point on the south coast.

Remarks

Hornera cæspitosa Busk, 1875 was synonomised with *H. americana* d'Orbigny, 1842, and is well-characterised by the corrugated basal surface with ridges and pores as well as the thickened peristomes (Marcus 1922). The specimens found in the current collection agree with the characteristics of *H. americana* and confidently assigned to this species. In both the original description and the current specimen, no gonozooids were observed.

Hornera erugata Hayward and Cook, 1983

Hornera sp.: Cook, 1968: 238.

Hornera erugata Hayward and Cook, 1983: 139 (figs. 33B-D).

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Material examined

SAMC-A073476, **FAL 503**.

<u>Other material examined:</u> *Hornera erugata*, SAMC-A026456 (paratype), station **SM 163** (33°04.6'S, 28°06.6'E), Off East London, Southeast Coast, South Africa, RV *Meiring Naude* Survey, heavy dredge, depth 90 m, 26 May 1978.

Substratum, depth and ecology

One fragmented colony. Depth range 42-90 m.

Geographic distribution

Cook (1968) reported *H. erugata* in west Africa, and in South Africa, previous samples collected in Cape of Good Hope on the south coast (Hayward and Cook 1983), extending its known range to False Bay, slightly east of Cape of Good Hope.

Remarks

In other *Hornera* species, the basal calcification is invariably corrugated, with large pores, pits and intervening ridges (Hayward and Cook 1983). Unlike other *Hornera* species, *H. erugata* has smooth basal calcification, without obvious pores, and the gonozooid also has a smooth surface without a raised rim (Hayward and Cook 1983). These features agree with the current specimen, although no gonozooid was observed in this fragment.

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Hayward and Cook (1983) mentioned that the bottom samples of *H. erugata* in the *Meiring Naude* cruises were fragments. Here, station data for FAL 503 noted in the remarks "rock", but fails to indicate whether specimens were attached to the rocks, or merely found unattached. Some *Hornera* species, such as *H. lichenoides*, have been found on coarse grounds offshore (Hayward and Ryland 1985: 118).

Hornera sp.

Plate 2, A-C

Material examined

SAMC-A029062, **AFR273 A31680**.

<u>*Other material examined:*</u> *Hornera erugata*, SAMC-A026456 (paratype), station **SM 163** (33°04.6'S, 28°06.6'E), Off East London, Southeast Coast, South Africa, RV *Meiring Naude* Survey, heavy dredge, depth 90 m, 26 May 1978.

Description

Colony erect, thick primary branch (1.75 mm), frequent secondary branching (distance between new branches range = 0.66-1.23 mm) in more than one plane. Zooids widely spaced in a contiguous series of 4-6; peristomes short, thickened rim, some peristomes form a blunt point usually directed laterally. Secondary branches formed by fascicles of 11-14 zooids. Basal extrazooidal calcification corrugated, finely granular, widely irregular spaced slit-like pores. No gonozooids observed.

Substratum, depth and ecology

Hard rocky substrata. Depth range 102-103 m.

Geographic distribution

Off Cape Point on the south coast.

Remarks

There are about 92 known *Hornera* species, of which more than half are fossil species (Bock 2013). This species has not been recorded in South Africa before and differs from *H. americana* and *H. erugata* found in South Africa in its basal calcification, branching and slit-like pores. It agrees well with characteristics of *H. ramosa* MacGillivray, 1887, an Australian species, by its frontal pores, circular orifice with thickened rim, but differs in frequency of secondary branching, thick primary branch and number of contiguous series of zooids. More *Hornera* material is required to warrant the erection of a new species, therefore this species will remain unnamed.

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Suborder CERIOPORINA von Hagenow, 1851

Family Cerioporidae Busk, 1859

Genus *Heteropora* de Blainville, 1830

Colony massive to branching, composed of a series of overgrowths. Zooid wall granular. Intermediate diaphragms common, basal diaphragms rare.

Type species: *Ceriopora cryptopora* Goldfuss, 1826, by subsequent designation, Gregory (1896: 201).

Heteropora sp.

Material examined

SAMC-A077342, **FAL 829**.

Description

Colony erect. Autozooids free-walled, apertures subcircular, often separated by one or more kenozooids. Kenozooids evidently smaller than autozooids. In some kenozooids, terminal diaphragms were observed. No brood chamber observed.

Substratum, depth and ecology

Encrusting on hydroid stem. Depth at 5 m.

Geographic distribution

Southwest of Strand, False Bay area.

Remarks

Cerioporid genera were revised in Nye (1976). This fragment is too small to identify to species-level and more material needs to be collected, but the presence of dimorphic zooids suggests *Heteropora* sp. (Dr Paul Taylor, pers. comm.). The only *Heteropora* species, the northern Pacific *H. pelliculata* Waters, 1879, reported in South Africa was found off Port Alfred (O'Donoghue 1924). The aborescent branching and intermediate diaphragms in *H. pelliculata*, typical for living species of *Heteropora*, have an average autozooid size of 0.14 mm and mural spines less developed (Taylor *et al.* 1989). Whether the current specimen may be a fragment of *H. pelliculata* is inconclusive, until further material is obtained.

Suborder RECTANGULATA Waters, 1887

Family Densiporidae Borg, 1944

Genus *Favosipora* MacGillivray, 1885

Colony adnate, simple and radial or large and irregular rows. Autozooids interior-walled, quincuncially or radially arranged, separated by kenozooids. Peristomes simple, cusped (pointed) or nodular, in some species sealed by a perforated or imperforated closure plates; occasionally forming secondary nanozooids. Kenozooids not closed by terminal diaphragms. Gonozooid consists of an expanded brood-chamber, granulated floor, exterior-

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walled roof densely pseudoporous, ooeciostome short and relatively simple. Marginal lamina soon conceals the ancestrula and early generation daughter zooids.

Type species: *Favosipora rugosa* MacGillivray, 1885, by monotypy.

Favosipora epiphyta sp. nov.

Plate 2, D-F

Material examined

Holotype: SAMC-028880, station **TRA 103** (34°25'S, 21°30'E), near Mossel Bay, South Coast, South Africa, UCT Ecological Survey, dredge, depth 55 m, March 1956.

<u>*Additional material:*</u> SAMC-A077412, **FAL 361**; SAMC-A077249, SAMC-A077253, **FAL 503**; SAMC-A077359, **FAL 730**.

Etymology

Epiphyte (Eng.) – These colonies live epizoically on other bryozoans.

Description

Colony pale peach to white, encrusting, circular to oval, up to 3.79 mm in diameter, zooids arranged more or less radially, with a short series (3-6) of autozooidal peristomes separated by kenozooids. Kenozooids with rounded outlines, kenozooidal apertures 0.08-0.12 mm in diameter not closed by terminal diaphragms; mural pinhead spines on wall interiors. Nanozooids absent. Autozooidal apertures mostly oval, peristomes cusped. Colonies surrounded by marginal lamina with markings that descend to the substratum as budding struts. Expanded gonozooid in the central parts of the colony, raised at the rim; brood chamber with densely pseudoporous floor, ooeciostome not seen.

Substratum, depth and ecology

Colonies attached to other bryozoans (*Menipea* spp. and *Gregarinidra spinuligera*). Depth range 26-55 m.

Geographic distribution

These specimens were found in the False Bay area and near Mossel Bay, south coast of South Africa.

Remarks

Densiporids are identified by their small, discoid or oval-shaped colonies. These colonies are confidently placed in this genus, distinguished by its densely pseudoporous expanded brood-chamber. This is the first *Favosipor*a species recorded from South Africa. The small size and difficulty in identifying cyclostomes in general, may have resulted in the densiporid group to be overlooked in previous South African samples and need to be investigated.

The current species closely resembles the New Zealand species *F. tincta* Gordon and Taylor, 2001 with regards to shape, radial zooidal arrangement, cusped peristome of

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autozooids and colony size – in *F. tincta*, colony diameter up to 3.90 mm and kenozooidal apertures up to 0.15 mm (Gordon and Taylor 2001). However, the brood-chamber in *F. tincta* is situated on the distalmost area of the colony and have uni- or biserial autozooids (up to 8 or clusters of 2-3) with uni- or bicuspid peristomes (Gordon and Taylor 2001). The pale peach colour of some colonies, unicuspid peristomes and number of connate autozooids make this species unique within the genus, and warrant the erection of this new species.

Family Lichenoporidae Smitt, 1867

Genus *Disporella* Gray, 1848

Autozooids in radial or quincuncial (i.e. five zooids arranged in a rectangle or square, with one zooid in the centre) series. Extrazooidal coelomic spaces between autozooids gradually reduced around edges by centripetal calcification, but retaining a central opening; all calcification imperforate. Small brood chambers occupy central parts of the colony, or situated between zooid rows. The short, tubular ooeciostome opens directly upwards, without flared aperture.

Type species: *Disporella hispida* (Fleming, 1828)

Disporella buski Harmer, 1915

Disporella ciliata Busk, 1875: 31 (pl. 30, fig. 6).

Disporella buski: Harmer, 1915: 189. Florence *et al.* 2007: 7 (fig. 2l).

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Material examined

SAMC-A073442, **FAL 302**; SAMC-A077457, **FAL 445**; SAMC-A077625**, FAL 475**; SAMC-A077514, **FAL 576**; SAMC-A029027, **TRA 93**.

Substratum, depth and ecology

Living epizoically, attached to other bryozoans. Previous known maximum depth was 20 m, but in the current collection, sampled down to 110 m.

Geographic distribution

This species was previously reported from Cape Town and Saldanha Bay on the west coast, but in this study, its known distribution range was extended up to the south coast, in False Bay and near Mossel Bay.

Remarks

This species is well-characterised by its discoid colony shape, raised centrally; autozooids radiating and may have irregular rows; terminally free peristome ends. Gonozooids occupy central parts, surrounded by extrazooidal calcification, and agrees with the current specimens. Ooeciostome not observed.

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Disporella novaehollandiae (d'Orbigny, 1853)

Unicavea novae-hollandiae d'Orbigny, 1853: 971.

Discoporella novae-hollandiae: Busk 1875: 33.

Discoporella novae-zelandiae: Busk, 1875: 32 (pl. 30, fig.2).

Lichenopora novae-zelandiae: Brood, 1976: 299 (figs. 17A-C) (not fig. 17G-I, = *Disporella sibogae* Borg). Hayward and Cook, 1983: 137.

Material examined

SAMC-A077532, **FAL 576**; SAMC-A077399, **FAL 165**; SAMC-A077690, **TRA 31**.

Other material examined: *Lichenopora novae-zelandiae* (= *Disporella novaehollandiae*), SAMC-A026745, station **SM 184** (33°39.4'S, 27°11.7'E), Off Port Alfred, South Coast, South Africa, RV *Meiring Naude* Survey, dredge, depth 86 m, 31 March 1978.

Substratum, depth and ecology

Living epizoically, attached to other bryozoans. Depth range 2-780 m.

Geographic distribution

Fairly widespread species, occurring in the Indo-Pacific, including Japan, Australia and New Zealand. In South Africa, *D. novaehollandiae* has been collected on the south and southeast coast.

Remarks

Much confusion surrounding the family Lichenoporidae Smitt, 1867 was resolved in Gordon and Taylor (2001). These authors suggest that fossil species in this family be assigned to the genus *Lichenopora* Defrance, 1823, while recent species belong to *Disporella* Gray, 1848 (Gordon and Taylor 2001). *Lichenopora novae-zelandiae* in the *Meiring Naude* specimens should be assigned to *D. novaehollandiae*, as discussed with associated synonymies (Gordon and Taylor 2001).

The current specimens agree well with the characteristics of *D. novaehollandiae* for its discoid shape, and connate peristomes as opposed to terminally free peristomes and irregular rows in *D. buski*. The aforementioned species, along with *D. ciliata* Busk, 1875 sampled in Cape of Good Hope (NHMUK 1899.7.1.519), have previously been reported from South Africa. However, *D. ciliata* was confirmed to be a synonym of *D. pristis* MacGillivray, 1884 found in Australia and New Zealand (Gordon and Taylor 2001).

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Class **Gymnoleamata** Allman, 1856

ORDER CTENOSTOMATA Busk, 1852

Superfamily Alcyonidioidea Johnston, 1838

Family Alcyonidiidae Johnston, 1838

Genus *Alcyonidium* Lamouroux, 1813

Colony encrusting or erect, fleshy or thin. Autozooids usually with a short peristome and puckered orificial region, mostly contiguous, kenozooids between them rare. Non-spinose kenozooids, where present. Intertentacular organ present or absent.

Type species: *Ulva diaphana* Hudson, 1778, alternatively, from d'Hondt, 2001: *Fucus gelatinosus* Hudson, 1762 (not Linnaeus)

Alcyonidium chondroides O'Donoghue and Watteville, 1937

Alcyonidium chondroides O'Donoghue and Watteville, 1937: 21.

Material examined

SAMC-A028825, **TRA 127**.

Substratum, depth and ecology

Forming tufts 2-3 cm in height. Known depth range from intertidal down to 51 m.

Geographic distribution

To date, only reported from South Africa, in localities around the Cape Peninsula, on the southwest and south coast.

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Remarks

O'Donoghue and de Watteville (1937) described this species as a slightly transparent mass of semi-erect, bilaminar, lobed and foliaceous. Zooids are more or less hexagonal or polygonal and regularly arranged in the central parts, but the sides of the lobes become curved and zooids are less regular in shape and arrangement (O'Donoghue and de Watteville 1937). These features, along with an oval-shaped orifice, agree with the one specimen found in the current collection, near Smitswinkel Bay. The current material indicate no remnants of internal organs and white granules situated medio-laterally observed within zooids, as described by O'Donoghue and de Watteville (1937).

Alcyonidium flustroides Busk, 1886

Alcyonidium flustroides Busk, 1886: 30 (pl. 10, figs. 13, 14).

Material examined

SAMC-A028865, **TRA 42**; SAMC-A028826, **TRA 46**; SAMC-A029137, **WCD 212**; SAMC-A029145, **WCD 217**.

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Other material examined: *Alcyonidium flustroides* (syntypes), NHMUK 1887.12.9.922, 1899.7.1.521, 1899.7.1.523, 1899.7.1.524 (slides), station **142** (35°04'S, 18°37'E), Simon's Bay, South Coast, South Africa, *Challenger* Expedition, depth 274 m, no additional information.

Substratum, depth and ecology

Forming dark brown tufts with narrow fronds. Previous known depth range inconclusive, but in this study, depth distribution range 70-400 m.

Geographic distribution

Endemic to South Africa. Only known record from Simon's Bay on the south coast (Busk 1886), but in this study, its known distribution range extended to include southwest of the Cape Peninsula to Cape Infanta.

Remarks

This species is characterised by its dark brown colour, narrow, branching fronds (3-6 mm), and zooids polygonal in irregular longitudinal series along the frond (Busk 1886; O'Donoghue and de Watteville 1937). These features were congruent with the current specimens, along with images sent of *A. flustroides* specimens housed at the NHMUK (Mary Spencer Jones, pers. comm.).

Alcyonidium rhomboidale O'Donoghue, 1924

Alcyonidium rhomboidale O'Donoghue, 1924: 57 (pl. 4, fig. 25).

Alcyonidium rhomboidale: Florence *et al.*, 2007: 8 (fig. 3A, 20A, 21B).

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Material examined

SAMC-A028963, **AFR270 A31418**; SAMC-A029055, **AFR273 A31631**; SAMC-A029056, **AFR273 A31650**; SAMC-A077185, **FAL 141**; SAMC-A073550, **FAL 222**; SAMC-A077483, **FAL 576**; SAMC-A073501, **FAL 61**; SAMC-A077314, **FAL 641**; SAMC-A077472, **FAL 793**; SAMC-A073420, **FAL 853**.

Other material examined: *Alcyonidium rhomboidale*, NHMUK 1923.7.26.22 (slide), St. James (34°07'23.5"S, 18°27'29.5"E), False Bay, South Coast, South Africa, beach cast, February 1917, no additional information; NHMUK 1899.7.1.5147 (slide), Algoa Bay (33°49'36.4"S, 25°47'43.0"E), Southeast Coast, South Africa, no additional information.

Substratum, depth and ecology

Forming short tufts attached to had substrata. Depth range down to 20 m.

Geographic distribution

This species has only been recorded from South Africa from Paternoster to False Bay.

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Remarks

Similar to *A. flustroides*, this species forms tufts, but with broad, bilaminar, foliaceous, anastomosing lobes (20-25 mm) with a dark yellow colour (O'Donoghue and de Watteville 1937; Florence *et al.* 2007). Zooids are arranged multiserially, alternating, rhomboidally or hexagonal shaped with a circular primary orifice that may be raised into a short blunt papilla (Florence *et al.* 2007). These characteristics were congruent with the current specimens.

Alcyonidium nodosum O'Donoghue and Watteville, 1944

Alcyonidium nodosum O'Donoghue and Watteville, 1944: 428 (pl. 16, figs. 17, 18).
Alcyonidium nodosum: O'Donoghue. 1957: 92. Florence *et al.*, 2007: 8 (figs. 3B, D).

Material examined

SAMC-A077592, **FAL 15**.

Substratum, depth and ecology

Living exclusively on the shells of *Burnupena papyracea* Bruguière, 1789 and *B. pubescens* Küster, 1858. Depth range 4-20 m.

Geographic distribution

In South Africa, this species occur from Port Nolloth to False Bay. However, the species *B. pubescens* may occur as far east as Port Elizabeth on the southeast coast.

Remarks

Easily distinguished by its brown colour (when dried) forming an extensive mammillate covering on the shells with regularly spaced mammilae (Florence *et al.* 2007). Rock lobsters are known to avoid *B. papyracea* and it is believed that the highly toxic chemicals found in this species protects the whelks (Florence *et al.* 2007).

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ORDER CHEILOSTOMATA Busk, 1852

Suborder INOVICELLINA Jullien, 1888

Superfamily **Aeteoidea** Smitt, 1868

Family Aeteidae Smitt, 1868

Genus *Aetea* Lamouroux, 1812

Tubular autozooids, each having a decumbent (i.e. along a surface) proximal portion and erect, free distal portion. Stolonic formations filiform or moniliform, i.e. slender sections separating dilatations, stolon ramifies, branches arise from dilatations. Typical anascan operculum as frontal membrane. No avicularia or vibracula. Embryos in external thin-walled ovisacs, not ovicells. Ovisacs situated either frontal and proximal to operculum, or distal to operculum, basal and subterminal.

Type species: *Sertularia anguina* Linnaeus, 1758

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Aetea anguina (Linnaeus, 1758)

Plate 3, A-C

Sertularia anguina Linnaeus, 1758: 816.

Aetea anguina: Hincks, 1880: 4 (pl. 1, figs. 4 and 5). Hasenbank 1932: 324. Hastings 1943: 471 (figs. 57A-C). O'Donoghue and de Watteville, 1944: 409. O'Donoghue, 1957: 72.

Material examined

SAMC-A028824, **TRA 93**.

Other material examined: *Aetea anguina*, SAMC-A028487, Kalk Bay (34°07'40"S, 18°26'5"E), False Bay, South Coast, South Africa, attached to *Menipea* sp., intertidal zone (< 10 m), no additional information; Unregistered NHMUK material of *A. anguina*, creeping on *Catenicella elegans* (NHMUK 1968.1.16.120).

Substratum, depth and ecology

Forming creeping colonies on other bryozoans. Usually found in shallow water depths, but known depth extended down to 110 m.

Geographic distribution

Cosmopolitan; has been reported throughout the temperate and tropical waters in the world, except polar waters (Hayward 1995). In South Africa, this species has been reported on the south coast in Kalk Bay to the east coast in Durban.

Remarks

Characteristic features of *A. anguina* include finely punctuated moniliform stolons, cylindrical middle portion distinctly annulated; distal portion comprises one-quarter to one-third length of total erect portion (0.6-0.8 mm long), spatulate frontal membrane finely punctuated – not annulated – and lastly, frontal membrane usually flexed facing downwards to substratum (Hayward and Ryland 1998), congruent with the current specimens. The unregistered specimen, found incidentally while scanning South African material of *Catenicella elegans* (NHMUK 1968.1.16.120) within the NHMUK collection, as well as the single specimen found in the current study, compares well with a catalogued specimen in the SAMC collection.

Aetea anguina closely resembles *A. sica* Couch, 1844, also a widespread species, but the latter has a straight erect portion as opposed to flexed; length variable, and a slightly longer erect portion (0.1-1.8 mm long) (Winston 1982). Unlike *A. anguina* and *A. sica*, *A. truncata* Landsborough, 1852 has an erect, straight portion (0.60-0.80 mm long) without annulations, rather tiny punctures (Winston 1982).

Even though no known specimens of *A. anguina* have been reported from the West coast of South Africa, *A. anguina* is widespread in temperate waters, therefore highly probable that this species occurs on the west coast. However, the tiny nature and taxonomic difficulty

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of *Aetea* species may have resulted in the species remaining undetected in other regions of the coastline.

Genus *Callaetea* Winston, 2008

Remarks

Winston (2008) described *Callaetea* as aeteid species with delicate networks of narrow encrusting stolons from which vertical stolons are budding at intervals. From the vertical stolons, ‘scoop-shaped’ zooids with curving proximal walls and a short oval frontal membrane develop. Calcification of walls and stolons are poorly developed.

There are only two known *Callaetea* species, *C. capillaris* (d'Hondt, 1986) and *C. liliacea* Winston, 2008. To date, *C. liliacea* is known from the Northeast and Cat Cays, Pelican Cays and Belize in the Caribbean, while *C. capillaris* is known only from the Pacific New Caledonia. It is possible that this genus has been overlooked, because of its small zooid size and almost transparent colour.

Callaetea cf. *spiralis* (Hasenbank, 1932) comb. nov.

Plate 3, D-F

Scruparia spiralis Hasenbank, 1932: 326 (fig. 2A-D) (in German).

Material examined

SAMC-A077255, **FAL 421**; SAMC-A077382, **FAL 341**; SAMC-A077385, **FAL 852**.

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Other material examined: *Aetea anguina*, SAMC-A028487, Kalk Bay (34°07’40”S, 18°26’5”E), False Bay, South Coast, South Africa, attached to *Menipea* sp., intertidal zone (< 10 m), no additional information; Unregistered NHMUK material of *A. anguina*, creeping on *Catenicella elegans* (NHMUK 1968.1.16.120).

Description

Colony erect, white, almost transparent. Erect, mostly paired individuals, stem arise from underneath the membrane of *Discoporella umbellata* (Defrance, 1823) zooids. Autozooids long and slender, distal portion with a smooth frontal membrane, wider than the stem, spatulate, occupying more than half of length (N_T = 2; range 0.61-0.74 mm) of the distal portion; usually flexed so that frontal membrane faces downwards. Distal portion about half to two-thirds of length of total erect portion (N_T = 2; range 0.97-1.08 mm). Cylindrical middle portion smooth and corrugated, not annulated, no fine punctuations, and may vary in length (N_T = 2; range 0.23-0.46 mm).

Substratum, depth and ecology

To date, this species is known to live exclusively on *Discoporella umbellata* colonies. Depth range 33-48 m.

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Geographic distribution

Endemic to South Africa and appear to be restricted to the south coast.

Remarks

The original description as *Scruparia spiralis*, with the type locality Cape Agulhas, is in German and only identifiable by its associated drawings (Hasenbank 1932: 327). Budding, in *Scruparia* species, takes places on the frontal surface, as well as distally or laterally of the autozooids (Hayward and Ryland 1998), but no budding was observed in the current material. However, the present specimens, and drawings from Hasenbank (1932), disagree with the latter description, resulting in a redescription of this species.

The individuals rise from a dilated creeping base (or ramifying stolon) as seen in other aeteids, but largely obscured by the membrane of *D. umbellata*. In addition to budding formation, autozooids arising from the basal surface of distal portion from the other autozooid and the shape of the frontal membrane as illustrated in Fig. 2D in Hasenbank (1932), agree with features of the genus *Callaetea* and not *Scruparia*.

In comparison to other known *Callaetea* species within the genus (*C. capillaris* and *C. liliacea*), *C. spiralis* differs from having a corrugated vertical stolon. *Callaetea* cf. *spiralis* appear to be exclusively associated with *D. umbellata* colonies, as observed in Hasenbank (1932). In some *D. umbellata* colonies, no specimens of *C. spiralis* were noted, for example in O'Donoghue (1924) and in localities on the southeast coast in this study. This may suggest a restricted distribution range of *C. spiralis* on the south coast. The holotype, held at the Berlin Museum in Germany, cannot be located (Dr C. Quaisser, pers. comm.).

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Suborder SCRUPARIINA Silén, 1941

Superfamily **Scruparioidea** Gray, 1848

Family Leiosalpingidae d'Hondt and Gordon, 1996

Genus *Leiosalpinx* Hayward and Cook, 1979

Colony erect, dichotomous branching, unjointed. Zooids uniserial. No spines, avicularia or ovicells.

Type species: *Alysidium inornata* Goldstein, 1882.

Leiosalpinx inornata (Goldstein, 1882)

Alysidium inornata Goldstein, 1882:42 (pl. 1, fig. 1).

Catenaria attenuata: Busk, 1884: 14 (pl. 2, fig. 1).

Brettia inornata: Hastings, 1943: 476.

Leiosalpinx inornata: Hayward and Cook, 1979: 66 (fig. 2C-D).

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Material examined

SAMC-A028780, **AFR 743**.

<u>*Other material examined:*</u> *Leiosalpinx inornata*, SAMC-A027269, Marion Island (46°52'34"S, 37°51'32"E), Prince Edward Islands, Sub-Antarctic Indian Ocean, bottom dredge, depth 460-560 m, 1 September 1988.

Substratum, depth and ecology

Forming small, entangled colonies attached to other bryozoans. Previously known from deep depths of 1000-1200 m (Hayward and Cook 1979), but in this study found in shallower waters of 364 m.

Geographic distribution

Previously known only from Marion and Heard Islands in the Southern Ocean and from the east coast of South Africa (Hayward and Cook 1979). This is the first record from the west coast of South Africa, near the Namibian border, extending its known distribution westwards. This suggests a widespread distribution in the southern hemisphere occurring in the South Atlantic and South Indian Ocean.

Remarks

The well-defined characteristics of *L. inornata* and comparison with specimens in the bryozoan collection and congruent with the current specimen. This is also the first record for *L. inornata* in the cool-temperate waters of the west coast in the Atlantic Ocean.

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Family Scrupariidae Gray, 1848

Genus *Scruparia* Oken, 1815

Colony erect, arising from a creeping base. Autozooids arranged uniserially in chains. Budding from the frontal surface, as well as distally and laterally of autozooids. Autozooids of nearly tubular form, subterminal frontal membrane with no marginal spines. Globular brood chambers situated distally on specialised reproductive autozooids. Each brood chamber bivalved, with a visible median keel along the line of the fusion.

Type species: *Sertularia chelata* Linnaeus, 1758

Scruparia chelata (Linneaus, 1758)

Sertularia chelata Linneaus, 1758: 816.

Eucratea chelata: Hincks, 1880: 14. Hasenbank, 1932: 325 (fig. 1A-C). O'Donoghue and de Watteville, 1944: 410.

Material examined

SAMC-A077599, **FAL 7**.

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Substratum, depth and ecology

Forming a clump of uniserial chains on hydroids. Depth from intertidal zone (< 10 m) down to 24 m.

Geographic distribution

Scruparia chelata has a European and North Atlantic distribution. In South Africa, this species was reported in Kalk Bay on the south coast and East London on the southeast coast.

Remarks

Creeping stolons give rise to the erect chains of autozooids, while frontal buds initiate free chains of autozooids, that may give rise to further chains (Hayward and Ryland 1998). Autozooids horn-shaped with an oval frontal membrane, which dips towards the distal end, relative to the basal wall (Hayward and Ryland 1998). These features agree with the current specimen of *S. chelata*, but no brood chambers observed.

The first reports of *S. chelata* from South Africa were collected at Kalk Bay pier and Bat's Cave Rocks in East London (O'Donoghue and de Watteville 1944). No figure or description was given, but the current specimen agrees with the figure in Hasenbank (1932: 326). However, considering its northern hemisphere distribution, molecular techniques should be carried out to confirm the identity of South African specimens.

Suborder MALACOSTEGINA Jullien, 1888

Superfamily **Membraniporoidea** Busk, 1854

Family Electridae Stach, 1937

Genus *Conopeum* Gray, 1848

Encrusting colony, autozooids with large opesial windows usually bordered by thin marginal spines. Kenozooids often present. The operculum as a membranous folded edge covering the orifice, but appears as a thick, crescentric structure, lightly chitinised, without a thin marginal sclerite when closed.

Type species: *Millepora reticulum* Linnaeus, 1767

Conopeum reticulum (Linnaeus, 1767)

Millepora reticulum Linnaeus, 1767: 1284.

Flustra lacroixii Audouin, 1826: 240.

Conopeum reticulum: O'Donoghue, 1957: 73. Ryland, 1965: 30 (fig. 13). Prenant and Bobin, 1966: 124 (fig. 32). Ryland and Hayward, 1977: 60. Lichtschein de Bastida and Bastida, 1980: 379 (figs. 3, 14-16). Zabala and Maluquer, 1988: 76 (fig. 65). Hayward and Ryland, 1998: 120 (figs. 23, 24A, B). Abdel-Salam and Ramadan, 2008: 6 (fig. 2). De Blauwe, 2009: 170 (figs. 146-149).

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Material examined

SAMC-A070058, **SB 201**.

Other material examined: *Conopeum seurati*, SAMC-A028735, Saldanha Bay (33°02'S, 17°58'E), West Coast, South Africa, Saldanha Bay Introduced Species Port Survey, scraping, depth unknown, 25 April 2001.

Substratum, depth and ecology

Important widespread fouling bryozoan encrusting hull of ships and other hard substrata such as stones and shells in shallow waters (< 30 m), even wooden structures (Abdel-Salam and Ramadan 2008).

Geographic distribution

This species is well-documented and fairly widespread in European waters from Skaggerak to Kattegat down the Atlantic coast, as well as recorded in the Azores, Canary and Cape Verde islands (Ryland 1965); also the Mediterranean (Prenant and Bobin 1966), France (Zabala and Maluquer 1988) and Egypt (Abdel-Salam and Ramadan 2008). Locally, this is the first record of *C. reticulum* for South Africa, encrusting on a shell found in Saldanha Bay.

Remarks

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This species is well-characterised by its variable, but mostly elongated-oval shaped autozooids, thin granular cryptocyst, with most of the frontal surface membranous, operculum has a distinct folded membranous edge, each zooid has a pair of small, distally situated triangular kenozooids or depressions, some may be larger than others (Harmer 1926; Abdel-Salam and Ramadan 2008). The present work specimens are congruent to previous descriptions, except that spines were not discernible in these specimens; spines, if present, are situated along the frontal area (Abdel-Salam and Ramadan 2008) .

Conopeum reticulum was first recorded in South Africa by O'Donoghue (1957) encrusting the valve of a barnacle and shell from the hull of a ship. However, O'Donoghue (1957: 73) noted that the triangular depressions were not discernible, and rounded projections sometimes occur in the triangular areas between zooids. These characters most certainly agree rather with *C. seurati* Canu, 1928 which has been considered introduced on the west coast and the False Bay transition zone (Mead *et al.* 2011a). Furthermore, this may not be considered a 'true' record from South Africa – the ship was dry-docked in Cape Town after a voyage in other oceanic regions.

Conopeum seurati specimen (SAMC-A028735) within the SAMC museum collection was collected during the Saldanha Bay Introduced Species Port Survey in 2001, but not found in the current collections. This species, along with its allied *C. reticulum*, may be found in seas and river mouths where salinity can be very low (Ryland 1965).

The status of *C. seurati* and C. *reticulum* in South Africa appears to be unknown albeit globally known to be introduced in various coasts or rivers. Very few publications have listed

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these species in South Africa (O'Donoghue 1957; Mead *et al.* 2011a, 2011b); one specimen from Port Elizabeth has been found (Dr. N. Miranda., unpublished data), but the extent of the introduction (invasive or not) is inconclusive to date. A project currently underway will be collecting potentially introduced bryozoan species from South Africa to establish their taxonomic validity using morphological and molecular techniques (Dr. W.K. Florence, pers. comm.).

Genus *Electra* Lamouroux, 1816

Autozooids with opesial window bordered with spines; proximo-medial spine consistent, but length varies, often reduced to a simple tubercule; marginal spines present or absent. First zooids budded mainly in lateral and distolateral directions from the ancestrula.

Type species: *Flustra verticillata* Ellis and Solander, 1786 = *Flustra pilosa* Linnaeus, 1767

Electra pilosa (Linnaeus, 1767)

Flustra pilosa Linnaeus, 1767: 1301.

Flustra verticillata Ellis and Solander, 1786: 15.

Electra verticillata: O'Donoghue and de Watteville, 1937: 12. O'Donoghue and de Watteville, 1944: 413 (pl. 15, fig. 3). O'Donoghue, 1957: 73. Cook, 1985: 88.

Electra pilosa: Hayward and Ryland, 1998: 128 (figs. 26, 27). Florence *et al.*, 2007:11 (figs. 3H-J).

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Material examined

SAMC-A077167, **FAL 141**; SAMC-A070054, **SB 193**; SAMC-A070056, **SB 238**; SAMC-A070059, **SB 88**; SAMC-A073380, **LB 380**.

<u>Other material examined:</u> *Electra pilosa*, NHMUK 1854.11.15.206, Cape of Good Hope (35°04'S, 18°37'E), Southwest Coast, South Africa, no additional information.

Substratum, depth and ecology

Forms cylindrical growths around branched algae such as *Gracillaria* spp. and *Caulerpa filiformis* or flat colonies on red algae. Occurs in shallow water and intertidal zone down to 20 m.

Geographic distribution

Temperate to warm-water distribution. In South Africa, this species has been reported from Port Nolloth on the west coast to East London on the southeast coast.

Remarks

Silén (1987) described in detail the growth patterns in *E. pilosa*. Two different types of colony morphs within *E. pilosa* may be found, namely the encrusting stellate or circular patch on broad sheets or lack of alternation in autozooidal rows, which presents a banded

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appearance in the '*verticillata*' morph. In South Africa, all specimens of *E. pilosa* exhibit the '*verticillata*' morph (Florence *et al.* 2007).

Genus *Harpecia* Gordon, 1982

Colony encrusting, large opesia, no occlusor laminae. Cryptocyst limited to a narrow groove between opesial rim and proximal spines; extensive gymnocyst, comprises most of the calcified part of suberect zooids. Stout oral spines completely encircle the opesia. No avicularia or ovicells.

Type species: *Chaperia spinosissima* Calvet, 1904

Harpecia sp.

Material examined

SAMC-A077192, **FAL 256**.

Substratum, depth and ecology

Encrusting on sheet-like algae. Depth 4-5.5 m.

Geographic distribution

A single specimen found in False Bay, near Boulder's Beach, Simon's Town.

Remarks

The current specimen coincide with the characteristics of the genus *Harpecia* by its extensive gymnocyst, proximally prominent, long spines surrounding the opesia with brown basal joints, avicularia and ovicells absent (Gordon 1982). It closely resembles the type species *H. spinosissima* Calvet, 1904 that has a South Atlantic distribution. This is the first record of *Harpecia* from South Africa, but will remain unnamed until more material is acquired to allow for a complete description.

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Family Membraniporidae Busk, 1852

Genus *Biflustra* d'Orbigny 1852

Colony erect or encrusting. Autozooids variably calcified, membranous frontal surface; no gymnocyst, well-developed cryptocyst forming a shelf proximally, typically granular. Spines, avicularia and ovicells absent.

Type species: *Membranipora ramosa* d'Orbigny, 1852

Biflustra khoisan sp.nov.

Plate 4, A-B, Table 4.1

Material examined

Holotype: SAMC-A029105, station **WCD 11** (34°9.4'S, 18°16.5'E), Off Kommetjie, West of Cape Peninsula, UCT Ecological Survey, dredge, depth 75 m, 24 March 1959.

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Paratype: SAMC-029105, same station locality.

Additional material: SAMC-A077618, SAMC-A077630, **FAL 475**; SAMC-A077611, **FAL 524**; SAMC-A077502, **FAL 576**; SAMC-A077269, **FAL 67**; SAMC-A073461**, FAL 739**; SAMC-A077474, **FAL 759**; SAMC-077323, **FAL 818;** SAMC-A028915, **TRA 122**; SAMC-A029088, **WCD 11**; SAMC-029128, **WCD 18**.

Etymology

Khoisan (E.) – Khoisan is the collective name for indigenous groups of people from South Africa, referring to this species being endemic to South Africa.

Description

Colony erect, delicate, broad or foliaceous, bilaminar sheet, anastomosing – some edges fusing to form small irregular or oval fenestrulae-like structures (some as small as 1 mm); fragments up to 32x18 mm. Light yellow in colour. Autozooids elongated, subrectangular, rounded at distal end; variable in size; frontal surface largely membranous, with closed operculum lightly chitinized and light brown slit. Oval to rectangular opesia, comprising more than one-third of total autozooid length. Gymnocyst absent; well-developed and granular cryptocyst, most frequently elongated proximally, up to half or one third of the total length of zooid, less elongated in older zooids; frequently forming a thickened, sometimes inconspicuous, distal ridge. Kenozooids situated on the inner fenestrulae-like wall; oval aperture opening, longer than wide, situated more or less in the middle of the kenozooid, less often in the first third distal portion of the autozooid. Multiporous septula present, one, two or three in the distal wall, one or two in the lateral wall. Spines, avicularia and ovicells absent.

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Substratum, depth and ecology

Forms erect, broad, bilaminar sheets, and often with other encrusting bryozoans and hydroids. Depth range 16-75 m.

Geographic distribution

Only known from South Africa, found off Kommetjie, west of the Cape Peninsula to False Bay area on the south coast.

Remarks

The genus *Biflustra* d'Orbigny 1852 has been frequently used in paleontology (see Berning 2006), but overlooked in recent faunas with species either assigned to *Membranipora* de Blainville, 1830 or *Acanthodesia* Canu and Bassler, 1920, even after Lagaaij (1952) resurrected the genus. *Biflustra* include erect vincularian membraniporid species, with no gymnocyst and moderate to extensive cryptocyst, whereas encrusting species may be assigned to *Acanthodesia* (Tilbrook *et al.* 2001; Taylor and Tan 2015). Taylor and Tan (2015) emphasized that the lack of ovicells and avicularia make species difficult to distinguish and that molecular studies are needed in *Acanthodesia* to clarify its diversity.

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Biflustra species are widespread and from seemingly shallow waters (< 30 m). *Biflustra* has been reported in the North Atlantic Ocean (Álvarez 1990; Souto *et al.* 2014), Mediterranean Sea (Álvarez 1992a, 1992b), Korean waters (Lee *et al.* 2011), Arabian Sea (Louis and Menon 2009), south Chinese waters (Canu and Bassler 1929; Lui 1992), South Pacific Ocean (Tilbrook *et al.* 2001; Tilbrook 2006), Atlantic Ocean (Canu and Bassler 1928), and the Indo-Pacific, including Australia (MacGillivray 1881; Tilbrook 2012) and New Zealand (Grange and Gordon 2005). O'Donoghue (1957) reported *Biflustra savartii* Audouin, 1826 in Cape Town from the hull of the *Sutherland* vessel. No figure was associated in the report, but the description coincided with the known description for the species and noted "the presence of a proximal denticle on the cryptocyst… may be absent or present as a small projection or as a short lamina terminating in 4 or 5 teeth" (O'Donoghue 1957: 73). However, no known record of *B. savartii* has been reported since and because the vessel was docked in Cape Town after returning from a voyage to England, Colombo, Durban and Brazil, this record can be considered as doubtful.

The current material, comprising of fragmented colonies, fits well with the description and figures of the genus *Biflustra*, but distinctly differs from other species within the genus. Colony morphology resembles the widespread *B. arborescens* Canu and Bassler, 1928 forming erect, narrow branching and anastomosing colonies, but the current species form erect, broad, bilaminar and anastomosing sheets. Additionally, *B. arborescens* possess cryptocystal prominence on the opesial rim (Souto *et al.* 2014), absent in the current material, and *B. arborescens* has larger-sized zooids, averaged at 0.44 x 0.32 mm (N_T = not given) (Souto *et al.* 2014), than the current material, averaged at 0.36 x 0.27 mm ($N_T = 30$) (Table 4.1).

Two colonies were found in the current samples (SAMC-A077611 and SAMC-A029088) encrusting on *Adeonella* spp., and not as erect sheets, that could be the encrusting part of the colony. All the material for this species were fragmented without basal attachments, therefore more material of the current specimens is needed to accurately determine whether its growth habit. This study presents the first known *Biflustra* species from South Africa, but from slightly deeper waters down to 75 m.

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Table 4.1. Measurements (in millimeters) for the holotype specimen of ***Biflustra khoisan*** sp. nov.

	Off Kommetjie, West Coast SAMC-A029105		
Characters	N_T	Average ± SD	Range
Lz	30	0.36 ± 0.03	0.32-0.43
lz	30	0.27 ± 0.03	0.23-0.33
Lo	27	0.19 ± 0.02	0.13-0.24
lo	30	0.14 ± 0.01	0.12-0.16

Genus *Jellyella* Taylor and Monks, 1997

Colony encrusting. Autozooids with moderately to well-developed gymnocyst produced into tubercles and/or spines proximally or around opesium. Cryptocyst negligible, forming a narrow, pustulose proximal shelf or absent; lateral vertical walls generally uncalcified bands, spinules typically numerous, branched elaborately.

Type species: *Membranipora eburnea* Hincks, 1891

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Jellyella tuberculata (Bosc, 1802)

Flustra tuberculata Bosc, 1802: 118.

Membranipora tuberculata: Marcus, 1922: 14 (fig. 8).

Jellyella tuberculata: Taylor and Monks, 1997: 41 (figs. 3, 14-15). Tilbrook, Hayward and Gordon, 2001: 37. Florence, Hayward and Gibbons, 2007: 10 (figs. 3G, 20K).

Material examined

SAMC-A073386, **LB 381**; SAMC-A070051, **SB 151**; A070065, **SB 168**; SAMC-A070062, **SB 261**.

Substratum, depth and ecology

Encrusting on fronds of the broad wine-weed, *Rhodymenia obtusa* (Greville) Womersley, 1996; often covering entire fronds. Depth range 4-20 m.

Geographic distribution

This species has a widespread distribution in warm seas and in South Africa, and has only been reported on the west coast.

Remarks

Jellyella tuberculata is characterised by its gymnocystal tubercle present at each proximal corner of the zooid and sclerite operculum situated distally (Florence *et al.* 2007). Moreover, this species was associated with *Sargussum* in warm seas, but the South African

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specimens appear to be limited to the cold Benguela region on the west coast, encrusting the broad wine-weed (Florence *et al.* 2007).

Genus *Membranipora* de Blainville, 1830

Typically encrusting, or erect from encrusting base. Autozooids rectangular, lightly calcified; tubercles present on corners; cryptocyst occasionally well-developed proximally, internal denticles present. Frontal membrane with chitinous spinules or absent; operculum bounded by a simple sclerite. Twinned ancestrula.

Type species: *Flustra membranacea* Linnaeus, 1767.

Membranipora rustica Florence, Hayward and Gibbons, 2007

Membranipora membranacea O'Donoghue, 1924:37. O'Donoghue and de Watteville, 1935: 204. O'Donoghue and de Watteville, 1937: 12. O'Donoghue and de Watteville, 1944: 413.

Membranipora rustica Florence *et al.*, 2007: 11 (fig. 3F).

Material examined

SAMC-A073506, **FAL 122**; SAMC-A073378, **LB 371**; SAMC-A028840, **TRA 42**.

Substratum, depth and ecology

Often forms large patches encrusting on kelp fronds (*Ecklonia maxima*), but also on branched algae. Previous known depth was down to 20 m, but in this study, the known depth range extended down to 70 m.

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Geographic distribution

This species has only been reported from South Africa, from Port Nolloth on the west coast to Durban on the east coast.

Remarks

The European species *Membranipora membranacea* was reported from False Bay in South Africa in earlier works (O'Donoghue 1924; O'Donoghue and de Watteville 1935, 1937, 1944). South African material of *M. membranacea* was re-examined in Florence *et al.* (2007) and the synonymy resolved by erecting *M. rustica*.

Suborder NEOCHEILOSTOMINA d'Hondt, 1985

Superfamily **Calloporoidea** Norman, 1903

Family Calloporidae Norman, 1903

Genus *Amphiblestrum* Gray, 1848

Colony encrusting. Gymnocyst of autozooids of variable area, extensive flat cryptocyst, opesia triblobed, thickened condylar processes separating oval distal portion from a variably bilobed proximal portion. Distal oral spines present, or rarely absent. Adventitious avicularia

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often on gymnocyst, frequently overlapping ovicell of preceeding autozooid. Ovicell hyperstomial, prominent; partly membranous ectooecium, separated by thickened ridge from frontal area of granular entooecium; not closed by autozooid operculum. Basal pore chambers present.

Type species: *Membranipora flemingii* Busk, 1854

Amphiblestrum triangularis (O'Donoghue, 1924)

Plate 4, C-D

Lepralia triangularis O'Donoghue, 1924: 43 (pl. 2, fig. 11-12).

Amphiblestrum triangularis: O'Donoghue, 1957: 74. Florence *et al.* 2007: 12 (fig. 4A-B).

Amphiblestrum inermis: Hayward and Cook, 1983: 12 (fig. 1D-F).

Membranipora inermis: Kluge, 1914: 663 (pl. 34, fig. 6).

Material examined

SAMC-A028819, **AFR 7071**; SAMC-A028799, **AFR 888**; SAMC-A077272, **FAL 67**; SAMC-A077168, **FAL 161**; SAMC-A077552, **FAL 366**; SAMC-A077432, SAMC-A077437, **FAL 432**; SAMC-A077568, **FAL 466**; SAMC-A077375, **FAL 491**; SAMC-A077248, **FAL 503**; SAMC-A077231, **FAL 504**; SAMC-A077509, SAMC-A077529, **FAL 576**; SAMC-A077390, **FAL 807**; SAMC-A070043, **SB 153**; SAMC-A029001,SAMC-A029006, **TRA 31**; SAMC-A028933, **TRA 37**; SAMC-A029087, **WCD 11**.

Substratum, depth and ecology

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Forms encrustations on shells, rocks, tube worms and bivalves. Previous known maximum depth was 100 m. In this study, known depth distribution is extended from intertidal zone (< 10 m) down to 287 m.

Geographic distribution

Reported from Antarctica, thereafter this species has been found from South Africa, distributed from Port Nolloth on the west coast, and Durban on the east coast.

Remarks

The material from these collections clearly coincided with descriptions and figures of *A. triangularis*. Florence *et al.* (2007) indicated *A. inermis* as a synonym of *A. triangularis* in Hayward and Cook (1983).

Family Chaperiidae Jullien, 1888

Genus *Chaperia* Jullien, 1881

Colony encrusting, or bilaminar and erect, or vincularian (cylindrical branching shoots). Cryptocyst typically granular, extensive; gymnocyst reduced or absent. Suborificial occlusor

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laminae well-developed. Spines on distal rim. Avicularia and ovicells absent. Multiporous mural septula present.

Type species: *Chaperia australis*, Jullien, 1881

Chaperia sp.

Plate 4, E-F

Material examined

SAMC-A077604, **FAL 133**; SAMC-A077193, **FAL 256**.

Substratum, depth and ecology

Encrusting on shells. Sampled from intertidal zone, depth range 2-5.5 m.

Geographic distribution

Occurs in southern Australia, and in False Bay, South Africa.

Remarks

Chaperia acanthina Lamouroux, 1824 was reported from South Africa (O'Donoghue and de Watteville 1937; O'Donoghue 1957; Hayward 1980), but differs from the current material by its concave proximal border and conspicuous distal border of the opesia, as well as the negligible gymnocyst. The current material rather resembles material of *C. albispina* (MacGillivray, 1882) from the Australian Museum, Sydney, examined by Gordon (1982). The distinguishing characteristics were zooids separated by deep furrows and concomitant exposure of the gymnocyst (Gordon 1982). Additionally, the position of the long spines do not exceed the proximolateral border of the opesia, appears congruent with the specimens found in False Bay.The occlusor laminae and nature of the cryptocyst in relation to the gymnocyst was unclear in the current specimens, therefore preclude a complete description. These specimens are provisionally assigned to *Chaperia* until more material is acquired and comparison with the type material of *C. albispina*.

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Chaperia capensis (Busk, 1884)

Amphiblestrum capense Busk, 1884: 67 (pl. 23, fig. 3).

Chaperia acanthina var. *australis*: Marcus, 1922: 6 (fig. 2).

Membranipora galeata var. *inermis*: O'Donoghue, 1924: 38 (pl. 1, fig. 9).

Chapperia acanthina var. *australis*: O'Donoghue and de Watteville, 1944: 415.

Chaperia acanthina: O'Donoghue, 1957: 74.

Chaperia capensis: Hayward and Cook, 1983: 22 (fig. 3F). Florence *et al.*, 2007: 12 (fig. 4G).

Material examined

SAMC-A028786, **AFR 957**; SAMC-A029064, **AFR273 A31619**; SAMC-A077574, **FAL 153**; SAMC-A077180, **FAL 154**; SAMC-A077403, **FAL 186**; SAMC-A077197, **FAL 233**;

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SAMC-077415, **FAL 331**; SAMC-A077571, **FAL 466**; SAMC-A077241, SAMC-A077247, SAMC-A077251, SAMC-A077476, **FAL 503**; SAMC-A077301, **FAL 509**; SAMC-A077614, **FAL 524**; SAMC-A077605, **FAL 525**; SAMC-A077377, **FAL 608**; SAMC-A077221, **FAL 621**; SAMC-A077379, **FAL 730**; SAMC-A077388, **FAL 807**; SAMC-A028837, **TRA 57**; SAMC-A028887, **TRA 94**; SAMC-A028931,**TRA 151**; SAMC-A028013, **TRA 127**.

Other material examined: *Chaperia capensis*, NHMUK 1899.7.1.298 (holotype), Simon's Bay (35°04'S, 18°37'E), Cape of Good Hope, South Coast, South Africa, no additional information; SAMC-A026485, station **SM 179** (33°30.3'S, 27°22.1'E), Off Great Fish River Mouth, Southeast Coast, South Africa, dredged, depth 80 m, 29 May 1978.

Substratum, depth and ecology

Forms cylindrical growths from an encrusting base around hydroid stems. Depth range from intertidal zone (< 10 m) down to 147 m.

Geographic distribution

This species is considered endemic to South Africa, reported from Oudekraal on the west coast to East London on the southeast coast.

Remarks

The orientation of the occlusor laminae and widely spaced distolateral spines are characteristic for this species (Florence *et al.* 2007), congruent with the current specimens and compares well with museum material.

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Chaperia septispina Florence, Hayward and Gibbons 2007

Chaperia septispina Florence, Hayward and Gibbons 2007: 14 (figs. 4D-E).

Material examined

SAMC-A077579, **FAL 42**; SAMC-A077208, **FAL 141**; SAMC-A077278, **FAL 563**.

Substratum, depth and ecology

Encrusting on other bryozoans or algae. Depth range 8-21.5 m.

Geographic distribution

Only known to occur in the False Bay area, South Africa.

Remarks

The diagnostic characters for this species, include five to seven distal oral spines with an articulated brown base and the orientation of the occlusor laminae originating distally and not prominently slanted (Florence *et al.* 2007).

Genus *Chaperiopsis* Uttley, 1949

Colony encrusting, or bilaminar and erect, or vincularian from an encrusting base. Opesia relatively large, cryptocyst smooth or granular, well-developed or reduced to rim.

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Gymnocyst well-developed proximally or negligible, smooth and frequently obscured by avicularian chambers. Occlusor laminae negligible or variously developed. Spines bordering opesia. Adventitious avicularia on gymnocyst or absent; or on mid-distal wall; vicarious avicularia occasional. Ovicell hyperstomial, typically with frontal area and ridges, often with one or more avicularia. Multiporous mural septula present.

Subgenus *Chaperiopsis* Uttley, 1949

Remarks

There are two subgenera in this genus, namely *Chaperiopsis* Uttley, 1949 and *Clipeochaperia* Uttley and Bullivant, 1972. The type species for the subgenus *Clipeochaperia* is *Chaperiopsis* (*Clipeochaperia*) *funda* Uttley and Bullivant, 1972, and contains species of *Chaperiopsis* with a frontal shield comprising one or more overarching avicularian columns or spines together with the proximal pair of oral spines and a distal oral rim typically strongly beaded. There are no known species belonging to the subgenus *Clipeochaperia* in South Africa. The subgenus *Chaperiopsis* is distinguished by the presence of simple and/or forked spines, adventitious avicularia borne proximally and/or mid-distally adventitious avicularia, ovicell present, usually with a frontal or proximal fenestra and often surrounded by one or more avicularia.

Type species: *Membranipora galeata* Busk, 1854.

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Chaperiopsis familiaris (Hayward and Cook, 1983) comb. nov.

Plate 5, A-B

Chaperia familiaris Hayward and Cook, 1983: 23 (figs. 3C-E, 7A).

Material examined

SAMC-A077585, **FAL 84**; SAMC-A077426, **FAL 415**; SAMC-A077435, SAMC-A077440, **FAL 432**.

Other material examined: *Chaperia familiaris* (= *Chaperiopsis familiaris*) SAMC-A026415 (holotype), station **SM 162** (32°55'S, 28°31'E), Off Morgan’s Bay, Southeast Coast, South Africa, depth 630 m, heavy dredge, 25 May 1978; SAMC-A026487, station **SM 163** (33°04.6'S, 28°06.6'E), Off East London, Southeast Coast, South Africa, depth 90 m, heavy dredge, 26 May 1978.

Substratum, depth and ecology

Forming small encrusting patches on hard substrata. Depth range 48-630 m.

Geographic distribution

Previously reported from the southeast coast, but in this study, the distribution range of *C. familiaris* is extended to include False Bay on the south coast.

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Remarks

The reddish-brown colour was present in very few colonies. The distinguishable characteristics for *C. familiaris* are hexagonal zooids, rounded distally, transversely oval opesia with distinct occlusor laminae, and two pairs of distolateral spines – distal pair cylindrical and proximal pair forked (Hayward and Cook 1983). The distinct hemispherical ovicell is broader than long, with a transversely oval frontal foramen (Hayward and Cook 1983). These features are congruent with the current specimens. Two colonies are badly damaged in this collection (SAMC-A028837 and SAMC-A077426), with few observable zooids sufficient for identification. It also appears that *C. familiaris* is better placed in the genus *Chaperiopsis*, due to the presence of a prominent ovicell.

Chaperiopsis (Chaperiopsis) chelata Fernández Pulpeiro and Reverter-Gil, 1998

Plate 5, C

Chaperiopsis chelata Fernández Pulpeiro and Reverter-Gil, 1998: 932 (figs. 1, 2).

Material examined

SAMC-A077350, **FAL 664**.

Substratum, depth and ecology

Small encrusting patches.

Geographic distribution

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This species has only been recorded from the south coast of South Africa, with its first record in False Bay from this study.

Remarks

Fernández Pulpeiro and Reverter-Gil (1998) redescribed *Chaperia cristata* specimen from South Africa, in the Museum National d'Histoire Naturelle, Paris, in the Jullien collection. The small colony (< 0.5 cm) found in this study attached to *Onchoporella buski* showed the distinct inward curved palmate spines, ovicells that possess two small lateral elliptical fenestra and one or two distal pedunculate avicularia, and therefore, confidently assigned to *C. chelata.* The mid-distal avicularium, forked spines, ovicell usually with proximal fenestra, support the assignment of species in the subgenus *Chaperiopsis*.

Chaperiopsis (Chaperiopsis) multifida (Busk, 1884)

Plate 5, D-E

Membranipora galeata var. *multifida* Busk, 1884: 64.

Chaperia multifida: Kluge, 1914: 673 (fig. 44). Marcus, 1922: 7 (fig. 3). Hayward and Cook, 1983: 20 (fig. 6).

Membranipora galeata var. *multifida*: O'Donoghue and de Watteville, 1935: 205.

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Chaperiopsis (Chaperiopsis) multifida: Florence *et al.*, 2007: 14 (figs. 4F, H-I, 21K).

Material examined

SAMC-A028788, **AFR 0002**; SAMC-A028966, **AFR 273 A31599**; SAMC-A028948, **AFR273 A31605**; SAMC-A028954, SAMC-A028956, **AFR273 A31617**; SAMC-A028951, **AFR273 A31624**; SAMC-A029065, **AFR273 A31680**; SAMC-A077578, **FAL 42**; SAMC-A077561, SAMC-A077285, **FAL 48**; SAMC-A073531, **FAL 96**; SAMC-A077203, **FAL 154**; SAMC-A077337, **FAL 170**; SAMC-A077290, **FAL 182**; SAMC-A077198, **FAL 233**; SAMC-A077416,**FAL 331**; SAMC-A077256, **FAL 435**; SAMC-A077456, **FAL 445**; SAMC-A077584, SAMC-A077566, **FAL 466**; SAMC-A077617, SAMC-A077640, **FAL 475**; SAMC-A077156, SAMC-A077157, SAMC-A077162, SAMC-A077553, **FAL 491**; SAMC-A077242, SAMC-A077243, SAMC-A077245, SAMC-A073468, **FAL 503**; SAMC-A073477, SAMC-A077235, **FAL 504**; SAMC-A077299, **FAL 509**; SAMC-A077609, **FAL 524**; SAMC-A077513, SAMC-A077518, SAMC-A077542, **FAL 576**; SAMC-A077547, **FAL 577**; SAMC-A077307, SAMC-A077362, **FAL 602**; SAMC-A077312, **FAL 621**; SAMC-A073488, **FAL 622**; SAMC-A077469, **FAL 632**; SAMC-A077372, **FAL 741**; SAMC-A073428, SAMC-A077392, SAMC-A077394, **FAL 783**; SAMC-A077476, **FAL 793**; SAMC-A073414, **FAL 833**; SAMC-A077480, **FAL 835**; SAMC-A070060, **SB 8**; SAMC-A070079, **SB 197**; SAMC-A029071, **WCD 71**; SAMC-A029080, **WCD 107**; SAMC-A029119, **WCD 159**; SAMC-A029120, **WCD 165**.

<ins>Other material examined:</ins> *Chaperia multifida* (= *Chaperiopsis multifida*), SAMC-A026495, station **SM 179** (33°30.3'S, 27°22.1'E), Off the Great Fish River Mouth, Southeast Coast, South Africa, dredge, depth 80 m, 29 May 1978.

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Substratum, depth and ecology

Colonies grow on hydroid stems, forming cylindrical growths or encrustating patches on surfaces of algae and other bryozoans. Colonies may also grow as erect, bilaminar contorted three-dimensional structures providing shelter for small sponges, polychaete worms and molluscs. Previous known maximum depth was 100 m, in this study, depth distribution range extended from intertidal zone (< 10 m) down to 273 m.

Geographic distribution

Endemic to South Africa, distributed from Robben Island and St Helena Islands, on the west coast, eastwards to Durban on the east coast.

Remarks

This species is well-characterised, but the most distinguishable features include large circular or oval opesia, occlusor laminae position, two pairs of thick distolateral spines are easily distinguished – distalmost spines are erect and hollow, proximalmost pair form multibranched palmate structures, ovicell with an oval or irregular frontal area and pedunculate avicularia (Florence *et al.* 2007). Colony growth variations were observed, namely encrusting

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and erect, bilaminar, contorted structures, the latter only seen in five (of 58) colonies (SAMC-A073428, SAMC-A073488, SAMC-A077162, SAMC-A077372 and SAMC-A077566). Gordon (1984) reported *C. multifida* from New Zealand, but described specimens with bifurcating distalmost spines, which is inconsistent with this species, and should be re-examined.

Chaperiopsis (Chaperiopsis) stephensoni (O'Donoghue and de Watteville, 1935)

Plate 6, A-B

Chaperia stephensoni O'Donoghue and de Watteville, 1935: 205 (pl. 5, fig. 1; pl. 6, fig. 11).
Chaperia stephensoni: O'Donoghue, 1957: 74. Hayward and Cook, 1983: 23.
Chaperiopsis stephensoni: Fernández Pulpeiro and Reverter-Gil 1998: 936 (figs. 3, 4).

Material examined

SAMC-A073445, **FAL 697**; SAMC-A029081, SAMC-A029085, **WCD 11**.

Substratum, depth and ecology

Encrusting on shells and other bryozoans. Depth range 26-90 m.

Geographic distribution

This species has only been found on the South Coast of South Africa, reported from False Bay to Preekstoel near Still Bay, but in this study two specimens were found off Kommetjie, west of the Cape Peninsula, therefore extending its known distribution range westward.

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Remarks

Chaperiopsis stephensoni closely resembles *C. chelata*, but differs from it by its oval zooid shape, wider pedunculate avicularia, proximalmost spines cylindrical, slender and poorly developed and ovicells possess one or two small lateral fenestra and proximal costae across the width of the ovicell. These features agree with the current specimens and was placed in the genus *Chaperiopsis* in Fernández Pulpeiro and Reverter-Gil (1998) and the presence of mid-distal adventitious avicularia and simple spines, places the species in the subgenus *Chaperiopsis*.

Chaperiopsis (Chaperiopsis) yinca sp. nov.

Plate 6, C-E

Material examined

Holotype: SAMC-A073421, station **FAL 775** (34°9'S, 18°27'E), False Bay, depth 19 m, dredge, collected by UCT Ecological Survey, 16 February 1965.

<u>*Additional material:*</u> SAMC-A028954, **AFR273 A31617**.

Etymology

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Yinca (Tsonga) – Means “ostrich” in Tsonga, one of South Africa’s official languages, referring to the pedunculate avicularia resembling the long neck and head of an ostrich.

Description

Colony erect, bilaminar, contorted; light red/maroon colour when dry. Autozooids oval, alternating, tightly packed. Opesia oval bordered by narrow smooth cryptocyst. Negligible gymnocyst in the distal third, but prominent proximally, coarsely granular; frontal membrane, with operculum in the distal third, completely covers zooid. Two pairs of long hollow distolateral spines, distal pair straight, some slightly curved and narrow; proximal pair straight, some slightly curved and thick, occasionally bifid and rarely palmate. Both erect pairs of spines persist in ovicelled autozooids and may be shorter than in non-ovicelled zooids. Non-ovicelled autozooids bear a single mid-distal avicularium, the rostrum directed distally. Occlusor laminae negligible to moderately developed in the distal zooidal wall, not exceeding half way down the lateral wall of the opesia. Ovicells smooth-surfaced, closed by operculum, with narrow transversely elongate or transversely oval proximal fenestra, surmounted by one or two pedunculate avicularia directed distally, or, rarely, a single large columnar mid-distal avicularia directed proximally, rostrum long, acute.

Substratum, depth and ecology

Forms erect, bilaminar colonies. Depth range 19-110 m.

Geographic distribution

Collected from Fish Hoek in False Bay, on the south coast, and off Algoa Bay on the southeast coast.

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Remarks

At first glance, this species closely resembles *C. multifida* by the light red/maroon bilaminar sheath and nature of spines and pedunculate avicularia. However, upon re-examination, the proximalmost spines in *C. multifida* develops as multi-branched palmate structures whereas the current specimen has bifid and palmate spines occasionally, but mainly straight, long and hollow spines. In non-ovicelled zooids, pedunculate avicularia is present adjacent to mid-distal sessile avicularium in *C. multifida*, while in ***C. yinca*** sp. nov., autozooids possess a single mid-distal avicularium. Moreover, ovicells in *C. multifida* has an oval or irregular fenestra in the frontal area, while the ovicells in the current species has an elongated, transverse fenestra on the proximal region of the ovicell. The frontal membrane obscures the opesial window, precluding zooidal measurements for this study.

This species also resembles *C. rubida*, reported from Australia and New Zealand. It differs from *C. rubida* by not possessing one or two columnar avicularia that bears 1-2 pairs of forward-projecting spikes (Gordon 1982). One South African specimen of *C. rubida* (NHMUK 1904.1.16.1) was collected in Algoa Bay, Southeast Coast, housed in the Bryozoa collection at NHMUK. Its Indo-Pacific distribution may well mean that *C. rubida* occurs in South Africa, but due to its close resemblance with the current species, the specimen needs to re-examined. This species agrees with respect to other characters in the genus and subgenus, but differs from all South African allied species, which warrant the erection of a new species.

Family Cupuladriidae Lagaaij, 1952

Genus *Discoporella* d'Orbigny, 1852

Colonies flat, discoidal, compact, densely calcified. Determinate growth, i.e. naturally self-limited growth with height-diameter ratio of about 0.32. Spines within opesiules coaslescing form a shield.

Type species: *Lunulites umbellata* Defrance, 1823

Discoporella umbellata (Defrance, 1823)

Plate 7, A-B

Lunulites umbellata Defrance, 1823: 361 (pl. 47, figs. 1a-b).

Discoporella umbellata: Cook, 1965*a*: 177 (pl. 1, fig.7; pl. 3. figs. 1, 3-6); 1965*b*: 221 (pl.3, figs. 3, 2h). O'Donoghue, 1924: 39. Hayward and Cook, 1979: 44; 1983: 8 (fig. 2).

Material examined

SAMC-A073494, **FAL 341**; SAMC-A077441, **FAL 415**; SAMC-A073403, **FAL 421**; SAMC-A077429, **FAL 432**; SAMC-A077449, **FAL 445**; SAMC-A073450, SAMC-A077309, **FAL 621**; SAMC-A073400, **FAL 852**; SAMC-A028886, **TRA 42**.

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Other material examined: *Discoporella umbellata 'peyroti'*, SAMC-A026463, station **SM 179** (33°30.3'S, 27°22.1'E), Off the Great Fish River Mouth, Southeast Coast, RV *Meiring Naude* Survey, dredge, depth 80 m, 29 May 1978.

Substratum, depth and ecology

Free-living colonies found at a depth range down to 780 m.

Geographic distribution

The *D. umbellata* species complex has been reported as widespread in tropical and subtropical regions of the Atlantic Ocean and western Indian Ocean distribution. However, the '*peyroti*-type' colonies have only been reported from South Africa.

Remarks

Taxonomy of recent *Discoporella* species was reviewed in Herrera-Cubilla *et al.* (2008). *Discoporella umbellata* species complex is well-characterised and distinguished by zooids with D-shaped opesia, complete cryptocyst lamina, punctured by several pairs of opesiules and other foramina (Hayward and Cook 1983). In later ontogeny, a layer of kenozooids with avicularia replaces the zooids on the basal surface, called the '*peyroti'*-type (Hayward and Cook 1983). Changes of the basal surface are seen in the current material, and to date, only

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observed in South African *D. umbellata* material (Cook 1965a, 1965b; Hayward and Cook 1983).

Family Foveolariidae Gordon and Winston *in* Winston, 2005

Genus *Foveolaria* Busk, 1884

Colony encrusting; or erect and vincularian, bilaminar, frondose or retiform forming an encrusting base. Opesia bordered by granular cryptocyst, steeply descending. Gymnocyst well-developed proximally, thickens with secondary calcification. Adventitious avicularia on gymnocyst. Ovicells hyperstomial, becoming immersed in secondary calcification.

Subgenus *Foveolaria* Busk, 1884

Colony erect and vincularian, bilaminar, frondose or retiform from an encrusting base. Zooidal characteristics as described for the genus.

Type species: *Foveolaria elliptica* Busk, 1884

Foveolaria (Foveolaria) imbricata (Busk, 1884)

Plate 7, C-D

Amphiblestrum imbratum Busk, 1884: 65 (pl. 15, fig. 3).

Membranipora imbrata: Marcus, 1922: 16 (fig. 9).

Foveolaria imbricata: Hayward and Cook, 1983: 16 (figs. 4A, B).

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Material examined

SAMC-A028988, **AFR273 A31599**; SAMC-A077267, **FAL 65**; SAMC-A077252, **FAL 503**; SAMC-A028934, **TRA 120**; Unnumbered specimen, **TRA 127**; SAMC-A029144, **WCD 217**.

<u>Other material examined:</u> *Foveolaria imbricata*, NHMUK 1899.7.1.35b, 1944.1.8.175, no additional information.

Substratum, depth and ecology

Forming erect, vincularian colonies from an encrusting sheet. Depth range 37-850 m.

Geographic distribution

Endemic to South Africa. Reported from localities on the west coast to the southeast coast.

Remarks

Descriptions and museum material of *F. imbricata* are congruent with material this study, distinguished by diamond-shaped zooids with the frontal surface obscured by a tall, broad avicularium situated proximal to the opesia. Ovicells in *Foveolaria* are usually immersed by secondary calcification, and no ovicells have been described in previous accounts of *F.*

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imbricata. This study provides the first description of ovicells in *F. imbricata*: hemispherical and cap-like, with slightly compressed median edges, but the proximolateral edges do not meet (Plate 7, D). In addition to that, *F. imbricata* form erect and vincularian (erect and cylindrical) colonies, thus better placed in the subgenus *Foveolaria* (Gordon 1986).

Superfamily **Buguloidea** Gray, 1848

Family Beaniidae Canu and Bassler, 1927

Genus *Beania* Johnston, 1840

Colony creeping, generally loosely attached to substrate; unilaminar, ramifying or reticulate, attached by rhizoids on the basal surface. Autozooids connected by tubular processes in a quincuncial series, or irregular, linear series; partly erect, or not, closely spaced or distant. Multiporous septula present at proximal end of each tube. Entire frontal surface of broad distal portion of autozooid covered by frontal membrane; marginal spines variously developed. Avicularia pedunculate, of the bird's head type, or absent. Ovicells present or absent, mostly vestigial and inconspicuous.

Type species: *Beania mirabilis* Johnston, 1840

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Beania magellanica (Busk, 1852)

Diachoris magellanica Busk, 1852: 54 (pl. 67, figs. 1-3).

Beania magellanica: Hastings, 1943: 414 (figs. 34C, 35G). O'Donoghue, 1924: 33. O'Donoghue and de Watteville, 1944: 419. O'Donoghue, 1957: 83. Hayward and Cook, 1983:42. Florence *et al.*, 2007: 20 (figs. 6F-G).

Material examined

SAMC-A028781, **AFR 743**; SAMC-A077551, **FAL 363**; SAMC-A077473, SAMC-A077477, **FAL 793**; SAMC-A028867, **TRA 59**; SAMC-A028866, **TRA 3300**.

<u>Other material examined:</u> *Beania magellanica*, SAMC-A026561, station **SM 179** (33°30.3'S, 27°22.1'E), Off Great Fish River Mouth, Southeast Coast, South Africa, RV *Meiring Naude* Survey, dredged, depth 80 m, 29 May 1978.

Substratum, depth and ecology

Encrusts algae, rocks and other bryozoans. Depth range 4-100 m.

Geographic distribution

This species has a widespread distribution from the Mediterranean to the Falkland Islands, Australia to Japan and throughout the Indian Ocean. In South Africa, reported from Table Bay on the west coast to East London on the southeast coast.

Remarks

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The current specimens agree with characteristics for *B. magellanica*. Diagnostic features include autozooids connected by six long tubes, paired avicularia situated distolaterally to each zooid, pointed distally, acute mandibles and slightly hooked; a single attachment pore located medially on the basal side between the points where the distalmost lateral tubes connect to the zooid; spines and ovicells absent. Additionally, O'Donoghue (1924: 33) noted that one avicularium was frequently present his material as was noted in the current collections.

Beania minuspina Florence, Hayward and Gibbons, 2007

Plate 7, E-F

Beania minuspina Florence, Hayward and Gibbons, 2007: 20 (figs. 6H-J).

Material examined

SAMC-A077349, **FAL 664**; SAMC-A077271, **FAL 67**.

Other material examined: *Beania minuspina*, SAMC-A028585 (holotype), Justin's Caves (33°58'90''S, 18°20'65''E), Oudekraal, SCUBA, depth 10 m, collected by W.K. Florence, 24 April 1999.

Substratum, depth and ecology

Encrusting certain algae, hydroids and other bryozoans. Depth range 4-26 m, thus only known from shallow waters.

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Geographic distribution

Endemic to South Africa, reported from Oudekraal on the west coast to False Bay, in this study, extending its known range slightly eastwards.

Remarks

The current material is congruent with the distinguishing features of *B. minuspina*. These include closely packed zooids connected to six other zooids by six short tubes; 4-5 tubular marginal spines on each side directed medially, overlapping at zooidal midline; two additional pairs of erect, hollow oral spines; a single attachment pore located medially on the basal surface, just below the distalmost connection tube, and no avicularia or ovicells (Florence *et al.*, 2007).

Beania vanhoeffeni Kluge, 1914

Plate 8, A-B

Beania vanhoeffeni Kluge, 1914: 647 (text.-fig 28).

Beania paucispinosa: O'Donoghue and de Watteville, 1935: 208 (pl. 5, fig. 2; pl. 6, fig. 12) (not O'Donoghue and de Watteville, 1925 in O'Donoghue and de Watteville, 1944). O'Donoghue and de Watteville, 1944: 420.

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Material examined

SAMC-A077289, **FAL 79**; SAMC-A073524, SAMC-A073496, **FAL 154**; SAMC-A073495, **FAL 182**; SAMC-A077219, **FAL 752**; SAMC-A077351, **FAL 846**.

Other material examined: *Beania paucispinosa* (= *Beania vanhoeffeni*), NHMUK 1968.1.18.8, no additional information.

Substratum, depth and ecology

Encrusting on other bryozoans. Depth range from the intertidal zone (< 10 m) down to 147 m.

Geographic distribution

This species is endemic to South Africa, only known from False Bay.

Remarks

Distinguished by its moderately closely packed sub-erect zooids joined by six connecting tubes arising from the basal surface; seven to eight marginal spines on each side curved mesially over the frontal wall, rarely overlapping (O'Donoghue and de Watteville 1935). Two additional pairs of spines – one pair of spines proximolateral to orifice, blunt and hollow, while the other pair is stout, hollow pair situated distally, shorter than the marginal spines and almost straight; no avicularia (O'Donoghue and de Watteville 1935). Even though the current material is in a poor condition, it is congruent with the descriptions and comparison with *B. vanhoeffeni* in the Bryozoa collection.

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Beania sp.

Plate 8, C-D, Table 4.2

Material examined

SAMC-A077612, **FAL 524**; SAMC-A077489, **FAL 576**; SAMC-A073377, **LB 285**; SAMC-A029132, **WCD 203**.

Substratum, depth and ecology

Encrusting on other bryozoans. Depth range 33-54 m.

Geographic distribution

Distribution range extends from off Schaapen Island on the west coast to False Bay on the south coast.

Remarks

Six species of *Beania* have been reported from South Africa, namely *B. inermis* Busk, 1852, *B. magellanica* Busk, 1852, *B. vanhoeffeni* Kluge, 1914, *B. uniarmata* O'Donoghue and de Watteville, 1944, *B. rediviva* Hayward and Cook, 1983 and *B. minuspina* Florence, Hayward and Gibbons, 2007. The latter three species are endemic to South Africa. Of the known *Beania* species from South Africa, the current specimens share the closest resemblance to *Beania*

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uniarmata, due to the single avicularium distolateral to (some) zooids and zooidal shape, but a distinct difference in *B. uniarmata* is the presence of marginal spines. The current material suggests a new bryozoan record from South Africa. However, the material is in a poor condition, and will remain unnamed until more material is acquired.

Table 4.2. Measurements (in millimeters) of *Beania* sp. material.

	Schaapen Island, West Coast SAMC-A073377		
Characters	N_T	Average ± SD	Range
Lz	5	0.44 ± 0.05	0.39-0.51
lz	5	0.27 ± 0.02	0.26-0.29

Genus *Dimorphozoum* Levinsen, 1909

Colonies erect, forming fronds, possess two layers of species in a commensal relationship, namely a cheilostomatous and an apparent ctenostome layer. The cheilostomatous layer has adventitious avicularia, hyperstomial ovicells and multiporous rosette-plate. Ctenostome layer has uncalcified zooids, operculum absent.

Type species: *Flustra nobilis* Hincks, 1891

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Dimorphozoum nobile (Hincks, 1891)

Plate 8, E-F, Table 4.3

Flustra nobilis Hincks, 1891: 288 (pl. 5, fig. 5).
Dimorphozoum nobile: Levinsen, 1909: 107.
Beania nobilis: Hastings, 1939: 327 (text-fig. 273A).

Material examined

SAMC-A028785, **AFR 957**; SAMC-A073497, **FAL 355**; SAMC-A028883, **TRA 94**.

Other material examined: *Beania nobilis* (=*Dimorphozoum nobile*), NHMUK 1891.10.16.1 (slides 1-6: parts of type), Port Elizabeth, Southeast Coast, South Africa, no additional information.

Substratum, depth and ecology

Forming tuft-like colonies. Depth 111 m.

Geographic distribution

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Only known from South Africa. Previously reported from Algoa Bay on the southeast coast and in this study found in the False Bay area to near Mossel Bay, south of Bull Point, on the south coast.

Remarks

This genus has a single species, *D. nobile*, first described by Hincks (1891) as *Flustra nobilis*. Subsequent authors (e.g. Hastings 1939) have considered that this species is closely related to the genus *Beania* due to avicularia attached to the proximal part of the zooid. This diagnostic feature is unusual for *Beania* species, but is found in *B. regularis* Thornely, 1916 (Hastings 1939). However, the genus *Beania* still needs further revision since a great range of forms are included in this genus, therefore the status of *Dimorphozoum* remains uncertain.

The flustrine colony, with rectangular to hexagonal zooids, tooth-like spines on the distal edge, no basal spines and free from the ctenostome layer agree with images of South African *D. nobile* material from NHMUK (Ms Mary Spencer Jones, pers. comm.). Unlike the drawings in Hincks (1891) and subsequent descriptions of *D. nobile*, pedunculate avicularia and marginal spines were absent or extremely rare in the British and current material. Except for one alcohol-preserved colony (SAMC-A028785) that showed avicularia, suggesting that dry preservation may have resulted in pedunculate avicularia falling off.

Additionally, the current material has bifurcating branches with branch width of about 5 cm and a clump of rootlets present at the point of bifurcation, not mentioned in previous accounts. The current specimen was tentatively assigned to *D. nobile* due to congruence of characteristics, until the type material is re-examined and/or new material collected that may warrant a redescription of the type species and genus.

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Table 4.3. Measurements (in millimeters) of *Dimorphozoum nobile*.

	Off Cape Infanta, South Coast SAMC-A028883		
Characters	N_T	Average ± SD	Range
Lz	8	1.29 ± 0.06	1.20-1.37
lz	7	0.72 ± 0.03	0.66-0.75

Family Bugulidae Gray, 1848

Genus *Bicellariella* Levinsen, 1909

Colony erect, branching, growing from an upright ancestrula; attached by rhizoids that originate distally from the basal face of the autozooids. Autozooids arranged biserially, alternating, horn-shaped with a short, wide forked base separated by constriction from a slender, middle portion (comprising most of the proximal half of the autozooid), in turn, separated by a second constriction from the flaring distal portion. Oval frontal membrane, with an operculum; several long marginal spines present. Bifurcation type 4. Pedunculate avicularia, bird's head avicularia, attached proximal to the frontal membrane. Ovicell helmet-shaped, situated at the inner margin of the membranous area and attached by a peduncle at right angles to the branch axis; membranous ectooecium.

Type species: *Sertularia ciliata* Linnaeus, 1758

Bicellariella bonsai Florence, Hayward and Gibbons, 2007

Bicellaria ciliata Hincks, 1880: 68 (pl. 8, figs. 1-5).
Bicellaria ciliata: Waters, 1909: 135. O'Donoghue and de Watteville, 1935: 207.
Bicellariella ciliata: O'Donoghue and de Watteville, 1944: 412. O'Donoghue, 1957: 77.
Bicellariella bonsai Florence, Hayward and Gibbons, 2007: 18 (figs. 6D, E).

Material examined

SAMC-A029156, **WCD 36**.

Other material examined: *Bicellariella bonsai*, SAMC-A028759, station **KNY 18** (34°04'S, 23°03'E), Fountain Point, Knysna, 16 July 1947, no additional information.

Substratum, depth and ecology

Usually living beneath overhangs low on the shore and in the subtidal, sometimes colonised by tiny molluscs. Known depth range was extended in this study 4-33 m.

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Geographic distribution

This species is endemic to South Africa, distributed from Lambert's Bay on the west coast to Isipingo Beach, Durban, on the east coast.

Remarks

The European *B. ciliata* was previously recorded from South Africa, but Florence *et al.* (2007) found that the South African specimens of *B. ciliata* clearly differed from the European specimens, therefore erected *B. bonsai*. *Bicellariella bonsai* can be distinguished by forming delicate tufts, slender branches, zooids biserial, alternating and tightly packed, four to seven long incurved spines that originate from the distal end of the zooid and a single bird's head avicularium situated proximal to the frontal membrane, attached to the outer edge (Florence *et al.* 2007). In this study, a single specimen found off Saldanha Bay also coincided with the *B. bonsai* specimen in the Bryozoa collection.

Genus *Bugula* Oken, 1815

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Colony erect or creeping, branching biserially; elongated autozooids, basal and lateral walls lightly calcified, mostly membranous frontal surface. Pedunculate bird's head avicularia present (except in *B. neritina*) attached to the proximal third of the lateral edge of zooid. Ovicell pedunculate, rarely reduced, spherical, attached to the inner distal margin of zooid; ovicell possess two calcified layers (ectooecium and entooecium) with an inner membranous ooecial vesicle; spines absent in ancestrula. Two bifurcation patterns: (i) type 4 and (ii) modified type 3, with long proximal gymnocyst.

Type species: *Sertularia neritina* Linnaeus, 1758

Bugula neritina (Linnaeus, 1758)

Sertularia neritina Linnaeus, 1758: 815.

Bugula neritina: Busk, 1852: 44 (pl. 43). O'Donoghue and de Watteville, 1944: 419. O'Donoghue, 1957: 83. Ryland and Hayward, 1977: 162 (fig. 78). Gordon, 1986: 45 (pl. 15A). Hayward and Ryland, 1998: 220 (fig. 68). Florence *et al.*, 2007: 18 (figs. 6A-C). Fehlauer *et al.*, 2015: 340.

Material examined

SAMC-A073425, **FAL 775**; SAMC-A073394, **LB 220**; SAMC-A073387, **LB 381**; SAMC-A028833, **TRA 35**; SAMC-A028834, **TRA 42**.

Substratum, depth and ecology

This is a well-known fouling species, forming tuft-like colonies attached to the hulls of ships and other bryozoans. Depth range 4-100 m.

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Geographic distribution

This species has a cosmopolitan distribution in warm-temperate and tropical regions, except in cold polar and subarctic/subantarctic regions (Gordon and Mawatari 1992; Winston and Woollacott 2008). Locally, *B. neritina* has been reported in all areas with harbours commonly fouling on the hulls of ships from Port Nolloth to Durban.

Remarks

Species in the genus *Bugula* were revised in Fehlauer-Ale *et al.* (2015), based on molecular phylogenetics and morphology to distinguish between species. The results yielded the erection of the genus *Virididentula* and the placement of some *Bugula* species to other genera (*Bugulina* and *Crisularia*) (Fehlauer-Ale *et al.* 2015).

Bugula neritina is unique within this genus easily distinguished by forming reddish-purple tufts (when alive) and lacks avicularia and spines (Florence *et al.*, 2007). These features were congruent with the current material. The presence of globular ovicells are a prominent feature in this species, as with other *Bugula* species, but some colonies of *B. neritina* lack ovicells. *Bugula neritina* has been studied extensively, especially for its anticarcinogenic biochemical bryostatin-1 (Davidson and Haygood 1999; Winston and Woollacott 2008).

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Genus *Bugulina* Gray, 1848

Colony erect, biserial to multiserial dichotomous branching; autozooids elongate, basal and lateral walls lightly calcified, mostly membranous frontal surface. Pedunculate bird's head avicularium situated at lateral edge of zooid; dimorphic avicularia present, on the inner zooids avicularia are smaller than on the outer zooids of branches. Ovicell centred in the midline, attached to the distal region of the zooid, ectooecium calcified laterally and proximally, membranous distofrontally; ancestrula possess spines. Biserial colonies with variable bifurcating patterns, usually type 5.

Type species: *Sertularia avicularia* Linnaeus, 1758; by original designation

Bugulina flabellata (Thompson in Gray, 1848)

Avicularia flabellata Thompson in Gray, 1848: 106.
Bugula flabellata: Busk, 1852: 44 (pl. 51, 52). Hincks, 1880: 80 (pl. 11, figs. 1-3).
Bugula calathus: O'Donoghue, 1957: 79 (figs. 3-5).
Bugula flabellata: Florence *et al.*, 2007: 17 (figs. 5G-I).

Material examined

SAMC-A077371, **FAL 270**; SAMC-A073375, **LB 181**; SAMC-A073385, **LB 378**; SAMC-A073366, **LB 386**; SAMC-A073364, **LB 392**; SAMC-A070057, **SB 141**; SAMC-A070045, **SB 153**; SAMC-A070066, **SB 168**; SAMC-A028871, **TRA 132**.

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Substratum, depth and ecology

This is a well-known fouling species, commonly found attached to the hulls of ships and other bryozoan species. Previous known minimum depth was 4 m, but in this study the depth range extended from 2.5-100 m.

Geographic distribution

Globally, *B. flabellata* has a widespread distribution in both warm and cold temperate waters in the northern and southern hemisphere (Gordon and Mawatari 1992). Locally, this species has a known distribution from Port Nolloth to Plettenberg Bay, but suggested to have a wider spread (Florence *et al.*, 2007).

Remarks

Bugula flabellata was placed in the genus *Bugulina* due to the presence of dimorphic avicularia and multiserial colonies (Fehlauer-Ale *et al.* 2015). In addition to that, characteristics of *B. flabellata* include multiserial (3-5 zooids) branching, two inner distal spines, avicularia situated one-third of the way down the lateral wall and the subglobular ovicell with a straight proximal border. These features coincide with the current material.

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Genus *Cornucopina* Levinsen, 1909

Colony erect, dichotomous branching, unjointed; secured by rhizoids. Zooids biserially arranged, club-shaped; the slender proximal region forms part of the main axis of the branch, the oval distal region projecting at right angles to the axis, alternating. Disto-basal region of the zooid comprises of a slender, tubular process, often bearing a few or many long spines along one edge. Pedunculate avicularia. Ovicell prominent, globular.

Type species: *Bicellaria grandis* Busk 1852

Cornucopina sp.

Table 4.4

Material examined

SAMC-A028832**, TRA 37**.

Description

Colony forms a dense bushy tuft, branching dichotomously, unjointed and developing a broad fan shape; rhizoids gather basally to form a stalk. Opesia elongate oval, occupying whole frontal surface of distal portion; proximal (axial) portion up to 0.49 mm. Disto-basal process prominent, with two or three stout, cylindrical curved spines, longer than opesia. Bird's head avicularium situated on the outer edge of the proximo-basal surface; sporadic. Ovicell globular.

Substratum, depth and ecology

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Forming dense clumps. Depth 73 m.

Geographic distribution

Collected off Cape Infanta on the south coast.

Remarks

This colony agrees well with the characteristics of the genus *Cornucopina*, therefore confidently placed within this genus. Only two *Cornucopina* species have been described from South Africa (*C. novissima* and *C. nupera*) from the *Galathea* deep-sea expedition at depths 3620-5340 m (Hayward 1981). It distinctly differs from the current material by the long distal processes (up to 1.1 mm in length), the number and position of the spines and the size, shape and position of the avicularia (Hayward 1981). These distinct differences suggest a new bryozoan record for South Africa. However, the fragility of the colony did not allow for SEM imaging and was difficult to prepare without breaking, therefore, until more material is collected, its identity remains in doubt.

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Table 4.4. Measurements (in millimeters) of *Cornucopina* sp. Autozooid length (Lz) comprises of proximal portion, forming part of axis.

	Off Cape Infanta, South Coast SAMC-A028832		
Characters	N_T	Average ± SD	Range
Lz	4	0.46 ± 0.02	0.44-0.49
Lo	5	0.23 ± 0.02	0.21-0.25
lo	6	0.15 ± 0.01	0.13-0.15
Ladav	2	0.19 ± 0.02	0.17-0.20
hadav	2	-	0.11

Genus *Virididentula* Fehlauer-Ale, Winston, Tilbrook, Nascimento and Vieira, 2015

Colony erect, strongly coloured, green to blue-green in colour, biserial dichotomous branching; bifurcation type 4. Elongated autozooids, basal and lateral walls well calcified, mostly membranous frontal surface directed towards the axis of the branches. Articulated spines present distally, a pedunculate bird's head avicularium situated on the outer lateral edge of the zooid; dimorphic avicularia sometimes present. Ovicell closed by operculum, situated in the distal region of the zooid, near the axis, slightly oblique; ectooecium reduced at the proximolateral edge, with a broad membranous frontal area, smooth endooecium; ancestrula with spines.

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Type species. *Acamarchis dentata* Lamouroux, 1816

Virididentula dentata (Lamouroux, 1816)

Acamarchis dentata Lamouroux, 1816: 35 (pl. 3, figs. 3a-b).

Bugula dentata: Busk, 1852: 46 (pl. 3, figs. 1-5). O'Donoghue 1924: 33. O'Donoghue, 1957: 82. Hayward and Cook, 1983: 42. Florence *et al.*, 2007: 17 (figs. 5E-F, 20 B, 21 L).

Material examined

SAMC-A077678, **AFR273 A31605**; SAMC-A029044, **AFR273 A31639**; SAMC-A077370, **FAL 6**; SAMC-A077374, **FAL 64**; SAMC-A077366, **FAL 122**; SAMC-A077367, **FAL 133**; SAMC-A077174, FAL 148; SAMC-A077369, **FAL 170**; SAMC-A077639, FAL 475; SAMC-A073447, **FAL 708**; SAMC-A073419, **FAL 741**; SAMC-A077373, **FAL 742**; SAMC-A073415, **FAL 752**; SAMC-A077355, **FAL 846**; SAMC-A028870, **TRA 33**; SAMC-A028831, **TRA 36**; SAMC-A028834, **TRA 42**; SAMC-A028869, **TRA 59**; SAMC-A028872, **TRA 109**.

Substratum, depth and ecology

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This species forms bushy tufts that provide habitats for sponges and small molluscs. Depth range 2-104 m.

Geographic distribution

Distribution is widespread and has been reported from Australia to New Guinea, the Celebes Sea, New Zealand, Japan, Madeira and more recently Brazil, with a pan-warm temperate-tropical distribution. In South Africa, *V. dentata* was reported from Oudekraal on the west coast of the Cape Peninsula to near Hamburg Nature Reserve on the east coast.

Remarks

Bugula dentata was placed in genus *Virididentula* due to its biserial branching, type 4 bifurcation and dimorphic avicularia (Fehlauer-Ale *et al.* 2015). Morphological variation have been noted throughout the range of *V. dentata* (Ryland 1974). Specimens from Victoria and New Zealand showed different positioning of avicularia when compared with specimens from Heron Island (Ryland 1974). Avicularial dimorphism was also demonstrated in specimens from central Indo-Pacific, where some autozooids had ‘giant’ avicularia rather than standard avicularia seen in specimens from other areas (Harmer 1926). South African material of *V. dentata* possess ‘giant’ avicularia as seen in the Indo-Pacific material, but does not exhibit dimorphism in avicularia (Florence *et al.* 2007). Even though some of the colonies were fragmented, characteristics were clearly identifiable as *V. dentata*.

Family Candidae d'Orbigny, 1851

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Genus *Caberea* Lamouroux 1816

Colony erect, dichotomous branching, typically forming a short, stiff fan; attached by bundles of rhizoids. Cylindrical stout branches, typically with keeled basal surface; apparently unjointed, but joints hidden by calcification. Two or more autozooids in longitudinal series, often faced away from each other at an angle; frontal membrane occupying most of frontal surface; reduced gymnocyst, often well-developed cryptocyst. Distal oral spines present; scutum either present or absent. Adventitious avicularia, frequently enlarged. Large vibricula present on basal surface of branch, with vibricula chambers often occupying most of its area, orientated obliquely medially to form the longitudinal keel. Ovicell hyperstomial, globular, typically with frontal ectooecial membranous area.

Type species: *Caberea dichotoma* Lamouroux 1816

Caberea darwinii Busk, 1884

Plate 9, A-B

Caberea darwinii (part) Busk, 1884: 29 (pl. 32, figs. 6c-f). Hastings, 1943: 374 (pl. 5, figs. 1-3, text-figs. 21, 22A-C, 23A-D, 24A).

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Material examined

SAMC-A028768, **AFR 723-5-7**; SAMC-A028769, **AFR 7071**; SAMC-A028836, **TRA 36**; SAMC-A028835, **TRA 109**.

Substratum, depth and ecology

Attached to hard substrata and other bryozoans. Depth range 58-366 m.

Geographic distribution

Globally, the geographical distribution of *C. darwinii* extends from New Zealand westward, to the Patagonian Shelf in the South Atlantic; considered widespread in Antarctic and Sub-Antarctic waters – has been reported in Kerguelen, Prince Edward Island and Marion Island – as discussed in Hastings (1943). Locally, this species was previously reported from the south and east coast, but in this study, specimens were found on the west coast, as far northwest as the border of Namibia.

Remarks

Variation in colony morphology of *C. darwinii* was described in detail in Hastings (1943). Three distinct types of *C. darwinii* were distinguished and associated with its geographical distribution: (i) the *minima* type with a subtropical to Sub-Antarctic distribution), (ii) Swain's Bay type with subtropical, Sub-Antarctic and Antarctic distribution and (iii) Antarctic type with an Antarctic distribution (Hastings 1943). These variations were most likely attributable to hydrological variation (Hastings 1943).

One of the three *C. darwinii* colonies at *Challenger* station 142 (South Africa) resembled the Swain's Bay type, which are less robust as compared to other types, frontal avicularia are less enlarged and two distal outer spines occur more frequently (Hastings 1943). The colony differed from the other Swain's Bay type colonies in having enlarged frontal avicularia observed to be associated with ovicelled zooids (Hastings 1943). It is clear that the current material was of the Swain's Bay type, with diagnostic enlarged frontal avicularia as noted by Hastings (1943).

Caberea darwinii occlusa Hastings, 1943

Plate 9, C-D

Caberea darwinii (part) Busk, 1884: 29 (pl. xxxii (32), figs. 6a, b). Hayward and Cook, 1983:38.

Caberea boryi: Hasenbank, 1932: 359 (text-fig. 28).

Caberea darwinii occlusa: Hastings, 1943: 385 (fig. 22D).

Material examined

SAMC-A077679, **AFR273 A31605**; SAMC-A029111, **WCD 156**.

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Other material examined: *Carberea darwinii* (= *Caberea darwinii occlusa*), SAMC-A026543, station **SM 184**, (33°39.4’S, 27°11.7’E), Off Port Alfred, South Coast, South Africa, RV *Meiring Naude* Survey, dredge, depth 86 m, 31 March 1978.

Substratum, depth and ecology

Attached to hard substrata and other bryozoans. Depth 86-275 m.

Geographic distribution

This species is endemic to South Africa. The current material was found off Mossel Bay and Hout Bay, west of the Cape Peninsula, therefore known distribution *D. darwinii occlusa* seems to be restricted to the southwest and south coast.

Remarks

Two of the three *C. darwinii* colonies found at *Challenger* station 142 appeared to be distinct – those specimens were previously assigned to *C. boryi* (Hasenbank 1932: 359), but redescribed as *C. darwinii occlusa* in Hastings (1943: 385). This species is distinguished by the expanded cryptocyst on outer distal part of the opesia so that about three-quarters of proximal border of the operculum contacts the distal edge of the cryptocyst (Hastings 1943). The remaining quarter is connected with a small process on the other side of the opesia and with the narrow distal lobe of scutum (Hastings 1943).

Hayward and Cook (1983) reported *C. darwinii* from the *Meiring Naude* collection, but no measurements or figures were given. However, upon re-examination of a single colony *C. darwinii* (SAMC-A026543) rather resembled *C. darwinii occlusa* with its enlarged cryptocyst. Additionally, in the current collection, a few fragmented colonies of this variety were observed. *Caberea darwinii* colonies in the *Meiring Naude* collection needs to be re-examined to validate which colony varieties, as described in Hastings (1943), exist.

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Genus *Hoplitella* Levinsen, 1909

Colony erect, dichotomous branching irregularly, forming a two-dimensional fan-shape, attached by rootlets, usually forming bundles at the base. Multiserial branches, unjointed. Autozooids oval to rhomboid shape, entire frontal surface membranous. Large avicularia present on the marginal zooids; no other avicularia. Ovicells absent.

Type species: *Carbasea armata* Busk, 1852

Hoplitella armata (Busk 1852b)

Plate 9, E-F, Plate 26, A, Table 4.5

Carbasea armata Busk, 1852: 50 (pl. 50, figs. 1, 2).

Flustra armata: Waters, 1896: 279-286.

Hoplitella armata: Levinsen, 1909: 136 (pl. 2, figs. 10a-e). Marcus, 1922: 10 (fig. 5).

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Material examined

SAMC-A028981, **AFR273 A31618**; SAMC-A028975, **AFR273 A31680**; SAMC-A073459, **FAL 683**; SAMC-A028858, **TRA 36**; SAMC-A028913, **TRA 56**; SAMC-A029104, **WCD 11**.

Substratum, depth and ecology

Attached to hard substrata. Depth range in this study 44-110 m.

Geographic distribution

This species is endemic to South Africa, reported from Cape Town on the west coast to Algoa Bay on the southeast coast.

Remarks

This species is easily distinguished by its maroon-brown colour (except for a beige coloured colony, SAMC-A073459), narrow fronds forming erect fan-shaped two-dimensional colonies, large zooids and distinct marginal avicularia. These features were congruent with the current material. Levinsen (1909) resolved the confusion surrounding the synonymy of this species in Busk (1852b) and Waters (1896) by erecting the genus *Hoplitella*. This single species in the genus is well-described by Levinsen (1909), however no zooidal measurements were given in previous accounts. Measurements for current material is presented in Table 4.5.

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Table 4.5. Measurements (in millimeters) of *Hoplitella armata*.

	Off Struisbaai, South Coast SAMC-A028975		
Characters	N_T	Average ± SD	Range
Lz	9	0.69 ± 0.05	0.62-0.78
lz	8	0.43 ± 0.04	0.37-0.49

Genus *Menipea* Lamouroux, 1812

Colony erect, branching; bushy tuft or flabellate; attached by rhizoids, usually forming bundles along branch margins. Biserial to multiserial branches, dichotomous, jointed or unjointed, jointed bifurcations normally conform to Type 17 or 18 as described in Harmer (1923). Autozooids with variably developed gymnocyst; extensive, oval opesia with a narrow, but distinct, cryptocyst; spines present at distal end of autozooid, scutum absent. Frontal and lateral avicularia often present, in some species with setiform mandibles; basal heterozooids absent or present. Ovicells globular and prominent, or reduced, cap-like, or absent.

Type species: *Cellularia crispa* Pallas, 1766 (= *Cellaria cirrata* Ellis and Solander, 1786)

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Menipea crispa (Pallas, 1766)

Cellularia crispa Pallas, 1766: 71.

Menipea cirrata: Busk, 1852: 21 (pl. 20, figs. 1, 2).

Menipea crispa: Marcus, 1922: 11. Hastings, 1943: 332. O'Donoghue, 1957: 75 (figs. 1-2). Hayward and Cook, 1983: 39. Florence *et al.*, 2007: 21 (figs. 8A-D).

Material examined

SAMC-A073401, **FAL 393**; SAMC-A077434, **FAL 432**; SAMC-A073479, **FAL 503**; SAMC-A073453, **FAL 621**; SAMC-A077322, **FAL 664**; SAMC-A073416, **FAL 741**; SAMC-A073410, **FAL 752**; SAMC-A073505, **FAL 757**; SAMC-A077481, **FAL 759**; SAMC-A073429, **FAL 783**; SAMC-A073430, **FAL 797**; Unnumbered specimen, **FAL 846**; SAMC-A070078, **SB 197**; SAMC-A070042, **SB 252**; SAMC-A028917, **TRA 42**; SAMC-A028928, **TRA 151**; SAMC-A029154, **WCD 36**; SAMC-A029078, **WCD 101**; SAMC-A029115, **WCD 159**; SAMC-A029138, **WCD 212**.

Substratum, depth and ecology

Attached to rocky substratum, sometimes colonised by small molluscs. Previous known depth range down to 100 m, but in this study, extended known depth range 4-400 m.

Geographic distribution

Extended known distribution range from Lambert's Bay on west coast of South Africa to Madagscar.

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Remarks

The confusion surrounding the synonymy was cleared in Florence *et al.* (2007: 23) and highlighted the presence of mural spines previously overlooked by preceding authors. Diagnostic features for *M. crispa* include six zooids per internode (starts with one zooid leading to two and then to three before the next joint), ends of branches curled inwards and a prominent columnar frontal avicularium situated proximally to the opesia, curving distally above frontal membrane with triangular mandible. The majority of the colonies in this collection were fragmented, but sufficient for an accurate identification.

Menipea marionensis Busk, 1884

Menipea marionensis Busk, 1884: 21 (pl. 4, figs. 3 and 3a).

Menipea marionensis: Harmer, 1923: 341 (pl. 17, fig. 22; pl. 19, figs. 43-45). Hayward and Cook, 1983: 40. Florence *et al.*, 2007: 23 (figs. 8E-I).

Material examined

SAMC-A077448, **FAL 518**; SAMC-A028916, **TRA 37**; SAMC-A028882, **TRA 93**; SAMC-A028844, **TRA 103**; SAMC-A029072, **WCD 11**.

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Substratum, depth and ecology

Erect colonies grow on rocky substrata. Previous maximum depth was 100 m; known depth range extended from 4-110 m.

Geographic distribution

This species is only known from South Africa.

Remarks

This species closely resembles *M. triseriata*, but differs from it by having a more prominent gymnocyst, one distolateral spine per outer zooid and shorter internodes (nine zooids as opposed to 15 zooids) (Florence *et al.* 2007).

Menipea ornata (Busk, 1852)

Cellularia ornata Busk, 1852: 20 (pl. 20, figs 3, 4)

Menipea flabellum: Marcus, 1922: 13 (fig. 7).

Menipea ornata: Harmer, 1923: 340. Hayward and Cook, 1983:39. Florence *et al.*, 2007: 21 (figs. 7F-I).

Cellularia infantae O'Donoghue, 1924: 30 (pl. 1, fig. 6). O'Donoghue and de Watteville, 1935: 207; 1937: 12.

Material examined

SAMC-A028773, **AFR 754**; SAMC-A028772, **AFR 7071**; SAMC-A073529, **FAL 133**; SAMC-A073523, **FAL 154**; SAMC-A077404, **FAL 213**; SAMC-A077417, **FAL 331**; SAMC-A077418, **FAL 372**; SAMC-A073473, **FAL 503**; SAMC-A077332, **FAL 818**; SAMC-A028841, **TRA 37**; SAMC-A029016, **TRA 56**; SAMC-A028842, **TRA 71**; SAMC-A028843, **TRA 93**; SAMC-A028904, **TRA 103**; SAMC-A028888, **TRA 115**; SAMC-A028918, **TRA 3300**; SAMC-A029077, **WCD 101**.

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Substratum, depth and ecology

Erect colonies grow on rocky substrata, but also found to grow epizooically on other bryozoans. Previous maximum depth was 100 m; known depth range extended from 4-287 m.

Geographic distribution

This species is endemic to South Africa.

Remarks

Hastings (1943: 332) resolved the confusion regarding the synonymy associated with *M. ornata*. This species is easily distinguished by the median zooid at the distal end of the internode has one avicularium below it and two above on either side (Florence *et al.* 2007).

Menipea triseriata Busk, 1852

Menipea triseriata Busk, 1852: 22 (pl. 23, figs 2-4). Harmer, 1923: 342 (pl. 17, fig. 18; pl. 19, figs. 40-42). O'Donoghue, 1957: 76. Hayward and Cook, 1983: 39. Florence *et al.*, 2007: 21 (figs. 7A-E).

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Material examined

SAMC-A028972, **AFR273 A31599**; SAMC-A028965, **AFR273 A31619**; SAMC-A028978, **AFR273 A31639**; SAMC-A029058, **AFR273 A31650**; SAMC-A028937, **AFR273 A31660**; SAMC-A028980, **AFR273 A31664**; SAMC-A029052, SAMC-A029060, **AFR273 A31680**; SAMC-A028775, **AFR 728**; SAMC-A028778, **AFR 754**; SAMC-A028774, **AFR 865**; SAMC-A028771, SAMC-A028776, **AFR 7071**; SAMC-A073528, SAMC-A077565, **FAL 21**; SAMC-A077557, **FAL 26**; SAMC-A073518, **FAL 48**; SAMC-A073520, **FAL 65**; SAMC-A073527, **FAL 79**; SAMC-A073519, **FAL 96**; SAMC-A073526, **FAL 108**; SAMC-A073522, **FAL 133**; SAMC-A077206, **FAL 141**; SAMC-A073521, SAMC-A077204, **FAL 154**; SAMC-A077400, **FAL 161**; SAMC-A077398, **FAL 165**; SAMC-A077401, **FAL 170**; SAMC-A077402, **FAL 186**; SAMC-A077406, **FAL 211**; SAMC-A077410, **FAL 218**; SAMC-A077407, **FAL 222**; SAMC-A077408, **FAL 230**; SAMC-A077409, **FAL 258**; SAMC-A077414, **FAL 331**; SAMC-A077411, **FAL 361**; SAMC-A077452, **FAL 445**; SAMC-A077638, **FAL 475**; SAMC-A077154, **FAL 491**; SAMC-A077486, SAMC-A077506, SAMC-A077519, SAMC-A077520, **FAL 576**; SAMC-A077360, **FAL 602**; SAMC-A077220, **FAL 621**; SAMC-A077378, **FAL 635**; SAMC-A077348, **FAL 664**; SAMC-A073446, **FAL 683**; SAMC-A077318, **FAL 708**; SAMC-A077356, **FAL 730**; SAMC-A073412, SAMC-A077397, **FAL 741**; SAMC-A073406, **FAL 752**; SAMC-A077471, **FAL 759**; SAMC-A073426, **FAL 775**; SAMC-A073424, **FAL 783**; SAMC-A073418, **FAL 830**; SAMC-A073417, **FAL 841**; SAMC-A077328, **FAL 846**; SAMC-A073382, **LB 165**; SAMC-A070070, **SB 168**; SAMC-A070077, **SB 197**; SAMC-A028851, **TRA 42**; SAMC-A028849, **TRA 59**; SAMC-A028853, **TRA 93**; SAMC-A028848, **TRA 109**; SAMC-A028852, **TRA 113**; SAMC-A028847, **TRA 120**; SAMC-A028850, **TRA 127**; SAMC-A028854, **TRA 132**; SAMC-A028845, **TRA 141**; SAMC-A028846, **TRA 3300**; SAMC-A029101, **WCD 11**; SAMC-A029117, **WCD 159**.

Substratum, depth and ecology

Erect colonies forming tufts on rocky substratum. Some colonies provide habitats for encrusting bryozoans and tiny polychaete worm tubes. In this study, the depth distribution was extended from 4 m down to 287 m.

Geographic distribution

This species is only known from South Africa.

Remarks

Florence *et al.* (2007) noted two colony variations exist in *M. triseriata*: irregular branching colonies and spiral whorl-like arrangement of branches. In this study, both colony variations were observed, the majority of material exhibit loosely arranged branching, while only four colonies exhibit spiral whorl-like arrangement (SAMC-A029101, SAMC-A070070, SAMC-A073520, SAMC-A077360).

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Colony variations may be affected by depth – spiral whorl-like colonies tend to occur in deeper depths (Dr W.K. Florence, pers. comm.). However, in the current study, no depth-related pattern prevails in the distribution of whorl-like colonies. Variation in substratum may influence colony variations, but more material of whorl-like colonies is acquired to assess the potential driving factors, if any.

Genus *Notoplites* Harmer, 1923

Colony branching, bifurcating frequently, erect or recumbent, attached to the substratum by separate or bundled rhizoids. Biserial, alternating arrangement, overlapping autozooids, branches jointed at the base; dichotomies and basal surface may be strengthened by tubular rhizoids. Autozooids elongate, with an oval opesia comprising about half the total length, tapered proximally. Opesia with narrow proximal and lateral cryptocystal border. Spines usually present around the distal border of opesia, and a scutum often present on the lateral border, obscuring the frontal membrane. Adventitious avicularia present, distolateral and frontal, often on basal surface. Ovicell generally prominent, enlarged and globular, typically with frontal fenestra.

Type species: *Notoplites rostratus* Harmer, 1923

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Notoplites cassidula Hayward and Cook, 1979

Notoplites cassidula Hayward and Cook, 1979: 58 (figs. 4A-C).

Material examined

SAMC-A029141, **WCD 217**.

Other material examined: *Notoplites cassidula*, SAMC-A026299 (holotype), station **SM 23** (27°44.4'S, 32°42.8'E), Off iSimangaliso Park, East Coast, South Africa, heavy dredge, depth 400-450 m, 26 May 1975.

Substratum, depth and ecology

Forming erect tuft-like colonies. Occur in deeper waters with depth range 360-810 m.

Geographic distribution

This species is only known from South Africa. Reported from False Bay area on the south coast in this study, extending its known distribution from the south to the east coast.

Remarks

This species is characterised by lacking a scutum and basal avicularium, small, helmet-shaped ovicell with transversely elongate frontal fenestra and two types of frontal avicularia (Hayward and Cook 1979).

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Notoplites sp.

Material examined

SAMC-A077217, **FAL 739**.

Substratum, depth and ecology

Attached to *Escharoides contorta* by a bundle of rootlets. Station depth 26-29 m.

Geographic distribution

Sampled in False Bay on the south coast.

Remarks

This worn fragment was difficult to distinguish, but resembles *N. cassidula* due to the adventitious avicularia present on the outer distal edge of each zooid, biserial arranged zooids and absent scutum. However, the number of spines and ovicell features was not seen in this specimen. Even though its features place this specimen within the genus *Notoplites*, without complete examination of appropriate material the identity of this specimen remains in doubt.

Superfamily **Microporoidea** Gray, 1848

Family Alysidiidae Levinsen, 1909

Genus *Alysidium* Busk, 1852

Colonies semi-erect, originating from stolonate networks, uniserial, dichotomous branching, forming clumped tufts, jointed. Distal half of the zooid with a depressed cryptocyst with an operculum and paired opesiules; zooids possess small depressed cryptocyst with a pore, arising from axial zooids. Single-pore mural rosette-plates. Bivalve ovicells. Avicularia and spines absent.

Type species: *Alysidium parasiticum* Busk, 1852

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Alysidium parasiticum Busk, 1852

Plate 10, A-C, Table 4.6

Alysidium parasiticum Busk, 1852: 14 (pl. 14, figs. 6 -9).

Alysidium parasiticum: Levinsen, 1909: 202 (pl. 7, figs. 3a-o). Marcus, 1922: 17 (fig. 10).

Material examined

SAMC-A028828, **TRA 35**; SAMC-A028829, **TRA 36**; SAMC-A028830, **TRA 37**; SAMC-A028827, **TRA 42**; SAMC-A029015, **TRA 56**.

Other material examined: *Alysidium parasiticum*, NHMUK 1968.1.16.120 (holotype), South Africa, C.H. O’Donoghue Collection, no additional information; SAMC-A028762, Fountain Point (34°4’0.01”S, 23°2’60”E), Knysna Head, Knysna, South Coast, South Africa, intertidal zone (depth < 10 m) attached to bryozoan *Bicellariella bonsai*, no additional information.

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Substratum, depth and ecology

Forms delicate tufted branches, attached to other bryozoans. Depth ranges from intertidal rocks to 77 m.

Geographic distribution

This species has a fairly widespread distribution throughout the Indo-Pacific region. In this study, *A. parasiticum* was found off Cape Infanta and Bull Point on the south coast, coinciding with previous known South African distribution from the south and east coast.

Remarks

Levinsen (1909: 201) described the family Alysidiidae from the type species *Alysidium parasiticum* Busk, 1852. Two species were assigned to *Alysidium*, namely *A. parasiticum* and *A. lafontii* Busk, 1852. The latter species was later placed in the genus *Savignyella*, therefore *A. parasiticum* remains the single species within genus.

This species is easily identified by its elongated zooids, distal half of the frontal surface comprises of a depressed cryptocyst, horn-like spine distolaterally on each side of the zooid and two frontal opesiules proximal to the transversely oval operculum (Levinsen 1909). Although, some zooids showed morphological variations, for example the horn-like spines may be reduced in some zooids. No measurements were given for *A. parasiticum* in Busk (1852b), therefore, zooidal measurements were provided for the holotype (Table 4.6).

Three colonies (SAMC-A028828, SAMC-A028829, SAMC-A028830) showed widely spaced, elongated, slender kenozooids on the stem axis and depressed distal area. Additionally, in the same colonies some zooids had no apparent opesiules below the operculum and lack disto-lateral spinous processes. These variations agree with the findings in O’Donoghue and de Watteville (1944: 410) which suggests that Busk only examined small colonies or parts of colonies. Another colony (SAMC-A028827) also showed no apparent opesiules, but here the zooids were slightly larger (N_T = 12; average length ± SD: 0.35 ± 0.02 mm; average width ± SD: 0.15 ± 0.01 mm) than other colonies.

Table 4.6. Measurements (in mm) of the holotype *Alysidium parasiticum*.

	Algoa Bay, Southeast Coast NHMUK 1968.1.16.120		
Characters	N_T	Average ± SD	Range
Lz	8	0.30 ± 0.02	0.28-0.33
lz	8	0.13 ± 0.01	0.12-0.14
Lo	6	0.047 ± 0.009	0.037-0.062
lo	5	0.067 ± 0.003	0.064-0.071

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Alysidium sp.

Material examined

SAMC-A077550, **FAL 361**.

Substratum, depth and ecology

Delicate tuft-like colonies living epizooically on other bryozoans. Depth at 30 m.

Geographic distribution

The current specimen is the only known record near Gordon's Bay in False Bay, south coast.

Remarks

The features in this colony, attached to *Gregarinidra spinuligera*, is congruent with the genus *Alysidium* by forming clumped tuft-like jointed colonies, uniserial arrangement of elongated zooids, dichotomous branching and depressed cryptocyst. This specimen closely resembles *A. parasiticum* and differs from it by having no frontal opesiules and lack disto-lateral spinous processes. The characteristics agree with zooidal variation in *A. parasiticum*, but ontogenetic variation in colonies is unclear and more material is required to validate the identification. No obvious ovicells were observed, therefore this specimen will remain unnamed until the complete examination of appropriate material.

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Genus *Catenicula* O'Donoghue, 1924

Colonies semi-erect, originating from stolonate networks, dichotomous branching, forming clumped tufts, uniserial, jointed. Zooids possess depressed triangular cryptocyst with sclerite operculum, frontal surface lack vitae (as seen in genus *Catenicella*), ovicell subterminal borne on enlarged zooid, composed of plate-like expansions to form a globular chamber. Lack avicularia. Modified spines give rise to new zooids.

Type species: *Catenicula corbulifera* O'Donoghue, 1924

Catenicula corbulifera O'Donoghue, 1924

Plate 10, D-F, Table 4.7

Catenicula corbulifera O'Donoghue, 1924: 28 (pl. 1, figs. 4, 5).

Material examined

SAMC-A028910, station **TRA 92**; SAMC-A077550, **FAL 361**.

Other material examined: *Catenicula compacta*, SAMC-A028743, station **D110B** (30°00'10.8"S, 30°56'42.5"E), Isipingo Beach, KwaZulu-Natal, South Africa, collected by Prof T.A. Stephenson (UCT Ecological Investigation), intertidal zone (< 10 m), 2 July 1935.

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Substratum, depth and ecology

Delicate tuft-like colonies living epizooically on other bryozoans. Known to occur at intertidal depths (< 10 m), and in this study the depth range was extended to 110 m.

Geographic distribution

The only known records exist in False Bay and near Mossel Bay, south coast.

Remarks

This is the first record of this species since it was described by O'Donoghue (1924). The type locality for this species is unknown (1924: 29) and no other existence can be traced for any type material. No measurements were given for *C. corbulifera* in O'Donoghue (1924), therefore, measurements for this species in the current collection were provided in Table 4.7.

The ovicell structure is a very distinct feature of *C. corbulifera* – the ovicelled zooid resembles a larger autozooid, but on the basal surface in the disto-lateral corners on each side a globular, hollow plates that may touch in the middle line arise. This special type of brood chamber is called a multivalved brood chamber (Ostrovsky 2013). In *Scruparia*, *Brettiopsis*, *Alysidium* and *Catenicula*, each valve/plate is kenozooidal, budded either from the maternal zooid or from each other (Ostrovsky 2013). However, no brood chambers were observed in the single colony found in this study.

The features in this colony were congruent with the description and drawings in O'Donoghue (1924). These features include uniserial arrangement of zooids, dichotomous branching, the frontal surface is transparent, distal portion of zooid forms a triangular membranous sac in which the sclerite operculum lies, distal hollow spines (up to 0.66 mm long) that give rise to daughter zooid that develops from disto-lateral spinous processes (O'Donoghue 1924).

Table 4.7. Measurements (in millimeters) of the neotype *Catenicula corbulifera*.

	Mossel Bay, South Coast SAMC-A028910		
Characters	N_T	Average ± SD	Range
Lz	8	0.42 ± 0.02	0.40-0.47
lz	5	0.20 ± 0.03	0.15-0.22
Lo	7	0.20 ± 0.02	0.17-0.23

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Family Aspidostomatidae Jullien, 1888

Genus *Aspidostoma* Hincks, 1881

Colony encrusting, or erect, cylindrical or bilaminate, branching or sheet-like plate, attached by a thick base of encrusting zooids. Thickly calcified; autozooids have an extensive granular cryptocyst, extending distal to the opesia, where knob-like or stout cervicorn processes are typically produced; few scattered frontal pores. Opesia small, typically comprising less than one-quarter of total autozooid length; lip thickened distally, reflected in some species, a pronounced median ridge proximal to lip frequent. Avicularia sparsely developed, interzooidal. No oral spines. Ovicell globular, recumbent on distally succeeding autozooid, sometimes partially immersed, with aperture distal to autozooid opesia framed by stout bar. Vertical walls of autozooids with small, recessed septula. Kenozooids sometimes present.

Type species: *Eschara gigantea* Busk, 1854 (= *Aspidostoma crassum* Hincks, 1881)

Aspidostoma livida Hayward and Cook, 1983

Plate 11, A-B

Aspidostoma livida Hayward and Cook, 1983: 36 (fig. 10).

Material examined

SAMC-A028823, **AFR 950**; SAMC-A028973, **AFR273 A31595**.

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<u>*Other material examined:*</u> *Aspidostoma livida*, SAMC-A026420 (holotype), station **SM 239** (32°14.8'S, 29°00.8'E), Off Mbhanyana River Mouth, Southeast Coast, South Africa, RV *Meiring Naude* Survey, double beam trawl, depth 90 m, 25 June 1979; *A. livida* (= *A. giganteum*), SAMC-A28660, station **ANO183** (33°56'S, 18°22'E), Off Clifton Beach, West Coast, depth 95 m, collected by G. Harkins, 30 May 2000.

Substratum, depth and ecology

Forming erect, bilaminar sheet-like colonies. Depth range 86-780 m.

Geographic distribution

Previously known only to occur between East London and Durban on the east coast. In this study, material was sampled southwest of Mossel Bay on the south coast, extending its known distribution range.

Remarks

Hayward and Cook (1983) described the colour of colonies as deep-bluish, distinguished from the cream white colour and dark brown colonies in collected material. a cream white colour (SAMC-A028823) and dark brown colour (SAMC-A028973). Other morphological characteristics for *A. livida* include thick, bilaminar and fenestrate plates, hexagonal zooids (average length and width 0.89 x 0.73 mm) with distolateral triangular

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avicularia, often paired (Hayward and Cook 1983). Although fragmented material was found, it was sufficient to establish congruency when compared to the type specimen in the collection.

The type species of the genus *A. giganteum*, has a widespread distribution in the South Atlantic Ocean, from Magellan Strait to the Falkland Isles, across the southern Patagonia Shelf, and also recorded in Gough Island and ranges to south to the South Shetland Isles in the Antarctic (Hayward 1995). Upon further inspection, the colony (SAMC-A28660) in the SAMC Bryozoa collection determined as *A. livida* is, in fact, the first record of *A. giganteum* in South Africa, on the west coast. This record is concurrent with the South Atlantic distribution of *A. giganteum*.

Aspidostoma staghornea sp. nov.

Plate 11, C-D, Table 4.8

Material examined

Holotype: SAMC-A029067, **AFR273 A31605** (34°25'22.4"S, 22°52'58.7"E), Off Mossel Bay, South Coast, South Africa, trawl, depth 100-102 m, 16 April 2011.

Other material examined: *Aspidostoma magna*, NHMUK 1978.2.2.31, no additional information.

Etymology

Staghorn (Eng.) – Derived from *staghorn*, antler of a male deer, referring to the processes above the opesia resembling staghorns.

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Description

Colony erect, rigid, forming broad, plate-like lobes, largest of three fragments 46 x 30 mm; dry-preserved material, retaining a dark maroon colour. Large zooids hexagonal, flat or convex, separated by distinct grooves, thickly calcified with finely granular surface with scattered pores. Frontal wall convex proximally, dipping distally with a small deep-set triangular or semicircular opesia; proximal border of opesia forms a thickened bilobed lip ($N_T = 9$; average ± SD: 0.23 ± 0.01 mm; range 0.22-0.26 mm). Distal end of zooid raised rim, and frequently developed blunt processes on each corner that in later ontogeny become long deer-like horns or cervicorn processes (average length ± SD: 0.38 ± 0.02 mm), intact in ovicelled zooids. Operculum oval and white. Ovicell globular, convex lip proximally, imperforate and finely granular. Kenozooids scattered throughout colony, often as large as zooids. No avicularia.

Substratum, depth and ecology

Forms thick, bilaminar plates. Depth range 100-102 m.

Geographic distribution

Only known from the south coast, off Knysna, of South Africa.

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Remarks

Aspidostoma is an ancient genus with fossil species known from Tertiary deposits of Patagonia, Australia and New Zealand (Brown 1952) and also reported from Cretaceous sediments based on some of d'Orbigny's specimens revised in Canu (1900). Only four known extant species have been described, namely the type species *A. giganteum* Busk, 1854, *A. coronatum* Thornely, 1924, *A. magna* Hayward and Cook, 1979 and *A. livida*; the latter two species are considered endemic to South Africa.

The Antarctic species *A. coronatum* Thornely, 1924, also found in Eocene material, possess similar characteristics to the current material, such as distolateral horns, sporadically developed kenozooids, irregularly distributed frontal pores, finely granular surface and convex hexagonal zooids (Hayward 1995). However, *A. coronatum* differs from it by forming nodular thick sheets and smaller zooids with length between 0.70-0.96 mm and width between 0.60-0.90 mm, interzooidal avicularia present and distinct marginal pores (Hayward 1995; Hara 2001).

The current material was compared to *A. livida* which possessed sporadic distolateral interzooidal avicularia and fenestrulae rimmed by single series of large kenozooids, smaller zooids (average length and width 0.89 x 0.73 mm) (Hayward and Cook 1983: 36). These characteristics are incongruent with the current specimen. Similarly, compared with *A. magna* that grows into erect, subcylindrical colonies, possess a frontal umbone on ovicells and a conical knob proximal to opesia, the current specimen differs (Hayward and Cook 1979: 74). However, apart from the differences, the current material relates closely to *A. magna* due to broad, lobes, bilaminar colony, convex zooidal shape and size (length 1.20-1.40 mm and about 0.80 mm wide), finely granular frontal surface, and deep semicircular opesia (Hayward 1979: 74). Even though the current material is fragmented, the lack of interzooidal avicularia, shape and size of zooids, appear sufficient to warrant the erection of this new species.

Table 4.8. Measurements (in millimeters) of the holotype ***Aspidostoma staghornea*** sp. nov.

	Off Mossel Bay, South Coast SAMC-A029067		
Characters	N_T	Average ± SD	Range
Lz	6	1.17 ± 0.11	1.07-1.35
lz	7	0.78 ± 0.08	0.63-0.87
Lo	6	0.15 ± 0.02	0.13-0.16
lo	7	0.34 ± 0.01	0.35-0.39
Lov	1	0.64	-

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lov	1	0.52	-

Family Microporidae Gray, 1848

Genus *Micropora* Gray, 1848

Colony encrusting. Frontal shield entirely of cryptocyst, with small perforations, opesia with operculum; lateral walls of autozooid forms a raised rim around the frontal membrane, thickened variably adjacent to opesia, often forming a pair of thickened knobs. Pair of small opesiules proximo-lateral to opesia, usually overarched by the lateral wall. Spines present or absent. Interzooidal or vicarious avicularia, sometimes absent. Ovicell partially immersed, aperture closed by operculum. Small basal pore-chambers present.

Type species: *Flustra coriacea* Johnston, 1847

Micropora erecta sp. nov.

Plate 11, E-H, Table 4.9

Material examined

Holotype: SAMC-A028821, station **AFR 866** (34°36.8'S, 19°16.4'E), Agulhas Bank, South Coast, South Africa, UCT Ecological Survey, dredge, depth 38 m, 9 January 1948.

Additional material: SAMC-A073536, **FAL 79**; SAMC-A073463, **FAL 503**; SAMC-A073482, **FAL 504**; SAMC-A077326, **FAL 818**; SAMC-A029102, **WCD 11**.

Etymology

Erectus (L.) – Derived from the latin word meaning erect, upright or raised, referring to the distinct colony form.

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Description

Colony forming broad, erect, bilaminar sheets, growing from an encrusting base. Rectangular, elongated zooids, sometimes tapered proximally. Frontal surface smooth with variable number of smooth-edged irregularly shaped pores, partially covered by secondary calcification; lateral walls form a raised rim around the zooid, thickened variably adjacent to the opesia with a distinct prominent, raised proximal border. Opesia wider than long, with an indentation at each proximal corner, closed by an operculum. A pair of opesiular depressions at the sides directly below the proximal border; no additional opesiules. No spines. Interzooidal avicularia; cross-bar complete, acute rostrum, directed obliquely upwards. Ovicell partially immersed, hemispherical and granular, except for a narrow, smooth proximal border.

Substratum, depth and ecology

Forming erect, bilaminar sheet-like colonies. Depth range 38-147 m.

Geographic distribution

Reported from the southwest west coast at Cape Peninsula to Agulhas Bank, including False Bay area, on the south coast.

Remarks

This species clearly belongs to the family Microporidae, which are typically encrusting, although less common as erect and foliaceous forms, lateral walls forming a rim around the frontal membrane, lacking a gymnocyst, but extensive cryptocyst, pierced by paired opesiules and interzooidal avicularia (Hayward 1995). This species is unique from other known *Micropora*, and other genera in Microporidae, since it forms encrustations on algal stems or branch-like bryozoans and grow into a broad, erect, bilaminar colony; elongated, rectangular zooids, smooth cryptocyst; irregularly shaped pores and thick proximal border of opesia. These distinct characteristics warrant the erection of a new species.

Table 4.9. Measurements (in millimeters) of the holotype ***Micropora erecta*** sp. nov.

	Agulhas Bank, South Coast SAMC-A028821		
Characters	N_T	Average ± SD	Range
Lz	14	0.70 ± 0.06	0.60-0.78
lz	16	0.30 ± 0.03	0.26-0.35
Lo	12	0.075 ± 0.008	0.058-0.085
lo	12	0.17 ± 0.01	0.13-0.19
Lintav	6	0.24 ± 0.02	0.21-0.26
lintav	6	0.21 ± 0.02	0.18-0.24

Micropora latiavicula Florence, Hayward and Gibbons, 2007

Micropora latiavicula Florence *et al.,* 2007: 23 (fig. 8J-L).

Material examined

SAMC-A077266, SAMC-A077264, **FAL 302**.

Substratum, depth and ecology

Encrusting shells, rocky substrata and other bryozoans. Occurring in shallow waters down to the subphotic zone, depth range 4-32 m.

Geographic distribution

Previously reported from Saldanha Bay on the west coast, in this study colonies were found in the False Bay area, extending its known distribution range.

Remarks

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This species can be distinguished by its slender autozooids, interzooidal avicularia with a broad sloping rostra, directed obliquely distally, deep and circular opesiules proximal to the orifice on either side and the accessory opesiule opening subjacent to the primary opesiules (Florence *et al.* 2007).

Micropora similis Hayward and Cook, 1983

Micropora similis Hayward and Cook, 1983: 31 (fig. 5B).

Material examined

SAMC-A077260, SAMC-A077424, **FAL 415**.

<u>*Other material examined:*</u> *Micropora similis*, SAMC-A026418 (holotype), station **SM 163** (33°04.6'S, 28°06.6'E), Off East London, Southeast Coast, RV *Meiring Naude* Survey, heavy dredge, depth 90 m, 26 May 1978; SAMC-A026525, same locality as above.

Substratum, depth and ecology

Encrusting on hard substrata. Depth range 48-540 m.

Geographic distribution

This species is only known to South Africa from East London to off Coffee Bay. This is the first record of *M. similis* from False Bay, extending its known distribution range from south to southeast coast.

Remarks

Micropora species is known from shallow water environments globally, including Antarctic and Arctic waters (Hayward 1995). In this study, *M. similis* was found at 48 m, shallower than previously reported depth 80 m down to 540 m from the *Meiring Naude* collection. This species can be distinguished by the small distinct bosses adjacent to the opesia, slender zooids and densely punctured frontal wall (Hayward and Cook, 1983).

Micropora sp.

Plate 12, A

Material examined

SAMC-A028999, **TRA 94**.

Description

Colony encrusting. Cream colour when dry. Autozooids arranged multiserially, alternating, separated by shallow grooves, rectangular to oval, in some zooids tapered proximally. Lateral walls raised, thickened towards distal end of zooid. Cryptocyst granular, becomes distally convex, and dips gently towards lateral opesiules, but proximally flat; numerous small round pores, mostly situated centrally. Opesiules oval to rounded, placed proximal to the orifice on both sides; irregularly shaped accessory opesiule present proximal

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to each opesiule. Opesia D-shaped, straight proximal border, wider than long. Two pairs of spines present – one disto-lateral pair and one pair lateral to the proximal border of opesia Ovicell globular, forming a hood over opesia.

Substratum, depth and ecology

Small colony encrusting on *Dimorphozoum nobile*. Depth at 110 m.

Geographic distribution

Near Mossel Bay, south of Bull Point on the south coast.

Remarks

The shape of the zooid, numerous small pores and accessory opesiules in the current specimen resembles *M. latiavicula*, and differs from it by its finely granular frontal shield and the accessory opesiules were irregularly shaped. The presence of oral spines throughout the colony, rarely seen in *Micropora* and absent in *M. latiavicula*, was the distinguishing characteristic in this specimen. Oral spines in *Micropora* may be present at the growing edge, but rarely present in late astogeny.

Micropora stenostoma Busk, 1854 from southern Australia and the Antarctic *M. notialis* Hayward and Ryland, 1993 possess distal oral spines (Hayward and Ryland 1993). However, in *M. notialis* spines are lost in later ontogeny, while intact in *M. stenostoma* (Hayward and Ryland 1993). The current specimen clearly differs from these species in zooidal characteristics. The description here, based on a worn colony with intact spines and one undamaged zooid, lacks visible avicularia and ovicells. Although clearly allied to *Micropora*, without an undamaged ovicell and interzooidal avicularia to allow for a complete description, the identity of this specimen remain unknown.

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Superfamily **Cellarioidea** Fleming, 1828

Family Cellariidae Fleming, 1828

Genus *Cellaria* Ellis and Solander, 1786

Colony erect, tufted, dichotomous branching; cylindrical internodes, stout or slender, connected by tubular chitinous nodes, continuous with basal autozooids of each new internode, or bundles of twisted and knotted chitinous rhizooids originating from the frontal surfaces of autozooids on each side of a simple fracture joint that marks the node. Auotozooids rhomboidal shape or hexagonal; opesia rarely larger than operculum, with raised proximal lip, often reflected; paired prominent denticles present on proximal corners of opesia, sometimes another pair on the distal border. Interzooidal avicularia present, situated between autozooids in a longitudinal series; or vicarious, replacing an autozooid. In the basal portions of the colony, chitinous rhizooids budding from the frontal surfaces of autozooids attach colony to substratum.

Type species: *Farcimia sinuosa* Hassall, 1840

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Cellaria punctata (Busk, 1852)

Salicornaria punctata Busk, 1852: 366 (*partim*).

Cellaria gracilis: Marcus, 1922: 19 (fig. 11).

Cellaria punctata: Hayward and Cook, 1983: 34 (fig. 8B).

Material examined

SAMC-A029017, SAMC-A077691, **TRA 56**; SAMC-A028909, **TRA 92**.

Substratum, depth and ecology

Forming erect tuft-like colonies attached to other bryozoans. Known from depths of 90-110 m.

Geographic distribution

This species is fairly widespread in the Indo-Pacific regions and have been reported from Australia and the Red Sea, but locally, distributed from St. Sebastian Bay on the south coast to East London on the southeast coast.

Remarks

No fertile zooids were observed in the current specimens and consisted of 6-10 zooids per internode as opposed to 5-7 zooids per internode, as described in Hayward and Cook (1983). Additional colony variations in material from Australia and the Red Sea were discussed in Hayward and Cook (1983). *Cellaria punctata* can be distinguished by joints consisting of tangled masses of brown tubes, autozooids typically hexagonal, granular and concave cryptocyst, semicircular opesia with lateral denticles and vicarious avicularia, as large as autozooid, typically situated in the distal end of an internode, close to joint (Hayward and Cook 1983), as seen in the current material.

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Superfamily **Flustroidea** Fleming, 1828

Family Flustridae Fleming, 1828

Genus *Carbasea* Gray, 1848

Erect colony, unilaminar fronds broaden distally, and may infrequently produce the foliose frond form such as typical *Flustra*. Autozooids rectangular and lightly calcified. No avicularia; spines may be reduced or absent. Embryos brooded in endozooidal ovicells closed by the autozooidal operculum.

Type species: *Flustra carbasea* Ellis and Solander, 1786

Carbasea carbasea (Ellis and Solander, 1786)

Plate 12, B-C, Table 4.10

Flustra carbasea Ellis and Solander, 1786: 14.

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Material examined

SAMC-A028884, **TRA 3300**.

Substratum, depth and ecology

Forming erect fronds, attached to rocky substrata. Depth 90 m.

Geographic distribution

This species has a very widespread distribution in the Northern Hemisphere. This is the first record of *C. carbasea* from South Africa, off Cape Infanta on the south coast.

Remarks

This species is well-characterised by forming a small tuft, light brown, thin and flexible colony (Hayward and Ryland 1998). Autozooids simple, elongated and rectangular, sometimes slightly wider in the middle region, spines absent, lateral and distal walls lightly calcified (Hayward and Ryland 1998). Beneath the frontal membrane, the vestiges of the cryptocyst may occur proximally and fronds bordered by a series of long, narrow kenozooids, about twice the length of normal autozooids (Hayward and Ryland 1998). Well chitinised operculum, light brown, with a thick marginal sclerite (Hayward and Ryland 1998). These characteristics are congruent with the current material and coincide with typical zooidal length (0.90-1.20 mm) and width (0.40 mm) of *C. carbasea* (Hayward and Ryland 1998). However, the Northern Hemisphere distribution of *C. carbasea* may warrant further molecular research and this specimen will provisionally be assigned to *C. carbasea*.

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Table 4.10. Measurements (in millimeters) of *Carbasea carbasea*.

	Off Cape Infanta, South Coast SAMC-A028884		
Characters	N_T	Average ± SD	Range
Lz	10	0.99 ± 0.06	0.91-1.08
lz	15	0.41 ± 0.07	0.31-0.54

Carbasea sp. 1

Material examined

SAMC-A028789, **AFR 688**.

<u>*Other material examined:*</u> “*Carbasea ovoidea*”, SAMC-A027079, station **MAD 43** (37°51'12.0"N, 46°40'13.2"W), South of Madagscar, South Indian Ocean, UCT Marion Island Survey, bottom dredge, 2 September 1988.

Substratum, depth and ecology

Forms erect and narrow fronds. Depth 318 m.

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Geographic distribution

West of St. Helena Bay on the west coast of South Africa.

Remarks

This single specimen closely resembles *C. elegans* Busk, 1852, reported from Australia. The description in Busk (1852a) was very vague – six alternating oblong or rectangular zooids, rounded distally, narrow multiserial fronds and smooth basal surface. The fragment found in this study showed similar characteristics, but 6-7 alternating zooids, marginal zooids oblong while the inner zooids were rhomboidal-shaped and distinct thickened sutures bordering the zooids and along the frond margin.

Thickened borders were described for *C. elegans* recorded from South Africa in O'Donoghue (1924). Specimens from Busk (1852a) and O'Donoghue (1924) need to be re-examined and compared with the current material. More material is required for an accurate diagnosis, therefore will remain unnamed.

In addition to that, *C. ovoidea* (SAMC-A027079) in the SAMC Bryozoa collection possess narrow fronds (about 3-4 alternating zooids) as opposed to broad lobate fronds described for *C. ovoidea* (Branch and Hayward 2007). This suggests misidentification of the subantarctic material, and needs to be re-examined.

Carbasea sp. 2

Material examined

SAMC-A028914, **TRA 37**.

Substratum, depth and ecology

Forms erect and narrow fronds. Depth 73 m.

Geographic distribution

Off Cape Infanta on the south coast of South Africa.

Remarks

This colony is erect, forming unilaminar, narrow frondose branches (2-4 mm wide) with straight distal ends, irregular dichotomous branching, rhomboid shaped zooids, lightly calcified, spines and avicularia absent. These characteristics coincide with *Carbasea*, but no known species resemble the current material and will remain unnamed until more material is acquired.

Genus *Gregarinidra* Barroso, 1949

Colony encrusting or forming erect colonies from encrusting base. Autozooids rectangular, bordered typically by marginal spines. Interzooidal avicularia present, acute. Ovicell endozooidal, immersed beneath a distal zooid or avicularia. Numerous mural pore-chambers present.

Type species: *Membranipora gregaria* Heller, 1867

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Gregarinidra spinuligera (Hincks, 1891)

Plate 12, D-E; Plate 26, B

Flustra spinuligera Hincks, 1891: 150 (pl. 6).

Spiralaria spinuligera: Marcus, 1922: 8 (fig. 4).

Gregarinidra spinuligera: Florence *et al.* 2007: 15 (figs. 5C-D).

Material examined

SAMC-A028949, SAMC-A029035, **AFR273 A31605**; SAMC-A028957, **AFR273 A31617**; SAMC-A028979, **AFR273 A31682**; SAMC-A073441, **FAL 331**; SAMC-A073508, **FAL 361**; SAMC-A073466, **FAL 503**; SAMC-A077444, **FAL 518**; SAMC-A077315, **FAL 664**; SAMC-A070075, **SB 197**; SAMC-A028922, **TRA 151**; SAMC-A029151, **WCD 32**; SAMC-A029161, **WCD 56**.

Other material examined: *Gregarinidra spinuligera*, SAMC-A073352, station **SWD 19** (26°37.5'S, 15°4.5'E), Off Diaz Point, South West Coast, Namibia, dredge, depth 35 m, 11 February 1963; SAMC-A073362, station **SWD 39** (26°37.5'S, 15°4.5'E), Off Diaz Point, South West Coast, Namibia, grab, depth 40 m, 12 February 1963.

Substratum, depth and ecology

Forming erect colonies that provide habitats for small sponges, polychaete worms and molluscs. This species was known to occur in shallow waters (4-20 m), but the current material was sampled at depths down to 127 m.

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Geographic distribution

This species is endemic to South Africa, previously reported only from the west coast, but in this study its known distribution was extended to south of Mossel Bay, south coast.

Remarks

The current material is congruent with this well-characterised species distinguished by its broad bilaminar fronds that widen distally; elongated, rectangular zooids interior wall bordered by stout spines, zooids distally rounded and narrowed proximally; and sporadically distributed interzooidal avicularia (Florence *et al.* 2007).

Family Incertae sedis

Genus *Klugeflustra* Moyano, 1972

Colony encrusting, unilaminar; or erect bilaminar fronds, with rhizoids budded from the frontal surfaces of autozooids. Almost entirely membraneous frontal wall of autozooid has a thin marginal rim of smooth cryptocyst and proximally, minimal development of gymnocyst; in some species paired oral spines are present. Vicarious avicularia, if present, occur at the bifurcation of autozooid rows, rostrum acute to frontal plane, slightly calcified and an extensive

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opesia proximal to mandible. Ovicell hyperstomial, median longitudinal suture, layers both calcified, ectooecium with frontal fenestra on each side of suture.

Type species: *Flustra vanhoffeni* Kluge, 1914

Klugeflustra jonesii Florence, Hayward and Gibbons 2007

Plate 12, F

Klugeflustra jonesii Florence, Hayward and Gibbons 2007: 15 (figs. 5A, B).

Material examined

SAMC-A028982, **AFR270 A31401**; SAMC-A077339, **FAL 186**; SAMC-A073489, **FAL 226**; SAMC-A077308, **FAL 621**; SAMC-A077384, **FAL 852**.

Substratum, depth and ecology

Forming erect and broad frondose colonies that provide habitats for small molluscs. Known from shallow waters (4-30 m), but sampled in depths down to 345 m in this study.

Geographic distribution

Only known to occur in South Africa, reported from the west coast and in this study, found in the False Bay area on the south coast.

Remarks

Klugeflustra jonesii closely resembles the Antarctic *K. drygalski* Kluge, 1914, but differs from it by having bilaminar broad fronds and interzooidal avicularia (Hayward 1995). In the current collections, most of the fragmented material was sufficient to identify with certainty.

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Superfamily **Hippothooidea** Busk, 1859

Family Hippothoidae Busk, 1859

Genus *Celleporella* Gray, 1848

Colony encrusting. Polymorphs include feeding autozooids, ovicellate female zooids, and smaller male zooids. Frontal wall smooth, non-porous. Autozooids sausage-shaped, convex frontally, lacking a cauda (tail-like structure), separated by sulci; orifice sinusoid. Orifce of female zooid typically wide without condyles. Tubular pore-chambers. Polypides without gizzard.

Type species: *Cellepora hyalina* Linnaeus, 1767

Celleporella annularis (Pallas, 1766)

Eschara annularis Pallas, 1766: 48.

Lepralia annularis: Busk, 1854: 85.

Hippothoa annularis: Levinsen, 1909: 277, pl. 21 (figs. 7a–f).

Schizoporella annularis: O’Donoghue, 1924: 5.

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Celleporella annularis: Florence *et al.*, 2007: 29 (figs. 10G, H).

Material examined

SAMC-A077176, **FAL 127**; SAMC-A073517, **FAL 133**; SAMC-A070071, **SB 168**.

Substratum, depth and ecology

Forms encrusting patches on the fronds of *Fucus* algae. Known to occur in shallow waters and sampled from slightly deeper waters in this study, therefore known depth range is 2-20 m.

Geographic distribution

This species has a widespread distribution in the southern Atlantic and Indian Ocean. Locally, *C. annularis* was known only from Oudekraal region on the west coast, but in this study, it was recorded in False Bay, extending its known distribution range eastwards.

Remarks

Easily distinguished by its budding pattern – daughter zooids are budded simultaneously, producing concentric rows of zooids (Hastings 1979). The present material is congruent with the descriptions and figures.

Celleporella hyalina (Linnaeus, 1767)

Cellepora hyalina Linnaeus, 1767: 1286.

Schizoporella hyalina: Hincks, 1880: 271 (pl.18, fig. 1).

Hippothoa hyalina: O' Donoghue, 1924: 41. O'Donoghue and de Watteville, 1937: 15. O'Donoghue and de Watteville, 1944: 424. O'Donoghue, 1957: 84.

Celleporella hyalina: Florence *et al.*, 2007: 29 (figs. 10D-F).

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Material examined

SAMC-A077598, **FAL 7**; SAMC-A073500, **FAL 348**; SAMC-A073405, **FAL 401**; SAMC-A073402, **FAL 410**; SAMC-A073498, **FAL 650**; SAMC-A077213, **FAL 776**; SAMC-A077329, **FAL 831**; SAMC-A073371, SAMC-A073372, SAMC-A073374, **LB 200**; SAMC-A070061, **SB 8**; SAMC-A070041, **SB 252**.

Substratum, depth and ecology

Forms small encrusting patches on the fronds of kelp and sometimes colonising pelagic plastic debris. Known depth range was extended in this study, from 4-35 m.

Geographic distribution

Known mainly from cold-water regions, such as Arctic waters down the European coast as far as the Bay of Biscay, and along some regions of the Americas (Florence *et al.* 2007). In South Africa, *C. hyalina* has been reported from the west to the east coast, up to Durban.

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Remarks

Celleporella hyalina is a large species complex comprising a number of unknown genetic species (Navarrete *et al.* 2005). Notwithstanding, this species can be typically identified by its elongated, transversely striated frontal wall, often with a lunate umbo below the orifice, orifice of the female zooid wide and very short, bearing a porous globular ovicell (Florence *et al.* 2007). The current material is congruent with descriptions and figures.

Family Trypostegidae Gordon, Tilbrook and Winston *in* Winston, 2005

Genus *Trypostega* Levinsen, 1909

Colony encrusting forming thin, unilaminar sheets. Autozooids elongated diamond-shape or irregularly polygonal, convex, separated by distinct sutures. Frontal shield gymnocystidean, smooth, hyaline, perforated by evenly spaced round pores, sometimes an imperforate umbo produced proximal to orifice. Primary orifice clithridiate, anter rounded, shallower poster separated by short condyles. Oral spines absent. Ovicell prominent, hyperstomial, frontal shield evenly perforated, closed by maternal operculum. Zooeciules appear distal to most autozooids and ovicells, with calcification and perforation similar to autozooids. Ancestrula similar in shape to autozooids, but smaller. Basal pore chambers present.

Type species: *Lepralia venusta* Norman, 1864

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Trypostega infantaensis sp. nov.

Plate 13, A-C, Table 4.11

Material examined

Holotype: SAMC-A028985, station **AFR273 A31666** (34°58'51"S, 21°36'52"E), South of Cape Infanta, South Coast, South Africa, *Africana* South Coast Demersal Survey, trawl, depth 95-97 m, 5 May 2011.

Etymology

Infanta – The species name is derived from the type locality, Cape Infanta, where a single colony was found.

Description

Colony encrusting, forming thin sheets. Autozooids oval to irregular polygonal in shape, convex slightly, separated by deep sutures. Frontal surface smooth, hyaline, perforated by numerous round pores, evenly spaced. Orifice pear-shaped, longer than wide; deep, rounded anter, separated by short, proximally directed condyles from the narrow, U-shaped sinus; slightly raised rim bordering the orifice. Zooeciules (modified avicularia) appear to be distal to most autozooids, may be single, twinned or between the outer lateral walls of two adjacent

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autozooids; perforations and calcification similar to autozooids; small, elliptical or rounded orifice. No ovicells observed.

Substratum, depth and ecology

Encrusting patches on hard substrata. Depth range 95-97 m.

Geographic distribution

Sampled off Cape Infanta on the south coast of South Africa.

Remarks

The most distinct characteristic feature of this species is the pear-shaped primary orifice with U-shaped sinus and the frequency of zooeciules. It closely resembles *T. henrychaneyi* Tilbrook, 2006 concerning the pear-shaped primary orifice, which differs from *T. dorothysouleae* Tilbrook, 2006, *T. johnsoulei* Tilbrook, 2006, *T. venusta* Norman, 1864 and *T. maculata* Tilbrook, Hayward and Gordon, 2001 that possess a broader and shallower sinus.

Unlike *T. henrychaneyi*, the current species has variably shaped autozooids and zooeciules; zooeciules are mostly distal to autozooids, but sporadic, and may form groups of up to six zooeciules. Even though few zooids were examined, it is clearly distinct from other known *Trypostega* species and appear to be sufficient to warrant the erection of this new species. The remaining part of this colony is intact, encrusting on hard coral, which made it difficult to remove undamaged.

Hayward and Cook (1983: 86) reported a few colonies of the widespread *T. venusta* on the southeast and east coast of South Africa. However, it is highly likely that these specimens were misidentified and in fact may belong to ***T. infantaensis*** sp. nov., thus needs to be re-examined.

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Table 4.11. Measurements (in millimeters) of ***Tryptostega infantaensis*** sp. nov. material.

	Cape Infanta, South Coast SAMC-A028985		
Characters	N_T	Average ± SD	Range
Lz	4	0.57 ± 0.04	0.53-0.62
lz	2	0.32 ± 0.02	0.31-0.34
Lo	5	0.13 ± 0.01	0.12-0.15
lo	6	0.08 ± 0.01	0.07-0.10

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Superfamily **Cribrilinoidea** Hincks, 1879

Family Cribrilinidae Hincks, 1879

Remarks

Genera in this family is characterised by zooids having a costae shield made up of hollow spines or costae (Hayward and Ryland 1979). The gaps between the costae are termed lacunae (true pores), while round pores leading to the interior part of the costal shield form windows, termed pelmitidia (or pelmata, for larger pores) (Hayward and Ryland 1979). An apertural bar is formed by the distal pair of costae, immediately proximal to orifice (Hayward and Ryland 1979).

Genus *Khulisa* gen.nov.

Etymology

Khulisa (Zulu) – Meaning "magnify" in Zulu, one of South Africa's official languages, referring to the enlarged dimorphic autozooids.

Description

Colony encrusting. Frontal wall without gymnocyst, but composed entirely of a costal shield. No branched costal spines, intercostal lacunae in rows, lumen pores present or absent. Oral tubercles present. Large interzooidal avicularia, distal to zooids. No ovicells, dimorphic zooids. Mural pore-chambers present.

Type species: ***Khulisa ukhololo*** sp. nov.

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Khulisa ukhololo sp. nov.

Plate 13, D-F, Table 4.12

Material examined

Holotype: SAMC-A029002, station **TRA 31** (34°49'S, 20°21.5'E), Off Arniston, South Coast, South Africa, UCT Ecological Survey, trawl, depth 86 m, 9 September 1947.

Additional material: SAMC-A077262, **FAL 330**.

Etymology

Ukhololo (Zulu) – Meaning "collar" in Zulu, one of South Africa's official languages, referring to the thick apertural bar.

Description

Colony encrusting. Autozooids composed of seven to ten pairs of costae, with flattened or convex frontal costal shield; three to four intercostal rounded lacunae in rows on each side and fuse completely along the mid-line where tips of the costae meet, sometimes forming a small lacunae pore. Zooids not densely packed, but rather evenly spaced. Orifice distal border straight, wider than long, rounded proximally; thick apertural bar obscuring orifice, with a pair

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of oral tubercles on the border, forming a median U-shaped sinus, sometimes becoming more V-shaped. Enlarged dimorphic zooids (N_T = 1; 0.69 x 1.27 mm) scattered in colony, nearly identical to its smaller autozooids; thick apertural bar with deep median V-shaped sinus; three to nine intercostal rounded lacunae on each side. Interzooidal avicularia (N_T = 1; 0.69 x 0.25 mm) sparsely scattered throughout the colony; ball flask-shaped, with distal and proximal ends rounded. Uniporous mural pore-chambers. No apparent ovicells observed.

Substratum, depth and ecology

Encrusting on hard substratum and bryozoans, for example *Reteroporella* sp. Depth range 51-86 m.

Geographic distribution

Sampled near Arniston and False Bay, east of Smitswinkel Bay, on the south coast.

Remarks

Eight known *Cribralaria* species occur in the Pacific Ocean (Soule *et al.* 1998; Tilbrook 2006). This is the first record of *Cribralaria* in South African waters, on the South Coast bordering the Atlantic and Indian Ocean. The current material agrees with the diagnostic characters of the genus *Cribralaria* Silén, 1941 including the complete costal shield with large intercostal lacunae and interzooidal avicularia. Its closest allied species, *C. curvirostris* Silén, 1941, share the numerous rounded lacunae on the frontal surface of autozooids, thick apertural bar and interzooidal avicularia (Bock and Cook 2001). However, this species is distinct from other known Cribrilinidae species by the presence of dimorphic zooids, and shape and position of interzooidal avicularia. It may be that the enlarged zooids are brooding zooids, however no larvae were found in the alcohol-preserved material. These distinct differences warrant the erection of a new genus and species.

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Table 4.12. Measurements (in millimeters) of ***Khulisa ukhololo*** sp. nov. material. Orifice length and width measured from top view, since thick apertural bar obscures the orifice.

	Off Arniston, South Coast SAMC-A029002		
Characters	N_T	Average ± SD	Range
Lz	10	0.66 ± 0.12	0.53-0.92
lz	10	0.42 ± 0.04	0.34-0.45
Lo	4	0.11 ± 0.01	0.10-0.12
lo	5	0.18 ± 0.01	0.17-0.20

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Superfamily **Catenicelloidea** Busk, 1852

Family Catenicellidae Busk, 1852

Genus *Catenicella* de Blainville, 1830

Uniserial sterile internodes, biserial at bifurcations. Fertile zooids triserial at bifurcations, between two zooids, ovicell pertaining to the proximal zooid. Frontal wall of zooids smooth, with a pair of narrow longitudinal pore chambers or vittae. Orifice with concave proximal rim, condyles present; spines absent, but distolateral corners protruding usually as avicularian processes. Distally and on the frontal side of the distolateral processes, paired smaller pore-chambers occur.

Type species: *Eucratea contei* Audouin, 1826

Catenicella elegans Busk, 1852

Catenicella elegans Busk, 1852b: 361 (fig. 2).

Catenicella elegans: Busk, 1852a: 10 (pl. 9). Busk, 1884: 12 (pl. 1, figs. 2, 3, 5). O'Donoghue, 1957: 85.

Vittaticella elegans: O'Donoghue and de Watteville, 1944: 421.

Vittaticella sp.: Hayward and Cook, 1983: 127 (fig. 11D).

Material examined

SAMC-A077200, **FAL 218**; SAMC-A073503, **FAL 622**.

<u>*Other material examined:*</u> *Catenicella elegans*, SAMC-A028745, station **D 103**, Isipingo Beach (30°00'10.8"S, 30°56'42.5"E), KwaZulu-Natal, South Africa, intertidal zone (< 10 m), 2 July 1935; *C. taurina*, SAMC-A028744, same locality as above.

Substratum, depth and ecology

Forming erect delicate colonies attached bryozoans. Known depth range from intertidal zone (< 10 m) down to 86 m.

Geographic distribution

Widespread global distribution reported from Three King Islands, Hauraki Gulf, Cook Strait, Chatham Rise, Kaikoura, Banks Peninsula, Bluff, Stewart Island; as well as southern Australia, Chile, southern California, Japan, Brazil and Bermuda. Locally, previously reported from the southeast and east coast, but in this study known distribution is extended to the south coast, False Bay.

Remarks

Catenicella elegans is the most widespread of all extant catenicellid species (Gordon 1984). South African *C. elegans* tend to have larger zooids with longer frontal vittae, variation in internode patterns and longer avicularian chambers with prominent projections (Busk 1852a, 1852b; O'Donoghue 1957) as seen in the current material. These variations may warrant molecular investigation of *C. elegans* to determine the validity of species.

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Superfamily **Adeonoidea** Busk, 1884

Family Adeonidae Jullien, 1903

Remarks

A number of genera used to be included in the family Adeonidae, but Cook (1973) concluded variation in the development of the frontal wall and protrusion apparatus of the lophophore, characters that ultimately separated the genera into two families, Adeonidae and Adeonellidae (Cook 1973). Genera placed in Adeonidae (e.g. *Adeona*, *Adeonellopsis*, *Reptadeonella*, *Bracebridgia*) the development in the frontal wall is umbonuloid, operculum not sinuate, possess marginal pores, frontal spiramina (evanescent or permanent; single or multiporous), adventitious and vicarious avicularia usually present with an acute rostra and sexual polymorphs sometimes present (Cook 1973: 246). Adeonellidae comprised of two genera, *Adeonella* and *Laminopora*, where the development of the frontal wall is cryptocystidean, primary orifice and operculum sinuate, possess marginal and usually frontal pores (pseudopores), sometimes peristomial spiramina present, acute avicularia and spathulate rostra often present (adventitious and vicarious), and sexual polymorphs sometimes present (Cook 1973: 246). However, there is a disagreement regarding the separation of these families (see Lidgard 1996). In this study, *Adeonella* and *Laminopora* will also be included in the family Adeonidae, following recent works (Hayward 2001; Bock and Gordon 2013; Almeida *et al.* 2015), until the issue surrounding the placement of genera is resolved.

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Genus *Adeonella* Busk, 1884

Colony erect, flat, bilaminar. Frontal wall umbonoloid, smooth, with large marginal pores. The orifice often forms an orificial bridge, a small spiramen proximally and a pair of small avicularia. Adventitious avicularia may be present. Brooding zooids are larger than other zooids, but rare.

Type species: *Adeonella polymorpha* Busk, 1884 (= *Eschara lichenoides* Lamarck, 1816)

Remarks

Owing to high morphological plasticity amongst the large number of *Adeonella* species, refer to species keys in Hayward (1988). *Adeonella* is a large genus that comprises of 51 known valid extant- and fossil species. A comprehensive review of extant *Adeonella* species revealed that 44 species are distributed throughout the Indo-West Pacific realm, the Mediterranean and South Atlantic Ocean (Hayward 1988; Amui 2005; Rosso and Novosel 2010). About sixty percent of extant adeonellids occur in South Africa, with the highest diversity of *Adeonella* species occuring along the East Coast of South Africa (Hayward 1988). This study yielded 15 valid species of *Adeonella* and one new species.

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Adeonella assegai sp. nov.

Plate 14, A-C, Plate 26, C, Table 4.13

Material examined

Holotype: SAMC-A028960, station **AFR273 A31650** (34°55'54"S, 23°17'7"E), Off Knysna, South Coast, South Africa, South Coast Demersal Survey, trawl, depth 211 m, 2 May 2011.

Other material examined: *Adeonella falcicula*, NHMUK 1983.8.2.2, *John Murray* station **105B** (34°24’-37°S, 39°14’06”-39°14’36”E), Zanzibar, Mozambique, depth 238 m, 11 January 1934.

Etymology

Assegai – An assegai, a term used by the Victorian British settlers, is a pole weapon with iron tip used for throwing by Zulu and Nguni tribes of southern Africa. The shape of the iron tip resembles the slender colony of this species.

Description

Colonies develop from narrow cylindrical bases (about 1 mm wide) to form slender, flat, straight to slightly curved sabre-like structures, up to 3 mm wide; longest branch 42 mm, showing no evidence of branching. Autozooids oval or hexagonal at growing edge; elongated and irregular in outline in later ontogeny; frontal wall finely granular and densely punctured. Primary orifice wider than long, no visible condyles, circular secondary orifice. Spiramen circular, situated immediately proximal to secondary orifice. Adventitious avicularia typically paired, arising proximolateral to spiramen, directed mostly distally, variably orientated in later ontogeny; mandibles acute triangular. Branch edges composed of single linear series of dimorphic zooids (N_T = 4; average 0.69 ± 0.05 mm; range 0.65-0.78 mm); orbicular to semicircular secondary orifice; typically paired adventitious avicularia, lateral to spiramen, directed distally or obliquely towards peristome corners. Branch edges may occasionally bear kenozooids with vicarious avicularia; acute mandible triangular, distally raised.

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Substratum, depth and ecology

Forms erect, slender colonies with an encrusting base. Two colonies collected at one station at a depth of 211 m.

Geographic distribution

Only known from South Africa, off Knysna on the south coast.

Remarks

Adeonella cultrata Hayward, 1981 and *A. falcicula* Hayward, 1981 are the only known species with slender, sabre-like branches. No material of these two species is housed at SAMC, but the holotypes are at the Zoological Museum of University of Copenhagen in Denmark and some material of *A. falcicula* at NHMUK. Additional images of *A. falcicula*, obtained from Ms Mary Spencer-Jones at NHMUK, were used to compare the current material with, while material of *A. cultrata* was unattainable at the time.

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Adeonella falcicula resemble the current material due to the nature of the slender colonies (up to 45 mm long and maximum width of 3 mm) from a cylindrical encrusting base (Hayward 1981). However, it differs from *A. falcicula* by the shape of zooid, orifice and spiramen, the occasional presence of marginal vicarious avicularia and the absence of an additional pair of distally situated adventitious avicularia in marginal autozooids. Additionally, *A. falcicula* has larger autozooids (N_T = 50; average 0.98 ± 0.11 mm; range 0.80-1.25 mm) (Hayward 1981: 45).

The encrusting base of *A. cultrata* figured in Hayward (1981: 46) is congruent with current the material. In *A. cultrata,* zooidal shape resembles the current specimens, but also has larger autozooids (N_T = 20, average 0.81 ± 0.14 mm; range 0.60-1.0 mm) (Hayward 1981: 46). Additionally, *A. cultrata* possess a large, oval spiramen, semicircular or oval secondary orifice, very rarely paired adventitious avicularia and only marginal vicarious avicularia, characteristics not shared by the current material.

Superficially, the current material share slender, sabre-like branches with *A. falcicula* and *A. cultrata*, but differs from its allied species and other known *Adeonella*. The diagnostic features for ***A. assegai*** sp. nov. were branches without secondary branching, shape of the secondary orifice and spiramen, marginal elongated gonozooids and lastly, the position and orientation of adventitious avicularia.

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Table 4.13. Measurements (in millimetres) of ***Adeonella assegai*** sp. nov. material.

	Off Knysna, South Coast SAMC-A028960		
Characters	N_T	Average ± SD	Range
Lz	15	0.77 ± 0.16	0.45-1.04
lz	16	0.37 ± 0.08	0.27-0.57
Lso	9	0.10 ± 0.01	0.09-0.13
lso	9	0.11 ± 0.01	0.08-0.12
Ladav	13	0.11 ± 0.02	0.09-0.14

Adeonella circumspecta Hayward, 1988

Adeonella sp. 4: Hayward, 1983: 585.

Adeonella circumspecta Hayward, 1988: 160 (fig. 17). Florence *et al.*, 2007: 30 (figs. 10I, L).

Material examined

SAMC-A029028, **TRA 94**; SAMC-A029127, **WCD 18**.

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<u>*Other material examined:*</u> *Adeonella circumspecta*, SAMC-A026913 (paratype), Port Natal (29°51'01.2"S, 31°03'09.7"E), Durban, East Coast, South Africa, no additional information.

Substratum, depth and ecology

Forms anastomosing branched colonies. Known depth range extended from 7-110 m.

Geographic distribution

Previously reported from Cape Province on the west coast to Durban on the east coast. In this study, the distribution range was extended northwestwards to Saldanha Bay.

Remarks

This species form an anastomosing colony, autozooids with relatively large spiramen, a single avicularium adjacent to spiramen, distally directed and vicarious avicularia on the edge of branches, often with a hooked tip (Hayward 1988).

Adeonella confusanea Hayward and Cook, 1983

Adeonella confusanea Hayward and Cook, 1983: 92 (figs. 21F-J). Hayward, 1988: 160 (fig. 16).

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Material examined

SAMC-A028814, **AFR 9670**; SAMC-A073546, **FAL 363**.

<u>*Other material examined:*</u> *Adeonella confusanea*, SAMC-A026439 (holotype), station **SM 185** (33°39.3'S, 27°11.6'E), Off Port Alfred, Southeast Coast, RV *Meiring Naude* Survey, dredge, depth 90 m, 31 May 1978.

Substratum, depth and ecology

Grows on hard substratum. Previously known from depths between 80-90 m, but in this study sampled from shallower depths, extending known depth range from 30-91 m.

Geographic distribution

Previously reported from the east coast of South Africa, but its known distribution range extends to near De Hoop on the south coast.

Remarks

The current material is congruent when compared with the holotype. Distinguishing characters include marginal kenozooids and vicarious avicularia, semi-circular primary orifice with a short U-shaped sinus, typically paired avicularia lateral to the spiramen and granular frontal wall (Hayward and Cook 1983). However, the peristome has a broad blunt denticle in the proximal border in early ontogeny, but not easily discerned in the current material.

Adeonella conspicua Hayward and Cook, 1983

Adeonella conspicua Hayward and Cook, 1983: 93 (figs. 22A-D). Hayward, 1988: 153 (fig. 14). Florence *et al.*, 2007: 32 (figs. 11G-I, 20J).

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Material examined

SAMC-A077600, **FAL 5**; SAMC-A077211, **FAL 7**; SAMC-A077538, **FAL 576**; SAMC-A073427, **FAL 777**; SAMC-A077327, **FAL 818**.

Other material examined: *Adeonella conspicua*, SAMC-A026440 (holotype), station **SM 179** (33°30.3'S, 27°22.1'E), Off Great Fish River Mouth, Southeast Coast, South Africa, dredged, depth 80 m, 29 May 1978.

Substratum, depth and ecology

Living on rocky substratum. Known depth range 4-80 m.

Geographic distribution

Endemic to South Africa – reported from Simon's Bay in the False Bay area on the south coast to north of Durban on the east coast.

Remarks

Adeonella conspicua closely resemble *A. pluscula*, but differs from it by the branching and robust nature of the colony, hexagonal irregularly shaped zooids, semicircular primary orifice with a short wide sinus, single or paired avicularia situated laterally to the spiramen while frontal avicularia may develop elsewhere later in ontogeny and gonozooids present at branch margins (Florence *et al.* 2007). The current material agrees well with the description and when compared to the holotype.

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Adeonella coralliformis O'Donoghue, 1924

Adeonella coralliformis O'Donoghue, 1924: 55 (pl. 4, fig. 24). Cook, 1973: 254. Hayward and Cook, 1979: 82 (figs. 10A-D). Hayward, 1988: 157 (figs. 15A, B).

Material examined

SAMC-A028767, **AFR 7071**.

Other material examined: *Adeonella coralliformis*, SAMC-A026316, no additional information; NHMUK 1923.7.26.13 (pt of type), Cape Province, South Coast, South Africa, O'Donoghue Collection, no additional information.

Substratum, depth and ecology

Forms erect, branching colonies. Depth range from intertidal zone (< 10 m) down to 880 m.

Geographic distribution

This species is endemic to South Africa.

Remarks

This species can be distinguished by paired peristomial avicularia, arising distal to the spiramen and directed medially, rostra converging almost distal to the secondary orifice and frontal wall proximal to spiramen convex (Hayward and Cook, 1983). These distinct features

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were congruent with the current specimens. *Adeonella coralliformis* closely resembles *A. regularis* Busk, 1884. However, owing to Busk's vague description and figure, O'Donoghue (1924) and Cook (1973) argued that Busk's material of *A. regularis* may belong to *A. coralliformis*.

Adeonella cracens Hayward and Cook, 1979

Adeonella cracens Hayward and Cook, 1979: 85 (figs. 10I-L). Hayward and Cook, 1983: 90.

Material examined

SAMC-A028950, **AFR273 A31605**.

<u>Other material examined:</u> *Adeonella cracens*, SAMC-A026312 (holotype), station **SM 86** (27°59.5'S, 32°40.8'E), St. Lucia MPA, East Coast, RV *Meiring Naude* Survey, heavy dredge, depth 550 m, 22 May 1975.

Substratum, depth and ecology

Grows on hard substrata. Occur in deep waters with known depth range 100-880 m.

Geographic distribution

This species is known only from South Africa. Reported previously from the southeast coast and this study extended its known distribution range to the south coast.

Remarks

This species is distinguished by the oblong, oval spiramen that becomes circular in later ontogeny, small paired avicularia develop lateral to the spiramen and kenozooids and vicarious avicularia along the edge of branches as seen in the current material (Hayward 1988).

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Adeonella expansa O'Donoghue, 1924

Adeonella expansa O'Donoghue, 1924: 52 (pl. 4, fig. 21). Hayward, 1988 184 (figs. 11A, B).

Material examined

SAMC-A029094, **WCD 11**.

Substratum, depth and ecology

Forms three-dimensional rigid structures attached to hard substrata. Depth range 75-80 m.

Geographic distribution

Previously known only from Green Point, KwaZulu-Natal, on the east coast of South Africa and sampled off Kommetjie, west of the Cape Peninsula, in this study, extending its known distribution range.

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Remarks

Only *A. expansa* and *A. purpurea* can be distinguished by forming colonies that produce massive, rigid, anastomosing and bilaminar plates. This colony structure is particularly adapted for turbulent, high-energy environments (Hayward 1988). *Adeonella expansa* is characterised by large autozooids with a laterally hooded spiramen, small adventitious avicularia situated lateral to the spiramen, directed distally and no gonozooids or vicarious avicularia (Hayward 1988). Even though only fragmented material was found in the current collection, all are considered sufficient for identification. This is the first record of *A. expansa* since its description in O'Donoghue (1924).

Adeonella fuegensis (Busk, 1854)

Plate 14, D-F

Eschara fuegensis Busk, 1854: 90 (pl. 107, figs. 1-3).
Adeonella fuegensis: Busk, 1884: 180. Hayward, 1988: 140 (fig. 8).

Material examined

SAMC-A028812, **AFR 866**; SAMC-A029096, **WCD 11**.

Substratum, depth and ecology

Growing erect, anastomosing colonies attached to hard substratum. Known depth range 35-75 m.

Geographic distribution

This is the only species within the genus that has a distribution on either side of the South Atlantic Ocean. *Adeonella fuegensis* was first reported from Tierra del Fuego. Locally, previously known to occur in Port Elizabeth, but this study extends known distribution to Kommetjie, west of the Cape Peninsula.

Remarks

The most characteristic features of *A. fuegensis* are colony form, orientation of secondary orifice and avicularia, and gonozooids. These features were very clear in the current material; the colony forms bilaminar folded or anastomose sheets, and become reticulate, forming irregularly oval fenestrulae. Spiramen situated close to the proximal edge of the peristome, deeply immersed; with one or two avicularia adjacent to spiramen, directed distally. Vicarious avicularia present along the margins of fenestrulae and branches. Gonozooids were present along the edges of fenestrulae, as well as along branch margins, at dichotomies.

Adeonella gibba Hayward and Cook, 1983

Plate 15, A-B

Adeonella gibba Hayward and Cook, 1983: 99 (figs. 23F-J).

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Adeonella pectinata: O'Donoghue, 1924: 51.

Adeonella gibba: Hayward, 1988: 149 (figs. 11C, D).

Material examined

SAMC-A029033, **AFR273 A31680**; SAMC-A077265, **FAL 302**; SAMC-A077425, **FAL 415**; SAMC-A077436, **FAL 432**; SAMC-A073470, **FAL 504**; SAMC-A077544, SAMC-A077549, **FAL 577**; SAMC-A028862, **TRA 37**; SAMC-A028863, **TRA 71**; SAMC-A028861, **TRA 94**; SAMC-A028859, **TRA 127**.

<u>Other material examined:</u> *Adeonella gibba*, SAMC-A026444 (holotype), station **SM 179** (33°30.3'S, 27°22.1'E), Off Great Fish River Mouth, Southeast Coast, South Africa, dredged, depth 80 m, 29 May 1978.

Substratum, depth and ecology

Branching colonies growing on hard substrata. Depth range 33-110 m.

Geographic distribution

Endemic to South Africa – reported previously only from the southeast coast, the current study extends its distribution to False Bay, south coast.

Remarks

This species is characterised by its primary orifice that possess a shallow sinus, autozooid with a small avicularium adjacent to spiramen, directed distally; often developing a second avicularium, distal to the first and directed distally or disto-medially, extending on to the secondary orifice (Hayward 1988). The current material is congruent with the description and when compared to the holotype.

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Adeonella ligulata O'Donoghue, 1924

Adeonella ligulata O'Donoghue, 1924: 53 (pl. 3, fig. 22). Hayward, 1988: 175 (fig. 24).

Material examined

SAMC-A028974, SAMC-A029038, **AFR273 A31680**; SAMC-A077296, **FAL 96**; SAMC-A073547, **FAL 208**; SAMC-A077494, **FAL 576**; SAMC-A073452, **FAL 703**; SAMC-A073407, **FAL 821**; SAMC-A073408, **FAL 848**; SAMC-A028864, **TRA 119**.

<u>Other material examined:</u> *Adeonella ligulata*, NHMUK 1923.7.26.16 (pt of type), Green Point, West Coast, South Africa, no additional information; NHMUK 7.26.16 (pt of type), same locality.

Substratum, depth and ecology

Grows on hard substratum. Known depth range 29-103 m.

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Geographic distribution

This species was only known from the southwest coast of South Africa, but sampled off Struisbaai on the south coast in this study, extending its known distribution range.

Remarks

Colony with flat, parallel-sided branches, regularly arranged autozooids, marginal zooids with enlarged peristomial avicularia, vicarious avicularia and gonozooids absent (Hayward 1988). Although ontogenetic variations, not described before and made for particularly difficult identification, were observed in the current collection – heavy secondary calcification replaced autozooids with kenozooids that occasionally bears enlarged avicularia.

Adeonella lobata Hayward, 1988

Plate 15, C-D

Adeonella lobata Hayward, 1988: 167 (fig. 21).

Material examined

SAMC-A029147, SAMC-A029152, **WCD 32**.

<u>*Other material examined:*</u> *Adeonella lobata*, SAMC-A026917 (paratype), Port Elizabeth (33°55'00.2"S, 25°39'08.4"E), Southeast Coast, South Africa, no additional information.

Substratum, depth and ecology

Forms oval lobes, attached to hard substrata. Depth 93 m.

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Geographic distribution

Previously known only from the type locality, Port Elizabeth, but this study extends its known distribution range west of the Cape Peninsula of South Africa.

Remarks

Some species develop short, broad, lobed growths, showing no evidence of branching, namely *A. lobata* Hayward, 1988, *A. spathulata* Hayward, 1988 and *A. alia* Hayward and Cook, 1983. However, this was based on limited material (Hayward 1988). Colonies of *A. lobata* developed as a short, oval lobe, autozooid possess an enlarged, slit-like spiramen, flanked by an avicularium of about equal length directed distally (Hayward 1988). The current specimens were congruent with the description for *A. lobata* and when compared to the paratype.

Adeonella pluscula Hayward, 1988

Plate 15, E-F

Adeonella pluscula Hayward, 1988: 181 (figs. 28A-D). Florence *et al.* 2007: 32 (figs. 12A-E, 21F).

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Material examined

SAMC-A073534, SAMC-A077211, **FAL 7**; SAMC-A073439, **FAL 302;** SAMC-A077380, **FAL 730**; SAMC-A028929, **TRA 151**.

<u>*Other material examined:*</u> *Adeonella pluscula*, SAMC-A026912 (paratype), Whittle Rock (34°15'S, 18°33'E), False Bay, South Africa, depth 30 m, no additional information.

Substratum, depth and ecology

Forms erect, rigid colonies, small barnacles may settle on the colony. Known only from shallow waters, depth range 22-35 m.

Geographic distribution

Previously reported only from False Bay, as in this study, but also found off Cape Agulhas, suggesting that this species may be restricted to the south coast of South Africa.

Remarks

This species forms short, broad lobes (4-5 mm wide), autozooids densely perforated, distinctly lozenge-shaped in older zooids, adventitious avicularia usually absent, if present, situated distal to the spiramen, directed medially or disto-medially; vaciarious avicularia along the branch edges and gonozooids along margins (Hayward 1988). The current material agree with the descriptions and when compared to the holotype.

Adeonella purpurea Hayward, 1988

Adeonella purpurea Hayward, 1988: 186 (figs. 30A-D). Florence *et al.* 2007: 32 (figs. 11D-F).

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Material examined

SAMC-A077201, SAMC-A077288, **FAL 79**; SAMC-A029090, SAMC-A029095, **WCD 11**; SAMC-A029109, **WCD 156**.

<u>*Other material examined:*</u> *Adeonella purpurea*, SAMC-A026911 (paratype), Vulcan Rock (34°04'S, 18°18'E), West of Cape Peninsula, South Africa, depth 25 m, no additional information.

Substratum, depth and ecology

Forming folded, anastomosing plates, attached to rocky substrata. Previously known from shallow waters (≤ 30 m), but sampled at 147 m in this study, therefore extended known depth range is 15-147 m.

Geographic distribution

Endemic to South Africa, known from Oudekraal on the west coast to False Bay on the south coast.

Remarks

Autozooids in this species are very distinctive, with a reticulate frontal surface, spiramen larger than secondary orifice, grouped six or seven gonozooids often surrounding on

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large vicarious avicularium (Hayward 1988). The current material agree with the descriptions and when compared to the holotype.

Adeonella regularis Busk, 1884

Adeonella regularis Busk, 1884: 186 (pl. 20, fig. 2). Hayward, 1988: 155 (figs. 15E-F). Florence *et al.* 2007: 29 (figs. 10J, K, 20I).

Material examined

SAMC-A028971, **AFR273 A31599**; SAMC-A028813, **AFR 728**.

Substratum, depth and ecology

Grows on rocky substratum. Previously known only to occur at 55 m, the current material extends its known depth range down to 272 m.

Geographic distribution

Previously known only from False Bay on the south coast, but in this study, its known distribution range extends to near the Western Cape border on the west coast.

Remarks

Easily distinguished by its semi-circular primary orifice with a long, deep, narrow sinus; thickened peristome, raised and granular; narrow peristomial bridge usually with a small umbo and sinus visible through large and circular spiramen (Hayward 1988). The current material was fragmented, but sufficient for an accurate diagnosis.

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Adeonella similis Hayward, 1988

Adeonella sp. 5: Hayward, 1983: 585.

Adeonella similis Hayward, 1988: 135 (fig. 5).

Material examined

SAMC-A077493, **FAL 576**.

Substratum, depth and ecology

Grows on hard substrata. Depth 33 m.

Geographic distribution

Previously reported from Cape of Good Hope, Cape Peninsula, in this study found in False Bay.

Remarks

Colony frequently anastomosing and slender branches, forming a reticulated structure. In addition to that, autozooids with shallow U-shaped sinus, peristomial avicularium acute, obliquely directed, sometimes overlapping secondary orifice and vicarious avicularia only

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along branch edges (Hayward 1988). Hayward (1988) noted the similarity of this species *A. lichenoides* Lamarck, 1816.

Adeonella tuberosa Hayward, 1988

Adeonella sp. 8: Hayward, 1983: 585.

Adeonella tuberosa Hayward, 1988: 163 (fig. 19).

Material examined

SAMC-A077386, **FAL 830;** SAMC-A029099, **WCD 11**.

<u>*Other material examined:*</u> *Adeonella tuberosa*, SAMC-A026910 (paratype), Hangklip Berg (34°29'54.5"S, 18°38'48.9"E), Agulhas Bank, South Coast, South Africa, depth 133.5 m, no additional information.

Substratum, depth and ecology

Forming stout branches. Previous known depth was 133.5 m, but in this study found in shallower waters, thus extended known depth range 5-133.5 m.

Geographic distribution

The current material extends its known distribution range from west of the Cape Peninsula to the Agulhas Bank, possibly restricted to the southwest and south coast.

Remarks

Stout branches, developing a distinct nodular midrib, autozooids possess paired peristomial avicularia, medially or disto-medially directed, in later ontogeny, further frontal avicularia may develop (Hayward 1988). The current material is congruent with the description and when compared to the paratype.

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Genus *Adeonellopsis* MacGillivray, 1886

Colony encrusting; or erect, bilaminar, foliaceous or dichotomous. Spiramen single or multiporous. Adventitious avicularia single or paired, vicarious avicularia usually present. Typically polymorphic, with brooding zooids. Numerous small basal pore-chambers present.

Type species: *Adeonellopsis foliacea* MacGillivray, 1886

Adeonellopsis sp.

Material examined

SAMC-A077597, **FAL 7**.

<u>*Other material examined:*</u> *Adeonellopsis meandrina*, SAMC-A028742, station **D 179**, Isipingo Beach (30°00'10.8"S, 30°56'42.5"E), KwaZulu-Natal, South Africa, UCT Ecological Investigation Survey, intertidal zone (< 10 m), 19 July 1935.

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Substratum, depth and ecology

Encrusting base growing into an erect colony. Depth at 24 m.

Geographic distribution

Sampled near Seal Island, False Bay.

Remarks

Comparing the current material with *Adeonellopsis meandrina* O'Donoghue and de Watteville, 1944 (SAMC-A028742), it clearly belongs to the genus *Adeonellopsis*, characterised by its erect, bilaminar, anastomosing colony forming a three-dimensional structure. Additionally, the zooids had a rugose and pitted frontal wall in early ontogeny, sub-circular primary orifice, spiramen and enlarged gonozooids with transversely oval primary orifice.

It differs from *A. meandrina* by having smaller zooids, single adventitious avicularia situated lateral to the spiramen as opposed to paired avicularia and marginal vicarious avicularia. These distinct differences suggest a new bryozoan record for South Africa. Although clearly allied to *Adeonellopsis*, more material is required to allow for a complete description, therefore its identity remains in doubt.

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Genus *Dimorphocella* Maplestone, 1903

Colony erect, branching, bilaminar. Frontal shield umbonuloid, autozooids bordered by frontal septula. Sinuate calcified secondary orifice in zooids. Dimorphic brooding zooids, larger than feeding zooids, with wide, non-sinuate orifices; several spiramina on frontal shields. Adventitious avicularia acute, unilateral or paired; interzooidal marginal avicularia present sometimes, mandibles slung on paired condyles.

Type species: *Dimorphocella pyriformis* Maplestone, 1903

Dimorphocella moderna Hayward and Cook, 1983

Dimorphocella moderna Hayward and Cook, 1983: 48 (figs. 12, 13).

Material examined

SAMC-A077527, **FAL 576**; SAMC-A029084, **WCD 11**.

Other material examined: *Dimorphocella moderna*, SAMC-A026424 (holotype), station **SM 239** (32°14.8'S, 29°00.8'E), Off Mbhanyana River Mouth, Southeast Coast, South Africa, RV *Meiring Naude* Survey, double beam trawl, depth 90 m, 25 June 1979; NHMUK 11.5.86, no additional information.

Substratum, depth and ecology

Forms erect, rigid colonies. Previous known depth range 80-200 m, but in this study sampled from shallower waters (33 m).

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Geographic distribution

This species is only known from South Africa. Previously reported from the southeast and east coast of South Africa, but the current material extends its known range to Kommetjie, west of the Cape Peninsula.

Remarks

Only three known *Dimorphocella* species exist, of which two are fossils from the Tertiary of Australia (Hayward and Cook 1983). *Dimorphocella moderna* can be distinguished by erect, bilaminar, fenestrate, frequently anastomosing plates, fenestral avicularia and direction of unilateral adventitious avicularia (Hayward and Cook 1983). Young, fragmented colonies were found in this collection, but material was sufficient for an accurate diagnosis.

Genus *Laminopora* Michelin, 1842

Colony encrusting. Zooids elongate, frontal wall perforated by areolar pores. Orifice oval, well-pronounced, deep sinus and prominent condyles. Avicularia situated near the orifice, small and circular. No ovicells, but dimorphic brooding zooids present.

Type species: *Laminopora contorta* Michelin, 1842

Laminopora jellyae (Levinsen, 1909)

Adeonella crassa Busk, 1884: 180 *nom. nud.* Waters, 1912: 494 footnote (not *A. bimunita* as stated).

Adeonella jellyae: Levinsen, 1909: 286 (pl. 14, figs. 4A–L). Marcus, 1922: 20 (fig. 12). O'Donoghue and de Watteville, 1944: 434.

Laminopora bimunita: Harmer, 1957: 820 (pl. 54, fig. 3, fig. 87B) (*cum syn.*). Cook, 1973: 255. Cook, 1982: 839 (figs. 4 and 7).

Laminopora jellyae: Florence *et al.* 2007: 34 (figs. 12F-I).

Material examined

SAMC-A077280, **FAL 42**; SAMC-A077270, **FAL 67**; SAMC-A073543, **FAL 79**; SAMC-A077315, SAMC-A077316, **FAL 650**; SAMC-A070049, **SB 155**.

Substratum, depth and ecology

Grows erect colonies. Previously known maximum depth was at 50 m, but in this study, depth distribution was extended to 147 m.

Geographic distribution

Endemic to South Africa, previously known from False Bay to East London. This is the first record of *L. jellyae* on the west coast in Saldanha Bay, extending known distribution from the west to the southeast coast.

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Remarks

Easily identified by the wide primary orifice, rounded distally with a deep sinus proximally, finely granular frontal surface and paired avicularia situated proximo-lateral to the orifice, long triangular rostrum, directed proximo-medially (Florence *et al.* 2007). The current material, although some were fragmented, is sufficient for identification.

Superfamily **Lepralielloidea** Vigneaux, 1949

Family Lepraliellidae Vigneaux, 1949

Genus *Celleporaria* Lamouroux, 1821

Colony encrusting to erect and massive, typically plurilaminar. Suberect to erect zooids, smooth with a few marginal pores. Orifice non-sinuate, denticles and oral spines present or absent. Suboral and vicarious avicularia present. Ovicells hyperstomial, imperforate.

Type species: *Cellepora cristata* Lamarck, 1816

Celleporaria capensis (O'Donoghue and de Watteville, 1935)

Holoporella capensis O'Donoghue and de Watteville, 1935: 203 (pl. 5, figs. 9-10; pl. 6, fig. 15).

Celleporaria capensis: Hayward and Cook, 1983: 126 (figs. 15I, J). Florence *et al.* 2007: 34 (figs. 12J-M).

Material examined

SAMC-A073544, **FAL 218**; SAMC-A073487, **FAL 357**; SAMC-A073507, **FAL 366**; SAMC-A073485, **FAL 368**; SAMC-A077257, **FAL 435**; SAMC-A077454, **FAL 445**; SAMC-A077234, **FAL 504**; SAMC-A077442, **FAL 518**; SAMC-A073492, **FAL 740**; SAMC-A028875, **TRA 56**; SAMC-A028876, **TRA 132**; SAMC-A029091, SAMC-A029093, **WCD 11**; SAMC-A029124, SAMC-A029125, SAMC-A029130, **WCD 18**; SAMC-A029131, **WCD 195**.

Substratum, depth and ecology

Forms thick encrustations on hard rocky substrata. Depth range 4-100 m.

Geographic distribution

This species is only known from South Africa and occur from Oudekraal on the west coast to Port Elizabeth on the southeast coast.

Remarks

Celleporaria is characterised by the nature of the colony form and orifice shape. The current material agrees well with the descriptions and figures of Hayward and Cook (1983). Its inconspicuous proximal umbo, short hollow spines and lack of denticles distinguish *C. capensis* (Hayward and Cook, 1983).

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Celleporaria tridenticulata (Busk, 1881)

Plate 15, A-C

Cellepora tridenticulata Busk, 1881: 343 (pl. 26, fig. 9).

Celleporaria tridenticulata: Harmer, 1957: 670 (pl.42, figs. 5-10). Hayward and Cook, 1983: 125 (fig. 19H).

Material examined

SAMC-A028964, **AFR273 A31619**; SAMC-A028983, **AFR273 A31680**; SAMC-A028820, **AFR 7290**; SAMC-A077170, SAMC-A077171, **FAL 161**; SAMC-A077458, **FAL 445;** SAMC-A077567, **FAL 466**.

Substratum, depth and ecology

Forms thick encrustations on hard rocky substrata. Depth range 39-630 m.

Geographic distribution

This is a widespread species, reported in the Indo-Pacific region, from the Great Barrier Reef and New Guinea to Ceylon and Mauritius. Locally, *C. tridenticulata* has been reported only from East London, on the southeast coast. This study extends its known distribution range to include the west and south coast.

Remarks

Distinguished by the D-shaped orifice with 3-4 short conspicuous denticles in the straight proximal border, peristome often forming a low rim around the distal and lateral borders of the orifice, 3-4 short distal oral spines, a median suboral avicularium present, cystid frequently columnar and vicarious avicularia with mandible narrowly spatulate or subtriangular, sparsely distributed. However, Gordon (1984: 115) reported *C. tridenticulata* in New Zealand, with a smoother frontal wall as opposed to granular, and also discussed varieties within this species.

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?Celleporaria umuzi sp. nov.

Plate 15, D-F

Material examined

Holotype: SAMC-A077331, **FAL 822**, Southwest of Kogel Bay (34°17.6'S, 18°45'E), False Bay area, South Coast, UCT Ecological Survey, dredge, depth 58 m, 18 February 1965.

<u>*Additional material:*</u> SAMC-A073532, **FAL 330**; SAMC-A073475, **FAL 504**; SAMC-A077515, SAMC-A077523, **FAL 576**; SAMC-A077461, SAMC-A077464, **FAL 603.**

Etymology

Umuzi (Zulu) – Means “homestead”, referring to a traditional African Zulu village consisting of a cluster of dome-shaped huts as family dwellings. Multilayered zooids in this species form a thick cluster on the substratum, and the orifice shape is dome-shaped, resembling the typical shape of a Zulu hut.

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Description

Colony encrusting, maroon to cream in colour when dead, forms nodular multilayered sheets. Zooids thickly calcified, finely granular, recumbent at the growing edge to semi-erect in later ontogeny. Imperforate centrally, convex, series of marginal pores, with few scattered frontal pores. Primary orifice wider than long, proximal border shallowly concave, non-sinuate, denticles, oral spines and condyles absent. In some zooids, peristome comprising of low, calcified, lateral edges, orifice is obscured by a thick, imperforate, prominent suboral avicularium, median to proximo-lateral, broadly oval rostrum, directed obliquely upwards. No vicarious avicularia and other adventitious avicularia observed. Ovicells not yet identified.

Substratum, depth and ecology

Form thick layers encrusting hard rocky substrate. Depth range 33-51 m.

Geographic distribution

A number of colonies were sampled in the False Bay area on the south coast.

Remarks

This species is difficult to place due to the overlapping characters shared between the genera *Trematooecia* Osburn, 1940 and *Cigclisula* Canu and Bassler, 1927 in the family Colatooeciidae Winston, 2005. The colony form, lack in oral spines and presence of pseudopores may place this species in Colatooeciidae, although also resembles the genus *Celleporaria* in the family Lepraliellidae. Colatooeciidae was reviewed in Almeida *et al.* (2014) where the frontal shield and structure of the ooecia were used to distinguish between the closely related genera.

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In the current material, there was no discernible ooecia, possibly due to secondary calcification, and closely resembles *C. nodulosa* Busk, 1881 in the irregular nodular colony growth, adventitious avicularia, orifice shape without denticles and peristomial rim. ***C. umuzi*** sp. nov., differs from *C. nodulosa* in its presence of oral spines, distinct large marginal areolae and additional small avicularia (Busk 1881). Therefore, this species is tentatively placed in *Celleporaria* until more material is required for an accurate diagnosis, but the lack of denticles, vicarious avicularia and oral spines; granular frontal wall with series of marginal pores and position of suboral avicularia distinguishes this species from other known *Celleporaria* species, and warrant the erection of this new species. Zooids are not easily discernible and zooidal measurements were not possible.

Superfamily **Smittinoidea** Levinsen, 1909

Family Bitectiporidea MacGillivray, 1895

Genus *Bitectipora* MacGillivray, 1895

Colony encrusting, unilaminar or multilaminar. Frontal wall of autozooids evenly perforated cryptocyst. Primary orifice sinuate or concave proximal border; condyles present.

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Oral spines absent. Ovicell with calcified ectooecium and entooecium, but unfused; ectooecium typically porous. Adventitious avicularia present. Vertical walls with uniporous or multiporous septula.

Type species: *Bitectipora lineata* Hall *in* MacGillivray, 1895

Bitectipora umboavicula Florence, Hayward and Gibbons, 2007

Bitectipora umboavicula Florence, Hayward and Gibbons, 2007: 39 (figs. 14E-H).

Material examined

SAMC-A028817, **AFR 866**; SAMC-A077233, **FAL 504**; SAMC-A077521, SAMC-A077524, **FAL 576**; SAMC-A028936, **TRA 94**.

Substratum, depth and ecology

Forms encrustations on rocks and shells. Previous known maximum depth was 20 m, although current material was sampled at 110 m. Extended known depth range 2-110 m.

Geographic distribution

Previously recorded only from Oudekraal, west coast, but the current study extended its known distribution range to near Mossel Bay on the south coast.

Remarks

Bitectipora has only been recorded in New Zealand, Australia and South Africa, suggesting an Indo-southwest-Pacific distribution (Bock 2013). However, *B. umboavicula* has been the only *Bitectipora* species recorded from South Africa. This species can be distinguished by its hexagonal autozooids, lepralioid frontal shield, convex with large pores, a median suboral avicularium with an elongated triangular rostrum, rising from the flattened flange of the poster, forming a stout conical umbo; ovicells prominent, flat frontally punctured by irregular pores (Florence *et al.* 2007).

Genus *Hippomonavella* Canu and Bassler *in* Bassler, 1934

Colony encrusting, or developing partly erect unilaminar sheets. Autozooids elongated, almost rectangular, frontal wall imperforate centrally with marginal areolae. Orifice typically circular, concave proximally, lacking a lyrula, with prominent condyles; typically positioned medially or in the proximal part of orifice. No oral spines. Adventitious avicularia, polymorphic, typically suboral, although lacking in some species; proximally directed, often raised. Ovicell hyperstomial, ectooecium perforated. Multiporous rosette plates in vertical walls.

Type species [selected by Bassler (1934)]: *Lepralia praeclara* MacGillivray, 1895

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Hippomonavella formosa (MacGillivray, 1887)

Porella formosa MacGillivray, 1887: 69 (pl. 2, fig. 6).

Hippomonavella formosa: Florence *et al.* 2007: 37 (figs. 14A-D).

Material examined

SAMC-A077210, **FAL 7**; SAMC-A077576, **FAL 42**; SAMC-A077155, SAMC-A077554, **FAL 491**; SAMC-A077237, **FAL 504**; SAMC-A077531, **FAL 576**; SAMC-A077216, **FAL 739**; SAMC-A077354, **FAL 846**; SAMC-A028943, **TRA 33**.

Substratum, depth and ecology

Encrusting on other bryozoans and tubes of polychaete worms. Previous known maximum depth was 20 m, but in this study, depth range was extended from 2-90 m.

Geographic distribution

Reported from Victoria in Australia, while locally known only from Saldanha Bay and Bakoven on the west coast. This study extended its known distribution range to False Bay and Cape Infanta on the south coast.

Remarks

Genera that possess zooids with a lepralioid frontal wall was placed in family Smittinidae, which used to include *Hippomonavella* (Gordon 1994). However, in *Hippomonavella* the lepralioid frontal wall is absent, therefore, the hippoporine orifice and lacking a lyrula suggested that *Hippomonavella* is better accommodated in the Bitectiporidae than Smittinidae (López de la Cuadra and García-Gómez 2000).

According to the genus description, *Hippomonavella* possess no oral spines. However, Florence *et al.* (2007) noted paired distal oral spine bases in *H. formosa* material and agrees with the current material. Oral spine bases have been described for *H. flexuosa* Hutton, 1873, but absent in *H. gymnae* Gordon, 1984. Consequently, the presence or absence of oral spine bases may be an unreliable diagnostic character at genus-level.

Hippomonavella cf. *flexuosa* (Hutton, 1873)

Plate 17, A-C, Table 4.14

Eschara flexuosa Hutton, 1873: 99. Hutton, 1880: 194.

Hemeschara fairchildi Hutton, 1873: 100 (pars.).

Lepralia flexuosa: Hamilton, 1898: 195. Hutton, 1904: 297.

Smittina flexuosa: Brown, 1952: 325. Macken, 1958: 105.

Hippomonavella flexuosa: Gordon, 1989: 56 (pl. 29, fig. E).

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Material examined

SAMC-A028955, **AFR273 A31617**; SAMC-A028998, **AFR273 A31599**; SAMC-A077273, **FAL 67**; SAMC-A077596, **FAL 846**.

Substratum, depth and ecology

Encrusting on shells, bryozoans and rocks. Some colonies grow erect, bilaminar colonies. Depth range 8-162 m, and in New Zealand sampled in depths down to 253 m.

Geographic distribution

Endemic to New Zealand, reported from Cook, Strait, Tasman Bay and Forveaux Strait (Gordon 1989). This may be the first record of *H. flexuosa* from South Africa, sampled from the south coast within the transition zone of False Bay and the Agulhas Bank.

Remarks

The current material closely resembles *H. flexuosa* Hutton, 1873 from New Zealand. *Hippomonavella flexuosa* forms encrusting to erect, foliaceous bilaminar colonies (Gordon 1989). Autozooids subrectangular, frontal shield smooth or unevenly textured with 5-15 conspicuous marginal areolae, depending on the length of the zooid (Gordon 1989). Orifice subquadrate, with a nearly straight proximal border and typically a slight median convexity; no peristome or lyrula, but proximally slanted condyles (Gordon 1989). Oral spine bases present, median avicularium proximal to the orifice, sub-lingulate, with a complete cross-bar, small opesia, fairly long palatal shelf and the rostrum rounded, proximally directed (Gordon 1989). Recumbent ovicell prominent with 28-39 frontal pores (Gordon 1989).

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In the current material, these characteristics were congruent with *H. flexuosa.* One colony (SAMC-A028998) is encrusting, while the other colony (SAMC-A077596) formed erect, bilaminar sheets. Additionally, the New Zealand material of *H. flexuosa* zooid length (0.30-1.30 mm) and width (0.17-0.60 mm) (Gordon 1989) was comparable with the current material. The South African specimens differ slightly in having 15-19 marginal areolae (N_T = 6) and 33-43 frontal pores in the ovicell (N_T = 3), slightly more than in the New Zealand material. The current South African material is provisionally assigned to *H. flexuosa*, due to the congruence with the descriptions and figures, until the holotype can be compared and/or molecular techniques applied to validate its identity.

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Table 4.14. Measurements (in millimetres) of South African *Hippomonavella* cf. *flexuosa* material.

	Agulhas Bank, South Coast SAMC-A028998		
Characters	N_T	Average ± SD	Range
Lz	15	0.73 ± 0.05	0.65-0.82
lz	16	0.53 ± 0.07	0.37-0.67
Lo	9	0.16 ± 0.01	0.15-0.17
lo	18	0.18 ± 0.01	0.16-0.21
Ladav	25	0.13 ± 0.1	0.09-0.15
ladav	25	0.074 ± 0.011	0.048-0.093

?Hippomonavella inconspicua (Hincks, 1891) comb. nov.

Plate 17, D-F

Schizoporella inconspicua Hincks, 1891:291 (pl. 7, Fig. 3). Marcus, 1922: 24 (figs. 14A-C).

Material examined

SAMC-A077601, SAMC-A077601, **FAL 23**; SAMC-A077603, **FAL 25**; SAMC-A077336, **FAL 213;** SAMC-A077622, **FAL 475**; SAMC-A077159, SAMC-A077163, SAMC-A077166, SAMC-A077555, **FAL 491**; SAMC-A077230, **FAL 504**; SAMC-A077302, **FAL 509**; SAMC-A077492, SAMC-A077504, SAMC-A077510, SAMC-A077516, SAMC-A077528, **FAL 576**; SAMC-A029005, **TRA 31**; SAMC-A028878, **TRA 33**; SAMC-A029008, SAMC-A029009, **TRA 3300**; SAMC-A029082, **WCD 11**

Substratum, depth and ecology

Forming encrustations on algae, rock and other bryozoans. Previously known to occur at depths down to 72 m, but in this study, extended depth range was from 11-90 m.

Geographic distribution

This species was known previously only from St. Sebastian Bay to Port Elizabeth on the south and southeast coast. In this study, the extended distribution range includes Kommetjie on the west coast and False Bay on the south coast.

Remarks

The most characteristic feature in this species is the semicircular sinuate orifice with conspicuous denticles of sinus, one to two series of marginal pores or areolae and proximomedian avicularium. Hincks (1891) described the small proximomedian avicularium is later replaced by broader spatulate avicularium, but only one colony (SAMC-A077230) in this

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study showed this variation. The current material rather agrees with Marcus (1922) description of *S. inconspicua* with small avicularia. In the current material, paired distal oral spines in zooids are seen in the growing edge, but oral spines are omitted from preceding accounts of *S. inconspicua*. Therefore, specimens used in Hincks (1891) and Marcus (1922) need to be re-examined to validate its identity.

The *Schizoporella* genus includes species with evenly porous frontal shield and adventitious avicularia adjacent to orifice – these features are inconsistent with features of *S. inconspicua* that possess marginal areolae and lack adventitious avicularia adjacent to orifice as described by Hincks (1891). The presence of suboral avicularia, condyles, oral spines, marginal areolae and ovicell characteristics suggest that *S. inconspicua* indeed belongs to the family Bitectiporidae, perhaps *Hippomonavella* genus. However, the distinct clithridiate orifice excludes it from current known genera within this family. This species will tentatively remain in *Hippomonavella* until further investigation can conclude the whether the erection of a new genus is warranted.

Hippomonavella lingulatus sp. nov.

Plate 18, A-C, Table 4.15

Material examined

Holotype: SAMC-A029050, station **AFR273 A31624** (33°48'24"S, 25°56'48"E), Algoa Bay, Southeast Coast, South Africa, South Coast Demersal Survey, trawl, depth 45 m, 21 April 2011.

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<u>Additional material:</u> SAMC-A028993, **AFR273 A31624**.

Etymology

Lingulatus (L.) – Derived from the Latin word "*lingua*" meaning "tongue", referring to the tongue-shaped avicularium in this species.

Description

Colony encrusting, radiating from ancestrula. Autozooids oval, rectangular to irregular polygonal, flat, separated by raised sutures. Frontal shield imperforate, nearly smooth or uneven texturing, with a single series of 17-23 conspicuous marginal areolae (N_T = 8). Orifice circular to roundly subquadrate, with slight median concave proximal rim, no peristome or lyrula, but a pair of proximally slanted condyles. A pair of distal oral spine bases usually present, except in ovicelled zooids. Avicularium median, proximal to orifice, sub-lingulate, small opesia, long palatal shelf, rounded rostrum proximally raised, almost one third of the total length of zooid, directed proximally, with incomplete or less frequent, complete crossbars. Ovicell hyperstomial, flattened frontally, recumbent on succeeding zooid, with 38 frontal pores (N_T = 1), ectooecium covering distal part of ovicell.

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Substratum, depth and ecology

Encrusting on bryozoan-formed rock, sampled at a depth of 45 m.

Geographic distribution

Only known from Algoa Bay on southeast coast.

Remarks

This species is confidently placed in *Hippomonavella*, because of marginal areolae, hippoporine orifice and adventitious suboral avicularia. The current material resembles *H. flexuosa* with respects to sub-lingulate median avicularium and other zooidal characteristics, but differs from it by lacking proximal median convexity and the large avicularium. The median avicularium covers almost one third of the total zooid length as opposed to almost one sixth of the total zooid length in *H. flexuosa*. The distinct size of the median avicularium distinguish the current specimens from known extant *Hippomonavella*.

Table 4.15. Measurements (in millimeteres) of ***Hippomonavella lingulatus*** sp. nov. material.

	Algoa Bay, Southeast Coast		
	SAMC-A029050		
Characters	N_T	Average ± SD	Range
Lz	17	0.78 ± 0.09	0.65-0.95
lz	14	0.50 ± 0.06	0.41-0.58
Lo	11	0.17 ± 0.01	0.15-0.18
lo	14	0.18 ± 0.01	0.17-0.19
Ladav	11	0.27 ± 0.03	0.23-0.32
ladav	16	0.14 ± 0.01	0.12-0.16

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Hippomonavella cf. *praeclara* MacGillivray, 1895

Plate 18, D-F, Table 4.16

Lepralia praeclara MacGillivray, 1895: 73 (pl. 10, fig. 14).

Hippomonavella praeclara: Wass and Yoo, 1983: 337 (figs. 18, 24-25).

Material examined

SAMC-A077381, **FAL 341**; SAMC-A077453, SAMC-A077459, **FAL 445**; SAMC-A077158, **FAL 491**; SAMC-A077224, **FAL 621**; SAMC-A028877, **TRA 59**; SAMC-A028879, **TRA 141**; SAMC-A029010, **TRA 3300**.

Description

Colony encrusting. Autozooids hexagonal, frontal wall smooth or unevenly textured with 15-26 marginal areolae, depending on the size of the autozooid. Orifice subquadrate with

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a wide median convex proximal border, becoming shallower to nearly straight in later ontogeny; condyles slanted proximally, situated at the proximal corners. Paired distal oral spine bases present. Adventitious avicularium situated proximo-medially to the orifice, small opesia with complete crossbar, triangular rostrum, directed proximally, becoming elevated in later ontogeny. Ovicells hyperstomial and porous.

Substratum, depth and ecology

Encrustations forming on shells and stones. Depth range 22-90 m.

Geographic distribution

This species is represented in Australia from the Tertiary and recent. In South Africa, material was collected in False Bay to Algoa Bay, on the south and southeast coast.

Remarks

The current material is confidently placed in *Hippomonavella* by the presence of the hipporine orifice, lyrula absent, median suboral avicularia directed proximally and marginal areolae. It differs from known *Hippomonavella* recorded from South Africa by the shape and position of the median suboral avicularia, suggesting a new record of bryozoan from South Africa.

This species closely resembles *H. praeclara* MacGillivray, 1895 described from the Tertiary and recent Victoria, southern Australia, but with slight morphological variations (Wass and Yoo 1983). In the fossil specimens, the position of the suboral avicularium may be situated to one side, slightly raised, and the position of the condyles varied (MacGillivray 1895; Wass and Yoo 1983). While in the recent specimens, the suboral avicularium is typically median and the condyles usually divide the orifice into a poster one-third and anter two-thirds (Wass and Yoo 1983). Recent *H. praeclara* closely resembles the specimens found in this study, but in Wass and Yoo (1983) the species exhibit elongated rectangular zooids rather than hexagonal. No measurements for the type material were given, therefore a detailed comparison between the current specimens and the type material is required

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Table 4.16. Measurements (in millimeteres) of *Hippomonavella* cf. *praeclara* material.

	Off Cape Infanta, South Coast SAMC-A029010		
Characters	N_T	Average ± SD	Range
Lz	20	0.73 ± 0.37	0.37-1.29
lz	29	0.45 ± 0.19	0.21-0.76
Lo	12	0.15 ± 0.07	0.07-0.23
lo	12	0.15 ± 0.06	0.07-0.23
Ladav	10	0.16 ± 0.01	0.14-0.17
ladav	19	0.10 ± 0.06	0.03-0.19

Genus *Schizomavella* Canu and Bassler, 1917

Colony encrusting, unilaminar or multilaminar; sheet-like, or partly developing erect, folded plates, or dome-like, mamillate growths. Cryptocystidean frontal shield, evenly perforated with small pseudopores. Primary orifice sinuate, condyles present, sometimes prominent. Oral spines present or absent. Adventitious avicularia usually suboral, monomorphic or polymorphic, and often associated with a prominent umbo. Ovicell prominent, with frontal perforations, not closed by autozooidal operculum. Multiporous or uniporous septula present.

Type species: *Lepralia auriculata* Hassall, 1842

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Schizomavella sp. 1

Material examined

SAMC-A077282, **FAL 42**; SAMC-A077274, SAMC-A077275, **FAL 67**; SAMC-A077629, SAMC-A077635, **FAL 475**; Unnumbered specimen, **FAL 650**; SAMC-A077320, **FAL 739**; SAMC-A029014, **TRA 127**.

Description

Colony encrusting, unlaminar. Autozooids radiating in a linear series, rectangular to polygonal, convex, separated by distinct sutures. Primary orifice wider than long, broadest distally; proximal border with shallow U-shaped sinus; operculum brown. Frontal wall nodular perforated by small, round pores, often with a low umbo developing immediately below the orifice. Avicularium situated close to sinus, its rostral rim continuous with sinus; normal or acute to frontal plane, proximally directed; rounded rostrum. Ovicell flattened frontally with irregular pores; developing a peripheral ooecial cover in later astogeny.

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Substratum, depth and ecology

Encrusting on small rocks and bryozoans. Depth range 15-51 m.

Geographic distribution

Sampled in the False Bay area at Gordon's Bay and near Buffels Point on the south coast.

Remarks

The current material agrees well with the characteristics of *Schizomavella* forming a white, unilaminar sheet-like patch, frontal wall perforated, suboral avicularium associated with a prominent umbo and ovicell with small frontal pores. No known *Schizomavella* species have been reported or described from South Africa and suggests a new bryozoan record.

Schizomavella auriculata Hassall, 1842 closely resembles the current material, but differs from it by lacking oral spines. However, encrusting colonies were damaged upon removal from substratum and produced poor SEM images, therefore precludes a complete description and accurate diagnosis.

Genus *Schizosmittina* Vigneaux, 1949

Colony encrusting to bilaminar. Frontal wall of autozooids perforated evenly. Primary orifice with a distinct sinus and usually an adjacent suboral avicularium. Ovicell hyperstomial, porous, not closed by the zooidal operculum.

Type species: *Schizosmittina planovicellata* Vigneaux, 1949

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Schizosmittina lizzya Florence, Hayward and Gibbons, 2007

Plate 19, A-C

Schizosmittina lizzya Florence, Hayward and Gibbons, 2007: 39 (figs. 15A-F).

Material examined

SAMC-A028941, **AFR 866**; SAMC-A077189, **FAL 270**; SAMC-A077621, SAMC-A077626, SAMC-A077634, **FAL 475**; SAMC-A077232, **FAL 504**; SAMC-A077300, **FAL 509**; SAMC-A077347, **FAL 664**; SAMC-A073397, **LB 485**; SAMC-A029007, **TRA 3300**.

Substratum, depth and ecology

Forms encrustations on shells and small stones. Extended known depth range in this study 4-90 m, previously recorded down to 20 m.

Geographic distribution

Endemic to South Africa, previously known only from Saldanha Bay on the west coast, but in this study extended to Cape Infanta on the south coast.

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Remarks

This species closely resembles the description of *Stomachetosella balani* O'Donoghue and de Watteville, 1944 reported from South Africa and South Atlantic Ocean (O'Donoghue and de Watteville 1944; O'Donoghue 1957; Hayward 1980; Hayward and Cook 1983). It differs from it only by the shape of the sinus: the shape of the sinus in *S. balani* and *S. lizzya* is clithridiate and transversely elongated, respectively, with the latter continuous along the smooth, raised and thickened proximal rim of the orifice. However, *S. balani* clearly does not belong in *Stomachetosella*, so its systematic affinities remain in doubt, as was noted in Hayward (1980). The similarities between the current material, and the description and figures of *S. balani*, suggest that these may be have been synonymised.

Family Smittinidae Levinsen, 1909

Genus *Smittina* Norman, 1903

Cryptocystidean frontal shield, uniformly porous. Orifice with lyrula and condyles; well-developed peristome, oral spines present or absent. Avicularia typically suboral, median, close to proximal border of orifice, proximally or transversely directed, occasionally absent. Ovicell with numerous small pores. Uniporous or mulitporous septula present.

Type species: *Lepralia landsborovii* Johnston, 1847

Smittina sp. 1

Plate 19, D-F

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Material examined

Unnumbered specimen, **TRA 31**; SAMC-A029011, **TRA 3300**.

Other material examined: *Smittina sitella*, SAMC-A026425 (holotype), station **SM 163** (33°04.6'S, 28°06.6'E), Off East London, Southeast Coast, RV *Meiring Naude* Survey, heavy dredge, depth 90 m, 26 May 1978; *S. ferruginea*, SAMC-A026426 (holotype), station **SM 239** (32°14.8'S, 29°00.8'E), Off Mbhanyana River Mouth, East Coast, RV *Meiring Naude* Survey, double beam trawl, depth 90 m, 25 June 1979.

Description

Colony encrusting, slightly purple colour. Autozooids oval to hexagonal, convex, separated by distinct sutures. Primary orifice wider than long; lyrula short and wide, with curved edges, occupying most of the proximal border of orifice, condyles short, blunt and inconspicuous. Oral spines absent. Peristome develop paired lateral flaps, slightly flared. Avicularium situated within proximal gap in peristome, swollen cystid develops a conical, apical, suboral umbo; rostrum acute to frontal plane, elongate triangular with hooked tip; proximal portion situated within peristome, hooked distal portion on suboral umbo. Frontal wall coarsely granular, eveny perforated by small round pores; secondary thickening in the region

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proximal to the orifice later become imperforate and coarsely granular, associated with the developing suboral avicularium and conical umbo. No visible ovicells.

Substratum, depth and ecology

Forming encrusting patches on hard substrata and bryozoans (e.g. *Reterorella* sp.). Depth at 90 m.

Geographic distribution

Sampled off Cape Infanta on the south coast.

Remarks

A single colony was found encrusting *Reteporella lata*, while a single zooid encrusted on ***R. ilala*** sp. nov. (SAMC-A028899), but remained undetected until re-examination. The latter zooid possessed paired oral spines, suggesting that spines may be present in early ontogeny. Characteristics in the current material indicate that this species clearly belongs to *Smittina* and appears to be distinct from known *Smittina* species occurring in South Africa.

The European *Smittina landsborovii* Johnston, 1847 was reported from South Africa (Hincks 1880; O'Donoghue and de Watteville 1944). However, O'Donoghue commonly assigned European species names to South African species, and may warrant molecular research to validate the identity of South African *S. landsborovii*. The current specimen differs from *S. landsborovii* by the presence of dimorphic avicularia – small, suboral avicularium with a semi-elliptical mandible, situated within the proximal gap in peristome, and large, spatulate avicularia directed laterally, sporadically present and occasionally abundant.

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Comparison of the holotype material of *S. sitella* Hayward and Cook, 1983 and *S. ferruginea* Hayward and Cook, 1983 with the current specimens, indicate clear differences, including the colour of colony, avicularia adjacent to orifice, avicularium shape and the presence of oral spines (Hayward and Cook 1983). The closest allied species, *S. sitella*, share characteristics such as a broad lyrula, inconspicuous condyles, medioproximal conical avicularian cystid and widely spaced pores. However, the current material will remain unnamed until more material is acquired for a complete description.

Genus *Smittoidea* Osburn, 1952

Colony encrusting, to erect foliaceous. Frontal shield of autozooid with marginal pores only. Primary orifice possess a lyrula and condyles; oral spines typically present. Avicularia adventitious, median suboral. Ovicell prominent, hyperstomial, perforated evenly, not closed by auotozooid operculum. Vertical walls with uniporous or multiporous septula.

Type species: *Smittoidea prolifica* Osburn, 1952

Smittoidea circumspecta Hayward and Cook, 1983

Smittoidea circumspecta Hayward and Cook, 1983: 59 (figs. 15G-H).

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Material examined

SAMC-A077391, **FAL 807**.

Other material examined: *Smittoidea circumspecta*, SAMC-A026427 (holotype), Off East London, Southeast Coast, RV *Meiring Naude*, station **SM 163** (33°04.6'S, 28°06.6'E), heavy dredge, depth 90 m, 26 May 1978.

Substratum, depth and ecology

Forming white patches, encrusting hard substrate. Depth 18 m.

Geographic distribution

Originally described from the east coast, this is the first record of this species from False Bay on the south coast.

Remarks

This species is distinguished by its elongated orifice, closely spaced oral spines and cluster of suboral avicularia (Hayward and Cook 1983). The current material is congruent with the type material and description of *S. circumspecta*, but lack distal oral spines, which may suggest ontogenetic variation.

Smittoidea errata Hayward and Cook, 1983

Smittoidea errata Hayward and Cook, 1983: 59 (fig. 15F).

Material examined

SAMC-A028991, **AFR273 A31599**; SAMC-A028938, **AFR 736**.

Other material examined: *Smittoidea circumspecta*, SAMC-A026427 (holotype), station **SM 163** (33°04.6'S, 28°06.6'E), Off East London, Southeast Coast, RV *Meiring Naude* Survey, heavy dredge, depth 90 m, 26 May 1978; *S. calcarata*, SAMC-A026429 (holotype), station **SM 233** (32°15.2'S, 29°09.8'E), Near Dwesa-Cwebe Wildlife Reserve and Marine Sanctuary, East Coast, RV *Meiring Naude* Survey, beam trawl, depth 540-580 m, 25 June 1979.

Substratum, depth and ecology

Forming encrustations on hard substrata and other bryozoans. Previously sampled at a depth of 90 m, in this study, sampled down to 201 m.

Geographic distribution

Previously reported only from the east coast of South Africa, but in this study its known distribution range is extended westwards to near Hondeklip Bay on the west coast.

Remarks

Smittoidea errata can be distinguished by the quadrate or hexagonal zooids, finely granular frontal shield with marginal pores, short square lyrula with distinct triangular condyles,

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peristomial rim enclosing orifice distally and laterally and suboral avicularium sometimes replaced by an enlarged spatulate avicularium (Hayward and Cook 1983).

Hayward and Cook (1983) described three to four “short” distal oral spines while in the current material, three to six distal oral spines were observed. Some intact spines were often long, ranging between 0.19-0.39 mm ($N_T = 5$; average length ± SD: 0.30 mm ± 0.09 mm). The length of the enlarged spatulate avicularium that sometimes replace the suboral avicularium, in material for this study, may range between 0.34-0.39 mm ($N_T = 4$; 0.36 mm ± 0.02 mm).

Family Lanceoporidae Harmer, 1957

Genus *Calyptotheca* Harmer, 1957

Colony encrusting, erect or discoidal. Frontal shield of autozooids usually more or less evenly perforated and dimorphic orifices. Oral spines absent. Small, adventitious avicularia adjacent to orifice and/or marginal, rarely large and vicarious or absent. Ovicell immersed or hyperstomial and conspicuous, closed by the zooidal operculum.

Type species: *Schizoporella nivea wasinensis* Waters, 1913

Calyptotheca nivea (Busk, 1884)

Plate 20, A-B

Schizoporella nivea Busk, 1884: 163 (pl. 17, fig. 1). Marcus, 1922: 25 (fig. 25).
Schizoporella tenuis: O’Donoghue and de Watteville, 1935: 214.
Emballotheca nivea: O’Donoghue and de Watteville, 1944: 424. O’Donoghue, 1957: 87.
Calyptotheca nivea: Hayward and Cook, 1983: 72 (fig. 17H). Florence *et al.* 2007: 43 (not figs. 16G-I).

Material examined

SAMC-A028967, **AFR273 A31599**; SAMC-A028987, **AFR273 A31605**; SAMC-A028992, **AFR273 A31664**; SAMC-A028976, **AFR273 A31666**; SAMC-A028770, **AFR 728**; SAMC-A077564, **FAL 21**; SAMC-A077207, **FAL 141**; SAMC-A073539, **FAL 154**; SAMC-A073474, **FAL 503**; SAMC-A077240, **FAL 504**; SAMC-A077222, **FAL 621**.

Other material examined: *Calyptotheca nivea*, SAMC-A026614, station **SM 163** (33°04.6'S, 28°06.6'E), Off East London, Southeast Coast, RV *Meiring Naude* Survey, heavy dredge, depth 90 m, 25 May 1978.

Substratum, depth and ecology

Encrusting or growing erect on rocky hard substrata; also on kelp holdfasts. Previous known depth range was 4-100 m, but this study extended its known depth range to 3-272 m.

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Geographic distribution

This species is known from the Atlantic and Indian Ocean, and also reported from Australia. Locally reported from False Bay on the south coast to East London on the southeast coast.

Remarks

Variations in astogeny have been noted within and between colonies of *C. nivea* (Florence *et al.* 2007). In early ontogeny, the proximal sinus may be shallower and adventitious avicularia may be present in varying numbers, mostly along the margin (Florence *et al.* 2007). Some colonies possess a prominent proximal umbo as seen in the current material (SAMC-A028967, SAMC-A073474, SAMC-A077222 and SAMC-A077240), coinciding with the literature (Marcus 1922; Florence *et al.* 2007). In addition to that, ovicelled zooids possess a shallower sinus than non-ovicelled zooids, conspicuous lateral quadrate condyles, rugose and evenly perforated frontal wall are the distinguishing characteristics in this species (Florence *et al.* 2007). These characteristics were congruent with the current material and when compared to *C. nivea* specimens in the Bryozoa collection.

Calyptotheca porelliformis (Waters, 1918)

Plate 20, C-D

Schizoporella porelliformis Waters, 1918: 15 (footnote) (pl. 2, figs. 19-21).

Calyptotheca porelliformis: Harmer, 1957: 1008; 1020. Hayward and Cook, 1983: 73 (figs. 17J-K). Florence *et al.*, 2007: 43 (figs. 16E-F, 21A).

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Material examined

SAMC-A077586, **FAL 84**; SAMC-A073525, **FAL 133**; SAMC-A077196, **FAL 270**; SAMC-A073499, **FAL 368**; SAMC-A077246, **FAL 503**; SAMC-A077488, SAMC-A077503, SAMC-A077541, **FAL 576**; SAMC-A077319, **FAL 708**; SAMC-A029000, **TRA 31**; SAMC-A029163, **WCD 6**; SAMC-A029133, **WCD 212**.

Other material examined: *Calyptotheca porelliformis*, SAMC-A026613, station **SM 163** (33°04.6'S, 28°06.6'E), Off East London, Southeast Coast, RV *Meiring Naude* Survey, heavy dredge, depth 90 m, 25 May 1978.

Substratum, depth and ecology

Encrusting on hard rocky substrata and commonly found growing on kelp holdfasts. Previous known depth down to 100 m, but this study extended the depth range from 2-400 m.

Geographic distribution

This species is endemic to South Africa, reported from Robben Island on the west coast to Port Elizabeth on the southeast coast.

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Remarks

Live colonies of *C. porelliformis* can be easily distinguished by the peach-orange colour (Florence *et al.* 2007). The shape of the primary orifice with the proximally slanted prominent condyles, hyperstomial ovicell with flattened punctured frontal surface and shorter anter in ovicelled zooids distinguishes *C. porelliformis* from other species within this genus. These characteristics were congruent with the current specimens, and when compared with material in the Bryozoa collection.

Family Watersiporidae Vigneaux, 1949

Genus *Watersipora* Neviani, 1896

Colony encrusting, multiserial arrangement of zooids, uni- to multilaminar or erect, foliaceous and bilaminar. Reddish to black colour in live colonies. Zooids subrectangular to hexagonal shape, separated by raised walls. Cryptocystidean frontal shield; numerous rounded pseudopores; sometimes latero-oral intrazooidal septula present proximolateral to orifice; intrazooidal septula sometimes present at proximal corners of frontal shield. Orifice subcircular to oval; poster occasionally with well-defined proximal sinus; condyles present. Operculum reddish-brown to black, frequently with a central band of distinct sclerites; lucidae also frequently present. Spines and avicularia absent. No ovicells; embryos internally brooded in the maternal zooid. Multiporous mural pore plate situated in the distolateral and tranverse distal walls. Ancestrula single, smaller than other zooids, often obscured in later astogeny.

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Type species: *Lepralia cucullata* Busk, 1854, by original designation

Watersipora subtorquata (d'Orbigny, 1852)

Plate 20, E-F

Cellepora subtorquata d'Orbigny, 1852: 399.

Watersipora cucullata: O'Donoghue and de Watteville, 1937: 20. O'Donoghue and de Watteville, 1944: 424.

Watersipora subovoidea: Hayward, 1980: 703.

Watersipora subtorquata: Florence *et al.* 2007: 39 (figs. 14I, J). See Vieira *et al.* (2014) for full synonymy list.

Material examined

SAMC-A028989, **AFR273 A31624**; SAMC-A077562, **FAL 16**; SAMC-A073551, **FAL 111**; SAMC-A073540, **FAL 148**; SAMC-A077338, **FAL 170**; SAMC-A073376, **LB 181**; SAMC-A073365, **LB 392**.

<u>Other material examined:</u> "*Watersipora subtorquata*", NHMUK 1.16.97, South Africa, no additional information.

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Substratum, depth and ecology

Forms crusty patches on hard rocky substrata and cylindrical growths around thin-branched algae. Previously known to occur in shallow waters (8-15 m), but this study extended its known depth range to 2.5-45 m.

Geographic distribution

Globally, this species is widespread occurring in the Atlantic (Brazil, Caribbean, Virgin Islands, Florida, Cape Verde, Senegal, Ghana and South Africa), Mediterranean (Italy, Alexandria), Red Sea, Arabian Sea and Pacific (China Sea, Korea, Hawaii and Australia). In South Africa, *W. subtorquata* has been reported from localities on the west coast in Saldanha Bay and in False Bay on the south coast. This study extended its known distribution range further westwards at Langebaan and eastwards up to Algoa Bay on the southeast coast.

Remarks

Vieira *et al.* (2014) revised the genus *Watersipora*, consequently many of the species in the genus were elucidated, two new species added, referred *Pachycleithonia nigra* to *Watersipora*, and placed *W. edmondsoni* and *W. subovoidea* into synonymy. All species of *Watersipora* reported from South Africa, namely *W. cucullata* and *W. subovoidea*, were found to be synonyms of *W. subtorquata* (Vieira *et al.* 2014). This species can be easily identified by its large autozooids, operculum with a parallel-sided dark central band, tooth-like condyles, projecting distomedially and orifice wider than long (Vieira *et al.* 2014). Although, *W. subtorquata* may differ across localities as found in Vieira *et al.* (2014) and more material is needed to provide a full diagnosis with other specimens, as it is highly possible that the NHMUK specimen of South African *W. subtorquata* was misidentified.

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Superfamily **Schizoporelloidea** Jullien, 1883

Family Calwellidae MacGillivray, 1887

Genus *Onchoporella* Busk, 1884

Colony foliaceous, unilaminar, strap-like or lobed fronds. Attached by bundles of rhizoids. Ovicell globular.

Type species: *Carbasea bombycina* Busk, 1852 (not *Flustra bombycina* Ellis and Solander, 1786); = *Onchoporella buskii* Harmer, 1923 by synonymy.

Onchoporella buskii (Harmer, 1923)

Carbasea bombycina Busk, 1852: 52 (pl. 48, figs. 4-7).

Onchoporella bombycina Busk, 1884: 104. O'Donoghue, 1924: 39. O'Donoghue and de Watteville, 1944: 423. O'Donoghue, 1957: 86 (figs. 6-7).

Onchoporella buskii Harmer, 1923: 314. Florence *et al.* 2007: 44 (figs. 17G-I, 20L, 21C).

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Material examined

SAMC-A028969, **AFR273 A31599**; SAMC-A077676, **AFR273 A31617**; SAMC-A028994, **AFR273 A31619**; SAMC-A029054, **AFR273 A31631**; SAMC-A028790, SAMC-A028807, **AFR 743**; SAMC-A028940, **AFR 865**; SAMC-A028779, **AFR 866**; SAMC-A077179, **FAL 154**; SAMC-A077445, SAMC-A077446, SAMC-A077447, **FAL 518**; SAMC-A077467, **FAL 618**; SAMC-A077345, **FAL 664**; SAMC-A077227, **FAL 697**; SAMC-A077365, **FAL 735**; SAMC-A073431, **FAL 783**; SAMC-A070074, **SB 197**; SAMC-A028889, **TRA 42**; SAMC-A028856, **TRA 109**; SAMC-A028890, **TRA 113**; SAMC-A028892, **TRA 132**; SAMC-A028855, **TRA 141**; SAMC-A028891, **TRA 3300**; SAMC-A029146, **WCD 30**; SAMC-A029155, **WCD 36**; SAMC-A029068, **WCD 89**; SAMC-A029079, **WCD 101**; SAMC-A029134, **WCD 212**.

<u>Other material examined:</u> *Onchoporella buskii*, NHMUK 2015.4.1.1, Wilderness (33°59′S, 22°35′E), Western Cape Province, South Coast, South Africa, beach cast collected by Ms M.J. Spencer Jones, 15 December 2011.

Substratum, depth and ecology

Grows on other bryozoans or algae. Previous known maximum depth was 60 m, but in this study known depth range was extended from 4-400 m.

Geographic distribution

Endemic to South Africa, reported from Port Nolloth on the west coast to Algoa Bay on the southeast coast.

Remarks

Onchoporella comprises of only two species, *O. buskii* and *O. selenoides* Ortmann, 1890. The South African *O. buskii* can easily be distinguished by the erect, tuft-like colony, unilaminar and dichotomous branching; pyriform-shaped and smooth autozooids multiserially arranged, two short spines present on either proximo-lateral side of the orifice, with two pores present on either side, a lunate median ascopore proximal to primary orifice and globular ovicells.

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Family Gigantoporidae Bassler, 1935

Genus *Gigantopora* Ridley, 1881

Colony encrusting; or erect, vincularian or foliaceous. Frontal wall with numerous pores, closely spaced, and granular surface. Orifice with shallow poster and small condyles in proximal corners. Peristomial spiramen vary in size and associated bridge bearing avicularia. Ovicells hyperstomial, perforated, or fully immersed. Uniporous septula present on vertical walls.

Type species: *Gigantopora lyncoides* Ridley, 1881

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Gigantopora polymorpha (Busk, 1884)

Gephyrophora polymorpha Busk, 1884: 167 (pl. 34, fig. 2).

Adeonella ponticula: O'Donoghue, 1924: 54 (pl. 4, fig. 23).

Gigantopora polymorpha: Brown, 1952: 208 (figs. 145–146). Hayward and Cook, 1979: 81. Hayward and Cook, 1983: 86. Florence *et al.* 2007: 41 (figs. 16A-D, 20C, 21G).

Material examined

SAMC-A028959, **AFR273 A31650**; SAMC-A028787, **AFR 0002**; SAMC-A077572, **FAL 153**; SAMC-A077306, **FAL 154**; SAMC-A073399, **FAL 435**; SAMC-A077641, **FAL 475**; SAMC-A073478, **FAL 503**; SAMC-A077236, SAMC-A077239, **FAL 504**; SAMC-A077303, **FAL 509**; SAMC-A077294, **FAL 570**; SAMC-A077508, **FAL 576**; SAMC-A077276, **FAL 563**; SAMC-A073509, SAMC-A077361, **FAL 602**; SAMC-A073458, **FAL 683**; SAMC-A077478, **FAL 835**; SAMC-A077353, **FAL 846**; SAMC-A029031, **TRA 127**; SAMC-A028839, **TRA 141**; SAMC-A028925, SAMC-A029025, **TRA 151**; SAMC-A029108, SAMC-A077692, **WCD 11**; SAMC-A029158, SAMC-A029162, **WCD 56**.

Other material examined: *Gigantopora foraminosa,* SAMC-A026437 (holotype), station **SM 163/4** (33°04.6'S, 28°06.6'E), Off East London, Southeast Coast, South Africa, RV *Meiring Naude* Survey, heavy dredge, depth 90 m, 26 May 1978.

Substratum, depth and ecology

Mostly grows erect on hard rocky substratum and provides sheltered habitats for small molluscs and polychaete worms. Depth range 4–600 m.

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Geographic distribution

Tertiary fossil specimens of *G. polymorpha* have been reported from New Zealand (Brown 1952), and recent specimens of this species have been reported from South Africa, distributed from Port Nolloth on the west coast to Cape Infanta on the south coast.

Remarks

Gigantopora polymorpha has been well characterised by large rectangular zooids, granular frontal wall with irregularly scattered small pores, orbicular orifice and elongated avicularia directed medially (Florence *et al.* 2007). Gordon (1984) reported extant *G. polymorpha* from New Zealand, however, discrepancies in the frontal wall in New Zealand material, compared to South African material, suggests a misidentification and needs to be re-examined.

Family Lacernidae Jullien, 1888

Genus *Arthropoma* Levinsen, 1909

Colony encrusting. Autozooids with cryptocystidean frontal shield, densely perforated by small pores. Primary orifice with narrow, U-shaped sinus. Spines or avicularia absent.

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Ovicell hyperstomial, prominent, imperforate, recumbent on distally succeeding autozooid; closed by autozooid operculum. Large multiporous septula in vertical walls.

Type species: *Flustra cecilii* Audouin, 1826

Arthropoma cecilii (Audouin, 1826)

Plate 21, A-C

Arthropoma cecilii Audouin, 1826: 239, pl. 8 (fig. 3). Hayward and Ryland, 1979: 190 (fig. 79). Hayward and Cook, 1983: 69.

Schizoporella cecilii: O'Donoghue, 1924: 42. O'Donoghue and de Watteville, 1935: 213.

Material examined

SAMC-A077423, **FAL 415**.

Substratum, depth and ecology

Forms encrusting patches. Depth range from the intertidal (< 10 m) down to 90 m.

Geographic distribution

This species has a widespread distribution in temperate, subtropical and tropical waters of the Atlantic, Indian and western Pacific oceans. Locally reported from the south and east coast.

Remarks

The widely distributed species was previously recorded in Still Bay on the south coast and on the East Coast (O'Donoghue 1924; Hayward and Cook 1983). The distinguishing characteristics included D-shaped orifice with straight proximal border, U-shaped sinus, porous frontal shield and distinct umbo proximal to sinus may form in later ontogeny (Hayward and Ryland 1999). In the current collection, fragmented colonies were found on hard substrate.

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Genus *Rogicka* Uttley and Bullivant, 1972

Colony enrusting. Zooids with convex frontal walls evenly perforated by numerous simple or minutely cribellate pores. Orifice bordered by numerous close-set slender spines. Non-articulated operculum. No avicularia. Ovicells prominent, smooth or evenly perforated, closed by operculum. Multiporous mural septula present.

Type species: *Schizoporella biserialis* Hincks, 1885

Rogicka lioneli (Florence, 2016) comb. nov.

Plate 21, D-F

Arthropoma sp.: Hayward and Cook, 1983: 70 (fig. 17D).

Arthropoma lioneli Florence, 2016: 8 (figs. 1G-I).

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Material examined

SAMC-A077341, **FAL 213;** SAMC-A029139, **FAL 217**; SAMC-A077226, **FAL 697**; Unnumbered specimen, **WCD 87**.

Substratum, depth and ecology

Form encrustations on shells. Depth range 36-95 m.

Geographic distribution

Endemic to South Africa and appears to be restricted to south and southeast coast – reported from False Bay to Port Alfred.

Remarks

Florence (2016) placed this species in the genus *Arthropoma* because of its U-shaped sinus and frontal pores and the current material, by all accounts, agrees with the description and figures of *A. lioneli*. However, the presence of three to six oral spines, small kidney-shaped frontal pores and the finely granular frontal surface of the ovicells rather places the species in the genus *Rogicka* Uttley and Bullivant, 1972.

There are only four *Rogicka* species, namely *R. biserialis* (Hincks, 1885), *R. joannae* Vieira, Gordon, Souza and Haddad, 2010, *R. oceanica* Gordon, 1984 and *R. scopae* (Canu and Bassler, 1928). This is the first known record of *Rogicka* in South Africa, while the other related species have a South Pacific and/or West Atlantic distribution.

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Family Microporellidae Hincks, 1879

Genus *Flustramorpha* Gray, 1872

Remarks

All three species of *Flustramorpha* known from South Africa were present collections. Hayward and Cook (1983:84) discussed morphological differences between the species. *Flustramorpha marginalis* possess avicularia with long setiform mandibles and a palate orientated at an oblique, or perpendicular, angle to the frontal plane, while *F. flabellaris* has short acuminate mandibles and a parallel palate. The distinguishing characteristics for *F. angusta* is a proportionally small, narrower and depressed ovicell, which is progressively obscured by secondary calcification, and a semi-elliptical orifice with a straight proximal border.

Type species: *Flustra marginata* Krauss, 1837

Flustramorpha angusta Hayward and Cook, 1979

Plate 22, A-B, Table 4.17

Flustramorpha angusta Hayward and Cook, 1979: 80 (fig. 11E). Hayward and Cook, 1983: 85 (figs. 20F, H).

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Material examined

SAMC-A028961, **AFR273 A31650**; SAMC-A077335, **FAL 186**; SAMC-A073548, **FAL 222**; SAMC-A073404, SAMC-A077420, SAMC-A077427, **FAL 415**; SAMC-A077433, **FAL 432**; SAMC-A077455, **FAL 445**; SAMC-A077594, **FAL 466**; SAMC-A077443, **FAL 518**; SAMC-A077313, **FAL 641**.

Substratum, depth and ecology

Growing on hard rocky substrata. Previously known from deeper waters (> 300 m), but in this study sampled at 33 m. Extended known depth range 33-384 m.

Geographic distribution

Endemic to South Africa, previously reported only from the East Coast up to the iSimangaliso Wetland Park, but the current material extends its known distribution to include False Bay and Knysna on the South Coast.

Remarks

This species forms slender, strap-like tufts with branch width about 3 mm (Hayward and Cook 1983). Characteristics not described in earlier accounts of *F. angusta* are finely toothed median ascopore and finely serrated proximal border of orifice, and zooids along the frond margin are narrower with raised proximal rim than zooids in the mid section.

Previous accounts of *Flustramorpha* species excluded zooidal measurements, except for *F. angusta*, but a single fragmented colony was described in Hayward and Cook (1979) with average zooid length (0.73 mm) and width (0.47 mm) of 10 measureable zooids. Therefore, seems fitting to indicate measurements for some material in this study (**TABLE 4.17**).

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Table 4.17. Measurements (in millimeters) of *Flustramorpha angusta* material.

	Off Knysna, south coast SAMC-A028961		
Characters	N_T	Average ± SD	Range
Lz	27	0.82 ± 0.052	0.71-0.92
lz	20	0.64 ± 0.040	0.58-0.73
Lo	19	0.10 ± 0.010	0.08-0.12
lo	22	0.16 ± 0.014	0.13-0.19

Flustramorpha marginata (Krauss, 1837)

Plate 22, C-D, Table 4.18

Flustra marginata Krauss, 1837: 35 (fig. 3).

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Flustramorpha marginata: Busk, 1884: 135, pl. 20 (fig. 8). Hayward and Cook, 1979: 80. Hayward and Cook, 1983: 84 (figs. 20B-C).

Material examined

SAMC-A028962, **AFR270 A31418**; SAMC-A029049, **AFR273 A31624**; SAMC-A028797, **AFR 723-5-7**; SAMC-A077643, **FAL 475**; SAMC-A073472, **FAL 503**; SAMC-A077535, **FAL 576**; SAMC-A029019, **TRA 37**; SAMC-A029143, **WCD 217**.

Other material examined: *Flustramorpha marginata*, NHMUK 1872.7.30.3 (holotype), Port Natal (29°52'S, 31°03'E), South Africa, presented by Colonel Bolton, no additional information; NHMUK 1968.1.16.82, South Africa, C.H. O'Donoghue Collection, no additional information; NHMUK 1899.7.1.19-20, South Africa, Busk Collection, no additional information; SAMC-A026639, station **SM 185** (33°39.3'S, 27°11.6'E), Off Port Alfred, Southeast Coast, RV *Meiring Naude* Survey, dredge, depth 90 m, 31 May 1978.

Substratum, depth and ecology

Living on hard rocky substrata and other bryozoans. Depth range 29-880 m.

Geographical distribution

This species has a Southeast Atlantic distribution; including the subantarctic region of Marion Island (Busk 1884; Branch and Hayward 2007). In South Africa, reported south of the Cape Peninsula to the east coast.

Remarks

Gray (1872) referred *Flustra marginata* to a newly erected the genus *Flustramorpha* upon re-examining Krauss's specimens. A research visit to the NHMUK in June 2013, part of the type for *F. marginata* (NHMUK 1899.7.1.466A) was examined, most probably the specimen used by Krauss (1837) and Gray (1872). However, this specimen clearly belonged to *F. flabellaris*. Gray (1872: 169) mentioned that Busk (1854: 91) originally described *Eschara flabellaris* from Algoa Bay, South Africa. The partial type specimen is most probably Busk's (1854) specimen of *Eschara flabellaris* (= *F. flabellaris*), labelled incorrectly as *F. marginata*.

Flustramorpha marginata typically forms a tufted colony of long, semi-flexible, bifurcating, narrow branching; some colonies in the current collections were blue in colour, quite distinct from the other allied species. In *F. marginata* and *F. angusta* the avicularium has a setiform mandible, directed at an oblique or perpendicular angle to the frontal plane (Hayward and Cook 1983). Not described for *F. marginata* in preceding literature were the smooth proximal orificial border and the crescentic ascopore, as wide as it is long, with a toothed rim. These characteristics are unlike those of the other two species.

Zooidal measurements for the holotype were not given in Krauss (1837) therefore this seems fitting to indicate measurements in this study for future comparisons (Table 4.18). This also indicated that *F. angusta* has larger zooids (average 0.82 x 0.64 mm) than *F. marginata*

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(average 0.52 x 0.45 mm), despite its more slender branches – another feature to distinguish between these allied species.

Table 4.18. Measurements (in millimeters) of the holotype *Flustramorpha marginata*.

	Port Natal, East Coast NHMUK 1872.7.30.3		
Characters	N_T	Average ± SD	Range
Lz	7	0.44 ± 0.041	0.40-0.50
lz	6	0.35 ± 0.041	0.30-0.40
Lo	7	0.069 ± 0.0077	0.06-0.08
lo	7	0.11 ± 0.011	0.09-0.13

Flustramorpha flabellaris (Busk, 1854)

Plate 22, E-F

Eschara flabellaris Busk, 1854:91, pl. 107 (figs. 7-10).
Microporella flabellaris Marcus, 1922:28 (fig. 16).
Flustramorpha flabellaris Hayward and Cook, 1983: 84 (fig. 20D).

Material examined

SAMC-A077534**, FAL 576**; SAMC-A073451, **FAL 697**; SAMC-A028885, **TRA 103**; SAMC- A028921, **TRA 151**.

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<u>*Other material examined:*</u> *Flustramorpha marginata* (= *F. flabellaris*), NHMUK 1899.7.1.466A (pt of type), South Africa, no additional information; NHMUK 1899.7.1.467, South Africa, no additional information.

Substratum, depth and ecology

Forming short, broad lobed colonies attached to hard substrata. Known depth range 22-90 m.

Geographic distribution

This species is known only to South Africa. This study presents the first record of *F. flabellaris* in False Bay and Cape Agulhas on the south coast, extending its known distribution range from False Bay to East London on the southeast coast.

Remarks

Unlike the other two species, *F. flabellaris* is distinguished by having a short acute mandible avicularium. Not described in previous accounts of *F. flabellaris* is the finely toothed ascopore, wider than it is long, and finely serrated proximal border of orifice. A specimen of *F. flabellaris* in the NHMUK collection was incorrectly labelled as *F. marginata* (see remarks for

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F. marginata). The material of *F. flabellaris* was in poor condition and covered with silt, precluding accurate zooidal measurements.

Genus *Microporella* Hincks, 1877

Colony encrusting. Porous frontal shield. Orifice with complete or serrated proximal orifice rim. Ascopore simple or cribellate. Avicularia and oral spines present. Ovicell prominent, frequently subimmersed. Well-developed basal pore chambers.

Type species: *Eschara ciliata* Pallas, 1766

Microporella lezinyosi sp. nov.

Plate 23, A-D, Table 4.19

Material examined

Holotype: SAMC-A028947, station **AFR273 A31605** (34°25'22.4"S, 22°52'58.7"E), Off Mossel Bay, South Coast, South Africa, trawl, depth 100-102 m, 16 April 2011.

Additional material: SAMC-A028810, **AFR 728**; Unnumbered specimen, **AFR 9670**; SAMC-A077194, **FAL 256**; SAMC-A073462, **FAL 305**; SAMC-A077623, SAMC-A077627, SAMC-A077637, **FAL 475**; SAMC-A077238, **FAL 504**; SAMC-A077490, SAMC-A077536, SAMC-A077511, **FAL 576**; SAMC-A077324, **FAL 818**; SAMC-A029086, **WCD 11**.

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Etymology

Lezinyosi (Zulu) – Meaning "honeycomb", referring to the reticulate ascopore resembling a honeycomb structure.

Description

Colony encrusting. Zooids polygonal and tapered proximally, frontal wall comprises of thick tubercles and numerous small perforations. Orifice D-shaped with a smooth proximal border, 3-4 distal oral spines. Ascopore lunate to large, reticulate, with a rim; may be raised proximally. Avicularia single, sometimes paired, generally situated immediately proximal to the ascopore on one or both sides, with complete cross-bar, triangular rostrum directed laterally, obliquely distal or obliquely forward. Ovicell prominent, imperforate except for row of marginal areolae around the periphery; a tall stout-like peristome arching over the ascopore, but not enclosing it; a pair of oral spines at the inner corners of the peristome.

Substratum, depth and ecology

Forms unilaminar patches on hard substrata, including bryozoans. Known depth range 4-272 m.

Geographic distribution

Sampled on the west coast, off the Western Cape border, to Mossel Bay on the south coast.

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Remarks

The description of two small colonies *Microporella* sp. in Hayward and Cook (1983: 82) closely agrees with the current material due to 3-4 distal oral spines, shape of orifice and position of adventitious avicularium, but the current specimens have developed ovicells and a distinct proximal peristomial bar, potentially an ontogenetic variance. The current material closely agrees with the description of *M. agonistes* Gordon, 1984 from New Zealand, however, discrepancies of the frontal wall are noted in figures *M. agonistes* in Gordon (1984: 183, plate 37, D-E, 1989: 139, plate 31, A). These noticeable differences in the figures suggest that the species are different. The current specimens resemble *M. agonistes* as figured in Gordon (1989) and may warrant molecular research with South African material, but differs from it by having larger zooids, ascopore with raised proximal rim, paired oral spine bases lateral of the orifice in ovicelled zooids, and apertural bar. These characteristics appear distinct from other known *Microporella* species in South Africa and warrant the erection of this new species.

Table 4.19. Measurements (in millimeteres) of holotype ***Microporella lezinyosi*** sp. nov. material.

	Off Mossel Bay, South Coast SAMC-A028947		
Characters	N_T	Average ± SD	Range
Lz	7	0.65 ± 0.06	0.57-0.74
lz	7	0.51 ± 0.04	0.45-0.57
Lo	4	0.23 ± 0.02	0.21-0.24
lo	6	0.30 ± 0.02	0.27-0.31
Ladav	7	0.40 ± 0.03	0.36-0.43
ladav	7	0.09 ± 0.01	0.08-0.11

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Microporella madiba Florence, Hayward and Gibbons, 2007

Microporella madiba Florence *et al.*, 2007: 43 (figs. 17A-C).

Material examined

SAMC-A077310, **FAL 621**.

Substratum, depth and ecology

Forms small encrustations on the shells of mussels. This species is known to occur in shallow waters (< 30 m). In this study material was sampled down to 26 m; extending its known depth range 4-26 m.

Geographic distribution

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Endemic to South Africa. Previously known only from Robben Island on the west coast, but this study extended its known distribution eastwards to False Bay, off Fish Hoek, on the South Africa.

Remarks

Diagnostic characteristics of *M. madiba* include the straight proximal border of the orifice, 2-4 distal oral spines and paired adventitious avicularia lateral to, or almost proximal to orifice, with long setiform mandibles directed distally. A single colony was found in this study and is congruent with the description and figures of *M. madiba*.

This genus is considered as one of the most speciose amongst bryozoans containing more than 120 species, however, problematic species-level taxonomy of these species have hindered the ‘true’ account of species richness within the genus (Harmelin *et al.* 2011). Only two known *Microporella* species exist in South Africa, of which one is a new species from this study, ***Microporella lezinyosii*** sp. nov.

Family Schizoporellidae Jullien, 1883

Superfamily **Celleporoidea** Johnston, 1838

Family Celleporidae Johnston, 1838

Genus *Turbicellepora* Ryland, 1963

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Colony encrusting, mamillate to nodular and massive; or erect and irregularly branched; multilaminar with variable autozooid orientation. Cryptocystidean frontal shield with few, often inconspicuous marginal pores. Lateral suboral avicularia distinct; additional adventitious and/or vicarious avicularia present, often abundant, frequently polymorphic. Ovicell hyperstomial, prominent, perforate, not closed by autozooidal operculum. Basal pore chambers present.

Type species: *Cellepora coronopus* Wood, 1844

Turbicellepora conica (Busk, 1884)

Cellepora conica Busk, 1884: 203 (pl. 28, fig. 10; pl. 36, fig. 1).

Cellepora conica: Hayward and Cook, 1983: 123 (figs. 31E-F).

Material examined

SAMC-A077419, **FAL 372**; SAMC-A077254, **FAL 503**; SAMC-A077607, **FAL 525**; SAMC-A077279, **FAL 563**; SAMC-A077507, SAMC-A077522, **FAL 576**; SAMC-A073510, **FAL 608**; SAMC-A077346, **FAL 664**; SAMC-A029024, **TRA 151**.

Substratum, depth and ecology

Forming small nodules on erect substrata. Depth range is 13-90 m.

Geographic distribution

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Endemic to South Africa. This species appears to be restricted to the south and southeast coast, from False Bay to East London.

Remarks

The small nodules may also develop into a branching colony with a stellate appearance. The peristome completely encircles the orifice, four or five small avicularia often grouped along the peristome rim in later ontogeny; the peristome may develop into cylindrical structure on the surface (Hayward and Cook 1983).

Turbicellepora protensa Hayward and Cook, 1979

Turbicellepora protensa Hayward and Cook, 1979: 96 (figs. 15E-H).

Material examined

SAMC-A029046, **AFR273 A31680**; SAMC-A028783, **AFR 787**.

<u>*Other material examined:*</u> *Turbicellepora protensa*, SAMC-A026301 (holotype), station **SM 86** (27°59.5'S, 32°40.8'E), St. Lucia MPA, East Coast, RV *Meiring Naude* Survey, heavy dredge, depth 550 m, 22 May 1975.

Substratum, depth and ecology

Forming erect, branching colonies, attached by a small encrusting base on hard substrata. Previously known to occur in deeper waters (400-880 m), but in this study found at depths from 102 m, therefore the extended known depth range is 102-880 m.

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Geographic distribution

Previously only reported from the east coast, but in this study, the distribution range extended westwards to include the south coast, off Cape Agulhas, and near Jacob's Bay on the west coast.

Remarks

Hayward and Cook (1979) noted that the appearance of the colony changes as continuous frontal budding produce multilaminar colonies. The type specimen (SAMC-A026301) is a young colony, and the specimens in this collection were older colonies, with some orifices deeply immersed in peristome.

Turbicellepora valligera Hayward and Cook, 1983

Plate 23, E-F

Turbicellepora valligera Hayward and Cook, 1983: 124 (figs. 31G-H). Florence *et al.* 2007: 48 (figs. 18H-K).

Material examined

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SAMC-A028782, **AFR 866**; SAMC-A077593, **FAL 15**; SAMC-A077563, **FAL 25**; SAMC-A077173, **FAL 122**; SAMC-A077175, **FAL 126**; SAMC-A077172, SAMC-A077183, **FAL 141**; SAMC-A077177, **FAL 161**; SAMC-A077405, **FAL 213**; SAMC-A077199, **FAL 218**; SAMC-A077376, **FAL 222**; SAMC-A077186, **FAL 233**; SAMC-A073437, **FAL 303**; SAMC-A073436, **FAL 305**; SAMC-A073433, **FAL 307**; SAMC-A073434, **FAL 330**; SAMC-A077263, **FAL 331**; SAMC-A077413, **FAL 361**; SAMC-A077212, **FAL 363**; SAMC-A073409, **FAL 389**; SAMC-A077421, **FAL 415**; SAMC-A077583, SAMC-A077569, **FAL 466**; SAMC-A077616, SAMC-A077633, SAMC-A077642, **FAL 475**; SAMC-A077244, **FAL 503**; SAMC-A073481, **FAL 504**; SAMC-A077613, **FAL 524**; SAMC-A077606, **FAL 525**; SAMC-A077277, **FAL 563**; SAMC-A077295, **FAL 570**; SAMC-A077487, SAMC-A077500, SAMC-A077512, SAMC-A077539, **FAL 576**; SAMC-A077546, SAMC-A077548, **FAL 577**; SAMC-A073514, **FAL 602**; SAMC-A077383, **FAL 614**; SAMC-A077466, **FAL 618**; SAMC-A077223, **FAL 621**; SAMC-A073493, **FAL 622**; SAMC-A077468, SAMC-A077470, **FAL 632**; SAMC-A073511, **FAL 635**; SAMC-A077225, **FAL 683**; SAMC-A077214, **FAL 708**; SAMC-A073423, **FAL 777**; SAMC-A077389, **FAL 807**; SAMC-A070076, **SB 197**; SAMC-A028873, **TRA 71**; Unnumbered specimen, **TRA 94**; SAMC-A028874, **TRA 116**; SAMC-A028911, **TRA 120**; Unnumbered specimen, **TRA 127**; SAMC-A029098, **WCD 11**; SAMC-A029126, **WCD 18**; SAMC-A029148, **WCD 32**; SAMC-A029160, **WCD 56**.

Other material examined: *Turbicellepora valligera*, SAMC-A026455 (holotype), station **SM 163** (33°04.6'S, 28°06.6'E), Off East London, Southeast Coast, RV *Meiring Naude* Survey, heavy dredge, depth 90 m, 26 May 1978.

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Substratum, depth and ecology

Forms erect growths on hard rocky substrata, sometimes forming large colonies. Extended known depth range is 4-110 m.

Geographic distribution

Endemic to South Africa. Reported from Port Nolloth on the west coast to the east coast.

Remarks

The erect, rigid, and thickened colony, often branching species was commonly found in this study in the False Bay area on the south coast. This species can be distinguished by the deep V-shaped poster, immersed by a peristomial rim peaked medially or forming one or two processes, paired cylindrical avicularia lateral to the orifice, and ovicell irregularly shaped, mostly oval, with numerous small pores (Hayward and Cook 1983). These characteristics are congruent with the current specimens and when compared to the holotype specimen in the Bryozoa collection.

Family Phidoloporidae Gabb and Horn, 1862

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Remarks

Phidoloporids have complex colony morphology (Hayward 2000). Colony structure of species within Phidoloporidae have bilaminate, fenestrate sheets of zooids, consisting each of a frontal layer of autozooids and basal surface layer of kenozooids; these sheets are usually intricately folded and anastomosing, regularly or irregularly forming three-dimensional colonies (Hayward 2000). The phidoloporid genera reported in Hayward (1999), namely *Triphyllozoon*, *Reteporella* and *Reteporellina*, were distinguished mainly by features of the ovicell and peristome. Previously, no known species of *Triphyllozoon* and *Reteporellina* were reported from South Africa, but of value to mention the diagnostic features due to difficulty in discriminating between genera.

In *Reteporella*, the ovicell usually has a single median frontal fissure, without cross-connections, and often there is a lip or labellum, overhanging its aperture (Hayward 1999). In *Triphyllozoon*, the ovicell has a distinctive trilobed frontal fissure, with numerous cross-connecting struts forming sieve-like structure (Hayward 1999). The ovicell in *Reteporellina* is small and pyriform; some species have a short frontal fissure, but in all, the aperture has a narrow labellum and lateral flaps that are distinctive (Hayward 1999).

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Genus *Phidolopora* Gabb and Horn, 1862

Colony erect, branching, fenestrate. Zooids opening on one face, few areolar pores, proximal and lateral. Primary orifice beaded, transversely oval with a weak sinus and indistinct condyles; secondary orifice with sinus or spiramen. Oral spines present. Avicularia suboral, frontal and basal, sometimes infrequent. Ovicell widely open proximally, no fissure present, but often with a median convexity.

Type species: *Phidolopora labiata* Gabb and Horn, 1862

Phidolopora cyclops sp. nov.

Plate 24, A-C

Material examined

Holotype: SAMC-A029097, station **WCD 11** (34°9.4'S, 18°16.5'E), Off Kommetjie, West of Cape Peninsula, UCT Ecological Survey, dredge, depth 75 m, 24 March 1959.

Additional material: SAMC-A073471, **FAL 504**; SAMC-A073516, **FAL 602**; SAMC-A028898, **TRA 119**.

Etymology

Cyclops (L.) – Derived from Greek (*Kuklōps*), the one-eyed giant from Greek mythology, referring to the median convexity of the ovicell.

Description

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Colony erect, fenestrate. Zooids frontal wall smooth, separated by conspicuous raised lines (vibices) fromtally and basally, 1-4 areolae proximally and/or laterally. Primary orifice beaded, transversely oval with weak sinus and indistinct condyles; secondary orifice with weak pseudosinus. No oral spines observed. Avicularia of two types – commonly a small oval to rounded avicularium with complete or incomplete cross-bar, suboral; rarely a large frontally projecting avicularium occupying most of the frontal wall, triangular rostrum prominently hooked. Kenozooids bordering the fenestrae; basal surface with up to five marginal areolae and similar types of avicularia, rarely more than one avicularia. Ovicell recumbent, widely open proximally, becoming immersed in secondary calcification, lacking frontal fissure, proximal rim usually with a median projection.

Substratum, depth and ecology

Forming erect colonies on hard rocky substrata, providing habitats for polychaetes and brittle stars. Depth range 40-75 m.

Geographic distribution

Only known from South Africa, near Kommetjie west of the Cape Peninsula and False Bay on the south coast.

Remarks

Phidolopora is a small genus comprising of only a few species (Gordon 1989). The current specimens were confidently placed in *Phidolopora*, characterised by its branching, fenestrate colony, sinuate orifice and the distinct ovicell with median convexity. This is the first record of *Phidolopora* from South Africa.

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The current specimens closely resemble *P. avicularis* MacGillivray, 1883 found in southeastern Australia and New Zealand. However, differs from it by lacking oral spines and a median spiramen. These characteristics distinguish the current material from other species and therefore, warrant the erection of this new species. Although, these specimens have distinct sutures, the secondary calcification does not allow for accurate zooidal measurements.

Genus *Reteporella* Busk, 1884

Colony erect, branching, typically reticulate, with branches (trabeculae) fusing regularly forming elongated spaces (fenestrulae) between. In few species, the trabeculae do not fuse, and may form infrequent anastomoses. Colony structure varies from tree-like, to a reticulated cup, or fenestrate sheets folded and anastomosing forming three-dimensional structures. Autozooids alternating in longitudinal series on frontal surface of colony; basal surface consisting of kenozooids separated by distinct sutures, bearing adventitious avicularia, or rarely consisting of a second layer of autozooids. Frontal wall of autozooids imperforate, with widely spaced marginal pores. Primary orifice oval or bell-shaped, proximal border concave below condyles. Oral spines present or absent. Peristome typically assymetrical proximally,

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with a prominent lip, often with a slit or fissure which partly closes a labial pore. Polymorphic adventitious avicularia, usually numerous; positioned peristomial, frontal and suboral. Enlarged avicularia present in most species. Ovicell prominent, hyperstomial, not closed by operculum, with variously developed longitudinal frontal fissure, sometimes hidden by short labellum. Mural septula present.

Type species: *Reteporella flabellata* Busk, 1884

Reteporella cf. *bullata* (Hayward and Cook, 1979)

Sertella bullata Hayward and Cook, 1979: 92 (figs. 15A-D).

Material examined

SAMC-A028794, **AFR 7071**; SAMC-A028798, **AFR 935**.

Substratum, depth and ecology

Erect colonies grow on hard rocky substrata. Previously known to occur in deeper waters (> 300 m), but in this study, material was sampled at 88 m, therefore extending its known depth range from 88-880 m.

Geographic distribution

Endemic to South Africa, previously reported only from east coast to near iSimangaliso Park, but in this study, distribution range extends to include the west coast.

Remarks

Reteporella bullata may be distinguished by the large-sized ovicell, shape of the avicularia and the papillose basal surface. In the current material, no ovicells were observed, but the nature and shape of the colony, thin peristome with flared distal edge and narrow median fissure, adventitious avicularia usually present along the margin becoming numerous in older zooids and papillose basal surface agrees with the description for *R. bullata*. However, without ovicells and a voucher or type specimen to validate the identification, this species will be provisionally assigned to *R. bullata*.

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Reteporella ilala sp. nov.

Plate 24, D-F; Plate 26, E-F, Table 4.20

Material examined

Holotype: SAMC-A028986, station **AFR273 A31624** (33°48'24"S, 25°56'48"E), Algoa Bay, Southeast Coast, South Africa, South Coast Demersal Survey, trawl, depth 45 m, 21 April 2011.

Additional material: SAMC-A028945, **AFR273 A31605**; SAMC-A029047, **AFR273 A31624**; SAMC-A073533, SAMC-A077209, SAMC-A077582, **FAL 42**; SAMC-A073438, **FAL 330**; SAMC-A077624, **FAL 475**; SAMC-A073464, **FAL 504**; SAMC-A077496, SAMC-

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A077526, **FAL 576**; SAMC-A077460, **FAL 603**; SAMC-A028899, **TRA 31**; SAMC-A029069, SAMC-A029168, **WCD 6**; SAMC-A029107, **WCD 11**; SAMC-A029149, SAMC-A029150, **WCD 32**; SAMC-A029119, **WCD 159**.

Other material examined: *Reteporella clancularia*, SAMC-A026304 (holotype), station **SM 23** (27°44.4'S, 32°42.8'E), Off iSimangaliso Park, East Coast, South Africa, RV *Meiring Naude* Survey, heavy dredge, depth 400-450 m, 26 May 1975; *R. dinotorhynchus*, SAMC-A026305 (holotype), same station locality.

Etymology

Ilala (Zulu) – A native palm tree in South Africa, used in hand woven palm baskets by Zulu people. The shape of the baskets resembles the distinct shape of a young colony of this species.

Description

Colony erect, rigid, forming a deep cup-shape, irregularly folded, but few anastomoses. Irregularly oval fenestrulae, 1.05 x 0.57 mm, sparsely spaced; trabeculae about 1.18 mm wide. Autozooids diamond-shaped at growing edge, slightly convex, separated by indistinct sutures. Frontal calcification finely granular, with conspicuous marginal pores, 4-6 marginal pores in zooids at the growing edge, frontal pores may develop. Primary orifice with paired distal processes only clearly visible at growing edge, obscured in early ontogeny by a deep proximal peristome, orifice wider than long, proximal border nearly straight or shallowly concave, beaded distal border, indistinct condyles, only visible at growing edge. Oral spines absent. Proximal peristome deep, developing a suboral avicularium, with a bluntly triangular rostrum and complete cross-bar, in early development a U-shaped pseudosinus formed by the suboral avicularium, sometimes closes over to form a pseudospiramen to one side. Small frontal avicularia, oval to rounded, with complete cross-bar. Ovicell inconspicuous, immersed in secondary calcification, possess a pronounced, short median labellum. Basal surface of colony with thickened sutures, bearing numerous oval avicularia; larger avicularia may occur along the inner edges of the fenestrulae, similar to smaller frontal type.

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Substratum, depth and ecology

Forming erect, rigid colonies on hard rocky substrata. Depth range 21.5-102 m.

Geographic distribution

Sampled west of the Cape Peninsula near Kommetjie to False Bay and Arniston on the south coast.

Remarks

Most of the current material were fragmented or young colonies, except for one colony (SAMC-A028986) that had a large, deep cup-shaped form about 10 cm in height (see Plate 23, E-F). This species clearly belong to *Reteporella* characterised by its colony shape with fenestrulae, alternating series of zooids, primary orifice oval with concave proximal border and

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condyles, well-developed peristome that obscures the orifice, forming a pseudosinus and polymorphic adventitious avicularia. This species closely resembles *R. ligulata* Gordon, 1989 in frontal surface texture, marginal pores, broad primary orifice with almost straight proximal border, and frontal avicularia. Current material differs from R. ligulata by its asymmetric pseudosinus, usually one kind of frontal avicularia (as opposed to three kinds) and in its cup-shaped colony growth form (as opposed to an erect, reticulated colony). Diagnostic characteristics include small size of fenestrulae, the suboral avicularia forming a pseudosinus to one side of the proximal peristome and types of avicularia.

Table 4.20. Measurements (in millimeteres) of holotype ***Reteporella ilala*** sp. nov. material.

	Algoa Bay, Southeast Coast SAMC-A028986		
Characters	N_T	Average ± SD	Range
Lz	11	0.60 ± 0.07	0.51-0.72
lz	11	0.57 ± 0.04	0.51-0.62
Ladav	10	0.11 ± 0.04	0.07-0.16
ladav	11	0.07 ± 0.01	0.05-0.08

Reteporella lata (Busk, 1884)

Plate 26, D

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Sertella lata Busk, 1884: 115 (pl. 27, fig. 1). Hayward and Cook, 1983: 105 (figs. 24F-G).

Reteporella lata: Florence *et al.* 2007: 52 (figs. 19E-G, 21E).

Material examined

SAMC-A029061, **AFR273 A31605**; SAMC-A029043, **AFR273 A31617**; SAMC-A029034, **AFR273 A31624**; SAMC-A029045, **AFR273 A31639**; SAMC-A029036, SAMC-A029042, **AFR273 A31680**; SAMC-A028795, **AFR 9670**; SAMC-A073535, **FAL 96**; SAMC-A077340, **FAL 208**; SAMC-A073444, **FAL 330**; SAMC-A077368, **FAL 363**; SAMC-A073484, **FAL 368**; SAMC-A073467, **FAL 503**; SAMC-A077501, **FAL 576**; SAMC-A077463, **FAL 603**; SAMC-A028897, **TRA 31**; SAMC-A028857, **TRA 33**; SAMC-A028896, **TRA 56**; SAMC-A028894, **TRA 103**; SAMC-A028900, **TRA 118**; SAMC-A028901, **TRA 3300**; SAMC-A029073, SAMC-A029076, **WCD 6**; SAMC-A029070, **WCD 71**; SAMC-A029114, **WCD 159**; SAMC-A029121, **WCD 165**.

Substratum, depth and ecology

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Forming erect colonies attached to hard substrata providing habitats for other small crustaceans and polychaetes. Previously known to occur in depths down to 100 m, but in this study, depth range extends from 4-110 m.

Geographic distribution

Endemic to South Africa. Known previously from Oudekraal on the southwest coast to East London on the southeast coast. In this study, the distribution range was extended westwards to include Saldanha Bay on the west coast.

Remarks

The most characteristic feature of *R. lata* is the pear-shaped ovicell with its very long labellum (Hayward and Cook 1983).

Genus *Rhynchozoon* Hincks, 1895

Colony encrusting. Often multilayered colonies, with recumbent to suberect autozooids. Frontal wall of autozooid typically smooth, with marginal pores. Orifice suborbicular to cleithridiate, with a variable sinus, beaded distal border, condyles present. Peristome usually with an assymetrical pseudosinus, and bearing a columnar mucro, a suboral avicularium, or both. Additional adventitious avicularia present. Ovicell usually subimmersed in frontal calcification, imperforate, with a smooth frontal area and often a labellum. Small basal pore-chambers present.

Type species: *Lepralia bispinosa* Johnston, 1847

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Rhynchozoon beatulum Hayward and Cook, 1983

Rhynchozoon beatulum Hayward and Cook, 1983:113 (fig. 28).

Material examined

SAMC-A028996, SAMC-A029048, SAMC-A029051, **AFR273 A31624**.

<u>*Other material examined:*</u> *Rhynchozoon beatulum*, SAMC-A026449 (holotype), station **SM 163** (33°04.6'S, 28°06.6'E), Off East London, Southeast Coast, South Africa, RV *Meiring Naude* Survey, heavy dredge, depth 90 m, 26 May 1978.

Substratum, depth and ecology

Forming sheet-like encrustations. Previously known from 80-90 m, but in this study sampled at 45 m.

Geographic distribution

This species is endemic to South Africa and appears to be restricted to the southeast coast.

Remarks

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Distinct marginal pores remain even in later ontogeny and an apically developed umbo with a laterally directed sub-oral avicularium distinguishes this species.

Rhynchozoon documentum Hayward and Cook, 1983

Plate 25, A-C

Rhynchozoon documentum Hayward and Cook, 1983: 110 (figs. 26B-C).

Material examined

SAMC-A029053, **AFR273 A31624**.

Other material examined: *Rhynchozoon documentum*, SAMC-A026448 (holotype), station **SM 163/4** (33°04.6'S, 28°06.6'E), Off East London, Southeast Coast, South Africa, RV *Meiring Naude* Survey, heavy dredge, depth 90 m, 26 May 1978.

Substratum, depth and ecology

Forming encrustations on hard rocky substrata. Extended depth range from 45 m down to 90 m.

Geographic distribution

This species is from the southeast coast of South Africa.

Remarks

Characteristic of this species are the marginal pores appearing as elongate tubular structures associated with numerous small adventitious avicularia in later ontogeny. This is congruent with the current material and when compared to the holotype specimen in the Bryozoa collection.

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Rhynchozoon ptarmicum Hayward and Cook, 1983

Rhynchozoon ptarmicum Hayward and Cook, 1983: 118 (fig. 30).

Material examined

SAMC-A028801, SAMC-A028942, **AFR 888**; SAMC-A073552, **FAL 368**; SAMC-A028926, **TRA 151**.

Other material examined: *Rhynchozoon ptarmicum*, SAMC-A026453 (holotype), station **SM 179** (33°30.3'S, 27°22.1'E), Off Great Fish River Mouth, Southeast Coast, South Africa, dredged, depth 80 m, 29 May 1978.

Substratum, depth and ecology

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Forms thick encrustations on rocky hard substrata. Previously known to occur in deeper waters (> 80 m), but in this study found in shallower waters, extending its known depth range from 22-200 m.

Geographic distribution

Previously reported only from the southeast coast, but in this study, material was sampled from False Bay on the south coast, extending its known distribution range westwards.

Remarks

The uncinate process is variably developed in *Rhynchozoon* species, from an inconspicuous structure in *R. incallidum* to the massive development seen in *R. oscitans* and *R. stomachosum* (Hayward and Cook 1983). However, there is no uncinate process in *R. ptarmicum*, doubting the validity of this species assigned to *Rhynchozoon* (Hayward and Cook 1983). Although, later stages of ontogeny are often subjected to great variation within a single colony, and cannot be used as reliable taxonomic characters (Hayward and Cook 1983). This species will remain in *Rhynchozoon* until further investigation of the phidoloporid genera. The current material agrees with the description and when compared to the holotype material in the Bryozoa collection.

Rhynchozoon stomachosum Hayward and Cook, 1983

Rhynchozoon stomachosum Hayward and Cook, 1983: 116 (figs. 27I-K, 29C).

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Material examined

SAMC-A028952, **AFR273 A31624**.

<u>Other material examined</u>: *Rhynchozoon stomachosum*, SAMC-A026452 (holotype), station **SM 234** (32°15'S, 29°09.1'E), Near Dwesa-Cwebe Wildlife Reserve and Marine Sanctuary, Southeast Coast, South Africa, double beam trawl, depth 500-520 m, 25 June 1979.

Substratum, depth and ecology

Forming thick, multilaminar encrustations on hard rocky substrata. Previously sampled from deeper waters 500-520 m, but the current material extended the known depth range from 44 m.

Geographic distribution

Known from the southeast coast of South Africa.

Remarks

Characterised by the large and conspicuous uncinate process, variable peristome typically forming a columnar proximomedially umbo and knobbed granular surface (Hayward and Cook 1983).

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Genus *Schizoretepora* Gregory, 1893

Colony erect, unilaminar, dichotomous branching, reteporiform. Zooids arranged multiserially with orifices opening on one side. Frontal wall imperforate, with few marginal pores, usually bearing one adventitious avicularium. Orifice with deep pseudosinus. Oral spines absent. Ovicell recumbent on the frontal wall of the distal zooid and later becomes (partly) immersed by secondary calcification in later ontogeny. Ooecium large, with semicircular slit. Large avicularia present on the basal surface of the colony.

Type species: *Retepora tessallata* Hincks, 1878

Schizoretepora tessellata (Hincks, 1878)

Retepora tessellata Hincks, 1878: 358 (pl. 19, figs. 9-12). Busk, 1884: 112 (pl. 27, fig. 8). O'Donoghue and de Watteville, 1935: 210; 1937: 15. O'Donoghue, 1957: 91.

Schizoretepora tessellata: Hayward and Cook, 1983: 106 (fig. 24H). Florence *et al.* 2007: 48 (figs. 19A-D, 21H).

Material examined

SAMC-A028995, **AFR273 A31624**; SAMC-A028796, **AFR 723-5-7**; SAMC-A028792, **AFR 736**; SAMC-A077556, **FAL 21**; SAMC-A077559, **FAL 42**; SAMC-A077287, **FAL 79**; SAMC-A077298, **FAL 96**; SAMC-A073538, **FAL 133**; SAMC-A073553, **FAL 141**; SAMC-A073541, SAMC-A073554, **FAL 154**; SAMC-A077333, **FAL 213**; SAMC-A077191, **FAL 236**; SAMC-A077187, **FAL 274**; SAMC-A073542, **FAL 278**; SAMC-A073443, **FAL 302**; SAMC-A073513, **FAL 353**; SAMC-A073491, **FAL 366**; SAMC-A077305, **FAL 368**; SAMC-A077229, **FAL 504**; SAMC-A077291, **FAL 573**; SAMC-A077462, **FAL 603**; SAMC-A077595, **FAL 846**; SAMC-A073383, SAMC-A073384, **LB 17**; SAMC-A028893, **TRA 93**; SAMC-A028902, **TRA 127**; SAMC-A028903, **TRA 141**; SAMC-A028923, SAMC-A028932, **TRA 151**; SAMC-A029103, **WCD 11**; SAMC-A029159, **WCD 56**.

Substratum, depth and ecology

Erect colonies growing on rocky substrate that provide habitats for other invertebrates like hydroids and polychaetes. Previously known depth range was 4-100 m, but this study the extended depth range was from 2-366 m.

Geographic distribution

Commonly found in South Africa, also reported from Australia.

Remarks

Schizoretepora tessellata has a smooth proximal orifice rim and minimally developed peristome. This species shows remarkable variation in colony morphology – colony erect, unilaminar and fenestrate or bilaminar and sheet-like colonies, or both in the same colony also

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seen in preceding accounts (Hayward and Cook 1983; Florence *et al.* 2007). These variations were also seen in the current study.

Schizoretepora was revised by Zágoršek *et al.* (2015), but the diagnosis included the absence of oral spines, which are clearly present in *S. tessellata*. Oral spines may not be a reliable diagnostic characteristic for this genus, but this needs to be re-examined.

Genus *Triphyllozoon* Canu and Bassler, 1917

Colony generally erect, reticulate, forming a lacey network with zooids opening on one side of the branches, and with extrazooidal calcification on the basal side; colony attachment by thickened extrazooidal calcification at proximal portion. Zooid frontal with marginal pores only, surface smooth or pustulose. Zooid orifice with a sinuate or orbicular orifice; primary orifice often obscured by thickening frontal calcification. A tubular pseudospiramen may develop on the proximal side of the peristome by coalescence of the marginal processes. Ovicells hyperstomial; prominent. Articulated oral spines may be present. Proximal margin of ovicell straight. Ovicell frontal with complex trifoliate dentate fissure. Avicularia of varied types; mainly adventitious, with interzooidal avicularia, usually at the proximal margin of a fenestra.

Type species: *Retepora monilifera* MacGillivray, 1860

Triphyllozoon sp.

Plate 25, D-F

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Material examined

SAMC-A028793, **AFR 730**; SAMC-A028791, **AFR 736**; SAMC-A028905, **TRA 73**.

Description

Colony erect, reticulate, forming a lacey network, zooids opening on one side of the branches, extrazooidal calcification on the basal side; basal attachment thickened by extrazooidal calcification. Elongated zooids, frontal wall smooth with few marginal pores. Orifice sinuate with frontal thickening, forming a peristome, along half the lateral sides of the orifice and proximally, marginal processes developing along the peristome. Paired oral spine bases. Ovicells hyperstomial, prominent, with trifoliate fissure. Adventitious avicularia sporadic, mandible acute triangular.

Substratum, depth and ecology

Forming erect colonies, attached to hard substrata by calcified proximal portion. Depth range 201-459 m.

Geographic distribution

Sampled off Hondeklip Bay and Lambert’s Bay on the west coast of South Africa.

Remarks

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Although the current material was fragmented and one damaged ovicell observed, the nature of this colony and zooidal features confidently place these specimens in the genus *Triphyllozoon*. This is the first known *Triphyllozoon* sp. recorded from South Africa. However, the identity remains in doubt as descriptions of known *Triphyllozoon* species and more material are required for an accurate diagnosis.

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CHAPTER 5. SPECIES RICHNESS AND BIOGEOGRAPHICAL DISTRIBUTION PATTERNS OF SOUTH AFRICAN BRYOZOA

1. Introduction

This chapter deals with species richness and biogeographical distribution patterns in South African bryozoans along the coastline. Species richness is the number of species in a community, landscape or region, and does not take into account species abundance or relative abundance (Colwell 2009). The best estimation of species richness is based on samples, and as the number of samples increase, the rate of discovery of new species declines steadily, with the assumption that sampling effort at locations is equal (Colwell 2009). In most cases, species richness in a community has not been fully inventoried or has been inventoried with unequal effort (Gotelli and Colwell 2001; Colwell 2009). Standardising data sets by area or sampling effort may produce very different results compared to standardising the number of individuals collected, and may influence observed biogeographical distribution patterns in species (Gotelli and Colwell 2001).

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Biogeography is defined as the study of species richness in an attempt to understand both past and present biological and spatial (geographic) distributions (Lourie and Vincent 2004; Lomolino *et al.* 2006). This includes the study of all patterns of geographic variations in nature – from genes to biological communities to ecosystems – and other elements of biological diversity or species richness across various gradients, for example area, isolation (such as island systems), latitude, depth (bathymetry) and elevation, and other aspects of macroecology (Lomolino *et al.* 2006; Tittensor *et al.* 2010). Although, the most dramatic gradients in species richness across the biosphere are latitudinal gradients, and between marine and terrestrial environments (Wiens 2011).

1.1. Species richness gradients

1.1.1. Latitudinal gradients

Large-scale latitudinal species richness gradients are well-described in terrestrial ecology (Clarke and Lidgard 2000; Tittensor *et al.* 2010). One of the most striking spatial patterns is the marked cline – but not necessarily linear – of high species richness at low latitudes (tropics), as seen in animals and plants in the tropics (Blackburn and Gaston 1996; Pemberton 1998; Qian 1999). Similar patterns have been reported for marine biota, where this trend in latitude has been described for East Atlantic fish populations (Macpherson and Duarte 1994; Kendall and Haedrich 2006), echinoderms and decapods (O’Hara and Poore 2000). Contrastingly, some marine taxa exhibit low species richness towards the tropics, such as benthic polychaetes (Hernandez *et al.* 2005), free-living nematodes (Lee and Riveros 2012),

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algae (Santelices and Marquet 1998) and peracarid crustaceans (Rivadeneira *et al.* 2011). However, latitudinal gradient species richness patterns cannot be generalised globally and a cline in species richness to the tropics is well-documented for regional spatial patterns in the Northern Hemisphere (Colwell and Hurtt 1994; Gaston and Chown 1999).

Our understanding of patterns in marine diversity on a global scale is limited and recently received more attention (Costello *et al.* 2010; Tittensor *et al.* 2010). In contrast to terrestrial latitudinal gradients, Tittensor *et al.* (2010) found two distinct spatial patterns of more than 11000 species across 13 marine taxa from zooplankton to marine mammals. Clear latitudinal gradients exist along the coastline of continents in primarily coastal taxa (coastal fishes, seagrasses, non-oceanic sharks, non-squid cephalopods, corals and mangroves), with peak species richness in the western Pacific (Tittensor *et al.* 2010). Primarily oceanic taxa (tunas, billfishes, oceanic sharks, foraminifera, squids, cetaceans and euphausiids) tend to show pantropical or circumglobal distributions, with species richness peaks at latitudes between 20° and 40° in all oceans (Tittensor *et al.* 2010). Unlike in terrestrial systems, but analogous to the elevational gradient, depth is an important dimension in the marine environment.

1.1.2. Depth-related gradients

Only recent data allow for making generalisations about the shallow:deep-sea gradient (Gray 2001). A central paradigm in marine diversity is that coastal areas tend to have high species richness and decreases towards deeper depths, as seen for some fish (Stevens 1996; Smith and Brown 2002; Kendall and Haedrich 2006) and benthic taxa (Cleary *et al.* 2005). Alternatively, marine species richness frequently peaks at intermediate depths (Pineda and Caswell 1998; Smith and Brown 2002). This parabolic or unimodal pattern can be observed in gastropods (Geange *et al.* 2012), benthic invertebrates (Witman *et al.* 2004), fishes (Benkendorfer and Soares-Gomes 2009), and deep-sea ostracods (Yasuhara *et al.* 2012). Even though recent studies reveal high species richness in deep seas, too few data preclude generalized patterns of richness along a depth gradient (Gray 2001).

1.1.3. Longitudinal gradients

In some marine taxa evidence for longitudinal gradients have been observed. Coral reef diversity is highest in Indonesia, with 600 species, and decreases radially from there across the Pacific and Atlantic (Veron 1995). Species richness of fossil and recent bivalves is highest in the southern China-Indonesia-northeast Australia region and closely associated to the world's richest development of coral reefs (Crame 2000). These data suggest a centre of marine faunal species richness occurs in the South East Asian area and that species have radiated out from this area (Gray 2001). In high-latitudes and polar regions some bivalves, such as the heteroconchs, have a markedly lower diversity than in tropical areas, which is

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associated with the youngest clades (Crame 2000). Crame (2000) suggested that this may reflect the fact that bivalve clades perhaps take periods of hundreds or millions of years to fully establish and disseminate across Earth's surface. A global study on patterns in deep seas found large areas of high species richness in the tropical Indo-Pacific region, while small areas of hotspots have been identified in the Atlantic, some associated with seamounts and ridges (Cheung *et al.* 2005). These spatial patterns are not yet well understood (Smith and Brown 2002), but the key mechanisms suggested to explain species richness gradients include biological interactions, area, energy-productivity, species ranges, random boundary hypothesis and evolutionary factors. However, little evidence support the species-range hypothesis (see Chown and Gaston 2000 for review). Here, Rapoport's species range rule suggests that species range lengths decrease towards the tropics and more species are able to coexist (Rapoport 1994).

1.2. *Hypotheses for gradients in species richness*

i) *Biological interactions*

Competition and predation play a vital role in community organisation for terrestrial and marine environments (Cowden *et al.* 1984; Wilson 1990; Olbers *et al.* 2009). Direct competitive interactions in the marine environment are found most frequently between closely related species or conspecifics, mainly for space, whereas some epibenthic predators (gastropods, decapod crustaceans, fish and shorebirds) and infaunal predators (primarily nemerteans and polychaetes) may influence communities significantly (Woodin 1983; Wilson 1990). However, local species richness is largely determined by regional species richness rather than local biological interactions (for references see Gray 2001). In the marine environment, corals have also shown that there is a strong correlation between local and regional species richness (Cornell and Karlson 1996; Karlson *et al.* 2004). If this observation is considered a general pattern, studies of biological interactions on local scales do not help in understanding mechanisms controlling species richness (Lawton 1999; Gray 2001).

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ii) *Species-area hypothesis*

A wide variety of plants and animals have shown that species richness increase as area sampled increase (Rohde 1999; Gray 2001). Rosenzweig (1995) suggested three arguments for this relationship: 1) a large area can contain more species than a small area due to space/niche requirements, 2) a large area can contain more habitats than a small area, therefore more species and 3) a large area can contain more individuals than a small area, hence more species. However, few examples exist of marine data over large areas and high species richness appears unrelated to marine habitat diversity (Gray 2001). Furthermore, no evidence suggests that there are fewer individuals per species in large deep-sea areas than coastal areas (Gray *et al.* 1997).

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iii) Energy-productivity hypothesis

Wright (1983) proposed that available energy (e.g. sea surface temperature or mean summer temperature) is maximal in the tropics and decrease towards higher latitudes. For example, latitudinal richness patterns in prosobranchs molluscs in the northern hemisphere are correlated with sea surface temperatures (Roy *et al.* 1998). Additionally, species richness is reduced in eutrophic marine sediment systems (Pearson and Rosenberg 1978). Towards the poles, primary productivity (production of chemical energy in organic compounds by living organisms) becomes more decoupled from grazing productivity, causing phytoplankton to settle on the seabed (Gray 2001). Some studies observed that species richness peaks at intermediate depths along a depth gradient, and possibly suggests favourable environmental conditions, such as optimal productivity at intermediate depths (Smith and Brown 2002). However, this relationship needs explicit tests, especially in marine systems (Gray 2001).

iv) Random boundary hypothesis

The latitudinal range of species is restricted to northern and southern boundaries, for example mountain ranges or environmental such as temperatures and precipitation (Gray 2001). The tropics encompass a large area either side of the equator, where species ranges tend to overlap rather than towards its low-latitude bounds, forcing a mid-domain peak in species richness (Colwell and Hurtt 1994; Gray 2001). Colwell and Lees (2000) called this pattern the mid-domain effect (MDE) and may explain unimodal depth-related patterns. Depth distribution ranges of species may also overlap within two spatial boundaries (shallow waters and abyssal depths), with low species richness at the two boundaries and high species richness in the mid-zone between the boundaries (Pineda and Caswell 1998).

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v) Evolutionary age hypothesis

Two key processes that control species richness in taxa over evolutionary time are through speciation and (local) extinction (Gray 2001; Wiens 2011). Speciation is a consequence of reproductive isolation and the ease with which reproductive barriers appear is likely to be related to the frequency of speciation in a group (Benton and Pearson 2001). Speciation and extinction events are generally correlated with major changes in oceanography and climate, but rates of speciation and extinction can vary greatly over space, time and taxa (Jackson 1994; Wiens 2011). It is speculated that higher speciation (or diversification) rates occur in tropical regions (Gray 2001). Alternatively, locations that have been occupied by a group for a longer period may tend to accumulate more species, since greater time for speciation occur, in the so-called time-for-speciation effect (Stephens and Wiens 2003). Therefore, time (for speciation) and diversification rates of species are considered major driving forces in spatial species richness patterns (Wiens 2011), although insufficient marine data exist to draw accurate conclusions.

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1.3. Marine species richness patterns in South Africa

South Africa is recognised for its rich terrestrial biodiversity (World Conservation Monitoring Centre 1992) and considered as one of the 25 biodiversity hotspots globally (Myers *et al.* 2000; Kier *et al.* 2005). The Cape Floristic Region contributes largely to this figure, boasting over 9000 plant species, many of which are highly endemic, most likely attributable to the unique climatic setting, geographic isolation and high diversification rates of species due to limited gene flow (Linder 2003; Kier *et al.* 2005).

However, species richness in the South African marine environment has been rarely studied in a global context (Griffiths *et al.* 2010). Recently, a review on global marine diversity indicates biodiversity hotspots occur in South Africa, along with the Philippines, Japan, China, Indonesia, Australia, India, Sri Lanka, the Caribbean and southeast USA (Tittensor *et al.* 2010). Hotspots occur most frequently in areas with medium or high degree of human impact, where human impact is defined by estimating ecosystem-specific differences in impact of anthropogenic drivers (e.g. commercial shipping, ocean-based pollution, ocean acidification and bycatch) of ecological change (Halpern *et al.* 2008; Tittensor *et al.* 2010).

South Africa has a limited latitudinal range (approximately 28-40°S) with a coastline that stretches 3650 km, and extends to a depth of 5 700 m (Griffiths *et al.* 2010). In the South African context, latitudinal gradients in species richness may not be apparent, but longitudinal gradients exist. Regional distribution patterns of nearly 13 000 species of fishes, macroalgae and a number of benthic marine invertebrate groups along the South African coast have been examined by Griffiths (2010).

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The main findings were that some groups (e.g. fish, gastropods, bivalves, brachyurans and echinoderms) increase progressively in species diversity towards the (more tropical) east coast, while other groups (e.g. amphipods, isopods and polychaetes) attain species richness peaks in the temperate southwest region (Griffiths *et al.* 2010). Overall, species richness is low on the entire west coast and relatively even species richness along the remainder of the coast (Griffiths *et al.* 2010). A marked decline in species richness to the extreme east is most certainly due to reduced sampling effort in that region (Griffiths *et al.* 2010).

The South African marine biota is characterised by high levels of endemicity (33% endemic species), where endemicity vary across taxa, but all groups peak along the South coast (Griffiths *et al.* 2010; Scott *et al.* 2012). High levels of endemism are found in Bryozoa (64%) and Mollusca (56%), while in some phyla such as Echinodermata (3.6%) and Porifera (8.8%) indicate much lower proportions of endemic species (Griffiths *et al.* 2010).

Spatial patterns of marine bioinvasions in South Africa show a different trend. Mead *et al.* (2011a) reported on a total of 86 introduced and 39 cryptogenic species from South Africa, of which 53% of introductions were concentrated in harbour areas. Marine bioinvasions are significantly higher on the west coast compared to the other coastal regions (Mead *et al.* 2011a). Ship fouling and ballast water were the dominant vector pathways for marine

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introductions, which explains the high concentrations of introduced species in harbours (Mead *et al.* 2011a).

These spatial patterns in species richness peaks coincide with localities in the Cape Peninsula/False Bay, Port Elizabeth and Durban where high sampling activities occur and contain large cities with museums and universities (Awad *et al.* 2002). Most of the benthic invertebrate samples have been collected along the west coast, while the south coast has been moderately well-sampled and the least sampled region is KwaZulu-Natal on the east coast (Griffiths *et al.* 2010). Notably, several inshore sites, most of which are associated with harbours, have been particularly well-sampled, including Lambert's Bay, Saldanha Bay/Langebaan Lagoon, St. Helena Bay and False Bay (Griffiths *et al.* 2010).

Even though strong sampling bias contributes in current observed spatial patterns, the aforementioned localities also coincide with biogeographic breaks, where species ranges in various taxa overlap (e.g. Emanuel *et al.* 1992; Gibbons 1999; Turpie *et al.* 2000; Bolton and Stegenga 2002; Sink *et al.* 2011b). The South African coastline can be roughly divided into four *a priori* bioregions, namely cool-temperate west coast, warm temperate south and southeast coast, and tropical east coast (Mead *et al.* 2011a). The southeast coast has been roughly defined as the region from Port Elizabeth to East London (Mead *et al.* 2011a). Two transition zones (i.e. zones lying between two marine bioregions) are False Bay, in the Western Cape and East London in the Eastern Cape (Mead *et al.* 2011a).

False Bay reefs are considered relatively distinct from other reefs within the Agulhas ecoregion, likely due to the significant shelter within the bay, and the influence of both the Agulhas Current and seasonal intermediate upwelling (Sink *et al.* 2011b). The complexity of False Bay is reflected in the nature and composition of benthic fauna, where the distribution of cold and warm water species is related to the pattern of water temperatures in summer (Day 1970). Similarly, great variety in bryozoan species composition and colonial growth forms is expected in the False Bay area. The correlation between the variety and distribution of colonial growth forms and the environments inhabited by the organisms, allows for both palaeoenvironmental and present-day environmental interpretations (Hageman *et al.* 1997).

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1.4. Correlation between colony morphotypes and environment

Marine bryozoans played a significant ecological role in shelf and upper slope communities since the Ordivician era (Hageman *et al.* 1997). The diversity of erect bryozoan species were markedly higher during the Paleozoic era, and since the Jurassic, encrusting species dominated bryozoan fauna, especially in the Neogene (McKinney and Jackson 1991). Stach (1935, 1936) studied colony morphotypes of recent species and its relation to the environment, and recognised that bryozoans can be separated into stable or unstable forms. Stable forms comprise of species not able to modify their morphotype irrespective of the environment or environmental changes, while unstable forms comprise of species able to

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modify their morphotype in response to the environment (Stach 1935, 1936). For example, the endemic bryozoan *Chaperiopsis* (*Chaperiopsis*) *multifida*, from South Africa, exhibit two types of morphotypes: the most common is the encrusting form, while some colonies form erect, contorted three-dimensional structures. Stach (1936) suggested that encrusting forms dominate in highly turbulent waters and quiet or less turbulent waters produce vertically elongated morphotypes.

More data are required to potentially apply the concept of stable and unstable forms of colony morphotypes in the paleoenvironment, but can be understood by examining living species in relation to its environment. McKinney and Jackson (1991) suggested that encrusting species belonging to a stable group have little significance, because this growth mode can occur in both quiet or less turbulent and high turbulent waters. However, where encrusting species dominate in the absence of vertical branching morphotypes suggest strong turbulent waters (McKinney and Jackson 1991). If an encrusting species belonging to an unstable group, also known to be branching, occurs in the absence of branching morphotype species, the environment is most likely to be occur in high turbulent waters (McKinney and Jackson 1991). The presence of branching morphotypes, particularly branching types of species belonging to an unstable group, most likely inhabit relatively quiet waters, while more robust branching types form rigid colonies that suggest high turbulent environments (McKinney and Jackson 1991). Lastly, the presence of both encrusting and branching type species from unstable groups in the same environment suggests environmental variability alternating between waters of low and high turbulence (McKinney and Jackson 1991). Therefore, the composition of bryozoan colony morphotypes can be used as a good indicator of environmental conditions (Amini *et al.* 2004).

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This is the first study examining species richness and biogeographical distribution patterns of bryozoans in South Africa. To examine species richness patterns, and, in Bryozoa, species-level datasets are pivotal for accurate results or predictions. Species-level data provide the baseline upon which conservation strategies can be applied to (e.g. Mittermeier *et al.* 1998; Olson and Dinerstein 1998; Myers *et al.* 2000) Species-level datasets will be the best tool to investigate relationships with abiotic variables, for example depth, sea surface temperatures, oxygen and salinity levels, since organisms react to their habitat (Bertrand *et al.* 2006). However, the scope of this project did not include the relationship between environmental variables and species richness, and should be addressed in future research by standardising methods of sampling.

1.5. Research questions and hypotheses

In this chapter, the aims are to examine species richness and biogeographical patterns of South African Bryozoa. The research questions that pertain to South African bryozoan species richness include:

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- What is the species richness and endemism of South African bryozoans, and how does bryozoan species richness compare to other southern latitude regions such as Australia and Brazil?
- Does bryozoan species richness patterns follow a gradient as seen in other South African marine taxa, and which biogeographical features may influence bryozoan community structure along the coastline? Are the results comparable with global marine species richness patterns?
- How rich is shallow-water bryozoans in colony morphotypes?

Hypotheses

Species richness patterns

H_0: Bryozoan species richness follows no obvious pattern along the South African coastline.

H_1: There is a pattern of bryozoan species richness along the South African coastline.

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2. Results

2.1. *Bryozoan species richness and endemism*

All the data in this study, including morpho-species, accounted for 368 bryozoan species, while the data considered for biogeographical analysis accounted for 286 species, including singletons (i.e. valid species recovered from single grids). These species belong to 154 genera, 75 families, three orders and two classes (Table 5.1). Three families were the richest in species composition, namely Adeonidae (37 species), Phidoloporidae (23 species) and Bugulidae (17 species). The most diverse fauna were found within three genera: *Adeonella* (31 species), *Rhynchozoon* (nine species) and *Reteporella* (eight species).

Overall apparent endemism was high – 164 species (57%) occur only within South African waters (Figure 5.1). Species with an Indo-Pacific or Atlantic distribution accounted for 33 species (12%) and 17 species (6%), respectively. Species with a widespread distribution accounted for 27 species (9%), while seven species (3%) are considered having a cosmopolitan distribution; these species include one ctenostome bryozoan, *Amathia gracilis*, and six cheilostome species, *Chorizopora brongniartii*, *Scruparia ambigua*, *Aetea anguina*, *Bugula neritina*, *Conopeum reticulum* and *Electra pilosa*.

The majority of the 38 species (13%) that have an apparent scattered distribution, may be considered doubtful and require revision. For example, O'Donoghue (1924) reported *Reteporella gilchristi* in South Africa, but this species is found in Canada. Some European species (*Smittina landsborovii*, *Plagioecia patina* and *Flustra foliacea*) were previously reported from South African localities (Hincks 1880; O'Donoghue and de Watteville 1944; Hayward and Cook 1983). Many of these species were reported once from a single locality in South Africa, and without figures and/or incomplete descriptions, further questions the validity of identifications.

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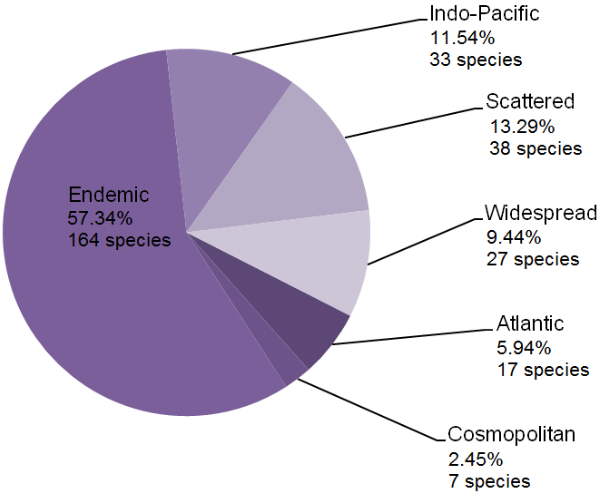

Figure 5.1. Distribution ranges of 286 valid species found in South African waters.

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Table 5.1. Taxonomic structure of bryozoan fauna from South Africa.

Family	**Total genera for each family and number of valid species in parentheses**
ADEONIDAE	*Adeona* (2), *Adeonella* (31), *Adeonellopsis* (1), *Dimorphocella* (1), *Laminopora* (2)
AETEIDAE	*Aetea* (1), Calaetea (1)
ALCYONIDIIDAE	*Alcyonidium* (4)
ALYSIDIIDAE	*Alysidium* (1), *Catenicula* (2)
ARACHNOPUSIIDAE	*Arachnopusia* (2)
ASPIDOSTOMATIDAE	*Aspidostoma* (4)
BATOPORIDAE	*Batopora* (3), *Lacrimula* (2)
BEANIIDAE	*Beania* (7), *Dimorphozoum* (1)
BIFAXARIIDAE	*Bifaxaria* (1), *Diplonotos* (1), *Domosclerus* (1), *Raxifabia* (1)
BITECTIPORIDAE	*Bitectipora* (1), *Hippomonavella* (5), *Hippoporina* (1), *Pentapora* (1), *Schizosmittina*(1)
BRYOCRYPTELLIDAE	*Porella* (1)
BUGULIDAE	*Bicellariella* (2), *Bugula* (4), *Bugulella* (2), *Bugulina* (2), *Cornucopina* (2), *Himantozoum* (3), *Kinetoskias* (3), *Virididentula* (1)
BUSKIIDAE	*Cryptopolyzoon* (1)
CALLOPORIDAE	*Amphiblestrum* (2), *Callopora* (1), *Crassimarginatella* (1)
CALWELLIDAE	*Onchoporella* (1)
CANDIDAE	*Caberea* (2), *Eupaxia* (1), *Hoplitella* (1), *Menipea* (4), *Notoplites* (2), *Tricellaria* (1)
CATENICELLIDAE	*Catenicella* (1), *Cornuticella* (1), *Costaticella* (1), *Talivittaticella* (1)
CELLARIIDAE	*Cellaria* (4), *Smitticellaria* (1)
CELLEPORIDAE	*Cellepora* (1), *Celleporina* (1), *Galeopsis* (4), *Lagenipora* (2), *Osthimosia* (1), *Turbicellepora* (6)
CHAPERIIDAE	*Chaperia* (5), *Chaperiopsis* (6), *Notocoryne* (1)
CHORIZOPORIDAE	*Chorizopora* (1)
CLEIDOSCHASMATIDAE	*Characodoma* (2), *Cleidochasma* (1)
CONESHARELLINIDAE	*Conescharellina* (1)
CRIBRILINIDAE	*Khulisa* (1), *Cribrilina* (2), *Figularia* (2), *Glabrilaria* (1), *Inversiscaphos* (1), *Puellina* (1)
CRISIIDAE	*Bicrisia* (1), *Crisia* (2), *Crisidia* (1), *Mesonea* (1)
CRYPTOSULIDAE	*Cryptosula* (1)
CUPULADRIIDAE	*Discoporella* (2), *Reussirella* (1)
DENSIPORIDAE	*Favosipora* (1)
DIAPEROECIIDAE	*Nevianipora* (1)
ELECTRIDAE	*Conopeum* (2), *Electra* (1)
ENTALOPHORIDAE	*Mecynoecia* (3)
ESCHARINIDAE	*Hippomenella* (1), *Taylorius* (1)
EUTHYRISELLIDAE	*Tropidozoum* (1)
EXOCHELLIDAE	*Escharoides* (3), *Exochella* (1)
FARCIMINARIIDAE	*Columnella* (3), *Farciminellum* (1)
FLUSTRELLIDRIDAE	*Elzerina* (1)
FLUSTRIDAE	*Carbasea* (3), *Flustra* (1), *Gregarinidra* (1)
FOVEOLARIIDAE	*Dactylostega* (2), *Foveolaria* (1)

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GIGANTOPORIDAE	*Gigantopora* (2)
HELIODOMIDAE	*Heliodoma* (1), *Setosellina* (1)
HETEROPORIDAE	*Heteropora* (1)
HIPPOPORIDRIDAE	*Fodinella* (1), *Hippoporella* (1), *Hippoporidra* (1)
HIPPOTHOIDAE	*Celleporella* (2), *Hippothoa* (2)
HORNERIDAE	*Hornera* (3)
INCERTAE SEDIS	*Klugeflustra* (1)
LACERNIDAE	*Arthropoma* (1), *Phonicosia* (1), *Rogicka* (1)
LANCEOPORIDAE	*Calyptotheca* (3), *Emballotheca* (1)
LEIOSALPINGIDAE	*Leiosalpinx* (1)
LEKYTHOPORIDAE	*Turritigera* (1)
LEPRALIELLIDAE	*Celleporaria* (3)
LICHENOPORIDAE	*Disporella* (3), *Patinella* (2)
MACROPORIDAE	*Macropora* (1)
MALILLOPORIDAE	*Anoteropora* (2)
MARGARETTIDAE	*Margaretta* (2)
MEMBRANIPORIDAE	*Biflustra* (1), *Jellyella* (1), *Membranipora* (1)
MICROPORELLIDAE	*Fenestrulina* (2), *Flustramorpha* (3), *Microporella* (2)
MICROPORIDAE	*Micropora* (3)
ONCOUSOECIIDAE	*Microeciella* (1)
PETALOSTEGIDAE	*Petalostegus* (1)
PETRALIELLIDAE	*Mucropetraliella* (1)
PHIDOLOPORIDAE	*Iodictyum* (1), *Phidolopora* (1), *Plesiocleidochasma* (1), *Reteporella* (8), *Rhynchozoon* (9), *Schizoretepora* (1), *Stephanollona* (1), *Triphyllozoon* (1)
PLAGIOECIIDAE	*Liripora* (1), *Plagioecia* (1)
QUADRICELLARIIDAE	*Nellia* (1)
RHABDOZOIDAE	*Rhabdozoum* (1)
ROMANCHEINIDAE	*Escharella* (3)
SCHIZOPORELLIDAE	*Schizoporella* (1)
SCRUPARIIDAE	*Scruparia* (2)
SMITTINIDAE	*Parasmittina* (2), *Smittina* (3), *Smittoidea* (4)
STEGINOPORELLIDAE	*Steginoporella* (1)
STOMACHETOSELLIDAE	*Stomachetosella* (1)
THALAMOPORELLIDAE	*Thalamoporella* (1)
TRYPOSTEGIDAE	*Trypostega* (2)
TUBULIPORIDAE	*Exidmonea* (2), *Idmidronea* (2), *Tennysonia* (1)
VESICULARIIDAE	*Amathia* (3)
WATERSIPORIDAE	*Watersipora* (1)

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2.1.1. Richness across marine bioregions

The southeast coast indicated the least number of samples (19 samples), while the east coast indicated the greatest number of samples (295 samples), but species richness in both marine regions were comparable, with 105 and 109 species, respectively (Table 5.2, Figure 5.2). These notable discrepancies between species richness in relation to the number of samples greatly varied across marine regions and depth zones. The shallow-water groups on the west and south coast produced an equal number of species per sample ratio (1:1), except for the subphotic west coast with double the number of species than samples. On the southeast, richness per sample is six and eight times greater in the intertidal and subphotic zone, respectively. Similarly, the east coast groups indicated richness three and five times greater per sample in the intertidal and subphotic zone, respectively. In deep-water groups, sample sizes (< 20 samples) were much lower than for groups in shallow waters, except for the bathyal east coast group with 214 samples. The east coast groups indicate that the number of samples in the bathyal and abyssal region were three and six times greater than the number of species recorded, respectively.

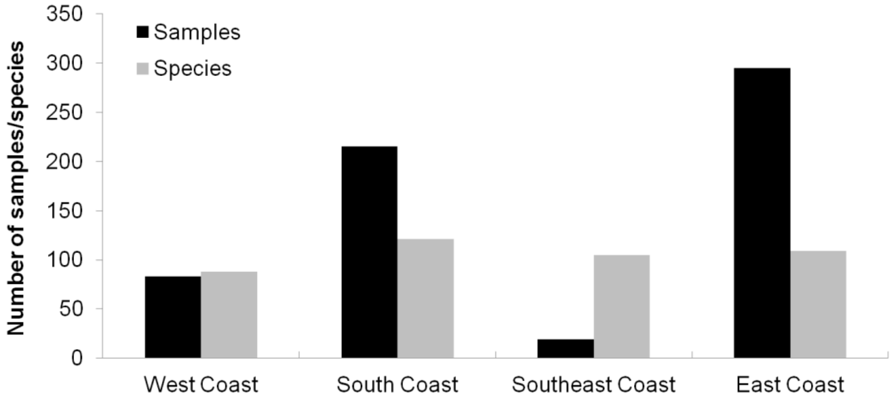

Figure 5.2. Total number of samples and species from each bioregion.

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Table 5.2. Number of samples and species, as well as sample:species ratio occurring in depth zones within marine bioregions.

	West Coast			South Coast			Southeast Coast			East Coast		
	$N_{samples}$	$N_{species}$	Ratio	$N_{samples}$	$N_{species}$	Ratio	$N_{samples}$	$N_{species}$	Ratio	$N_{samples}$	$N_{species}$	Ratio
Shallow waters	47	61	1:1	98	107	1:1	5	30	1:6	3	16	1:5
Subphotic zone	31	59	1:2	113	128	1:1	13	103	1:8	19	66	1:3
Shelf edge	-	-	-	-	-	-	-	-	-	15	19	1:1
Bathyal zone	5	6	1:1	4	18	1:5	1	7	1:7	214	76	3:1
Abyss	-	-	-	-	-	-	-	-	-	44	7	6:1
Total	**83**	**88**	**1:1**	**215**	**121**	**1:2**	**19**	**105**	**1:6**	**295**	**109**	**3:1**

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2.2.2. Species richness in other regions

Regions adjacent to or within the Indo-Pacific include the African east coast, Australia, New Zealand and the South China Sea, while regions in the Atlantic Ocean include the Mediterranean Sea, Brazil and the Gulf of Mexico. The Southern Ocean, south of the South African EEZ, encompasses Antarctica. A global dataset on marine diversity has been compiled by Costello *et al.* (2010), which is considered here to compare with South Africa. Bryozoan species richness in South Africa is markedly lower than Australia (987 species), China (671 species) and New Zealand (639 species), and nearly comparable richness with the Mediterranean region (337 species), Antarctica (328 species) and the Gulf of Mexico (307 species) (Fig. 5.3a). Brazil also has high species richness of 458 species[4], as opposed to the 91 species recorded in Costello *et al.* (2010). Costello *et al.* (2010) compared total richness in relation to seabed area (in km^2), but bryozoans are mostly dependent on available substrate and heterogeneity along coastlines. It seems fitting to compare bryozoan species richness in relation to coastline lengths, obtained from Brinkhoff (2016).

South Africa indicates a markedly high bryozoan richness per kilometers of coastline of 1:8 km – this means, one bryozoan species for every 8 km of coastline - than when compared to regions with longer coastlines. Brazil's coastline (7 491 km) is almost four times longer than South Africa's coastline (2798 km), with a species to coastline ratio of 1:20 km, although it should be noted that this number includes marine and freshwater bryozoan species. Australia has the eighth longest coastline in the world (> 25000 km) with a species to coastline ratio of 1:26 km. New Zealand boasts with a coastline length of 15134 km (Fig. 5.3b), the eleventh longest coastline in the world, and species to coastline ratio of 1:15 km. Similarly, the species to coastline ratio of the Mediterranean region is 1:14 km, with a coastline three times shorter than New Zealand. The coastline length of Antarctica (17968 km) is nearly comparable with New Zealand, although species to coastline ratio is markedly lower with 1:55 km.

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[4] This number includes marine and freshwater bryozoan species. Available at: http://fauna.jbrj.gov.br/fauna/listaBrasil/FichaPublicaTaxonUC/FichaPublicaTaxonUC.do?id=157416. Accessed on 21 March 2017.

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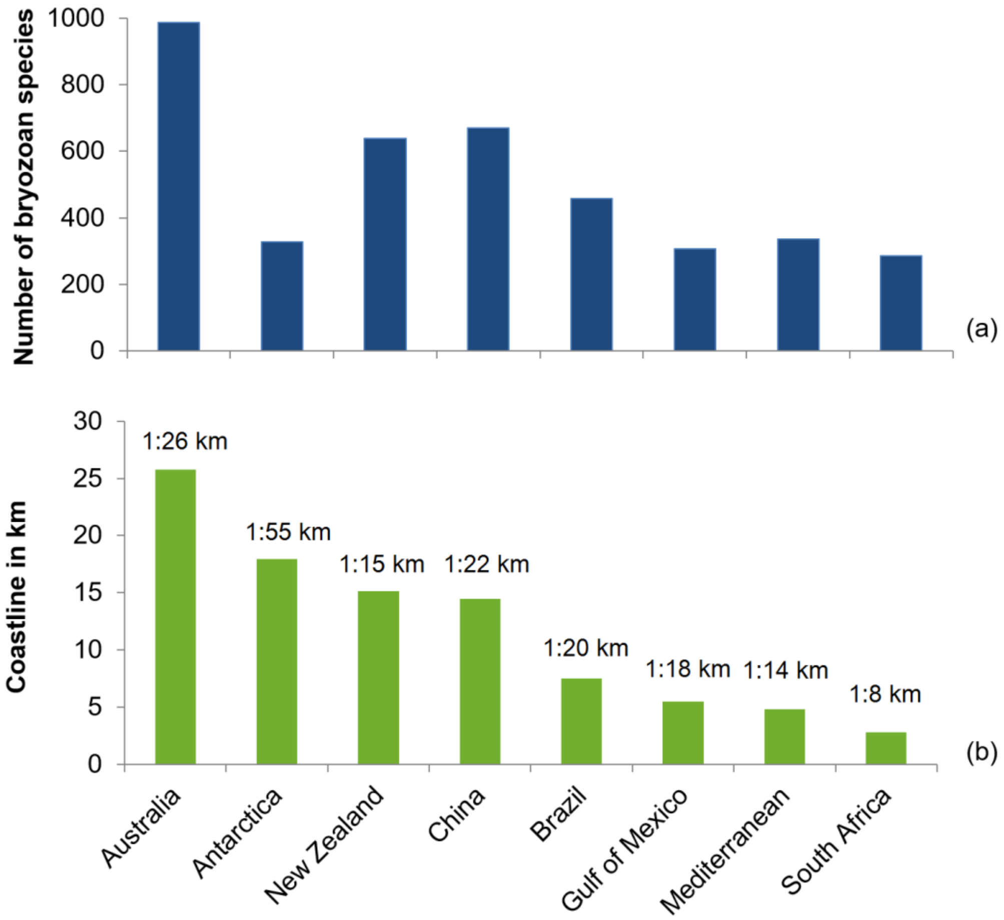

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Figure 5.3. (a) Data for bryozoan diversity extracted from Costello *et al.* (2010), except South Africa (this study). (b) Coastline lengths, from Brinkhoff (2016), in decreasing order, indicating bryozoan species to coastline length (in kms) ratios.

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2.2. Species richness patterns along the South African coastline

2.2.1. Longitudinal gradient

The interpolated dataset used for analyses considered here include species with depth and location data associated with a gridded cell. The patterns in species richness across a longitudinal gradient from the west to east coasts vary greatly between depth zones (Fig. 5.4). In shallow waters (Fig. 5.4a), species richness is uniformly low on the west coast up to grid 5, slightly increases through grids 6-9, then increases markedly from grids 10-12 before decreasing discontinuously towards the east coast. The species richness pattern in the subphotic zone (Fig. 5.4b) is low on the west coast at grid 28, but increases through grids 29-30, markedly increasing from grid 31 and stabilising through grids 41-43 towards the south coast before increasing through grids 44-47. Thereafter, species richness gradually decreases toward the southeast coast up to grid 78, sharply increases at grid 79 and decreases from grid 80 towards the east coast. Discontinuous richness patterns in the bathyal zone (Fig. 5.4c) indicate low species richness along the west to southeast coast, sharply increases from grid 117 and stabilising to grid 125 on the east coast, thereafter decreasing.

Areas of species richness peaks occur in overlapping grids 11 and 42 (88 species) west of the Cape Peninsula (west coast), grids 12 and 47 (90 species) in False Bay area (south coast). Richness peaks on the southeast and east coast occur in grids 79 (80 species) and 123 (38 species), respectively (Fig. 5.5). All depth zones indicate low species richness at the country boundary extremities on the west and east coast.

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Patterns of apparent endemism follow that of species richness (see Fig. 5.4). In shallow waters, apparent endemism is low on the west coast, increases towards the south coast until grid 13, thereafter decreasing discontinuously towards the east coast. Apparent endemism in the subphotic zone is low on the west and east coast extremities, while markedly high through grids 32-85, mainly on the south coast, with a peak at grid 47 (56 endemic species). In the bathyal zone, overall apparent endemism is low and discontinuous along the west to the southeast coast, increasing in the east coast and peaks at grid 123 (23 endemic species). Grids 131 and 132 on the extreme east coast indicated no known endemic species.

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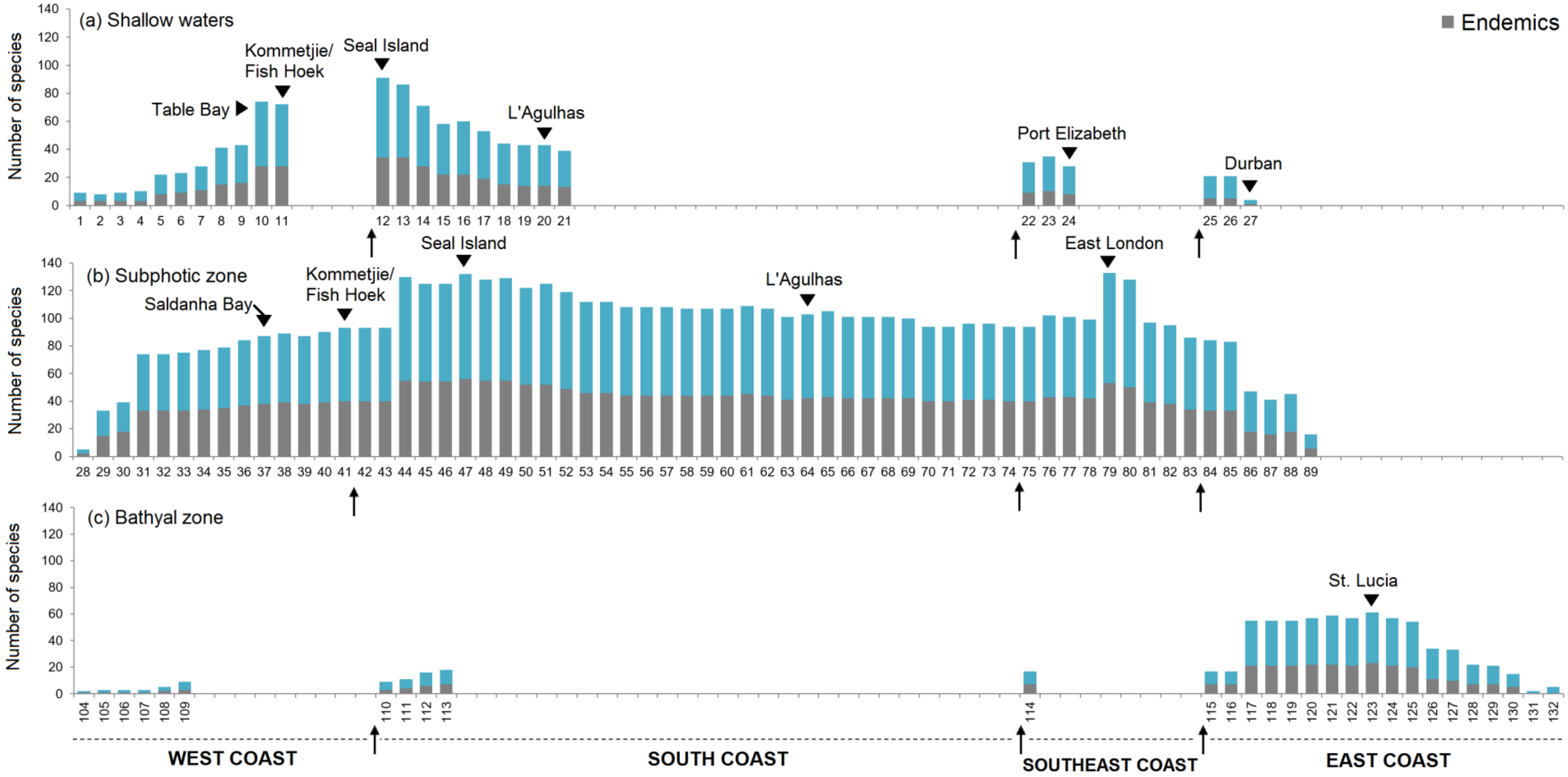

Figure 5.4. Interpolated data of the number of species per QDGC or gridded cell ordered by (a) shallow waters (≤ 30 m), (b) subphotic (31-300 m) zone and (c) bathyal zone (501-3500 m). Triangles represent some known localities within the gridded cells. Arrows indicate the break between marine bioregions.

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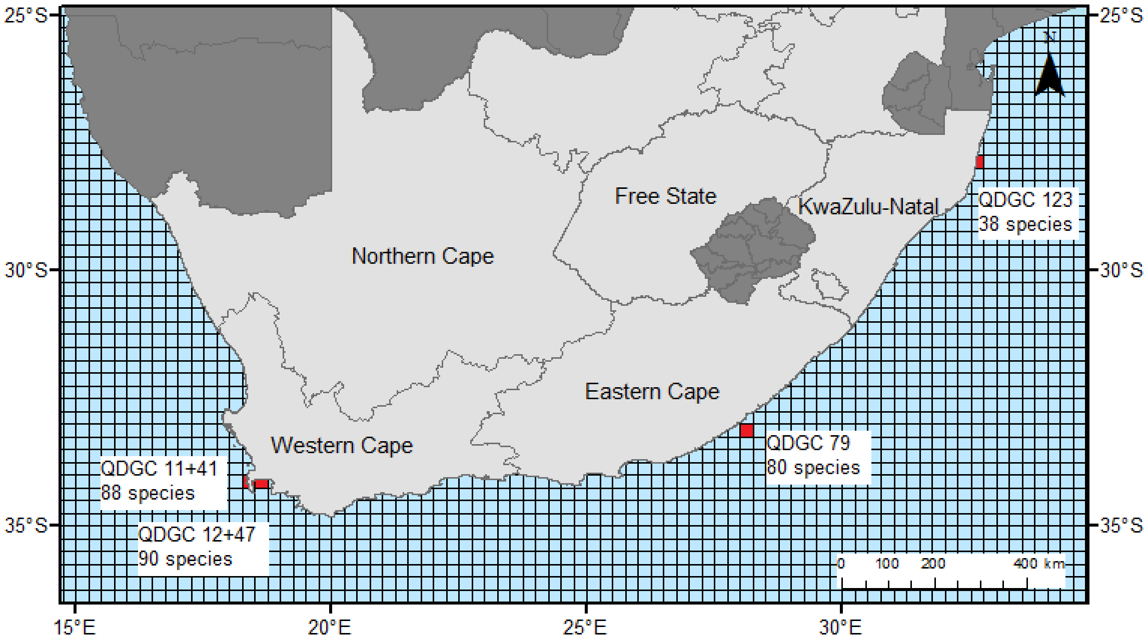

Figure 5.5. The gridded cells associated with species richness peaks among bioregions. Localities associated with the QDGC's are as follows: QDGC's 11 and 41 (west coast) and QDGC's 12 and 47 (south coast) containing the Cape Peninsula/False Bay areas, East London in QDGC 79 (southeast coast) and St. Lucia in QDGC 123 (east coast).

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A clear biogeographic structure to bryozoan communities exist as revealed by cluster analysis and MDS plots, indicating two faunal breaks (Cape Peninsula/False Bay and Durban) in the shallow-water group and three faunal breaks (Port Nolloth, East London and Durban) in the subphotic and bathyal groups (Cape Peninsula/False Bay, East London and Durban) (Fig. 5.6). At 40% similarity, three groups formed in the shallow waters (Fig. 5.7a): **A**) the cool-temperate Namaqua Inner Shelf extends along the southwest to Saldanha Bay (grid 8) and Langebaan (grid 9); replaced by Southwestern Cape Inshore in Table Bay (grid 10) and Southwestern Inner Shelf at Kommetjie (grid 11) on the west coast of the Cape Peninsula. Thereafter, it is replaced by **B)** the subtropical Agulhas Inner Shelf at Fish Hoek (grid 11), stretching until Port Elizabeth (grid 24) into the Natal Inshore (grids 25-26), and lastly forming **C)** Durban (grid 27). In the subphotic zone, four groups formed at 40% similarity (Fig. 5.7b): **A)** off Port Nolloth (grid 28) forms part of the Southern Benguela Outer Shelf and extends until Cape Point (grid 42), while Kommetjie (grid 41) overlaps with the Southwestern Inner Shelf. **B)** Grids 43-78 encompass the Agulhas Inner and Outer Shelf, extending to **C)** East London (grid 79) to grid 83 where it is replaced by the narrow Natal Shelf from grids 84-88, and lastly formed **D)** Durban (grid 89). Four groups also formed in the bathyal zone at a 40% level of similarity (Fig. 5.7c): gridded cells were distributed sparsely across the **A)** Southeast Atlantic ecoregion

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extending from grids 104-109. However, grid 109 formed **B)** which extends into the Southwest Indian ecoregion. The remaining grids formed **C)** through grids 117-125, including St. Lucia (grid 123), and lastly, **D)** grids 131 and 132 on the east coast.

The results of a one-factor ANOSIM indicate that there is an overall strong species composition structure between depth zones along a longitudinal gradient (from west to east coasts). Significant differences (significance level $p = 0.001$) were indicated for the shallow-water (global R-value = 0.68) and subphotic (global R-value = 0.86) groups, while the bathyal group (global R-value = 0.57) showed no significant differences ($p > 0.1$) between communities. This suggests greater variability among subphotic communities than among shallow-water communities. All comparisons from pairwise tests in the subphotic group were significant and yielded strong differences between the west and south coast (R-value = 0.87), and the south and southeast coast (R-value = 0.81) communities, with the least difference between the southeast and east coast communities (R-value = 0.57) (Table 5.3). This suggests highly heterogeneous communities between the west and south coast, while communities on the southeast and east coast are relatively homogeneous. In the shallow-water group, a pairwise comparison was significant between the west and south coast (R-value = 0.70), while the remaining pairwise tests were not significant. In some groups, insufficient data resulted in less than 20 permutations, therefore pairwise comparison values may be considered as doubtful. The latter groups included comparisons between the south and southeast coast communities (for bathyal), and the southeast and east coast communities (for shallow-water and bathyal).

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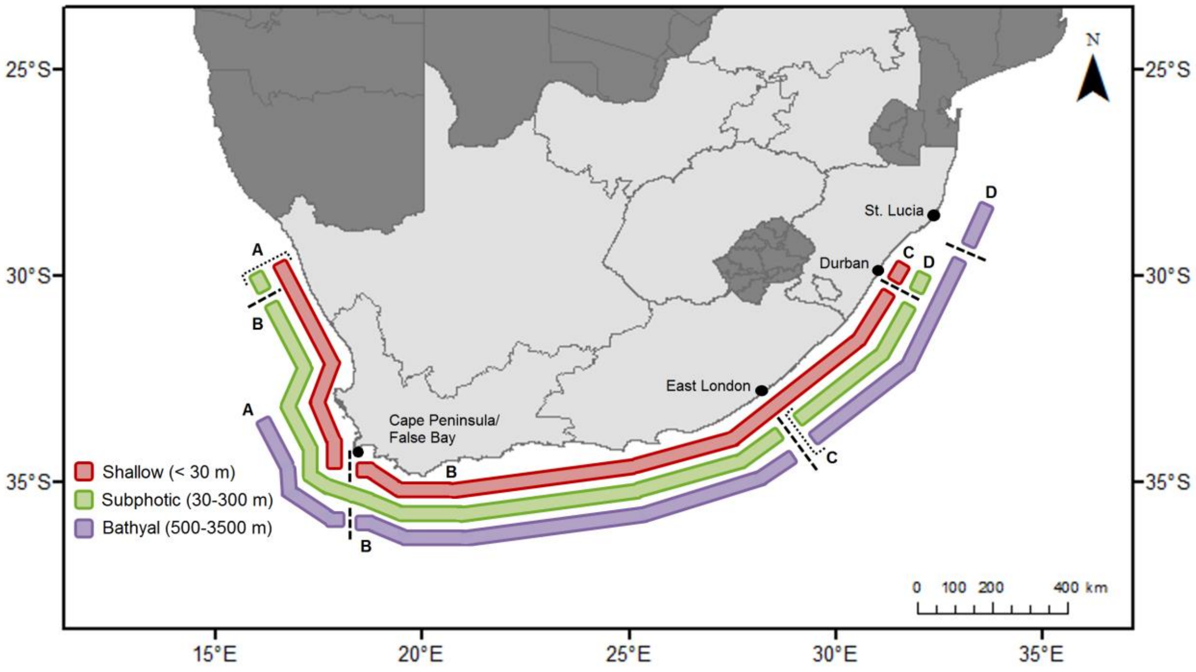

Figure 5.6. Graphic visualization of the biogeographic structure, from MDS results, of bryozoan communities in the shallow waters, subphotic and bathyal zones. Dashed lines indicate faunal breaks. Group numbers (A-D) follow those in MDS plots in figure 5.7.

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2.2.2. Depth-related gradient

The data were stratified into depth bins, separated by assumed marine bioregions, and revealed no obvious pattern in species richness along a depth-related gradient. High species richness was indicated for the 10 m, 90 m and 1000 m depth bins containing 71, 91 and 65 species, respectively. Segregation of communities was evident between assumed bioregions as revealed by cluster analysis and MDS plots (Fig. 5.8). At 20% similarity, three groups formed on the west coast (Fig. 5.8a): **A**) the shallow-water and subphotic gridded cells grouped together, forming three subgroups at 40% similarity (grids 1-4, 5-11 and 29-42), while **B)** grid 28 and **C)** the bathyal gridded cells were separate. On the south coast, two groups were formed at 20% similarity (Fig. 5.8b), namely **A**) the shallow-water and subphotic gridded cells, each forming a separate subgroup at 40% similarity, and **B)** the bathyal groups (grids 110-113). At 20% similarity, two groups formed on the southeast coast (Fig. 5.8c) with **A)** containing two subgroups at 40% similarity, shallow-water (grids 22-24) and subphotic (grids 75-83), while **B)** contained one bathyal gridded cell (grid 114). Four groups formed on the east coast at a 20% level of similarity (Fig. 5.8d), separating **A)** shallow-water gridded cells (grids 26 and 27), **B)** subphotic gridded cells (grids 84-89), and the bathyal zone was separated into **C)** grids 115-130 and **D)** grids 131 and 132. Overall, shallow-water and subphotic groups clumped together at 20% similarity, clearly separating from bathyal groups, and suggests strong differences in species composition in bryozoan communities between shallower waters and deep waters.

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The results of a one-factor ANOSIM indicated strong differences among communities on the west coast (global R-value = 0.88), south coast (global R-value = 1), southeast coast (global R-value = 1) and the east coast groups (global R-value = 0.84). Pairwise tests between communities by depth zones (shallow-water, subphotic and bathyal) indicated that all comparisons among west, south and east coast groups were significant (significance level $p = 0.001$), except between the shallow-water and bathyal south coast communities, and shallow-water and subphotic east coast communities ($p > 0.1$) (Table 5.4). The southeast coast groups yielded no significant differences between communities. The greatest variability in community structure was evident between the subphotic and bathyal west coast communities, and between all south coast communities (R-values = 1). Less variability were indicated between shallow-water and subphotic west coast communities (R-value = 0.77), and on the east coast between the shallow-water and bathyal (R-value = 0.87), and subphotic and bathyal (R-value = 0.82) communities.

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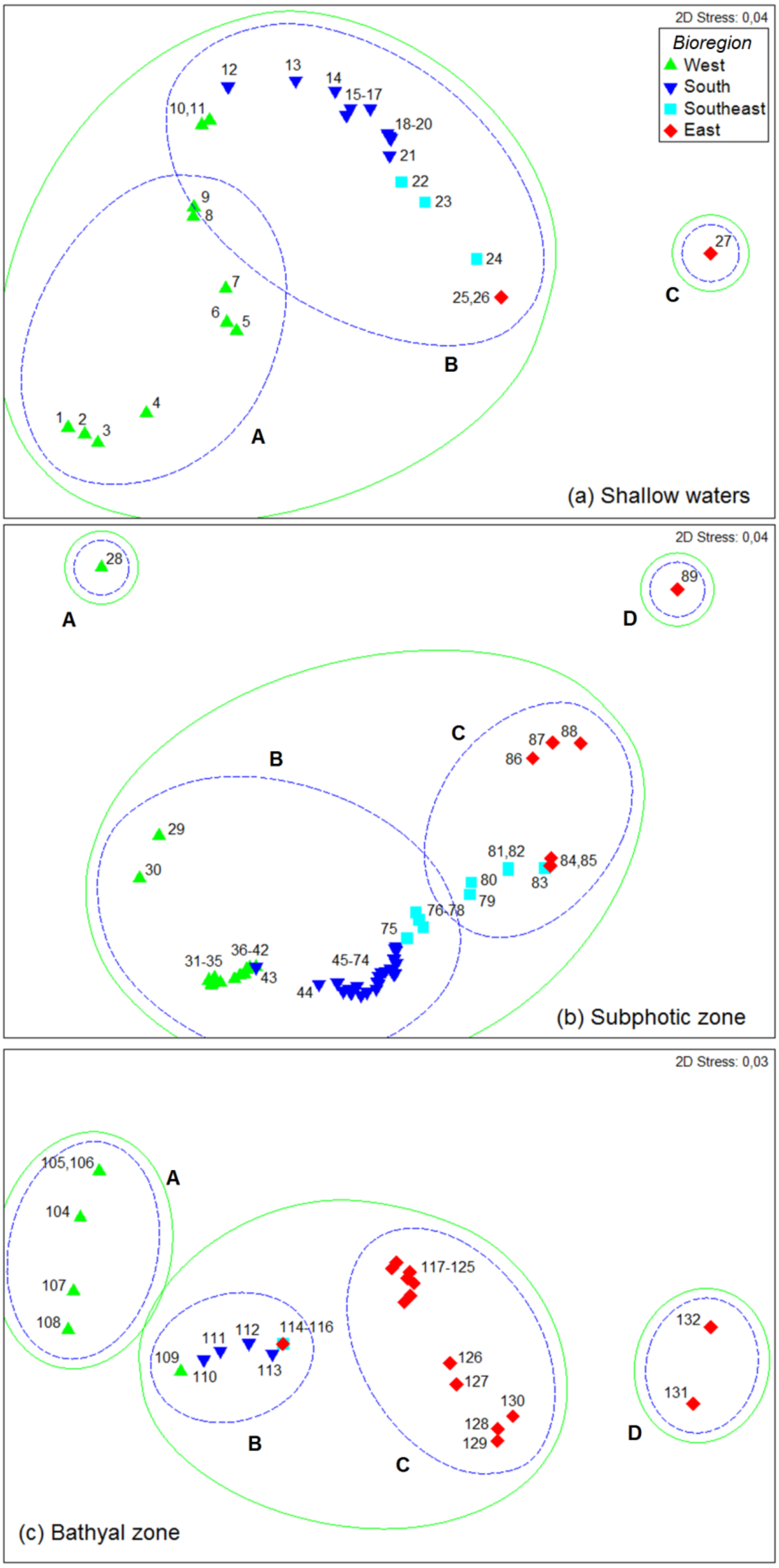

Figure 5.7. Non-metric multidimensional scaling (MDS) plots showing the similarity (Bray–Curtis measure) between gridded cells along the South African coastline with stress values shown in the upper right corner: (a) shallow waters, (b) subphotic and (c) bathyal zone. Grid numbers follow those in Figure 5.4. The lines encircling the grid numbers represent levels of similarity: solid, 20%; dashed, 40%.

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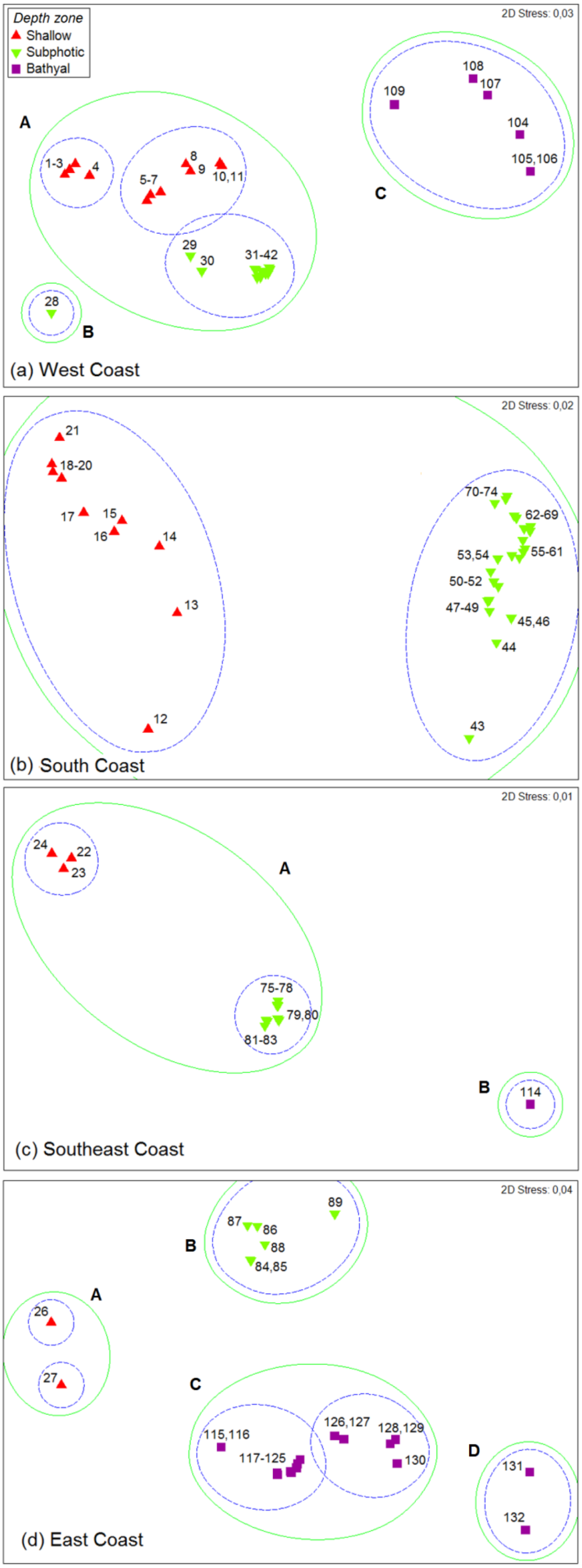

Figure 5.8. Non-metric multidimensional scaling (MDS) plots showing the similarity (Bray–Curtis measure) between gridded cells along the South African coastline with stress values shown in the upper right corner: (a) west coast, (b) south coast, excluding bathyal groups, (c) southeast coast and (d) east coast. Grid numbers follow those in Figure 5.4. The lines encircling the grid numbers represent levels of similarity: solid, 20%; dashed, 40%.

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Table 5.3. Results of pairwise comparison in ANOSIM between assumed marine bioregions within depth zones. Closer to +1 state strong significant differences in species composition between communities. R-values with significant p-values (in underlined bold) are indicated.

	Shallow			**Subphotic**			**Bathyal**		
	South	Southeast	East	South	Southeast	East	South	Southeast	East
West	**0.70**	0.71	0.95	**0.87**	**0.82**	**0.84**	0.65	0.84	**0.83**
South		0.58	0.96		**0.81**	**1**		0.17	0.40
Southeast			0.33			**0.57**			0.12

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Table 5.4. Results of pairwise comparison in ANOSIM between depth zones within assumed marine bioregions. Closer to +1 state strong significant differences in species composition between communities. R-values with significant p-values (in underlined bold) are indicated.

	West Coast		**South Coast**		**Southeast Coast**		**East Coast**	
	Subphotic	Bathyal	Subphotic	Bathyal	Subphotic	Bathyal	Subphotic	Bathyal
Shallow	**0.77**	**1**	**1**	1	1	1	1	**0.87**
Subphotic		**0.99**		**1**		1		**0.82**

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SIMPER analysis will indicate which of the 286 species influence the biogeographic structure between groups within depth zones. The results from SIMPER indicating similarity and dissimilarity indices are tabulated in Appendices 3 and 4. The species contributing most to the differences in species composition between bryozoan communities were separated into depth zones (Fig. 5.9), and are as follows:

i) Shallow-water groups

A number of species contributed to the average similarity within communities (Fig. 5.9a). On the west coast, the most important contributors for the community structure (average similarity = 56%) were *Electra pilosa*, *Menipea crispa*, *M. ornata*, *Alcyonidium nodosum* and *Onchoporella buskii* each species contributing 12%. South coast communities (average similarity = 79%) indicated fourteen species (each contributing ≈ 5%) that largely contributed to its structure such as *Adeonella pluscula*, *Bugula neritina*, *Calytotheca nivea*, *Chaperia capensis*, *Escharoides custodis*, *Gigantopora polymorpha* and *Gregarinidra spinuligera*. Thirteen species (each contributing ≈ 6%) contributed largely to the community structure in the southeast coast (average similarity = 76%), of these species included *Flustramorpha marginata*, *Mucropetraliella asymmetrica*, and *Schizoretepora tessellata* also highly contributed (each contributing ≈ 17%) to east coast community structure (average similarity = 54%).

The average dissimilarity between coasts was highest between west and south coast communities (average dissimilarity = 65%). The species that contributed the most to the dissimilarity were *Aetea anguina*, *Catenicella elegans*, *Flustramorpha marginata*, *Menipea ornata*, *Steginoporella buskii*, *Tennysonia stellata* and *Turbicellepora conica* (each contributing ≈ 3%) being absent on the west coast, while present in the majority of the south coast communities. Furthermore, *Adeonella pluscula*, *Escharoides custodis* and *Gigantopora polymorpha* (each contributing ≈ 5%) were present in south coast communities, but absent on the southeast coast, contributed the most to the dissimilarity between the south and southeast coast (average dissimilarity = 38%). The absence of *Celleporaria capensis*, *Laminopora jellyae* and *Menipea triseriata* (each contributing ≈ 7%) on the east coast, while present on the southeast coast, contributed the most to the dissimilarities between the southeast and east coast (average dissimilarity = 45%). However, the differences between the south and southeast coast communities, and southeast and east coast communities may be considered insignificant and/or doubtful as indicated in ANOSIM.

ii) Subphotic groups

A number of species influenced the average similarity within subphotic communities (Fig. 5.9b). Communities on the west coast (average similarity = 75%) indicated that the

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highest contributors to the average similarity were *Mucropetraliella asymmetrica* and *Schizoretepora tessellata* (each contributing ≈ 4%). The highest average similarity was indicated for south coast communities (average similarity = 88%), attributable to 30 species (each contributing ≈ 2%). Similarly, 30 species (each contributing ≈ 2%) contributed the most to the average similarity within southeast coast communities (average similarity = 78%). The lowest average similarity was within east coast communities (average similarity = 66%), mostly influenced by nine species (each contributing ≈ 5%) such as *Crassimarginatella marginalis*, *Dimorphocella moderna* and *Micropora similis*.

Average dissimilarities were fairly low (< 50%) with the lowest between communities on the south and southeast coast (average dissimilarity = 37%). Four species (each contributing ≈ 2%) contributed mostly to the dissimilarity, namely *Adeonella regularis* and *Dactylostega tubigera* present on the south coast, absent on the southeast coast, while *Rhynchozoon beatulum* and *Rhynchozoon stomachosum* is present on the southeast coast, and absent on the south coast. The average dissimilarity (48%) between the west and south coast communities was influenced mostly by the absence of seventeen species (each contributing ≈ 2%) on the west coast, but present on the south coast. Dissimilarities between the southeast and east coast communities (average dissimilarity = 48%) were mostly accounted for by the presence of six species (*Hoplitella armata*, *Chaperiopsis multifida*, *Exidmonea atlantica*, *Greganiridra spinuligera*, *Onchoporella buskii* and *Reteporella lata*) in the southeast coast communities, but absent on the east coast.

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iii) Bathyal zone groups

Average similarities within bathyal groups were low (≈ 50%), except for the bathyal south coast communities, in comparison to the shallow-water and subphotic groups (Fig. 5.9c). West coast communites (average similarity = 54%) were largely influenced by *Adeonella coralliformis* and *Kinetoskias pocillum* (each contributing %). The highest average similarity was indicated for south coast communities (average similarity = 82%) mostly influenced by six species (*Adeonella coralliformis*, *Calyptotheca nivea*, *Flustramorpha angusta*, *Flustramorpha marginata*, *Gigantipora polymorpha* and *Kinetoskias pocillum*) each contributing 15%. The highest contributors in the east coast communities (average similarity = 50%) were *Calyptotheca nivea* and *Galeopsis circella* (each contributing ≈ 7%). Analysis including the single gridded cell (QDGC 114) in the southeast coast community was disregarded. No significant differences were indicated between all bathyal zone groups, although the average dissimilarity was high between the west and south coast communities (average dissimilarity = 65%). The absence of *Flustramorpha angusta* (contributing ≈ 15% to the average dissimilarity) in west coast communities, but present on the south coast, largely accounted for the differences.

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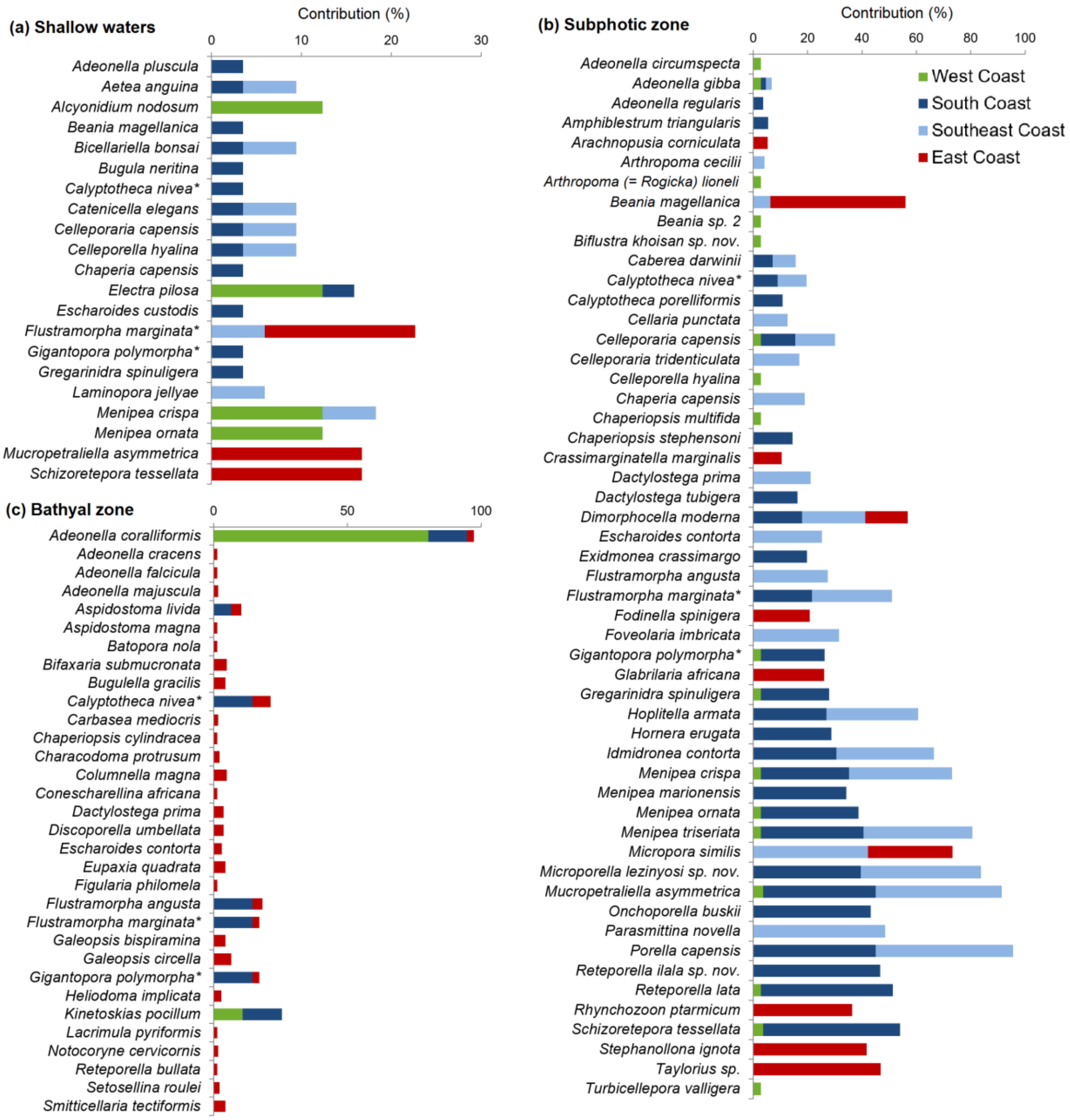

Figure 5.9. The results from SIMPER analysis indicating species that contributed to the average similarity between depth zones (a) shallow waters, (b) subphotic zone and (c) bathyal zones, and within marine bioregions. The contribution percentages (in %) of species that contributed to a cumulative ≈ 50% similarity are shown in the graph. Species occurring in all three depth zones have an asterisk (*).

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2.3. Colony morphotypes of shallow-water bryozoans

2.3.1. Species richness in False Bay

In this study, 127 cheilostomatous bryozoan species (including morpho-species), from 136 samples, have been recorded from False Bay, including 73 species endemic to South Africa. The majority of known species were found in depths below 60 m and decreasing non-linearly down to 150 m, while the 10 m (57 species) and 40 m (58 species) depth bins indicated the highest species richness.

2.3.2. Colony morphotypes

Cheilostomatous bryozoans of False Bay were characterised by a high diversity of colonial forms, particularly below 60 m attributable to high species richness (Appendix 5, Plate 24). Seventeen morphotypes have been recognised: membraniporiform A (42 species), adeoniform (14 species), celleporiform (12 species), buguliform (10 species), reteporiform (7 species), eschariform (6 species), petraliform (6 species), scrupariiform (5 species), flustriform (4 species), cellulariiform (4 species), membraniporiform B (4 species), adeonelliform (3 species), cellariform (3 species), catenicelliform (2 species), vinculariform (2 species), lunulitiform (1 species) and pseudovinculariform (1 species) (Plate 27). The greatest number of morphotypes (15 types) was indicated for the 30 m depth bin, and more than 10 morphotypes in depth bins 10-50 m. The number of morphotypes in this study region is markedly higher than the nine morphotypes reported at deeper stations in Hayward and Cook (1979) (Fig. 5.10).

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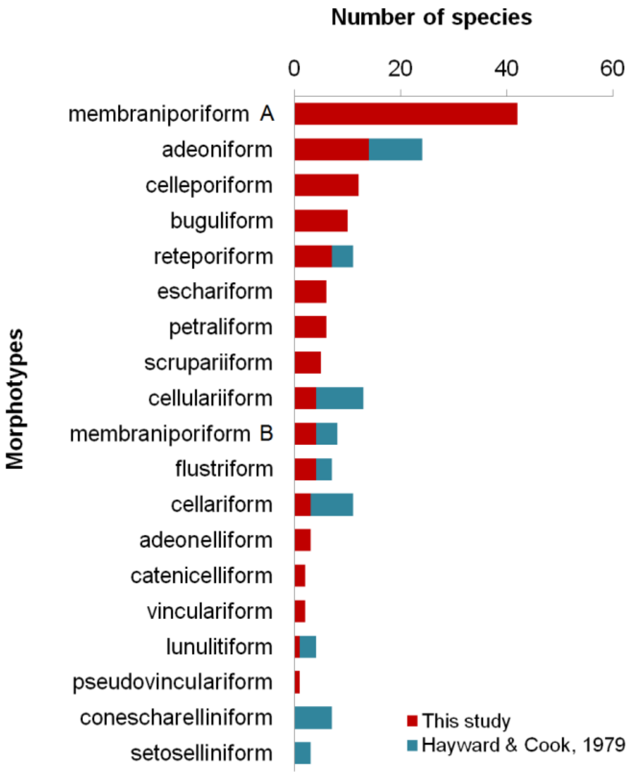

Figure 5.10. The number of species for each colony morphotype recognised in False Bay from shallower waters (< 150 m) and Hayward and Cook (1979) from deep waters (> 500 m), in decreasing order.

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3. Discussion

3.1. *Bryozoan species richness and endemism*

Our knowledge of the distribution patterns of South African bryozoans is limited. This study took advantage of existing previously undetermined bryozoan material and collated data from the literature and museum records. Examining existing museum material increased known bryozoan species richness in South Africa from the 270 species in Florence *et al.* (2007) by 6%, resulting in an overall 286 identified species and 70 morpho-species yet to be fully described. However, species richness in relation to sample sizes vary greatly across marine bioregions and depth zones.

This study suggests that, in shallow waters, species abundance (i.e. the number of individuals) is low in southeast and east coast groups, but greater bryozoan diversity per sample (or locality). Contrastingly, bryozoan richness and sample size in the west and south coast groups is comparable, but diversity appears to be lower than compared to the southeast and east coast. In deep-waters on the east coast, this study suggests very low species richness, but great species abundance, most likely attributed to the few known exclusively deep-water species. In addition to that, a number of species may not have been recorded in the adjacent offshore regions yet. Even though overall bryozoan richness in South Africa is markedly lower when compared to the Australasian region, the highest levels of cheilostome richness and endemism in the Southern Hemisphere is centred around South Africa, south-west Australia and South Island in New Zealand (Barnes and Griffiths 2007).

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The coastline lengths may influence the high levels of richness shared by these regions, since available (or suitable) coastline is a good indicator of bryozoan diversity, and there is a direct correlation between bryozoan fauna and substratum (MacArthur and Wilson 1967; Hayward and Ryland 1999). South Africa indicated the lowest ratio of bryozoan species per kilometres of coastline length (1:8 km), while regions associated with markedly higher richness have longer coastlines, but higher ratios of species richness per kilometres of coastline length when compared to South Africa, for example New Zealand (1:15 km), Brazil (1:20 km) and Australia (1:26 km). Nonetheless, a varied seafloor supports a wide variety of marine biota, as in New Zealand, due to processes in the geological history, physical, geological, oceanographic and biological setting (Gordon *et al.* 2010). South Africa’s almost linear coastline, with a few bays and inlets, supports great marine diversity with high endemism levels (28%), but endemicity varies between taxa (Griffiths and Robinson 2016).

In South Africa, a number of marine taxa appear to be highly endemic (Awad *et al.* 2002) and thus coincides with bryozoans in this study. The apparent endemism reported in this study (57%) was slightly lower than the 64% reported in Griffiths *et al.* (2010), because doubtful species were excluded in the current dataset. The high endemicity of marine bryozoans noted along the south coast (> 60% endemics) reflect the potentially restricted

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distribution ranges of species, driven by life history traits, methods of sampling and analysis (Scott *et al.* 2012).

Many marine organisms exhibit bipartite life histories, comprising of free-living planktonic larval stage that settle and develop into sedentary adults (Scott *et al.* 2012). The majority of bryozoan species are brooders and produce non-feeding, lecithotrophic larvae, which generally settle within a few hours of release and typically display limited dispersal (Hayward and Ryland 1999; Clarke and Lidgard 2000). The large number of endemic bryozoan species in South Africa appears to support typically limited dispersal and short species distribution ranges. It is also possible that many species with supposed range-restriction and/or endemic, are more widespread, but their full distribution in southern Africa has not yet been documented (Scott *et al.* 2012).

Planktonic larvae in bryozoans are rare, although genera in the family Membraniporidae Busk, 1852 and Electridae D'Orbigny, 1851 include species that produce feeding planktotrophic larvae that may grow for several weeks or months in the plankton before settlement. These larvae are able to move great distances and thus reflecting such widespread distributions, for example *Jellyella tuberculata* Bosc, 1802, *Electra pilosa* Linnaeus, 1767, *Conopeum reticulum* Linnaeus, 1767 and *C. seurati* Canu, 1928. Species or genera that are widespread, abundant or dispersive, are able to avoid extinction in both the marine and terrestrial environments and both fossil and extant lineages (for references see Reaka *et al.* 2008).

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Bryozoans are among the animal groups, including bivalves and gastropods that have relatively good fossil records (Benton and Pearson 2001). They are a good model taxon to aid in the reconstruction of the palaeozoogeographical history around fragments of the former supercontinent of Gondwanaland (Barnes and Griffiths 2007). It has been hypothesized that the break-up of Gondwanaland in the Mesozoic era, led to an increase in marine diversity as seen in for example, the Indo-Australian region, primarily because of the separation and fusion of tectonic plates over millions of years (Valentine and Moores 1970). In South Africa, bryozoan fossils are poorly studied, but the faunal similarities in extant cheilostomes (> 60% similarity) from South Africa and Australia likely reflect past connectivity, geographical proximity and isolation of land masses surrounded by oceans (Barnes and Griffiths 2007).

However, there is no compelling evidence for geological vicariance events in southern Africa, including historical oceanic dispersal barriers (e.g. currents, upwelling cells, freshwater plumes), that suggest the populations of coastal taxa could have been completely isolated and consequently driven simultaneous divergence in multiple species (Teske *et al.* 2011). Oceanic dispersal barriers can restrict the dispersal of planktonic larvae between neighbouring sites that can lead to higher genetic differentiation (or speciation) over small spatial scales than predicted from isolation-by-distance analyses (e.g. White *et al.* 2010). However, these barriers

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appear to be more important in the structuring of more recent spatial patterns than phylogeographical patterns as revealed through genetic lineages (Teske *et al.* 2011). Teske *et al.* (2011) suggested rather that ecological divergence scenarios linked to climate oscillations led to species adapting to cooler and warm climatic phases congruent with phylogeographic breaks. The coastal morphology in South Africa has changed considerably due to climatic oscillations (or glaciation periods) during the Pleistocene era (2 million to 10 000 years ago) (Teske *et al.* 2011). This agrees with patterns of freshwater crabs (*Sinopotamon*) in China that coincide with past climatic fluctuations and Pleistocene glacial activities, which may have led to *Sinopotamon* diversity, a high endemism rate and a widespread distribution (Fang *et al.* 2013).

3.2. Species richness patterns along the South African coastline

3.2.1. Longitudinal gradient

Great spatial and temporal (seasonal) variability exist in thermal regimes along the South African coastline (Wieters *et al.* 2009). Species richness around the coast of South Africa generally increases from the west to the east for shallow-water communities and marine taxa (Steffani *et al.* 2015). This coincides with bryozoans from the Chukchi Sea in the Arctic, with a longitudinal trend of increasing species richness from west to east (Denisenko and Grebmeier 2015). However, bryozoans from South Africa do not conform to this pattern.

The limited larval dispersal abilities of most bryozoan species from South Africa implies that oceanic dispersal barriers, for example the Agulhas Current, are highly likely to influence regional richness patterns. Furthermore, despite the general Northern Hemisphere distribution of bryozoans, in warmer months, bryozoans are commonly found in areas where water temperatures range between 15-28°C (Thorp and Rogers 2010). Changes in water temperatures can affect the settlement of larvae in some bryozoans (e.g. Saunders and Metaxas 2007; Denisenko and Grebmeier 2015) and it is well-documented that, in South Africa, the west coast is characterised by cool-temperate waters and warm temperate to tropical waters towards the east coast.

This study revealed that there is a clear biogeographic structure to regional bryozoan fauna of South Africa. The results from the biogeographic analysis indicate five faunal breaks: in the vicinity of Port Nolloth on the west coast, around the Cape Peninsula on the southwest, in the vicinity of East London on the southeast coast, and in Durban and St. Lucia on the east coast. The Port Nolloth break seems to be arbitrary and most likely due to sampling bias along the northern west coast, while the remainder of the faunal breaks coincide with known phylogeographic breaks and/or high richness peaks in marine biota.

On the west coast, the northward-flowing Benguela Current shows the strongest evidence for unidirectional gene flow (Von der Heyden *et al.* 2008) and, in addition to upwelling

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events, most likely influences the low species richness patterns noted in some marine taxa (Griffiths *et al.* 2010; Teske *et al.* 2011). This pattern agrees with bryozoan richness along the west coast towards the southwest, with a faunal break for shallow-water bryozoans in the Cape Peninsula, part of an area stretching from about Cape Point to Cape Agulhas. Previous studies have found this region to be a biogeographic disjunction between cool-temperate and warm-temperate biota, characterised by distinct genetic lineages of marine biota in the southwest transition zone and high levels of endemism (Emanuel *et al.* 1992; Mead *et al.* 2011a; Teske *et al.* 2011). Bryozoan richness and endemism peaks in this region and coincides with richness peaks of amphipods, isopods, and polychaetes (Griffiths *et al.* 2010). Strong significant differences between west and south coast shallow-water communities may suggest that the faunal break is real, owing to the apparent absence of a number of bryozoan species, particularly *Flustramorpha marginata* on the west coast, whilst they are present in the south coast communities.

Subphotic bryozoans did not indicate a faunal break at the southwest, but indicated strong significant differences between all communities along the coast. The Agulhas Current can carry larvae southwards and mostly facilitates in long distance dispersal, whilst studies have also pointed out that eastward-flowing counter currents in the Agulhas Current system produce a bidirectional flow (Lutjeharms 2006a; Teske *et al.* 2011; Scott *et al.* 2012). The bidirectional dispersal of larvae can possibly explain the great variability of communities along the south coast, and the least variability of communities along the southeast and east coast. The second faunal break occurs in the vicinity of East London, and coincides with the biogeographic disjunction, stretching from Algoa Bay to near the Wild Coast, between warm-temperate and subtropical biota (Emanuel *et al.* 1992; Mead *et al.* 2011a). Exact locations for the phylogeographic breaks differ between species, while in some species, there are considerable overlap of genetic lineages found in the southeast transition zone (Teske *et al.* 2011). The third faunal break, in the vicinity of Durban, occurred in the shallow-water and subphotic communities, but analysis indicated significant differences within the subphotic group. This break agrees with Awad *et al.* (2002), who found species richness of some groups (e.g. octocorals, chitons, echinoderms, fishes, seaweeds) to peak in Port Elizabeth and Durban, which they attributed to high sampling activity in the region.

However, in this study, the break in Durban does not represent a peak in species richness – only three bryozoan species were reported – and is likely related to unsampled areas or very limited bryozoan distribution data further north of Durban, particularly in depths shallower than 300 m. Some common South African bryozoans, for example *Chaperiopsis multifida*, *Gregarinidra spinuligera*, *Onchoporella buskii* and *Reteporella lata*, are assumed to be absent on the east coast. It is highly probable that relevant bryozoan material exist, taking

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into account that sampling activity is high in the region, but perhaps have remained undetermined and housed at museums or other institutions.

No significant differences were indicated for bathyal communities along the coast. The observed patterns and associated faunal breaks (around the Cape Peninsula, East London and St. Lucia) are most likely related to the patchiness of sampled offshore areas and biased taxonomic efforts on the southeast and east coast. Even though the faunal break at St. Lucia coincides with the phylogeographic break of subtropical and tropical (coastal) biota (Teske *et al.* 2011), the trend cannot be considered ‘real’. Widespread bryozoans (*Columnella magna*, *Himantozoum leontodon*, *Cornucopina novissima* and *Bifaxaria submucronata*) is present in community in the east coast extremity, reported from Scottish National Antarctic Expedition in Hayward (1980). This may reflect the mixing of oceanic water masses in the Southeast Indian offshore region pertaining to larval dispersal from the Indo-Pacific region, however, few genetic studies in offshore regions exist to support this hypothesis.

3.2.2. Depth-related gradient

Generally, bryozoan richness decline with depth and is largely a function of hard substrate availability (Eggleston 1972). However, in this study, bryozoans produced no depth-related trends in species richness, but high species richness (> 65 species) was noted in the 10 m, 90 m and 1000 m depth bins. Areas associated with depths below 10 m, include rocky intertidal shores and harbours that are easily accessible, and low tides expose rocky shores whereby bryozoan material can be collected by hand. During the 20th Century sampling increased largely in the intertidal areas (< 10 m). Contrastingly, despite some deep-water collections in South African waters from the 19th Century by the *HMS Challenger*, amongst other voyages, regions with depths deeper than 30 m are poorly sampled, because hard substrata are less accessible for scuba divers (Griffiths *et al.* 2010).

O’Donoghue, along with de Watteville, (O’Donoghue 1924, 1957, O’Donoghue and de Watteville 1935, 1937, 1944) published the taxonomic results for a number of shallow-water bryozoan collections, while Florence *et al.* (2007) examined more recent shallow-water collections around the Cape Peninsula. Deep-water collections collated for this study, contained material collected in the *Meiring Naude* cruises and published in the reports of Hayward and Cook (1979, 1983). The majority of the sampling stations were at depths of 90 m and 1000 m, therefore the high species richness indicated for the 10 m, 90 m and 1000 m depth bins appear to be related to both sampling bias and taxonomic efforts.

Community differences along the longitudinal gradient were less pronounced than the differences along the depth gradient. Significant differences in community composition were indicated among communities (shallow-water, subphotic and bathyal) on the south coast and between the subphotic and bathyal communities on the west coast. Generally, the shallow-

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water and subphotic communities clustered together – most likely because these communities are within the continental shelf – while all the bathyal communities clearly separated in the MDS plots. However, taking into account that the exclusion of bryozoans from the shelf edge in this study, may explain the marked differences between the continental shelf and the bathyal.

Steffani *et al.* (2015) found that water depth and distance from the Orange River mouth strongly influenced the structure of infaunal communities (polychaetes, amphipods, bivalves etc.) along the west coast off Namaqualand of South Africa and off the Namibian coast. Sediment texture (muddy versus gravel) played a secondary role in community structure, but the authors suggested that communities may largely be affected by unmeasured variables (e.g. dissolved oxygen, food availability and disturbance) (Steffani *et al.* 2015). In this study, the separation of bryozoan communities within the continental shelf and the bathyal zone may imply that communities are likely structured due to environmental variables that change with depth such as productivity, habitat heterogeneity/availability (Smith and Brown 2002), light transparency (Roberts and Davis 1996) and changes in temperatures (Brayard *et al.* 2005).

3.3. Colony morphotypes of shallow-water bryozoans

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The majority of species in False Bay occurred in depths below 60 m, which is expected since the greatest part of the bay has depths shallower than 80 m (Day 1970). This agrees with similar studies in the Chukchi Sea (Denisenko and Grebmeier 2015) and Admiralty Bay (Pabis *et al.* 2014) with the highest species richness in depths below 60 m and 70 m, respectively. However, the majority of the stations sampled in the Chukchi Sea were in depths shallower than 60 m (Denisenko and Grebmeier 2015), and most probably skewed the results as with the current study. Even though inconsistencies in sampling methods do not allow for accurate observations in species richness patterns, bryozoan diversity is expected to be high in shallower waters. This is mainly attributed to sheltered rocky shores and areas with high wave action, rich in suspended particles, that support a large number of bryozoans in addition to other filter- and suspension feeders (Hayward and Ryland 1999; Gage 2001; Gray 2002). Therefore, water energy, or turbulence, and sediment accumulation rate are two of the main parameters driving bryozoan distribution patterns (Reid 2010).

The present collections indicate a high dominance of encrusting (membraniporiform) bryozoans (46 species). Encrusting bryozoans are commonly found in shallow, rocky intertidal areas, affected by high wave action and other types of disturbances (Kukliński 2009), and this agrees with other shallow-water environments (Schäfer 2007; Pabis *et al.* 2014; Denisenko and Grebmeier 2015). The erect and rigid group contain the second and third most common morphotypes, the adeoniform (14 species) and the celleporiform (12 species), as well the adeonelliform and reteroporiform (< 10 species) morphotypes. The buguliform (10 species)

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and less the speciose morphotypes of flustriform and cellulariiform, forms part of the tuft-like group. Rigid or tuft-like bryozoans are more at risk in environments with large quantaties of inorganic suspension that may clog their feeding apparatus (Moore 1977; Pabis *et al.* 2014). Furthermore, tuft-like bryozoan species indicate a positive relationship between abundance, increasing depth and distance away from disturbance (Boyer *et al.* 1990).

McKinney and Jackson (1991) suggested that encrusting species can occur in both high and low turbulent waters, and very strong turbulent waters are associated with more robust and rigid forms. It is well-documented that the reefs and hard grounds within False Bay (e.g. Roman Rock, A-Frame and Pyramid Rock) produce great physical heterogeneity and are considered relatively distinct most likely due to the influence of both the Agulhas Current and seasonal intermediate upwelling (Sink *et al.* 2011b). Therefore, the morphotypes in this study coincide with the environmental conditions as predicted by McKinney and Jackson (1991).

Contrastingly, very few encrusting species were found in the deep-water collections of Hayward and Cook (1979), and dominated by the conesharelliniform and setoselliniform species that are generally exclusive to deep-water species. In deeper waters, hard substrate is uncommon and sandy or muddy habitats dominate (Eggleston 1972, Hayward and Cook 1979). Diversity may be lower in deeper waters, less disturbed waters, but some bryozoan species commonly act as microhabitats for smaller invertebrates including other bryozoans (Barnes 1994; Pabis *et al.* 2014). The most common habitat-forming bryozoans in the current collection were *Reteporella lata* and *Schizoretepora tessellata.* In an attempt to understand the relationship between colony morphotypes and the environment, studies need to address the inconsistent sampling and spatio-temporal differences in environmental variables (e.g. turbidity, water temperature, substrata).

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CHAPTER 6. SYNTHESIS

This study was aimed at updating known bryozoan species richness and examining spatial distribution patterns of bryozoans along the South African coastline. The key research questions proposed for the present study is in Chapter 1. Chapter 2 dealt with the history of the Iziko South African Museum, and its collections, adapted from Boonzaaier *et al.* (2014)[5]. Large collections of marine invertebrates housed at museums and universities were sampled during the marine exploration era from the mid-nineteenth Century. Scientific cruises such as the HMS *Challenger* and RV *Meiring Naudé* around southern Africa conducted systematic research to assess global marine biodiversity. Therefore, European colonialism brought upon a new era of scientific discoveries by conducting large marine surveys along the South African coastline, and importing scientific knowledge into South Africa. These studies, however, were focussed mainly on fish, molluscs and crustaceans, and certain taxa of benthic marine invertebrates, such as sponges and bryozoans, were neglected, resulting in a large amount of bryozoan material housed in the Iziko South African Museum to remain undetermined. Consequently, taxonomic studies on the South African bryozoans are, in part, outdated and fragmented with spatial and temporal gaps in our biodiversity knowledge. This sixth chapter aims to summarise the main findings of Chapters 4 and 5, and the implications of these findings for conservation and management of sensitive marine areas.

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6.1. Updating bryozoan species richness

As part of a broader project to increase biodiversity knowledge of marine invertebrates from South Africa, a taxonomic account of previously undetermined bryozoan material in the Iziko South African Museum was presented in Chapter 4. These collections yielded 162 species, and about 70 morpho-species in genera (e.g. *Harpecia*, *Schizomavella* and *Triphyllozoon*) previously not known from South Africa. Morpho-species will remain unnamed until further investigation, particularly where type material or appropriate material is required that preclude a complete description. Twelve new species (*Favosipora epiphyta* sp. nov., *Chaperiopsis* (*Chaperiopsis*) *yinca* sp. nov., *Aspidostoma staghornea* sp. nov., *Micropora erecta* sp. nov., *Trypostega infantaensis* sp. nov., *Khulisa ukhololo* sp. nov., *Adeonella assegai* sp. nov., *Celleporaria umuzi* sp. nov., *Hippomonavella lingulatus* sp. nov., *Microporella lezinyosi* sp. nov., *Phidolopora cyclops* sp. nov.and *Reteporella ilala* sp. nov.) were described.

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[5] Citation: Boonzaaier, M.K., Florence, W.K. and Spencer Jones, M.E. 2014. Historical review of South African bryozoology: a legacy of European endeavour. In: *Annals of Bryozoology 4: aspects of the history of research on bryozoans*, (eds) P.N. Wyse Jackson and M.E. Spencer Jones, p.1-34. International Bryozoology Association, Dublin.

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Five species previously assigned to genera *Eurystotos*, *Aetea*, *Schizoporella, Chaperia* and *Arthropoma* are transferred to *Microeciella*, *Callaetea*, *Hippomonavella, Chaperiopsis* and *Rogicka*, respectively (*Microeciella* cf. *planus* comb. nov., *Callaetea* cf. *spiralis* comb. nov., *Hippomonavella inconspicua* comb. nov., *Chaperiopsis familiaris* comb. nov. and *Rogicka lioneli* comb. nov.). Five genera (*Biflustra*, *Callaetea*, *Favosipora, Rogicka* and *Phidolopora*) are newly recorded from South Africa. A new genus (*Khulisa*) was introduced for one species, *Khulisa ukhololo* sp. nov.

This study revealed the first records of *Conopeum reticulum*, *Aspidostoma giganteum* and *Carbasea carbasea* from South Africa. Two species (*C. reticulum* and *C. carbasea*) have a widespread distribution in the Northern Hemisphere (Hayward and Ryland 1998), while *A. giganteum* has a widespread distribution in the South Atlantic Ocean, including Gough Island and the South Shetland Isles in the Antarctic (Hayward 1995). Although the species agree with descriptions and figures, type material and molecular research is required to validate its identity, particularly owing to its widespread distribution.

Two species (*Hippomonavella* cf. *flexuosa* and *Hippomonavella* cf. *praeclara*) potentially from New Zealand and Australia were recorded in this study and have potentially been introduced to South Africa, but also require type material to validate its identity. The high probability of these species being introduced to South Africa may be supported by a marked faunal affinity with the Indo-West-Pacific region (Hayward and Cook 1979; Branch and Hayward 2007). One of the major shortcomings in biodiversity assessments in South Africa, especially for neglected marine taxa and this study, is a lack of pre-invasion information (Mead *et al.* 2011a).

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Over 400 years of European colonial history resulted in a long history of shipping activities in South Africa with major shipping routes along the coastline, where marine introductions of exotic species took place consistently (Mead *et al.* 2011a). The large number of bryozoan material (including fossils) that still remain undetermined in museum(s) will markedly increase the discovery of new species and introduced species. Therefore, valuable historical and recent data “locked” in museum collections have the potential to aid us in understanding marine benthic diversity.

6.2. Spatial distribution patterns of South African bryozoans

Chapter 5 has dealt with the spatial distribution patterns and biogeographical analyses of 286 bryozoan species collated from the literature and museum records. This study has greatly contributed to our understanding of bryozoan communities along the South African coast. Bryozoans do not conform to apparent latitudinal and depth-related species richness patterns as seen in other marine taxa in South Africa. However, the majority of known bryozoan diversity occurs within the continental shelves (< 100 m), and, in addition to the exclusion of

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bryozoans from the shelf edge and abyss, prevents accurate conclusions. In New Zealand, habitat availability/heterogeneity, sedimentary perturbation and primary production was proposed to explain the observed patterns in the relationship between bryozoan community composition/biodiversity and depth (Rowden *et al.* 2004). New Zealand is considered one of the best studied regions in Australasia (Costello *et al.* 2010), and may explain the observed patterns in South Africa along a depth gradient.

Bryozoans in shallow waters (< 30 m) and bathyal (500-3 500 m) depths indicated no obvious longitudinal trends and discontinuous patterns of richness. A slight longitudinal trend was observed in bryozoans in the subphotic zone (30-300 m), where species richness is fairly high and uniform along the south and southeast coast, and decreases towards the west and east coasts. The main findings in this study were that:

- South African bryozoans exhibit high levels of apparent endemism;
- The west coast communities indicated the lowest species richness, while the highest species richness was indicated for the south coast;
- Ocean currents and cold-water upwelling most likely influence regional spatial patterns of bryozoans;
- Bryozoans produced a clear biogeographic structure in communities along the coastline;
- Four faunal breaks were identified at Cape Peninsula/False Bay, East London, Durban and around St. Lucia;
- Encrusting species dominate False Bay commonly found in shallow, rocky intertidal areas, affected by high wave action and other types of disturbances.

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South Africa has a rich marine biota and high levels of apparent endemism (Griffiths *et al.* 2010; Scott *et al.* 2012), and agrees with the high overall species richness and endemism in South African bryozoans. The apparent endemism in South African bryozoans (57%) is comparable with Australia (50%) (Chapman 2009) and New Zealand (61%) (Gordon *et al.* 2009). Areas of peaks in richness and endemism occur around the Cape Peninsula/False Bay, East London, Durban and St. Lucia, and are adjacent or situated in recognised biogeographic breaks of invertebrate assemblages (Scott *et al.* 2012). In this study, the faunal break at Durban was most likely due to limited distribution data north and south of Durban. These areas of richness peaks coincide with enhanced research and shipping activities, transporting exotic species (Mead *et al.* 2011a; Scott *et al.* 2012).

The highest proportion of introduced (annelids, crustaceans, mollusc etc.) is in harbour areas such as Langebaan and Saldanha Bay, on the west coast, while the Cape Point region on the south coast, supports the highest number of endemics (Mead *et al.* 2011a; Scott *et al.*

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2012). Bryozoans in this study also indicated high endemism along the south coast, and peaks around the Cape Peninsula/False Bay. Of the 286 known species in South Africa, 161 species were reported in this study from False Bay, from these 127 species were cheilostomes.

Seventeen colony morphotypes were recognised, of which encrusting species dominated, followed by robust and rigid species, and tuft-like species. This is suggestive of an area with great physical heterogeneity. However, to understand the diversity of morphotypes in relation to the modern environment, more studies are required and can be used in paleoenvironmental reconstruction. The limitations in this study are as follows:

Firstly, large spatial gaps and unequal sampling effort across depth zones, marine bioregions and coastal habitats (Mead *et al.* 2011a). This is particularly true in the present study for deep-water regions and areas on the west and east coast. Hard substrata in depths deeper than 30 m and less accessible to scuba divers are very poorly sampled, largely attributed to the great cost of collecting samples and lacking locally-based capacity to conduct sampling at great depths (Griffiths *et al.* 2010).

Secondly, temporal gaps exist because the seasonality of occurrence and the reproduction period result in the presence or absence of bryozoan species at a location (e.g. Seed *et al.* 1981; Winston 1982). Some species can be collected in winter when water temperatures drop to below 10°C and in tropical regions, few taxa may survive temperatures of at least 37°C (Thorp and Rogers 2010). In this study, the majority of examined material in this study was collected at stations during summer and autumn months (February – July), although some stations were sampled in spring (October – November), and should be taken into consideration when assessing the diversity of bryozoans.

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Thirdly, very few trained specialist taxonomists in South Africa are available to make authorative identifications. Additionally, Eurocentric tendencies in assigning European names to South African specimens was very common, especially in some of the works of O'Donoghue in the 20th Century, of which some synonymies remain unresolved. Besides synonymies, the majority of observational bryozoan records have no associated voucher specimen to validate the identification made by a generalist (or amateur) taxonomist.

The digitization era brought about the availability of valuable historical and recent data to use in richness patterns and predicting (paleo) environmental conditions. However, a number of records have been duplicated and/or incorrect data were entered, and addressing this issue may add great value to marine conservation planning when using the 'clean' data. These limitations suggest that the conclusions drawn from the present data in this study, and from other less studied marine benthic taxa, may reflect potential interpretation bias in marine biodiversity assessments.

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6.3. *Implications of this study for conservation planning*

High biodiversity values are generally used in marine conservation planning (e.g. Awad *et al.* 2002), but in the light of limited information on the distribution of biodiversity in regions like South Africa for certain taxa, the use of surrogates or indicator groups, that is representative of other elements of biodiversity, have been proposed (Gladstone 2002). Gladstone (2002) found that molluscs appeared to be a reliable indicator for areas to conserve and contained significantly more species than compared to macroalgae in rocky shore locations in southeast Australia. Their findings were based on the significant relationship between the richness of molluscs and the richness of all species, and between the rarity of molluscs and the rarity of all species in the localities (Gladstone 2002).

Rowden *et al.* (2004) used bryozoans in New Zealand as an indicator taxon for marine protected areas, and indicated particular areas of the shelf and deep-sea environment that could be protected to conserve New Zealand's marine biodiversity. The highest levels of regional bryozoan richness and endemism in cheilostomes were centred around south-west Australia, South Island in New Zealand and South Africa (Barnes and Griffiths 2007). Additionally, timely investment in the protection of areas with centers of endemism may result in conserving targeted taxa or species (Roberts *et al.* 2002). It is useful to consider endemism to interpret richness values in the Southern Hemisphere, as there are many large isolated landmasses like Antarctica, Australia, New Zealand and Madagascar (Barnes and Griffiths 2007).

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In South African, overall endemicity peaks on the south coast for several marine taxa, including bryozoans from this study, because of biogeographic distinctness. However, endemicity values are also biased by the distance from defined political boundaries, differences in sampling effort locally and in neighbouring countries (Griffiths and Robinson 2016). Although there is a significant conservation value in using standardised and consistent measures of endemicity, the authors suggested that distribution range restriction would be a better measure of conservation status (Griffiths and Robinson 2016). Scott *et al.* (2012) indicated that the largest peaks of range-restricted endemic species for major marine taxa occurred in False Bay, Port Elizabeth, Durban, St Lucia and Maputo Bay, which agrees with most of the known biogeographical breaks.

Benthic diversity assessments may be used to identify potential sites for marine conservation or marine protection (Rouse *et al.* 2014). As benthic data layers improve through increased sampling effort, particularly in unstudied areas, greater understanding into the relationship between the physical environment, diversity and spatial distribution patterns of benthic fauna will be gained (Rouse *et al.* 2014). This study provides an example of the application of methods to assess spatial patterns in benthic diversity, and serves as a baseline for long-term monitoring of changes in biodiversity in this poorly studied Phylum.

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Future research

The current study emphasizes on the importance of examining existing museum collections in an effort to boost biodiversity knowledge of Bryozoa, and other marine invertebrate taxa. To assess Bryozoa ‘true’ richness in South Africa, spatial and temporal biodiversity gaps need to be addressed in future research. Marine benthic taxa (e.g. molluscs, corals, sponges, polychaetes and bryozoans) are usually sensitive to environmental changes such as pollution, increasing water temperatures and ocean acidification (Byrne 2011; Smith 2014; Bhadury 2015). Research on climate change and paleoenvironmental reconstruction using bryozoans is required to understand historical changes. Lastly, the need for trained specialist taxonomists is emphasized.

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Appendix 1. Station data of the 254 sampled stations examined in this study. Inferred depth data for hand collected samples are indicated (in **bold**).

Station	Collection Date	Latitude	Longitude	Depth	Gear type
UCT Ecological Survey					
RV Africana					
AFR 0002	6/6/1949	33°10'S	17°57'E	73 m	Dredge
AFR 688	7/5/1947	32°34.2'S	17°3.2'E	318 m	Trawl
AFR 693	9/5/1947	32°26.5'S	17°28.5'E	208 m	-
AFR 7071	26/5/1947	31°39.5'S	16°55.2'E	287 m	Trawl
AFR 723-5-7	10/8/1947	31°30'S	17°0'E	366 m	-
AFR 728	15/8/1947	31°14.1'S	16°36.5'E	272 m	Dredge
AFR 7290	15/8/1947	31°22.8'S	16°20.2'E	366 m	Dredge
AFR 730	15/8/1947	31°29.7'S	16°3.4'E	459 m	Dredge
AFR 736	17/8/1947	30°42.4'S	15°59.2'E	201 m	Dredge
AFR 743	21/8/1947	30°2'S	15°2'E	364 m	Dredge
AFR 754	7/9/1947	30°10.5'S	16°25.6'E	187 m	Dredge
AFR 774	15/9/1947	29°13'S	14°58.6'E	197 m	Dredge
AFR 775	15/9/1947	29°15.9'S	14°47.5'E	238 m	Dredge
AFR 787	27/9/1947	32°53.3'S	17°30'E	309 m	Dredge
AFR 865	8/1/1948	34°35.5'S	19°18.2'E	37 m	Dredge
AFR 866	9/1/1948	34°36.8'S	19°16.4'E	38 m	Dredge
AFR 888	11/2/1948	34°45.1'S	19°16'E	57 m	Dredge
AFR 935	12/3/1948	34°23.8'S	18°41.1'E	88 m	Dredge
AFR 950	20/3/1948	36°44'S	21°18'E	201 m	Dredge
AFR 957	22/3/1948	35°13'S	21°19.3'E	111 m	Dredge
AFR 9670	23/3/1948	35°7'S	20°49'E	91 m	Dredge
False Bay Survey					
FAL 108	23/1/1953	34°9.3'S	18°51'E	8-12 m	-
FAL 111	27/1/1953	34°12'S	18°27'E	4-5 m	Dive
FAL 122	17/2/1953	34°9'S	18°25'E	7 m	Dive
FAL 126	17/2/1953	34°9'S	18°25'E	2-4 m	Dive
FAL 127	17/2/1953	34°9'S	18°25'E	2-7 m	Dive
FAL 133	27/2/1953	34°12'S	18°27'E	2 m	Dive

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Station	Collection Date	Latitude	Longitude	Depth	Gear type
FAL 141	9/3/1953	34°12'S	18°27'E	5 m	Dive
FAL 148	12/3/1953	34°12'S	18°27'E	4.5-5.5 m	Dive
FAL 15	5/3/1952	34°12'S	18°27'E	8-9 m	Dredge
FAL 153	21/4/1953	34°12'S	18°27'E	3 m	Dive
FAL 154	21/4/1953	34°12'S	18°27'E	3 m	Dive
FAL 16	5/3/1952	34°12'S	18°27'E	8-9 m	Dredge
FAL 161	23/5/1953	34°12'S	18°27'E	2 m	Dive
FAL 165	10/6/1953	34°12'S	18°27'E	2-4 m	Dive
FAL 170	10/6/1953	34°12'S	18°27'E	4-6.5 m	Dive
FAL 182	7/9/1953	34°12'S	18°27'E	5 m	Dive
FAL 186	10/9/1953	34°12.8'S	18°36.5'E	46 m	-
FAL 208	10/9/1953	34°9.9'S	18°42.4'E	36.5 m	-
FAL 21	5/3/1952	34°3'S	18°28'E	11-12 m	Plankton Net
FAL 211	9/9/1953	34°7.1'S	18°35.6'E	21.7 m	-
FAL 213	10/9/1953	34°12.4'S	18°43.5'E	42 m	-
FAL 218	9/9/1953	34°7'S	18°32.5'E	18 m	-
FAL 222	9/9/1953	34°13.9'S	18°31.6'E	40 m	-
FAL 226	9/9/1953	34°10.5'S	18°32.4'E	36 m	-
FAL 23	5/3/1952	34°3'S	18°28'E	11-12 m	Plankton Net
FAL 230	9/9/1953	34°17.4'S	18°31.4'E	49 m	-
FAL 233	10/9/1953	34°15.3'S	18°44.8'E	48 m	-
FAL 236	10/9/1953	34°21.1'S	18°46.8'E	64 m	-
FAL 25	5/3/1952	34°3'S	18°29'E	21-15 m	Dredge
FAL 256	17/11/1953	34°12'S	18°27'E	4-5.5 m	Dive
FAL 258	21/11/1953	34°12'S	18°27'E	10.5 m	Dive
FAL 26	5/3/1952	34°3'S	18°29'E	21-15 m	Dredge
FAL 260	21/11/1953	34°11'S	18°27'E	14 m	Dive
FAL 270	18/9/1954	34°10'S	18°27'E	14-17 m	Dive
FAL 274	21/9/1954	34°10'S	18°27'E	14-17 m	Dive
FAL 278	23/9/1954	34°10'S	18°27'E	12-14 m	Dive
FAL 302	8/10/1902	34°23'S	18°36'E	35 m	-
FAL 303	9/10/1902	34°26'S	18°37'E	73 m	-
FAL 305	27/9/1998	34°13'S	18°33'E	56 m	-

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Station	Collection Date	Latitude	Longitude	Depth	Gear type
FAL 307	21/9/1954	34°10'S	18°27'E	14-17 m	Dive
FAL 330	31/1/1959	34°15'S	18°36'E	51 m	Dredge
FAL 331	31/1/1959	34°15'S	18°36'E	51 m	Dredge
FAL 341	31/1/1959	34°11'S	18°35.5'E	44 m	Dredge
FAL 344	31/1/1959	34°11'S	18°33.5'E	38 m	Dredge
FAL 348	31/1/1959	34°8.7'S	18°31.6'E	27 m	Dredge
FAL 353	24/2/1959	34°20.2'S	18°46'E	73 m	Dredge
FAL 355	24/2/1959	34°23.3'S	18°39.4'E	97 m	Trawl
FAL 357	24/2/1959	34°18.8'S	18°39'E	73 m	Dredge
FAL 361	25/2/1959	34°9.1'S	18°46.6'E	30 m	Dredge
FAL 363	25/2/1959	34°9.15'S	18°46.6'E	30 m	Dredge
FAL 366	25/2/1959	34°9.15'S	18°46.6'E	30 m	Dredge
FAL 368	25/2/1959	34°12.6'S	18°46.7'E	40 m	Dredge
FAL 372	25/2/1959	34°15.1'S	18°44.8'E	54 m	Dredge
FAL 389	15/11/1960	34°12.6'S	18°29.1'E	40 m	Van Veen grab
FAL 393	20/11/1960	34°20.5'S	18°49.1'E	21 m	Van Veen grab
FAL 401	16/5/1961	34°8.8'S	18°33.5'E	31 m	Van Veen grab
FAL 410	16/5/1961	34°8.8'S	18°33.5'E	31 m	Van Veen grab
FAL 415	15/5/1961	34°12.5'S	18°37'E	48 m	Van Veen grab
FAL 42	25/6/1952	34°9.6'S	18°49.2'E	21.5 m	-
FAL 421	15/5/1961	34°12.5'S	18°37'E	48 m	Van Veen grab
FAL 432	15/5/1961	34°12.5'S	18°37'E	48 m	Dredge
FAL 435	16/5/1961	34°15.2'S	18°33.2'E	41 m	Van Veen grab
FAL 445	22/5/1961	34°13.3'S	18°31.3'E	39 m	Dredge
FAL 466	24/10/1961	34°12'S	18°32'E	40 m	Dredge
FAL 475	25/10/1961	34°7'S	18°42'E	29 m	Dredge
FAL 48	25/6/1952	34°9.3'S	18°49.6'E	18 m	-
FAL 491	24/10/1961	34°16'S	18°32'E	62 m	Dredge
FAL 5	22/2/1952	34°9.5'S	18°35'E	35 m	Dredge
FAL 503	27/10/1961	34°14'S	18°30'E	42 m	Dredge
FAL 504	27/10/1961	34°14'S	18°30'E	42 m	Dredge
FAL 509	27/10/1961	34°14'S	18°30'E	68 m	Dredge
FAL 518	7/3/1962	33°34'S	18°21'E	17 m	Dredge

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Station	Collection Date	Latitude	Longitude	Depth	Gear type
FAL 524	10/7/1962	34°10.2'S	18°35.8'E	36 m	Van Veen grab
FAL 525	10/7/1962	34°10.2'S	18°35.8'E	36 m	Van Veen grab
FAL 55	25/6/1952	34°9.3'S	18°49.6'E	18 m	-
FAL 563	10/7/1962	34°6.8'S	18°30.7'E	13 m	Van Veen grab
FAL 570	12/9/1962	34°13.2'S	18°47.2'E	36 m	Van Veen grab
FAL 573	30/10/1962	34°17.1'S	18°34.2'E	54 m	Dredge
FAL 576	30/10/1962	34°8.9'S	18°43'E	33 m	Dredge
FAL 577	30/10/1962	34°8.9'S	18°43'E	33 m	Dredge
FAL 6	22/2/1952	34°8.3'S	18°35.3'E	24 m	Dredge
FAL 602	1/2/1963	34°9.7'S	18°38.3'E	40 m	Dredge
FAL 603	1/2/1963	34°15.2'S	18°46.5'E	42 m	Dredge
FAL 608	21/2/1964	34°10.3'S	18°48.6'E	29 m	Dredge
FAL 61	29/7/1952	34°17.5'S	18°49.2'E	22 m	-
FAL 614	24/2/1964	34°15'S	18°35'E	50 m	Dredge
FAL 618	20/2/1964	34°7.2'S	18°35.6'E	22 m	Dredge
FAL 621	21/2/1964	34°8.9'S	18°28.8'E	26 m	Dredge
FAL 622	21/2/1964	34°8.9'S	18°28.8'E	26 m	Dredge
FAL 632	21/2/1964	34°8'S	18°49'E	7-9 m	Dredge
FAL 635	20/2/1964	34°10.6'S	18°29.6'E	35 m	Dredge
FAL 64	29/7/1952	34°17.3'S	18°48.7'E	37-38 m	-
FAL 641	21/2/1964	37°9'S	18°34.6'E	33 m	Dredge
FAL 65	29/7/1952	34°17.3'S	18°48.7'E	37-38 m	-
FAL 650	20/2/1964	34°6.6'S	18°33'E	15 m	Dredge
FAL 664	20/2/1964	34°7'S	18°36'E	26 m	Dredge
FAL 67	29/7/1952	34°17.2'S	18°48.7'E	16-19 m	-
FAL 683	25/2/1964	34°12.4'S	18°43.2'E	44-48 m	Dredge
FAL 697	25/2/1964	34°10'S	18°43'E	36 m	Dredge
FAL 7	22/2/1952	34°8.3'S	18°35.3'E	24 m	Dredge
FAL 700	25/2/1964	34°11.5'S	18°39'E	44 m	Van Veen grab
FAL 703	25/2/1964	34°13'S	18°45.1'E	44 m	Van Veen grab
FAL 708	25/2/1964	34°5.5'S	18°39'E	17 m	Dredge
FAL 730	26/2/1964	34°8.9'S	18°45'E	26-29 m	Dredge
FAL 735	26/2/1964	34°8.5'S	18°41'E	36 m	Dredge

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Station	Collection Date	Latitude	Longitude	Depth	Gear type
FAL 739	26/2/1964	34°6.8'S	18°41'E	26-29 m	Dredge
FAL 740	26/2/1964	34°6.8'S	18°41'E	26-29 m	Dredge
FAL 741	16/2/1965	34°9.5'S	18°50.6'E	7 m	Dredge
FAL 742	16/2/1965	34°9.5'S	18°50.6'E	7 m	Dredge
FAL 752	16/2/1965	34°4.5'S	18°35'E	4 m	Dredge
FAL 757	17/2/1965	34°14.5'S	18°38.8'E	53 m	Van Veen grab
FAL 759	22/2/1965	34°18.6'S	18°42.9'E	71 m	Dredge
FAL 772	15/2/1965	34°17'S	18°29.2'E	27 m	Van Veen grab
FAL 775	16/2/1965	34°9'S	18°27'E	19 m	Dredge
FAL 776	16/2/1965	34°9'S	18°27'E	19 m	Dredge
FAL 777	16/2/1965	34°13'S	18°49'E	19 m	Dredge
FAL 783	15/2/1965	34°17'S	18°29.2'E	17 m	Dredge
FAL 79	29/7/1952	34°16.5'S	18°49.5'E	147 m	-
FAL 793	18/2/1965	34°19.8'S	18°48.6'E	87 m	Dredge
FAL 797	17/2/1965	34°10.7'S	18°26.3'E	87 m	Dredge
FAL 807	17/2/1965	34°10.7'S	18°26.3'E	18 m	Van Veen grab
FAL 818	18/2/1965	34°17.7'S	18°47.6'E	78 m	Dredge
FAL 821	18/2/1965	34°17.6'S	18°45'E	58 m	Dredge
FAL 822	18/2/1965	34°17.6'S	18°45'E	58 m	Dredge
FAL 829	16/2/1965	34°7.1'S	18°47.3'E	5 m	Dredge
FAL 830	16/2/1965	34°5.5'S	18°36.9'E	5 m	Dredge
FAL 831	16/2/1965	34°5.5'S	18°36.9'E	5 m	Dredge
FAL 833	15/2/1965	34°14.3'S	18°29.7'E	5 m	Dredge
FAL 835	17/2/1965	34°15'S	18°49'E	29 m	Dredge
FAL 84	29/7/1952	34°16.5'S	18°49.5'E	147 m	-
FAL 846	16/2/1965	34°5'S	18°41.3'E	8 m	Dredge
FAL 848	17/2/1965	34°15'S	18°49'E	29 m	Van Veen grab
FAL 852	17/2/1965	34°14.5'S	18°38.8'E	33 m	Dredge
FAL 853	17/2/1965	34°16.6'S	18°48.8'E	26 m	Dredge
FAL 920	17/9/1967	34°11'S	18°50'E	20 m	Dive
FAL 96	17/9/1952	34°10.6'S	18°47.3'E	36 m	-
Langebaan Survey					
LB 165	26/4/1948	33°'S	18°'E	0-1 m	Hand collected

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Station	Collection Date	Latitude	Longitude	Depth	Gear type
LB 17	15/7/1946	33°9'S	18°4.2'E	3 m	-
LB 181	26/4/1949	33°7'S	18°1'E	0-1 m	Hand collected
LB 200	28/4/1949	33°5'S	18°1'E	-	-
LB 220	12/12/1950	33°5'S	18°1'E	-	-
LB 248	2/5/1951	33°5'S	18°1'E	-	-
LB 285	4/5/1951	33°5'S	18°1'E	-	-
LB 314	4/5/1951	33°5'S	18°1'E	-	-
LB 336	5/5/1951	33°7'S	18°1'E	-	-
LB 371	7/5/1953	33°5'S	18°1'E	-	-
LB 375	7/5/1953	33°5'S	18°1'E	-	-
LB 378	7/5/1953	33°6'S	18°1'E	3 m	-
LB 380	7/5/1953	33°6'S	18°0'E	4.5 m	Dredge
LB 381	7/5/1953	33°6'S	18°0'E	4.5 m	Dredge
LB 386	8/5/1953	33°6'S	18°1'E	**< 10 m**	Hand collected
LB 392	8/5/1953	33°7'S	18°1'E	2.5 m	Dredge
LB 485	2/5/1956	33°5'S	18°0'E	12 m	Dredge
Saldanha Bay Survey					
SB 141	2/5/1957	33°2'S	18°2'E	**< 10 m**	Hand collected
SB 151	22/9/1957	33°2'S	18°2'E	**< 10 m**	Hand collected
SB 153	22/9/1957	33°2'S	18°2'E	**< 10 m**	Hand collected
SB 155	22/9/1957	33°2'S	18°2'E	**< 10 m**	Hand collected
SB 158	22/9/1957	33°2'S	18°2'E	**< 10 m**	Hand collected
SB 159	23/9/1957	32°59'S	17°56'E	-	-
SB 168	25/9/1957	33°2'S	18°2'E	**< 10 m**	Hand collected
SB 193	30/4/1959	33°07'S	17°58.4'E	8 m	Dredge
SB 197	1/5/1959	33°4.4'S	17°56.4'E	35 m	Dredge
SB 201	2/5/1959	33°3.5'S	17°57.5'E	31 m	Dredge
SB 238	5/5/1960	33°07'S	18°04'E	7 m	Van Veen grab
SB 252	22/4/1962	33°03'S	17°56.6'E	35 m	Dredge
SB 261	21/4/1962	33°04.2'S	18°01.4'E	5 m	Dredge
SB 8	14/7/1946	33°04.9'S	18°00.4'E	4.5-5.5 m	-
SB 88	13/7/1946	33°00.1'S	17°59.2'E	7 m	-
Trawler Survey					

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Station	Collection Date	Latitude	Longitude	Depth	Gear type
TRA 103	-/3/1956	34°25'S	21°30'E	55 m	Dredge
TRA 109	8/9/1956	34°19.3'S	18°32.3'E	58 m	Dredge
TRA 113	8/9/1956	34°19.3'S	18°32.3'E	58 m	Dredge
TRA 115	29/11/1956	34°15'7"S	18°43'6"E	53 m	Dredge
TRA 116	29/11/1956	34°11'4"S	18°39'1"E	45 m	Dredge
TRA 118	25/1/1957	34°13.5'S	18°44.7'E	44 m	Dredge
TRA 119	25/1/1957	34°11.7'S	18°44.5'E	40 m	Dredge
TRA 120	25/1/1957	34°12'S	18°44'E	37 m	Dredge
TRA 122	25/1/1957	34°13.5'S	18°44.7'E	44 m	Dredge
TRA 127	23/2/1957	34°18.5'S	18°29.5'E	51 m	Dredge
TRA 129	10/3/1957	32°26.5'S	16°38'E	480 m	Trawl
TRA 132	-/2/1957	34°19.6'S	18°30'E	55 m	Dredge
TRA 141	27/3/1957	34°18.2'S	18°30.6'E	51 m	Dredge
TRA 151	6/3/1958	34°51'S	19°55'E	22 m	-
TRA 31	9/11/1947	34°49'S	20°21.5'E	86 m	Trawl
TRA 33	20/7/1949	34°55'S	21°10'E	90 m	Trawl
TRA 3300	20/7/1949	34°55'S	21°10'E	90 m	Trawl
TRA 35	21/1/1950	34°34'S	20°50'E	70 m	Trawl
TRA 36	21/1/1950	34°34'S	20°50'E	73 m	Trawl
TRA 37	-/7/1950	34°30'S	20°50'E	73 m	Trawl
TRA 42	-/7/1951	34°30'S	20°55'E	70 m	-
TRA 46	24/9/1952	31°25'S	16°20'E	366 m	Dredge
TRA 56	28/11/1952	34°40'S	21°35'E	70-77 m	Trawl
TRA 57	27/11/1952	34°24'S	21°55'E	59 m	Trawl
TRA 59	26/11/1952	34°28'S	21°45'E	70 m	Trawl
TRA 71	5/2/1953	32°5'S	18°14'E	66 m	Dredge
TRA 73	3/2/1953	32°6'S	16°37'E	311 m	Dredge
TRA 92	-/1/1954	35°3'S	21°50'E	110 m	Trawl
TRA 93	-/1/1954	35°3'S	21°50'E	110 m	Trawl
TRA 94	-/1/1954	35°3'S	21°50'E	110 m	Trawl
West Coast Dredge					

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Station	Collection Date	Latitude	Longitude	Depth	Gear type
WCD 101	2/7/1961	32°5.5'S	18°17.3'E	27 m	Dredge
WCD 107	3/7/1961	33°6.5'S	17°32.9'E	273 m	Dredge
WCD 11	24/3/1959	34°9.4'S	18°16.5'E	75 m	Dredge
WCD 156	22/10/1963	34°1.7'S	18°14.7'E	100 m	Dredge
WCD 159	21/9/1960	33°55.8'S	18°21.3'E	37 m	Van Veen grab
WCD 165	7/10/1963	33°52'S	18°25'E	29 m	Dive
WCD 18	29/4/1959	33°5.6'S	17°54.5'E	64 m	Dredge
WCD 195	28/4/1963	33°7.6'S	17°56.6'E	79 m	Dredge
WCD 203	29/4/1964	33°8.6'S	17°57.3'E	50-54 m	Dredge
WCD 212	12/10/1965	34°30'-34°27.1'S	18°16.6'-18°15.6'E	400 m	Dredge
WCD 217	29/8/1967	34°43.3'-34°42.8'S	18°12.5'-18°08.8'E	360-365 m	Dredge
WCD 30	15/12/1959	34°10.5'S	18°14.3'E	122-129 m	Dredge
WCD 32	15/12/1959	34°10'S	18°16'E	93 m	Dredge
WCD 36	2/5/1960	33°6.5'S	17°56.7'E	18-33 m	Dredge
WCD 56	21/9/1960	32°4.6'S	18°18'E	18 m	Dredge
WCD 6	24/3/1959	34°9.3'S	18°17.5'E	43 m	Dredge
WCD 71	22/9/1960	33°6.5'S	17°49'E	88 m	Dredge
WCD 87	3/7/1961	33°6.2'S	17°49'E	88 m	Van Veen grab
WCD 89	2/7/1961	32°5'S	18°16.7'E	36 m	Dredge
South Coast Demersal Survey					
Africana cruise AFR273					
A31595	14/4/2011	36°19'52.4"-36°18'35.028"S	20°59'52.4"-20°58'26.472"E	147-151 m	Trawl
A31599	15/4/2011	36°07'60.0"-36°8'44.772"S	21°33'28.8"-21°31'34.86"E	160-162 m	Trawl
A31605	16/4/2011	34°25'22.4"-34°26'12.48"S	22°52'58.7"-22°51'19.08"E	100-102 m	Trawl
A31614	18/4/2011	33°59'52.2"-34°1'33.528"S	25°46'51.6"-25°46'36.12"E	52-53 m	Trawl
A31617	19/4/2011	34°07'48.6"-34°7'16.248"S	25°50'58.9"-25°52'54.012"E	109-110 m	Trawl
A31618	19/4/2011	34°04'46.0"-34°4'19.272"S	26°05'24.5"-26°7'27.228"E	108-110 m	Trawl
A31619	20/4/2011	33°55'18.9"-33°55'0.012"S	26°35'32.4"-26°37'37.272"E	100-103 m	Trawl
A31624	21/4/2011	33°48'23.5"-33°49'39.612"S	25°56'48.0"-25°55'25.428"E	45 m	Trawl

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Station	Collection Date	Latitude	Longitude	Depth	Gear type
A31631	23/4/2011	34°44'34"-34°44'27"S	24°20'1"-24°22'6"E	174-179 m	Trawl
A31639	25/4/2011	34°24'24.66"-34°24'18.252"S	23°7'31.8"-23°9'36.072"E	103-104 m	Trawl
A31650	2/5/2011	34°55'53.76"-34°55'35.292"S	23°17'7.152"-23°19'11.712"E	211 m	Trawl
A31660	4/5/2011	34°37'24.312"-34°36'39.528"S	21°57'35.028"-21°59'34.62"E	81-82 m	Trawl
A31664	5/5/2011	35°4'35.508"-35°4'19.092"S	22°11'38.04"-22°13'39.972"E	111-112 m	Trawl
A31666	5/5/2011	34°58'50.988"-34°58'46.92"S	21°36'51.66"-21°38'59.892"E	95-97 m	Trawl
A31680	10/5/2011	34°57'29.52"-34°56'53.412"S	20°27'24.66"-20°28'37.488"E	102-103 m	Trawl
A31682	11/5/2011	35°33'56.988"-35°32'26.592"S	21°32'43.368"-21°31'37.02"E	126-127 m	Trawl
West Coast Demersal Survey					
Africana cruise AFR270					
A31401	25/1/2011	32°38'46.2"-32°37'30.432"S	16°53'48.0"-16°52'20.28"E	343-345 m	Trawl
A31418	29/1/2011	31°54'11.1"-31°53'1.248"S	16°47'45.0"-16°46'18.048"E	303-304 m	Trawl

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Appendix 2. An updated species list of 368 South African bryozoans (including morpho-species), indicating new species (in **bold**), genera newly recorded (with an asterisk) from this study and global distribution range or affinities, where applicable: Endemic (E), Atlantic (A), Indo-Pacific (I), Widespread (W), Cosmopolitan (C) and Scattered (S).

Species/Family	Range
ADEONIDAE	
Adeona costata	E
Adeona intermedia	E
Adeonella abdita	E
Adeonella assegai sp. nov.	E
Adeonella alia	E
Adeonella aspera	E
Adeonella atlantica	A
Adeonella circumspecta	E
Adeonella concinna	E
Adeonella confusanea	E
Adeonella conspicua	E
Adeonella coralliformis	E
Adeonella cracens	E
Adeonella cultrata	E
Adeonella damicornis	E
Adeonella decipiens	E
Adeonella distincta	E
Adeonella expansa	E
Adeonella falcicula	E
Adeonella fuegensis	S
Adeonella gibba	E
Adeonella guttata	E
Adeonella inaequalis	W
Adeonella infirmata	E
Adeonella ligulata	E
Adeonella lobata	E
Adeonella majuscula	E
Adeonella pluscula	E
Adeonella purpurea	E
Adeonella regularis	E
Adeonella similis	E
Adeonella sp. 1	-
Adeonella spathulata	E
Adeonella tuberosa	E
Adeonellopsis meandrina	E
Adeonellopsis sp.	-
Dimorphocella moderna	E
Laminopora bimunita	I
Laminopora jellyae	E
AETEIDAE	
Aetea anguina	C
Callaetea cf. *spiralis* comb. nov.*	-
ALCYONIDIIDAE	
Alcyonidium chondroides	E
Alcyonidium flustroides	E
Alcyonidium nodosum	S
Alcyonidium rhomboidale	E
ALYSIDIIDAE	
Alysidium parasiticum	I
Catenicula cf. *compacta*	-
Catenicula corbulifera	-
Catenicula compacta	E
ARACHNOPUSIIDAE	
Arachnopusia corniculata	E
Arachnopusia labiosa fragilis	
ASPIDOSTOMATIDAE	
*Aspidostoma giganteum**	
Aspidostoma livida	E
Aspidostoma magna	E
Aspidostoma staghornea sp. nov.	E
BATOPORIDAE	
Batopora lagaaiji	E
Batopora murrayi	S
Batopora nola	E
Lacrimula burrowsi	I
Lacrimula pyriformis	S
BEANIIDAE	
Beania hirtissima	A
Beania inermis	S
Beania magellanica	W
Beania minuspina	E
Beania rediviva	E
Beania sp. 1	-
Beania sp. 2	-
Beania uniarmata	E
Beania vanhoeffeni	E

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Species/Family	Range
Dimorphozoum nobile	E
BIFAXARIIDAE	
Bifaxaria submucronata	S
Diplonotos inornatus	S
Domosclerus corrugatus	S
Raxifabia longicaulis	S
BITECTIPORIDAE	
Bitectipora umboavicula	E
Hippomonavella cf. *flexuosa**	I
Hippomonavella formosa	S
?Hippomonavella inconspicua comb. nov.	E
Hippomonavella lingulatus sp. nov.	-
Hippomonavella cf. *praeclara**	I
Hippoporina rostrata	-
Pentapora foliacea	A
Schizosmittina lizzya	E
BRYOCRYPTELLIDAE	
Porella capensis	E
BUGULIDAE	
Bicellariella bonsai	E
Bicellariella chuakensis	-
Bugula capensis	E
Bugula decipiens	S
Bugula neritina	C
Bugula robusta	I
Bugulella gracilis	W
Bugulella problematica	E
Bugulina avicularia	S
Bugulina flabellata	W
Cornucopina novissima	I
Cornucopina nupera	I
Cornucopina sp.	-
Himantozoum leontodon	W
Himantozoum sinuosum	I
Himantozoum taurinum	S
Kinetoskias cyathus	A
Kinetoskias elegans	A
Kinetoskias pocillum	W
Kinetoskias sp.	-
Viridentula dentata	W
BUSKIIDAE	
Cryptopolyzoon concretum	I
Cryptopolyzoon sp.	-
CALLOPORIDAE	
Amphiblestrum pontifex	E
Amphiblestrum triangularis	S
Callopora jamesi	E
Crassimarginatella marginalis	I
CALWELLIDAE	
Onchoporella buskii	E
CANDIDAE	
Caberea darwinii	S
Caberea darwinii occlusa	E
Eupaxia quadrata	I
Hoplitella armata	E
Menipea crispa	E
Menipea marionensis	E
Menipea ornata	E
Menipea triseriata	E
Notoplites candoides	E
Notoplites cassidula	E
Notoplites sp.	-
Tricellaria varia	E
CATENICELLIDAE	
Catenicella elegans	W
Cornuticella taurina	I
Costaticella carotica	E
Talivittaticella incomperta	E
CELLARIIDAE	
Cellaria fistulosa	S
Cellaria mandibulata	I
Cellaria paradoxa	E
Cellaria punctata	I
Cellaria sp.	-
Smitticellaria tectiformis	E
CELLEPORIDAE	
Cellepora pustulata	
Celleporina solida	E
Galeopsis bispiramina	E
Galeopsis circella	E
Galeopsis mutabilis	
Galeopsis pentagonus	W
Lagenipora echinacea	S
Lagenipora spinifera	E
Osthimosia cf. *simonensis*	-
Osthimosia simonensis	E
Turbicellepora avicularis	S

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Species/Family	Range
Turbicellepora canaliculata	A
Turbicellepora cf. *canaliculata*	-
Turbicellepora conica	E
Turbicellepora coralliformis	A
Turbicellepora protensa	E
Turbicellepora redoutei	I
Turbicellepora sp. 1	-
Turbicellepora valligera	E
CHAPERIIDAE	
Chaperia acanthina	-
Chaperia capensis	E
Chaperia sp.	-
Chaperia septispina	E
Chaperiopsis chelata	E
Chaperiopsis cylindracea	S
Chaperiopsis familiaris comb. nov.	E
Chaperiopsis multifida	E
Chaperiopsis rubida	I
Chaperiopsis stephensoni	E
Chaperiopsis yinca sp. nov.	E
Notocoryne cervicornis	E
CHORIZOPORIDAE	
Chorizopora brongniartii	C
CLEIDOSCHASMATIDAE	
Characodoma cribritheca	E
Characodoma protrusum	S
Cleidochasma affinis	-
CONESHARELLINIDAE	
Conescharellina africana	I
CRIBRILINIDAE	
Cribrilina dispersa	E
Cribrilina simplex	E
Figularia fissa	I
Figularia philomela	I
Figularia sp.	-
Glabrilaria africana	E
Inversiscaphos setifer	E
Khulisa ukhololo sp. nov.*	E
Puellina innominata	S
Puellina venusta	S
CRISIIDAE	
Bicrisia edwardsiana	W
Crisia elongata	W
Crisia holdsworthii	S
Crisidia cornuta	A
Mesonea radians	I
CRYPTOSULIDAE	
Cryptosula pallasiana	W
CUPULADRIIDAE	
Discoporella umbellata	A
Discoporella umbellata peyroti	E
Reussirella multispinata	A
DENSIPORIDAE	
Favosipora epiphyta sp. nov.*	-
DIAPEROECIIDAE	
Nevianipora pulcherrima	W
ELECTRIDAE	
Conopeum reticulum	C
Conopeum seurati	W
Electra pilosa	C
Harpecia sp.*	-
ENTALOPHORIDAE	
Mecynoecia australis	I
Mecynoecia clavaeformis	E
Mecynoecia delicatula	I
ESCHARINIDAE	
Hippomenella avicularis	I
Taylorius waiparaensis	-
EUTHYRISELLIDAE	
Tropidozoum burrowsi	S
EXOCHELLIDAE	
Escharoides contorta	E
Escharoides custodis	E
Escharoides distincta	E
Escharoides sp.	-
Escharoides sp. 1	-
Escharoides sp. 2	-
Escharoides sp. 3	-
Exochella tricuspis	I
FARCIMINARIIDAE	
Columnella accincta	E
Columnella graminea	E
Columnella magna	W
Farciminellum hexagonum	I
FLUSTRELLIDRIDAE	
Elzerina blainvillii	I
FLUSTRIDAE	
*Carbasea carbasea**	W

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Species/Family	Range	Species/Family	Range
Carbasea elegans	I	LEIOSALPINGIDAE	
Carbasea mediocris	E	*Leiosalpinx inornata*	E
Carbasea sp. 1	-	LEKYTHOPORIDAE	
Carbasea sp. 2	-	*Turritigera stellata*	S
Flustra foliacea	S	LEPRALIELLIDAE	
Gregarinidra spinuligera	E	*Celleporaria capensis*	E
FOVEOLARIIDAE		*Celleporaria* sp.	-
Dactylostega prima	E	*Celleporaria* sp. 1	-
Dactylostega tubigera	E	***?Celleporaria umuzi*** sp. nov.	E
Foveolaria imbricata	E	*Celleporaria tridenticulata*	S
GIGANTOPORIDAE		LICHENOPORIDAE	
Gigantopora foraminosa	E	*Disporella algoensis*	E
Gigantopora polymorpha	E	*Disporella buski*	W
HELIODOMIDAE		*Disporella novaehollandiae*	S
Heliodoma implicata	A	*Disporella* sp. 1	-
Setosellina roulei	A	*Patinella radiata*	S
HETEROPORIDAE		*Patinella verrucaria*	S
Heteropora pelliculata	-	MACROPORIDAE	
HIPPOPORIDRIDAE		*Macropora africana*	E
Fodinella spinigera	S	MALILLOPORIDAE	
Hippoporella labiata	E	*Anoteropora inarmata*	E
Hippoporidra senegambiensis	A	*Anoteropora latirostris*	W
HIPPOTHOIDAE		MARGARETTIDAE	
Celleporella annularis	W	*Margaretta levinseni*	I
Celleporella hyalina	S	*Margaretta opuntioides*	I
Hippothoa musivaria	E	MEMBRANIPORIDAE	
Hippothoa patagonica	-	***Biflustra khoisan*** sp. nov.*	E
HORNERIDAE		*Jellyella tuberculata*	W
Hornera americana	A	*Membranipora rustica*	E
Hornera erugata	E	MICROPORELLIDAE	
Hornera sp.	-	*Fenestrulina elevora*	E
INCERTAE SEDIS		*Fenestrulina indigena*	E
Klugeflustra jonesii	E	*Fenestrulina* sp. 1	-
LACERNIDAE		*Fenestrulina* sp. 2	-
Arthropoma cecilii	W	*Flustramorpha angusta*	E
Arthropoma sp.	E	*Flustramorpha flabellaris*	E
Rogicka lioneli comb. nov.	-	*Flustramorpha marginata*	A
Phonicosia circinata	I	***Microporella lezinyosi*** sp. nov.	E
LANCEOPORIDAE		*Microporella madiba*	E
Calyptotheca capensis	E	MICROPORIDAE	
Calyptotheca nivea	W	***Micropora erecta*** sp. nov.	E
Calyptotheca porelliformis	E	*Micropora latiavicula*	E
Emballotheca ambigua	E	*Micropora similis*	I
		Micropora sp.	-

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Species/Family	Range	Species/Family	Range
ONCOUSOECIIDAE		RHABDOZOIDAE	
Microeciella planus comb. nov.	E	*Rhabdozoum stephensoni*	E
PETALOSTEGIDAE		ROMANCHEINIDAE	
Petalostegus bicornis	I	*Escharella anatirostris*	E
PETRALIELLIDAE		*Escharella discors*	E
Mucropetraliella asymmetrica	E	*Escharella serratilabris*	E
Mucropetraliella sp.	-	SCHIZOPORELLIDAE	
PHIDOLOPORIDAE		*Schizoporella unicornis*	W
Iodictyum flosculum	E	SCRUPARIIDAE	
Phidolopora cyclops sp. nov.*	E	*Scruparia ambigua*	C
Plesiocleidochasma perspicuum	E	*Scruparia chelata*	S
Reteporella bullata	E	SMITTINIDAE	
Reteporella clancularia	E	*Parasmittina novella*	E
Reteporella dinotorhynchus	E	*Parasmittina* sp.	-
Reteporella gilchristi	S	*Parasmittina tropica*	W
Reteporella ilala sp. nov.	-	*Smittina ferruginea*	E
Reteporella lata	E	*Smittina landsborovii*	S
Reteporella magellensis	A	*Smittina sitella*	E
Reteporella sp. 1	-	*Smittina* sp. 1	-
Reteporella sp. 2	-	*Smittoidea calcarata*	E
Reteporella verecunda	E	*Smittoidea circumspecta*	E
Rhynchozoon abscondum	E	*Smittoidea errata*	E
Rhynchozoon beatulum	E	*Smittoidea hexagonalis*	E
Rhynchozoon documentum	E	*Smittoidea* sp.	-
Rhynchozoon fulgidum	E	STEGINOPORELLIDAE	
Rhynchozoon incallidum	E	*Steginoporella buskii*	W
Rhynchozoon longirostris	I	STOMACHETOSELLIDAE	
Rhynchozoon oscitans	E	*Stomachetosella balani*	E
Rhynchozoon ptarmicum	E	THALAMOPORELLIDAE	
Rhynchozoon stomachosum	E	*Thalamoporella spiravicula*	E
Schizoretepora tessellata	S	TRYPOSTEGIDAE	
Schizoretepora tessellata var. caespitosa	E	***Trypostega infantaensis*** sp. nov.	E
Schizoretepora tessellata var. pubens	E	*Trypostega venusta*	W
Stephanollona ignota	I	TUBULIPORIDAE	
Triphyllozoon sp.*	-	*Exidmonea atlantica*	A
PLAGIOECIIDAE		*Exidmonea crassimargo*	E
Liripora lineata	-	*Exidmonea* sp.	-
Plagioecia patina	S	*Idmidronea contorta*	E
Plagioecia sp.	-	*Idmidronea parvula*	-
Plagioecia sp. 1	-	*Tennysonia stellata*	E
Plagioecia sp. 2	-	VESICULARIIDAE	
QUADRICELLARIIDAE		*Amathia gracilis*	C
Nellia sp.	-	*Amathia lendigera*	W
		Amathia populea	S

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Species/Family	Range
WATERSIPORIDAE	
Watersipora subtorquata	W

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Appendix 3. Results of SIMPER analysis indicating the species that contributed most to the similarity of compared replicates within the depth- and coastal groups. Average abundance, average similarity with standard deviation (Av. Sim. ± SD), contribution percentage (Contrib. %) and cumulative contribution percentage (Cum. %) were tabulated for each species. The bathyal southeast group had less than two groups to compare, therefore SIMPER analysis was not able to calculate similarity index. The grey line indicates cumulative contribution percentage ≈ 50%.

Species	**Av. Abundance**	**Av. Sim ± SD**	**Contrib. (%)**	**Cum. (%)**
Average similarity = 56.18		Shallow, West Coast		
Alcyonidium nodosum	1	6.95 ± 1.65	12.37	12.37
Electra pilosa	1	6.95 ± 1.65	12.37	24.74
Menipea crispa	1	6.95 ± 1.65	12.37	37.11
Menipea ornata	1	6.95 ± 1.65	12.37	49.48
Onchoporella buskii	1	6.95 ± 1.65	12.37	61.85
Jellyella tuberculata	0.73	3.12 ± 0.84	5.55	67.4
Celleporella hyalina	0.73	2.42 ± 0.87	4.31	71.71
Bicellariella bonsai	0.64	1.57 ± 0.72	2.79	74.5
Gigantopora polymorpha	0.64	1.57 ± 0.72	2.79	77.29
Gregarinidra spinuligera	0.64	1.57 ± 0.72	2.79	80.08
Menipea triseriata	0.64	1.57 ± 0.72	2.79	82.87
Schizoretepora tessellata	0.64	1.57 ± 0.72	2.79	85.66
Turbicellepora valligera	0.64	1.57 ± 0.72	2.79	88.45
Average similarity = 78.95		Shallow, South Coast		
Adeonella pluscula	1	2.76 ± 5.73	3.5	3.5
Aetea anguina	1	2.76 ± 5.73	3.5	7
Beania magellanica	1	2.76 ± 5.73	3.5	10.5
Bicellariella bonsai	1	2.76 ± 5.73	3.5	14
Bugula neritina	1	2.76 ± 5.73	3.5	17.5
Calyptotheca nivea	1	2.76 ± 5.73	3.5	21.01
Catenicella elegans	1	2.76 ± 5.73	3.5	24.51
Celleporaria capensis	1	2.76 ± 5.73	3.5	28.01
Celleporella hyalina	1	2.76 ± 5.73	3.5	31.51
Chaperia capensis	1	2.76 ± 5.73	3.5	35.01
Electra pilosa	1	2.76 ± 5.73	3.5	38.51
Escharoides custodis	1	2.76 ± 5.73	3.5	42.01
Gigantopora polymorpha	1	2.76 ± 5.73	3.5	45.51
Gregarinidra spinuligera	1	2.76 ± 5.73	3.5	49.01
Laminopora jellyae	1	2.76 ± 5.73	3.5	52.51
Menipea crispa	1	2.76 ± 5.73	3.5	56.02
Menipea triseriata	1	2.76 ± 5.73	3.5	59.52

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Species	**Av. Abundance**	**Av. Sim ± SD**	**Contrib. (%)**	**Cum. (%)**
Schizoretepora tessellata	1	2.76 ± 5.73	3.5	63.02
Steginoporella buskii	1	2.76 ± 5.73	3.5	66.52
Turbicellepora redoutei	1	2.76 ± 5.73	3.5	70.02
Virididentula dentata	1	2.76 ± 5.73	3.5	73.52
Flustramorpha marginata	0.9	2.33 ± 1.88	2.95	76.47
Tennysonia stellata	0.9	2.33 ± 1.88	2.95	79.41
Turbicellepora conica	0.9	2.33 ± 1.88	2.95	82.36
Alcyonidium rhomboidale	0.9	2.13 ± 1.86	2.7	85.06
Mucropetraliella asymmetrica	0.8	1.91 ± 1.25	2.42	87.48
Schizomavella sp. 1	0.8	1.75 ± 1.24	2.21	89.69
Average similarity = 75.61		Shallow, Southeast Coast		
Aetea anguina	1	4.49 ± 17.53	5.93	5.93
Bicellariella bonsai	1	4.49 ± 17.53	5.93	11.87
Catenicella elegans	1	4.49 ± 17.53	5.93	17.8
Celleporaria capensis	1	4.49 ± 17.53	5.93	23.74
Celleporella hyalina	1	4.49 ± 17.53	5.93	29.67
Flustramorpha marginata	1	4.49 ± 17.53	5.93	35.61
Laminopora jellyae	1	4.49 ± 17.53	5.93	41.54
Menipea crispa	1	4.49 ± 17.53	5.93	47.48
Menipea triseriata	1	4.49 ± 17.53	5.93	53.41
Mucropetraliella asymmetrica	1	4.49 ± 17.53	5.93	59.35
Schizoretepora tessellata	1	4.49 ± 17.53	5.93	65.28
Steginoporella buskii	1	4.49 ± 17.53	5.93	71.22
Virididentula dentata	1	4.49 ± 17.53	5.93	77.15
Average similarity = 54.39		Shallow, East Coast		
Flustramorpha marginata	1	9.1 ± 3.69	16.73	16.73
Mucropetraliella asymmetrica	1	9.1 ± 3.69	16.73	33.47
Schizoretepora tessellata	1	9.1 ± 3.69	16.73	50.2
Adeonellopsis meandrina	0.67	2.08 ± 0.58	3.83	54.03
Aetea anguina	0.67	2.08 ± 0.58	3.83	57.86
Alysidium parasiticum	0.67	2.08 ± 0.58	3.83	61.69
Bicellariella bonsai	0.67	2.08 ± 0.58	3.83	65.52
Catenicella elegans	0.67	2.08 ± 0.58	3.83	69.35
Catenicula compacta	0.67	2.08 ± 0.58	3.83	73.19
Celleporella hyalina	0.67	2.08 ± 0.58	3.83	77.02
Cornuticella taurina	0.67	2.08 ± 0.58	3.83	80.85
Elzerina blainvillii	0.67	2.08 ± 0.58	3.83	84.68
Margaretta opuntioides	0.67	2.08 ± 0.58	3.83	88.51
Menipea crispa	0.67	2.08 ± 0.58	3.83	92.34

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Species	Av. Abundance	Av. Sim ± SD	Contrib. (%)	Cum. (%)
Average similarity = 74.51		Subphotic, West Coast		
Mucropetraliella asymmetrica	1	2.72 ± 2.41	3.65	3.65
Schizoretepora tessellata	1	2.72 ± 2.41	3.65	7.29
Adeonella circumspecta	0.93	2.09 ± 2.2	2.8	10.09
Adeonella gibba	0.93	2.09 ± 2.2	2.8	12.89
Rogicka lioneli	0.93	2.09 ± 2.2	2.8	15.69
Beania sp. nov. 2	0.93	2.09 ± 2.2	2.8	18.49
Biflustra khoisan sp. nov.	0.93	2.09 ± 2.2	2.8	21.29
Celleporaria capensis	0.93	2.09 ± 2.2	2.8	24.09
Celleporella hyalina	0.93	2.09 ± 2.2	2.8	26.89
Chaperiopsis multifida	0.93	2.09 ± 2.2	2.8	29.69
Gigantopora polymorpha	0.93	2.09 ± 2.2	2.8	32.49
Gregarinidra spinuligera	0.93	2.09 ± 2.2	2.8	35.28
Menipea crispa	0.93	2.09 ± 2.2	2.8	38.08
Menipea ornata	0.93	2.09 ± 2.2	2.8	40.88
Menipea triseriata	0.93	2.09 ± 2.2	2.8	43.68
Reteporella lata	0.93	2.09 ± 2.2	2.8	46.48
Turbicellepora valligera	0.93	2.09 ± 2.2	2.8	49.28
Adeonella ligulata	0.87	1.68 ± 1.63	2.26	51.54
Reteporella ilala sp. nov.	0.87	1.68 ± 1.63	2.26	53.8
Tennysonia stellata	0.87	1.68 ± 1.63	2.26	56.06
Average similarity = 87.85		Subphotic, South Coast		
Adeonella gibba	1	1.58 ± 13.65	1.8	1.8
Adeonella regularis	1	1.58 ± 13.65	1.8	3.6
Amphiblestrum triangularis	1	1.58 ± 13.65	1.8	5.4
Caberea darwinii	1	1.58 ± 13.65	1.8	7.19
Calyptotheca nivea	1	1.58 ± 13.65	1.8	8.99
Calyptotheca porelliformis	1	1.58 ± 13.65	1.8	10.79
Celleporaria capensis	1	1.58 ± 13.65	1.8	12.59
Chaperiopsis stephensoni	1	1.58 ± 13.65	1.8	14.39
Dactylostega tubigera	1	1.58 ± 13.65	1.8	16.19
Dimorphocella moderna	1	1.58 ± 13.65	1.8	17.99
Exidmonea crassimargo	1	1.58 ± 13.65	1.8	19.78
Flustramorpha marginata	1	1.58 ± 13.65	1.8	21.58
Gigantopora polymorpha	1	1.58 ± 13.65	1.8	23.38
Gregarinidra spinuligera	1	1.58 ± 13.65	1.8	25.18
Hoplitella armata	1	1.58 ± 13.65	1.8	26.98
Hornera erugata	1	1.58 ± 13.65	1.8	28.78
Idmidronea contorta	1	1.58 ± 13.65	1.8	30.58

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Species	Av. Abundance	Av. Sim ± SD	Contrib. (%)	Cum. (%)
Menipea crispa	1	1.58 ± 13.65	1.8	32.37
Menipea marionensis	1	1.58 ± 13.65	1.8	34.17
Menipea ornata	1	1.58 ± 13.65	1.8	35.97
Menipea triseriata	1	1.58 ± 13.65	1.8	37.77
Microporella lezinyosi sp. nov.	1	1.58 ± 13.65	1.8	39.57
Mucropetraliella asymmetrica	1	1.58 ± 13.65	1.8	41.37
Onchoporella buskii	1	1.58 ± 13.65	1.8	43.17
Porella capensis	1	1.58 ± 13.65	1.8	44.96
Reteporella ilala sp. nov.	1	1.58 ± 13.65	1.8	46.76
Reteporella lata	1	1.58 ± 13.65	1.8	48.56
Schizoretepora tessellata	1	1.58 ± 13.65	1.8	50.36
Smittoidea errata	1	1.58 ± 13.65	1.8	52.16
Turbicellepora valligera	1	1.58 ± 13.65	1.8	53.96
Average similarity = 78.03		Subphotic, Southeast Coast		
Adeonella gibba	1	1.64 ± 10.02	2.11	2.11
Arthropoma cecilii	1	1.64 ± 10.02	2.11	4.21
Beania magellanica	1	1.64 ± 10.02	2.11	6.32
Caberea darwinii	1	1.64 ± 10.02	2.11	8.43
Calyptotheca nivea	1	1.64 ± 10.02	2.11	10.54
Cellaria punctata	1	1.64 ± 10.02	2.11	12.64
Celleporaria capensis	1	1.64 ± 10.02	2.11	14.75
Celleporaria tridenticulata	1	1.64 ± 10.02	2.11	16.86
Chaperia capensis	1	1.64 ± 10.02	2.11	18.96
Dactylostega prima	1	1.64 ± 10.02	2.11	21.07
Dimorphocella moderna	1	1.64 ± 10.02	2.11	23.18
Escharoides contorta	1	1.64 ± 10.02	2.11	25.29
Flustramorpha angusta	1	1.64 ± 10.02	2.11	27.39
Flustramorpha marginata	1	1.64 ± 10.02	2.11	29.5
Foveolaria imbricata	1	1.64 ± 10.02	2.11	31.61
Hoplitella armata	1	1.64 ± 10.02	2.11	33.71
Idmidronea contorta	1	1.64 ± 10.02	2.11	35.82
Menipea crispa	1	1.64 ± 10.02	2.11	37.93
Menipea triseriata	1	1.64 ± 10.02	2.11	40.04
Micropora similis	1	1.64 ± 10.02	2.11	42.14
Microporella lezinyosi sp. nov.	1	1.64 ± 10.02	2.11	44.25
Mucropetraliella asymmetrica	1	1.64 ± 10.02	2.11	46.36
Parasmittina novella	1	1.64 ± 10.02	2.11	48.46
Porella capensis	1	1.64 ± 10.02	2.11	50.57
Rhynchozoon beatulum	1	1.64 ± 10.02	2.11	52.68

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Species	Av. Abundance	Av. Sim ± SD	Contrib. (%)	Cum. (%)
Rhynchozoon ptarmicum	1	1.64 ± 10.02	2.11	54.79
Rhynchozoon stomachosum	1	1.64 ± 10.02	2.11	56.89
Smittoidea errata	1	1.64 ± 10.02	2.11	59
Turbicellepora conica	1	1.64 ± 10.02	2.11	61.11
Turbicellepora valligera	1	1.64 ± 10.02	2.11	63.21
Average similarity = 65.88		Subphotic, East Coast		
Arachnopusia corniculata	1	3.43 ± 2.96	5.21	5.21
Crassimarginatella marginalis	1	3.43 ± 2.96	5.21	10.41
Dimorphocella moderna	1	3.43 ± 2.96	5.21	15.62
Fodinella spinigera	1	3.43 ± 2.96	5.21	20.83
Glabrilaria africana	1	3.43 ± 2.96	5.21	26.03
Micropora similis	1	3.43 ± 2.96	5.21	31.24
Rhynchozoon ptarmicum	1	3.43 ± 2.96	5.21	36.45
Stephanollona ignota	1	3.43 ± 2.96	5.21	41.65
Taylorius sp.	1	3.43 ± 2.96	5.21	46.86
Beania magellanica	0.83	1.91 ± 1.29	2.89	49.75
Caberea darwinii	0.83	1.91 ± 1.29	2.89	52.65
Escharoides contorta	0.83	1.91 ± 1.29	2.89	55.54
Flustramorpha marginata	0.83	1.91 ± 1.29	2.89	58.44
Microporella lezinyosi sp. nov.	0.83	1.91 ± 1.29	2.89	61.33
Mucropetraliella asymmetrica	0.83	1.91 ± 1.29	2.89	64.22
Parasmittina novella	0.83	1.91 ± 1.29	2.89	67.12
Parasmittina tropica	0.83	1.91 ± 1.29	2.89	70.01
Porella capensis	0.83	1.91 ± 1.29	2.89	72.9
Rhynchozoon stomachosum	0.83	1.91 ± 1.29	2.89	75.8
Smittina sitella	0.83	1.91 ± 1.29	2.89	78.69
Smittoidea circumspecta	0.83	1.91 ± 1.29	2.89	81.58
Smittoidea errata	0.83	1.91 ± 1.29	2.89	84.48
Trypostega venusta	0.83	1.91 ± 1.29	2.89	87.37
Turbicellepora valligera	0.83	1.91 ± 1.29	2.89	90.26
Average similarity = 53.68		Bathyal, West Coast		
Adeonella coralliformis	1	43.05 ± 2.72	80.2	80.2
Kinetoskias pocillum	0.5	5.81 ± 0.46	10.83	91.03
Average similarity = 82.21		Bathyal, South Coast		
Adeonella coralliformis	1	12.01 ± 6.2	14.61	14.61
Calyptotheca nivea	1	12.01 ± 6.2	14.61	29.21
Flustramorpha angusta	1	12.01 ± 6.2	14.61	43.82
Flustramorpha marginata	1	12.01 ± 6.2	14.61	58.43
Gigantopora polymorpha	1	12.01 ± 6.2	14.61	73.03

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Species	**Av. Abundance**	**Av. Sim ± SD**	**Contrib. (%)**	**Cum. (%)**
Kinetoskias pocillum	1	12.01 ± 6.2	14.61	87.64
Aspidostoma livida	0.75	5.4 ± 0.91	6.57	94.21
Average similarity = 49.50		Bathyal, East Coast		
Calyptotheca nivea	0.89	3.29 ± 1.47	6.64	6.64
Galeopsis circella	0.89	3.29 ± 1.47	6.64	13.29
Bifaxaria submucronata	0.67	2.4 ± 0.63	4.86	18.14
Columnella magna	0.67	2.4 ± 0.63	4.86	23
Bugulella gracilis	0.78	2.2 ± 1.1	4.45	27.45
Eupaxia quadrata	0.78	2.2 ± 1.1	4.45	31.9
Galeopsis bispiramina	0.78	2.2 ± 1.1	4.45	36.34
Smitticellaria tectiformis	0.78	2.2 ± 1.1	4.45	40.79
Aspidostoma livida	0.72	1.84 ± 0.93	3.72	44.51
Dactylostega prima	0.72	1.84 ± 0.93	3.72	48.23
Discoporella umbellata	0.72	1.84 ± 0.93	3.72	51.95
Flustramorpha angusta	0.72	1.84 ± 0.93	3.72	55.67
Escharoides contorta	0.67	1.53 ± 0.8	3.1	58.77
Heliodoma implicata	0.67	1.4 ± 0.85	2.83	61.6
Adeonella coralliformis	0.61	1.25 ± 0.69	2.53	64.13
Flustramorpha marginata	0.61	1.25 ± 0.69	2.53	66.66
Gigantopora polymorpha	0.61	1.25 ± 0.69	2.53	69.18
Characodoma protrusum	0.61	1.1 ± 0.74	2.22	71.4
Setosellina roulei	0.61	1.1 ± 0.74	2.22	73.62

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Appendix 4. Results of SIMPER analysis indicating the species that contributed most to the dissimilarity of compared replicates between depth zones and marine bioregions. Average abundance, average dissimilarity with standard deviation (Av. Diss. ± SD), contribution percentage (Contrib%) and cumulative contribution percentage (Cum%) were tabulated for each species. The grey line indicates cumulative contribution percentage ≈ 50%.

Species	**Average abundance**		**Ave. Dissim ± SD**	**Contrib%**	**Cum%**
Average dissimilarity = 64.75	Shallow, West Coast	Shallow, South Coast			
Aetea anguina	0	1	1.93 ± 3.35	2.99	2.99
Catenicella elegans	0	1	1.93 ± 3.35	2.99	5.98
Steginoporella buskii	0	1	1.93 ± 3.35	2.99	8.96
Flustramorpha marginata	0	0.9	1.8 ± 2.23	2.78	11.74
Menipea ornata	1	0.1	1.8 ± 2.23	2.78	14.52
Tennysonia stellata	0	0.9	1.8 ± 2.23	2.78	17.3
Turbicellepora conica	0	0.9	1.8 ± 2.23	2.78	20.08
Adeonella pluscula	0.18	1	1.71 ± 1.83	2.64	22.72
Calyptotheca nivea	0.18	1	1.71 ± 1.83	2.64	25.37
Escharoides custodis	0.18	1	1.71 ± 1.83	2.64	28.01
Laminopora jellyae	0.18	1	1.71 ± 1.83	2.64	30.65
Turbicellepora redoutei	0.18	1	1.71 ± 1.83	2.64	33.29
Virididentula dentata	0.18	1	1.71 ± 1.83	2.64	35.93
Alcyonidium nodosum	1	0.2	1.65 ± 1.71	2.55	38.49
Mucropetraliella asymmetrica	0	0.8	1.65 ± 1.71	2.55	41.04
Schizomavella sp. 1	0	0.8	1.56 ± 1.7	2.41	43.45
Beania magellanica	0.36	1	1.42 ± 1.24	2.19	45.64
Bugula neritina	0.36	1	1.42 ± 1.24	2.19	47.84
Chaperia capensis	0.36	1	1.42 ± 1.24	2.19	50.03
Jellyella tuberculata	0.73	0	1.38 ± 1.44	2.12	52.15
Celleporaria capensis	0.45	1	1.25 ± 1.04	1.93	54.08
Alcyonidium rhomboidale	0.45	0.9	1.17 ± 1.02	1.81	55.88

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Species	Average abundance		Ave. Dissim ± SD	Contrib%	Cum%
Chaperiopsis stephensoni	0	0.6	1.11 ± 1.13	1.72	57.6
Onchoporella buskii	1	0.5	1.11 ± 0.93	1.71	59.32
Cellaria mandibulata	0	0.5	1.05 ± 0.94	1.63	60.94
Amphiblestrum triangularis	0.18	0.6	1 ± 1.08	1.54	62.49
Beania minuspina	0.18	0.6	1 ± 1.08	1.54	64.03
Escharoides contorta	0.18	0.6	1 ± 1.08	1.54	65.57
Turbicellepora valligera	0.64	0.3	1 ± 1.06	1.54	67.11
Hippomonavella formosa	0.36	0.6	0.97 ± 1.01	1.5	68.61
Biflustra khoisan sp. nov.	0	0.5	0.89 ± 0.94	1.37	69.99
Bicellariella bonsai	0.64	1	0.88 ± 0.73	1.36	71.34
Gigantopora polymorpha	0.64	1	0.88 ± 0.73	1.36	72.7
Gregarinidra spinuligera	0.64	1	0.88 ± 0.73	1.36	74.06
Menipea triseriata	0.64	1	0.88 ± 0.73	1.36	75.42
Schizoretepora tessellata	0.64	1	0.88 ± 0.73	1.36	76.78
Membranipora rustica	0.55	0.1	0.88 ± 1.02	1.35	78.14
Chaperiopsis multifida	0.27	0.5	0.86 ± 0.96	1.33	79.47
Menipea marionensis	0	0.5	0.82 ± 0.94	1.27	80.74
Disporella buski	0.45	0.2	0.75 ± 0.92	1.17	81.91
Celleporella hyalina	0.73	1	0.67 ± 0.59	1.03	82.94
Nevianipora pulcherrima	0	0.4	0.63 ± 0.78	0.98	83.91
Schizosmittina lizzya	0.36	0.2	0.63 ± 0.83	0.98	84.89
Stomachetosella balani	0.36	0.2	0.63 ± 0.83	0.98	85.87
Beania inermis	0.36	0.1	0.57 ± 0.78	0.88	86.75
Bugulina flabellata	0.36	0.1	0.57 ± 0.78	0.88	87.63
Watersipora subtorquata	0.36	0.1	0.57 ± 0.78	0.88	88.52
Reteporella lata	0.18	0.3	0.56 ± 0.75	0.86	89.38
Turbicellepora canaliculata	0	0.2	0.46 ± 0.48	0.72	90.09

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Species	**Average abundance**		**Ave. Dissim ± SD**	**Contrib%**	**Cum%**
Average dissimilarity = 38.41	Shallow, South Coast	Shallow, Southeast Coast			
Adeonella pluscula	1	0	1.72 ± 6.32	4.48	4.48
Escharoides custodis	1	0	1.72 ± 6.32	4.48	8.97
Gigantopora polymorpha	1	0	1.72 ± 6.32	4.48	13.45
Turbicellepora conica	0.9	0	1.6 ± 2.73	4.15	17.6
Alcyonidium rhomboidale	0.9	0	1.51 ± 2.66	3.94	21.55
Schizomavella sp. 1	0.8	0	1.39 ± 1.89	3.62	25.16
Adeonellopsis meandrina	0	0.67	1.15 ± 1.34	2.98	28.14
Bugula neritina	1	0.33	1.15 ± 1.34	2.98	31.13
Elzerina blainvillii	0	0.67	1.15 ± 1.34	2.98	34.11
Margaretta opuntioides	0	0.67	1.15 ± 1.34	2.98	37.09
Alysidium parasiticum	0.1	0.67	1.08 ± 1.25	2.81	39.91
Turbicellepora canaliculata	0.2	0.67	1 ± 1.17	2.61	42.52
Chaperiopsis stephensoni	0.6	0	1 ± 1.18	2.6	45.11
Amphiblestrum triangularis	0.6	0	0.93 ± 1.18	2.42	47.53
Beania minuspina	0.6	0	0.93 ± 1.18	2.42	49.95
Escharoides contorta	0.6	0	0.93 ± 1.18	2.42	52.37
Hippomonavella formosa	0.6	0	0.93 ± 1.18	2.42	54.79
Cellaria mandibulata	0.5	0	0.93 ± 0.98	2.42	57.21
Biflustra khoisan sp. nov.	0.5	0	0.8 ± 0.97	2.09	59.3
Chaperiopsis multifida	0.5	0	0.75 ± 0.97	1.96	61.26
Menipea marionensis	0.5	0	0.75 ± 0.97	1.96	63.22
Onchoporella buskii	0.5	0	0.75 ± 0.97	1.96	65.17
Tennysonia stellata	0.9	0.67	0.64 ± 0.73	1.66	66.83
Turbicellepora avicularis	0.1	0.33	0.64 ± 0.73	1.66	68.49
Beania magellanica	1	0.67	0.6 ± 0.68	1.56	70.05
Calyptotheca nivea	1	0.67	0.6 ± 0.68	1.56	71.6
Catenicula compacta	0	0.33	0.6 ± 0.68	1.56	73.16

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Species	**Average abundance**		**Ave. Dissim ± SD**	**Contrib%**	**Cum%**
Chaperia capensis	1	0.67	0.6 ± 0.68	1.56	74.72
Cornuticella taurina	0	0.33	0.6 ± 0.68	1.56	76.27
Electra pilosa	1	0.67	0.6 ± 0.68	1.56	77.83
Gregarinidra spinuligera	1	0.67	0.6 ± 0.68	1.56	79.39
Turbicellepora redoutei	1	0.67	0.6 ± 0.68	1.56	80.94
Nevianipora pulcherrima	0.4	0	0.58 ± 0.79	1.51	82.45
Adeonella conspicua	0.3	0	0.41 ± 0.64	1.08	83.53
Chaperia septispina	0.3	0	0.41 ± 0.64	1.08	84.61
Reteporella lata	0.3	0	0.41 ± 0.64	1.08	85.69
Turbicellepora valligera	0.3	0	0.41 ± 0.64	1.08	86.76
Favosipora epiphyta sp. nov.	0.2	0	0.29 ± 0.49	0.75	87.51
Reteporella ilala sp. nov.	0.2	0	0.29 ± 0.49	0.75	88.26
Adeonella purpurea	0.2	0	0.26 ± 0.49	0.68	88.94
Alcyonidium nodosum	0.2	0	0.26 ± 0.49	0.68	89.62
Beania sp. nov. *1*	0.2	0	0.26 ± 0.49	0.68	90.3
Average dissimilarity = 45.43	Shallow, Southeast Coast	Shallow, East Coast			
Celleporaria capensis	1	0	3.07 ± 4.29	6.75	6.75
Laminopora jellyae	1	0	3.07 ± 4.29	6.75	13.51
Menipea triseriata	1	0	3.07 ± 4.29	6.75	20.26
Beania magellanica	0.67	0	1.97 ± 1.26	4.33	24.6
Calyptotheca nivea	0.67	0	1.97 ± 1.26	4.33	28.93
Chaperia capensis	0.67	0	1.97 ± 1.26	4.33	33.26
Electra pilosa	0.67	0	1.97 ± 1.26	4.33	37.59
Gregarinidra spinuligera	0.67	0	1.97 ± 1.26	4.33	41.92
Tennysonia stellata	0.67	0	1.97 ± 1.26	4.33	46.26
Turbicellepora canaliculata	0.67	0	1.97 ± 1.26	4.33	50.59
Turbicellepora redoutei	0.67	0	1.97 ± 1.26	4.33	54.92
Catenicula compacta	0.33	0.67	1.61 ± 0.99	3.54	58.46

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Species	**Average abundance**		**Ave. Dissim ± SD**	**Contrib%**	**Cum%**
Cornuticella taurina	0.33	0.67	1.61 ± 0.99	3.54	62.01
Adeonellopsis meandrina	0.67	0.67	1.46 ± 0.81	3.22	65.23
Alysidium parasiticum	0.67	0.67	1.46 ± 0.81	3.22	68.46
Elzerina blainvillii	0.67	0.67	1.46 ± 0.81	3.22	71.68
Margaretta opuntioides	0.67	0.67	1.46 ± 0.81	3.22	74.91
Aetea anguina	1	0.67	1.32 ± 0.66	2.92	77.82
Bicellariella bonsai	1	0.67	1.32 ± 0.66	2.92	80.74
Catenicella elegans	1	0.67	1.32 ± 0.66	2.92	83.65
Celleporella hyalina	1	0.67	1.32 ± 0.66	2.92	86.57
Menipea crispa	1	0.67	1.32 ± 0.66	2.92	89.48
Steginoporella buskii	1	0.67	1.32 ± 0.66	2.92	92.4
Average dissimilarity = 47.74	Subphotic, West Coast	Subphotic, South Coast			
Adeonella conspicua	0	0.97	0.96 ± 3.78	2	2
Arthropoma cecilii	0	0.97	0.96 ± 3.78	2	4
Celleporaria tridenticulata	0	0.97	0.96 ± 3.78	2	6
Chaperia capensis	0	0.97	0.96 ± 3.78	2	8.01
Chaperiopsis familiaris	0	0.97	0.96 ± 3.78	2	10.01
Dactylostega prima	0	0.97	0.96 ± 3.78	2	12.01
Discoporella umbellata	0	0.97	0.96 ± 3.78	2	14.01
Disporella novaehollandiae	0	0.97	0.96 ± 3.78	2	16.01
Escharoides contorta	0	0.97	0.96 ± 3.78	2	18.01
Exidmonea atlantica	0	0.97	0.96 ± 3.78	2	20.02
Flustramorpha angusta	0	0.97	0.96 ± 3.78	2	22.02
Flustramorpha flabellaris	0	0.97	0.96 ± 3.78	2	24.02
Foveolaria imbricata	0	0.97	0.96 ± 3.78	2	26.02
Hippomonavella formosa	0	0.97	0.96 ± 3.78	2	28.02
Hippomonavella lingulatus sp. nov.	0	0.97	0.96 ± 3.78	2	30.02
Micropora similis	0	0.97	0.96 ± 3.78	2	32.02

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Species	Average abundance		Ave. Dissim ± SD	Contrib%	Cum%
Turbicellepora conica	0	0.97	0.96 ± 3.78	2	34.03
Rhynchozoon ptarmicum	0	0.94	0.93 ± 3.07	1.94	35.97
Caberea darwinii	0.13	1	0.88 ± 2.25	1.83	37.8
Porella capensis	0.13	1	0.87 ± 2.24	1.83	39.63
Beania magellanica	0	0.88	0.87 ± 2.32	1.82	41.46
Virididentula dentata	0	0.88	0.87 ± 2.32	1.82	43.28
Rogicka lioneli	0.93	0.06	0.84 ± 2.5	1.76	45.04
Beania sp. nov. 2	0.93	0.06	0.84 ± 2.5	1.76	46.8
Celleporella hyalina	0.93	0.06	0.84 ± 2.5	1.76	48.56
Calyptotheca nivea	0.2	1	0.82 ± 1.83	1.71	50.27
Bitectipora umboavicula	0	0.81	0.79 ± 1.92	1.65	51.91
Disporella buski	0	0.81	0.79 ± 1.92	1.65	53.56
Biflustra khoisan sp. nov.	0.93	0.16	0.77 ± 1.89	1.62	55.18
Biflustra sp.	0.8	0.06	0.7 ± 1.76	1.46	56.64
Phidolopora cyclops sp. nov.	0.8	0.06	0.7 ± 1.76	1.46	58.1
Smittoidea errata	0.4	1	0.64 ± 1.17	1.34	59.44
Adeonella purpurea	0.8	0.22	0.63 ± 1.4	1.32	60.76
Bugulina flabellata	0.8	0.22	0.63 ± 1.4	1.32	62.08
Tennysonia stellata	0.87	0.31	0.62 ± 1.3	1.3	63.38
Carbasea sp. 2	0	0.63	0.61 ± 1.24	1.28	64.67
Adeonella tuberosa	0.8	0.28	0.6 ± 1.29	1.26	65.93
Adeonella fuegensis	0.8	0.31	0.59 ± 1.24	1.23	67.16
Micropora erecta sp. nov.	0.8	0.31	0.59 ± 1.24	1.23	68.4
Kinetoskias sp.	0	0.59	0.59 ± 1.16	1.23	69.63
Adeonella regularis	0.47	1	0.58 ± 1.03	1.21	70.84
Flustramorpha marginata	0.47	1	0.58 ± 1.03	1.21	72.05
Idmidronea contorta	0.47	1	0.58 ± 1.03	1.21	73.27
Celleporaria umuzi sp. nov.	0.73	0.28	0.57 ± 1.21	1.2	74.47

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Species	**Average abundance**		**Ave. Dissim ± SD**	**Contrib%**	**Cum%**
Hornera americana	0.67	0.16	0.57 ± 1.24	1.19	75.65
Escharoides custodis	0.8	0.38	0.56 ± 1.14	1.17	76.83
Cribralaria ukhololo sp. nov.	0	0.56	0.53 ± 1.1	1.11	77.94
Cellaria punctata	0	0.5	0.52 ± 0.96	1.09	79.02
Exidmonea crassimargo	0.53	1	0.52 ± 0.9	1.08	80.11
Hornera sp.	0	0.47	0.46 ± 0.91	0.96	81.07
Caberea darwinii occlusa	0.8	0.59	0.46 ± 0.87	0.96	82.03
Parasmittina novella	0	0.44	0.46 ± 0.85	0.96	82.98
?Hippomonavella inconspicua	0.8	0.63	0.44 ± 0.84	0.93	83.91
Osthimosia cf. simonensis	0.8	0.72	0.4 ± 0.75	0.84	84.75
Adeonella ligulata	0.87	0.72	0.37 ± 0.7	0.77	85.52
Nevianipora pulcherrima	0.4	0.06	0.37 ± 0.83	0.77	86.3
Adeonella confusanea	0	0.34	0.36 ± 0.7	0.76	87.06
Alysidium parasiticum	0	0.38	0.35 ± 0.76	0.74	87.8
Alcyonidium rhomboidale	0	0.38	0.35 ± 0.76	0.73	88.52
Schizosmittina lizzya	0	0.31	0.29 ± 0.66	0.6	89.12
Onchoporella buskii	0.73	1	0.27 ± 0.6	0.57	89.69
Reteporella bullata	0.13	0.22	0.27 ± 0.63	0.57	90.25
Average dissimilarity = 35.79	Subphotic, South Coast	Subphotic, Southeast Coast			
Adeonella regularis	1	0	0.81 ± 11.17	2.25	2.25
Dactylostega tubigera	1	0	0.81 ± 11.17	2.25	4.51
Rhynchozoon beatulum	0	1	0.81 ± 11.17	2.25	6.76
Rhynchozoon stomachosum	0	1	0.81 ± 11.17	2.25	9.01
Hippomonavella formosa	0.97	0	0.78 ± 4.97	2.18	11.19
Adeonella decipiens	0	0.89	0.71 ± 2.72	1.99	13.18
Reteporella ilala sp. nov.	1	0.11	0.71 ± 2.72	1.99	15.16
Rhynchozoon incallidum	0	0.89	0.71 ± 2.72	1.99	17.15
Hippomonavella lingulatus sp. nov.	0.97	0.11	0.69 ± 2.45	1.93	19.08

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Species	**Average abundance**		**Ave. Dissim ± SD**	**Contrib%**	**Cum%**
Adeonella circumspecta	0.84	0	0.67 ± 2.27	1.87	20.96
Bitectipora umboavicula	0.81	0	0.64 ± 2.04	1.8	22.75
Disporella buski	0.81	0	0.64 ± 2.04	1.8	24.55
Viridentula dentata	0.88	0.22	0.57 ± 1.53	1.59	26.14
Adeonella ligulata	0.72	0	0.57 ± 1.58	1.58	27.72
Osthimosia cf. simonensis	0.72	0	0.57 ± 1.58	1.58	29.3
Adeonella conspicua	0.97	0.33	0.52 ± 1.36	1.45	30.75
Carbasea sp. 2	0.63	0	0.5 ± 1.28	1.4	32.15
?Hippomonavella inconspicua	0.63	0	0.49 ± 1.28	1.37	33.52
Kinetoskias sp.	0.59	0	0.48 ± 1.2	1.34	34.86
Caberea darwinii occlusa	0.59	0	0.46 ± 1.2	1.3	36.15
Rhynchozoon documentum	0	0.56	0.45 ± 1.11	1.25	37.4
Parasmittina novella	0.44	1	0.44 ± 1.12	1.23	38.63
Adeonella confusanea	0.34	0.67	0.44 ± 1.1	1.22	39.85
Adeonella abdita	0	0.56	0.44 ± 1.1	1.22	41.07
Anoteropora latirostris	0	0.56	0.44 ± 1.1	1.22	42.29
Arachnopusia corniculata	0	0.56	0.44 ± 1.1	1.22	43.51
Characodoma cribritheca	0	0.56	0.44 ± 1.1	1.22	44.73
Crassimarginatella marginalis	0	0.56	0.44 ± 1.1	1.22	45.95
Crisia elongata	0	0.56	0.44 ± 1.1	1.22	47.17
Escharella discors	0	0.56	0.44 ± 1.1	1.22	48.39
Fodinella spinigera	0	0.56	0.44 ± 1.1	1.22	49.61
Glabrilaria africana	0	0.56	0.44 ± 1.1	1.22	50.83
Macropora africana	0	0.56	0.44 ± 1.1	1.22	52.05
Parasmittina tropica	0	0.56	0.44 ± 1.1	1.22	53.27
Plagioecia patina	0	0.56	0.44 ± 1.1	1.22	54.49
Puellina innominata	0	0.56	0.44 ± 1.1	1.22	55.71
Reteporella dinotorhynchus	0	0.56	0.44 ± 1.1	1.22	56.93

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Species	Average abundance		Ave. Dissim ± SD	Contrib%	Cum%
Smittina sitella	0	0.56	0.44 ± 1.1	1.22	58.15
Smittoidea circumspecta	0	0.56	0.44 ± 1.1	1.22	59.37
Steginoporella buskii	0	0.56	0.44 ± 1.1	1.22	60.59
Taylorius sp.	0	0.56	0.44 ± 1.1	1.22	61.81
Trypostega venusta	0	0.56	0.44 ± 1.1	1.22	63.03
Cribralaria ukhololo sp. nov.	0.56	0	0.44 ± 1.12	1.22	64.25
Flustramorpha flabellaris	0.97	0.44	0.43 ± 1.1	1.21	65.46
Laminopora bimunita	0	0.56	0.43 ± 1.11	1.2	66.67
Mecynoecia australis	0	0.56	0.43 ± 1.11	1.2	67.87
Notocoryne cervicornis	0	0.56	0.43 ± 1.11	1.2	69.08
Reussirella multispinata	0	0.56	0.43 ± 1.11	1.2	70.28
Rhynchozoon oscitans	0	0.56	0.43 ± 1.11	1.2	71.48
Cellaria punctata	0.5	1	0.39 ± 0.99	1.08	72.57
Hornera sp.	0.47	0	0.37 ± 0.93	1.05	73.62
Chaperiopsis familiaris	0.97	0.56	0.36 ± 0.89	1.01	74.63
Hornera erugata	1	0.56	0.36 ± 0.89	1	75.63
Stephanollona ignota	0	0.44	0.36 ± 0.89	1	76.63
Alysidium parasiticum	0.38	0	0.29 ± 0.77	0.81	77.45
Discoporella umbellata	0.97	0.67	0.29 ± 0.72	0.81	78.25
Disporella novaehollandiae	0.97	0.67	0.29 ± 0.72	0.81	79.06
Escharoides custodis	0.38	0	0.29 ± 0.77	0.8	79.86
Alcyonidium rhomboidale	0.38	0	0.29 ± 0.77	0.8	80.67
Amphiblestrum triangularis	1	0.67	0.28 ± 0.7	0.78	81.45
Calyptotheca porelliformis	1	0.67	0.28 ± 0.7	0.78	82.23
Chaperiopsis stephensoni	1	0.67	0.28 ± 0.7	0.78	83.02
Exidmonea crassimargo	1	0.67	0.28 ± 0.7	0.78	83.8
Gigantopora polymorpha	1	0.67	0.28 ± 0.7	0.78	84.58
Menipea marionensis	1	0.67	0.28 ± 0.7	0.78	85.37

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Species	**Average abundance**		**Ave. Dissim ± SD**	**Contrib%**	**Cum%**
Menipea ornata	1	0.67	0.28 ± 0.7	0.78	86.15
Schizoretepora tessellata	1	0.67	0.28 ± 0.7	0.78	86.93
Aspidostoma livida	0.03	0.33	0.26 ± 0.72	0.72	87.66
Adeonella fuegensis	0.31	0	0.24 ± 0.67	0.67	88.32
Micropora erecta sp. nov.	0.31	0	0.24 ± 0.67	0.67	88.99
Tennysonia stellata	0.31	0	0.24 ± 0.67	0.67	89.66
Schizosmittina lizzya	0.31	0	0.24 ± 0.67	0.66	90.32
Average dissimilarity = 48.28	Subphotic, Southeast Coast	Subphotic, East Coast			
Hoplitella armata	1	0	1.11 ± 5.22	2.3	2.3
Chaperiopsis multifida	0.89	0	0.97 ± 2.44	2.01	4.31
Exidmonea atlantica	0.89	0	0.97 ± 2.44	2.01	6.32
Gregarinidra spinuligera	0.89	0	0.97 ± 2.44	2.01	8.34
Onchoporella buskii	0.89	0	0.97 ± 2.44	2.01	10.35
Reteporella lata	0.89	0	0.97 ± 2.44	2.01	12.36
Arthropoma cecilii	1	0.17	0.96 ± 2.03	1.99	14.35
Calyptotheca nivea	1	0.33	0.81 ± 1.36	1.67	16.02
Cellaria punctata	1	0.33	0.81 ± 1.36	1.67	17.7
Celleporaria capensis	1	0.33	0.81 ± 1.36	1.67	19.37
Celleporaria tridenticulata	1	0.33	0.81 ± 1.36	1.67	21.05
Chaperia capensis	1	0.33	0.81 ± 1.36	1.67	22.72
Dactylostega prima	1	0.33	0.81 ± 1.36	1.67	24.4
Flustramorpha angusta	1	0.33	0.81 ± 1.36	1.67	26.07
Foveolaria imbricata	1	0.33	0.81 ± 1.36	1.67	27.75
Menipea crispa	1	0.33	0.81 ± 1.36	1.67	29.42
Rhynchozoon beatulum	1	0.33	0.81 ± 1.36	1.67	31.1
Turbicellepora conica	1	0.33	0.81 ± 1.36	1.67	32.77
Adeonella decipiens	0.89	0.33	0.75 ± 1.25	1.55	34.32
Rhynchozoon incallidum	0.89	0.33	0.75 ± 1.25	1.55	35.86

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Species	**Average abundance**		**Ave. Dissim ± SD**	**Contrib%**	**Cum%**
Adeonella confusanea	0.67	0	0.72 ± 1.33	1.49	37.35
Amphiblestrum triangularis	0.67	0	0.72 ± 1.33	1.49	38.83
Calyptotheca porelliformis	0.67	0	0.72 ± 1.33	1.49	40.32
Chaperiopsis stephensoni	0.67	0	0.72 ± 1.33	1.49	41.8
Discoporella umbellata	0.67	0	0.72 ± 1.33	1.49	43.29
Disporella novaehollandiae	0.67	0	0.72 ± 1.33	1.49	44.77
Exidmonea crassimargo	0.67	0	0.72 ± 1.33	1.49	46.26
Gigantopora polymorpha	0.67	0	0.72 ± 1.33	1.49	47.74
Menipea marionensis	0.67	0	0.72 ± 1.33	1.49	49.23
Menipea ornata	0.67	0	0.72 ± 1.33	1.49	50.71
Schizoretepora tessellata	0.67	0	0.72 ± 1.33	1.49	52.2
Idmidronea contorta	1	0.5	0.62 ± 0.97	1.29	53.49
Menipea triseriata	1	0.5	0.62 ± 0.97	1.29	54.78
Chaperiopsis familiaris	0.56	0	0.61 ± 1.07	1.27	56.05
Hornera erugata	0.56	0	0.61 ± 1.07	1.27	57.32
Rhynchozoon documentum	0.56	0	0.61 ± 1.07	1.27	58.59
Stephanollona ignota	0.44	1	0.61 ± 1.07	1.27	59.86
Laminopora bimunita	0.56	0	0.58 ± 1.07	1.21	61.07
Mecynoecia australis	0.56	0	0.58 ± 1.07	1.21	62.28
Notocoryne cervicornis	0.56	0	0.58 ± 1.07	1.21	63.49
Reussirella multispinata	0.56	0	0.58 ± 1.07	1.21	64.7
Rhynchozoon oscitans	0.56	0	0.58 ± 1.07	1.21	65.91
Anoteropora latirostris	0.56	0.33	0.57 ± 1	1.18	67.1
Characodoma cribritheca	0.56	0.33	0.57 ± 1	1.18	68.28
Escharella discors	0.56	0.33	0.57 ± 1	1.18	69.46
Macropora africana	0.56	0.33	0.57 ± 1	1.18	70.64
Puellina innominata	0.56	0.33	0.57 ± 1	1.18	71.83
Reteporella dinotorhynchus	0.56	0.33	0.57 ± 1	1.18	73.01

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Species	Average abundance		Ave. Dissim ± SD	Contrib%	Cum%
Steginoporella buskii	0.56	0.33	0.57 ± 1	1.18	74.19
Crisia elongata	0.56	0.5	0.56 ± 0.96	1.15	75.35
Plagioecia patina	0.56	0.5	0.56 ± 0.96	1.15	76.5
Adeonella abdita	0.56	0.5	0.56 ± 0.96	1.15	77.65
Parasmittina tropica	0.56	0.83	0.53 ± 0.9	1.1	78.75
Smittina sitella	0.56	0.83	0.53 ± 0.9	1.1	79.84
Smittoidea circumspecta	0.56	0.83	0.53 ± 0.9	1.1	80.94
Trypostega venusta	0.56	0.83	0.53 ± 0.9	1.1	82.04
Arachnopusia corniculata	0.56	1	0.51 ± 0.86	1.06	83.1
Crassimarginatella marginalis	0.56	1	0.51 ± 0.86	1.06	84.16
Flustramorpha flabellaris	0.44	0	0.51 ± 0.86	1.06	85.23
Fodinella spinigera	0.56	1	0.51 ± 0.86	1.06	86.29
Glabrilaria africana	0.56	1	0.51 ± 0.86	1.06	87.35
Taylorius sp.	0.56	1	0.51 ± 0.86	1.06	88.41
Adeonella gibba	1	0.67	0.43 ± 0.69	0.89	89.3
Carbasea mediocris	0	0.33	0.43 ± 0.69	0.89	90.19
Average dissimilarity = 65.38	Bathyal, West Coast	Bathyal, South Coast			
Flustramorpha angusta	0	1	9.47 ± 4.11	14.48	14.48
Calyptotheca nivea	0.17	1	8.29 ± 1.94	12.69	27.17
Flustramorpha marginata	0.17	1	8.29 ± 1.94	12.69	39.85
Gigantopora polymorpha	0.17	1	8.29 ± 1.94	12.69	52.54
Aspidostoma livida	0	0.75	6.5 ± 1.57	9.94	62.48
Kinetoskias pocillum	0.5	1	5.15 ± 0.94	7.87	70.35
Dactylostega prima	0	0.5	3.85 ± 0.97	5.89	76.24
Discoporella umbellata	0	0.5	3.85 ± 0.97	5.89	82.14
Escharoides contorta	0	0.5	3.85 ± 0.97	5.89	88.03
Kinetoskias elegans	0.33	0	3.3 ± 0.67	5.05	93.08
Average dissimilarity = 20.42	Bathyal, South Coast	Bathyal, Southeast Coast			

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Species	**Average abundance**		**Ave. Dissim ± SD**	**Contrib%**	**Cum%**
Kinetoskias pocillum	1	0	5.47 ± 7.74	26.81	26.81
Galeopsis circella	0.25	1	4.28 ± 1.48	20.98	47.78
Dactylostega prima	0.5	1	3.03 ± 0.87	14.85	62.64
Discoporella umbellata	0.5	1	3.03 ± 0.87	14.85	77.49
Escharoides contorta	0.5	1	3.03 ± 0.87	14.85	92.35

Average dissimilarity = 59.51	Bathyal, Southeast Coast	Bathyal, East Coast			
Bifaxaria submucronata	0	0.67	2.5 ± 1.03	4.21	4.21
Columnella magna	0	0.67	2.5 ± 1.03	4.21	8.41
Bugulella gracilis	0	0.78	2.17 ± 1.5	3.65	12.06
Eupaxia quadrata	0	0.78	2.17 ± 1.5	3.65	15.71
Galeopsis bispiramina	0	0.78	2.17 ± 1.5	3.65	19.36
Smitticellaria tectiformis	0	0.78	2.17 ± 1.5	3.65	23.01
Adeonella coralliformis	1	0.61	1.9 ± 0.7	3.2	26.21
Flustramorpha marginata	1	0.61	1.9 ± 0.7	3.2	29.41
Gigantopora polymorpha	1	0.61	1.9 ± 0.7	3.2	32.6
Escharoides contorta	1	0.67	1.73 ± 0.63	2.91	35.51
Heliodoma implicata	0	0.67	1.66 ± 1.28	2.79	38.31
Aspidostoma livida	1	0.72	1.56 ± 0.57	2.63	40.94
Dactylostega prima	1	0.72	1.56 ± 0.57	2.63	43.57
Discoporella umbellata	1	0.72	1.56 ± 0.57	2.63	46.2
Flustramorpha angusta	1	0.72	1.56 ± 0.57	2.63	48.83
Characodoma protrusum	0	0.61	1.44 ± 1.19	2.42	51.25
Setosellina roulei	0	0.61	1.44 ± 1.19	2.42	53.67

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Species	**Average abundance**		**Ave. Dissim ± SD**	**Contrib%**	**Cum%**
Adeonella majuscula	0	0.44	1.43 ± 0.8	2.4	56.07
Carbasea mediocris	0	0.44	1.43 ± 0.8	2.4	58.48
Notocoryne cervicornis	0	0.56	1.27 ± 1.07	2.14	60.62
Adeonella cracens	0	0.5	1.1 ± 0.97	1.86	62.47
Adeonella falcicula	0	0.5	1.1 ± 0.97	1.86	64.33
Aspidostoma magna	0	0.5	1.1 ± 0.97	1.86	66.18
Batopora nola	0	0.5	1.1 ± 0.97	1.86	68.04
Chaperiopsis cylindracea	0	0.5	1.1 ± 0.97	1.86	69.89
Conescharellina africana	0	0.5	1.1 ± 0.97	1.86	71.75
Figularia philomela	0	0.5	1.1 ± 0.97	1.86	73.6
Lacrimula pyriformis	0	0.5	1.1 ± 0.97	1.86	75.46
Reteporella bullata	0	0.5	1.1 ± 0.97	1.86	77.31
Reteporella clancularia	0	0.5	1.1 ± 0.97	1.86	79.17
Reteporella dinotorhynchus	0	0.5	1.1 ± 0.97	1.86	81.03
Turbicellepora protensa	0	0.5	1.1 ± 0.97	1.86	82.88
Batopora lagaaiji	0	0.44	0.98 ± 0.87	1.64	84.52
Batopora murrayi	0	0.44	0.98 ± 0.87	1.64	86.17
Costaticella carotica	0	0.39	0.86 ± 0.77	1.44	87.61
Notoplites cassidula	0	0.39	0.86 ± 0.77	1.44	89.05
Calyptotheca nivea	1	0.89	0.83 ± 0.34	1.4	90.45

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Appendix 5. Cheilostomatous bryozoan morpho-species of False Bay, South Africa. Interpolated depth distribution was plotted for each species. Seventeen morphotypes: adeoniform (A), adeonelliform (Ad), buguliform (Bu), catenicelliform (Ca), cellariform (Ce), celleporiform (Cp), cellulariiform (Cu), eschariform (E), flustriform (F), lunulitiform (L), membraniporiform A (Ma), membraniporiform B (Mb), petraliform (Pe), pseudovinculariform (Ps), reteporiform (Re), scrupariiform (Sc) and vinculariform (Vi).

		Depth (in m)										
Species	**Morph**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**	**150**
Adeonella cf. *purpurea*	A				■							
Adeonella circumspecta	A	■										
Adeonella confusanea	A			■								
Adeonella conspicua	A	■	■	■	■	■	■	■	■			
Adeonella gibba	A				■	■	■					
Adeonella guttata	A	■	■	■	■	■	■	■	■	■	■	■
Adeonella ligulata	A			■	■	■	■					
Adeonella pluscula	A	■	■	■	■							
Adeonella purpurea	A	■	■	■	■	■	■	■	■	■	■	■
Adeonella regularis	A	■										
Adeonella similis	A				■							
Adeonella tuberosa	A	■	■	■	■	■	■	■	■	■	■	■
Adeonellopsis sp.	A			■								
Gigantopora polymorpha	A	■	■	■	■	■	■	■				
Biflustra khoisan	Ad		■	■	■	■	■	■	■			
Dimorphocella moderna	Ad				■							
Laminopora jellyae	Ad		■	■	■	■	■	■	■	■	■	■
Bicellariella bonsai	Bu	■										
Bugula neritina	Bu	■	■									
Bugulina avicularia	Bu	■										
Bugulina flabellata	Bu		■	■	■	■	■					
Flustramorpha angusta	Bu		■	■	■	■						
Flustramorpha flabellaris	Bu				■							
Flustramorpha marginata	Bu			■	■	■						
Hoplitella armata	Bu					■						
Onchoporella buskii	Bu	■	■	■	■	■	■					
Virididentula dentata	Bu	■	■	■	■	■	■					
Catenicella elegans	Ca		■	■								
Catenicula cf. *corbulifera*	Ca			■								
Caberea darwinii	Ce						■					
Cellaria sp. 1	Ce	■										
Margaretta levinseni	Ce	■										
Celleporaria capensis	Cp	■	■	■	■	■	■	■	■			
Celleporaria sp.	Cp				■							
Celleporaria sp. 1	Cp				■	■	■	■				
Celleporaria tridenticulata	Cp	■	■	■	■							

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		Depth (in m)										
Species	**Morph**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**	**150**
Celleporaria umuzi	Cp				■	■	■					
Stomachetosella balani	Cp	■	■	■								
Turbicellepora avicularis	Cp	■										
Turbicellepora cf. *canaliculata*	Cp	■	■	■	■							
Turbicellepora conica	Cp		■	■	■	■	■					
Turbicellepora redoutei	Cp	■										
Turbicellepora sp. 1	Cp	■	■									
Turbicellepora valligera	Cp	■	■	■	■	■	■	■	■			
Menipea crispa	Cu	■	■	■	■	■	■	■	■	■		
Menipea marionensis	Cu		■									
Menipea ornata	Cu	■	■	■	■	■	■	■	■			
Menipea triseriata	Cu	■	■	■	■	■	■	■	■	■	■	■
Escharoides contorta	E		■	■	■	■	■	■	■	■	■	
Escharoides custodis	E	■	■	■	■	■						
Escharoides sp. 1	E				■	■						
Escharoides sp. 2	E		■									
Micropora erecta	E					■	■	■	■	■	■	■
Steginoporella buskii	E		■									
Carbasea sp. 2	F										■	
Gregarinidra spinuligera	F		■	■	■	■	■					
Klugeflustra jonesii	F			■	■	■						
Notoplites sp.	F			■								
Discoporella umbellata	L			■	■	■						
Amphiblestrum triangularis	Ma	■	■	■	■	■	■	■				
Arthropoma cecilii	Ma					■						
Rogicka lioneli	Ma				■	■						
Biflustra sp.	Ma				■							
Bitectipora umboavicula	Ma				■	■						
Callopora jamesi	Ma	■										
Calyptotheca nivea	Ma	■	■	■	■	■						
Calyptotheca porelliformis	Ma	■	■	■	■	■						
Celleporella annularis	Ma	■										
Celleporella hyalina	Ma	■	■	■	■							
Chaperia acanthina	Ma	■										
Chaperia sp.	Ma	■										
Chaperia septispina	Ma	■	■	■								
Chaperiopsis familiaris	Ma	■	■	■		1						
Chaperiopsis (Chaperiopsis) chelata	Ma			■								
Chaperiopsis (Chaperiopsis) multifida	Ma	■	■	■	■	■	■	■	■	■		
Chaperiopsis (Chaperiopsis) stephensoni	Ma	■	■	■	■							
Cribrilina dispersa	Ma	■										
Fenestrulina elevora	Ma				■							
Fenestrulina sp. 1	Ma				■							

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Species	Morph	Depth (in m)										
		10	20	30	40	50	60	70	80	90	100	150
Fenestrulina sp. 2	Ma		■									
Harpecia sp.	Ma	■										
Hippomonavella cf. *praeclara*	Ma		■	■	■							
?Hippomonavella inconspicua	Ma		■	■	■	1		1				
Hippomonavella formosa	Ma	■	■	■	■	■	■	■				
Hippomonavella lingulatus	Ma			■	■	■	■	■				
Hippomonavelle cf. *flexuosa*	Ma		■	■	■	■	■					
Khulisa ukhololo	Ma		■	■	■	■	■					
Membranipora galeata furcata	Ma		■									
Membranipora rustica	Ma	■	■									
Micropora latiavicula	Ma				■							
Micropora similis	Ma					■						
Microporella lezinyosi	Ma	■	■	■	■	■	■	■	■			
Microporella madiba	Ma			■								
Mucropetraliella asymmetrica	Ma	■	■	■								
Schizoporella sp. 1	Ma			■								
Schizosmittina lizzya	Ma		■	■	■	■	■	■				
Smittina landsborovii	Ma	■										
Smittoidea cf *calcarata*	Ma				■							
Smittoidea cf. *circumspecta*	Ma		■	■	■							
Thalamoporella spiravicula	Ma	■										
Watersipora subtorquata	Ma	■										
Celleporina solida	Mb											■
Dactylostega prima	Mb					■						
Dactylostega tubigera	Mb				■							
Rhynchozoon ptarmicum	Mb				■							
Beania inermis	Pe	■										
Beania magellanica	Pe	■	■	■	■	■	■	■	■	■		
Beania minuspina	Pe		■	■								
Beania sp. 1	Pe	■	■	■								
Beania sp. 2	Pe				■							
Beania vanhoeffeni	Pe	■	■	■	■	■	■	■	■	■	■	■
Electra pilosa	Ps	■	■	■								
Phidolopora cyclops	Re				■	■						
Reteporella bullata	Re									■		
Reteporella ilala	Re			■	■	■	■					
Reteporella lata	Re			■	■	■	■					
Reteporella sp.	Re					■						
Schizoretepora sp.	Re				■							
Schizoretepora tessellata	Re	■	■	■	■	■	■	■	■	■	■	■
Aetea anguina	Sc	■	■	■								
Callaetea cf. *spiralis*	Sc				■	■						
Hippothoa musivaria	Sc	■										

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		Depth (in m)										
Species	**Morph**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**	**150**
Hippothoa sp. 1	Sc				■							
Scruparia ambigua	Sc	■										
Chaperia capensis	Vi	■	■	■	■	■	■	■				
Foveolaria imbricata	Vi				■	■	■					
Total no. species		**57**	**42**	**50**	**57**	**45**	**25**	**11**	**10**	**5**	**2**	**9**

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PLATES 1-27

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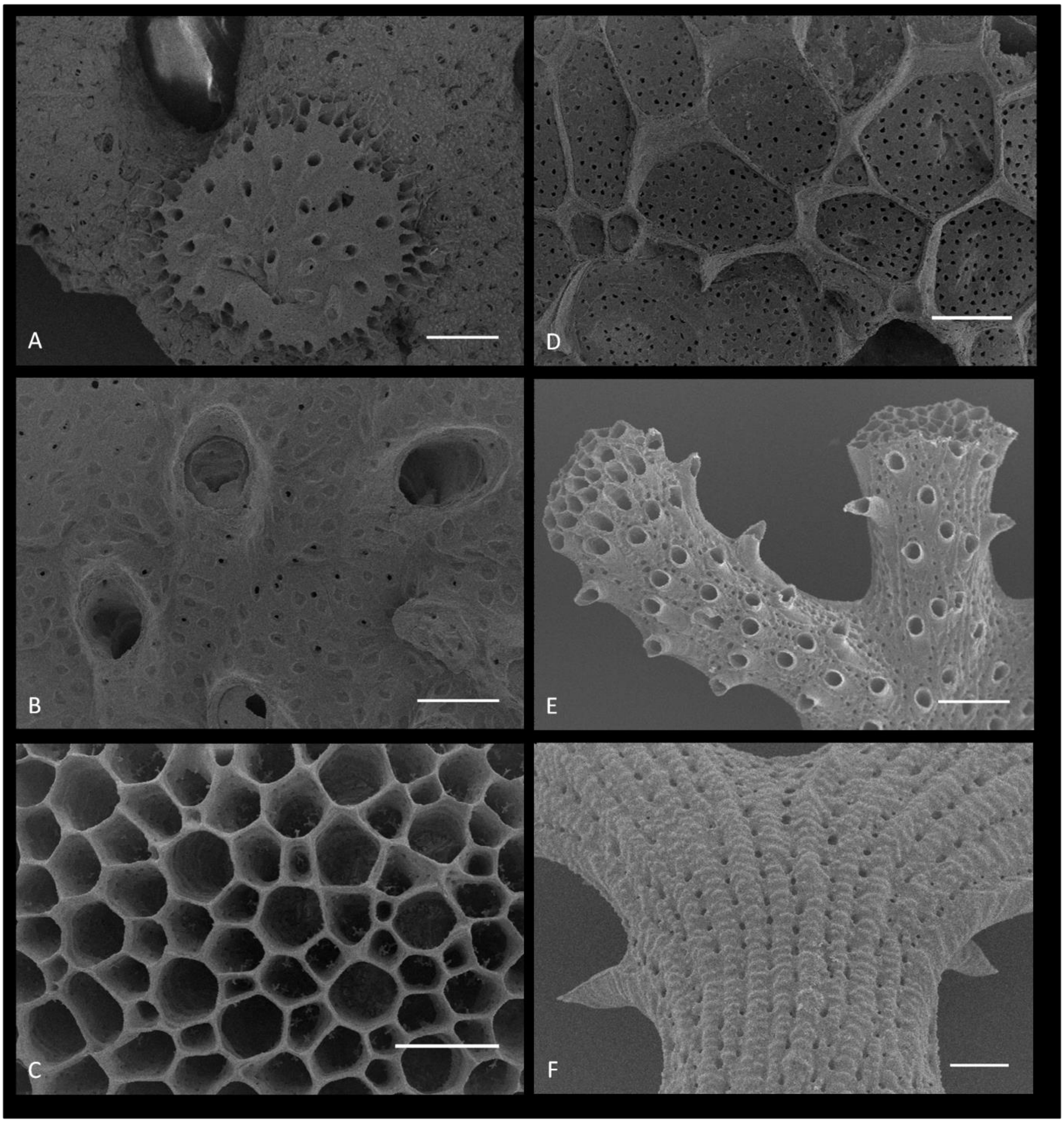

Plate 1. A-B. *Microeciella* cf. *planus*, SAMC-A029005. A. Spot colony encrusting *Reteporella* sp. (scale bar = 0.5 mm, magnified x35). B. Short peristome and finely punctuate surface. C-D. *Tennysonia stellata*, SAMC-A028927. C. Frontal view of autozooids and kenozooids, note mural spines (scale bar = 0.5 mm, magnified x50). D. Brood chambers found at the distal part of the colony (scale bar = 0.2 mm, magnified x100). E-F. *Hornera americana*, SAMC-A029041. E. Frontal view of distal end of branch (scale bar = 0.2 mm, magnified x75). F. Basal surface corrugated and porous (scale bar = 0.5 mm, magnified x35).

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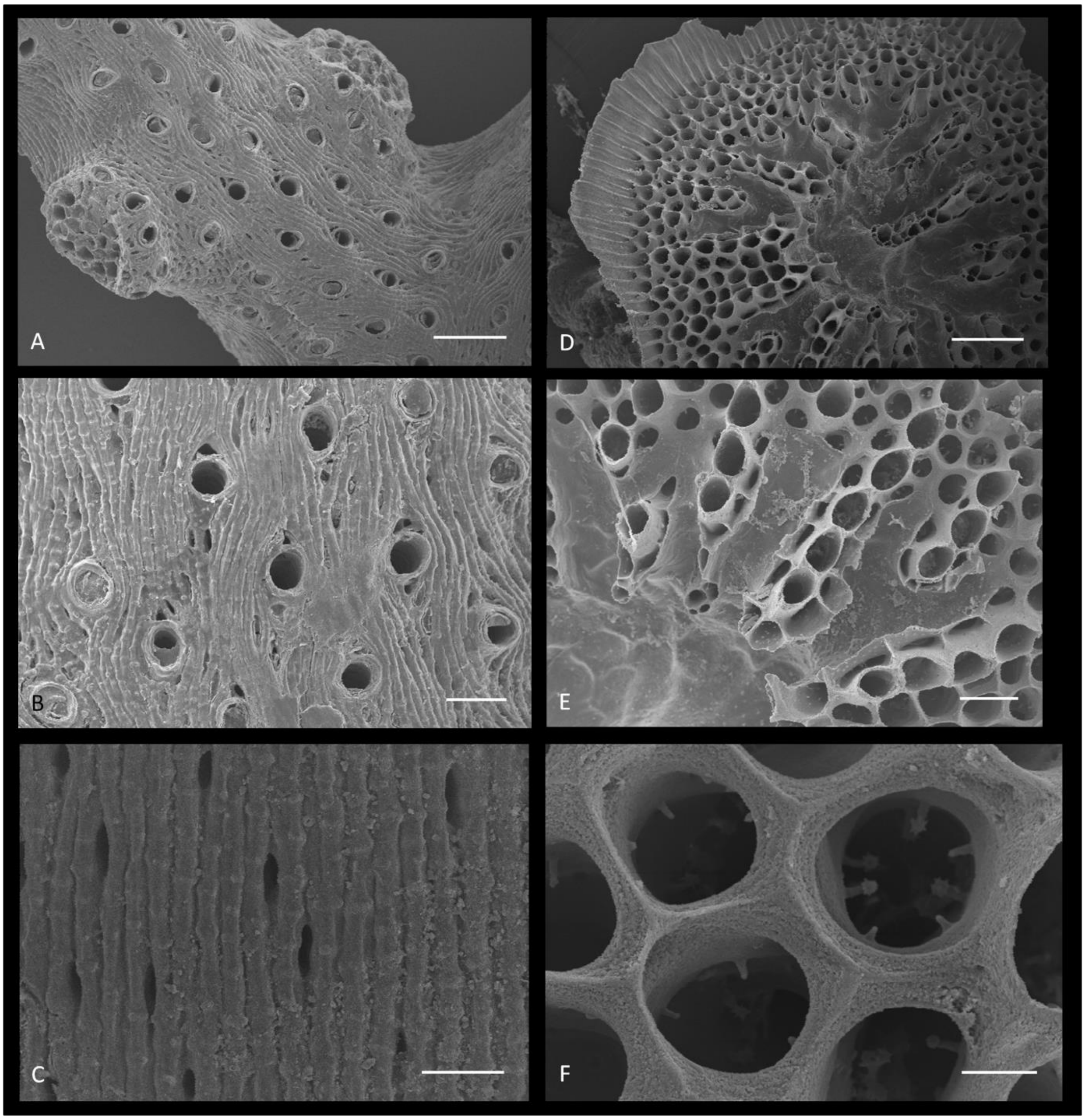

Plate 2. A-C. *Hornera* sp., SAMC-A029062. A. Frontal view near bifurcation with secondary branching (scale bar = 0.5 mm, magnified x35). B. View of zooids with circular orifice, slightly thickened peristomial rim and slit-like pores (scale bar = 0.2 mm, magnified x75). C. Basal surface with slit-like pores and ridges (scale bar = 0.1 mm, magnified x200). D-F. ***Favosipora epiphyta*** sp. nov., SAMC-028880. D. Fertile colony showing marginal lamina and distinct brood chamber in the central part of the colony (scale bar = 0.5 mm, magnified x35). E. Adnate zooids with the densely porous surface of brood chamber (scale bar = 0.2 mm, magnified x75). F. Circular kenozooidal apertures showing mural pinhead spines on the wall interior (scale bar = 0.05 mm, magnified x350).

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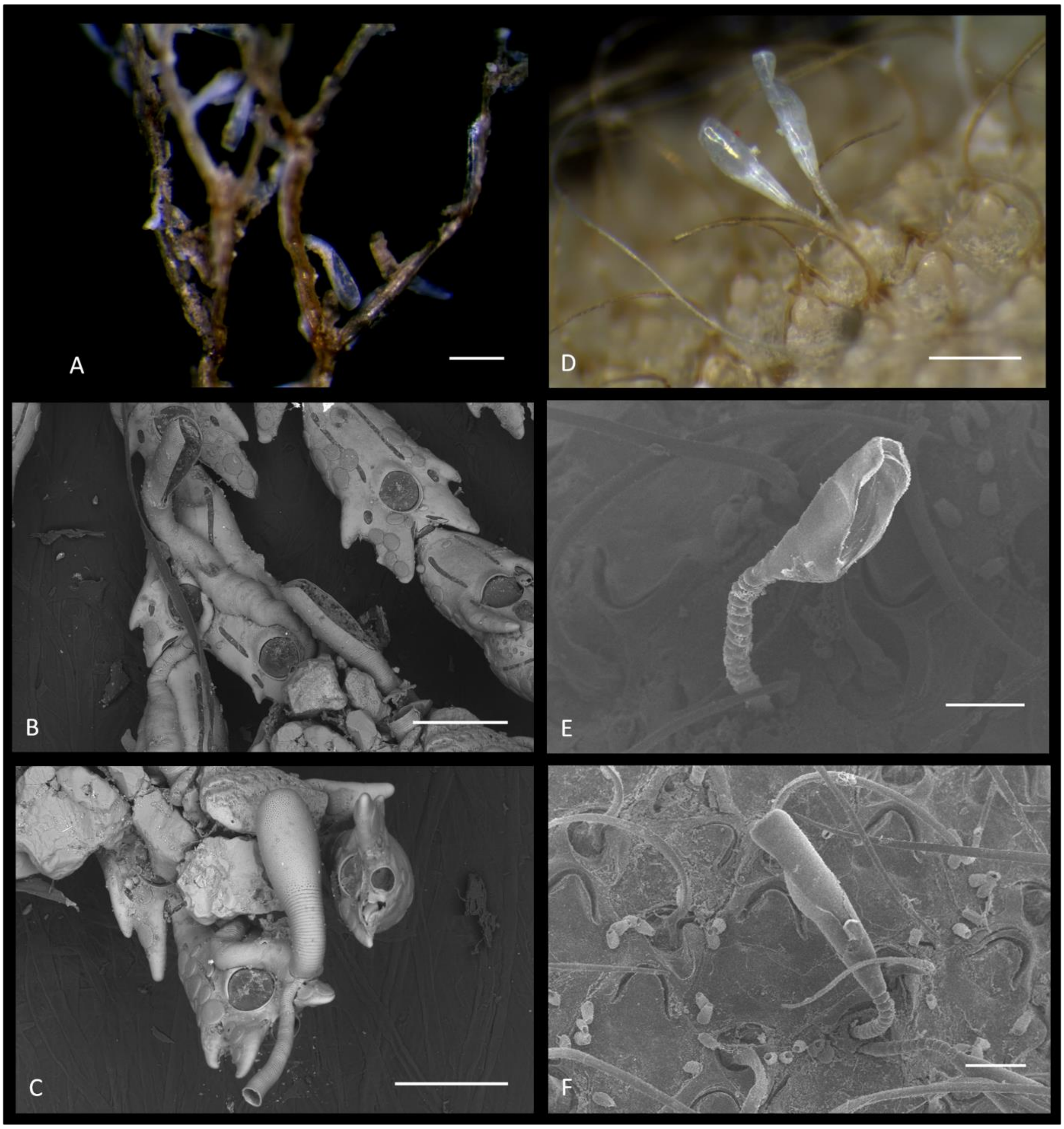

Plate 3. A-C. *Aetea anguina*. A. SAMC-A028824 (unbleached). Zooids attached to hydroids (scale bar = 0.5 mm, magnified x25). B. NHMUK specimen (no catalogue number), single zooid with finely punctuated stolon (scale bar = 0.2 mm, magnified x350). C. Basal surface of cylindrical portion annulated and the frontal membrane finely punctuated (scale bar = 0.2 mm, magnified x300). D-F. *Callaetea* cf. *spiralis*, SAMC-A077255 (unbleached). D. White, almost translucent colonies (scale bar = 0.5 mm, magnified x50). E. A single zooid, cylindrical portion corrugated (scale bar = 0.2 mm, magnified x100). F. Smooth basal surface (scale bar = 0.2 mm, magnified x75).

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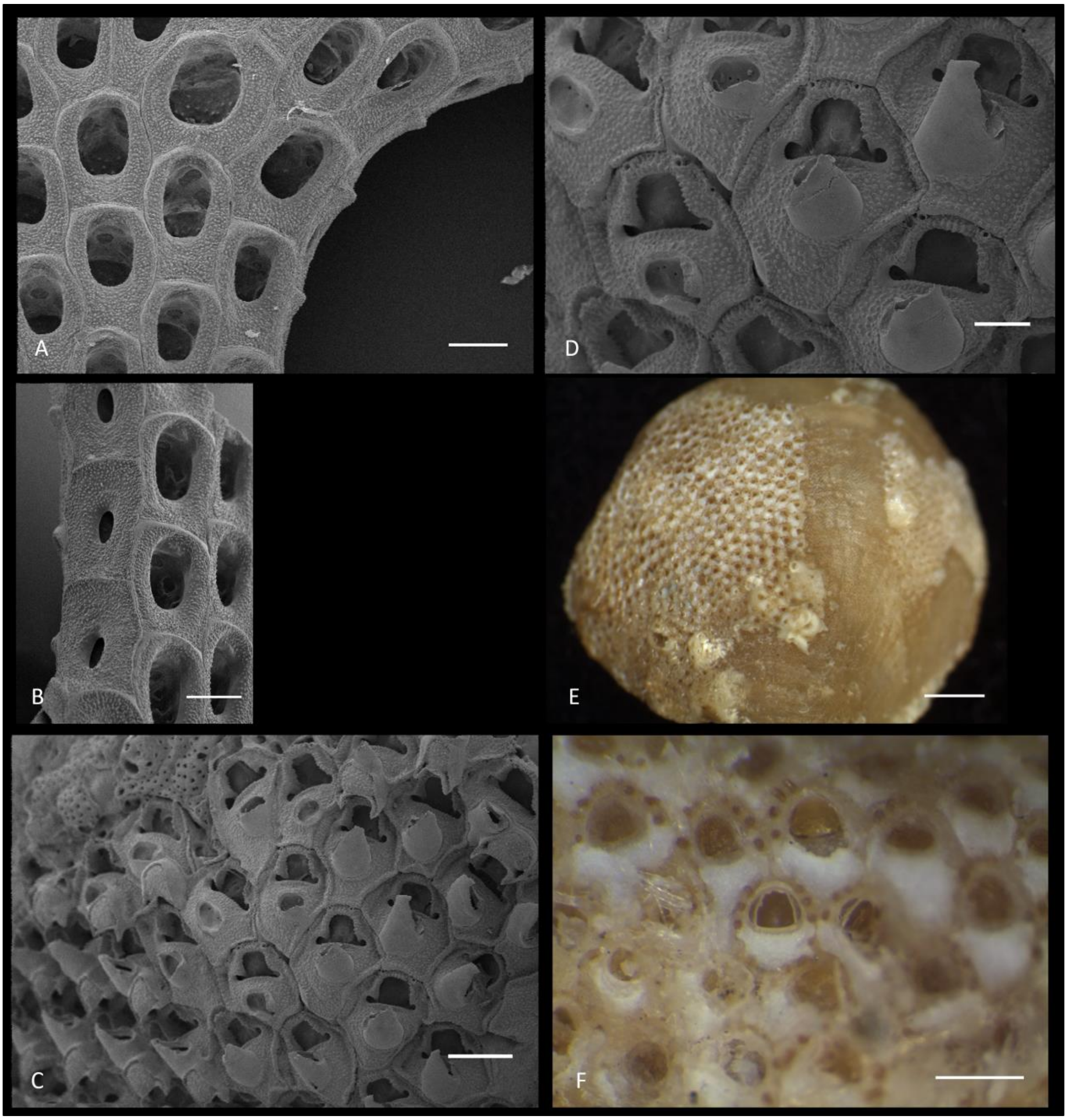

Plate 4. A-B. ***Biflustra khoisan*** sp. nov., SAMC-A029105. A. Frontal view of zooids near the edge (scale bar = 0.2 mm, magnified x75). B. Marginal kenozooids (scale bar 0.2 mm, magnified x75). C-D. *Amphiblestrum triangularis*, SAMC-A028799. C. Zooids at the growing edge, ovicells can be seen (scale bar = 0.5 mm, magnified x35). D. Frontal view of a single zooid (scale bar = 0.2 mm, magnified x75). E-F. *Chaperia* sp., SAMC-A077193. E. Encrusting on shell (scale bar = 2 mm, magnified x6). F. Zooids showing occlusor laminae and spines bases (scale bar = 0.4 mm, magnified x50).

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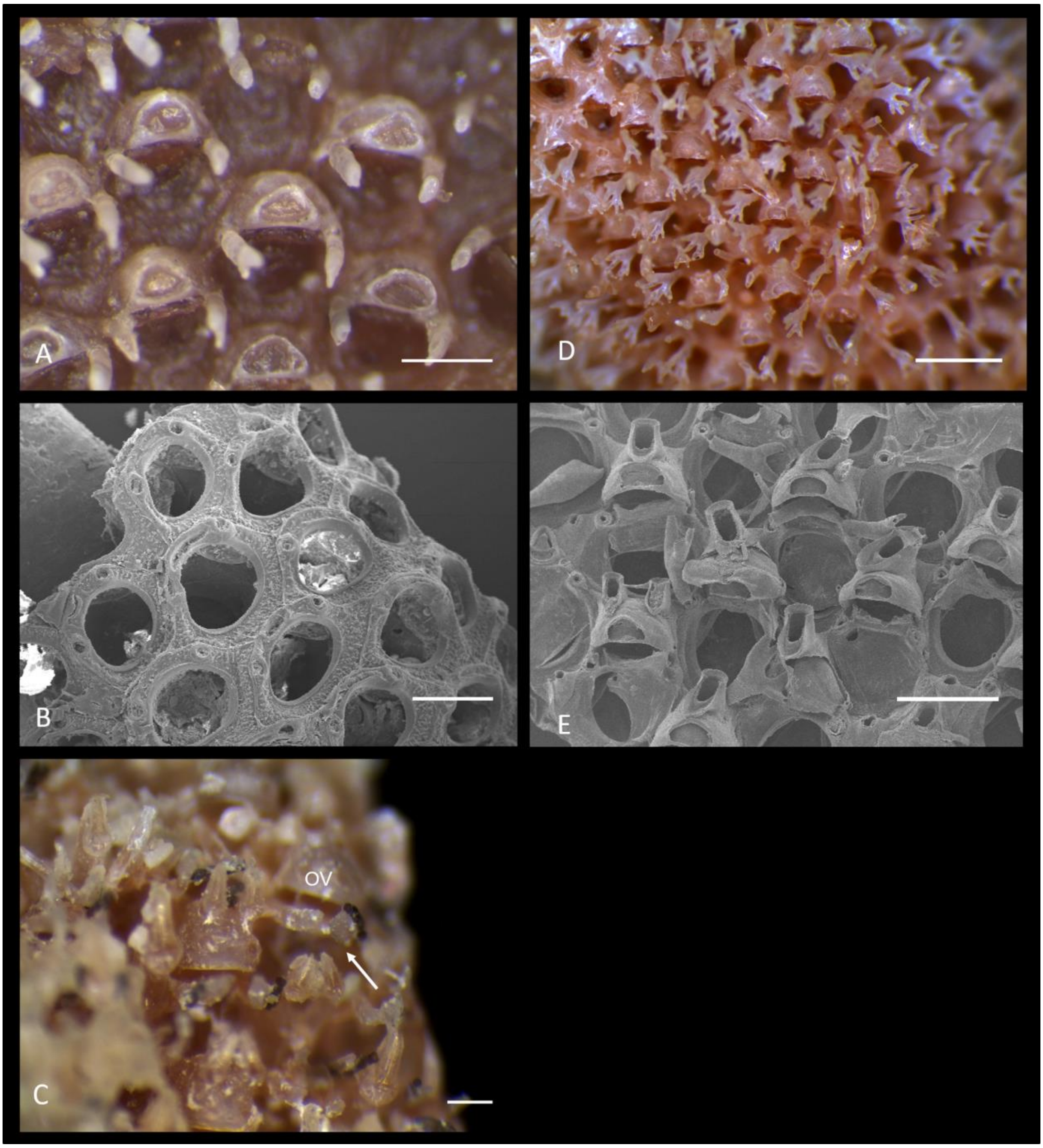

Plate 5. A-B. *Chaperiopsis familiaris*. A. SAMC-A077435 (unbleached). Frontal view of poorly developed spines and ovicells with oval frontal foramen (scale bar = 0.4 mm, magnified x50). B. SAMC-A028837. Bleached specimen to expose the frontal membrane (scale bar = 0.4 mm, magnified x50). C. *Chaperiopsis chelata* SAMC-A077350. View of ovicell (OV) with two small lateral fenestra and curved proximal spines (arrow) (scale bar = 0.2 mm, magnified x50). D-E. *Chaperiopsis multifida*. D. SAMC-A073414. Microscope image of a colony with ovicells (scale bar = 1 mm, magnified x25). E. SAMC-A028951. Ovicelled and non-ovicelled zooids (scale bar = 0.5 mm, magnified x50).

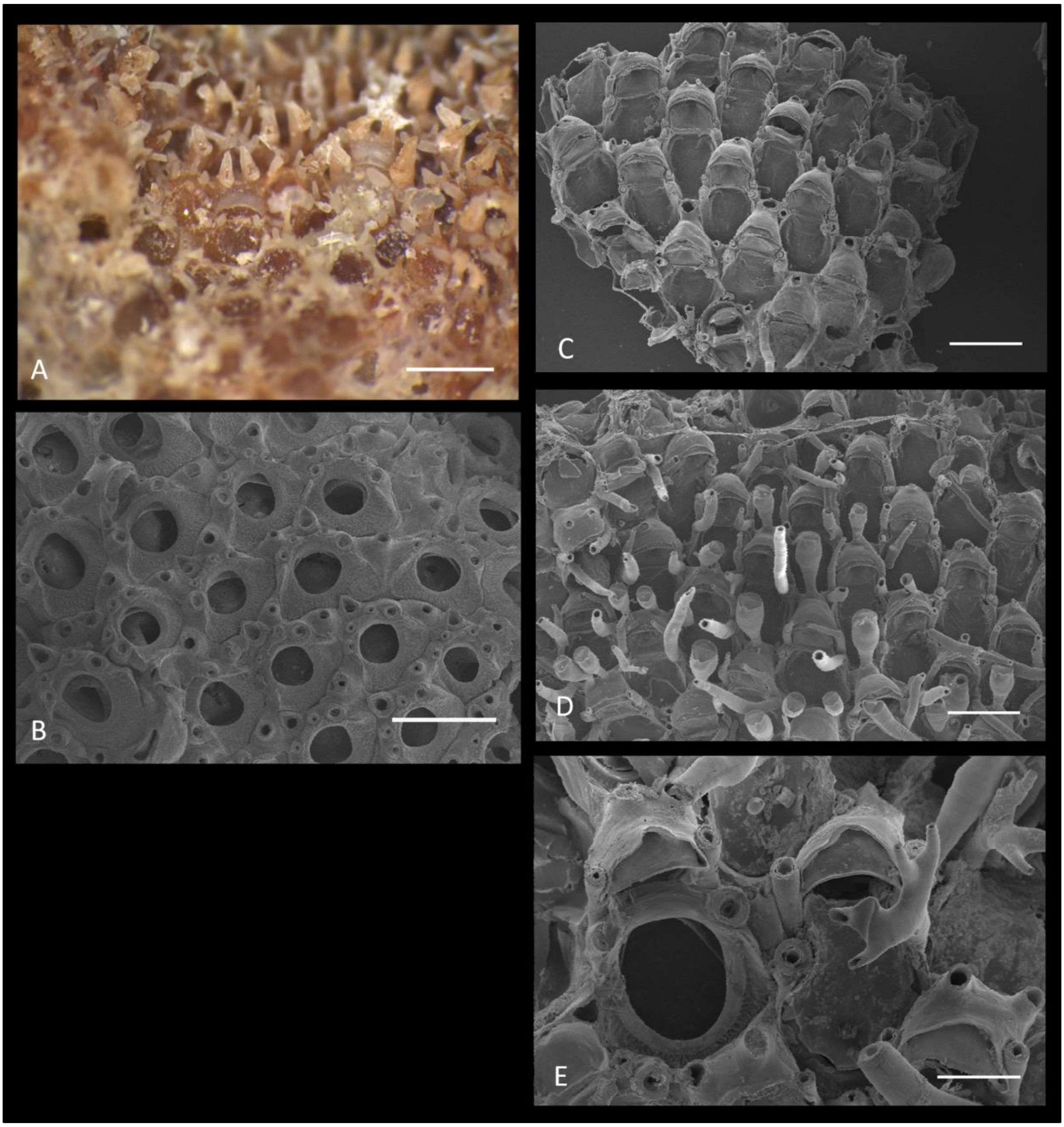

Plate 6. A-B. *Chaperiopsis stephensoni*, SAMC-A029085. A. Microscope image of a colony with ovicells (scale bar = 1 mm, magnified x25). B. An ovicelled zooid (scale bar = 0.5 mm, magnified x50). C-E. *Chaperiopsis yinca* sp. nov. C. SAMC-A073421. A few zooids (bleached) exposing the tightly packed zooids without spines obscuring the frontal surface (scale bar = 0.5 mm, magnified x35). D. Frontal view of the growing edge (unbleached) showing pedunculate spines and ovicells, some spines broken (scale bar = 0.5 mm, magnified x35). E. SAMC-A028953. Oval opesia and frontal area exposed showing negligible occlusor laminae (scale bar = 0.2 mm, magnified x100).

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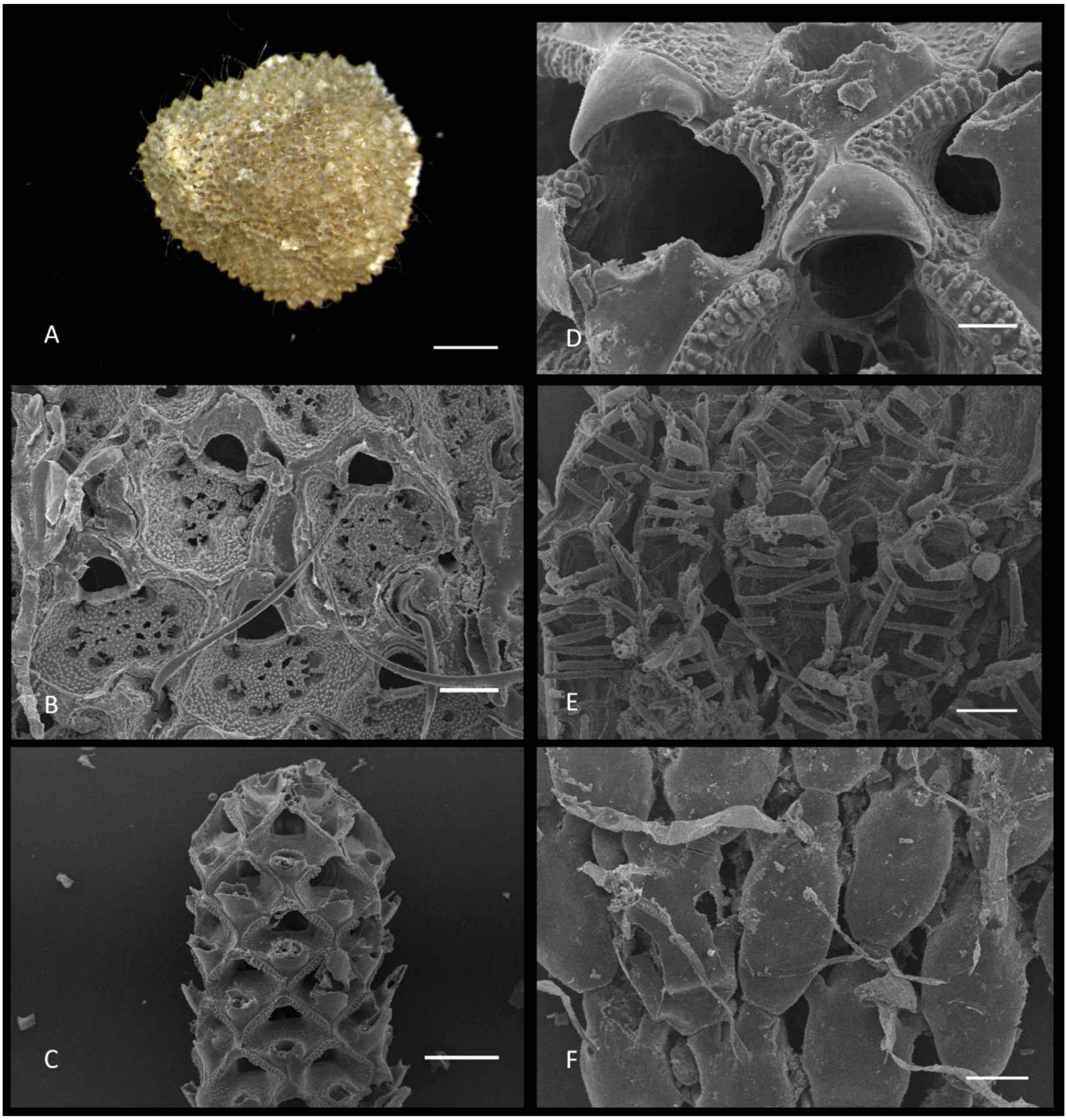

Plate 7. A-B**.** *Discoporella umbellata*. A. SAMC-A077441. Microscope image of a colony (scale bar = 2 mm, magnified x6). B. SAMC-A028886. Frontal view of zooids (scale bar = 0.2 mm, magnified x75). C-D. *Foveolaria imbricata*, SAMC-A028988. C. Frontal view of zooids at growing edge (scale bar = 0.5 mm, magnified x35). D. Ovicells (scale bar = 0.2 mm, magnified x150). E-F. *Beania minuspina*, SAMC-A077271 (unbleached). E. Frontal view of zooids (scale bar = 0.2, mm magnified x75). F. Basal surface (scale bar = 0.2 mm, magnified x75).

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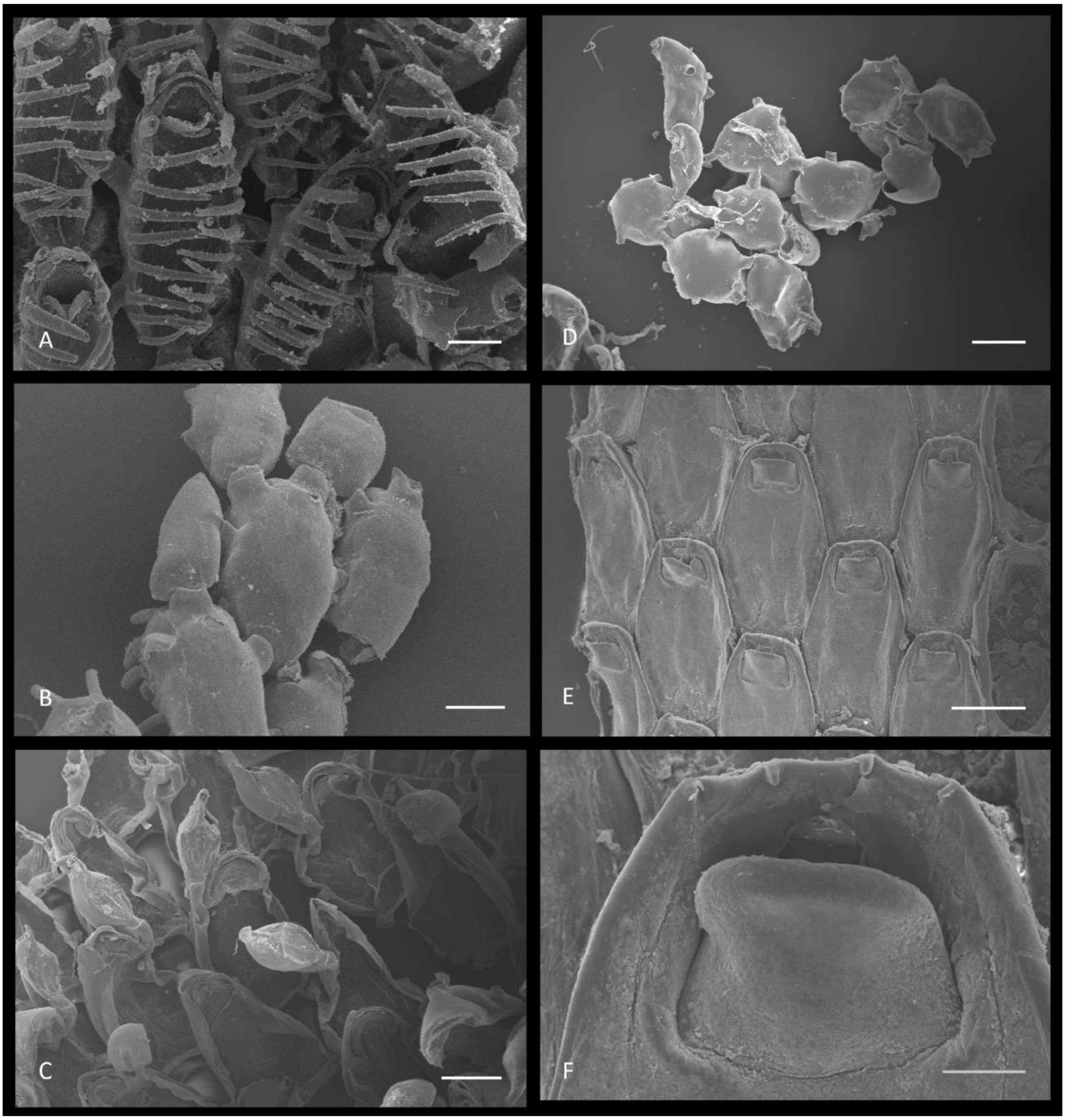

Plate 8. A-B. *Beania vanhoeffeni*, SAMC-A073524 (unbleached). A. Frontal view of zooids (scale bar = 0.2 mm, magnified x75). B. Basal surface (scale bar = 0.2 mm, magnified x75). C-D. *Beania* sp., SAMC-A073377 (unbleached). C. Frontal view of zooids (scale bar = 0.2 mm, magnified x75). D. Basal surface (scale bar = 0.5 mm, magnified x50). E-F. *Dimorphozoum nobile*, SAMC-A028883. E. Frontal view of zooids (scale bar = 0.5 mm, magnified x35). F. Thick operculum (scale bar = 0.1 mm, magnified x200).

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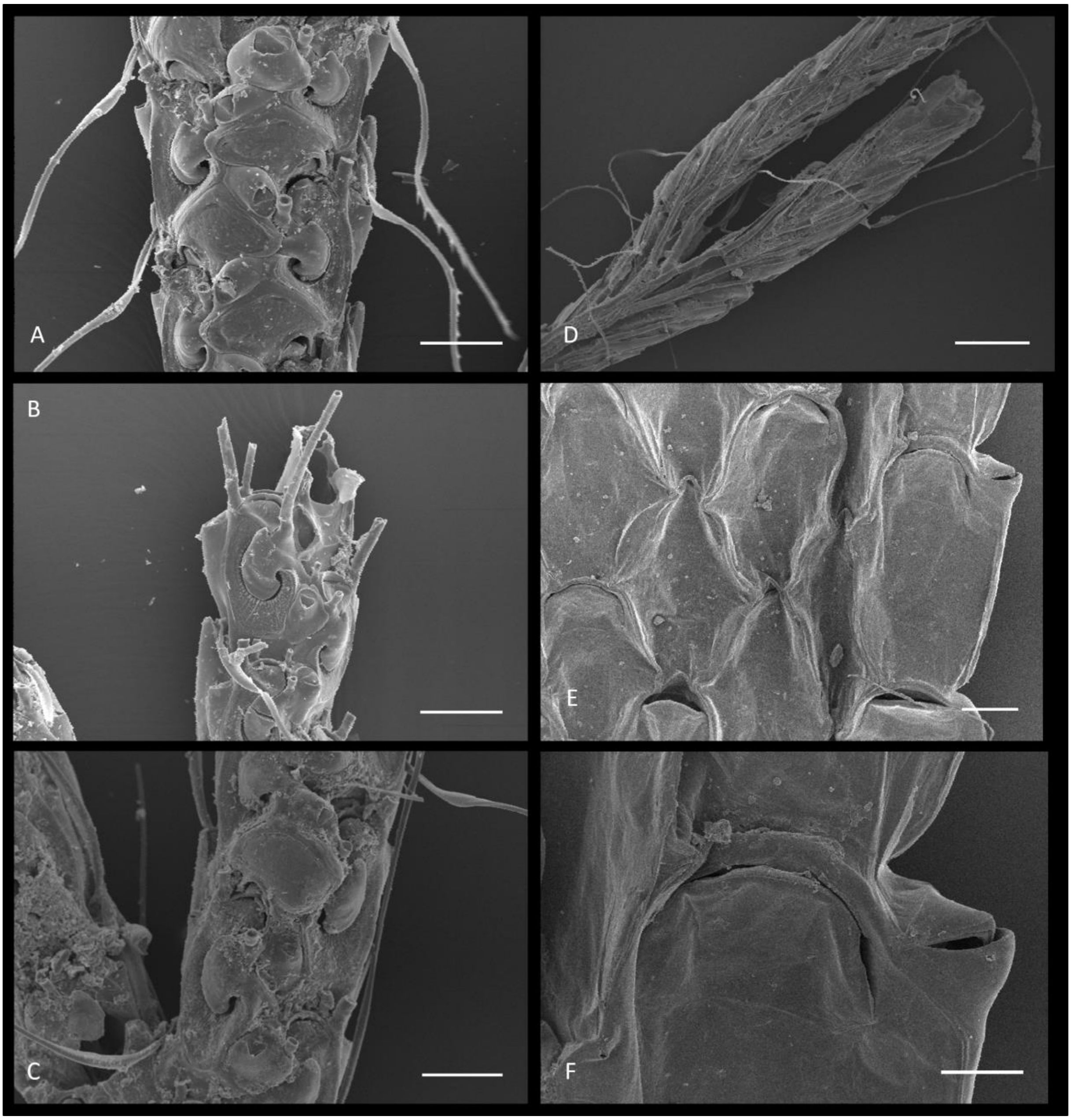

Plate 9. A-B. *Caberea darwinii*, SAMC-A028835. A. Ovicelled zooids with enlarged avicularia (scale bar = 0.2 mm, magnified x100). B. Single zooid at growing edge (scale bar = 0.2 mm, magnified x100). C-D. *Caberea darwinii occlusa*, SAMC-A029111. C. Ovicelled zooid (scale bar = 0.2 mm, magnified x100). D. Basal surface showing vibriculum chambers (scale bar = 0.5 mm, magnified x35). E-F. *Hoplitella armata*, SAMC-A028975. E. Marginal zooids (scale bar = 0.2 mm, magnified x75). F. Distal avicularium (scale bar = 0.1 mm, magnified x200).

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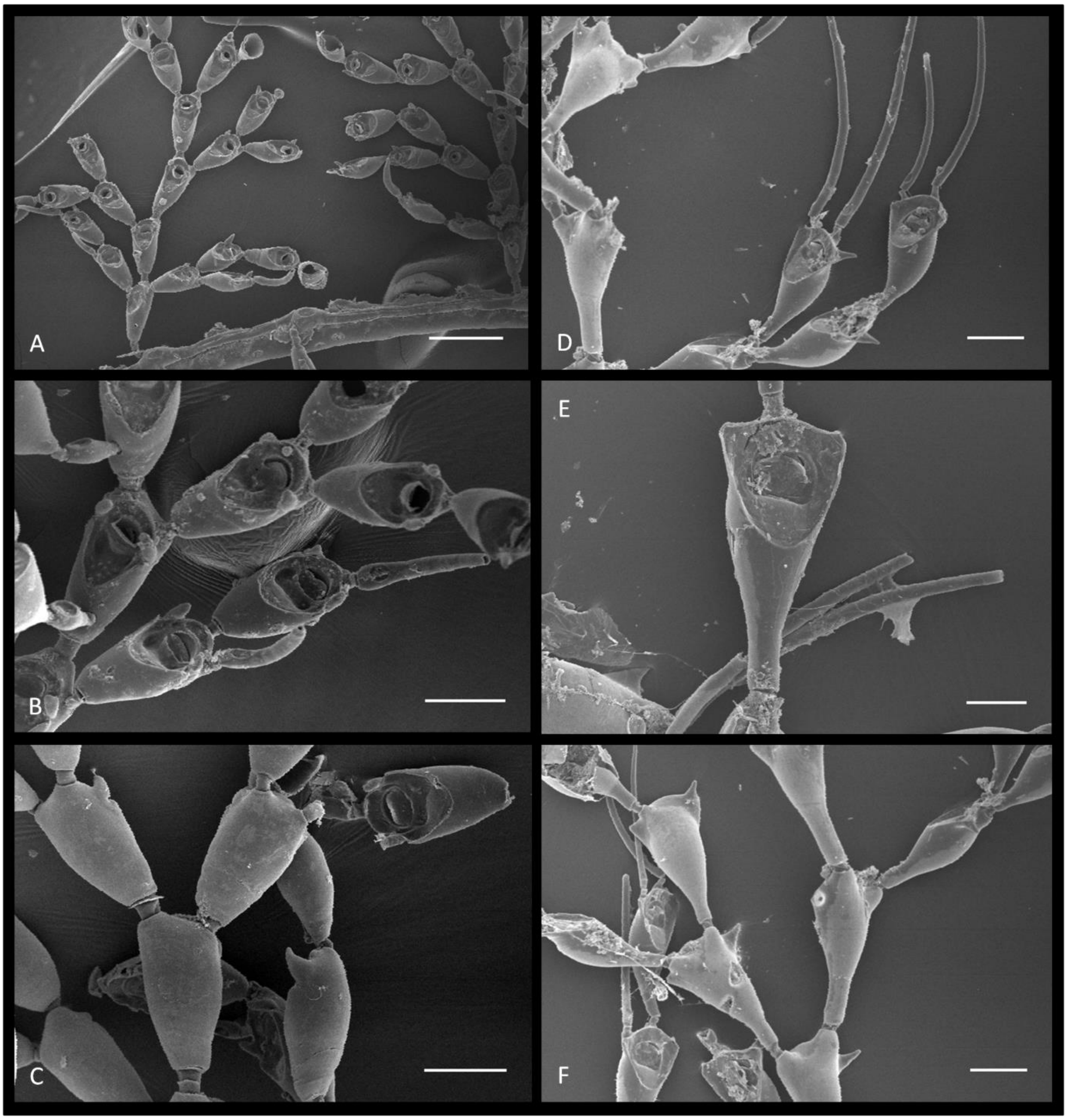

Plate 10. A-C. *Alysidium parisiticum*, SAMC-A028827. A. Colony arising from stolonate ancestrula (scale bar = 0.5 mm, magnified x35). B. A few budding zooids (scale bar = 0.2 mm, magnified x100). C. Basal surface (scale bar = 0.2 mm, magnified x100). D-F. *Catenicula corbulifera*, SAMC-A028910. D. Budding zooids (scale bar = 0.2 mm, magnified x75). E. Single zooid (scale bar = 0.1 mm, magnified x150). F. Basal surface (scale bar = 0.2 mm, magnified x75).

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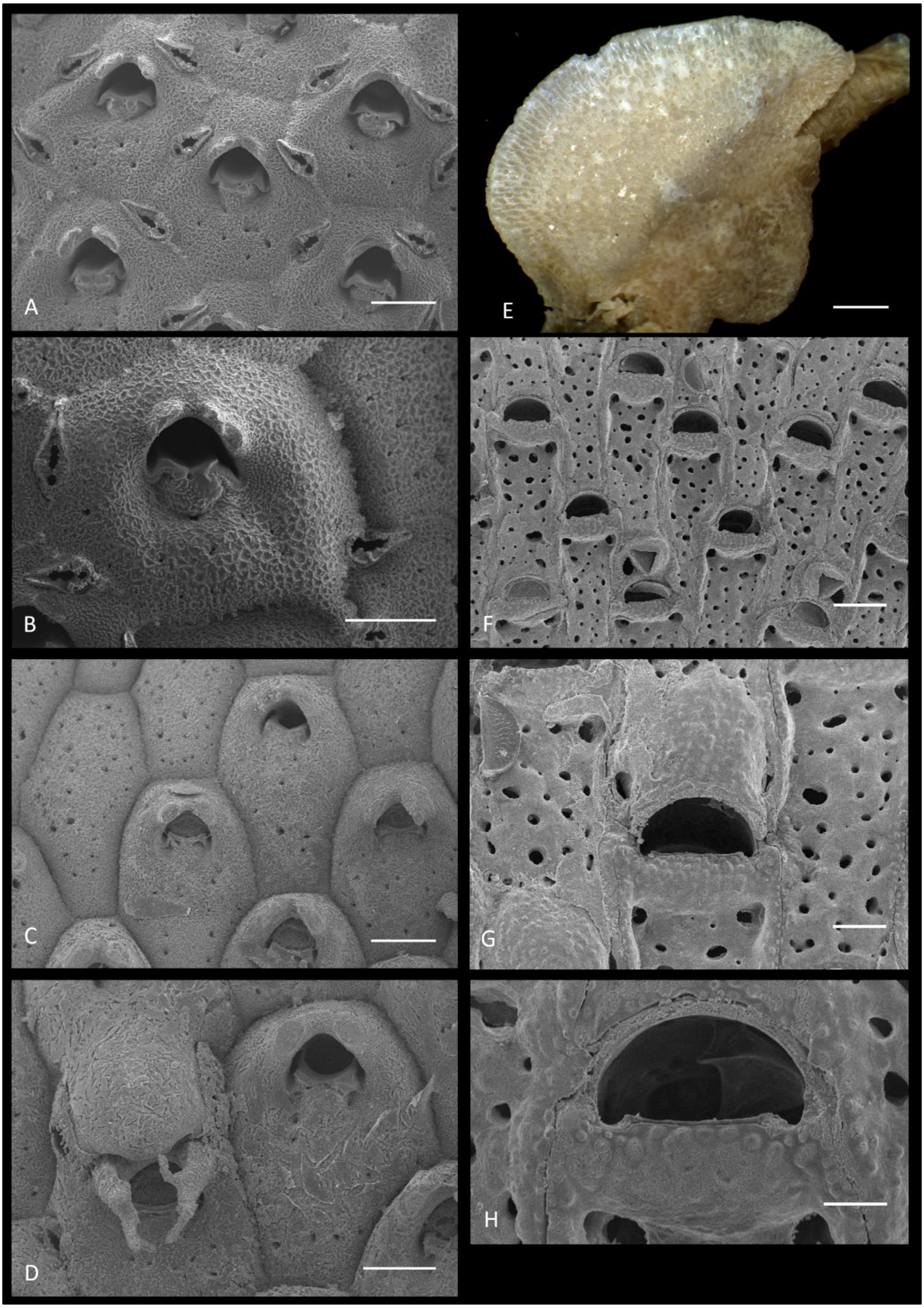

Plate 11. A-B. *Aspidostoma livida*, SAMC-A028823. A. Frontal view of zooids (scale bar = 0.5 mm, magnified x35). B. Single zooid with adventitious avicularia (scale bar = 0.5

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mm, magnified x50). C-D. ***Aspidostoma staghornea*** sp. nov., SAMC-A029067. C. Zooids and kenozooid with frontal pores (scale bar = 0.5 mm, magnified x35). D. Ovicell and horn-like processes (scale bar = 0.4 mm, magnified x50). E-H. ***Micropora erecta*** sp. nov. E. SAMC-A073482. Colony grows erect, forming bilaminar sheets (scale bar = 2 mm, magnified x6). F. SAMC-A28821. Zooids with interzooidal avicularia (scale bar = 0.2 mm, magnified x75). G. An ovicelled zooid (scale bar = 0.1 mm, magnified x150). H. A young orifice, showing proximal indentations (scale bar = 0.05 mm, magnified x350).

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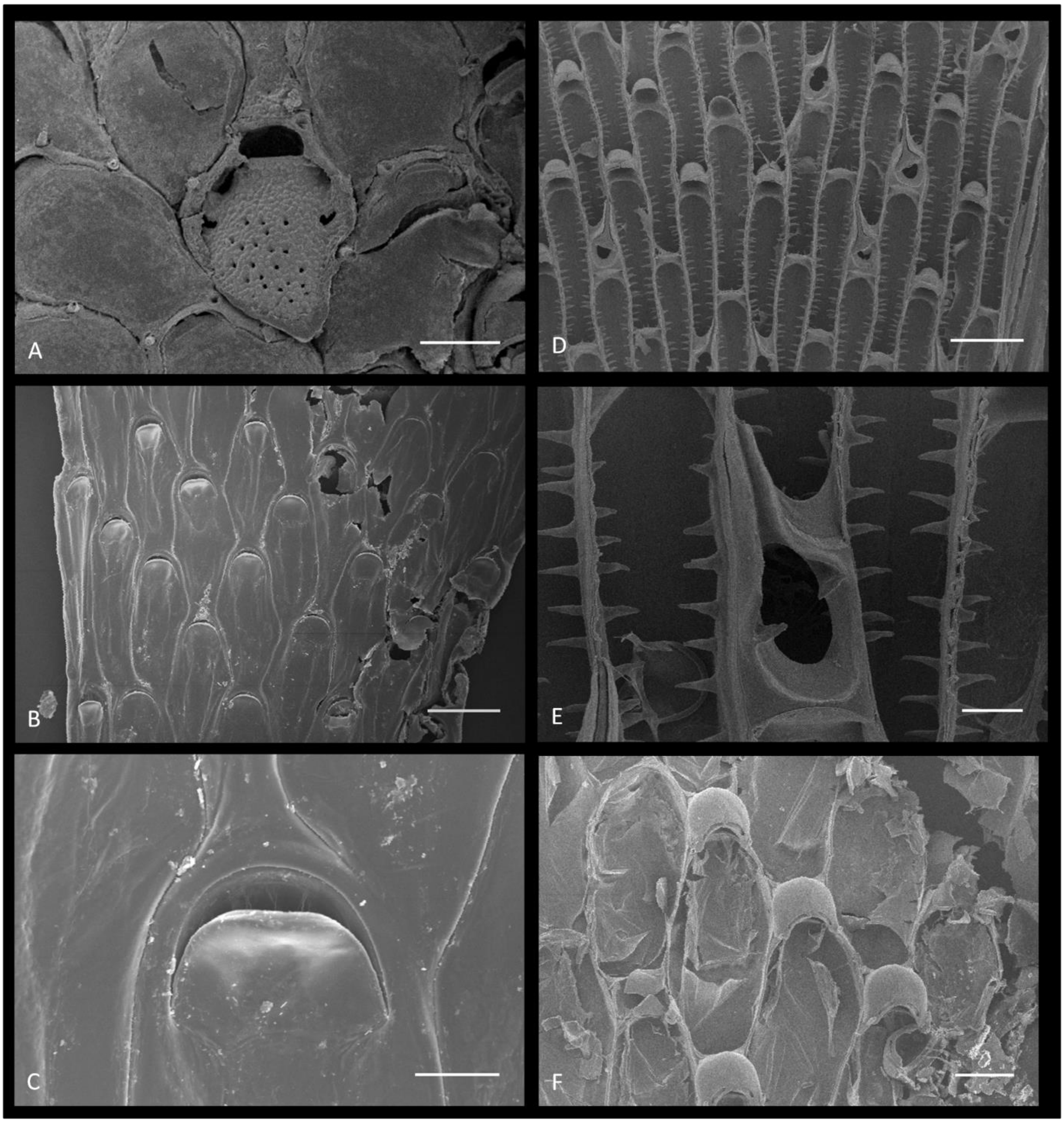

Plate 12. A. *Micropora* sp., SAMC-A028999. A single visible zooid (scale bar = 0.2 mm, magnified x100). B-C. *Carbasea carbasea*, SAMC-A028884. B. Zooids with elongated marginal zooids (scale bar = 0.5 mm, magnified x35). C. Operculum (scale bar = 0.1 mm, magnified x200). D-E. *Gregarinidra spinuligera*, SAMC-A029035. D. Rectangular zooids and ovicells (scale bar = 0.5 mm, magnified x35). E. Interzooidal avicularia (scale bar = 0.1 mm, magnified x150). F. *Klugeflustra jonesii*, SAMC-A028982. Ovicelled zooids (scale bar = 0.2 mm, magnified x75).

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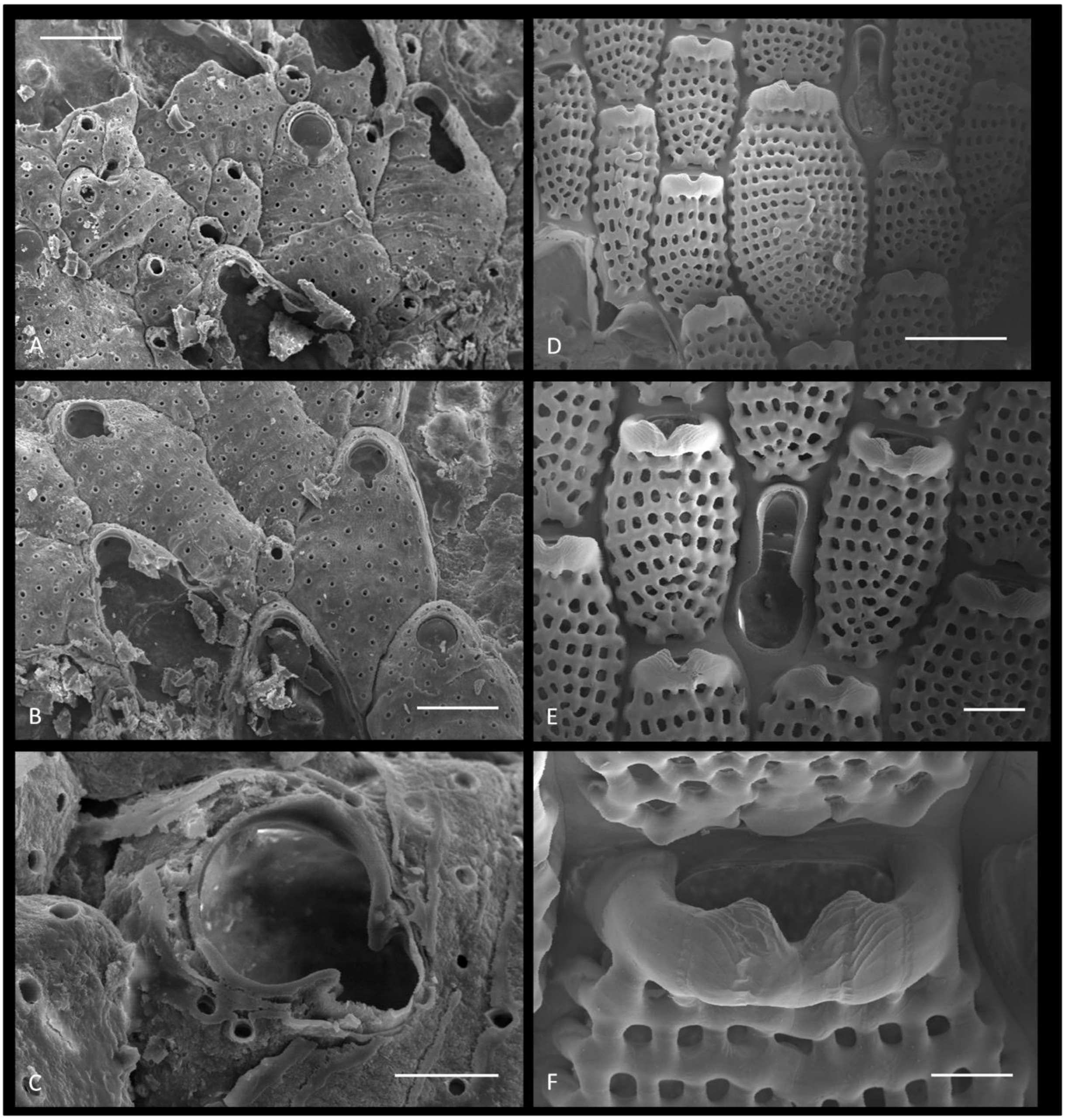

Plate 13. A-C. ***Trypostega infantaensis*** sp. nov., SAMC-A028976. A, B. Zooids and kenozooids (scale bar = 0.2 mm, magnified x100). C. Clithridiate orifice (scale bar = 0.05 mm, magnified x500). D-F. ***Khulisa ukhololo*** sp. nov., SAMC-A029002. D. Autozooids with a single dimorphic zooid and an avicularium (WD = 10, scale bar = 0.5 mm, magnified x50). E. Autozooids and interzooidal avicularium (WD = 10, scale bar = 0.2 mm, magnified x75). F. Orificial rim of a dimorphic zooid (WD = 10, scale bar = 0.1 mm, magnified x200).

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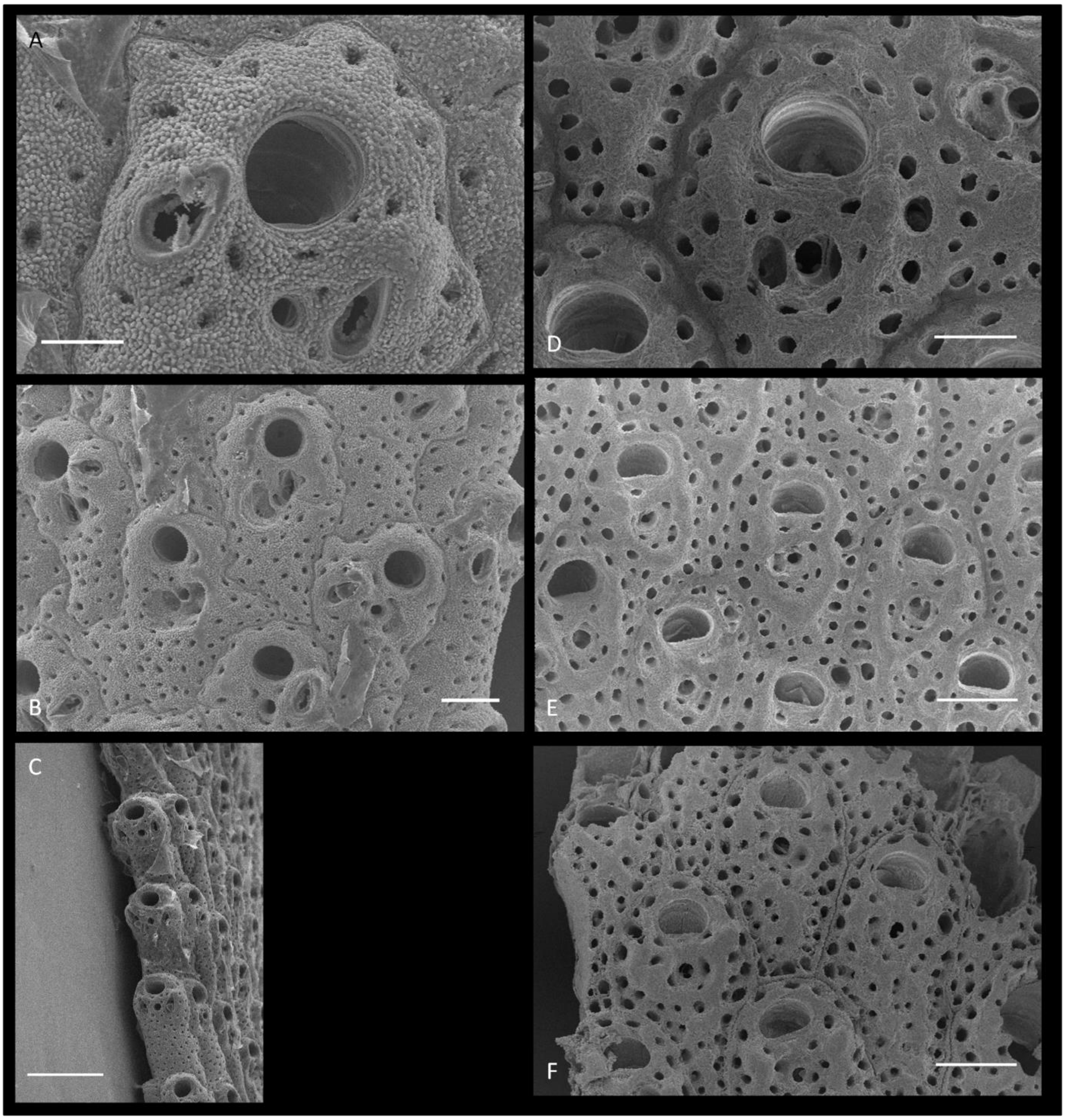

Plate 14. A-C. ***Adeonella assegai*** sp. nov. SAMC-A028960. A. Secondary orifice of older zooid with paired avicularia and small spiramen (WD = 10, scale bar = 0.1 mm, magnified x200). B. A single older zooid (WD = 10, scale bar = 0.2 mm, magnified x100). C. Enlarged zooids and occasional kenozooids with avicularium on colony margin (WD = 10, scale bar = 0.5 mm, magnified x50). D-F. *Adeonella fuegensis*, SAMC-A028812. D. Orifice and spiramen (scale bar = 0.1 mm, magnified x200). E. Older zooids (scale bar = 0.2 mm, magnified x100). F. Young zooids (scale bar = 0.2 mm, magnified x100).

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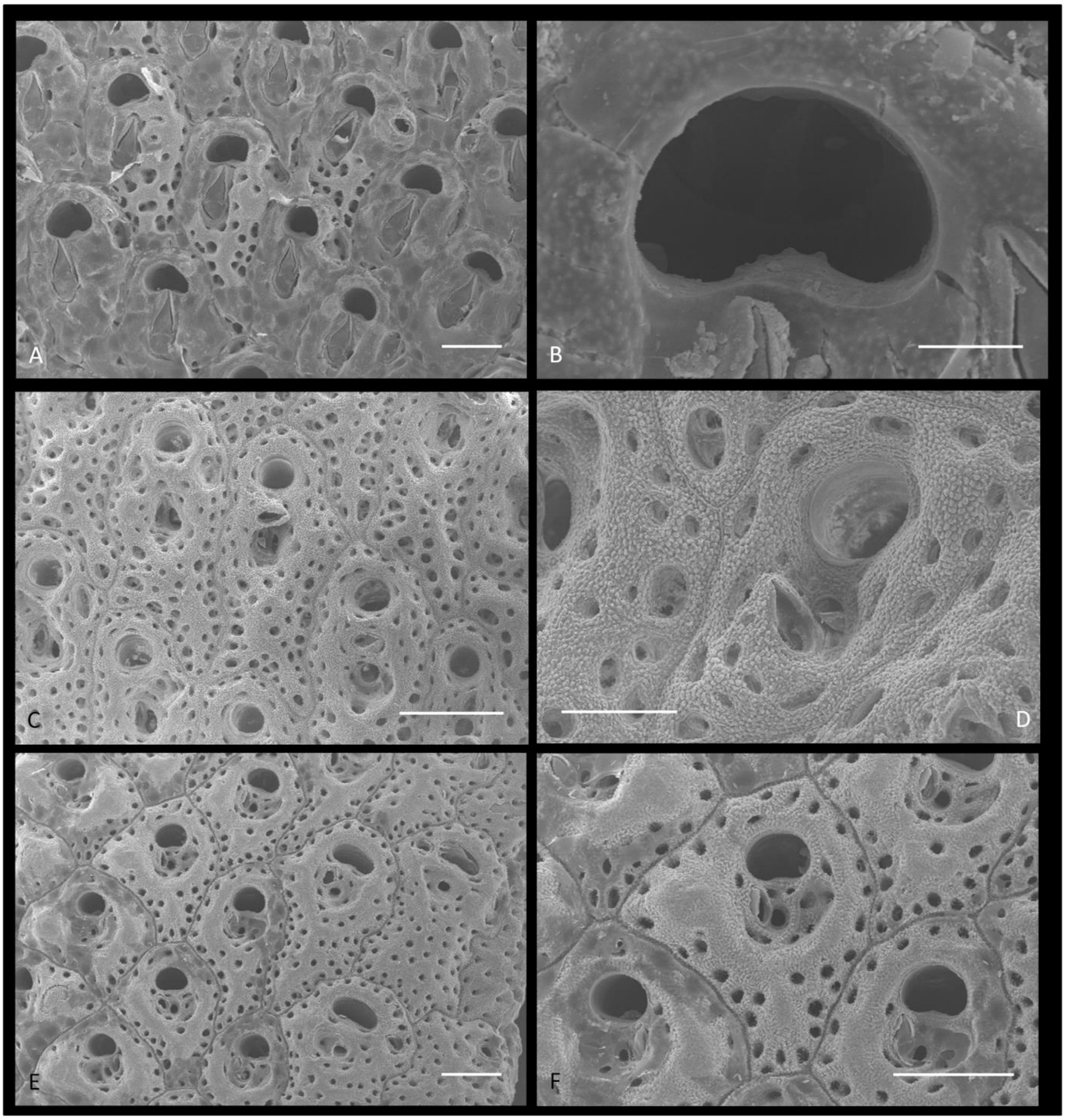

Plate 15. A-B. *Adeonella gibba*, SAMC-A077265. A. Older zooids (scale bar = 0.2 mm, magnified x75). B. Orifice (scale bar = 0.05 mm, magnified x500). C-D. *Adeonella lobata*, SAMC-A029152. C. Older zooids (scale bar = 0.5 mm, magnified x50). D. Avicularium deeply immersed (scale bar = 0.2 mm, magnified x150). E-F. *Adeonella pluscula*, SAMC-A073439. E. Zooids at growing edge (scale bar = 0.2 mm, magnified x75). F. Single zooid (scale bar = 0.2 mm, magnified x150).

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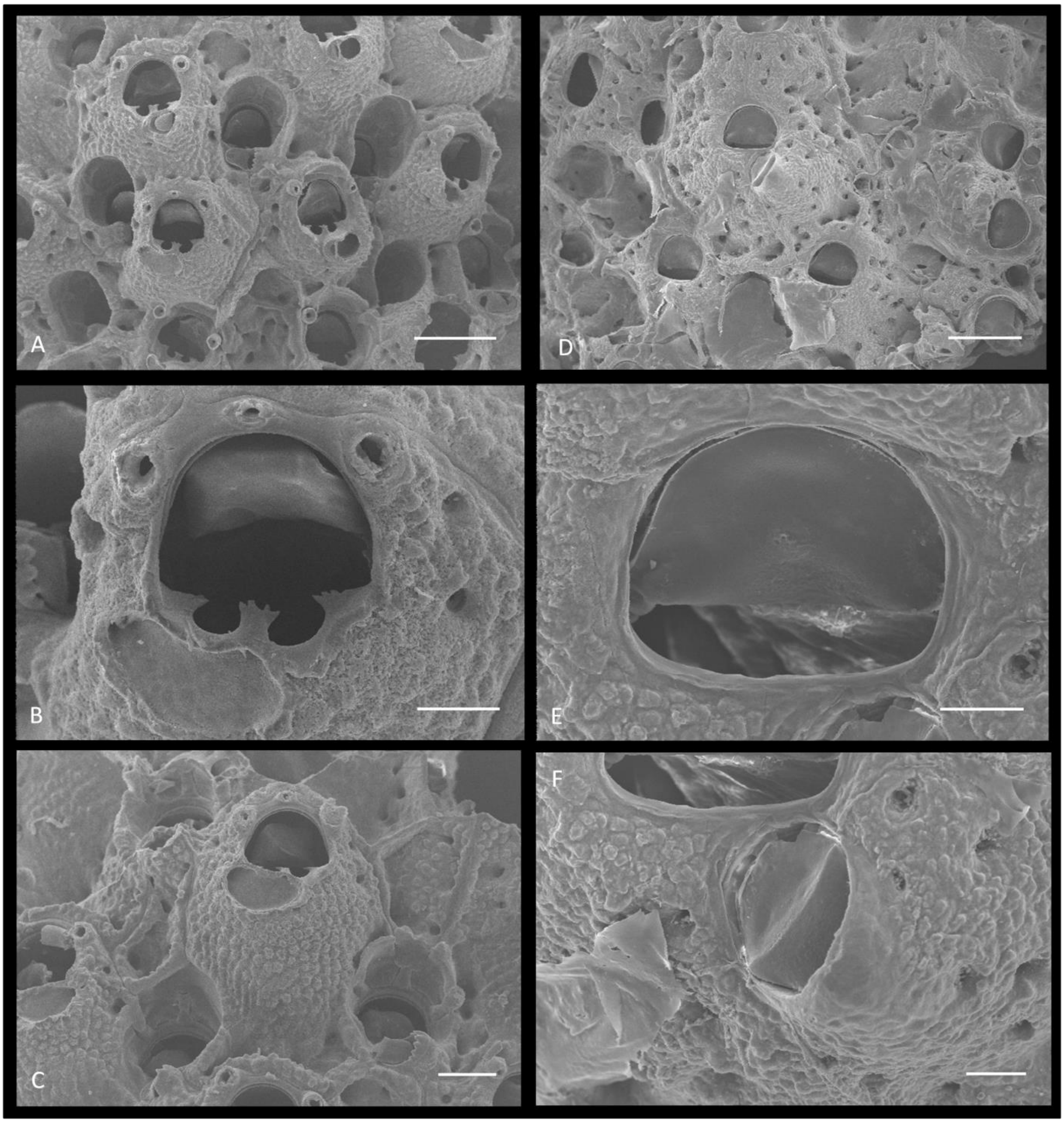

Plate 16. A-C. *Celleporaria tridenticulata*, SAMC-A028983. A. Frontal view of zooids (scale bar = 0.4 mm, magnified x50). B. Orifice (scale bar = 0.2 mm, magnified x200). C. Single zooid (scale bar = 0.2 mm, magnified x75). D-F. ***Celleporaria umuzi*** sp. nov., SAMC-A077331. D. Frontal view of zooids (scale bar = 0.5 mm, magnified x35). E. Orifice (scale bar = 0.1 mm, magnified x200). F. Suboral avicularium (scale bar = 0.1 mm, magnified x150).

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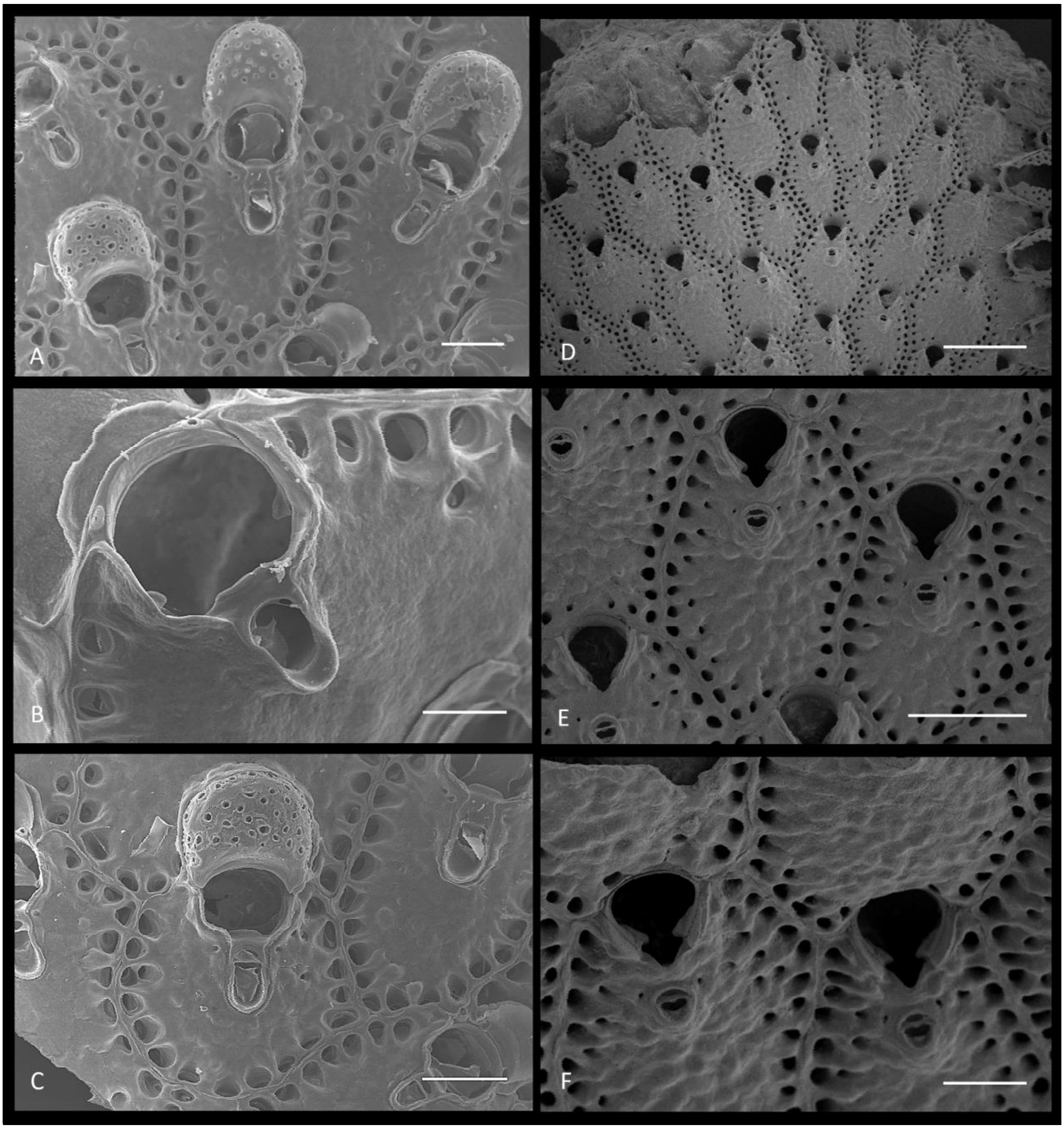

Plate 17. A-C. *Hippomonavella* cf. *flexuosa*, SAMC-A028955. A. Zooids (scale bar = 0.2 mm, magnified x75). B. Orifice, note median convexity (scale bar = 0.1 mm, magnified x200). C. Ovicelled zooid (scale bar = 0.2 mm, magnified x100). D-F. D-F. *?Hippomonavella inconspicua*, SAMC-A029008. D. Zooids at growing edge (scale bar = 0.4 mm, magnified x50). E. Single older zooid (scale bar = 0.2 mm, magnified x150). F. Orifice and condyles (scale bar = 0.1 mm, magnified x200).

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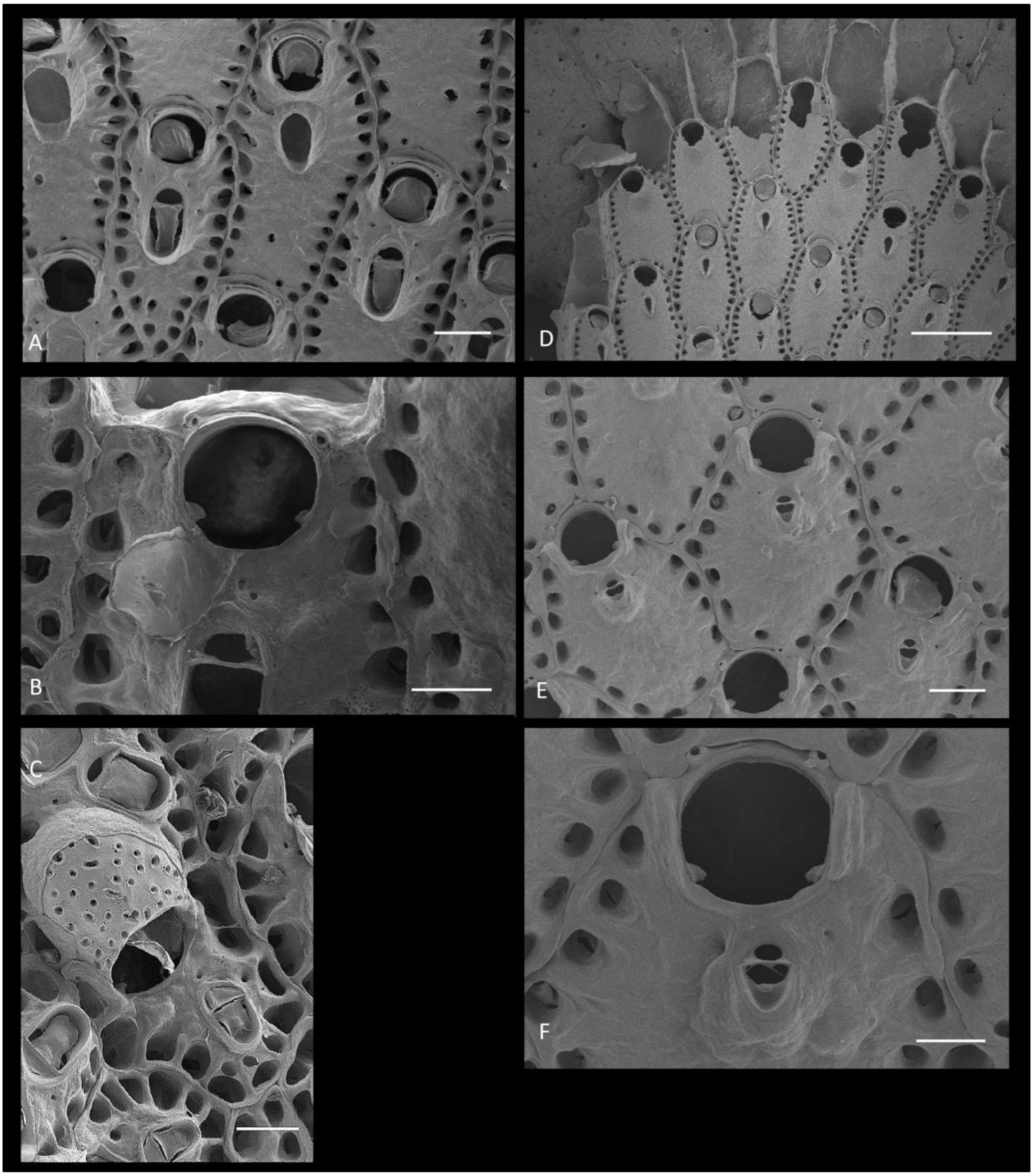

Plate 18. A-C. ***Hippomonavella lingulatus*** sp.nov., SAMC-A029050. A. Zooids (scale bar = 0.2 mm, magnified x75). B. Young orifice (scale bar = 0.1 mm, magnified x200). C. Ovicelled zooid in the astogenic zone (scale bar = 0.1 mm, magnified x150). D-F. *Hippomonavella* cf. *praeclara*, SAMC-A029010. D. Zooids at the growing edge, with young orifices (scale bar = 0.4 mm, magnified x50). E. Older zooids with spine bases (scale bar = 0.1 mm, magnified x150). F. Orifice with condyles and suboral avicularium (scale bar = 0.05 mm, magnified x350).

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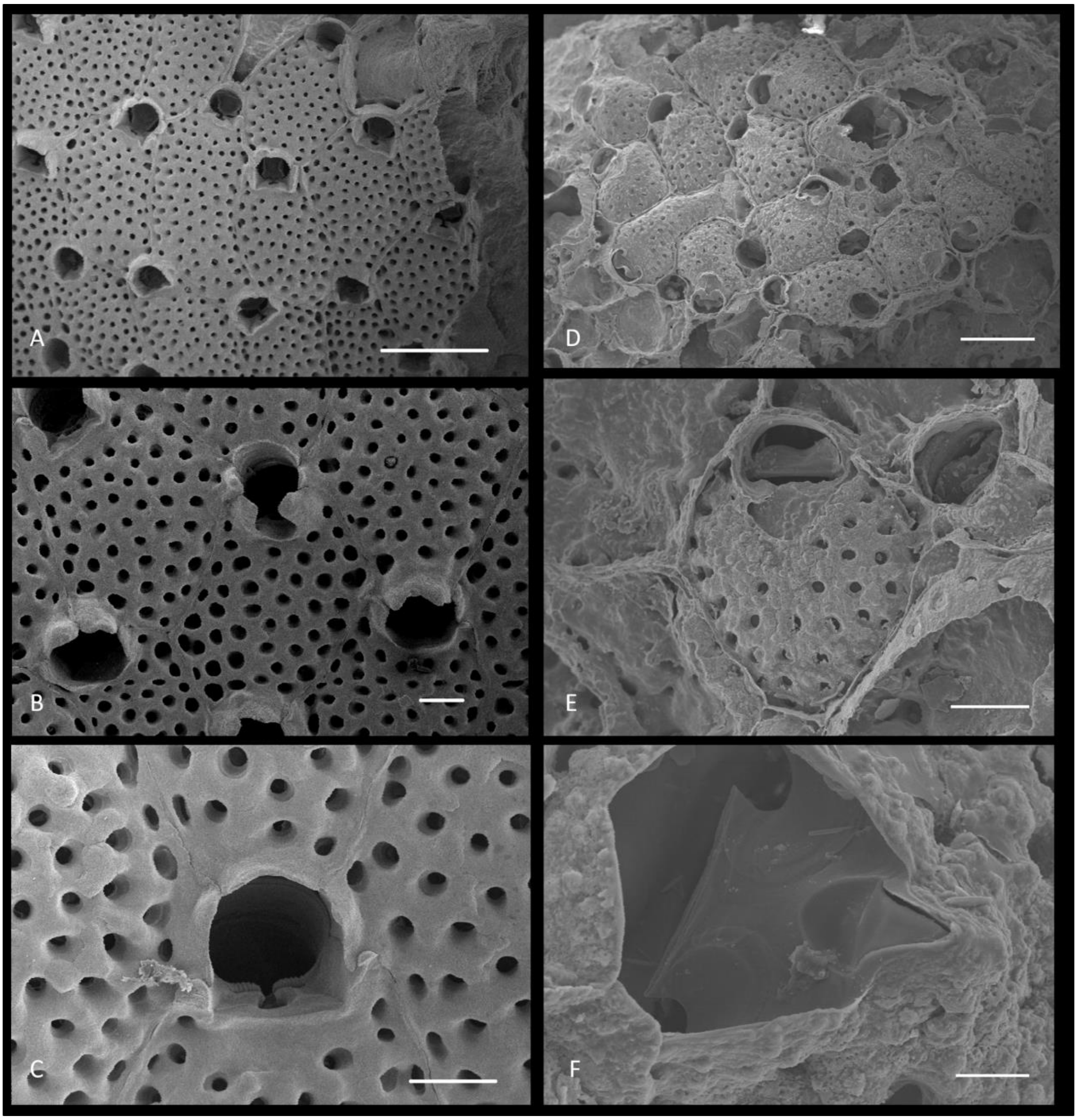

Plate 19. A-C. *Schizosmittina lizzya*, SAMC-A028941. A. Zooids at growing edge (scale bar = 0.5 mm, magnified x50). B. Zooids with developing raised proximal orificial rim (scale bar = 0.1 mm, magnified x100). C. Sinus transversely elongated with an elongated corrugated condyle on each side (scale bar = 0.1 mm, magnified x200). D-F. *Smittina* sp. 1, SAMC-A028901. D. Small spot colony (scale bar = 0.5 mm, magnified x35). E. Single young zooid (scale bar = 0.2 mm, magnified x100). F. Lyrula and suboral avicularium (scale bar = 0.05 mm, magnified x350).

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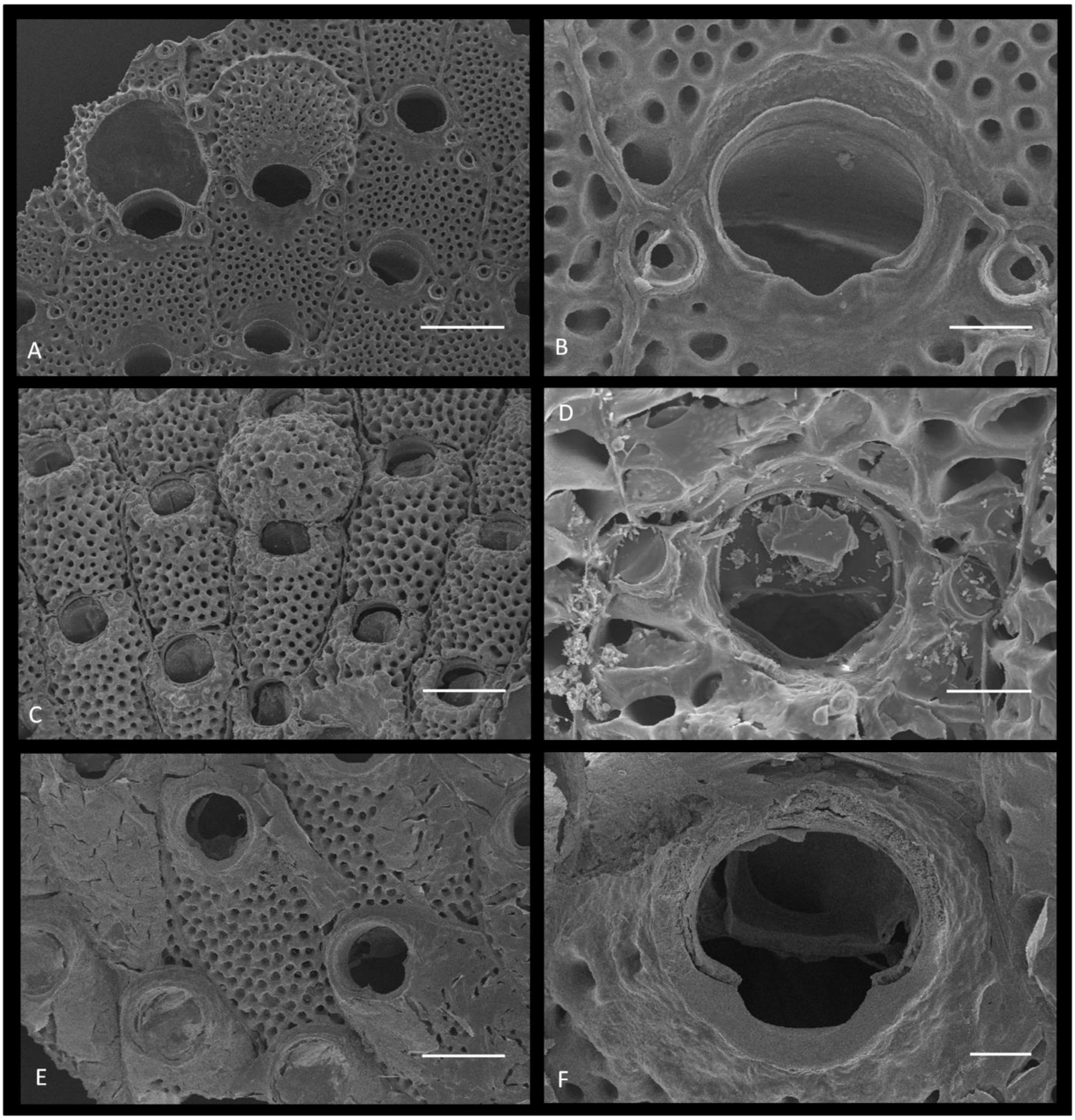

Plate 20. A-B. *Calyptotheca nivea*, SAMC-A028987. A. Ovicelled and non-ovicelled zooids (scale bar = 0.4 mm, magnified x50). B. Orifice (scale bar = 0.1 mm, magnified x200). C-D. *Calyptotheca porelliformis*. C. SAMC-A077246. Ovicelled and non-ovicelled zooids (scale bar = 0.4 mm, magnified x50). D. SAMC-A077196. Orifice (scale bar = 0.1 mm, magnified x200). E-F. *Watersipora subtorquata*, SAMC-A028979. E. Single clear zooid (scale bar = 0.4 mm, magnified x50). F. Orifice (scale bar = 0.1 mm, magnified x150).

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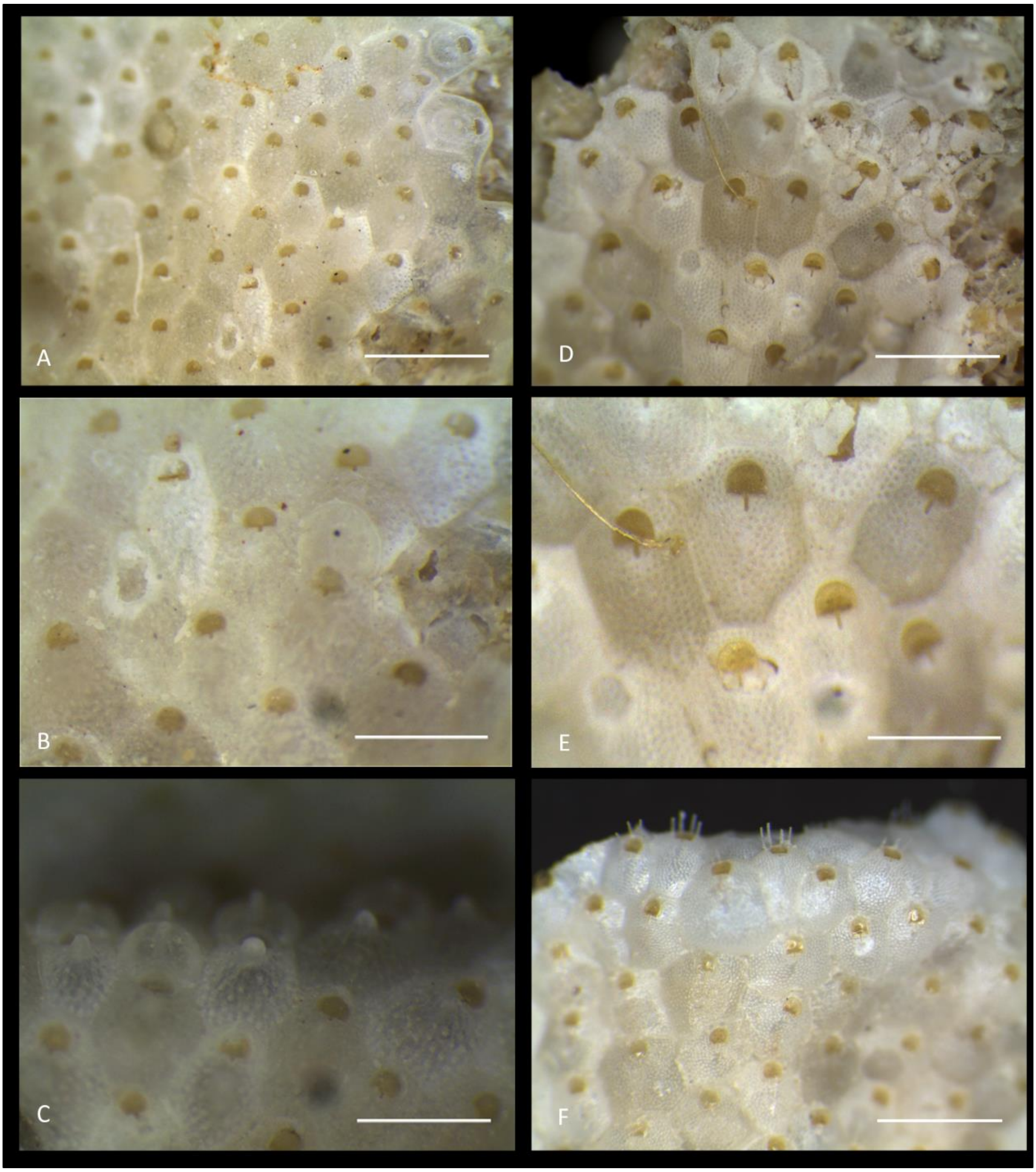

Plate 21. A-C. *Arthropoma cecilii*, SAMC- A077423. A. Zooids with ovicelled zooid (scale bar = 1 mm, magnified x25). B. Orifice and ovicelled zooid (scale bar = 0.5 mm, magnified x50). C. Umbo (scale bar = 0.5 mm, magnified x50). D-F. *Rogicka lioneli*. D. SAMC-A077226. Zooids (scale bar = 1 mm, magnified x25). E. Orifice and avicularium (scale bar = 0.5 mm, magnified x50). F. SAMC-A077341. Distal oral spines (scale bar = 1 mm, magnified x25).

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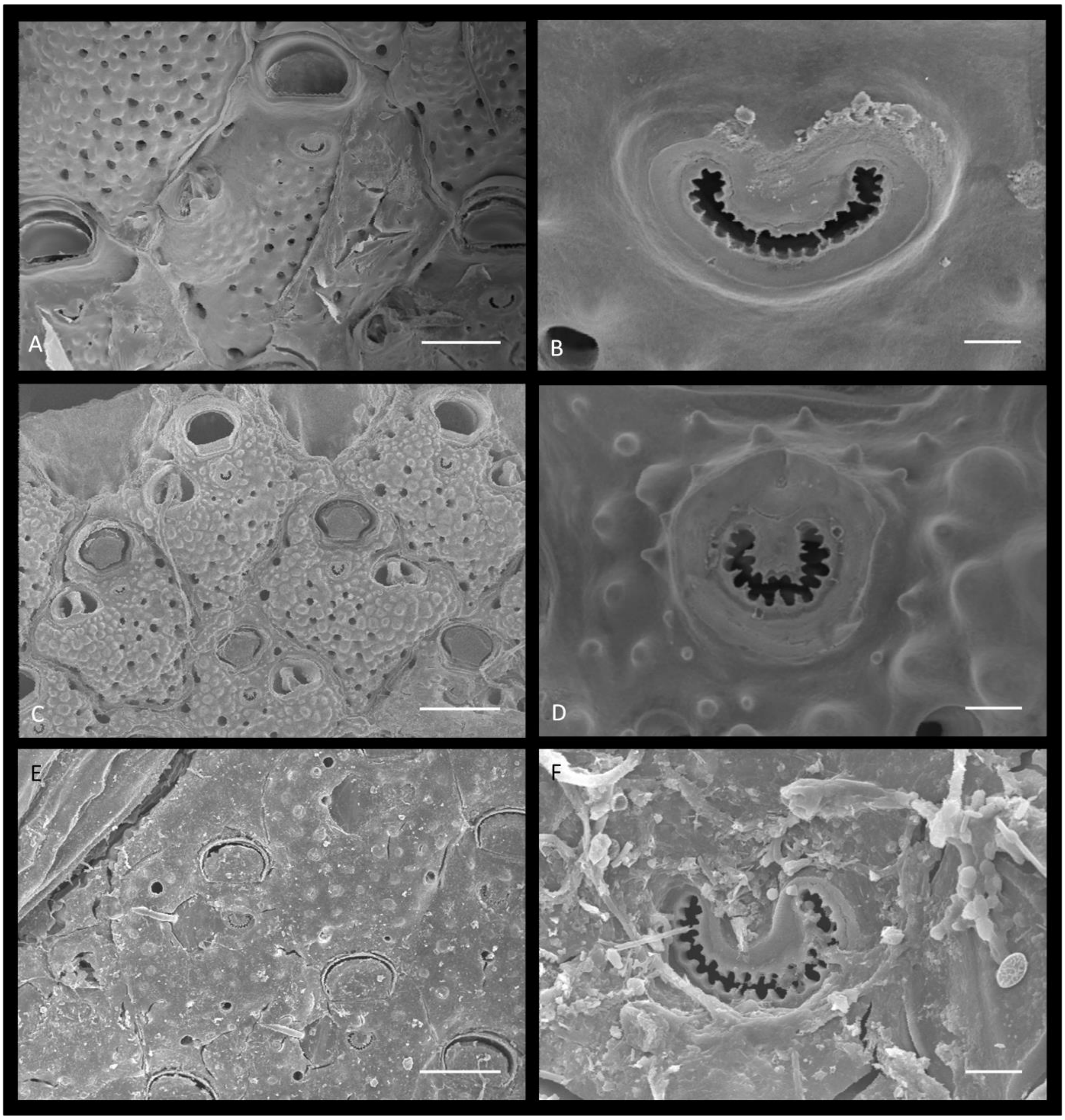

Plate 22. A-B. *Flustramorpha angusta*, SAMC-A028961. A. Single zooid (scale bar = 0.2 mm, magnified x100). B. Ascopore (scale bar = 0.02 mm, magnified x750). C-D. *Flustramorpha marginata*, SAMC-A029049. C. Few zooids (scale bar = 0.2 mm, magnified x100). D. Ascopore (scale bar = 0.02 mm, magnified x750). E-F. *Flustramorpha flabellaris*, SAMC-A028885. E. Silt-covered zooids, but clear acute avicularia (scale bar = 0.2 mm, magnified x100). F. Ascopore (scale bar = 0.02 mm, magnified x750).

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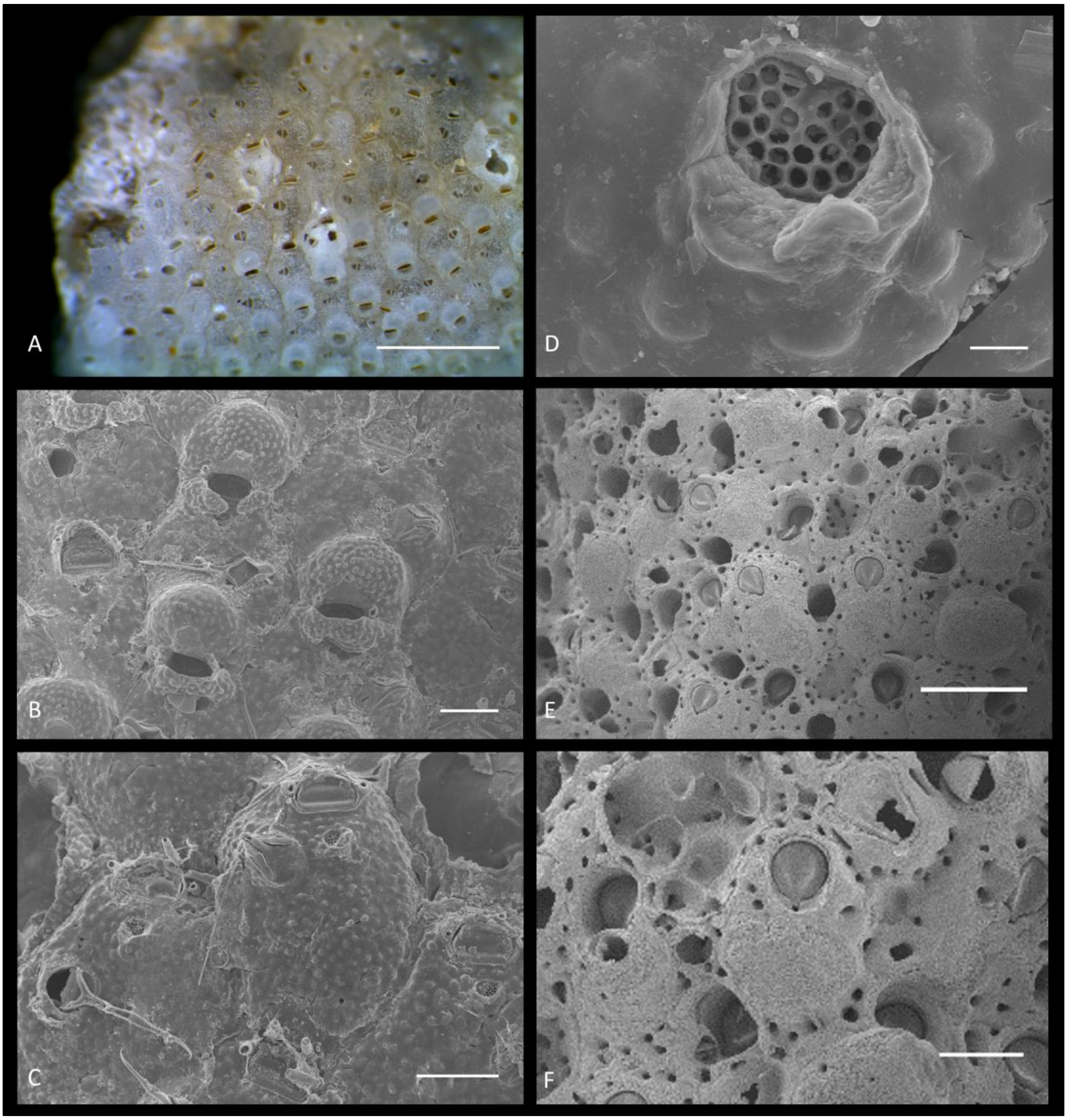

Plate 23. A-D. ***Microporella lezinyosi*** sp.nov., SAMC-A077687. A. Ovicelled and non-ovicelled zooids (scale bar = 1 mm, magnified x25). B. Ovicells with remaining paired spine bases and peristome arch (scale bar = 0.2 mm, magnified x75). C. Non-ovicelled zooids (scale bar = 0.2 mm, magnified x100). D. Reticulated ascopore (scale bar = 0.02 mm, magnified x750). E-F. *Turbicellepora valligera*, SAMC-A029098. E. Zooids (scale bar = 0.5 mm, magnified x50). F. Single older zooid (scale bar = 0.2 mm, magnified x100).

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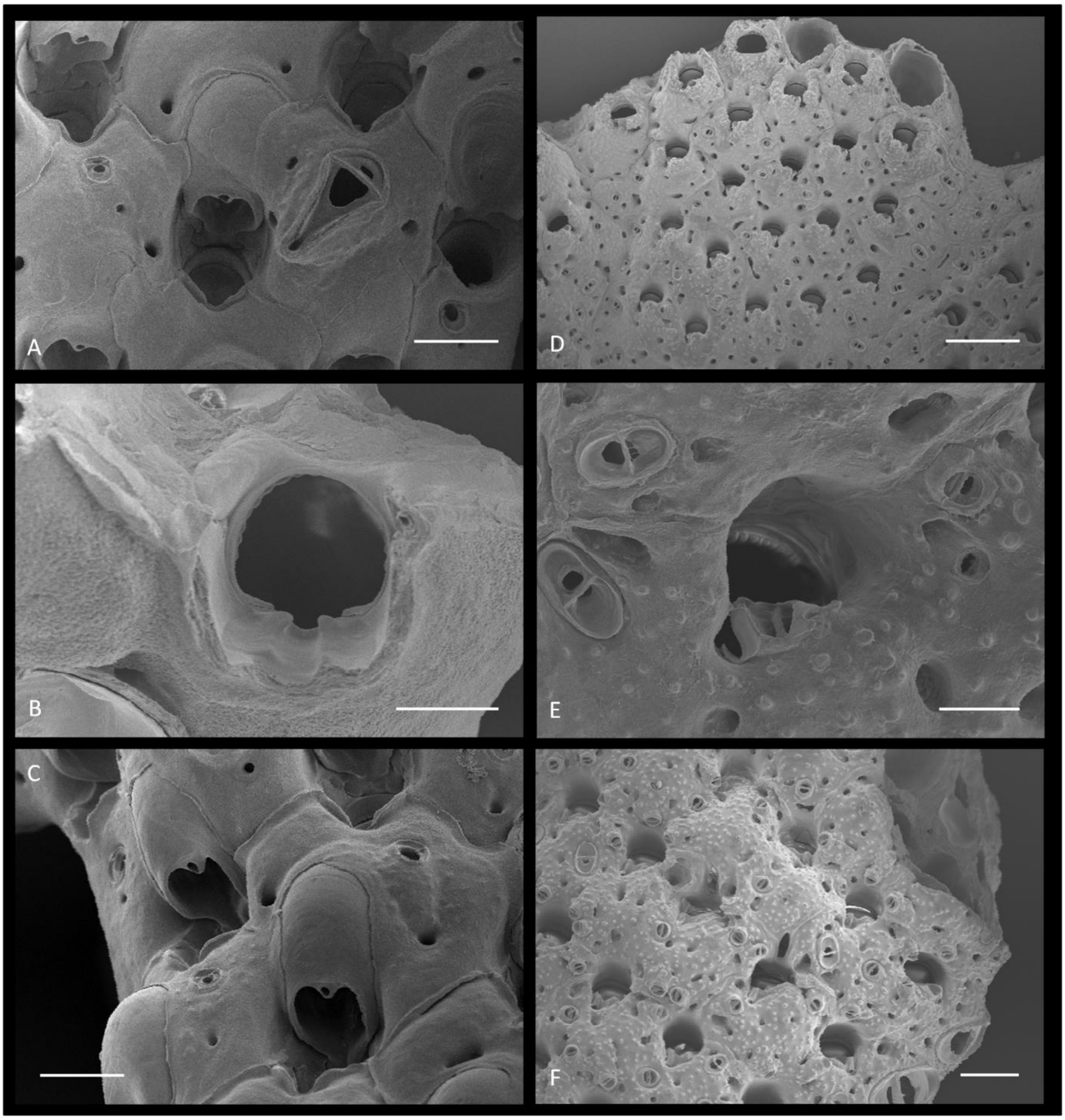

Plate 24. A-C. ***Phidolopora cyclops*** sp. nov., SAMC-A029097. A. Ovicelled zooids and two types of avicularia (scale bar = 0.1 mm, magnified x200). B. Young orifice with beaded rim and weak sinus (scale bar = 0.05 mm, magnified x500). C. Ovicells with median convexity and secondary calcification (scale bar = 0.1 mm, magnified x200). D-F. ***Reteporella ilala*** sp. nov., SAMC-A028986. D. Zooids at the growing edge (scale bar = 0.5 mm, magnified x35). E. Orifice with beaded rim and suboral avicularium forming a pseudosinus (scale bar = 0.1 mm, magnified x200). F. Ovicell immersed in secondary calcification and short labellum (scale bar = 0.2 mm, magnified x75).

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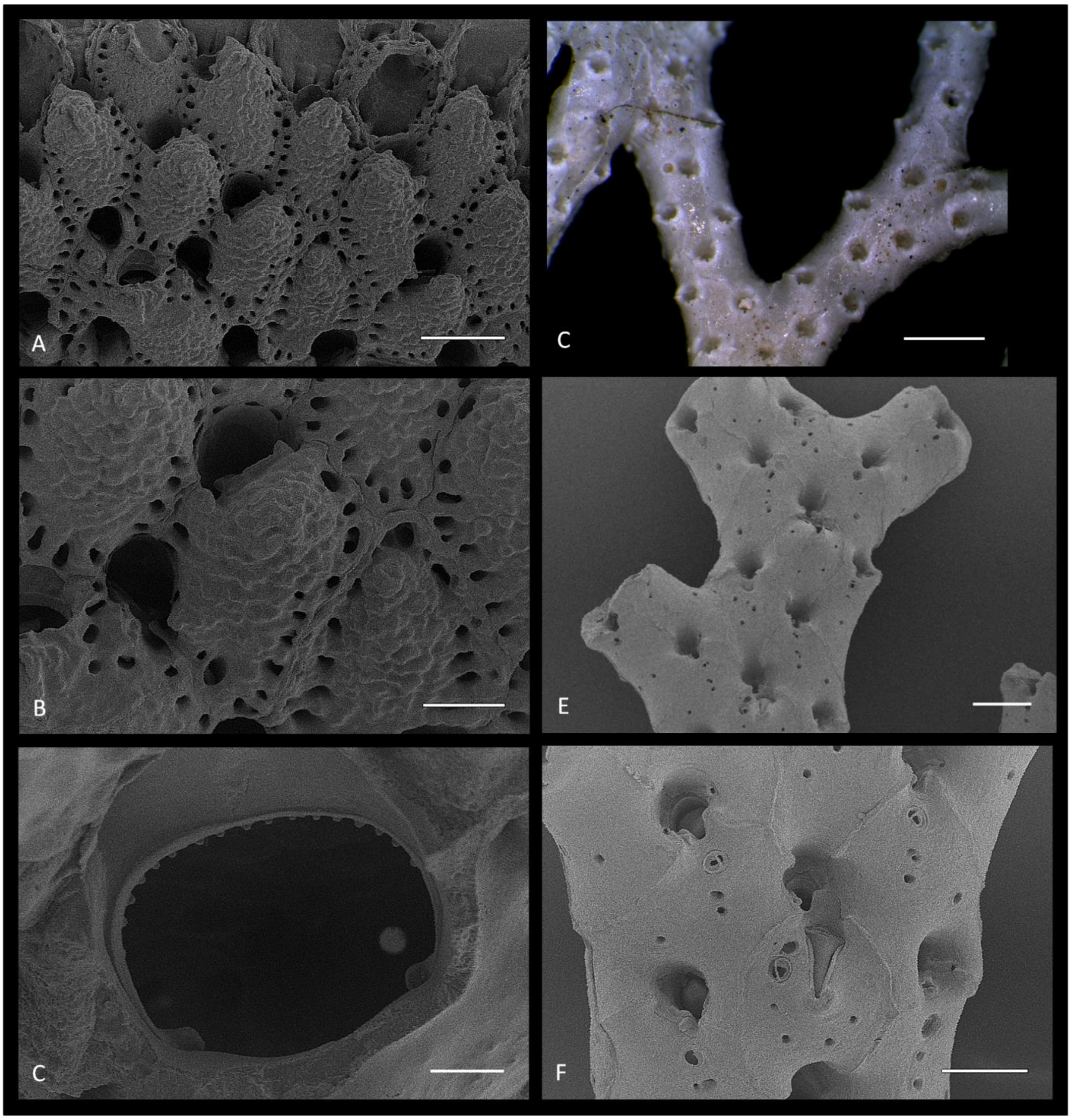

Plate 25. A-C. *Rhynchozoon documentum*, SAMC-A029053. A. Growing edge (scale bar = 0.4 mm, magnified x50). B. Single zooid (scale bar = 0.02 mm, magnified x100). C. Orifice with beaded rim (scale bar = 0.05 mm, magnified x350). D-F. *Triphyllozoon* sp. D. SAMC-A028793. Colony (scale bar = 1 mm, magnified x25). E. SAMC-A028905. Zooids (scale bar = 0.4 mm, magnified x35). F. Orifice and adventitious avicularia (scale bar = 0.2 mm, magnified x75).

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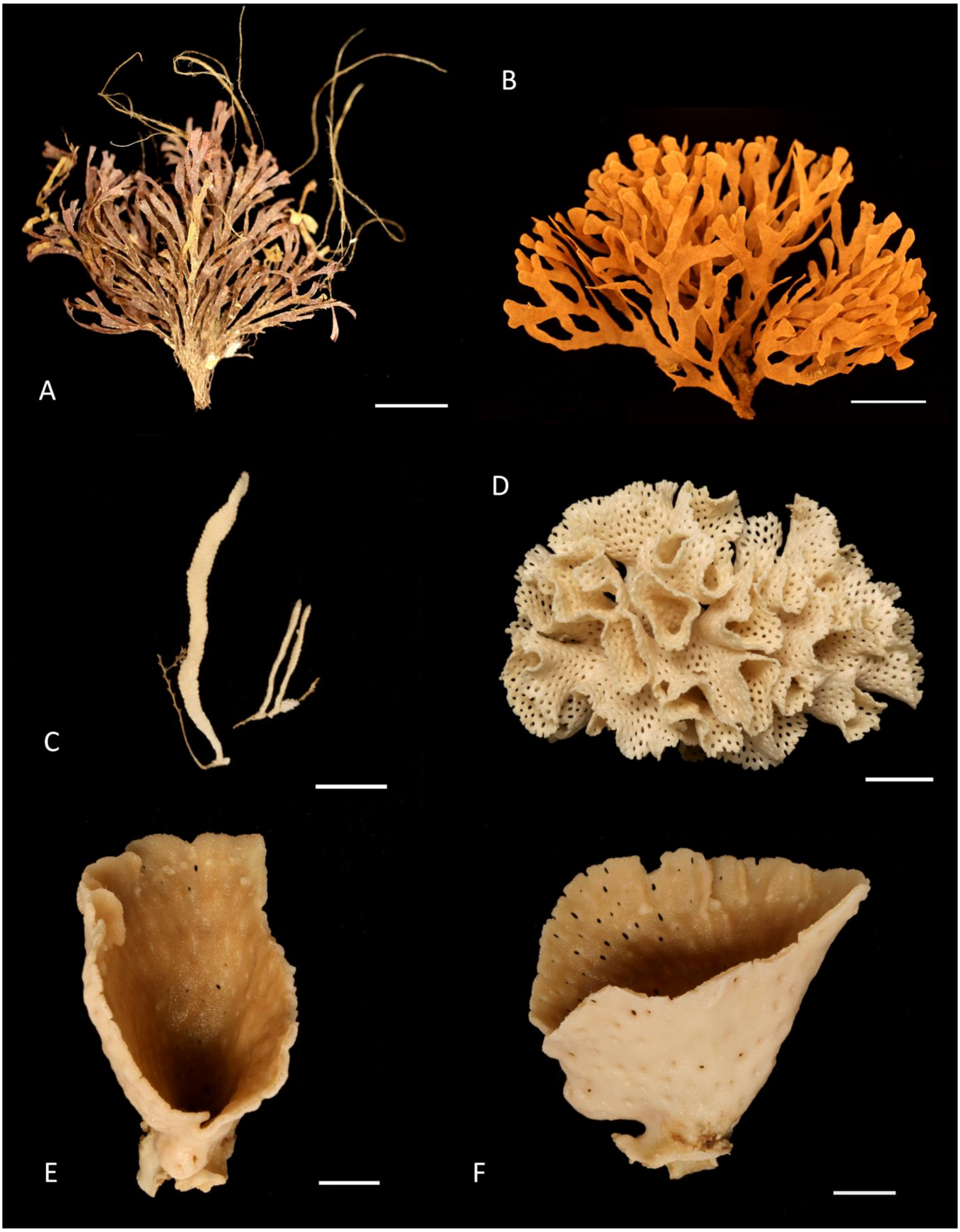

Plate 26. A. *Hoplitella armata*, SAMC-A028981 (scale bar = 40 mm). B. *Gregarinidra spinuligera,* SAMC-A028979 (scale bar = 40 mm). C. ***Adeonella assegai*** sp. nov., SAMC-A028960 (scale bar = 10 mm). D. *Reteporella lata*, SAMC-A029114 (scale bar = 10 mm). E-F. ***Reteporella ilala*** sp. nov., SAMC-A029168 (scale bar = 10 mm).

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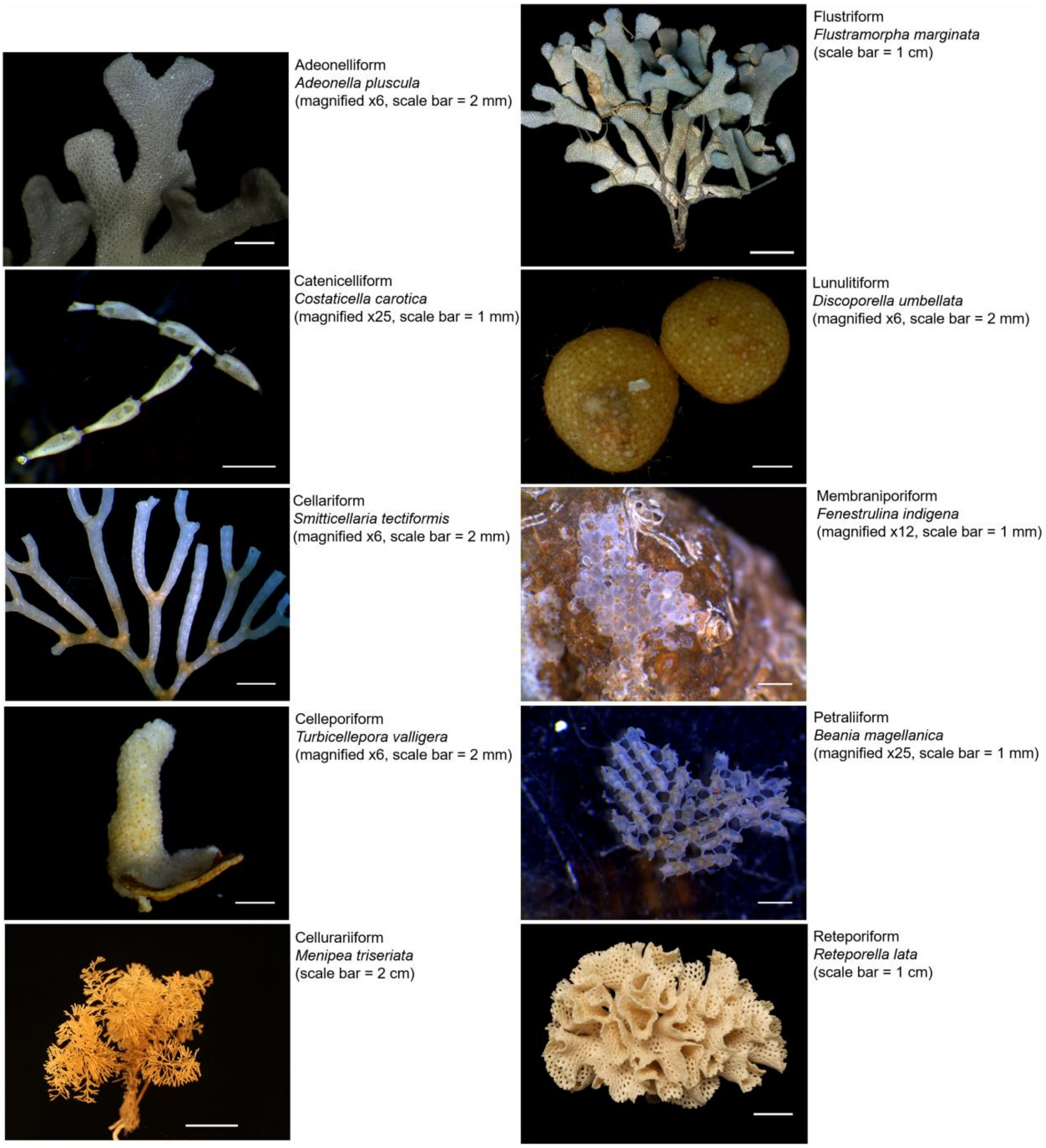

Adeonelliform
Adeonella pluscula
(magnified x6, scale bar = 2 mm)

Catenicelliform
Costaticella carotica
(magnified x25, scale bar = 1 mm)

Cellariform
Smitticellaria tectiformis
(magnified x6, scale bar = 2 mm)

Celleporiform
Turbicellepora valligera
(magnified x6, scale bar = 2 mm)

Cellurariiform
Menipea triseriata
(scale bar = 2 cm)

Flustriform
Flustramorpha marginata
(scale bar = 1 cm)

Lunulitiform
Discoporella umbellata
(magnified x6, scale bar = 2 mm)

Membraniporiform
Fenestrulina indigena
(magnified x12, scale bar = 1 mm)

Petraliiform
Beania magellanica
(magnified x25, scale bar = 1 mm)

Reteporiform
Reteporella lata
(scale bar = 1 cm)

Plate 27. Examples of 10 out of 17 morphotypes recognised in this study.

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