EOCENE BRYOZOA OF THE ST VINCENT BASIN, SOUTH AUSTRALIA – TAXONOMY, BIOGEOGRAPHY AND PALAEOENVIRONMENTS

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ABSTRACT

The first extensive and stratigraphically detailed taxonomic study of fossil bryozoans within the Late Eocene sediments of the St Vincent Basin has revealed a range of faunas from very high abundance and diversity to almost monotypic assemblages. Overall 177 species of Cheilostomes and 33 species of cyclostomes were positively identified, with an additional 35 and 30 unclassified taxa respectively.

Biogeographic comparisons show a mixture of temporal and spacial components. Approximately two thirds of the species are new, and therefore regarded as 'basin endemic'. The common Cellariidae are represented by 20 species, none of which can confidently be assigned to species of the equally diverse fauna of the Otway Basin Tertiary in Victoria. Seven new genera are also only known to occur in the St Vincent Basin. All the prviously described species are endemic to the Australian region. Many of the genera are equally restricted to Australia throughout the Tertiary to the Recent. This distinct endemism is typical of the isolated Australia in the Neogene. Minor links with other continents still exist as well. Shared taxa include *Reticrescis* (Eocene, Antarctica) and a potentially new genus of Romancheinidae (Eocene Eastern Europe and North America). Taxa considered to have originated in the Eocene, which rapidly dispersed throughout the world before the end of that Epoch, occur commonly, such as the Phidoloporidae (13 species in 6 genera) and the Smittinidae (19 species in 3 genera). This shows strong dipersal links still existed between all continents. The fauna has a distinct Cretaceous character, characterised by the abundance and diversity of erect Onychocellidae, which are generally rare after the earliest Palaeogene. Four species are tentatively assigned to species which still exist in Recent waters of the Australian region (*Rhamphosmittina lateralis*, *Hiantopora quadricornis*, *Melicerita angustiloba*., *Arachnopusia unicornis*). The implied time range is very long for bryozoan species. Nine genera have their oldest recorded occurrence here (*Antropora, Chaperiopsis, Hippoporina, Dactylostega, Foveolaria (Odontionella), Otionellina*, *Acerinucleus*, *Strophipora*, *Stenostomaria*). Wide dispersal of genera and families was probably facilitated by interconnected continental shelves and low latitudinal temperature gradients. Species level endemism is promoted by the short range of dispersal of most larvae.

Palaeoenvironmental analysis indicates that within the small geographic area and relatively short period of deposition in the Eocene, St. Vincent Basin saw a wide range of depositional facies. The initial transgressive marine facies on all margins saw the greatest diversity and abundance of bryozoans. These basal facies also contained most of the 'deep water' taxa and sand-fauna growth forms. This represents a well oxygenated and moderate energy environment. Higher sea levels probably flooded the Kangaroo Island basement high to allow sufficient open ocean access. The very different overlying assemblages indicate a more restricted environment, which represents a shallowing, with the Kangaroo Island High restricting open ocean access. The embayments on the eastern margin became very silica and organic carbon rich, with a low diversity and low abundance bryozoan fauna. Occasional fossiliferous beds dominated by *Celleporaria* and a few other erect ascophorans represent a brief reprive allowing a few opportunists to flourish, but too short for any others. Bryozoa are essentially absent on the western margin, with only a few rooted forms occuring in the siliciclastic sediments of the Rogue Formation. This margin was dominated by rivers and the resulting high sedimentation rate and low salinity inhibited bryozoan colonisation. The shallow sediments of the Lower Kingscote Limestone on the southern margin are dominated by infaunal echinoids, and bryozoans are occasionally sub-dominant. This was probably a shallow passage through a chain of 'Kangaroo Islands'.

Declaration

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

I give consent for this copy of my thesis, when deposited in the University Library, being available for loan and photocopying.

Signed:

Date: 10/7/2003

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"Uproot your questions from the ground and their dangling roots will be seen. More questions!"

F. Herbert (1985) *Chapter House Dune* (New English library Books)

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Also eternal thanks to Museum Victoria for supporting my efforts to finish this monster, while giving me the opportunity to work with fossils and get paid for it!

My contact address at time of submission is: Museum Victoria; PO Box 666E
Melbourne, Vic 3001, Australia

Dedication

To my best friend

To my soulmate

To my wife

To Charni.

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PREFACE

Rationale

Bryozoans have not received the same detailed taxonomic and biological studies that other phyla have, despite their almost ubiquitous presence in most marine environments, both ancient and present. They have only received significant attention in Europe and North America. Australian Bryozoa have been studied by a series of prominent researchers, although these studies have been of limited geographic extent and, in the case of the fossil faunas, of low stratigraphic resolution. Bryozoan limestones are one of the most common and extensive sediments in the Cainozoic rock record of Australia. Understanding these rock-forming animals is therefore of interest to both geologists and (palaeo)biologists. The current lack of taxonomic lists of species makes proposed biogeographic scenarios within Australia specultative at the best. Bryozoans have long been recognised to have potential as palaeoenvironmental indicators, but for them to be reliable and useful in various circumstances, more work is needed. This study encompasses both normal and unusual facies. Thus it both tests and expands our current understanding of the role of bryozoans as palaeoenvironmental indicators. The impetus for this research was therefore to extend our knowledge of the earliest Cainozoic bryozoan fossil record within Australia. Inferences regarding the biogeography will still be specultative in this work, but it will help place future research on more solid foundations.

Specific Aims

The principle aim of this research is to establish a taxonomically, geographically and stratigraphically comprehensive and accurate inventory of the bryozoan species present within the Eocene St Vincent Basin. These taxa are compared with existing knowledge of fossil and recent faunas in Australia and other regions to enhance understanding of bryozoan evolution and dispersal. Bryozoan taxa and growth forms are used for the first time to interpret the palaeoenvironments of the Eocene St Vincent Basin.

Structure of thesis

The geology introduction briefly gives the global and regional physical scenario in which this research is set. A brief introduction is also given to the biology, life histories, evolution and taxonomy of Bryozoa. More detailed relevant information is given in the Biogeography and Palaeoenvironment chapters. Only aspects of importance to later discussions are described in detail. Often only the references are given where good discussions and summaries are given elsewhere.

The sytematic palaeontology chapter is placed ahead of the Biogeography and Palaeoenvironment chapters as it summarises all the detailed information about each taxon. Each species is described in detail as observed in the samples collected by the author. The assigned genera and families are often also described to indicate the reasons for the classification. The comparisons section below each taxon includes a discussion about possibly related taxa and how it differs from these taxa. The remarks section gives additional discussions such as biogeographical and ecological aspects.

The biogeography and palaeoenvironment chapters summarise and discuss the relationships observed and places them in a broader context.

Chapter 1: Introduction

"... there cannot be a more entertaining employment and amusement than to inspect the innumerable varieties of form which a small fragment of rock contains within itself – to trace out the perfect remains of these tiny organisations, and to reflect that Time, which has crumbled the bones of mighty kings, and torn down cities, has spared these atoms, the date of whose existence is so remote, that 'the twilight of fable' is but as yesterday in comparison."

Reverend Julian E. Tenison Woods (1862) *Geological observations in South Australia: principally in the district south-east of Adelaide* (Longman, Green, Longman, Roberts & Green; London)

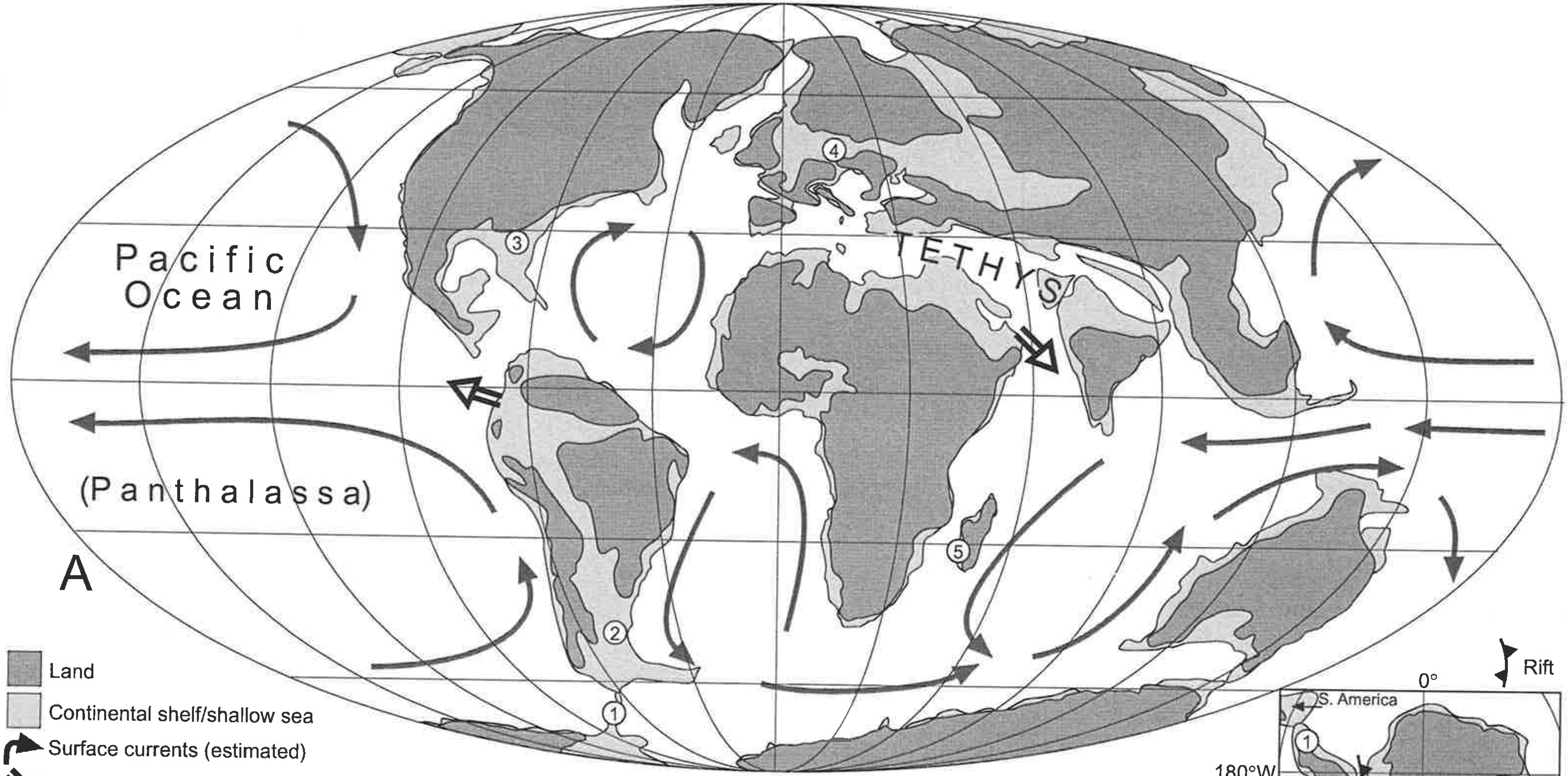
Part 1: Geology and Environments

1.1. Eocene Environments and Geological Evolution

One must bear in mind when inspecting the fossils of this study, that during the Eocene the continental arrangements, oceanic circulation patterns and global climate were still more reminiscent of the later Mesozoic than of modern conditions. It was not until the end of the Eocene that Gondwana finally fragmented completely and a more modern world began emerging.

The continental extension and rifting between Australia and Antarctica began in the Jurassic and created the Australian Southern Rift System (Veevers, 2000). Subsequently, the southern basins developed and started accumulating a succession of synrift and postrift sediment fills. The continent ocean boundary developed in the Cenomanian (~96 Ma). Spreading remained slow at less than 1 cm per year until the early Middle Eocene. Spreading then accelerated from the late Middle Eocene to the current 3 cm per year (Cande & Mutter, 1982; Veevers, 2000). Many of the basins along the western and southern Australian margin flooded because sea levels were relatively high in the Palaeogene (Figs 1 & 2). They all contain a succession of fluvial to deltaic to estuarine to open marine carbonate sediments, which implies a relative sea level low followed by a transgression. These sedimentary successions generally initiate progressively later towards the east, following the tectonically separating Australian/Antarctic margins. Most sediments are bryomol (Bryozoa and Mollusca dominated) facies, typical of cool water shelf environments (James *et al.*, 2001). Most Australian and New Zealand carbonate sequences are thought to have accumulated at rates of 1 – 3 cm per 1000 years (James & Bone, 1991), which correlates well with carbonate production rates obtained from modern analogues (Smith & Nelson, 1994: 232).

Ocean current systems were still very different to those operating today until the terminal Eocene due to the continental configurations (in particular in the southern hemisphere; Fig. 1). Australia and East Antarctica were still connected via Tasmania, forming a 'Great Southern Gulf' off the southern Australian margin (Fig. 2). The mouth of this gulf was to the west, and only shallow currents were able to flow across the submerged shelf to the west. This configuration, together with the ongoing join between



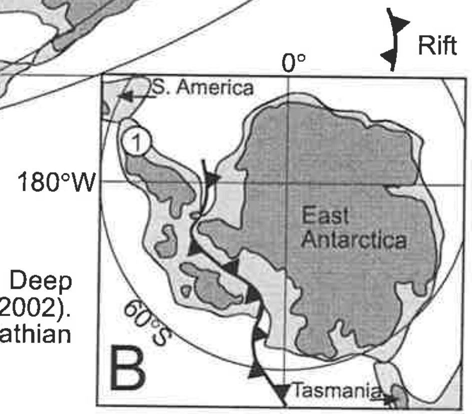


Figure 1: **A**, Continental configurations and estimated currents in the Eocene. The currents indicated are mainly surface currents. Deep water halothermal currents originating in low latitude regions such as Tethys often flow in different directions (modified from Veevers, 2002). Numbers undicate other Eocene localities discussed in text: (1) Seymour Island, (2) Argentinia, (3) Virginia, USA, (4) Alpine-Carpathian region, (5) Madagaskar. **B**, Antarctica in the Eocene, showing West Antarctic Rif System (modified from Dalziel & Taylor, 2001).

South America and West Antarctica, inhibited the development of an Antarctic Circumpolar Current (ACC). Halothermal circulation (Proteus) thus predominated in Mesozoic to Eocene times, driven by the evaporative production of warm and dense saline water at low (Tethyan) latitudes, which sank to produce deep-ocean currents (Kennett & Stott, 1990). This had the potential to transport large amounts of heat via deep-water currents to high latitudes, as major circulation patterns were probably north–south (Fig. 1). The 'Proteus' circulation system also meant that no upwelling in the modern sense (cold water rich in nutrients) existed prior to the Oligocene (D.B. Lazarus, pers. comm., 2002). The drop in temperatures at the Eocene/Oligocene boundary was largely caused by the initiation of a proto-ACC when Australia and East Antarctica fully separated. This deep water current probably only encircled East Antarctica, passing through the deep rifts south of Tasmania and West Antarctica respectively, and resulting in the isolation of East Antarctica and the subsequent growth of the icecaps. Initially, the climate remained temperate rather than polar, even when large parts of Antarctica were covered in ice during a transitional period in the Oligocene (Ehrmann & Mackensen, 1992). Deep-water circulation became fully driven by thermohaline circulation (Oceanus), through the formation of cold, dense polar waters in the ice-cap dominated Neogene, following the final separation of Southa America and West Antarctica (Kennett & Stott, 1990). Major circulation patterns were more east–west directed and thus gave rise to higher latitudinal temperature gradients.

A further important factor in the Australian environment is the Leeuwin Current (Fig. 2). This current is operative when the South Equatorial Current (a low salinity surface current of the global thermohaline system) flows past the islands to the north of Australia from east to west, with a small volume siphoned off to the south through the Indonesian Gateway due to counter-gyral deflection (McGowran *et al.*, 1997). Its presence is not constant, however, and its early history is somewhat enigmatic. The Leeuwin Current is at its strongest during warm times, when it flows along western Australia to the southern margin. Its influence can extend as far east as the Otway Basin during these times, bringing with it tropical faunas. The Subtropical Convergence shifts north during cooling events and shuts off this current by "closing the gateway" (McGowran *et al.*, 1997). The Leeuwin Current has been episodically active at least since the Australia/Indonesian Arc collision at approximately 25 Ma in the Late Oligocene. This event also caused the development of the Equatorial Counter Current. It is postulated that a 'Proto-Leeuwin Current' was already active in the Eocene (McGowran, 1993; McGowran et al., 1997), despite the dramatically different global and regional current regimes. This is based on the observation that large tropical foraminifera occur as far south as the Madagascar Ridge (40°S) and New Zealand. Surprisingly, however, there are none in Western Australia (e.g. Carnarvon Basin at 45°S) in the Lower Eocene. These Foraminifera occur simultaneously along the southern margin as far east as the Otway Basin by the upper Middle Eocene (Tortachilla Transgression) (McGowran *et al.*, 1997). This 'proto-current' is indicated as originating in the Indian Ocean (and Tethys?) rather than in the Indo-Pacific warm pool north of Australia as it does today. McNamara (1999) also invoked proto-Leeuwin Current activity in the Palaeocene-Eocene to explain the diachronous distribution of echinoids (e.g. *Monostychia*) occurring first in the Eocene Carnarvon Basin, but not until the Miocene in the Eucla Basin. Species of *Monostychia*, however, occur commonly in the Eocene Tortachilla and Kingscote Limestones (F.A. Holmes, pers. comm., 2003), which negates this observation. This apparent 'homogenisation' effect ceased by the Early Miocene, by which time northwestern and southeastern Australia developed disparate echinoid faunas. This change is explained

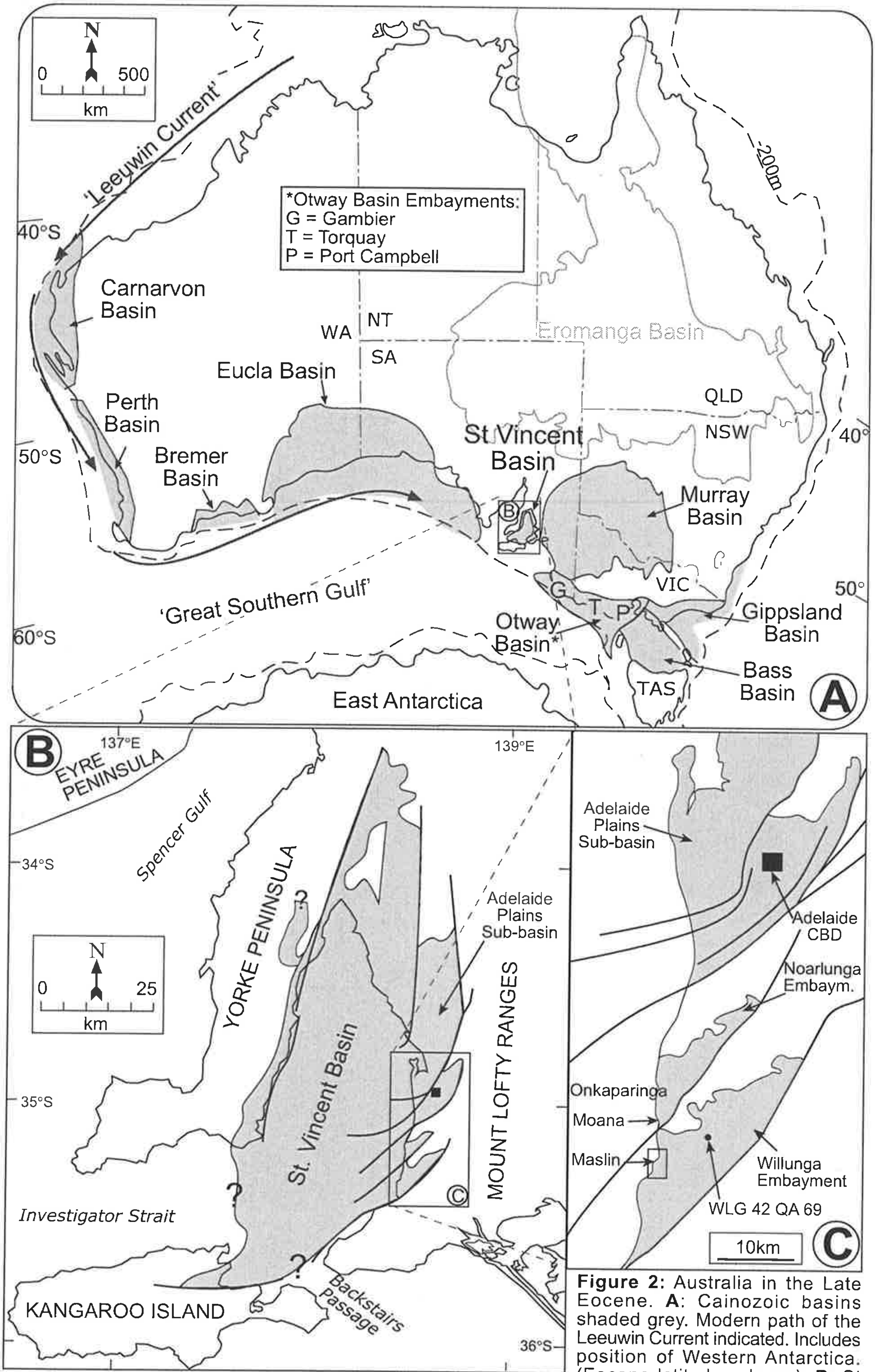


Figure 2: Australia in the Late Eocene. **A**: Cainozoic basins shaded grey. Modern path of the Leeuwin Current indicated. Includes position of Western Antarctica. (Eocene latitudes shown). **B**: St Vincent Basin showing major faults (modern latitudes and longitudes shown; '?' indicate uncertain basin margins). **C**: Eastern basin margin embayments, showing main localities and location of MESA drill core WLG 42 QA 69 (Box around Maslins indicates area of map in Fig. 4C).

by the newly developed ACC blocking the proto-Leeuwin Current and isolating the two regions. The Leeuwin Current is considered to have followed the same path as it does today since the Pliocene. The understanding of such current patterns is crucial in the context of interpreting palaeobiogeographic patterns. Such apparent 'diachroneity' in the appearance of taxa in the Palaeogene may also be an artefact of the diachronous onset of extensive cool water carbonate accumulation, which occurred progressively from west to east along the Australian continental margin as it gradually separated from Antarctica (see Fig. 3).

The Eocene represented the last stages of a truly greenhouse state earth, before the 'descent' into the icehouse (with a short reprise in the Late Miocene). The Early Eocene was probably the warmest time of the Cainozoic era, with the possible exception of the Middle Miocene Climatic Optimum. Deep-ocean $\delta^{18}O$ temperature indicators and global sea levels point to an overall decline in global temperatures from Early Eocene to the present. This trend was interrupted by three significant warm periods, each of which was terminated by a so-called 'Chill' or rapid cooling event. The Middle to Late Eocene was one such reversal, termed the Khirthar Restoration (McGowran *et al.*, 1997). During this major warming episode, the 20°C isotherm appears to have shifted from approximately the equator (due to 'Chill 1') to at least 45°S in the Late Eocene (Frakes *et al.*, 1987). The 20°C isotherm shifted back to ~5°S in earliest Oligocene. This 'Chill 2' is considered to be the biggest oceanic change in the Cainozoic, although all the causes are still not clear (Prothero & Berggren, 1992; Prothero, 1994a, b).

There is evidence for Antarctic ice sheets by the Middle to Late Eocene in the form of $\delta^{18}O$ shifts, ice rafting and an increase in the rates of physical weathering (Ehrmann & Mackensen, 1992). The global climate was still warm enough, however, that the southern Australian climate was mesothermal (subtropical) with extensive rainforests (Scriven, 1993), although the region was positioned at 55°S (i.e. 20° latitude further south than today; McGowran *et al.*, 1997). The palaeobotanical record indicates that southern Australia had warm, humid, extensive rainforests beyond 60° palaeolatitude (Kemp, 1978). The flora in the southeast during the Paleocene consisted mainly of conifer-dominated wet forests. It was dominated by non-seasonal angiosperm rainforests by the Early Eocene. This implies a megathermal coastal environment (>24°C mean air temperature, corresponding to tropical) and mesothermal inland (>14°C mean air temperature, corresponding to sub-tropical to temperate), with high rainfall and insolation in both cases. The flora also included a species of the Araucariaceaen conifer *Agathis*, which was similar to one found today in North Queensland (Ludbrook *in* Cochrane, 1956). The associated freshwater runoff into the Eocene Basins was significantly higher than it is in today's arid climate (James & Bone, 2000).

Much of the earlier Palaeogene was a period of extensive regional silica weathering and silcrete formation in the region from what is now the Mt Lofty Ranges to the Nullarbor Plain and northwards to Coober Pedy. This was a consequence of a high water table and precipitation (in today's arid climate ferricrete forms where subsurface rocks are siliceous, whereas calcrete forms where it is calcareous; no extensive carbonates were yet present in the early Palaeogene). Large quantities of silica were probably released into the water runoff as a result (Gammon *et al.*, 2000). This may be a significant source for the opaline silica and common syndepositional silicification in many of the early Cainozoic sediments around Southern Australia.

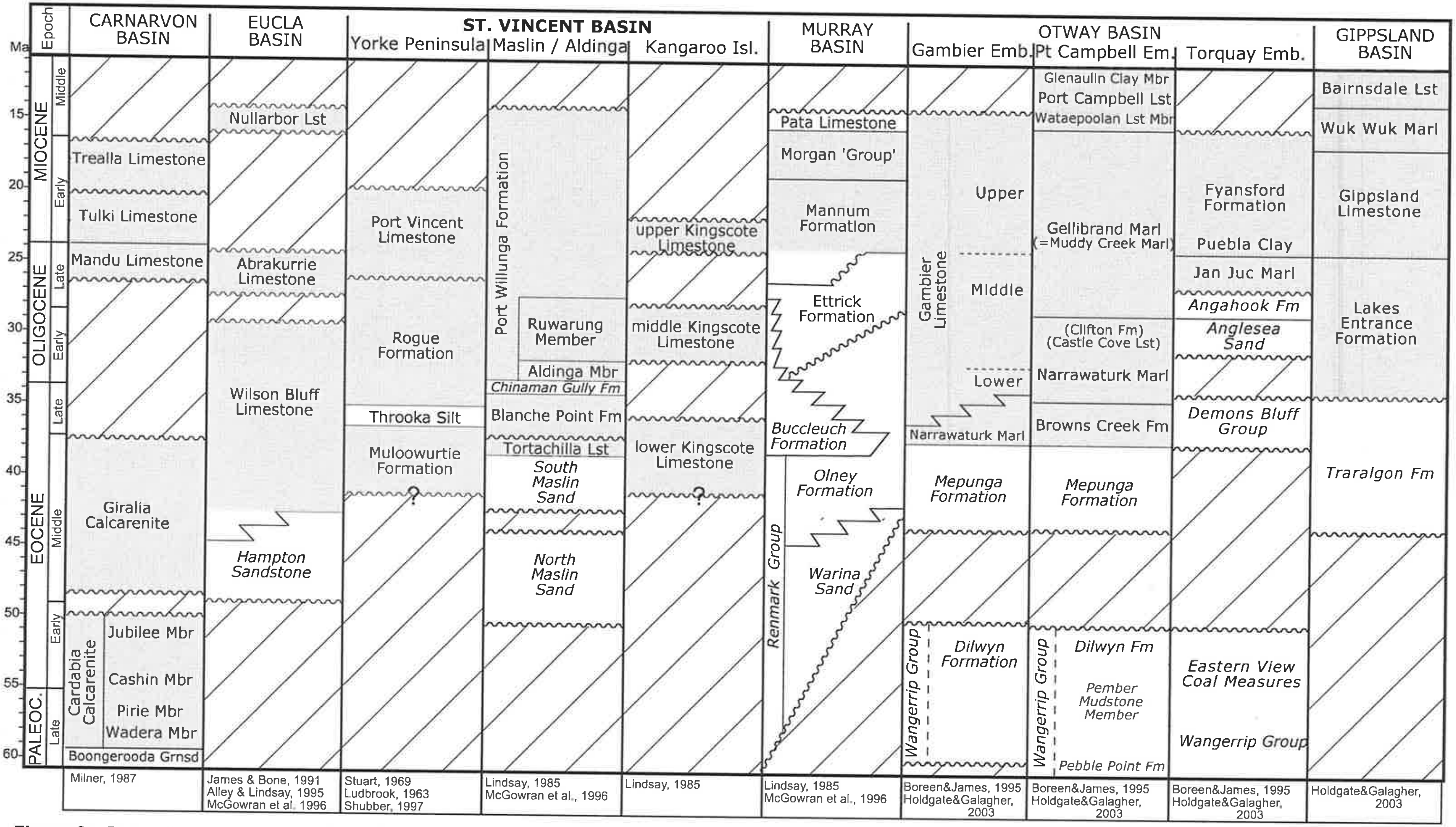


Figure 3: Generalised Cainozoic stratigraphy and correlation of basins in southern and western Australia. Grey shading indicates marine sediments containing bryozoans; names in italics indicate non-marine formations (Sources indicated under each column).

Additionally, the Eocene is considered to represent the peak in taxonomic diversification for many groups of organisms since the Cretaceous/Palaeogene boundary event (Sepkoski, 1998). These climatic, geographic and biotic characteristics significantly affected the bryozoan fauna. It is still a matter of debate which factors were causes and which effects (or both).

1.2. St Vincent Basin Geology

The St Vincent Basin covers an area of 250 km north–south by 100 km east–west, with a total area of ~15,000 km^2 (Fig. 2B). This makes it one of the smallest Australian Cainozoic marine basins. The modern Gulf St Vincent covers about 60% of the basin. It overlies the Cambrian Stansbury and Permian Troubridge Basins. It is a largely Cainozoic structure, formed when the initially extensional stress regime of the Australian plate changed to a compressional stress regime after the collision of India and Asia in the Middle Eocene. The structural depression of the St Vincent Basin closely resembles that of a shallow foreland basin (Flöttmann & Cockshell, 1996). The Murray Basin on the opposite side of the Mt. Lofty Ranges formed in a similar fashion, but it is larger (i.e. it has a longer wave-length) because of a higher heat flow. Middle to Late Eocene uplift of the ancestral Mt Lofty Ranges occurred with down-faulting adjacent to the ranges.

The eastern margin of the basin is bordered by the Adelaide fold-thrust belt. Reactivation of major arcuate faults inherited from the Early Palaeozoic Delamerian Orogeny resulted in half-grabens, which are tilted to the south east (Twidale, 1976; Bourman & Lindsay, 1989). Tokarev *et al.* (1998) however, suggest that these bounding faults bear little relationship to the Palaeozoic structures. The deformation produced several embayments during the Cainozoic, namely the Willunga, Noarlunga and Golden Grove Embayments as well as the Adelaide Plains Sub-basin. Significant deformation of Cainozoic sediments towards the normal fault scarps lying to the south of each fault block is common (Howchin, 1911). Further tilting of 2° to 5° towards the south during the Miocene Basin inversion has also occurred.

The western margin is bordered by the tectonically relatively inactive Gawler Craton. North–south trending faults running along the east coast of Yorke Peninsula possibly produced a relatively steep palaeotopography. The Pirie Basin (equivalent with the modern Spencer Gulf) to the west did not exist in the Palaeogene (Alley & Lindsay, 1995), and the extensive hinterland may have gathered significant amounts of surface run-off and flushed it into the western basin area.

The southern margin is formed by the granitic basement high centred on Kangaroo Island. This probably remained elevated as a barrier island chain throughout the Cainozoic (James & Bone, 2000).

The main marine entrances to the open ocean during the Eocene are unclear. Both the Investigator Straight and Backstairs Passage contain almost no Palaeogene sediments. They are today shallow (locally <30 m) and were probably episodically emergent in the past (James & Bone, 2000). Sediments in the Kingscote-Cygnet Embayment between western Kangaroo Island and Dudley Peninsula, however, suggest the location of a marine straight there (Cooper & Lindsay, 1978). A possible connection across northern Yorke Peninsula to the Pirie Basin did not exist until the later Cainozoic (Alley & Lindsay, 1995). All these passages were probably relatively shallow and occasionally emergent, frequently resulting in a restricted basin setting (James & Bone, 2000). Circulation patterns are uncertain, but may have been largely clock-wise within the basin (James & Bone, 2000), and would have had a significant influence upon the distribution of environmental factors, sedimentary facies and faunal assemblages.

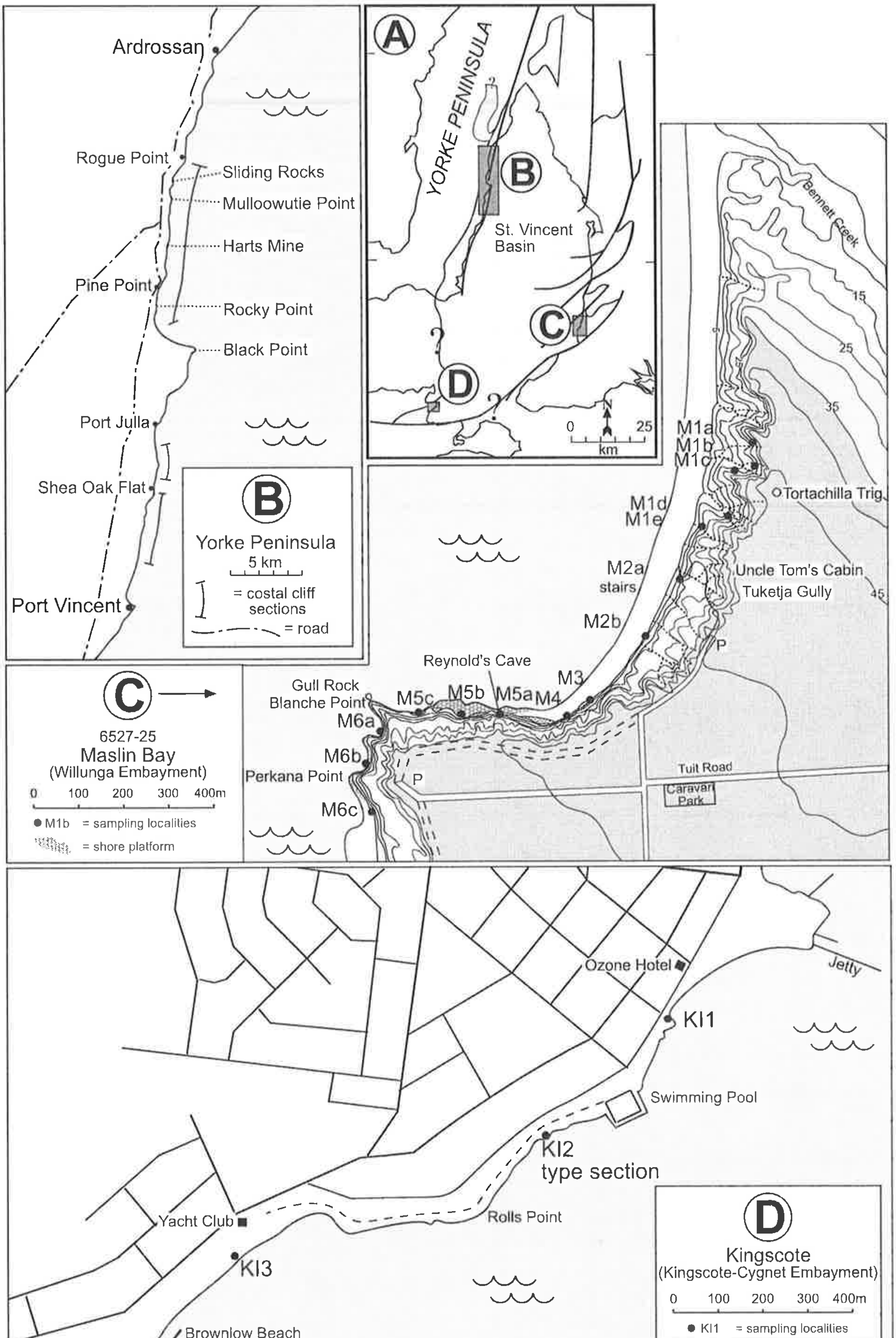


Figure 4: Sampling localities. **A**: St Vincent Basin showing locations of enlarged maps. **B**: East coast of Yorke Peninsula; coastal outcrops of Eocene sediments indicated by I———I with main reference points indicated. **C**: Maslin Beach: Main sampling composite sections indicated by M1 to M6. **D**: Kingscote, Kangaroo Island; : Main sampling composite sections indicated by KI1 to KI3. (note: only C shows elevation contours as scale in B is too large and elevations in D are less than 5 m).

The modern St Vincent Gulf is generally shallower than 40 m at its deepest part. Global Eocene sea levels are often estimated at up to 200 m higher than Present (Haq *et al.*, 1987), but this value is likely to be significantly affected by local effects in the basins upon which the curve is based. Local effects (e.g. the still thermally uplifted southern margin from the recent Australia-Antarctic rifting event) probably enabled only a slightly deeper basin during Eocene times.

1.2.1. St Vincent Basin Sediments and Stratigraphy

The Cainozoic sediments unconformably overlie the deeply weathered Proterozoic and Cambrian sediments of the Adelaide Geosyncline and in places unconsolidated Permian glacial tills. Middle to Upper Eocene sediments within the St Vincent Basin mainly outcrop along the coastal cliffs around the Gulf St. Vincent. Boreholes, especially along the eastern margin, also commonly intersect Eocene sediments at relatively shallow depths. The basin differs from most other basins due to the presence of a basement-high centred on Kangaroo Island along its southern margin. This restricted access to the open ocean created a variety of unusual environments (James & Bone, 2000). Similarly restricted basins do, however, occur occasionally throughout geological history. The larger Murray Basin was restricted during the Cainozoic by the Padthaway Ridge, a chain of granite 'islands' along its south western margin. On an even larger scale, the Mesozoic Eromanga Basin to the north was very shallow and restricted at its northern opening by a structural ridge. This still persists in the smaller modern equivalent, the Gulf of Carpentaria (D. Haig, pers. comm., 2002).

The sediments differ significantly between the eastern, western and southern margins, and are therefore described separately below (see also Fig. 3).

1.2.2. Eastern Basin Margin

The Cainozoic sequence on the eastern margin of the St. Vincent Basin was first investigated in detail by Tate (1878) and Tate & Dennant (1896). The stratigraphic nomenclature of the sequence was, however, first properly defined by Reynolds (1953). His nomenclature has essentially remained, with only a few refinements (Jenkins *et al.*, 1982). Cores indicate that the depositional environments within each embayment varied. Sediments tend to become more marginal marine and less calcareous further inland. Inland outcrops are generally of poor quality and uncertain stratigraphy.

1.2.2.1. North Maslin Sand

The basal North Maslin Sand is Middle Eocene in age and consists of coarse quartz sands with common clay lenses, which often contain well-preserved plant remains. It represents a meandering fluvial to deltaic environment (Dyson, 1998). The lignitic deposits of the Clinton Formation in the northern areas of the basin are equivalent sediments. The sands are less than 30 m thick near the coast, but both units probably continued being deposited along the basin margin as marginal equivalents of the later marine deposits.

1.2.2.2. South Maslin Sand

A disconformity, thought to represent a tidal ravinement surface after a minor regression (Dyson, 1998), is followed by the overlying up to 40 m thick South Maslin Sand. It consists of cross-bedded coarse, limonitic quartz sands with common goethite pellets (hydrated iron oxides, possibly originating from previous laterite surfaces, but possibly also replacing faecal pellets or glauconite). It was deposited in an estuarine environment. It contains rare body fossils, consisting mainly of shark teeth (Pledge, 1967) and planktonic foraminifera (Lindsay, 1981). Sponge spicules, echinoid spines, bryozoans and molluscs are rare, and usually poorly preserved. It often contains trace fossils, such as ?medusa impressions (Glaessner & Pledge, 1985), echinoid burrows and *Thalassinoides* towards the top.

1.2.2.3. Tortachilla Limestone

The contact between the South Maslin Sand and the overlying Tortachilla Limestone is problematic, but appears to represent a dissolution front (James & Bone, 2000) rather than a wave-ravinement surface (Dyson, 1998). The contact is highly irregular in places and the fossils at this level are chalky. The composition of the South Maslin Sand also appears to mirror that of the non-carbonate lower Tortachilla Limestone. Both these features support the hypothesis of post-depositional dissolution. The primary contact between the two formations would therefore now be largely obliterated, but may have been relatively continuous. The goethite pellets are of uncertain origin but probably resulted from weathering of laterite surfaces. Quartz is only a minor constituent, which is a distinct difference with the underlying South Maslin Sands and the contemporaneous sediments elsewhere in the basin.

The lower unit of the Tortachilla Limestone (To_A of James & Bone, 2000) is less than 1 m thick. It is a quartz and goethite rich fossiliferous packstone to grainstone, which locally becomes a bryozoan-bivalve floatstone. It contains a diverse fossil fauna dominated by bryozoans, with common bivalves (especially Pectinidae) and echinoids (regular and irregular), and some brachiopods, foraminifera, sponge spicules, ostracods, barnacle plates, serpulids and corals. *Thalassinoides* burrows are common throughout but increase towards the top where a hard ground terminated the unit.

The middle unit (To_B of James & Bone, 2000) is ca. 1.5 m thick. It is a bryozoan rudstone-floatstone. Fossils frequently comprise over 90% of the bulk sediment. The unit can be subdivided into several thinner horizons, which are often bedded, but with the bedding often indistinct due to burrowing. The top 0.3 m is formed by a well-cemented packstone-wackstone. Much of the clay content in the samples is considered to be from recent infiltration of overlying Pleistocene clays (James & Bone, 1998).

The upper unit (To_C of James & Bone, 2000) is ca. 0.5 m thick. It is often a very cemented glauconitic molluscan (particularly the turritellid *Spirocolpus*) floatstone. It is less fossiliferous than the other two units but contains common bryozoans, brachiopods and both infaunal and epifaunal bivalves and echinoids. The glauconite is probably due to infiltration from the overlying glauconite-rich sediments or post-depositional precipitation (James & Bone, 2000).

The Tortachilla/Blanche Point Formation boundary may correlate with the Bartonian/Priabonian (Middle/Upper Eocene) boundary (B. McGowran, pers. comm., 1998).

1.2.2.4. Blanche Point Formation

The Blanche Point Formation was deposited with no marginal marine influence evident in the coastal outcrops (Cooper, 1979). It is subdivided into four members:

Tuketja Member

The basal Tuketja Member is a glauconitic calcareous clay (mostly smectite) with silica present in the form of Opal-CT (Jones & Fitzgerald, 1984). It contains minor bryozoans, whereas molluscs are much more common, especially pectinids. It is also rich in sponge spicules and brachiopods.

Gull Rock Member

The subsequent Gull Rock Member is darker in colour, indicating the presence of unoxidised organic matter due to low oxygen levels (Beecroft, 1980). It has a characteristic decimetre scale banding of alternating cemented and softer layers. The macrofauna is dominated by sponges, the turritellid gastropod *Spirocolpus* and *Thalassinoides* burrow traces. Bryozoa and other macrofossils, such as corals, nautiloids, crabs and penguin bones, are present in variable but mostly low abundance and diversity. They become common and moderately diverse in only a few beds.

Perkana Member

The boundary with the Perkana Member is gradational, represented by the gradual absence of the cemented layers, although the decimetre scale banding continues. It is rich in sponge spicules but contains rare other macrofauna. The silica is present in Opal-A form (Jones & Fitzgerald, 1984).

Tuit Member

The final Tuit Member is similar to the Blanche Point Member in appearance and composition, but has only few outcrops. It was not accessible during the course of this investigation and is therefore not further discussed in this study. It can be considered to to have a similar origin as the Gull Rock Member due to their apparent similar appearance.

The Tortachilla Limestone and the Blanche Point Formation depositional environments are thought to have been during low energy conditions and significant variations in oxygen levels (Beecroft, 1980).

1.2.2.5. Post-Eocene Formations

The thin overlying clay-rich Chinaman Gully Formation is considered to be a regressive, terrestrial deposit. It is probably the manifestation of the short but significant regression that signifies the Eocene/Oligocene boundary.

The Oligo-Miocene Port Willunga Formation is again a richly fossiliferous limestone dominated by bryozoans. The basal Aldinga Member is quartz rich, occasionally cross-bedded, and only contains goethite or glauconite in the basal 5 cm. A thin glauconite-rich unit also occurs in the upper part. The Ruwarung Member is similarly fossiliferous but with a higher silt component and contains occasional chert bands.

1.2.3. Western Basin Margin

The sediments on the east coast of Yorke Peninsula are generally thinner and more siliciclastic than those on the eastern margin of the basin. This is probably due to the more marginal facies exposed in the outcrops. These differences may also be due to the circulation patterns that prevailed within the basin. The major stratigraphic work on this sequence was carried out by Stuart (1969, 1970; Reference to sections such as 'Stuart's section 2' are made in the stratigraphic columns, see Appendix A1), while Shubber (1997) concentrated on the Oligo-Miocene. The dating and correlation of the sediments is still uncertain and represents an ongoing effort.

1.2.3.1. Mulloowurtie Formation

The Middle to Upper Eocene Mulloowurtie Formation directly overlies the Cambrian basement. Most of the formation consists of well-bedded muddy silts, with rare fossils. Bryozoans are mainly present as nodular rooted forms. The basal few centimetres of an outcrop overlying elevated Cambrian quartzites north of Hartz Mine is the only outcrop that contains a diverse, bryozoan-dominated fossil assemblage, and is probably stratigraphically equivalent with lower parts of the formation elsewhere. Correlations are not clear, but the lower part is considered to be the equivalent of the Tortachilla Limestone (Cooper, 1985; Alley & Lindsay, 1995). The Quartoo Member is a coarse sandy unfossiliferous local facies.

1.2.3.2. Throoka Silts

The Throoka Silts are clay rich and unfossiliferous. They are thought to correlate with either the Gull Rock Member or the hiatus between Tortachilla Limestone and Blanche Point Formation (James & Bone, 2000) or the regressive Chinaman Gully Formation (Veevers, .

1.2.3.3. Rogue Formation

The Rogue Formation is considered uppermost Eocene to Lower Oligocene, with the lower part correlating with the Blanche Point Formation (Cooper, 1985; Alley & Lindsay, 1995). The Port Julia Greensand Member is correlated with either the upper glauconitic Tortachilla Limestone (incompatible with the correlation of Throoka Silts with the Blanche Point Formation), the Chinaman Gully Formation (James & Bone, 2000), the greensand horizon within the Aldinga Member (Cooper, 1985), or none of the above. Resolution of this uncertainty is ongoing by Strontium isotope analyses (Y. Bone, pers comm., 2003). The samples analysed in this study all came from the Lower Rogue Formation below the Port Julia Greensand Member.

1.2.3.4. Post-Eocene Formations

The Oligo-Miocene Port Vincent Formation is partially equivalent with the Ruwarung Member of the Port Willunga Formation. It is generally highly fossiliferous, with the fossils dominated by bryozoans.

1.2.4. Southern Basin Margin

The Kingscote Limestone is the only Palaeogene marine formation on Kangaroo Island. It is subdivided into three members (Milnes *et al.*, 1983). The main outcrops occur along the coast around Kingscote. There are further outcrops on the north and south coast of Kangaroo Island, but these are weathered and do not yield fossils of sufficient quality to be identifiable.

1.2.4.1. Kingscote Limestone

The Lower Kingscote Limestone is up to 30 m thick and correlates with the Tortachilla Limestone and the basal Blanche Point Formation. It is a coarse-grained and sometimes bedded limestone, which is locally strongly cemented. It is fossiliferous and mostly dominated by infaunal echinoids (*Fibularia* spp. and '*Monostychia*' sp.), but with a significant proportion of bryozoans.

The middle unit is usually less than 1 m thick and considered Lower to Middle Oligocene. It contains common bryozoans and echinoids, and is often extensively recrystallised.

The upper 3 m thick unit is Upper Oligocene and contains bryozoans but fewer echinoids.

The stratigraphy and correlations are not clear. Recent work has indicated that the echinoid-rich facies may be Eocene in age, while the other facies are Oligo-Miocene (James & Bone, 2000).

1.2.5. Intrabasinal Correlations and the Nature of the Sequence

The eastern and western margins of the basin have local outcrops with good within-locality exposure of most of the Cainozoic sequence. The outcropping sections of the southern margin, however, are patchy in nature and together with the variable facies, makes it difficult to obtain a complete picture of the sequence. Correlation between margins as well as actual dating of the formations is still debatable. Indeed, even the position of the Eocene/Oligocene boundary is not clear. On the eastern margin it is considered to be represented by the distinctive clays and silts of the Chinaman Gully Formation. This may represent a sharp sea level drop at the end of the restricted Blanche Point Formation, after which the sediments change to the 'open marine' Port Willunga Formation. On the western margin the boundary is currently placed in the middle of the Rogue Point Formation without any similar evidence of a break or any facies shift. Even the position of the distinctive Port Julia Greensand Member is unclear, and if any of the current correlations are correct, there does not appear to be a distinct sedimentological manifestation of the Chinaman Gully Formation Event on this basin margin. For this reason, the placement of the Eocene/Oligocene boundary should still be regarded as uncertain.

The highly variable facies of the different formations also makes it difficult to establish any biostratigraphic faunal assemblages, as species presences are controlled more by facies rather than actual first and last appearances. Detailed Strontium isotope analyses of brachiopods and pectinids, which is being carried out by Bone *et al.*, is aimed at resolving this uncertainty (Y. Bone, pers. comm., 2002).

The lack of quartz sand in the Tortachilla Limestone and Blanche Point Formation may be due to several factors, which may also influence bryozoan distributions. Most of the Tortachilla Limestone outcrops are further away from the basin margins than the outcrops on Yorke Peninsula. It is therefore likely that most of the coarser sediments were deposited in more marginal facies similar to the South Maslin Sands. The Mt Lofty Ranges did not become uplifted until later in the Oligo-Miocene. The low topography would not have resulted in extensive erosion. The Spencer Gulf also did not exist until Oligo-Miocene, so Yorke Peninsula had a widespread hinterland from whence run-off could have brought in sediment. Silcrete formation during earlier Eocene could have slowed actual erosion (the resulting silica was then 'flushed out' in the later Eocene and may have contributed to the Blanche Point Formation sediments).

1.2.6. Diagenetic History

The fluctuating sea levels during the deposition of these sediments meant that they variously had seawater or fresh ground water pumping through them, or were even sub-aerially exposed (James & Bone, 2000). The limestones of this basin are also generally good aquifers (Cochrain, 1956), and the prolonged contact with fresh water resulted in extensive diagenetic alteration. The resulting, often complex history of cements is summarised by James & Bone (2000) and Rahimpour-Bonab & Bone (2001).

1.2.7. Previous Palaeontological Work

The fossils of the St. Vincent Basin are both abundant and diverse, similar to those in many other Australian Cainozoic sequences. Most of the past research has been done on the Foraminifera (e.g. Howchin & Parr, 1938; Crespin, 1954; Glaessner, 1956; Lindsay, 1969, 1974, 1986, 1988; McGowran & Beecroft, 1986; Lindsay, 1967, 1968), palynology/palaeobotany (Chapman, 1935; Steel, 1961; Lang 1970; Lang & Smith, 1971; Harris, 1972; Hos, 1972; Christophel & Blackburn, 1978; Blackburn, 1981; Meakin, 1985; Christophel & Greenwood, 1987; Alley, 1987; Alley & Broadridge, 1992; Scriven, 1993), ostracods (McKenzie, 1979, 1987, McKenzie *et al.*, 1991; Majoran, 1993, 1995, 1996a, 1996b) and molluscs (Buonaiuto, 1979). Dinoflagellates (Harris, 1985), echinoids (McNamara, 1987), trace fossils (Glaessner & Pledge, 1985) and vertebrates (Jenkins, 1974) have also been studied in some detail.

Bryozoans generally constitute a significant proportion of the abundance and diversity of the fossils, often to the extent of comprising the bulk of the sediment. Bryozoan research, however, has been restricted to a few, now very old taxonomic papers by Tenison Woods (1865), Waters (1885) and Stach (1936). None of these papers give adequate stratigraphic or locality information for species occurrences, even for the type specimens.

1.3. Geology of other Australian Cretaceous to Cainozoic Marine Basins

Most other Cainozoic basins in the Australian region began accumulating sediment in the Palaeogene and eventually included marine carbonates containing bryozoans (Fig. 3). Comparisons with these sediments are necessary for palaeogeographical, evolutionary and palaeoenvironmental reasons. The formations referred to during later comparisons are described in greater detail below.

When comparing the sediments and fossil faunas of the St Vincent Basin with other Palaeogene southern Australian basins, it must be remembered that this was a basin with a restricted character, due to basement highs along its southern margin, similar to the Murray Basin.

1.3.1. Carnarvon Basin

The Carnarvon Basin is situated in north western Western Australia (Fig. 2). It contains a discontinuous succession of sediments, starting with marine in the Permo-Carboniferous, through marginal marine in the Triassic and Jurassic, and becoming marine again and increasingly carbonate rich in the Cretaceous and Cainozoic. Bryozoans are found from the Upper Cretaceous through to the Recent (Quilty, 1975).

The Upper Cretaceous Korojon Calcarenite is characterised by abundant and locally coquinoid accumulations of the large cold water bivalve *Inoceramus*. The overlying Miria Marl is softer and contains ammonites. Rare bryozoans have been found in both formations (W.A.M. and own collections).

The Cardabia Calcarenite consists of an Lower Paleocene to Lower Eocene sequence of marine sediments (Hocking, 1990a). The basal Boongerooda Greensand Member is a thin (<1 m thick) loose glauconitic sand. The Wadera Member (28 m thick) is a friable and locally hard glauconitic calcarenite. The Pirie Member (22 m thick) (latest Paleocene; Milner, 1987) is a friable marly calcarenite. The Cashin Member (8 m thick) is a friable and hard recrystallised calcarenite. The Jubilee Member (11 m thick) is also a friable and hard recrystallised calcarenite, but contains glauconite (Hocking, 1990a). Bryozoans are common to abundant in all these sediments.

The Giralia Calcarenite is hard and recrystallised but friable. It is fossiliferous and dominated by bryozoans and echinoids (some of which are similar to those in the Bremer Basin; McNamara, 1999), with some pectinid bivalves and terebratulid brachiopods and contains limonite grains.

The Upper Oligocene to Middle Miocene Cape Range Group contains common bryozoans, along with echinoids and molluscs. Zooxanthellate corals become common in the Trealla Limestone.

No thorough taxonomic research on the bryozoans has yet been published, but there has been provisional work done on the lunulitiform fauna (E. Håkansson, pers. comm., 1998).

The Perth Basin is possibly continuous with the southern Carnarvon Basin, but does not contain sediments from which bryozoans are known.

1.3.2. Bremer Basin

The Bremer Basin mainly contains an Lower to Upper Eocene sequence of marginal marine to estuarine siliciclastic sediments comprising the Werrilup Formation, Pallinup Siltstone, Princess Royal Spongolite and Norseman Limestone (Hocking, 1990b). Most of the sediments are dominated by sponges, which often occur as complete body fossils (Clarke *et al.*, 1996; Gammon *et al.*, 2000; Gammon & James, 2001). Bryozoans are a common component of all the formations.

The only taxonomic reference to bryozoans is in Gregory (1916), who lists a few species for the Norseman Limestone. Clarke *et al.* (1996) discuss the bryozoan fauna on a growth form basis.

1.3.3. Eucla Basin

The Eucla Basin contains a thick and laterally extensive sequence of bryozoal carbonate deposits, which today make up the cliffs of the Great Australian Bight. The basal Middle Eocene Hampton Sandstone is deltaic sand with few fossils. The Middle to Upper Eocene Wilson Bluff Limestone is white, thick, fossiliferous and contains abundant bryozoans (James & Bone, 1991). It contains occasional horizons with chert nodules. The Upper Oligocene Abrakurrie Limestone is relatively thin, fossiliferous and also contains abundant bryozoans (James & Bone, 1994). The Miocene Nullarbor Limestone is fossiliferous with common bivalves but rare bryozoans (James & Bone, 1991). The Nullarbor Plain is essentially the sea floor of the Miocene continental shelf.

The bryozoans of these limestones have not been taxonomically analysed in great detail since Cockbain (1970) listed 52 species without descriptions or figures. Although he gives relatively detailed stratigraphic information, it is not possible to ascertain the true identities of the species as the whereabouts of the collections are currently unknown (A.E. Cockbain, pers. comm., 1999). James & Bone (1994) have more recently investigated the bryozoans at the generic and growth form level.

1.3.4. Murray Basin

Most of the Paleogene within the Murray Basin is represented by the terrestrial deposits of the Olney Formation, Renmark Beds, Buccleuch Beds, Compton Conglomerate, Ettrick Formation and the Geera Clay (all Middle – Upper Eocene). The first marine deposits occur in the Upper Oligocene to Lower Miocene Mannum Limestone (see also Lukasik & James, 1998; Lukasik *et al.*, 2000). It contains common bryozoans, but also a diverse and common assemblage of echinoids, bivalves, gastropods and many other fossil groups (Schmidt, 1997; Davies, 1996). The Middle to Upper Miocene Morgan Group is similar but dominated by bryozoans (Lukasik *et al.*, 2000).

Both limestones were deposited in warm-water environments and contain tropical Foraminifera such as *Lepidocyclina* (Lindsay & Giles, 1973). This Basin was also restricted from the open ocean due to the basement highs of the Padthaway Ridge along its south-western margin.

The only taxonomic bryozoan publication is by Waters (1885), while Chapman (1943) mentions some bryozoan species without descriptions.

1.3.5. Gambier Embayment (Otway Basin)

The Gambier Basin is often classed as a western extension of the Otway Basin, but it could also be considered the 'unrestricted' part of the Murray Basin, as it lies between the two basins. The main fossil-bearing strata of this basin are the Upper Eocene Narrawaturk Marl, which is very fine grained and often glauconitic but poorly fossiliferous, and the Lower Oligocene to Lower Miocene Gambier Limestone, which is a several hundred metre thick bryozoan calcarenite (James & Bone, 1988). The bryozoans of the latter have received some taxonomic attention from Busk (1859, whose list of new species are all *nomen nuda*, however), Tenison Woods (1877) and Waters (1882).

1.3.6. Otway, Gippsland & Bass Basins

The bryozoans of the Otway Basin have been the most extensively studied of all the Australian post-Palaeozoic occurences. A good summary of the sediments is given by Abele *et al.* (1988) and Holdgate & Galagher (2003). Extensive Cretaceous sediments occur but are largely terrestrial. The Cainozoic stratigraphy is quite complex, occurring across the Torquay and Port Campbell Embayments with many diachronous facies and grading into the Gambier Embayment at many levels. The Paleocene to Middle Eocene sediments are mostly fluvial to estuarine. The earliest marine sediments are the Upper Eocene to Lower Oligocene limonitic and glauconitic clays and sands of the Browns Creek Formation (Waghorn, 1989), which contains a diverse and superbly preserved bryozoan fauna. The Upper Eocene to Lower Oligocene transgressive Narrawaturk Marl only has sparse bryozoans. The Oligocene sediments of the Castle Cove Limestone and the Glen Aire Clay contain more bryozoans, but the Upper Oligocene to Middle Miocene Gellibrand Marl is the first major development of shelf carbonates. The Middle to Upper Miocene Port Campbell Limestone is the last shelf carbonate facies with bryozoans.

The Gippsland Basin has a similar sequence of sediments and facies as the Otway Basin although they are quite separate entities. Marine sediments containing bryozoans do not, however, occur until the Miocene Gippsland Limestone.

Bryozoan research has been extensive in Victoria, but is still ongoing with both revisions of previous taxonomic identifications as well as new findings. Publications including samples from the Otway Basin include Tenison Woods (1860, 1877, 1879, 1880), Etheridge (1877), Waters (1881, 1882, 1883), MacGillivray (1895), Maplestone (1898, 1899, 1900a, b, 1901a, b, 1902a, b, 1903, 1904a, b, 1908, 1911, 1913, 1915), Stach (1933, 1935, 1936a, b), Canu & Bassler (1935), Brown (1958), Cockbain (1971), Wass & Yoo (1973), Bock & Cook (1993a, b, 1995a, b, 1996, 1999, 2000, 2001a, b, c, 2002), Cook & Bock (2001). Almost one thousand species of cheilostomes and cyclostomes have been identified in these publications. These publications comprise the largest regional 'species list' for the bryozoans of the Australian Cainozoic, but most lack good stratigraphic information as sample localities rather than formations are given. Many localities have outcrops of several formations, which sometimes differ significantly in age.

The Bass Basin is an offshore basin in the middle of the Bass Strait with the southern margin onlapping northern Tasmania. Samples need to be collected by marine cores, and bryozoans have not been properly studied. Uplifted Cainozoic rocks of the Upper Oligocene to Lower Miocene Table Cape Group occur on the north western coast of Tasmania.

This is the only Australian region which experienced volcanic activity in the Cainozoic. A local peak of volcanism in what is now eastern Victoria occurred between 43 and 38 Ma (Nichols & Gray, 2003), which coincides with the age of the sediments studied in the St Vincent Basin. Because this volcanism occurred over 1000 km away from the St Vincent Basin, it is unclear to what extent it affected the environments and sediments.

1.3.7. Eromanga Basin *sensu lato* & Queensland subsurface Cainozoic

Most of the formations are terrestrial and lacustrine, but some bryozoans have been reported. These reports have, however not been followed up or confirmed. Jack & Etheridge (1892: 409, 441) cite "*Lepralia*? *oolitica* Moore" as occurring in the Lower Cretaceous Rolling Downs Formation. Etheridge, (1901) described *Lunulites abnormalis* based on moulds from the same formation. Three anascan colonies encrusting an opalised bivalve, *Fissilunula clarkei* (SAM P5238) from Aptian sediments near Coober Pedy have been observed by myself. Some subsurface bryozoan fossils may be identified in future as ODP cores off the Queensland coast are investigated.

1.3.8. Papuan Basin

The Papuan Basin in southern Papua New Guinea was a part of the northern Australian continental margin throughout its tectonic history, yet it is often disregarded by both geologists and palaeontologists when discussing the geological history of Australia. Extensive sediments of both Palaeogene and Neogene age are known, and often contain common Bryozoa (D. Haig, pers. comm., 2002). No studies have been published on these.

1.3.9. New Zealand

New Zealand has a range of formations containing bryozoans, including the Paleocene Red Bluff Tuff of the Chatham Islands (Gordon & Taylor, 1999), the Paleocene Kauru Formation near Oamaru (Gordon & Taylor, 1999), the Upper Eocene to Lower Oligocene Kaiata Formation (Pt Elizabeth; Waghorn, 1989) and the Oligocene TeKuiti Group (Wanganui Basin, North Island; Nelson, 1978). New Zealand experienced its own distinctive environmental history since its separation from Australia in the Late Cretaceous. The biogeographic connections between Australia and New Zealand are still poorly understood, and dispersal patters of various phyla are often contradictory.

Most of the research on Cainozoic bryozoan taxonomy has been carried out by Stoliczka (1865), Waters (1887), Brown (1948, 1952), Uttley (1949, 1951), Nelson *et al.* (1988), Gordon *et al.* (1994), and Gordon & Taylor (1999).

1.3.10. Palaeogene Bryozoa of Other Gondwana Regions

Antarctica: Cainozoic sediments are rare in Antarctica but an important bryozoan fauna has been identified from the late Lower to Upper Eocene La Meseta Formation on Seymour Island, Antarctic Peninsula (Hara, 2001). Possible future investigations of the Oligo-Miocene Polonez Cove and Cape Melville Formations on King George Island (South Shetland Islands) and Eocene sediments in West McMurdo Sound may uncover more bryozoans.

South America: The accounts of Canu (1911) on the Danian (Lower Paleocene) Roca Formation and Canu (1904) on the "patagonien" (possibly Oligocene marine sediments as earlier Eocene sediments are terrestrial) in Argentina are the only ones for the South American Palaeogene.

Africa: Paleocene cyclostomes from Madagascar were reported by Brood (1976).

India: Eocene bryozoans occur in the Mt Everest region, but have not been researched (Y. Bone, pers. comm. 2003).

The accounts of Canu (1911), Brood (1976) and Gordon & Taylor (1999) are the only published taxonomic reports of Paleocene bryozoans in the southern hemisphere. The Paleocene of the Carnarvon Basin contains abundant and diverse bryozoans, but they have not been taxonomically investigated apart from unpublished reports (Quilty, 1975; Håkansson, pers. comm., 1999).

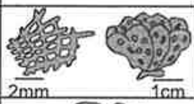
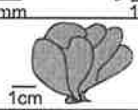
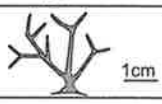
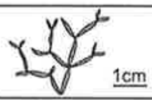
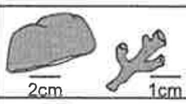
GROWTH FORM NAME		SHAPE	NELSON et al. 1988	ARCHETYPAL CLASSIFICATION Cheilostome	Cyclostome
ERECT RIGID	1. FENESTRATE		ER ERfe	Reteporiform	Reticulate diastoporiform
ERECT RIGID	2. FOLIOSE		ERfo	Eschariform	Bilaminar diastoporiform
ERECT RIGID	3. FLAT ROBUST BRANCHING		ERro	Adeoniform	Horneriform?
ERECT RIGID	4. DELICATE BRANCHING		ERde	Vinculari form	Idmidroniform, Pustuliporiform, Cavarid diastoporiform
ERECT RIGID	5. FUNGIFORM		————	(rare)	Lichenoporiform?
ERECT FLEXIBLE	6. ARTICULATED BRANCHING		EF	Cellariform	Crisiform
ERECT FLEXIBLE	7. ARTICULATED ZOOIDAL		EF	Catenicelliform	(unknown)
8. ENCRUSTING			ENul	Membraniporiform	Stomatoporiform
9. MULTILAMINAR/ MASSIVE			ENml	Celleporiform	Atractosoeciform
10. NODULAR			ENml	Conescharelliform?	Cerioporiform
11. FREE-LIVING			FL	Lunulitiform	(unknown)

Figure 5: Bryozoan Growth Forms. The 'Growth Form Name' column gives the eleven generalised growth form categories used in this study, 'Shape' gives graphic examples of each category, 'Nelson et al. 1988' gives the equivalent terminology of Nelson et al.(1988), 'Archaetypal Classification' gives commonly used names in older literature derived from 'type genera' (modified from Bone & James, 1993).

PART 2: BRYOZOA

Bryozoans are predominantly marine colonial animals. Sexually reproduced colonies originate from a larva, which metamorphoses into an original zooid, the ancestrula. They form variably calcified colonies in a range of sizes and shapes, consisting of a few to thousands of compartments (zooids) housing the individual polypides, which are connected to neighbouring zooids. The lophophore, which is protruded through an orifice, contains the mouth, anus and a ring of tentacles bearing beating cilia to generate the currents from which they gather their food. They are, therefore, active filter feeders, similar to brachiopods and sponges, and unlike passive suspension feeders like corals. The majority of bryozoans are sessile. The order Cyclostomata possess tube-shaped zooecia, which can potentially keep growing. The order Cheilostomata possess uniquely box-shaped zooecia which do not grow larger once the zooid is mature. They possess an operculum with which they can close off the orifice. The sessile lifestyle has led to them becoming efficient at clearing themselves when covered with sediment with the use of modified zooids. Cheilostomes possess avicularia, which have modified the operculum (usually closing the orifice in feeding zooids) into a range of mandibles or hair-like setae.

A variety of good summaries on the life history of bryozoans exist (Ryland, 1976; McKinney & Jackson, 1989), so that only features relevant to this project will be discussed here.

1.4. Bryozoan Evolution

The fossil record of bryozoans starts in the Ordovician. Most of the early orders are thought to have died out by the Triassic, but the post-Palaeozoic cyclostomes are currently contemplated to be a polyphyletic grouping of survivors of these classes (Boardman, 1984). Cheilostomes do not occur until the Upper Jurassic in Europe. By the Cretaceous they had diversified rapidly to become the most diverse order of Bryozoa (Taylor & Larwood, 1990). Following the end Cretaceous extinction event, which brought to a close the major radiations of the Late Mesozoic, the Eocene represents a peak in overall bryozoan diversification, after which it appears to plateau for some time (Taylor & Larwood, 1990: 214).

Bryozoans have traditionally been systematically placed close to the Brachiopoda and Phoronida in the 'Lophophorates'. Some observations, however, indicate that their phylogeny may not be this straightforward. Their restructuring post-larval metamorphosis, in particular, indicates that their affinities need to be re-evaluated (Dewel et al., 2002).

1.5. Colonial Growth Forms

The morphologies of individual zooids of this phylum, particularly the Cheilostomes, have evolved into diverse forms. The overall colony structures, however, are not as diverse, with most structures evolving repeatedly in different groups. This enables comparisons of the fossil forms with modern ones for palaeoenvironmental speculation. Cheetham (1971) considers that zooidal structure may be an important determinant of colony form and therefore influence the ability of species to exploit different environments.

Hageman (1998) has proposed a flexible multivariate classification system, which accommodates all growth forms. This system of classification is utilised here ('Analytical Bryozoan Growth Habit Classification'; see Chapter 4: p. 31.). Other classification systems have previously been used, but are often highly subjective (Stach, 1936; Blake, 1981; Nelson *et al.*, 1988; Bone & James, 1993; Smith, 1995).

Older names such as 'vinculariiform', 'adeoniform' etc. can be confusing and are often inaccurate. The boundaries between such generic growth form terms are generally subjective and may be interpreted differently by different researchers. This makes comparisons between different investigations difficult, and mandatory that the system used in any publication is clearly stated. (see Fig. 5)

1.6. Ecological Factors in Bryozoan Occurrence

Any palaeoenvironmental interpretation must largely rely on knowledge of present day (and fossil) distributions of closely related taxa and similar growth forms. Much of the oceans is still unexplored and consequently organisms such as bryozoans are still being discovered in new and unexpected places. Any interpretation will therefore always be 'pending new discoveries'.

When interpreting the environments, which influence bryozoans, it must be remembered that water depth, water currents, wave activity, sedimentation rate, nature of substrate, predation and competition are interrelated, i.e. they co-vary (Hageman *et al.*, 1997). Distributions of bryozoans often appear to be related to depth. Depth, however, is not the cause itself, but rather influences the factors that actually control bryozoan distribution. These are treated individually below. All these factors change with depth, yet they are very much interconnected and a single causative agent for bryozoan occurrence is usually impossible to distinguish.

Overall bryozoan abundance peaks at 40 – 90 m depth on the continental shelf (Cuffey & Turner, 1987; Smith, 1995) and falls off with increasing water depth (Gordon, 1987; Harmelin, 1988; McKinney & Jackson, 1989). James *et al.* (2001), however, found an increase in bryozoan abundance off-shore near the Great Australian Bight shelf edge, indicating local environmental factors have a stronger influence than just depth. Moderate water energy provides continuous food and removes small sediment particles (Ziko & Hamza, 1987), but low energy faunas can also be diverse (Kelly & Horowitz, 1987).

Blake (1981) distinguishes a four-stage succession in many marine communities: 1. stabilisation, 2. colonisation, 3. diversification, 4. domination. Bryozoans are most important in stages 1 and 2, and are often among the first organisms to colonise a locality. An absence of bryozoans where they would otherwise be expected to be present may indicate factors such as smothering by suspended sediment, low salinity, lack or instability of substrates, or regular disturbance.

1.6.1. Temperature

Temperature is often quoted as the main controlling factor on bryozoan occurrences when regional distributions across depth and latitudes are being considered. Diversity appears to stay similar from high to low latitudes, and from shallow to deep waters. It is the abundance, however, that decreases in both cases. Interestingly, in the case of latitude, the decrease in abundance occurs as temperatures increase, and in the case of depth, as temperature decreases. It is therefore possible that they are only indirectly affected by temperature, and more directly by other factors such as competition (corals, sponges, etc.) or nutrients.

1.6.2. Nutrients and Food

Bryozoans acquire their food mainly by filtering plankton out of the water. This is mostly unarmoured phytoplankton <0.050 mm (McKinney & Jackson, 1989: 119), but the size can vary with the mouth sizes of the different bryozoan species. The range of mouth sizes is usually between 0.015 mm (these eat nanoplankton) and 0.102 mm (these can also eat larger phytoplankton and small zooplankton) (Winston, 1981). The lophophore diameter can often be predicted using orifice width and inter-zooidal orifice spacings (Winston, 1981). The size of the orifice (and to a lesser extent the opesia) is also thought to correlate with mouth size in the living zooid, and can thus be used as a proxy to infer potential food size.

The food quality can affect the size, shape and structure of colonies (Winston, 1976; Kitamura & Hirayama, 1984). Bacteria are too small and insufficient as food. The value of correctly-sized plankton varies even within same genus (Jebram, 1975; Winston, 1976).

It has been suggested that bryozoans may be more efficient at intracellular rather than extracellular digestion (Dewel *et al.*, 2002) and possibly rely on symbiotic organisms (Spjeldnaes, pers. comm., 2001). If such is the case, the above correlations would be meaningless. Why in such a case, however, have a large mouth at all? The limited data available, nevertheless, indicates that plankton provides a significant, if not the main, food source (Winston, 1976; Jebram, 1975; Kitamura & Hirayama, 1984).

1.6.3. Salinity

Bryozoa are generally stenohaline. Different taxa can occur in waters from 20‰ to 49‰ salinity (Osburn, 1957; Blake, 1981). Most cheilostome and cyclostome species prefer normal marine salinity (~35‰), but some are euryhaline and can tolerate a range of salinities. Bryozoan abundance and diversity usually drops dramatically where salinity becomes estuarine (~20‰, such as near shore environments where rivers enter the sea). This indicates that most marine taxa are sensitive to salinity fluctuations (Tasch, 1973; Bone & Wass, 1990; Bone, 1991).

1.6.4. Oxygen

Most species prefer normal oxygen levels. Bryozoans may, theoretically, be able to cope with lower levels of dissolved oxygen in the water, because they are active filter feeders. This enables them to pass higher volumes of water through their feeding structures than passive filter feeders such as cnidarians. If this ability indeed lets them exploit oxygen depleted environments, it raises the question of whether other active filter feeders such as brachiopods and sponges are able to exploit this ability as well. It is also not clear if all bryozoan taxa are the same in this respect.

1.6.5. Hydrodynamic Factors

The energy regime, which prevails in an environment, is a strong controlling mechanism on what types of growth forms (and thus also species) of bryozoans live in a given setting. High energy waters will increase the risk of breakage in delicate erect forms. It will also disturb unstable sediment and increase turbidity or damage through abrasion. On the positive side, it can also increase the volume of water that a colony can access for filtering food (see below).

1.6.6. Light and 'Depth'

The bathymetric distribution of bryozoans ranges from almost intertidal to abyssal. This is partly due to the fact that they are heterotrophs (as opposed to autotrophs such as zooxanthellate corals), and light is only restrictive if it limits food sources such as phytoplankton (Schopf, 1977). Photosynthetic activity in clear water column occurs up to 150 m depth (peaking at 10 – 20 m) in the open ocean and up 40 m depth in typical coastal waters. In many species, however, light may be directly relevant during larval settlement (Wendt, 1999).

1.6.7. Sedimentation Rates and Turbidity

Bryozoans generally do not colonise areas of high turbidity and sedimentation rates (>100 cm/ka, Lagaaij & Gautier, 1965), with the exception of free-living forms (Bone & James, 1993). High sediment supply directly limits feeding and indirectly swamps potential substrate (Harmelin, 1988). Suspended sediment can become ingested and inhibit food uptake. The relatively inefficient digestive system does not enable them to easily dispose of non-digestible matter (Winston, pers. comm., 2001). Some bryozoans can tolerate the presence of suspended fine sediment if it does not settle on colonies (Gordon *et al.*, 1994), while others can 'shake' it off (e.g. erect flexible colonies).

1.6.8. Substrate Availability and Selection

Bryozoans are poor competitors for space and are generally outcompeted by other clonal organisms such as sponges, ascidians and corals on stable substrata (Gordon, 1972; Kay & Keough, 1981; Jackson & Winston, 1982). If a patch is cleared, however, bryozoans show the highest rate of recruitment. On the other hand, on small ephemeral substrata or rocks, the community composition is determined mostly by rates of recruitment and habitat selection of larvae, rather than by post-recruitment interactions of established organisms (McKinney & Jackson, 1989: 152), providing sponges and ascidians are almost absent. The highest bryozoan diversities, therefore, usually occur on hard and gravelly bottoms, often with well over 100 species at a single locality, while soft bottoms have much lower diversities.

The type of substrate also strongly controls the dominant type of growth form. Two dimensional encrusters make up the majority of species where hard substrates are available. This dominance is independent of depth (Gordon, 1987). Various rooted and free-living forms often dominate on unconsolidated sediments, and encrusters are only present on occasional larger hard particles. Overall a firm and coarse substrate is generally considered important for bryozoan abundance, as are hardgrounds (Voigt, 1973). Most erect rigid forms require hard substrate (Harmelin, 1988). Bryozoans are also notably absent in sediments composed of more than 90% mud.

Bryozoan larvae are also capable of active substrate, and consequently ecological niche, selection (Hayward, 1980). Some bryozoan larvae, in particular the cyphonautes type, have the ability to actively explore for suitable substrate, even swimming up-stream to locate specific, obligatory settlement sites by tracking water-borne chemicals to their sources (Abelson, 1997; Abgrall & Walters, 2000). Littoral species exhibit more detailed substrate selection than infralittoral species (Ryland, 1962).

1.7. Reproduction

The larval life of bryozoans is poorly understood, with the exception of a few species. There are essentially two types of larvae (see Taylor, 1988, for summary and references).

The planktotrophic (cyphonautes) larvae can live for 4 to 8 weeks before settling. This type of larva appears to be restricted among cheilostomes to malacostegan genera of the families Electridae and Membraniporidae, which are partly characterised by not posessing any brooding structures.

The lecitotrophic (brooded) larvae appear to only have life spans on the order of hours to days, with some possibly surviving for longer, but most usually less than 24 hours (Nielsen, 1981; Cook, 1985). These settle very soon after release from the brood chamber of the parent colony (Taylor, 1988).

Many taxa also have the ability to regenerate from fragments. In some instances this is the only way of 'reproduction' (Cheetham, 2001).

1.8. Predation

The low organic content (dry weight) of bryozoans relative to their skeletal mass, results in them not being the prey of choice for most predators. Nonetheless, sea urchins and nudibranchs are the main predators on colonies (Blake, 1981). Certain nudibranchs, pycnogonids (Wyer & King, 1973), immature sea stars (Birkeland *et al.*, 1971) attack individual zooids. Predation usually occurs at a slower rate than zooid regrowth (Barnes, pers. comm., 2001).

1.9. Competition for nutrients

The main food source is unarmoured phytoplankton for which the main competitors are mostly sponges as well as hydroids, barnacles and tunicates (McKinney and Jackson, 1989:120).

1.10. Bryozoan Taxonomy

Bryozoans are one of the more difficult phyla to identify taxonomically. Their characters often exhibit high degrees of convergence between different taxa, while displaying great diversity among closely related taxa.

The potential of many cheilostome taxa to be identified to genus or even species level from a single zooid is a double edged sword: it allows even small fragments to be identified accurately, but it can also place a bias on easily identifiable taxa being noted in surveys, rather than the whole fauna. Most species and even genera, however, require the observation of several morphological features to allow a positive identification. The characters considered to be most useful at a species level are the primary orifice, ovicell and polymorph morphology, as well as zooid morphology at growing edges. For higher systematic level classification, these characteristics are also important, but others such as frontal shield morphology, internal structures are of equal or more important value. It is often difficult to accurately observe these features in fossils, as orifices and internal structures may be filled with cemented sediment, ovicells may be abraded, and growing edges are rare in most facies, except in some encrusters.

Cyclostomes pose even more difficulties for taxonomists. They often have very few easily distinguishing characters, and thus the absence of any one of them may make it impossible to identify the genus or even family. The higher classification relies on colony form, skeletal organisation, autozooid morphology, brood chamber morphology and polymorphic zooids. Quantitative characters are utilised at species level (P.D. Taylor pers. comm., 2001).

CHAPTER 2. SIGNIFICANCE & AIMS

"But of bliss and glad life there is little to be said, before it ends; as works fair and wonderful, while still they endure for eyes to see, are their own record, and only when they are in peril or broken for ever do they pass into song."

J.R.R. Tolkien (1977) *The Silmarillion*. (Unwin, London)

2.1. Bryozoan Taxonomy

AIM 1: ***To produce a taxonomically accurate and stratigraphically detailed species list of the fossil bryozoans of the Eocene St Vincent Basin sediments which can be used as the basis for further research in this arena and by other researchers.***

The limestones along the southern Australian margin have long intrigued bryozoologists for their abundant and diverse bryozoan fauna. Little is currently known about the taxonomy of these bryozoans. Any results in any biological reseach become almost meaningless without a solid taxonomic basis, and cannot be compared against other research. Detailed taxonomic investigations are thus long overdue, before any conclusive investigation into the biogeography and palaeoenvironments of the bryozoans can be carried out. Comparisons with other basins in the region are difficult, because the limited data that exists is often outdated or imprecise. This research must therefore be considered as another piece in the puzzle.

Detailed taxonomy inevitably reveals new species and even new genera. This makes it currently particularly relevant, as the section of the Treatise on Invertebrate Paleontology on the order Cheilostomata is being revised.

2.2. Bryozoan Biogeography

AIM 2: ***To place the fossil bryozoan fauna into a regional and global context with respect to the distribution of bryozoans through the Tertiary and their relation to the present complement of Australia's Bryozoa.***

The Eocene sediments studied here are particularly interesting as they preserve some of the first post-Palaeozoic bryozoans along the southern margin of Australia. They do so with a population that is dominated by a diverse cheilostome fauna. Their origins are still poorly understood. Many researchers consider that the closest relatives of the Tertiary Australian bryozoans are the modern Australian species, rather than the co-existing Tertiary species from other continents. With only a geographically limited and Neogene focussed knowledge of the Australian palaeofauna, such statements may need re-evaluation. Many species were initially also shoe-horned into existing European species names, making these identifications useless at face-value.

Extending the knowledge of fossil bryozoans geographically as well as temporally will shed more light on their origins and the evolution within Australia (and Australasia), patterns of migration to or from Australia, first appearances, and concurrently reveal endemic species.

2.3. Palaeoenvironmental Analyses using Bryozoans

AIM 3: ***To use stratigraphically precise taxonomic and growth form assemblage data to enhance current palaeoenvironmental interpretations of the sediments.***

It is crucial to understand the type of ecological niche to which a taxon is adapted, in order to understand its distribution and evolutionary success. It is also crucial to understand which taxa or growth forms are indicative of certain environments for correct interpretations of palaeoenvironments. It is clear that the understanding of each of these two fields are intertwined and can enhance each other.

Bryozoans have different overall life histories (colonial, sessile, active filter-feeding, short-lived larvae) from other phyla, which occur in these sediments. They therefore have the potential to add to the facies interpretation by recording environmental factors that other animals do not show as clearly. This is particularily important in the St Vincent Basin, as this small and restricted basin created diverse and, as yet, somewhat enigmatic environmental conditions.

Various information can be gleaned from taxonomic assemblages, ranging from species level up to class level. In addition, their colonial life style has allowed them to grow in a range of shapes, where the particular morphology is generally independent of systematic relationship, and can thus give additional information. It is productive to look at these characters in terms of assemblages. Furthermore, intraspecific variations in colony shape can give clues about the biological and physical environments, and changes occuring within them. Associated biota can assist in such interpretations, such as the competitive interaction between bryozoans and other encrusters.

Chapter 3. Materials & Methods

"Science is not a heartless pursuit of objective information. It is a creative human activity, its geniuses acting more as artists than as information processors."

S.J. Gould (1992) *Ever Since Darwin* (Norton & Co.)

3.1. Sampling Strategy and Methodology

Detailed stratigraphic columns were measured for each section to enable the establishment of precise sample locations. Fossiliferous sediments were sampled by taking bulk samples for each distinguishable layer. The goal was to acquire at least 1kg for each sample. To avoid local sampling bias effects, several sites along each continuous layer were sampled at each outcrop. In addition, separate samples of selected specific fossils (e.g. lunulitiform, complete or well-preserved colonies, etc.) were taken. Sediments containing only sparse fossils were mainly sampled for specific fossils, although bulk samples were taken to check for fossils not easily distinguished with the hand lens. Sampling several centimetres into the exposure to avoid some of the surficial weathering effects was generally ineffective due to the long diagenetic history of weathering and ground water affecting most formations.

An important consideration during sampling was to avoid sampling from burrow infill at the same time as sampling the burrowed layer. This was especially necessary at the top of the Tortachilla Limestone where the Tuketja Member infills into burrows (James & Bone, 2000). Such 'contamination' would significantly influence the resulting assemblages.

3.2. Sample Preparation

The standard amount used from each bulk sample was 250g. The sample size was kept constant rather than attempting to acquire a consistent number of specimens (e.g. 1000 specimens/sample) from each sample, as is usually done in micropalaeontological studies. The advantage of a consistent specimen number would be more comparable statistical analyses from the data. It was, however, not possible to achieve this with the wide ranges in fossil content, fragment sizes and cementation of the sediments. Micropalaeontology studies also deal with complete individuals whereas with bryozoans there is the problem of how many fragments came from one original colony.

Any notable characteristics were also recorded, such as degree of cementation, sand or mud content, degree and types of encrustation etc.

The samples were all well washed to ensure no halite or other soluble minerals remained which could damage type and figured specimens in storage. The wide variety of sediment types, fossil content and specimen preservation required customised sample preparation.

3.2.1. Friable samples

Most of the fossiliferous samples are friable (uncemented) and easily disaggregated. After initial weight measurements were made, these samples were dry sieved through a column of seven standard sieves, with diminishing mesh sizes to separate them into standard grain size fractions (this was done to allow individual treatment of each size fraction):

4.0 mm (removes cemented rock fragments and large fossils; combined with the 2 mm fraction),

2.0 mm (gravel, many larger colony fragments),

1.0 mm (very coarse sand),

0.5 mm (coarse sand),

0.25 mm (medium sand; this is slightly finer than most known cheilostome zooid sizes),

0.125 mm (fine sand; usually only contains zooid fragments and occasional small Catenicellidae),

0.063 mm (very fine sand; no identifiable fragments of bryozoans but was retained for reference),

< 0.063 mm (silt and mud; this fraction was discarded).

Each size fraction was then soaked in vials in a warm solution of approx. 5% H_2O_2 (higher concentrations may attack the carbonate; K.M. Brown, pers. comm., 1999) and heated for 5 – 10 minutes (longer for the large size fractions) whilst slightly agitating or stirring. This facilitated the dislodging and dispersal of clay from crevices within the specimens. The fractions were then placed in a sonic bath. This was only done for less than a minute for the fine fractions, as by this time most of the clay was removed and more time could have damaged delicate specimens. Up to several minutes were used for the very coarse fractions with occasional stirring to disaggregate the slightly cemented specimens.

The whole sample was then re-combined and wet sieved again through the above mentioned sieves to wash out the mud and sediment and also to fully separate the size fractions.

The dry-weight of each fraction was measured after the size fractions were air dried. This was often significantly lower than the initial bulk measurement, indicating a high silt and mud content. Each fraction was stored in a separate, labelled bag ready for further study.

It was attempted to separate out the goethite where it was present before sieving, using either liquid flotation or magnetic separation. Neither technique proved to be efficient with the equipment available and separation was therefore left to the hand-picking stage. This gives different original weight values of samples containing goethite compared to those without. These values are, however, not crucial to the final results, as values for analyses were taken of total picked fossil counts.

Specimen picking was carried out using a gridded tray under a binocular microscope. Samples were picked using either a pair of fine tweezers (larger and heavier specimens) or a fine wet brush (small and fragile specimens) and separated into cheilostome growth forms (foliose, fenestrate, flat robust branching, delicate branching, articulated branching, encrusting, multilaminar/nodular, free-living), cyclostome growth forms (fenestrate, delicate branching, articulated branching, encrusting), other fossils, and other components (quartz, goethite, etc). The 4 and 2 mm fractions were completely picked and placed together in photographic film containers as the 'coarse fraction'. The 1 mm fractions was also picked completely and placed into small vials. The 0.5 mm fraction was only picked partially and placed on micropalaeontological slides with gum tragacanth. Only one tray was picked from the 0.25 mm fraction and the specimens were also placed on micropalaeontology slides. The

0.125 mm fraction was briefly looked at for the presence of any identifiable material.

Larger volumes of the coarser fractions were picked than of the finer ones for several reasons:

a) the smaller specimens are less confidently identifiable.

b) practicality allows coarser fractions to be more easily picked, as there are less fragments per gram than in the finer fractions.

c) if fragments of a species occur in both coarser and finer fractions, it is likely that the smaller fragments may have come from one of the larger specimens; if counted it would overestimate that species' abundance. This causes a dilemma. The decision taken for this study was that only those species that hadn't been found in the coarser fractions were counted. Therefore more attention was paid to those species in the finer fractions that had not been observed in the coarser fractions. In particular the Catenicellidae and *Crisia* usually only occurred in the fine fraction.

Further sedimentary and fossil characteristics were noted during picking (including general composition, grainsize, fragmentation/ abrasion, degree of recrystallisation/ alteration). Thus interpretations could be done in conjunction with other characters observed in the sediments. These include sedimentology (sediment type, sediment structures, fragmentation, rounding, sorting, colour), distribution of other fauna, trace fossils, facies (vertical and lateral variation).

3.2.2. Cemented Samples

Highly cemented samples were analysed by first breaking up the sample as much as possible without damaging the specimens too much.

A freeze/thaw method was attempted with cemented samples, but the fact that it tends to break samples preferably where specimens are, is a mixed blessing where bryozoans are concerned. Although such a break generally revealed hidden bryozoan colonies, many of the specimens were severely damaged by the ice expanding within the zooid chambers, while the external walls (which contain the taxonomically significant features) remained firmly stuck to the matrix.

Mechanical disaggregation using a hammer and fine chisel was only done in rare cases, as it is too physically severe and suffers from similar problems as the freeze/thaw method.

The chemical method of artificial weathering described by Zágorsek (2000) was not available in time to use for this research, but will be attempted in future. It would possibly be useful to extract specimens from the well cemented samples of the Blanche Point Formation.

Where further disaggregation was not possible, the fossils were identified and counted on the outer surfaces of fragments and estimates as to the abundance within were made. This possibly biased the abundance and diversity data towards the unlithified sediments, but it did give a general idea of relative abundances.

3.3. Data Acquisition

Quantifying the abundance of colonial animals has problems not encountered in unitary animals. How should colonial fragments be counted? Methods of acquiring quantitative values for the abundance of taxa and growth forms within bulk samples fall into several categories:

a) *Counts of fragments (specimens)*: Each fragment is equivalent to one whole count. This is probably one of the most widely used methods. It is the easiest and most straightforward way of counting, although the numbers may need to be indexed (see below). Problems include the fact that some colony morphologies break into many fragments (e.g. articulated branching), whereas others stay intact, giving an over-representation of the former.

b) *Weight*: This is potentially the easiest method. Problems include how to weigh encrusters without including the substrate, how to weigh samples that are cemented together, how to weigh very small and rare species or growth forms. Differences between heavily (re)calcified and delicate (and/or not recrystallised) specimens of similar size may also skew the resulting numbers.

c) *Volume*: This can be achieved by immersing the sample in a known volume of water and measuring the displacement. This would be an important method to estimate the contribution a particular group makes to the volume of the sediment. Problems include that it is not accurate or feasible for small amounts and small specimens; it is also not accurate for encrusters as it will include the volume of the substrate, for samples that are cemented together, and for delicate or lightly calcified species.

d) *Surface area*: This would give an idea of the feeding area. Problems include unfeasibility for highly three dimensional or very small specimens. It would also require special considerations for bilaminar colonies and ones with maculae and closed-off zooids.

e) *Counts of zooids per fragment*: This can also give an idea of the 'productive area' (number of 'feeding' individuals) of a species or growth form, and it relates the fragment size to number of fragments. To be feasible, it would require the counts to be indexed into categories of zooid numbers for each species or growth form (see also Hageman *et al.*, 1997). Counts of zooids can easily be converted into a count of fragments. It does pose problems regarding the treatment of unilaminate vs. bilaminate vs. multilaminate colonies. In some species the number of zooids per colony is also constrained, whereas in others it may be limitless. The different size of zooids may also need to be considered, as they may range over one or two orders of magnitude for different taxa, most notably between cheilostomes and cyclostomes.

A ubiquitous problem which cannot be avoided is the varied effect of both physical and chemical taphonomic processes on different growth forms. Robust forms will fragment less easily and compact forms often dissolve less easily (Smith *et al.*, 1992; Smith & Nelson, 1996). Any form of correction applied to the raw numbers, would involve many assumptions and could result in even greater inaccuracies.

A further problem with all of these methods is that none of the resulting numbers are directly indicative of original abundance. Large fragments (thus many zooids, high weight, etc.) do not necessarily indicate higher abundance of colonies. It may simple indicate greater robustness, faster growth, or longer life-span.

As a compromise, counts of fragments were recorded separately for each size fraction (>2 mm, 1 – 2 mm, <1 mm). This allowed minor adjustments to be made for species occurring across a range of size fractions. Growth forms were also recorded separately in cases where species displayed more than one growth form (e.g. *Porina spongiosa*).

3.4. SEM Image Recording

Most detailed images of specimens were obtained through Scanning Electron Microscopy, using the Philips XL20 SEM and XL30 FESEM (the latter for uncoated specimens) at the Centre for Electron Microscopy and MicroStructure Analysis (CEMMSA) at the University of Adelaide.

The digital images captured from the SEM had to be adjusted by stretching vertically relative to the horizontal by 110%. This is necessary as the original digital images are calibrated to the Philips display screen, the pixel resolution of which is not exactly 1:1 (i.e. the monitor pixels are slightly elongated vertically resulting in a 1:1.1 ratio). This can create horizontal artefacts in the corrected images, which may appear due to interference patterns cased by the stretching. Various published SEM images are suspected to have been taken on similar machines but not corrected for this factor. This is generally only obvious when the object has a known geometric shape (such as a circle) and it appears slightly compressed in the image.

3.5. Taxonomic Measurements

Measurements of zooidal characters were carried out under the SEM where possible. They were done under a binocular microscope at 70x magnification with an eye-piece grid for additional specimens. The grid was calibrated using a very finely graduated template. The measurements of both techniques agreed well, and can therefore be considered reliable. The dimensions which were measured are explained in Chapter 4.1.5 (p. 30) and Fig. 6.

3.6. Growth Form Classification Scheme

The classification scheme for growth forms in the taxonomy section is the Analytical Bryozoan Growth Habit Classification (ABGHC) of Hageman *et al.* (1998; see Chapter 4.1.6, p. 31). The advantage of this system is that individual components can be used for separate analyses (e.g. attachment method only). The discussion, however, uses more generalised terms to distinguish general groups (adapted from Bone & James, 1993), which, for consistency, is given in the description for each species as well. Such simplifications of growth form categories can easily be done from the existing character matrices. A problem with this classification is that frequently characters such as attachment method or frequency and dimensions of bifurcations are not preserved. It is nonetheless a useful method.

CHAPTER 4: SYSTEMATIC PALAEONTOLOGY

"...Only masochists study bryozoans. Some moss animals exhibit a variety of growth forms and a range of color which makes identifications by the non-specialist almost impossible. The rest of us take the specialists' word for it and as there are so few of them, they are reluctant to disagree with one another, which makes for a form of biological freemasonry. That is about as much as anybody needs to know about bryozoa."

Paddy Ryan (1994) *The snorkellors guide to the Coral Reef – from the Red Sea to the Pacific Ocean.* (Exile Publishing Ltd., London)

4.1. Introduction

4.1.1. Scope

The main focus of this study were the Cheilostomata, which are therefore described and discussed in greater detail than the Cyclostomata. Frontal wall morphology is today considered one of the most important taxonomic and phylogenetic characters in cheilostomes. It was however not possible to investigate greater details such as internal structures and crystallite morphology due to the poor preservation and recrystallisation.

The Cyclostomata are analysed to a lesser extent. This was partly due to the fragmentary nature of most specimens and the importance of colonial morphology in cyclostome taxonomy. Some comparisons between the abundances of the two orders are made, so a brief taxonomic outline of the most common and recognisable cyclostome species is included along with growth form classifications. It is likely, however, that this species list is an underestimate of the actual diversity of the Cyclostomata.

4.1.2. Repositories of material studied

Specimens collected from the St Vincent Basin during this study are deposited with the South Australian Museum. Generally only the figured specimens have been assigned register numbers. Where a range in characters occurs, several specimens were registered. Repositories of other material examined are abbreviated as follows:

MM ....Manchester Museum, Manchester, UK.

MNHN.....Musée Nationale d'Histoire Naturelle, Paris, France.

NMV........Museum Victoria, Melbourne, Victoria, Australia.

NMNH.....National Museum (Natural History), London, UK.

SAM ....South Australian Museum, Adelaide, S.A., Australia.

USNM.....United States National Museum (Smithsonian Institution), Washington, D.C., USA.

WAM ....Western Australian Museum, Perth, W.A., Australia.

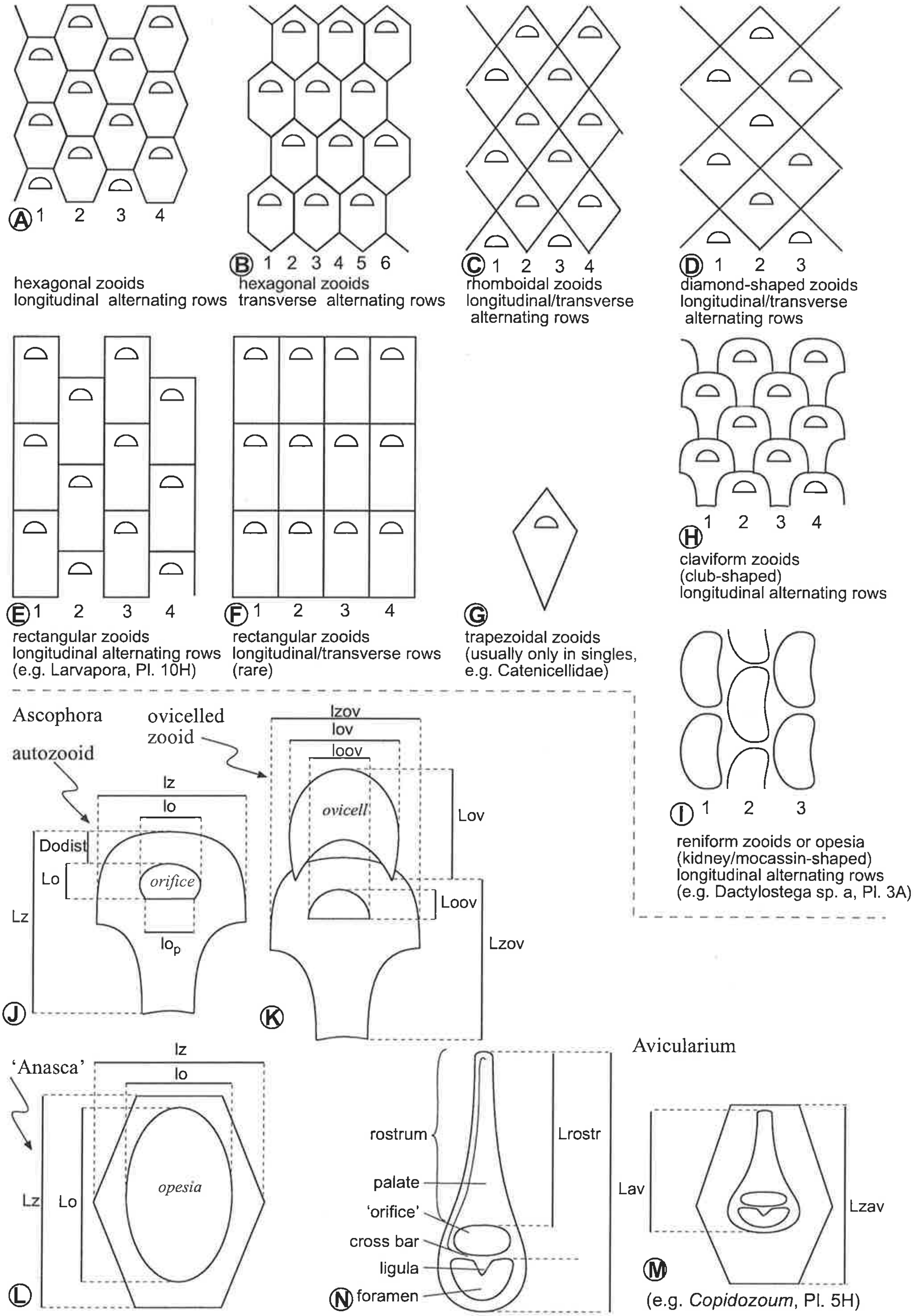


Figure 6: **A-I**, Terminology of Bryozoan zooidal shapes (row numbers below each diagram refer to the growth direction, i.e. if an erect radial colony is described with 'zooids in 6 alternating transverse rows'). **J-M**, Terminology of zooidal characters and dimensions measured; **J**, **K**, ascophoran zooid; **L**, anascan zooid; **M, N**, avicularium.

4.1.3. Species descriptions

The terms used within the description section are descriptive, rather than genetic (e.g. 'pleurocyst') or generalised (e.g. 'hippoporine') (see also Cheetham, 1966: 14), as such terms continually change with advances in our understanding of their biology and ontogeny and therefore their taxonomy. Zooid shape terminology is explained in figure 6.

The descriptions for the species in this study are only of the specimens collected and observed from the St Vincent Basin. Comparisons with other species (including the type specimens of the species they are assigned to) are given in the comparisons section below each species description.

Taxonomic terms used in the nomenclature (after Bengtson, 1988: 226):

sp. nov.......indicates that this species belongs to a new species and cannot be assigned to any known species.

aff...............(*affinis*) relates a new, undescribed taxon to a named species; it indicates that they are two distinct but similar species.

cf................(*confer* = compare to) indicates the identification is provisional, and the species may or may not be the same as the one it is compared to.

?.................placed *after* the species, genus or family name indicates that the identification at the respective taxonomic level is uncertain.

'...'.............(inverted commas) indicates that the name (species, genus or family) is obsolete in the immediate context of systematic interest.

sp...............(*not* 'sp. a', 'sp. b', etc.) indicates that specific identification is not possible (often due to poor preservation of taxonomic characters).

The substantial number of new species and new genera identified during this study poses a challenge within the section on the discussion of the fauna. The format of this thesis does not fall within the prescriptions of the I.C.Z.N. regarding the valid establishment of new taxon names, so it is not desirable to give the taxa new names at this stage. Instead, the closest related genus is used in inverted commas ('...'). This does not imply any close evolutionary connection between the name used and the taxon from this study. New species are simply designated with 'sp. nov. a', sp. nov b' etc. Correct publication protocol and naming of all species referred to in this thesis will follow as soon as possible.

Many specimens upon which the following identifications are based are small (<20 zooids). This is due to the fragmentary nature of most sediments investigated (with the exception of the Blanche Point Formation and rare local horizons of other formations). This poses several challenges for detailed taxonomic investigation. Many species and genera display significant variation in zooidal character across an individual colony, such as secondary thickening, senescence, frontal budding, or totally different zooid morphology within the same colony (e.g. *Dimetopia hirta* (MacGillivray) and *Corbulipora* MacGillivray; see Bock & Cook, 2001). Descriptions of the species based on such fragments must therefore be regarded as possibly incomplete until more complete colonies can be found.

4.1.4. Occurrences

Abbreviations of the stratigraphic and geographic origins of registered specimens as well as sample numbers are as follows:

Formation – Member (horizon)	Abbreviation	Sample no.	Location (see fig. 4)
St Vincent Basin			
Tortachilla Limestone	TL		
Tortachilla Limestone – Lower	LTL	18/002	M2
Tortachilla Limestone – Middle	MTL		
Tortachilla Limestone – Middle (lower)	MTL(l)	18/003	M2
Tortachilla Limestone – Middle (middle)	MTL(m)	18/006	M2
Tortachilla Limestone – Middle (upper)	MTL(u)	18/009	M2
Tortachilla Limestone – Upper (glauconitic)	UTL	21/***	M2
Blanche Point Formation	BPF		
Blanche Point Formation – Tuketja Member	BPFtk	11/011	M3
Blanche Point Formation – Gull Rock Member	BPFgr		
Blanche Point Formation – Perkana Member	BPFp		
Port Willunga Formation	PWF		
Port Willunga Formation – Aldinga Member	PWFa		
Mullowurtie Formation	MF	cliffs between Sliding Rocks & Rocky Point	
Mullowurtie Formation – basal member	MF(b)	28/008	Stuart section 7
Rogue Formation	RF		
Rogue Formation – Lower (limestone facies)	LRF(l)	22/041	Sheoak Flat South
Rogue Formation – Lower (sand facies)	LRF(s)	22/042	Sheoak Flat South
Rogue Formation – Upper (above Port Julia Gsd)	URF		
Port Vincent Formation	PVF		
Kingscote Limestone – Lower (lowest)	LKL(l1)	23/035	Yacht Club
Kingscote Limestone – Lower (lower)	LKL(l2)	23/008	Yacht Club
Kingscote Limestone – Lower (middle)	LKL(m)	23/005	Type section
Kingscote Limestone – Lower (upper)	LKL(u)	23/004	Type section
Kingscote Limestone – Lower (top)	LKL(t)	23/002	Type section

Formation (Basin in bold)	Abbreviation	Age *(see also Fig. 3)*
Murray Basin (occurrence preceeded by MB)		
Mannum Formation	MnF	Upper Oliogocene – Lower Miocene
Morgan Group (Morgan Limestone)	MG	Middle Miocene
Otway Basin etc (occurrence preceeded by OB)		
Gambier Limestone	GL	Upper Eocene – Lower Miocene
Browns Creek Clay	BCC	Upper Eocene
Gellibrand Marl	GM	Lower Miocene
Port Campbell Limestone	PCL	Middle Miocene
Jan Juc Formation	JJF	Upper Oligocene
Fyansford Clay	FC	Middle Miocene
Eucla Basin (occurrence preceeded by EB)		
Wilson Bluff Limestone	WBL	Middle Eocene – Lower Oliogocene
Abrakurrie Limestone	AL	Upper Oligocene
Nullabor Limestone	NL	Middle Miocene
Carnarvon Basin (occurrence preceeded by CB)		
Cardabia Calcarenite	CC	Upper Paleocene – Lower Eocene
Giralia Calcarenite	GC	Middle Eocene

The relative abundance of the secies in each horizon is given in brackets after the stratigraphic name:

[p]	present	only one specimen found
[r]	rare	2 – 4 specimens found
[i]	infrequent	more than 5, but less than 1% of total bryozoan specimens in sample
[f]	frequent	>1% but <2% of total bryozoan specimens in sample
[c]	common	>2% but <5% of total bryozoan specimens in sample
[a]	abundant	>5% but <10% of total bryozoan specimens in sample
[d]	dominant	>10% of total bryozoan specimens in sample

4.1.5. Measurements

The measurements of taxonomic characters for each species are given as small tables below the description. The number of different fragments (treated as proxy for colonies) used to acquire the measurements are indicated at the top of each table.

Column one: taxonomic character measured (see list of abbreviations below).
Column two: number of measurements made for the given character.
Column three: average of all values for the given character.
Column four: standard deviation to indicate the variability of each character.
Column five: observed range of values (i.e. minimum and maximum values).

All measurements give the maximum dimension. Length (L) is generally measured longitudinally (parallel to growth direction) while width (l) is usually measured perpendicular to this, unless the maximum values . Avicularian length is measured parallel to the rostrum. All measurements are made on zooids within the zone of repetition where possible, unless otherwise stated. Measurements for characters of ovicelled zooids (other than the ovicell itself) are only given if they significantly differ from those of autozooids. In these cases measurements of zooid length are mostly done excluding the ovicell itself. Sometimes the margins of characters are not distinct (e.g. secondary thickening or deeply immersed ovicells). Approximate measurements are marked with an asterisk (e.g. 'Lzov*').

Abbreviations

Only abbreviations for length 'L' are given here, width is indicated by substituting 'l':

Lz .... length of autozooid
Lo .... length of primary orifice/opesia
Lo_2........ length of secondary orifice (usually opening of peristome)
Lz2 .... length of lateral zooid in a doublet (Catenicellidae)
Lo2 .... length of orifice of lateral zooid in a doublet (Catenicellidae)
loprox... width of proximal orificial margin (if different to main orifice)
Dodist .. distance of distal orifical margin to distal zooidal margin
Do_2-as . distance between orifice and ascopore on frontal wall (≈ peristome length?)
La .... length of ancestrula
Lcost.... length of costal shield (Cribrilinidae)
Lspir..... length of spiraminal area (e.g. *Adeonellopsis*)
Lov .... length of ovicell/brood chamber
Loov..... length of ovicelled zooids mouth
Lzov..... length of ovicelled/fertile zooid
Lovfen.. length of fenestra in ovicell (e.g. *Trigonopora*)
Lav .... length of vicarious/interzooidal avicularium
Lrostr ... length of rostrum (if significantly different from whole avicularium)
Loav..... length of avicularian orifice
Lav-ad . length of adventitious avicularium
Lav-o.... length of oral avicuarium (e.g. Smittinidae)
Lav-ov.. length of adventitious avicularium associated with the ovicell
Lav-ch.. length of avicularian chamber (if avicularium broken, e.g. *Celleporaria*)
Lp .... length of polymorph (e.g. *Antropora savartii*)
..(marg) character in a marginal zooid
øo-p ..... diameter of polymorph opesia/orifice
øcol ...... diameter of colony
ø… .... diameter of any character

4.1.6. Analytical Bryozoan Growth Habit Classification

The Analytical Bryozoan Growth Habit Classification (A.B.G.H.C.) section follows the recommendations of Hageman *et al.*, (1998). The purpose of describing the colonial growth forms in this way is to allow analyses (e.g. multivariate) of the assemblages. Classifications given in italics are inferred (e.g. '*rooted attachment*' for species of Cellariidae was not observed, but assumed, based on observations of extant species). In many instances it was difficult or impossible to evaluate character states, such as bifurcation aspects, and these are indicated with question marks.

A. Orientation relative to substrate
Encrusting....................1
Massive....................2
Erect-continuous....................3
Pedunculate....................4
Fungiform....................5

B. Attachment to substrate
Cemented....................1
Rooted....................2
Free-living, sedentary or tumbled....................3
Free-living, avicularia supported....................4
Endolithic....................5
Regenerated (erect)....................6

C. Construction
Rigid contiguous....................1
Articulated, indeterminant cuticular joints....................2
Articulated, determinant cuticular joints....................3
Flexible weakly-calcified....................4
Uncalcified....................5

D. Arrangement of zooecial series
Uniserial....................1
Biserial....................2
Oligoserial (3~12)....................3
Macroserial nonmaculate....................4
Macroserial maculate....................5

E. Arrangement of frontal surfaces
Unilaminate....................1
Bilaminate....................2
Trilaminate....................3
Quadrate....................4
Radial....................5
Multilaminate....................6

F. Secondary thickening
No secondary skeletal thickening....................1
Frontal/obverse skeletal thickening....................2
Basal/reverse skeletal thickening....................3
Frontal and basal skeletal thickening....................4

G. Structural units
Single zooecium....................1
Cluster of 2-5 zooecia....................2
Runner-branch with flat surface....................3
Runner-branch with convex surface....................4
Sheet....................5
Lobe....................6
Disc....................7
Solid cylinder....................8
Hollow cylinder....................9
Solid cone-cap-dome....................10
Hollow cone-cap-dome....................11
Spheroid to ellipsoid....................12
Nodule....................13

H. Dimensions of structural units
Straight or flat....................1
Curved or folded....................2
Primary 3-D object....................3

I. Frequency of bifurcation
No bifurcations....................1
Infrequent bifurcations (1-2 from primary)....................2
Frequent bifurcations (3-5 from primary)....................3
Very frequent bifurcations (6 or more)....................4

J. Dimensions of bifurcation
No bifurcations....................1
Bifurcation in one plane (fan)....................2
Bifurcation in more than one plane (bush)....................3

K. Connection of structural units
No lateral connections....................1
Fused structural units....................2
Extrazooecial skeletal connections....................3
Cuticular tubes connecting structural units....................4
Stolonate connection of zooecial units....................5
Calcified tubes connecting structural units....................6

Substrate type
Hard primary........'bed rock'
Hard secondary...Bivalve......... exterior/interior
..............................Echinoid....... exterior/interior
..............................Bryozoa....... erect/not
..............................other encruster
Particulate............Lithic fragment
..............................Quartz
..............................Goethite
..............................Carbonate
Live organic

4.1.7. Comparisons with species of other authors

Positive comparisons with most (type)specimens of researchers such as Waters, MacGillivray and Maplestone are difficult as these specimens are generally sealed under glass wells or cover slips on slides. This does not allow SEM images to be taken. Details are often difficult to distinguish under the light microscope due to the glassy nature of the material. It is not possible to view the reverse of the specimen, which may contain critical detail, when a wood or cardboard slide was used. Sediment from the specimen has come loose in many cases and is now stuck to the slide or cover slip, further obscuring the view. Most of the specimens are glued to the slide and in several cases too much glue was used and subsequently filled in many of the features (e.g. MV P27670, *Adeonella triton* MacGillivray) or even completely enveloped the specimen. In a few cases (especially with the Catenicellidae) the specimen was glued too far towards the edge of the well, so that it is now difficult to see. All these factors must be taken into account when considering the following identifications.

It was considered best to refrain from calling similar species 'closely related'. This would imply evolutionary and phylogenetic connections. Such connections are difficult to ascertain with certainty in fossil taxa. Bryozoa are particularly difficult in this respect, as taxa frequently display strong convergence of characters at either or both zooid and colony levels. Such relatedness must, however, be assumed when making biogeographic comparisons.

Comparisons of taxa (at any systematic level) are only meaningful if they can be regarded as monophyletic. Thus there is no significance in the statement "family X has a wide ecological tolerance" (equally applicable to biogeography or evolution) if it turns out that the genera within such a family do not share a unique (different to all other genera) common ancestor (i.e. it is a polyphyletic taxon).

Information on the occurrence of species cited in most publications by MacGillivray, Maplestone and Waters only consists of geographic localities. Most of these have been correlated with appropriate formations and ages by Bock & Cook (e.g. 2001). In some cases, however, the locality is informal or not possible to define with certainty (e.g. 'Yarra Yarra'). The commonly used 'Schnapper Point' itself does not have any fossiliferous outcroppings. It is located halfway between Fossil Beach, where the Balcombian lower Fyansford Formation outcrops, and Grices Creek, where the Bairnsdalian upper Fyansford Formation outcrops (T.A. Darragh, pers. comm., 2003; Bock & Cook, 2001, consider Fossil Beach most likely). Both ages are Middle Miocene, which is sufficient for use in this study, but both sections will nedd to be resampled for more detailed biostratigraphic studies.

4.1.8. Plates

Each species has at least one SEM image, which is scaled to one of several uniform magnifications (indicated at the bottom of the plate caption). This allows images of different species to be more accurately compared. Additional images are usually at different magnifications. Scale bars are used, rather than magnification degree, as the latter are relative and change when scaled (e.g. through photocopying).

Phylum **BRYOZOA** Ehrenberg, 1831
Class **GYMNOLAEMATA** Allman, 1896
Order **CHEILOSTOMATA** Busk, 1852

Suborder **MALACOSTEGA** Levinsen, 1902

REMARKS: This group is probably paraphyletic. It is characterised by a planktotrophic cyphonautes larva (Taylor, 1987), and therefore a lack of brooding structures. Most genera also lack avicularia, but where these structures are present, they are poorly developed.

Superfamily **MEMBRANIPOROIDEA** Busk, 1852

Family **MEMBRANIPORIDAE** Busk, 1852

DESCRIPTION: "Colony encrusting, or erect from an encrusting base. Zooidal frontal membrane covering all or much of the surface, the gymnocyst reduced or absent, the cryptocyst variable in extent, usually little developed. Tubercles may occur at the distal corners of zooids and spines may be present around the opesia. Avicularia rare, basal pore-chambers and ovicells absent. Larvae planktotrophic, of the cyphonautes type." (Gordon, 1984)

REMARKS: The distinguishing feature of the Membraniporidae is their twinned ancestrula (Taylor & Monks, 1997). As the ancestrular region is rarely preserved in specimens from this study, assignment of the following species to this family is tentative.

BIOGEOGRAPHY: The first occurrence of the Membraniporidae is *Biflustra savartii texturata* (Reuss, 1848) in the ?Priabonian (Upper Eocene) of Italy (Braga & Barbin, 1988).

Genus ***Biflustra*** d'Orbigny, 1852

TYPE SPECIES: *Flustra ramosa* d'Orbigny, 1852

DESCRIPTION: Colony encrusting, or erect bifoliate from an encrusting base. Gymnocyst reduced, a cryptocyst occasionally well developed proximally, with proximal serrate denticles. Opesia occupying most of frontal area and covered by simple frontal membrane.

REMARKS: *Biflustra* probably originated in the Late Eocene (Priabonian; see above). If the species tentatively assigned here to *Biflustra* indeed belong to this genus, they would constitute one of its earliest occurrences.

The following species are the most distinctive ones found and probably represent only a fraction of species in this catch-all group, as many of the very common fragments of single to a few zooids are too featureless, altered and/or abraded to be distinguished as distinct species.

***Biflustra*? sp. nov. a**

Plate 1D, E, F

MATERIAL: SAM P39466 (TL), P39467 (TL)

DESCRIPTION: Colony unilaminar encrusting.

Zooids irregularly oval to hexagonal, clearly defined by furrow, which often contains a ridge of variable width, gymnocyst of variable width, often wider proximally (mainly in elongated zooids), sloping slightly inwards.

Opesia oval to rounded rectangular (often mirrors the shape of the zooid itself), commonly with distal shelf, which may extend proximally to half the opesial length and up to a level just below the opesial opening, the shelf appears to curve around underneath itself in many zooids.

Ovicells and avicularia not observed.

MEASUREMENTS: (2 specimens)

Lz	5	0.64	0.043	0.62-0.72
lz	5	0.49	0.036	0.42-0.52
Lo	5	0.47	0.033	0.40-0.48
lo	5	0.28	0.013	0.26-0.28

A.B.G.H.C:

A. Orient. substr.	1. Encrusting
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: LTL *[r]*, MTL(l) *[p]*, MTL(m) *[p]* (especially as individual zooids)

COMPARISONS: This species is similar to *Membranipora elliptica* MacGillivray (1895: 35, pl. 4, fig. 12; Middle Miocene, Otway Basin) , but differs in the distinctive broad distal 'shelf'. It also resembles various species of *Alderina* Norman, but the absence of avicularia and ovicells distinguish it from that genus.

REMARKS: The individual zooids appear to become detached from one another relatively easily and are often found as individual zooids or fragments within the finer sediment fractions. This tendency to fragment, together with the relatively featureless zooids, makes this a difficult species to define.

***Biflustra*? sp. nov. b**

Plate 1A, B, C

MATERIAL: SAM P39352 (TL)

DESCRIPTION: Colony erect delicate branching or bilaminar with flat branches; at bifurcation the zooid rows vigorously divide, with most central rows terminating at distal junction.

Zooids hexagonal, clearly defined by furrow, gymnocyst very narrow, often only visible proximally, cryptocyst almost concentrically granular, moderately wide, especially proximally.

Opesia oval to rounded rectangular, very narrow sloping ridge just below distal margin, large pore centrally perforates lower part of distal wall, with small pore (indentation) on either side.

Ovicells and avicularia not observed.

MEASUREMENTS: (2 specimens)

Lz	6	0.60	0.074	0.55-0.74
lz	6	0.44	0.039	0.41-0.50
Lo	6	0.37	0.020	0.35-0.41
lo	6	0.25	0.021	0.23-0.29

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	2. Bilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: Foliose: LTL *[p]*, MTL(l) *[r]*, MTL(m) *[r]*, ILRF(l) *[r]*;

Delicate branching: MTL(m) *[r]*.

COMPARISONS: *Amphiblestrum robustum* Maplestone (1900b: 3, pl. 1, fig. 8; Middle Miocene, Otway Basin) is similarly erect branching, but the type specimen (NMV P10121) has larger zooidal measurements (Lz = 0.92, lz = 0.50, Lo = 0.50, lo = 0.32) and possibly an opesial rim of small spine bases. The zooids of the Australian Recent species *Biflustra perfragilis* MacGillivray appear similar overall, but as both are relatively featureless, this may simply be coincidence.

REMARKS: The very delicate basal stem of this colony and the much wider upper branches would probably be very fragile in a higher energy environment. It therefore appears to indicate a low energy environment.

Cheetham (1971) considered that erect colony forms depend on ability of zooids to calcify their frontal surface. The above species however, achieves definite erect branching form with completely uncalcified frontal zooid surfaces. The individual zooids also appear similar to those that are frequently found loosely within the sediment (cf. *Biflustra* sp. a), indicating that zooids may not be joined very strongly. These features, together with the basal colony stem being much thinner that the upper branches, should conventionally imply growth within a low energy environment. Judging from the coexisting growth forms, however, this may only have been a transient situation

Biflustra? sp. nov. c

Plate 1G

MATERIAL: SAM P39468 (TL), P393469 (TL)

DESCRIPTION: Colony ?encrusting unilaminate.

Zooids irregularly oval to rectangular, defined by narrow shallow furrow, frontal wall finely granular, slightly convex (especially proximally) but sloping in towards opesia, sometimes with rim circling opesia.

Opesia oval to rounded rectangular, occupying distal 3/4 of zooid, positioned near, but not abutting, distal zooid margin, where it forms a small narrow lip above a ledge of varying width where it onlaps distal zooid; proximal margin with short triangular denticle, placed slightly off-centre medially, one pore chamber in distal wall, large paired dietellae at base of disto-lateral corners.

Ovicells and avicularia not observed.

MEASUREMENTS: (2 specimens)

Lz	10	0.39	0.052	0.32-0.48
lz	10	0.26	0.013	0.24-0.28
Lo	10	0.24	0.022	0.20-0.26
lo	10	0.19	0.045	0.14-0.24

A.B.G.H.C:

A. Orient. substr.	?1. Encrusting
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	?1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(m) *[r]*, MTL(u) *[r]*.

COMPARISONS: The presence of distinct proximal opesial denticles indicates that this is may be a true *Biflustra*. This species somewhat resembles *Membranipora deborahae* (Brown, 1952; Lower Oligocene, New Zealand), but the lack of features on both species makes this only a tentative comparison.

REMARKS: The large zooid shown at the bottom right in Plate 2G is reminiscent of a brooding zooid in some anascan genera, but which are absent in the Membraniporidae. It is, however, more likely to represent the point of fusion of two zooid rows.

Biflustra? sp. nov. d

Plate 2D, E, F

MATERIAL: SAM P39351 (TL)

DESCRIPTION: Colony ?encrusting unilaminar, possibly multilaminar.

Zooids hexagonal, clearly defined by furrow, gymnocyst very narrow, but often very wide proximally, cryptocyst concentrically granular, moderately wide.

Opesia oval to rounded rectangular, narrow ridge sloping down from distal margin, large pore centrally perforates lower part of sloping distal wall, often halfway along zooid, sometimes with small pore on either side, pair of large muscle-scars tucked into distolateral corners and indenting cryptocyst.

Vicarious avicularia present at bifurcations of zooid rows, rostrum small, directed proximally and abfrontally.

Ovicells not observed.

MEASUREMENTS: (2 specimens)

Lz	11	0.54	0.090	0.43-0.74
lz	11	0.37	0.080	0.29-0.50
Lo	11	0.33	0.053	0.25-0.41
lo	11	0.21	0.052	0.14-0.29

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	2. Bilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: TL *[r]*

COMPARISONS: *Membranipora pegma* Brown (1958: 34; Port Campbell Limestone, Middle Oligocene, Otway Basin) has a very similar internal zooid structure (pores and distal shelf), but the colony is delicate branching and no avicularia exist on the type specimen (NMV P73122).

'*Biflustra*' cf. *orbicularis* (MacGillivray)

Plate 2G, H

Membranipora striata MacGillivray, 1895: 35, pl. 4 (fig. 9) (part)

Membranipora striata orbicularis MacGillivray, 1895: 35, pl. 4 (fig. 10)

Material: SAM P39318 (TL)

Other material examined: NMV P27561 (holotype of *Membranipora striata orbicularis*, MacGillivray coll., Middle Miocene); P39934, P39955, P39956, P138666 ('*Membranipora striata*', MacGillivray coll.; not P39935, which is the type of *M. striata*).

Description: Colony encrusting unilaminar, substrate not observed.

Zooids very large, longitudinal hexagonal to diamond-shaped, margin defined by shallow narrow furrow, with a narrow ridge running along each side, a broad smooth ridge (probably gymnocyst) bordering opesial margin directly abuts the marginal ridge except at proximal margin, which is a flat and finely granular area of varying width.

Opesia rounded diamond shaped to oval, positioned centrally and occupying most of zooid area, occasional additional rim along opesial margin indicating regenerated zooid.

Paired adventitious polymorphs at distal margin, roughly tear-drop shaped, directed towards each other and slightly distally, prominent proximal margin, decreasing distally so rostral areas often merging with each other.

Ovicells not observed.

Measurements: (1 specimen)

Lz	4	1.24	0.019	1.22-1.26
lz	4	0.86	0.025	0.82-0.88
Lo	4	0.96	0.099	0.84-1.06
lo	4	0.53	0.026	0.50-0.56

Lav	4	0.22	0.043	0.16-0.26
lav	4	0.15	0.010	0.14-0.16

A.B.G.H.C:

A. Orient. substr.	?1. Encrust or ?3. Erect
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	?1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

Occurrence: MTL(m) *[p]*, MF(b) *[r]*; (OB) FC [Schnapper Point], GM [Muddy Creek?]

Comparisons: Among MacGillivray's material for *Membranipora striata*, P39934, P39955, P39956 and P138666 appear very similar to this species, while P39935 looks very different (no distal polymorphs, different zooid shape, opesia positioned close to distal margin) and is the only one, which has the 'concentrically striated margin'. The two groups probably belong to different species and P39935 agrees most closely with *M. striata sensu stricto*. Because the material (P27561) for *Membranipora striata orbicularis* (MacGillivray, 1895) appears very similar to other specimens, these should be included in this taxon. *M. orbicularis* should also be raised to species status due to its distinctiveness.

'Biflustra' cf. orbicularis (MacGillivray) continued:

The paired distal polymorphs (?avicularia) are reminiscent of a variety of genera in the family Calloporidae, such as *Antropora* and *Akatopora*, but are interzooidal in these genera rather than adventitious as in *M. orbicularis*. The wide gymnocyst, and the small proximal cryptocyst are also dissimilar from any of these genera, and a new genus may be required. Bock & Cook (2002: 411) noted similarities between their *Parastichopora* sp. and MacGillivray's *M. striata orbicularis*, but were not able to examine the type specimens and had to rely on the description and illustrations provided. Both were inadequate as they relied on heterogeneous material as discussed above. It is certain, however, that this species does not belong to *Parastichopora*.

The large size of the zooids approaches those of *Gontarella gigantea* Grishenko *et al.* (2002). In *G. gigantea* the square root of Lz x lz is 1250 μm, which is much larger than the next largest extant cheilostome species at less than 900 μm (Grishenko *et al.*, 2002). The same measurement of *M. orbicularis* is 1032 μm on average, but reaches 1045 μm, which is about halfway between the two extant species cited above.

Suborder **FLUSTRINA** Smitt, 1868 (part)

Superfamily **CALLOPOROIDEA** Norman, 1903

Family **CALLOPORIDAE** Norman, 1903

DESCRIPTION: Colony encrusting, or erect bilaminar to delicate branching, from an encrusting base. Zooids with frontal membrane conspicuous in most species, occasionally partly obscured by spines. Gymnocyst and/or cryptocyst present, often very extensive. Avicularia vicarious, adventitious, or absent. Ovicell hyperstomial, often prominent and ornamented with knobs, ridges or avicularia; or reduced in size. Pore-chambers large, basal, or small and mural. (after Gordon, 1984; Hayward, 1995)

REMARKS: The family description needs to be amended to accommodate the lunulitiform growth form of the new genus described on page 56.

Genus ***'Antropora'*** Norman, 1903

TYPE SPECIES: *Membranipora granulifera* Hincks, 1880

DESCRIPTION: "Colony encrusting. Zooidal cryptocyst moderately developed, gymnocyst negligible or absent. Spines absent. Avicularia small, interzooidal, or absent. Ovicells endozooidal. Basal pore-chambers present." (Gordon, 1986)

REMARKS: *Antropora s.s.* is partly characterised by small interzooidal avicularia (see Cook, 1968). The interzooidal polymorphs in the following species are very undifferentiated and may not correspond directly to avicularia. If this is a true *Antropora*, it may be the oldest Australian record of this genus, which is considered to have originated in the Cretaceous of Europe.

Antropora? cf. _savartii_ (sensu MacGillivray, non Audouin)

Plate 2A, B, C

? *Biflustra savartii* MacGillivray, 1890: 79, pl. 9 (fig. 6). (*non* Audouin)

Membranipora savartii MacGillivray; MacGillivray, 1895: 38, pl. 5 (figs 6, 7).

Material: SAM P39349 (TL), P39350 (TL).

Description: Colony erect bifoliate, rare encrusting.

Zooids irregularly oval, margins clearly defined by furrow, narrow (?gymnocystal) ridge surrounding zooid, frontal wall finely granular cryptocyst, flat and sloping inwards to opesia; opesia approx. half zooid size, oval with flattened distal margin closer to zooid margin than proximally and often gently sloping down to basal wall; large pore in basal distal wall connecting to pore chamber, paired smaller pores in distolateral walls.

Polymorphs ?interzooidal with similar appearance to autozooids but much smaller, triangular with small circular opening, positioned in one or rarely both proximolateral corners (adventitious avicularia?)

Ovicells and avicularia not observed.

Measurements: (2 specimens)

Lz	16	0.51	0.057	0.42-0.60
lz	16	0.32	0.030	0.22-0.36
Lo	16	0.32	0.025	0.28-0.36
lo	16	0.16	0.017	0.14-0.19

Lp	11	0.12	0.026	0.07-0.16
lp	11	0.10	0.024	0.08-0.13
Øpoly	11	0.02	0.001	0.02

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	2. Bilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

Occurrence: MTL(m) *[i]*

Comparisons: *Antropora savartii* (as considered here) was initially described by MacGillivray (1880) from the Recent Australia. It should not be confused with the cosmopolitan tropical *Biflustra savartii* (Audouin, 1826), and therefore requires a new specific name. There are two of MacGillivray's specimens, both (NMV P27573, P27574) resemble the species of this study.

Amphiblestrum variabile Maplestone (1901a: 188, pl. 24, fig. 13; Gellibrand Marl; Middle Miocene; Otway Basin) has similar proximal polymorphs. It also displays evidence of marginal spines and has ovicells (NMV P10143).

This is probably not a true *Antropora* (family Calloporidae), as species of this genus only have a minor cryptocyst and are encrusting. Due to the distinctive proximal ?adventitious polymorphs, it also appears similar to some *Conopeum* species (family Electridae), but differs in important aspects, as the latter have a proximal gymnocyst, only a narrow cryptocyst, and encrusting colony growth. *Membrendoecium* Canu & Bassler also seems to have a similar proximal polymorph.

Genus ***Dactylostega*** Hayward & Cook, 1983

TYPE SPECIES: *Dactylostega prima* Hayward & Cook, 1983

DESCRIPTION: Colony encrusting, unilaminar, or erect, bilaminar. Cryptocyst developed as a narrow rim; gymnocyst reduced, obscured. Avicularia interzooidal, developed from a series of chambers present between the autozooids; other chambers with simple frontal foramina assumed to be kenozooidal. Secondary calcification originating from interzooidal chambers projecting over the frontal membrane of the autozooids as a series of blunt, irregular spikes infilling concavities between autozooids and forming an enveloping ooecial cover. Autozooids communicating with interzooidal chambers via small uniporous septula. Ovicell hyperstomial, closed by zooidal operculum. Spines absent or present.

REMARKS: Cook & Hayward (1983: 26) had initially placed *Dactylostega* within the Hiantoporidae, which may be quite reasonable, due to the similarities in the zooidal characters.

The gradational similarity between *Dactylostega* sp. a, *D.* sp. b and *Arachnopusia* sp. b (and similarly other species of *Arachnopusia*) could be significant in evolutionary terms. The single spine lateral to the orifice/opesia, the morphology of the ovicell and the shape and distribution of the numerous adventitious avicularia are in common between all the species. The Ascophora are often considered to have polyphyletically arisen from the Calloporidae. *Arachnopusia* itself used to be placed within the Anasca (Bassler, 1953: 167). The quite striking similarity of *Dactylostega.* sp. b with *Glenelgia crawfordensis* Brown (1952: 36, fig. 10; Miocene, Otway Basin) is also interesting.

Busk (1884: 68) noted " ..a short wide trumpet-shaped hollow articulated process, closed with a circular chitinous lid." "...may probably be a form of avicularium." The lateral spine base may also correspond with the attachment for a scutum (cf. *Scrupocellaria*, *Caberea*) but is possibly too small for such a structure.

Using the lateral spine as a distinguishing generic feature may be problematic, however, as the type species, *Dactylostega prima* Hayward & Cook, does not have any apparent opesial spine.

BIOGEOGRAPHY: This may be the earliest known occurrence of *Dactylostega.* *Callopora jerseyensis* Ulrich & Bassler (1907) from the Vincetown Formation (Palaeocene – Eocene; New Jersey, Delaware), however, may belong to *Dactylostega*, and thus make it the earliest known occurrence.

Dactylostega? sp. nov. a

Plate 3A, B, C

MATERIAL: SAM P39384 (TL), P39385 (TL), P39386 (TL), P39387 (TL), P39388 (MF)

DESCRIPTION: Colony ? erect bilaminar sheet.

Zooids oval, margins often obscured by secondary thickening, especially in proximal area, but often locally with deep furrow widest in zooid corners.

Opesia reniform, occupying most of zooid area, single spine base just distal to centre on the side with indentation, large paired pores in distolateral corners of vertical walls, smaller paired pores at base of distal wall.

Adventitious avicularium on proximal margin (mainly associated with ovicelled zooids) directed laterally or slightly distolaterally, ellipsoid, small condyles positioned at proximal one third; two or three smaller adventitious avicularia near distal opesial margin, directed in various directions, no cross-bar or condyles.

Ovicell hyperstomial, slightly immersed, globular of varying size, opening above normal zooidal margin, endooecium visible through proximal triangular ectooecial window, paired adventitious avicularia on proximolateral areas, generally circular (possibly eroded) sometimes tear-drop shaped with cross bar.

MEASUREMENTS: (3 specimens)

Lz	8	0.53	0.099	0.44-0.70
lz	8	0.38	0.074	0.24-0.46
Lo	8	0.38	0.059	0.32-0.50
lo	8	0.23	0.024	0.20-0.26
Lav	8	0.12	0.029	0.08-0.16
lav	8	0.08	0.020	0.05-0.11

Lzov	7	0.54	0.099	0.42-0.62
lzov	7	0.42	0.054	0.36-0.48
Loov	7	0.41	0.032	0.36-0.46
loov	7	0.27	0.015	0.25-0.28
Lav-ov	7	0.15	0.045	0.10-0.24
lav-ov	7	0.10	0.024	0.08-0.14
Lov	7	0.22	0.035	0.18-0.26
lov	7	0.31	0.046	0.22-0.36

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	2. Bilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: LTL *[f]*, MTL(l) *[r]*, MTL(m) *[p]*, MF(b) *[r]*, MF *[p]*, LRF(l), *[r]*LKL(l1) *[r]*, LKL(t) *[f]*.

COMPARISONS: *Membraniporidra asymmetrica* Canu & Bassler (1935: 4, pl. 1, fig. 9; Gellibrand Marl; Middle Miocene, Otway Basin) also has reniform zooids with a single opesial spine, large proximal avicularia and interzooidal cavities and should also be in *Dactylostega*, but it lacks the smaller avicularia and the ovicell is more globular and smooth.

Although some characters are superficially similar of other genera (e.g. *Amphiblestrum, Adenifera, Membraniporidra, Conopeum, Pyrulella, Vibracellina*), the distinctive single opesial spine distinguishes this species as *Dactylostega* (cf. *D. tubigera* (Busk) in Hayward & Cook, 1983: 24). *Cauloramphus* species have a similar spine but the morphology of the small and inconspicuous ovicell is different.

Dactylostega sp. nov. b

Plate 4A, B, C

MATERIAL: SAM P39407 (TL), P39408 (TL), P39409 (TL)

DESCRIPTION: Colony unilaminar encrusting.

Zooids alternating in rows (often irregularly), rectangular to oval, margins defined by irregularly disjunct deep gaps, lateral and proximal opesial margins developing several flat broadly rounded triangular projections into proximal half of zooid, appearing like an incomplete or broken frontal shield.

Orifice with rounded squarish distal margin (proximal margin uncalcified), large spine base on one lateral margin, often directed in towards zooid.

Paired (sometimes single) distolateral adventitious avicularia, small, oval, no condyles(?), rostrum directed distally medially; larger avicularium occasionally situated distally to non-ovicelled zooids.

Ovicell ?hyperstomial, large rounded squarish, immersed in distal area, convex, narrow area of endooecium exposed proximally, proximal margin of ectooecium forming broad lip, lateral ooecial margins separated from neighbouring zooids by deep furrow.

MEASUREMENTS: (2 specimens)

Lz	3	0.53	0.031	0.50-0.56
lz	3	0.33	0.095	0.26-0.44
Lo	3	0.36	0.060	0.30-0.42
lo	3	0.20	0.035	0.18-0.24
La	3	0.14	0.029	0.11-0.16
la	3	0.09	0.012	0.08-0.10

Lzov	6	0.63	0.055	0.54-0.70
lzov	6	0.31	0.048	0.24-0.36
Loov	6	0.35	0.043	0.28-0.40
loov	6	0.19	0.027	0.15-0.22
Lov	6	0.23	0.030	0.20-0.28
lov	6	0.25	0.030	0.22-0.30

A.B.G.H.C:

A. Orient. substr.	?1. Encrusting
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	?1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: Foliose; MTL(u) *[c]*, LKL(u) *[c]*.
Encruster; LTL *[p]*, MTL(l) *[r]*, MTL(m) *[r]*.

COMPARISONS: This species is similar to various other species, some of which are placed in other genera. The most striking similarity is with *Glenelgia crawfordensis* Brown (1958: 36; Pt Campbell Limestone; Middle Miocene, Otway Basin), which has a similar 'jagged' opesial margin and similar arrangement of avicularia. It is not clear if *G. crawfordensis* also has an opesial spine. The ovicell morphology, however, is quite different, and the colony is flat robust branching with conspicuous lateral avicularia. The delicate branching '*Membranipora*' *crespinae* Brown (1958: 34; Pt Campbell Limestone) also has the two types of avicularia and their arrangement and may be closely related.

REMARKS: The opesial projections are quite certainly the initial stages of a frontal shield, which (in this species at least) never grow big enough to join medially. They are probably not the same as the costae of the Cribrilinidae, but may be hollow nonetheless.

Dactylostega? sp. nov. c

Plate 3D, E

MATERIAL: SAM P39402 (TL)

DESCRIPTION: Colony ?encrusting unilaminate.

Zooids hexagonal, margins indistinct sometimes defined by variably broad furrows, smooth gymnocyst wide proximally, but only narrow around opesia, cryptocyst narrow and slightly depressed below gymnocyst, slightly broader proximally, faintly granular.

Opesia variably circular to slightly oval to very slightly diamond-shaped, single small spine base in one distolateral corner adjacent contact with gymnocyst causing slight constriction of opesia, several pores at base of distal wall, becoming smaller laterally.

Adventitious avicularia numerous, one placed off-centre on proximal gymnocyst, two additional ones in distolateral corners, small, pyriform with large foramen and small acute condyles, variably acute rostrum slightly elevated abfrontally.

Ovicells not observed.

MEASUREMENTS: (1 specimen)

Lz	5	0.70	0.046	0.63-0.75
lz	5	0.57	0.019	0.55-0.59
Lo	5	0.43	0.010	0.42-0.44
lo	5	0.40	0.012	0.38-0.41
Lav	5	0.12	0.023	0.10-0.14
lav	5	0.08	0.018	0.06-0.10

A.B.G.H.C:

A. Orient. substr.	?1. Encrusting
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	?1. Unilaminate.
F. 2° skel. thick.	1. None
G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: LTL *[p]*, MTL(l) *[i]*, MTL(m) *[r]*, LKL(l1) *[p]*, LKL(l2) *[r]*, (WLG 42 QA 69 *[p]*)

REMARKS: This species looks like an intermediate between *Odontionella* sp. a (which has the same shape opesia and a similarly large gymnocyst but a wider cryptocyst and serrated proximal margin) and *Dactylostega* sp. a (which has the single lateral spine but more elongate zooids and frontal thickening). This may indicate a relationship between the genera *Dactylostega* and *Odontionella*.

Genus ***Foveolaria*** Busk, 1884

TYPE SPECIES: *Foveolaria elliptica* Busk, 1884. [subsequent designation Canu, 1900]

DESCRIPTION: "Colony encrusting; or erect and vincularian, bilamellar, frondose or retiform from an encrusting base. Cryptocyst surrounding the opesia, granular, steeply descending. Gymnocyst well developed proximally, becoming thicker with secondary calcification. Avicularia adventitious on the gymnocyst. Ovicells hyperstomial, becoming immersed in secondary calcification." (Gordon, 1986)

REMARKS: Moyano (1996) considers *Foveolaria* to be a genus, which evolved in the Neogene of the austral region. *Foveolaria vibraculata* Zágorsek (2002), however, occurs in Priabonian (Upper Eocene) sediments. The Tortachilla Limestone (upper Middle Eocene) specimens represent an even older, and possibly the oldest, recorded occurrence of *Foveolaria.*

Subgenus **Odontionella** Canu & Bassler, 1917

TYPE SPECIES: *Membranipora hians* Hincks, 1885 (*Membranipora cyclops* Busk, 1854 = sen. subj. syn.)

DESCRIPTION: "Encrusting or erect *Foveolaria* with the zooidal cryptocyst denticular proximally and projecting into the opesia." (Gordon, 1986)

***Foveolaria* (*Odontionella*) sp. nov. a**

Plate 4D, E, F, G, H

MATERIAL: SAM P39395 (TL)

DESCRIPTION: Colony erect bilaminar sheet.

Zooid margins indistinct with wide distal half and narrow proximal half, the proximal area apparently of kenozooidal origin, consisting of a gymnocystal rim with a central triangular concave granular cryptocyst and a central pore; gymnocyst only narrow in distal half, cryptocyst slightly depressed below gymnocyst in an almost perfectly circular area, sometimes with narrow but deep separating furrow, broadest proximally and almost absent distally, sloping downwards, faintly granular.

Opesia rounded trapezoidal, proximal margin with a narrow finely serrated fringe separated from cryptocyst by a furrow, a pair of spine bases in distolateral corner adjacent contact with gymnocyst, a pair of large pores in distolateral corners at base of distal wall, 2 – 3 pairs of small pores along base of lateral walls.

Adventitious avicularia placed centrally on gymnocyst immediately proximal to opesial cryptocyst, pyriform with large oval foramen, small rounded condyles, wide proximal cryptocyst, acute rostrum slightly elevated abfrontally with elevated margins and slightly downward curved end directed laterally and slightly proximally.

No ovicells observed.

MEASUREMENTS: (1 specimen)

Lz	5	0.91	0.015	0.90-0.92
lz	5	0.48	0.038	0.41-0.51
Lo	5	0.32	0.010	0.31-0.42
lo	5	0.27	0.014	0.25-0.29
Lav	5	0.21	0.019	0.13-0.22

A.B.G.H.C:

A. Orient. substr.	?1. Encrust or ?3. Erect
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	?1. Unilam. or 2. bilam.
F. 2° skel. thick.	1. None
G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: LRF(I) *[f]*, (WLG 42 QA 69 *[p]*)

COMPARISONS: *Foveolaria vibraculata* Zágorsek (2001: 34, pl. 5, figs 6, 7, 8) is similar in general appearance, but the opesia is more elongated, the cryptocyst slopes more steeply, the spines are placed more distally. Zágorsek described the adventitious avicularia as placed distal to the opesiae. From the present specimens it appears more likely that they originate near the proximal opesial margin. *Amphiblestrum planulatum* Maplestone (1901a: 188, pl. 24, fig. 12; 'Aire Coastal Beds', Upper Eocene or Oligocene, Otway Basin) differs mainly in the absence of an opesial spine. *Membranipora ligulata* Maplestone (1901b: 204, pl. 34, fig. 1; 'Aire Coastal Beds') does not have any cryptocyst.

Genus ***Ramphonotus*** Norman, 1894

TYPE SPECIES: *Ramphonotus minax* Busk, 1860

DESCRIPTION: Large avicularium on pedicle near opesial proximal border. (Bassler, 1953)

Remarks: *Ramphonotus minax* may actually be a species of *Amphiblestrum* (P.E. Bock. pers. comm., 2001)

Ramphonotus**?** sp. a

Plate 4I

MATERIAL: SAM P39394 (TL)

DESCRIPTION: Colony encrusting unilaminar.

Zooids hexagonal, margins clearly defined by deep furrow, convex gymnocyst along margins very narrow except along proximal area where it is often quite wide, moderately narrow granular cryptocyst borders and slopes in towards opesia, paired small spine bases at distolateral corners (on gymnocyst); large chamber at distal wall.

Opesia occupying most of zooid area, roughly following shape of zooid, substrate visible at base;

Adventitious avicularium occasionally on proximal gymnocyst positioned on distal margin of large oval prominence, slightly to one side of zooid, no cross-bar or condyles, long narrow rostrum slightly curved (proximally) and directed laterally across zooid,

Ovicells not observed.

MEASUREMENTS: (1 specimen)

Lz	3	0.57	0.031	0.54-0.60
lz	3	0.42	0.021	0.40-0.44
Lo	3	0.43	0.064	0.38-0.50
lo	3	0.32	0.021	0.30-0.34

Lav	1	0.21	-	-
lav	1	0.12	-	-

A.B.G.H.C:

A. Orient. substr.	1. Encrusting
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: TL *[p]*

COMPARISONS: Although this species is definitely Calloporidae, the limited material makes generic, let alone specific identification difficult.

Genus ***Ellisina*** Norman, 1903

Type species: *Membranipora levata* Hincks, 1882 (*non* Norman, 1903)

Description: Colony encrusting. Zooidal frontal membrane extensive, the gymnocyst and cryptocyst little developed. Avicularia interzooidal, distal, acute. Ovicell usually prominent, closed by the zooidal operculum, sometimes surmounted by an avicularium. Basal pore-chambers present. (Gordon, 1984)

Remarks: There is a diversity of species of *Ellisina* and similar genera in the Australian Tertiary, but a lot of the synonymy needs revision.

Ellisina? sp. nov. a

Plate 4J, K, L

Material: SAM P39582 (TL), P39583 (TL)

Description: Colony encrusting unilaminar.

Zooid margins defined by shallow furrow, irregularly ellipsoid to diamond-shaped, narrow ?cryptocyst; Opesia occupies most of zooids area, shape similar to zooid.

Adventitious avicularium at distal margin of each zooid, drop-shaped with condyles, rostrum directed laterally.

Ovicells placed in series distally, globular with an avicularium on distal corner, acute rostrum directed distolaterally, frontal wall broken in all specimens..

Measurements: (2 specimens)

Lz	12	0.45	0.052	0.36-0.54
lz	12	0.30	0.069	0.24-0.44
Lo	12	0.30	0.044	0.26-0.36
lo	12	0.21	0.043	0.14-0.32

Lov	2	0.18	0.000	0.18
lov	2	0.18	0.028	0.16-0.18
Lav	10	0.11	0.013	0.08-0.12
lav	10	0.07	0.018	0.05-0.11

A.B.G.H.C:

A. Orient. substr.	1. Encrusting
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	Hard secondary

Occurrence: MTL(l) *[p]*, MTL(m) *[i]*, UTL *[p]*, MF(b) *[i]*, LKL(l1) *[p]*

Comparisons: This may not be a species of *Ellisina s.s.*, and could belong to *Cranosina* (Calloporidae).

Genus ***Allantopora*** Lang, 1914

TYPE SPECIES: *Hippothoa irregularis* Gabb & Horn, 1860

DESCRIPTION: Colony encrusting, uniserial, normally with bilateral branching, rarely multiserial; zooecia monomorphic, divided into a proximal caudal and distal capitular portion; termen beaded; extraterminal front wall well developed proximally, plain with no median ridge or groove; intra-terminal front wall represented by a narrow bevel, tending to become broader proximally; circle of spines around aperture. (after Lang, 1914)

Allantopora**?** sp. a

Plate 4M, N

MATERIAL: SAM P39584 (TL)

DESCRIPTION: Colony encrusting uniserially branching.

Zooids claviform, sometimes slightly rhomboid, convex smooth gymnocyst extensive proximally, cryptocyst very narrow to absent, sloping down into opesia, 2 or 3 pairs of widely spaced small spine bases on gymnocyst along lateral (and distal) opesial margin.

Opesia longitudinally oval, occupying central half of zooid

Ovicell and avicularia not observed.

MEASUREMENTS: (1 specimen)

Lz	8	0.56	0.039	0.50-0.62
lz	8	0.38	0.016	0.35-0.39
Lo	8	0.25	0.024	0.22-0.29
lo	8	0.19	0.014	0.17-0.21

A.B.G.H.C:

A. Orient. substr.	1. Encrusting
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	1. Uniserial
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	1. Flat
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	Hard secondary

OCCURRENCE: MTL(l) *[r]*, MTL(m) *[i]*, MF(b) *[r]*.

COMPARISONS: The specimens are relatively featureless, and specific or even generic identification is therefore difficult, but it fits the diagnosis of *Allantopora* relatively well.

REMARKS: One specimen encrusted the internal surface of an irregular echinoid shell, indicating that the test was sufficiently broken and lying on the sea floor before the bryozoan settles. Alternatively the test may have been relatively complete and the bryozoan used it as a protective 'cave'.

Genus *Crassimarginatella* Canu, 1900

TYPE SPECIES: *Membranipora crassimarginata* Hincks, 1880b

DESCRIPTION: Colony encrusting; or erect, bilamellar or vincularian, from an encrusting base. Zooidal cryptocyst moderate or very narrow, the opesia occupying the larger part of the frontal area. Gymnocyst present, conspicuous or much reduced. Spines present or absent. Avicularia vicarious, with or without a pivot bar. Ovicell generally prominent, hyperstomial, with a crescentic frontal area, or small and cap-like; may be closed by the zooidal operculum. Mural septula or basal pore-chambers present. (after Gordon, 1984; Ryland & Hayward, 1992)

Crassimarginatella sculpta (MacGillivray)

Plate 5D, E

Membranipora sculpta MACGILLIVRAY, 1895: 36, pl. 6 (fig. 1)

MATERIAL: SAM P39344 (TL), P39345 (MF)

OTHER MATERIAL EXAMINED: NMV P27568 (type specimen of *Membranipora sculpta* MacGillivray coll., Muddy Creek)

DESCRIPTION: Colony encrusting unilaminar.

Zooids irregularly oval, margins defined by shallow furrow, relatively narrow (smooth?) cryptocyst surrounds large opesia, which is same shape as zooid and occupies most of zooid.

Avicularia vicarious, similar shape to autozooids, large complete cross-bar across proximal 1/3 of zooid, proximal area flat and smooth with flattened semi-circular foramen, distal area slightly convex with ridges radiating away from large semi-circular lumen pore.

Ovicells hyperstomial, rounded squarish wider distally, globular, arched proximally with corners rising above zooid margin, paired ectooecial fenestrae on proximal half, faint median furrow in distal half.

MEASUREMENTS: (2 specimens)

Lz	8	0.42	0.030	0.36-0.46
lz	8	0.34	0.037	0.28-0.40
Lo	8	0.32	0.058	0.22-0.38
lo	8	0.23	0.021	0.18-0.24

Lov	2	0.18	0.000	0.18
lov	2	0.25	0.014	0.24-0.26
Lzav	2	0.36	0.028	0.34-0.38
lzav	2	0.31	0.014	0.30-0.32
Loav	2	0.19	0.014	0.18-0.20
loav	2	0.14	0.000	0.14
Dxbar	2	0.06	0.014	0.05-0.07

A.B.G.H.C:

A. Orient. substr.	?1. Encrusting
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

(continued next page)

OCCURRENCE: MTL(l) *[r]*, MTL(l) *[p]*, MF(b) *[c]*; (OB) FC [Schnapper Point], GM [Muddy Creek]

REMARKS: The very distinctive morphology of the vicarious avicularia allows a confident specific identification. Measurements of the type specimen (NMV P27568) are significantly larger than the specimens of the current study.

***Crassimarginatella*? sp. nov. a**

Plate 5A, B, C

MATERIAL: SAM P39341 (TL), P39342 (TL), P39343 (TL)

DESCRIPTION: Colony encrusting unilaminate, basal surface follow contours of substrate closely.

Zooids (irregularly) oval (egg-shaped?) to hexagonal, narrower and flattened distally, margins defined by furrow, narrow gymnocystal margin often wider proximally, sloping up towards opesia which is bordered by narrow (varying width) cryptocyst sloping in towards opesia; 7–8 pairs of evenly spaced spine bases along ridge separating the two regions, the largest pair in the proximolateral corners.

Opesia oval and flattened distally to distinctly egg-shaped, occupying most of zooidal area, margins with broad rounded ridge with 4–5 pairs of spine bases on (disto)lateral part, sometimes leaving narrower distal area free, narrow distal shelf often present, straight or inwardly arched.

Ovicells recumbent on gymnocyst of distal zooid, semicircular to rounded squarish outline, crescentic ectooecial window near proximal margin, which narrows slightly in the middle.

Avicularia not observed.

MEASUREMENTS: (3 specimens)

Lz	14	0.45	0.039	0.37-0.50
lz	14	0.32	0.026	0.29-0.37
Lo	14	0.27	0.029	0.24-0.31
lo	14	0.18	0.015	0.15-0.20
Lov	5	0.18	0.016	0.16-0.20
lov	5	0.21	0.013	0.20-0.23

A.B.G.H.C:

A. Orient. substr.	1. Encrusting
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None
G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	Hard secondary

OCCURRENCE: MTL(l) *[r]*. MTL(m) *[i]*, UTL *[p]*, MF(b) *[r]*.

COMPARISONS: This species differs from *Membranipora spiculifera* Maplestone (1900b: 1, pl. 1, fig. 3; Miocene, Otway Basin) in wider zooids and zooidal margins, larger ovicell (measurements of the type specimen NMV P10116: Lz = 0.46, lz = 0.23, Lo = 0.32, lo = 0.18 mm; note: this specimen is not cylindrical as stated by Maplestone, but actually encrusts the branch of a Phidoloporid).

***Crassimarginatella*? sp. nov. b**

Plate 5F

MATERIAL: SAM P39346 (TL)

DESCRIPTION: Colony encrusting unilaminar.

Zooids oval to hexagonal, defined by shallow furrow, frontal wall composed of narrow convex gymnocyst, lateral walls not very tall.

Opesia oval to diamond-shaped or drop-shaped.

Ovicells forming small cap on distal margin, smooth, margin confluent with zooidal margin, small angular process placed centrally on proximal margin.

Avicularia not observed.

MEASUREMENTS: (1 specimen)

Lz	7	0.54	0.028	0.50-0.57
lz	7	0.51	0.046	0.42-0.56
Lo	7	0.42	0.019	0.40-0.44
lo	7	0.35	0.029	0.30-0.40

Lov	3	0.23	0.012	0.22-0.24
lov	3	0.33	0.015	0.32-0.35

A.B.G.H.C:

A. Orient. substr.	1. Encrusting
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	Hard secondary

OCCURRENCE: MTL(I) *[i]*, LKL(I2) *[p]*.

REMARKS: This resembles species of both *Aplousina* Canu & Bassler and *Ogivalina* Canu & Bassler in the shape of the ovicell, but these genera have a larger proximal cryptocyst.

Genus ***Amphiblestrum*** Gray, 1848

TYPE SPECIES: *Membranipora flemingii* Busk, 1854

DESCRIPTION: "Colony encrusting. Zooids with extensive cryptocyst occupying about one-third of the frontal area; the gymnocyst small, proximal. Opesia oval or trifoliate. Avicularia adventitious, usually on the gymnocyst. Spines few or absent. Ovicell prominent, not closed by the zooidal operculum. Basal pore-chambers present." (Gordon, 1984)

Amphiblestrum sp.

Plate 5G

MATERIAL: SAM P39347 (TL)

DESCRIPTION: Colony encrusting.

Zooids oval, defined by furrow, margins raised, (?cryptocystal) frontal wall mostly convex (sometimes slight bulge in proximal area), slightly raised towards opesia.

Opesia trifoliate, with straight proximal margin and round corners wider than squarish distal part (constricted at proximal 1/3).

Ovicell and avicularia not observed.

MEASUREMENTS: (1 specimen)

Lz	3	0.31	0.021	0.29-0.33
lz	3	0.25	0.031	0.22-0.28
Lo	3	0.09	0.006	0.09-0.10
lo	3	0.09	0.003	0.09

A.B.G.H.C:

A. Orient. substr.	1. Encrusting
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	hard (shell)

OCCURRENCE: LTL *[p]*, MTL(l) *[r]*, MTL(m) *[r]*.

REMARKS: The specimens observed are extensively recrystallised and specific identification is therefore impossible.

Genus *Copidozoum* Harmer, 1926

TYPE SPECIES: *Membranipora plana* Hincks, 1880

DESCRIPTION: "Normal interzooecial avicularium with mandible broad at base and narrowed into a long, linear point." (Bassler, 1953)

Copidozoum sp. nov. a

Plate 5H, I

MATERIAL: SAM P39348 (MF)

DESCRIPTION: Colony encrusting unilamellar sheet.

Zooids oval, defined by suture between raised margins, frontal wall finely granular cryptocyst slightly concave but mostly flat (a flat area of granular gymnocyst often extending proximally beyond raised margins).

Opesia oval with flattened distal margin positioned almost at zooid margin, lateral margins sometimes slightly curved inwards, margins with short spines.

Avicularia interzooidal with extensive cryptocystal area (similar to autozooid), oval area in middle slightly raised with avicularian structure in middle, rostrum narrow and acute, directed distally and abfrontally, large opesia, condyles extending as ridges to outside margins.

Ovicells hyperstomial recumbent on gymnocyst of distal zooid, globular, subcircular, coarsely granular, faint thread at base of distal margin, narrow opening above (normal) zooidal margin.

MEASUREMENTS: (1 specimen)

Lz	9	0.52	0.047	0.43-0.59
lz	9	0.28	0.027	0.24-0.31
Lcryp	9	0.34	0.011	0.32-0.35
Lo	9	0.23	0.014	0.20-0.24
lo	9	0.13	0.008	0.12-0.14

Lov	5	0.18	0.016	0.16-0.20
lov	5	0.18	0.009	0.17-0.19
Lzav	4	0.43	0.024	0.40-0.45
lzav	4	0.26	0.062	0.17-0.30
Lav	4	0.17	0.027	0.15-0.21
lav	4	0.13	0.020	0.10-0.14

A.B.G.H.C:

A. Orient. substr.	1. Encrusting
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	hard (erect bryozoan)

OCCURRENCE: MTL(m) *[p]*, MF(b) *[p]*.

COMPARISONS: This species also resembles species of the genus *Onychoblestrum* Gordon, especially in the morphology of the ovicell and avicularium, but the opesia is not as clearly trifoliate.

Genus *'Lunulites'* (**Calloporidae gen. nov.**)

NOTE: The following two species are definitely not true *Lunulites*, but because it is impossible to place them adequately into a known genus, and lunulitiform bryozoans are often 'dumped' into this genus, it is used as a provisional name for convenience only.

DIAGNOSIS: Calloporidae with lunulitiform colony growth form, lacking basal pores. Opesia very large with paired spines or adventitious avicularia at distolateral corners, cryptocyst steeply descending, gymnocyst absent. Large interzooidal avicularia with complete cross-bar. Ovicells not known.

REMARKS: *'Lunulites'* sp. a and sp. b appear superficially similar to *Lunulites rutella* (Tenison-Woods, 1879; Middle Miocene to Lower Pliocene, Otway Basin; see also Cook & Chimonides, 1985: 352, and 1986, discussion of *Lunularia capulus* (Busk)), as especially the internal area of the zooids look similar. The following species require a separate genus, however, because the avicularia of *L. rutella* occur in a regular pattern, are asymmetrical, have no cross-bar and there are also no distal opesial spines or avicularia. The ancestrula, which is rarely preserved, does not appear to have the distal and proximal triads of zooids characteristic of *L. rutella*.

These species exhibit similarities with some of the Calloporidae of the European Cretaceous , such as *Callopora lyra* (von Hagenow) (Medd, 1966) and *'Membranipora' sagittaria* Brydone (Taylor, 1987). Each has the paired distal avicularia, and interzooidal avicularia (although in both cases without cross-bars and rostra are not acute). *C. lyra* also displays the distinct paired 'muscle scars' (Medd, 1964). Both European species also have distinctive ovicells, however, which are never present here. The interzooidal avicularia are similar to those in *Copidozoum planum* (Hincks).

The colony is not the same lunulitiform shape as found in genera such as *Selenaria* and *Cupuladria*, which look like an overturned bowl. The centre of the colony is rather conical. In the Tortachilla Limestone each colony encrusts a goethite grain. These grains may be selected because of advantage in terms of stability, as they are relatively heavy. Bryozoan larvae are capable of very precise substrate selection (Abelson, 1997).

'*Lunulites*' sp. nov. a

Plate 6A, B, C, D

MATERIAL: SAM P39319 (TL), P39321 (TL), P39322 (TL)

DESCRIPTION. Colony lunulitiform, large flattened cone. Basal surface formed by extrazooidal radial convex sectors representing zooidal rows, without pores, occasional ridges along margins of sectors, especially near colony margin.

Zooids hexagonal to oval, often irregular shape, defined by shallow furrows, relatively narrow steeply descending granular cryptocyst around whole margin, gymnocyst not apparent; two very small spine bases on distal edges of each zooid.

Opesia large, occupying 80–90% of zooid length, similar shape to zooid; pair of ?occlusor muscle scars below distal margin, one large pore at distal base and several smaller one along lateral walls.

Interzooidal avicularia large, hexagonal to distally extended pentagonal, distinct cross-bar with large proximal denticle, blunt rostrum; positioned at bifurcation points, distal end positioned in middle of proximal area of following zooid.

Ovicells not observed.

MEASUREMENTS: (3 specimens)

Lz	5	0.56	0.022	0.52-0.58
lz	5	0.46	0.071	0.38-0.52
Lo	5	0.38	0.047	0.32-0.42
lo	5	0.30	0.036	0.26-0.34

Lav	2	0.55	0.014	0.54-0.56
lav	2	0.34	0.028	0.32-0.36
Dxbar	2	0.17	0.042	0.140.20
Loav	2	0.38	0.028	0.36-0.40

ø-col	3	12

A.B.G.H.C:

A. Orient. substr.	?1. Encrust.
B. Attachm. substr.	3. Free living
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	?1. Unilam.
F. 2° skel. thick.	1. None

G. Struct. units	?11. hollow dome
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	particulate

OCCURRENCE: LTL *[f]*, MTL(l) *[c]*, MTL(m) *[f]*, MTL(u) *[r]*.

COMPARISONS: (see discussion in REMARKS section of genus discussion, previous page)

'Lunulites' sp. nov. b

Plate 7A, B, C, D, E

MATERIAL: SAM P39320 (TL)

DESCRIPTION: Colony lunulitiform, flattened cone. Basal surface formed by extrazooidal radial sectors, without pores.

Zooids circular to oval, often irregular shape, relatively narrow steeply descending granular cryptocyst around whole margin, gymnocyst not apparent.

Opesia large, occupying 80–90% of zooid length, similar shape to zooid; pair of ?occlusor muscle scars below distal margin, one large pore at distal base and several smaller one along lateral walls.

Interzooidal avicularia large, trapezoidal (diamond-shaped with extended distal corners), with distinct cross-bar, margins raised and overarching rostrum. Positioned at bifurcation points, distal end positioned in middle of proximal area of following zooid.

Two adventitious avicularia on distal edges of each zooid (including interzooidal avicularia), pointing towards each other, cross-bar incomplete.

Ovicells not observed.

MEASUREMENTS: (1 specimen)

Lz	12	0.61	0.051	0.54-0.68
lz	12	0.53	0.032	0.48-0.56
Lo	12	0.44	0.079	0.36-0.60
lo	12	0.34	0.032	0.30-038
Lav-ad	12	0.14	0.023	0.11-0.18
Lav-ad	12	0.08	0.13	0.06-0.10

Lav	4	0.68	0.066	0.60-0.74
lav	4	0.42	0.115	0.32-0.58
Dxbar	4	0.20	0.049	0.14-0.26
Loav	4	0.35	0.066	0.26-0.42

ø-col	1	7.5

A.B.G.H.C:

A. Orient. substr.	?1. Encrusting
B. Attachm. substr.	3. Free living
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	?1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	?11. Hollow dome
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	particulate

OCCURRENCE: LTL *[p]*, MTL(l) *[i]*, MF(b) *[c]*, LKL *[r]*.

COMPARISONS: Differs from *'Lunulites'* sp. nov. a in interzooidal avicularia morphology and the presence of the paired adventitious avicularia. The latter may be an astogenetic effect as in some marginal zooids spine bases are present (pl. 7B).

Remarks: While *L.* sp. nov. a only occurs in the Tortachilla Limestone (from lowest to uppermost horizons), *L.* sp. nov. b occurs in the lowest sediments on all three basin margins.

Family **CHAPERIIDAE** Jullien, 1888

DESCRIPTION: "Colony encrusting; or erect, bilamellar or vincularian, from an encrusting base. Zooids with moderate to large opesia, sometimes obscured by an aviculiferous spinose shield. The cryptocyst generally well developed. Gymnocyst present, or absent, or supporting avicularia which obscure it. Intra-orificial ridges or laminae associated with the insertion of the opercular occlusor muscles well developed to absent. Oral spines present or absent. Avicularia adventitious and/or vicarious, or absent. Ovicell hyperstomial, endozooidal, or absent. Mural septula present." (Gordon, 1984)

Genus ***Chaperiopsis*** Uttley, 1949

TYPE SPECIES: *Membranipora galeata* Busk, 1854

DESCRIPTION: "Colony encrusting; or erect, bilamellar or vincularian, from an encrusting base. Opesia moderately large, the cryptocyst a conspicuous shelf or narrowing to a rim. Gymnocyst negligible or well developed proximally, frequently obscured by avicularian chambers. Occlusor laminae variously developed or negligible. Spines present, bordering the opesia. Avicularia present on the gymnocyst or absent, one often present on the mid-distal wall; vicarious avicularia occasional. Ovicell hyperstomial, usually with a frontal area and ridges; often surmounted by one or more avicularia." (Gordon, 1984)

REMARKS: *Chaperiopsis* differs from *Chaperia* Jullien mainly in the presence of avicularia and ovicells and the smaller and more distal positioned occlusor laminae.

These species may represent the oldest recorded occurrence of *Chaperiopsis*.

Chaperiopsis cf. ***columnella*** (Brown)

Plate 7F, G, H, I

? *Amphiblestrum annulus* (Manzoni); MACGILLIVRAY, 1895: 43, pl. 6 (fig. 3). (*non* Manzoni)

Chaperia columnella BROWN, 1952: 106, figs 53, 54.

MATERIAL: SAM P39353 (TL), P39354 (TL), P39355 (TL)

OTHER MATERIAL EXAMINED: BMNH D. 36596 (holotype of *Chaperia columnella*, Oligocene, N.Z.); D. 36597 (paratype)

DESCRIPTION: Colony unilaminar encrusting (mostly detached from substrate). Ancestrula tatiform ca 0.17 mm diameter or 1/3 – 1/2 size of autozooid, circular with narrow granular gymnocyst, bearing ca 10 spine bases around the margin.

Zooids irregularly oval (pentagonal?) , with distal margin slightly raised above level of next zooid and forming a small lip; gymnocyst narrow, wider proximally with one or rarely two large hollow columnar projections (sometimes slightly flattened) directed distally at shallow angle to zooid surface (all broken, may have borne avicularia). 2 to 3 paired spine bases on distal margin, the two most proximal ones larger and slightly constricting cryptocyst. Large distal dietella and 2 smaller paired lateral ones.

Opesia oval occupying 2/3 of zooid, sometimes slightly flattened and wider at proximal border, surrounded by relatively wide granular cryptocyst, occlusor laminae converging distally at shallow angle, proximal end positioned in distal 1/4 of opesia.

Adventitious avicularium placed medially at distal margin, small, drop shaped, very short broad blunt condyles, acute rostrum directed distally.

Ovicells hyperstomial, slightly overarching opesia, domed with flattened proximal surface which contains a crescentic ?ectooecial fenestra.

MEASUREMENTS: (4 specimens)

Lz	15	0.36	0.053	0.28-0.44
lz	15	0.26	0.021	0.24-0.30
Lo	15	0.18	0.035	0.13-0.22
lo	15	0.15	0.016	0.13-0.18

Lov	4	0.22	0.011	0.21-0.23
lov	4	0.24	0.007	0.22-0.25
Lav	11	0.08	0.012	0.07-0.10
lav	11	0.06	0.015	0.05-0.07

A.B.G.H.C:

A. Orient. substr.	?1. Encrust.
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	?1. Unilam.
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(l) *[i]*, MTL(m) *[r]*, UTL *[p]*, MF(b) *[r]*; (OB) Miocene [Bairnsdale], GM [Muddy Creek?], ?age [Moorabool]; (NZ) 'Kakanui Limestone'-Lower Oligocene [Oamaru].

COMPARISONS: The specimens agree well with those of *Chaperia columnella* Brown (1952), but differ in the exclusively encrusting colony form, rather than the erect bilaminar form of the New Zealand specimens. Brown's (1952) *Chaperia multifida* (Busk, 1884) has much longer occlusor laminae and is probably a true *Chaperia*. *Chaperiopsis rubida* (Hincks) has very different proximal avicularia.

***Chaperiopsis*? sp.**

Plate 7J

MATERIAL: SAM P39356 (TL)

DESCRIPTION: Colony unilaminar encrusting.

Zooids oval, wider proximally, defined by furrow, margins raised especially in distal part, very narrow marginal gymnocyst, wide proximal cryptocyst, 2–3 paired spine bases in distolateral corners.

Opesia circular, wide occlusor laminae converging distally at shallow angle (forming shelf along distal wall), proximal end positioned in distal 1/4 of opesia.

Ovicells and avicularia not observed.

MEASUREMENTS: (2 specimens)

Lz	4	0.49	0.049	0.43-0.55
lz	4	0.35	0.033	0.30-0.38
Lo	4	0.19	0.027	0.15-0.21
lo	4	0.18	0.026	0.14-0.20

A.B.G.H.C:

A. Orient. substr.	?1. Encrust. or ?3 erect
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	?1. Unilam.
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	? (substrate lost)

OCCURRENCE: MTL(l) *[p]*, MTL(m) *[i]*, MTL(u) *[p]*, UTL *[p]*, MF(b) *[p]*, LKL(l2) *[p]*.

REMARKS: Most of the available specimens are too abraded and recrystallised for recognition of specific characters. The specimens classified under this name may therefore comprise more than one species.

Family **BRYOPASTORIDAE** d'Hondt & Gordon, 1997

DESCRIPTION: "Zoarium dressé, en forme de baguette et non ramifié, ou articulé et ramifié, portant des rhizöides à sa base. Axe et branches à quatre faces, cylindriques, et/ou en forme de lentilles bilaminaires; zoécies alternates." (d'Hondt & Gordon, 1997)

Genus ***Pseudothyracella*** Labracherie, 1975

TYPE SPECIES: *Pseudothyracella pulchella* Labracherie, 1975

Pseudothyracella? sp. nov. a

Plate 8A, B, C

MATERIAL: SAM P39358 (TL), P39359 (TL)

DESCRIPTION: Colony erect cylindrical or flattened branches.

Zooids alternating in 10–12 longitudinal rows, 'hexagonal' contracted proximally and broadly rounded distally, zooids bordered by ?gymnocystal ridge which slightly overarches distally (space between it and zooid margin), cryptocyst becoming granular in proximal portion, slightly concave especially around opesia; basal pore level with proximal opesia margin, two pairs of lateral pores (seen through opesia), lateral walls converge at base distally, possibly towards a communication pore.

Opesia depressed, rounded trapezoidal to semicircular, narrow proximal serrated ledge.

Ovicells and avicularia not observed.

MEASUREMENTS: (2 specimens)

Lz	11	0.40	0.032	0.35-0.42
lz	11	0.25	0.034	0.22-0.32
Lo	11	0.13	0.014	0.10-0.15
lo	11	0.11	0.011	0.10-0.14

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	3. Oligoser./4. Macro.
E. Arrang. front. surf.	5. Radial/2. Bilaminate
F. 2° skel. thick.	1. None

G. Struct. units	8. Cylindrical/6. Lobe
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	?1. None
J. Dim. bifurc.	?1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: Delicate branching: MTL(u) *[f]*, LKL(m) *[i]*; FRB: MTL(m) *[p]*.

COMPARISONS: The serrated proximal opesial margin is reminiscent of the genus *Biflustra*.

REMARKS: Plate 8C shows a colony apparently with bipolar growth. It is unclear from the specimen if this is a primary feature or the result of repair after fracture.

Genus ***Bryopastoridae Gen. indet. A***

Bryopastoridae Gen. indet. A sp. nov. a

Plate 8D

MATERIAL: SAM P39360 (TL)

DESCRIPTION: Colony erect cylindrical ?branching.

Zooids alternating in ca. 14 rows; zooid claviform (oval often with elongated contracted proximal area), margins slightly raised, highest along distal margin, frontal wall smooth (?cryptocyst) and slightly concave.

Opesia oval to elliptical, occupying most of frontal area; basal half of lateral wall converges distally (?occlusor muscle scars) to large pore in base of distal wall, two pore pairs along base of lateral wall below opesia.

Ovicells and avicularia not observed.

MEASUREMENTS: (1 specimen)

Lz	6	0.39	0.029	0.35-0.42
lz	6	0.20	0.017	0.18-0.23
Lo	6	0.20	0.004	0.19-0.20
lo	6	0.10	0.008	0.10-0.12

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser (3. Oligo.)
E. Arrang. front. surf.	5. Radial
F. 2° skel. thick.	1. None

G. Struct. units	8. Cylindrical
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	?2. Infrequent
J. Dim. bifurc.	?2. One plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: LTL *[c]*, UTL *[p]*.

Genus ***Bryopastoridae? Gen. indet. B***

Bryopastoridae? Gen. indet. B sp. nov a

Plate 8E, F, G

MATERIAL: SAM P39361 (TL)

DESCRIPTION: Colony encrusting unilaminate or erect bilaminar sheet.

Zooids pentagonal (hexagonal with angular distal margin), defined by distal margins broadly raised relative to neighbouring zooids, frontal wall [recrystallised], slightly concave sloping down towards opesia.

Opesia rounded triangular, proximal margin with serrated ledge projecting inward medially.

Fertile zooids highly dimorphic, very large (occupying space of at least 4 autozooids), rounded diamond-shaped, opesia occupying most of area, distal margin slightly raised.

No avicularia observed.

MEASUREMENTS: (1 specimen)

Lz	6	0.65	0.032	0.64-0.70
lz	6	0.38	0.044	0.31-0.44
Lo	6	0.19	0.009	0.18-0.20
lo	6	0.20	0.014	0.18-0.22

Lzov	3	1.01	0.095	0.91-1.10
lzov	3	0.72	0.036	0.69-0.76
Loov	3	0.74	0.035	0.70-0.77
loov	3	0.54	0.049	0.51-0.60

A.B.G.H.C:

A. Orient. substr.	?1. Encrust. or 3. Erect
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	?1. Unilam. or 2. Bilam.
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	?1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(l) *[p]*, MTL(m) *[i]*.

COMPARISONS: The strongly dimorphic zooids make this a very distinctive species. The triangular shape of the autozooids and the very large brooding zooids (if this is what they are) are reminiscent of the cyclostome family Eleidae d'Orbigny (*Meliceritites* Römer is usually delicate branching). This unique group comprises the only genera of cyclostomes possessing calcified opercula. The gonozooid usually has a frontal wall and a distal atrial ring below the ooeciopore. They also have eleozooids, resembling avicularia. None of these appear to be present in the available specimen. The recrystallised state of the present specimen makes it difficult to observe the presence of small structures such as a pseudoporous frontal shield, which could indicate eleid affinities. The time range for Eleidae is from Barremian (Early Cretaceous) to Danian (Early Palaeocene) (Taylor, 1994).

The dimorphic structures are also reminiscent of bioclaustrations (calcification encircling another organism, possibly a symbiont) found in some Cretaceous Bryozoa (P.D. Taylor, pers. comm., 2002)

Family **QUADRICELLARIIDAE** Gordon, 1984

DESCRIPTION: "Colony erect, articulated, flexible. Zooids elongate, the gymnocyst little developed, the cryptocyst a moderately developed shelf proximally. Adventitious avicularia present or absent. Ovicells and spines wanting. Ancestrula resembling an autozooid but smaller, erect, on an uncalcified radicular support." (Gordon, 1984)

Genus ***Nellia*** Busk, 1852b

TYPE SPECIES: *Cellaria tenella* Lamarck, 1816

DESCRIPTION: Colony erect, branching, jointed; internodes square-sectioned, consisting of four longitudinal series of autozooids, arranged in alternating, back-to-back pairs. Autozooids with well-developed gymnocyst; opesia with broad, proximal border of cryptocyst and surrounded by raised mural rim. No spines. Avicularia adventitious. Ovicells small, partly immersed.

'*Nellia*' sp. nov. a

Plate 8H, I

MATERIAL: SAM P39362 (TL)

DESCRIPTION: Colony erect delicate ?branching.

Zooids alternating in 4 longitudinal rows, hexagonal (rounded distally), defined by furrow, finely granular cryptocyst sloping in towards opesia.

Opesia elongated oval, 2/3 zooid length, large pore in distal wall, 3 paired smaller dietellae in distolateral part of lateral walls.

Avicularia not observed.

MEASUREMENTS: (1 specimen)

Lz	4	0.62	0.040	0.57-0.66
lz	4	0.38	0.042	0.33-0.42
Lo	4	0.41	0.019	0.40-0.41
lo	4	0.17	0.029	0.14-0.20

A.B.G.H.C:

A. Orient. substr.	3 Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid or 3. Articulate
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	4. Quadrate
F. 2° skel. thick.	1. None

G. Struct. units	8. Cylindrical
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	?1. None/2. infrequent
J. Dim. bifurc.	?1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(u) *[p]*.

COMPARISONS: This species may not be *Nellia s.s.*, as it does not have the adventitious avicularia, which are characteristic. It may rather fit in *'Biflustra'*.

Genus ***Quadricellaria*** d'Orbigny, 1851

TYPE SPECIES: *Quadricellaria elegans* d'Orbigny, 1851

DESCRIPTION: Colony cellariiform, dichotomously branching, the branches four-sided in cross-section. Zooids with well developed cryptocyst and small proximal gymnocyst. Avicularia, spines and ovicells absent. (after Gordon, 1984)

Quadricellaria sp. nov. a

Plate 8J, K

MATERIAL: SAM P39363 (TL), P39364 (TL)

DESCRIPTION: Colony erect delicate ?branching, no articulations observed.

Zooids alternating in 4 or 6 longitudinal rows, rectangular (rounded distally), defined by furrow, margins sometimes raised, finely granular cryptocyst flat or gently sloping in towards opesia.

Opesia oval, 2/3 zooid length, margins sometimes raised, proximal acute opesial denticle placed slightly off centre.

Ovicells and avicularia not observed.

MEASUREMENTS: (3 specimens)

Lz	12	0.48	0.025	0.45-0.51
lz	12	0.25	0.026	0.21-0.29
Lo	12	0.21	0.033	0.18-0.28
lo	12	0.12	0.008	0.11-0.13

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid or 3. Articulate
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	4. Quadrate/ 5. Radial
F. 2° skel. thick.	1. None

G. Struct. units	8. Cylindrical
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	1. None/ 2. infrequent
J. Dim. bifurc.	?1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(l) *[i]*, MTL(m) *[r]*, LKL(l2) *[f]*.

COMPARISONS: The proximal opesial denticle is similar to that in *Tretosina*, but the colony is bifoliate in that genus.

Family **HIANTOPORIDAE** Gregory, 1893

Genus ***Hiantopora*** MacGillivray, 1887

TYPE SPECIES: *Lepralia ferox* MacGillivray, 1868

DESCRIPTION: Colony encrusting. Zooids contiguous or interconnected by short tubes, supported off the substratum by basal processes. One or more spinose processes from the lateral walls partly or wholly overarching the opesia; aviculiferous processes larger than the others. Ovicell hyperstomial with an ectooecial fenestra. Multiporous pore-chambers present. (Gordon, 1984)

REMARKS: First occurrence is *Hiantopora tripora* Canu (1911), Danian, Argentina. Gordon (1984) considered *Hiantopora* to have close affinities with the Chaperiidae.

Hiantopora cf. ***quadricornis*** (Maplestone)

Plate 9A, B

Inversiula quadricornis MAPLESTONE, 1911: 282, pl. 48 (fig. 39).

MATERIAL: SAM P39365 (TL, internal surface of echinoid test)

OTHER MATERIAL EXAMINED: NMV P12106 (type of *Inversiula quadricornis*, Cape Otway, ?Glen Aire Clay, ?Lower Oligocene)

DESCRIPTION: Colony encrusting unilaminar .

Zooid oval, margins distinct where not obscured by frontal spine, distal margin concave with 3 paired distolateral columnar spine bases (lateral pair larger and protruding even where ovicell present).

Opesia bordered proximally by broad-based aviculiferous cervicorn spine arising from one of either sides and closing area between lateral spine bases, forming proximal margin to secondary orifice; avicularium positioned to one side (opposite side to where spine originates) with hooked acute rostrum directed abfrontally to highest point, proximal area formed of broad branching spinules which slope downwards.

Ovicells hyperstomial, hood-shaped and somewhat triangular, ectooecium terminates halfway with small lip, exposing endooecium, which terminates in a more pronounced lip.

MEASUREMENTS: (1 specimen)

Lz	5	0.38	0.026	0.35-0.41
lz	5	0.23	0.016	0.22-0.25
Lo	5	0.05	0.005	0.04-0.05
lo	5	0.10	0.008	0.09-0.11

Lov	3	0.14	0.005	0.13-0.14
lov	3	0.20	0.010	0.19-0.21
Lav	3	0.14	0.015	0.12-0.15
lav	3	0.05	0.006	0.04-0.05
Lavch	3	0.19	0.006	0.18-0.19

A.B.G.H.C:

A. Orient. substr.	1. Encrust.
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	?1. Unilam.
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	hard 2°

OCCURRENCE: MTL(m) *[p]*; (OB) Calder River Lst ['Wilkinson's locality 4, Aire Coast].

COMPARISONS: It appears very similar to *Hiantopora ferox* (MacGillivray, 1869; Recent, Australia), but has different overarching spinose process, avicularium and spines. *Hiantopora staminis* (Canu & Bassler, 1935; Middle Miocene, Otway Basin) has finer and more numerous processed on the overarching spine.

Maplestone wrongly assigned this species to *Inversiula* due to the shape of the secondary opesial opening, because it is more curved proximally than distally.

REMARKS: One specimen encrusted internal part of irregular (infaunal) echinoderm shell and overgrew *Ellisina*, *Smittoidea* and *Diastopora* colonies. Encrustation occurred before this shell fragment was broken off, as the colonies indicate that some of their ancestrulae were on a different fragment.

Superfamily **BUGULOIDEA** Gray, 1848

Family **CANDIDAE** d'Orbigny, 1851

DESCRIPTION: Colony erect, unilamellar, branching, the zooids usually in two series, sometimes more; attached by rhizoids issuing from a septulum or a vibracular chamber; jointed. Zooids generally well calcified except for the membranous frontal area. Cryptocyst typically narrow, gymnocyst often well developed. Distal spines typically present and a flattened scutum usually over the frontal area. Adventitious avicularia typical, and vibracula may occur basally. Ovicell hyperstomial, with or without pores or a fenestra. (after Gordon, 1984)

Genus ***Caberea*** Lamouroux, 1816

TYPE SPECIES: *Caberea dichotoma* Lamouroux, 1816 [SD Harmer, 1923]

DESCRIPTION: "Colony erect, dichotomously branched, generally stiff and fan-shaped, anchored by clustered rhizoids. Zooids in two or more series, alternating. Apparently unjointed, but the chitinous connections covered by calcification. The oval frontal area typically overarched by a scutum. Cryptocyst and gymnocyst variable in extent, sometimes well developed. Distal spines present, sometimes inconspicuous. Avicularia sessile; small laterally; often larger, or occasionally giant, avicularia occur sporadically frontally. Basal vibracula well developed, covering much of the surface, each with a long, oblique setal groove; seta long, generally barbed. Rhizoids issue from the proximal ends of many vibracular chambers, descending towards the base of the colony. Ovicell hyperstomial, usually with a broad frontal exposure of ectooecium." (Gordon, 1984)

Caberea sp. nov. a

Plate9C, D

MATERIAL: SAM P39366 (TL)

DESCRIPTION: Colony erect unilaminate articulated, comprised of four zooid rows, occasional odd zooid projecting past lateral margin.

Basal wall relatively flat and smooth, vibracular chambers separate from each other diamond shaped, very convex tapering proximally, vibracular gutters broad proximally and becoming very narrow and deep distally directed distolaterally and emerging at lateral margin halfway between zooids, one small rhizoid pore at base of chamber at level of distal margin of zooid.

Zooids claviform, defined by shallow narrow furrow, proximal area gymnocyst, cryptocyst elevated, bordering and sloping down toward opesia.

Opesia oval, slightly constricted distally, 2–3 pairs of spine bases on distolateral margins, distal ones almost outside of cryptocyst, proximal ones very large.

Adventitious avicularium in middle of proximal gymnocyst, single in marginal zooids, paired in median row, margins strongly raised, oval with somewhat acute rostrum directed proximally.

Ovicells not observed.

MEASUREMENTS: (1 specimen)

Lz	5	0.36	0.015	0.34-0.38
lz	5	0.17	0.013	0.16-0.19
Lo	5	0.16	0.008	0.15-0.17
lo	5	0.09	0.007	0.08-0.10

A.B.G.H.C:

A. Orient. substr.	3. Erect contin.
B. Attachm. substr.	2. Rooted
C. Construction	?3. artic. det. cut. joints
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	3. Branch with flat surf.
H. Dim. struct. units	?1. Straight
I. Freq. bifurc.	?2. Infrequent
J. Dim. bifurc.	?
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: TL *[p]*

COMPARISONS: This species resembles *Caberea darwinii* Busk *sensu* MacGillivray (1895: 25, pl. 3, figs 10, 11; Middle Miocene, Otway Basin) in general, but the branches here are much wider and the zooids less reniform.

Caberea **sp. nov. b**

Plate 9E, F, G

MATERIAL: SAM P39367 (TL)

DESCRIPTION: Colony erect unilaminate articulated, comprised of five zooid rows.

Zooids oval to rectangular, poorly defined, gymnocyst very narrow marginally, cryptocyst moderately wide bordering and sloping down toward opesia.

Opesia oval to peanut-shaped.

Adventitious avicularia paired , distolateral to ovicell (probably belong to frontal wall of distal zooid, i.e. not directly associated with ovicell), small, pyriform, with condyles.

Ovicells recumbent and slightly immersed distally, large, globular to slightly squarish, widening distally, smooth, opening above opesia.

Basal wall convex with vibracular chambers closely adjoining and curving around to lateral margins, rounded distally and tapering for a long way proximally (ca. 1.5 mm), vibracular gutters narrow proximally and widening slightly distally, directed distolaterally and emerging at lateral margin halfway between zooids, one small rhizoid pore at base of chamber at level of distal margin of zooid.

MEASUREMENTS: (1 specimen)

Lz	5	0.31	0.019	0.29-0.34
lz	5	0.20	0.004	0.19-0.20
Lo	5	0.22	0.018	0.20-0.25
Lo	5	0.12	0.005	0.12-0.13

Lov	5	0.18	0.016	0.16-0.20
lov	5	0.19	0.020	0.16-0.21
Lav	2	0.17	0.007	016-0.17
lav	2	0.15	0.007	0.14-0.15

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	2. Rooted
C. Construction	?3. Artic. det. cut. joints
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	3. Branch with flat surf.
H. Dim. struct. units	?1. Straight
I. Freq. bifurc.	?2. Infrequent
J. Dim. bifurc.	?
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: TL *[p]*

COMPARISONS: *Caberea morningtoniensis* Maplestone (1900a: 164, pl. 17, fig. 7; NMV P10103; Fyansford Formation, Middle Miocene, Otway Basin) has a distal shelf and two avicularia.

Other genera, which could also accommodate this species, are *Canda* Lamouroux (see Harmer, 1958; MacGillivray, 1895) and *Amastigia* Busk, which has a pair of avicularia distal to ovicell.

Genus ***Scrupocellaria*** Lamouroux, 1816

TYPE SPECIES: *Sertularia scruposa* Linné, 1758

DESCRIPTION: Colony bushy or repent, branched, anchored by rhizoids. Branches comprise alternating zooids in two series; dividing dichotomously regularly at intervals, each ramus jointed at its base. Zooids with oval frontal membrane and well developed gymnocyst. Spines usually present distally and a specially modified flattened spine (scutum) typically overarches the frontal membrane. Heterozooids polymorphic: lateral avicularia typically occur as angular prominences at outer distal angles of autozooids, often dimorphic; frontal avicularia often present on gymnocyst, also often dimorphic; vibracula typically basolateral and/or in the axils of bifurcations. Ovicell hyperstomial, globular, with or without pores or larger fenestrae. Ancestrula vase-like, attached to the substratum by rhizoids. (after Gordon, 1984; Ryland & Hayward, 1992)

REMARKS: *Scrupocellaria* species occur in a wide range of environment, from cool-water to tropical.

Scrupocellaria sp. nov. a

Plate 10A, B, C

MATERIAL: SAM P39368 (MF)

DESCRIPTION: Colony erect delicate articulated branching, unilamellar, ca. 0.3 mm wide, at least 1.4 mm long internodes.

Zooids claviform with smooth gymnocystal proximal area; basal area smooth, without scuta.

Opesia oval with narrow raised margin, occupying most of zooid, lateral walls sloping inwards (V-shape cross-section), broad distal ledge?, opesia frequently closed off to varying extent by flat irregular spines radiating inwards from margins.

Adventitious[?] avicularia of varying size generally at proximal margin of opesia, sometimes almost at colony margin, not present on every zooid, positioned on proximal area of conical process, rostrum acute directed abfrontally and hooked upwards at end.

Ovicells not observed.

MEASUREMENTS: (1 specimen)

Lz	7	0.43	0.050	0.36-0.47
lz	7	0.16	0.015	0.14-0.18
Lo	7	0.17	0.020	0.13-0.19
lo	7	0.12	0.014	0.10-0.13
Lav	7	0.09	0.008	0.08-0.10
lav	7	0.07	0.010	0.06-0.08

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	2. Rooted
C. Construction	?3. Artic. det. cut. joints
D. Arrang. zooid ser.	2. Biserial
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None
G. Struct. units	3. Branch with flat surf.
H. Dim. struct. units	?1. Straight
I. Freq. bifurc.	?2. Infrequent
J. Dim. bifurc.	?
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MF(b) *[p]* (single specimen broken during investigations).

Superfamily **MICROPOROIDEA** Gray, 1848

Family **MICROPORIDAE** Gray, 1848

DESCRIPTION: "Colony encrusting; or erect, articulated or flustrine. Cryptocyst extensive, frequently extending as far as the operculum; opesia correspondingly reduced. Opesiules present when opesia is restricted to opercular area. Oral spines rare. Avicularia adventitious, interzooidal, or vicarious. Ovicell recumbent, or immersed, or absent. Pore-chambers or mural septula present." (Gordon, 1984)

Genus ***Micropora*** Gray, 1848

TYPE SPECIES: *Flustra coriacea* Johnston, 1847 (*non* Esper, 1796) [by monotypy]

DESCRIPTION: "Colony encrusting. Zooids with lateral walls raised somewhat above the level of the cryptocyst, which is granular, minutely perforated, with opesiules near the orifice. Oral spines rare. Avicularia adventitious, or interzooidal, or absent. Ovicell recumbent, or immersed, or absent; closed by the zooidal operculum. Basal pore-chambers present." (Gordon, 1984)

Micropora cf. **elegans** Maplestone

Plate 10D, E

Micropora elegans Maplestone, 1901b: 205, pl. 34 (fig. 4).

MATERIAL: SAM P39369 (MF).

OTHER MATERIAL EXAMINED: NMV P10151 (type of *Micropora elegans*, 'Aire Coastal Beds', Maplestone coll.)

DESCRIPTION: Colony encrusting unilaminar.

Zooids diamond shaped to hexagonal in longitudinal rows, margins clearly defined by narrow ridge, frontal wall of finely granular slightly convex cryptocyst, with a few scattered small pores in proximal half.

Opesia positioned at distal rim, flattened semicircular, corners without indentations, paired opesiular depressions at peripheral ridge just proximal to opesia, proximal opesial margin gently elevated (to level with peripheral ridge).

Interzooidal avicularia present at bifurcation points, broadly drop-shaped, with complete cross-bar, short acute rostrum directed distolaterally at 45° angle.

Ovicells hyperstomial (slightly immersed in distal zooid), squarish-globular, coarsely granulated, opesia appear slightly flattened.

MEASUREMENTS: (2 specimens)

Lz	12	0.36	0.024	0.32-0.40
lz	12	0.27	0.019	0.23-0.29
Lo	12	0.03	0.006	0.02-0.04
lo	12	0.10	0.005	0.09-0.11

Lov	7	0.15	0.017	0.13-0.18
lov	7	0.18	0.011	0.17-0.20
Lav	2	0.12	0.007	0.11-0.12
lav	2	0.10	0.007	0.09-0.10

A.B.G.H.C:

A. Orient. substr.	1. Encrusting
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	Hard secondary

OCCURRENCE: LTL *[p]*, MTL(l) *[f]*, MTL(m) *[f]*, MF(b) *[i]*; (OB) ?Upper Eocene – Oligocene [Aire Coast].

COMPARISONS: The opesia of the type specimen of *Micropora elegans* (NMV P10151) are slightly longer, but the overall appearance corresponds well. Many of the species of *Micropora* occurring in Australia, however, appear very similar to each other.

BIOGEOGRAPHY: *Micropora elegans* also occurs in the Recent of Australia and New Zealand (Gordon, 1986)

Family **CALESCHARIDAE** Cook & Bock, 2001

DESCRIPTION: Colony encrusting to erect, branched, adeoniform, quadriserial or bilaminar. Zooids large, with raised mural rim, communicating through a row of uniporous septular pores placed in the middle of the vertical walls. Zooids with a well-developed cryptocyst, often produced on the proximal edge to form a median process or denticle. Ovicells nearly always very large; always endozooidal, closed by a wide operculum. Ovicell capsule protruding into the cavity of the next distal zooid, beneath its cryptocyst. Spines and avicularia present. (after Cook & Bock, 2001)

Genus ***Tretosina*** Canu & Bassler, 1927

TYPE SPECIES: *Tretosina arcifera* Canu & Bassler, 1927b

DESCRIPTION: Colony erect, adeoniform, arising from an encrusting base. Autozooids elongated, with a well-developed cryptocyst surrounding an oval opesia. Median process absent or very small. Ovicell complex large. (after Cook & Bock, 2001)

***Tretosina*? sp. nov. a**

Plate 11A, B

MATERIAL: SAM P39374 (TL), P39375 (TL).

DESCRIPTION: Colony erect bifoliate.

Zooids elongate hexagonal, defined by very small ridge, rounded distal margin elevated relative to neighbouring zooids, gymnocyst restricted to proximolateral corners or absent, finely granular cryptocyst extensive proximally, narrow laterally and almost absent distally.

Opesia longitudinally oval to rounded rectangular, placed near distal margin, proximal margin beaded, numerous pores in vertical walls, largest distally and becoming smaller proximally.

Ovicells and avicularia not observed.

MEASUREMENTS: (2 specimens)

Lz	5	0.69	0.102	0.59-0.83
lz	5	0.33	0.031	0.30-0.36
Lo	5	0.31	0.022	0.28-0.34
lo	5	0.19	0.035	0.16-0.24

A.B.G.H.C:

A. Orient. substr.	?1. Encrust. / ?3. Erect
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	?2. Bilaminate.
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	? (substrate lost)

OCCURRENCE: TL (WLG 42 QA 69) *[f]*

COMPARISONS: *Membranipora cochleare* MacGillivray (1895: 40, pl. 5, figs 17, 18; Middle Miocene, Otway Basin) may also belong to *Tretosina*, but the orifice is as long as wide and the proximal cryptocyst is much longer and narrower than the specimens of this study.

Allocation to the Calescharidae seems appropriate, but both *Tretosina* and *Caleschara* have a distinct proximal denticle, which appears absent or strongly reduced here.

Family **ASPIDOSTOMATIDAE** Jullien, 1888

DESCRIPTION: Colony encrusting, or erect bifoliate from an encrusting base. Zooids with extensive cryptocyst, generally concave towards the opesia, which typically has proximolateral indentations. Avicularia interzooidal. Ovicells recumbent or immersed, the opening separate from the zooidal orifice. (after Gordon, 1986)

Genus ***Crateropora*** Levinsen, 1909

TYPE SPECIES: *Crateropora flacata* Levinsen, 1909

***Crateropora*?** sp.

Plate 11C

MATERIAL: SAM P39377 (TL).

DESCRIPTION: Colony encrusting or erect.

Zooids irregularly rectangular to claviform, defined by narrow recessed ridge, frontal wall cryptocystal and finely granular with a few irregularly scattered pores in proximal 1/3, single row of pores along margins, proximal half flat but sloping distally towards opesia, peripheral ridge (also granular) starting to develop from middle of zooid and becoming very pronounced around distal margin (pores running along outside) where the area facing the opesia is smooth and contains paired pores above opesial corners.

Opesia eye-shaped (proximal margin sometimes arched more strongly than the distal), often pronounced lip along proximal margin with the furrow ending in deeply recessed opesiules.

Ovicells and avicularia not observed.

MEASUREMENTS: (1 specimen)

Lz	3	0.77	0.148	0.67-0.94
lz	3	0.55	0.049	0.49-0.58
Lo	3	0.14	0.015	0.13-0.16
lo	3	0.20	0.015	0.19-0.22

A.B.G.H.C:

A. Orient. substr.	?1. Encrust. / ?3. Erect
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	?1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	? (substrate lost)

OCCURRENCE: TL *[p]*.

COMPARISONS: This identification is based on a single specimen and no ovicells or avicularia were observed. Based on the few available zooids, it may equally well belong to either *Larvapora, Chondriovelum* or *Labioporella*. The autozooids and especially the orifice show strong similarities with *Steginoporella patula sensu* MacGillivray (1895: 54, pl. 6, figs 19, 20; Middle Miocene, Otway Basin). It is unlikely to be a true *Steginoporella* Smitt as it lacks the characteristic calcified polypide tube.

Family **ONYCHOCELLIDAE** Jullien, 1882

DESCRIPTION: Colony encrusting or erect. Zooids with extensive cryptocyst, gymnocyst absent. Opesia with proximolateral opesiular indentations or rarely enclosed opesiules. Avicularia vicarious, mandible with symmetrical or asymmetrical lateral expansions. Ovicells endozooidal.

REMARKS: After appearing in the Cenomanian, this family dominated much of the Late Cretaceous Tethyan faunas, but declined in faunal importance in the Cainozoic.

Genus '***Onychocella***' gen. nov.

NOTE: The species described here do not fit under *Onychocella* Jullien, 1882 *s.s.*, and require a new genus (Schmidt & Bone, in press). Closely allied species are *'Macrocamera' clarkei* (Tenison Woods, 1877: 148, figs 4–7) and *Cellaria gigantea* Maplestone (1901: 184, pl. 28, fig. 4) (see below for occurrences).

DIAGNOSIS: Onychocellidae with variable growth form, mostly erect. D-shaped opesia with distinct distal shelf. Interzooidal avicularia symmetrical, with proximal cryptocystal foramen and condyles. Ovicells endozooidal, often without clear opening.

BIOGEOGRAPHY: The oldest record of '*Onychocella*' (as considered here) is from the Paleocene Cardabia Calcarenite of the Carnarvon Basin, where common specimens of *'O.'* sp. a occur. The apparent absence of '*Onychocella*' in younger sediments may be due to the lack of detailed analysis. Gregory (1916) recorded '*Macropora clarkei*' from the Eocene Norseman Limestone, which is probably *'O.'* sp. b. Cockbain (1970) recorded '*Aspidostoma' clarkei* (Woods)' from the Eocene Wilson Bluff Limestone and the Oligo-Miocene Abrakurrie and Nullarbor Limestones in the Eucla Basin. He noted that the vinculariiform (delicate branching, possibly *'O.'* sp. c) colonies only occurred in the Wilson Bluff Limestone while the eschariform (foliose, possibly *'O.'* sp. a) colonies occurred only in the Abrakurrie Limestone. It is unclear where in the Murray Basin or from which formation Waters' (1885) specimens of '*Monoporella sexangularis*' (possibly *'O.' clarkei*) were collected, but the Miocene Mannum or Morgan Limestones are the most likely. In the Otway Basin *'O.' clarkei* has only been found in Early Miocene sediments, which is the general age of outcropping formations at the localities, which early collectors cite. Tenison Woods (1877) states "Muddy Creek, Hamilton, Victoria" as the main locality, where mainly Middle Miocene sediments of the Gellibrand Marl outcrop. In the Gambier Embayment it also occurs "as short stems" (= *'O.' ?gigantea*) "from the Mount Gambier polyzoan limestones". This is probably in the bryozoan rich Oligo-Miocene Gambier Limestone.

From the above summary it appears that occurrences of *'Onychocella'* species progress from the Paleocene of north-western Australia, through the Eocene of southern Australia, to the Oligo-Miocene of south-eastern Australia. Such a seemingly chronological progression along the coast could indicate an origin in the north-western region of Australia sometime during the earliest Tertiary. The most likely dispersal mechanism in this case would have been an early form of the Leeuwin Current, which today flows from the Indonesia Gateway south along the western coast of Australia and then east into the Great Australian Bight (McGowran *et al.*, 1997b). Other bryozoans and groups such as brachiopods

(Craig, 2000) and echinoids (McNamara, 1999) are generally considered to have dispersed via this current. Alternatively, this pattern may simply be a product of the diachronous progression of marine influence from northwest to southeast as Australia and Antarctica rifted and separated.

Many of the erect onychocellid species of the European Cretaceous resemble *'Onychocella'*, possibly indicating a Tethyan relationship. This is not impossible considering its first appearance in the Paleocene. Voigt (1985), however, believes most, if not all the erect onychocellids, which were common in the Late Cretaceous, did not survive past the K/T boundary. Considering the quite distinct character of the Australian bryofauna, a local evolution is also likely.

The time range of *'Onychocella'* ascertained by this study, along with reliable citations in the literature, places the first appearance in the Late Paleocene of the Carnarvon Basin and the last appearance in the Middle Miocene of south-eastern Australia. This gives a range of approximately 50 million years. No Recent representatives of this genus are yet known. The time range for *'Onychocella'* sp. a alone is a minimum 20 million years and possibly over 30 million years. Although no post-Miocene species of *'Onychocella'* are yet known, it is quite possible that they may still occur somewhere on the still poorly investigated Australian continental shelf.

'*Onychocella*' sp. nov. a

Plate 12G, H, I

Monoporella sexangularis (Goldfuss); Waters, 1885: 291, pl. 7 (fig. 2). (pars)

Material: SAM P39310 (TL)

Other material examined: SAM P39307 (PWFa), P39308 (PWFa), P39309 (PWFa), P39311 (Pirie Member, Cardabia Calcarenite, Paleocene, Giralia, Western Australia)

Description: Colony erect, bilamellar flat robust branching of varying shapes, probably from an encrusting base.

Autozooids elongated subhexagonal, frontal wall generally smooth to faintly coarsely granular, sometimes with two parallel furrows running from each opesiular indentation to the proximal zooid margin, very concave, relatively thin.

Opesiae with prominent opesiular indentations at proximal corners often continuing as narrow furrows, raised broad oral rim almost level with zooid margins. Distinct distal opesial shelf with granular surface and a smooth very narrow peripheral furrow.

Large symmetrical trapezoidal subvicarious avicularia, with large faintly granulated cryptocyst surrounding a small proximal foramen, opesiae semi-circular with small proximal denticle, lateral condyles faint or absent, sibling zooids generally oriented in the normal distal direction.

Ovicells endozooidal, forming a slight bulge on the distal zooidal margin. Kenozooids occurring at colony margins roughly the same size as the autozooids but with only a small central opening.

Continued next page

'*Onychocella*' sp. nov. a continued:

MEASUREMENTS: (4 specimens)

Lz	35	0.93	0.090	0.82-1.14
lz	35	0.70	0.077	0.54-0.86
Lo	35	0.24	0.011	0.20-0.26
lo	35	0.25	0.015	0.22-0.28
loprox	35	0.20	0.014	0.18-0.23
lo-shlf	35	0.09	0.012	0.07-0.11

Loov	11	0.20	0.060	0.10-0.34
loov	11	0.21	0.061	0.16-0.28
Lov	11	0.37	0.018	0.34-0.39
lov	11	0.23	0.044	0.16-0.30
Lav	4	0.80	0.050	0.74-0.86
lav	4	0.44	0.041	0.38-0.48
Loav	4	0.08	0.017	0.06-0.10
loav	4	0.12	0.013	0.10-0.13
Lrostr	4	0.36	0.025	0.32-0.38

A.B.G.H.C:

A. Orient. substr.	3. Erect
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	2. bilam.
F. 2° skel. thick.	?1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	2. Infrequ.
J. Dim. bifurc.	2. on plane
K. Conn. struct. units	1. None
L. Substr. type	? (substrate lost)

OCCURRENCE: LTL *[c]*, MTL(m) *[f]*, UTL *[f]*, LKL(l2) *[r]*, LKL(t) *[r]*; PWF(a) *[c]*; (CB) CC [Giralia].

COMPARISONS: The specimens from the Paleocene Cardabia Calcarenite of the Carnarvon Basin are almost identical to those of the Eocene–Oligocene specimens from the St Vincent Basin.

REMARKS: *'O.'* sp. a and *'O.'* sp. b are common in the Tortachilla Limestone. In the overlying Blanche Point Formation very large colonies (over 20cm diameter) of *'O.'* sp. nov. b are present in a few horizons. The basal Aldinga Member of the Port Willunga Formation contains common *'O.'* sp. nov. a and *'O.'* sp. nov. c. only the basal Late Eocene Mulloowurtie Formation and the bryozoan-rich Oligocene Port Vincent Formation have yielded specimens of *'O.'* sp. nov. b. Only one large *'O.'* sp. nov. b colony was observed in the Late Eocene Kingscote Limestone on Kangaroo Island.

'*Onychocella*' sp. nov. b

Plate 12A, B, C, D, E; 13E

Monoporella sexangularis (Goldfuss); WATERS, 1885: 291, pl. 7 (Fig. 2). (pars)

MATERIAL: SAM P39303 (TL), P39304 (TL), P39305 (TL), P39306 (TL)

OTHER MATERIAL EXAMINED: NMNH D33053 ("Miocene, Janjukian" [=?Tortachilla Limestone], Aldinga, South Australia, F.S. Dutton coll.)

DESCRIPTION: Colony erect, bilamellar with fenestrae (cribrate).

Autozooids hexagonal separated by shallow furrow.

Opesiae with small opesiular indentations at proximal corners, and narrow raised oral rim with distal part sometimes forming a lip. Distinct distal opesial shelf with granular surface and a smooth peripheral furrow of varying width. Frontal wall finely granular, slightly concave with thick frontal walls, possibly due to secondary thickening (up to 0.17 mm).

Continued next page

Onychocella sp. b continued

Subvicarious avicularia with finely granular cryptocyst, often surrounding a proximal foramen, opesiae sub-circular with small proximal denticle and strong lateral condyles, common at zooid bifurcations and sometimes around the fenestrulae, their appearance may sometimes resemble the autozooids. Sibling zooids generally highly torqued towards the avicularium.

Ovicells forming bulge on the distal zooidal margin, widening the shelf and narrowing the opesia. Zooids with ovicells generally occurring in clusters within the colony. Kenozooids of very irregular shapes occurring at base of new 'lamina' appear to be the result of self-overgrowth or even frontal budding.

MEASUREMENTS: (2 specimens)

Lz	20	0.78	0.060	0.66-0.91
lz	20	0.67	0.026	0.62-0.72
Lo	20	0.22	0.017	0.18-0.24
lo	20	0.26	0.012	0.24-0.28
loprox	20	0.21	0.014	0.18-0.24
lo-shlf	20	0.08	0.014	0.06-0.11

Lov	12	0.24	0.032	0.18-0.30
lov	12	0.30	0.039	0.22-0.36
Loov	12	0.14	0.043	0.10-0.18
loov	12	0.28	0.014	0.26-0.30
Lav	7	0.79	0.068	0.72-0.92
lav	7	0.56	0.078	0.50-0.72
Loav	7	0.21	0.025	0.16-0.24
loav	7	0.23	0.033	0.18-0.27
Lrostr	7	0.29	0.044	0.20-0.34

A.B.G.H.C:

A. Orient. substr.	3. Erect
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	2. Bilam.
F. 2° skel. thick.	?1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	2. Folded
I. Freq. bifurc.	3. Frequent
J. Dim. bifurc.	3. More than one
K. Conn. struct. units	2. fused units
L. Substr. type	? (substrate lost)

OCCURRENCE: MTL(l) *[f]*, MTL(m) *[f]*, BPF(gr) *[i]*, MF(b) *[c]*, LKL(l1) *[p]*, LKL(m) *[r]*, LKL(u) *[c]*; PVL *[c]*.

COMPARISONS: The main differences with *'Onychocella' clarkei* (Tenison Woods) are the significantly smaller zooid measurements (Lz = 1.15, lz = 0.92, Lo = 0.27, lo = 0.30, loprox = 0.25, lo-shelf = 0.11), the absence of avicularia and the lack of a distinct furrow in the opesial shelf.

REMARKS: Colonies of this species are frequently extensively encrusted, often with multiple layers of several bryozoan (especially cyclostome) species and occasionally serpulids. This could indicate that it is part of the early stages of faunal successions and acts as the substrate for later arrivals. It also occurs in a wide range of sedimentary facies, indicating it may have been an opportunistic species.

Very large colonies (over 20cm diameter) of *'O.'* sp. nov. b are present in a few Blanche Point Formation horizons.

The complexly folded colony form is reminiscent of many modern species of *Adeona*. *'Onychocella'* sp. nov. b did not, however, possess a similar root structure of calcified plates, but rather appears to have initially encrusted on ephemeral three dimensional substrates (e.g. sponges). The subsequent erect growth originated from the back to back joining of two unilaminar encrusting parts of the colony.

'*Onychocella*' sp. nov. c

Plate 13A, B, C, D

MATERIAL: SAM P39312 (TL), P39313 (PWFa), P39314 (PWFa)

DESCRIPTION: Colony erect delicate branching, probably from an encrusting base.

Autozooids large subhexagonal to rectangular.

Frontal wall very finely granular to almost smooth, slightly concave.

Opesiae proximally constricted, with straight proximal margin and very small opesiular indentations at proximal corners. Narrow opesial shelf with granular surface and a smooth peripheral furrow of varying width. No separating furrow between zooids visible unless dissolution has occurred.

Avicularia and ovicells not observed.

MEASUREMENTS: (2 specimens)

Lz	9	1.06	0.076	0.90-1.12
lz	9	0.67	0.059	0.54-0.76
Lo	9	0.23	0.013	0.21-0.25
lo	9	0.23	0.023	0.18-0.26

loprox	9	0.16	0.013	0.14-0.17
lo-shlf	9	0.06	0.013	0.04-0.07

A.B.G.H.C:

A. Orient. substr.	3. Erect
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	5. Radial
F. 2° skel. thick.	1. None

G. Struct. units	?8. Solid cylinder
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	2. infrequent
J. Dim. bifurc.	?1. one plane
K. Conn. struct. units	1. None
L. Substr. type	? (substrate lost)

OCCURRENCE: TL *[r]*; PWF(a) *[c]*

COMPARISONS: This species is very similar to *Cellaria gigantea* Maplestone, but has opesiae with more contracted proximal margins and less concave frontal walls. The zooidal dimensions are also larger in *C. gigantea* (Lz = 1.25, lz = 0.89, Lo = 0.36, lo = 0.33, loprox = 0.21, lo-shelf = 0.17).

The opesia appear very similar to those of the only observed specimen of a completely encrusting form. This may therefore be the same species, but the preservation of the latter is insufficient to allow a positive identification.

Genus ***Ogiva*** Jullien, 1881

TYPE SPECIES: *Eschara actea* d'Orbigny, 1851 [by original designation]

DESCRIPTION: Opesia elliptical, opesiules indistinct, avicularia elongate. (after Bassler, 1953)

'***Ogiva***' sp. nov. a

Plate 11D, E, F

MATERIAL: SAM P39378 (TL), P39379 (MF)

DESCRIPTION: Colony erect bilaminar flat robust lobes with acute margins.

Zooids alternating in 6–12 longitudinal rows, zooids hexagonal to diamond shaped, as wide as long (marginal zooids somewhat larger), zooid margins defined clearly by furrow (secondary?), frontal wall smooth (cryptocyst?) and concave.

Opesia round to longitudinally oval, with very narrow marginal ledge (this is probably secondary through regeneration of a damaged zooid); large pore in distal wall.

Vicarious avicularia resemble autozooids, but opesia is elongated, narrowing distally into slightly acute point, raised above distal zooid.

No fertile zooids observed.

MEASUREMENTS: (2 specimens)

Lz	11	0.44	0.045	0.39-0.50
lz	11	0.34	0.036	0.30-0.40
Lo	11	0.17	0.030	0.12-0.20
lo	11	0.15	0.023	0.12-0.17

Lzav	4	0.55	0.080	0.45-0.64
lzav	4	0.38	0.044	0.31-0.40
Loav	4	0.20	0.014	0.18-0.21
loav	4	0.14	0.005	0.13-0.14

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	2. Bilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	?1. None
J. Dim. bifurc.	?1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: LTL *[p]*, MTL(l) *[c]*, MTL(m) *[i]*, MTL(u) *[r]*, UTL *[f]*, MF(b) *[i]*, LKL(l1) *[c]*, LKL(l2) *[d]*, LKL(u) *[c]*, LKL(t) *[r]*.

COMPARISONS: *Melicerita elliptica* Maplestone (1901a: 184, pl. 23, fig. 3; Upper Eocene or Oligocene, Aire Coast, Otway Basin) has very similar colony, zooid and opesia shapes. The "cucullate avicularia, situated on the proximal part of zooecia" of Maplestone, are probably the points of origin of rhizoids. Measurements of the type specimen (NMV P10135) are much smaller (Lz = 0.26, lz = 0.18, Lo = 0.10, lo = 0.07 mm) than those of specimens of this study. This smaller size is contrary to other species which are identified here with pre-existing species. *Amphiblestrum arethusa sensu* MacGillivray (1895: 41, pl. 5, fig. 21; Gellibrand Marl) also has a bilaminate colony flat, but opesia are rounded triangular shape. In *Omoiosia elongata* Canu & Bassler (1935: 14, pl. 3, fig. 11; Gellibrand Marl) the colony form is the same, and zooids, avicularia and opesia appear similar, but the opesial margins are slightly elevated. *Ogiva incompta* Gordon & Taylor (1999: 23; Upper Paleocene to Lower Eocene, Chatham Island) has more convex frontal walls with a shallow but broad furrow between zooids. The avicularia are similar but the rostrum is more elongate and acute.

This is probably not a true *Ogiva s.s.*, but considering the difficult status of many of the Onychocellidae (see Gordon & Taylor, 1999: 23) it is an appropriate provisional placement.

REMARKS: This is one of the most widely occurring species within the basin. It occurs throughout all the fossiliferous limestones. It is however completely absent from the Blanche Point Formation and the Rogue Formation.

Family **Incertae Sedis**

Genus ***Ogivalia*** Jullien, 1881

TYPE SPECIES: *Vincularia elegans* d'Orbigny, 1839

DESCRIPTION: Slender cylindrical branches. (Bassler, 1953)

***Ogivalia*?** sp. nov. a

Plate 11G, H, I

MATERIAL: SAM P39380 (TL), P39381 (TL), P39382 (TL)

DESCRIPTION: Colony erect branching, cylindrical with 10 zooid rows.

Zooids hexagonal to diamond-shaped, defined by broad raised margins, frontal wall depressed distinctly below margin, flat to slightly concave, faintly granular cryptocyst covering proximal half.

Opesia elongated semicircular to rounded triangular, with slightly concave proximal margin, placed near distal margin, narrow rounded shelf on distal wall just below opesial margin with large pore placed medially halfway down.

Avicularia Interzooidal, similar to autozooids, but more triangular and slightly smaller, distal shelf larger and also running partway along lateral walls, constricting opesia.

No fertile zooids observed.

MEASUREMENTS: (3 specimens)

Lz	11	0.42	0.027	0.39-0.47
lz	11	0.23	0.020	0.20-0.26
Lo	11	0.17	0.023	0.15-0.20
lo	11	0.10	0.016	0.08-0.13

Lzav	1	0.38	-	
lzav	1	0.19	-	
Loav	1	0.17	-	
loav	1	0.10	-	

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	5. Radial
F. 2° skel. thick.	1. None

G. Struct. units	8. Solid cylinder
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	3. Frequent
J. Dim. bifurc.	2. One plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(l) *[f]*, MTL(m) *[c]*, MTL(u) *[f]*, UTL *[f]*, MF(b) *[r]*, LKL(l1) *[d]*, LKL(l2) *[d]*.

Remarks: This species has a similar distribution to '*Ogiva*' sp. nov. a.

Superfamily **Incertae Sedis**

Family **MACROPORIDAE** Uttley, 1949

Genus ***Macropora*** MacGillivray, 1895

TYPE SPECIES: *Macropora centralis* MacGillivray, 1895 [subsequent designation Canu & Bassler, 1917 *(?=Lepralia grandis* Hutton, 1873)]

DESCRIPTION: Colony encrusting or erect, foliaceous. Zooids typically dimorphic, large, the cryptocystal frontal wall convex, with scattered pores serving as opesiules. Opesia completely reduced, wholly coinciding with the orifice. Operculum thick, calcareous, semicircular. A second type of orifice may occur, which is wider and sinuate distally. Small oral spines present or absent. Ovicell huge, as large as or larger than autozooids, recumbent upon other zooids, kenozooids or the substratum; closed by the zooidal operculum. Basal pore-chambers present. (after Gordon, 1984)

REMARKS: First occurrence of this family is *Macropora aquia* Canu & Bassler (1920), from the 'Bryozoan Bed' at base of Aquia Formation, Upper Marlboro, Maryland (Thanetian).

Macropora sp. nov. a

Plate 13F, G, H, I, J

MATERIAL: SAM P39383 (MF)

DESCRIPTION: Colony encrusting (possibly erect or self overgrowing with zooids different sizes on each side).

Zooids elongated hexagonal, clearly defined by furrow within a flat smooth area of varying width (wider in corners), frontal wall flat to convex around orifice, very finely and faintly granular, evenly but randomly perforated by (medium sized) pores (sometimes one row near margin) within slight depressions.

Orifice D-shaped, slightly narrowing proximally, distal margin slightly elevated, proximal and lateral margins slightly depressed (forming narrow shelf), distal oral shelf very narrow, no orificial spines observed, some with calcified opercula in place.

'Avicularia' vicarious, same size and appearance as autozooids, except for orifice: larger with distolateral corners extended into round corners forming slight depressions in wide oral shelf, lateral margins straight and distal margin curved inwards while oral shelf remains D-shaped, three spines along distal margin and paired spines just proximal to distolateral corners.

Ovicells cover most of the proximal area of the distal zooid, with numerous ribs radiating from the central area outwards but not reaching the edge.

MEASUREMENTS: (1 specimen)

Lz	6	1.01	0.062	0.90-1.08
lz	6	0.64	0.039	0.58-0.68
Lo	6	0.15	0.015	0.12-0.16
lo	6	0.19	0.013	0.18-0.21

Lzav	1	1.02	-	
lzav	1	0.64	-	
Loav	1	0.24	-	
loav	1	0.22	-	

A.B.G.H.C:

A. Orient. substr.	?1. Encrust./ ?3. Erect
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	?1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(l) *[i]*, MTL(m) *[f]*, UTL *[p]*, MF(b) *[i]*.

COMPARISONS: The vicarious avicularia are different from any other known species of *Macropora*.

Family **OTIONELLIDAE** Bock & Cook, 1998

Genus ***Otionellina*** Bock & Cook, 1998

TYPE SPECIES: *Otionella australis* Cook *et al.* 1985b

DESCRIPTION: "Colonies rarely larger than 8 mm in diameter, often 'bun-shaped' and solid basally, secondary thickening with scattered pores. Ancestrula with one (occasionally two) distal, and one proximal avicularium; budding radial. Autozooids with a well-developed, depressed cryptocyst surrounding a terminal or subterminal, rounded opesia. Brooding zooids peripheral, with enlarged, often subtriangular opesia. Avicularia in scattered patterns or radial series, symmetrical, or if asymmetrical, with the direction of asymmetry to the left (viewed frontally); peripheral avicularia often encroaching onto the basal surface. Avicularian cryptocyst marginal or serrated, or forming a perforated lamina. Condyles paired, occasionally fused. Mandibles short and paddle-shaped or long, curved, serrated, sometimes expanded; basal mandibles leaf-like." (Bock & Cook 1998: 197)

REMARKS: Lunulitiform colonies such as those of *Otionellina* are considered to be the most resistant to dissolution effects due to their compactness (Smith & Nelson, 1996). The solid basal calcification of all specimens investigated here, however, is missing (assuming that this genus always developed this basal calcification; see also Greeley, 1969). The reason for this is not clear but likely to be due to bimineralic composition.

The early Tertiary species *O. cupola* and *O. exigua* resemble some of the smaller forms of Cretaceous and Tertiary *Lunulites* from Europe. The early astogenetic pattern of Australian species is consistent and distinctive, and a close relationship with *Lunulites* is unlikely (Bock & Cook, 1998: 197).

Otionella differs from *Otionellina* in the arrangement of the periancestrular zooids (no avicularia), direction of asymmetry of the avicularia, lack of skeletally distinct zones of brooding zooids. *Otionella* is considered American, while *Otionellina* considered Australian endemic. It probably originated in the Early Eocene in on the western Australian margin

Otionellina cf. ***exigua*** (Tenison Woods)

Plate 14A, B, C, D, E

Lunulites exigua TENISON WOODS, 1880: 8, pl. 2 (fig. 7a, b, c).

Otionella exigua (Tenison Woods), COOK & CHIMONIDES, 1985: 596, figs 8, 21, 28. (*cum syn.*)

Otionellina exigua (Tenison Woods), COOK & BOCK, 1998: 197.

MATERIAL: SAM P39327 (TL), P39328 (TL), P39329 (TL), P39330 (TL)

OTHER MATERIAL EXAMINED: SAM P1548E (lectotype), A-D (paralectotypes of *Lunulites exigua*, Tenison Woods coll.)

DESCRIPTION: Colony free living, cap-shaped.

Zooids circular to oval hexagonal, margins clearly defined by furrow, frontal cryptocyst wall finely granular and concave especially proximally, convex near opesia.

Basal area only preserves sack-shaped zooidal chambers with some ridges in between, other calcification dissolved away, a central smooth convex area of calcification remains where the initial zooids used to be attached to substrate, which is lost on all specimens.

Opesia transversely oval to rounded rectangular, positioned near but separate from distal margin.

Interzooidal avicularia symmetrical or with only slight asymmetry to the left (viewed frontally), oval with proximal cryptocystal area, median broad blunt condyles, sometimes depressed below level of zooids.

Ancestrula with distal and proximal interzooidal avicularia, early astogenetic zooids often with calcified operculum.

MEASUREMENTS: (2 specimens)

Lz	7	0.32	0.058	0.26-0.40
lz	7	0.27	0.047	0.22-0.34
Lo	7	0.09	0.017	0.07-0.12
lo	7	0.11	0.032	0.08-0.16
Lzan	2	0.24	0.028	0.22-0.26
lzan	2	0.17	0.042	0.14-0.20
Loan	2	0.07	0.000	0.07
loan	2	0.07	0.014	0.06-0.08

Lav	5	0.18	0.063	0.12-0.26
lav	5	0.12	0.039	0.08-0.16
Loav	5	0.06	0.028	0.04-0.10
loav	5	0.05	0.013	0.03-0.06

Ø-col	3		~1.5-3.5

A.B.G.H.C:

A. Orient. substr.	4. Free-liv. avic. supp.
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	?1. Unilam.
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	? (substrate lost)

OCCURRENCE: LTL *[f]*, MTL(l) *[c]*, MTL(m) *[i]*, MF(b) *[f]*, LKL(l2) *[r]*; Muddy Creek; Nanarup; Wilson Bluff; Tasmania.

COMPARISONS: Although the ancestrular measurements closely agree with those of the types of *O. exigua*, the measurements of mature zooids are larger and are more similar to those of *O. cupola*.

The ancestrula of the colony figured in Plate14D does not appear to have the proximal avicularium characteristic of *Otionellina*, and is more similar to those in species of *Otionella*. This may be an artefact, and it is placed under *Otionellina* because of its symmetrical avicularia.

Otionellina* cf. *cupola (Tenison Woods)

Plate 14F, G

Lunulites cupola Tenison Woods, 1880: 8, pl. 1 (fig. 5a, b, c).

Otionella cupola (Tenison Woods), Cook & Chimonides, 1985: 596, figs 18, 19, 26, 27, 32. (*cum syn.*)

Otionellina cupola (Tenison Woods), Cook & Bock, 1998: 197.

Material: SAM P39323 (TL)

Other material examined: SAM P1545E (lectotype), B, C, F, G, J, K, L, M, N, O, P (paralectotypes of *Lunulites cupola*, Tenison Woods coll.; designated by Cook & Chimonides, 1985: 596)

Description: Colony free living, cap-shaped.

Zooids oval to irregularly hexagonal, margins clearly defined by furrow between raised zooidal margins, frontal cryptocyst wall finely granular and concave, especially proximally, convex near opesia, three distinct blunt processes along distal margin.

Basal area only preserves sack-shaped zooidal chambers with some ridges in between, other calcification dissolved away.

Opesia rounded rectangular to longitudinally oval, positioned near but separate from distal margin.

Interzooidal avicularia not torqued, diamond-shaped with proximal cryptocystal area, median broad blunt condyles, sometimes almost touching in middle.

Ancestrula not observed.

Measurements: (1 specimen)

Lz	5	0.32	0.019	0.29-0.34
lz	5	0.28	0.004	0.27-0.28
Lo	5	0.13	0.011	0.12-0.14
lo	5	0.12	0.004	0.12-0.13

Lav	4	0.26	0.013	0.24-0.27
lav	4	0.17	0.015	0.16-0.19
Lovav	4	0.11	0.010	0.10-0.12
lovav	4	0.06	0.005	0.05-0.06
Ø-col	1	~5		

A.B.G.H.C:

A. Orient. substr.	4. Free-liv. avic. supp.
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	?1. Unilam.
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	? (substrate lost)

Occurrence: MTL(l) *[p]*, MTL(m) *[r]*, LRF(l) *[r]*; Muddy Creek; Wilson Bluff

Comparisons: This species differs from *Otionella exigua* mainly in the presence of the tuberculate peripheral zooids. It also resembles many of the Cretaceous species of *Lunulites*.

Superfamily **CELLARIOIDEA** Fleming, 1828

Family **CELLARIIDAE** Fleming, 1828

DESCRIPTION: Colony erect, jointed or unjointed. Zooids typically rhomboidal or hexagonal, facing from all sides of internodes or branches. Lateral walls of zooids raised, forming a rim delimiting the frontal area. Cryptocyst depressed, imperforate. Orifice more or less semicircular, the proximal rim straight or convex, usually with condyles laterally. Avicularia vicarious or absent. Ovicell endotoichal, usually inconspicuous. (after Gordon, 1984)

REMARKS: Gordon & Taylor (1999: 4) considered 7 species of Cellariidae, including 4 species of *Cellaria* as an exceptionally high diversity assemblage. The assemblages of the current study contain at least 16 species, including 13 species of *Cellaria*. Despite this diversity, they only constitute a significant proportion (>20%) of the sediment volume or specimen numbers in a few of the horizons (chiefly in relatively low diversity assemblages such as the Lower Rogue Formation and the upper Lower Kingscote Limestone).

Genus ***Larvapora*** Moyano, 1970

TYPE SPECIES: *Cellaria mawsoni* Livingstone, 1928

Larvapora? sp. nov. a

Plate 10F, G, H, I

MATERIAL: SAM P39370 (TL), P39371 (TL), P39372 (TL), P39373 (TL).

DESCRIPTION: Colony erect bilaminar branching, with wide branches; occasionally encrusting.

Zooids in alternating longitudinal rows, elongated rectangular to distally rounded hexagonal, margins clearly defined by broad ridge, frontal wall flat, smooth to coarsely granular and perforated by several scattered small pores mainly concentrated in proximal area.

Opesia positioned near distal margin, primary opesia semicircular with large rounded proximolateral condyles, very thin short peristome with distal margin elevated relative to proximal, closely abutting broad distal ridge, which is slightly higher than peristome and sometimes continues proximally merging with lateral ridges, secondary opesia compressed semicircular with slightly concave proximal margin, proximolateral corners with narrow opesiules cutting down to level with frontal wall and directed proximolaterally.

Interzooidal avicularia at bifurcation points (faint furrow with distal zooid often indistinct), small foramen, rostrum lingulate to pyriform (sometimes slightly torqued), directed proximolaterally.

Ovicells endotoichal?, small, bulge only to height of peristome, small transversely oval opening immediately distal to zooidal orifice, additional paired larger semicircular openings distolateral to orifice, directed laterally, no openings associated with zooidal orifice.

Kenozooids interspersed with autozooids, same shape but frontal wall slightly convex and perforated relatively evenly by moderately large pores, opesia completely occluded.

MEASUREMENTS: (4 specimens)

Lz	17	0.91	0.120	0.76-1.21
lz	17	0.52	0.080	0.40-0.69
Lo	17	0.12	0.018	0.10-0.16
lo	17	0.22	0.018	0.19-0.25
Lav	7	0.46	0.042	0.39-0.52
lav	7	0.28	0.049	0.22-0.34
Lrostr	7	0.28	0.033	0.24-0.31
lrostr	7	0.15	0.035	0.12-0.21

Lzov	5	0.83	0.094	0.68-0.92
lzov	5	0.56	0.078	0.50-0.69
Loov	5	0.11	0.008	0.10-0.12
loov	5	0.22	0.013	0.21-0.24
Lov	5	0.17	0.033	0.14-0.22
lov	5	0.50	0.015	0.49-0.52
Lovfen	5	0.16	0.013	0.15-0.18
lovfen	5	0.11	0.005	0.11-0.12

A.B.G.H.C:

A. Orient. substr.	3 Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	2. Bilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	2. Infrequent
J. Dim. bifurc.	2. One plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: Foliose: LTL *[r]*, MTL(l) *[i]*, MTL(m) *[i]*, MF(b) *[f]*, LKL(m) *[p]*;
Flat robust branching: LTL *[r]*, MTL(m) *[i]*, MF(b) *[r]*.

COMPARISONS: This species very closely resembles *Micropora patula sensu* Waters (1885: 290, pl. 7, fig. 4; ?Oligo-Miocene, Murray Basin; ?Miocene, Otway Basin), but not *M. patula s.s.* (Waters, 1881: 326; Oligo-Miocene, Gambier Embayment). *Larvapora mawsoni* (Livingstone) (Recent, Antarctica) is very similar, in particular the ovicell is almost identical; but the frontal wall is imperforate, it has paired ?spine bases at distal opesial margin, and the opesiules are different.

Some of the autozooidal features are similar to genera such as *Crateropora*, *Chondriovelum* or *Labioporella*, but in each case the ovicell (where it is known) is different.

Genus ***Melicerita*** Milne-Edwards, 1836

TYPE SPECIES: *Melicerita charlesworthii* Morris, 1843

DESCRIPTION: Colony erect, bilamellar, typically with acute margins, not articulated. Zooids typically hexagonal, arranged in transverse rows, adjacent cryptocysts separated by distinct ridges. Opesia with proximolateral indentations and median convexity, wider than long, usually with a pair of distal denticles. Avicularia vicarious to interzooidal, usually found at colony margins. Ovicells entotoichal, visible as bulges, the opening associated with subjacent finely beaded and/or porous area(s). (after Gordon, 1986; Brown, 1952)

BIOGEOGRAPHY: "Early Oligocene - Recent distribution in Australasia (Brown 1952, Gordon 1986)

ENVIRONMENTS: This is generally a deep water genus, as according to Rosso (1992) "no living species of *Melicerita* (New Caledonia, N.Z., S. Atlantic, Antarctica) occurs shallower than 74 m" (cited by Gordon, 2000), and it occurs at depths of 760–1676 m around New Zealand and always >100 m on the slope of the southern Australian shelf (Hageman *et al.,* 1996). The St Vincent Basin was probably always shallower than this, indicating that other factors than depth *per se* are the controlling factor in the distribution.

Melicerita cf. ***angustiloba*** Tenison Woods

Plate 14H, I, J, K

Melicerita angustiloba BUSK, 1860: 261. (*nomen nudum*)
Melicerita angustiloba TENISON WOODS, 1862: 73.
Melicerita angustiloba Tenison Woods; ETHERIDGE, 1877: 143. (listed)
Cellaria angustiloba Tenison Woods; MACGILLIVARY, 1895: 27, pl. 3 (fig. 16).
? *Cellaria acutimarginata* MACGILLIVRAY, 1895: 28, pl. 3 (fig. 17).
Melicerita angustiloba Tenison Woods; BROWN, 1952: 165 (cum syn.), fig. 113.
Melicerita angustiloba Tenison Woods; WASS & YOO, 1983: 307.
Melicerita angustiloba Tenison Woods; GORDON, 1986: 77, pl. 31a.

MATERIAL: SAM P39389 (TL)

TYPE MATERIAL: The original holotype is unknown, probably lost. Brown (1952: 165) designated NMNH D.32934 as lectotype, which compares well with the material of this study.

OTHER MATERIAL EXAMINED: NMNH D.32934 (lectotype of *Cellaria angustiloba*, Mt Gambier, South Australia, Tenison Woods coll.); NMV P27540 (Muddy Creek, MacGillivray coll.); NMV P39876 (holotype of *Cellaria acutimarginata*, Schnapper Point; MacGillivray coll.)

DESCRIPTION: Colony erect bifoliate with acute margins, branches ca. 20 rows of zooids wide (appearing as whorls of 9–10 zooids), 4mm across, up to at least 20 mm long (no articulations observed).

Zooids arranged in transverse rows, hexagonal, equal sided near central row, becoming torqued towards lateral margin, very straight margins clearly defined by raised margins with sides sloping down along distal margins to an almost flat frontal wall, which slopes down slightly towards proximal margin of opesia.

Opesia positioned just distal of zooid centre, oriented distally in central row of colony and gradually orienting more laterally until oriented at ca 45° to longitudinal axis at margins, crescentic with moderately broad rounded proximal corners, almost straight proximal margin with denticle at each acute corner and forming a narrow curved lip, long slender paired denticles on distolateral margin pointing inwards (right angle to opesial margin).

Interzooidal avicularia occur frequently at the colony margin in alternate rows, oriented at 45° to longitudinal axis, narrow ellipse-shaped, large condyles in distolateral area

Ovicells deeply immersed, opening in large triangular slit just distal to orifice, usually concentrated in central three zooid rows.

MEASUREMENTS: (2 specimens)

Lz	16	0.50	0.035	0.44-0.56
lz	16	0.36	0.036	0.30-0.42
Lo	16	0.08	0.010	0.08-0.10
lo	16	0.18	0.012	0.16-0.20
Dodist	16	0.17	0.020	0.14-0.20
Lav	2	0.19	0.071	0.14-0.24
lav	2	0.23	0.099	0.16-0.30
Loav	2	0.07	0.021	0.05-0.08
loav	2	0.07	0.021	0.05-0.08

Lz(marg)	4	0.51	0.077	0.44-0.62
lz(marg)	4	0.54	0.050	0.48-0.60
Lo(marg)	4	0.08	0.013	0.07-0.10
lo(marg)	4	0.16	0.005	0.16-0.17
Dodist	4	0.21	0.077	0.12-0.30

A.B.G.H.C:

A. Orient. substr.	3 Erect continuous
B. Attachm. substr.	?1. Cement/2. Rooted
C. Construction	3. Artic. det. cut. joints
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	2. Bilaminate.
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	?2. Infrequent
J. Dim. bifurc.	?2. One plane
K. Conn. struct. units	?4. Cutic. tubes
L. Substr. type	?

OCCURRENCE: MTL(l) *[r]*, MTL(m) *[f]*, MTL(u) *[r]*, LKL(l1) *[c]*, LKL(l2) *[f]*, LKL(m) *[r]*; Otway Basin (Oligo-Miocene)

COMPARISONS: MacGillivray (1895: 28, pl. 3, fig. 17) cited as features distinguishing *M. acutimarginata* (MacGillivray) from *M. angustiloba* the absence of lateral avicularia and the transverse rather than longitudinal arrangement of zooids in the latter. The presence and absence of lateral avicularia is purely due to space, and varies along the length of the colonies, which often change in width (Pl. 14H & K). In the specimens of the present study only colonies with transverse rows occur, and some lack avicularia. They do not, however, have proximal denticles rather than the opesial lip, and opesia going right to the colony margin, which may be a more diagnostic characteristic of *M. acutimarginata* if this is a separate species. Brown (1958: 49), however, concluded that these two names were synonymous, a conclusion that is followed here.

BIOGEOGRAPHY: *M. angustiloba* has a long time range from Middle Eocene to Recent in Australia and New Zealand. Some of the citations, however may need to be confirmed to be conspecific.

Genus ***Cellaria*** Ellis & Solander, 1786

Type species: *Farcimia sinuosa* Hassall, 1840 (by synonym; see Ryland, 1968)

Description: Cellariidae with typically jointed, occasionally unjointed colonies. Orifice with condyles. Avicularia vicarious, lacking pivot bar. Ovicell generally inconspicuous. (Gordon, 1984)

Remarks: None of the species here have large interzooidal avicularia (common in the Victorian species), but only small vicarious avicularia.

Cellaria sp. nov. a

Plate 15A, B, C

Material: SAM P39391 (TL)

Description: Colony as cylindrical straight branches, sometimes of varying thickness (no articulations or bifurcations seen).

Zooids alternating in 8 longitudinal rows, very elongated hexagonal, boundaries indistinct, cryptocyst slightly concave, smooth.

Opesia semi-circular to squarish, paired denticles close to but separate from proximolateral corners, connected by narrow ridge, paired opposing smaller denticles on distal margin slightly closer together.

Ovicells common, endotoichal (frontal wall generally broken in the specimens observed).

Avicularia not observed.

Measurements: (1 specimen)

Lz	6	0.47	0.037	0.42-0.52
lz	6	0.24	0.015	0.22-0.26
Lo	6	0.09	0.012	0.07-0.10
lo	6	0.10	0.004	0.10-0.11
Dodist	6	0.12	0.018	0.10-0.14

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	2. Rooted
C. Construction	3. Artic. det. cut. joints
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	5. Radial
F. 2° skel. thick.	1. None

G. Struct. units	8. Solid cylinder
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	?3. Frequent
J. Dim. bifurc.	3. More than one plane
K. Conn. struct. units	?4. Cutic. tubes
L. Substr. type	?

Occurrence: MF(b) *[r]*.

Comparisons: The orifice of this species is similar to *Cellaria rigida* MacGillivray (1895: 29, pl. 3, fig. 21, NMV P27544, but not pl. 3, fig. 20, NMV P27543, which only has proximal denticles and has very concave zooids; Middle Miocene, Otway Basin; ?Recent, Australia), but the zooids are hexagonal rather than rhomboid and less concave.

Cellaria sp. nov. b

Plate 15D, E

MATERIAL: SAM P39392 (TL), P39393 (TL)

DESCRIPTION: Colony in straight cylindrical branches (no articulations or bifurcations seen).

Autozooids elongated rectangular, alternating, arranged in 10 longitudinal series (pentaserial = 5x2 around branch)

Opesia broad and crescentic to reniform, large denticles near proximal corners which protrude slightly abfrontally out of the opesia, very smaller opposing denticles on distal margin, often with a series of 'granulations' or beading progressively getting smaller towards middle of margin.

Ovicells very deeply immersed between zooids (possibly endotoichal), usually without frontal wall (this could be through abrasion), no connection to opesia or zooid evident.

Interzooidal avicularia ellipsoidal, lacking pivotal bar, condyles in (proximo)lateral corners on narrow cryptocystal area, in front of circular 'opesia'. placed in series with autozooids.

MEASUREMENTS: (1 specimen)

Lz	5	0.35	0.011	0.34-0.36
lz	5	0.18	0.004	0.17-0.18
Lo	5	0.06	0.000	0.06
lo	5	0.12	0.005	0.11-0.12
Dodist	5	0.12	0.018	0.10-0.14

Lav	1	0.12	-	-
lav	1	0.06	-	-
Loav	1	0.04	-	-
loav	1	0.04	-	-

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	2. Rooted
C. Construction	3. Artic. det. cut. joints
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	5. Radial
F. 2° skel. thick.	1. None

G. Struct. units	8. Solid cylinder
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	?3. Frequent
J. Dim. bifurc.	3. More than one plane
K. Conn. struct. units	?4. Cutic. tubes
L. Substr. type	?

OCCURRENCE: LKL(m) *[r]*.

COMPARISONS: This slightly resembles *Cellaria* sp. nov. c.

REMARKS: Zooids immediately proximal to an avicularium are slightly shorter than others (0.32 mm), but all other dimensions are identical. The absence of a frontal ooecial wall is probably due to abrasion (as evidenced by the irregular borders) rather than a primarily uncalcified ooecial wall.

Cellaria? sp. nov. c

Plate 15F, G, H, I

MATERIAL: SAM P39337 (TL), P39339 (TL)

DESCRIPTION: Colony in straight cylindrical branches (no articulations or bifurcations seen). Autozooids alternating, arranged in 12 (?10) longitudinal series (hexaserial = 6x2 around branch).

Autozooids rectangular, cryptocyst very concave, especially in proximal area, with prominent marginal ridges (salient threads) rounded at corners, additional sinuous ridges between distal corners of neighbouring zooids in adjacent series.

Opesia placed just distal of median zooid line, crescentic/reniform, sometimes slightly flattened distally, two large denticles in proximal corners

Ovicells very common (almost ubiquitous), endozooidal, occupying distal 1/3 of zooid, inconspicuous apart from slight bulge distal to opesia and narrow crescentic slit along distal margin, almost level with salient zooidal margin (as in *Cellaria*), do not reach down to centre of colony.

Interzooidal avicularia placed in series with autozooids, transversely ellipsoidal, lacking pivotal bar, broad condyles in (proximo)lateral corners on narrow cryptocystal area, in front of circular 'opesia'.

MEASUREMENTS: (1 specimen)

Lz	7	0.35	0.010	0.34-0.36
lz	7	0.19	0.014	0.17-0.20
Lo	7	0.05	0.007	0.04-0.06
lo	7	0.10	0.016	0.06-0.10
Dodist	7	0.10	0.011	0.09-0.12

Lav	2	0.11	0.007	0.10-0.11
lav	2	0.18	0.007	0.17-0.18
Loav	2	0.04	0.007	0.03-0.04
loav	2	0.06	0.000	0.06

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	2. Rooted
C. Construction	3. Artic. det. cut. joints
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	5. Radial
F. 2° skel. thick.	1. None

G. Struct. units	8. Solid cylinder
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	?3. Frequent
J. Dim. bifurc.	3. More than one plane
K. Conn. struct. units	?4. Cutic. tubes
L. Substr. type	?

OCCURRENCE: MTL(l) *[r]*, LKL(u) *[c]*.

COMPARISONS: This is an unusual species and may not fit properly into *Cellaria s. s.* because it bears some resemblance with *Paracellaria* (Hayward, 1995).

REMARKS: Zooids immediately proximal to an avicularium are shorter than others (average Lz = 0.28 mm), but all other dimensions are identical.

Cellaria sp. nov. d

Plate 15J, K

MATERIAL: SAM P39396 (TL)

DESCRIPTION: Colony erect articulated branches with 12 (14?) rows of zooids, ca. 0.6mm diameter and up to at least 5mm long.

Zooids hexagonal, defined by broadly raised margins, frontal wall concave, very coarsely granular.

Opesia placed just distal to middle of zooid, crescentic with slightly flattened distal margin, proximal lip triangular with acute tip deflected slightly abfrontally, large denticles in proximolateral corners and projecting slightly abfrontally.

Avicularia vicarious, frequently placed in between successive autozooids, transversely oval with large elliptical distal foramen and shallow condyles along margin of proximal cryptocyst.

Ovicells not observed.

MEASUREMENTS: (1 specimen)

Lz	6	0.32	0.023	0.30-0.34
lz	6	0.20	0.006	0.19-0.21
Lo	6	0.03	0.005	0.03-0.04
lo	6	0.10	0.000	0.10
Dodist	6	0.11	0.005	0.10-0.11

Lav	4	0.10	0.006	0.10-0.11
lav	4	0.13	0.008	0.12-0.14
Loav	4	0.04	0.003	0.04-0.05
loav	4	0.06	0.005	0.05-0.06

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	2. Rooted
C. Construction	3. Artic. det. cut. joints
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	5. Radial
F. 2° skel. thick.	1. None

G. Struct. units	8. Solid cylinder
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	?3. Frequent
J. Dim. bifurc.	3. More than one plane
K. Conn. struct. units	?4. Cutic. tubes
L. Substr. type	?

OCCURRENCE: LTL *[r]*, MF(b) *[i]*.

COMPARISONS: This species is similar to *Cellaria* sp. c, but appears less 'ornamented'.

Cellaria sp. nov. e

Plate 15L, M, N

MATERIAL: SAM P39397 (TL)

DESCRIPTION: Colony erect branches, 16 zooid rows, ca. 1mm diameter.

Zooids rhombic to elongate hexagonal, defined by raised margins, frontal wall depressed centrally with dispersed granulations.

Opesia semicircular with broad rounded proximolateral indentations, large denticles placed inside indentations slightly away from lateral margins and projecting into opesia.

Ovicells and avicularia not observed.

MEASUREMENTS: (1 specimen)

Lz	4	0.42	0.019	0.40-0.44
lz	4	0.31	0.056	0.25-0.38
Lo	4	0.06	0.009	0.05-0.07
lo	4	0.11	0.014	0.09-0.11
Lz	4	0.42	0.019	0.40-0.44

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	2. Rooted
C. Construction	3. Artic. det. cut. joints
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	5. Radial
F. 2° skel. thick.	1. None

G. Struct. units	8. Solid cylinder
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	?3. Frequent
J. Dim. bifurc.	3. More than one plane
K. Conn. struct. units	?4. Cutic. tubes
L. Substr. type	?

OCCURRENCE: TL *[p]*.

COMPARISONS: No comparable species was found.

Cellaria sp. nov. f

Plate 15O, P

MATERIAL: SAM P39398 (TL), P39399 (TL)

DESCRIPTION: Colony thin cylindrical branches (no articulations or bifurcations seen).

Zooids alternating in longitudinal rows of 6 zooids; rhomboidal or hexagonal with short proximal/distal border; oval ridge running from distal corner almost to proximal corner, cryptocyst in between very convex; Opesia crescentic/reniform, paired large denticles near proximolateral corners, margins raised.

Ovicells[?] endozooidal in distal quarter of zooids, with circular opening just distal to opesia.

Avicularia placed in series, transversely oval with lateral condyles.

MEASUREMENTS: (2 colonies)

Lz	5	0.32	0.020	0.30-0.34
lz	5	0.20	0.014	0.18-0.22
Lo	5	0.05	0.011	0.04-0.06
lo	5	0.09	0.009	0.08-0.10
Dodist	5	0.07	0.010	0.06-0.08

Lav	1	0.14	-	
lav	1	0.10	-	
Loav	1	0.04	-	
loav	1	0.03	-	

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	2. Rooted
C. Construction	3. Artic. det. cut. joints
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	5. Radial
F. 2° skel. thick.	1. None

G. Struct. units	8. Solid cylinder
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	?3. Frequent
J. Dim. bifurc.	3. More than one plane
K. Conn. struct. units	?4. Cutic. tubes
L. Substr. type	?

OCCURRENCE: LTL *[r]*, MTL(l) *[f]*, MTL(m) *[f]*, MTL(u) *[p]*, MF(b) *[f]*, LKL(l1) *[i]*.

COMPARISONS: *Cellaria australis sensu* MacGillivray, 1895: 29, pl. 3, fig. 19, NMV P27542; Middle Miocene, Otway Basin) has a similar orifice, avicularia and distal hollow, but no marginal rim. *Cellaria depressa* Maplestone(1900a: 166, pl. 18, fig. 15; ?Miocene, Otway Basin) differs mainly in the shape of the frontal wall, and the absence of any avicularia or ovicells (which may simply be absent in Maplestone's specimens).

This species bears some resemblance to the Recent Antarctic genus *Paracellaria* Moyano.

Cellaria sp. nov. g

Plate 15Q, R, S

MATERIAL: SAM P39400 (TL)

DESCRIPTION: Colony erect ?articulated branching.

Zooids alternating in 10 longitudinal rows, defined by rhomboidal steeply raised margins with broad smooth top, separate narrow ridge rounding off lateral corners, frontal wall smooth, relatively flat.

Opesia positioned distally, D-shaped with slightly raised margins, convex proximal margin forming lip, small denticles in proximal corners.

Avicularia or ovicells in distal corners.

MEASUREMENTS: (1 specimen)

Lz	4	0.41	0.010	0.40-0.42
lz	4	0.20	0.010	0.18-0.20
Lo	4	0.07	0.010	0.06-0.08
lo	4	0.09	0.012	0.08-0.10
Dodist	4	0.09	0.012	0.08-0.10

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	2. Rooted
C. Construction	3. Artic. det. cut. joints
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	5. Radial
F. 2° skel. thick.	1. None

G. Struct. units	8. Solid cylinder
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	?3. Frequent
J. Dim. bifurc.	3. More than one plane
K. Conn. struct. units	?4. Cutic. tubes
L. Substr. type	?

OCCURRENCE: LKL(m) *[i]*.

COMPARISONS: This species bears some resemblance to the genus *Erinella* Canu & Bassler.

Cellaria sp. nov. h

Plate 16A, B

MATERIAL: SAM P39401 (TL)

DESCRIPTION: Colony cylindrical branches (no articulations or bifurcations seen).

Zooids in 5 rows, rhomboidal with very broadly rounded raised margins, frontal wall smooth to faintly granular, small concave area proximal to opesia.

Opesia placed centrally, semicircular to slightly crescentic, distinct proximal lip, no denticles, minor distal lip rare, opesial margins usually sloping downward.

No ovicells or avicularia observed.

MEASUREMENTS: (1 specimen)

Lz	5	0.46	0.030	0.42-0.50
lz	5	0.29	0.011	0.28-0.30
Lo	5	0.08	0.005	0.08-0.09
lo	5	0.11	0.013	0.09-0.12
Dodist	5	0.13	0.013	0.12-0.15

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	2. Rooted
C. Construction	3. Artic. det. cut. joints
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	5. Radial
F. 2° skel. thick.	1. None

G. Struct. units	8. Solid cylinder
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	?3. Frequent
J. Dim. bifurc.	3. More than one plane
K. Conn. struct. units	?4. Cutic. tubes
L. Substr. type	?

OCCURRENCE: MF(b) *[r]*, LKL(l1) *[i]*, LKL(l2) *[p]*.

COMPARISONS: No comparable species was found.

Cellaria sp. nov. i

Plate 16C, D

MATERIAL: SAM P39338 (MF)

DESCRIPTION: Colony erect ?articulated branching, curved.

Zooids alternating in 8–10 longitudinal rows, rhomboidal, defined by raised margins with very broad flat smooth top (gymnocyst?), frontal wall granular, convex sloping down toward opesia, sometimes with slight bulge in proximal half.

Opesia positioned just distal of median line, D-shaped with slight indentations at proximal corners, proximal margin forming small lip, no denticles.

Ovicells and avicularia not observed.

MEASUREMENTS: (1 specimen)

Lz	4	0.57	0.024	0.54-0.59
lz	4	0.35	0.008	0.34-0.36
Lo	4	0.06	0.003	0.06-0.07
lo	4	0.12	0.004	0.12-0.13
Dodist	4	0.18	0.017	0.16-0.20

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	2. Rooted
C. Construction	3. Artic. det. cut. joints
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	5. Radial
F. 2° skel. thick.	1. None

G. Struct. units	8. Solid cylinder
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	?3. Frequent
J. Dim. bifurc.	3. More than one plane
K. Conn. struct. units	?4. Cutic. tubes
L. Substr. type	?

OCCURRENCE: MTL(u) *[p]*, MF(b) *[r]*, LRF(l) *[r]*, LKL(m) *[r]*.

COMPARISONS: No comparable species was found.

***Cellaria*? sp. nov. j**

Plate 16E, F, G

MATERIAL: SAM P39403 (MF)

DESCRIPTION: Colony erect ?articulated branching, straight cylindrical branches.

Zooids alternating in 8 longitudinal rows, elongated rhomboidal, defined by raised margins, completely cryptocystal frontal wall granular in lines radiating away from opesia, slightly convex but raised around opesia.

Opesia positioned just distal of median line, semi-circular slightly narrowing proximally with rounded proximal corners, straight proximal margin, paired short rounded denticles in proximal corners.

Ovicells and avicularia not observed.

MEASUREMENTS: (1 specimen)

Lz	6	0.55	0.009	0.54-0.56
lz	6	0.33	0.017	0.31-0.35
Lo	6	0.10	0.002	0.10-0.11
lo	6	0.11	0.005	0.11-0.12
Dodist	6	0.14	0.009	0.13-0.15

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	2. Rooted
C. Construction	3. Artic. det. cut. joints
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	5. Radial
F. 2° skel. thick.	1. None

G. Struct. units	8. Solid cylinder
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	?3. Frequent
J. Dim. bifurc.	3. More than one plane
K. Conn. struct. units	?4. Cutic. tubes
L. Substr. type	?

OCCURRENCE: MF(b) *[r]*.

COMPARISONS: This is a very distinctive species, but unlike any other previously described.

Cellaria sp. nov. k

Plate 16H, I, J, K

MATERIAL: SAM P39404 (TL)

DESCRIPTION: Colony in slightly curved thin cylindrical branches, tapering (at least proximally) to narrow smooth area before a joint, 8 rows of zooids around, 0.4 – 0.5 mm diameter.

Zooids distinctly hexagonal, zooids in alternating transverse rows of 4 (?5), shallowly raised margins, granular cryptocyst barely concave, slight semi-circular ridge proximal to opesia.

Opesia just distal of middle, semicircular, bordered by raised margin, large denticles in proximal corners, smaller opposing denticles on distal border; cryptocyst slightly concave, slight semicircular ridge running from opesial corners through middle of proximal area.

Possible polymorph for rootlet with strongly elevated opesial margins, especially at distal margin.

Ovicells not observed.

MEASUREMENTS: (2 specimens)

Lz	13	0.53	0.051	0.46-0.60
lz	13	0.30	0.050	0.20-0.36
Lo	13	0.10	0.012	0.08-0.12
lo	13	0.12	0.009	0.10-0.13
Dodist	13	0.12	0.015	0.08-0.13

Lav	1	0.49	-	
lav	1	0.30	-	
Loav	1	0.13	-	
loav	1	0.12	-	

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	2. Rooted
C. Construction	3. Artic. det. cut. joints
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	5. Radial
F. 2° skel. thick.	1. None

G. Struct. units	8. Solid cylinder
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	?3. Frequent
J. Dim. bifurc.	3. More than one plane
K. Conn. struct. units	?4. Cutic. tubes
L. Substr. type	?

OCCURRENCE: LTL *[r]*, MTL(l) *[p]*, MTL(m) *[i]*, MF(b) *[f]*, LKL(l1) *[p]*.

COMPARISONS: This species closely resembles *Cellaria robusta* Maplestone (1902a: 72, pl. 9, fig. 18: ?Miocene, Otway Basin). The measurements for the type are Lz = 0.70, lz = 0.40, Lo = 0.16, lo = 0.18. *Cellaria myaringensis* Brown (1958: 48; Lower Miocene, Gambier Embayment) has very similar orifice, frontal wall and zooid shape, but the frontal is more granular and there appears to be no distal pair of denticles. *Cellaria stachi* Brown (1958: 48; Upper Oligocene, Otway Basin) also appears generally similar but there is a ridge connecting the distal pair of denticles, and it also possesses large vicarious avicularia.

REMARKS: The joint is probably the basal colony attachment, and the two specimens observed with these structures represent the only articulation joints seen in all the specimens of the species of Cellariidae in this study.

Cellaria sp. nov. I

Plate 16L, M

MATERIAL: SAM P39336 (TL)

DESCRIPTION: Colony as thin cylindrical branches (no articulations or bifurcations seen).

Zoids alternating in transverse rows of 4 (5?) each, rhomboidal, margins becoming slightly raised towards distal corner with furrow between zooids; coarsely granular cryptocyst concave, but central area below opesia often with convex bulge.

Opesia narrow and crescentic, often almost occluded by the proximal 'curled lip'.

Ovicells and avicularia not observed.

MEASUREMENTS: (1 specimen)

Lz	5	0.43	0.041	0.36-0.46
lz	5	0.29	0.011	0.28-0.30
Lo	5	0.02	0.000	0.02
lo	5	0.11	0.009	0.10-0.12
Dodist	5	0.11	0.019	0.09-0.14

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	2. Rooted
C. Construction	3. Artic. det. cut. joints
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	5. Radial
F. 2° skel. thick.	1. None

G. Struct. units	8. Solid cylinder
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	?3. Frequent
J. Dim. bifurc.	3. More than one plane
K. Conn. struct. units	?4. Cutic. tubes
L. Substr. type	?

OCCURRENCE: MTL(m) *[i]*.

COMPARISONS: Both *Cellaria laticella* MacGillivray (1895: 31, pl. 3, fig. 27; Middle Miocene, Otway Basin) and *Cellaria ovicellosa* Stoliczka (*sensu* Maplestone, 1900a: 166, pl. 18, fig. 12; ?Miocene, Otway Basin) are thinner, zooids are further apart, and the lip and proximal cryptocyst are less pronounced; in the latter there are also much more salient rims around the zooids. *Cellaria mitrata* Brown (1958: 48; Upper Oligocene, Otway Basin) has similar zooid shape and frontal wall. Only some zooids have the overhanging "hood" described by Brown (1958: 48) for his specimens (NMV P73139).

Cellaria? sp. nov. m

Plate 16N, O, P, Q

MATERIAL: SAM P39340 (TL), P39335 (TL)

DESCRIPTION: Colony very thin cylindrical branches, ?articulations (no bifurcations seen).

Zooids alternating in transverse rows of 3 zooids; shape elongated hexagonal, wider distally, salient thread marks zooidal boundaries; inverted tear drop shaped ridge surrounding opesia and shallowing strongly proximally.

Opesia semicircular, distal margins slightly raised, paired denticles near proximolateral corners, joined by bar, often making denticles indistinct.

Ovicells and avicularia not observed.

MEASUREMENTS: (2 specimens)

Lz	7	0.42	0.045	0.38-0.52
lz	7	0.22	0.011	0.19-0.22
Lo	7	0.03	0.008	0.02-0.04
lo	7	0.09	0.012	0.07-0.11
Dodist	7	0.10	0.018	0.08-0.12

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	2. Rooted
C. Construction	3. Artic. det. cut. joints
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	5. Radial
F. 2° skel. thick.	1. None

G. Struct. units	8. Solid cylinder
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	?3. Frequent
J. Dim. bifurc.	3. More than one plane
K. Conn. struct. units	?4. Cutic. tubes
L. Substr. type	?

OCCURRENCE: LTL *[c]*, MTL(l) *[i]*, MTL(m) *[r]*, MTL(u) *[r]*, UTL *[d]*.

COMPARISONS: *Cellaria laticella* MacGillivray (1895: 31, pl. 3, fig. 27; Middle Miocene, Otway Basin; ?Recent, Australia) appears similar, but has significantly thicker branches. *Cellaria gracilis* Busk (*sensu* MacGillivray, 1895: 30, pl. 3, fig. 26; Middle Miocene, Otway Basin) has distinct proximal denticles and more heart-shaped margins around the zooids.

This species may be equally well placed in *Euginoma* Jullien.

REMARKS: This appears to be a species restricted to the Tortachilla Limestone.

Cellaria? sp. n

Plate 16R, S

MATERIAL: SAM P39410 (TL)

DESCRIPTION: Colony thin cylindrical branches, bifurcating, not articulated.

Zooids alternating in longitudinal rows of 6 zooids; hexagonal (inverted drop-shape); granular cryptocyst slightly concave.

Opesia flattened semicircular with slightly raised margins, denticles not present or very indistinct.

Ovicells and avicularia not observed.

MEASUREMENTS: (1 specimen)

Lz	6	0.46	0.037	0.44-0.50
lz	6	0.20	0.013	0.18-0.22
Lo	6	0.06	0.000	0.06
lo	6	0.10	0.008	0.09-0.11
Dodist	6	0.10	0.015	0.08-0.12

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?2. Rooted
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	5. Radial
F. 2° skel. thick.	1. None

G. Struct. units	8. Solid cylinder
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	?3. Frequent
J. Dim. bifurc.	2. One plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(m) *[r]*.

REMARKS: Zooids at the branching point are shorter but wider (Lz=0.38, lz=0.21), while other dimensions are identical.

***Cellaria*? sp. nov. o**

Plate 16T, U, V

MATERIAL: SAM P39411 (TL)

Description: Colony very thin and long cylindrical branches (no articulations or bifurcations seen).

Zooids alternating in transverse rows of 4 zooids; rhomboidal or hexagonal but with very short lateral side, slightly/shallowly raised margins, ellipsoid ridge running from distal corner almost to proximal corner, cryptocyst in between convex, smooth.

Opesia placed in distal third of zooid, crescentic/reniform with proximal margin triangular, as wide as long, denticles?, margins raised slightly,

Ovicells as small chamber in distal corner of zooid?

Avicularia may be represented by the circular holes between zooids.

MEASUREMENTS: (1 specimen)

Lz	4	0.38	0.037	0.34-0.42
lz	4	0.19	0.019	0.16-0.20
Lo	4	0.04	0.008	0.03-0.05
lo	4	0.08	0.010	0.06-0.08
Dodist	4	0.08	0.013	0.06-0.09

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	2. Rooted
C. Construction	3. Artic. det. cut. joints
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	5. Radial
F. 2° skel. thick.	1. None

G. Struct. units	8. Solid cylinder
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	?3. Frequent
J. Dim. bifurc.	3. More than one plane
K. Conn. struct. units	?4. Cutic. tubes
L. Substr. type	?

OCCURRENCE: LTL *[r]*, MTL(l) *[p]*, MTL(m) *[r]*, MF(b) *[f]*.

COMPARISONS: Both the Recent species *Cellaria tenuirostris* (Busk, 1952) and *C. australis* MacGillivray (1895) have similar zooids and opesiae, but the colony branches are much thicker.

Cellaria sp. nov. p

Plate 16W

MATERIAL: SAM P39412 (TL)

DESCRIPTION: Colony erect articulated branches with 8 rows of zooids, ca. 0.4 mm diameter.

Zooids elongate hexagonal to elliptical with slightly constricted distal part, defined by raised margins, frontal wall concave, faintly granular.

Opesia placed some distance from distal margin, almost trifoliate with semicircular distal part and smaller rounded corners deflected proximolaterally, denticles not observed (obscured by sediment).

Ovicells and avicularia not observed.

MEASUREMENTS: (1 specimen)

Lz	2	0.48	0.003	0.48
lz	2	0.18	0.005	0.18-0.19
Lo	2	0.07	0.009	0.06-0.08
lo	2	0.08	0.018	0.07-0.10
Lz	2	0.48	0.003	0.48

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	2. Rooted
C. Construction	3. Artic. det. cut. joints
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	5. Radial
F. 2° skel. thick.	1. None

G. Struct. units	8. Solid cylinder
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	?3. Frequent
J. Dim. bifurc.	3. More than one plane
K. Conn. struct. units	?4. Cutic. tubes
L. Substr. type	?

OCCURRENCE: TL *[p]*

COMPARISONS: *Cellaria contigua* MacGillivray (1895: 28, pl. 3, fig. 18; Miocene, Otway Basin widespread) and *C. crassimarginata* Maplestone (1900a: 166, pl. 18, fig. 14; ?Miocene, Otway Basin), which may be synonymous with the former, both have a very similar orifice, but the frontal wall is very concave and they have large avicularia.

Genus ***Acerinucleus*** Brown, 1958

Omoiosia Canu & Bassler, 1935

TYPE SPECIES: *Cellaria incudifera* Maplestone, 1902a

DESCRIPTION: Free, erect, delicate branching with large, sub-central, oval opesia often with a raised rim. Ovicell chamber large, entotoichal. Distal wall of zooecium bearing a rounded eminence which projects proximally into the opesia, avicularia vicarious or probably adventitious. (after Brown, 1958)

REMARKS: This is an unusual genus within the family Cellariidae because of the single distal denticle and the shape of the orifice.

The reasons for replacing *Omoiosia* Canu & Bassler with *Acerinucleus* Brown have been summarised by Brown (1958). It appears that Brown had initially intended a different name for the genus, as his *derivatio nominis* states "Lat., *acer*, the maple; *saxum*, a stone; in honour of C. M. Maplestone." (footnote, p. 50). The genus name would then have been *Acerisaxum*. Instead he used *nucleus* (Latin for core, kernel).

The morphology of the opesia is interesting as it appears to be upside down (distally flattened) when compared with other Cellariidae. The single off-centre denticle on the distal margin is also somewhat unusual. It is difficult to determine the placement of the operculum from fossil specimens but it may be possible that it was attached distally, as is the case in species of *Inversiula*. In this case it is unlikely that its placement within the Cellariidae (or indeed any other existing Family) can be maintained. This is, however not the place for the proposal of new names. There is no evidence of either branching or articulation points in any specimen, raising the question if this genus simply had individual sticks as colonies.

Acerinucleus sp. nov. a

Plate 17A, B, C, D, E, F

MATERIAL: SAM P39413 (TL), P39414 (TL), P39415 (TL)

DESCRIPTION: Colony in delicate straight branches, circular cross-section, rare bifurcations seen. Autozooids alternating, arranged in 6 longitudinal series.

Zooids hexagonal to rectangular, margins defined by very salient ridge, frontal wall very concave, evenly finely granular.

Opesia positioned in centre of zooid, semi-circular to rounded rectangular, distal margin sometimes wider than proximal, margins raised (sometimes strongly so), large blunt denticle inside distal margin, generally slightly to left of centre.

Ovicell forms large hollow (same size as opesia) in distal third of zooid, directly adjoining distal margin of opesia (=?endotoichal), depth varies, possibly indicating incomplete ovicell.

Occasional tubular structures below opesiae may have been origins of rootlets.

MEASUREMENTS: (3 colonies)

Lz	25	0.58	0.045	0.48-0.64
lz	25	0.36	0.038	0.24-0.40
Lo	25	0.16	0.023	0.10-0.20
lo	25	0.17	0.015	0.14-0.20

Dodist	25	0.18	0.016	0.14-0.21

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?2. Rooted
C. Construction	3. Artic. det. cut. joints
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	5. Radial
F. 2° skel. thick.	1. None

G. Struct. units	8. Solid cylinder
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	?3. Frequent
J. Dim. bifurc.	?1. One plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: LTL *[c]*, MTL(l) *[c]*, MTL(m) *[f]*, LKL(u) *[r]*.

COMPARISON: *Cellaria cucullata* (MacGillivray, 1895: 31, pl. 22, fig. 15; Lower Oligocene, Otway Basin) has broader and flatter margins, is less concave, and the denticle is almost absent. In *Cellaria incudifera* Maplestone (1902: 71, pl. 9, fig. 7; ?Miocene, Otway Basin) the zooids are also less concave, the ovicells much larger, and the denticle bifurcated.

REMARKS: There is no significant difference in the measurements (including the size of the area distal to the opesia) for zooids with or without ovicells. The presence of what appear to be the skeletal manifestation of rootlets indicate that colonies of this species (and maybe the whole genus) were anchored by rootlets to the substrate. This method of attachment is very common in the Cellariidae.

Acerinucleus **sp. nov. b**

Plate 17G, H

MATERIAL: SAM P39416 (LKL(u))

DESCRIPTION: Colony in thick straight branches, circular cross-section, no bifurcations seen. Autozooids alternating, arranged in 18 longitudinal series.

Zooids hexagonal to rhomboidal.

Opesia positioned in centre of zooid, semi-circular to rounded rectangular, distal margin sometimes wider than proximal, margins raised (sometimes very), large blunt denticle inside distal margin, generally slightly to left of centre.

Ovicell forms large hollow (same size as opesia) in distal third of zooid, directly adjoining distal margin of opesia (?endotoichal), frontal calcification variable, sometimes only leaving small triangular opening immediately distal of opesial margin.

MEASUREMENTS: (1 colony)

Lz	7	0.50	0.009	0.49-0.52
lz	7	0.39	0.016	0.36-0.40
Lo	7	0.17	0.011	0.16-0.18
lo	7	0.19	0.015	0.16-0.20
Dodist	7	0.14	0.012	0.12-0.16

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?2. Rooted
C. Construction	3. Artic. det. cut. joints
D. Arrang. zooid ser.	4. Macroserial
E. Arrang. front. surf.	5. Radial
F. 2° skel. thick.	1. None
G. Struct. units	8. Solid cylinder
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	?3. Frequent
J. Dim. bifurc.	3. More than one plane
K. Conn. struct. units	?4. Cutic. tubes
L. Substr. type	?

OCCURRENCE: LKL(u) *[f]*.

COMPARISON: This species differs from *Acerinucleus* sp. nov. a in the much thicker branches, the very small denticle and the partly calcified ovicells.

REMARKS: As with *Acerinucleus* sp. nov. a there is no significant difference in the measurements (including the size of the area distal to the opesia) for zooids with or without ovicells.

Suborder **ASCOPHORA** Levinsen, 1909

Infraorder **ACANTHOSTEGOMORPHA** Levinsen, 1902

Superfamily **CRIBRILINOIDEA** Hincks, 1879

Family **CRIBRILINIDAE** Hincks, 1879

DESCRIPTION: "Colony encrusting or erect. Frontal surface of autozooid with a shield formed from flattened spines (costae) arched over the frontal membrane and fused along midline. Costae fused laterally to a greater or lesser extent, with small pores or large lacunae between, allowing the passage of water into the epistege – the space between the shield and the underlying frontal membrane. Some genera with uncalcified spots (pseudopores or pelmata) on the surfaces of the costae. Gymnocyst variably developed proximally and laterally to the costate frontal shield. Avicularia present or absent, adventitious, vicarious and/or interzooidal. Oral spines present or absent. Ovicell hyperstomial. Pore chambers and/or mural septula present." (Hayward, 1995)

REMARKS: The Cribrilinidae are neither diverse nor relatively common in the sediments of this study.

Genus ***Figularia*** Jullien, 1886

TYPE SPECIES: *Lepralia figularis* Johnston, 1847

DESCRIPTION: Colony encrusting. Costal shield extensive, or considerably reduced with concomitant enlargement of the gymnocyst; the costae fused in the mid-line, contiguous or apart along their length with a few irregular pores between points of fusion, often with one or more lumen pores on each. Orifice rounded-quadrangular; operculum pivoting on lateral condyles, frequently compound, with a transverse line of flexure level with the condyles. Oral spines sometimes present. Avicularia vicarious or interzooidal, generally sparse. Ovicells hyperstomial, prominent, closed by autozooidal operculum; typically with a longitudinal, median suture, and one or more large pores or fenestrae on each side. Uniporous or multiporous mural septula present. Ancestrula tatiform. (after Gordon, 1984; Ryland & Hayward, 1992)

REMARKS: *Figularia* probably originated in the Eocene (Gordon, 2000: 19) making this occurrence one of the earliest for the genus.

***Figularia* cf. *rugosa* (Maplestone)**

Plate 18C, D, E, F, G, H, I

? *Membranipora incurvata* MAPLESTONE, 1900b: 2, pl. 1 (fig. 6).

Membraniporella rugosa MAPLESTONE, 1901b: 207, pl. 34 (fig. 8).

MATERIAL: SAM P39421 (TL), P39422 (MF)

OTHER MATERIAL EXAMINED: NMV P10155 (type of *Membraniporella rugosa*, Maplestone coll., Miocene, 'Mitchell River' Bairnsdale, Victoria)

DESCRIPTION: Colony unilaminar encrusting, zooids in longitudinal bifurcating rows.

Zooid outline hexagonal to oval (tapering proximally to a point), margins clearly defined by shallow furrow; narrow smooth gymnocyst along border, much wider lateral and distal to orifice; slightly convex frontal shield of 11–12 pairs of closely contiguous costae (sometimes odd total number, i.e. 23 or 25) fused completely medially without carina, central 1/3 of costae contain 'knobs' forming 2–3 concentric V-shaped rows, pair proximal to orifice almost twice as wide as others.

Autozooids orifice oval to squarish, concave proximal margin, 2 small proximolateral condyles, distal margin with distinct sharp lip. Ovicelled orifice with almost straight proximal margin.

Hyperstomial ovicells large, bulbous, rounded rectangular shape, slightly wider distally, covering proximal half of distal zooid; opening just above zooid orifice (does not appear to be modified in shape or size from normal autozooid orifice), probably not closed by operculum; faint often slightly irregular median suture slightly raised; round and sometimes drop-shaped pores with raised margins scattered especially on lateral areas.

Avicularia not observed.

MEASUREMENTS: (2 specimens)

Lz	10	0.56	0.146	0.38-0.74
lz	10	0.40	0.044	0.38-0.48
Lo	10	0.12	0.16	0.10-0.14
lo	10	0.15	0.23	0.12-0.18

Lzov	11	0.52	0.088	0.38-0.66
lzov	11	0.43	0.061	0.32-0.50
Loov	11	0.11	0.015	0.09-0.15
loov	11	0.17	0.017	0.14-0.19
Lov	11	0.25	0.058	0.14-0.36
lov	11	0.31	0.070	0.19-0.40

A.B.G.H.C:

A. Orient. substr.	1. Encrusting
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	6. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	Hard secondary

OCCURRENCE: MTL(l) *[r]*, MTL(m) *[p]*, MF(b) *[r]*; (OB) ?Miocene.

COMPARISONS: The type specimen of *Figularia rugosa* (NMV P10155) has significantly larger dimensions (Lz=0.73, lz=0.50, Lo=0.19, lo=0.17, Lzov=0.73, lzov=0.45, Loov=0.18, loov=0.18, Lov=0.42, lov=0.41), but fewer costae (9–10 pairs). This may be partly an environmental effect (see Chapter 6

Palaeoenvironments). The differences may, however, be taxonomically significant and then this should be a new species.

Membranipora incurvata Maplestone (1900b: 2; Lower Miocene, Otway Basin) appears like a specimen of *F. rugosa* with the costal area broken. Maplestone noted the distal "incurved margin" as peculiar. This is probably what remains of the orifice. If *M. incurvata* and *F. rugosa* are conspecific, the former name should take precedence. This identification is, however, not certain, and even if it were, the type material (and thus the description) of *M. incurvata* are inadequate, and *F. rugosa* is therefore used here. *Membraniporella tenuicosta* MacGillivray (1895: 56, pl. 15, 16; Middle Miocene, Otway Basin) has similar autozooids with larger gymnocyst, but the orifice is much more elongated and the ovicells have large paired crescentic ectooecial fenestrae.

REMARKS: Interzooidal avicularia are a characteristic feature of *Figularia* species, but none were observed in the numerous specimens of this study.

This species is commonly found encrusting branches of *Acerinucleus*.

Genus ***Anaskopora*** Wass, 1975

Corbulipora (Anaskopora) Wass, 1970: 170
Anaskopora Bock & Cook, 2001: 180

TYPE SPECIES: *Cribrilina elevata* MacGillivray, 1895

DESCRIPTION: Colonies encrusting usually small substrata, frequently multilaminar. Basal walls calcified only peripherally, autozooids with marginal gymnocyst and extensive costal shield. Peripheral, vertical component of costae without lateral fusions; central horizontal component medially fused. Lacunae present, marginal pelmatidia present or absent. Secondary orifice with or without condyles, peristome raised distally. Oral spines paired. Chambered pores large, forming kenozooids surrounding each autozooid. Avicularia interzooidal, budded in series with kenozooids, usually distal or distolateral and single, occasionally proximal and even paired; rostrum raised, palate rounded or subtriangular, oriented distally or laterally, with paired condyles. Dimorphic brooding zooids unknown. (after Bock & Cook, 2001)

REMARKS: Separated from *Corbulipora* MacGillivray, according to Bock & Cook (2001). Although all the species currently included in this genus share the distal avicularium, orificial morphology and the interzooidal kenozooids, it is a relatively heterogeneous group in general appearance. The species identified here is erect bilaminar and thus does not agree with the conventional genus definition of *Anaskopora*. It agrees well in zooidal characters and is therefore placed in this genus.

The earliest published occurrence of *Anaskopora* is from the Miocene of south-eastern Australia. The common specimens of the present study significantly extend the range of this genus.

Anaskopora **sp. nov. a**

Plate 18A, B

MATERIAL: SAM P39417 (TL), P39418 (TL), P39419 (MF)

DESCRIPTION: Colony erect bilaminar, occasionally encrusting.

Zooids oval, sometimes irregular; frontal shield of 7–9 pairs of broad costae, slightly separated at margins becoming closely contiguous, fused completely medially without carina, lumen pore half-way.

Orifice circular with distinct proximolateral condyle, distal margin slightly raised; lateral spines present.

Avicularia interzooidal, small, oval to drop-shaped with large blunt condyles, rostrum raised up and directed distally.

Ovicells not observed.

MEASUREMENTS: (3 specimens)

Lz	8	0.72	0.053	0.64-0.78
lz	8	0.45	0.063	0.36-0.56
Lo	8	0.14	0.005	0.13-0.14
lo	8	0.16	0.025	0.12-0.20

Lav	8	0.16	0.022	0.13-0.20
lav	8	0.14	0.026	0.10-0.18

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	1. Cemented?
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	2. Bilaminate
F. 2° skel. thick.	6. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MF(b) *[r]*

COMPARISONS: It differs from *Anaskopora elevata* (MacGillivray, 1895: 59, pl. 8, fig. 19; Middle Miocene, Otway Basin) in growing as an erect bifoliate sheet. The costal shield is very similar to *A. elevata* but less convex. Other species of *Anaskopora* such as *A. cornuta* (MacGillivray, 1895: 58, pl. 8, figs 10, 11, 12;Upper Oligocene – Middle Miocene, Otway Basin) have a very different costal shield of non-bifurcating costae connected by numerous thin ribs.

REMARKS: One specimen appears to have been attached to a thin flat ephemeral substrate such as the 'leaf' of an aquatic plant or alga, as it wraps around at the edge while maintaining a small gap between the two layers. (see also discussion in Chapter 6 Palaeoenvironments).

Genus ***Cribrilinidae Gen. indet.***

Cribrilinidae Gen. indet. sp. nov. a

Plate 17I, J, K

MATERIAL: SAM P39420 (TL)

DESCRIPTION: Colony delicate ?branching, 4 to 5 longitudinal zooid rows.

Zooids oval, margins moderately to poorly defined; gymnocyst circles outer 1/3, steeply descending cryptocyst forms middle 1/3 (with ridge separating both) and opesia inner 1/3 of zooid area; costal shield is formed by six costae (three along each lateral margin), which are initially oriented perpendicular to frontal surface, then each bifurcates at a large angle and fuses with the neighbouring branch to form a horizontal branch (seven in total) directed to the central area where they all fuse; the two costae proximal to orifice fuse at an angle and form a 'lip'.

Orifice poorly defined by costae and opesial margin, almost rectangular.

Single proximal ?adventitious avicularium, almost as long as zooid width, drop-shaped with condyles, acute rostrum directed laterally.

Ovicells not observed.

MEASUREMENTS: (1 specimen)

Lz	4	0.62	0.017	0.60-0.64
lz	4	0.38	0.033	0.35-0.42
Lorif	1	0.19	-	
lorif	1	0.09	-	

Lav	4	0.21	0.013	0.20-0.23
lav	4	0.09	0.010	0.08-0.10
Lop	4	0.30	0.016	0.28-0.32
lop	4	0.15	0.024	0.12-0.15

A.B.G.H.C:

A. Orient. substr.	3. Erect cont.?
B. Attachm. substr.	1. Cemented?
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	2. Bilaminate
F. 2° skel. thick.	6. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: TL *[p]*

COMPARISONS: With respect to the simple orificial structure and the delicate growth form it resembles *Corbulipora ornata* MacGillivray (1895: 60, pl. 8, figs 20, 21; Middle Miocene, Otway Basin). *C. ornata,* however, does not have the proximal avicularium and the costal shield has a slightly different structure.

REMARKS: The undifferentiated shape of the orifice means that this species cannot be placed into *Anaskopora* with certainty. Apart from the frontal shield, it may actually be better placed among the Calloporidae (the proximal avicularium is reminiscent of *Dactylostega*). The 'costal shield' appears like a very simple and 'primitive' structure'. The costal shield of *Anaskopora* sp. a, however, has some characteristics in common. Although there are many more costae, they also appear to start vertically and curve towards the horizontal where they bifurcate and fuse with neighbouring costae. The central fused area is possibly simply the result of the larger number of costae.

Superfamily **CATENICELLOIDEA** Busk, 1852

Family **CATENICELLIDAE** Busk, 1852

DESCRIPTION: Colony erect, flexible, jointed, attached to the substratum by rhizoids, internodes comprising one or a few zooids. Zooids with variable frontal walls, usually with perforations, the orifices dimorphic, being larger in ovicelled zooids. Avicularia present or absent. Pore-chambers present, variable, sometimes very large; uniporous septula present in distal walls. (see Gordon, 1984, for taxonomic discussion)

REMARKS: Although the Catenicellidae are moderately diverse in these sediments, they lack significant taxonomic elements of those found in the Victorian Oligo-Miocene and the modern Australian faunas, such as any species with large frontal pores (e.g. *Scuticella*).

Because all genera of this family have colonies composed of one or a few zooids articulated with its neighbours, the colony completely disintegrates soon after death. The resulting fragments (zooids) therefore behave hydrodynamically like the silt fraction, and are generally winnowed out of higher energy facies such as the Tortachilla Limestone. The following species is therefore likely to be a strong underestimate of the actual diversity (and an even greater underestimate of abundance).

BIOGEOGRAPHY: The first recorded representative of this family is 'Vittaticellid new genus' from the Upper Paleocene (Thanetian) of DSDP Site 117, Rockall, North Atlantic (Cheetham & Håkansson, 1972).

Genus ***Strophipora*** MacGillivray, 1895

TYPE SPECIES: *Catenicella harveyi* Wyville Thompson, 1858

DESCRIPTION: Zooids without fenestrae or vittae, a raised ridge running proximally from the orifice with a suboral 'pore', and one or more similar bands on the posterior surface; orifice large, similar to that of *Catenicella*, arched above and straight below. (after MacGillivray, 1895: 16)

REMARKS: The function of the 'pore' on central frontal ridge (if it is indeed a pore and perforates the frontal wall) is unclear. It is unlikely to be an ascopore, but may have elements of a remnant costal area (compare Catenicellidae *Gen. nov. E* sp. nov a, pl. 19P).

Strophipora **sp. nov. a**

Plate 19F, G

MATERIAL: SAM P39429 (TL), P39430 (TL)

DESCRIPTION: Zooid 'kite-shaped', narrow longitudinal gymnocystal ridge running down the median frontal area, with a 'pore' placed just suborally, additional ridge along the lateral edge, interceding area comprised of very enlarged pore-chambers, a row of 4-8 pores running along the middle in the frontal pore-chambers.

Orifice circular, flattened proximally, with proximolateral condyles; small circular pore surrounded by gymnocystal ridge immediately proximal to orifice.

Adventitious avicularia very small and placed in distolateral corners.

Ovicells not observed.

MEASUREMENTS: (2 specimens)

Lz	2	0.70	0.071	0.65-0.75
lz	2	0.35	0.000	0.35
Lo	2	0.13	0.007	0.12-0.13
lo	2	0.12	0.014	0.11-0.13

Lz2	1	0.57	-	
lz2	1	0.34	-	
Lo2	1	0.13	-	
lo2	1	0.12	-	

A.B.G.H.C:

A. Orient. substr.	3. Erect cont.
B. Attachm. substr.	2. Rooted
C. Construction	3. Artic. determ.
D. Arrang. zooid ser.	1. Uniserial
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	1. Single/2. Cluster 2-5
H. Dim. struct. units	2. Curved
I. Freq. bifurc.	4. Very frequent
J. Dim. bifurc.	3. More than 1 plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(u) *[c]*.

COMPARISONS: This species resembles *Catenicella harveyi* Wyville Thomsen (*sensu* Waters, 1883: 431, pl. 12, fig. 5; Middle Miocene, Otway Basin), but has straighter zooidal margins and is less convex.

Genus ***Stenostomaria*** MacGillivray, 1895

TYPE SPECIES: *Catenicella solida* Waters, 1881

DESCRIPTION: Broad zooids with salient ridge running down centre of frontal and abfrontal wall, orifice rounded above, with a narrow acutely pointed proximal sinus and paired proximolateral condyles. Abfrontal surface with a grooved vertical ridge, on each side of which it is smooth. No fenestrae or true vittae. (after MacGillivray, 1895:16)

REMARKS: *Stenostomaria* was regarded as a subgenus of *Strophipora* MacGillivray by Bassler (1953: 224), but should probably be a separate genus because of the different proximal orificial margin.

Stenostomaria **sp. nov a**

Plate 19A, B, C, D, E

MATERIAL: SAM P39424 (TL), P39425 (TL), P39426 (TL), P39424 (TL), P39427 (TL), P39428 (TL)

DESCRIPTION: Autozooid with roughly triangular or shield-shaped outline with truncated distolateral corners creating a lateral rounded angular flange just distal from mid-line, abfrontal surface broadly keel-shaped in cross-section; narrow gymnocystal ridges along the median frontal and basal areas as well as along the lateral edge, interceding area comprised of very enlarged pore-chambers (flat to slightly concave), an irregular row of 5–10 pores running along the middle in each of the frontal areas, and close to the lateral ridges along the basal areas; bizooidal segments (internodes) with gymnocystal ridge between zooids.

Orifice circular with slightly flattened distal margin, proximal sinus and proximolateral condyles ('key-hole shaped').

Avicularia adventitious, small, placed on distolateral corners, with complete cross-bar, acute rostrum projecting and directed distally.

Ovicelled segments with two zooids situated in line, ovicell roughly the size of a single zooid and covering frontal area of distal zooid up to orifice, perforated regularly by pores, ridge along periphery, indent lateral to orifice, opening arches well over primary orifice, frontal wall 'slopes up' towards orifice.

MEASUREMENTS: (9 specimens)

Lz	8	0.74	0.055	0.66-0.82
lz	8	0.59	0.096	0.52-0.70
Lo	6	0.17	0.021	0.14-0.20
lo	6	0.17	0.018	0.14-0.19
Lz2	5	0.50	0.048	0.44-0.56
lz2	5	0.52	0.041	0.46-0.56
Lo2	3	0.18	0.053	0.12-0.22
lo2	3	0.17	0.029	0.14-0.19

Lzov1	1	0.50	-	
lzov1	1	0.40	-	
Loov1	1	0.10	-	
loov1	1	0.14	-	
Lzov2	1	0.62	-	
lzov2	1	0.44	-	
Loov2	1	0.12	-	
loov2	1	0.12	-	
Lov	1	0.48	-	
lov	1	0.42	-	

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	2. Rooted
C. Construction	3. Artic. determ.
D. Arrang. zooid ser.	1. Uniserial
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	1. Single/2. Cluster 2-5
H. Dim. struct. units	2. Curved
I. Freq. bifurc.	4. Very frequent
J. Dim. bifurc.	3. More than 1 plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: LTL *[d]*, MTL(l) *[f]*, MTL(m) *[f]*.

COMPARISONS: This species is similar to *Catenicella solida* Waters (1881: 318, pl. 16, figs 37, 38; ?Miocene, Otway Basin) but differs from it in a more simple appearance to the gymnocystal ridges and much smaller proximolateral condyles.

The orificial morphology resembles the genus *Claviporella* MacGillivray.

Stenostomaria **sp. nov. b**

Plate 19 I

MATERIAL: SAM P39436 (TL)

DESCRIPTION: Autozooid with narrow shield-shaped outline, abfrontal surface broadly keel-shaped in cross-section; very narrow gymnocystal ridges along the median frontal and basal areas as well as along the lateral edge, occasionally slightly depressed below level of frontal wall, interceding area comprised of very enlarged pore-chambers (slightly concave), an irregular row of 5–6 pores running along the middle in each of the frontal areas, and close to the lateral ridges along the basal areas; bizooidal segments (internodes) with gymnocystal ridge between zooids.

Orifice circular, proximal sinus and proximolateral condyles.

Avicularia adventitious, small, placed on distolateral corners, with complete cross-bar, acute rostrum projecting and directed distally.

Ovicell not observed.

MEASUREMENTS: (1 specimen)

Lz	1	0.68	-	
lz	1	0.31	-	
Lo	1	0.14	-	
lo	1	0.14	-	

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	2. Rooted
C. Construction	3. Artic. determ.
D. Arrang. zooid ser.	1. Uniserial
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	1. Single/2. Cluster 2-5
H. Dim. struct. units	2. Curved
I. Freq. bifurc.	4. Very frequent
J. Dim. bifurc.	3. More than 1 plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: TL *[r]*

COMPARISONS: This species is similar to *Stenostomaria* sp. nov. a, but is much narrower and the gymnocystal ridges are much less prominent.

Genus ***Caloporella*** MacGillivray, 1895

TYPE SPECIES: *Caloporella insignis* MacGillivray, 1895

DESCRIPTION: "Zooids small, mostly narrow and elongated; a lateral or anterior usually linear depression (vitta) on each side, with a single or double series of pores; orifice small, subcircular or with the lower margin straighter and usually having a small denticle on either side" (MacGillivray, 1895).

Remarks: Gordon (1984) discussed the reasons for accepting *Caloporella* despite its similar spelling to *Calloporella* Ulrich.

Caloporella cf. ***speciosa*** MacGillivray

Plate 19L, Q

Caloporella speciosa MacGillivray, 1895: 19, pl. 2 (fig. 15).
Vittaticella speciosa (MacGillivray); Stach, 1933: 90, pl. (figs 1, 2, 3)

MATERIAL: SAM P39434 (TL), P39439 (TL)

OTHER MATERIAL EXAMINED: NMV P27511 (type of *Caloporella speciosa*, 'Schnapper Pt' Balcombe Bay, M. Miocene Fyansford Clay, MacGillivray coll.), NMV P13730 (Dartmoor, Miocene, Stach coll.), NMV P13731 (Glencoe Bore 7, 580ft, Miocene, Stach coll.)

DESCRIPTION: Zooid narrow triangular with slightly convex margins, medium sized distolateral avicularian chambers directed distally with avicularium along complete length; frontal wall smooth, narrow longitudinal row of depressed pore-chambers (vittae) slightly frontal of lateral margin running from level of proximal orificial margin to proximal zooid margin, with double row of pores.

Orifice subcircular, slightly flattened proximally, small proximolateral condyles creating slight constriction, often with calcified opercula.

Avicularia not observed.

Ovicell not observed.

MEASUREMENTS: (1 specimen)

Lz	2	0.54	0.007	0.53-0.54
lz	2	0.22	0.014	0.21-0.23
Lo	2	0.09	0.007	0.08-0.09
lo	2	0.08	0.007	0.07-0.08
Lvittae	1	0.35	-	
lvittae	1	0.06	-	

Lz2	1	0.33	-	
lz2	1	0.17	-	
Lo2	1	0.08	-	
lo2	1	0.07	-	

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	2. Rooted
C. Construction	3. Artic. determ.
D. Arrang. zooid ser.	1. Uniserial
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	1. Single/2. Cluster 2-5
H. Dim. struct. units	2. Curved
I. Freq. bifurc.	4. Very frequent
J. Dim. bifurc.	3. More than 1 plane
K. Conn. struct. units	1. None
L. Substr. type	?

***Caloporella speciosa* continued:**

OCCURRENCE: MTL(l) *[i]*, MF(b) *[i]*.

COMPARISONS: It resembles *Caloporella speciosa* MacGillivray (Middle Miocene, Otway Basin) very closely, but the angle between the two zooids in a bizooidal segment is possibly significantly greater. The specimens of *Vittaticella speciosa*, which Stach (1933: 90, pl. 8, figs 1–3; ?Oligo-Miocene, Otway Basin) figures, display closed orifices, but are somewhat wider and may be a different species similar to *Caloporella* sp. nov. a described below. *Caloporella praetenuis* MacGillivray (1895: 20, pl. 2, fig. 20; Middle Miocene, Otway Basin) has much narrower vittae, but the angle between the bizooidal zooids is more similar to the present specimens.

***Caloporella* sp. nov. a**

Plate 19K

MATERIAL: SAM P39438 (TL)

DESCRIPTION: Zooid inverted drop shape, medium sized distolateral avicularian chambers directed distally with avicularium along complete length; frontal wall smooth, wide longitudinal row of depressed pore-chambers (vittae) slightly frontal of lateral margin running from level of proximal orificial margin to proximal zooid margin, with 2–3 irregular rows of pores.

Orifice subcircular, slightly flattened proximally, small proximolateral condyles creating slight constriction, often with calcified opercula.

Avicularia not observed.

Ovicell not observed.

MEASUREMENTS: (1 specimen)

Lz	1	0.61	-	
lz	1	0.39	-	
Lo	1	0.11	-	
lo	1	0.12	-	

Lvittae	1	0.41	-	
lvittae	1	0.08	-	

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	2. Rooted
C. Construction	3. Artic. determ.
D. Arrang. zooid ser.	1. Uniserial
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	1. Single/2. Cluster 2-5
H. Dim. struct. units	2. Curved
I. Freq. bifurc.	4. Very frequent
J. Dim. bifurc.	3. More than 1 plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: TL *[r]*.

COMPARISONS: This species is very similar to *Caloporella speciosa* MacGillivray (1895: 19), but is much wider with curved margins and wider pore-chambers. *Caloporella enormis* Maplestone (1898: 18, pl. 2, fig. 11; Middle Miocene, Otway Basin) has much more pores in a wider area.

Genus ***Costaticella*** Maplestone, 1899

Costicella Levinsen, 1909
Costaticellina Stach, 1934

TYPE SPECIES: *Catenicella lineata* MacGillivray, 1895

DESCRIPTION: Zooids ovoid, rather flat. Frontal surface with numerous narrow, elongated ribs diverging from a median line. (after Maplestone, 1899: 9)

Costaticella sp. nov. a
Plate 19N, O

MATERIAL: SAM P39431 (TL), P39432 (TL)

DESCRIPTION: Zooid elliptical with distolateral triangular avicularian chambers extended just wider than zooid width; gymnocyst 1/3 width of frontal wall , central costal area consisting of 10–12 narrow contiguous costae fused centrally without carina (pairs not always aligned), distal joint slightly extended.

Orifice semicircular with slightly concave proximal margin, angular condyles in proximolateral corners.

Avicularia not observed.

Ovicell not observed.

MEASUREMENTS: (2 specimens)

Lz	2	0.53	0.007	0.52-0.53
lz	2	0.26	0.021	0.24-0.27
Lo	2	0.10	0.004	0.10
lo	2	0.10	0.007	0.09-0.10

Lcost	2	0.29	0.057	0.25-0.33
lcost	2	0.17	0.021	0.15-0.18

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	2. Rooted
C. Construction	3. Artic. determ.
D. Arrang. zooid ser.	1. Uniser. / 2. Biserial
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	1. Single/2. Cluster 2-5
H. Dim. struct. units	2. Curved
I. Freq. bifurc.	4. Very frequent
J. Dim. bifurc.	3. More than 1 plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(I) *[r]*.

COMPARISONS: This species differs from the type species of *Costaticella*, *Catenicella lineata* MacGillivray (1895: 14, pl. 1, fig. 30; Middle Miocene, Otway Basin) in having very distinct distolateral avicularian chambers.

***Costaticella*? sp. nov. b**

Plate 19M

MATERIAL: SAM P39433 (TL)

DESCRIPTION: Zooid inverted drop-shaped with distolateral large triangular avicularian chambers projecting significantly distolaterally, avicularia small, placed at lateral base of chamber, gymnocyst half of frontal wall, central suboral costal shield semicircular, ca. 8 pairs of closely contiguous costae radiating inwards and fusing centrally without carina, single small lumen pore at lateral margin of each costa.

Orifice probably semicircular.

Avicularia not observed.

Ovicell not observed.

MEASUREMENTS: (1 specimen)

Lz	1	0.52	-	
lz	1	0.37	-	
Lo	1	0.11	-	
lo	1	0.12	-	

Lcost	1	0.21	-	
lcost	1	0.18	-	

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	2. Rooted
C. Construction	3. Artic. determ.
D. Arrang. zooid ser.	1. Uniserial
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	1. Single/2. Cluster 2-5
H. Dim. struct. units	2. Curved
I. Freq. bifurc.	4. Very frequent
J. Dim. bifurc.	3. More than 1 plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: TL *[p]*

COMPARISONS: It looks similar to *Catenicella ampilata* Maplestone (1899: 8, pl. 2, fig. 16; Middle Miocene, Otway Basin) in general appearance, but seems narrower and the lumen pores are much smaller.

Genus *Catenicellidae Gen. nov. A*

Catenicellidae Gen. nov. A sp. nov a

Plate 19P

MATERIAL: SAM P39437 (TL)

DESCRIPTION: Zoid probably tubular with large joint pores, single large adventitious avicularium at distolateral corner, subcircular with complete cross-bar.

Frontal wall only with one narrow central gymnocystal ridge and numerous scattered pores; very small suboral costal area composed of three almost triangular closely contiguous costae, each with a large central lumen pore.

Orifice elongated semicircular with distal rim.

Avicularia not observed.

Ovicell not observed.

MEASUREMENTS: (1 specimen)

Lz	0	?		
lz	0	?		
Lo	0	?		
lo	0	?		

Lz2	1	0.60	-	
lz2	1	0.36	-	
Lo2	1	0.17	-	
Lo2	1	0.15	-	

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	2. Rooted
C. Construction	3. Artic. determ.
D. Arrang. zooid ser.	1. Uniserial
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	1. Single/2. Cluster 2-5
H. Dim. struct. units	2. Curved
I. Freq. bifurc.	4. Very frequent
J. Dim. bifurc.	3. More than 1 plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: TL *[p]*

COMPARISONS: This is a very distinctive species, even though only a single fragment of a lateral zooid from a bizooidal segment was found. The character of the small costal area, the frontal wall and the avicularium justify a new genus.

Genus ***Catenicellidae Gen. indet. B***

Catenicellidae Gen. indet. B sp. nov. a

Plate 19H, J

MATERIAL: SAM P39435 (TL)

DESCRIPTION: Zooid oval to inverted drop-shaped, with moderately broad distolateral avicularian chambers. Frontal wall smooth except for two irregular lateral rows of pores.

Orifice subcircular with flattened proximal margin.

Avicularia not observed.

Ovicell not observed.

MEASUREMENTS: (1 specimen)

Lz	1	0.70	-	
lz	1	0.41	-	
Lo	1	0.15	-	
lo	1	0.10	-	

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	2. Rooted
C. Construction	3. Artic. determ.
D. Arrang. zooid ser.	1. Uniserial
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	1. Single/2. Cluster 2-5
H. Dim. struct. units	2. Curved
I. Freq. bifurc.	4. Very frequent
J. Dim. bifurc.	3. More than 1 plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: TL *[p]*

COMPARISONS: This species appears similar to those of *Stenostomaria* but it does not have the distinctive ridges and a sinuate orifice.

Genus ***Caberoides*** Canu, 1908

TYPE SPECIES: *Caberoides canaliculata* Canu, 1908

DESCRIPTION: Colony jointed, Zooids biserial, with a row of vibracula on front and elongate vibracula only on back.

Caberoides? sp. nov. a

Plate 19R, S, T

MATERIAL: SAM P39440 (TL)

DESCRIPTION: Colony erect articulated unilaminate branches with biserial rows of three zooids length each, articulated by large circular hollow joints (one at proximal end of first zooid, one each at distal end of distalmost zooids), basal surface smooth, no avicularia or vibraculae.

Zooid diamond shaped to inversed triangular, frontal wall smooth, imperforate, slightly convex, central join of rows defined by anastamosing elevated ridge following zooidal outline, oval adventitious avicularium with complete crossbar near each internal lateral corner, elevated in distal direction and directed laterally towards colony centre with rostrum twisted slightly proximally, external zooid corner elongated and curved distally (especially in final distal zooids of internode), bearing avicularium along distal margin.

Orifice with semicircular distal margin, wide U-shaped proximal sinus, proximolateral rounded condyles, margins (mainly proximal) broadly elevated.

Ovicell recumbent on distal zooid, large globular, smooth, with large rectangular ectooecial window in frontal centre, smooth endooecium visible.

Avicularia adventitious, one on lateral corner facing median branch line of each zooid, slightly reniform with broad rostrum directed laterally.

MEASUREMENTS: (1 specimen)

Lz	6	0.40	0.019	0.38-0.43
lz	6	0.29	0.021	0.27-0.32
Lo	6	0.09	0.009	0.08-0.10
lo	6	0.09	0.010	0.07-0.09

Lov	1	0.21	-	
lov	1	0.24	-	
Lav	6	0.09	0.008	0.08-0.10
lav	6	0.04	0.004	0.04-0.05

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?2. Rooted
C. Construction	3. Artic. det. cut. joints
D. Arrang. zooid ser.	2. Biserial
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	2. Cluster 2-5
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	?3. Frequent
J. Dim. bifurc.	2. One
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: TL*[p]*.

COMPARISONS: Although the zooids and the frontal avicularia are similar to species of *Caberoides*, this species clearly does not fit well into *Caberoides s.s.* as it lacks any vibracula on its basal surface. The colony form of *Ditaxipora* MacGillivray is very similar but the zooids resemble those of

Stenostomaria in the frontal ridges and sinuate orifice. It resembles *Caberea* in the ovicell with the ectooecial fenestra, but there is no evidence of a scutum.

REMARKS: Only a single specimen was found of this species, so many of the characters (e.g. number of zooids per internode) may vary. The specimen was accidentally destroyed during investigation.

Family **CONCATENELLIDAE** Bock & Cook, 1996

DESCRIPTION: Colonies small, most zooids budded frontally. Autozooids with a small costate frontal shield. Basal and antipical pores present, inferred to have been the origins of rhizoids. (after Bock & Cook, 2001)

Genus ***Concatenella*** Bock & Cook, 1996

TYPE SPECIES: *Lagenipora airensis* Maplestone, 1902

DESCRIPTION: Primary zooids paired, one on each side of the ancestrula, remaining zooids budded frontally and interzooidally. All zooids with large lateral and antipical septular pores. Ancestrula with rhizoid pores proximally and antipically.

Concatenella airensis (Maplestone)

Plate 18J, K

Lagenipora airensis MAPLESTONE, 1902: 24, pl. 2 (fig. 17)

Lagenipora airensis Maplestone; MAPLESTONE, 1904: 216 (listed)

Concatenella airensis (Maplestone) BOCK & COOK, 1996: 48, Figs. 1-6

MATERIAL: SAM P39423 (TL)

OTHER MATERIAL EXAMINED: NMV P10206 (holotype of *Lagenipora airensis*, 'Aire Coastal Beds', Maplestone coll.)

DESCRIPTION: Colony shape probably globular, possibly multilaminar, up to several millimetres diameter, zooids arranged irregularly.

Zooid rounded diamond-shaped, frontal wall very convex, imperforate, smooth gymnocyst, except for central suboral costal area about 1/4 – 1/3 zooid length, consisting of 5–6 broad flat costae, completely fused in central area but becoming slightly separated towards margin, small lumen pore near margin, margin slightly elevated above gymnocyst and anastamosing (inflected in centre of costae).

Orifice semicircular distal margin, sometimes slightly flattened, very broad and shallow U-shaped proximal sinus, constricted proximolaterally with rounded condyles, distal margin elevated (small peristome?).

Avicularia and ovicells not observed.

MEASUREMENTS: (1 specimen)

Lz	3	0.78	0.057	0.71-0.82
lz	3	0.57	0.046	0.52-0.62
Lo	3	0.24	0.010	0.23-0.25
lo	3	0.21	0.011	0.20-0.22

Lcost	3	0.23	0.017	0.21-0.24
lcost	3	0.21	0.028	0.20-0.25

A.B.G.H.C:

A. Orient. substr.	?2. Massive
B. Attachm. substr.	?2. Rooted/3. Tumbled
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	?1. Unilam./6. Multilam.
F. 2° skel. thick.	1. None

G. Struct. units	?13. Nodule
H. Dim. struct. units	3. 3D
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(l) *[f]*, MTL(m) *[p]*.

REMARKS: The available material is only three colonies, of which only a single colony fragment of three zooids preserves adequate detail. Although the peristome is thinner and the sinus is shallower and wider than in the type specimen of *C. airensis*, the morphology of the costal shield is sufficiently similar to make it the same species. This would significantly expand the geographical range of this species, which was previously only known from the Otway Basin.

Infraorder **HIPPOTHOOMORPHA** Gordon, 1989

Superfamily **HIPPOTHOOIDEA** Busk, 1859

Family **HIPPOTHOIDAE** Busk, 1859

DESCRIPTION: "Colony encrusting or erect. Frontal wall gymnocystal, thin, imperforate or with scattered fine pores. Orifice with a proximal sinus, and without spines. Avicularia uncommon, vicarious or interzooidal, never adventitious. Pore-chambers within the wall or tubular. Ovicell prominent, perforate or imperforate; gonads in autozooids and/or special sexual polymorphs." (Gordon, 1984)

Genus ***Hippothoa*** Lamouroux, 1821

TYPE SPECIES: *Hippothoa divaricata* Lamouroux, 1821

DESCRIPTION: Colony diffuse and ramifying widely over substrate, with uniserial chains of cruciform branching zooids, each producing one distal and paired lateral buds. Polymorphs include feeding autozooids, female zooids bearing ovicells, and minute zooeciules (of unknown function). Autozooids clavate, with a slender stolon-like proximal portion. Frontal wall smooth, non-porous, sometimes with transverse ridges. Orifice with sinus and paired condyles; that of female zooids similar to that of autozooids. Pore-chambers small, conical, in the base of lateral walls, not tubular. Ancestrula kenozooidal or tatiform. (after Gordon, 1984; Ryland & Hayward, 1992; Hayward, 1995)

Hippothoa sp. nov.? a

Plate 20A, B, C, D

MATERIAL: SAM P39441 (TL)

DESCRIPTION: Colony encrusting uniserial, branching cruciform with four caudae linking each zooid with other disjunct zooids, each autozooid producing one distal and two lateral buds, generally relatively straight, lateral pore chambers usually short, distal one to two times zooid length (often terminating when encountering pre-existing pore-chambers).

Zooid elongate oval to almost diamond-shaped, frontal wall convex, smooth (longitudinal corrugations secondary?), faintly ridged or corrugated transversely.

Orifice positioned near distal margin, circular with U-shaped sinus and condyles, margins raised distinctly.

Ovicell globular to slightly conical, orifice flattened semicircular, flattened proximally, v-shaped sinus, the proximal caudal stolon is much shorter than in autozooids, only the distal buds developed, no lateral buds present.

MEASUREMENTS: (1 specimen)

Lz	7	0.27	0.027	0.23-0.30
lz	7	0.18	0.008	0.17-0.18
Lo	7	0.05	0.004	0.04-0.05
lo	7	0.04	0.004	0.03-0.04
Lcaud	7	0.40	0.118	0.20-0.55

Lzov	4	0.17	0.027	0.15-0.21
lzov	4	0.16	0.026	0.12-0.18
Loov	4	0.02	0.006	0.02-0.03
loov	4	0.05	0.004	0.05-0.06
Lcaud	4	0.06	0.017	0.04-0.06
Lov	4	0.12	0.014	0.11-0.14
lov	4	0.20	0.014	0.19-0.22

A.B.G.H.C:

A. Orient. substr.	1. Encrusting
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	1. Uniserial
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	1. Single zooecium
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	4. Very frequent
J. Dim. bifurc.	2. 1 plane
K. Conn. struct. units	1. None
L. Substr. type	?hard (shell)

OCCURRENCE: TL *[r]*.

COMPARISONS: This species does not have many distinguishing characters, and although it appears similar to *Hippothoa divaricata pacifica* Gordon (1984; Recent, New Zealand), the compressed ovicelled zooids are different.

REMARKS: The termination of the caudal stolon of many zooids when it intersects that of another zooid is reminiscent of *Herpetopora* (Taylor, 1988: 533, fig. 7).

ENVIRONMENTS: Uniserial taxa such as *Hippothoa* are often considered to have a better chance of finding a spatial refuge or locating favourable environments because they can cover a larger area more quickly than multiserial colonies. This could be an advantage in unstable environments such as a shifting shelly sea floor. Uniserial colonies are exceedingly rare in the sediments investigated.

Genus ***Celleporella*** Gray, 1848

TYPE SPECIES: *Cellepora hyalina* Linnaeus, 1767

DESCRIPTION: Colony encrusting, rarely uniserial. Zooids with smooth imperforate frontal wall, the cauda short or wholly truncated. Orifice sinusoid, lacking spines. No avicularia. No zooeciules, supposed male zooids usually present. Ovicelled zooids typically with wider orifices lacking condyles; ovicell usually perforate. Pore-chambers tubular, rarely otherwise. Ancestrula schizoporelloid, rarely tatiform. (Gordon, 1984)

REMARKS: *Celleporella* was placed into synonymy with *Hippothoa* by Hastings (1979: 535), but the species included in it are distinct enough to warrant a separate genus.

***Celleporella*?** sp. a

Plate 20E, F

MATERIAL: SAM P39442 (TL)

DESCRIPTION: Colony encrusting unilaminar. Ancestrula may be double.

Zooids diamond-shaped, frontal wall smooth, imperforate and convex (esp. distally) with small umbo proximal to orifice (less distinct in early astogeny).

Orifice transversely oval (flattened proximally) with U-shaped sinus, and small paired condyles (not present in early astogeny and sloping down distally).

Ovicells and avicularia not observed.

MEASUREMENTS: (1 specimen)

Lz	5	0.41	0.021	0.38-0.43
lz	5	0.30	0.023	0.26-0.32
Lo	5	0.06	0.005	0.05-0.06
lo	5	0.06	004	0.06-0.07

A.B.G.H.C:

A. Orient. substr.	1. Encrusting.
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	Hard secondary (shell)

OCCURRENCE: MTL(l) *[r]*, MF(b) *[p]*.

COMPARISONS: This may not be a true *Celleporella* species, but in the absence of ovicells it is difficult to be certain.

Infraorder **UMBONULOMORPHA** Gordon, 1989
Superfamily **ARACHNOPUSIOIDEA** Jullien, 1888

Family **ARACHNOPUSIIDAE** Jullien, 1888

DESCRIPTION: "Colony encrusting to erect, uni- or bilamellar. Frontal wall perforated with few or numerous relatively large pores, often with secondary layers of calcification. Oral spines present. Avicularia adventitious and/or interzooidal or vicarious. Ovicell prominent or recumbent. Basal pore-chambers and/or mural septula present." (Gordon, 1984)

Genus ***Arachnopusia*** Jullien, 1888

TYPE SPECIES: *Lepralia monoceros* Busk, 1854

DESCRIPTION: "Colony encrusting to erect, uni- to bilamellar. Frontal wall perforated by numerous relatively large pores. The orifice typically with a single long spine emerging from one side. Adventitious avicularia often on the frontal wall and/or adjacent to the orifice. Interzooidal avicularia present or absent. Ovicell recumbent, usually with a frontal exposure of endooecium. Multiporous mural septula present." (Gordon, 1984)

REMARKS: Species of *Arachnopusia* have often been placed in *Hiantopora* and *vice versa* (see Harmer, 1926: 236 and Brown, 1952: 174 for discussions). This is despite *Hiantopora* not being an ascophoran.

BIOGEOGRAPHY: Recent species of *Arachnopusia* are restricted to the southern Pacific region between Australia, Antarctica and South America.

ECOLOGY: Recent species of *Arachnopusia* occur in a variety of environments ranging from polar waters (the greatest diversity is around Antarctica) to tropical waters (Moyano, 1996)

Arachnopusia cf. **unicornis** (Hutton)

Plate 21E, F, G

Eschara unicornis HUTTON, 1873: 99.

Hiantopora monoceros Busk; MACGILLIVRAY, 1895: 62, pl. 8 (fig. 22) (*non* Busk, 1854: 72, pl. 93, figs 5, 6).

Arachnopusia unicornis (Hutton); BROWN, 1952: 175, figs. 120, 121 (*cum syn.*).

Arachnopusia unicornis (Hutton); BROWN, 1958: 52.

MATERIAL: SAM P39447 (TL)

OTHER MATERIAL EXAMINED: NMV P27644 (*Hiantopora monoceros*, Muddy Creek, MacGillivray coll.)

DESCRIPTION: Colony unilaminar encrusting.

Zooidal margins indistinct, frontal shield often thickened, several small drop-shaped foramina.

Orifice positioned near distal margin, semicircular to rounded squarish, proximal margin projecting strongly with two to three adventitious avicularia on proximal margin, one lateral oral spine surrounded by calcification on one (either) side, broad apertural plate below distal margin.

Adventitious avicularium distal to orifice, oval to drop-shaped, no condyles, rostrum directed proximally and abfrontally.

Ovicells not observed.

MEASUREMENTS: (1 specimen)

Lz	4	0.35	0.026	0.31-0.36
lz	4	0.27	0.025	0.24-0.30
Lo	4	0.12	0.010	0.11-0.13
lo	4	0.10	0.006	0.09-0.10

A.B.G.H.C:

A. Orient. substr.	1. Encrusting
B. Attachm. substr.	?2. Rooted
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	?1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(m) *[r]*; Miocene – Recent, Australia and New Zealand.

COMPARISONS: The suboral and lateral avicularia are very similar to *A. unicornis*. The frontal wall has larger and apparently more pores, but secondary calcification may have obscured these in this study's specimens.

REMARKS: *A. unicornis* was originally described from the Recent of New Zealand, and is also considered to occur in the Recent of southern Australia (occurrences in Miocene and Pliocene sediments of both regions are also recorded, see Brown, 1952: 178). The occurrence in the Middle Eocene of this study gives *A. unicornis* a long lime range.

Arachnopusia sp. nov. a

Plate 20G, H, I, J

MATERIAL: SAM P39445 (TL), P39446 (MF)

DESCRIPTION: Colony unilaminar encrusting, basal surface with short conical projections in centre of each zooid.

Zooids alternating in longitudinal rows, diamond-shaped to hexagonal, margins generally indistinct, sometimes as shallow furrow, frontal shield often thickened, three large reniform foramina in U-shaped arrangement.

Orifice semicircular to rounded squarish, a variably developed squarish projection on proximal margin, extending into orifice, one lateral oral spine placed well outside orificial margin on one (either) side, with that proximolateral corner extending further proximally than the other, narrow apertural plate below distal margin.

Adventitious avicularia numerous, small, surrounding orifice, oval to drop-shaped, with condyles, rostrum directed variably, often elevated slightly abfrontally.

Ovicells endozooidal, immersed in distal zooid, slightly elevated above frontal wall, covered in several small adventitious avicularia.

MEASUREMENTS: (2 specimens)

Lz	6	0.46	0.034	0.40-0.50
lz	6	0.29	0.021	0.26-0.32
Lo	6	0.11	0.007	0.10-0.12
lo	6	0.19	0.021	0.16-0.22
Lov	1	0.18	-	
lov	1	0.21	-	

A.B.G.H.C:

A. Orient. substr.	1. Encrusting
B. Attachm. substr.	?1. Cement/2. Rooted
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	?1. None
G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(l) *[r]*, MTL(m) *[p]*, MF(b) *[i]*.

COMPARISONS: This resembles some of the specimens regarded by other authors as forms of *Arachnopusia liversidgei* (Tenison Woods, 1877: 149, figs. 11, 12, 13; ?Oligo-Miocene, Gambier Embayment) and *Mucronella mucronata sensu* Waters (1881: 328, pl. 17, fig. 66; ?Miocene, Otway Basin), which may be synonymous with the former species. Because of the absence of any type material for *A. liversidgei* and the varied interpretation of the specific characters, the current species is not included in *A. liversidgei*.

Arachnopusia sp. nov. b

Plate 21A, B, C, D

MATERIAL: SAM P39444 (TL, WLG 42 QA 69)

DESCRIPTION: Colony erect bifoliate sheet.

Zooids alternating in longitudinal rows, diamond-shaped to hexagonal with very short distal and proximal margins, margins generally indistinct, usually convex (secondary calcification), sometimes as shallow furrow or fold, frontal shield often thickened, 2–3(4?) pairs of reniform foramina in U or V-shaped arrangement (often odd number with single one at proximal end), with bi- or tri-furcating spines on median margin, median area with additional smaller circular pores, areas of uncalcified grooves in frontal shield.

Orifice positioned somewhat proximal to distal margin (avicularium), semicircular to rounded squarish, condyles? in proximolateral corners, two broad flat-topped denticles on proximal margin often almost fused, extending to level of condyles, one lateral oral spine (recessed/not projecting, i.e. not always visible) on one (either) side, broad apertural plate below distal margin, narrow oral rim below thickened calcification on distal margin extending to condyles.

Adventitious avicularia (proximo)lateral to orifice (almost at zooid margin), oval to drop-shaped, condyles, rostrum directed distally (towards orifice margin), often projecting slightly abfrontally; single similar avicularium on median distal margin, rostrum usually directed distally, additional rare avicularia along zooid margins.

Ovicells endozooidal, immersed in distal zooid, indistinct and almost not elevated above frontal wall.

MEASUREMENTS: (1 specimen)

Lz	6	0.82	0.076	0.76-0.96
Lz	6	0.42	0.032	0.36-0.44
Lo	6	0.16	0.013	0.14-0.18
lo	6	0.18	0.004	0.18-0.19
Lav	6	0.12	0.020	0.12-0.16
lav	6	0.10	0.020	0.08-0.12

Lzov	4	0.93	0.060	0.86-1.00
lzov	4	0.34	0.083	0.24-0.44
Loov	4	0.16	0.017	0.14-0.18
loov	4	0.19	0.010	0.18-0.20
Lov	4	0.25	0.026	0.22-0.26
lov	4	0.31	0.019	0.30-0.32

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?2. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. Non-mac.
E. Arrang. front. surf.	2. Bilaminate
F. 2° skel. thick.	?1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(m) *[p]*, LKL(t) *[p]*, TL(WLG 42 QA 69) *[p]*

COMPARISONS: This appears to be a fragile species and the only clearly identifiable specimen was found in the WLG 42 QA 69 core. Specimens from outcrop samples occur, but are too recrystallised to be positively identified. It may therefore simply be a very well preserved specimen of *Arachnopusia* sp. nov. a.

Family **EXECHONELLIDAE** Harmer, 1957

DESCRIPTION: "Colony encrusting. Zooids with evenly perforated frontal wall and long or short tubular peristome. Oral spines wanting. Avicularia, where present, adventitious, frontal. Ovicells usually lacking; where present, small, distal to the peristome. Mural septula present." (Gordon, 1984)

REMARKS: First occurrences of this family are '*Exechonellidae*? sp. 1 & sp. 2', Lower Eocene (?Ypresian), DSDP Site 246, Indian Ocean (Labracherie, 1975) and *Exechonella* sp., Selsey Formation (Upper Bracklesham Beds, Lower Eocene, ?Lutetian), Sussex, England (Cheetham, 1966).

Genus ***Exechonella*** Duvergier, 1924

TYPE SPECIES: *Cyclicopora? grandis* Duvergier, 1921

DESCRIPTION: Colony encrusting. Zooidal frontal wall with numerous perforations; these relatively large and often rimmed in developing zooids. Peristome generally tubular, tall, imperforate. Avicularia, spines and ovicells wanting. Multiporous mural septula present. (Gordon, 1984)

REMARKS: If the below species is a true *Exechonella*, the generic diagnosis needs to be amended to accommodate the erect branching growth form.

Exechonella? sp. nov. a

Plate 22A, B, C, D

MATERIAL: SAM P39448 (TL)

DESCRIPTION: Colony erect branching, cylindrical, 16–20 zooid rows, branch diameter about 2 mm.

Zooids rhomboid (distorted in branching junction), margins clearly defined by ridge; frontal wall flat to slightly convex, 3 very large circular pores with broadly raised margins occupying most of frontal area (one in proximal corner, two below lateral corners; can be two proximal pairs in branching junctions).

Orifice positioned in distal corner, circular to transversely oval, large (ca. 1/3 to 1/2 zooid length), margins very raised to same level all around (~peristome?) directed slightly distally.

Avicularia adventitious, circular, paired, just above lateral corners, directed laterally (detailed featured obscured by recrystallisation.

Ovicells not observed.

MEASUREMENTS: (1 specimen)

Lz	6	0.72	0.052	0.64-0.80
lz	6	0.58	0.071	0.42-0.62
Lo	6	0.19	0.028	0.14-0.23
lo	6	0.21	0.054	0.11-0.28

Lav	6	0.08	0.008	0.06-0.08
lav	6	0.09	0.010	0.08-0.10
øpore	6	0.07	0.010	0.06-0.08

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	5. Radial
F. 2° skel. thick.	?1. None

G. Struct. units	8. Solid cylinder
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	?2. Infrequent
J. Dim. bifurc.	?2. One plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(u) *[p]*.

COMPARISONS: All other species of *Exechonella* have more than three frontal pores. *Hiantopora magna* MacGillivray (1895: 62, pl. 8, fig. 23, pl. 10, fig. 27; Middle Miocene, Otway Basin) also has very large pores. However there are more pores and the colony is bilaminar (Interestingly, *H. magna* was erroneously cited by Bassler (1953) as the type species of *Exechonella*). *Exechonella* cf. *paucipunctata* Brown (1956:600; Pliocene, St Vincent Basin) similarly has more and smaller pores.

Superfamily **ADEONOIDEA** Busk, 1884

Family **ADEONIDAE** Busk, 1884

DESCRIPTION: "Frontal wall development umbonuloid. Operculum not sinuate. Marginal pores present. Frontal spiramina evanescent or permanent, single or multiporous. Avicularia usually present, adventitious and vicarious. Sexual polymorphs sometimes present; brooding internal." (Gordon, 1984)

REMARKS: First recorded occurrence of the Adeonidae is either *Adeonellopsis wetherelli* Gregory, from the London Clay (Ypresian), S.E. England, or *Bracebridgia*? sp. from the ?Ypresian of DSDP Site 246, Indian Ocean (Labracherie 1975). As both occurrences are from Upper Eocene sediments but far apart, an even earlier origin is likely to allow for such wide dispersal.

Genus ***Adeonellopsis*** MacGillivray, 1886

TYPE SPECIES: *Adeonellopsis foliacea* MacGillivray, 1886

DESCRIPTION: Colony encrusting; or erect, bilamellar, foliaceous or branching. Spiramen single or multiporous. Adventitious avicularia paired or single, vicarious avicularia often present. Often polymorphic, with brooding zooids. Numerous small basal pore-chambers present. (Gordon, 1984)

REMARKS: None of the specimens here was observed with either brooding zooids or vicarious avicularia, which are generally a common and distinctive feature of *Adeonellopsis* species.

Modern *Adeonellopsis* commonly have aragonitic skeletons (Smith *et al.*, 1998). Many of the moulds of flat robust branching colonies observed in thin sections of Tortachilla Limestone have therefore been identified as *Adeonellopsis* where only the central calcite axis is preserved (N.P. James, pers. comm., 1999). But the specimens in this study are all relatively well preserved, even after extensive diagenesis in the Tortachilla Limestone, so this connection may not be valid.

Adeonellopsis symmetrica (Waters)

Plate 23E, F

Microporella symmetrica WATERS, 1881: 332, pl. 18 (fig. 83).

Adeonellopsis symmetrica (Waters) MACGILLIVRAY, 1895: 70, pl. 9 (fig. 12).

MATERIAL: SAM P39452 (TL)

OTHER MATERIAL EXAMINED: holotype of *Microporella symmetrica* MM 7974 (?Curdies Creek, ?Gellibrand Marl, Middle Miocene, Waters coll.), NMV P27659 (Muddy Creek, Gellibrand Marl, Middle Miocene, MacGillivray coll.)

DESCRIPTION: Colony erect bilaminar branching, usually 6 rows across.

Zooids elongated hexagonal, rounded distal margins with thin salient thread marking margins, narrow elongated marginal pores running just inside of margin, frontal wall convex, with variably depressed central transversely oval area containing 3 or 4 pairs of ?stellate pores (compound spiramen).

Orifice transverse oval to semicircular with flat or slightly notched proximal margin, slightly raised on short peristome; paired suboral avicularia raised above level of secondary orifice, together wider than orifice, drop-shaped, acute rostrum directed in towards middle of orifice, no cross bar or condyles.

No brooding zooids observed.

MEASUREMENTS: (1 specimen)

Lz	7	0.53	0.022	0.50-0.56
lz	7	0.26	0.038	0.18-0.28
Lo	7	0.06	0.008	0.06-0.08
lo	7	0.10	0.010	0.09-0.12

Lav	7	0.08	0.005	0.07-0.08
lav	7	0.06	0.005	0.05-0.06
Lspir	7	0.16	0.027	0.12-0.20
lspir	7	0.07	0.015	0.06-0.10

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	2. Bilaminate
F. 2° skel. thick.	?1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: LTL *[r]*, MTL(l) *[i]*, MTL(m) *[c]*, MTL(u) *[f]*, UTL *[r]*, MF(b) *[c]*, LRF(s) *[c]*, LKL(l1) *[i]*, LKL(m) *[c]*, LKL(u) *[d]*, LKL(t) *[c]*.

COMPARISONS: MacGillivray's (1895) specimen of *A. symmetrica* (NMV P27659) has stellate spiramen, which are consistently depressed, and there are no polymorphs on the lateral colony margins. The zooidal measurements are also distinctly smaller (Lz: 0.32–0.33, lz: 0.16–0.18) while the spiramen area is larger (Lspir: 0.11–0.13mm).

***Adeonellopsis* cf. *yarraensis* (Waters)**

Plate 23G, H, I, J

Microporella yarraensis Waters, 1881: 331, pl. 15 (figs 27, 18)

MATERIAL: SAM P39453 (TL), P39454 (TL), P39455 (TL)

OTHER MATERIAL EXAMINED: ?holotype of *Microporella yarraensis* MM 7972 (?Curdies Creek, ?Gellibrand Marl, Middle Miocene, Waters coll.),

DESCRIPTION: Colony erect bilaminar branching.

Zooids elongated hexagonal to diamond shaped, ridge marking margins, small round marginal pores running just inside of ridge, frontal wall flat to convex, single or paired rounded prominence in or just distal to lateral corners [sometimes only one where one suboral avicularium, generally two especially where two suboral avicularia], with shallowly to very sharply depressed central transversely oval to circular area containing 6 or 7 ?stellate pores arranged around a central pore [together = compound spiramen?], sometimes smaller second depression proximal to this one.

Orifice transversely oval to semicircular with flat proximal margin, sometimes almost triangular, primary orifice?, slightly raised on short peristome.

Adventitious avicularia paired or single suboral, raised to or above level of secondary orifice, together wider than orifice, drop-shaped, rostrum pointing in towards middle of orifice, no cross bar or condyles.

Brooding zooids not observed.

MEASUREMENTS: (2 specimens)

Lz	13	0.40	0.048	0.36-0.52
lz	13	0.22	0.038	0.16-0.28
Lo	13	0.04	0.006	0.03-0.05
lo	13	0.07	0.010	0.06-0.08

Lav	13	0.05	0.010	0.04-0.06
lav	13	0.05	0.010	0.04-0.06
Lspir	13	0.09	0.023	0.06-0.14
lspir	13	0.06	0.020	0.03-0.09

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	2. Bilaminate
F. 2° skel. thick.	?1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	?1. None
J. Dim. bifurc.	?1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(l) *[i]*, MTL(m) *[i]*, MF(b) *[f]*; widespread with long time range (see below)

COMPARISONS: *Adeonellopsis yarraensis* has been commonly recorded from south-eastern Australia and New Zealand throughout the Cainozoic and even the Recent. It is a variable species and all the recorded occurrences need detailed revision. It is unlikely that the Recent species referred to *A. yarraensis* (e.g. Gordon, 1984) are actually conspecific with *A. yarraensis* (P.E. Bock, pers. comm., 2000). *A. clavata sensu* MacGillivray (1895: 70, pl. 9, figs 15–18; NMV P27665, Middle Miocene, Otway Basin) also appears similar the specimens from the current study and may be synonymous.

Adeonellopsis sp. nov. a

Plate 23A, B, C

MATERIAL: SAM P39450 (TL), P39451 (TL)

DESCRIPTION: Colony erect delicate ?branching, columnar or slightly flattened, 3–5 transverse rows of zooids on both sides; some colonies very wide or even ?encrusting.

Zooids elongated hexagonal, strongly convex with thin salient thread marking margins, no marginal pores observed, central transversely oval area raised with 3 or 4 pairs of ?stellate pores and one proximal pore, sometimes wider area with several extra pores in centre (compound spiramen); orifice oval to semicircular or crescentic with rounded corners, primary orifice?; always paired suboral avicularia raised to be level with secondary orifice, together as wide as orifice, circular, no cross bar or condyles.

Interzooidal polymorphs (?avicularia) along marginal area occupying space of zooid, appearance and size like suboral avicularia.

Brooding zooids not observed

MEASUREMENTS: (2 specimens)

Lz	7	0.41	0.041	0.36-0.48
lz	7	0.22	0.021	0.20-0.26
Lo	7	0.05	0.008	0.04-0.06
lo	7	0.08	0.012	0.06-0.10

Lav	7	0.15	0.028	0.12-0.20
lav	7	0.11	0.015	0.08-0.12
Lspir	7	0.06	0.005	0.05-0.06
lspir	7	0.06	0.005	0.05-0.06

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	2. Bilaminate
F. 2° skel. thick.	?1. None

G. Struct. units	5. Sheet / 8. Cylinder
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: LTL *[r]*, MTL(l) *[r]*.

COMPARISONS: This species is similar to *A. symmetrica* (Waters), but the distinct oligoserial branches, the elevated spiraminal area and the lateral polymorphs set it apart.

Adeonellopsis sp. nov. b

Plate 23L, M, N, K

MATERIAL: SAM P39457 (TL)

DESCRIPTION: Colony erect bilaminar branching, 6–8 zooids across.

Zooids elongated hexagonal to diamond shaped, margins faintly defined by immersed ridge, small elongated marginal pores running inside of ridge, frontal wall flat to slightly convex, single low rounded prominence in or just distal to lateral corners, with shallowly to very sharply depressed central transversely oval to circular area containing 6 distinctly stellate pores, sometimes smaller second depression proximal to this one.

Orifice transverse oval to reniform; paired suboral avicularia raised above level of secondary orifice, together wider than orifice, drop-shaped, acute rostrum directed towards middle of orifice, no cross bar or condyles. Additional adventitious avicularium off-centre on proximal frontal wall.

Brooding zooids similar to autozooids but distinctly larger, especially wider, orifice wider but narrower, almost crescentic.

MEASUREMENTS: (1 specimen)

Lz	4	0.38	0.030	0.34-0.40
lz	4	0.23	0.022	0.21-0.25
Lo	4	0.04	0.005	0.04-0.05
lo	4	0.08	0.006	0.07-0.08
Lav	4	0.04	0.006	0.04-0.05
lav	4	0.03	0.005	0.04-0.05
Lspir	4	0.05	0.005	0.04-0.05
lspir	4	0.04	0.002	0.04-0.05

Lzov	2	0.49	0.008	0.458-0.49
lzov	2	0.34	0.009	0.34-0.35
Loov	2	0.02	0.011	0.01-0.03
loov	2	0.12	0.029	0.10-0.14
Lavov	2	0.05	0.004	0.05
lavov	2	0.04	0.000	0.04
Lspirov	2	0.10	0.021	0.08-0.11
lspirov	2	0.08	0.007	0.07-0.08

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	2. Bilaminate
F. 2° skel. thick.	?1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(m) *[r]*, MF(b) *[i]*, LRF(l) *[r]*.

COMPARISONS: This is similar to *A. yarraensis* (Waters) but the different spiraminal area, the consistently paired suboral avicularia and the additional proximal avicularium set it apart.

Genus ***Anarthropora*** Smitt, 1868

TYPE SPECIES: *Lepralia monodon* Busk, 1868

DIAGNOSIS: Incrusting, with semicircular orifice, frontal wall perforated by stellate pores; oral avicularia; no ovicell or spines. (after Brown, 1952)

Anarthropora sp. a

Plate 22E, F, G, H

MATERIAL: SAM P39458 (TL), P39459 (TL)

DESCRIPTION: Colony encrusting.

Zooid broadly drop-shaped, frontal wall convex, with few very small pores; 6–10 marginal areolae, especially well developed along proximal margin.

Primary orifice shape transversely ?oval, secondary orifice transverse rectangular to oval, peristome often overlapping distal zooid. Narrow drop-shaped adventitious avicularia with raised margins on distal and proximal surface of peristome, distal one often almost vertical due to steepness of peristome, no cross-bars.

1–2 narrow drop-shaped adventitious avicularia with raised margins sometimes positioned at zooid margin, rostrum pointing towards centre of zooid, no cross-bar.

Ovicell not observed.

MEASUREMENTS: (2 specimens)

Lz	10	0.47	0.032	0.42-0.52
lz	10	0.27	0.015	0.22-0.30
Lo	10	0.06	0.004	0.06-0.07
lo	10	0.08	0.007	0.07-0.09

Lavad	10	0.11	0.012	0.10-0.12
lavad	10	0.05	0.006	0.04-0.05
Lavo	3	0.07	0.008	0.06-0.08
lavo	3	0.05	0.006	0.04-0.05

A.B.G.H.C:

A. Orient. substr.	1. Encrusting
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	?1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(l) *[p]*, MTL(m) *[p]*.

COMPARISONS: *Anarthropora voigti* Brown (1958: 81; Upper Oligocene, Gippsland Basin) is very similar in most characters, but the frontal wall has a very distinctive series of radiating rows of moderately large circular stellate pores, separated by faint ridges.

REMARKS: The adventitious avicularia are not present in all zooids. The peristomial avicularia are generally the same size, but may vary in shape (possibly an artefact of abrasion).

Genus ***Dimorphocella*** Maplestone, 1903

TYPE SPECIES: *Dimorphocella pyriformis* Maplestone, 1903

DESCRIPTION: Two distinct forms of cells. Zooecial cells elongated of rhomboidal, distinct. Thyrostome arched above, with a sinus in the lower lip. Ooecial zooids much larger than the autozooids, elongate, pyriform or oval, with a broad aperture and a perforated area in front. (Maplestone, 1903: 140)

Remarks: The main difference between *Dimorphosella* and *Schizostomella* Canu & Bassler (1927) is the morphology of the enlarged brooding zooids. As these are all broken in the specimens of this study, a positive assignment to one or the other genus cannot be made. *Dimorphosella* appears to be an austral genus, while *Schizostomella* is common in the northern hemisphere.

Dimorphocella sp. nov. a

Plate 24A, B, C, D, E, F

MATERIAL: SAM P39462 (TL), P39463 (TL), P39464 (TL)

DESCRIPTION: Colony erect bilaminar sheet.

Zooids hexagonal to arrow shaped with rounded distal margin, defined by narrow ridge, frontal wall flat to slightly convex, smooth to faintly pustulose or tuberculate, single row of small marginal areolae around complete zooid, with dividing ribs around orifice, single or paired pores proximal to orifice.

Primary orifice a semicircle, sometimes longitudinally elongated, proximal margin straight with rounded broad U-shaped sinus, narrow condyles up to sinus, peristome relatively short becoming very broad with secondary calcification, secondary orifice subcircular to oval.

Adventitious avicularia single or rarely paired, placed immediately lateral and just proximal to orifice, with acute rostrum directed distally and sometimes extending almost to distal margin, no cross bar or condyles, very rare similar avicularia on frontal wall directed laterally across zooid.

Ovicelled zooids dimorphic, similar length but much wider and more convex than autozooids, always with paired adventitious avicularia, orifice very wide, other frontal wall features unknown as all specimens had broken ovicells.

MEASUREMENTS: (4 specimens)

Lz	16	0.57	0.068	0.48-0.70
lz	16	0.32	0.031	0.28-0.34
Lo	16	0.13	0.010	0.12-0.14
lo	16	0.11	0.012	0.09-0.13
Lavad	16	0.13	0.028	0.09-0.20
lavad	16	0.08	0.013	0.06-0.10

Lzov	3	0.57	0.090	0.48-0.66
lzov	3	0.48	0.060	0.42-0.54
Loov*	3	0.29	0.012	0.28-0.30
loov	3	0.25	0.031	0.22-0.28
Lavov	3	0.15	0.012	0.14-0.16
lavov	3	0.07	0.012	0.06-0.08

***Dimorphosella* sp. nov. a continued:**

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?2. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	2. Bilaminate
F. 2° skel. thick.	?1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: LTL *[r]*, MTL(l) *[i]*, MTL(m) *[i]*, MF(b) *[r]*, LRF(l) *[r]*.

COMPARISONS: The frontal wall structures of ovicelled zooids in the species of this genus are of significant taxonomic value. These features are not known from the available specimens due to extensive breakage. It is very similar to *Dimorphosella triton* (MacGillivray, 1895: 90, pl. 9, fig. 23, as *Adeonella triton*; Middle Miocene, Otway Basin) with respect to the autozooids, but, although the present specimens are all broken, the brooding zooids of *D. triton* appear to be different in not having the paired lateral ?avicularia (although these may simply be the chambers of ones placed more centrally originally) but possessing a distal shelf below the opesial margin (see also Maplestone, 1903: 141, fig. 2). The type specimen of *D. triton* was the only one MacGillivray 'observed' of this species. *D. pyriformis* (Maplestone: 141, fig. 1; Miocene, Otway Basin) was considered synonymous with *D. triton* by Hayward & Cook (1983: 47).

Of MacGillivray's (1895) two specimens of '*Schizoporella submersa* Waters', one (NMV P27706) is missing, while the other (NMV P27707) is unrecognisable due to salt crystallisation. Material of *S. submersa'* in the BMNH (especially D1987; Waters coll.) appears quite different to the present material. MacGillivray's (1895: 76, pl. 14, fig. 28) '*Lepralia monilifera* Milne-Edwards' (specimen NMV P27802 is missing) is very similar to *D. triton*. It is unclear why MacGillivray placed these three obviously cogeneric (if not conspecific) species in three different genera. All three occur at Muddy Creek (Gellibrand Marl, Upper Oligocene – Lower Miocene), possibly within the same sediments.

***Dimorphocella*? sp. nov. b**

Plate 24G, H, I

MATERIAL: SAM P39465 (TL, WLG 42 QA 69)

DESCRIPTION: Colony erect bilaminate sheet.

Zooid irregularly pyriform to diamond shaped with rounded distal margin, defined by very narrow ridge, frontal wall flat, finely granulated with occasional larger smooth bulges, single row of small marginal areolae around complete zooid, paired pores proximal to orifice.

Primary orifice situated a short distance from distal margin, a semicircle, proximal margin [straight] with broad rounded condyles creating rounded broad U-shaped sinus, peristome encircling large oval spiramen, secondary orifice semicircular to reniform.

Adventitious avicularia paired, placed proximolateral to orifice, with long almost parallel-sided acute rostrum directed distally inwards towards proximolateral margin of orifice, no cross bar or condyles, margins slightly raised and slightly inflected at base of rostrum.

Ovicelled zooids not observed.

MEASUREMENTS: (4 specimens)

Lz	3	0.67	0.050	0.62-0.72
lz	3	0.24	0.008	0.24-0.25
Lo	3	0.07	0.018	0.07-0.09
lo	3	0.10	0.007	0.09-0.10

Lav	3	0.09	0.010	0.08-0.10
øpore	3	0.06	0.003	0.05-0.06

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	2. Bilaminate
F. 2° skel. thick.	?1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: TL(WLG 42 QA 69) *[p]*.

COMPARISONS: This species also resembles *Schizostomella* Canu & Bassler or *Adeonella* Busk, but in the absence of brooding zooids in the single specimen found, no definitive placement can be made.

Family **INVERSIULIDAE** Vigneaux, 1949

DESCRIPTION: "Zooidal frontal wall with numerous tubercles and small pores. Orifice reversed, the operculum opening distally, with straight distal rim and concave proximal rim. No condyles or oral spines. A suboral ascopore present. Avicularia paired, at the corners of the orifice. Embryos brooded in ordinary zooids or modified brooding zooids. Numerous small basal pore-chambers present." (Gordon, 1984)

REMARKS: The first occurrence of this family has until now been considered to be *Inversiula airensis* Maplestone from the 'Aire Coast Beds', Victoria. The formations there are either Late Eocene or Oligocene in age, but it is most likely that Maplestone's specimen's were collected from the Oligocene sediments, as he cites 'Wilkinson's No. 4' as the locality. Either way, this occurrence from the Middle Eocene is older and therefore the oldest recorded for this family as well as *Inversiula*.

Genus ***Inversiula*** Jullien, 1888

TYPE SPECIES: *Inversiula nutrix* Jullien, 1888

DESCRIPTION: Characters as for the family.

REMARKS: This is an interesting genus, because the operculum is hinged distally rather than proximally as in most other Cheilostomes. It is not clear why (or how) this evolved in *Inversiula.*

Inversiula cf. **airensis** (Maplestone)

Plate 22I, J

Inversiula airensis Maplestone, 1902: 281, pl. 48 (fig. 38).

MATERIAL: SAM P39460 (TL), P39461 (TL)

OTHER MATERIAL EXAMINED: NMV P12105 (holotype of *Inversiula airensis*, 'Aire Coastal Beds', Maplestone coll.)

DESCRIPTION: Colony unilaminar encrusting.

Zooids alternating in longitudinal rows, subhexagonal but frequently irregular shape (round, diamond or worse), frontal wall convex with 8–12 ?stellate pores with raised margins, ascopore shape unclear , ca 24 distinct marginal areolae with stout separating ridges in between each, converging with ridge separating zooids.

Orifice on distal margin, transversely oval with straight distal margin, raised margins.

Paired adventitious avicularia in proximolateral corners close to zooid margin, oval to circular shape, no cross bar, margins raise to similar level as orifice.

Brooding zooids not observed.

MEASUREMENTS: (2 specimens)

Lz	14	0.50	0.067	0.42-0.62
lz	14	0.44	0.051	0.34-0.52
Lo	14	0.05	0.008	0.04-0.06
lo	14	0.11	0.009	0.10-0.13

Lavo	14	0.09	0.008	0.08-0.10

A.B.G.H.C:

A. Orient. substr.	1. Encrusting
B. Attachm. substr.	2. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(m) *[p]*, MF(b) *[r]*.

COMPARISONS: The zooidal measurements of the type specimen (NMV P12105) are almost identical with those of the Tortachilla Limestone specimens.

REMARKS: An apparently paired zooid occurs in one specimen (Pl. 22J), which seems to be the result of space-problems at a zooid row bifurcation. Many other genera develop interzooidal or vicarious avicularia or polymorphs in such situations (see e.g. '*Lunulites*' sp. nov. a, Pl. 6B; '*Onychocella*' sp. b, Pl13E; *Larvapora* sp. nov. a, Pl. 10H; note: none of these species are ascophorans). No such avicularia are known in *Inversiula*.

Superfamily **LEPRALIELLOIDEA** Vigneaux, 1949

Family **LEPRALIELLIDAE** Vigneaux, 1949

BIOGEOGRAPHY: First occurrence of Lepraliellidae is *Celleporaria granulosa* etc. (Canu & Bassler, 1920) (not Haswell) from the Cook Mountain Formation (Clairbornian = Bartonian), Caldwell Co., Texas (see also below under *Celleporaria*)

REMARKS: Due to the irregular growth resulting from frontal budding in multilaminar colonies, the measurements for the zooidal dimensions are estimated rather than accurately observed, as zooidal boundaries are mostly obscured.

Genus ***Celleporaria*** Lamouroux, 1821

TYPE SPECIES: *Cellepora cristata* Lamarck, 1816

DESCRIPTION: Colony encrusting to erect and massive, usually multilaminar developed by frontal budding of successive autozooid generations. Zooids recumbent at growing margins, suberect to erect elsewhere with varying orientation, smooth, with a few indistinct marginal pores. Orifice non-sinuate, with or without denticles, oral spines typically present. Suboral and vicarious avicularia present. Ovicells hyperstomial, small and spherical, imperforate. (after Gordon, 1984; Ryland & Hayward, 1992)

REMARKS: The distinction of species within this genus is confusing for various reasons. The zooidal characters are quite variable and often obscured or altered due to irregular frontal budding. In addition, the synonymy of many of the species described from Australia is uncertain.

Cellepora gambierensis was listed by Busk (1860) as a new species from Mount Gambier, without illustration or description other than "... a large and massive *Cellepora*...", and is therefore a *nomen nudum*. This citation is actually preceded by Tenison Woods' (1860) reference to "*Cellepora Gambierensis* (sp. n.), Busk" and "...branched *Cellepora Gambierensis"* by several pages in the same volume of the Proceedings. The next reference to it is by Tenison Woods (1862: 74, 85, 91) as "*Cellepora gambierensis* Busk (MS)" in his discussion of the Gambier Limestone. He gave only three diagrams of branching colonies and one of a group of very stylised zooids (p. 74) and no description. As with most of Tenison Woods' type collections of Bryozoa, the specimens studied for the 1862 publication are probably lost. These circumstances make Tenison Woods (1862) also effectively invalid as first author. Waters (1885: 302) placed "*Cellepora gambierensis* Busk" into synonymy with *Cellepora coronopus* S. Wood, a Recent European species. This is unlikely as it was based on a single poorly preserved specimen he had received from Prof. Tate. Of all his publications, Maplestone (1904: 215) cited *Cellepora gambierensis* Busk only in his list of Victorian Tertiary Bryozoa. Interestingly, neither MacGillivray, Stach nor Brown referred to it in any of their publications.

The frequent citations by more recent non-taxonomic publications on the southern Australian Tertiary sediments of '*Cellepora*', 'arborescent bryozoans', and more rarely '*Cellepora gambierensis*' (e.g. Reekman, 1979; James & Bone, 1989, 1991; Boreen *et al.*, 1992; Bone & James, 1993: 267, as *Celleporaria*; Boreen & James, 1995: 152, fig. 17), are generally presumed to all refer to *Celleporaria gambierensis*. As with Busk's initial 'diagnosis', all these identifications appear to rely solely upon the multilaminar arborescent growth form with hollow branches. This characteristic is probably not in itself of specific value, and is of little use to identify the abundant smaller fragments that occur in many of the sediments.

The specimens from the current study of colonies with the distinctive arborescent multilaminar hollow branches all have zooidal characters the could easily be assigned to either *C. tridenticulata* or *C. nummularia* if the growth form was not known. Considering that a large proportion of the other specimens are only fragments, the growth form is actually not known for most, and the practicality (or indeed the reality) of distinguishing these species may be unjustified. The lunulitiform colonies of *C. nummularia* are, however, so distinctive, that this may warrant a separate species (see also Gordon, 1989: 33, on the justification of *C. emancipata* as a separate species from *C. tridenticulata*).

Ongoing detailed work on recent specimens of *C. tridenticulata* from a range of localities around Australia appear to indicate a number of cryptic species, requiring the species to be split (J. Mackie, pers. comm., 2002). The range of zooidal character morphologies in the specimens of this study may indicate that the Tertiary species also requires splitting.

BIOGEOGRAPHY: *Celleporaria* appears to have originated during the Eocene. It is particularly diverse in the Middle Eocene of south-eastern North America: *C. albirostris*, *C. crassicollis*, *C. discus*, *C. 'granulosa'*, *C. micropora*, *C. pisiformis*, *C. separata* (Canu & Bassler, 1920). The combined effect of frontal budding and the preservation of the examined material from the St. Vincent Basin makes positive separation into species difficult. It is likely that there are at least two or three separate species. Their presence within the Tortachilla Limestone is contemporaneous with the North American ones.

ECOLOGY: *C. tridenticulata* was originally described from Cape Yorke by Busk (1884: 198). The tropical to subtropical documented Recent distribution does not conflict with its occurrence in the Eocene southern Australia, as water temperatures were probably subtropical.

Self-overgrowth or frontal budding allows increase in colony thickness. These features are rare in species on ephemeral unstable substrates (McKinney & Jackson, 1989: fig. 1.21)

Celleporaria preserve poorly in high-energy environments and turn to carbonate mud. This is because of thinly calcified walls, less (if at all) due to geochemistry (see Smith & Nelson, 1994), as the colonies, which preserve, do so almost without recrystallisation. This is the case in the Tortachilla Limestone and many other formations. In quiet facies (e.g. Blanche Point Formation) the colonies preserve well and often completely as 'thickets'. As smaller fragments occur commonly in other formations it is likely that similar 'thickets' also occurred there, but did not survive the taphonomic processes intact (probably higher energy).

The colonies appear to focus or concentrate cementing fluids in the formations (the interior of zooids usually completely infilled with cement, while most other species appear to remain cement free on the interior even if there has occurred extensive cementation or recrystallisation on the skeletal walls). This may be the primary cause of the preferential 'silicification', although the actual process is not understood yet.

Most colonies only have minor encrustation, which may be a primary condition, as encrusters could have 'stabilised the surface against abrasion.

Celleporaria* cf. *gambierensis? (Tenison Woods)

Plate 25F, G; 26A, B, C, D, E, F, G, H

? *Eschara celleporacea* STURT, 1833: 253, pl. 3 (fig. 1). (*nomen nudum*).
Cellepora gambierensis; TENISON WOODS, 1860: 256 (cited).
Cellepora gambierensis BUSK, 1860: 261 (*nomen nudum*).
Cellepora gambierensis Busk (MS); TENISON WOODS, 1862: 74, 85, 91.
Cellepora gambierensis Busk; WILKINSON, 1864.
Cellepora gambierensis Busk; TENISON WOODS, 1865: 4, pl. 1 (fig. 3).
Cellepora gambierensis Busk; TENISON WOODS, 1876: 14.
Cellepora gambierensis Busk; ETHERIDGE, 1877: 130, 135.
Cellepora gambierensis Busk; ETHERIDGE, 1878: 145. (listed)
Celleporaria gambierensis (Busk); TENISON WOODS, 1880: 26. [in addendum revised as *Cellepora*?]
Cellepora coronopus S. Wood; WATERS, 1885: 302.
Cellepora coronopus S.V. Wood; CHAPMAN, 1926: 135.
Cellepora gambierensis; BOREEN & JAMES, 1995: 152 (cited).
Celleporaria gambierensis; BONE & JAMES, 1993: 267 (cited).

It is likely that some of the references to *C. tridenticulata* may be mixed with this species complex:
Cellepora tridenticulata "n. sp." BUSK, 1859: 261 (*nomen nudum*).
Cellepora tridenticulata Busk; BUSK, 1881: 347 (*nomen nudum*).
Cellepora tridenticulata Busk; WATERS, 1887a: 68.
Holoporella tridenticulata (Busk); BROWN, 1952: 365.

MATERIAL: SAM P39470 (TL), P39471 (TL), P39472 (TL), P39473 (TL), P39474 (TL)

OTHER MATERIAL EXAMINED: BMNH D6564–6567 (?*Celleporaria gambierensis*, Mt Gambier, Wood coll. [pres. Miss Busk 13/7/1899])

DESCRIPTION: Colony encrusting to erect multilaminate, massive and/or branching, branches hollow or solid in centre.

Zooids oval to elliptical, frontal wall smooth, very convex, several small marginal areolae, large suboral avicularian chamber (usually broken, avicularium not completely observed).

Orifice circular, proximal margin variably flattened, three moderately long rectangular denticles, distally variably flared and notched, proximally variably separated, one or two spine pairs often visible on distal margin.

Avicularia elevated, elongate peanut-shaped, complete cross-bar placed very proximally, foramen large, palatal shelf slightly less than half the length of avicularium.

Ovicells not observed.

MEASUREMENTS: (3 specimens)

Lz	7	0.79	0.091	0.68-0.91
lz	7	0.52	0.133	0.40-0.75
Lo	7	0.14	0.016	0.12-0.16
lo	7	0.18	0.031	0.15-0.22

Lav	2	0.50	0.078	0.44-0.55
lav	2	0.26	0.007	0.25-0.26

A.B.G.H.C:

A. Orient. substr.	2. Massive
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	?4. Macroser.non-mac.
E. Arrang. front. surf.	6. Multilaminate
F. 2° skel. thick.	?1. None

G. Struct. units	?13. Nodule
H. Dim. struct. units	3. 3-D
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: LTL *[f]*, MTL(l) *[i]*, MTL(m) *[c]*, MTL(u) *[p]*, UTL *[p]*, BPF(t) *[f]*, BPF(gr) *[d]*, MF(b) *[c]*, LRF(l) *[r]*, LRF(s) *[c]*, LKL(l1) *[f]*, LKL(l2) *[p]*, LKL(m) *[f]*, LKL(t) *[c]*; common occurrences in other sediments throughout the Australian Cainozoic require reinvestigating to determine actual species.

COMPARISONS: The only taxonomic description of *Cellepora gambierensis* is given by Tenison Woods (1876: 14), who noted that no diagnosis had yet been written since Busk (1860) introduced the name: "This Polyzoary, large cylindrical branching irregularly, branches hollow, rarely encrusting, cells inflated, irregular, with large avicularium at each side of mouth, probably a socket for a vibraculum above". It is not clearly stated if this description is based on specimens from the Cape Otway region (which he had discussed in the previous paragraph) or from Table Cape in Tasmania (from which the discussed fossils are cited to be from). If it is indeed from the Tasmanian Cainozoic, it cannot be taken for granted that it is necessarily conspecific with the mainland species (of which there may also be several species grouped under that same name). Recent work on modern *C. 'tridenticulata'* indicates the existence of numerous cryptic species (J. Mackie, pers. comm., 2002), all similar to each other and the Cainozoic species.

C. agglutinans (Hutton) from Kaipuke Siltstone and modern Tasman Bay in New Zealand (Gordon *et al.*, 1994), which Stoliczka (1865) referred to "*Celleporaria gambierensis*", is not the same species. It also grows in distinctive hollow multilaminar branches, but the orifice has no denticles and only faint condyles. The suboral avicularia are torqued and the vicarious avicularia have an acute rostrum.

Recent '*Celleporaria tridenticulata*' has been reported from a wide geographic range around Australia and New Zealand

REMARKS: The hollow interior of *C. 'gambierensis'* is interpreted by modern analogue to represent moulds of the substrate (probably digitate sponges) over which the colonies grew. The internal surfaces of the branches of *C. 'gambierensis'* do not show any bioimmured structures of the substrate, if indeed there ever was one. Many specimens of arborescent *Celleporaria* do not have these hollow centres, but appear to be conspecific with the ones which do. It may therefore need to be reinvestigated as to what the cause of the hollow branches actually was. Many branches have hollow centres, which close off for several centimetres only to become hollow again further along the branch. This would be unlikely to happen if the cause of the hollow centre was only owing to the substrate. *C. agglutinans* appears to grow as hollow branches without any internal 'substrate'. It lives in New Zealand waters between 20 – 220 m depth and 8 – 20°C (Gordon *et al.*, 1994). The hollow branches could also preserve evidence of a symbiotic organism. Tilbrook (1997) discussed the apparent symbiotic relationship of *Celleporaria palmata* (Michelin) with the scleractinian coral *Culicia woodii* (Milne Edwards & Haime) in the Pliocene of England. The normal *C. palmata* colony consists of solid multilamellar branches, until the coral is recruited at the tip and becomes enclosed in the bryozoan. In this case, however, the coral regularly buds off corallites to the side, leaving structures not evident in any of the present specimens. As mentioned before, there is no obvious evidence preserved of any organism inside the branches.

Celleporaria nummularia (Tenison Woods)

Plate 26I, J, K, L

? *Cellepora escharoides*? STURT, 1833: 254, pl. 3 (fig. 5). (*nomen nudum*)

Cellepora nummularia BUSK, 1860: 261. (*nomen nudum*)

Cellepora nummularia Busk MS; TENISON WOODS, 1862: fig. 1 facing p. 73

Cellepora nummularia Busk MS; TENISON WOODS, 1865: fig. 1.

Cellepora nummularia Busk; ETHERIDGE, 1878: 145. (listed)

Celleporaria nummularia (Busk); TENISON WOODS, 1880: 26. [in addendum revised as *Cellepora*?]

Cellepora biradiata WATERS, 1885: 306, pl. 7 (figs 11, 12).

Cellepora tridenticulata Busk; WATERS, 1885: 306.

Cellepora tridenticulata var. *nummularia* Busk; MACGILLIVRAY, 1895: 108, pl. 6 (fig. 6).

Cellepora biradiata Waters; CHAPMAN, 1926: 136, pl. 10 (figs 8, 9).

MATERIAL: SAM P39331 (TL), P39332 (TL), P39333 (TL), P39334 (TL)

OTHER MATERIAL EXAMINED: NMV P27781 ('*Cellepora tridenticulata nummularia*', Gellibrand River, MacGillivray coll.)

DESCRIPTION: Colony free-living, crescentic to semicircular in cross-section, multilaminate, thickest in central apical region, becoming thinner (fewer zooid layers) near colony margin; basal surfaces concave to various degrees with radiating rows, imperforate.

Orifice roughly circular, proximally three broad denticles, which are often split into two or even three to varying extent; suboral avicularian chamber usually broken, probably originally carrying small avicularium.

Ovicells and interzooidal avicularia not observed.

MEASUREMENTS: (1 specimen)

Lz	4	0.59	0.048	0.55-0.65
lz	4	0.35	0.016	0.33-0.37
Lo	4	0.17	0.008	0.16-0.18
lo	4	0.19	0.017	0.16-0.20

Ldent	4	0.05	0.11	0.04-0.07

Øcol.		5-55 mm

A.B.G.H.C:

A. Orient. substr.	2. Massive
B. Attachm. substr.	3. Free-living, sedent.
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	?5. Macroser. macul.
E. Arrang. front. surf.	6. Multilaminate
F. 2° skel. thick.	?1. None

G. Struct. units	10. Solid dome
H. Dim. struct. units	3. 3-D
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	Forams, shell

OCCURRENCE: MTL(I) *[r]*, MTL(m) *[r]*; Morgan Limestone (Murray Basin), Otway Basin

COMPARISONS: *C. nummularia* may be synonymous with *C. tridenticulata* (of which it was initially designated a subspecies by Busk, 1860), because it is very similar at the zooidal level, but the distinct lunulitiform growth form may justify separate identity. *Celleporaria emancipata* Gordon (1989) from the recent of New Zealand appears very similar. The main difference is the size of the orifice (Lz: 0.23 mm) and shape of the denticles.

Waters (1885: 306) describes *Cellepora biradiata* from the River Murray Cliffs with both colonial and zooidal characteristics almost identical with *Cellepora tridenticulata*. The main difference given is apparently that in *C. biradiata* three rudimentary teeth can be distinguished in the oral aperture. This cannot be taken as a distinguishing characteristic, as it is a product of preservation.

REMARKS: Colonies frequently encrust larger Foraminifera. The growth form is, however, unlikely to simply be the result of outgrowing a small substrate. The establishment of a distinct basal area instead of simply forming a nodule, is probably not an easily achieved trait, and in itself probably warrants separation into a distinct species.

These specimens do not grow as large and dome-shaped as those found in the Oligo-Miocene of the Murray and Otway Basins. There they are often over 100mm in diameter but remain relatively thin (often less than 0.5 mm thick in the ancestrular region).

***Celleporaria*? sp.**

Plate 24M, N

MATERIAL: SAM P39475 (TL), P39476 (TL)

DESCRIPTION: Similar to *Celleporaria* cf. *gambierensis* but zooids with three pairs of distinctive oral spines around distal margin, suboral avicularian chamber with distal 'lyrula' and no proximal oral denticles.

OCCURRENCE: TL

COMPARISONS: The material was too poor to allow proper identification, but the specimens may simply be ancestrular areas.

Genus ***Sphaeropora*** Haswell, 1881

TYPE SPECIES: *Sphaeropora fossa* Haswell, 1881

DESCRIPTION: Colony multilaminate, sub-spherical, slightly depressed, with a with large avicularian chamber proximal to orifice. Cells and vibracular pits very irregularly arranged; cells ventricose, granular; mouth semicircular with straight proximal edge; a secondary aperture, larger than the mouth and of similar form, occupied by membrane. (after Haswell, 1880)

Sphaeropora? sp. nov? a

Plate 25A, B, C

MATERIAL: SAM P39477 (TL)

DESCRIPTION: Colony spheroidal multilaminar, approx. 3 mm diameter, the substrate is usually lost from the basal surface, but where its is preserved it is either a sand grain or a small goethite pellet.

Zooids small, erect, frontal wall convex, smooth.

Orifice semicircular to slightly trapezoidal, proximal margin flat, suboral avicularian chamber sometimes almost as large as orifice.

Ovicells not observed.

MEASUREMENTS: (1 specimen)

Lz	3	0.33	0.026	0.30-0.35
lz	3	0.24	0.015	0.22-0.25
Lo	3	0.10	0.003	0.10
lo	3	0.11	0.003	0.11-0.12

Lavch	3	0.10	0.006	0.10-0.11
lavch	3	0.14	0.006	0.13-0.14

A.B.G.H.C:

A. Orient. substr.	2. Massive
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	?4. Macroser.non-mac.
E. Arrang. front. surf.	6. Multilaminate
F. 2° skel. thick.	?1. None

G. Struct. units	?13. Nodule
H. Dim. struct. units	3. 3-D
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	qtz sand or goethite

OCCURRENCE: LTL *[c]*, MTL(l) *[d]*, MTL(m) *[i]*, UTL *[f]*, MF *[f]*, LKL(m) *[i]*, LKL(t) *[p]*.

COMPARISONS: Species of *Sphaeropora* are notoriously difficult to identify as the frontal structures abrade easily. The distinctive bioimmuration on the basal colony surface of the substrate, which is now lost, is also typical of specimens found of early forms in the Otway Basin (P.E. Bock, pers. comm., 2002).

Sphaeropora? sp. nov? b

Plate 25D, E

MATERIAL: SAM P39478 (TL)

DESCRIPTION: Colony flattened dome-shaped with flat basal area (zooids all round), multilaminar, approx. 3mm diameter, possibly attached via 1–5 rootlets on basal surface (preserved as small hollows).

Zooids small, erect, frontal wall convex, smooth.

Orifice semicircular to slightly trapezoidal, proximal margin flat, suboral avicularian chamber usually larger than the orifice.

Ovicells not observed(?).

MEASUREMENTS: (1 specimen)

Lz	3	0.43	0.021	0.41-0.45
lz	3	0.35	0.006	0.35-0.36
Lo	3	0.08	0.010	0.07-0.09
lo	3	0.13	0.010	0.12-0.14

Lavch	3	0.20	0.006	0.20-0.21
lavch	3	0.28	0.030	0.25-0.31

A.B.G.H.C:

A. Orient. substr.	2. Massive
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	?4. Macroser.non-mac.
E. Arrang. front. surf.	6. Multilaminate
F. 2° skel. thick.	?1. None

G. Struct. units	?13. Nodule
H. Dim. struct. units	3. 3-D
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(u) *[p]*, MF(b) *[i]*.

COMPARISONS: The colony form resembles that of *Sphaeropora fossa* (Haswell; *sensu* MacGillivray, 1895: 108, pl. 14, figs 8, 10; Miocene, Otway Basin), but does not have the distinctive basal rootlet structures. It also resembles the colony form of *Celleporaria 'hemisphaerica'* (Busk?), although this is an indistinct species.

REMARKS: This is locally the only bryozoan occurring in sandy sediments such as the Mulloowurtie Formation.

Genus ***Lepraliella*** Levinsen, 1917

TYPE SPECIES: *Cellepora ramulosa* contigua Smitt, 1867

DESCRIPTION: "Colony encrusting. Zooidal frontal wall with marginal pores only. Orifice with broad poster and prominent lateral condyles, the distal arch smooth or beaded. Oral spines present. Avicularia adventitious, usually small. Basal pore-chambers present." (Gordon, 1984)

***Lepraliella*?** sp. nov. a

Plate 24J, K, L

MATERIAL: SAM P39479 (TL), P39480 (TL)

DESCRIPTION: Colony encrusting unilaminar. Ancestrula double or even triple.

Zooids hexagonal, defined by furrow, frontal wall very convex, smooth.

Orifice semicircular with straight proximal margin (or circular with broad lyrula?), two pairs of columnar spine bases on distal margin, rest of margin surrounded by a collar or peristome, which is upright along lateral margins but notched/folds down to a projecting lip proximally (spout-like).

Ovicells and avicularia not observed.

MEASUREMENTS: (2 specimens)

Lz	6	0.47	0.020	0.46-0.51
lz	6	0.36	0.034	0.32-0.42
Lo	6	0.06	0.008	0.05-0.07
lo	6	0.08	0.005	0.07-0.08

A.B.G.H.C:

A. Orient. substr.	1. Encrusting
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	?6. Multilaminate
F. 2° skel. thick.	?1. None

G. Struct. units	13. Nodule
H. Dim. struct. units	3. 3-D
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: TL *[p]*

COMPARISONS: It has some resemblance of species of *Escharella* such as *Escharella* cf. *spinosissima* (Hincks) (see Brown, 1952)

Family **ROMANCHEINIDAE** Jullien, 1888

DESCRIPTION: "Colony encrusting or erect. Zooidal frontal wall with marginal pores only, generally conspicuous. Primary orifice typically with lyrula and condyles; enclosed by a well developed peristome and with conspicuous oral spines; sometimes one or more supraopercular denticles proximally. Oral spines present. Avicularia often bilateral or may be absent. Ovicell hyperstomial or recumbent, sometimes subimmersed in secondary calcification, imperforate or with marginal pores only. Basal pore-chambers or mural septula present." (Gordon, 1984)

Genus ***Escharoides*** Edwards, 1836

TYPE SPECIES: *Cellepora coccinea* Abildgaard, 1806 [subsequent designation Norman, 1903]

DESCRIPTION: "Colony encrusting. Frontal wall with conspicuous marginal areolae. Proximal border of orifice with denticles and/or spout-like peristome. Oral spines present. Avicularia often paired, lateral to the orifice. Ovicell usually prominent. Ancestrula tatiform." (Gordon, 1984)

REMARKS: The following two species are placed in the family Romancheinidae because of the umbonuloid frontal wall. A placement near the genera *Hippomenella* and *Hippoporella*, into which *H. testu* had previously been placed, is not correct as these have lepraliomorph frontal walls (Gordon, pers. comm., 2002). The type of *Hippopleurifera*, *H. biauriculata* (Reuss), which was illustrated by Hastings (1966) has biperforate ovicells, but a fully pseudoporous shield. A new genus is therefore probably required to accommodate these two species. This new genus may also incorporate several other species occurring around the world, on account of the appearances of the ovicell, orifice and frontal wall. Several North American Tertiary species assigned to '*Hippomenella*' (see Canu & Bassler, 1920) display great similarities, despite there being a range of frontal shields, where some have only marginal areolar-septular pores, while others are proximally pseudoporous. A common Recent New Zealand species, *Hippomenella vellicata* (Gordon, 1989), has a partly pseudoporous, partly umbonuloid frontal shield and evenly perforated ovicell, but may not be a species of *Hippomenella s.s.* A Recent Japanese species attributed to *Hippomenella* has ovicells like many of Canu & Bassler 's and the present species. Both the Japanese form and some of Canu & Bassler 's species require a new genus. The present species may be an early precursor of some of the North American morphologies, but evidently wholly umbonuloid-shielded. Zágorsek (1996: Pl. 1, Fig. 3) figured *Hippomenella bragai* from the Alpine-Carpathian region in eastern Europe, which also resembles some Canu & Bassler forms from North America (and possibly the Japanese form). A new Recent encrusting genus and species from Spirit's Bay, New Zealand (Gordon, 2001: 4), is unusual among romancheinids for the biperforate ovicell and lack of avicularia.

'*Escharoides*' sp. nov. a

Plate 27A, B, C, D, E

MATERIAL: SAM P39482 (TL)

DESCRIPTION: Colony encrusting unilaminar.

Zooids alternating in longitudinal rows, approximately elongated hexagonal, margins clearly defined by shallow furrow, frontal wall smooth and very convex, single row (locally more than single row, especially in corners) of numerous, round areolar septulopores immediately inside of margin, with low separating ridges (ridges very pronounced around ovicell margin).

Orifice at distal zooid margin, distal margin semicircular and approximately horizontal, proximal margin almost straight with rounded corners projecting well past distal part (this shape is only visible when viewed looking in proximal direction), broad lip along proximal margin, proximal pair of spine bases at corner between distal and proximal parts of orifice, second pair of spine bases distal to these and directed distally, elevated on columns adjacent to opesia.

Adventitious avicularia at lateral orifice corners directed proximolaterally, tilted distally, paired, rostrum lingulate and torqued distally (ear-shaped) with cross bar (condyles?).

Ovicells hyperstomial (acleithral), globular, slightly immersed into distal zooid, smooth except for two transversely oval, slightly depressed (esp. distally) granular patches, approximately in centre of each lateral half, lip formed along proximal margin would be, opening arches over orificial rim (with lip), the shape of orifice is exactly the same as in autozooids.

MEASUREMENTS: (1 specimen)

Lz	7	0.78	0.141	0.64-0.98
lz	7	0.56	0.055	0.46-0.60
Lo	7	0.21	0.022	0.18-0.24
lo-dist	7	0.33	0.020	0.30-0.36
lo-prox	7	0.23	0.013	0.22-0.25
Lav	7	0.13	0.026	0.09-0.16
lav	7	0.09	0.011	0.07-0.10

Lzov	3	0.80	0.053	0.74-0.84
lzov	3	0.62	0.060	0.56-0.68
Loov	3	0.18	0.006	0.17-0.18
loov	3	0.33	0.012	0.32-0.34
Lo2ov	3	0.22	0.020	0.20-0.24
Lavov	3	0.14	0.035	0.12-0.18
lavov	3	0.08	0.000	0.08
Lov	3	0.37	0.012	0.36-0.38
lov	3	0.48	0.015	0.46-0.49
øfenov	3	0.10	0.006	0.09-0.10

A.B.G.H.C:

A. Orient. substr.	?1. Encrusting
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MF(b) *[p]*, LKL(m) *[r]*.

COMPARISONS: This is a very distinctive species and does not seem to resemble any others.

'*Escharoides*' sp. nov. b

Plate 27F, G, H, I

MATERIAL: SAM P39483 (TL), P39484 (TL)

DESCRIPTION: Colony encrusting unilaminar.

Zooids alternating in longitudinal rows, approximately hexagonal, margins clearly defined by shallow furrow, frontal wall smooth and very convex, single row of numerous small, round regularly spaced areolar septulopores immediately inside of margin (locally more than single row, esp. in corners and next to orifice).

Orifice at distal zooid margin circular and simple (when viewed looking in proximal direction), with broad lip along proximal and sometimes lateral margins, two pairs of spine bases in distolateral corners, elevated on columns adjacent to opesia.

Adventitious avicularia near lateral corners directed laterally, horizontal, paired, single or absent, oval with cross bar (condyles?).

Ovicells hyperstomial (acleithral?), globular, barely sitting on distal zooid, smooth except for two transversely oval, slightly depressed granular patches, approximately in centre of each lateral half, adpressed lip formed where normal orificial margin would be.

MEASUREMENTS: (1 specimen)

Lz	3	0.67	0.031	0.64-0.70
lz	3	0.55	0.061	0.48-0.60
Lo	3	0.24	0.010	0.23-0.25
lo	3	0.27	0.023	0.26-0.30
lo2	3	0.17	0.050	0.12-0.22
Lav	3	0.13	0.012	0.12-0.14
lav	3	0.09	0.012	0.08-0.10

Lzov	9	0.74	0.096	0.58-0.88
lzov	9	0.56	0.077	0.50-0.68
Loov	9	0.21	0.066	0.16-0.38
loov	9	0.28	0.035	0.24-0.36
Lo2ov	9	0.20	0.044	0.10-0.26
Lavov	9	0.13	0.022	0.09-0.16
lavov	9	0.09	0.007	0.08-0.10
Lov	9	0.32	0.045	0.28-0.40
lov	9	0.42	0.039	0.36-0.48
øfenov	9	0.11	0.010	0.10-0.12

A.B.G.H.C:

A. Orient. substr.	?1. Encrusting
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Flat
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: TL *[r]*.

COMPARISONS: This species somewhat resembles *Hippoporella testu* Canu & Bassler (1935) but the frontal wall is much more convex and the orifice is more circular. The lateral avicularia in *H. testu* are paired and close to the orifice. At the genus level it bears resemblance with *Escharella* .

REMARKS: Although the orifice of this species appears different from that of *'Escharoides'* sp. a, it may simply be due to the degree to which the margins adjacent to the spines are pinched in. Other features, such as the biperforate hyperstomial ovicell, the shape of the umbonuloid frontal wall, lateral adventitious avicularia, orificial spines, are similar enough to suggest them to be congeneric.

Genus ***Trigonopora*** Maplestone, 1902b

TYPE SPECIES: *Trigonopora vermicularis* Maplestone, 1902b

DESCRIPTION: Colony encrusting or erect bilamellar. Zooids elongated, quadrate, with marginal areolae. Orifice inversely subtriangular to rounded quadrate, curved distally, with a mucro in the proximal angle. Adventitious avicularia in distolateral corners common. Ovicells hyperstomial with paired semicircular to crescentic perforations. (after Maplestone, 1902)

REMARKS: *Trigonopora* is not synonymous with *Metrarabdotos* Canu, as Canu & Bassler (1935) postulated (see also Brown, 1958: 64, for discussion; he considered the ovicell to be endozooidal, but it is instead hyperstomial as the opening is above the orificial operculum, Pl. 28E). Bassler (1953) placed *Trigonopora* under Adeonidae, which is unlikely to be correct due to the morphology of the frontal wall. Maplestone cited as distinguishing features of *Trigonopora* the "inversely triangular" orifice with the "proximal mucro", both of which also occur in *Exochella*. The perforated ovicell seems to be more distinctive, but was not noted by Maplestone. Canu & Bassler (1935: 53, pl. 8, fig. 12) placed this species into *Metrarabdotos*, based on the "endozooecial ovicell, form of aperture and pleurocystal frontal with lateral areolae". This is a strange judgement as neither the orifice nor the ovicell in their specimen bear any resemblance to those in *Metrarabdotos*.

Trigonopora has an Eocene to Recent range.

Trigonopora*? aff. *personata (Maplestone)

Plate 28A, B, C, D, E

Mucronella personata MAPLESTONE, 1902b: 22, pl. 2 (fig. 13).
? *Hippomenella perforata* (Maplestone); CANU & BASSLER, 1920: 380 (listed).
Mucronella personata (Maplestone); BROWN, 1949: 518.
Trigonopora personata (Maplestone); BROWN, 1958: 65.

MATERIAL: SAM P39485 (TL), P39486 (TL), P39487 (TL), P39488 (TL)

OTHER MATERIAL EXAMINED: NMV P10202 (type of *Mucronella personata*, Aire Riv., Maplestone coll.)

DESCRIPTION: Colony encrusting unilaminar or erect bilaminar foliose.

Zooids irregularly oval to hexagonal, margins clearly defined by sinuous furrow, frontal wall flat to slightly convex, smooth, single row (sometimes double along proximal margin) of marginal areolae with small dividing ridges.

Orifice positioned at distal margin, semicircular to rounded squarish, lateral and proximal margins sometimes slightly indented, small proximal lip, paired spine bases on distal margin (often obscured by calcification of distal zooid).

Paired adventitious avicularia adjacent to (disto)lateral corners of orifice, drop shaped, rostrum tip rounded, directed distolaterally, complete cross bar.

Ovicells ?hyperstomial, globular, smooth ectooecium, paired large squarish to crescentic (concave down) windows (through both ecto- and endooecium; broken?) in proximal area, closed by operculum.

MEASUREMENTS: (5 specimens)

Lz	14	0.62	0.071	0.52-0.73
lz	14	0.42	0.038	0.35-0.48
Lo	16	0.16	0.018	0.13-0.18
lo	16	0.17	0.016	0.15-0.21
Lav	16	0.12	0.026	0.09-0.19
lav	16	0.07	0.016	0.07-0.10
Lov	10	0.27	0.051	0.22-0.35
lov	10	0.35	0.034	0.30-0.40
Lovfen	7	0.04	0.008	0.04-0.05
lovfen	7	0.06	0.025	0.05-0.07

A.B.G.H.C:

A. Orient. substr.	?1. Encrusting
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None
G. Struct. units	5. Sheet
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(l) *[p]*, MTL(m) *[p]*, LKL(l1) *[p]*.

COMPARISONS: *Mucronella personata* Maplestone (1902b: 22; NMV P10202; ?Upper Eocene – Lower Oligocene, Otway Basin) is almost identical to the species of this study, including the ooecial fenestrae, but the proximal opesial margin is more angled inwards. Measurements: Lz = 1.00, lz = 0.40, Lo = 0.20, lo = 0.16Lov = 0.30, lov = 0.30)

Trigonopora vermicularis Maplestone (1902b: 23, pl. 2, fig. 14; Lower Oligocene, Otway Basin) is also quite similar apart from the very distinctive meandering furrows ("vermiform ornamentation") on the frontal wall, which radiate away from the proximal orifice and terminate at the marginal areolae. *T. plana* Brown (1958: 65; Lower Miocene, Gambier Embayment) also has the vermiform structures, but the orifice is more similar to *T. plana*.

The actual generic placement of this species, and the following one is difficult. They have similarities with various genera such as *Hippaliosina* , but the shape of the orifice and the structure of the ovicell are too different. A new genus may be required, which is allied with that of '*Escharoides*' sp. a and sp. b above.

This species also resembles some of Canu & Bassler's (1920) *Hippomenella* species from the North American Palaeogene.

***Trigonopora*? sp. nov. a**

Plate 28F

MATERIAL: SAM P39489 (MF)

DESCRIPTION: Colony encrusting unilaminar.

Zooids oval to elongate hexagonal, margins defined by furrow, frontal wall flat to slightly convex, smooth, single row of marginal areolae, with two to three additional rows proximally.

Orifice placed near distal margin, elongate semicircular to longitudinally elliptical with convex proximal margin.

Paired adventitious avicularia in distolateral corners, oval to drop shaped with raised margins, no cross bar?, rostrum short, directed distally and slightly inward.

Ovicells small globular, with faint fenestrae not perforated.

MEASUREMENTS: (1 specimen)

Lz	5	0.90	0.037	0.85-0.94
lz	5	0.46	0.019	0.44-0.49
Lo	5	0.18	0.006	0.17-0.18
lo	5	0.15	0.004	0.15-0.16

Lav	5	0.12	0.009	0.11-0.13
lav	5	0.05	0.006	0.04-0.05

A.B.G.H.C:

A. Orient. substr.	?1. Encrusting
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(m) *[i]*, MTL(u) *[p]*, UTL *[p]*, MF(b) *[p]*.

COMPARISONS: This species resembles *Trigonopora personata* but the orifice is more elongated and the oral avicularia are placed more distally. It lacks the paired perforations of the ovicell, which is granular, and may therefore not be a true *Trigonopora*.

Genus ***Exochella*** Jullien, 1888

TYPE SPECIES: *Mucronella tricuspis* Hincks, 1881 [subsequent designation Canu, 1908]

DESCRIPTION: Colony encrusting, unilaminar. Frontal wall imperforate except for single row of conspicuous marginal areolae. Orifice obscured in early ontogeny by a complex peristome, its lobed proximal border edge corresponding with ridges on its inner face which delimit one or two narrow channels; at the lip of the proximal border of peristome these channels open between denticles that may fuse to form one or two spiramina. Oral spines typically present. Avicularia adventitious, budded from marginal pores proximolateral to orifice, usually paired, but may be single or multiple. Ovicell spherical, imperforate, recumbent, sometimes partly immersed, not closed by autozooid operculum. Basal or mural pore chambers present. (after Gordon, 1984; Ryland & Hayward, 1992)

REMARKS: Ryland & Hayward (1992) noted that today this is a southern hemisphere genus, almost exclusively living in cold temperate to Antarctic waters, with only *E. conjuncta* Brown (1952) known from tropical environments. Its relatively common and diverse occurrence in the Eocene of the St Vincent Basin indicates that in the past this genus was more common in warmer waters than it is today.

Exochella sp. nov. a

Plate 29A, B

MATERIAL: SAM P39493 (TL)

DESCRIPTION: Colony unilaminar encrusting.

Zooids irregularly hexagonal to oval, defined by faint furrow, frontal wall smooth, imperforate except for single row of numerous marginal areolae with distinct dividing ribs.

Primary orifice subcircular, tapering proximally with two distinct triangular notches, two pairs of raised spine based on distal margin, rest of orifice surrounded by short peristome, secondary orifice same shape as primary.

Avicularia adventitious, single or absent, placed somewhere between lateral corner and orifice, with complete crossbar, variable sizes, either small with acute rostrum or large with long and variably broad lingulate rostrum directed laterally and resting on neighbouring zooid and often with large avicularian chamber.

Ovicells hyperstomial recumbent on distal zooid, ?smooth with marginal areolae similar to autozooid, proximal margin with two shallow notches mirroring those of zooidal orifice, opening separate to zooidal orifice with basal shelf.

MEASUREMENTS: (1 specimen)

Lz	8	0.64	0.049	0.58-0.72
lz	8	0.42	0.051	0.38-0.50
Lo	8	0.12	0.012	0.10-0.13
lo	8	0.13	0.008	0.12-0.14

Lov	5	0.30	0.080	0.21-0.42
lov	5	0.33	0.058	0.25-0.40
Lav	6	0.19	0.076	0.11-0.30
lav	6	0.08	0.015	0.07-0.11

A.B.G.H.C:

A. Orient. substr.	?1. Encrusting
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(m) *[r]*.

COMPARISONS: This species is similar to *Mucronella praestans* Hincks *sensu* MacGillivray (1895: 98, pl. 13, fig. 6; Middle Miocene, Otway Basin), but unlikely to be conspecific with Hincks' (1882) Recent species.

Exochella sp. nov. b

Plate 29C, D

MATERIAL: SAM P39494 (TL)

DESCRIPTION: Colony unilaminar encrusting.

Zooids slightly erect, broadly hexagonal, defined by furrow, frontal wall smooth convex.

Primary orifice subcircular, peristome, secondary orifice with three pairs of distal and lateral columnar spine bases, proximal margin projecting abfrontally, with two deep but narrow U-shaped notches which curve outwards.

Avicularia adventitious, small, elevated on small avicularian chamber, placed in one lateral corner and slightly abfrontally from margin, no crossbar?, directed laterally with acute rostrum angled proximolaterally.

Ovicells hyperstomial recumbent on distal zooid, medium sized globular, smooth and imperforate except for very small marginal areolae.

MEASUREMENTS: (1 specimen)

Lz	5	0.43	0.022	0.40-0.46
lz	5	0.42	0.020	0.40-0.45
Lo	5	0.07	0.008	0.06-0.08
lo	5	0.09	0.005	0.08-0.10

Lov	2	0.15	0.007	0.14-0.15
lov	2	0.22	0.007	0.21-0.22
Lav	5	0.11	0.008	0.10-0.12
lav	5	0.07	0.009	0.06-0.08

A.B.G.H.C:

A. Orient. substr.	?1. Encrusting
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(l) *[i]*, MTL(m) *[p]*.

COMPARISONS: This may be a variant of the previous *Exochella* sp. nov. a.

***Exochella*? sp. nov. c**

Plate 29E, F, G

MATERIAL: SAM P39495 (TL)

DESCRIPTION: Colony unilaminar encrusting

Zooids rectangular to elongated hexagonal, poorly defined by furrow or ridge, frontal wall finely granulated, flat, single row of six large marginal areolae along lateral margins only.

Primary orifice not seen, peristome poorly developed, secondary orifice subcircular to transversely oval, without spines, proximal margin with two very deep broad parallel U-shaped notches variably constricted distally and occasionally completely closed off and forming pair of peristomial spiramina.

Avicularia adventitious placed in one lateral corner, drop-shaped without crossbar?, long acute rostrum directed laterally.

Ovicells not observed.

MEASUREMENTS: (2 specimens)

Lz	4	0.74	0.103	0.65-0.85
lz	4	0.48	0.087	0.40-0.55
Lo	4	0.11	0.010	0.10-0.12
lo	4	0.14	0.013	0.12-0.15

Lav	2	0.17	0.007	0.16-0.17
lav	2	0.06	0.000	0.06

A.B.G.H.C:

A. Orient. substr.	?1. Encrusting
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: TL(WLG 42 QA 69) *[p]*.

COMPARISONS: No comparable species were found.

Genus ***Romancheinidae? Gen. indet.***

Romancheinidae? Gen. indet. sp.

Plate 29H, I, J

MATERIAL: SAM P39497 (TL)

DESCRIPTION: Colony encrusting unilaminar. Ancestrula twinned?

Zooids suberect, hexagonal to oval, defined by furrow, frontal wall very convex, smooth.

Orifice subcircular, no spine bases, surrounded by a short peristome with minor lip proximally.

Ovicells very small hyperstomial, globular, smooth, recumbent behind orifice but almost not resting on distal zooid.

Avicularia not observed.

MEASUREMENTS: (1 specimen)

Lo	8	0.71	0.058	0.50-0.76
lz	8	0.54	0.037	0.50-0.60
Lo	6	0.08	0.005	0.08-0.09
lo	6	0.09	0.008	0.08-0.10

Lov	3	0.17	0.010	0.16-0.18
lov	3	0.23	0.010	0.22-0.24

A.B.G.H.C:

A. Orient. substr.	1. Encrusting
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	Erect bryozoan

OCCURRENCE: LTL *[p]*, MTL(l) *[i]*, MTL(m) *[r]*.

COMPARISONS: This may be a species of *Escharella* but the poorly visible orifice makes positive identification difficult.

Family **BRYOCRYPTELLIDAE** Vigneaux, 1949

Genus ***Porella*** Gray, 1848

TYPE SPECIES: *Millepora compressa* J. Sowerby, 1805

DESCRIPTION: "Colony encrusting or erect. Zooidal frontal wall with marginal pores only. Primary orifice with lyrula and condyles variously developed, occasionally absent. Oral spines typically absent. Avicularium suboral, usually within a peristome. Vicarious avicularia absent. Ovicell prominent or becoming immersed, usually imperforate or a single small pore; not closed by the zooidal operculum. Basal pore-chambers present." (Gordon, 1984)

Porella*? cf. *angustata Maplestone

Plate 29K, L, M

Porella angustata Maplestone, 1902b: 21, pl. 1 (fig. 10).

MATERIAL: SAM P39498 (TL)

OTHER MATERIAL EXAMINED: NMV P10199 (type of *Porella angustata*, Bairnsdale, Miocene, Maplestone coll.)

DESCRIPTION: Colony encrusting unilaminar.

Zooids clearly defined by narrow ridge, hexagonal to diamond-shaped, elongated distally, frontal wall convex, perforated by very small pores, single larger pore in one of the lateral corners, possibly representing a polymorph or avicularium.

Primary orifice circular to squarish, acute proximolateral condyles, very small lyrula, narrow peristome well developed, slightly flared around margins, merges distolaterally with marginal ridge, suboral avicularium oval with complete crossbar, situated on proximal rim or peristome and sloping in towards orifice, forming a ridge , which joins with lyrula.

Ovicells not observed.

MEASUREMENTS: (1 specimen)

Lz	6	0.46	0.048	0.38-0.52
lz	6	0.36	0.082	0.30-0.52
Lo	6	0.12	0.012	0.10-0.13
lo	6	0.12	0.021	0.10-0.15

Lav-o	6	0.05	0.009	0.04-0.06

A.B.G.H.C:

A. Orient. substr.	1. Encrusting
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(m) *[p]*.

COMPARISONS: This may not be a species of *Porella s.s.*, but seems to fit better in this genus than into others.

Genus ***Porelloides*** Hayward, 1979

TYPE SPECIES: *Cellepora laevis* Fleming, 1828

DESCRIPTION: "Colony erect, with frontal and basal surfaces, attached by an encrusting basal portion, or strictly encrusting. Zooidal frontal wall with marginal pores only. Primary orifice with lyrula and no condyles. Peristome incorporating a suboral avicularium. Ovicell imperforate; not closed by zooidal operculum. Vertical walls deep with multiporous mural septula." (Gordon, 1984)

Porelloides? sp. nov. a

Plate 29N, O

MATERIAL: SAM P39523 (TL)

DESCRIPTION: Colony erect delicate branching, branches usually of 6 zooid rows

Zooid margins poorly defined by broadly raised margins, frontal wall slightly concave, perforated by a few small scattered pores.

Primary orifice placed near distal margin, circular, with broad and long alate lyrula (distal edge straight and slightly thickened), no condyles; peristome moderately developed with very broad proximal sinus, suboral convex avicularian chamber with (mostly broken) avicularium sloping in towards orifice and protruding into sinus.

Ovicells not observed

MEASUREMENTS: (1 specimen)

Lz	6	0.66	0.075	0.58-0.76
lz	6	0.22	0.033	0.20-0.28
Lo	6	0.10	0.010	0.09-0.12
lo	6	0.09	0.011	0.08-0.10

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	5. Radial
F. 2° skel. thick.	?1. None

G. Struct. units	8. solid cylinder
H. Dim. struct. units	?1. Straight
I. Freq. bifurc.	?2. Infrequent
J. Dim. bifurc.	?2. One plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: TL *[p]*.

COMPARISONS: This species resembles *Porelloides glabra* Gordon (1984: 98, pl. 36C, D; Recent Kermadec Isl., N.Z., 398–412 m), but has a wider lyrula.

Genus ***Rhamphosmittina*** Hayward & Thorpe, 1988b

TYPE SPECIES: *Rhamphostomella bassleri* Rogick, 1956

DESCRIPTION: Colony encrusting to erect, unilamellar. Frontal shield imperforate, with marginal areolae. Orifice with lyrula and condyles. Transverse suboral avicularium; other avicularia may be present. Ovicell hyperstomial, smooth with a few small pores.

REMARKS: According to Hayward & Thorpe (1988b), *Rhamphostomella* von Lorenz (1886) is a northern hemisphere genus with a circumpolar distribution, "all species of which display umbonuloid frontal wall ontogeny". Apart from this geographic distinction, it is difficult to distinguish between *Rhamphosmittina* and *Rhamphostomella*, indicating that the former genus may not be viable.

Drepanophora Harmer (1957) is similar but has a hooked proximal denticle within the orifice.

Rhamphosmittina cf. ***lateralis*** (MacGillivray)

Plate 28G, H, I

Smittia lateralis MACGILLIVRAY, 1895: 94, pl. 12 (fig. 25).
Smittina rogickae BROWN, 1958: 73, fig. 68.
? *Rhamphostomella biperforata* POWELL, 1967: 332.
? *Rhamphostomella rogickae* (Brown); GORDON, 1984: 98, pl. 36A.
? *Rhamphosmittina rogickae* (Brown); GORDON, 1989: 54.
? *Drepanophora rogickae* (Brown, 1958); TILBROOK *et al.* 2001: 73 (cited).

MATERIAL: SAM P39491 (TL)

OTHER MATERIAL EXAMINED: NMV P27750 (syntype of *Smittia lateralis*, Waurn Ponds, Victoria)

DESCRIPTION: Colony unilamellar encrusting.

Zooids clearly defined by ridge, elongate hexagonal, frontal wall smooth, convex, single row of small marginal areolae directly abutting marginal ridge (not always clearly visible)

Primary orifice transversely oval, small condyles, broad short alate lyrula, peristome moderately to well developed, suboral avicularium facing laterally with long acute rostrum directed along one side of the peristomial rim, gap with peristomial wall on the other side forming deep lateral peristomial sinus.

Ovicells recumbent, not immersed, with a pair of often elongated moderately large pores situated medially.

MEASUREMENTS: (2 specimens)

Lz	10	0.54	0.077	0.48-0.62
lz	10	0.32	0.071	0.28-0.50
Lo	10	0.09	0.013	0.06-0.10
lo	10	0.10	0.012	0.08-0.12

Lov	5	0.09	0.095	0.16-0.20
lov	5	0.13	0.140	0.24-0.28
Lav-o	10	0.09	0.009	0.08-0.10

***Rhamphosmittina* cf. *lateralis* continued:**

A.B.G.H.C:

A. Orient. substr.	1. Encrusting
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(I) *[p]*, MF(b) *[p]*; (OB) Upper Oligocene, Middle Miocene; ?Recent Australia, N.Z., Vanuatu.

COMPARISONS: The type specimen of *Smittia lateralis* MacGillivray (NMV P27750; Miocene, Otway Basin) has relatively large round ooecial pores placed far apart and roughly central or slightly distal. The avicularium is often very large with large chamber, directed abfrontally, two distinct distal spine bases on autozooid orifice, large marginal areolae often with high but narrow ridges. The zooidal measurements are, however, almost identical. Only the avicularia are significantly larger.

Smittina rogickae Brown is very similar, apart from a wide alate lyrula, the salient ridge at the zooid boundaries, a very deep sinus and an acute raised avicularian tip. Brown (1958) states for *S. rogickae* "this species, with its asymmetrical orifice and avicularium, bears little resemblance to previously described species of *Smittina*...". He was aware of MacGillivray's (1895) description of *S. lateralis*, as he mentioned a specimen under this name (p. 72) but didn't compare the two.

REMARKS: If the Palaeogene and Recent forms are indeed conspecific, this would be another species with a very long time range.

Although the zooid dimensions are similar in the specimen from the Miocene Otway Basin (Lz = 0.48 – 0.53 mm, lz = 0.33 – 0.36mm), the orificial dimensions are somewhat larger (Lo = 0.10 – 0.11 mm, lo = 0.15 – 0.16 mm)

Rhamphosmittina sp. nov. a

Plate28K, L, M

MATERIAL: SAM P39492 (TL)

DESCRIPTION: Colony erect bilaminate sheet?

Zooids hexagonal, defined by narrow raised margin, frontal wall flat, smooth, single row of moderately large marginal areolae, occasional additional pores at proximal corners.

Orifice inverted triangular with arched distal margin, suboral avicularium inside on lateral orificial margin, acute rostrum directed distally and slightly abfrontally

Ovicells not observed

MEASUREMENTS: (1 specimen)

Lz	5	0.74	0.145	0.58-0.92
lz	5	0.43	0.039	0.38-0.48
Lo	5	0.18	0.058	0.14-0.28
lo	5	0.12	0.004	0.12-0.13

Lav	5	0.09	0.009	0.08-0.10

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	2. Bilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	?1. Flat
I. Freq. bifurc.	?1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(m) *[r]*, UTL *[p]*.

COMPARISONS: This species differs from *Rhamphosmittina lateralis* mainly in the larger lateral pores and the avicularium placed further inside the peristome.

Superfamily **BATOPOROIDEA** Neviani, 1900

Family **Lekythoporidae** Levinsen, 1909

DESCRIPTION: The colonies are encrusting, orbicular, or erect more or less strongly branched. The zooids, which have no spines, are solidly calcified, thick-walled and provided with a well-chitinised operculum. A strongly developed, sometimes immersed, sometimes freely projecting, tube-shaped peristome, the aperture of which is armed with one or usually several avicularia. Scattered small or large avicularia may also occur. Both the distal wall and the lateral walls are provided with numerous small, scattered, uniporous rosette-plates, which are situated at the bottom of shorter or longer canals. The ooecia have the form of a hemispherical expansion of the frontal wall of the peristomial tube and become later hidden by covering calcareous layers. Aperture buried at base of peristom e on distal, instead of proximal side of ovicell opening. Family characterized by position of ovicell opening. (after Levinsen, 1909; Bassler, 1953)

Genus ***Aulopocella*** Maplestone,1903

Solenopora Maplestone, 1903a (*non* Dybowski, 1877)
Aulopocella Maplestone, 1903b

TYPE SPECIES: *Solenopora tubulifera* Maplestone, 1903

DESCRIPTION: "Colonies with irregularly cylindrical branches, arising from a small encrusting base. Autozooids primary orifice with a small sinus. Autozooid frontal usually smooth, with prominent marginal and other frontal septular pores becoming sunken in the calcification. Peristomes long, often prominent, with contained tubular subrostral chambers of marginal avicularia. Frontally budded interzooidal avicularia often present. Ovicells imperforate." (Bock & Cook, 2000: 168)

Aulopocella? sp. nov. a

Plate 26M, N

MATERIAL: SAM P39481 (PWF)

DESCRIPTION: Colony nodular.

Zooids erect cylindrical, smooth walls, with narrow ridges interconnecting neighbouring zooids (possibly representing the remnants of earlier zooids).

Primary orifice circular with constricted narrow deep sinus, peristome very thick, secondary orifice circular.

Avicularia adventitious, circular.

MEASUREMENTS: (1 specimen)

Lz	2	0.47	0.021	0.45-0.48
lz	2	0.31	0.014	0.30-0.32
Lo	2	0.08	0.007	0.07-0.08
lo	2	0.09	0.004	0.09

A.B.G.H.C:

A. Orient. substr.	2. Massive
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	?4. Macroser.non-mac.
E. Arrang. front. surf.	6. Multilaminate
F. 2° skel. thick.	?1. None

G. Struct. units	?13. Nodule
H. Dim. struct. units	3. 3-D
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MF *[r]*, PWF(a) *[r]*

Comparisons: The zooidal morphology does not clearly place this species in *Aulopocella*, but it apparently has the 'tubular subrostral chambers of marginal avicularia', which would place it with this genus, rather than with the Lepraliellidae.

Genus ***Lekythoporidae Gen. nov.*** (**'*Lekythopora*'**)

REMARKS: This is probably a new genus of Lekythoporidae. The thick cylindrical branches are unknown in other genera of this family. The orifice is inverted, as is typical of the family.

'Lekythopora' sp. nov a

Plate 30A, B, C, D, E, F, G, H, I, J, K

MATERIAL: SAM P39563 (TL), P39564 (MF)

DESCRIPTION: Colony erect cylindrical branches, very thick, more than 12 zooidal rows around and more than 1.5mm diameter, frequently branching.

Zooidal shape indistinct due to extensive frontal thickening, exterior surface flat, perforated by several moderately large pores; zooidal chamber appears almost tubular and perpendicular to central colony axis, lateral walls perforated by numerous medium size pores.

Primary orifice inverted drop-shaped, with large blunt condyles just below middle, peristome of variable length, secondary orifice also drop-shaped but larger.

Adventitious avicularia present in most zooids, placed in centre of zooid, apparently of two types, the smaller is oval with complete cross bar and rostrum directed distally, the larger is broadly lingulate with condyles and very broad almost triangular rostrum directed distolaterally, sometimes intersecting proximal orificial margin.

Ovicells appear to be peristomial, broad but short and shallow, proximal margin protruding into peristome below secondary orifice, becoming completely immersed in secondary calcification.

MEASUREMENTS: (2 specimens)

Lo	5	0.45	0.023	0.43-0.47
lz	5	0.24	0.012	0.22-0.25
Lo	5	0.12	0.007	0.11-0.13
lo	5	0.09	0.008	0.08-0.10

Lov	1	0.17	-	
lov	1	0.10	-	
Lav1	3	0.09	0.006	0.08-0.09
lav1	3	0.05	0.003	0.05-0.06
Lav2	3	0.15	0.025	0.12-0.17
lav2	3	0.11	0.020	0.09-0.13

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	5. Radial
F. 2° skel. thick.	1. None

G. Struct. units	8. Solid cylinder
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	3. Frequent
J. Dim. bifurc.	?3. > one plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: LTL *[p]*, MTL(m) *[i]*, MTL(u) *[p]*, UTL *[p]*, MF(b) *[c]*, LKL(l1) *[i]*, LKL(l2) *[r]*.

COMPARISONS: The colony and zooid growth style is similar to that in *Chiplonkaria bretoni* Taylor & Badve (1995: 644), an anascan 'cyclostome homeomorph' from the Cretaceous of Germany.

Infraorder **LEPRALIOMORPHA** Gordon, 1989

Superfamily **SMITTINOIDEA** Levinsen, 1909

Family **SMITTINIDAE** Levinsen, 1909

DESCRIPTION: "Colony encrusting or erect. Frontal wall evenly perforated or with marginal areolae only. Primary orifice with lyrula and/or proximolateral condyles; peristome typically developed, with or without oral spines. Ovicell usually prominent, perforate or imperforate. Avicularia frequently suboral; often large spatulate adventitious avicularia, rarely vicarious. Pore-chambers or mural septula present." (Gordon, 1984)

REMARKS: The morphology and ornamentation of the ovicell are important generic and specific distinguishing characters in the Smittinidae. Most specimens of the current study, however, have abraded ovicells and identifications may therefore be uncertain. Similarly the shape of the lyrula is diagnostic at the species level, but is often broken or recrystallised in the specimens observed.

The Smittinidae are rare in the Lower Kingscote Limestone, and their greatest abundance and diversity occurs in the Lower and Middle Tortachilla Limestone and the basal Mulloowurtie Formation.

BIOGEOGRAPHY: First recorded occurrences of this family are 'Smittinid n. gen. ? n. sp.' from DSDP site 308, Koko Seamount, Pacific (Cheetham, 1975) and '*Porella* sp.' (which is now placed in Porellidae) along with 'indet. Smittinids' from DSDP Site 246, Indian Ocean (Labracherie, 1975), both of which are considered of Ypresian (Early Eocene) age.

The Smittinidae are mostly present in the lower to middle Tortachilla Limestone and the basal Mulloowurtie Formation, while they are almost absent from the Lower Kingscote Limestone.

Genus ***Smittoidea*** Osburn, 1952

TYPE SPECIES: *Smittoidea prolifica* Osburn, 1952

DESCRIPTION: "Colony encrusting. Zooidal frontal wall imperforate centrally, with marginal areolae. Primary orifice with lyrula and condyles. Avicularia adventitious, usually situated medially on the frontal wall immediately proximal to the orifice, often partly enveloped by the peristome, typically proximally directed. Ovicell hyperstomial, evenly perforated, not closed by the zooidal operculum. Mural septula present." (Gordon, 1984)

REMARKS: Although the above diagnosis for the genus *Smittoidea* states that it produces only encrusting colonies, the erect species found here fit the generic diagnosis regarding the zooidal characters. As bryozoans are notoriously plastic in their growth forms, this 'discrepancy' is not considered sufficient to place the species described here in a different or even new genus.

Smittoidea? cf. **dennanti** (Maplestone)

Plate 31D, E, F

Porella dennanti Maplestone, 1902b: 20, pl. 1 (fig. 7)

MATERIAL: SAM P39502 (TL)

OTHER MATERIAL EXAMINED: NMV P10196 (type of *Porella dennanti*, Bairnsdale, Victoria, Miocene, Maplestone coll.)

DESCRIPTION: Colony erect bilaminar sheet.

Zooids elongated hexagonal, margins defined by shallow furrow, frontal wall smooth and flat, single row of 5-6 marginal areolae.

Primary orifice placed at distal margin, subcircular, acute condyles and small lyrula; peristome short and moderately broad, enclosing avicularian chamber (broken in all specimens), which sticks into orifice.

Ovicells not observed.

MEASUREMENTS: (2 specimens)

Lz	8	0.63	0.063	0.54-0.74
lz	8	0.27	0.041	0.22-0.34
Lo	8	0.12	0.014	0.10-0.14
lo	8	0.11	0.010	0.10-0.12

Lav-o	8	0.05	0.009	0.04-0.06

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	2. Bilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	?1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(l) *[p]*, MTL(m) *[r]*, MF(b) *[i]*.

COMPARISONS: The specific assignment to *S. dennanti* (Maplestone; ?Miocene, Otway Basin) is only tentative, as the characters are similar to other species, and the specimens of the current study are not adequate to distinguish them with certainty.

Smittoidea sp. nov. a

Plate 31B, C

MATERIAL: SAM P39499 (TL)

DESCRIPTION: Colony unilaminar encrusting.

Zooids usually regularly hexagonal, occasionally oval, margins clearly defined by furrow, frontal wall smooth and convex, single row of moderately large marginal areolae.

Primary orifice placed at distal margin, subcircular, acute condyles and long, broad alate lyrula, which is clearly visible; peristome moderately developed, five spine bases along distal margin becoming immersed in calcification.

Suboral avicularium placed immediately proximal to orifice, directed almost vertically on distal surface of a convex avicularian chamber.

Ovicells not observed.

MEASUREMENTS: (1 specimen)

Lz	5	0.58	0.033	0.55-0.61
lz	5	0.38	0.024	0.35-0.41
Lo	5	0.08	0.006	0.07-0.09
lo	5	0.10	0.003	0.10-0.11

Lav	5	0.05	0.004	0.04-0.05
lav	5	0.05	0.005	0.05-0.06

A.B.G.H.C:

A. Orient. substr.	1. Encrusting
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	Hard secondary

OCCURRENCE: MTL(l) *[r]*, MF(b) *[p]*.

COMPARISONS: This species remotely resembles *Smittoidea acaroensis* (Levinsen; Recent, South Australia), in which the larger marginal areolae and the more granular frontal wall may be the result of secondary calcification in later astogeny. However, the lyrula is narrower and the orificial spines are much larger.

REMARKS: The specimen investigated represents an early ontogenetic stage, and may prove to be similar to others which show more mature zooids. It is also one of the few specimens found with a growing edge preserved.

Smittoidea sp. nov. b

Plate 31A

MATERIAL: SAM P39500 (TL), P39501 (TL)

DESCRIPTION: Colony unilaminar encrusting.

Zooids usually regularly hexagonal, occasionally oval, margins clearly defined by moderately broad ridge, frontal wall smooth and convex, row of marginal areolae directly abutting marginal ridge.

Primary orifice placed at distal margin, subcircular, small condyles and short, broad lyrula; peristome well developed at lateral margins sloping proximally and forming small sinus, three large spine bases along distal margin, large lingulate suboral avicularium placed centrally immediately proximal to peristomial sinus, with complete crossbar, large palatal shelf directed proximally.

Ovicell not observed.

MEASUREMENTS: (2 specimens) partly taken near ancestrula

Lz	7	0.50	0.126	0.38-0.70
lz	7	0.32	0.043	0.26-0.34
Lo	7	0.09	0.023	0.06-0.12
lo	7	0.11	0.022	0.08-0.14

Lav-o	7	0.09	0.027	0.06-0.12
lav-o	7	0.06	0.008	0.06-0.07

A.B.G.H.C:

A. Orient. substr.	1. Encrusting
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(l) *[r]*. MTL(m) *[r]*, LKL(m) *[p]*.

COMPARISONS: *Smittina uttleyi* Brown (1958: 72; Lower Oligocene, Gambier Embayment) appears very similar but has smaller suboral avicularia and no apparent oral spines.

The columnar oral spine bases are reminiscent of *Hemismittoidea* Soule & Soule and *Parasmittina* Osburn, but in these genera the suboral avicularium is not placed centrally.

Smittoidea sp. nov. c

Plate 31I, J, K

MATERIAL: SAM P39510 (TL)

DESCRIPTION: Colony encrusting unilaminar, possibly able to grow multilaminar.

Zooids hexagonal, margins variably defined by small ridge or furrow, frontal wall flat with single row of marginal areolae of various sizes, sometimes more pores occurring in zooid corners.

Primary orifice subcircular with very small condyles and lyrula, secondary orifice light-bulb shaped, prominent avicularium in proximal sinus, largely placed vertically on peristome, but rostrum curving proximally onto frontal wall.

Ovicells not observed.

MEASUREMENTS: (1 specimen)

Lz	9	0.48	0.110	0.26-0.64
lz	9	0.22	0.043	0.38-0.46
Lo	9	0.09	0.011	0.08-0.16
lo	9	0.12	0.014	0.10-0.14
Lav-o	9	0.04	0.005	0.03-0.04

A.B.G.H.C:

A. Orient. substr.	?1. Encrusting
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate?
F. 2° skel. thick.	1. None
G. Struct. units	5. Sheet
H. Dim. struct. units	?1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(l) *[r]*, MTL(m) *[p]*.

COMPARISONS: This species somewhat resembles *Smittoidea dennanti* (Maplestone) but the relative dimensions of both the orifice and zooid are wider.

REMARKS: One of the colonies displays evidence of frontally budded zooids.

***Smittoidea*? sp. nov. d**

Plate 31G, H

MATERIAL: SAM P39503 (TL)

DESCRIPTION: Colony erect bilaminar sheet.

Zooids elongated rectangular (shape varies at bifurcation points: one zooid tapers proximally), margins clearly defined by moderately broad ridge, frontal wall smooth and convex, row of marginal areolae directly abutting marginal ridge.

Primary orifice placed at distal margin, subcircular, acute condyles and small lyrula; peristome short and moderately broad, enclosing avicularian chamber (broken in all specimens), which sticks into orifice.

Ovicells not observed.

MEASUREMENTS: (1 specimen)

Lz	7	0.57	0.063	0.50-0.68
lz	7	0.20	0.014	0.18-0.20
Lo	7	0.11	0.008	0.10-0.12
lo	7	0.10	0.004	0.10-0.11
Lav	7	0.05	0.008	0.04-0.06

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	2. Bilaminate
F. 2° skel. thick.	1. None
G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(l) *[p]*, MTL(m) *[r]*, MF(b) *[r]*.

COMPARISONS: This species is quite distinct from any others known.

***Smittoidea*? sp. nov. e**

Plate 32A, B

MATERIAL: SAM P39511 (TL)

DESCRIPTION: Colony erect bilaminate sheet.

Zooids rectangular, margins variably defined by small low ridge, frontal wall flat with single row of marginal areolae of various sizes, sometimes more pores occurring in proximal zooid corners.

Primary orifice subcircular with acute condyles and small lyrula [abraded?], secondary orifice circular to transversely oval, prominent avicularium in deep broad proximal sinus, largely placed vertically on peristome, but most of rostrum curving proximally onto frontal wall.

Ovicells not observed.

MEASUREMENTS: (1 specimen)

Lz	9	0.50	0.085	0.30-0.60
lz	9	0.27	0.048	0.22-0.38
Lo	9	0.10	0.013	0.08-0.12
lo	9	0.12	0.007	0.10-0.12
Lav-o	9	0.04	0.005	0.03-0.05

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	2. Bilaminate
F. 2° skel. thick.	1. None
G. Struct. units	5. Sheet
H. Dim. struct. units	?1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: LTL *[r]*, MTL(m) *[r]*, MF(b) *[d]*.

COMPARISONS: The apparent occurrence of additional small pores on the proximal frontal wall may make its placement in *Smittina* more appropriate than *Smittoidea*.

Smittoidea sp. f

Plate 32C, D

MATERIAL: SAM P39507 (TL)

DESCRIPTION: Colony erect unilaminar sheet, rarely encrusting.

Zooids oval to elongate hexagonal, margins defined by very fine ridge, frontal wall smooth and flat, single row of large marginal areolae, generally elongated towards centre, a pair of small pores proximal to suboral avicularia on frontal wall.

Primary orifice placed at distal margin, circular, small acute condyles, short broad alate lyrula, peristome poorly developed, secondary orifice circular to triangular (distal margin flattened), suboral avicularium subcircular with complete cross-bar, surrounded by narrow rim, placed just proximal to orifice on frontal wall.

Ovicells deeply immersed in distal zooid, flat to slightly convex, circular to slightly longitudinally elongated, frontal surface with faint but large perforations (probably only in ectooecium).

MEASUREMENTS: (1 specimen)

Lz	7	0.71	0.074	0.58-0.82
lz	7	0.35	0.078	0.30-0.52
Lo	7	0.13	0.020	0.10-0.14
lo	7	0.13	0.015	0.10-0.14
Lav-o	7	0.04	0.007	0.03-0.05
Lav-o	7	0.04	0.008	0.04-0.06

Lzov	4	0.58	0.016	0.56-0.60
lzov	4	0.30	0.010	0.28-0.30
Loov	4	0.10	0.017	0.08-0.12
loov	4	0.12	0.010	0.10-0.12
Lov	4	0.23	0.012	0.22-0.24
lov	4	0.25	0.026	0.22-0.28

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	?1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: Erect: LTL *[p]*, MTL(l) *[p]*; Encrusting: MF(b) *[i]*.

COMPARISONS: This species closely resembles *Smittina eageri* Brown (1958: 72, figs 62, 63; Upper Oligocene, Otway Basin) in the orificial shape, but the avicularium is narrower and the frontal wall is convex. The broken ovicells in the current specimens makes comparison difficult.

Smittina perforata Canu & Bassler (1935: 37, pl. 7, fig. 3; Middle Miocene, Otway Basin) has a similar pair of suboral pores, but the overall specimen (USNM 85757) is very worn and details are difficult to compare.

Smittoidea **sp. nov. g**

Plate 32E, F

MATERIAL: SAM P39508 (TL), P39509 (TL)

DESCRIPTION: Colony erect bilaminate sheet, rarely encrusting.

Zooids oval to rectangular, margins defined by very shallow furrow, frontal wall smooth and flat, single row of marginal areolae.

Primary orifice placed at distal margin, circular, small acute condyles, short broad alate lyrula, occasionally paired spine bases on distal margin becoming immersed in calcification, peristome poorly developed, secondary orifice slightly rectangular, suboral avicularium oval with small condyles, distinct palatal shelf and surrounded by narrow rim, placed a short distance proximal to orifice on frontal wall, sometimes connected with the orifice by a shallow sinus.

Ovicells not observed.

MEASUREMENTS: (2 specimens)

Lz	10	0.78	0.095	0.62-0.90
lz	10	0.29	0.043	0.22-0.36
Lo	10	0.14	0.021	0.08-0.16
lo	10	0.14	0.012	0.12-0.16

Lav-o	10	0.08	0.016	0.06-0.10

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	2. Bilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	?1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: Erect: MTL(l) *[r]*, MTL(m) *[i]*, MF(b) *[r]*; Encrusting: MTL(l) *[p]*.

Smittoidea sp. nov. h

Plate 32G, H, I

MATERIAL: SAM P39513 (TL)

DESCRIPTION: Colony erect bilaminate sheet.

Zooids strongly hexagonal, margins defined by shallow furrow, frontal wall flat, smooth, single row of very large marginal areolae, generally elongated towards centre.

Primary orifice placed at distal margin, circular to squarish, one or two pairs of distal spine bases often visible, small condyles, short and moderately broad alate lyrula with flat distal margin, peristome poorly developed; secondary orifice circular, often irregular shape due to encroaching calcification of neighbouring zooids; suboral avicularium elongated oval with condyles and short palatal shelf, surrounded by flat rim, placed proximal to orifice on frontal wall.

Ovicells hyperstomial, partly immersed in distal zooid, circular outline, globular, frontal wall (endooecium?) evenly perforated by numerous small pores with raised margins.

MEASUREMENTS: (2 specimens)

Lz	3	0.45	0.023	0.44-0.48
lz	3	0.34	0.053	0.30-0.40
Lo	3	0.13	0.012	0.12-0.14
lo	3	0.15	0.012	0.14-0.16

Lav-o	3	0.07	0.012	0.06-0.08
lav-o	3	0.05	0.006	0.05-0.06
Lov	2	0.19	0.007	0.18-0.19
lov	2	0.22	0.007	0.21-0.22

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	2. Bilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	?1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(l) *[p]*, MF(b) *[f]*.

REMARKS: This may be the same species as *Smittoidea* sp. nov. i, and simply shows zooids at branching points, which may create more hexagonal zooids. The suboral avicularia, however, are different as well.

Smittoidea sp. nov. i

Plate 32J, K, L

MATERIAL: SAM P39504 (TL), P39505 (TL), P39506 (TL)

DESCRIPTION: Colony erect bilaminate sheet.

Zooids oval to coffin-shaped, margins defined by very fine ridge, frontal wall flat, smooth or faintly granulated, single row of large marginal areolae, generally elongated towards centre, a pair of small pores proximal to orifice but just distal to level of suboral avicularium on frontal wall.

Primary orifice placed at distal margin, transversely oval to rectangular, pair of small distal spine bases visible where secondary calcification broken away, small acute condyles deflected proximally, narrow moderately long alate lyrula with rounded distal margin; peristome poorly developed, secondary orifice circular to rectangular, suboral avicularium elongated oval without cross-bar or condyles[?], surrounded by flat rim, placed a short distance proximal to orifice on frontal wall.

Ovicells globular, slightly immersed in distal zooid, finely perforated (most specimens broken).

MEASUREMENTS: (1 specimen)

Lz	3	0.80.	0.139	0.70-0.94
lz	3	0.46	0.133	0.30-0.56
Lo	3	0.13	0.031	0.10-0.16
lo	3	0.17	0.023	0.16-0.20
Lav-o	3	0.10	0.015	0.08-0.1
Lav-o	3	0.06	0.010	0.05-0.07

Lzov	4	0.86	0.071	0.80-0.94
lzov	4	0.32	0.037	0.28-0.36
Loov	4	0.15	0.012	0.14-0.16
loov	4	0.17	0.020	0.16-0.20
Lov	4	0.21	0.025	0.18-0.24
lov	4	0.23	0.038	0.20-0.28

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	2. Bilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(l) *[p]*, MTL(m) *[r]*, MF(b) *[r]*.

COMPARISONS: This species is very similar to *Smittina flexuosa* (Hutton; Pliocene to Recent, New Zealand), but significantly has a median lyrula, which *S. flexuosa* does not have according to Brown's (1952: 326) definition based on his selection of the lectotype.

It also resembles *Smittia reticulata calceolus sensu* MacGillivray (1895; 93, pl. 12, fig. 22; Middle Miocene, Otway Basin; originally described from the Recent Australia, MacGillivray, 1886), but in that species the suboral avicularium is distinctly acute.

Genus ***Smittina*** Norman, 1903

pro *Smittia* Hincks, 1879 (*non* Holmgren, 1869)

TYPE SPECIES: *Lepralia landsborovii* Johnston, 1847

DESCRIPTION: Frontal wall uniformly porous. Orifice with lyrula and condyles; peristome usually present, with or without oral spines. Usually a median suboral avicularium, close to proximal border of orifice and directed proximally or transversely, sometimes absent, occasionally large spatulate avicularia. Ovicell punctured by numerous pores. Mural uniporous or multiporous septula present. (after Hayward & Ryland, 1979; Gordon, 1984)

REMARKS: Most of the earlier Australian publications used *Smittia* Hincks (1879) for this taxon. This was however already occupied by *Smittia* Holmgren (1869), a chironomid genus, and therefore replaced with *Smittina* by Norman (1903).

Smittina sp. nov. a

Plate 32M, N, O

MATERIAL: SAM P39512 (TL)

DESCRIPTION: Colony unilaminate encrusting or erect bilaminate sheet.

Zooidal margins indistinct, frontal wall flat perforated by pores, becoming immersed in secondary calcification, which forms minor trabeculae.

Primary orifice circular, small lyrula and condyles, secondary orifice lightbulb-shaped, broad shallow sinus largely occupied by avicularium, which is almost level with frontal wall.

Ovicells deeply immersed in secondary calcification, almost level with rest of zooid, perforated by random pores mainly around margin.

MEASUREMENTS: (2 specimens)

Lz	9	0.65	0.056	0.58-0.72
lz	9	0.26	0.017	0.24-0.28
Lo	9	0.13	0.017	0.12-0.14
lo	9	0.14	0.014	0.12-0.16
La	9	0.04	0.007	0.03-0.05
Lov	9	0.15	0.028	0.14-0.20
lov	9	0.21	0.018	0.20-0.24

A.B.G.H.C:

A. Orient. substr.	1. Encr./3. Erect cont.
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilam./2. Bilam.
F. 2° skel. thick.	1. None
G. Struct. units	5. Sheet
H. Dim. struct. units	?1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(m) *[r]*.

COMPARISONS: Similar species are *Smittina bathydonta* Waters and *Smittina julieni* Hayward & Thorpe (1990; Recent, Antarctic). In the latter, however, the pores go right to orifice.

Smittina sp. nov. b

Plate 33A, B

MATERIAL: SAM P39514 (TL)

DESCRIPTION: Colony erect bilaminar sheet.

Zooid margins obscured by secondary calcification, frontal wall flat with scattered pores, secondary calcification forming irregular trabeculae around pores, sinuous narrow ridges running from proximolateral corners of some orifices to the orifice of the proximolateral zooids.

Primary orifice subcircular with small lateral condyles, lyrula small and rounded (secondarily?), short peristome forming very broad bulge (collar) around whole orifice, secondary orifice with distinct proximal sinus, margin variably surrounded by narrow rim, small suboral avicularium completely within secondary orifice.

Ovicells not observed.

MEASUREMENTS: (1 specimen)

Lz	7	0.78	0.059	0.72-0.90
lz	7	0.30	0.023	0.28-0.34
Lo	7	0.17	0.020	0.14-0.20
lo	7	0.12	0.005	0.11-0.12

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	2. Bilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	?1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: LTL *[p]*, MF(b) *[i]*.

COMPARISONS: This species differs from *Smittina* sp. nov. a in the character of suboral avicularium, which is not level with the frontal wall, but rather vertically placed inside peristome.

The extensive secondary calcification may be obscuring the primary characters to allow proper comparison with the other species.

***Smittina*? sp. nov. c**

Plate 33C, D

MATERIAL: SAM P39515 (TL), P39516 (TL)

DESCRIPTION: Colony erect bilaminar.

Zooids elongated oval, margins defined by narrow ridge, sometimes obscured by secondary thickening, frontal wall slightly convex, evenly perforated by medium sized pores, minor trabeculae formed by secondary thickening.

Primary orifice sub-circular, lyrula of medium width and length with small alae, small lateral condyles, peristome thick and somewhat elevated, small avicularium on proximal wall positioned vertically completely inside secondary orifice, secondary orifice transversely oval, often flattened distally, distinct proximal pseudo-sinus of variable width formed by proximo-lateral corners of peristome folding over orifice.

Ovicells recumbent on distal zooid, opening into peristome, not as high as edge of secondary orifice, smooth with only occasional pores and minor ridges.

MEASUREMENTS: (2 specimens)

Lz	7	0.73	0.073	0.58-0.80
lz	7	0.43	0.050	0.38-0.50
Lo	7	0.14	0.014	0.12-0.16
lo	7	0.14	0.008	0.12-0.14
Lav-o				

Lzov	5	0.88	0.082	0.78-1.00
lzov	5	0.42	0.068	0.34-0.52
Loov	5	0.18	0.023	0.16-0.22
loov	5	0.16	0.017	0.14-0.18
Lov	5	0.18	0.022	0.16-0.22
lov	5	0.32	0.061	0.30-0.46

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	2. Bilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	?1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(m) *[p]*, MF(b) *[r]*

COMPARISONS: No comparable species have been seen.

Smittina sp. nov. d

Plate 33E, F

MATERIAL: SAM P39517 (TL)

DESCRIPTION: Colony erect bilaminate foliose.

Zooids irregularly hexagonal to rectangular, clearly defined by very elevated narrow marginal ridge with occasional small circular adventitious avicularia, frontal wall convex, slightly tuberculate, evenly perforated by pores.

Orifice positioned at distal margin, short broad lyrula with curved alae, condyles small or absent, peristome moderately low, distally arched, abruptly turning inward at lateral corners (lightbulb shaped?), broad proximal pseudosinus containing circular to peanut-shaped avicularium with complete cross-bar.

Ovicells not observed.

MEASUREMENTS: (1 specimen)

Lz	3	0.65	0.133	0.50-0.74
lz	3	0.53	0.103	0.44-0.64
Lo	3	0.14	0.020	0.12-0.16
lo	3	0.16	0.015	0.14-0.17

Lav-o	3	0.05	0.006	0.04-0.05

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	2. Bilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	?1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MF(b) *[p]*

COMPARISONS: Both *Porella rhomboidalis* Maplestone (1902b: 19, pl. 1, fig. 4; Middle Miocene, Torquay Embayment) and *Porella cylindrorostris* Canu & Bassler (1935: 41, pl. 7, fig. 9; ?Oligocene; Torquay Embayment) have similarly raised margins, frontal pores, peristome, and suboral avicularium, but neither has the marginal adventitious avicularia.

Smittina sp. nov. e

Plate 33G, H

MATERIAL: SAM P39518 (TL)

DESCRIPTION: Colony erect bilaminar, rarely unilaminar encrusting.

Zooids elongated hexagonal, defined by irregular marginal ridge, some [indistinct] marginal areolae, frontal wall convex, smooth, evenly perforated by moderately large pores except on small suboral area,

Orifice positioned at distal margin, transversely oval, moderately large proximolateral acute condyles, lyrula short, narrow and non-alate [abraded?], peristome moderately developed but not raised much above frontal wall; medium-sized suboral avicularium median oval to drop-shaped with complete cross-bar, directed proximally and projecting into orifice,

Only broken ovicells observed, globular, not very large.

MEASUREMENTS: (1 specimen)

Lz	6	0.58	0.039	0.52-0.62
lz	6	0.39	0.016	0.38-0.42
Lo	6	0.12	0.008	0.11-0.13
lo	6	0.14	0.012	0.13-0.16

Lav-o	6	0.04	0.05	0.04-0.05

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	2. Bilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	?1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(m) *[p].*

COMPARISONS: This species slightly resembles *Smittina ordinata* (MacGillivray, 1895: 93, pl. 12, figs 18, 19; Middle Miocene, Otway Basin)

***Smittina*? sp. nov. f**

Plate 34A, B, C

MATERIAL: SAM P39519 (TL)

DESCRIPTION: Colony erect bilaminar or encrusting.

Zooids elongate hexagonal with rounded distal margins, margins clearly defined by low narrow ridge, frontal wall slightly convex, evenly perforated by small pores which become smaller towards central area.

Primary orifice transversely oval with short and very broad lyrula and only very small condyles; peristome with semi-circular distal and triangular proximal area, small suboral avicularium just inside peristome, avicularian chamber creates a wide proximal peristomial area.

Ovicell not observed.

MEASUREMENTS: (1 specimen)

Lz	3	0.70	0.065	0.62-0.70
lz	3	0.40	0.038	0.36-0.40
Lo	3	0.14	0.010	0.13-0.15
lo	3	0.14	0.006	0.13-0.14

Lav-o	3	0.03	0.006	0.02-0.03

A.B.G.H.C:

A. Orient. substr.	3. Erect cont./1. Encr.
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	2. Bilam./1. Unilam.
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	?1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: LTL *[r]*

Smittina sp. nov. g

Plate 34D, E, F

MATERIAL: SAM P39520 (TL)

DESCRIPTION: Colony erect bilaminar branching, branches usually 4 zooid rows wide.

Zooid margins very poorly defined, frontal wall flat to slightly concave (secondary thickening), perforated by irregularly scattered medium sized pores.

Orifice sub-circular with proximal sinus largely occupied by small oval avicularium just below frontal surface and directed proximally, lyrula indistinct (possibly broken); orifice occluded by smooth convex calcification in many zooids, giving the colony a patchy appearance.

Ovicells largely immersed in calcification, visible as a bulge with proximal margin overarching the orifice, which is somewhat smaller than in other zooids.

MEASUREMENTS: (1 specimen)

Lz	7	0.54	0.081	0.44-0.66
lz	7	0.30	0.035	0.26-0.34
Lo	7	0.14	0.014	0.12-0.16
lo	7	0.11	0.028	0.06-0.14

Lav-o	7	0.05	0.005	0.04-0.05

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	2. Bilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	?1. Flat
I. Freq. bifurc.	?2. Infrequent
J. Dim. bifurc.	2. One plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(l) *[r]*, MF(b) *[r]*, LKL(u) *[i]*.

REMARKS: Zooids with occluded orifice have the same measurements/dimensions as the normal autozooids.

***Smittina*? sp. nov. h**

Plate 34G, H, I

MATERIAL: SAM P39521 (TL)

DESCRIPTION: Colony erect bilaminar branching.

Zooids elongate oval, frontal wall flat, single row of marginal areolae.

Primary orifice placed at distal margin, subcircular without condyles or lyrula, peristome slightly developed, not projecting above frontal wall, arching over proximolateral corners of orifice and forming a proximal sinus; many of the orifices are occluded by secondary calcification, which is convex and leaves the original orifice outline clearly visible.

Ovicells and avicularia not observed.

MEASUREMENTS: (1 specimen)

Lz	5	0.49	0.013	0.48-0.51
lz	5	0.23	0.011	0.21-0.24
Lo	5	0.10	0.010	0.09-0.11
lo	5	0.09	0.006	0.08-0.10

A.B.G.H.C:

A. Orient. substr.	?3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	?4. Macroser.non-mac.
E. Arrang. front. surf.	2. Bilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	2. Infrequent
J. Dim. bifurc.	2. One plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: LTL *[r]*, MTL(l) *[r]*, MTL(m) *[r]*, MF(b) *[p]*.

COMPARISONS: This species may not fit into either *Smittina* or *Smittoidea*, as it has no avicularia, and somewhat resembles *Smittinella*.

Genus ***Prenantia*** Gautier, 1962

TYPE SPECIES: *Lepralia cheilostomata* Manzoni, 1869

DESCRIPTION: "Colony encrusting or erect, branching. Zooids with perforated frontal shields. Orifice with lyrula and condyles; no oral spines. Suboral avicularium present or absent. Ovicell recumbent to immersed, perforate or imperforate, closed by the zooidal operculum. Basolateral septula present." (Gordon, 1989)

Prenantia sp. nov. a

Plate 34J, K

MATERIAL: SAM P39522 (TL)

DESCRIPTION: Colony erect bilaminar.

Zooids irregularly elongated hexagonal, margins defined by very faint ridge, frontal wall flat, perforated by numerous pores except for area proximal to orifice, becoming immersed in secondary calcification, which creates flat and wide areas between the pores.

Primary orifice placed at distal margin, transversely oval to ellipsoid, long narrow lyrula ?without alae; peristome poorly developed, secondary orifice ellipsoid with short narrow proximal sinus.

Ovicells not observed.

MEASUREMENTS: (1 specimen)

Lz	3	0.63	0.050	0.58-0.68
lz	3	0.40	0.060	0.34-0.46
Lo	3	0.12	0.015	0.11-0.14
lo	3	0.15	0.012	0.14-0.16

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	2. Bilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	?1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(l) *[p]*. MF(b) *[p]*.

Superfamily **SCHIZOPORELLOIDEA** Jullien, 1883

Family **GIGANTOPORIDAE** Bassler, 1935

DESCRIPTION: Colony encrusting or erect. Zooidal frontal wall evenly perforated. Orifice with shallow rounded poster and condyles. Paired avicularia typically present, connected by a bridge-like peristomial process across the orifice leaving a subcircular proximal spiramen. Ovicells hyperstomial or completely immersed. (Gordon, 1984)

Genus ***Cosciniopsis*** Canu & Bassler, 1927

TYPE SPECIES: *Cosciniopsis coelatus* Canu & Bassler, 1927

DESCRIPTION: "Colony encrusting. Zooids relatively robust, generally pigmented, the frontal shield evenly perforated and tubercular. No oral spines. Lateral-oral avicularia present or absent. Ovicell subimmersed in distal zooid, visible as a bulge of its frontal shield, closed by the zooidal operculum." (Gordon, 1989)

REMARKS: *Cosciniopsis* is considered to have originated in the Eocene (Bassler, 1953), making this one of the earliest records.

Cosciniopsis sp. nov. a

Plate 35H, I, J

MATERIAL: SAM P39527 (TL)

DESCRIPTION: Colony encrusting (?self-overgrowing) or erect bilaminar.

Zooids hexagonal, distally elongated, defined by narrow ridge, frontal wall flat to slightly convex, perforated by many small pores and granulated, except area immediately proximal to orifice.

Orifice subcircular to very rounded triangular, distal margin slightly raised, blunt condyle just proximal to centre of both lateral margins.

Paired adventitious avicularia lateral to orifice, drop-shaped with complete cross bar, acute rostrum directed distally in toward orifice and in line with distal margin.

Ovicells globular, smooth, imperforate, immersed in distal zooid and covering most of frontal wall area of distal zooid.

MEASUREMENTS: (1 specimen)

Lz	6	0.90	0.057	0.81-0.96
lz	6	0.71	0.009	0.70-0.72
Lo	6	0.20	0.005	0.19-0.20
lo	6	0.21	0.007	0.20-0.21

Lav	10	0.18	0.026	0.14-0.20
lav	10	0.11	0.009	0.10-0.12

A.B.G.H.C:

A. Orient. substr.	1. Encr./2. Erect cont.
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilam./2. Bilam.
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	?1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(m) *[r]*, LKL(l1) *[r]*.

COMPARISONS: The orificial morphology is somewhat different to that of most species in *Cosciniopsis* but is not distinct enough to warrant placement into a different genus.

Genus ***Gigantoporidae? Gen indet. A***

Gigantoporidae? Gen indet. A sp. a

Plate 35F, G

MATERIAL: SAM P39528 (TL)

DESCRIPTION: Colony unilaminar encrusting.

Zooids drop-shaped, defined by furrow, frontal wall very convex, evenly porous and granular.

Primary orifice not observed, peristome recumbent, secondary orifice subcircular, peristomial avicularium on one lateral orifice margin, possibly paired.

Ovicell not observed.

MEASUREMENTS: (1 specimen)

Lz	3	0.29	0.032	0.25-0.31
lz	3	0.14	0.017	0.13-0.16
Lo	3	0.05	0.015	0.04-0.07
lo	3	0.06	0.006	0.06-0.07

Lav	3	0.06	0.003	0.06-0.07
lav	3	0.05	0.003	0.05

A.B.G.H.C:

A. Orient. substr.	1. Encrusting
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	?1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	Erect Bryozoan

OCCURRENCE: LTL *[r]*, MTL(m) *[r]*, MF(b) *[r]*.

COMPARISONS: This is a very small species and the features are difficult to distinguish. It may be a species of *Cosciniopsis*.

REMARKS: The ancestrula is much smaller than the mature zooids, and budding appears to occur only in the distal and lateral directions. In the specimen figured, the ancestrula is situated directly over the orifice of the encrusted bryozoan. This would seem unlikely to have happened while the encrusted bryozoan, or at least the zooid in question, was still alive. This would mean a post-mortem encrustation, and require the encrusted bryozoan to lie on the seafloor for sufficient time for encrustation to occur.

Family **indet. (Gigantoporidae?)**

Genus ***Gigantoporidae? Gen indet. B***

Gigantoporidae? Gen indet. B sp. nov. a

Plate 35A, B, C, D, E

MATERIAL: SAM P39524 (TL), P39525 (TL), P39526 (TL)

DESCRIPTION: Colony erect delicate ?branching, 6 – 8 longitudinal zooid rows.

Zooids elongated rectangular, margins clearly defined by broad rounded ridge, frontal wall flat (becoming convex around peristome), faintly granulated, single row of round marginal areolae, scattered small pores especially on proximal area, large pore pair lateral to peristome often pinching it in.

Primary orifice transversely oval to circular, no condyles, peristome variably developed, usually moderately long, but distal portion never raised above frontal wall, secondary orifice circular, directed distally, large peristomial spiramen circular to transversely oval, placed directly above primary orifice, distal portion of peristome.

Ovicells immersed in distal zooid, frontal smooth and slightly convex (actual interior appears fairly shallow in broken ones), surrounded by large pores with separating ridges, opening within peristome but well above primary orifice.

Peristomial avicularia possibly present at one or both distolateral corners of ovicelled peristomes.

MEASUREMENTS: (3 specimens)

Lz	8	1.24	0.091	1.10-1.40
lz	8	0.61	0.092	0.50-0.80
Lo	8	0.24	0.020	0.20-0.26
lo	8	0.25	0.024	0.20-0.28

Lov	3	0.65	0.102	0.51-0.73
lov	3	0.56	0.093	0.48-0.65

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	5. Radial
F. 2° skel. thick.	1. None

G. Struct. units	8. Solid cylinder
H. Dim. struct. units	?1. Flat
I. Freq. bifurc.	?2. Infrequent
J. Dim. bifurc.	2. One plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(I) *[r]*.

COMPARISONS: Although this species has the superficial appearance of *Gigantopora*, the peristomial spiramen is not formed by a pair of adventitious avicularia, and the frontal wall and ovicells are not evenly perforated. It may require a new genus.

Family **PORINIDAE** d'Orbigny, 1852

Genus ***Porina*** d'Orbigny, 1852

TYPE SPECIES: *Eschara gracilis* Lamarck, 1816 [subsequent designation Lang, 1917]

DESCRIPTION: Colony erect. Zooidal frontal wall with numerous pores. Primary orifice with a weakly defined poster or definite sinus. Circular peristome, usually paired avicularia and a ring of pores (chambers of avicularia) on the peristomial rim. Spiramen proximally at the base of the peristome. Ovicell deeply immersed opening into the peristome. (after Gordon, 1984)

REMARKS: The suboral pore has often been considered to be a true ascopore (Bassler, 1953), indicating it opens into the ascus within the body cavity proximal to the orifice. However, in several specimens in the present study (Pl. 36F,G) it appears that the pore opens into the peristome above the primary orifice. The two polymorphs adjacent to the central pore appear to originate at the level of the primary orifice and grow with frontal thickening to create an arch similar to *Gigantopora*. Because this is how the central pore is created, it is a spiramen. This may not be the manner in which the spiramen in all species of *Porina* is formed, because it often opens much further proximal to the secondary orifice. However, it may still be that the initial formation of the spiramen occurs via fusion of the suboral avicularia near the primary orifice, but then migrates away from there to varying degrees with secondary calcification.

MacGillivray (1895: 103) considered the "essential character of this genus is the presence of one or more suboral pores opening into the peristomial chamber in front of the operculum, and so differing from the special pores of the Microporellidae, which open into the body cavity". Bock (1982) referred to it as "special pore" and pointed out that "it has been considered to be an ascopore, but dissection of specimens shows that it communicates with the peristome rather than the zooid".

Porina cf. ***spongiosa*** (MacGillivray)

Plate 36A, B, C, D, E, G, H

Mucronella spongiosa MACGILLIVRAY, 1895: 99, pl. 13 (fig. 8).

MATERIAL: SAM P39529 (TL), P39530 (TL), P39531 (TL), P39532 (LTL; basal attachment)

OTHER MATERIAL EXAMINED: NMV P27763 (type of *Mucronella spongiosa*, Moorabool Valley, MacGillivray coll.)

DESCRIPTION: Colony erect bilaminate cylindrical branches of variable thickness (delicate to robust) or lobes of variable width; sometimes frequently branching (especially delicate colonies).

Zooecial margins indistinct through secondary calcification, frontal wall perforated by numerous pores, which persist individually through secondary calcification and become much larger.

***Porina* cf. *spongiosa* continued:**

Primary probably circular, hidden by very long and curved peristome, secondary orifice level with frontal surface (common in lobate colonies) or broadly protruding to various degrees (common in cylindrical colonies), semicircular to transversely oval, pair of very small pores immediately proximal to orifice, often joined in a shallow depression, a pair of circular polymorphs adjacent to these pores on proximal half of peristomial rim, large subcircular spiramen proximal to these pores.

Ovicells poorly visible, peristomial, deeply immersed.

MEASUREMENTS: (4 specimens)

Lz	20	0.55	0.100	0.40-0.72
lz	20	0.23	0.019	0.20-0.26
Lo	20	0.10	0.010	0.08-0.12
lo	20	0.12	0.016	0.10-0.16

Øspir	20	0.04	0.013	0.02-0.07
Lov	2	0.13	0.014	0.12-0.14
lov	2	0.29	0.014	0.28-0.30

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	2. Bilam. or 5. Radial
F. 2° skel. thick.	2. Frontal

G. Struct. units	6. Lobe or 8. Solid cyl.
H. Dim. struct. units	?1. Flat
I. Freq. bifurc.	?1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	bivalves

OCCURRENCE: FRB: LTL *[c]*, MTL(m) *[i]*, UTL *[p]*, LRF(l) *[r]*, LKL(l1) *[i]*, LKL(l2) *[f]*, LKL(t) *[r]*; Delicate branching: LTL *[f]*, MTL(l) *[c]*, MTL(m) *[f]*, MF(b) *[d]*, LKL(l1) *[r]*, LKL(l2) *[p]*, LKL(u) *[r]*; PWF(a); Otway Basin (Oligo-Miocene)

COMPARISONS: It is unclear why MacGillivray (1895) did not assign this species to *Porina*, but did so for his *P. cribrosa* (actually *Gigantopora*) and *P. larvalis* (actually *Didymosella*). This species is similar to *Porina gracilis* (Lamarck, 1816; Recent, Australia). It differs significantly, however, in the shape of the spiramen, and also in the arrangement of the peristomial polymorphs.

REMARKS: This is a highly variable species, and there appears to be a gradation between the forms with oval orifice and avicularia around the peristomial rim (Pl. 35G) to those with distinctive arrangement of polymorphs and pores (Pl. 35B). Because of this variability, the following species may be similar enough to be considered conspecific, or at least closely related. If they are indeed several distinct species, such a diversity of closely related species within such a small geographical area and short geological time would be interesting from a population perspective.

Porina sp. nov. a

Plate 36K, L, F

MATERIAL: SAM P39533 (TL)

DESCRIPTION: Colony erect bilaminate lobes.

Zooecial margins indistinct through secondary calcification, frontal wall perforated by numerous pores.

Primary orifice difficult to view, probably circular, peristome very long and curved, secondary orifice level with frontal surface, subcircular, 4 – 6 small circular avicularia surrounding orifice, often with complete cross-bar, spiramen indistinct.

Ovicells not observed.

MEASUREMENTS: (1 specimen)

Lz	5	0.69	0.044	0.64-0.76
lz	5	0.34	0.026	0.32-0.38
Lo	5	0.10	0.005	0.09-0.10
lo	5	0.11	0.009	0.10-0.12

Øpore	5	0.02	0.005	0.02-0.03

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	2. Bilam. or 5. Radial
F. 2° skel. thick.	2. Frontal

G. Struct. units	6. Lobe
H. Dim. struct. units	?1. Flat
I. Freq. bifurc.	?1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: LTL *[p]*, MTL(m) *[p]*, MTL(u) *[p]*, MF(b) *[i]*.

COMPARISONS: This species is distinguished from *P.* cf. *spongiosa* mainly in the subcircular secondary orifice, different arrangement of polymorphs around the peristomial margin, much smaller spiramen (almost not noticeable in most zooids, but obviously present in the cross-section in Pl. 36F), and smaller frontal pores.

Porina sp. nov. b

Plate 36I, J

MATERIAL: SAM P39534 (TL)

DESCRIPTION: Colony erect cylindrical branching.

Zooecial margins indistinct through secondary calcification, frontal wall perforated by pores.

Secondary orifice elevated above frontal surface, subcircular to transversely oval, 4–6 circular polymorphs arranged around peristomial rim on elevated columns, spiramen indistinct.

Ovicells poorly visible, peristomial.

MEASUREMENTS: (1 specimen)

Lz	5	0.85	0.033	0.81-0.90
lz	5	0.31	0.008	0.30-0.32
Lo	5	0.11	0.008	0.10-0.12
lo	5	0.12	0.007	0.11-0.13

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	5. Radial
F. 2° skel. thick.	1. None

G. Struct. units	8. Solid cylinder
H. Dim. struct. units	?1. Straight
I. Freq. bifurc.	?2. Infrequent
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: LTL *[p]*, MTL(m) *[p]*, MF(b) *[c]*, LKL(m) *[r]*.

COMPARISONS: This may be *Porina gracilis tubulifera* (MacGillivray, 1895: 103, pl. 14, fig. 23; Middle Miocene, Otway Basin) as the very salient peristomes and peristomial polymorphs are similar. The poor preservation of the available specimens hampers comparisons.

REMARKS: Much of the indistinctness of features is probably due to the poor condition of the available specimens, rather than being primarily indistinct.

Family **BITECTIPORIDAE** MacGillivray, 1895

DESCRIPTION: Colony mostly encrusting. Zooidal front generally an olocyst or pleurocyst; proximal border without sinus; aperture horseshoe-shaped with 2 lateral denticles serving as pivot for operculum. Ovicell hyperstomial. (after Bassler, 1953)

REMARKS: This family is considered to originate in the Chattian (Late Oligocene; Taylor, 1993) but Cheetham (1962: 330) identified *Hippoporina respertillio* Canu & Bassler from the Eocene

Genus ***Hippoporina*** Neviani, 1895

TYPE SPECIES: *Cellepora pertusa* Esper, 1796 [subsequent designation Waters, 1918].

DESCRIPTION: Colony encrusting, or erect from an encrusting base. Frontal wall evenly perforated. Orifice with condyles. Adventitious avicularia often present. Ovicell hyperstomial, perforated. Multiporous septula present. Spines present only on the ancestrula. (after Gordon, 1984)

Hippoporina sp. nov. a

Plate 39J, K

MATERIAL: SAM P39541 (TL)

DESCRIPTION: Colony erect cylindrical ?branching, 8 rows of zooids.

Zooids elongate hexagonal to rectangular, defined low ridge, frontal wall flat, evenly perforated by pores and slightly trabeculate.

Orifice with circular anter and broad U-shaped poster, slightly elevated margins.

No ovicells or avicularia observed.

MEASUREMENTS: (1 specimen)

Lz	7	0.60	0.041	0.54-0.66
lz	7	0.33	0.015	0.30-0.34
Lo	7	0.13	0.008	0.12-0.14
lo	7	0.10	0.006	0.09-0.11

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	5. Radial
F. 2° skel. thick.	1. None

G. Struct. units	8. Solid cylinder
H. Dim. struct. units	?1. Flat
I. Freq. bifurc.	?1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: TL *[p]*

COMPARISONS: *Phorioppnia cookae* (Gordon & d'Hondt, 1997; Recent, New Caledonia) and other phorioppniids, have a similar superficial appearance, but differ in the weak or absent condyles, the clockwise or anti-clockwise trending zooidal arrangement. The lack of ovicells in the present material makes positive generic assignment difficult.

It is very similar to *Schizoporella filiformis* Waters (1882a: 274, pl. 7, fig. 12; ?Oligo-Miocene, Gambier Embayment), but lacks the small lateral adventitious avicularium.

***Hippoporina*? sp. nov. b**

Plate 38A, B, C, D, E, F, G

MATERIAL: SAM P39559 (TL), P39560 (TL), P39561 (TL), P39562 (TL)

DESCRIPTION: Colony erect bilaminar sheet, relatively flat.

Zooids elongate hexagonal to diamond-shaped, margins becoming obscured by calcification, frontal wall probably imperforate, generally covered in large and irregular trabeculae, often creating a second rim around the orifice.

Orifice circular with broad shallow V-shaped sinus, condyles in proximolateral corners, margin very broadly raised.

Adventitious avicularium single or paired, near proximolateral corners close to orificial margin of neighboring zooid. Adventitious avicularia in areas of frontal thickening larger, subcircular to egg-shaped, complete cross-bar.

Secondary thickening with minute ?polymorphs (0.02–0.06 mm diameter) is not raised above 'non-thickened' frontal wall, and leaves small areas of a few orifices open.

Ovicells not observed.

MEASUREMENTS: (3 specimens)

Lz	10	0.88	0.084	0.83-1.00
lz	10	0.35	0.031	0.31-0.40
Lo	9	0.16	0.011	0.14-0.17
lo	9	0.15	0.005	0.14-0.15

Lav	6	0.13	0.039	0.07-0.18
lav	6	0.12	0.039	0.06-0.18

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	2. Bilaminate
F. 2° skel. thick.	2. Frontal

G. Struct. units	5. Sheet
H. Dim. struct. units	?1. Flat
I. Freq. bifurc.	?1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: LTL *[p]*, MTL(m) *[i]*.

COMPARISONS: This species resembles *Hippoporina incomposita* Brown (1958: 63, figs 49, 50; Upper Oligocene, Otway Basin) but in that the margins are clearer (raised with marginal furrow) and frontal perforations more even.

The actual generic allocation is also highly uncertain. It shares characters with genera such as *Laminopora* Michelin (Lepraliellidae), *Characodoma* Maplestone (Cleidochasmatidae), and *Mamillopora* Smitt (Mamilloporidae), but the extensive secondary calcification obscures many primary features. An internal view of the frontal wall (Pl. 42C) also does not reveal any distinguishing features.

Family **EMINOOECIIDAE** Hayward & Thorpe, 1988a

DESCRIPTION: "Autozooids with cryptocystidean frontal wall development. Vertical wall with multiporous septula. Primary orifice with well developed condyles; proximal border concave to deeply U-shaped. Frontal wall with few marginal pores, defined as frontal septula. Adventitious avicularia present. Ovicell budded from frontal pores of autozooid distal to maternal autozooid, closely associated with avicularian polymorphs or inferred homologues; imperforate." (Hayward & Thorpe, 1988a)

REMARKS: This family is considered endemic to Antarctic waters in living occurrences (Hayward & Thorpe, 1988a). The presence of species of this family in the Cainozoic of Australia indicates it was more widespread in the past. The fact that in only survives in the Recent of Antarctica and not Australia suggests that the Eminooeciidae is a family adapted to cool water environments. This contradicts the interpretation of a warm water environment for the sediments the specimens from this study occur in.

Genus ***Macrocamera*** Gordon & d'Hondt, 1997

TYPE SPECIES: *Macrocamera erecta* Gordon & d'Hondt, 1997

DESCRIPTION: "Colony erect and rigid, dichotomously branching, the zooids facing on one side. Zooidal frontal shield imperforate, with sparse areolar pores. Orifice with a wide V-shaped poster delimited from the anter by condyles. No oral spines. Suboral avicularium present, the crossbar complete. Female zooids with somewhat wider orifice; ovicell huge, the ectooecial surface resembling the frontal shield; not closed by zooidal operculum." (Gordon & d'Hondt, 1997: 43)

REMARKS: The placement of *Macrocamera* in the family Eminooeciidae is uncertain and requires revision (Gordon, pers. comm. 1999).

Macrocamera robusta Bock & Cook

Plate 41A, B, C, D, E, F, G

Macrocamera robusta Bock & Cook, 2001: 140, figs 1A-C.

MATERIAL: SAM P39549 (TL), P39550 (TL), P39551 (TL), P39552 (TL), P39553 (TL)

OTHER MATERIAL EXAMINED: NMV P310571 (holotype, Browns Creek, Victoria, Bock & Cook coll.)

DESCRIPTION: Colony erect cylindrical branches, zooids facing all around branches in 6–8 rows.

Zooids rectangular to very elongate hexagonal, margins defined by prominent narrow ridge, frontal wall slightly convex (becoming concave with secondary thickening), usually 8 large marginal areolae, all these features become immersed in extensive secondary calcification.

Orifice placed at distal margin, circular with proximolateral condyles bordering a shallow broad rounded sinus, margins slightly raised, a pair of small columnar distolateral spine bases.

Adventitious avicularia placed almost centrally on frontal wall, pyriform, with complete cross-bar, short acute rostrum directed laterally (direction often alternates between successive zooids in a row) and elevated abfrontally by the avicularian chamber.

Ovicells not observed.

MEASUREMENTS: (4 specimens)

Lz	15	0.66	0.051	0.57-0.75
lz	15	0.35	0.037	0.30-0.43
Lo	15	0.10	0.006	0.09-0.11
lo	15	0.10	0.004	0.10-0.11

Lav	15	0.11	0.015	0.09-0.14
lav	15	0.09	0.015	0.06-0.12

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	?1. Rigid contiguous
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	5. Radial
F. 2° skel. thick.	2. Frontal

G. Struct. units	8. Solid cylinder
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	?2. Infrequent
J. Dim. bifurc.	?2. One plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(l) *[r]*, MTL(m) *[i]*.

COMPARISONS: The specimen figured in Plate 41D–F fits *M. robusta* well. The different appearance of the specimen figured in Plate 41A–B (in particular the salient margins and elevated avicularia and orifice) is attributed to the lack of secondary calcification characteristic of most other specimens.

Macrocamera? sp. nov. a

Plate 41H, I. J. K. L

MATERIAL: SAM P39554 (TL), P39555 (TL)

DESCRIPTION: Colony erect bifoliate branch

Zooids elongate hexagonal to rectangular, defined by broad rounded ridge, frontal wall convex, finely granulated, 10-12 large marginal areolae directly abutting marginal ridge, single drop-shaped avicularium without condyles or cross bar present midway alongside some zooids, directed laterally

Primary orifice semicircular, straight proximal margin with small U-shaped sinus, peristome variably developed, broad margin, secondary orifice transversely oval with larger U-shaped sinus connected by furrow to sinus or primary orifice.

Ovicells deeply immersed in secondary calcification, opening above operculum into peristome, often visible as narrow lip on distal margin.

MEASUREMENTS: (2 specimens)

Lz	9	0.60	0.043	0.54-0.66
lz	9	0.34	0.059	0.26-0.44
Lo	9	0.13	0.011	0.11-0.14
lo	9	0.12	0.004	0.11-0.12
Lav	9	0.13	0.009	0.12-0.14

Lzov	2	0.52	0.000	0.52
lzov	2	0.31	0.014	0.30-0.32
Loov	2	0.12	0.000	0.12
loov	2	0.12	0.000	0.12
Lavov	2	0.15	0.014	0.14-0.16
Lov	2	0.13	0.014	0.12-0.14
lov	2	0.21	0.014	0.20-0.22

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	2. Bilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	?1. Flat
I. Freq. bifurc.	?1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(l) *[r]*, MTL(m) *[r]*, MF(b) *[i]*, LKL(u) *[r]*.

COMPARISONS: This species show close affinity with *Macrocamera*, but the lobate growth form is different to any known species of that genus.

Family **PETRALIELLIDAE** Harmer, 1957

DESCRIPTION: "Colony encrusting or erect, unilamellar. Zooids generally large, the frontal wall regularly perforated with numerous pores. Often a suboral mucro, with or without avicularia; primary orifice with or without oral spines and condyles. Avicularia adventitious only, usually associated with the orifice and/or frontal. Ovicell recumbent, with numerous small frontal pores. Basal wall usually smooth, with one or more pore-chambers giving rise to supportive rhizoids. Septula mainly multiporous." (Gordon, 1984)

REMARKS: First occurrence of this family is considered to be *Hippopetraliella*? sp. (Labracherie, 1975) Lower Eocene (Ypresian), DSDP Site 246, Indian Ocean.

Genus ***Mucropetraliella*** Stach, 1936

TYPE SPECIES: *Cellepora verrucosa* Lamarck, 1816 [subsequent designation Gray, 1848]

DESCRIPTION: "Colony encrusting or erect, unilamellar. Frontal wall evenly perforated. Orifice with aviculiferous suboral mucro associated with either a lyrula or an asymmetrical peristomial sinus. Other small or larger avicularia often present. Oral spines present or absent. Ovicell recumbent, porous. Supportive rhizoids from basal pore-chambers and multiporous septula present." (Gordon, 1984)

***Mucropetraliella*? sp. nov. a**

Plate 37A, B, C, D, E, F, G

MATERIAL: SAM P39538 (TL), P39539 (TL)

DESCRIPTION: Colony unilaminar encrusting.

Zooid shape indistinct, probably elongate hexagonal to oval, frontal wall smooth or slightly irregular, large circular marginal areolae; frontal largely covered by (hollow?) tall globular avicularian chamber or umbo directly abutting orifice, distal surface bearing large circular to slightly drop-shaped avicularium with complete crossbar, rostrum directed abfrontally, smaller similar avicularium on summit of umbo, rostrum directed proximally or laterally to varying degrees.

Orifice semicircular with short proximolateral condyles and a medioproximal alate lyrula, distal margin with narrow shelf with two pairs if rimmed spine bases, with occasional single larger spine base on one lateral margin.

Large lingulate adventitious avicularium on proximal frontal wall (apparently where the umbo is absent), complete crossbar, rostrum with long and shallow palate, terminating at neighboring umbo wall.

Ovicells hyperstomial, ectooecium partly embedded in umbo of distal zooid, wrapping around proximally into endooecium, no complete ovicells preserved past edges of distal zooid's umbo.

MEASUREMENTS: (2 specimens)

Lz	4	0.33	0.036	0.30-0.38
lz	4	0.22	0.022	0.20-0.25
Lo	4	0.08	0.006	0.07-0.08
lo	4	0.09	0.006	0.08-0.09

Lov	2	0.26	0.007	0.24-0.25
lov	0	?	-	
Lav	2	0.26	0.007	0.25-0.26
lav	2	0.11	0.007	0.10-0.11

A.B.G.H.C:

A. Orient. substr.	1. Encrusting
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	?4. Macroser.non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: TL *[p]*

COMPARISONS: The generic and even familial position is uncertain for this species. It could also fit in the Lepraliellidae on account of the suboral avicularian chamber, the adventitious avicularian morphology, and the orifice.

REMARKS: Several patches of zooids with variably occluded orifices may have been parts of maculae, or result of damage or predation.

Family ?**SCHIZOPORELLIDAE** Jullien, 1883

DESCRIPTION: "Frontal wall evenly perforated, or with marginal pores only, or imperforate. Primary orifice with a large anter and a small sinus. Ovicell mostly hyperstomial. Avicularia present or absent. Multiporous septula or pore-chambers present." (Gordon, 1984)

REMARKS: First occurrence of this family is 'Schizoporellidae gen. et sp. indet.' (Labracherie, 1975), Lower Eocene (Ypresian), DSDP Site 246, Indian Ocean.

Genus ***Escharina*** Milne-Edwards, 1836

TYPE SPECIES: *Eschara vulgaris* Moll, 1803

DESCRIPTION: "Colony encrusting to erect. Frontal wall evenly perforated with small pores and/or with marginal areolae. Orifice with narrow sinus, and often oral spines. Avicularia adventitious or interzooidal, developed from pore-chambers, the mandible varied. Ovicell hyperstomial or deeply immersed. Basal pore-chambers present." (Gordon, 1984)

REMARKS: If the following species are indeed *Escharina*, they represent the oldest recorded occurrence of this genus, which was previously thought to occur from the Oligocene onwards.

Escharina? cf. **nitidissima** (Maplestone)

Plate 39A, B, C

Schizoporella nitidissima Maplestone, 1902a: 65, pl. 7 (fig. 1).

MATERIAL: SAM P39542 (TL), P39543 (TL)

OTHER MATERIAL EXAMINED: NMV P10169 (type of *Schizoporella conservata*, Bairnsdale, Middle Miocene, Maplestone coll.)

DESCRIPTION: Colony unilamellar encrusting; ancestrula tatiform.

Zooids oval to elongate hexagonal defined by low narrow ridge, frontal wall convex, evenly perforated by small pores, coarsely and evenly granular, single pore in each distolateral corner, single adventitious avicularium at either lateral corner.

Orifice almost exact semicircle, straight proximal margin with narrow distally constricted sinus, broad smooth elevated area surrounds whole orifice, two pairs of large and often columnar spine bases in distolateral areas.

Ovicells medium sized, globular, imperforate, covered in same granulations as frontal wall, margins sometimes gradual with distal zooid.

MEASUREMENTS: (2 specimens)

Lz	6	0.51	0.031	0.47-0.55
lz	6	0.29	0.029	0.24-0.31
Lo	6	0.08	0.012	0.06-0.09
lo	6	0.10	0.005	0.09-0.10

Lov	2	0.18	0.014	0.17-0.19
lov	2	0.24	0.057	0.20-0.28
Lav	6	0.09	0.017	0.06-0.11
lav	6	0.06	0.009	0.05-0.07

A.B.G.H.C:

A. Orient. substr.	1. Encrusting
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(l) *[r]*, MTL(m) *[r]*; (OB) ?BL

COMPARISONS: The type specimen of *Schizoporella nitidissima* Maplestone (NMV P10169) is composed of only the ancestrula and the first five zooids. They show the same pattern of budding from only the distal ancestrular margin as the specimen (SAM P39543) figured in Plate 39A.

***Escharina*? cf. *granulata* (MacGillivray)**

Plate 39D, E, F, G

Schizoporella granulata MacGillivray, 1895:87, pl. 11 (fig. 27).
? *Exochella grandis* Canu & Bassler, 1935: 32, pl. 9 (fig. 3).

MATERIAL: SAM P39544 (TL)

OTHER MATERIAL EXAMINED: NMV P14537 (type of *Schizoporella granulata*, Muddy Creek, Oligocene, MacGillivray coll.); USNM

DESCRIPTION: Colony erect bilaminate sheet.

Zooids elongate hexagonal defined by faint ridge or furrow, frontal wall flat, faintly granular, very large marginal areolae with separating ribs around whole margin (also distally of orifice).

Primary orifice placed slightly proximal of distal margin, with transversely elongate oval to rectangular anter and sinus distally strongly constricted, almost separating off circular proximal poster, recessed somewhat below level of frontal wall with secondary orifice larger and thus creating a shelf, which surrounds the primary and is widest along proximal margin, secondary transversely oval with a small rounded triangular inflection overarching the sinus.

Ovicells deeply immersed in distal zooid but do not reach base, imperforate and granular like the frontal wall, not closed by operculum.

MEASUREMENTS: (1 specimen)

Lz	6	0.65	0.464	0.60-0.70
lz	6	0.38	0.274	0.35-0.40
Lo	6	0.10	0.052	0.10-0.11
lo	6	0.14	0.049	0.14-0.15

Lov	3	0.15	0.058	0.15-0.16
lov	3	0.25	0.100	0.24-0.26

A.B.G.H.C:

A. Orient. substr.	?3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	2. Bilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	?1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(I) *[p]*, Otway Basin (Miocene)

COMPARISONS: *Exochella grandis* Canu & Bassler (1935: 32, pl. 9, fig. 3; USNM 85711; Middle Miocene, Otway Basin) is very similar, however, the lateral avicularia are somewhat longer and acute, but the present specimens may simply be more abraded. Canu & Bassler apparently did not notice the sinus in the primary orifice, which is easily hidden by the 'mucro' on the secondary orifice, making it unlikely to be a true *Exochella* species. The ovicell is also less prominent than is indicated by their illustration.

Genus ***Schizoporellidae Gen. indet. A ('Schizoporella')***

'Schizoporella' sp. nov. a

Plate 39H, I

MATERIAL: SAM P39545 (TL)

DESCRIPTION: Colony erect delicate branching.

Zooids elongate oval, margins faintly defined by broad low ridge, flat to slightly convex, perforated by moderately large pores, several marginal areolae abutting marginal ridge.

Orifice semicircular to transversely oval with shallow U-shaped sinus.

Ovicells not observed.

MEASUREMENTS: (1 specimen)

Lz	4	0.75	0.044	0.70-0.80
lz	4	0.33	0.019	0.32-0.36
Lo	4	0.11	0.010	0.10-0.12
lo	4	0.11	0.010	0.10-0.12

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	5. Radial
F. 2° skel. thick.	1. None

G. Struct. units	8. Solid cylinder
H. Dim. struct. units	?1. Flat
I. Freq. bifurc.	?2. Infrequent
J. Dim. bifurc.	2. One plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: TL *[p]*

Genus ***Chiastosella*** Canu & Bassler *in* Bassler, 1934

TYPE SPECIES: *Schizoporella daedala* MacGillivray, 1882

DESCRIPTION: Colony encrusting or foliaceous. Frontal wall evenly perforated with simple, rarely stellate, pores, and with marginal areolae. Orifice with sinus, and condyles on proximal shoulders. Oral spines present. Avicularia single or paired, directed laterally or obliquely distally, sometimes absent. Ovicells hyperstomial, somewhat immersed, the ectooecium areolated, the endooecium exposed as a pitted triangular or crescentic area. (after Gordon, 1984)

REMARKS: All the species of *Chiastosella* found here are different from others previously described. A distinct difference is the restriction of frontal perforations to the single row of marginal areolae (although *C. gibbera* Canu & Bassler may also only have marginal areolae). As the ovicellular as well as the orificial and avicularian morphologies closely match those of *Chiastosella*, the following species are assigned to it.

Genus ***Chiastosella*** sp. nov. a

Plate 40A, B, C

MATERIAL: SAM P39546 (TL)

DESCRIPTION: Colony unilaminar encrusting (e.g. on bivalve shell interior).

Zooids hexagonal with rounded distal margin, margins clearly defined by suture/furrow, numerous small marginal areolae running just inside from margin up to orifice and sometimes around adventitious avicularia, frontal wall convex and covered in tubercles, sometimes appearing very coarsely granular.

Orifice close to distal margin, circular, sometimes slightly flattened proximally, with long thin sinus, sometimes with short spike in centre, condyles shallow, up to sinus margin, three pairs of spine bases around distal margin, pair of shallow suboral pores just below level of base of oral sinus, slight ridge rims orifice and sinus forming flat areas either side of sinus and with a small umbo on proximal margin.

Adventitious avicularium in lateral corner area, usually with complete cross bar, moderately long with very thin rostrum directed laterally at various angles, sometimes absent.

Ovicells recumbent on distal zooid, circular shape, flat bulbous with crescentic porous 'gutter' along distal area, umbo in centre; not closed by operculum.

MEASUREMENTS: (1 specimen)

Lz	8	0.52	0.036	0.48-0.56
lz	8	0.46	0.037	0.40-0.50
Lo	8	0.09	0.009	0.08-0.10
lo	8	0.09	0.009	0.08-0.10

Lav	8	0.15	0.024	0.12-0.18
lav	8	0.05	0.009	0.04-0.06
Lov	4	0.28	0.010	0.26-0.28
lov	4	0.31	0.010	0.30-0.32

A.B.G.H.C:

A. Orient. substr.	1. Encrusting
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(m) *[r]*.

Chiastosella sp. nov. b

Plate 40D, E, F

MATERIAL: SAM P39547 (TL)

DESCRIPTION: Colony erect (flat robust branching), unilaminar, abfrontal surface slightly concave, perforated evenly by pores, and with several criss-crossing narrow ridges (not corresponding with zooid outlines).

Zooids alternating in longitudinal rows, slightly elongated hexagonal, margins sinuous and often irregular, clearly defined by suture/furrow, frontal wall smooth and flat, numerous distinct marginal areolae with minor separating ridges, running just inside from margin up to orifice and sometimes smaller around adventitious avicularia.

Orifice on distal margin, semicircular to proximally flattened oval shape, with broad and deep U-shaped sinus, condyles very shallow or absent, one pair of spine bases in disto-lateral corners, second distal pair usually overgrown by distal zooid, pair of shallow suboral pores level with base of oral sinus.

Adventitious avicularium common in one of the lateral corners, complete cross bar sometimes slightly curved, either drop-shaped with short blunt rostrum or long and scoop-shaped rostrum sometimes embedded in neighbour zooid, directed laterally.

Ovicells not observed.

MEASUREMENTS: (1 specimen)

Lz	6	0.55	0.049	0.49-0.62
lz	6	0.38	0.027	0.36-0.42
Lo	6	0.13	0.012	0.12-0.15
lo	6	0.16	0.010	0.15-0.18

Lav1	2	0.12	0.000	0.12
lav1	2	0.08	0.007	0.07-0.08
Lav2	2	0.30	0.007	0.29-0.30
lav2	2	0.08	0.000	0.08

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	?1. Flat
I. Freq. bifurc.	?2. Infrequent
J. Dim. bifurc.	2. One plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: TL *[p]*.

Chiastosella sp. nov. c

Plate 40G, H, I, J

MATERIAL: SAM P39548 (TL)

DESCRIPTION: Colony erect or encrusting unilaminar.

Zooids alternating in longitudinal rows, slightly elongated hexagonal, margins clearly defined by slightly sinuous suture/furrow, numerous distinct marginal areolae, running just inside from margin up to orifice and sometimes around adventitious avicularia, frontal wall smooth and slightly convex.

Orifice on distal margin, transversely oval, sometimes slightly proximally flattened, with squarish sinus, which sometimes has a short spike in centre, condyles shallow, up to sinus margin, two pairs of spine bases, one in disto-lateral corners, other on distal margin, pair of shallow suboral pores just below level of base of oral sinus, slight ridge rims orifice and sinus.

Adventitious avicularia in each lateral corner, sometimes single or rarely absent, directed laterally, drop shaped, usually with complete cross bar sometimes slightly curved, acute to lingulate rostrum.

Ovicells partly immersed in distal zooid, semicircular to faintly triangular shape, relatively flat proximal area sloping upwards, distal area sloping back down with crescentic (slightly porous) 'gutter'.

MEASUREMENTS: (1 specimen)

Lz	5	0.52	0.016	0.50-0.54
lz	5	0.21	0.011	0.20-0.23
Lo	5	0.17	0.005	0.16-0.17
lo	5	0.12	0.004	0.11-0.12

Lov	1	0.31	-	0.31
lov	1	0.20	-	0.20
Lav	10	0.14	0.008	0.13-0.15
lav	10	0.07	0.007	0.06-0.08

A.B.G.H.C:

A. Orient. substr.	1. Encrusting
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(l) *[p]*, MTL(m) *[r]*, MF(b) *[r]*.

COMPARISONS: This species slightly resembles *Schizoporella protensa* Waters (1885: 301, pl. 7, fig. 14; 'Aldinga'), but the orifice is more elongated and the avicularia are longer.

Family **Incertae sedis**

Genus ***Hippomenella*** Canu & Bassler, 1917

TYPE SPECIES: *Lepralia mucronelliformis* Waters, 1899

DESCRIPTION: Colony erect or encrusting. Frontal wall with numerous marginal pores and a central imperforate area. Orifice high-arched, longer than wide, with a wide shallow poster. Oral spines present. Avicularia adventitious, small, usually adjacent to the orifice. Ovicell hyperstomial, prominent, finely perforated. Multiporous mural septula present. (Gordon, 1984)

Hippomenella cf. ***magna*** Canu & Bassler

Plate 37H, I, J

Hippomenella magna Canu & Bassler, 1935: 35, pl. 8 (fig. 13).

? *Schizoporella clypeata* Canu & Bassler, 1935: 30, pl. 6 (fig. 11).

MATERIAL: SAM P39540 (TL), P39490 (TL)

OTHER MATERIAL EXAMINED: USNM 85754 (type of *Hippomenella magna*, Torquay, Janjukian, Canu & Bassler coll.); USNM 85855 (type of *Schizoporella clypeata*, Dartmoor, Janjukian, Canu & Bassler coll.)

DESCRIPTION: Colony unilaminar encrusting.

Zooids alternating (sometimes irregularly) in rows, zooids elongated hexagonal, margins clearly defined by shallow furrow, often with very thin central ridge; frontal gymnocyst wall convex and smooth, several rows of small pores from margins up to imperforate central oval area extending up to orifice.

Orifice positioned at distal margin, trifoliate with large circular distal part and narrow internal rim, two pairs of spine bases placed distally and laterally just outside of orificial rim, proximolateral areas very small and rounded, proximal margin straight, surrounded by very small ridge

Adventitious avicularium in one (sometimes both) of the lateral corners, small with complete crossbar and moderately long narrow and acute rostrum directed laterally across neighboring zooid.

Ovicells hyperstomial, globular, with granulated and imperforate surface.

MEASUREMENTS: (2 specimens)

Lz	9	0.75	0.064	0.67-0.85
lz	9	0.51	0.089	0.40-0.65
Lo	9	0.13	0.014	0.10-0.14
lo	9	0.15	0.019	0.12-0.18

Lav	9	0.12	0.022	0.10-0.16
lav	9	0.05	0.024	0.03-0.09
Lov	4	0.32	0.019	0.30-0.34
lov	4	0.36	0.019	0.35-0.39

A.B.G.H.C:

A. Orient. substr.	1. Encrusting
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

Occurrence: LTL *[r]*, MTL(l) *[p]*, MTL(m) *[i]*, MF(b) *[r]*.

Comparisons: *Schizoporella clypeata* (Canu & Bassler, 1935: 30, pl. 6, fig. 11; Lower Oligocene, Gambier Embayment) is almost identical with *H. magna* (Canu & Bassler; Lower Oligocene, Torquay Embayment), apart from the orifice, which is described as "oval, axially disarranged, terminated by a narrow proximal sinus rounded at its extremity. A small oral avicularium, adjacent to the peristome is placed between the anter and the sinus" (Canu & Bassler, 1935: 31). Close inspection of the type specimen (USNM 85855) gives the impression that the off centre sinus and suboral avicularium are simply artefacts created by sediment stuck to the proximal orificial margin (the extensively retouched photo obscures this fact; the lateral areolar pores are also much smaller in the actual specimens). Without the sediment the orifice is identical to that of *H. magna*. Although *S. clypeata* (p. 30) has page preference to *H. magna* (p. 35) in the synonymy, the latter name should be given preference, as the description of the former was incorrect and a slight chance exists that the orifice is actually a different shape (the orifice is also longer than wide, as opposed to as wide or wider than long as in *H. magna* and the material of this study).

It differs from *Hippomenella vellicata* (Hutton) by the smaller and fewer frontal pores, fewer adventitious avicularia, and the shape of the orifice.

Remarks: Overall zooidal measurements are significantly larger in the Victorian specimens (*H. magna*: Lz = 1.10–1.65, lz = 0.55–0.65, Lo = 0.22, lo = 0.29 mm; *S. clypeata*: Lz = 1.40, lz = 0.65–0.75, Lo = 0.26, lo = 0.20 mm)

Superfamily **SIPHONICYTAROIDEA** Harmer, 1957

Family **SIPHONICYTARIDAE** Harmer, 1957

DESCRIPTION: (see extensive discussion in Bock & Cook, 2001)

REMARKS: First occurrence of family is considered to be *Siphonicytara clypeata* (Waters 1881), Early Eocene (Priabonian) of Eua, Tonga (Cheetham 1972; see Taylor 1993: 474). The species found in the Tortachilla Limestone extend this the family range back slightly to the Bartonian.

The only other genus included in this family (and indeed superfamily) is *Tubucella* Canu & Bassler, 1917, the type species of which, *T. mammillaris* (Milne Edwards, 1836), is found in the Eocene of Europe.

Genus ***Siphonicytara*** Busk, 1884

Siphonicytara Busk, 1884: 101, 168.
Tubitrabecularia Canu & Bassler, 1934 (*sensu lato*): 408.

TYPE SPECIES: *Siphonicytara serrulata* Busk, 1884

DESCRIPTION: Colonies erect cylindrical to flat robust branching, frontal wall lepralioid. Zooids with extensive frontal calcification, often divided into compartments by septal ridges. Ascopore located centrally within a septal ridge, distant from the secondary orifice. Avicularia adventitious, arising from marginal septular pores. Brooding unknown. (after Bock & Cook, 2001b)

REMARKS: This is still a relatively poorly known genus. A detailed taxonomic investigation into the species has only recently been made (Bock & Cook, 2001b)

Measurements of zooidal length are approximated by the distance between peristomes. This can occasionally be misrepresentative, as the length of the peristome may not be fixed. This could potentially be checked against the distance between secondary orifice and ascopore (the latter is assumed to be at a constant distance relative to the primary orifice; this may, however, itself vary as the ascopore may not necessarily be perpendicular to the thickened frontal wall and could slope away from the primary position)

ENVIRONMENTS: Almost all modern species listed above occur at depths of over 300 m (see above list), which is well below the photic zone and the storm wave base. All species have colonies, which are anchored by rhizoids to the substrate (Cook & Chimonides, 1986: 691), and are therefore apparently adapted to living on unconsolidated substrates (see Hayward & Cook, 1979). The Tertiary formations in which the fossil species occur are, however, considered to have been deposited in relatively shallow water, usually 100 m or less. This could either represent an adaptational shift towards deeper environments, or simply a lack of samples from Tertiary deep water facies, which would give a biased impression of their habitats.

BIOGEOGRAPHY: Of the 17 species of *Siphonicytara* known, 12 are modern and distributed throughout the Indo-West Pacific region. The following list is sorted by increasing minimum depth of occurrence (see Environments below):

S. occidentalis Bock & Cook, 2001 .... Western Australia .... 119 – 137 m.

S. excentrica Gordon & d'Hondt, 1997 .... New Caledonia, ... 360 m.

S. vittata Gordon & d'Hondt, 1997 .... New Caledonia, ... 435 – 700 m.

S. formosa Harmer, 1957 .... western Irian, ... 469 m.

S. mosaica Gordon & d'Hondt, 1997 .... New Caledonia, ... 480 – 1980 m.

S. armata Gordon & d'Hondt, 1997 .... New Caledonia, ... 675 m.

S. granulosa Gordon & d'Hondt, 1997 .... New Caledonia, ... 760 – 790 m.

S. glabra Gordon & d'Hondt, 1997 .... New Caledonia, ... 965 m.

S. serrulata Busk, 1884 .... Celebes Islands (Sulawesi), ... 1508 m.

S. cylindrica Harmer, 1957 .... Celebes Islands (Sulawesi), ... 1901 m.

S. symetrica David *et al.*,1986 .... southeast of Madagascar (Indian Ocean), ... 4297 m.

S. insolita (Canu & Bassler, 1929) .... Philippines .... ?

Tertiary species are almost exclusively from Australia:

S. airensis (Maplestone, 1902) .... Late Eocene, Victoria.

S. clypeata (Waters, 1881) .... Late Eocene, Eua (Tonga); Miocene, southern Australia.

S. irregularis (Maplestone, 1902) .... Miocene, southern Australia.

S. elevata (Waters, 1881) .... Miocene, southern Australia.

S. proditor (Canu & Bassler, 1935) .... Miocene, southern Australia.

It is interesting that one of the earliest recorded occurrences is not from Australia but from the southern Pacific island of Eua, Tonga (Cheetham, 1972).

Siphonicytara irregularis (Maplestone)

Plate 42A, B, C, D, E, F, G, H, I, J, K

? non *Eschara elevata* TENISON WOODS, 1876: 148, fig. 10.

Microporella elevata Tenison Woods; WATERS, 1881: 330, pl. 17 (figs 63, 64)

Microporella elevata Tenison Woods; WATERS, 1882b: 503, 508 (listed).

Microporella elevata Tenison Woods; WATERS, 1883: 427, 436 (listed)

Microporella elevata Tenison Woods; WATERS, 1885: 296, pl. 7 (figs 6, 9)

Tessarodoma elevata Tenison Woods; MacGillivray, 1895: 66, pl. 9 (fig. 20; given as 'figure 28' on p. 66)

Mucronella irregularis MAPLESTONE, 1902b: 21, pl. 2 (fig. 11).

Tubitrabecularia proditor CANU & BASSLER, 1935: 18, pl. 4 (fig. 10).

Tubitrabecularia elevata Tenison Woods; BROWN, 1958: 75.

Siphonicytara irregularis (Maplestone); BOCK & COOK, 2001: 311, figs 1A-E, 2A-D.

MATERIAL: SAM P39573 (TL), P39574 (TL), P39575 (TL), P39576 (TL), P39577 (MF)

OTHER MATERIAL EXAMINED: NMV P10200 (holotype of *Mucronella irregularis*, Maplestone coll.); USNM 85886 (holotype of *Tubitrabecularia proditor*, Muddy Creek, Miocene)

DESCRIPTION: Colony erect bifoliate.

Zooids alternating irregularly in longitudinal radiating rows; zooid margins indistinct (obscured by surface ornamentation), zooids near colony margins becoming slightly torqued towards margin. Frontal wall slightly granular with very pronounced ridges.

Primary orifice rounded rectangular; secondary orifice similar size to primary, circular to transversely oval, not tilted, with rounded denticle on proximal wall just inside of opening, very distal from ascopore at end of long peristome incorporated in colony surface, pronounced ridge circling orifice including 1–2 distal and 1 proximal pair of pores, ridge interrupted by two (proximo)lateral circular avicularia adjacent to orifice, sometimes dimorphic in size, crossbar complete (usually broken), rostrum directed towards orifice; ridges from proximolateral corners running to avicularia of proximal zooid; pronounced longitudinal ridge along peristome up to ascopore, two to three pairs of large pores (areolae?) along margin of peristome; small circular ascopore with raised margin positioned slightly proximal to level of neighbouring orifices and transverse ridge connecting avicularia of neighbouring zooids, areas between ridges deeply depressed.

Interzooidal avicularia along colony margin, circular to egg-shaped, complete crossbar very close to proximal margin.

Ovicells not observed.

MEASUREMENTS: (1 specimen)

Lz	6	0.77	0.073	0.68-0.86
lz	6	0.25	0.033	0.21-0.30
Lo_2	6	0.10	0.010	0.09-0.11
lo_2	6	0.12	0.003	0.11-0.12

Lav-ad	9	0.14	0.017	0.10-0.19
lav-ad	9	0.13	0.031	0.10-0.17
Do_2-as	6	0.53	0.026	0.50-0.55
Lav-iz	4	0.28	0.016	0.26-0.30
lav-iz	4	0.25	0.025	0.22-0.28

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	2. Bilaminate
F. 2° skel. thick.	?2. Frontal

G. Struct. units	5. Sheet
H. Dim. struct. units	?1. Flat
I. Freq. bifurc.	?1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: LTL *[r]*, MTL(l) *[i]*, MTL(m) *[i]*, MF(b) *[i]*, MF *[p]*, LKL(l1) *[r]*.

COMPARISONS: The type specimen of *S. irregularis* is highly obscured by adhering sediment, but distinctive characters such as the round avicularia, the frontal wall structure and the orificial denticle are easily visible. Although the zooidal dimensions are significantly larger, the orificial dimensions are identical with the present material (Lz = 1.10, lz = 0.32, Lo = 0.10, lo = 0.12 mm).

See Bock & Cook (2001b) for discussion of the synonymy.

REMARKS: The peristomial denticle is possibly also present in the Recent *Siphonicytara occidentalis* Bock & Cook (2001b; fig 6).

Siphonicytara sp. nov a

Plate 43A, B

MATERIAL: SAM P39578 (TL)

DESCRIPTION: Colony flat bifoliate or flat robust ?branching.

Zooids alternating in longitudinal radiating rows; zooid margins indistinct (obscured by strong ?secondary calcification).

Secondary orifice circular, peristome elevated and tilted distally, ascopore with deep irregularly crescentic furrow along proximal margin, other deep often sinuous furrows along one (at colony edge) or both (in colony centre) sides of peristome.

Lateral avicularia semicircular behind complete crossbar, acute rostrum (sometimes very long and thin) facing proximally inward and directed abfrontally.

Ovicells not observed.

MEASUREMENTS: (1 specimen)

Lz	4	0.69	0.015	0.68-0.71
lz	4	0.33	0.015	0.31-0.34
Lo_2	4	0.08	0.006	0.07-0.08
lo_2	4	0.08	0.005	0.08-0.09

Lav	4	0.16	0.016	0.14-0.18
lav	4	0.12	0.010	0.10-0.12
Do_2-as	4	0.49	0.010	0.48-0.50

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	2. Bilaminate
F. 2° skel. thick.	?2. Frontal

G. Struct. units	5. Sheet
H. Dim. struct. units	?1. Flat
I. Freq. bifurc.	?1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: LTL *[f]*, MF(b) *[i]*.

COMPARISONS: This species resembles '*Microporella' elevata* Tenison Woods (*sensu* Waters, 1881).

Siphonicytara sp. nov. b

Plate 43C, D, E

MATERIAL: SAM P39579 (TL)

DESCRIPTION: Colony flat bifoliate sheet.

Zooids alternating in longitudinal radiating rows; zooid margins indistinct (obscured by strong secondary calcification); frontal wall solid with 3–4 pairs of marginal pores and sinuous central ridge between orifice and ascopore.

Secondary orifice circular, peristome strongly elevated and tilted distally, ascopore indistinct.

Ovicells not observed.

MEASUREMENTS: (1 specimen)

Lz	3	0.90	0.056	0.84-0.95
lz	3	0.38	0.026	0.35-0.40
Lo_2	3	0.08	0.006	0.08-0.09
lo_2	3	0.09	0.006	0.08-0.09

Lav	3	0.18	0.021	0.16-0.20
lav	3	0.11	0.006	0.11-0.12
Do_2-as	3	0.42	0.021	0.40-0.43

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	2. Bilaminate
F. 2° skel. thick.	?2. Frontal

G. Struct. units	5. Sheet
H. Dim. struct. units	?1. Flat
I. Freq. bifurc.	?1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(m) *[r]*.

COMPARISONS: This species differs from *Siphonicytara* sp. nov. a in the structure of the frontal wall, the long peristomes and the shape of the avicularia.

Siphonicytara sp. nov. c

Plate 43F, G, H

MATERIAL: SAM P39580 (TL)

DESCRIPTION: Colony erect, delicate ?branching, columnar, not straight.

Zooids alternating in 8 longitudinal rows; zooid margins indistinct (obscured by surface ornamentation); primary orifice not observed; frontal wall with several low ridges.

Secondary orifice circular, tilted steeply distally, very distal from ascopore at end of long peristome adpressed to colony surface, pair of small distolateral pores; two (proximo)lateral circular avicularia adjacent to orifice, crossbar complete (usually broken), rostrum directed towards orifice; longitudinal ridge along peristome up to ascopore, two pairs of large pores (areolae?) along margin of peristome; small circular ascopore with raised teardrop shaped margin positioned slightly proximal to level of neighboring orifices, surrounded by reniform (flattened distally and laterally) ridge (='septal line' of Harmer, 1957?) (distolateral corners touching avicularia of neighboring zooids; ridges from proximolateral corners running to avicularia of proximal zooid), paired pores in (disto)lateral corners.

Ovicells not observed.

MEASUREMENTS: (1 specimen)

Lz	6	0.63	0.059	0.54-0.72
lz	6	0.33	0.015	0.31-0.34
Lo_2	6	0.12	0.011	0.10-0.13
lo_2	6	0.12	0.010	0.10-0.13

Lav	6	0.12	0.012	0.11-0.14
lav	6	0.10	0.015	0.09-0.13
Do_2-as	6	0.37	0.037	0.31-0.40

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	5. Radial
F. 2° skel. thick.	1. None

G. Struct. units	8. Solid cylinder
H. Dim. struct. units	?1. Flat
I. Freq. bifurc.	?2. Infrequent
J. Dim. bifurc.	?2. one plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: TL *[p]*

COMPARISONS: This species resembles *Siphonicytara clypeata* (Waters, 1881: 332, pl. 17, fig. 67; ?Oligo-Miocene, Gambier Embayment) as well as the Recent *Siphonicytara vittata* Gordon & d'Hondt (1997).

Siphonicytara **sp. nov. d**

Plate 43I, J, K

MATERIAL: SAM P39581 (TL)

DESCRIPTION: Colony erect, delicate ?branching, columnar, not straight.

Zooids alternating in 6 longitudinal rows; zooid margins indistinct (obscured by surface ornamentation); primary orifice?; frontal wall with numerous salient ridges.

Secondary orifice oval to semicircular, tilted steeply distally, very distal from ascopore at end of long peristome adpressed to colony surface, proximal lip of orifice protruding to a point and pointing distally, pair of small distolateral pores; two proximolateral circular avicularia separate from orifice, crossbar complete, rostrum directed abfrontally, with ridges running slightly proximal towards longitudinal ridge along peristome up to ascopore, two pairs of large pores (areolae?) along margin of peristome in (disto)lateral corners; small circular ascopore with raised teardrop shaped margin positioned slightly proximal to level of neighboring orifices, tilted proximally, surrounded by rectangular ridge (distolateral corners touching avicularia of neighboring zooids; ridges from proximolateral corners running to avicularia of proximal zooid, occasional median ridge to proximal orifice).

Ovicells not observed.

MEASUREMENTS: (1 specimen)

Lz	4	0.66	0.052	0.60-0.72
lz	4	0.27	0.022	0.25-0.30
Lo_2	4	0.11	0.013	0.10-0.13
lo_2	4	0.09	0.003	0.09-0.10
Lav	4	0.11	0.006	0.10-0.11
lav	4	0.09	0.005	0.09-0.10
Do_2-as	4	0.38	0.038	0.32-0.40

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	5. Radial
F. 2° skel. thick.	1. None
G. Struct. units	8. Solid cylinder
H. Dim. struct. units	?1. Flat
I. Freq. bifurc.	?2. Infrequent
J. Dim. bifurc.	?2. one plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: TL *[p]*.

COMPARISONS: This species differs from *Siphonicytara* sp. nov. c in additional and more pronounced ridges. This could be a factor of less abrasion.

Superfamily **DIDYMOSELLOIDEA** Brown, 1952

Family **DIDYMOSELLIDAE** Brown, 1952

DESCRIPTION: They possess a deep, peristomial brood-chamber (not the true peristomial ovicell of *Tubucellaria* cf. Levinsen 1909:65), large, immersed, adventitious avicularia with complete cross-bar, and a thick, chitinous integument covering the porous frontal shield. (Brown, 1952)

REMARKS: First recorded occurrence is *Didymosella* sp. (Labracherie, 1971) from the Middle Eocene (?Lutetian/?Bartonian) of North Aquitaine, France.

Genus ***Tubiporella*** Levinsen, 1909

TYPE SPECIES: *Lepralia magnirostris* MacGillivray, 1883

DESCRIPTION: Colonies semi-encrusting, with free expansions. Zooids with long, tubular peristomes and a frontal spiramen. Frontal and basal septulae numerous, and extrazooidal calcification considerable. Avicularia lateral, arising from several frontal septulae, subrostral chambers large. Rostra acute, directed laterally, mandible slung on a complete bar. Brooding zooids with a slightly enlarged orifice. (after Cook & Chimonides, 1981)

REMARKS: Cook & Chimonides (1981: 77) noted that "*Tubiporella*, like *Didymosella*, has an Australian Tertiary record, although this only extends to Miocene deposits". The occurrence here therefore extends back the known time range for this genus by up to 20 million years.

Tubiporella magna (Tenison Woods)

Plate 44A, B, C, D, E, F, G, H

Lunulites magna TENISON WOODS, 1880: 7, pl. 1 (figs 6a-d).

Microporella magna (Tenison Woods), WATERS, 1885: 295, pl. 7 (fig. 7).

Tubiporella magna (Tenison Woods), COOK & CHIMONIDES, 1981: 77.

Tubiporella magna (Tenison Woods), COOK & CHIMONIDES, 1986: 691.

MATERIAL: SAM P39325 (TL), P39326 (TL)

OTHER MATERIAL EXAMINED: NMNH D33050 (Janjukian, Aldinga), NMNH D 31940, (River Murray Cliffs)

HOLOTYPE: The catalogue of the SAM states "The syntypes from Aldinga have most probably been lost or destroyed". As there does not appear to be any confusion as to the identity of this species, and there only seems to be one species with this distinct growth form, it is not considered necessary to establish a neotype at this point. Tenison Woods cites as the type horizon and locality the "Glauconitic limestone, Aldinga". This is likely to be the upper Tortachilla Limestone. Alternately, though less likely, it could be the glauconitic horizon of the Port Willunga Formation. The species of this study is therefore undoubtedly the same.

DESCRIPTION: Colony lunulitiform, large hollow dome with wavy, sinuous (curtain-like) margins (level at base) (Pl. 47G, H), basal surface not observed due to cemented sediment in all specimens (SAM 39324 is an external mould of a lunulitiform colony, and may have originally been *T. magna*).

Zooidal margins usually indistinct due to secondary calcification, but at zooidal base they are hexagonal to circular, with thick lateral walls and 8 communication chambers (Pl. 47D); frontal wall with 5–10 small pores, often in small furrows or depressions.

Single lateral adventitious avicularium with complete slightly curved cross-bar across large round to oval opesia which tapers distally.

Brooding zooids common (especially at ancestrular/apical region), external appearance similar to autozooids, peristomial brood chamber.

MEASUREMENTS: (2 specimens)

Lz	10	0.68	0.109	0.58-0.92
lz	10	0.61	0.068	0.50-0.68
Lo	10	0.15	0.017	0.12-0.18
lo	10	0.16	0.025	0.12-0.20
Lav	10	0.27	0.045	0.22-0.38
lav	10	0.17	0.032	0.12-0.22
øpore	10	0.04	0.007	0.03-0.05
Dxbar	10	0.09	0.010	0.08-0.10

Lzov	2	0.68	0.113	0.60-0.76
lzov	2	0.57	0.014	0.56-0.58
Loov	2	0.14	0.000	0.14
loov	2	0.18	0.028	0.16-0.20
Lov	2	0.26	0.028	0.24-0.28
lov	2	0.14	0.028	0.12-0.16

øcolony	2	20.0	Colony height	7.0

A.B.G.H.C:

A. Orient. substr.	?1. Encrusting
B. Attachm. substr.	3. Free-living, sedent
C. Construction	1. Rigid continuous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	?2. Frontal

G. Struct. units	11. Hollow dome
H. Dim. struct. units	3. 3-D
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

Occurrence: MTL(m) *[r]*, MTL(u) *[p]*; (OB) GL.

Comparisons: *Pachystomaria parvipucta* MacGillivray (1895: 96, pl. 8, fig. 24; Middle Miocene, Otway Basin) appears to be very closely related and may be conspecific, but it has a very finely porous frontal area and the orifice is more oval.

Remarks: Tenison Woods (1880) gave the "glauconitic limestone, Aldinga" as the origin of his specimens. This is likely to be the upper Tortachilla Limestone, in which no *T. magna* was found in this study. Waters (1885) found this species at "Aldinga and Mt Gambier" (the latter being Miocene).

Superfamily **CELLEPOROIDEA** Johnston, 1838

Family **CELLEPORIDAE** Johnston, 1838

Description: "Colony encrusting to erect, vincularian or nodular and massive. Zooids closely packed' usually recumbent or semi-erect with irregular orientation. Frontal wall typically smooth with only marginal pores. Adventitious avicularia typically adjacent to the orifice and often associated with a peristome. Vicarious and/or inter-zooidal spatulate avicularia often present. Ovicell hyperstomial, with a frontal area and/or pores; not closed by the zooidal operculum." (Gordon, 1984)

Genus ***Buffonellaria*** Canu & Bassler, 1917

Type species: *Hippothoa divergens* Smitt, 1873

Description: "Colony encrusting. Zooidal frontal wall with marginal pores only. Primary orifice with sinus and condyles; no oral spines. Avicularia adventitious, paired or single, near the orifice; often larger, spatulate avicularia also present. Ovicell prominent or subimmersed, with an imperforate tabulate area. Basal pore-chambers present." (Gordon, 1984)

Buffonellaria cf. ***roberti*** (Brown)

Plate 47A, B, C, D, E, F

Schizoporella roberti Brown, 1958: 61, fig. 45.

Material: SAM P39556 (TL), P39557 (TL), P39558 (TL)

Other material examined: NMV P73164 (holotype of *Schizoporella roberti*, Nangeela, Victoria, Oligocene)

***Buffonellaria* cf. *roberti* continued**

DESCRIPTION: Colony erect bifoliate, often with curved branches or foliae; occasionally encrusting.

Zooid margins poorly defined by depression between zooids, rounded hexagonal, frontal wall smooth and convex, a few small pores along margin (usually at zooidal corners).

Orifice semicircular surrounded by narrow rim, with shallow V-shaped sinus and broad condyles often protruding into sinus, narrow crescentic slit just distal to orifice.

Two types of adventitious avicularia on each zooid, both directed proximolaterally: one is situated immediately proximolaterally to orifice, oval with complete cross bar; the other situated lateral to orifice on other side, approximately the same size as the first but rostrum very acute and much longer, both avicularian chambers forming convex bulges on frontal wall.

Larger ?adventitious avicularia rare, complete cross bar, long rostrum directed distally.

Ovicells recumbent on, but not immersed in distal zooid, becoming immersed in secondary calcification, orifice not closed by operculum, endooecium visible through large semicircular ectooecial window on proximal half; the larger adventitious avicularium of the distolateral zooecium often appears to encroach upon the ovicell.

MEASUREMENTS: (3 specimens)

Lz	8	0.61	0.037	0.54-0.66
lz	8	0.37	0.072	0.20-0.42
Lo	8	0.12	0.005	0.11-0.12
lo	8	0.12	0.004	0.12-0.13
Lav-ad	8	0.11	0.020	0.09-0.15

Lzov	5	0.55	0.036	0.50-0.58
lzov	5	0.39	0.105	0.22-0.44
Loov	5	0.09	0.010	0.08-0.10
loov	5	0.11	0.011	0.10-0.12
Lav-ad	5	0.10	0.018	0.08-0.12
Lov	5	0.32	0.046	0.28-0.38
lov	5	0.29	0.046	0.22-0.34

A.B.G.H.C:

A. Orient. substr.	3. Erect/1. Encrusting
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	2. Bilam./1. Unilam.
F. 2° skel. thick.	?1. None/2. Frontal

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat/2. Curved
I. Freq. bifurc.	1. None/2. Infrequent
J. Dim. bifurc.	1. None/3. >one plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: Foliose: MTL(l) *[i]*, MTL(m) *[r]*, UTL *[p]* , LKL(l1) *[r]*, LKL(l2) *[r]*, LKL(m) *[i]*; Encrusting: LTL *[r]*, MTL(l) *[i]*, MTL(m) *[f]*, MF(b) *[r]*; (OB) ?Lower Oligocene.

COMPARISONS: There are several named species, which also resemble the current species. *Schizoporella strictifissa* MacGillivray (1895: 83, pl. 11, fig. 12; Middle Miocene, Otway Basin) has only one lateral avicularium, a deeper and narrower sinus and may be multilaminar. The specimen of *Schizoporella biaperta sensu* MacGillivray (1895: 85, pl. 11, fig. 20; Middle Miocene, Otway Basin) does not show enough features to be positively compared (NMV P27718). In *Schizoporella profunda* MacGillivray (1895: 83, pl. 11, fig. 14; Middle Miocene, Otway Basin) the avicularia are oriented differently and the orifice. *Schizoporella fenestrata* Waters (1881: 339) (BMNH D1985) only has one avicularium, the sinus is U-shaped and contracted above.

At a generic level *Buffonellodes* has many similar characteristics, but the ovicells are smooth and imperforate (the tabula on proximal area of ovicell is characteristic of *Buffonellaria*), the sinus is U-shaped, and there is only one suboral avicularium.

Genus ***Celleporina*** Gray, 1848

TYPE SPECIES: *Lepralia hassallii* Johnston, 1847

DESCRIPTION: “Colony encrusting, pisiform or nodular, typically multilaminar. Orifice with a sinus, with 1–2 peristomial avicularia. No oral spines. Additional spatulate avicularia present or absent. Ovicell prominent, with a perforated ooecial exposure (tabula). Small basal pore-chambers present.” (Gordon, 1984)

***Celleporina*?** sp. nov. a

Plate 46A, B, C, D, E, F, G, H, I

MATERIAL: SAM P39535 (TL), P39536 (TL), P39537 (TL)

DESCRIPTION: Colony erect bifoliate.

Zooids rectangular to elongate hexagonal, poorly defined by raised margins or occasional thin ridge, frontal wall flat, smooth to slightly irregular, usually 6–8 medium sized pores near margin

Orifice subcircular to transversely oval, suboral avicularium (possible complete cross-bar) placed inside orificial margin, positioned slightly to one side with acute rostrum curved strongly distally, producing a pseudo-sinus. Regions of occluded zooids possibly forming maculae.

Adventitious avicularia elongate oval with complete cross bar (often broken), occasionally present on proximal half of zooid, directed laterally or proximally.

Ovicell endozooidal, level with zooidal frontal walls, semicircular window in ectooecium with finely radiating ridges exposed (endooecium?), probably opening above operculum.

MEASUREMENTS: (3 specimens)

Lz	10	0.94	0.173	0.76-1.20
lz	10	0.54	0.058	0.50-0.64
Lo	10	0.28	0.017	0.26-0.30
lo	10	0.25	0.019	0.22-0.26

Lov	6	0.41	0.048	0.35-0.48
lov	6	0.44	0.042	0.39-0.50
Lav	5	0.15	0.009	0.14-0.16
lav	5	0.10	0.007	0.09-0.11

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	?5. Macroser. mac.
E. Arrang. front. surf.	2. Bilaminate
F. 2° skel. thick.	?2. Frontal

G. Struct. units	5. Sheet
H. Dim. struct. units	?1. Flat
I. Freq. bifurc.	?1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(l) *[p]*, MTL(m) [m].

COMPARISONS: Although the ovicellular sculpture places this species into the family Celleporidae, the actual generic affinities are less clear.

Genus *Osthimosia* Jullien, 1888

TYPE SPECIES: *Cellepora eatonensis* Busk, 1881

DESCRIPTION: "Colony encrusting, pisiform, nodular or erect, multilaminar. Orifice with a sinus; 1–2 peristomial avicularia. No oral spines. Additional spatulate avicularia typically present. Ovicell prominent, with an imperforate tabula." (Gordon, 1984)

REMARKS: This is among the earliest records for *Osthimosia.*

Osthimosia? sp. nov. a

Plate 47G, H, I, J

MATERIAL: SAM P39571 (TL)

DESCRIPTION: Colony encrusting unilaminar.

Zooids diamond-shaped to hexagonal [indistinct shape], margins defined by faint suture or thread, frontal wall smooth and entirely occupied by tall (>0.2 mm) hollow cone-shaped umbo, distal surface steep and bearing circular avicularium with complete crossbar, a few small circular marginal areolae occur.

Orifice circular with small acute proximolateral condyles, distal margin slightly raised, two closely paired/adjacent spine bases on each distolateral margin (one on orifice margin, the other on zooid margin), pair of spine bases of distal margin with single spine in between (all slightly columnar) often becoming embedded in calcification of distal zooid.

No ovicells observed.

MEASUREMENTS: (1 specimen)

Lz	5	0.34	0.034	0.30-0.39
lz	5	0.27	0.017	0.26-0.30
Lo	5	0.08	0.007	0.07-0.09
lo	5	0.08	0.005	0.07-0.09

Lav	5	0.05	0.004	0.05-0.06
lav	5	0.05	0.002	0.05-0.06

A.B.G.H.C:

A. Orient. substr.	1. Encrusting
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contig.
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(l) *[r]*, MTL(m) *[r]*.

COMPARISONS: The presence of spines in this species places this generic placement in doubt, but it faces similar incompatibilities in other genera. It shows similarities with species of genera such as *Celleporina*, *Celleporaria*, *Buffonellodes*

Genus ***Palmicellaria*** Alder, 1864

TYPE SPECIES: *Palmicellaria elegans* Alder, 1864

DESCRIPTION: Colony erect, inarticulate, cylindrical, smooth, branching dichotomously. Zooids in four longitudinal alternate series, those in the two opposite series being on the same level, elongate, bearing thick high peristome. Apertures circular, opening vertically, within a slight concavity, with a broad projecting, palmate expansion in front, bearing an avicularium. Frontal and areolar pores but no lyrula or cardelles. (after Alder, 1864; Bassler, 1953)

Palmicellaria? sp. nov. a

Plate 47L,M

MATERIAL: SAM P39572 (TL)

DESCRIPTION: Colony erect very delicate branches, 4 rows of zooids (alternating in back-to-back pairs), approximately 0.5 mm diameter.

Zooids elongate tapering proximally, defined by narrow immersed thread, frontal wall convex, smooth, perforated by a few small pores.

Peristome very long (same length as main zooid), slightly inflated, several small pores around base, marginal areolae, secondary orifice subcircular, slightly flattened distally, short blunt protrusion on proximal margin, peristomial rim flared especially laterally, distal part elevated above distal zooid, zooidal marginal thread runs to peristomial rim.

Ovicells and avicularia not observed.

MEASUREMENTS: (1 specimen)

Lz	1	1.70	-	
lz	1	0.37	-	
Lo	1	0.15	-	
lo	1	0.15	-	

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	?1. Rigid contiguous
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	4. Quadrat or 5. Radial
F. 2° skel. thick.	1. None

G. Struct. units	8. Solid cylinder
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	?2. Infrequent
J. Dim. bifurc.	?2. One plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: LTL *[p]*, MTL(l) *[p]*, MTL(m) *[i]*, UTL *[p]*, MF(b) *[f]*.

Family **PHIDOLOPORIDAE** Gabb & Horn, 1862

Reteporidae Smitt, 1867

Sertellidae Jullien *in* Jullien & Calvet, 1903

Description: Colony generally erect reticulate, forming a lacey network with zooids opening on one side of the branches, with extrazooidal calcification on the basal side and projections (vibices) on back not connected with zooecia; colony attachment by thickened extrazooidal calcification at proximal portion; some colonies are delicate and branching, not forming networks; or encrusting, unilaminar or multilaminar, often massive. Zooid frontal with marginal pores only, surface smooth or pustulose. Primary orifice variable, with or without a sinus, or orbicular, condyles present, the distal orificial border typically beaded; oral spines present or absent; 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 initially, becoming immersed in secondary calcification; proximal margin of orifice may be elaborated into a projecting lip, or straight, or indented; frontal may have entire calcification, or may be perforate with a pore, slit, or complex dentate fissure; opening not closed by the zooidal operculum. Avicularia generally present, of varied types in different groups; mainly adventitious, with interzooidal avicularia in a few species. (after Gordon, 1984)

Remarks: There appears to be a gradation between morphological features of the different species investigated here, so that generic groupings and distinctions often become difficult. They also often display a mixture of characters assigned to current genera. At this early stage in the evolution of the family Phidoloporidae it may well be the case that intermediate forms existed. This poses the choice of either assigning the species to existing genera by executive decision, or establishing new genera to accommodate them.

Biogeography: The first representative of family is often considered to be *Psilosecos angustidens* (Levinsen, 1925) from the Upper Danian, Denmark (Berthelsen, 1962). Canu & Bassler (1933: 82) placed this genus tentatively under the 'Reteporidae' because of the presence of areolar pores similar to *Malleatia* and *Hippelozoon.* Unlike typical members of the Phidoloporidae, which have branches with autozooidal orifices opening on one side only, *Psilosecos* has orifices opening on both sides of the branches. Therefore, assignment to the Phidoloporidae is somewhat tentative (Voigt 1985:334). Harmer also preferred to reject it from this family in his notebooks, and rather noted possible relations with *Bracebridgia.*

If *Psilosecos* is not included in the Phidoloporidae, there are several contenders for the crown of the earliest known representative of this family. Until recently '*Reteporellina*? sp.' (Cheetham, 1972) from the Upper Eocene (Priabonian) of the island of Eua, Tonga, has been cited (Taylor, 1993: 476). Bassler (1953) also cites *Hippopozoon typicum* Canu & Bassler (1929) from the Eocene of Belgium. Recent work by Zágorsek & Kázmér (2001) recorded *Stephanollona otophora* (Reuss), *Iodictyum rubeschi* (Reuss), *I. labellatum* Zágorsek & Kázmér, *Reteporella tuberculata* (Reuss), *R. simplex* (Busk), *R. subovata* (Stoliczka) and *Sparsiporina elegans* (Reuss) from the Upper Eocene of Hungary, while Hara (2001) recorded *Reteporella* sp. and *Rhynchozoon quadratus* Hara from La Meseta Formation on Seymour Island in Antarctica, which may be as old as late Early Eocene. The diverse assemblage from the Tortachilla Limestone is late Middle Eocene. These geographically dispersed but nearly contemporaneous appearances of this family are intriguing.

The Phidoloporidae have for most of their time range been cosmopolitan, ranging from the tropics to polar waters and from high to low energy environments (see below). If such a taxonomic group has this capacity to permeate all corners of the globe today, it is not surprising that it did this soon after it originally evolved.

All the above speculation of course assumes that the family Phidoloporidae is a monophyletic (or at least paraphyletic) grouping.

ENVIRONMENTS: Fenestrate growth occurs in a variety of hydrodynamic regimes from high energy (Lagaaij & Gautier, 1965) to moderate and low energy (Schopf, 1969; Pedley, 1976). Branch linkage makes branches more stable in strong water flow (McKinney & Jackson, 1989: 174; Hass, 1948; Lagaaij & Gautier, 1965). Most modern and Palaeozoic fenestrates prefer quiet sheltered conditions and require an unusual lyre-shaped form in order to colonise higher-energy environments (McKinney *et al.*, 1993). This does not appear to be the case in southern Australia, where they frequently live in higher energy environments especially attached to sea grass stems (Y. Bone, pers. comm., 2002).

Genus ***Reteporella*** Busk, 1884

Sertella Jullien *in* Jullien & Calvet, 1903

TYPE SPECIES: *Reteporella flabellata* Busk, 1884

DESCRIPTION: Colony erect, fenestrate; branches (trabeculae) anastomosing, leaving a series of open spaces (fenestrulae) between them, fan-shaped, cup-shaped or complexly folded. Zooids opening on one face only, the basal surface consisting of kenozooids, crossed by vibices, usually bearing adventitious avicularia. Frontal wall with a few marginal pores. Primary orifice variable, with or without a broad sinus, distal margin beaded. Peristome lyrulate or with a notch, fissure or pore. Oral spines in young zooids. Avicularia adventitious, polymorphic. Ovicell prominent or subimmersed, with a median frontal fissure and the free edge produced into a labellum. Small multiporous septula present. (Gordon, 1984, as *Sertella*)

REMARKS: This genus probably includes most of the species designated as '*Retepora*' in the older literature on Australian Bryozoa, and all of the *Sertella* species.

Reteporella aff. _rimata_ (Waters)

Plate 48A, B, C, D, E, F

Retepora rimata Waters, 1881: 343, pl. 16 (figs 48, 53).

Retepora rimata Waters, MacGillivray, 1895: 112, pl. 15 (figs 12, 13).

'Retepora' rimata Waters, Brown, 1958; 26 (listed).

Material: SAM P39585 (TL), P39586 (TL), P39587 (TL)

Other material examined: MM 9246, 9247, 9248 (Curdies Creek, Waters coll.); NMV P27814 (fig. 12; Schnapper Point), P27815 (fig. 13; ?Schnapper Point), P38904, P38905, P38942, P38943 (Bairnsdale), P38906–10 (Geelong), P38926 (Hamilton), P38911–7 (Mornington), P309197 (MacGillivray coll.); NMV P73199 (Werrikee, Brown coll.)

Description: Colonies erect fenestrate, branches (trabeculae) about 0.8 mm wide, with 4–5 zooid rows, lateral rows of zooids projecting and facing slightly outwards. Basal colony surface smooth but 'bumpy' with narrow ridges originating near orifice of lateral zooid and converging disto-centrally into a sinuous median ridge; ?kenozooid with opening of similar size to the zooidal orifice place just distolaterally behind lateral zooid orifices.

Zooids irregularly hexagonal to diamond-shaped, margins defined by shallow furrow, but often indistinct; frontal wall smooth, single immersed pore placed centrally; lateral zooids slightly torqued outwards and occasionally with central adventitious avicularia.

Primary orifice transversely oval without sinus, peristome distally recumbent, very broad laterally, with deep proximal sinus, which is distally slightly constricted, 1–4 spine bases occasionally visible on distal and lateral corners of peristome (apparently becoming immersed in calcification, a pair of closely spaced spine bases often on distal margin, single large columnar spine base often protruding from one lateral corner of peristome).

Ovicells and avicularia not observed.

Measurements: (2 specimens)

Lz	7	0.40	0.022	0.36-0.42
lz	7	0.20	0.019	0.18-0.22
Lo	7	0.07	0.005	0.06-0.07
lo	7	0.08	0.005	0.07-0.08

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid continuous
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	?2. Frontal

G. Struct. units	3. Flat branch
H. Dim. struct. units	2. Folded
I. Freq. bifurc.	4. Very frequent
J. Dim. bifurc.	2. One plane
K. Conn. struct. units	2. Fused struct. units
L. Substr. type	?

Occurrence: LTL *[p]*, MTL(l) *[p]*, MTL(m) *[f]*, UTL *[p]*.

Comparisons: *Retepora rimata* (Waters, 1881; Middle Miocene, Otway Basin) has a proximal adventitious avicularium, but is otherwise very similar.

Reteporella sp. nov. a

Plate 48G, H, I, J, K, L

MATERIAL: SAM P39588 (TL), P39589 (TL), P39590 (TL)

DESCRIPTION: Colonies erect fenestrate, branches (trabeculae) about 0.5–0.6 mm wide, with 3–5 zooid rows, lateral rows of zooids projecting and facing slightly outwards. Basal colony surface smooth but bumpy with narrow ridges originating near orifice of lateral zooid and converging disto-centrally into a sinuous median ridge; ?kenozooid with opening of similar size to the zooidal orifice place just distolaterally behind lateral zooid orifices.

Zooid margins poorly defined by narrow ridge, frontal wall smooth, single immersed pore placed centrally, a pair of large longitudinally oval protrusions placed near proximolateral corners.

Primary orifice transversely oval with broad very short lyrula, without sinus, peristome distally recumbent, broad laterally, proximolateral groove/suture? running down inside of peristome but usually not manifested in secondary orifice, secondary orifice with near-median labial suture joined to off-centre spiramen, a pair of spine bases occasionally on distolateral corners of peristome.

Single large oval adventitious avicularium placed centrally on frontal wall (between spiramen and frontal pore), complete cross-bar (often broken), large flat palateal rostrum directed proximally, slightly immersed and surrounded by a narrow ridge.

Ovicells endozooidal, completely immersed in distal zooid, opening into peristome, ectooecium with central vertical suture or faint fissure, distal margin defined by narrow crescentic ridge.

MEASUREMENTS: (3 specimens)

Lz	11	0.30	0.020	0.26-0.32
lz	11	0.17	0.013	0.17-0.20
Lo	11	0.05	0.004	0.05-0.06
lo	11	0.08	0.014	0.07-0.11

Lov	7	0.11	0.017	0.09-0.14
lov	7	0.11	0.005	0.11-0.12
Lav	11	0.08	0.011	0.08-0.11
lav	11	0.09	0.008	0.04-0.07

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid continuous
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	?2. Frontal

G. Struct. units	3. Flat branch
H. Dim. struct. units	2. Folded
I. Freq. bifurc.	4. Very frequent
J. Dim. bifurc.	2. One plane
K. Conn. struct. units	2. Fused struct. units
L. Substr. type	?

OCCURRENCE: LTL *[p]*, MTL(m) *[r]*.

COMPARISONS: It resembles *R. rimata* (Waters) in the proximal avicularium and the ovicell with longitudinal ribs, but is otherwise quite different.

Reteporella **sp. nov. b**

Plate 48M, N, O

MATERIAL: SAM P39591 (TL)

DESCRIPTION: Colonies erect fenestrate, branches (trabeculae) about 0.4–0.5 mm wide, with 2–3 zooid rows, up to 0.9 mm wide at junctions with 5 zooid rows.

Zooid margins poorly defined by broadly raised sutures, frontal wall smooth, 2–5 variably sized pores scattered some distance from zooidal margins.

Primary orifice transversely oval to inverted trapezoidal without sinus, peristome fairly short, not protruding past (secondarily thickened) frontal surface, distally immersed, secondary orifice with serrated proximal margin, labial suture joined to off-centre spiramen, suboral avicularium oval with complete cross-bar and rostrum (no palatal shelf) directed laterally away from spiramen, both spiramen and avicularium surrounded by raised rims; a pair of conspicuous spine bases on lateral corners of peristome.

Ovicells endozooidal, largely immersed in distal zooid, visible as slight bulge with large central elongate pore, opening into peristome, opening margin arched downwards and overarching secondary orifice, but leaving lateral spines free, ectooecium with central subcircular fissure.

MEASUREMENTS: (1 specimen)

Lz	6	0.36	0.023	0.34-0.40
lz	6	0.24	0.015	0.21-0.25
Lo	6	0.05	0.002	0.05
lo	6	0.09	0.004	0.09-0.10

Lov	2	0.17	0.014	0.16-0.18
lov	2	0.19	0.007	0.18-0.19
Lav	6	0.06	0.019	0.05-0.10
lav	6	0.05	0.004	0.04-0.05

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid continuous
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	?2. Frontal

G. Struct. units	3. Flat branch
H. Dim. struct. units	2. Folded
I. Freq. bifurc.	4. Very frequent
J. Dim. bifurc.	2. One plane
K. Conn. struct. units	2. Fused struct. units
L. Substr. type	?

OCCURRENCE: LTL *[r]*, MTL(m) *[r]*, MF(b) *[i]*.

COMPARISONS: It resembles *Retepora coriensis* MacGillivray (1895: 116, pl. 15, fig. 19; NMV P72821; ?Miocene, Otway Basin) in the orificial avicularia and spines, but the absence of ovicells in the type specimen make a positive comparison difficult.

***Reteporella*? sp. nov. c**

Plate 49A, B, C, D, E, F, G

MATERIAL: SAM P39592 (TL), P39593 (TL)

DESCRIPTION: Colonies erect branching (not fenestrate), branches about 0.6–0.8 mm wide, with 4–6 zooid rows. Basal colony surface smooth but bumpy with narrow ridges originating near orifice of lateral zooid and converging disto-centrally into a sinuous median ridge; lingulate adventitious avicularium mainly present along lateral colony margins lateral to marginal zooid orifice.

Zooid margins poorly defined by broadly raised sutures, frontal wall smooth, single pore placed centrally in proximal half.

Primary orifice transversely oval without sinus (but with short broad lyrula?), peristome variably developed, occasionally (usually in zooids in central rows) proximal portion very elongated and elevated abfrontally at ~45° in a distal direction, secondary orifice subcircular with deep and slightly constricted proximolateral groove running down inside of peristome, suboral avicularium oval, complete cross-bar, placed on top of very long avicularian chamber, which runs for most of the length of the peristome and tapers proximally (this is broken in most specimens appears like a long parallel sided to V-shaped concavity on frontal wall); a pair of small spine bases on lateral corners of peristome.

Ovicells recumbent and immersed in distal zooid, opening at top of peristome, opening margin slightly inflected, frontal with central suture.

MEASUREMENTS: (3 specimens)

Lz	20	0.41	0.049	0.32-0.50
lz	20	0.19	0.022	0.14-0.22
Lo	20	0.06	0.008	0.06-0.09
lo	20	0.07	0.005	0.06-0.09

Lov	2	0.17	0.007	0.16-0.17
lov	2	0.13	0.014	0.12-0.14

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid continuous
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	?2. Frontal

G. Struct. units	3. Flat branch
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	?4. Very frequent
J. Dim. bifurc.	?2. One plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: LTL *[r]*, MTL(l) *[i]*, MTL(m) *[i]*, MF(b) *[i]*.

***Reteporella*? sp. nov. d**

Plate 49H, I, J

MATERIAL: SAM P39594 (TL)

DESCRIPTION: Colonies erect possibly fenestrate, branches (trabeculae) about 0.5–0.7 mm wide, with 3–5 zooid rows.

Zooid margins defined by salient ridge, frontal wall smooth and slightly convex, single pore usually placed in proximal half.

Primary orifice transversely oval without sinus, peristome slightly developed, secondary orifice subcircular with small off-centre sinus adjacent to suboral avicularium oval with complete cross-bar, placed on top of very long avicularian chamber; a pair of small spine bases on lateral corners of peristome.

Ovicells recumbent on distal zooid, very elongate and high-domed, opening into peristome, opening margin arched upwards and overarching secondary orifice, ectooecium with central suture along most of length, occasionally open at distal end; single circular adventitious avicularium with complete cross-bar on a short triangular elevation distomedial to each ovicell.

MEASUREMENTS: (1 specimen)

Lz	6	0.51	0.041	0.45-0.56
lz	6	0.21	0.033	0.16-0.26
Lo	6	0.05	0.007	0.05-0.07
lo	6	0.07	0.008	0.06-0.08

Lov	3	0.32	0.015	0.30-0.33
lov	3	0.19	0.015	0.17-0.20

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid continuous
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	?2. Frontal

G. Struct. units	3. Flat branch
H. Dim. struct. units	?2. Folded
I. Freq. bifurc.	?4. Very frequent
J. Dim. bifurc.	?2. One plane
K. Conn. struct. units	?2. Fused struct. units
L. Substr. type	?

OCCURRENCE: MTL(m) *[r]*, LKL(m) *[f]*.

***Reteporella*? sp. nov. e**

Plate 50K, L

MATERIAL: SAM P39595 (TL)

DESCRIPTION: Colonies erect possibly fenestrate, branches (trabeculae) about 1.0–1.3 mm wide, with 6–9 zooid rows.

Zooid margins poorly defined by narrow ridge, frontal wall smooth, slightly concave, single pore placed centrally in proximal half.

Primary orifice not seen, peristome poorly developed, secondary orifice subcircular with deep and slightly constricted proximolateral groove running down inside of peristome; rarely a pair of small spine bases on lateral corners of peristome.

Avicularium adventitious placed centrally on frontal wall, oval with complete cross-bar, long rostrum directed proximally.

Ovicells not observed.

MEASUREMENTS: (1 specimen)

Lz	4	0.31	0.015	0.30-0.33
lz	4	0.19	0.008	0.18-0.20
Lo	4	0.07	0.007	0.07-0.08
lo	4	0.06	0.003	0.06

Lav	4	0.10	0.005	0.10-0.11
lav	4	0.06	0.005	0.05-0.06

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid continuous
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	?2. Frontal

G. Struct. units	3. Flat branch
H. Dim. struct. units	?2. Folded
I. Freq. bifurc.	?4. Very frequent
J. Dim. bifurc.	?2. One plane
K. Conn. struct. units	?2. Fused struct. units
L. Substr. type	?

OCCURRENCE: TL *[p]*.

COMPARISONS: *R. aciculifera* MacGillivray (1895: pl. 15, figs 2–4; NMV P27804–6; Mornington, Middle Miocene, Otway Basin) has similar orifice with sinus, and frontal single pore; however, the avicularium is acute and raised, there are numerous basal avicularia and no orificial avicularia.

Genus ***Iodictyum*** Harmer, 1933

TYPE SPECIES: *Retepora phoenicea* Busk, 1854 (selected by Harmer, 1933)

DESCRIPTION: "Zooarium fenestrate. Peristomes dimorphic, at first projecting, their orifices with more or less distinct marginal teeth and marginal denticles, but without spines. Descending lamina of ovicell produced with a projecting lip (labellum) bearing a median keel, generally terminating distally in a minute pore which is the only representative of a stigma. Small round and oval avicularia usually absent. Primary basal kenozooecia biserial." (Harmer, 1934)

Iodictyum**?** sp. nov. a

Plate 49K, L, M, N

MATERIAL: SAM P39596 (TL)

DESCRIPTION: Colonies erect fenestrate, branches (trabeculae) about 0.2–0.4 mm wide, with 3–4 zooid rows. Basal colony surface covered in shallow pits, with narrow ridges originating near orifice of lateral zooid and converging disto-centrally into a sinuous median ridge; small oval adventitious avicularium scattered apparently randomly.

Zooid margins defined by ridges and raised sutures, frontal wall faintly granulated or shallowly pitted.

Primary orifice D-shaped, distally beaded, straight proximal margin with sinus, peristome variably developed, often with proximal portion elongated, secondary orifice also D-shaped with continuation of sinus, suboral avicularium occasionally present (usually in marginal zooids), complete cross-bar, placed the side of sinus facing fenestrule, acute rostrum directed towards fenestrule.

Ovicells not observed.

MEASUREMENTS: (1 specimen)

Lz	4	0.37	0.034	0.35-0.42
lz	4	0.20	0.016	0.18-0.22
Lo	4	0.10	0.005	0.09-0.10
lo	4	0.09	0.006	0.08-0.09

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid continuous
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	?2. Frontal

G. Struct. units	3. Flat branch
H. Dim. struct. units	2. Folded
I. Freq. bifurc.	4. Very frequent
J. Dim. bifurc.	2. One plane
K. Conn. struct. units	2. Fused struct. units
L. Substr. type	?

OCCURRENCE: MTL(m) *[r]*, LKL(m) *[c]*.

COMPARISONS: *Retepora schnapperensis* MacGillivray (1895: 113, pl. 15, fig. 6; NMV P27808; Mornington, Middle Miocene, Otway Basin) looks similar but has a pair of proximal pores.

Genus ***Reteporellina*** Harmer, 1933

TYPE SPECIES: *Retepora denticulata* Busk, 1884

DESCRIPTION: "Colony erect, branching, sometimes anastomosing but never tightly fenestrate. Zooids without oral spines; peristomes often subtubular and protruding, with marginal or internal processes, with an open or closed pseudosinus. Frontal avicularium typically present. Ovicell with proximal lateral processes between which is an inset labellum." (Gordon, 1989)

REMARKS: The strict generic definition that the colonies are "never tightly fenestrate" would preclude the following species.

Reteporellina sp. nov. a

Plate 50A, B, C, D, E

MATERIAL: SAM P39597 (TL), P39598 (TL)

DESCRIPTION: Colony erect, fenestrate, branches (trabeculae) about 0.5–0.8 mm wide, with 2–4 zooid rows.

Zooidal margins indistinct, defined by raised suture; frontal wall evenly and shallowly pitted.

Primary orifice subcircular, peristome barely protruding, secondary orifice subcircular with pseudosinus slightly off-centre and running down inside of peristome, occasionally an adventitious avicularium placed on lip of secondary orifice adjacent to the sinus, oval with complete cross-bar, directed laterally away from sinus.

Ovicell semicircular and globular, smooth becoming immersed in calcification but clearly visible as bulge, opening with two straight fissures up to half the length of ovicell and adjacent to broad U-shaped labellum.

MEASUREMENTS: (2 specimens)

Lz	4	0.33	0.032	0.30-0.37
lz	4	0.17	0.010	0.16-0.18
Lo	4	0.08	0.006	0.07-0.08
lo	4	0.10	0.010	0.09-0.11

Lov	4	0.16	0.012	0.15-0.17
lov	4	0.12	0.015	0.11-0.14

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid continuous
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	?2. Frontal

G. Struct. units	3. Flat branch
H. Dim. struct. units	2. Folded
I. Freq. bifurc.	4. Very frequent
J. Dim. bifurc.	2. One plane
K. Conn. struct. units	2. Fused struct. units
L. Substr. type	?

OCCURRENCE: TL *[p]*.

***Reteporellina*? sp. nov. b**

Plate 50F, G, H, I, J

MATERIAL: SAM P39599 (TL), P39600 (TL)

DESCRIPTION: Colony erect, fenestrate, branches (trabeculae) about 0.6–0.9 mm wide, with 4–5 zooid rows. Basal colony wall evenly and finely pitted, with medium sized bumps, sinuous ridges from margin converging proximally with central ridge.

Zooidal margins indistinct, frontal smooth.

Primary orifice subcircular, peristome variably thick not protruding especially proximally, secondary orifice irregularly subcircular with broad pseudosinus slightly off-centre and running down inside of peristome.

Ovicell recumbent, relatively small and tapering distally, smooth with faint fissure down middle, becoming slightly immersed in calcification, opening with sinuous margin (giving appearance of 'nostrils').

Avicularia not observed.

MEASUREMENTS: (2 specimens)

Lz	4	0.31	0.013	0.29-0.32
lz	4	0.16	0.005	0.16-0.17
Lo	4	0.07	0.009	0.06-0.07
lo	4	0.08	0.010	0.07-0.09

Lov	4	0.10	0.006	0.09-0.10
lov	4	0.11	0.005	0.10-0.11

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid continuous
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	?2. Frontal

G. Struct. units	3. Flat branch
H. Dim. struct. units	2. Folded
I. Freq. bifurc.	4. Very frequent
J. Dim. bifurc.	2. One plane
K. Conn. struct. units	2. Fused struct. units
L. Substr. type	?

OCCURRENCE: TL *[p]*.

Genus ***Triphyllozoon*** Canu & Bassler, 1917

TYPE SPECIES: *Retepora monilifera* MacGillivray, 1860

DESCRIPTION: "Colony erect, fenestrate, attached by an encrusting base. Fan- or cup-shaped, or with the edges complexly folded to form a squat, three-dimensional bun shape. Autozooids opening on one face only of fenestrate sheet, in alternating series along the branches (trabeculae), which anastomose at regular intervals defining oval fenestrulae. Basal surfaces of colony crossed by thickened sutures. Primary orifice with denticulate rim, obscured by a deep peristome with a longitudinal slit (pseudosinus), often partly closed except for a proximal pseudospiramen, typically with a small peristomial avicularium. Oral spines present. Frontal wall with few, large marginal pores. Avicularia adventitious, polymorphic. Ovicell prominent, with a conspicuous, trilobed frontal suture, and a well developed labellum overhanging the aperture." (Ryland & Hayward, 1992)

REMARKS: The following species may not be a true *Triphyllozoon* as the trilobed ovicellular structure is only faint and may not be the same as in true species of the genus.

'*Triphyllozoon*' sp. nov. a

Plate 51A, B, C, D, E, F, G, H, I, J, K

MATERIAL: SAM P39601 (TL), P39602 (TL), P39947 (TL), P39948 (TL)

DESCRIPTION: Colony erect fenestrate, trabeculae 0.5–1.0 mm wide, 3–5 zooid rows across. Basal colony wall smooth, with medium sized lumps, sinuous ridges from margin converging proximally with central ridge, occasional medium sized oval adventitious avicularia with complete cross bars.

Zooid margins usually poorly defined, occasionally by narrow ridge, frontal wall smooth, slightly convex, 1–4 small scattered pores, sometimes 2 larger pores near proximolateral corners, usually one circular avicularium with complete cross-bar placed centrally or slightly off-centre.

Orifice circular, slightly beaded distally, proximal margin sometimes flattened, with inflected proximolateral condyles giving it a trifoliate appearance, surrounded by thin rim, one pair of large distolateral spine bases.

Ovicells recumbent to deeply immersed in distal zooid's secondary calcification, large spherical, slightly flattened proximally, smooth and imperforate with faint ridges, opening slightly sinuous, above but not overarching zooid orifice or spines.

MEASUREMENTS: (2 specimens)

Lz	5	0.30	0.027	0.25-0.32
lz	5	0.18	0.025	0.14-0.20
Lo	5	0.06	0.000	0.06
lo	5	0.06	0.004	0.05-0.06

Lov	3	0.18	0.012	0.17-0.19
lov	3	0.18	0.010	0.17-0.19
Lav	5	0.06	0.004	0.05-0.06
lav	5	0.06	0.004	0.06-0.07

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid continuous
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	?2. Frontal

G. Struct. units	3. Flat branch
H. Dim. struct. units	2. Folded
I. Freq. bifurc.	4. Very frequent
J. Dim. bifurc.	2. One plane
K. Conn. struct. units	2. Fused struct. units
L. Substr. type	?

OCCURRENCE: MTL(l) *[p]*, MTL(m) *[r]*, MF(b) *[r]*.

COMPARISONS: This species is similar to *Retepora porcellana* MacGillivray (1895: 115, pl. 15, fig. 15; NMV P27817; Corio Bay, ?Miocene, Otway Basin), but the adventitious avicularium is much more elongated, there is a suboral avicularium, and the orificial condyles are not very pronounced.

'*Triphyllozoon*' sp. nov. b

Plate 51L, M, N

MATERIAL: SAM P39949 (TL)

DESCRIPTION: Colony erect branching (not fenestrate), branches at least 2 mm wide, 8–9 zooid rows across. Basal colony wall smooth.

Zooid margins poorly defined, frontal wall smooth, slightly convex, 3–5 large pores, mainly near proximal margin.

Orifice trifoliate, with large circular anter, with proximolateral condyles separating very small poster, proximal margin straight, surrounded by thin rim, one pair of small distolateral spine bases.

Ovicells recumbent and immersed in distal zooid, spherical, mostly broken, smooth and imperforate, opening slightly sinuous, above but not overarching zooid orifice or spines, interior of endooecium with transverse ridges.

MEASUREMENTS: (1 specimen)

Lz	3	0.41	0.055	0.35-0.45
lz	3	0.21	0.010	0.20-0.22
Lo	3	0.08	0.006	0.07-0.08
lo	3	0.07	0.006	0.07-0.08

Lov	3	0.16	0.038	0.13-0.20
lov	3	0.16	0.026	0.14-0.19

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid continuous
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	?2. Frontal

G. Struct. units	3. Flat branch
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	4. Very frequent
J. Dim. bifurc.	2. One plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: LTL *[p]*.

Genus ***Phidoloporidae Gen. indet. A***

Phidoloporidae Gen. indet. A sp. nov. a

Plate 48P, Q, R

MATERIAL: SAM P39950 (TL)

DESCRIPTION: Colony erect fenestrate, branches 0.4–0.6 mm wide, 3–4 zooid rows across. Basal colony surface with ridges and adventitious avicularia, drop-shaped with cross-bar, usually directed proximal to lateral.

Frontal wall smooth and flat.

Primary orifice not observed, peristome poorly developed and flat, secondary orifice elliptical with slight proximal lip.

Avicularia adventitious often central on frontal wall, drop-shaped with acute rostrum strongly raised above frontal and slightly curved proximally.

Ovicells not observed.

MEASUREMENTS: (1 specimen)

Lz	4	0.46	0.046	0.40-0.50
lz	4	0.23	0.038	0.20-0.28
Lo	4	0.05	0.005	0.05-0.06
lo	4	0.08	0.005	0.07-0.08

Lav	3	0.12	0.020	0.10-0.14
lav	3	0.08	0.006	0.08-0.09

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid continuous
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	?2. Frontal

G. Struct. units	3. Flat branch
H. Dim. struct. units	2. Folded
I. Freq. bifurc.	4. Very frequent
J. Dim. bifurc.	2. One plane
K. Conn. struct. units	2. Fused struct. units
L. Substr. type	?

OCCURRENCE: MF(b) *[r]*.

COMPARISONS: *Retepora fissa hexagona* MacGillivray (1895: 111, pl. 15, fig. 9; NMV P27811; Hamilton, Middle Miocene, Otway Basin) has similar projecting frontal avicularia, but a secondary orifice with sinus.

Genus ***Phidoloporidae Gen. indet. B***

Phidoloporidae Gen. indet. B sp. nov. a

Plate 51O, P, Q, R

MATERIAL: SAM P39951 (TL), P39952 (TL)

DESCRIPTION: Colony erect branching, possibly fenestrate, branches 0.5 mm wide, 3 zooids across. Basal colony surface with ridges running into central ridge, large adventitious avicularia behind each zooid, drop-shaped with cross-bar and acute rostrum directed proximally (often broken and appearing as oval holes).

Zooids diamond-shaped, defined by narrow ridge, frontal wall smooth and slightly convex.

Orifice subcircular with rounded proximolateral condyles, peristome moderately developed and recumbent, secondary orifice semicircular often with straight proximal margin and very shallow rounded sinus, one or two pairs of small distolateral spine pairs.

Avicularia not observed.

Ovicells hyperstomial recumbent on distal zooid, not immersed, globular, slightly longer than wide, some directly above secondary orifice, others placed a long distance distally with opening far from zooid.

MEASUREMENTS: (2 specimens)

Lz	5	0.53	0.028	0.51-0.58
lz	5	0.21	0.009	0.20-0.22
Lo	5	0.07	0.005	0.07-0.08
lo	5	0.08	0.011	0.08-0.10

Lov	4	0.22	0.029	0.20-0.26
lov	4	0.18	0.013	0.17-0.20

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid continuous
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	?2. Frontal

G. Struct. units	3. Flat branch
H. Dim. struct. units	2. Folded
I. Freq. bifurc.	4. Very frequent
J. Dim. bifurc.	2. One plane
K. Conn. struct. units	2. Fused struct. units
L. Substr. type	?

OCCURRENCE: TL *[r]*.

REMARKS: The very distally placed ovicells are a distinctive feature.

Phidoloporidae? Gen. indet. B sp. nov. b

Plate 51S, T, U, V

MATERIAL: SAM P39953 (TL)

DESCRIPTION: Colonies erect branching, branches about 0.4–0.5 mm wide, with 2–4 zooid rows.

Zooid margins poorly defined, frontal wall smooth, two pores placed near proximolateral corners.

Primary orifice circular without sinus, peristome poorly developed, secondary orifice subcircular to longitudinally elongated with small narrow sinus centrally, a pair of small spine bases on lateral corners of peristome.

Ovicells spheroid [mostly broken] recumbent on and slightly immersed in distal zooid, opening above secondary orifice.

MEASUREMENTS: (1 specimen)

Lz	4	0.50	0.043	0.45-0.55
lz	4	0.17	0.010	0.16-0.18
Lo	4	0.08	0.005	0.07-0.08
lo	4	0.07	0.006	0.06-0.07

Lov	4	0.20	0.008	0.19-0.21
lov	4	0.17	0.017	0.15-0.19

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid continuous
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	?2. Frontal

G. Struct. units	3. Flat branch
H. Dim. struct. units	2. Folded
I. Freq. bifurc.	4. Very frequent
J. Dim. bifurc.	2. One plane
K. Conn. struct. units	2. Fused struct. units
L. Substr. type	?

OCCURRENCE: TL *[p]*.

Family **INCERTAE SEDIS A**

Genus ***Gen. indet. A***

Gen. indet. A sp. nov. a

Plate 45I, J, K, L

MATERIAL: SAM P39565 (TL)

DESCRIPTION: Colony erect cylindrical branching, 10 – 12 zooidal rows around, 1.1 – 1.6 mm diameter.

Zooids hexagonal, margins poorly defined by shallow furrow, frontal wall flat, a few (about 6) large marginal pores and several scattered smaller pores across rest of frontal area.

Orifice longitudinally oval, short acute condyles just distal to proximolateral corners, very short peristome, secondary orifice slightly wider than primary but same shape, suboral ?avicularian chamber (only noticeable when broken, but normally no external structure visible?).

Ovicells and avicularia not observed.

MEASUREMENTS: (1 specimen)

Lo	5	0.66	0.053	0.60-0.74
lz	5	0.35	0.031	0.30-0.38
Lo	5	0.17	0.008	0.16-0.18
lo	5	0.13	0.011	0.11-0.14

Lav	2	0.06	0.007	0.05-0.06
lav	2	0.03	0.004	0.03

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	?1. Rigid contiguous
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	5. Radial
F. 2° skel. thick.	?2. Frontal

G. Struct. units	8. Solid cylinder
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	?2. Infrequent
J. Dim. bifurc.	?2. One plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(l) *[i]*, MTL(m) *[r]*, LKL(l1) *[r]*, LKL(m) *[r]*.

COMPARISONS: This species superficially resembles species of *Hippoporina* Neviani, but the frontal wall is not evenly perforated and the suboral polymorph is also distinct.

Family **INCERTAE SEDIS B**

Genus ***Gen. indet. B***

Gen. indet. B sp. nov. a

Plate 30L, M, N

MATERIAL: SAM P39566 (TL)

DESCRIPTION: Colony encrusting unilaminar.

Zooids hexagonal, margins defined by shallow furrow, sometimes with low ridge, frontal wall smooth, imperforate.

Orifice subcircular to transversely oval, proximal margin completely straight, a pair of small but distinct proximolateral condyles, orificial margin slightly and broadly raised.

Avicularia adventitious, single, placed near proximolateral orifice corner, drop-shaped, cross-bar or condyles possibly present, short acute rostrum directed laterally to distolaterally.

Ovicells not observed.

MEASUREMENTS: (1 specimen)

Lo	4	1.07	0.050	1.03-1.14
lz	4	0.72	0.066	0.65-0.79
Lo	4	0.22	0.008	0.21-0.23
lo	4	0.26	0.014	0.25-0.28

Lav	4	0.23	0.014	0.21-0.24
lav	4	0.17	0.013	0.15-0.18

A.B.G.H.C:

A. Orient. substr.	1. Encrusting
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilam. / 6. Multilam.
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(l) *[p]*, MTL(u) *[f]*,

Family **INCERTAE SEDIS C**

Genus ***Gen. indet. C***

Gen. indet. C sp. nov. a

Plate 45A, B, C, D

MATERIAL: SAM P39567 (TL), P39568 (TL)

DESCRIPTION: Colony erect cylindrical branches, 6 rows of zooids, 0.4 mm diameter.

Zooids very elongate hexagonal to oval (narrower proximally), margins defined by very narrow low ridge inside a slightly raised suture, frontal wall slightly convex, smooth, imperforate, approximately 8 small to medium sized marginal areolae.

Orifice slightly semicircular, proximal margin variably convex to concave, margins slightly and narrowly raised, no condyles, sinus or spine bases.

Adventitious avicularium/polymorph placed near one proximolateral zooid corner, oval, margins raised, very small blunt condyles.

Ovicells not observed.

MEASUREMENTS: (2 specimens)

Lz	7	0.72	0.072	0.63-0.81
lz	7	0.25	0.017	0.23-0.27
Lo	7	0.09	0.011	0.07-0.10
lo	7	0.10	0.005	0.09-0.10

Lav	7	0.07	0.013	0.06-0.09
lav	7	0.06	0.010	0.05-0.08

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	?1. Rigid contiguous
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	5. Radial
F. 2° skel. thick.	1. None

G. Struct. units	8. Solid cylinder
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	?2. Infrequent
J. Dim. bifurc.	?2. One plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(m) *[p]*.

COMPARISONS: This species superficially resembles *Macrocamera inarmata* Bock & Cook (2001: 146; NMV P10192, P310588; Miocene, Otway Basin), but the extremely proximal position of the avicularium and the absence of a sinus preclude this allocation.

Gen. Indet. C sp. b

Plate 45E, F, G, H

MATERIAL: SAM P39569 (TL), P39570 (TL)

DESCRIPTION: Colony erect cylindrical branches, 8 rows of zooids, 0.4mm diameter.

Zooids very elongate claviform to almost inverted drop-shaped, margins defined by narrow ridge, frontal wall convex, smooth, imperforate, approximately 8 very small marginal areolae directly abutting marginal ridge.

Orifice subcircular slightly flattened proximally, margins slightly and narrowly raised, no condyles, sinus or spine bases.

Adventitious avicularium/polymorph placed in one proximolateral zooid corner, oval, margins raised.

Ovicells recumbent (slightly immersed?), elongate oval, slightly asymmetrical and deflected to one side, frontal wall smooth convex, not all ovicelled zooids have a proximal avicularium.

MEASUREMENTS: (2 specimens)

Lz	8	0.74	0.039	0.69-0.79
lz	8	0.22	0.019	0.19-0.25
Lo	8	0.10	0.017	0.08-0.12
lo	8	0.10	0.008	0.09-0.11

Lov	4	0.22	0.019	0.21-0.25
lov	4	0.23	0.013	0.21-0.24
Lav	6	0.07	0.020	0.05-0.10
lav	6	0.06	0.010	0.05-0.08

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	?1. Rigid contiguous
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	5. Radial
F. 2° skel. thick.	1. None

G. Struct. units	8. Solid cylinder
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	?2. Infrequent
J. Dim. bifurc.	?2. One plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(m) *[p]*.

COMPARISONS: This species strongly resembles Gen. indet. C sp. a, but the rounder orifice, more salient marginal ridges and smaller marginal areolae set it apart.

Class **STENOLAEMATA**
Order **CYCLOSTOMATA**

REMARKS: It is not possible to treat the cyclostomes is similar taxonomic detail as the cheilostomes in this study, mainly due to time constraints . The quality of preservation of most specimens was also insufficient for positive identification (see also Chapters 1.10. and 4.1.1.)

Suborder **TUBULIPORINA** Milne-Edwards, 1838

Family **FILISPARSIDAE** Borg, 1944

Genus ***Nevianipora*** Borg, 1944

TYPE SPECIES: *Idmonea milneana* d'Orbigny, 1839

Nevianipora sp. a
Plate: 52A, B, C

MATERIAL: SAM P39954 (TL), P39955 (TL), P39956 (TL)

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	3. Flat branch
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	?2. Infrequent
J. Dim. bifurc.	2. One plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: LTL *[r]*, MTL(l) *[p]*, MTL(m) *[i]*, UTL *[c]*.

COMPARISONS: This species resembles *Nevianipora* cf. *milneana* (*sensu* MacGillivray, 1895).

Family **DIAPEROECIIDAE** Canu, 1918

Genus ***Diaperoecia*** Canu, 1918

TYPE SPECIES: *Pustulopora intricaria* Busk, 1875

Diaperoecia? sp. a
Plate: 52H, I

MATERIAL: SAM P39957 (TL)

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	5. Radial
F. 2° skel. thick.	1. None

G. Struct. units	8. Solid cylinder
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	?1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: LTL *[p]*, MTL(l) *[r]*, MTL(m) *[i]*.

***Diaperoecia*? sp. b**
Plate: 52D, E

MATERIAL: SAM P3983758 (TL)

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	5. Radial
F. 2° skel. thick.	1. None

G. Struct. units	8. Solid cylinder
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	?2. Infrequent
J. Dim. bifurc.	2. One plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(l) *[r]*, MTL(m) *[i]*.

COMPARISONS: *Entalophoroecia*

Genus ***Entalophoroecia*** Harmelin1976

TYPE SPECIES: *Tubulipora deflexa* Couch, 1844 (1842?)

Entalophoroecia ? sp. a
Plate: 52J

MATERIAL: SAM P39959 (TL)

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	5. Radial
F. 2° skel. thick.	1. None

G. Struct. units	8. Solid cylinder
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	?2. Infrequent
J. Dim. bifurc.	2. One plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: LTL *[p]*, MTL(l) *[r]*, MTL(m) *[r]*, MF(b) *[p]*, LKL(m) *[f]*.

Family **TERVIIDAE** Jullien, 1883

Genus ***Tervia*** Bronn, 1825

TYPE SPECIES: *Tervia solida* Jullien, 1883

Tervia sp. a
Plate: 52F, G

MATERIAL: SAM P39960 (TL)

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	8. Solid cylinder
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	?2. Infrequent
J. Dim. bifurc.	2. One plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: LTL *[p]*, MTL(l) *[i]*, MTL(m) *[r]*, MF(b) *[r]*.

REMARKS: *Tervia* is today restricted to the Atlantic (Y. Bone, pers. comm., 2002)

Genus ***Terviidae Gen. indet.***

Terviidae? Gen. indet.? sp. a
Plate: 52K, L, M

MATERIAL: SAM P39961 (TL), P39962 (TL)

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	5. Radial
F. 2° skel. thick.	1. None

G. Struct. units	8. Solid cylinder
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	?2. Infrequent
J. Dim. bifurc.	2. One plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: LTL *[r]*.

Family **STOMATOPORIDAE** Pergens & Meunier, 1886

Genus ***Stomatopora*** Bronn, 1825

TYPE SPECIES: *Alecto dichotoma* Lamouroux, 1821

Stomatopora cf. ***geminata*** MacGillivray, 1886
Plate: 53C

Stomatopora geminata MACGILLIVRAY, 1886: 130, pl. 20 (fig. 1)

MATERIAL: SAM P39842 (TL)

A.B.G.H.C:

A. Orient. substr.	1. Encrusting
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	2. Infrequent
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(l) *[r]*, MTL(m) *[r]*.

Stomatopora sp. a
Plate: 53A, B

MATERIAL: SAM P39843 (TL)

A.B.G.H.C:

A. Orient. substr.	1. Encrusting
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	4. Runner convex
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	?3. Frequent
J. Dim. bifurc.	2. One plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(l) *[r]*, MTL(m) *[i]*, MF(b) *[p]*.

'***Stomatopora***' sp. b
Plate: 53D, E

MATERIAL: SAM P39872 (TL)

A.B.G.H.C:

A. Orient. substr.	1. Encrusting
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	1. Uniserial
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	4. Very frequent
J. Dim. bifurc.	2. One plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(l) *[r]*, MTL(m) *[i]*, MF(b) *[r]*, LKL(l2) *[p]*.

Family **TUBULIPORIDAE** Johnston, 1838

Genus ***Eximonea*** Braga & Barbin, 1988

TYPE SPECIES: *Alecto dichotoma* Lamouroux, 1821

Exidmonea**?** sp. a
Plate: 54A, B, C

MATERIAL: SAM P39844 (TL), P39845 (TL), P39846 (TL)

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous	G. Struct. units	4. Convex branch
B. Attachm. substr.	?1. Cemented	H. Dim. struct. units	1. Straight
C. Construction	1. Rigid contiguous	I. Freq. bifurc.	?2. Infrequent
D. Arrang. zooid ser.	3. Oligoserial	J. Dim. bifurc.	2. One plane
E. Arrang. front. surf.	1. Unilaminate	K. Conn. struct. units	1. None
F. 2° skel. thick.	1. None	L. Substr. type	?

OCCURRENCE: LTL *[f]*, MTL(l) *[f]*, MTL(m) *[f]*, MTL(u) *[c]*, UTL *[c]*, MF(b) *[f]*, LKL(l1) *[f]*, LKL(l2) *[c]*, LKL(t) *[p]*.

COMPARISONS: *Idmonea atlantica* MacGillivray (1895), *Idmonea serialis* MacGillivray (1895)

Exidmonea**?** sp. b
Plate: 54D

MATERIAL: SAM P39847 (TL)

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous	G. Struct. units	4. Convex branch
B. Attachm. substr.	?1. Cemented	H. Dim. struct. units	1. Straight
C. Construction	1. Rigid contiguous	I. Freq. bifurc.	?2. Infrequent
D. Arrang. zooid ser.	3. Oligoserial	J. Dim. bifurc.	2. One plane
E. Arrang. front. surf.	1. Unilaminate	K. Conn. struct. units	1. None
F. 2° skel. thick.	1. None	L. Substr. type	?

OCCURRENCE: MTL(m) *[p]*, MF(b) *[p]*.

Exidmonea**?** sp. c
Plate: 54E, F, G, H

MATERIAL: SAM P39848 (TL)

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous	G. Struct. units	4. Convex branch
B. Attachm. substr.	1. Cemented	H. Dim. struct. units	2. Curved
C. Construction	1. Rigid contiguous	I. Freq. bifurc.	3. Frequent
D. Arrang. zooid ser.	3. Oligoserial	J. Dim. bifurc.	2. One plane
E. Arrang. front. surf.	1. Unilaminate	K. Conn. struct. units	1. None
F. 2° skel. thick.	1. None	L. Substr. type	?

OCCURRENCE: TL *[p]*.

Family **CINCTIPORIDAE** Boardman, Taylor & McKinney, 1992

Genus ***Attinopora*** Boardman, McKinney & Taylor, 1992

TYPE SPECIES: *Pustulopora zealandica* Mantell, 1850

***Attinopora*?** sp. a
Plate: 56K

MATERIAL: SAM P39870 (TL)

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	5. Radial
F. 2° skel. thick.	1. None

G. Struct. units	8. Solid cylinder
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	?1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: LTL *[f]*, MTL(l) *[r]*, MTL(m) *[p]*, MTL(u) *[p]*, UTL *[f]*, LKL(l1) *[p]*, LKL(l2) *[r]*, LKL(m) *[i]*.

Family **Indeterminate**

Genus ***'Berenicea'***

'Berenicea' sp. a
Plate: 58K

MATERIAL: SAM P39869 (TL)

A.B.G.H.C:

A. Orient. substr.	1. Encrusting
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	5. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: LTL *[p]*, MTL(l) *[r]*, MTL(m) *[i]*, MF(b) *[r]*.

Suborder **CANCELLATA** Gregory, 1896
Family **HORNERIDAE** Gregory, 1899

Genus ***Hornera*** Lamouroux, 1821

TYPE SPECIES: *Hornera frondiculata* Lamouroux, 1821

Hornera cf. foliacea? MacGillivray, 1889
Plate: 55A

MATERIAL: SAM P39850 (TL)

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	?1. None

G. Struct. units	4. Branch convex
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	3. Frequent
J. Dim. bifurc.	2. One plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(m) *[r]*, MTL(u) *[p]*, MF(b) *[r]*, LKL(m) *[c]*.

COMPARISONS: *Hornera robusta* generally has bigger and thicker branches, and is not fenestrate.

Hornera cf. ***frondiculata*** *sensu* MacGillivray
Plate: 55C

Hornera frondiculata MacGillivray, 1895: 126, pl. 18 (figs 7, 8), pl. 19 (fig. 7)

MATERIAL: SAM P39851 (TL)

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	?1. None

G. Struct. units	4. Branch convex
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	2. Infrequent
J. Dim. bifurc.	2. One plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: TL *[p]*.

Hornera sp. a
Plate: 55B

MATERIAL: SAM P39849 (TL)

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	5. radial
F. 2° skel. thick.	?1. None

G. Struct. units	8. Solid cylinder
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	?2. Infrequent
J. Dim. bifurc.	?2. One plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: TL *[p]*.

Hornera sp. b
Plate: 55D, E, F

MATERIAL: SAM P39852 (TL)

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	?1. None

G. Struct. units	4. Branch convex
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	3. Frequent
J. Dim. bifurc.	2. One plane
K. Conn. struct. units	?2. Fused struct. units
L. Substr. type	?

OCCURRENCE: MTL(l) *[r]*, MF(b) *[f]*, LKL(l2) *[r]*.

Family **CRISINIDAE**

Genus ***Crisina*** d'Orbigny, 1853

TYPE SPECIES: *Crisina normaniana* d'Orbigny, 1853

Crisina sp. a
Plate: 56A, B, C, D, E,

MATERIAL: SAM P39853 (TL)

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	?1. None

G. Struct. units	4. Branch convex
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	2. Infrequent
J. Dim. bifurc.	2. One
K. Conn. struct. units	?1. None
L. Substr. type	?

OCCURRENCE: LTL *[p]*, MTL(l) *[f]*, MTL(m) *[i]*, LKL(m) *[c]*.

COMPARISONS: *Polyascosoeciella* is similar to *Crisina* but does not have basal kenozooids.

Genus ***Polyascosoeciella*** Taylor & McKinney, 1996

TYPE SPECIES: *Idmonea foraminosa* Reuss, 1851

Polyascosoeciella sp. a
Plate: 56F

MATERIAL: SAM P39854 (TL)

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	?3. Oligoserial
E. Arrang. front. surf.	?1. Unilaminate
F. 2° skel. thick.	?

G. Struct. units	4. Branch convex
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	?3. Frequent
J. Dim. bifurc.	2. One plane
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MF(b) *[p]*.

Suborder **ARTICULINA**
Family **CRISIIDAE** Johnston, 1838

Genus ***Crisia*** Lamouroux, 1812

TYPE SPECIES: *Sertularia eburnea* Linnaeus, 1758

Crisia sp. a
Plate: 56H

MATERIAL: SAM P39855 (TL)

A.B.G.H.C:

A. Orient. substr.	3. erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	3. Artic. determ. joints
D. Arrang. zooid ser.	2. biserial
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	3. Branch flat
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	?3. Frequent
J. Dim. bifurc.	?
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: LTL *[c]*, MTL(l) *[i]*, MTL(m) *[i]*, UTL *[i]*, LKL(l1) *[d]*, LKL(l2) *[d]*.

Crisia sp. b
Plate: 56I, J

MATERIAL: SAM P39856 (TL)

A.B.G.H.C:

A. Orient. substr.	3. erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	3. Artic. determ. joints
D. Arrang. zooid ser.	2. biserial
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	3. Branch flat
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	?3. Frequent
J. Dim. bifurc.	?
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(m) *[r]*, LKL(l1) *[i]*.

Suborder **CERIOPORINA** von Hagenow, 1851
Family **CERIOPORIDAE** Waters, 1880 [Heteroporidae]

Genus ***Heteropora*** de Blainville, 1830

TYPE SPECIES: *Ceriopora cryptopora* Goldfuss, 1826

?***Heteropora*** cf. ***pisiformis*** MacGillivray, 1895
Plate: 56G

MATERIAL: SAM P39857 (TL)

A.B.G.H.C:

A. Orient. substr.	2. Massive
B. Attachm. substr.	?3. Tumbled
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	6. Multilaminate
F. 2° skel. thick.	?2. Frontal

G. Struct. units	13. Nodule
H. Dim. struct. units	3. 3-D object
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(m) *[p]*.

Genus ***Reticrescis*** Hara, 2001

TYPE SPECIES: *Reticrescis plicatus* Hara, 2001

DESCRIPTION: Colony erect, reticulate, branches compressed horizontally, bilamellar, autozooids exserted, arranged in quincunx, more or less irregular or in short rows. Peristomes thick, slightly oblique. ?Kenozooids numerous, more or less cordiform in shape, with a characteristic prominent projection which is similar to a pseudolunarium. Brood chamber subcircular in outline with a floor covered by zooids. (Hara, 2001: 60)

REMARKS: Originally described from the Antarctic Early Eocene, Hara (2001) placed this genus tentatively into the family Cerioporidae, and mentioned the similarities of *R. plicatus* with *Reticulipora transennata* Waters (1884; see below). *Reticulipora patagonica* Ortman (see Canu, 1904; ?Eocene, Argentina) is also very similar and closer investigation of the zooidal structures may reveal its generic affinities.

Reticrescis cf. ***transennata*** (Waters)
Plate: 57A, B, C, D, E

Reticulipora transennata WATERS, 1884

MATERIAL: SAM P39858 (TL), P39859 (TL)

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	?1. Unilaminate
F. 2° skel. thick.	?

G. Struct. units	4. Convex branch
H. Dim. struct. units	?2. Curved
I. Freq. bifurc.	4. Very frequent
J. Dim. bifurc.	2. One plane
K. Conn. struct. units	2. Fused units
L. Substr. type	?

OCCURRENCE: LTL *[r]*, MTL(l) *[r]*, MTL(u) *[r]*, UTL *[p]*, MF(b) *[i]*.

COMPARISONS: *Holostoma airensis*

Reticrescis sp. b
Plate: 57F, G, H, I, J

MATERIAL: SAM P39860 (TL)

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	3. Oligoserial
E. Arrang. front. surf.	?1. Unilaminate
F. 2° skel. thick.	?

G. Struct. units	4. Convex branch
H. Dim. struct. units	?2. Curved
I. Freq. bifurc.	4. Very frequent
J. Dim. bifurc.	2. One plane
K. Conn. struct. units	2. Fused units
L. Substr. type	?

OCCURRENCE: TL *[p]*.

Suborder **RECTANGULATA** Waters, 1887
Family **LICHENOPORIDAE** Smitt, 1867

Genus ***Disporella*** Gray, 1848

TYPE SPECIES: *Discopora hispida* Fleming, 1828

Disporella sp. a
Plate: 58A, B

MATERIAL: SAM P39861 (TL), P39862 (TL), P39863 (TL)

A.B.G.H.C:

A. Orient. substr.	1. Encrusting
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	1. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(l) *[p]*, MTL(m) *[r]*, MF(b) *[r]*.

Disporella sp. b
Plate: 58C, D

MATERIAL: SAM P39864 (TL)

A.B.G.H.C:

A. Orient. substr.	?5. Fungiform
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	1. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(m) *[p]*, LKL(l1) *[r]*, LKL(m) *[p]*.

COMPARISONS: *Discofascigera* d'Orbigny (Frondiporidae Busk, 1875; under Tubuliporina)

Lichenoporidae Gen. A sp. a
Plate: 61D, E

MATERIAL: Due to the cemented nature of the horizons in which they occur no specimens were able to be sampled for closer analysis

A.B.G.H.C:

A. Orient. substr.	1. Encrusting
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	1. Sheet
H. Dim. struct. units	1. Flat
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: LKL *[r]*.

Lichenoporidae Gen. B sp. a
Plate: 58I

MATERIAL: SAM P39865 (TL)

A.B.G.H.C:

A. Orient. substr.	1. Encrusting
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	1. Sheet
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MTL(m) *[r]*, UTL *[p]*, MF(b) *[p]*.

Lichenoporidae Gen. C sp. a
Plate: 58G, H

MATERIAL: SAM P39866 (TL)

A.B.G.H.C:

A. Orient. substr.	5. Fungiform
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	1. Sheet
H. Dim. struct. units	?3. 3D
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: TL *[p]*.

COMPARISONS: Similar fungiform genera recorded from Australia are *Supercytis* d'Orbigny (Cytididae; Cancellata) and *Discofascigera* d'Orbigny (Frondiporidae).

Lichenoporidae Gen. C sp. b
Plate: 58E, F

MATERIAL: SAM P40002 (TL)

A.B.G.H.C:

A. Orient. substr.	5. Fungiform
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	1. Sheet
H. Dim. struct. units	?3. 3D
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: TL *[p]*.

Lichenoporidae Gen. D sp. a
Plate: 58J

MATERIAL: SAM P39867 (TL)

A.B.G.H.C:

A. Orient. substr.	1. Encrusting	G. Struct. units	1. Sheet
B. Attachm. substr.	1. Cemented	H. Dim. struct. units	1. Straight
C. Construction	1. Rigid contiguous	I. Freq. bifurc.	1. None
D. Arrang. zooid ser.	4. Macroser. non-mac.	J. Dim. bifurc.	1. None
E. Arrang. front. surf.	1. Unilaminate	K. Conn. struct. units	1. None
F. 2° skel. thick.	1. None	L. Substr. type	?

OCCURRENCE: MTL(l) *[p]*, MTL(m) *[r]*.

Family **Incertae sedis**

Gen indet. A sp. a
Plate: 57L

MATERIAL: SAM P39871 (TL)

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous	G. Struct. units	8. Solid cylinder
B. Attachm. substr.	1. Cemented	H. Dim. struct. units	1. Straight
C. Construction	1. Rigid contiguous	I. Freq. bifurc.	?2. Infrequent
D. Arrang. zooid ser.	3. Oligoserial	J. Dim. bifurc.	2. One plane
E. Arrang. front. surf.	5. Radial	K. Conn. struct. units	1. None
F. 2° skel. thick.	1. None	L. Substr. type	?

OCCURRENCE: LTL *[p]*, MF(b) *[p]*.

Family **Incertae sedis**

Gen indet. B sp. a
Plate: 56L

MATERIAL: SAM P39873 (TL)

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous	G. Struct. units	8. Solid cylinder
B. Attachm. substr.	?1. Cemented	H. Dim. struct. units	1. Straight
C. Construction	1. Rigid contiguous	I. Freq. bifurc.	?2. Infrequent
D. Arrang. zooid ser.	3. Oligoserial	J. Dim. bifurc.	2. One plane
E. Arrang. front. surf.	5. Radial	K. Conn. struct. units	1. None
F. 2° skel. thick.	1. None	L. Substr. type	?

OCCURRENCE: TL *[p]*.

Family **Incertae sedis**

Gen indet. C sp. a
Plate: 57K

MATERIAL: SAM P39873 (TL)

A.B.G.H.C:

A. Orient. substr.	3. Erect continuous
B. Attachm. substr.	?1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	2. Biserial
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	?4. Convex branch
H. Dim. struct. units	2. Curved/1. Straight
I. Freq. bifurc.	?1. None
J. Dim. bifurc.	?1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: MF(b) *[r]*.

Family **Incertae sedis**

Gen indet. D sp. a
Plate: 58L

MATERIAL: SAM P39868 (TL)

A.B.G.H.C:

A. Orient. substr.	1. Encrusting
B. Attachm. substr.	1. Cemented
C. Construction	1. Rigid contiguous
D. Arrang. zooid ser.	4. Macroser. non-mac.
E. Arrang. front. surf.	1. Unilaminate
F. 2° skel. thick.	1. None

G. Struct. units	1. Sheet
H. Dim. struct. units	1. Straight
I. Freq. bifurc.	1. None
J. Dim. bifurc.	1. None
K. Conn. struct. units	1. None
L. Substr. type	?

OCCURRENCE: LTL *[r]*.

Chapter 5: Biogeography

"The bryozoan faunas [of the Australian Tertiary] are so unlike the standard associations in the Tertiary of Europe and America that no definite correlations have been made so far. Indeed, their nearest relations seem to be in the recent seas around Australia."

(Bassler *in* Canu & Bassler, 1935)

5.1. Introduction

The above statement by R.S. Bassler indicates a paradigm shift from the earlier attempts by A.W. Waters (1881, 1882a, b, 1883, 1884, 1885, 1887) to shoehorn the Australian Cainozoic bryozoan species he described into ones he was familiar with from Europe. Brown (1958) later echoed the sentiment in the quote by Bassler. Interestingly, Tenison Woods (1880: 5) had already stated much earlier "...I think it may safely be affirmed that any one seeing the present collection of fossil Selenariadæ would not hesitate to pronounce them Australian in character, and we may therefore *assume* that in Miocene times the polyzoa had already acquired an Australian facies". It became recognised that the Australian marine fauna has been uniquely endemic since early in the formation of the modern oceans. This endemism had already been more obvious and thus recognised for the terrestrial fauna. This differentiation from other faunas had probably progressed relatively gradually from the initial interconnected Gondwana faunas. Evidence of pre-Cainozoic Bryozoa is scarce in Australia, just as it is in much of the southern hemisphere (P.D. Taylor, pers. comm., 2001). It is likely that all classes of Bryozoa existed in the waters around Australia since shortly after they originated, but their presence is not indicated in the observed rock record. Most of the past taxonomic research on the Australian Cainozoic Bryozoa has concentrated around the easily accessible Oligo-Miocene formations in south-eastern Australia. Australia had already fully separated from all other continents by the Oligocene, and biogeographical isolation was established. The Eocene, on the other hand, still represented a different time in continental arrangements, global currents and climates (Fig. 1). Indeed, in some respects it more closely resembled the Cretaceous than the Neogene (see also 'Chapter 1: Geology Introduction').

The Eocene is an important epoch in bryozoan evolution, as it appears to have been the first time since the Late Cretaceous that major diversifications occurred within the Bryozoa (Gordon & Taylor, 1999). The Ypresian (Early Eocene), in particular, contrasts with the low rate of diversification throughout the Paleocene (Gordon & Voigt, 1996; Gordon & Taylor, 1999). A similar trend has been observed for other phyla, with high diversity and rate of originations occurring during the Eocene. This was also one of the warmest times of the Cainozoic, with subsequently high sea levels. The associated flooding of continental margins had several consequences for the marine faunas. The extensive areas of flooded shallow continental shelf produced many diverse ecosystems, which subsequently engendered an increase in innovation and speciation. It also meant that larger areas of continental shelf sea floor were available for sediment accumulation. A larger volume of sediments, and thus fossils, were therefore also available to potentially be preserved in the rock record. Nonetheless, the Eocene diversity seems to be only rivalled by Late Cretaceous and Late Miocene diversity.

High diversity assemblages occur in just a few of the sediments sampled during this study (Tortachilla Limestone, basal Mulloowurtie Formation and Lower Kingscote Limestone). These facies probably represented normal marine facies during a marine transgression. 177 cheilostome and 33 cyclostome species were identified with certainty. They belong to 90 and 17 genera respectively. Approximately another 35 cheilostome and 30 cyclostome 'taxa' were distinguished, but the specimens were either too poorly preserved, too small and/or too few in number to be confidently assigned a taxonomic identity. It is therefore probably no exaggeration to consider the Eocene fauna of the St Vincent Basin to comprise over 250 species (over 200 cheilostome and 60 cyclostome species). These numbers do not include species, which could not be sampled, either because they occurred in facies not present in the accessed outcrops, or because they were simply not preserved due to destructive diagenetic effects.

Approximately 1000 species of Cainozoic Bryozoa (Cheilostomata and Cyclostomata) have been formally described from Australia to date (2003), although a significant proportion may be synonymous. The majority of these have been described from Oligo-Miocene sediments in south-eastern Australia. These species are assigned to approximately 220 currently accepted genera. The 116 new species and 10 new genera therefore significantly add to the Australian fossil bryozoan fauna.

5.2. Biogeographic Elements

Faunal assemblages can generally be subdivided into three general categories at species level:

1) widespread or cosmopolitan species
2) endemic species of widespread/cosmopolitan genera
3) endemic species of endemic genera

None of the Eocene bryozoan species of the St. Vincent Basin can be confidently assigned to any species occurring outside of the Australian region, except tentatively *Chaperiopsis columnella* in New Zealand. Although certain species can attain a global distribution by their own means, many of the living cosmopolitan species may have been dispersed via anthropogenic means. Many of these cosmopolitan species are also 'featureless' species such as *Membranipora membranacea* (L.), which can often be difficult to differentiate in the fossil record.

All species are endemic to the Australian region, and belong to a mixture of endemic and wide-ranging genera. Such high endemism is not altogether surprising, as few Recent species are truly cosmopolitan (at least without anthropogenic influence). The use of species is therefore of limited use in establishing biogeographic patterns, and genera or even families are more useful in this discussion.

This fauna can be divided into several biogeographic groupings at generic and subgeneric level:

1) Local basin endemic
2) Australia endemic
3) Widespread (Indo-Pacific/Tethyan; Southern/Antarctic; or Global/Cosmopolitan)

5.2.1. Distributions within St Vincent Basin

The faunas on each margin of the basin have some distinctly different taxonomic signatures. This is probably largely due to the disparate sedimentary facies, which co-occurred in close proximity. Several

Species⇓ / Basin & Age ⇒	Otway Eocene	Otway Oligocene	Otway Miocene	Murray Miocene	Eucla Eocene	Carnarvon Paleocene	Carnarvon Eocene	New Zealand
'Biflustra' orbicularis (MacGillivray)			●					
'Antropora' savartii (MacGillivray, *non* Savigny & Audouin)			●					
Crassimarginatella sculpta (MacGillivray)		O	●					
Chaperiopsis columnella (Brown)			O					●
Hiantopora quadricornis (Maplestone)			O					
Micropora elegans Maplestone			●					
'Onychocella' sp. nov. a					O	●	O	
'Onychocella' sp. nov. b				O	O			
Otionellina exigua (Tenison-Woods)			●		●			
Otionellina cupola (Tenison-Woods)		●	●		●			
Melicerita angustiloba (Tenison-Woods)		●	●					
Figularia rugosa (Maplestone)			●					
Caloporella speciosa MacGillivray			●					
Concatenella airensis (Maplestone)	●	●	●					
Arachnopusia unicornis (Hutton)		●	●					
Adeonellopsis symmetrica (Waters)		O	●					
Adeonellopsis clavata (Stoliczka)	O	●	●	O				O
Adeonellopsis cf *yarraensis* (Waters)	O	●	●	O				O
Celleporaria cf *'gambierensis'* (Tenison-Woods)	O	●	●	●	●			O?
Celleporaria nummularia (Tenison-Woods)		●	●	●				
Trigonopora personata (Maplestone)			●					
Porella angustata Maplestone			●					
Rhamphosmittina lateralis MacGillivray		●	●					rec.
Smittoidea cf *dennanti* (Maplestone)			●					
Porina spongiosa (MacGillivray)			●					
Escharina nitidissima (Maplestone)			●					
Escharina granulata (MacGillivray)			●					
Hippomenella magna Canu & Bassler		O	●					
Buffonellaria roberti (Brown)			●					
Macrocamera robusta Bock & Cook	●	●	●					
Siphonicytara irregularis (Maplestone)	●	●	●					
Tubiporella magna (Tenison-Woods)		O	●					
Reteporella rimata (Waters)		O	●					
Stomatopora geminata MacGillivray			●					
Hornera cf *'frondiculata'* MacGillivray			●	O				
Hornera cf *robusta* MacGillivray			●					
Heteropora cf *pisiformis* MacGillivray			O					
Reticrescis transennata (Waters)		O	●	O				

Table 1: Occurrences in other basins of species found in the Eocene St Vincent Basin. ● = certain or confirmed occurrence; O = uncertain occurrence (non-specific locality information or uncertain species identity)

common species occur across the basin, but in varying abundances (e.g. *Porina spongiosa, Ogiva* sp. nov. a, *Crisia* a). The difference in sedimentary facies appears to end with Oligo-Miocene limestones, which display similar lithologies across the basin. Further research on the younger formations is required to confirm such a trend towards homogeneity for the Bryozoa within the basin.

One species is observed to 'switch' basin margins across the Eocene/Oligocene boundary. In the Eocene *'Onychocella'* sp. b only occurs on the eastern margin (Tortachilla Limestone and Blanche Point Formation), but in the Oligocene it occurs only on the western margin (Port Vincent Limestone), while *'O.'* sp. a and *'O.'* sp. c occur on the eastern margin (Port Willunga Formation). It is not clear why this occurred as the Oligocene formations are more similar to each other across the basin, than they are to any of the directly underlying Eocene formations on the same basin margin (Fig. 3)

5.2.2. Local Basin Endemic Taxa

The data from this study shows that about two thirds of the cheilostome species (ca. 116 of the 177) are endemic to the Basin (species, which are here deemed new or of uncertain specific placement, are at this point considered such 'basin endemics'). Detailed investigation of the Western Australian Eucla, Bremer and Carnarvon Basins may extend the geographic range of some species, however, and result in a reduction in this apparent endemicity.

An excellent example of this level of endemism is seen in the species of Cellariidae. The St Vincent Basin species are as diverse as those found in the Victorian Cainozoic, but are composed of different species. There are 16 species of *Cellaria* differentiated here, but only seven are similar to species identified previously, and not sufficiently so to be considered conspecific. Even *Cellaria contigua* MacGillivray, which is one of the most common and ubiquitous species in the Cainozoic of Victoria, has not been identified with certainty from any of the current samples.

Such local species endemism is not surprising, as many bryozoan taxa do not have a high rate of genetic interchange between populations because of their sessile life history and short larval life span. The resulting poor gene flow between populations can easily cause allopatric and even sympatric speciation (Jablonski, 1986; Taylor, 1988).

Ten new are genera required for the cheilostome species, of which seven are known only from the St Vincent Basin. This implies that almost 8% of the genera observed in this study are endemic to the St Vincent Basin. This points towards significant isolation of the populations within the basin.

5.2.3. Regional Australasia Endemic Taxa

All the species found in the St Vincent Basin are probably endemic to the Australian region. Most of those species considered to be conspecific with ones already described by other authors, are also found to the south-east in the Murray and Otway Basins (see Table 1). Although most of these species are only tentatively assigned to their Victorian counterparts, they are probably closely related. This shows that 34 of the 177 cheilostome species (~17%) and 5 of the 33 cyclostome species (~15%) are closely related with the known Otway Basin Cainozoic faunas. Several other similar looking species are clearly not conspecific with the species of the Otway Basin faunas. This is the case with the species *'Onychocella'* sp. nov. b from the St Vincent Basin and *'Onychocella' clarkei* (Tenison Woods, 1877) from the Otway Basin (Schmidt & Bone, in press).

Few species are only found in basins to the west of the St Vincent Basin, such as *'Onychocella'* sp. a, which also occurs in the Wilson Bluff Limestone (Eucla Basin) and the Cardabia Calcarenite (Carnarvon Basin). This low number could be due largely to lack of knowledge of the western faunas, and the number of shared species will increase with further taxonomic studies.

Chaperiopsis columnella (Brown) is the only species found also in New Zealand (*Adeonellopsis yarraensis* and *A. clavata* are possibly also shared), giving only a minor cross-Tasman link. This represents only a minor link compared to many other animal groups (e.g. echinoids, gastropods), which indicate a ready exchange of taxa between these two regions. Only 9 of the 32 genera described by Gordon & Taylor (1999) from the latest Paleocene to earliest Eocene from the Chatham Island are shared with the St Vincent Basin fauna.

Seven of the 107 genera are also restricted to Australia throughout the Cainozoic to the Recent (*Otionellina, Acerinucleus, Anaskopora, Strophipora, Stenostomaria, Dimorphosella, Macrocamera*). Two new genera are limited to the Australian Cainozoic. *'Onychocella'* gen. nov. occurs commonly in all Cainozoic basins around the southern and western Australian margin. It has not been recorded outside of Australia. *'Biflustra' orbicularis* is a species of unclear affinities, and probably requires a new genus that is endemic to Australia.

5.2.4. Widespread Taxa

The Cainozoic (including Eocene) Bryozoa of the Otway Basin are different to those of other contemporary continents, but similar to the modern Australian fauna (P.E. Bock, pers. comm., 2002). This is not true to the same degree for the St Vincent Basin Eocene Bryozoa. There are distinct similarities to faunas of other Palaeogene continents, but differences to modern Australia and, as mentioned above, contemporary Victoria. This difference is interesting, as it indicates the possibility of two faunal realms.

5.2.4.1. Indo-Pacific/Tethyan Taxa

The St Vincent Basin fauna has links to those of other contemporary Eocene continents (e.g. Eastern Europe and North America) at a supraspecific taxonomic level (family and even genus). The species of a new genus of Romancheinidae (classed here as two species of *'Escharoides'*, p. 164, Pl. 27) discussed here show strong similarities with species recorded in the Palaeogene of both North America (Canu & Bassler, 1920) and Eastern Europe (Zágorsek, 1998), as well as the Recent of New Zealand (Gordon, 2001) and Japan (D.P. Gordon, pers. comm., 2000). Some of these species may also be closely related to the *Trigonopora personata* found in this study. Although the distribution of this genus could be classed as 'global', it does follow a Tethyan arc, which could be significant regarding its dispersal.

5.2.4.2. Southern Taxa

In contrast to the northern warmer water Tethyan connection, there is a minor link with the temperate and cool regions to the south. The cyclostome *Reticrescis* (Pl. 57A–J) is only known from the Australian and Antarctic Eocene (Hara, 2001). However, overall only nine of the 23 genera (39%) recorded from the Eocene La Meseta Formation on Seymour Island also occur in the St Vincent Basin. Although environmental factors my play a crucial role, a more extensive taxonomic link could be expected, considering the close geographic link between these two continents and the relatively temperate climate of the Antarctic Peninsula in the Eocene. Molluscs similarly don't appear to show a taxonomic link between the Eocene of southern Australia and Seymour Island (T.A. Darragh, pers. comm., 2003), apparently disproving the 'Wedellian Province' proposed by Zinsmeister (1982).

5.2.4.3. Global Taxa

Many of the major modern cheilostome families (e.g. Smittinidae, Phidoloporidae), originated during the Eocene. Within a geologically short time they achieved a cosmopolitan range. Many of these families currently have their earliest records in the southern hemisphere. They appear in the Middle Eocene St Vincent Basin with a high diversity already established this early in their stratigraphic record.

a) The family Smittinidae is first recorded in the Lower Eocene (Ypresian) of Seymour Island, Antarctica (Hara, 2001). Its first occurrence in the Middle Eocene St Vincent Basin already consists of 19 species in four genera. They also appear in great diversity in the Upper Eocene of North America (Canu & Bassler, 1920) and Eastern Europe (Zágorsek, 1998).

b) The family Phidoloporidae shows a similar pattern of occurrence to the Smittinidae, and made an almost instantaneous appearance on all continents in the Eocene. It appears in the Middle Eocene St Vincent Basin with a diversity of 14 species in 6 genera.

5.2.5. Cretaceous Tethyan Component

In addition to simply having a geographic link with the Tethyan realm, some elements of the bryozoan fauna of the Eocene St Vincent Basin have a Late Cretaceous Tethyan character. Several taxa are highly reminiscent of the kinds of bryozoans that dominated much of the Tethyan region until the end of the Mesozoic:

a) The diversity of erect growth morphologies of the species of Onychocellidae are similar to the species of the same family, which dominated much of the Maastrichtian faunas, but had largely vanished by the Early Paleocene (Voigt, 1985).

b) The species of *'Lunulites'* display similarities with several taxa of Cretaceous Calloporidae (e.g. *Callopora lyrula* (von Hagenow); see Medd, 1964). Such similarities may, however, be convergent as the Calloporidae is a diverse family.

c) The species tentatively included here under the Bryopastoridae (Pl. 8E, F, G), has characters reminiscent of the cyclostome family Eleidae, which has an accepted time range from Barremian (early Middle Cretaceous) to Danian (Early Palaeocene). No calcified opercula were observed in the present species, and it cannot therefore be confirmed as an eleid or even a cyclostome. The large 'gonozooids' are also similar to bioclaustrations (embedment structures) formed by some species of Middle Cretaceous cyclostomes around a symbiont organism (P.D. Taylor, pers. comm., 2002). Either way this species further contributes to the 'Cretaceous' character of the fauna.

Gordon & Taylor (1999) also observed that the Paleocene Chatham Islands bryofaunas "are composed of a number of genera reminiscent of the Cretaceous of the Northern Hemisphere and of families that are common in the Neogene and recent Southern Hemisphere". This is also true for the Early Eocene Seymour Island (Hara, 2001).

5.2.6. 'Living Fossils'

Three Eocene St Vincent Basin species are sufficiently similar to Recent species, which still occur in Australian waters, to be considered conspecific (for references see respective synonymies):

Melicerita angustiloba. (widespread in Australia and New Zealand)

Arachnopusia unicornis (New Zealand)

Rhamphosmittina lateralis (Australia, New Zealand and Vanuatu)

The species *Celleporaria tridenticulata* (Busk), which has been identified by some authors in the Cainozoic (see synonymy of *C. 'gambierensis'*) is possibly the same species as *C. gambierensis*. Both appear very similar to the actual modern species *C. tridenticulata.*

These species have persisted for almost 40 million years if they are truly conspecific with modern ones. Oligocene species such as *Amphiblestrum hastingsae* Brown (Gordon, 1984) have indeed been found in modern seas. This is roughly an order of magnitude longer than what is considered the average life-span of marine animal species (Sepkoski, 1997). Bryozoan species themselves may have an even shorter average life-span, as they tend to speciate relatively rapidly (Mackie *et al.*, 2000; Cheetham *et al.*, 1993, 1994, 1995).

5.2.7. Ranges of Taxa

5.2.7.1. First Occurrences of Species

As this study sampled some of the earliest occurrences of post-Palaeozoic bryozoans in Australia investigated to date, all of the known and 'new' species will therefore inevitably have their 'first' occurrences here. This may only be a transitional status, as planned studies of older sediments in Western Australia may extend the ranges of some species.

5.2.7.2. First Occurrences of Genera

Possible first occurrences of genera include (Unless indicated otherwise these genera were previously first recorded from the Oligocene of Victoria; previous recorded first occurrences in brackets):

Antropora..................................(Late Eocene; Sepkoski 2002)

Chaperiopsis............................(Oligocene?)

Hippoporina ....(Early Oligocene?, New Zealand; Brown, 1952)

Dactylostega ....(Oligocene?)

Foveolaria (Odontionella) ....(Pliocene; Sepkoski 2002)

Otionellina.................................(Late Eocene, Otway Basin; Bock & Cook, 1998)

Acerinucleus.............................(Early Oligocene, Otway Basin; Brown, 1958)

Strophipora...............................(Early Miocene, Otway Basin; Sepkoski 2002)

Stenostomaria..........................(Early Miocene, Otway Basin; Brown, 1958)

Caberea ....(Early Oligocene; Lidgard, unpubl.)

Caberoides...............................(Late Eocene; Lidgard, unpubl.)

Trigonopora..............................(Late Eocene; Lidgard, unpubl.)

Several other genera have their first recorded occurrences in Lower to Middle Eocene strata in other parts of the world. Their occurrence in the Middle Eocene St Vincent Basin is thus very early on in the history of these genera. *Celleporaria, Smittina, Smittoidea, Osthimosia* and *Reteporella* currently have their oldest stratigraphic record in the Lower Eocene La Meseta Formation, Antarctica (Hara, 2001). All of these genera are very speciose and have a long stratigraphic record throughout the world. Judging by the range of facies in which *Celleporaria* and some Phidoloporidae occur in this study, they had wide ecological tolerances, which probably enabled them to rapidly disperse widely.

5.2.7.3. First Occurrences of Families

Using taxonomic groupings such as families in evolutionary analyses is problematic, as such taxa are often paraphyletic or even polyphyletic, and thus cannot be treated as evolutionary entities. They are nonetheless commonly used in interpretations of evolution, as they give a more robust indication of patterns through time.

Many of the families well represented in the St Vincent Basin originated in the Early Eocene (Ypresian) of the southern hemisphere:

Adeonidae (see Labracherie, 1975)

Smittinidae (see Cheetham, 1962; Labracherie, 1975; Hara, 2001)

Exechonellidae (see Cheetham, 1975)

Schizoporellidae (see Hara, 2001)

Petraliellidae (see Hara, 2001)

Lepraliellidae (see Hara, 2001)

Smittinidae (see Hara, 2001)

Hara (2001) speculated that the first representatives of these families originated on the Early Eocene of the Antarctic Peninsula. They dispersed from there throughout South America, Australia, New Zealand in the Late Eocene and into the Northern Hemisphere in the Neogene.

The Phidoloporidae also probably originated in the Early Eocene, if the dubious familial assignment of the Paleocene *Psilosecos angustidens* (Levinsen) from North America (Vincetown Formation; Canu & Bassler, 1933) is discounted. After their first appearance in Antarctica (Hara, 2001), their next occurrence is in the Middle Eocene of Australia (this study), after which they appear in the Late Eocene of Tonga (Cheetham, 1972), North America (Canu & Bassler, 1920) and Europe (Zágorsek, 1994). The lack of occurrences in the Palaeogene of other Tethyan areas may be due to the lack of knowledge of these fossil bryozoans.

Six families possibly have their first reported occurrence in the St Vincent Basin. This is a significant number of first occurrences for this region (age of previous first occurrences given in brackets):

Didymosellidae (Bartonian; Late Eocene; Taylor, 1993)

Siphonicytaridae (Priabonian, Late Eocene; Australia and Tonga; Bock & Cook, 2001)

Inversiulidae (Rupelian, Early Oligocene; Taylor, 1993)

Bitectiporidae (Chattian, Late Oligocene; Cheetham, 1962: 330, however, cited *Hippoporina respertillio* Canu & Bassler from the Eocene of North America)

Lekythoporidae (Chattian, Late Oligocene; Taylor, 1993)

Chaperiidae (Middle Oligocene; New Zealand; Brown, 1952)

5.2.7.4. Last Occurrences of Taxa

There do not appear to be any species, which extend the occurrence of any taxa forwards in geological time. '*Ogiva*' sp. nov. a is not a true species of *Ogiva s.s.* It therefore cannot be considered a forward extension of this genus, which is considered to last appear in the Coniacian (Cretaceous; Sepkoski, 2002).

5.2.8. Conspicuous Absences

Some genera and growth forms are completely absent from the Eocene St Vincent Basin, although they are common in contemporaneous or slightly younger sediments of other basins.

Species of Otionellidae are common in the St Vincent Basin, but there are no Selenariidae. Species of *Selenaria* appear in southern Victoria, with the first appearance of open marine facies in the Late Eocene (P.L. Cook, pers. comm., 2001). Most modern Australian lunulitiform groups have their main connection with South America, where they are also recorded in the Eocene (Canu, 1911). Their migration eastwards from South America across Antarctica continental shelves seems most likely. There should have been contemporaneous faunas in Antarctica, but none have yet been found yet (e.g. Hara, 2001).

The first fossils species of *Adeona sensu stricto* occur in the Early Miocene sediments of the Otway Basin. *Adeona sensu lato* may, however, already be present in the Oligocene and possibly in the Eocene of the Otway Basin (P.E. Bock, pers. comm., 1999). These Palaeogene species of *Adeona* are difficult to distinguish from the sister genus *Adeonellopsis* if the 'stem' is not visible, as only flat robust branching but not fenestrate colonies of *Adeona* occur. No evidence of this genus is found in the contemporaneous Eocene St. Vincent Basin.

The absence of bryozoan-hermit crab associations throughout the Cainozoic of Australia is confirmed for the St Vincent Basin. These associations are common throughout the Cainozoic and Recent of New Zealand (Taylor *et al.*, 1989), and also occur in the Cainozoic of South America (Taylor 1994b), the Miocene of North America (*Celleporaria minuta* Canu & Bassler, 1923 and *C. maculata* Ulrich & Bassler; see Canu & Bassler, 1923: 182, pl. 25), and the Cretaceous of Antarctica (Aguirre Urreta & Olivero, 1992). This symbiotic relationship is polyphyletic (for review see Taylor 1994b), and so it is unclear why it never evolved in Australia.

5.3. Bryozoan Dispersal

Dispersal modes and routes of bryozoans cannot be discussed meaningfully here for two main reasons. Firstly, there is a paucity of knowledge of the distribution of bryozoan species in both space and time, especially in the southern hemisphere. Secondly, the factors promoting and discouraging dispersal in living bryozoans are also not well understood. Despite this, several things can be noted which may be useful both in focussing further research, as well as creating a framework within which interpretations can be made. Likely dispersive connections to and from Australia fall into several regional categories:

1) *Southern connection* to Antarctica and thus to South America (and possibly North America). A virtually continuous continental shelf still existed between South America, Antarctica and Australia until the end of the Eocene. Close connections with the Cainozoic of Antarctica (Hara, 2001) and South America (Canu, 1904, 1908; Hastings, 1943; Moyano, 1996) can be seen in the faunas (see also Lawver *et al.*, 1992: figs 12–13). Migration northwards from Antarctica is often implied (Bottjer & Jablonski,

1988; Hara, 2001 and references therein). Recent bryozoan distributions still preserve these faunal links (Moyano 1996).

2) *Eastern connection* to Pacific regions. There are few Palaeogene records of Bryozoa in the Pacific Ocean. The exceptions are the Early Eocene bryozoans from Tonga (Cheetham, 1972) and from the Koko Seamount (Cheetham, 1975). Species tentatively assigned to the Smittinidae have been identified in both cases.

3) *North-western connection* to Eurasia via Tethys and the Indian Ocean. This route into northern Australia is hard to verify at this point, as the fossil Bryozoa from Indonesia have not yet been described. There are records of bryozoans from the Late Cretaceous of India (Guha & Nathan, 1996; Taylor & Badve, 1994, 1995), the Cretaceous (Brood, 1976) and Early Eocene from south of Madagascar (Labracherie & Sigal, 1975), as well as from the Eocene of Nepal (Department of Mines and Geology, Kathmandu; Y. Bone, pers. comm., 2003). Braga (1986) considered a Tethyan origin for most Australian clades. This was largely based on stratigraphically and geographically limited data from the southern hemisphere. Bock & Hageman (2000), on the other hand, believe that as taxonomic research continues, an actual austral origin for many of these groups becomes apparent. It seems likely that a mixture of adventive and endemic originations is the case, with a shift towards higher degrees of endemism in the later Cainozoic.

The connections discussed above indicate it is geographically possible for interchange of taxa between continents. It must, however, also be biologically possible. Dispersal can occur at two stages in bryozoan life history: larval or adult. Factors that can act as barriers to dispersal are mainly temperature, salinity and nutrients.

Most of the routes of dispersal listed above require cross-latitudinal migration. Taxa occurring in high latitudes are often considered to be naturally 'restricted' to the northern or southern hemisphere, as cross-latitudinal migration would entail major temperature changes. Such a transition is considered to be difficult for most species and even genera. This conclusion is mainly based on the distribution of modern faunas in Quaternary environments, where the isotherms are closely spaced and there is a high gradient between polar and equatorial climates. The Eocene was dramatically different, however, and the 20°C marine isotherm was at 45° S (Frakes *et al.*, 1994) rather than the Recent 20°–25° S latitude. The flatter thermal gradients would have been a much weaker ecological barrier.

These factors, together with their sessile adult life, place into question the importance, and indeed necessity, of regional current directions in the dispersal of most bryozoan taxa. The exception is where rafting occurs.

5.3.1. Larval Dispersal

The short life duration of the lecitotrophic larva makes it likely that significant larval dispersal occurred only in the presence of submarine 'land bridges' and maybe with favourable currents. Australia has only been directly connected to Antarctica since the Late Cretaceous. However, Antarctica in turn was close to South America, which was close to North America, which was close in higher latitudes to Eurasia. Australia was therefore still 'connected' to all the continents until the Late Eocene.

Regional currents may be important in the dispersal of taxa with longer-lived planktotrophic (cyphonautes) larvae. Most cheilostomes, however have short-lived lecitotrophic (brooded) larvae, which often settle soon after release (Taylor, 1988). Larvae usually travel short distances, and many exhibit active selection of substrate (Abelson, 1997), on which to settle. Bryozoan dispersal may therefore be less dependent on regional currents (such as a proto-Leeuwin Current) and more on faunal barriers such as temperature, salinity, nutrients and/or substrate availability.

5.3.2. Adult Dispersal

Dispersal during the (usually) sessile adult stage can occur by rafting or the regeneration of transported fragments. Fragmentation is important in the numerous taxa that appear to predominantly reproduce asexually (Thomsen & Håkansson, 1995). In the case of non-attached forms, for example, direct colony transport is possible on strong currents. Rafting is only possible for epiphytic (epizooic?) species and in the cases where colonies encrust pieces of driftwood. In the Eocene of Australia such taxa would have occurred on kelp, as there is no conclusive evidence for sea-grasses in Australian waters until the Miocene (Larkum *et al.*, 1989). Species with erect or free-living colonies are unlikely to be dispersed by rafting due to the substrates they select (Taylor, 1988).

5.3.3. Comparisons with Biogeography of other Fauna

The biogeographic patterns of many marine invertebrates have been ascribed to the existence of a proto-Leeuwin Current by the Middle Eocene, flowing from the north-west to the south-east along the Western Australian coast (Fig. 2A). If indeed this current already existed at this time, this does not preclude faunal migrations in the opposite direction. Even today, this current varies strongly in intensity over short and long time scales (McGowran *et al.*, 1997). It does not affect all shelf regions because it is narrow (usu. <200 km) and shallow (<200 m) (James *et al.*, 1999). Onshore counter currents are a common feature, which would aid dispersal in any direction.

Different animal groups have different life histories, in particular at the reproductive and larval stages, and therefore show different dispersal patterns. Once settled, bryozoans, like most benthic invertebrates, can be considered stationary in terms of regional scale distribution rates. This status may change if the substrate is moved through rafting or on strong currents.

The Brachiopoda and Echinodermata usually have larvae that only live for one hour to two days before settling. Both groups appear to show a dispersal trend from north-western to south-eastern Australia via the south-western corner through the early Cainozoic (Craig, 2000; Richardson, 2000; McNamara, 2000).

Molluscs, which have similar larval types to bryozoans (Taylor, 1988), can mostly be considered sessile during their adult life and have similar constraining factors on dispersal, also show a mixture of biogeographic elements similar to those observed in this study (Darragh, 1985; Maxwell & Darragh, *in* McGowran *et al.*, 2000). Darragh (1985) also observed that whereas the faunas of the basins along the southern margin were similar until the Late Eocene, two distinct faunal regions had developed by the Miocene: A) Austral Indo-Pacific Province (Carnarvon, Eucla, St Vincent Basins) and B) South-Eastern Australian Province (Murray, Otway, Bass, Gippsland Basins). These two regions belong to the larger Southern Australian Region, which was established by the Late Eocene, and composed of several elements whose proportions fluctuated with time:

1. Neo-Zealandic (Australian-New Zealand Element), which probably had its origin in the southern-circum Pacific Palaeoaustral Fauna,
2. Tethyan Indo-Pacific,
3. Endemic,
4. Cosmopolitan.

Overall the biogeographic characteristics of the Mollusca are thus similar to the Bryozoa.

Sponges, which are in many ways ecologically similar to bryozoans, have not been researched in great detail in the Australian Cainozoic. No detailed taxonomic or biogeographical research has been carried out on the Australian Cainozoic sponges, apart from that on the exceptionally preserved body fossils in the Bremer Basin (Gammon & James, 2001).

Foraminiferal distributions (McGowran & Li, 2000) show a distinct influence by the 'Leeuwin Current'. Foraminifera are, however, not sessile and therefore probably disperse differently to Bryozoa. Much of the evidence for the Eocene activity of the proto-Leeuwin Current is based on the larger Foraminifera, which live in warm shallow water because of their photosymbionts. Bryozoans are still common well below this photic zone, where bottom currents may bear no resemblance to surface currents (James *et al.*, 1999). Comparisons between the biogeography of these two groups must therefore be considered tentative at the best.

McNamara (1999) also invoked proto-Leeuwin Current activity in the Palaeocene and Eocene to explain the diachronous distribution of echinoids in the Carnarvon and Eucla Basins, such as *Giraliaster* in the Paleocene and Eocene respectively, and *Monostychia* in the Eocene and Miocene respectively. This 'homogenisation' stops by the Early Miocene, by which time both regions developed disparate echinoid faunas. This is explained by the ACC blocking the Leeuwin Current and isolating the two regions. Such apparent 'diachroneity' in the appearance of taxa in the Palaeogene may also be an artefact of the diachronous onset of extensive cool water carbonate accumulation along the Australian continental margin as it separated from Antarctica. The understanding of such current patterns is crucial in the context of interpreting palaeobiogeographic patterns.

A note of caution regarding the utilisation of first occurrence records of taxa as their absolute origination ages, and their use to deduce areas of origination and subsequent dispersals. The incompleteness of the fossil record, combined with the often diachronous nature of sedimentary facies, can result in significant biogeographic artefacts. The Australia-Antarctica rifting margin produced a strongly diachronous spread of the marine facies from north-west to south-east. This created an apparent first occurrence and dispersal trend of many taxa in the same direction (e.g. Brachiopoda, see Craig 2000).

5.4. Evolutionary Trends

The environments of the different formations within the St Vincent Basin are too disparate to enable significant investigation of evolutionary trends, as many variations may be due more to local environmental factors than larger phylogenetic changes.

It was not within the scope of this study to evaluate the rich bryozoan fauna within the Early Oligocene limestone overlying the Eocene sediments in all areas of the basin. Generalised observations of the rich bryofauna in the Port Willunga Formation and Port Vincent Limestone indicate that, although growth form assemblages are similar, the taxonomic composition may be significantly different. This difference seems to be more on a species level, rather than higher taxonomic level.

Brown (1958) considered the bryozoans to be of considerable value for correlation. This would seem plausible, as the low probability of speciation and extinction (i.e. long species durations) should be a consequence of bryozoan eurytopy and broad geographic range (Jackson *et al.*, 1985). This ignores the importance of the low rate of dispersal and low gene flow between populations, which should promote a higher chance of speciation. The genetics of modern bryozoans indicate that they often quickly develop genetically distinct populations and therefore speciate easily (Mackie *et al.*, 2000; Cheetham *et al.*, 1993, 1994, 1995). Therefore bryozoans may only be useful for local correlations, rather than for larger regional correlation.

5.5. Conclusions

The taxonomic composition of the Eocene sediments of the St Vincent Basin displays a mixed geographic and temporal character. Stilwell (1997) suggested that the Maastrichtian Kahuitara Tuff (Chatham Islands, NZ) faunule "represents evolutionary divergence, reflecting range retractions of a former cosmopolitan, early to late Mesozoic world". Gordon & Taylor (1999: 42) also observed that the Paleocene Chatham Islands bryofaunas as well as the Early Eocene Seymour Island (Hara, 2001) "are composed of a number of genera reminiscent of the Cretaceous of the Northern Hemisphere and of families that are common in the Neogene and recent Southern Hemisphere". A similar assemblage is found in the St Vincent Basin, where some of the taxa are similar to northern hemisphere Maastrichtian and Danian faunas, while taxa that occur mainly in the Neogene and Recent southern hemisphere co-occur. The Eocene of the St Vincent Basin similarly seems to sit on the cusp of a change from the remnants of the late Mesozoic to the 'new world order' of the Neogene. In addition, there is a range from highly endemic taxa to global relationships.

A distinction between Palaeogene and Neogene faunas is not surprising, as Australia experienced a relatively sudden isolation from the Oligocene onwards with the initiation of the Circum Antarctic Current. The 'death' of the Neo-Tethys to the North may also have restricted the advent of Eurasian taxa.

Endemic taxa also comprise a substantial proportion of the fauna. All are endemic to Australia at a species level, and more than half appear restricted to the St Vincent Basin. There are 7 genera (~7%), which are also endemic to Australia at a genus level, and there is a significant additional proportion of genera (~7%), which appear restricted to the St Vincent Basin.

This research is only one step towards understanding the biogeography and evolution of bryozoans in the Australian region. Similar work on cheilostomes and cyclostomes needs to be done in other basins containing limestones of Eocene or older age in Australia and neighbouring regions. This will enable more accurate comparisons between regions to be made.

Chapter 6. Palaeoenvironments

"Moss animals are relatively insignificant, and apart from the fact that they foul the bottoms of ships or choke water pipes, they really have little value or interest to anybody but a scientist. People sometimes ask why is it necessary to spend so much time studying animals of this kind?..."

Burton, M. & Burton, R. (1976) *Encyclopaedia of the Animal Kingdom*. (Phoebus Publ., London)

6.1. Introduction

Far from being insignificant, the almost ubiquitous presence of Bryozoa in recent and fossil marine assemblages makes them of major importance in ecological studies. The methodology for their application to palaeoenvironmental analysis, however, is still subject to much debate.

Bryozoa are eurytopic, meaning that they occur on a wider range of substrates and over wide depth ranges. Indeed, they cover a wider range than many other groups of sessile animals (McKinney & Jackson, 1989: 117). Soule *et al.* (1979) identified temperature as the single most important factor controlling occurrence, followed by phytoplankton abundance (at least for estuarine faunas).

Palaeoenvironmental interpretations are generally formed by extrapolations based on observations of modern faunas. This correlation is based on the assumption that the present is the key to the past. Although this assumption appears to generally hold up, such uniformitarianism can have exceptions. Bottjer & Jablonski (1988) demonstrated that for several macroinvertebrate groups, including cheilostomes, environmental associations have varied, often in a systematic way over time.

The environmental interpretations presented here are based on the samples obtained from the localities where the formations outcrop and where specimens are preserved adequately (Fig. 2). This gives a bias towards which types of facies were investigated, as the outcrops mainly occur along the coastal cliffs. Only a few occur further inland along river cliffs, and these are often of poor quality. The fossils in the few road cuttings where the Eocene formations are intersected proved too altered. Preliminary investigations of bryozoans obtained from one core from an inland site (WLG 42 QA 69; Fig. 2C) were sufficiently distinct from the coastal samples to indicate that the latter may only represent one of a number of environments within the basin. This would also explain the strong differences between the sedimentary facies and bryozoan faunas of the western area (where the cliffs are close to the basin margin) and the eastern area (where the cliffs are often further from the basin margin).

Palaeoenvironmental information from bryozoans can come from two types of assemblages, namely taxonomic and morphological. Each of these can yield different and complimentary information.

6.1.1. Taxonomic Ecology

The taxonomic composition of an assemblage can be utilised in three general ways in palaeoenvironmental interpretations (see e.g. Bottjer & Jablonski, 1988).

a) The simple presence of certain taxa, which are considered to have adapted to specific environmental conditions in which they occur, can be used as indicators. Such taxa are rare (e.g. Cook, 1981), and most bryozoan taxa are not clear indicators of a particular environment by their presence alone.

b) The relative abundances of taxa (specimens per species) can give an indication of prevailing conditions. The dominance of some taxa relative to others can be used similarly (e.g. Bone & Wass, 1990).

c) The overall diversity of an assemblage (number of species per sample) can be a measure of the environment i.e. if it was 'normal' (high diversity) or 'stressed' (low diversity).

Changes within these categories can give a good indication of how the environment fluctuated. Species and specimen abundances often follow the same pattern (Lagaaij & Gautier, 1965: 46). The highest diversities are usually found at moderate depths between 50 to 125 m, (Schopf, 1969; Gautier, 1961), whereas a decrease in abundance and species diversity indicates stressed environmental conditions (Harmelin, 1988).

Cheetham (1963) has noted that "faunal differences are more distinctive than lithological differences; significant faunal differences between areas are expressed chiefly in species composition, whereas differences within areas are expressed in relative abundance."

6.1.2. Growth Form Ecology

The growth-forms of bryozoans have long been considered to correlate with the environments each species inhabits (e.g. Stach, 1936; see Hageman *et al.*, 1997, 1998, for extensive reference lists). Colony growth forms are often used to interpret palaeodepth. In reality, however, they are probably more indicative of environmental energy levels (Cockbain, 1970: Fig. 63), which are not always the same for a given water depth. Bryozoa may therefore not be a straightforward indicator of water depth, as depth *per se* is not a controlling factor of their distribution (see also Chapter 1: p. 15). The risk of mortality in a given environment theoretically selects for different growth forms to be prevalent, but the relative intensity of different factors involved in this process has apparently changed significantly through Phanerozoic (in particular predation, competition and nutrients). This is manifested by extensive temporal shifts in environmental distribution of different growth forms (McKinney & Jackson, 1989).

Current interpretations of environments for many species or growth forms may not always be correct. The initial discovery of an organism in a certain environment or association often encourages subsequent research to target similar environments for the particular organism, which further reinforces the interpretation of such an organism's niche. This scenario is particularly true in the case of commercially interesting animals and plants, which living bryozoans have recently become (e.g. *Bugula neritina* (L.)).

Stach (1936c) classed the growth forms which bryozoans grew in as either stable (only able to grow in one shape regardless of environment) or unstable (vary with environment). Most cheilostomes are 'unstable' but few adopt more than a limited range of growth habits (Cheetham 1971).

Growth forms must be taken as assemblages, similar to the taxonomic ecology, as individual growth forms are rarely indicative of one specific environment. High species diversity among individual colony forms indicates favourable conditions for those particular forms (Moyano, 1979).

Some growth forms seem to be limited in the geochemical make-up of their carbonate skeletons. They often fall into distinct groups of Low Magnesium Calcite (LMC, 0.5-3.99 mol % Mg, relatively stable), Intermediate Magnesium Calcite (IMC, 4.0-11.99 mol % Mg, moderately stable), High Magnesium Calcite (HMC, >12.0 mol % Mg, relatively unstable) and Aragonite (unstable). Although these trends seem fairly consistent, the data is limited both geographically and taxonomically (e.g. Bone & James, 1993) and further studies are required. Colony growth form has a significant influence on how well a colony survives taphonomic processes (Smith *et al.*, 1992; Smith & Nelson, 1996). Thus colonies of free-living groups such as the Selenariidae, which are compact in structure, survive much better than some robust branching colonies.

It is important to account for post-mortem processes, as the relict grains of growth forms typically occur in a wider and often deeper distribution than their living counterparts (Bone & James, 1993).

6.1.2.1. Encrusting

Encrusting taxa usually inhabit environments shallower than 150 m depth (Bone & James, 1993), with peaks in abundances between 0 and 30 m depth for unilaminar and 20 to 50 m depth for multilaminar forms (Nelson *et al.*, 1988: 310). They appear to be very opportunistic and settle on a wide variety of substrates (Cook, 1977). Predators also appear to prefer erect forms (Bone & James, 1993) and encrusters may therefore predominate in shallower waters where predators are more common and diverse.

Encrusters of flexible substrates generally have a well-calcified dorsal wall, whereas encrusters of stones and shells do not (Schopf, 1969: 239). This can help to infer the original substrate if the colony has become detached.

6.1.2.2. Erect Rigid

An advantage of the erect form is the greater access of its zooids to resources above the substratum, while at the same time escaping harmful processes such as competition and many forms of predation. Colony surface area and biomass are also significantly increased relative to other growth forms. It does, however, impose more stringent mechanical demands on the skeletal structure (McKinney & Jackson, 1989). Most erect rigid forms require relatively hard substrata, unless they have long 'rootlets' (e.g. *Adeonellopsis*) that penetrate deep into the shifting substrate (Bone & James, 1993). Erect rigid forms can be grouped into several broad categories:

Erect Foliose colonies usually inhabit shallow water (<80 m depth) and attach to hard substrates (Bone & James, 1993). The colonies are usually composed of aragonite, with some species containing IMC to HMC (Bone & James, 1993).

Erect Robust Branching colonies (also called 'flat robust branching', here abbreviated to FRB) occur shallowly and have peak abundances between about 100 and 150 m depth on the modern southern Australian shelf (Bone & James 1993) and up to 200 m depth in New Zealand (Nelson *et al.*, 1988). This relatively shallow predominance occurs despite a greater vulnerability of such colonies to damage in high-energy environments (Cheetham & Thomsen, 1981). Branch diameters tend to decrease with increasing water depth (Thomsen, 1977a, b; Harmelin, 1973). Although this is often considered a response to the decrease in water energy and thus a necessity for skeletal robustness, it may be more a result of decreasing light and thus food availability (Schopf *et al.*, 1980). This could explain why this growth form is common in shallow waters.

Erect Delicate Branching colonies are generally restricted to low energy environments due to their fragility (Labracherie, 1973: 132), but peaks in abundances have been found to be 70 to 160 m depth (Nelson *et al.*, 1988: 310) and from 130 to 450 m depth (the limit of sampling; Bone & James, 1993).

Erect Fenestrate colonies are considered to be an adaptation to higher energy environments. They occur from very shallow to ~130 m depth (rare up to 220 m), with peak abundances between 50 and 80 m depth (Nelson *et al.*, 1988: 310). They are usually attached to hard substrates or sea-grass stalks (Bone & James, 1993). This is not always the case as they are sometimes found to flourish in deep or sheltered areas (Cuffey & McKinney, 1982). They prefer environments where deposition is slow or absent (Lagaaij & Gautier, 1965). This interpretation refers to the classical 'lace coral' types, and may not be applicable to the cribrate variety (e.g. '*Onychocella* sp. nov. b).

Fungiform colonies are difficult to classify, but are here included in the erect group as the zooids are elevated above the substrate. They mainly occur among cyclostomes but rare cheilostomes are known with this growth form (Taylor & Grishenko, 1999). They occur in a range of environments from tranquil caves (Harmelin, 1985; Scholz & Hillmer, 1995) to higher energy open marine (Hillmer *et al.*, 1997). The main advantage may be the elevation of feeding zooids away from competition at the substrate level (both for food and encrustation).

6.1.2.3. Erect Flexible

Erect colonies can become flexible by having organic articulations either between the rigid branches or between the individual zooids. Colonies that are weakly calcified and thus flexible (e.g. many Flustridae such as *Carbasea*) fossilise poorly and are not discussed here. Advantages are the ability to move with water movements and thus to passively shake off settling sediment while not breaking.

Erect Articulated Branching are widespread and diverse up to 250 m depth and often comprise most of the bulk sediment (Bone & James, 1993; Labracherie, 1973). Flexible species are often the only erect forms in water shallower than 35 m depth (Schopf, 1969), and can tolerate higher sedimentation rates than most others as they can shake it off. This is contrary to Brown's (1958) interpretation that a diverse *Cellariidae* assemblage suggests offshore deposition and no strong currents. They occur on a wide range of substrates (Gautier 1962), but seem to prefer unconsolidated sediments as part of the 'sand fauna' of Cook (1981). The basal rootlets also allow them to cling to other erect organisms. When they die and disarticulate they produce a disproportionately large amount of fragments per colony compared to other growth forms.

Erect Articulated Zooidal species are considered opportunistic, as they are capable of rapid colonisation of firm and unstable sediments (Bone & James, 1993). They inhabit a variety of environments from shallow (8 – 35 m depth) attaching to red algae (Stach, 1936; Lagaaij & Gautier, 1965) but are often common out to the shelf edge (James *et al.*, 2001).

6.1.2.4. Multilaminar Massive

Multilaminar colonies have a wide range of morphologies and can produce almost any shape, including encrusting, erect rigid, nodular and even free-living, all of which occur in the studied sediments. Massive arborescent colonies often form thickets and today rarely occur shallower than 90 m, with their greatest concentration between 120 and 250 m depth (i.e. below swell wave base), where they can constitute up to 50% of the bulk sample (James & Bone, 1989, 1991; Boreen *et al.*, 1992). Massive multilaminar colonies indicate strong hydrodynamic conditions and rather shallow marine setting (e.g. at base of transgressive series; Walter 1989), but other factors may influence multilaminar growth, such as limited substrate space, and seasonality of the climate, which directly controls the seasonal supply of nutrients (see Barnes, 1995; Scholz & Hillmer, 1995; Craig, 2000). It is often considered that they had a similar depth distribution in the Tertiary (Bone & James, 1993). Large three-dimensional colonies such as *Celleporaria agglutinans* in New Zealand (Gordon *et al.*, 1994) significantly increase the diversity of microhabitat and therefore the local biodiversity. Hara (2001: 88) used a large number of massive multilaminar colonies as well as associated fauna to suggest warm to temperate-warm conditions.

The growth rate of massive multilaminar colonies is considered to be slow (Moissette & Pouyet, 1991; Taylor & Voigt, 1999), but this may vary between the different genera. The zooidal walls of *Celleporaria*, the main multilaminar genus in these sediments, are relatively thin. This may indicate that they can rapidly bud and calcify new zooids, thus allowing rapid growth.

6.1.2.5. Free-Living

Colonies that as a rule completely envelop or outgrow their substrate are effectively unattached or 'free-living'. They inhabit coarse sand to mud substrates but never rocky substrates. They have a wide range of occurrence from 20 to 500 m depth, being most abundant around 50 to 150 m depth. They also occur in various current regimes as well as temperature and salinity ranges (Cook & Chimonides, 1983; Bone & James, 1993). They are often the only growth forms occurring near deltaic environments (Lagaaij, 1963: 1730). The only growth form to become more abundant with depth is the minute rooted form (McKinney & Jackson, 1989).

6.1.2.6. Relative abundances

One of the fundamental divisions regarding growth forms is that between purely encrusting and erect forms. Many species often do not become erect until conditions are conducive to do so. The relative abundances (taxonomic and abundance) of these two groups are often used to indicate depth, with erect species often becoming more common and diverse than encrusters below about 100 – 500 m depth (McKinney & Jackson, 1989: Fig. 4.11). Erect species are considered to have been forced to 'move' below 100 m depth because of an increase in effective grazing, browsing and gouging 'machinery' (Vermeij, 1977; Steneck, 1983), particularly the appearance of sea urchins with a well-developed Aristotle's lantern (mid-Mesozoic), and fish capable of excavating calcareous material (Eocene). Physical disturbances such as waves, currents, sedimentation, fluctuations in salinity and oxygen also decrease with depth (McKinney & Jackson, 1989).

Erect flexible vs. rigid ratios appear to decrease with depth (McKinney & Jackson, 1989: Fig. 4.12), possibly because lower water energy reduces the risk of breakage.

It must be remembered that fossil assemblages (thanatocoenoces) usually do not precisely reflect the living assemblage (biocoenoces) due to various taphonomic processes, such as fragmentation, winnowing, and dissolution. The wide variety of colonial forms in bryozoans behave differently post-mortem and can create biased assemblages. Many of the erect colonies have sturdier morphologies than the unilaminar encrusters, and thus have a greater chance of preservation (Gordon, 2000).

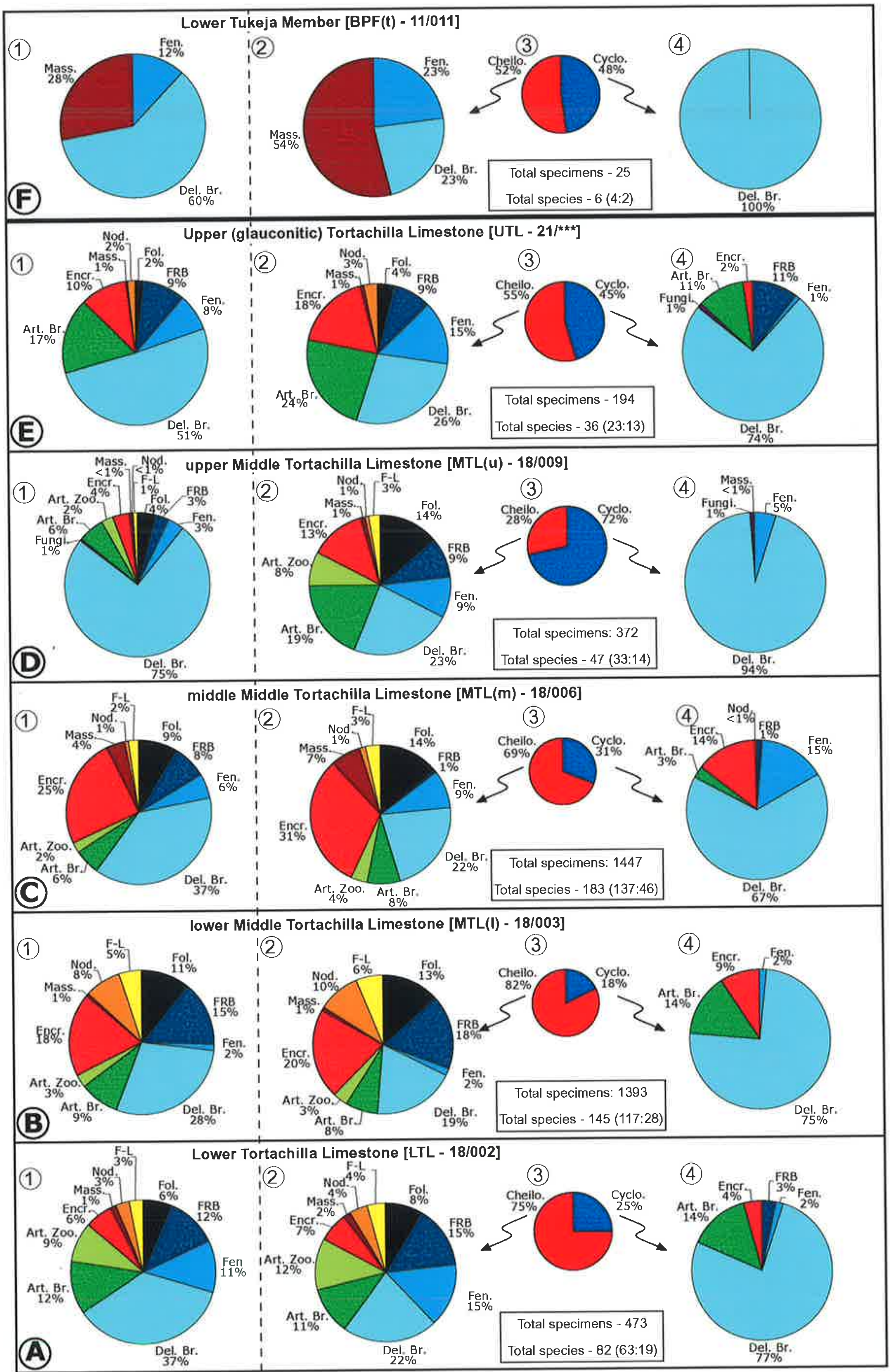


Figure 7: Tortachilla Limestone & Tuketja Member growth forms. Pie charts with percentages for each fraction given for each sample; from left to right: 1) percentage of each growth form of all Bryozoa, 2) percentage of each growth form of cheilostomes, 3) percentage of cheilostomes vs cyclostomes, 4) percentage of each growth form of cyclostomes. Total specimens counted and total species diversity [all Bryozoa (cheilostomes:cyclostomes)] also given for each sample.

6.2. Bryozoan Assemblages – Results and Discussions

The disparate nature of the sediments investigated in this study requires each one to be treated separately. Reasons for these differences and changes are also discussed. The restricted nature of the basin in the Eocene may have been the cause of such diverse environments in close proximity.

The taxonomic assemblages at the family and genus level show only minor differences between most formations, despite significant lithological differences. Many of the species are even shared between facies. This indicates that many of the taxa are opportunistic with wide ecological tolerances. The presence of so many opportunistic taxa may be the result of continuously changing environments.

All percentages represent the proportion of total specimens from a sample for the combination of all sediment size fractions from that sample.

6.2.1. Tortachilla Limestone

The bryozoans dominate the fauna numerically and volumetrically throughout the Tortachilla Limestone. Many species occur commonly throughout, but the abundance of most is relatively low and none clearly dominate the fauna.

Other common fossils include bivalves (especially Pectinidae), turritellid gastropod moulds, various irregular echinoid tests, spines of regular echinoids, and terebratulid brachiopods. Minor components are serpulids, barnacle plates, corals and sponge spicules (probably siliceous). These macrofaunal groups together comprise 10 – 50% of the sediment volume and similar percentage of specimens (mostly in the coarse fraction).

6.2.1.1. Lower Tortachilla Limestone Unit Assemblage (Figs 7A & 8)

Growth forms: Erect delicate colonies constitute the majority of specimens (37%), where very delicate cyclostome colonies make up well over half of this proportion. Other erect forms each constitute about another 10% each, are all dominated by cheilostomes (although cyclostomes constitute almost half of articulated branching forms). Notable are the articulated zooidal forms, which make up 9%. Encrusting species constitute only a small proportion of the bryozoan fauna (6%), most of which are anascan cheilostomes. Most larger fragments of shells and other bryozoans only have one or two small encrusters and many have none. Other encrusting organisms (e.g. serpulids) are similarly rare. Most encrustation occurs on bivalve shells (both internal and external surfaces). Nodular and free-living forms are a minor though notable constituent.

Taxonomic assemblage: Cheilostomes outnumber cyclostomes 4:1. None of the species is significantly dominant, with only *Stenostomaria* sp. nov. a and Bryopastoridae gen. indet. A sp. a comprising over 5% each. *Acerinucleus* sp. nov. a, *Crisia* sp. nov. a, *Cellaria* sp. nov. n, *Cellaria* sp. nov. m, '*Onychocella*' sp. nov. a and *Sphaeropora* sp. nov. a each comprises over 2%.

Other fauna: Fossils of other groups of animals comprise less than half of all fossils.

6.2.1.2. Middle Tortachilla Limestone Unit Assemblage

Lower horizon (Figs 7B & 8):

Growth forms: Encrustation increases significantly in the middle unit, making up 22% of bryozoan fragments. Occasional shells with up to seven layers of different unilaminar encrusters overgrowing

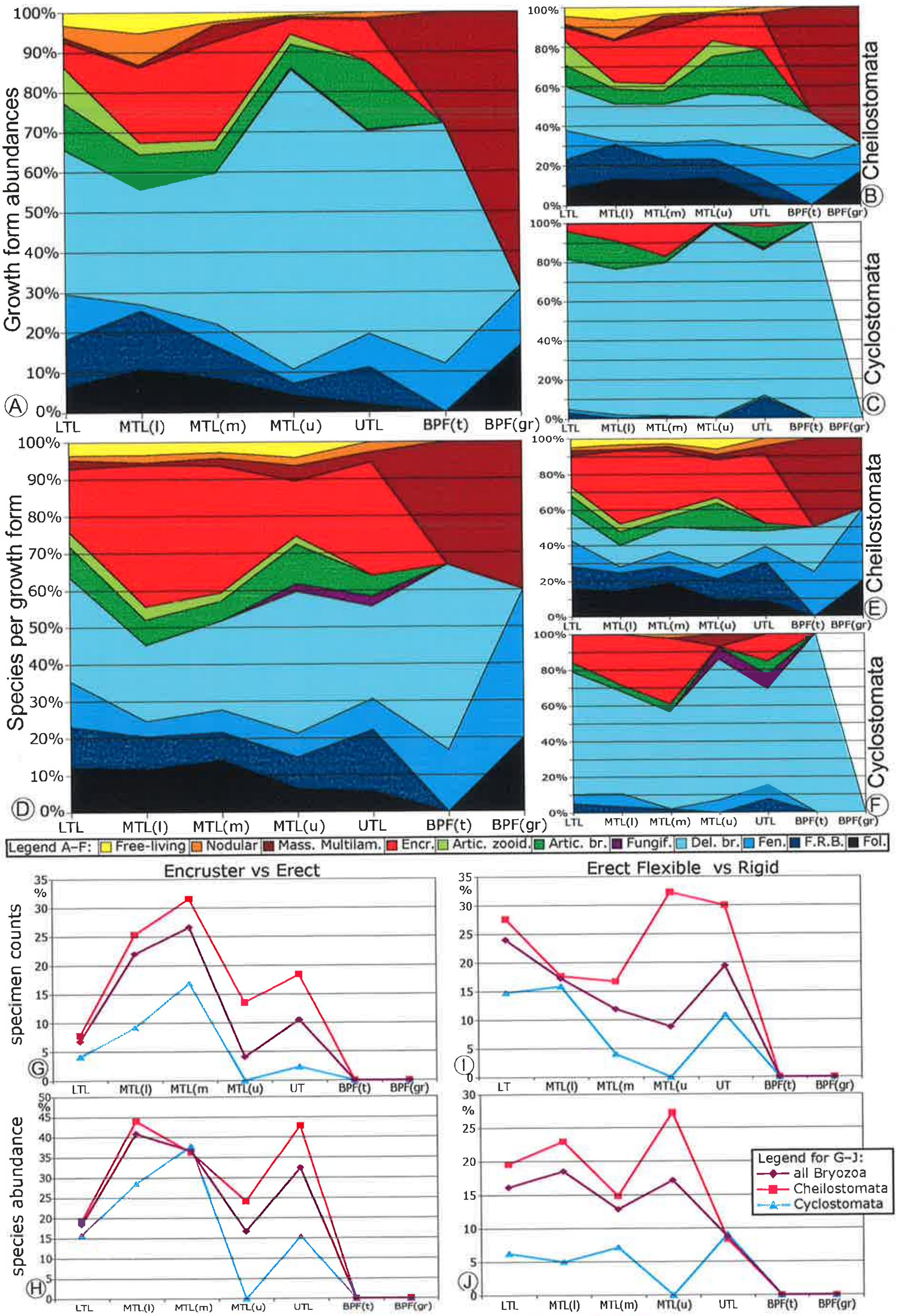


Figure 8: Tortachilla Limestone & Blanche Point Formation growth forms. **A, B, C**: cumulative relative abundance charts for growth forms (specimens for each growth form as percent of total specimens of each sample). **D, E, F**: cumulative relative abundance charts for species diversity within growth forms (species for each growth form as percent of total species of each sample). **G, H**: % encrusters relative to erect growth forms. **I, J**: % of flexible erect relative to rigid erect growth forms. [y-axes for G, H: *% of Encr. = encr./(encr.+erect)x100*, for I, J: *% of Flex. = flex./(flex.+rigid)x100*; Note: massive, nodular and free-living forms not included in these calculations]

each other were observed, along with several cyclostome spot encrusters. Erect delicate branching colonies decrease to 28%, with cyclostomes and cheilostomes contributing almost equal amounts (cheilostomes are more common in the coarser fraction while cyclostomes are in the finer fraction). Articulated branching remain at 11%, but cyclostomes only make up 10% of these. Articulated zooidal forms decrease to 3%. Nodular and free-living forms increase to 8% and 5% respectively.

Taxonomic assemblage: Cheilostomes outnumber cyclostomes 5:1. *Sphaeropora* sp. nov. a sp. nov. a >5%. *Acerinucleus* sp. nov. a, *Lunulites* sp. nov. a, *Otionellina exigua*, *Porina spongiosa* and *Ogivalia* sp. nov. a >2% each.

Other fauna: Fossils of other groups of animals are common. The main constituents are small brachiopods, pectinids, irregular echinoids and serpulids. Others include barnacle plates, small bivalves (?*Dimya*), sponge spicules, and rare ostracods, forams and asteroid plates.

Middle horizon (Figs 8C & 8):

Growth forms: Delicate branching forms increase to over one third of the fauna, and fenestrates increase slightly to 8%, while all other erect forms decrease in abundance. Encrusting forms comprise one quarter of the fauna, of which 80% are cheilostomes.

Taxonomic assemblage: Cheilostomes outnumber cyclostomes 2:1. *Ogivalia* sp. nov. a, *Celleporaria* spp. >5%. *Adeonellopsis symmetrica*, *Porina spongiosa* >2%. (*'Onychocella'* sp. nov. a, *Acerinucleus* sp. nov. a, *Melicerita angustiloba*, *Macropora* sp. nov. a, *Micropora elegans*, *Buffonellaria roberti*).

Other fauna: Serpulids and *Spirobis* are abundant, encrusting many bryozoans and echinoids. They are frequently found on one surface while encrusting bryozoans are present on the opposite surface of the fragment. Large fragments of echinoids and small brachiopods are also common, while bivalves and solitary corals are less common.

Upper Horizon (Figs 7D & 8):

Growth forms: Delicate branching forms dominate 75% of the fauna and are largely composed of cyclostomes. All other forms are present in low abundance. Fungiform cyclostomes make a first appearance.

Taxonomic assemblage: Cyclostomes outnumber cheilostomes almost 3:1. *Ogivalia* sp. nov. a, *Exidmonea* sp. nov. a, *Strophipora* sp. nov. a, *Dactylostega* sp. nov. a >2%.

Other fauna: Infaunal echinoids and brachiopods are common.

6.2.1.3. Upper Tortachilla Limestone (glauconitic) Unit Assemblage (Figs 7E & 8)

Growth forms: Delicate branching forms decrease to 51%, while articulated branching increase to 17%. Flat robust branching, fenestrae and encrusters each increase to about 10%. Free-living forms are absent for the first time. Unilaminar encrusters are more common and frequently produce multi-specific layers on other organisms.

Taxonomic assemblage: Cheilostomes and cyclostomes are present in roughly equal abundances. *Cellaria* sp. nov. m constitutes 10%, and is the only species to achieve this percentage within the Tortachilla Limestone. *Nevianopora* sp. nov. a and *Exidmonea* sp. nov. a each comprise over 5%.

Other fauna: Turritellid gastropods are abundant. Other macrofauna include pectinid bivalves and terebratulid brachiopods.

Bryozoan specimens comprise a smaller percent of both the sediment and the overall fauna (~10–20% compared with 40–60% in the other horizons). *Celleporaria 'gambierensis'* is relatively common and is more encrusted by other bryozoans than in the lower members.

6.2.1.4. Discussion of the Tortachilla Limestone

The Tortachilla Limestone overall contains a high abundance and high diversity (regarding both taxonomic and growth form assemblages) bryozoan fauna, which shows little dominance of any group (regarding mainly taxonomic, but to a large degree also growth form assemblages). The 183 bryozoan species (137 cheilostome and 46 cyclostome) occurring just in the middle horizon of the Middle Tortachilla Limestone constitute a high diversity assemblage. In comparison, the Maastrichtian bryozoan fauna at Stevns Klint, Denmark, is estimated to contain over 1000 species and is possibly the highest diversity assemblage known (E. Håkansson, pers. comm., 2002). This indicates a relatively normal marine bryozoan meadow assemblage.

There is a possibility that the fossil assemblages do not represent biocoenoces. The substantial breakage and variable abrasion of all of the colonies of the lower and middle units indicate extensive periods of high water energy. This can be a result of mixing through storm events or time averaging through prolonged exposure. Even if the fossils are therefore partly or largely allochthonous, it is unlikely that larger fragments were washed in from far away, as the small and restricted basin did not have a big enough fetch for significant waves to form (similar to the modern Gulf St Vincent). Reconstruction of the life assemblage to enable a correct palaeoenvironmental interpretation may be impossible here, as there is neither a straightforward way to determine which components of each bed are allochthonous and which are autochthonous, nor which species co-occurred at a particular time. The fact that all the assemblages are significantly different from each other, however, may indicate that they have not completely lost their primary character.

The differences observed between the three samples of the middle unit may also occur in the lower and upper units. However, because these units were extensively burrowed and less thick, it was less easy to differentiate separate horizons

The percentages of encrusters relative to erect forms never exceed 30% and are generally well below that. If these ratios are compared with those of many modern assemblages (e.g. McKinney & Jackson, 1988), then water depths of 1000 m or more are implied for the duration of deposition (see also Zágorsek, 1996). Additionally, the presence of the modern deep-water genera *Melicerita* (Pl. 14H-K) and *Siphonicytara* (Pls 42 & 43) in the lower horizons of each margin are intriguing in this shallow basin. Such deep-water indicators are difficult to reconcile with the relatively shallow character of the basin. The modern basin is less than 40 m at its deepest. Even with the higher relative sea level during the Eocene, it is unlikely to have reached depths greater than 100 m, especially in the relatively marginal areas from which the outcrop samples were collected (Fig. 2C).

Lunulitiform species occur in a relatively high diversity and abundance in the Tortachilla Limestone (6 species in 4 genera). This contrasts with the complete absence of any lunulitiform species in all the other Eocene formations, where rooted forms remain common.

Colonies of *Celleporaria* appear free of any encrusters most of the time. This could not be observed for certain, however, as none of the large biohermal colonies was observed complete in these sediments, but rather only as smaller fragments. However, it would seem that encrusters could add strength to the overall colony, thus preventing it from becoming fragmented.

The lower and middle unit facies is often interpreted as a sea grass meadows environment (James & Bone, 2000). Sea grasses evolved in the Early Cretaceous of northern Europe (Voigt & Domke, 1955), but are generally believed to have arrived in the Asia-Pacific region waters in the Eocene (van Keulen, 1995, Larkum & den Hartog, 1989). Definitive evidence of their occurrence in Australia has not been found in sediments older than Miocene. No direct evidence of sea grasses (e.g. bioimmured stems or leaves) were found during this study. One specimen of *Figularia rugosa* appears to wrap around a relatively thin (<0.5mm) flat substrate. This could have been a sea grass leaf, but could more likely have been a kelp frond.

6.2.2. Blanche Point Formation

The Blanche Point Formation contains strikingly different facies to the Tortachilla Limestone. It is overall more fine grained and richer in organic carbon, opaline silica and sponge spicules. The change in facies is not sudden, as the basal Tuketja Member is still relatively fossiliferous and contains common glauconitic pellets. The bryozoan fauna is, however, impoverished.

6.2.2.1. Tuketja Member Assemblage (Figs 7F & 8)

Growth forms: Delicate branching forms constitute almost two thirds and are dominantly composed of cyclostomes. Multilaminar colonies make up over a quarter, and fenestrate forms constitute the rest.

Taxonomic assemblage: Cheilostomes and cyclostomes are present in roughly equal abundances. There is a low diversity assemblage, dominated by *Celleporaria*.

Other fauna: The most common macrofauna are bivalves, with turritellid gastropods and brachiopods also constituting a significant amount.

6.2.2.2. Gull Rock Member Assemblage (Fig. 8)

Growth forms: The most common and conspicuous are the multilaminar arborescent forms. In fossiliferous horizons fenestrate and foliose (cribrate) forms are also common. No other forms were observed.

Taxonomic assemblage: Only Cheilostomes were found. The dominant species is *Celleporaria 'gambierensis'*.

Other fauna: The dominant fossils are sponges, but apart from common digitate and rare lithistid sponges, which are preserved as body fossils, only siliceous spicules are preserved.

6.2.2.3. Perkana Member Assemblage

No bryozoans were observed in the Perkana Member.

The common definition of the boundary between the Gull Rock and Perkana Members at the outcrop level is the absence of the (quasi) cyclic bedding. It is not surprising that this distinction has generally lead to uncertain and inconsistent perceptions of where the boundary should be placed, as the only

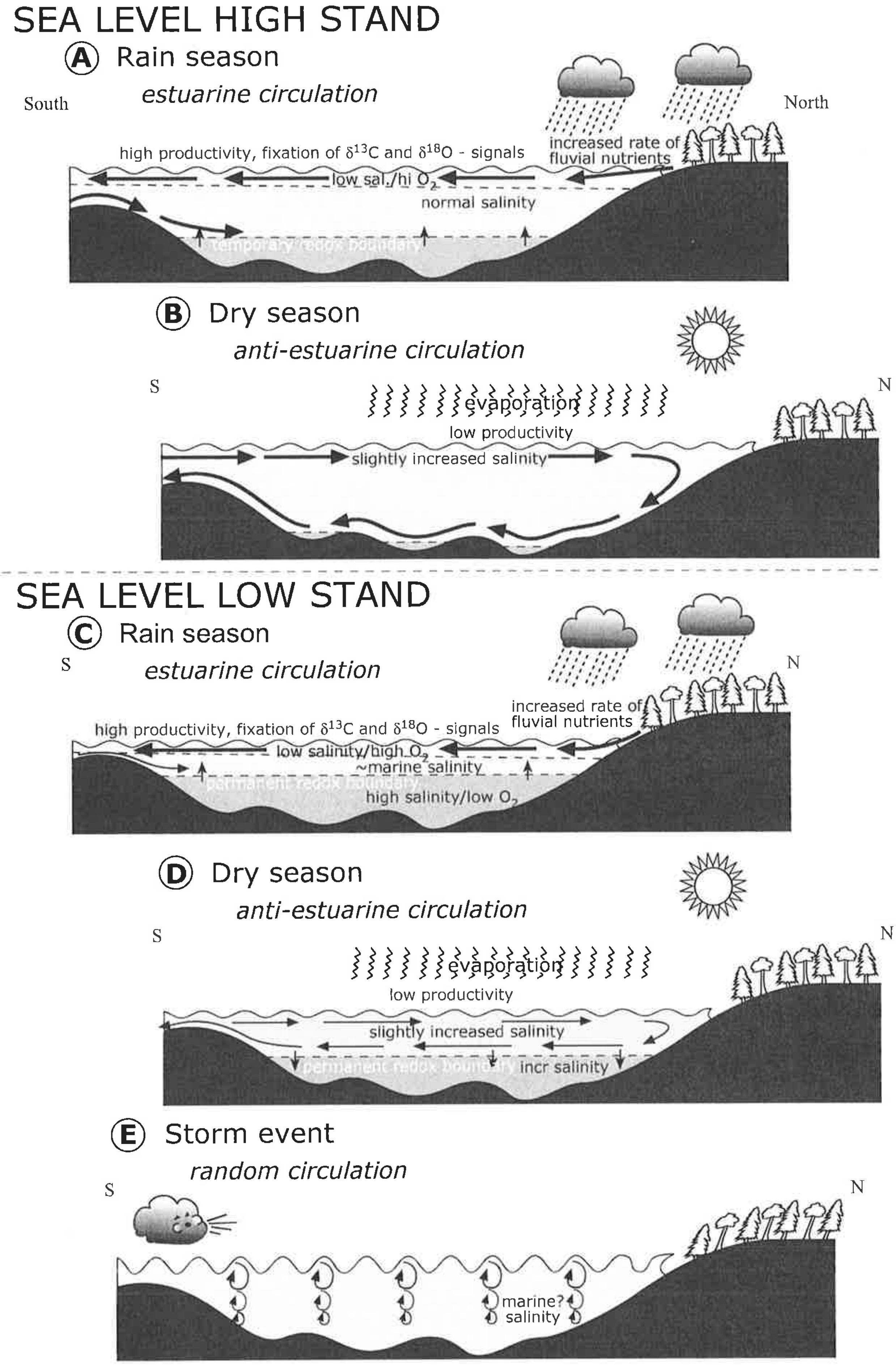


Figure 9: Model for circulation patterns in a restricted basin with associated oxygen levels. The diagram is based on a model for the Jurassic Posidonia Shale (Röhl *et al.*, 2001), where the 'rain season' is interpreted as 'monsoon season'. Australia in the Eocene was too far south to be within the monsoon belt, but may have experienced winter rain and summer dry seasons. (modified from Röhl *et al.*, 2001)

feature that does not continue are the strongly cemented bands and (probably more importantly) the absence of fossiliferous layers. This change occurs gradually, often over several metres. The Perkana Member is not a uniform package either, but rather contains more or less distinct layers (Pl. 59E), and the microfauna also displays significant fluctuations on various scales (McGowran & Beecroft, 1986).

6.2.2.4. Discussion of the Blanche Point Formation

The Blanche Point Formation is usually interpreted to represent a relative deepening of the basin compared with the Tortachilla Limestone, possibly through eustatic sea level rise. This is based on the finer grained sediment, complete fossils (including sponges) and undisturbed layers. Not all indicators, however, appear to agree on a simple scenario. Darker organic carbon-rich sediments imply eutrophic environments, whereas coccoliths and planktonic diatoms imply clear surface waters. Ostracoda have indicated deep-water facies of between 75 to 100 m depth (McKenzie, 1979) or even deeper (Majoran, 1996), along with low oxygen levels, poor circulation and cool temperatures (~15°C). Low ratios of the Foraminifera *Cibicedes/Uvigerina* are generally taken to indicate oxygen deficiency. Indeed, ratios are low in the unfossiliferous horizons of the Gull Rock and Perkana Members (Faehrman, 1979: 18), but high in the fossiliferous ones. Corliss *et al.* (1986), however, found that *Uvigerina* levels can vary independently of oxygen levels. Gastropods such as *Spirocolpus* are also often interpreted as an indicator of sub-oxic conditions. This is based on the fact that many species are infaunal filter feeders, which could theoretically survive in low oxygen conditions because of the high rate of water flow generated. Some species also have symbiotic algae, which provide oxygen (Buonaiuto *in* Faehrman, 1979: 15). This interpretation is not always reliable as the life styles vary dramatically between species of turritellids, and they are not always indicative of lower oxygen levels (Allmon, 1988). Additionally, if simply filter feeding allows them to cope with low oxygen levels, then it would be expected that bryozoans and brachiopods should similarly thrive in the same facies. These groups, however, do not consistently co-occur.

The enclosed layout of the basin, therefore, may not lend itself to such straightforward interpretations. A rise in relative sea level would enable the Kangaroo Island basement high to be flooded and thus no longer act as a barrier. This would increase the access of the open ocean to the basin and in turn bring in higher energy waves and currents from the much longer fetch of the widening Southern Ocean. It would still not be the same as being directly overrun by the large swell, but it would increase the overall agitation of the basin waters, thus producing an environment more like that, which prevailed during the deposition of the Tortachilla Limestone. The correlation of the Throoka Silts on Yorke Peninsula with the Gull Rock Member would make sense as a lowering of sea level could result in almost deltaic sediments on the western margin.

The Blanche Point facies may therefore rather be the result of a shallowing through relative sea level fall (Fig. 9C & D). The marine passages could have been mostly emergent and the high surface runoff of the prevailing climate may have dramatically lowered the salinity to create estuarine conditions. Most bryozoans and other animals, which usually live in normal marine conditions, do not tolerate hyposaline conditions. Contemporaneous sediments in the Bremer Basin are also estuarine (Gammon *et al.*, 2000) and although the sediments and fossils (mostly *in situ* body fossils of sponges) give the impression of cool deep-water conditions, they are actually shallow warm water deposits. Local declines in bryozoan diversity near river outlets are a commonly recognised phenomenon (e.g. Rhône Delta, Lagaaij & Gau-

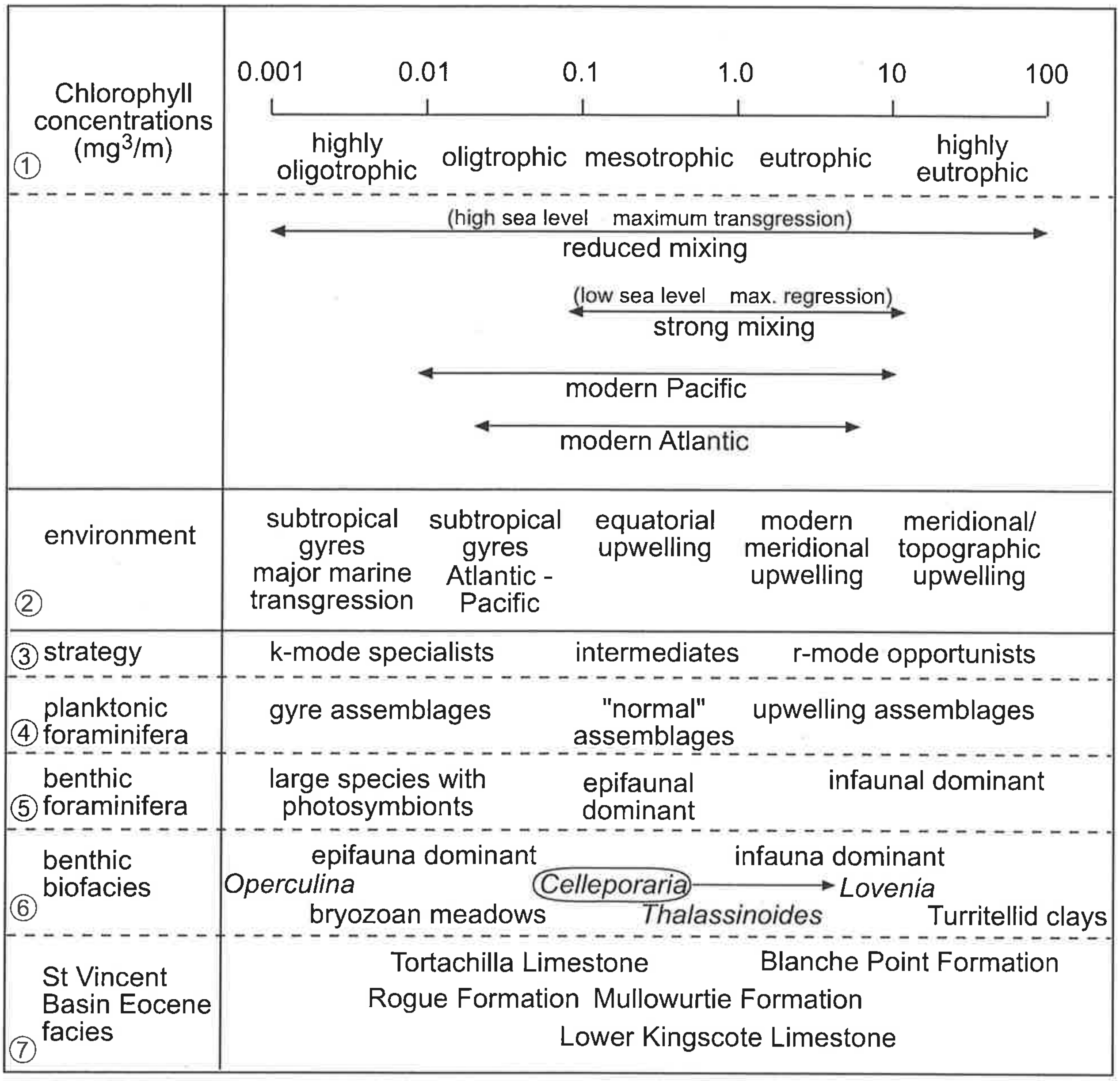


Figure 10: The Trophic Resource Continuum (T.R.C.) scaled to chlorophyll concentrations. Showing characteristic conditions which produce these nutrient levels and the faunas that are adapted to them (after McGowran & Li, 1995). (*Operculina* is a large foraminiferan genus, *Lovenia* is an infaunal sea-urchin, *Thalassinoides* is a trace fossil typical of infaunal shrimp). Celleporaria is placed in the traditional spot along the scale, but the arrow indicates where the current study would place it (i.e. in the eutrophic range among the r-mode opportunists).

tier, 1965; Patawallonga River outlet, S.A., and Western Australian coast river outlets, Y. Bone, pers. comm., 2000). The relative abundance of ascophorans compared to anascans, however, seems to negate the low salinity interpretation (McKinney & Jackson, 1989: 88).

Occasional horizons within the Blanche Point Formation (mainly the Gull Rock Member) contain higher diversity fossil assemblages, including a significant component of bryozoans. These may have been the result of temporary deepening events, which resulted in more normal marine environments through open ocean access or even storm events (Fig. 9A, B). Such events may have been short lived and only allowed early stage colonising species to establish themselves. Stressed conditions may have then returned before the communities could reach a diversification stage. Alternately storm events may have mixed the waters in the basin, and temporarily created oxygenated bottom conditions (Fig. 9E)

The Tuketja Member shares similarities with both the underlying Tortachilla Limestone (abundant delicate branching forms) and the overlying Gull Rock Member (common fenestrate and multilaminar colonies). It appears to be a transitional facies between the two on bryozoan evidence: no longer open marine, but not yet completely restricted.

The genera and even some species occurring in the Gull Rock Member also occur in the Tortachilla Limestone. They are simply a less diverse and abundant assemblage, dominated by a few taxa, in particular *Celleporaria 'gambierensis'*, *'Onychocella'* sp. b and various species of Phidoloporidae. This may indicate that these particular taxa are generalists or r-strategists, which thrive in eutrophic and often unstable environments (Fig. 10). They appear to cope with unstable environments by colonising other organisms such as sponges (digitate sponges are postulated for *Celleporaria*). The interpretation that Phidoloporidae prefer environments where deposition is slow or absent (Lagaaij & Gautier, 1965) fits well with this formation. None of the taxa characteristic of later stages in the succession are present, such as encrusters and erect delicate branching forms. This corroborates the interpretation that the suitable conditions were only temporary and subject to fluctuations on a short time-scale. It is unclear, however, what the timeframe of these alternations was. Assuming the Blanche Point Formation was deposited over a period of between 1.5 million years (McGowran & Beecroft, 1986) and 3 million years (the duration of the Late Eocene), and assuming relatively constant sedimentation rate for the deposition of the 20 to 30 m thickness, this gives a relatively slow sedimentation rate of 1 to 3 cm/ka. This rate falls within what is normally considered continental slope to abyssal plain situations (Schopf, 1969: 235). The 5 packets of unfossiliferous/fossiliferous cycles (James & Bone, 2000) could each represent approx. 300,000 years on average, while the individual silicified/unsilicified couplets would range from several thousand to many tens of thousands of years. These are relatively long periods of time for 'short-term' fluctuations.

Although growth rates of massive multilaminar colonies are usually considered to be slow (Moissette & Pouyet, 1991; Taylor & Voigt, 1999), modern *Celleporaria* species have been found to have some of the highest growth rates (Key, Jamet & Smith, 1999). Their dominance in the fossiliferous horizons and the absence of cyclostomes, which overall have the lowest growth rates, supports the idea that these horizons represent short-lived events. These fossiliferous layers and in particular the large colonies of *Celleporaria* generally coincide with the more cemented horizon in the Gull Rock Member. They have generally been interpreted as sea floor firm grounds or even hard grounds, potentially allowing the settlement of sessile organisms such as bryozoans. Closer inspection appears to show a correlation of the *Celleporaria* 'rafts' with intense cementation or silicification, pointing towards some causal relationship. The concentration of silicification around these rafts may point to the multilaminar bryozoans acting like 'nucleation centres'. This is a post-depositional effect and indicates that the degree of cementation (silicification) is dependent upon the skeletal carbonate content. This may, therefore, also affect the whole horizon in which the fossil, and therefore carbonate, content is higher, and result in a higher degree of lithification. The presence of carbonate in silica-rich sediment is known to greatly increase the solubility of the silica through the increase of pH of fluids (D. Lee, pers. comm., 2002). Sponges mainly dominate the softer, less fossiliferous layers. This is similar to the whole of the overlying Perkana Member, which is less lithified and contains relatively fewer calcareous fossils. Conversely, whatever environmental conditions caused the stronger banding in the Gull Rock also enabled more macrofauna to flourish.

A similar situation of alternating stressed and normal conditions has been proposed for the Lower Jurassic Posidonia Shale in Germany (Röhl *et al.*, 2001, Fig. 16). This Formation was deposited in the South-West German Basin, which was of similar size to the St Vincent Basin but connected to a series of other small basins. It was restricted from the Tethyan Ocean by a series of islands and sills. Monsoonal rains in summer created a surficial low salinity layer and produced estuarine circulation, while high rates of evaporation in winter created anti-estuarine circulation. These season-driven circulation patterns allowed thorough mixing of the whole basin when sea level was high. The exchange with the open ocean was weaker and a permanent redox-boundary could establish itself near the sea floor throughout the whole year when sea level was low. The low oxygen and high salinity conditions at the sea floor would only temporarily have ceased when storm events thoroughly mixed the water column (Fig. 9E). This could have allowed a brief period of colonisation. The redox boundary (H_2S/O_2) would have remained close to the sediment water interface, however, thus inhibiting most organisms from establishing themselves.

The Posidonia Shale epifauna, however, is characterised by possessing planktotrophic larvae, which could survive in the surface waters. Infauna are rare, as they are characterised by lecitotrophic larvae, live near the parent and cannot survive regularly recurring anoxia (Röhl *et al.*, 2001). The bryozoans of the Blanche Point Formation probably all had lecitotrophic larvae, indicating that this facies comparison may not completely hold up.

Surface run-off from the high rainfall in surrounding hinterland may have increased the levels of tannins (Christophel & Greenwood, 1987; Scriven, 1994) in the surface waters, significantly lowering photic levels and creating artificial 'deepening' effect for light dependent organisms. This would have influenced the ostracod fauna, which has been shown to be characteristic of normally deeper water conditions. It does not agree with the clear surface waters indicated by other fauna such as coccoliths.

Much has been speculated on the origin of the large amount of opaline silica contained in these sediments, including volcanic, marine and terrestrial sources (McGowran, 1998; McGowran & Beecroft, 1986). Regional volcanism is often inferred (Jones & Fitzgerald, 1984, 1986, 1987), but it is unclear if Late Eocene volcanism from southern Australia was substantial and extended enough to have such an impact. Johnson's (1989) 'Group 2' volcanic activity in the Otway Basin region terminates before the Late Eocene, and the 'Group 3' activity is Late Eocene but located far to the east. A marine origin through upwelling of deep-water currents has also been considered (McGowran *et al.*, 1997). The

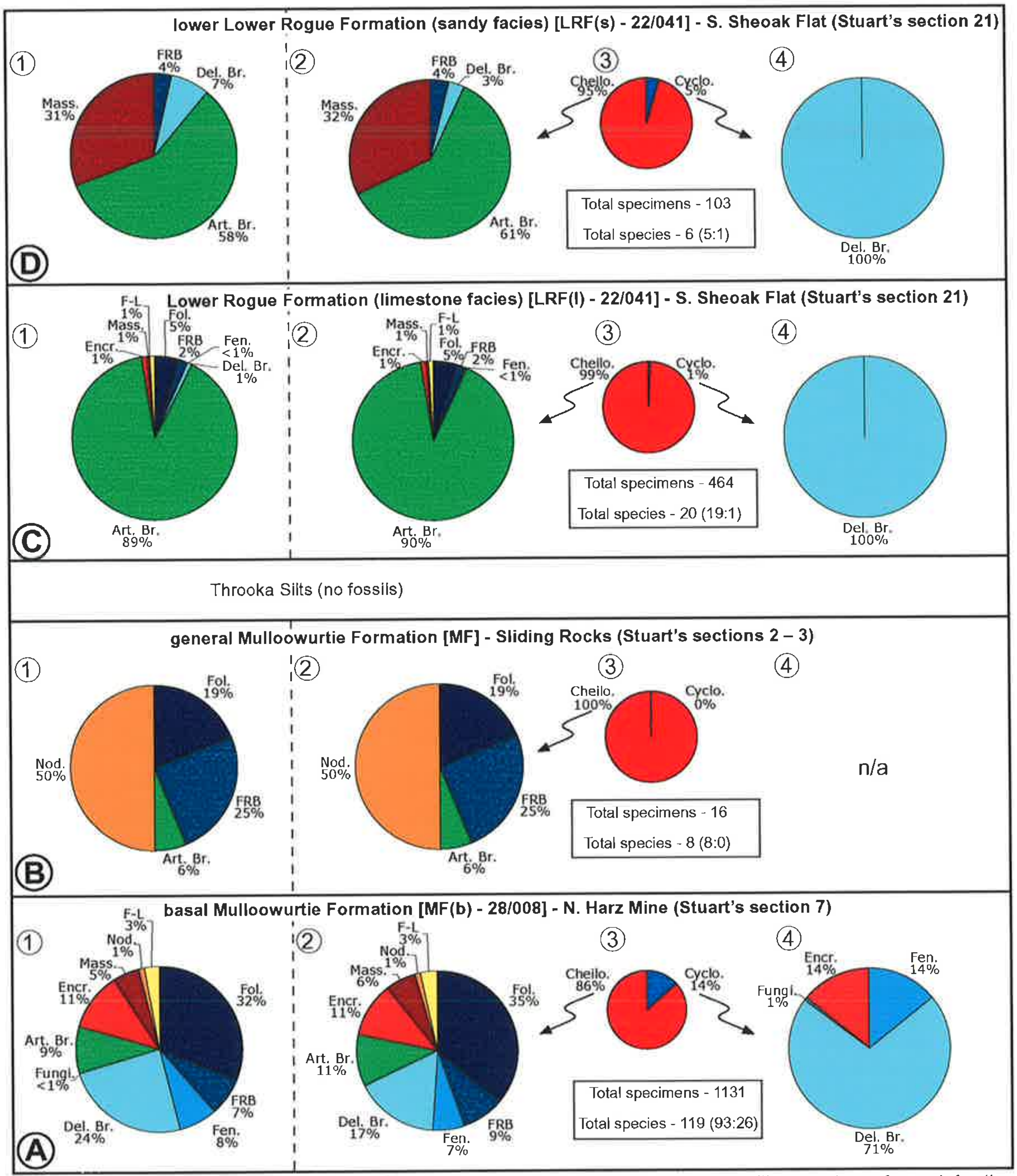


Figure 11: Yorke Peninsula (Mulloowurtie and Rogue Formations) growth forms. Pie charts with percentages for each fraction given for each sample; from left to right: 1) percentage of each growth form of all Bryozoa, 2) percentage of each growth form of cheilostomes, 3) percentage of cheilostomes vs cyclostomes, 4) percentage of each growth form of cyclostomes. Total specimens counted and total species diversity [all Bryozoa (cheilostomes:cyclostomes)] also given for each sample.

behaviour of water masses in the Australia-Antarctic gap is unclear, however, and large-scale upwelling may be rare in greenhouse climates (D. Lazarus, pers. comm. 2002). Deep-water currents were probably halothermally driven from the tropics (see Introduction) and may not have carried the same amount of nutrients as today. The extensive silcrete formation during most of the Eocene would have resulted in much of the silica in solution being flushed out in the humid climate of the Late Eocene (Gammon, pers. comm., 2001). It is also not clear whether a high silica input is really the main cause to explain the abundance of sponge spicules and the type of opaline silica anyway. There is no evidence in any contemporary basins along the south eastern margin of similar silica levels.

6.2.3. Mulloowurtie Formation Assemblages

6.2.3.1. Basal facies (Figs 11A & 12)

The only highly fossiliferous horizon within the Mulloowurtie Formation is located in a shallow depression on a basement high north of Harts Mine (Pl. 60A, B). It consists largely of bryozoan fragments with significant coarse quartz sand. The taxonomic assemblage is similar to that of the Tortachilla Limestone, but with different dominances.

Growth forms: The growth form assemblage is dominated by foliose colonies at one third., Delicate branching colonies comprise one quarter

Taxonomic assemblage: Cyclostomes only comprise just over one eighth of the fauna. The dominant species are *Smittoidea* sp. nov. e, *Porina spongiosa* and *Buffonellaria roberti* at over 5% each. *Celleporaria* spp., *Adeonellopsis symmetrica*, *Lekythopora* sp. nov. a, *Porina* sp. a, *Onychocella* sp. nov. b, *Crassimarginatella* sculpta and *Lunulites* sp. nov. b each comprise over 2%.

Other fauna: Pectinidae are common, as are brachiopods, regular echinoid spines, irregular echinoid tests and serpulids.

No evidence of any encrustation, such as oysters or basal colony attachments, was found on the basement rock (Cambrian metamorphic rock) along the whole outcrop of this horizon during this study. The fossils are relatively unfragmented, compared to the Tortachilla Limestone.

6.2.3.2. General silt facies (Figs 11B & 12)

Growth forms: Nodular (probably rooted) forms are present in low concentrations but make up half the bryozoan forms. Flat robust branching constitute a quarter, foliose a fifth and articulated branching the remainder.

Taxonomic assemblage: Only *Sphaeropora* sp. and *Aulopocella*? sp. are moderately common.

Other fauna: Common bivalve and brachiopod fragments occur. Rare infaunal echinoids (e.g. *Fibularia*) and occasional serpulid tubes also occur. An articulated crinoid stem and several still articulated ostracods were also observed.

6.2.3.3. Discussion of the Mulloowurtie Formation

The Eocene sediments on Yorke Peninsula are overall more quartz rich and generally have low fossil assemblages of abundance and diversity. The Mulloowurtie Formation is almost completely devoid of bryozoans and other fossils throughout most of the sections, apart from pervasive burrowing trace fossils. The largely homogenous silty to fine sand sediment was probably always unconsolidated at the sea floor and therefore did not offer a suitable substrate for most sessile benthic organisms. It was

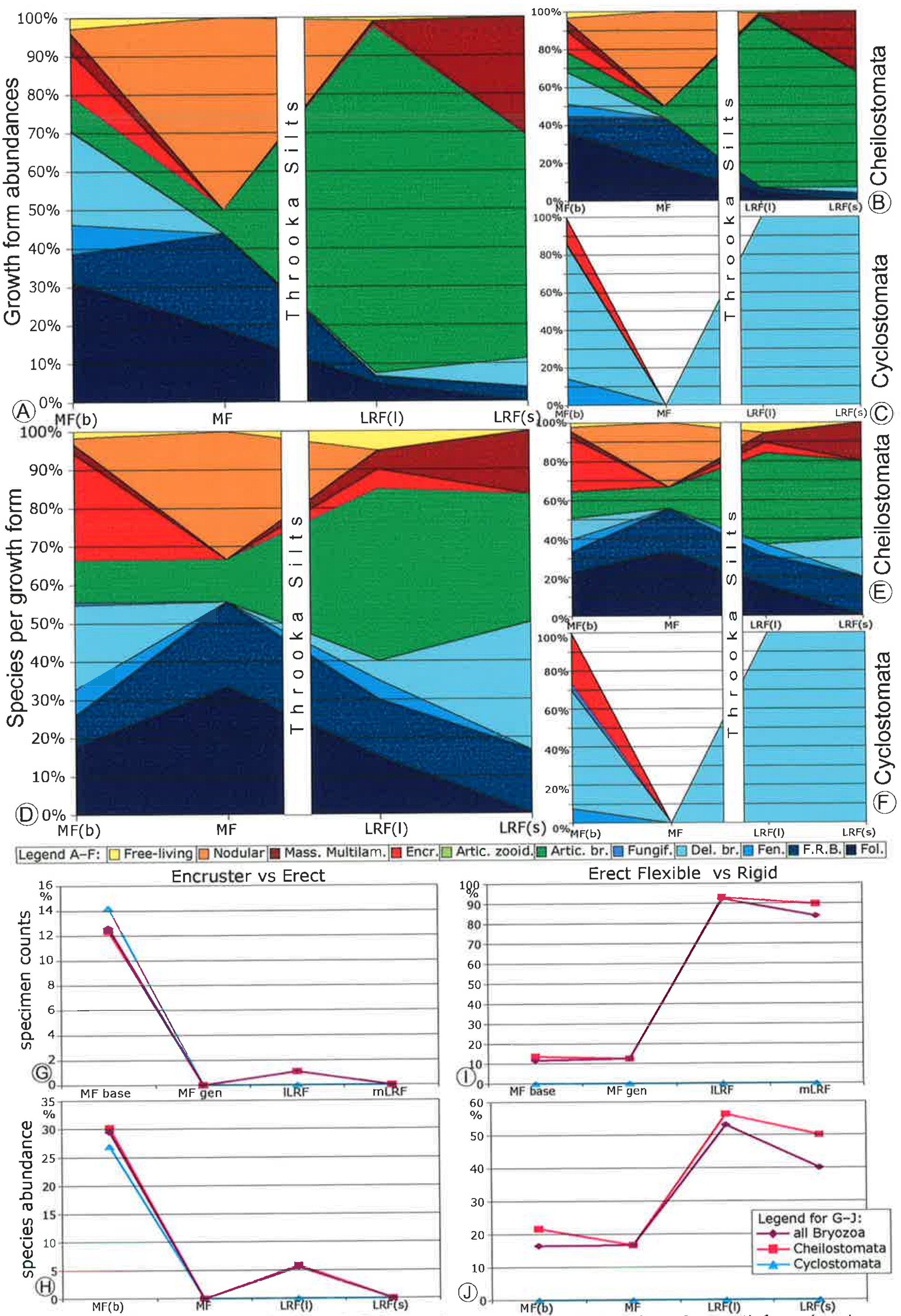


Figure 12: Yorke Peninsula growth forms. **A, B, C**: cumulative relative abundance charts for growth forms (specimens for each growth form as percent of total specimens of each sample). **D, E, F**: cumulative relative abundance charts for species diversity within growth forms (species for each growth form as percent of total species of each sample). **G, H**: % encrusters relative to erect growth forms. **I, J**: % of flexible erect relative to rigid erect growth forms. [y-axes for G, H: *% of Encr. = encr./(encr.+erect)x100*, for I, J: *% of Flex. = flex./(flex.+rigid)x100*; Note: massive, nodular and free-living forms not included in these calculations]

probably also near-shore and slightly brackish, discouraging colonisation by much of the benthic fauna. Some rooted forms have been shown to be the only bryozoans to settle relatively close to river outlets.

The fossiliferous locality overlying the basement may not be a straightforward 'normal marine' interpretation. It would be expected that some intertidal encrusters such as oysters and barnacles would be found, considering that this was probably a shallow or even emergent island, but none of these were observed. Stuart (1970) noted only a single oyster *in situ* on the basement rock. The low degree of fragmentation is also unusual, as the elevated nature of this 'island' could have placed the fauna within the wave zone. The slight concavity of the basement rock containing the fossiliferous outcrop may have created a local environment sheltered from wave energy, while at the same time allowing quicker accumulation of sediment, and thus not enabling direct colonisation of the bedrock.

6.2.4. Lower Rogue Formation Assemblage

Most of the Rogue Formation consists of silty and sandy poorly fossiliferous sediments. There are numerous horizons with abundant fossils, but these are almost exclusively composed of bivalves. Few bryozoans are present, and when they are, they are usually poorly preserved.

6.2.4.1. Limestone facies (Figs 11C & 12)

Growth forms: Strongly dominated by articulated branching forms (90%), which are all cheilostome. Most other forms (apart from fungiform, articulated zooidal and nodular) are present in low abundance.

Taxonomic assemblage: Cyclostomes comprise only 1%. *Buffonellaria roberti* is the only identifiable species to comprise a significant proportion (3%). The numerous *Cellaria* specimens are too altered to identify specifically, but may contain species that make up a significant percentage on their own.

Other fauna: Common bivalve fragments.

6.2.4.2. Sandy facies (Figs 11D & 12)

Growth forms: Dominated by delicate branching (58%), but multilaminar forms are also significant at almost one third. The only other forms are flat robust branching and delicate branching.

Taxonomic assemblage: Cyclostomes remain low at 5%. Celleporaria sp. comprised almost one third of the fauna. Adeonellopsis is the only other significant species at over 3%.

Other fauna: Pectinidae are abundant, relatively unfragmented and none is encrusted.

6.2.4.3. Discussion of the Rogue Formation

The environment was probably near-shore and possibly occasionally brackish from the proximity to high surface run-off. The relatively consistent and decimetre scale beds with only rare cross-bedding appears to indicate low disturbance. The dominance of articulated branching forms creates a 'sand fauna' assemblage (Cook, 1981). The absence of *Melicerita angustiloba* is interesting as it is a rooted sand fauna genus and present in sediments on both the eastern and southern margins.

No specimens of the articulated Catenicellidae or *Crisia* were found in any of the samples from Yorke Peninsula. Both taxa are common and even dominant in both the Maslin Beach and Kangaroo Island sections. Their absence could be primary or secondary. Secondary causes are likely as they are small and thus easily removed through winnowing or diagenesis, but are not important in the context of palaeoenvironments. If their absence is primary, it would indicate unfavourable environments

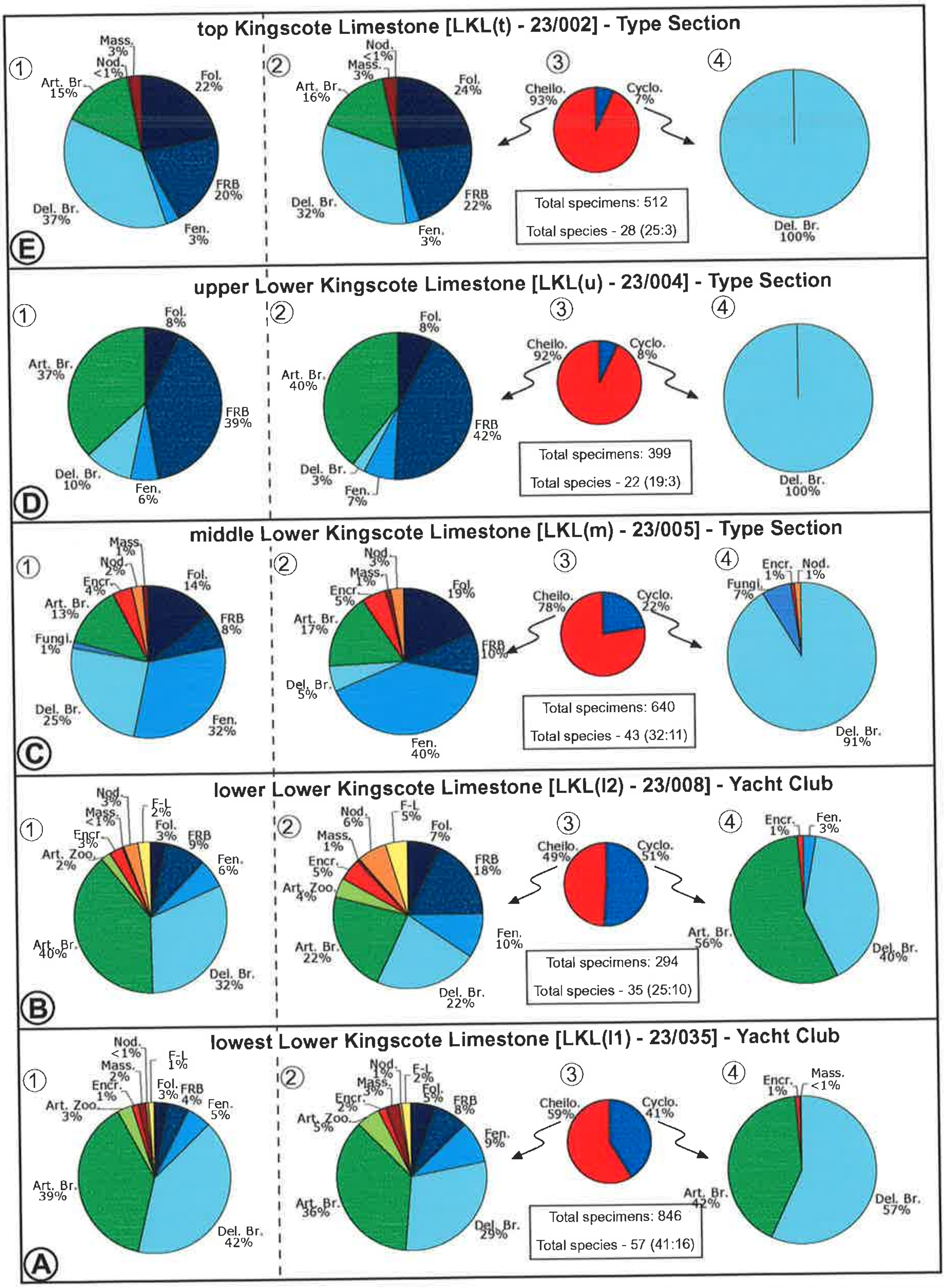


Figure 13: Kangaroo Island (Kingscote Limestone) growth forms. Pie charts with percentages for each fraction given for each sample; from left to right: **(1)** percentage of each growth form of all Bryozoa, **(2)** percentage of each growth form of cheilostomes, **(3)** percentage of cheilostomes vs cyclostomes, **(4)** percentage of each growth form of cyclostomes. Total specimens counted and total species diversity [all Bryozoa (cheilostomes:cyclostomes)] also given for each sample.

6.2.5. Lower Kingscote Limestone Assemblage

6.2.5.1. lowest Lower Kingscote Limestone (Figs 13A & 14)

Growth forms: Both Articulated branching and delicate branching are dominant at about 40% each overall, and constitute almost all cyclostomes. All other forms apart from fungiform are present, but all at 5% or less.

Taxonomic assemblage: Cheilostomes outnumber cyclostomes 3:2. *Crisia* sp. nov. a is the most common species at over 15%. Ogivalia sp. nov. a is also common at over 10%. *Ogiva* sp. nov. a and *Melicerita angustiloba* are the only other species to reach over 5%, while *Quadricellaria* sp. nov. a and *Celleporaria* sp. reach over 2%.

Other fauna: Straight unattached serpulid tubes are common.

6.2.5.2. lower Lower Kingscote Limestone (Figs 13B & 14)

Growth forms: Both articulated branching and delicate branching are dominant at about 40% each. All other forms apart from fungiform are present, but all at 5% or less.

Taxonomic assemblage: Cheilostomes and cyclostomes are present in equal numbers. *Crisia* sp. nov. a is the most common species at over 15%. Ogivalia sp. nov. a is also common at over 10%. *Ogiva* sp. nov. a and *Melicerita angustiloba* are the only other species to reach over 5%, while *Quadricellaria* sp. nov. a and *Celleporaria* sp. reach over 2%.

Other fauna: Straight unattached serpulid tubes are common.

6.2.5.3. middle Lower Kingscote Limestone (Figs 13C & 14)

Growth forms: Fenestrate forms become most common at one third, while delicate branching decrease to one quarter and articulate branching decrease to 13%. Fungiform colonies constitute a significant part of the cyclostomes (7%, the only time they comprise over 1%). Free-living and articulated zooidal forms are absent from here upwards.

Taxonomic assemblage: Cheilostomes outnumber cyclostomes almost 4:1. *Hornera robusta*, *Iodictyum* sp. nov. a, *Adeonellopsis symmetrica*, *Entalophoroecia* sp. nov. a and *Crisina* sp. nov. a all comprise just over 2%.

Other fauna: The small irregular echinoid *Fibularia* sp. is common.

6.2.5.4. upper Lower Kingscote Limestone (Figs 13D & 14)

Growth forms: Flat robust branching and articulated branching each constitute well over one third each. Foliose, fenestrate and delicate branching (dominated by cyclostomes) are the only other forms. All cyclostomes are delicate branching.

Taxonomic assemblage: Cheilostomes outnumber cyclostomes 9:1. *Adeonellopsis symmetrica* strongly dominates the fauna with one third. The next most common species are *Dactylostega* sp. nov. a, *Ogiva* sp. nov. a, *Onychocella* sp. nov. b and *Cellaria* sp. nov. c at just over 2% each.

Other fauna: *Fibularia* and *Monostychia* (often subhorizontal) common.

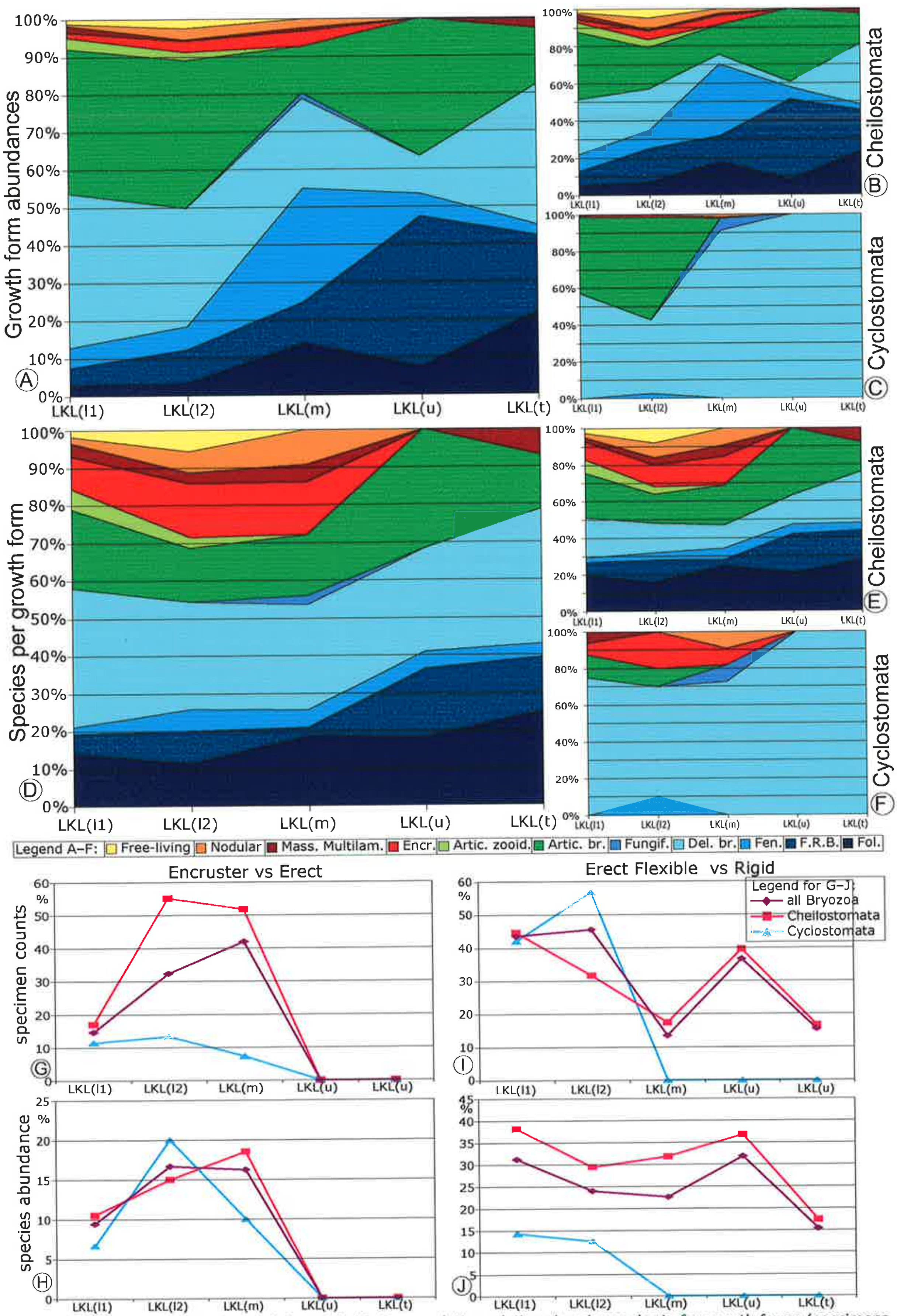


Figure 14: Kangaroo Island growth forms. **A, B, C**: cumulative relative abundance charts for growth forms (specimens for each growth form as percent of total specimens of each sample). **D, E, F**: cumulative relative abundance charts for species diversity within growth forms (species for each growth form as percent of total species of each sample). **G, H**: % encrusters relative to erect growth forms. **I, J**: % of flexible erect relative to rigid erect growth forms. [y-axes for G, H: *% of Encr. = encr./(encr.+erect)x100*, for I, J: *% of Flex. = flex./(flex.+rigid)x100*; Note: massive, nodular and free-living forms not included in these calculations]

6.2.5.5. top Lower Kingscote Limestone (Figs 13E & 14)

Growth forms: Delicate branching dominate with one third and foliose increase to almost a quarter, while flat robust branching drop to one fifth and articulated branching to 15%. Fenestrae and multilaminar constitute 3% each. All cyclostomes are again delicate branching.

Taxonomic assemblage: Cheilostomes outnumber cyclostomes 9:1. *Adeonellopsis symmetrica* is still most abundant but only at over 2% along with *Celleporaria*.

Other fauna: Regular echinoid spines, bivalves (in particular Pectinidae) and various gastropods are common, but may actually be burrow infills and thus actually originate from the overlying Middle Kingscote Limestone.

6.2.5.6. Discussion of the Kingscote Limestone

These horizons are the only ones in the Eocene basin where clearly dominant species occur. The articulate branching cyclostome *Crisia* is dominant in the two lower samples, while the delicate branching cheilostome *Ogivalia* and flat robust branching *Ogiva* are slightly less dominant.

The rooted *Melicerita* is abundant in the lowermost sample (along with the also rooted *Siphonicytara*) but becomes increasingly less common in the overlying two samples and is finally absent in the uppermost samples. In direct contrast, *Adeonellopsis symmetrica* becomes more common up section until it comprises a third of the fauna near the top of the Lower Kingscote Limestone – the dominant species in any of the fossiliferous formations studied here.

This unit differs from the other sediments on this basin margin, in that it is dominated by echinoids. *Fibularia* cf. *gregata* sometimes almost forms coquinas. *'Monostychia'* sp. is also common in some horizons.

Erect robust (delicate) branching forms dominate the bryozoan fauna. All of the identifiable species appear similar to those in the Tortachilla Limestone. The cyclostomes are proportionally more common than in the Tortachilla Limestone. *Celleporaria 'gambierensis'* is less common, but a multilaminar species of *Lichenopora*, which forms large spherical colonies, only occurs here (Pl. 61; due to the cemented nature of the horizons in which they occur no specimens were able to be sampled for closer analysis).

The area where the Kingscote Limestone is found is often considered to be one of the shallow inlets to the Eocene basin (Milnes *et al.*, 1983). This may have therefore been one of the only places where there was almost normal marine waters flowing over the sea floor (at least during estuarine circulation). It was also more likely emergent during low sea level due to its elevated nature, and much of the Late Eocene may be represented by a hiatus. Evidence for such a long hiatus, however, does not appear to be present in the studied sections.

6.3. General Trends

There do not appear to be any clear environmental indicator taxa or growth form assemblages in any of the sediments. All growth forms are present in most samples.

There is an overall intra-basinal difference in macrofaunal assemblages between the three margins. In general terms, the Eocene western margin of the St Vincent Basin was dominated by infaunal organisms, in particular echinoids, and occasionally molluscs, the southern margin was dominated by shallow infaunal echinoids and to a lesser extent bryozoans, and the eastern margin was initially dominated by bryozoans and to a lesser extent molluscs, echinoids and sponges and later by sponges and to a lesser extent molluscs and bryozoans. These are quite contrasting assemblages. Although the relative abundance patterns of bryozoan growth forms also display strong variations within the sections and overall patterns appear very different between the sections on the three basin margins, there are some common trends shared among them (Figs 8, 12, 14). These could be indicative of larger scale environmental conditions and changes, which are less influenced by local effect.

6.3.1. Encrusters

Encrusters consistently show a greater relative species diversity than relative specimen abundance (compare A, B, C with D, E, F respectively of Figures 8, 12, 14). This may indicate a greater original abundance of encrusters in the biocoenoces, which are not preserved in the thanatocoenoces due to various post-mortem effects (Gordon, 2000; see also Chapter 6.1.3). This indicates that it may be necessary to correct the absolute specimen numbers for these effect. It is, however, difficult to ascertain the correction factor that needs to be applied, and no previous study has definitively dealt with this problem. It is likely that each horizon requires its own *ad hoc* correction depending on the apparent degree of destructive post-mortem effects. Even if the observed specimen abundance of encrusters is double, however, the encruster/erect ratios still remain low (encrusters mostly below 50% of encrusters + erect; see A, H of Figures 8, 12, 14).

It is therefore unrealistic to compare the percentages obtained in this study directly with those of studies on Recent faunas (e.g. McKinney & Jackson, 1989: fig. 4.11). For the abundance of encrusters relative to erect forms, such direct comparisons would indicate depths greater than 300 m (encr./erect ratio = 1.0 = 50% encrusters) for all the Eocene St Vincent Basin, and even deeper than 1000 m (encr./erect ratio = 0.5 = 33% encrusters) for many horizons. It is therefore more informative to use the fluctuations of percentages as a means to estimate relative (not absolute) sea level changes (see also Zágorsek & Kázmér, 2001: 9). In this case both the Tortachilla Limestone and the Lower Kingscote Limestone are initially relatively deep and shallow in the middle horizons, only to dramatically deepen again towards the top. The Mulloowurtie Formation also has a relatively deep assemblage in the basal facies, but it then deepens even further in the general Mulloowurtie Formation and the Lower Rogue Formation. This appearance of rapid deepening in the later Eocene horizons could again be an effect of the restricted environment within the enclosed basin.

If the dominance of erect growth forms over encrusters is actually a primary feature, it could be the result of a lack of predators. Predators in shallow water usually preferentially prey on erect colonies, and their increased efficiency through the Phanerozoic has possibly 'pushed' erect colony forms into deeper water (McKinney & Jackson, 1989: 210). The environments of the St Vincent Basin may have been hostile to predatory organisms at times, and thus enabled erect bryozoans to flourish.

6.3.2. Sand Fauna

The two rooted genera *Siphonicytara* and *Melicerita* and the free-living colony forms are all most common in the lowermost sediments throughout the basin and become less common up-section, until they are absent in the Upper Eocene. This indicates a decrease in 'sand fauna' facies through the Eocene of the basin. In an inverse trend, cyclostomes become increasingly dominated by delicate branching forms towards the Upper Eocene throughout the basin. Both trends may be indicative of initial transgressive shallow facies with subsequent deepening. This contradicts the interpretation of shallower water for the Blanche Point Formation than for the Tortachilla Limestone. The 'deep water' character of the Blanche Point Formation, however, may be an artefact of the restricted basin as discussed earlier.

6.3.3. Zooidal Measurements

Zooid measurements are consistently smaller than those for the colonies of the same 'species' from the Victorian Oligo-Miocene sediments. Even if some represent different species, size differences are significant and consistent enough to require consideration. Smaller zooidal sizes are possibly indicative of cooler temperatures (Okamura & Bishop, 1988). This would contradict the interpretation of almost sub-tropical conditions during the Late Eocene, which as warm, if not warmer than the Miocene, and much warmer than the Oligocene. It is likely that the restricted character of the St Vincent Basin created a local 'climatic' effect. In this case it was not the temperature itself that was cooler, as a shallow and enclosed basin such as the St Vincent Basin would easily warm up. It is more likely that other factors such as nutrient levels caused the zooids to grow smaller.

6.3.4. Multilaminar Bioherms

Celleporaria is the only genus producing multilaminar colonies in the St Vincent Basin Eocene, along with the minor occurrence of a multilaminar '*Lichenopora*' in the Kingscote Limestone. Many other fossil and recent occurrences of common multilaminar colonies are composed of multi-specific and even multi-generic assemblages (Hara, 2001).

The Early Eocene La Meseta Formation of Seymour Island is dominated by diverse erect massive growth forms, especially cerioporid (dominant) and celleporiform colonies (Hara, 2001: 88). Cerioporid growth form is independent of water depth but dependent on availability of hard substratum (Brood, 1972). They are usually attached by strong basal laminae and can live in strongly agitated waters. Many different kinds of colonial forms of bryozoans with a clear preponderance of massive multilaminar colonies suggests favourable environmental conditions for the development of bryozoans, such as shallow-water, moderate to high energy and near shore environment with abundant supply of nutrients (Hara, 2001). It is unclear why there is no similar diversity among the multilaminates here.

6.3.5. Other Environmental Considerations

Comparing assemblages found on open shelves of the modern 'Ice House' with those in the restricted St Vincent Basin of the Eocene 'Greenhouse' obviously carries problems. Bryozoans are not dependent on depth *per se*, so their use as palaeodepth indicators may not be realistic if the general facies setting is not well understood. 'Deep water' assemblages can be an indicator of temperature or nutrients or predation levels or all of these. All these factors are known to vary both geographically and temporally.

Cyclostomes occur in relatively low abundance compared with cheilostomes. Although low cyclostome to cheilostome ratios are typical for post-Mesozoic assemblages (Taylor, 2001), this ratio may also be indicative of environmental factors. Low cyclostome to cheilostome ratios are typical of modern shallow tropical waters, such as the Northwest Shelf in Australia. Cyclostomes become more common deeper than ca. 500 m (Y. Bone, pers. comm., 2000). In polar shallow waters, on the other hand, cyclostomes can make up the majority of the bryozoan assemblage.

The rich bryozoan fauna of this study does not contradict the interpretation that the local climate was sub-tropical in the Eocene. Recently investigated areas such as the tropical Northwest Shelf in Australia contain an abundant bryozoan fauna in deeper water below 80 m depth (Y. Bone, pers. comm., 1999).

6.4. Conclusions

Neither the growth form nor taxonomic assemblages appear to give results that allow straightforward interpretations using current ecological understanding. The presence of deep-water taxa along with assemblages indicating water depths exceeding several hundred metres are contradictory to both the other fauna present and the shallow nature of the basin. This may indicate that our knowledge of Recent faunas is still incomplete and/or that the present is not always the key to the past, especially when dealing with environments, for which no modern representative exists (such as the Blanche Point facies).

The small geographic area and relatively short period of deposition in the Eocene St Vincent Basin saw a wide range of depositional facies. The initial transgressive marine facies on all margins saw the greatest diversity and abundance of bryozoans. This may have been the 'deepest' environment the basin experienced in the Eocene, with well-oxygenated and moderate energy conditions prevailing.

The subsequent assemblages, however, differ dramatically and may represent a shallowing, with the Kangaroo Island high efficiently restricting open ocean access. The embayments on the eastern margin became silica and organic carbon-rich, with a low diversity and low abundance fauna. Occasional fossiliferous beds dominated by *Celleporaria* and a few other erect ascophorans represent a brief reprieve to allow some opportunists to flourish, but it was too short for any others. Bryozoans are essentially absent from the western margin, with only a few rooted forms occurring in the siliciclastic sediments. Rivers and the resulting high sedimentation rate dominated this margin and low salinity inhibited bryozoan colonisation. The shallow sediments on the southern margin are dominated by infaunal echinoids throughout and bryozoans are occasionally sub-dominant. This was probably a shallow passage through a chain of 'Kangaroo Islands'.

It appears that, although shedding light on some aspects of the St Vincent Basin's palaeoenvironments, the findings of this study emphasise how further in-depth research on bryozoans may well elucidate the answers to the still remaining questions.

REFERENCES

Abele, C., Gloe, C.S., Hocking, J.B., Holdgate, G., Kenley, P.R., Lawrence, C.R., Ripper, D., Threlfall, W.F. & Bolger, P.F. (1988) Tertiary. *In* J.G. Douglas & J.A. Ferguson (eds) *Geology of Victoria* (Jenkin Buxton Printers Pty. Ltd. for Victorian Division, Geological Society of Australia, Melbourne): 251-350.

Abelson, A. (1997) Settlement in flow: Upstream exploration of substrata by weakly swimming larvae. *Ecology* **78**(1): 160-166.

Abgrall, M.J. & Walters, L.J. (2000) Settlement preferences and recruitment of the bryozoan *Bugula neritina* on drift macroalgae in Mosquito Lagoon, Florida. *American Zoologist* **40**(6): 925-925.

Aguirre-Urreta, M.B. & Olivero, E.B. (1992) A Cretaceous Hermit-Crab from Antarctica - Predatory Activities and Bryozoan Symbiosis. *Antarctic Science* **4**(2): 207-214.

Alley, N.F. & Lindsay, J.M. (1995) Chapter 10: Tertiary. *In* J.F. Drexel & W.V. Preiss (eds) *The Geology of South Australia. Vol. 2, The Phanerozoic* (Geological Survey of South Australia, Bulletin **54**: 150-217.

Audouin, J.V. (1826) Explication sommaire des planches de polypes de l'Égypte et de la Syrie, publiées par Jules-César. **Tome 1**(4 partie): 339.

Barnes, D.K.A. (1995) Seasonal and annual growth in erect species of Antarctic Bryozoans. *Journal of Experimental Marine Biology and Ecology* **188**(2): 181-198.

Bassler, R.S. (1953) *Bryozoa. In* R.C. Moore (ed.) Treatise on Invertebrate Paleontology - Part G (Geological Society of America, Universiy of Kansas Press, Lawrence, Kansas) xiii + 253 p.

Beecroft, A.S. (1980) *Foraminiferal biofacies of the Tortachilla Limestone and Blanche Point Formation, Late Eocene, Willunga Sub-Basin, South Australia.* (B.Sc. (Hons.) Thesis, University of Adelaide, Adelaide). 35 pp.

Bengtson, P. (1988) Open nomenclature. *Palaeontology* **31**: 222-227.

Berthelsen, O. (1962) Cheilostome Bryozoa in the Danian deposits of east Denmark. *Danmarks Geologiske Undersíglese* **83**: 1-287.

Blake, D.B. (1981) Paleoecology of Bryozoa. *In* T.W. Broadhead (ed.) *Lophophorates - Notes for a short course*, Cincinnati, Ohio): 37-51.

Boardman, R.S. (1984) Origin of the Post-Triassic Stenolaemata (Bryozoa): a taxonomic oversight. *Journal of Paleontology.* **58**: 19-39.

Bock, P.E. (1982) Bryozoa. *In* S.A. Shepherd & I.M. Thomas (eds) *Marine Invertebrates of Southern Australia Part I* (D.J. Woolman, Adelaide): 319-394.

Bock, P.E. & Cook, P.L. (1993a) *Catenariopsis morningtoniensis* Maplestone (Bryozoa, Anasca) - a Tertiary chaperiid from Victoria. *Alcheringa* **17**: 153-157.

Bock, P.E. & Cook, P.L. (1993b) *Quadriscutella* gen. nov. (Bryozoa, Cheilostomata) from the Tertiary and recent of Victoria and South Australia. *Alcheringa* **17**: 159-171.

Bock, P.E. & Cook, P.L. (1995a) *Chasmozoon* gen. nov., a new genus of ascophoran bryozoan for *Cellepora abdita* MacGillivray, from the Tertiary of Victoria. *Alcheringa* **19**: 113-117.

Bock, P.E. & Cook, P.L. (1995b) *Pachystomaria parvipuncta* MacGillivray, a 'sand fauna' bryozoan species from the Tertiary of Victoria. *Alcheringa* **19**: 171-174.

Bock, P.E. & Cook, P.L. (1996) Concatenellidae, a new family of Catenelloidea (Cheilostomatida) for *Concatenella airensis* (Maplestone) from the Tertiary of Victoria. *In* D.P. Gordon, A.M. Smith & J.A. Grant-Mackie (eds) *Bryozoans in Space and Time; Proceedings of the 10th International Bryozoology Conference* (National Institute of Water & Atmospheric Research, Wellington, NZ): 47-53.

Bock, P.E. & Cook, P.L. (1998) Otionellidae, a new family including five genera of free-living lunulitiform Bryozoa (Cheilostomatida). *Memorie di Scienze Geologiche* **50**: 195-211.

Bock, P.E. & Cook, P.L. (1999) Notes on Tertiary and Recent 'Lunulite' Bryozoa from Australia. *Memorie di Scienze Geologiche* **51**: 415-430.

Bock, P.E. & Cook, P.L. (2000) Lekythoporidae (Bryozoa, Cheilostomata) from the Tertiary anf Recent of southeastern Australia. *Memorie di Scienze Geologiche* **52**: 167-174.

Bock, P.E. & Cook, P.L. (2001a) Revision of Tertiary species of *Anaskopora* Wass (Bryozoa: Cribrimorpha). *Memoirs of Museum Victoria* **58**(2): 179-189.

Bock, P.E. & Cook, P.L. (2001b) A review of Australian *Siphonicytara* Busk (Bryozoa: Cheilostomatida). *Records of the Western Australian Museum* **20**: 307-322.

Bock, P.E. & Cook, P.L. (2002) First fossil finds of some Australian Bryozoa (Cheilostomata). *Alcheringa* **25**: 407-424.

Bock, P.E. & Hageman, S.J. (2000) Australasian palaeobiogeography: the Palaeogene and Neogene record - Bryozoa. *In* A.J. Wright, G.C. Young, J.A. Talent & J.R. Laurie (eds) *Palaeobiogeography of Australasian faunas and floras* (Memoir of the Association of Australasian Palaeontologists **23**: 422-423.

Bone, Y. (1991) Population explosion of the bryozoan *Membranipora aciculata* in the Coorong Lagoon in late 1989. *Australian Journal of Earth Sciences* **38**: 121-123.

Bone, Y. & James, N.P. (1993) Bryozoans as carbonate sediment producers on the cool-water Lacepede Shelf, Southern Australia. *Sedimentary Geology* **86**(3-4): 247-271.

Bone, Y. & Wass, R.E. (1990) Sub-Recent bryozoan-serpulid buildups in the Coorong Lagoon, South Australia. *Australian Journal of Earth Sciences* **37**: 207-214.

Boreen, T.D., James, N.P. & Bone, Y. (1992) A proposed facies model for cool water carbonate shelves. *AAPG* **76**: 765.

Bottjer, D.J. & Jablonski, D. (1988) Paleoenvironmental patterns in the evolution of post-Paleozoic benthic marine invertebrates. *Palaios* **3**: 540-560.

Bourman, R.P. & Lindsay, J.M. (1986) Timing, extent and character of late Cainozoic faulting on the eastern margin of the Mt. Lofty Ranges, South Australia. *Transactions of the Royal Society of South Australia* **113**(1-2): 63-67.

Braga, G. (1986) Tethyan migration of some Tertiary Bryozoa *International Symposium on Shallow Tethys 2.* (Wagga Wagga, Australia): 379-385.

Braga, G. & Barbin, V. (1988) Le Bryozoaires du Priabonien stratotypique (Province Vicenza, Italie). *Revue de Paléobiologie.* **7**: 495-556.

Brood, K. (1976) Cyclostomatous Bryozoa from the Paleocene and Maestrictian of Majunga Basin, Madagascar. *Geobios* **9**: 393-423.

Brown, D.A. (1948) Six new recent and Tertiary genera of Cheilostomatous Bryozoa from New

Zealand. *Annals and Magazine of Natural History, London, series 12* **1**: 108-122.

Brown, D.A. (1952) *The Tertiary Cheilostomatous Polyzoa of New Zealand* (Trustees of the British Museum (Natural History), London) xii + 405 p.

Brown, D.A. (1956) Some Pliocene Polyzoa from South Australia. *Annals and Magazine of Natural History, London, Series 12* **9**: 593-611.

Brown, D.A. (1958) Fossil Cheilostomatous Polyzoa from south-west Victoria. *Memoirs of the Geological Survey of Victoria* **20**: 1-90.

Buonaiuto, M.F. (1979) *Late Eocene molluscs and related composite species from southern Australia.* (Ph.D. Thesis, University of Adelaide, Adelaide). 235p.

Busk, G. (1860) Note on the fossil Polyzoa collected by Rev. J.E. Woods near Mount Gambier, South Australia. *Quarterly Journal of the Geological Society, London* **16**: 260-261.

Busk, G. (1884) Report on the Polyzoa collected by H.M.S. *Challenger* during the years 1873-76. Part I. - The Cheilostomata. *Report on the Scientific Results of the Voyage of H.M.S. Challenger, Zoology* **10**(30): xxiv + 216p.

Cande, S.C. & Mutter, J.C. (1982) A revised identification of the oldest searloor spreading anomalies between Australia and Antarctica. *Earth and Planetary Science Letters* **58**: 151-160.

Canu, F. (1904) Les Bryozoaires du Patagonien. Echelle des Bryozoaires pour les terrains tertiaires. *Mémoires de la Société Géologique de France, Paléontologie* **12**(3): 1-30, pls 4-8.

Canu, F. (1908) Iconographie des bryozoaires fossiles de l'Argentine, pt 1. *Annales musee nacional Buenos Aires.* **10**: 245-341.

Canu, F. (1911) Iconographie des Bryozoaires fossiles de l'Argentine. *Annales musee nacional Buenos Aires.* **t.14**: 215-91.

Canu, F. & Bassler, R.S. (1920) North American Early Tertiary Bryozoa. *Bulletin of the United States National Museum* **106**: (Vol.1, Text) xx + 879 p., (Vol.2, Plates) 162 pls.

Canu, F. & Bassler, R.S. (1922) Studies on the cyclostomatous Bryozoa. *Proceedings of the U.S. National Museum.* **61**: 1-160.

Canu, F. & Bassler, R.S. (1923) North American Later Tertiary and Quaternary Bryozoa. *Bulletin of the United States National Museum* **125**: 1-302.

Canu, F. & Bassler, R.S. (1933) The Bryozoan fauna of the Vincetown Limesand. *Bulletin of the United States National Museum* **165**: 1-108.

Canu, F. & Bassler, R.S. (1935) New species of Tertiary Cheilostome Bryozoa from Victoria, Australia. *Smithsonian Miscellaneous Collections* **93**(9): 1-54.

Chapman, F. (1935) Plant remains of Lower Oligocene age near Blanche Point, Aldinga, South Australia. *Transactions of the Royal Society of South Australia* **59**: 237-240.

Chapman, F. (1943) Notes on fossiliferous rocks from Tertiary outcrops to the south-west of Coonalpyn, South Australia. *Transactions of the Royal Society of South Australia* **67**(1): 39-41.

Cheetham, A.H. (1962) Eocene Bryozoa from the McBean Formation in Georgia. *Micropaleontology* **8**(3): 323-336.

Cheetham, A.H. (1966) Cheilostomatous Polyzoa from the Upper Bracklesham Beds (Eocene) of Sussex. *Bulletin of the British Museum (Natural History), Geology* **13**(1): 1-115.

Cheetham, A.H. (1971) Functional morphology and biofacies distribution of cheilostome Bryozoa in the Danian Stage (Paleocene) of southern Scandinavia. *Smithsonian Contributions to Paleobiology* **6**: iv + 52.

Cheetham, A.H. (1972) Cheilostome Bryozoa of Late Eocene age from Eua, Tonga. *Professional Paper of the United States Geological Survey* **640-E**: i-vii, E1-26.

Cheetham, A.H. (1975) Preliminary report on Early Eocene cheilostome bryozoans from Site 308 - Leg 32, Deep Sea Drilling Poject. *In* R.L. Larson, R. Moberly *et al.* (eds) *Initial Reports of the Deep Sea Drilling Poject* (U.S. Government Printing Office, Washington, D.C.) **32**: 835-851.

Cheetham, A.H. & Håkansson, E. (1972) Preliminary report on Bryozoa (Site 117). *In* A.S. Laughton, *et al.* (eds) *Initial Reports of the Deep Sea Drilling Project*, Washington) **XII**: 432-441, pls. 13-28.

Cheetham, A.H., Jackson, J.B.C. & Sanner, J. (2001) Evolutionary significance of sexual and asexual modes of propagation in Neogene species of the bryozoan *Metrarabdotos* in tropical America. *Journal of Paleontology* **75**(3): 564-577.

Cheetham, A.H. & Thomsen, E. (1981) Functional morphology of arborescent animals: strength and design of cheilostome bryozoan skeletons. *Paleobiology* **7**: 355-383.

Christophel, D.C. & Greenwood, D.R. (1987) A megafossil flora from the Eocene of Golden Grove, South Australia. *Transactions of the Royal Society of South Australia* **111**: 155-162.

Clarke, J.D.A., Bone, Y. & James, N.P. (1996) Cool-water carbonates in an Eocene palaeoestuary, Norseman Formation, Western Australia. *Sedimentary Geology* **101**(3-4): 213-226.

Cochrane, G.W. (1956) The geology and hydrology of the Willunga Basin. *Report of Investigations of the Geological Survey of South Australia* **8**: 18.

Cockbain, A.E. (1970) Appendix 2: Notes on the cheilostomatous Bryozoa from the Eucla Group, Western Australia. *Bulletin of the Western Australian Geological Survey* **122**: 192-199.

Cockbain, A.E. (1971) Tertiary cheilostomatous Bryozoa from Victoria; a revised stratigraphical distribution. *Proceedings of the Royal Society of Victoria (n.s.)* **84**(1): 173-181.

Cook, P.L. (1968) Polyzoa from West Africa - the Malacostega, Part 1. *Bulletin of the British Museum (Natural History), Zoology* **16**(3): 113-160.

Cook, P.L. (1981) The potential of minute bryozoan colonies in the analysis of deep sea sediments. *Cahiers de Biologie Marine* **22**: 89-106.

Cook, P.L. (1985) Bryozoa from Ghana - a preliminary survey. *Koninklijk Museum voor Midden-Afrika (Tevuren, België), Zoologische Wetenschappen - Annals* **238**: 1-315.

Cook, P.L. & Bock, P.E. (2001) Calescharidae, a new family for the Tertiary and Recent genera *Caleschara* MacGillivray and *Tretosina* Canu & Bassler (Bryozoa: Cheilostomata). *Invertebrate Taxonomy* **15**: 527-550.

Cook, P.L. & Chimonides, P.J. (1981) Morphology and systematics of some interior-walled cheilostome Bryozoa. *Bulletin of the British Museum (Natural History), Zoology* **41**(2): 53-89.

Cook, P.L. & Chimonides, P.J. (1985) Recent and fossil Lunulitidae (Bryozoa: Cheilostomata) 4. American and Australian species of *Otionella*. *Journal of Natural History* **19**(2): 575-603.

Cook, P.L. & Chimonides, P.J. (1986) Recent and fossil Lunulitidae (Bryozoa: Cheilostomata) 6. *Lunulites* sensu lato and the genus *Lunularia* from Australia. *Journal of Natural History* **20**(3): 681-705.

Cooper, B.J. (1979) *Eocene to Miocene stratigraphy of the Willunga Embayment* Report of

Investigations of the Geological Survey of South Australia **50** (Department of Mines and Energy, Adelaide, South Australia) 101 p.

Cooper, B.J. (1985) The Cainozoic St. Vincent Basin - tectonics, structure, stratigraphy. *In* J.M. Lindsay (ed.) *Stratigraphy, palaeontology, malacology; papers in honour of Dr. Nell Ludbrook (Special Publication - South Australian Department of Mines and Energy)* (D.J. Woolman, Government Printer, Adelaide) **5**: 35-49.

Cooper, B.J. & Lindsay, J.M. (1978) Marine entrance to the Cainozoic St. Vincent Basin. *Quarterly Geological Notes of the Geological Survey of South Australia* **67**: 4-6.

Craig, R.S. (2000) The Cenozoic brachiopods of the Carnarvon Basin, Western Australia. *Palaeontology* **43**(1): 111-152.

Crespin, I. (1954) *Stratigraphy and micropalaeontology of the marine Tertiary rocks between Adelaide and Aldinga, South Australia*, Bureau of Mineral Resources, Geology & Geophysics, Australia **12**.

Cuffey, R.J. & Turner, R.F. (1987) Modern bryozoans on the Kodiak Shelf, southern Alaska. *In* J.R.P. Ross (ed.) *Bryozoa: Present and Past - Proceedings of the 7th International Bryozoology Association Conference* (Western Washington University Press, Bellingham): 65-72.

Daily, B., Firman, J.B., Forbes, B.G. & Lindsay, J.M. (1976, reprinted 1988) Geology. *In* C.R. Twidale, M.J. Tyler & B.P. Webb (eds) *Natural history of the Adelaide region* (Royal Society of South Australia, Occasional Publications, Adelaide) **1**: 5-42.

Dalziel, I. & Taylor, F. (2001) *Crustal movements beneath the WAIS.* (web page: www.ig.texas.edu/research/projects/gps/wais_bedrock/wagn.pdf *by* University of Texas Institute for Geophysics; accessed 15 May 2003)

Darragh, T.A. (1985) Molluscan biogeography and biostratigraphy of the Tertiary of southern Australia. *Alcheringa* **9**: 83-116.

Dewel, R.A., Winston, J.E. & McKinney, F.K. (2002) Deconstructing bryozoans: origin and consequences of a unique body plan. *In* P.N. Wyse-Jackson, C.J. Buttler & M.E. Spencer-Jones (eds.) *Bryozoan Studies 2001 - Proceedings of the 12th I.B.A. Conference* (A.A. Balkema Publishers, Lisse, Netherlands): 93-99.

Dyson, I.A. (1998) Estuarine facies of the North Maslin Sand and South Maslin Sand, Maslin Beach. *MESA Journal* **11**: 42-46.

Ehrmann, W.U. & Mackensen, A. (1992) Sedimentological evidence for the formation of an East Antarctic ice sheet in Eocene/Oligocene time. *Palaeogeography, Palaeoclimatology, Palaeoecology* **93**: 85-112.

Etheridge, R. (1877) A synopsis of the known species of Australian Tertiary Polyzoa. *Journal and Proceedings of the Royal Society of New South Wales* **10**: 129-143.

Etheridge, R. (1901) Additional notes on the Palaeontology of Queensland (part 2). *Bulletin of the Geological Survey of Queensland* **13**: 1-58.

Flöttman, T. & Cockshell, C.D. (1996) Palaeozoic basins of Southern Australia: new insights into their structural history from regional seismic data. *Australian Journal of Earth Sciences* **43**: 45-55.

Frakes, L.A., McGowran, B. & Bowler, J.M. (1987) Evolution of Australian Environments. *In* G.R. Dyne & D.W. Walton (eds) *Fauna of Australia. General Articles* (Australian Government Publishing Service, Canberra) **1A**: 1-16.

Frakes, L.A., Probst, J.-L. & Ludwig, J. (1994) Latitudinal distribution of paleotemperature on land and sea from early Cretaceous to middle Miocene. *Comptes Rendues Académie Science Paris* **318**(série 2): 1209-1218.

Gammon, P.R. & James, N.P. (2001) Palaeogeographical influence on Late Eocene biosiliceous sponge-rich sedimentation, southern Western Australia. *Sedimentology* **48**: 559-584.

Glaessner, M.F. & Wade, M. (1958) The St. Vincent Basin. *In* M.F. Glaessner & L.W. Parkin (eds) *The geology of South Australia* (Geological Society of Australia, Journal **5**: pp. 115-126.

Gordon, D.P. (1972) Biological Relationships of an Intertidal Bryozoan Population. *Journal of Natural History* **6**(5): 503-514.

Gordon, D.P. (1984) The marine fauna of New Zealand: Bryozoa (Gymnolaemata) of the Kermadec Ridge. *Memoir of the New Zealand Oceanographic Institute* **91**: 198.

Gordon, D.P. (1986) The marine fauna of New Zealand: Bryozoa: Gymnolaemata (Ctenostomata and Cheilstomata Anasca) from the western South Island continental shelf and slope. *Memoir of the New Zealand Oceanographic Institute* **95**: 1-87.

Gordon, D.P. (1987) The deep-sea Bryozoa of the New Zealand region. *In* J.R.P. Ross (ed.) *Bryozoa: Present and Past - Proceedings of the 7th International Bryozoology Association Conference* (Western Washington University Press, Bellingham): 97-104.

Gordon, D.P. (1989) The marine fauna of New Zealand: Bryozoa: Gymnolaemata (Ascophora) from the western South Island continental shelf and slope. *Memoir of the New Zealand Oceanographic Institute* **97**: 1-107.

Gordon, D.P. (1994) Tertiary bryozoan genera in the present-day Australasian fauna - implications for classification and biogeography. *Invertebrate Taxonomy* **8**: 283-298.

Gordon, D.P. (2000) Towards a phylogeny of the cheilostomes - Morphological models of frontal wall/shield evolution. *In* A. Herrera-Cubilla & J.B.C. Jackson (eds) *Proceedings of the 11th International Bryozoology Association Conference* (Smithsonian Tropical Research Institute, Balboa, Rep. Panamá): 17-37.

Gordon, D.P. (2001) Exceptional bryozoan diversity in New Zealand shelf environments. *Biodiversity Update - NIWA* **2001**(3): 4-5.

Gordon, D.P. & d'Hondt, J.-L. (1997) Bryozoa: Lepraliomorpha and other Ascophorina, mainly from New Caledonian waters. *In* A. Crosnier (ed.) *Résultats des Campagnes Musorstom, Vol. 18* (Mémoires du Muséum National d'Histoire Naturelle, Paris) **176**: 9-124.

Gordon, D.P., Stuart, I.G. & Collen, J.D. (1994) Bryozoan fauna of the Kaipuke Siltstone, northwest Nelson: a Miocene homologue of the modern Tasman Bay coralline bryozoan grounds. *New Zealand Journal of Geology and Geophysics* **37**(3): 239-247.

Gordon, D.P. & Taylor, P.D. (1999) Latest Paleocene to earliest Eocene bryozoans from Chatham Island, New Zealand. *Bulletin of the Natural History Museum, London (Geology)* **55**(1): 1-45.

Gordon, D.P. & Voigt, E. (1996) The kenozooidal origin of the ascophorine hypostegal coelom and associated frontal shield. *In* D.P. Gordon, A.M. Smith & J.A. Grant-Mackie (eds) *Bryozoans in Space and Time; Proceedings of the 10th International Bryozoology Conference* (National Institute of Water and Atmospheric Research, Wellington, NZ): 89-107.

Greeley, R. (1969) Basally "uncalcified" zoaria of lunulitiform Bryozoa. *Journal of Paleontology* **43**(2):

252-256.

Gregory, J.W. (1916) The age of the Norseman Limestone, Western Australia. *Geological Magazine (n.s.), dec. 6* **3**(6): 320-321.

Grischenko, A.V., Taylor, P.D. & Mawatari, S.F. (2002) A new cheilostome bryozoan with gigantic zooids from the north-west Pacific. *Zoological Science* **19**: 1279-1289.

Guha, A.K. & Nathan, D.S. (1996) Bryozoan fauna of the Ariyalur Group (Late Cretaceous), Tamil Nadu and Pondicherry, India. *Palaeontologia Indica, New Series* **49**: 217.

Hageman, S.J., Bone, Y., McGowran, B. & James, N.P. (1997) Bryozoan colonial growth-forms as paleoenvironmental indicators: evaluation of methodology. *Palaios* **12**(5): 405-419.

Haq, B.U., Hardenbol, J. & Vail, P.R. (1987) Chronology of fluctuating sea levels since the Triassic. *Science* **235**: 1156-1167.

Hara, U. (2001) Bryozoans from the Eocene of Seymour Island, Antarctic Peninsula. *Palaeontologia Polonica* **60**: 33-154.

Harmelin, J.-G. (1988) Les bryozoaires, de bons indicateurs bathymétriques en paléoécologie? *Géologie Méditerranéenne* **40**(1): 49-63.

Harmer, S.F. (1926) The Polyzoa of the Siboga Expedition. Part 2. Cheilostomata Anasca, with additions to previous reports. *Report Siboga Expeditie Leiden* **28b**: 181-501, pls 13-34.

Harmer, S.F. (1934) The Polyzoa of the Siboga Expedition. Part 3. Cheilostomata Ascophora. I. Family Reteporidae. *Report Siboga Expeditie Leiden* **28c**: 503-640, pls 35-41.

Harmer, S.F. (1957) The Polyzoa of the Siboga Expedition. Part 4. Cheilostomata Ascophora. II. Ascophora, except Reteporidae, with additions to Part 2, Anasca. *Report Siboga Expeditie Leiden* **28d**: 641-1147, pls 42-74.

Harris, W.K. (1985) Middle to late Eocene depositional cycles and dinoflagellate zones in southern Australia. *In* J.M. Lindsay (ed.) *Stratigraphy, Palaeontology, Malacology, Papers in Honour of Dr Nell Ludbrook* (D.J. Woolman, Government Printer, Department of Mines and Energy, Adelaide) Special Publication **5**: 133-144.

Hass, H. (1948) Beitrag zur Kenntnis der Reteporiden. *Zoologica.* **101**: 1-138.

Hastings, A.B. (1966) Observations on the type-material of some genera and species of Polyzoa. *Bulletin of the British Museum (Natural History), Zoology* **14**(3): 57-78.

Hastings, A.B. (1979) The genus *Hippothoa* Lamouroux (Polyzoa [Bryozoa] Cheilostomata). *Journal of Natural History* **13**(5): 535-560.

Hayward, P.J. (1980) Cheilostomata (Bryozoa) from the South-Atlantic. *Journal of Natural History* **14**(5): 701-722.

Hayward, P.J. (1995) *Antarctic Cheilostomatous Bryozoa* (Oxford University Press, Oxford) 355 p.

Hayward, P.J. & Cook, P.L. (1979) The South African Museum's *Meiring Naude* cruises. Part 9. Bryozoa. *Annals of the South African Museum* **79**(4): 43-130.

Hayward, P.J. & Cook, P.L. (1983) The South African Museum's *Meiring Naude* cruises. Part 13, Bryozoa II. *Annals of the South African Museum* **91**(1): 1-161.

Hayward, P.J. & Thorpe, J.P. (1988a) A New Family of Cheilostome Bryozoa Endemic to Antarctica. *Zoological Journal of the Linnean Society* **93**(1): 1-18.

Hayward, P.J. & Thorpe, J.P. (1988b) New genera of Antarctic cheilostome Bryozoa. *Cahiers de*

Biologie Marine **29**(2): 277-296.

Hayward, P.J. & Thorpe, J.P. (1990) Some Antarctic and Sub-Antarctic Species of Smittinidae (Bryozoa, Cheilostomata). *Journal of Zoology, London* **222**: 137-175.

Hillmer, G., Voigt, E. & Scholz, J. (1997) Neue fungiforme Bryozoen-Genera (Cyclostomata) aus dem subhercynen Santonium und ihre Ökologie. *Courier Forschungsinstitut Senckenberg* **201**: 201-223.

Hocking, R.M. (1990a) Carnarvon Basin *Geology and Mineral Resources of Western Australia* (Geological Survey of Western Australia, Memoir **3**: 457-495.

Hocking, R.M. (1990b) Bremer Basin *Geology and Mineral Resources of Western Australia* (Geological Survey of Western Australia, Memoir **3**: 561-563.

Holdgate, G. & Galagher, S. (2003, in press) Tertiary - a period of transition to marine basin environments. *In* W. D. Birch (ed.) *Geology of Victoria* (Geological Society of Australia, Melbourne) Special Publication **23**.

Howchin, W. (1911) Description of a disturbed area of Cainozoic rocks in South Australia with remarks on its geological significance. *Transactions of the Royal Society of South Australia* **35**: 47- 59.

Howchin, W. & Parr, W.J. (1938) Notes on the geological features and foraminiferal fauna of the Metropolitan Abbattoirs Bore, Adelaide. *Royal Society of South Australia, Transactions* **62**: 287-317, pls 15-19.

Jablonski, D. (1986) Larval ecology and macroevolution in marine invertebrates. *Bulletin of Marine Science* **39**: 565-587.

Jackson, J.B.C. & Winston, J.E. (1982) Ecology of cryptic coral reef communities. I. Distribution and abundance of major groups of encrusting organisms. *Journal of Experimental Marine Biology and Ecology* **57**: 135-147.

James, N.P. & Bone, Y. (1989) Petrogenesis of Cenozoic temperate water calcarenites, South Australia; a model for meteoric/shallow burrial diagenesis os shallow water calcite sediments. *Journal of Sedimentary Petrology* **59**(2): 191-203.

James, N.P. & Bone, Y. (1991) Origin of a cool-water, Oligo-Miocene deep shelf limestone, Eucla Platform, southern Australia. *Sedimentology* **38**(2): 323-341.

James, N.P. & Bone, Y. (1994) Paleoecology of cool-water, subtidal cycles in Mid-Cenozoic limestones, Eucla platform, southern Australia. *Palaios* **9**(5): 457-476.

James, N.P. & Bone, Y. (2000) Eocene cool-water carbonate and biosiliceous sedimentation dynamics, St. Vincent Basin, South Australia. *Sedimentology* **47**(4): 761-786.

James, N.P., Bone, Y., Collins, L.B. & Kyser, T.K. (2001) Surficial sediments of the Great Australian Bight: Facies dynamics and oceanography on a vast cool-water carbonate shelf. *Journal of Sedimentary Research* **71**(4): 549-567.

James, N.P., Collins, L.B., Bone, Y. & Hallock, P. (1999) Subtropical carbonates in a temperate realm: modern sediments on the southwestern Australian shelf. *Journal of Sedimentary Research* **69**(6): 1297-1321.

Jebram, D. (1975) Effects of different foods on *Conopeum seurati* (Canu) (Bryozoa Cheilostomata) and *Bowerbankia gracilis* Leidy (Bryozoa Ctenostomata). *In* S. Pouyet (ed.) *Bryozoa 74 - Proceedings of the 3rd International Bryozoology Association Conference* (Université Claude Bernard, Lyon) Documents des Laboratoires de Géologie de la Faculté des Sciences de Lyon, H.S. 3 **1**: 97-108.

Jenkins, R.J.F. (1974) A new giant penguin from the Eocene of Australia. *Palaeontology* **17**(2): 291-310.

Jenkins, R.J.F., Jones, J.B., McGowran, B., Beecroft, A.S. & Fitzgerald, M.J. (1982) Lithostratigraphic subdivision of the Blanche Point Formation, Late Eocene, Willunga Embayment. *Quarterly Geological Notes of the Geological Survey of South Australia* **84**: 2-7.

Jones, J.B. & Fitzgerald, M.J. (1984) Extensive volcanism associated with the separation of Australia and Antarctica. *Science* **226**(4672): 346-348.

Jones, J.B. & Fitzgerald, M.J. (1986) Silica-rich layering at Blanche Point, South Australia. *Australian Journal of Earth Sciences* **33**: 529-551.

Jones, J.B. & Fitzgerald, M.J. (1987) An unusual and characteristic sedimentary mineral suite associated with the evolution of passive margins. *Sedimentary Geology* **52**: 45-63.

Kay, A.M. & Keough, M.J. (1981) Occupation of patches in the epifaunal communities on pier pilings and the bivalve *Pinna bicolor* at Edithburgh, South Australia. *Oecologia* **48**: 123-130.

Kelly, S.M. & Horowitz, A.S. (1987) Growth forms and palaeoecology of Mississippian bryozoans: critical applications of Stach's 1936 model, eastern United States. *In* J.R.P. Ross (ed.) *Bryozoa: Present and Past - Proceedings of the 7th International Bryozoology Association Conference* (Western Washington University Press, Bellingham): 137-144.

Kemp, E.M. (1978) Tertiary climatic evolution and vegetation history in the Southeast Indian Ocean region. *Palaeogeography, Palaeoclimatology, Palaeoecology* **24**: 169-208.

Kennett, J.P. & Stott, L.D. (1990) Proteus and Proto-Oceanus, Paleogene oceans as revealed from Antarctic stable isotope results, ODP Leg 113. *In* P.F. Barker & J.P. Kennett (eds) *Proceedings Ocean Drilling Program, Science Results* **113**: 865-880.

Key, M.M., Jr., Jamet, C.M. & Smith, A.M. (1999) Bryozoan skeletal growth rates: a new tool for determining carbonate production rate, Otago Shelf, New Zealand. *In* G.F. Camoin & W.-C. Dullo (eds) *Paleoceanology of Reefs and Carbonate Platform: Miocene to Modern*, Aix-au-Provence): 121-122.

Labracherie, M. & Sigal, J. (1975) Les Bryozoaires cheilostomes des formations Eocene Inferieur du Site 246 (crosiere 25, Deep Sea Drlling Project). *In* S. Pouyet (ed.) *Bryozoa 74 - Proceedings of the 3rd International Bryozoology Association Conference* (Université Claude Bernard, Lyon) Documents des Laboratoires de Géologie de la Faculté des Sciences de Lyon, H.S. 3 **1**: 449-466.

Lagaaij, R. & Gautier, Y.V. (1965) Bryozoan assemblages from marine sediments of the Rhône delta, France. *Micropaleontology* **11**: 39-58.

Lamarck, J.B.P.A. de M. de (1816) Histoire naturelle des Animaux sans Vertèbres ... précédée d'une introduction offrant la détermination des. **2**: 568.

Lang, W.D. (1914) Some new genera and species of Cretaceous cheilostome Polyzoa. *Geological Magazine (n.s.), dec. 6* **1**(10): 436-444.

Larkum, A.W.D. & den Hartog, C. (1989) Evolution and biogeography of seagrasses. *In* A.W.D. Larkum, A.J. McComb & S.A. Shepherd (eds) *Biology of seagrasses: a treatise on the biology of seagrasses with special reference to the Australian region.* (Elsevier, Amsterdam): 841.

Lindsay, J.M. (1969) *Cainozoic foraminifera and stratigraphy of the Adelaide Plains Sub-basin, South*

Australia **42** (Geological Survey South Australia, Bulletin, Adelaide) 47 p.

Lindsay, J.M. (1974) Marine foraminifera from Eocene carbonaceous sediments; Polda, Cummins, and Wanilla basins, Eyre Peninsula. *Mineral Resources Review - South Australia Department of Mines and Energy* **136**: 46-51.

Lindsay, J.M. (1981) Stratigraphic outline of the Longyear bore, southern Adelaide Plains. *Geological Survey of South Australia, Quarterly Geological Notes* **78**: 11-14.

Lindsay, J.M. (1986) Eastern St. Vincent Basin. *In* A.J. Parker (ed.) *One day geological excursions of the Adelaide region, including the Barossa Valley, Mount Lofty Ranges and Fleurieu Peninsula* (Geological Society of South Australia, Adelaide, South Australia): pp. 55-64.

Lindsay, J.M. (1988) *Preliminary report of Late Oligocene foraminiferal age of fossiliferous sandstones at Gawler.* (Report Book, South Australian Department of Mines and Energy **88/31**.

Lindsay, J.M. & Giles, S.D. (1973) The *Lepidocyclina* zone in the Morgan limestone, along the Murray River, South Australia. *Royal Society of South Australia, Quarterly Geological Notes* **45**: 1-7.

Lukasik, J.J. & James, N.P. (1998) Lithostratigraphic revision and correlation of Oligo-Miocene Murray Supergroup, western Murray Basin, South Australia. *Australian Journal of Earth Sciences* **45**: 889-902.

Lukasik, J.J., James, N.P., McGowran, B. & Bone, Y. (2000) An epeiric ramp: low-energy, cool-water carbonate facies in a Tertiary inland sea, Murray Basin, South Australia. *Sedimentology* **47**(4): 851-881.

MacGillivray, P.H. (1895) A Monograph of the Tertiary Polyzoa of Victoria. *Transactions of the Royal Society of Victoria* **4**: 1-166.

Majoran, S. (1993) Palaeoecological implications of late Eocene Ostracoda in the highly siliceous Blanche Point Formation, South Australia. *In* M. Siverson (ed.) *Lundadagarna I; Historik geologi och paleontologi; III abstracts (Translated Title: Historical geology and paleontology; III abstracts.)* (Lund Publications in Geology; University of Lund, Department of Geology, Lund, Sweden) **109**: 20.

Majoran, S. (1995) Late Eocene ostracode biofacies of the Tortachilla Limestone, and the Tuketja Member of the Blanche Point Formation, South Australia. *GFF (Geological Society of Sweden.)* **117**(2): 75-80.

Majoran, S. (1996a) Late Eocene Ostracoda of the Blanche Point Formation, South Australia. *Revista Española de Paleontologia* **11**(1): 18-34.

Majoran, S. (1996b) Palaeobathymetry of ostracode associations before and after the Chinaman Gully regression ("Eocene/Oligocene boundary") in South Australia. *Alcheringa* **20**: 245-267.

Maplestone, C.M. (1898) Further descriptions of the Tertiary Polyzoa of Victoria, I. *Proceedings of the Royal Society of Victoria (n.s.)* **11**: 14-22.

Maplestone, C.M. (1899) Further descriptions of the Tertiary Polyzoa of Victoria, II. *Proceedings of the Royal Society of Victoria (n.s.)* **12**: 1-13.

Maplestone, C.M. (1900a) Further descriptions of the Tertiary Polyzoa of Victoria, III. *Proceedings of the Royal Society of Victoria (n.s.)* **12**: 162-169.

Maplestone, C.M. (1900b) Further descriptions of the Tertiary Polyzoa of Victoria, IV. *Proceedings of the Royal Society of Victoria (n.s.)* **13**: 1-9.

Maplestone, C.M. (1900c) On a new name "*Vittaticella*", for the polyzoan genus *Caloporella*, McG. *Proceedings of the Royal Society of Victoria (n.s.)* **13**: 201-203.

Maplestone, C.M. (1901a) Further descriptions of the Tertiary Polyzoa of Victoria, V. *Proceedings of the Royal Society of Victoria (n.s.)* **13**: 183-190.

Maplestone, C.M. (1901b) Further descriptions of the Tertiary Polyzoa of Victoria, VI. *Proceedings of the Royal Society of Victoria (n.s.)* **13**: 204-13.

Maplestone, C.M. (1902a) Further descriptions of the Tertiary Polyzoa of Victoria, VII. *Proceedings of the Royal Society of Victoria (n.s.)* **14**: 65-74.

Maplestone, C.M. (1902b) Further descriptions of the Tertiary Polyzoa of Victoria, VIII. *Proceedings of the Royal Society of Victoria (n.s.)* **15**: 17-27.

Maplestone, C.M. (1903) Further descriptions of the Tertiary Polyzoa of Victoria, IX. *Proceedings of the Royal Society of Victoria (n.s.)* **4**: 140-146.

Maplestone, C.M. (1904a) Notes on the Victorian fossil Selenariidae and descriptions of some new species (recent and fossil). *Proceedings of the Royal Society of Victoria (n.s.)* **16**: 207-216.

Maplestone, C.M. (1904b) Tabulated list of the fossil Cheilostomatous Polyzoa in the Victorian Tertiary deposits. *Proceedings of the Royal Society of Victoria (n.s.)* **17**: 183-219.

Maplestone, C.M. (1908) Further descriptions of the Tertiary Polyzoa of Victoria, X. *Proceedings of the Royal Society of Victoria (n.s.)* **21**: 233-239.

Maplestone, C.M. (1911) Further descriptions of the Tertiary Polyzoa of Victoria, XI. *Proceedings of the Royal Society of Victoria (n.s.)* **23**: 266-284.

Maplestone, C.M. (1913) Further descriptions of the Tertiary Polyzoa of Victoria, XII. *Proceedings of the Royal Society of Victoria (n.s.)* **25**(2): 355-356.

McGowran, B. (1986) Cainozoic oceanic events: the Indo-Pacific biostratigraphic record. *In* W. A. Berggren (ed.) *Global stratigraphic correlation of Mesozoic and Cainozoic sediments* (Palaeogeography, Palaeoclimatology, Palaeoecology **55**: 247-265.

McGowran, B., Archer, M., Bock, P.E., Darragh, T.A., Godthelp, H., Hageman, S., Hand, S.J., Hill, R., Li, Q., Maxwell, P.A., McNamara, K.J., Macphail, M., Mildenhall, D., Partridge, A.D., Richardson, J., Shafik, S., Truswell, E.M. & Warne, M. (2000) Australasian palaeobiogeography: the Palaeogene and Neogene record. *In* A.J. Wright, G.A. Young, J.A. Talent & J.R. Laurie (eds) *Memoir 23 of the Association of Australiasian Palaeontologists* (Association of Australiasian Palaeontologists, Canberra) **23**: 405-470.

McGowran, B. & Beecroft, A.S. (1986) Foraminiferal biofacies in a silica-rich neritic sediment, Late Eocene, South Australia. *Palaeogeography, Palaeoclimatology, Palaeoecology* **52**: 321-345.

McGowran, B., Li, Q., Cann, J.H., Padley, D., McKirdy, D.M. & Shafik, S. (1997) Biogeographic impact of the Leeuwin Current in southern Australia since the late Middle Eocene. *Palaeogeography, Palaeoclimatology, Palaeoecology* **136**: 19-40.

McKenzie, K.G. (1979) Notes on Ostracoda from Willunga Embayment boreholes WLG38, WLG4O and WLG42. Appendix 2. *In* B.J. Cooper (ed.) *Eocene to Miocene stratigraphy of the Willunga Embayment* (Report of Investigations, Geological Survey of South Australia **50**: 90-101.

McKenzie, K.G. & Guha, D.K. (1987) A comparative analysis of Eocene/Oligocene boundary Ostracoda from southeastern Australia and India with respect to their usefulness as indicators of petroleum potential. *Transactions of the Royal Society of South Australia* **111**: 15-23.

McKenzie, K.G., Reyment, R.A. & Reyment, E.R. (1991) Eocene-Oligocene Ostracoda from South Australia and Victoria, Australia. *Revista Española de Paleontologia* **6**: 135-175.

McKinney, F.K. & Jackson, J.B.C. (1989) *Bryozoan evolution* (Unwin Hyman, Boston) 238 p.

McKinney, F.K., Taylor, P.D. & Zullo, V.A. (1993) Lyre-shaped hornerid bryozoan colonies: homeomorphy in colony form between Paleozoic Fenestrata and Cenozoic Cyclostomata. *Journal of Paleontology* **67**(3): 343-354.

McNamara, K.J. (1987) Taxonomy, evolution and functional morphology of southern Australian Tertiary hemiasteroid echinoids. *Palaeontology* **30**(2): 319-352.

McNamara, K.J. (1999) Biogeographic evolution of Cenozoic echinoids in Western Australia. *In* M. D. Carnevali &F. Bonasoro (eds.) *Echinoderm Research 1998* (Balkema, Rotterdam): 333-338.

Medd, A.W. (1964) On the musculature of some Cretaceous membranimorph Polyzoa. *Annals and Magazine of Natural History, London, Series 13* **7**: 185-187.

Milner, G.J. (1987) *Biostratigraphy and depositional environment of the Cardabia Calcarenite, Carnarvon Basin, Western Australia*. (Honours Thesis, University of W.A., Perth).

Milnes, A.R., Ludbrook, N.H., Lindsay, J.M. & Cooper, B.J. (1983) The succession of Cainozoic marine sediments on Kangaroo Island, South Australia. *Transactions of the Royal Society of South Australia* **107**: 1-35.

Moissette, P. & Pouyet, S. (1991) Bryozoan masses in the Miocene-Pliocene and Holocene of France, North Africa and the Mediterranean. *Bryozoaires Actuels et Fossiles: Bryozoa Living and Fossil*: 271-9.

Moyano G., H.I. (1996) Holocene bryozoan links between Australia, New Zealand, southern South America, and Antarctica - a preliminary evaluation. *In* D.P. Gordon, A.M. Smith & J.A. Grant-Mackie (eds) *Bryozoans in Space and Time - Proceedings of the 10th International Bryozoology Conference*. (Wellington, NZ, National Institute of Water and Atmospheric Research): 207-219.

Nelson, C.S. (1978) Temperate shelf carbonate sediments in the Cenozoic of New Zealand. *Sedimentology* **25**: 737-771.

Nelson, C.S., Hyden, F.M., Keane, S.L., Leask, W.L. & Gordon, D.P. (1988) Application of bryozoan zooarial growth-form studies in facies analysis of non-tropical carbonate deposits in New Zealand. *Sedimentary Geology* **60**(1-4): 301-322.

Nielsen, C. (1981) Morphology and reproduction of *'Hippodiplosia' insculpta* (Hincks). *In* G.P. Larwood & C. Nielsen (eds.) *Recent and Fossil Bryozoa - Proceedings of the 5th International Bryozoology Association Conference* (Olsen & Olsen, Fredensborg, Denmark): 314.

Osburn, R.C. (1957) Marine Bryozoans. *Memoir of the Geological Society of America* **67**(1): 1109-1111.

Palumbi, S.R. & Jackson, J.B.C. (1982) Ecology of cryptic coral reef communities. II. Recovery from small disturbance events by encrusting bryozoa: the influence of "host" species and lesion size. *Journal of Experimental Marine Biology and Ecology* **64**(2): 103-115.

Pedley, H.M. (1976) A palaeoecological study of the Upper Coralline Limestone, *Terebratula-Aphelesia* bed (Miocene, Malta) based on bryozoan growth-form studies and brachiopod distributions. *Palaeogeography, Palaeoclimatology, Palaeoecology* **20**(3): 209-234.

Pledge, N.S. (1967) Fossil elasmobranch teeth of South Australia and their stratigraphic distribution. *Transactions Royal Society of South Australia* **91**: 135-160.

Price, R.C., Nichols, A. & Gray, C.M. (2003) Cainozoic igneous activity - widespread volcanism resulting from long-term mantle instability and rifiting. *In* W.D. Birch (ed.) *Geology of Victoria* (Geological Society of Australia, Melbourne) Special Publication **23**.

Prothero, D.R. (1994a) The Late Eocene-Oligocene extinctions. *Annual Reviews of Earth and Planetary Science* **22**: 145-165.

Prothero, D.R. (1994b) *The Eocene-Oligocene Transition: Paradise Lost* (Columbia University Press, New York) 291 p.

Prothero, D.R. & Bergren, W.A. (eds.) (1992) *Eocene-Oligocene Climatic and Biotic Evolution.* (Princetown University Press, Princetown) 568 p.

Quilty, P.J.G. (1975) An annotated bibliography of the palaeontology of Western Australia, 1814-1974. *Geological Survey of Western Australia, Report* **3**: 264.

Rahimpour-Bonab, H. & Bone, Y. (2001) Isotopic signature of the diagenetic fluids and cement in the Tortachilla Limestone, South Australia. *Iranian Journal of Science*: 33–54.

Reynolds, M.A. (1953) The Cainozoic succession of Maslin and Aldinga Bays, South Australia. *Transactions of the Royal Society of South Australia* **76**: 114-140.

Röhl, H.-J., Schmid-Röhl, A., Oschmann, W., Frimmel, A. & Schwark, L. (2001) The Posidonia Shale (Lower Toarcian) of SW-Germany: an oxygen depleted ecosystem controlled by sea level and palaeoclimate. *Palaeogeography, Palaeoclimatology, Palaeoecology* **165**(1-2): 27-52.

Ryland, J.S. (1962) The Association between Polyzoa and Algal Substrata. *Journal of Animal Ecology* **31**(2): 331-338.

Ryland, J.S. (1976) Physiology and ecology of marine bryozoans. *Advances in Marine Biology* **14**: 285-443.

Ryland, J.S. & Hayward, P.J. (1992) Bryozoa from Heron Island, Great Barrier Reef. *Memoirs of the Queensland Museum* **32**: 223-301.

Scholz, J. & Hillmer, G. (1995) Reef-bryozoans and bryozoan microreefs: Control factor evidence from the Philippines and other regions. *Facies* **32**: 109-144.

Schopf, T.J.M. (1969) Paleoecology of ectoprocts (bryozoans). *Journal of Paleontology* **43**: 234-244.

Scriven, L. (1993) *Diversity of the mid-Eocene Maslin Bay flora, South Australia.* (PhD Thesis, The University of Adelaide, Adelaide).

Sepkoski, J.J., Jr. (1997) Biodiversity: Past, present, and future. *Journal of Paleontology* **71**(4): 533-539.

Sepkoski, J.J., Jr. (1998) Rates of speciation in the fossil record. *Philosophical Transactions of the Royal Society of London, B* **353**: 315-326.

Sepkoski, J.J., Jr. (2002) A compendium of fossil marine animal genera. *Bulletins of American Paleontology* **363**: 560.

Smith, A.M. (1995) Palaeoenvironmental interpretation using bryozoans: a review. *In* W.J. Bosence & A. Allison (eds) *Marine Palaeoenvironmental Analysis from Fossils* (Geological Society (London) Special Publication, Boulder) **83**: 231-243.

Smith, A.M. & Nelson, C.S. (1994) Calcification rates of rapidly-colonizing bryozoans in Hauraki Gulf, northern New Zealand. *New Zealand Journal of Marine and Freshwater Research* **28**(2): 227-234.

Smith, A.M. & Nelson, C.S. (1996) Differential abrasion of bryozoan skeletons: taphonomic implications for paleoenvironmental interpretation. *In* D.P. Gordon, A.M. Smith & J.A. Grant-Mackie (eds) *Bryozoans in Space and Time - Proceedings of the 10th International Bryozoology Conference* (National Institute of Water and Atmospheric Research, Wellington, NZ): 305-313.

Smith, A.M., Nelson, C.S. & Spencer, H.G. (1998) Skeletal carbonate mineralogy of New Zealand bryozoans. *Marine Geology* **151**(1-4): 27-46.

Stach, L.W. (1933) Victorian Tertiary Catenicellidae (Bryozoa), Part I. *Proceedings of the Royal Society of Victoria (n.s.)* **45**(2): 85-98.

Stach, L.W. (1935) Victorian lower Pliocene Bryozoa. Part I. *Proceedings of the Royal Society of Victoria (n.s.)* **47**(2): 338-351.

Stach, L.W. (1936a) South Australian Cainozoic Bryozoa, Part I. *Transactions and Proceedings of the Royal Society of South Australia* **60**: 127-136.

Stach, L.W. (1936b) An Upper Oligocene Bryozoan Faunule. *Proceedings of the Royal Society of Victoria (n.s.)* **49**: 62-71.

Stach, L.W. (1936c) Correlations of zooarial form with habitat. *Journal of Geology* **44**: 60-65.

Stillwell, J.D. (1997) Tectonic and palaeobiogeographic significance of the Chatham Islands, South Pacific, Late Cretaceous fauna. *Palaeogeography, Palaeoclimatology, Palaeoecology* **136**: 97-119.

Stoliczka, F. (1865) Fossile Bryozoen aus dem tertiären Grünsandsteine der Orakei-Bay bei Auckland. *Reise der Österreichischen Fregatte "Novara" um die Erde in den Jahren 1857, 1858, 1859. - Geologischer Theil* **1**(2): 89-158.

Stuart, W.J.J. (1969) *Stratigraphic and structural development of the St Vincent Tertiary Basin, South Australia.* (PhD Thesis, The University of Adelaide, Adelaide).

Stuart, W.J.J. (1970) The Cainozoic stratigraphy of the eastern coastal area of Yorke Peninsula, South Australia. *Transactions of the Royal Society of South Australia* **94**: 151-178.

Sturt, C. (1833) *Two expeditions into the Interior of Southern Australia during the years 1828, 1829, 1830 and 1831; with observations on the soil, climate and general resources of N.S.W.* (Elder Smith & Co., London).

Tasch, P. (1973) Chapter 6: Bottom tenements: The many animals of the single skeleton (Ectoprocts/Bryozoa). *In* P. Tasch (ed.) *Paleobiology of the Invertebrates* (John Wiley & Sons, Inc., New York): 211-250.

Tate, R. (1879) The natural history of the country around the Head of the Great Australian Bight. *Royal Society of South Australia, Transactions* **2**: 94-128.

Tate, R. & Dennant, J. (1896) Correlation of the marine Tertiaries of Australia. Part III, South Australia and Tasmania. *Royal Society of South Australia, Transactions* **20**: 118-148.

Taylor, P.D. (1987) Skeletal morphology of malacostegan grade cheilostome Bryozoa. *In* J.R.P. Ross (ed) *Bryozoa: Present and Past - Proceedings of the 7th International Bryozoology Association Conference* (Western Washington University Press, Bellingham): 269-276.

Taylor, P.D. (1988) Major radiations of cheilostome bryozoans: triggered by the evolution of a new larval type? *Historical Biology* **1**: 45-64.

Taylor, P.D. (1993) Bryozoa. *In* M. J. Benton (ed.) *The Fossil Record 2* (Chapman & Hall, London):

465-489.

Taylor, P.D. & Badve, R.M. (1994) The mid-Cretaceous bryozoan fauna from the Bagh Beds of central India: composition and evolutionary significance. *In* P.J. Hayward, J.S. Ryland & P.D. Taylor (eds) *Biology and Palaeobiology of Bryozoans; Proceedings of the 9th International Bryozoology Conference* (Olsen & Olsen, Fredensborg) International Symposium Series: 181-186.

Taylor, P.D. & Badve, R.M. (1995) A new cheilostome bryozoan from the Cretaceous of India and Europe: a cyclostome homeomorph. *Palaeontology* **38**(3): 627-657.

Taylor, P.D. & Larwood, G.P. (1990) Major evolutionary radiations in the Bryozoa. *In* P.D. Taylor & G.P. Larwood (eds.) *Major Evolutionary Radiations* (Clarendon Press, Oxford) Systematics Association Special Volume **42**: 209-233.

Taylor, P.D. & Monks, N. (1997) A new cheilostome bryozoan genus pseudoplanktonic on molluscs and algae. *Invertebrate Biology* **116**(1): 39-51.

Taylor, P.D., Schembri, P.J. & Cook, P.L. (1989) Symbiotic association between hermit crabs and bryozoans from Otago region, southeastern New Zealand. *Journal of Natural History* **23**(5): 1059-1085.

Taylor, P.D. & Voigt, E. (1999) An unusually large Cyclostome Bryozoan (*Pennipora anomalopora*) from the Upper Cretaceous of Maastricht. *Bulletin de l'Institut royal des Sciences naturelles de Belgique* **69**: 165-171.

Tenison Woods, J.E. (1859) Remarks on a Tertiary deposit in South Australia. *Transactions of the Philosophical Institute of Victoria* **3**: 85-94.

Tenison Woods, J.E. (1860) On the Tertiary deposits at Portland Bay, Victoria. *Transactions of the Philosophical Institute of Victoria (=Royal Society)* **4**(2): 169-172.

Tenison Woods, J.E. (1860) On some Tertiary rocks in the colony of South Australia. *Quarterly Journal of the Geological Society, London* **16**(3): 253-260.

Tenison Woods, J.E. (1865) On some Tertiary fossils in South Australia. *Transactions and Proceedings of the Royal Society of New South Wales* **6**: 3-6.

Tenison Woods, J.E. (1865) On some Tertiary depostits in the colony of Victoria, Australia. *Quarterly Journal of the Geological Society, London* **21**(4): 389-394.

Tenison Woods, J.E. (1875) On some Tertiary fossils from Table Cape, Tasmania. *Papers and Proceedings of the Royal Society of Tasmania* **March, April, May**: 13-26.

Tenison Woods, J.E. (1877) On some Tertiary Australian Polyzoa. *Journal and Proceedings of the Royal Society of New South Wales* **10**: 147-150.

Tenison Woods, J.E. (1879) On some Australian Tertiary fossil corals and Polyzoa. *Journal and Proceedings of the Royal Society of New South Wales* **12**: 57-61.

Tenison Woods, J.E. (1880) On some recent and fossil species of Australian Selenariadae (Polyzoa). *Transactions, Proceedings and Report of the Royal Society of South Australia* **3**: 1-12.

Tenison Woods, J.E. (1880) *Corals and Bryozoa of the Neozoic Period in New Zealand* Palaeontology of New Zealand (Colonial Museum and Geological Survey Department, Wellington) 34 p.

Thomsen, E. (1977a) Relations between encrusting bryozoans and substrate: an example from the

Danian of Denmark. *Bulletin of the Geological Society of Denmark.* **26**: 133-45.

Thomsen, E. (1977b) Phenetic variability and functional morphology of erect cheilostome bryozoans from the Danian (Paleocene) of Denmark. *Paleobiology* **3**(4): 360-376.

Thomsen, E. & Håkansson, E. (1995) Sexual and asexual dispersal in clonal animals: examples from cheilostome bryozoans. *Paleobiology* **21**(4): 496-508.

Tilbrook, K.J. (1997) Barnacle and bivalve associates of a bryozoan-coral symbiosis from the Coralline Crag (Pliocene) of England. *Tertiary Research* **18**: 7-22.

Tilbrook, K.J., Hayward, P.J. & Gordon, D.P. (2001) Cheilostome Bryozoa from Vanuatu. *Zoological Journal of the Linnean Society* **131**(1): 35-109.

Twidale, C.R. (1976) Geomorphological evolution. *In* C.R. Twidale, M.J. Tyler & B.P. Webb (eds) *Natural history of the Adelaide region* (Royal Society of South Australia, Occasional Publications **1**: 43-59.

Uttley, G.H. (1949) The Recent and Tertiary Polyzoa (Bryozoa) in the collection of the Canterbury Museum, Christchurch. *Records of the Canterbury Museum* **5**(4): 167-192.

Uttley, G.H. (1951) The Recent and Tertiary Polyzoa (Bryozoa) in the collection of the Canterbury Museum, Christchurch. Part II. *Records of the Canterbury Museum* **6**(1): 15-39.

Veevers, J.J. (ed.) (2000) *Billion-year earth history of Australia and neighbours in Gondwana.* (GEMOC Press, Macquarie University, Sydney) 400 p.

Voigt, E. (1973) Environmental conditions of bryozoan ecology of the hardground biotope of the Maastrichtian Tuff-Chalk, near Maastricht (Netherlands). *In* G.P. Larwood (ed.) *Living and Fossil Bryozoa - Recent Advances in Research* (Academic Press, New York and London): 185-197.

Voigt, E. (1985) The Bryozoa of the Cretaceous-Tertiary boundary. *In* C. Nielsen & G.P. Larwood (eds) *Bryozoa: Ordovician to Recent - Proceedings of the 6th International Bryozoology Association Conference* (Olsen & Olsen, Fredensborg): 329-342.

Waghorn, D.B. (1989) Middle Tertiary calcareous nannofossils from the Aire district, Victoria: a comparison with equivalent assemblages in South Australia and New Zealand. *Marine Micropaleontology* **14**: 237-255.

Wass, R.E. & Yoo, J.J. (1973) Stratigraphic ranges of some bryozoan species in the Tertiary of south-eastern Australia. *Reports of Geological Sciences, University of Sydney* **3**: 1-13.

Waters, A.W. (1881) On fossil chilostomatous Bryozoa from south-west Victoria, Australia. *Quarterly Journal of the Geological Society, London* **37**: 309-347.

Waters, A.W. (1882) On fossil chilostomatous Bryozoa from Mount Gambier, South Australia. *Quarterly Journal of the Geological Society, London* **38**: 257-276.

Waters, A.W. (1883) Fossil Chilostomatous Bryozoa from Muddy Creek, Victoria, etc. *Quarterly Journal of the Geological Society, London* **39**: 423-443.

Waters, A.W. (1884) Fossil cyclostomatous Bryozoa from Australia. *Quarterly Journal of the Geological Society, London* **40**(4): 674-696.

Waters, A.W. (1885) Chilostomatous Bryozoa from Aldinga and the River-Murray Cliffs, South Australia. *Quarterly Journal of the Geological Society, London* **41**: 279-310.

Waters, A.W. (1887) On Tertiary chilosomatous Bryozoa from New Zealand. *Quarterly Journal of the Geological Society, London* **43**: 40-72.

Wendt, D.E. & Woollacott, R.M. (1999) Ontogenies of phototactic behavior and metamorphic competence in larvae of three species of *Bugula* (Bryozoa). *Invertebrate Biology* **118**(1): 75-84.

Winston, J.E. (1976) Experimental culture of the estuarine ectoproct *Conopeum tenuissimum* from Chesapeake Bay. *Biological Bulletin, Woods Hole.* **150**: 318-35.

Winston, J.E. (1981) Feeding behavior of modern bryozoans. *In* T.W. Broadhead (ed.) *Lophophorates - Notes for a short course*, Cincinnati, Ohio): 1-51.

Wyer, D.W. & King, P.E. (1973) Relationships between some British littoral and sublittoral bryozoans and pycnogonids. *In* G. P. Larwood (ed.) *Living and Fossil Bryozoa - Recent Advances in Research* (Academic Press, New York and London): 199-207.

Zágorsek, K. (1994) Late Eocene (Priabonian) Cheilostomata (Bryozoa) from the Liptov Basin - Western Carpathians (Slovakia). *Neues Jahrbuch für Geologie und Paläontologie Abhandlungen* **193**(3): 361-382.

Zágorsek, K. (1996) Paleoecology of the Eocene bryozoan marl in the Alpine-Carpathian region. *In* D.P. Gordon, A.M. Smith & J.A. Grant-Mackie (eds) *Bryozoans in Space and Time - Proceedings of the 10th International Bryozoology Conference.* (Wellington, NZ, National Institute of Water and Atmospheric Research): 413-422.

Zágorsek, K. (1997) Eocene anascan Bryozoa from new localities in the western Carpathians, Slovakia. *Geologia Carpathica* **48**(6): 401-409.

Zágorsek, K. (2002) An Upper Eocene bryozoan fauna from Perwang-1 borehole, Salzburg, Austria. *In* P.N. Wyse-Jackson, C.J. Buttler & M.E. Spencer-Jones (eds) *Bryozoan Studies 2001 - Proceedings of the 12th I.B.A. Conference* (A.A. Balkema Publishers, Lisse, Netherlands): 367-375.

Zágorsek, K. & Kázmér, M. (2001) Eocene Bryozoa from Hungary. *Courier Forschungsinstitut Senckenberg* **231**: 1-159.

Ziko, A. & Hamza, F.H. (1987) Bryozoan fauna from a post-Pliocene outcrop north of the Giza Pyramids Plateau, Egypt. *In* J.R.P. Ross (ed.) *Bryozoa: Present and Past - Proceedings of the 7th International Bryozoology Association Conference* (Western Washington University Press, Bellingham): 301-308.

Zinsmeister, W.J. (1982) Late Cretaceous – Early Tertiary molluscan biogeography of southern circum-Pacific. *Journal of Paleontology* **56**: 84-102.

APPENDICES

A1. Stratigraphic Sections

The following stratigraphic sections are only those from which samples were taked that are analysed and discussed in the text. to enable precise sampling and sample location.

Metres	= above base level (given for each)
Colour	= general qualitative colour of the sediments in outcrop
Lithology (litho)	= general composition of the sediments (see box 1 below)
Structures	= sedimentary structures (see box 2 below)
Induration (indur)	= relative and qualitative indication of degree of induration (lithification, cementation): left to right: poor - moderate - well
Fossils	= macrofossils occuring in a horizon with relative ranking according to abbundance (see box 3 below); where relative abundances are significantly different, a 'greater than' symbol (>) is used.
Comments	= comments and other observations
Sample	= number of sample analysed and discussed in text. (001/001 = trip no./sample no.)

A1.1. Maslin Beach - Tortachilla Limestone / Blanche Point Formation (composite section)
A1.2. Yorke Peninsula (Sliding Rocks) - Mulloowurtie Formation (composite section)
A1.3. Yorke Peninsula (Sheoak Flat South) - Lower Rogue Formation
A1.4. Kangaroo Island (Ozone Hotel) - Lower Kingscote Limestone
A1.5. Kangaroo Island (Type Section) - Kingscote Limestone
A1.6. Kangaroo Island (Yacht Club) - Lower Kingscote Limestone

1. Lithology

- Sand
- Limestone
- Marl
- Spiculite
- silicified
- Mud

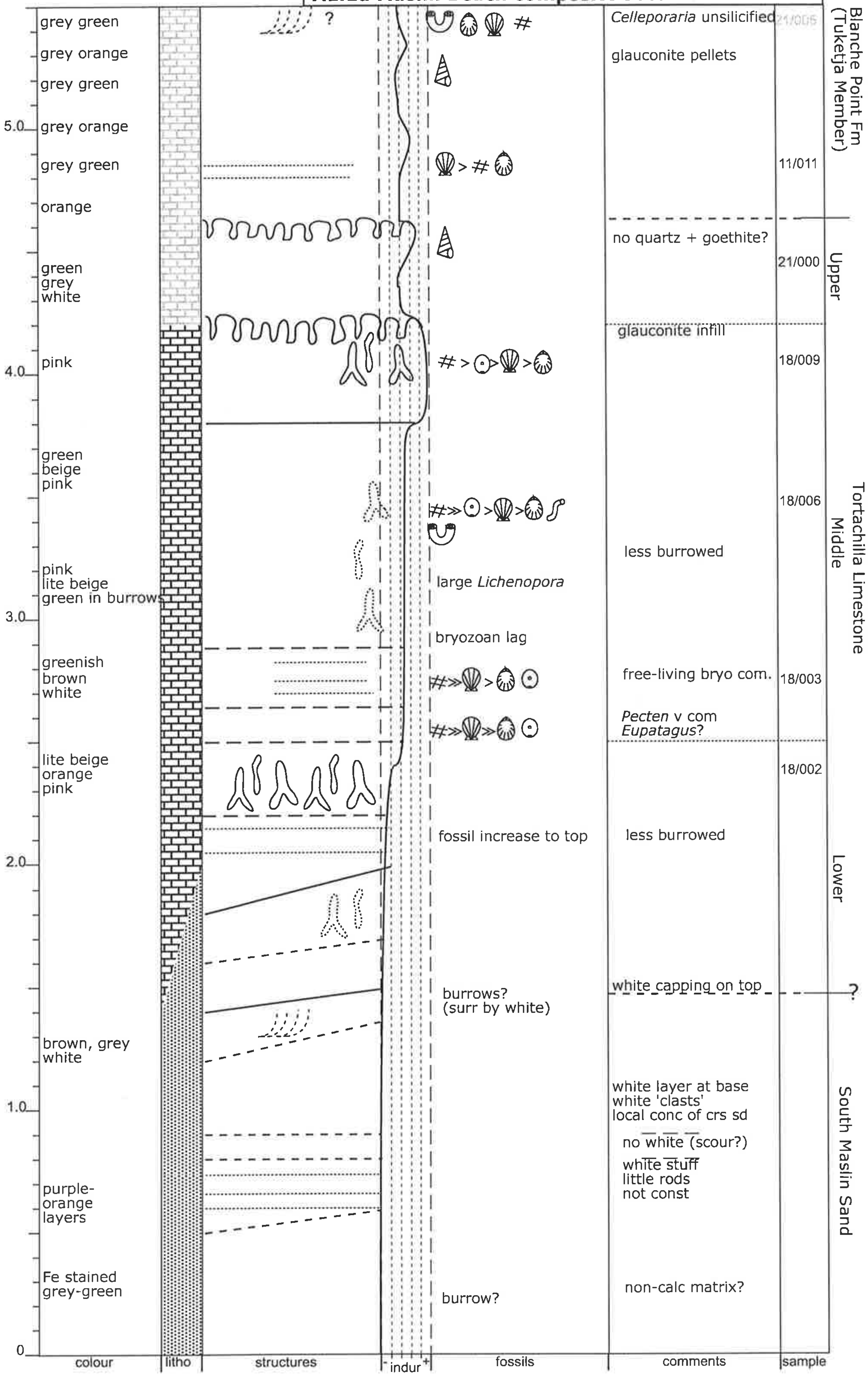
2. Structures

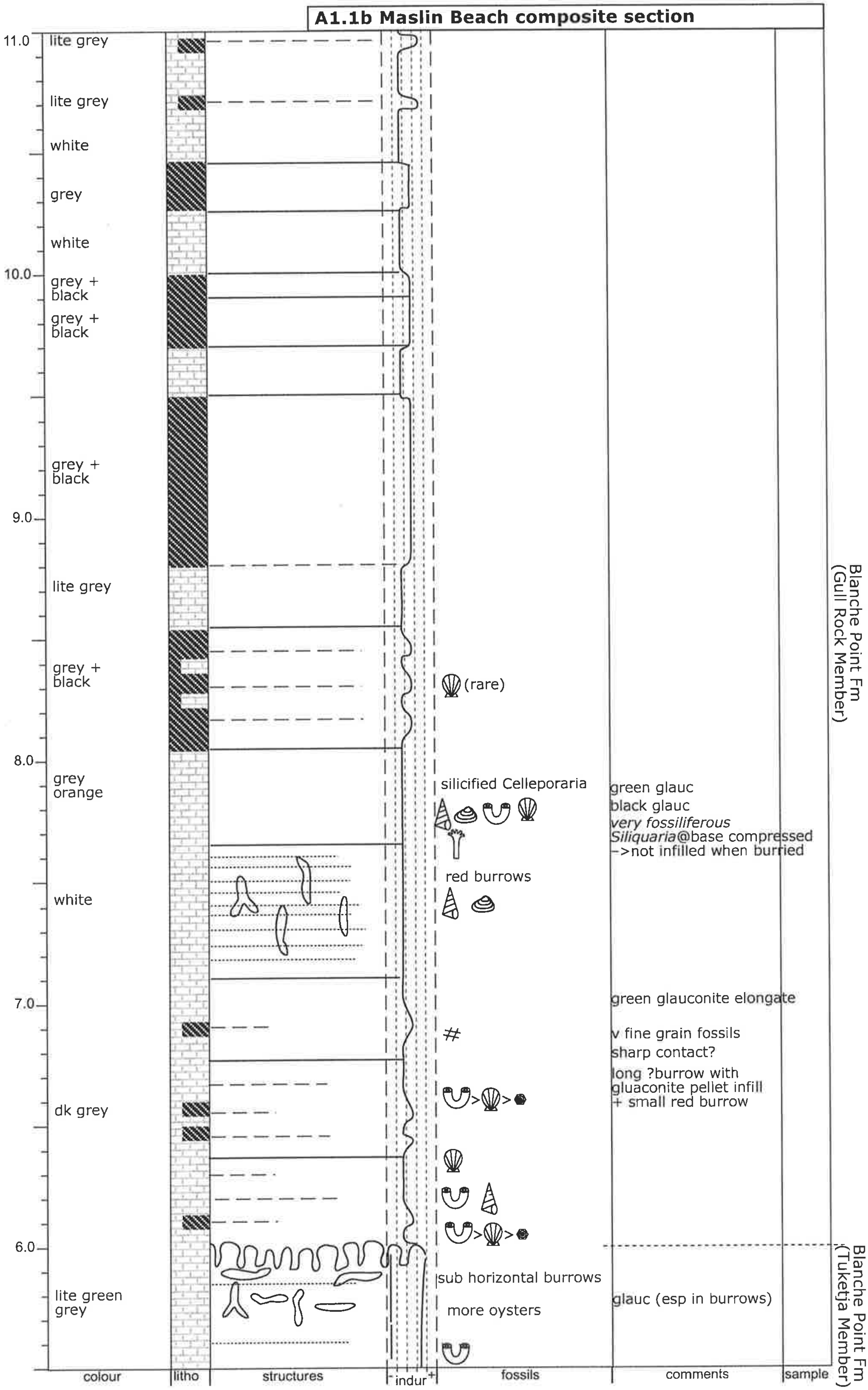
- Hard ground/ burrowed surface
- *Thalassinoides* burrows
- cross-bedding
- bedding
- uncertain boundary

3. Fossils

- Bryozoa general
- Large *Celleporaria* sp.
- Pectenidae
- Bivalva (general)
- *Siliquaria* (infaunal bivalve)
- Gastropoda (general)
- *Spirocolpus* (turritellid)
- Serpulid tubes
- Brachiopods
- Irregular Echinoids
- *Fibularia*
- *Monostychia*
- Regular Echinoids (usu. spines)
- Solitary (azooxanthellate) corals
- *Nodosaria* (Foraminifera)

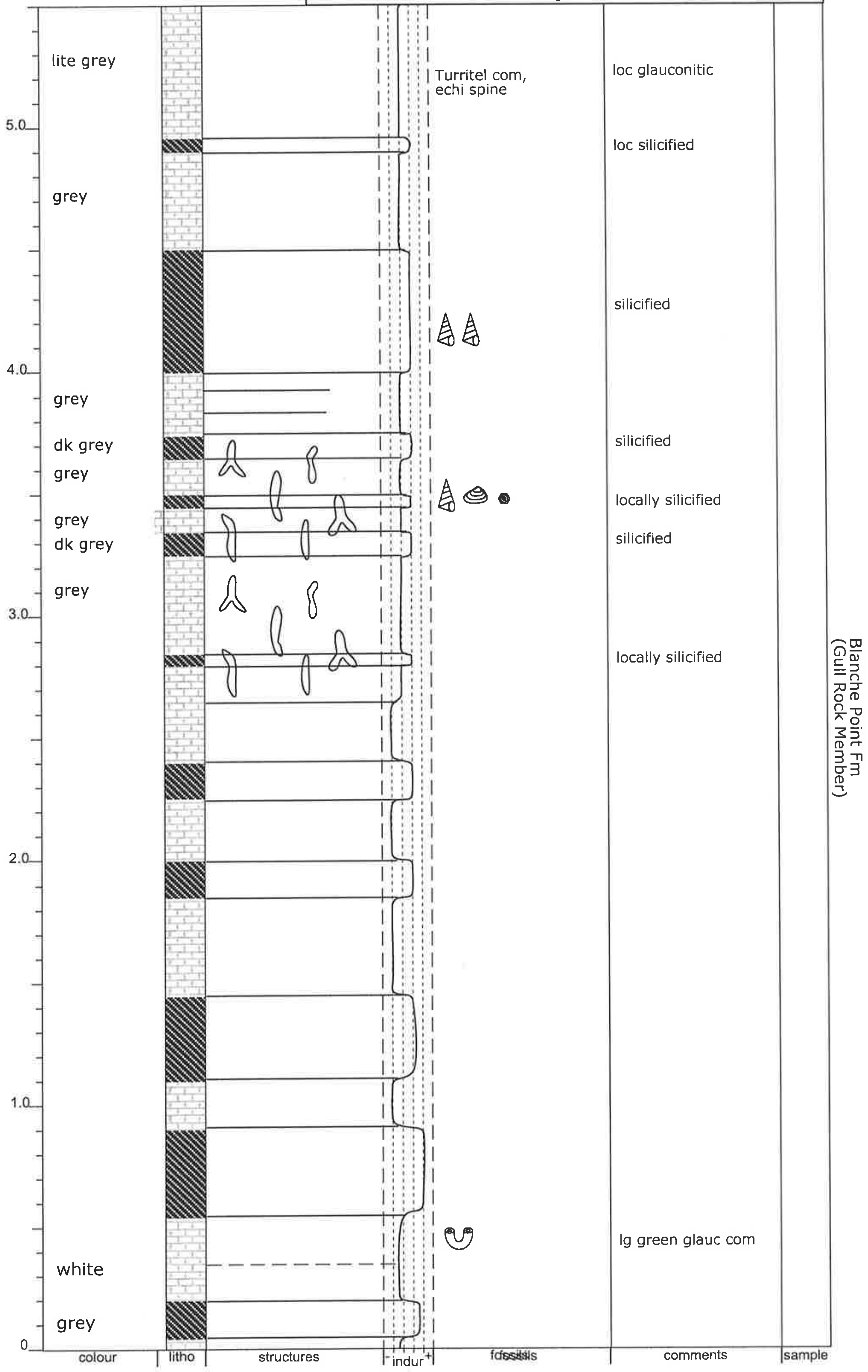
A1.1a Maslin Beach composite section



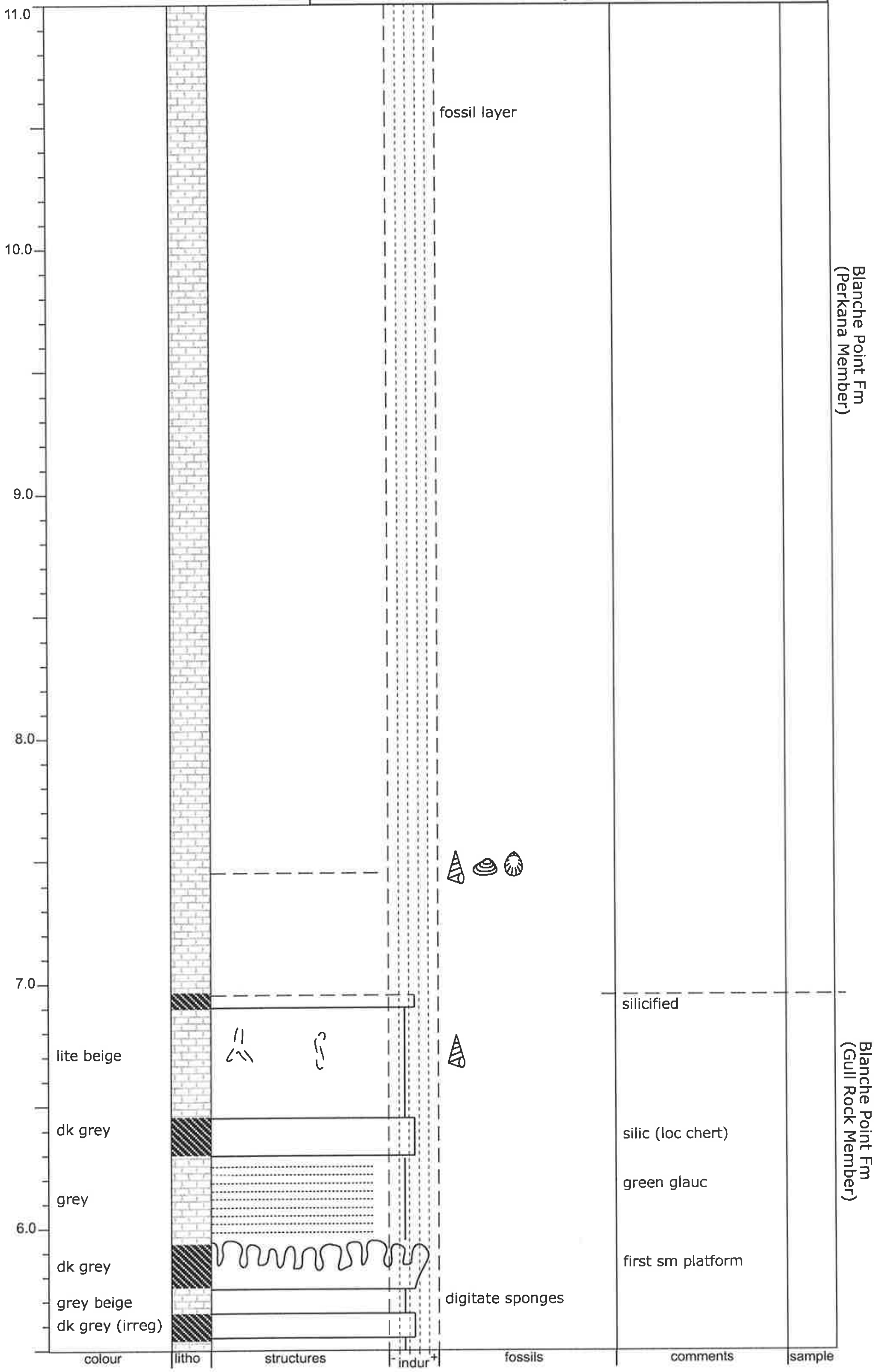


A1.1b Maslin Beach composite section
11.0
lite grey
lite grey
white
grey
white
10.0
grey + black
grey + black
grey + black
9.0
lite grey
grey + black
(rare)
8.0
grey orange
silicified Celleporaria
green glauc
black glauc
very fossiliferous
Siliquaria@base compressed
->not infilled when burried
white
red burrows
7.0
green glauconite elongate
v fine grain fossils
sharp contact?
long ?burrow with
gluaconite pellet infill
+ small red burrow
dk grey
6.0
lite green grey
sub horizontal burrows
more oysters
glauc (esp in burrows)
colour
litho
structures
indur
fossils
comments
sample
Blanche Point Fm (Gull Rock Member)
Blanche Point Fm (Tuketja Member)

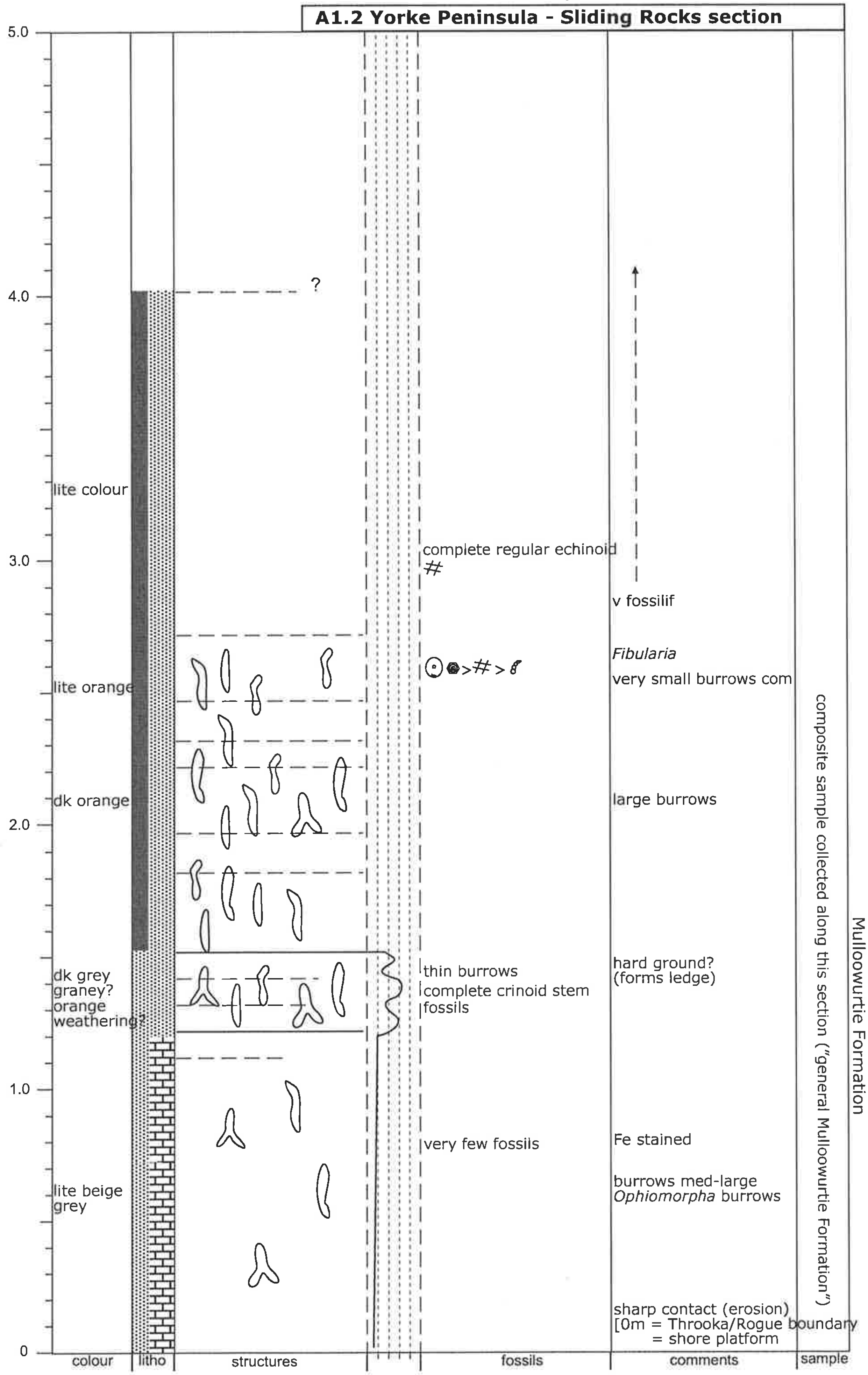
A1.1c Maslin Beach composite section



A1.1d Maslin Beach composite section

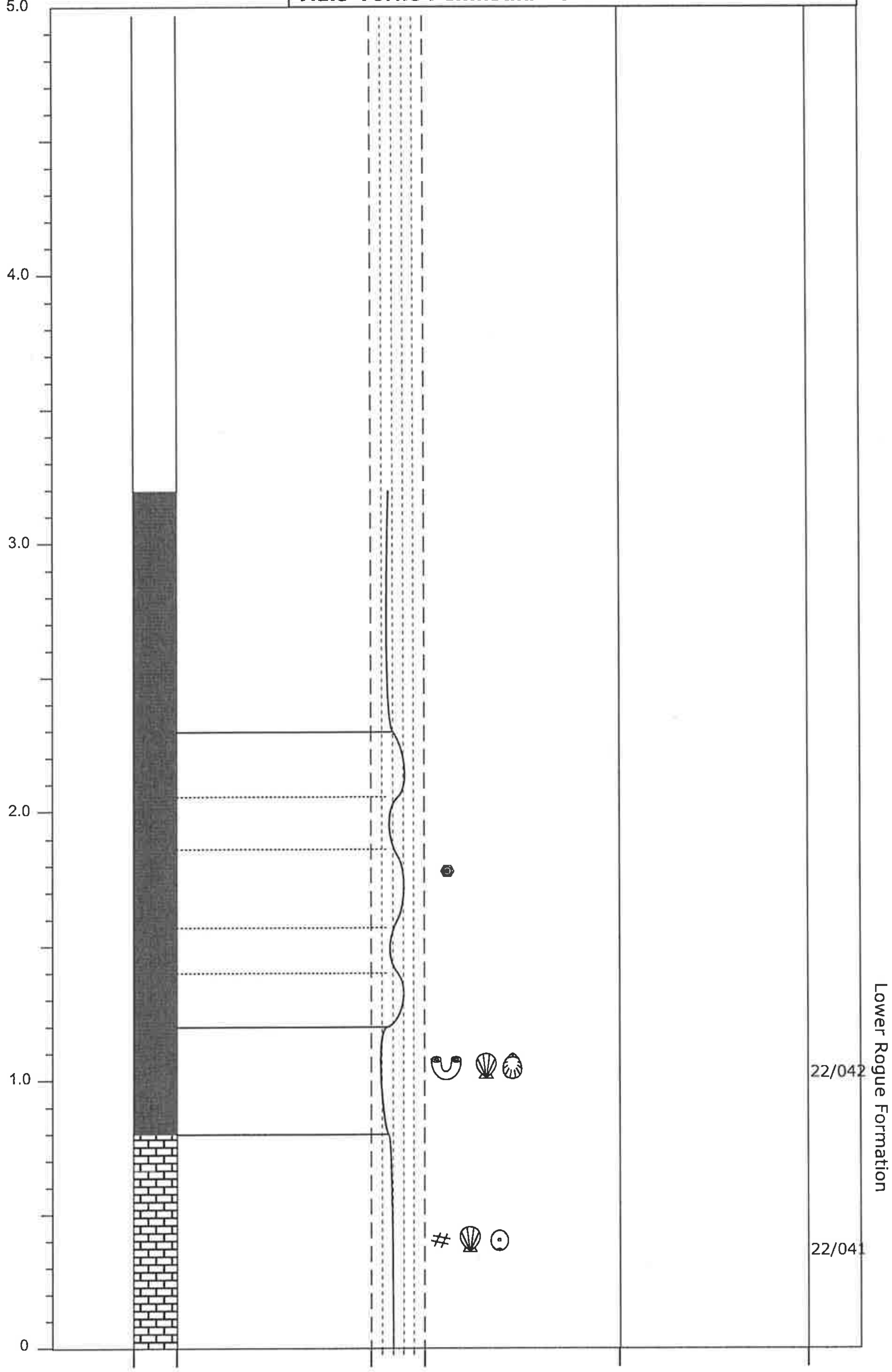


(Stuart's sections 2 & 3)

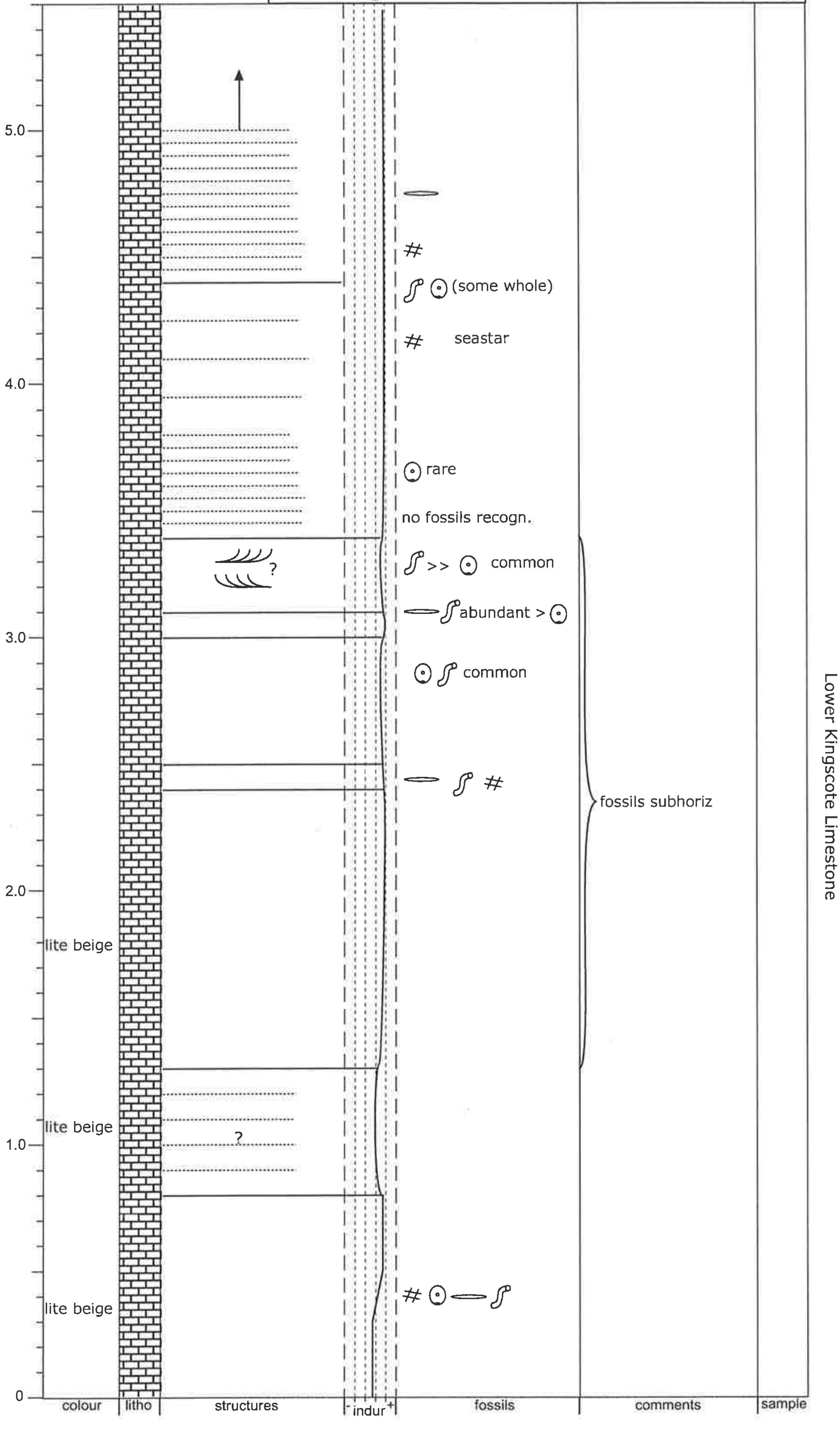


(Stuart's section 21)

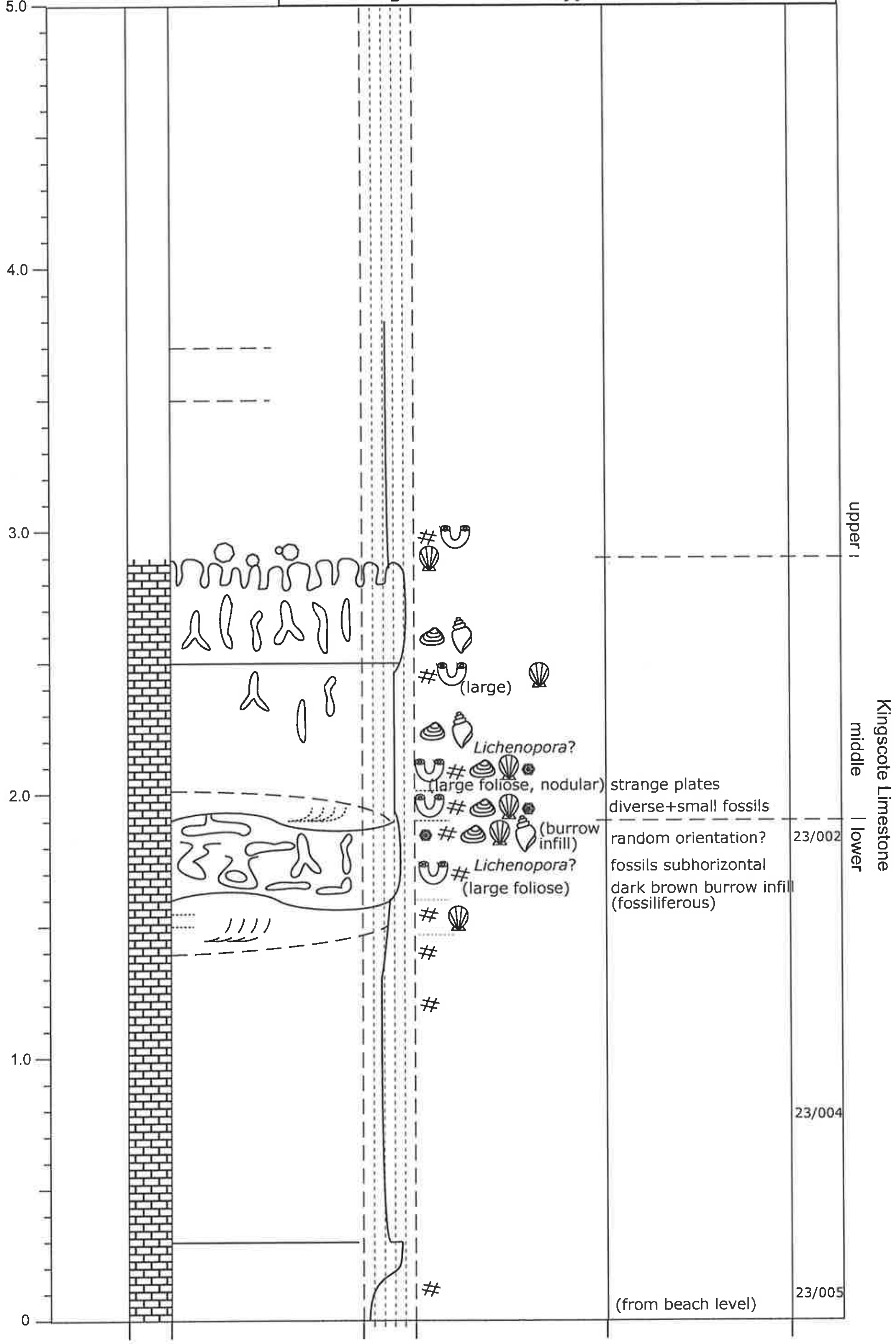
A1.3 Yorke Peninsula - Sheoak Flat South section



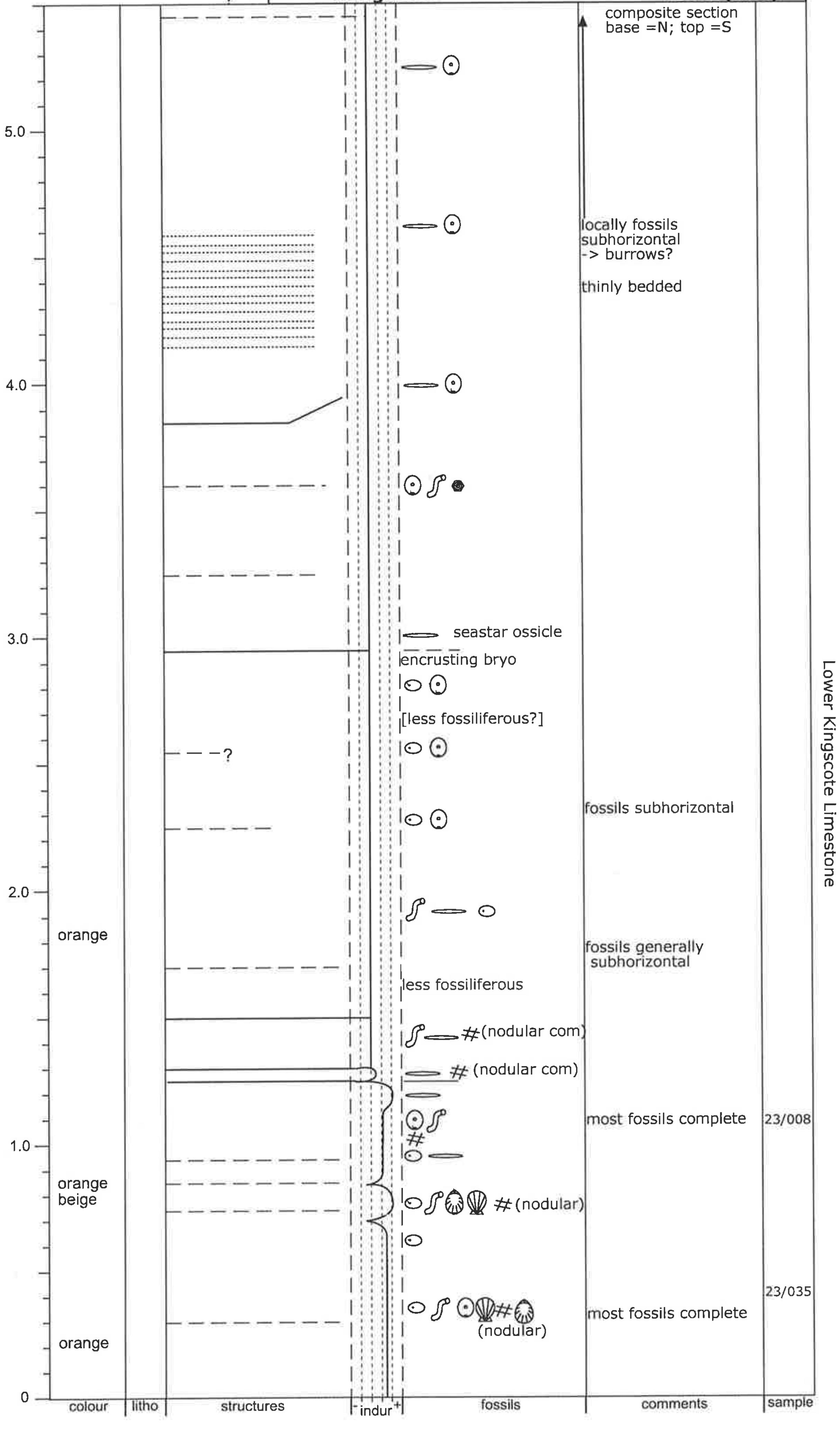
A1.4 Kangaroo Island - Ozone Hotel section (KI1)



A1.5 Kangaroo Island - Type section (KI2)



A1.6 Kangaroo Island - Yacht Club section (KI3)



A2. Data Tables

The following tables give the raw numbers aquired from the sediment samples for bryozoans.

A2.1 Specimens per species:

The numbers from the 'totals' columns were used to generate the graphs in Figures 7, 8, 11, 12, 13 and 14. Raw numbers for the main size fractions are also separately given.

The species in these tables are grouped accorfing to growth form. Species names highlighted grey are present in more than one growth form (e.g. *Buffonellaria roberti* occurs as foliose and encrusting colonies.

Cells for the totals of species in each sample are highlighted according to the percentage they comprise of the overall specimens in the sample: light grey indicates >1%, dark grey indicates >2% and black with white numbers indicates >5%.

A2.2 Species per growth form:

The last table gives the numbers of species for each growth form in each sample.

MASLIN BEACH SECTIONS

ERECT FOLIOSE	Lower Tortachilla Lst (18/002)				lower Mid Tortachilla Lst (18/003)				mid Mid Tortachilla Lst (18/006)				upper Mid Tortachilla Lst (18/009)				Upper Tortachilla Lst (21/TL glauc)				Tuketja Member - BPF (11/011)			
species	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals
Biflustra **? sp. nov. b FOL**	1			1	2			2	6	1		7				0				0				0
Biflustra ***'perfragilis'***				0				0	2			2				0				0				0
'Antropora' cf. ***savartii*** (MacGillivray)				0				0	10	2		12				0				0				0
Dactylostega ? sp. nov. a	2	5		7	2			2	1			1				0				0				0
Dactylostega ? sp. nov. b FOL				0				0				0	6	2		8				0				0
Dactylostega ? sp. nov. c FOL				0				0				0				0				0				0
'Onychocella' sp. nov. b				0	8	16		24	14			14				0				0				0
Larvapora ? sp. nov. a FOL	2	1		3	2	4		6	8	2		10				0				0				0
Anaskopora sp. nov. a				0				0				0				0				0				0
Arachnopusia sp. nov. b				0				0	1			1				0				0				0
Rhamphosmittina sp. nov. a				0				0	2			2				0	1			1				0
Smittoidea ? cf. dennanti				0	1			1	2			2				0				0				0
Smittoidea ? sp. nov. d				0	1			1	2			2				0				0				0
Smittoidea ? sp. nov. e	4			4				0	3			3				0				0				0
Smittoidea sp. nov. f	1			1				0	1			1				0				0				0
Smittoidea sp. nov. g				0	3			3	5			5				0				0				0
Smittoidea sp. nov. h				0	1			1				0				0				0				0
Smittoidea sp. nov. i				0	1			1	3			3				0				0				0
Smittina sp. nov. a				0				0	2			2				0				0				0
Smittina sp. nov. b	1			1				0				0				0				0				0
Smittina ? sp. nov. c				0				0	1			1				0				0				0
Smittina sp. nov. d				0				0				0				0				0				0
Smittina sp. nov. e				0				0		1		1				0				0				0
Smittina ? sp. nov. f	1	1		2				0				0				0				0				0
Prenantia sp. nov. a				0		1		1				0				0				0				0
Smittoidea indet.				0				0	7			7				0				0				0
general Smittinid	1			1	4			4				0	1			1				0				0
Cosciniopsis sp. nov. a				0				0	3			3				0				0				0
Hippoporina ? sp. nov. b		1		1				0	8			8				0				0				0
Escharina cf. ***granulata*** (MacGillivray)				0		1		1				0				0				0				0
Siphonicytara irregularis (Mapl)		2		2	2	4		6	6	1		7				0				0				0
Siphonicytara sp. nov. a	7			7				0				0				0				0				0
Siphonicytara sp. nov. b				0				0	2			2				0				0				0
Celleporina ? sp. nov. a				0	1			1	3			3				0				0				0
Schizoporellidae? smooth				0				0	7	1		8				0				0				0
Bitectiporidae?				0				0	1			1				0				0				0
Buffonellaria roberti FOL				0	8			8	2	1		3				0	1			1				0
general foliose				0	10	80		90	13			13	5	2		7	2			2				0
TOTAL ERECT FOLIOSE	20	10	0	30	46	106	0	152	115	9	0	124	12	4	0	16	4	0	0	4	0	0	0	0

MASLIN BEACH SECTIONS

ERECT FENESTRATE, FRB, FUNGIFORM	Lower Tortachilla Lst (18/002)				lower Mid Tortachilla Lst (18/003)				mid Mid Tortachilla Lst (18/006)				upper Mid Tortachilla Lst (18/009)				Upper Tortachilla Lst (21/TL glauc)				Tuketja Member - BPF (11/011)			
species	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals
Reteporella aff. ***rimata*** (Waters)		1		1		1		1	1	16		17				0	1			1				0
Reteporella sp. nov. a		1		1				0	2			2				0				0				0
Reteporella sp. nov. b		3		3				0	2			2				0				0				0
Reteporella ? sp. nov. d				0				0	2	1		3				0				0				0
Reteporella ? sp. nov. e				0				0				0				0				0				0
Iodictyum ? sp. nov. a				0				0	4			4				0				0				0
Reteporellina sp. nov. a				0				0				0				0				0				0
Reteporellina ? sp. nov. b				0				0				0				0				0				0
'*Triphyllozoon*' sp.nov. a				0	1			1	2	2		4				0				0				0
Phidol Gen. A sp. nov. a				0				0				0				0				0				0
Phidol Gen. B sp. nov. a				0				0				0				0				0				0
Phidol Gen. B sp. nov. b				0				0				0				0				0				0
general fenestrate cheilo	16	28		44	4	5		9	23	21		44	5	6		11	14			14		3		3
TOTAL CHEILO fenestr	16	33	0	49	5	6	0	11	36	40	0	76	5	6	0	11	15	0	0	15	0	3	0	3
Reticrescis cf. ***transennata*** (Waters)	2			2	1	1		2				0	1	1		2	1			1				0
Reticrescis sp. a				0				0				0				0				0				0
Hornera sp. b				0	2			2				0				0				0				0
TOTAL CYCLO fenestr	2	0	0	2	3	1	0	4	0	0	0	0	1	1	0	2	1	0	0	1	0	0	0	0
TOTAL FENESTRATE	18	33	0	51	8	7	0	15	36	40	0	76	6	7	0	13	16	0	0	16	0	3	0	3
Pseudothyracella sp. a FRB				0				0	1			1				0				0				0
'*Ogiva*'? sp. nov. a	1			1	6	14		20	1	12		13	2			2	2			2				0
'*Onychocella*' sp. nov. a	14	1		15				0	14	8		22				0	1	2		3				0
Larvapora ? sp. nov. a FRB	2	1		3				0	8	2		10				0				0				0
Nellia? FRB				0				0				0				0	1			1				0
Macrocamera ? sp. nov. a				0	3			3	4			4				0				0				0
Adeonellopsis symmetrica (Waters)	1	3		4	3	4		7	13	17		30	2	2		4	2			2				0
Adeonellopsis yarraensis (Waters)				0	1	6		7	3	4		7				0				0				0
Adeonellopsis sp. nov. b				0				0		3		3				0				0				0
Dimorphocella sp. nov. a	2	2		4	1	9		10	7			7				0				0				0
Dimorphocella ? sp. nov. b				0				0				0				0				0				0
Dimorphocella sp. nov. c				0				0	1			1				0				0				0
Smittina sp. nov. g				0	3			3				0				0				0				0
Smittina ? sp. nov. h	2	1		3	2			2	3			3				0				0				0
Smittoidea? sp.				0				0				0	1			1				0				0
Porina cf. ***spongiosa*** (MacGillivray) FRB	4	17		21				0	4	1		5				0	1			1				0
Porina sp. nov. a		1		1				0	1			1	1			1				0				0
Chiastosella sp. nov. b				0				0				0				0				0				0
Reteporella ? sp. nov. c		2		2	4	3		7	4	1		5				0				0				0
'*Triphyllozoon*' sp.nov. b	1			1				0				0				0				0				0
general FRB				0	50	100		150				0	2	1		3				0				0
TOTAL Flat Robust Branching	27	28	0	55	73	136	0	209	64	48	0	112	8	3	0	11	7	2	0	9	0	0	0	0
Nevianipora sp. a		4		4	1			1	3	4		7				0			9	9				0
TOTAL Flat Robust Branching	0	4	0	4	1	0	0	1	3	4	0	7	0	0	0	0	0	0	9	9	0	0	0	0
TOTAL Flat Robust Branching	27	32	0	59	74	136	0	210	67	52	0	119	8	3	0	11	7	2	9	18	0	0	0	0
Lichenoporid GenC sp. a				0				0				0				0				0				0
Lichenoporid GenC sp. b				0				0				0				0				0				0
fungiform				0				0				0				0		1		1				0
Disporella cf. sp. b				0				0				0	2			2				0				0
TOTAL FUNGIFORM	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	1	0	1	0	0	0	0

MASLIN BEACH SECTIONS

ERECT DELICATE BRANCHING	Lower Tortachilla Lst (18/002)				lower Mid Tortachilla Lst (18/003)				mid Mid Tortachilla Lst (18/006)				upper Mid Tortachilla Lst (18/009)				Upper Tortachilla Lst (21/TL glauc)				Tuketja Member - BPF (11/011)			
species	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals
Biflustra ? sp. nov. b DEL BR				0				0		2		2				0				0				0
Pseudothyracella sp. a DEL BR				0				0				0		5		5				0				0
Bryopastorid GenA sp.a	28	3		31				0				0				0	1			1				0
'Nellia '? sp. a				0				0				0		1		1				0				0
Quadricellaria sp. nov. a				0		2	4	6		3		3				0				0				0
'Onychocella ' sp. nov. b del br				0	2			2				0				0				0				0
'Onychocella ' sp. nov. c				0				0				0				0				0				0
Ogivalia ? sp. nov. a				0	2	15		17	3	28		31	5			5	3			3				0
Ogivalia? sp. nov. b		2		2	4	8		12	10	30	1	41	1	8		9	2	2		4				0
Cellaria sp. n				0				0		2		2				0				0				0
Acerinucleus sp. nov. a	16			16	10	26		36	5	15		20				0				0				0
Acerinucleus sp. nov. b				0				0				0				0				0				0
Cribrilinid GenIndet sp.a				0				0				0				0				0				0
Exechonella ? sp. nov. a				0				0				0	1			1				0				0
Adeonellopsis sp. nov. a.	2	1		3		4		4				0				0				0				0
Porelloides ? sp. nov. a				0				0				0				0				0				0
'Lekythopora' sp. nov. a	1			1				0	8			8	1			1	1			1				0
GigantoporidaeGenA sp.a	1	1		2				0	1	3		4				0				0				0
Porina cf. sponglosa (MacGillivray) DEL BR	5	3		8	14	15		29	10	16		26				0				0				0
Porina sp. nov. b	1			1				0	1			1				0				0				0
Hippoporina ? sp. nov. a				0				0				0				0				0				0
'Schizoporella' sp.nov. a				0				0				0				0				0				0
Macrocamera robusta Bock & Cook				0		2		2		6		6				0				0				0
Siphonicytara sp. nov. c				0				0	1	6		7				0				0				0
Siphonicytara sp. nov. d				0				0		1		1				0				0				0
Palmicellaria ? sp. nov. a	1			1		1		1		7		7				0	1			1				0
Genus indet. A sp. nov. a				0	5			5	2			2				0				0				0
Genus indet. C sp. nov. a				0				0		1		1				0				0				0
Genus indet. C sp. nov. b				0				0		1		1				0				0				0
Genus indet (distal avic?)				0				0		1		1				0				0				0
general cheilo del br	13			13		100		100	8	26		34	5			5	16	2		18		3		3
TOTAL CHEILO del br	68	10	0	78	37	173	4	214	49	146	1	196	13	14	0	27	24	4	0	28	0	3	0	3
Diaperoecia ? sp. a		1		1	2	2		4		8		8				0				0				0
Diaperoecia ? sp. b				0		3		3	1	4		5				0				0				0
Entalophoroecia ? sp. a		1		1			3	3	1	2		3				0				0				0
Tervia sp. a		1		1		8		8		4		4				0				0				0
Terviid Gen. indet. sp. b		4		4				0				0				0				0				0
Exidmonea ? sp.a	2	5		7		11		11	6	7	1	14	1	8		9			9	9				0
Exidmonea ? sp.b				0				0		1		1				0				0				0
Exidmonea ? sp.c				0				0				0				0				0				0
Exidmonea? large				0				0				0	1			1				0				0
Attinopora ? sp. a		5		5	1	1		2	3	1		4	1			1			2	2				0
Attinopora ? sp. b (smaller orifice) Gen B?				0	7			7		2		2				0				0				0
Hornera cf. robusta ?				0		2		2		1		1				0				0				0
Hornera cf. frondiculata				0				0				0				0				0				0
Hornera sp. a				0				0				0				0				0				0
Hornera sp.				0				0				0				0		1	3	4				0
Crisina sp. a		1		1			18	18	1	6		7				0				0				0
Polyascosoeciella sp. a				0				0				0				0				0				0
Cyclostomata GenA sp. a		1		1				0				0				0				0				0
Cyclostomata GenB sp. a				0	1	6		7	1	6		7				0				0				0
Cyclostomata GenC sp. a		1		1				0	2			2				0				0				0
Lichenoporid GenC sp. a				0				0				0				0				0				0
cyclo del 1				0				0				0	1			1				0				0
cyclo del 2				0				0				0	1			1				0				0
Gen. indet. (long flared peristome)				0				0	6			6				0				0				0
general cyclo del br		70		70	1	53	40	94	4	250	40	294	18	100	120	238	21	16	18	55		12		12
general cyclo del br (very delicate)				0		27		27				0				0				0				0
TOTAL CYCLO del br	2	90	0	90	12	113	61	174	25	292	41	333	23	108	120	228	21	17	32	49	0	12	0	12
TOTAL DEL BRANCH	70	100	0	100	49	286	65	351	74	438	42	480	36	122	120	242	45	21	32	53	0	15	0	15

MASLIN BEACH SECTIONS

ERECT FLEXIBLE	Lower Tortachilla Lst (18/002)				lower Mid Tortachilla Lst (18/003)				mid Mid Tortachilla Lst (18/006)				upper Mid Tortachilla Lst (18/009)				Upper Tortachilla Lst (21/TL glauc)				Tuketja Member - BPF (11/011)			
species	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals
Caberea sp. nov. a				0				0				0				0				0				0
Caberea sp. nov. b				0				0				0				0				0				0
Scrupocellaria sp.nov. a				0				0				0				0				0				0
Candidae indet				0				0				0				0				0				0
'*Caberoides* '? sp. nov. a				0				0			3	3				0				0				0
Melicerita cf. *angustiloba* (T-W)				0	3			3	15	6		21	2			2				0				0
Cellaria sp. nov. a				0				0				0				0				0				0
Cellaria sp. nov. b				0				0				0				0				0				0
Cellaria ? sp. nov. c				0		2		2				0				0				0				0
Cellaria sp. nov. d	4			4				0				0				0				0				0
Cellaria sp. nov. e				0				0				0				0				0				0
Cellaria sp. nov. f	2		2	4	1	14	3	18	4	8	2	14		1		1				0				0
Cellaria sp. nov. g				0				0				0				0				0				0
Cellaria sp. nov. h				0				0				0				0				0				0
Cellaria sp. nov. i				0				0				0		1		1				0				0
Cellaria ? sp. nov. j				0				0				0				0				0				0
Cellaria sp. nov. k	3		1	4		1		1	1	8		9				0				0				0
Cellaria sp. nov. l				0				0		1		1				0				0				0
Cellaria ? sp. nov. m			12	12			9	9		1	3	4			2	2			24	24				0
Cellaria ? sp. nov. o			3	3		1		1		2	2	4				0				0				0
Cellaria sp. nov. p				0				0				0				0				0				0
Cellaria indet	10		2	12		50	3	53	3	10		13	6	8	2	16				0				0
TOTAL CHEILO artic branch	19	0	20	39	4	68	15	87	23	36	10	69	8	10	4	22	0	0	24	24	0	0	0	0
Crisia sp. a		3	14	17			36	36			12	12				0			9	9				0
Crisia sp. b				0				0			3	3				0				0				0
TOTAL CYCLO artic branch	0	3	14	17	0	0	36	36	0	0	15	15	0	0	0	0	0	0	9	9	0	0	0	0
TOTAL ARTIC BRANCH	19	3	34	56	4	68	51	123	23	36	25	84	8	10	4	22	0	0	33	33	0	0	0	0
Strophipora sp. nov. a				0				0				0			9	9				0				0
Stenostomaria sp. nov. a			33	33			15	15			15	15				0				0				0
Stenostomaria sp. nov. b				0				0				0				0				0				0
Caloporella cf. *speciosa* MacG				0			6	6				0				0				0				0
Caloporella sp. nov. a				0				0				0				0				0				0
Costaticella sp. nov. a				0			3	3				0				0				0				0
Costaticella ? sp. nov. b				0				0				0				0				0				0
Caten Gen A sp. nov a				0				0				0				0				0				0
Caten Gen. sp. nov. a				0				0				0				0				0				0
Catenicellidae Indet			6	6			15	15			9	9				0				0				0
Strophipora sp. nov. b			3	3				0				0				0				0				0
Catenicellidae smooth				0				0			9	9				0				0				0
TOTAL ARTIC ZOOID	0	0	42	42	0	0	39	39	0	0	33	33	0	0	9	9	0	0	0	0	0	0	0	0

MASLIN BEACH SECTIONS

ENCRUSTING 1	Lower Tortachilla Lst (18/002)				lower Mid Tortachilla Lst (18/003)				mid Mid Tortachilla Lst (18/006)				upper Mid Tortachilla Lst (18/009)				Upper Tortachilla Lst (21/TL glauc)				Tuketja Member - BPF (11/011)			
species	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals
Biflustra **?** sp. nov. a			3	3		1		1	1			1				0				0				0
Biflustra **?** sp. nov. c				0		2		2	3			3				0				0				0
Biflustra **?** sp. nov. d				0				0				0				0				0				0
'*Biflustra*'? cf. ***orbicularis*** ? (MacG)				0				0	1			1				0				0				0
Membranipora perfragilis				0	1			1				0				0				0				0
Biflustra general	1	8		9	1			1	3	12	10	25	1	2		3				0				0
Dactylostega sp. nov. b ENCR	1			1	4			4	2			2				0				0				0
Dactylostega ? sp. nov. c EMCR	1			1	3	2		5	3			3				0				0				0
Foveolaria (Odontionella) sp. nov. a				0				0				0				0				0				0
Antropora savartii				0	1			1				0				0				0				0
Ramphonotus ? sp. a				0				0				0				0				0				0
Ellisina ? sp. nov. a				0	1			1	9			9				0	1			1				0
Allantopora ? sp. a				0	4			4	5			5				0				0				0
Crassimarginatella sculpta (MacG)				0	1	1		2	1			1				0				0				0
Crassimarginatella sp.a				0	2	1		3	5			5				0	1			1				0
Crassimarginatella sp.b				0	7			7				0				0				0				0
Amphiblestrum sp.	1			1	2			2	2			2				0				0				0
Copidozoum sp. nov. a				0				0	1			1				0				0				0
Crassimarginatella sp.?				0	1	1		2				0				0				0				0
Chaperiopsis cf. ***columnella*** (Brown)				0	5	1		6	2			2				0	1			1				0
Chaperiopsis ? sp. a				0	1			1	7	1		8	1			1	1			1				0
Bryopastorid GenB sp.a				0		1		1	5	8		13				0				0				0
Hiantopora cf. ***quadricornis*** (Mapl)				0				0	1			1				0				0				0
Micropora cf. ***elegans*** Maplestone	1			1	11	4		15	18	1		19				0				0				0
Tretosina ? sp. nov. a				0				0				0				0				0				0
Crateropora ? sp.				0				0				0				0				0				0
Macropora sp. nov. a				0	6			6	16	5		21				0	1			1				0
general Anasca				0		16	20	36	1			1				0				0				0
Figularia rugosa (Maplestone)				0	1	1		2	1			1				0				0				0
Anaskopora sp?				0	3			3				0				0				0				0
Concatenella airensis (Maplestone)				0				0				0				0				0				0
Hippothoa sp. nov.? a				0				0				0				0				0				0
Celleporella ? sp. nov. a				0	4			4				0				0				0				0
Celleporella? B				0	1			1				0				0				0				0
Arachnopusia cf. ***unicornis*** ? (Hutton)				0				0	2			2				0				0				0
Arachnopusia sp. nov. a				0	2	1		3	1			1				0				0				0
Anarthropora sp. nov. a				0	1			1		1		1				0				0				0
Inversiula cf. ***airensis***				0				0		1		1				0				0				0
Lepraliella ? sp. nov. a				0				0				0				0				0				0
'*Escharoides*' sp. nov. a				0				0				0				0				0				0
'*Escharoides*' sp. nov. b				0				0				0				0				0				0
Trigonopora ? aff. ***personata*** (Mapl)				0		1		1	1			1				0				0				0
Trigonopora ? sp. nov. a				0				0	10	3		13	1			1	1			1				0
Exochella sp. nov. a				0				0	3			3				0				0				0
Exochella sp. nov. b				0	4	2		6	1			1				0				0				0
Exochella ? sp. nov. c				0				0				0				0				0				0
Romancheinid GenIndet sp.a	1			1	8	1		9	3			3				0				0				0
Romancheinid ??				0				0				0	1			1				0				0
Gen. indet. (peristome&lateral avic)				0				0	4			4				0				0				0
Porella ? cf. ***angustata*** Maplestone				0				0	1			1				0				0				0

MASLIN BEACH SECTIONS

ENCRUSTING 2	18/002				18/003				18/006				18/006				21/TL glauc				11/011			
species	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals
Rhamphosmittina lateralis (Mac)				0		1		1				0				0				0				0
Smittoidea sp. nov. a				0	2			2				0				0				0				0
Smittoidea sp. nov. b				0	3			3	3			3				0				0				0
Smittoidea sp. nov. c				0	1	2		3	1			1				0				0				0
Smittina sp c?				0	1			1				0				0	1			1				0
Smittoidea sp g				0	1			1				0				0				0				0
Smittoidea indet				0				0	11	1		12				0				0				0
Smittinidae indet				0		3		3	4			4				0				0				0
Gigantoporid Gen. indet. B sp. a				0	2			2				0				0				0				0
Mucropetralia sp. nov. a				0				0				0				0				0				0
Escharina ? cf. nitidissima (Mapl)				0	2			2	3			3				0				0				0
Chiastosella sp. nov. a				0				0	2			2				0				0				0
Chiastosella sp. nov. c				0	1			1	4			4				0				0				0
Escharina/Chiast? Unilam				0	2			2				0				0				0				0
Celleporaria/ juvenile/				0				0	3			3				0				0				0
Hippomenella cf. magna C & B	3			3	1			1	6			6				0				0				0
Buffonellaria cf. roberti (Brown) ENCR	1	1		2	8	4		12	19			19				0				0				0
Osthimosia ? sp. nov. a				0		2		2	1	1		2				0				0				0
Genus indet. B sp. nov. a				0	1			1				0	4			4				0				0
Macroporid?				0				0	12			12				0				0				0
general cheilo	3			3	61	13		74	43			43	4			4	8			8				0
cheilo indet smooth (very small)				0				0	5	6		11	1			1	3			3				0
cheilo indet (flanges)				0				0	1			1				0				0				0
TOTAL CHEILO encr	13	9	3	25	161	61	20	242	231	40	10	281	13	2	0	15	18	0	0	18	0	0	0	0
Stomatopora cf. geminata				0	2			2	2			2				0				0				0
Stomatopora sp. a				0	4			4	7	2		9				0				0				0
'Stomatopora ' sp. b				0	4			4	7	2		9				0				0				0
'Berenicea' sp. a	1			1	3			3	7			7				0				0				0
Disporella sp. a				0	1			1	2			2				0				0				0
Disporella sp. b				0				0	1			1				0				0				0
Disporella sp. c		2		2				0	10	1		11				0				0				0
Stomatopora sp.				0	6			6				0				0				0				0
Lichenoporid GenB sp.a				0				0	3			3				0	1			1				0
Lichenoporid GenD sp. a				0	1			1	3			3				0				0				0
Lichenoporid GenE sp. a				0				0				0				0				0				0
'Lichenopora' sp. a		2		2				0				0				0				0				0
strange Lichenoporid				0				0	8			8				0				0				0
Stomatoporid 1				0				0	5			5				0				0				0
Stomatoporid 2				0				0	1			1				0				0				0
Stomatoporid 3				0				0	9			9				0				0				0
Berenicea 2				0				0	2			2				0				0				0
Disporella multilam?				0				0	1			1				0				0				0
Disporella sp. c (ovicelled?)				0				0	2			2				0				0				0
multiserial/uniserial				0				0				0				0	1			1				0
general cyclo				0	2			2	1			1				0				0				0
TOTAL CYCLO encr	1	4	0	5	23	0	0	23	71	5	0	76	0	0	0	0	1	0	0	1	0	0	0	0
TOTAL ENCRUSTER	14	13	3	30	184	61	20	265	302	45	10	357	13	2	0	15	19	0	0	19	0	0	0	0

MASLIN BEACH SECTIONS

MULTILAMINAR & FREE-LIVING	Lower Tortachilla Lst (18/002)				lower Mid Tortachilla Lst (18/003)				mid Mid Tortachilla Lst (18/006)				upper Mid Tortachilla Lst (18/009)				Upper Tortachilla Lst (21/TL glauc)				Tuketja Member - BPF (11/011)			
species	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals
Otionellina* cf. *exigua (Tenison-Woods)		7		7	4	25		29		12		12				0				0				0
Otionellina* cf. *cupola (Tenison-Woods)				0	1			1		2		2				0				0				0
***'Lunulites'* sp. nov. a**	1	6		7	30	2		32	15			15	2			2				0				0
***'Lunulites'* sp. nov. b**	1			1	8			8				0				0				0				0
Tubiporella magna (Tenison-Woods)				0				0	2			2	1			1				0				0
Celleporaria nummularia (T-W)				0	3			3	2			2				0				0				0
TOTAL FREE LIVING	2	13	0	15	46	27	0	73	19	14	0	33	3	0	0	3	0	0	0	0	0	0	0	0
***Sphaeropora* ? sp. nov.? a**	14			14	90	6		96	9	1		10				0	3			3				0
***Sphaeropora* ? sp. nov.? b**				0				0				0	1			1				0				0
Celleporaria nodular				0	1			1				0				0				0				0
Concatenella airensis				0	8	6		14		1		1				0				0				0
***Aulopocella* ? sp. nov. a**				0				0				0				0				0				0
TOTAL NODULAR cheilo	14	0	0	14	99	12	0	111	9	2	0	11	1	0	0	1	3	0	0	3	0	0	0	0
Heteropora* ? cf. *pisiformis				0				0	1			1				0				0				0
TOTAL NODULAR cyclo	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL NODULAR	14	0	0	14	99	12	0	111	10	2	0	12	1	0	0	1	3	0	0	3	0	0	0	0
***Celleporaria* cf. *gambierensis* ? (T-W)**	1			1	8			8	13			13				0	1			1	2			2
Celleporaria gambierensis sheet	4	1		5				0	6			6				0				0				0
***Celleporaria* ? sp. nov. a**				0				0	3			3				0				0	3	2		5
Celleporaria? nodular encruster				0				0	12			12				0				0				0
Celleporaria indet				0				0	22	7		29	1			1				0				0
TOTAL CHEILO multilam	5	1	0	6	8	0	0	8	56	7	0	63	1	0	0	1	1	0	0	1	5	2	0	7
***Lichenoporid GenA* sp. a**				0				0				0	1			1				0				0
TOTAL CYCLO multilam	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
TOTAL MULTILAMINAR	19	1	0	20	107	12	0	119	66	9	0	75	3	0	0	3	4	0	0	4	5	2	0	7

YORKE PENINSULA SECTIONS

ERECT FOLIOSE	28/008				MF				22/041				22/042			
species	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals
Biflustra ? sp. nov. b FOL				0				0				0				0
'Antropora' ? cf. ***savartii*** (MacGillivray)				0				0				0				0
Dactylostega ? sp. nov. a	3	3		6	1			1		3		3				0
Dactylostega ? sp. nov. b FOL				0				0				0				0
Dactylostega ? sp. nov. c FOL				0				0				0				0
'Onychocella' sp. nov. b	15	10		25				0				0				0
Larvapora ? sp. nov. a FOL	16	1		17				0				0				0
Anaskopora sp. nov. a	2	2		4				0				0				0
Arachnopusia sp. nov. b				0				0				0				0
Trigonopora FOL				0				0	1			1				0
Rhamphosmittina sp. nov. a				0				0				0				0
Smittoidea ? cf. dennanti	6	2		8				0				0				0
Smittoidea ? sp. nov. d	2			2				0				0				0
Smittoidea ? sp. nov. e	82	11		93				0				0				0
Smittoidea sp. nov. f	1			1				0				0				0
Smittoidea sp. nov. g	3			3				0				0				0
Smittoidea sp. nov. h	16	4		20				0				0				0
Smittoidea sp. nov. i	2			2				0				0				0
Smittina sp. nov. a				0				0				0				0
Smittina sp. nov. b	5			5				0				0				0
Smittina ? sp. nov. c	2		2	4				0				0				0
Smittina sp. nov. d		1		1				0				0				0
Smittina sp. nov. e				0				0				0				0
Smittina ? sp. nov. f				0				0				0				0
Prenantia sp. nov. a	1			1				0				0				0
Smittina sp (cf g)	1			1				0				0				0
Smittoidea indet	17	10		27				0		4		4				0
general Smittinid	32	22		54				0				0				0
Cosciniopsis sp. nov. a				0				0				0				0
Hippoporina ? sp. nov. b				0				0				0				0
Escharina ? cf. ***granulata*** (MacGillivray)				0				0				0				0
Siphonicytara irregularis (Mapl)	4	2		6	1			1				0				0
Siphonicytara sp. nov. a	9			9				0				0				0
Siphonicytara sp. nov. b				0				0				0				0
Celleporina ? sp. nov. a				0				0				0				0
Hippomenella FOL	3			3				0				0				0
Porina spongiosa FRB/FOL	10			10				0				0				0
Buffonellaria roberti without avic FOL				0				0				0				0
Buffonellaria roberti with avic Fol	62	13		75	1			1	7	8		15				0
general cheilo FRB	8			8				0				0				0
TOTAL ERECT FOLIOSE	302	81	2	385	3	0	0	3	8	15	0	23	0	0	0	0

YORKE PENINSULA SECTIONS

FENESTRATE, FLAT ROBUST BR, FUNGIFORM	28/008				MF				22/041				22/042			
species	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals
Reteporella aff. ***rimata*** (Waters)				0				0				0				0
Reteporella sp. nov. a				0				0				0				0
Reteporella sp. nov. b	4	2		6				0				0				0
Reteporella ? sp. nov. d				0				0				0				0
Reteporella ? sp. nov. e				0				0				0				0
Iodictyum ? sp. nov. a				0				0				0				0
Reteporellina sp. nov. a				0				0				0				0
Reteporellina ? sp. nov. b				0				0				0				0
'*Triphyllozoon*' sp.nov. a	3			3				0				0				0
Phidol Gen. A sp. nov. a				0				0				0				0
Phidol Gen. B sp. nov. a				0				0				0				0
Phidol Gen. B sp. nov. b				0				0				0				0
general fenestrate	30	25		55				0	1			1				0
TOTAL CHEILO fenestr	37	27	0	64	0	0	0	0	1	0	0	1	0	0	0	0
								0								
Reticrescis cf. ***transennata*** (Waters)	2	3		5				0				0				0
Reticrescis sp. a				0				0				0				0
Hornera sp. b	14	5		19				0				0				0
TOTAL CYCLO fenestr	16	8	0	24	0	0	0	0	0	0	0	0	0	0	0	0
								0								
TOTAL FENESTRATE	53	35	0	88	0	0	0	0	1	0	0	1	0	0	0	0
Pseudothyracella sp. a FRB				0				0				0				0
'*Ogiva*'? sp. nov. a	2	3		5				0				0				0
'*Onychocella*' sp. nov. a				0				0				0				0
Larvapora ? sp. nov. a FRB				0	2			2				0				0
Adeonellopsis symmetrica (Waters)	12	15	1	28				0				0		4		4
Adeonellopsis cf. ***yarraensis*** (Waters)	5	7		12				0				0				0
Adeonellopsis sp. nov. b	5	1	1	7				0		3		3				0
Dimorphocella sp. nov. a	1		2	3				0		3		3				0
Dimorphocella ? sp. nov. b				0				0				0				0
Adeonellopsis sp. dissolved		4	12	16				0				0				0
Smittina sp. nov. g	4			4				0				0				0
Smittina ? sp. nov. h	1			1				0				0				0
Porina cf. ***spongiosa*** (MacGillivray) FRB				0				0		2		2				0
Porina sp. nov. b	4	4		8				0				0				0
Macrocamera ? sp. nov. a	8			8				0				0				0
Chiastosella sp. nov. b				0				0				0				0
Reteporella ? sp. nov. c	5		1	6				0				0				0
'*Triphyllozoon*' sp.nov. b				0				0				0				0
general FRB				0				0				0				0
TOTAL Flat Robust Branching	47	34	17	98	2	0	0	2	0	8	0	8	0	4	0	4
Nevianipora sp. a				0				0				0				0
TOTAL Flat Robust Branching	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL Flat Robust Branching	47	38	18	103	2	0	0	2	0	8	0	8	0	4	0	4
Lichenoporid GenC sp. a				0				0				0				0
Lichenoporid GenC sp. b				0				0				0				0
fungiform	1			1				0				0				0
TOTAL FUNGIFORM	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0

YORKE PENINSULA SECTIONS

ERECT DELICATE BRANCHING	28/008				MF				22/041				22/042			
species	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals
Biflustra ? sp. nov. b DEL BR				0				0				0				0
Pseudothyracella sp. a DEL BR				0				0				0				0
Bryopastorid GenA sp.a				0				0				0				0
'*Nellia* '? sp. a				0				0				0				0
Quadricellaria sp. nov. a				0				0				0				0
'*Onychocella* ' sp. nov. c				0				0				0				0
Ogivalia ? sp. nov. a	1	1	2	4				0				0				0
Ogivalia? sp. nov. b	1	7		8				0				0				0
Cellaria sp. n				0				0				0				0
Acerinucleus sp. nov. a				0				0				0				0
Acerinucleus sp. nov. b				0				0				0				0
Cribrilinid GenIndet sp.a				0				0				0				0
Exechonella ? sp. nov. a				0				0				0				0
Adeonellopsis sp. nov. a.				0				0				0				0
Porelloides ? sp. nov. a				0				0				0				0
'*Lekythopora*' sp. nov. a	22	6		28				0				0				0
GigantoporidaeGenA sp.a		3		3				0				0				0
Porina cf. *spongiosa* (MacGillivray) del	50	37	1	88				0				0				0
Porina sp. nov. b	21	6		27				0				0				0
Hippoporina ? sp. nov. a				0				0				0				0
'*Schizoporella*' sp.nov. a				0				0				0				0
Macrocamera robusta Bock & Cook				0				0				0				0
Siphonicytara sp. nov. c				0				0				0				0
Siphonicytara sp. nov. d				0				0				0				0
Palmicellaria ? sp. nov. a			12	12				0				0				0
Genus indet. A sp. nov. a				0				0				0				0
Genus indet. C sp. nov. a				0				0				0				0
Genus indet. C sp. nov. b				0				0				0				0
delicate anascan (diamond)		1	3	4				0				0				0
strange knobly ?cheilo	2			2				0				0				0
anascan FRB?		1		1				0				0				0
general cheilo del br				0				0				0		3		3
TOTAL CHEILO del br	97	62	18	177	0	0	0	0	0	0	0	0	0	3	0	3
Diaperoecia ? sp. a				0				0				0				0
Diaperoecia ? sp. b				0				0				0				0
Entalophoroecia ? sp. a		1		1				0				0				0
Tervia sp. a		2		2				0				0				0
Terviid Gen. indet. sp. b				0				0				0				0
Exidmonea ? sp.a	1		12	13				0				0				0
Exidmonea ? sp.b		1		1				0				0				0
Exidmonea ? sp.c				0				0				0				0
Attinopora ? sp. a				0				0				0				0
Hornera cf. *robusta* ?		1	2	3				0				0				0
Hornera cf. *frondiculata*				0				0				0				0
Hornera sp. a				0				0				0				0
Crisina sp. a	2	2	2	6				0				0				0
Polyascosoeciella sp. a		1		1				0				0				0
Cyclostomata GenA sp. a		1		1				0				0				0
Cyclostomata GenB sp. a		2		2				0				0				0
Cyclostomata GenC sp. a				0				0				0				0
Lichenoporid GenC sp. a				0				0				0				0
cyclo with lots of orifice long peristome	1			1				0				0				0
cyclo with lots of orifice	4			4				0				0				0
general cyclo del br	27	50	8	85				0		3		3		2	3	5
TOTAL CYCLO del br	35	61	24	85	0	0	0	0	0	3	0	3	0	2	3	5
TOTAL DEL BRANCH	132	123	42	165	0	0	0	0	0	3	0	3	0	5	3	8

YORKE PENISNULA SECTIONS

ERECT FLEXIBLE	28/008				MF				22/041				22/042			
species	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals
Caberea sp. nov. a				0				0				0				0
Caberea sp. nov. b				0				0				0				0
Scrupocellaria sp.nov. a				0				0				0				0
Candidae indet				0				0				0				0
'*Caberoides* '? sp. nov. a				0				0				0				0
Melicerita cf. *angustiloba* (T-W)				0				0				0				0
Cellaria sp. nov. a			3	3				0				0				0
Cellaria sp. nov. b				0				0				0				0
Cellaria ? sp. nov. c				0				0				0				0
Cellaria sp. nov. d			6	6				0				0				0
Cellaria sp. nov. e				0				0				0				0
Cellaria sp. nov. f		1	12	13				0				0				0
Cellaria sp. nov. g				0				0				0				0
Cellaria sp. nov. h			3	3				0				0				0
Cellaria sp. nov. i	1	1	2	4				0		3		3				0
Cellaria ? sp. nov. j		2	2	4				0				0				0
Cellaria sp. nov. k		2	12	14				0				0				0
Cellaria sp. nov. l				0				0				0				0
Cellaria ? sp. nov. m				0				0				0				0
Cellaria ? sp. nov. o		4	10	14				0				0				0
Cellaria sp. nov. p				0				0				0				0
Acerinucleus sp. nov. a	8			8				0				0				0
Acerinucleus sp. nov. b				0				0				0				0
Cellaria indet			36	36	1			1	2	100	15	117		7	12	19
Cellaria cf i		3		3				0				0				0
Cellaria cf j?			6	6				0				0				0
Cellaria sp. z									21	280	4	305	7	35	1	43
TOTAL CHEILO artic branch	9	13	92	114	1	0	0	1	23	383	19	425	7	42	13	62
Crisia sp. a				0				0				0				0
Crisia sp. b				0				0				0				0
TOTAL CYCLO artic branch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL ARTIC BRANCH	9	13	92	114	1	0	0	1	23	383	19	425	7	42	13	62
Strophipora sp. nov. a				0				0				0				0
Stenostomaria sp. nov. a				0				0				0				0
Stenostomaria sp. nov. b				0				0				0				0
Caloporella cf. *speciosa* MacG				0				0				0				0
Caloporella sp. nov. a				0				0				0				0
Costaticella sp. nov. a				0				0				0				0
Costaticella ? sp. nov. b				0				0				0				0
Caten Gen A sp. nov a				0				0				0				0
Caten Gen. sp. nov. a				0				0				0				0
Catenicellidae Indet				0				0				0				0
TOTAL ARTIC ZOOID	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

YORKE PENINSULA SECTIONS

ENCRUSTING 1	28/008				MF				22/041				22/042			
species	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals
Biflustra **?** sp. nov. a				0				0				0				0
Biflustra **?** sp. nov. c	2			2				0				0				0
Biflustra **?** sp. nov. d				0				0				0				0
'*Biflustra*'? cf. ***orbicularis*** ? (MacG)				0				0				0				0
Membranipora perfragilis				0				0				0				0
Biflustra general	1		2	3				0				0				0
Antropora savartii	1			1				0				0				0
Dactylostega sp. nov. b ENCR				0				0				0				0
Dactylostega ? sp. nov. c ENCR				0				0				0				0
Foveolaria (Odontionella) sp. nov. a				0				0	1	4		5				0
Ramphonotus ? sp. a				0				0				0				0
Ellisina ? sp. nov. a	9	1	1	11				0				0				0
Allantopora ? sp. a		3		3				0				0				0
Crassimarginatella sculpta (MacG)	17	7	1	25				0				0				0
Crassimarginatella sp.a	1	1		2				0				0				0
Crassimarginatella sp.b				0				0				0				0
Amphiblestrum sp.				0				0				0				0
Copidozoum sp. nov. a				0				0				0				0
Chaperiopsis cf. ***columnella*** (Brown)	4			4				0				0				0
Chaperiopsis ? sp. a	1			1				0				0				0
Bryopastorid GenB sp.a				0				0				0				0
Hiantopora cf. ***quadricornis*** (Mapl)				0				0				0				0
Micropora cf. ***elegans*** Maplestone	9			9				0				0				0
Tretosina ? sp. nov. a				0				0				0				0
Crateropora ? sp.				0				0				0				0
Macropora sp. nov. a	7			7				0				0				0
Figularia rugosa (Maplestone)	4			4				0				0				0
Concatenella airensis (Maplestone)				0				0				0				0
Hippothoa sp. nov.? a				0				0				0				0
Celleporella ? sp. nov. a	1			1				0				0				0
Arachnopusia cf. ***unicornis*** ? (Hutton)				0				0				0				0
Arachnopusia sp. nov. a	6	1		7				0				0				0
Anarthropora sp. nov. a				0				0				0				0
Inversiula cf. ***airensis***	2			2				0				0				0
Lepraliella ? sp. nov. a				0				0				0				0
'*Escharoides*' sp. nov. a		1		1				0				0				0
'*Escharoides*' sp. nov. b				0				0				0				0
Trigonopora ? aff. ***personata*** (Mapl)				0				0				0				0
Trigonopora ? sp. nov. a				0				0				0				0
Exochella sp. nov. a				0				0				0				0
Exochella sp. nov. b				0				0				0				0
Exochella ? sp. nov. c				0				0				0				0
Romancheinid GenIndet sp.a				0				0				0				0
Porella ? cf. ***angustata*** Maplestone				0				0				0				0
Rhamphosmittina lateralis (Mac)	1			1				0				0				0

YORKE PENINSULA SECTIONS

ENCRUSTING 2	28/008				MF				22/041				22/042			
species	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals
Smittoidea sp. nov. a	1			1				0				0				0
Smittoidea sp. nov. b				0				0				0				0
Smittoidea sp. nov. c				0				0				0				0
Smittoidea sp. nov. f	5			5				0				0				0
Smittina ? sp. nov. f	1		2	3				0				0				0
Smittina? sp. nov. a encruster	4			4				0				0				0
Cosciniopsis sp. nov. a				0				0				0				0
Gigantoporid Gen. indet. B sp. a				0				0				0				0
Mucropetralia sp. nov. a				0				0				0				0
Escharina ? cf. ***nitidissima*** (Mapl)				0				0				0				0
Chiastosella sp. nov. a				0				0				0				0
Chiastosella sp. nov. c	2			2				0				0				0
Hippomenella cf. ***magna*** C & B	2	1		3				0				0				0
Buffonellaria cf. ***roberti*** (Brown) ENCR	4			4				0				0				0
Osthimosia ? sp. nov. a				0				0				0				0
Genus indet. B sp. nov. a				0				0				0				0
small cheilo smooth	1			1				0				0				0
general cheilo	11			11				0				0				0
TOTAL CHEILO encr	97	15	6	118	0	0	0	0	1	4	0	5	0	0	0	0
Stomatopora cf. ***geminata***				0				0				0				0
Stomatopora sp. a	1			1				0				0				0
'Stomatopora ' sp. b	2			2				0				0				0
'Berenicea' sp. a	4			4				0				0				0
Disporella sp. a	3			3				0				0				0
Disporella sp. b				0				0				0				0
Disporella sp. c				0				0				0				0
Lichenoporid GenB sp.a		1		1				0				0				0
Lichenoporid GenD sp. a				0				0				0				0
Lichenoporid GenE sp. a				0				0				0				0
'Lichenopora' sp. a				0				0				0				0
Stomatopora biserial	3			3				0				0				0
Disporella d	5	4		9				0				0				0
Lichenoporid cf GenB	1			1				0				0				0
TOTAL CYCLO encr	19	5	0	24	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL ENCRUSTER	116	20	6	142	0	0	0	0	1	4	0	5	0	0	0	0

YORKE PENINSULA SECTIONS

MULTILAMINAR & FREE-LIVING	28/008				MF				22/041				22/042			
species	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals
Otionellina cf. ***exigua*** (Tenison-Woods)	3	9		12				0				0				0
Otionellina cf. ***cupola*** (Tenison-Woods)				0				0		4		4				0
'Lunulites' sp. nov. a				0				0				0				0
'Lunulites' sp. nov. b	14	9		23				0				0				0
Tubiporella magna (Tenison-Woods)				0				0				0				0
Celleporaria nummularia (T-W)				0				0				0				0
TOTAL FREE LIVING	17	18	0	35	0	0	0	0	0	4	0	4	0	0	0	0
Sphaeropora ? sp. nov.? a				0	3			3				0				0
Sphaeropora ? sp. nov.? b	8	3		11				0				0				0
Aulopocella ? sp. nov. a	2			2	3			3				0				0
Concatenella airensis				0				0				0				0
Celleporaria nodular				0				0				0				0
nodular indet				0	12			12				0				0
TOTAL NODULAR cheilo	10	3	0	13	18	0	0	18	0	0	0	0	0	0	0	0
				0				0				0				0
Heteropora ? cf. ***pisiformis***				0				0				0				0
				0				0				0				0
TOTAL NODULAR cyclo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL NODULAR	10	3	0	13	18	0	0	18	0	0	0	0	0	0	0	0
Celleporaria cf. ***gambierensis*** ? (T-W)	9			9				0	3			3	3	30		33
Celleporaria gambier sheet				0				0				0				0
Celleporaria ? sp. nov. a	2			2				0				0				0
Celleporaria nodular	27	6		33				0				0				0
Celleporaria general	20			20				0				0				0
TOTAL CHEILO multilam	58	6	0	64	0	0	0	0	3	0	0	3	3	30	0	33
Lichenoporid GenA sp. a				0				0				0				0
TOTAL CYCLO multilam	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL MULTILAMINAR	58	6	0	64	0	0	0	0	3	0	0	3	3	30	0	33

KANGAROO ISLAND SECTIONS

ERECT FOLIOSE	LKL(l1) (23/035)				LKL(l2) (23/008)				LKL(m) (23/005)				LKL(u) (23/004)				LKL(t) (23/002)			
species	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals
Biflustra **?** sp. nov. b FOL				0				0				0	2			2				0
'*Antropora*' ? cf. ***savartii*** (MacGillivray)				0				0				0				0				0
Dactylostega ? sp. nov. a	2			2				0				0				0	6			6
Dactylostega ? sp. nov. b FOL				0				0				0	12			12				0
Dactylostega ? sp. nov. c FOL				0	1			1	4			4				0				0
'*Onychocella*' sp. nov. b	1			1				0	1	2		3	2	6		8				0
Larvapora ? sp. nov. a FOL				0				0	1			1				0				0
Anaskopora sp. nov. a				0				0				0				0				0
Arachnopusia sp. nov. b				0				0				0				0	1			1
Rhamphosmittina sp. nov. a				0				0				0				0				0
Smittoidea ? cf. dennanti				0				0				0				0				0
Smittoidea ? sp. nov. d				0				0				0				0				0
Smittoidea ? sp. nov. e				0				0				0				0				0
Smittoidea sp. nov. f				0				0				0				0				0
Smittoidea sp. nov. g				0				0				0				0				0
Smittoidea sp. nov. h				0				0				0				0				0
Smittoidea sp. nov. i				0				0				0				0				0
Smittina sp. nov. a				0				0				0				0				0
Smittina sp. nov. b				0				0				0				0				0
Smittina ? sp. nov. c				0				0				0				0				0
Smittina sp. nov. d				0				0				0				0				0
Smittina sp. nov. e				0				0				0				0				0
Smittina ? sp. nov. f				0				0				0				0				0
Prenantia sp. nov. a				0				0				0				0				0
Smittoidea sp	4			4				0				0				0				0
general Smittinid		4		4	2	1		3	1			1	8			8				0
Cosciniopsis sp. nov. a	2			2				0				0				0				0
Hippoporina ? sp. nov. b				0				0				0				0				0
Escharina ? cf. ***granulata*** (MacGillivray)				0				0				0				0				0
Siphonicytara irregularis (Mapl)	4			4				0				0				0				0
Siphonicytara sp. nov. a				0				0				0				0				0
Siphonicytara sp. nov. b				0				0				0				0				0
Celleporina ? sp. nov. a				0				0				0				0				0
Buffonellaria roberti FOL without avic	4			4	3			3	5			5				0				0
general foliose cheilo	5			5	3			3	20	40		60				0	85	20		105
TOTAL ERECT FOLIOSE	22	4	0	26	9	1	0	10	32	42	0	74	24	6	0	30	92	20	0	112

KANGAROO ISLAND SECTIONS

FENESTRATE, FLAT ROBUST BR, FUNGIFORM	LKL(l1) (23/035)				LKL(l2) (23/008)				LKL(m) (23/005)				LKL(u) (23/004)				LKL(t) (23/002)			
species	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals
Reteporella aff. ***rimata*** (Waters)				0				0				0				0				0
Reteporella sp. nov. a				0				0				0				0				0
Reteporella sp. nov. b				0				0				0				0				0
Reteporella ? sp. nov. d				0				0		6		6				0				0
Reteporella ? sp. nov. e				0				0				0				0				0
Iodictyum ? sp. nov. a				0				0	5	12		17				0				0
Reteporellina sp. nov. a				0				0				0				0				0
Reteporellina ? sp. nov. b				0				0				0				0				0
'Triphyllozoon' sp.nov. a				0				0				0				0				0
Phidol Gen. A sp. nov. a				0				0				0				0				0
Phidol Gen. B sp. nov. a				0				0				0				0				0
Phidol Gen. B sp. nov. b				0				0				0				0				0
general fenestrate	13	32		45	8	6		14	35	80	32	147	18	6		24	4	10		14
TOTAL CHEILO fenestr	13	32	0	45	8	6	0	14	40	98	32	170	18	6	0	24	4	10	0	14
Reticrescis cf. ***transennata*** (Waters)				0				0				0				0				0
Reticrescis sp. a				0				0				0				0				0
Hornera sp. b				0	4			4				0				0				0
TOTAL CYCLO fenestr	0	0	0	0	4	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL FENESTRATE	13	32	0	45	12	6	0	18	40	98	32	170	18	6	0	24	4	10	0	14
Pseudothyrasella sp. nov. a FRB				0				0				0				0				0
'Ogiva '? sp. nov. a	14	10		24	16	2		18				0	8			8	3			3
'Onychocella ' sp. nov. a				0	1	2		3				0				0	2			2
Ogiva? sp				0				0				0	12			12				0
Larvapora ? sp. nov. a FRB				0				0				0				0				0
Adeonellopsis symmetrica (Waters)			5	5				0	11	6		17	89	42		131	11			11
Adeonellopsis cf. ***yarraensis*** (Waters)				0				0				0				0				0
Adeonellopsis sp. nov. b				0				0				0				0				0
Dimorphocella sp. nov. a				0				0				0				0				0
Dimorphocella ? sp. nov. b				0				0				0				0				0
Smittina sp. nov. g				0				0				0	6			6				0
Smittina ? sp. nov. h				0				0				0				0				0
Porina cf. ***sponglosa*** (MacGillivray) FRB	5			5	5			5				0				0	3			3
Porina sp. nov. a				0				0				0				0				0
Macrocamera ? sp. nov. a				0				0				0	2			2				0
Chiastosella sp. nov. b				0				0				0				0				0
Reteporella ? sp. nov. c				0				0				0				0				0
'Triphyllozoon' sp.nov. b				0				0				0				0				0
general FRB	4			4				0		24		24				0	65	20		85
TOTAL Flat Robust Branching	23	10	5	38	22	4	0	26	11	30	0	41	117	42	0	159	84	20	0	104
Nevianipora sp. a				0				0				0				0				0
TOTAL Flat Robust Branching	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL Flat Robust Branching	23	10	5	38	22	4	0	26	11	30	0	41	117	42	0	159	84	20	0	104
Lichenoporid GenC sp. a				0				0				0				0				0
Lichenoporid GenC sp. b				0				0				0				0				0
fungiform				0				0			9	9				0				0
TOTAL FUNGIFORM	0	0	0	0	0	0	0	0	0	0	9	9	0	0	0	0	0	0	0	0

KANGAROO ISLAND SECTIONS

ERECT DELICATE BRANCHING	LKL(l1) (23/035)				LKL(l2) (23/008)				LKL(m) (23/005)				LKL(u) (23/004)				LKL(t) (23/002)			
species	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals
Biflustra ? sp. nov. b DEL BR				0				0				0				0				0
Pseudothyracella sp. a DEL BR				0				0		6		6				0				0
Bryopastorid GenA sp.a				0				0				0				0				0
'Nellia '? sp. a				0				0				0				0				0
Quadricellaria sp. nov. a			15	15				0				0				0				0
'Onychocella ' sp. nov. c				0				0				0				0				0
Ogivalia ? sp. nov. a	16	6		22	11	13		24				0				0				0
Ogivalia? sp. b	5	22		27				0				0				0				0
Cellaria sp. n				0				0				0				0				0
Acerinucleus sp. nov. a				0				0				0	2			2				0
Acerinucleus sp. nov. b				0				0				0	6			6				0
Cribrilinid GenIndet sp.a				0				0				0				0				0
Exechonella ? sp. nov. a				0				0				0				0				0
Adeonellopsis sp. nov. a.				0				0				0				0				0
Porelloides ? sp. nov. a				0				0				0				0				0
'Lekythopora' sp. nov. a	9			9	2			2				0				0				0
GigantoporidaeGenA sp.a				0				0				0				0				0
Porina cf. ***spongiosa*** (MacGillivray) DEL	2	2		4		1		1				0	2			2				0
Porina sp. nov. b				0				0	2	2		4				0				0
Hippoporina ? sp. nov. a				0				0				0				0				0
'Schizoporella' sp.nov. a				0				0				0				0				0
Macrocamera robusta Bock & Cook				0				0				0				0				0
Siphonicytara sp. nov. c				0				0				0				0				0
Siphonicytara sp. nov. d				0				0				0				0				0
Palmicellaria ? sp. nov. a				0				0				0				0				0
Genus indet. A sp. nov. a	2			2				0		4		4				0				0
Genus indet. C sp. nov. a				0				0				0				0				0
Genus indet. C sp. nov. b				0				0				0				0				0
general cheilo del br	31	36		67	3	2		5		12		12				0	105	50		155
TOTAL CHEILO del br	65	66	15	146	16	16	0	32	2	24	0	26	10	0	0	10	105	50	0	155
Diaperoecia ? sp. a				0				0				0				0				0
Diaperoecia ? sp. b				0				0				0				0				0
Entalophoroecia ? sp. a				0				0	5	4	6	15				0				0
Tervia sp. a				0				0				0				0				0
Terviid Gen. indet. sp. b				0				0				0				0				0
Exidmonea ? sp.a	10			10	6	2		8				0				0	1			1
Exidmonea ? sp.b				0				0				0				0				0
Exidmonea ? sp.c				0				0				0				0				0
Attinopora ? sp. a	4			4	2			2	1	6		7				0				0
Hornera cf. ***robusta*** ?				0				0	3	8	12	23				0				0
Hornera cf. ***frondiculata***				0				0				0				0				0
Hornera sp. a				0				0				0				0				0
Hornera sp				0	2			2	4			4				0				0
Crisina sp. a				0				0	3		12	15				0				0
Polyascosoeciella sp. a				0				0				0				0				0
Cyclostomata GenA sp. a				0				0				0				0				0
Cyclostomata GenB sp. a				0				0				0				0				0
Cyclostomata GenC sp. a				0				0				0				0				0
Lichenoporid GenC sp. a				0				0				0				0				0
general cyclo del br	62	45	110	217	23	16	28	67	4	10	48	62	18	12		30	15	20		35
TOTAL CYCLO del br	76	45	110	155	33	18	28	46	20	28	78	106	18	12	0	12	16	20	0	20
TOTAL DEL BRANCH	141	111	125	236	49	34	28	62	22	52	78	130	28	12	0	12	121	70	0	70

KANGAROO ISLAND SECTIONS

ERECT FLEXIBLE	LKL(l1) (23/035)				LKL(l2) (23/008)				LKL(m) (23/005)				LKL(u) (23/004)				LKL(t) (23/002)			
species	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals
Caberea **sp. nov. a**				0				0				0				0				0
Caberea **sp. nov. b**				0				0				0				0				0
Scrupocellaria sp.nov. a				0				0				0				0				0
Candidae indet				0				0				0				0				0
'*Caberoides* '? sp. nov. a				0				0				0				0				0
Melicerita cf. ***angustiloba*** (T-W)	5	16		21	3			3		2		2				0				0
Cellaria sp. nov. a				0				0				0				0				0
Cellaria sp. nov. b				0				0	2			2				0				0
Cellaria ? sp. nov. c				0				0				0	10			10				0
Cellaria sp. nov. d				0				0				0				0				0
Cellaria sp. nov. e				0				0				0				0				0
Cellaria sp. nov. f		8		8				0				0				0				0
Cellaria sp. nov. g				0				0		4		4				0				0
Cellaria sp. nov. h	5	2		7		1		1				0				0				0
Cellaria sp. nov. i				0				0	2			2				0				0
Cellaria ? sp. nov. j				0				0				0				0				0
Cellaria sp. nov. k	1			1				0				0				0				0
Cellaria sp. nov. l				0				0				0				0				0
Cellaria ? sp. nov. m				0				0				0				0				0
Cellaria ? sp. nov. o				0				0				0				0				0
Cellaria sp. nov. p				0				0				0				0				0
Cellaria indet	30	54	60	144	12	12	4	28	12	34	24	70	76	60		136	37	40		77
TOTAL CHEILO artic branch	41	80	60	181	15	13	4	32	16	40	24	80	86	60	0	146	37	40	0	77
Crisia sp. a			135	135			84	84				0				0				0
Crisia sp. b			10	10				0				0				0				0
TOTAL CYCLO artic branch	0	0	145	145	0	0	84	84	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL ARTIC BRANCH	41	80	205	326	15	13	88	116	16	40	24	80	86	60	0	146	37	40	0	77
Strophipora sp. nov. a				0				0				0				0				0
Stenostomaria sp. nov. a				0				0				0				0				0
Stenostomaria sp. nov. b				0				0				0				0				0
Caloporella cf. ***speciosa*** MacG			5	5				0				0				0				0
Caloporella sp. nov. a				0				0				0				0				0
Costaticella sp. nov. a				0				0				0				0				0
Costaticella ? sp. nov. b				0				0				0				0				0
Caten Gen A sp. nov a				0				0				0				0				0
Caten Gen. sp. nov. a				0				0				0				0				0
Catenicellidae Indet			10	10			6	6				0				0				0
Catenicellidae smooth			10	10				0				0				0				0
TOTAL ARTIC ZOOID	0	0	25	25	0	0	6	6	0	0	0	0	0	0	0	0	0	0	0	0

KANGAROO ISLAND SECTIONS

ENCRUSTING 1	LKL(i1) (23/035)				LKL(i2) (23/008)				LKL(m) (23/005)				LKL(u) (23/004)				LKL(t) (23/002)			
species	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals
Biflustra ? sp. nov. a				0				0				0				0				0
Biflustra ? sp. nov. c				0				0				0				0				0
Biflustra ? sp. nov. d				0				0				0				0				0
'*Biflustra*'? cf. ***orbicularis*** ? (MacG)				0				0				0				0				0
Membranipora perfragilis				0				0				0				0				0
Biflustra general				0				0	1	4		5				0				0
Dactylostega sp. nov. b ENCR	3			3		1		1				0				0				0
Dactylostega ? sp. nov. c ENCR				0				0				0				0				0
Foveolaria (Odontionella) sp. nov. a				0				0				0				0				0
Ramphonotus ? sp. a				0				0				0				0				0
Ellisina ? sp. nov. a	1			1				0				0				0				0
Allantopora ? sp. a				0				0				0				0				0
Crassimarginatella sculpta (MacG)				0				0				0				0				0
Crassimarginatella sp.a				0				0				0				0				0
Crassimarginatella sp.b				0	1			1				0				0				0
Amphiblestrum sp.				0				0				0				0				0
Copidozoum sp. nov. a				0				0				0				0				0
Chaperiopsis cf. ***columnella*** (Brown)				0				0				0				0				0
Chaperiopsis ? sp. a				0	1			1				0				0				0
Bryopastorid GenB sp.a				0				0				0				0				0
Hiantopora cf. ***quadricornis*** (Mapl)				0				0				0				0				0
Micropora cf. ***elegans*** Maplestone				0				0				0				0				0
Tretosina ? sp. nov. a				0				0				0				0				0
Crateropora ? sp.				0				0				0				0				0
Macropora sp. nov. a				0				0				0				0				0
Figularia rugosa (Maplestone)				0				0				0				0				0
Concatenella airensis (Maplestone)				0				0				0				0				0
Hippothoa sp. nov.? a				0				0				0				0				0
Celleporella ? sp. nov. a				0				0				0				0				0
Arachnopusia cf. ***unicornis*** ? (Hutton)				0				0				0				0				0
Arachnopusia sp. nov. a				0				0				0				0				0
Arachnopusia sp. z				0				0	2	4		6				0				0
Anarthropora sp. nov. a				0				0				0				0				0
Inversiula cf. ***airensis***				0				0				0				0				0
Lepraliella ? sp. nov. a				0				0	2			2				0				0
'*Escharoides*' sp. nov. a				0				0				0				0				0
'*Escharoides*' sp. nov. b				0				0				0				0				0
Trigonopora ? aff. ***personata*** (Mapl)	1			1				0				0				0				0
Trigonopora ? sp. nov. a				0				0				0				0				0
Exochella sp. nov. a				0				0				0				0				0
Exochella sp. nov. b				0				0				0				0				0
Exochella ? sp. nov. c				0				0				0				0				0
Romancheinid Genlndet sp.a				0				0				0				0				0
Porella ? cf. ***angustata*** Maplestone				0				0				0				0				0
Rhamphosmittina lateralis (Mac)				0				0				0				0				0

KANGAROO ISLAND SECTIONS

ENCRUSTING 2	LKL(l1) (23/035)				LKL(l2) (23/008)				LKL(m) (23/005)				LKL(u) (23/004)				LKL(t) (23/002)			
species	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals
Smittoidea **sp. nov. a**				0				0				0				0				0
Smittoidea **sp. nov. b**				0				0	1			1				0				0
Smittoidea **sp. nov. c**				0				0				0				0				0
Gigantoporid Gen. indet. B sp. a				0				0				0				0				0
Mucropetralia sp. nov. a				0				0				0				0				0
Escharina ? cf. ***nitidissima*** (Mapl)				0				0				0				0				0
Chiastosella sp. nov. a				0				0				0				0				0
Chiastosella sp. nov. c				0				0				0				0				0
Hippomenella cf. ***magna*** C & B				0				0				0				0				0
Buffonellaria cf. ***roberti*** (Brown) ENCR				0				0				0				0				0
Osthimosia ? sp. nov. a				0				0				0				0				0
Genus indet. B sp. nov. a				0				0				0				0				0
encruster smooth small				0				0	2	6		8				0				0
TOTAL CHEILO encr	5	0	0	5	2	1	0	3	6	8	0	14	0	0	0	0	0	0	0	0
Stomatopora cf. ***geminata***				0				0				0				0				0
Stomatopora sp. a				0				0				0				0				0
'Stomatopora ' sp. b				0	1			1				0				0				0
'Berenicea' sp. a				0				0				0				0				0
Disporella sp. a				0				0				0				0				0
Disporella sp. b	4			4				0	1			1				0				0
Disporella sp. c				0	1			1				0				0				0
Lichenoporid GenB sp.a				0				0				0				0				0
Lichenoporid GenD sp. a				0				0				0				0				0
Lichenoporid GenE sp. a				0				0				0				0				0
'Lichenopora' sp. a				0				0				0				0				0
				0				0				0				0				0
TOTAL CYCLO encr	4	0	0	4	2	0	0	2	1	0	0	1	0	0	0	0	0	0	0	0
TOTAL ENCRUSTER	9	0	0	9	4	1	0	5	7	8	0	15	0	0	0	0	0	0	0	0

KANGAROO ISLAND SECTIONS

MULTILAMINAR & FREE-LIVING	LKL(l1) (23/035)				LKL(l2) (23/008)				LKL(m) (23/005)				LKL(u) (23/004)				LKL(t) (23/002)			
species	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals	>2mm	2-1mm	<1mm	Totals
Otionellina cf. ***exigua*** (Tenison-Woods)	3	6		9	1	3		4				0				0				0
Otionellina cf. ***cupola*** (Tenison-Woods)				0				0				0				0				0
'*Lunulites*' sp. nov. a				0	3			3				0				0				0
'*Lunulites*' sp. nov. b				0				0				0				0				0
Tubiporella magna (Tenison-Woods)				0				0				0				0				0
Celleporaria nummularia (T-W)				0				0				0				0				0
TOTAL FREE LIVING	3	6	0	9	4	3	0	7	0	0	0	0	0	0	0	0	0	0	0	0
Sphaeropora ? sp. nov.? a				0				0		4		4				0	1			1
Sphaeropora ? sp. nov.? b				0				0				0				0				0
Sphaeropora sp. with rootlet hole				0	6			6				0				0				0
Aulopocella ? sp. nov. a				0				0				0				0				0
Concatenella airensis				0				0				0				0				0
Celleporaria nodular	4			4	3			3	1	4		5				0				0
flat nodular				0				0	2	2		4				0				0
TOTAL NODULAR cheilo	4	0	0	4	9	0	0	9	3	10	0	13	0	0	0	0	1	0	0	1
				0				0				0				0				0
Heteropora ? cf. ***pisiformis***				0				0				0				0				0
nodular cyclo?				0				0		2		2				0				0
TOTAL NODULAR cyclo	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0
TOTAL NODULAR	4	0	0	4	9	0	0	9	3	12	0	15	0	0	0	0	1	0	0	1
Celleporaria cf. ***gambierensis*** ? (T-W)				0				0	1			1				0	9			9
Celleporaria gambierensis sheet				0				0				0				0				0
Celleporaria ? sp. nov. a				0				0				0				0	4			4
Celleporaria? sp.	15			15	1			1	5			5				0				0
TOTAL CHEILO multilam	15	0	0	15	1	0	0	1	6	0	0	6	0	0	0	0	13	0	0	13
Lichenoporid GenA sp. a				0				0				0				0				0
nodular cyclo?	1			1				0				0				0				0
TOTAL CYCLO multilam	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL MULTILAMINAR	16	0	0	16	1	0	0	1	9	12	0	21	0	0	0	0	14	0	0	14

SPECIES PER GROWTH FORM

Growth Form	LTL (18/002)	lMTL (18/003)	mMTL (18/006)	uMTL (18/009)	UTL (21/glauc)	Tuk (11/011)	GR	Perk
FOLIOSE	10	17	26	3	2	0	1	0
FRB cheilo	8	12	13	4	5	0	0	0
FRB cyclo	1	1	1	0	1	0	0	0
FRB	9	13	14	4	6	0	0	0
FEN cheilo	9	4	11	2	2	1	2	0
FEN cyclo	1	2	0	1	1	0	0	0
FENESTRATE	10	6	11	3	3	1	2	0
DEL BR cheilo	10	14	19	7	2	1	0	0
DEL BR cyclo	13	16	25	11	7	2	0	0
DEL BRANCH	23	30	44	18	9	3	0	0
FUNGIFORM	0	0	0	1	1	0	0	0
ART BR cheilo	6	9	8	5	1	0	0	0
ART BR cyclo	1	1	2	0	1	0	0	0
ARTIC BRANCH	7	10	10	5	2	0	0	0
ARTIC ZOOID	3	5	4	1	0	0	0	0
ENCR cheilo	11	48	46	7	9	0	0	0
ENCR cyclo	3	8	17	0	2	0	0	0
ENCRUSTER	14	56	63	7	11	0	0	0
MULTILAM cheilo	2	1	4	1	1	2	2	2
MULTILAM cyclo	0	0	0	1	0	0	0	0
MULTILAMINAR	2	1	4	2	1	2	2	2
NODULAR cheilo	1	3	2	1	1	0	0	0
NODULAR cyclo	0	0	1	0	0	0	0	0
NODULAR	1	3	3	1	1	0	0	0
FREE-LIVING	3	4	4	2	0	0	0	0
Total Cheilo	63	117	137	33	23	4	5	2
Total Cyclo	19	28	46	14	13	2	0	0
TOTAL	82	145	183	47	36	6	5	2
Erect	62	81	109	35	23	4	3	0
Encrust	16	57	67	9	12	2	2	2
Freeliving	4	7	7	3	1	0	0	0

Growth Form	base MF (28/008	MF gen	LRF1 (22/041)	LRF2 (22/042)
FOLIOSE	21	3	3	0
FRB cheilo	10	2	3	1
FRB cyclo	0	0	0	0
FRB	10	2	3	1
FEN cheilo	6	0	1	0
FEN cyclo	2	0	0	0
FENESTRATE	8	0	1	0
DEL BR cheilo	10	0	0	1
DEL BR cyclo	16	0	1	1
DEL BRANCH	26	0	1	2
FUNGIFORM	1	0	0	0
ART BR cheilo	13	1	9	2
ART BR cyclo	0	0	0	0
ARTIC BRANCH	13	1	9	2
ARTIC ZOOID	0	0	0	0
ENCR cheilo	26	0	1	0
ENCR cyclo	7	0	0	0
ENCRUSTER	33	0	1	0
MULTILAM cheilo	3	0	1	1
MULTILAM cyclo	0	0	0	0
MULTILAMINAR	3	0	1	1
NODULAR cheilo	2	3	0	0
NODULAR cyclo	0	0	0	0
NODULAR	2	3	0	0
FREE-LIVING	2	0	1	0
Total Cheilo	93	9	19	5
Total Cyclo	26	0	1	1
TOTAL	119	9	20	6
Erect	79	6	17	5
Encrust	36	0	2	1
Freeliving	4	3	1	0

Growth Form	lKL1L (23/035)	lLKL2 (23/008)	mLKL (23/005)	uLKL (23/004)	tLKL (23/002)
FOLIOSE	8	4	8	4	7
FRB cheilo	3	3	1	4	4
FRB cyclo	0	0	0	0	0
FRB	3	3	1	4	4
FEN cheilo	1	1	2	1	1
FEN cyclo	0	1	0	0	0
FENESTRATE	1	2	2	1	1
DEL BR cheilo	9	4	4	3	7
DEL BR cyclo	12	6	8	3	3
DEL BRANCH	21	10	12	6	10
FUNGIFORM	0	0	1	0	0
ART BR cheilo	10	4	7	7	4
ART BR cyclo	2	1	0	0	0
ARTIC BRANCH	12	5	7	7	4
ARTIC ZOOID	3	1	0	0	0
ENCR cheilo	4	3	5	0	0
ENCR cyclo	1	2	1	0	0
ENCRUSTER	5	5	6	0	0
MULTILAM cheilo	1	1	2	0	2
MULTILAM cyclo	1	0	0	0	0
MULTILAMINAR	2	1	2	0	2
NODULAR cheilo	1	2	3	0	0
NODULAR cyclo	0	0	1	0	0
NODULAR	1	2	4	0	0
FREE-LIVING	1	2	0	0	0
Total Cheilo	41	25	32	19	25
Total Cyclo	16	10	11	3	3
TOTAL	57	35	43	22	28
Erect	48	25	31	22	26
Encrust	7	6	8	0	2
Freelving	2	4	4	0	0

A3. Publication List

A3.1. Journal Articles:

SCHMIDT, R. & BONE, Y. (in press) Biogeographic Trends of Eocene Bryozoans from the St Vincent Basin, South Australia. *Lethaia (Proceedings of the 1st International Palaeontological Convention).*

SCHMIDT, R. & BONE, Y. (in press) Australian Cainozoic Bryozoa, 1: *Nudicella* gen. nov. (Onychocellidae, Cheilostomata) with palaeoenvironments and biogeography. *Alcheringa.*

A3.2. Conference Proceedings:

SCHMIDT, R. & BONE, Y. (2002) Eocene Bryozoan Assemblages of the St Vincent Basin, South Australia. *In* P. N. Wyse-Jackson, C. J. Buttler & M. E. Spencer-Jones (eds.) *Bryozoan Studies 2001 - Proceedings of the 12th I.B.A. Conference* (A.A. Balkema Publishers, Lisse, Netherlands): 293-298.

BROWN, K.M., SCHMIDT, R. & BONE, Y. (2002) Observations on the ecological adaptations of *Lanceopora smeatoni* (MacGillivray), West Island, South Australia. *In* P.N. Wyse-Jackson, C.J. Buttler & M.E. Spencer-Jones (eds.) *Bryozoan Studies 2001 - Proceedings of the 12th I.B.A. Conference* (A.A. Balkema Publishers, Lisse, Netherlands): 61-65.

A3.3. Conference Abstracts:

SCHMIDT, R. & BONE, Y. (1997) Cheilostome Bryozoans as Palaeoenvironment Indicators of the Late Eocene Limestones of the St. Vincent Basin, S.A.- Preliminary Results. *In* E. Campbell and Y. Bone (eds.) *Third Australian Marine Geoscience Conference - Abstracts Volume.* (Adelaide, South Australia): 50.

SCHMIDT, R. & BONE, Y. (1998) Lunulitiform Bryozoans in Late Eocene Limestones, St. Vincent Basin, South Australia *14th Australian Geological Convention.* (Townsville, Queensland, Australia).

SCHMIDT, R. & BONE, Y. (1999) Biogeographic and Palaeoenvironmental Significance of a Bryozoan Mimicking the Growth Form of *Adeona* in the Eocene of South Australia. *In* L. Collins (ed.) *Fourth Australian Marine Geoscience Conference - Abstracts Volume.* (Exmouth, Western Australia).

SCHMIDT, R. & BONE, Y. (2001) Late Eocene Bryozoan assemblages of the St Vincent Basin, South Australia - preliminary results. *In* P. N. Wyse-Jackson (ed.) *12th International Bryozoology Association Conference.* (Dublin, Ireland): 94.

SCHMIDT, R. & BONE, Y. (2002) Biogeography of Eocene Bryozoans of the St Vincent Basin, South Australia. *In* G. A. Brock & J. A. Talent (eds.) *First International Palaeontological Congress.* (Sydney, Geological Society of Australia, Abstracts, **68**): 140-141.

SCHMIDT, R. & BONE, Y. (2002) Australobryozoopalaeobiogeography. *15th Australian Geological Convention.* (Adelaide, South Australia).

PLATES

The specimen registration number for the South Australian Museum is given below each caption in brackets, eg. (SAM P39334)

One scale bar is placed on each plate. The size of the scale bar units for each figure is indicated by the number in square brackes at the end of each figure caption. This number represents one of the following five standard magnifications:

[1.00] ... each subdivision = 1.0 mm (scale bar = 5.0mm)
[0.50] ... each subdivision = 0.5 mm (scale bar = 2.5 mm)
[0.25] ... each subdivision = 0.25 mm (scale bar = 1.25mm)
[0.10] ... each subdivision = 0.1 mm (scale bar = 0.5mm)
[0.05] ... each subdivision = 0.05 mm (scale bar = 0.25mm)

This key is again given at the bottom of each page as the length of the bar in mm (with the length of each subdivision in brackets):

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

Plate 1

A: ***Biflustra* sp. nov. b**, autozooids [0.10]
(SAM P39352)
B: ***Biflustra* sp. nov. b**, oblique view of autozooid detail showing distal wall with pore (arrow) [0.10]
(SAM P39352)
C: ***Biflustra* sp. nov. b**, bifurcating colony fragment (composite SEM) [0.50]
(SAM P39352)
D: ***Biflustra* sp. nov. a**, individual autozooid [0.10]
(SAM P39467)
E: ***Biflustra* sp. nov. a**, same autozooid in lateral view [0.10]
(SAM P39467)
F: ***Biflustra* sp. nov. a**, colony fragment [0.25]
(SAM P39466)
G: ***Biflustra* sp. nov. d**, autozooids, arrows indicate possible muscle scars [0.10]
(SAM P39468)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

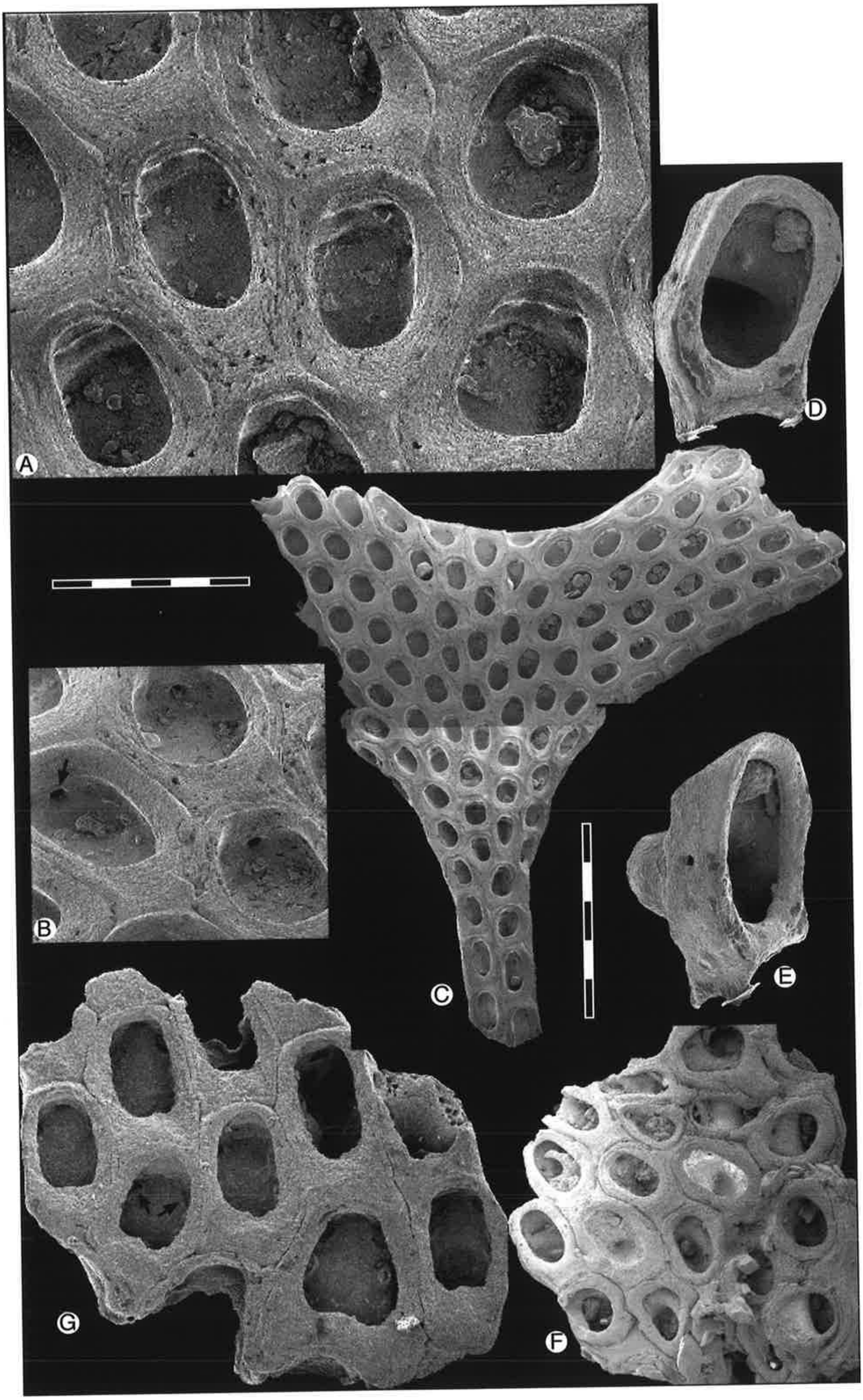

A
B
C
D
E
F
G

Plate 2

A: ***Antropora* cf. *savartii***, bilaminar colony fragment [0.25]
(SAM P39349)
B: ***Antropora* cf. *savartii***, autozooids and polymorphs from the same colony [0.10]
(SAM P39349)
C: ***Antropora* cf. *savartii***, view of proximal autozooid margins of the same colony [0.10]
(SAM P39349)
D: ***Biflustra* sp. nov. c**, bilaminar colony fragment [0.25]
(SAM P39351)
E: ***Biflustra* sp. nov. c**, interzooidal avicularium [0.10]
(SAM P39351)
F: ***Biflustra* sp. nov. c**, autozooids [0.10]
(SAM P39351)
G: **'*Biflustra* cf. *orbicularis*'**, autozooid [0.10]
(SAM P39318)
H: **'*Biflustra* cf. *orbicularis*'**, colony fragment [0.25]
(SAM P39318)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

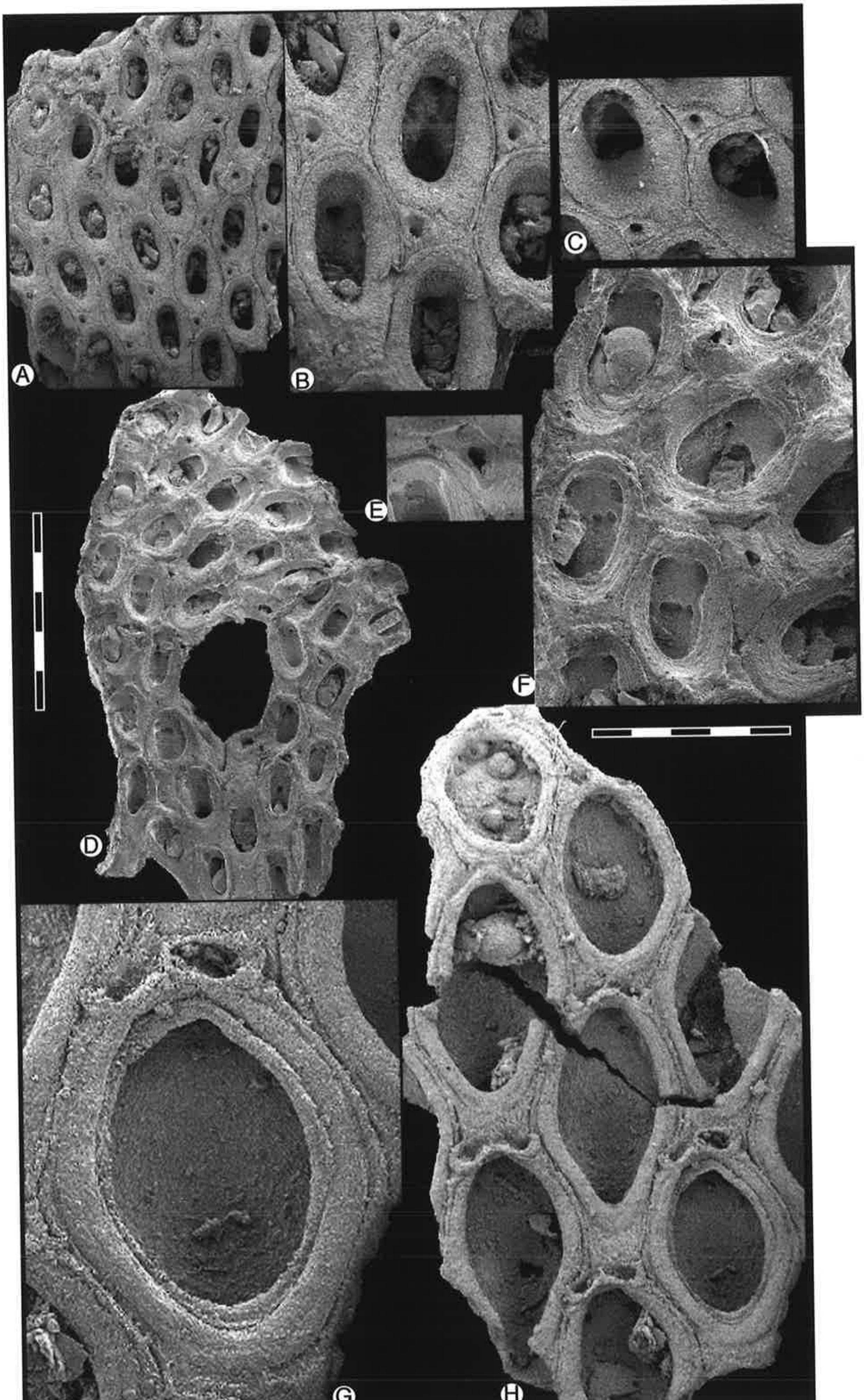

A
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Plate 3

A: ***Dactylostega* sp. nov. a**, ovicelled zooids [0.10]
(SAM P39384)

B: ***Dactylostega* sp. nov. a**, zooids tilted to show ovicellular orifice [0.10]
(SAM P39384)

C: ***Dactylostega* sp. nov. a**, autozooids, with an ovicelled zood at top [0.10]
(SAM P39385)

D: ***Dactylostega* sp. nov. c**, colony fragment [0.25]
(SAM P39402)

E: ***Dactylostega* sp. nov. c**, autozooids, opesial spine base arrowed [0.10]
(SAM P39402)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

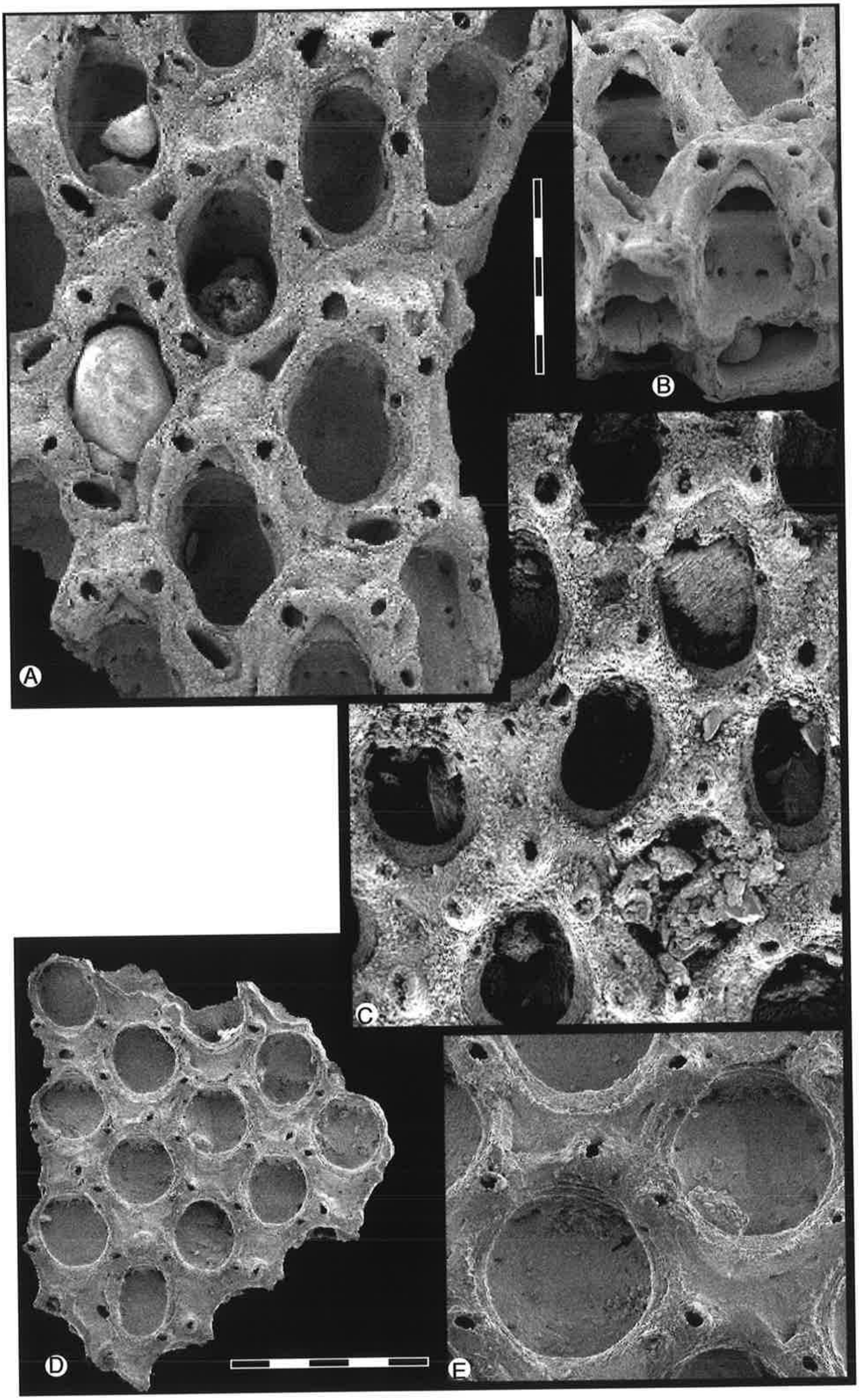
A
B
C
D
E

Plate 4

A: ***Dactylostega* sp. nov. b**, colony fragment [0.25]
(SAM P39407)

B: ***Dactylostega* sp. nov. b**, ovicelled zooids (arrow indicates lateral opesial spine base) [0.10]
(SAM P39408)

C: ***Dactylostega* sp. nov. b**, autozooids [0.10]
(SAM P39409)

D: ***Foveolaria (Odontionella)* sp. nov. a**, colony fragment [0.25]
(SAM P39395)

E: ***Foveolaria (Odontionella)* sp. nov. a**, autozooids [0.10]
(SAM P39395)

F: ***Foveolaria (Odontionella)* sp. nov. a**, close-up of serrated proximal margin [0.05]
(SAM P39395)

G: ***Foveolaria (Odontionella)* sp. nov. a**, distal zooid margin with pores [0.05]
(SAM P39395)

H: ***Foveolaria (Odontionella)* sp. nov. a**, close-up of suboral avicularium [0.05]
(SAM P39395)

I: ***Ramphonotus* sp. nov. a**, autozooids [0.10]
(SAM P39394)

J: ***Ellisina* sp. nov. a**, colony with ancestrular area [0.25]
(SAM P39582)

K: ***Ellisina* sp. nov. a**, autozooids [0.10]
(SAM P39582)

L: ***Ellisina* sp. nov. a**, ovicelled zooids with distal avicularia [0.10]
(SAM P39583)

M: ***Allantopora* sp. nov. a**, portion of colony encrusting echinoid [0.25]
(SAM P39584)

N: ***Allantopora* sp. nov. a**, individual autozooid, showing spine bases (arrow) [0.10]
(SAM P39584)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

Plate 4

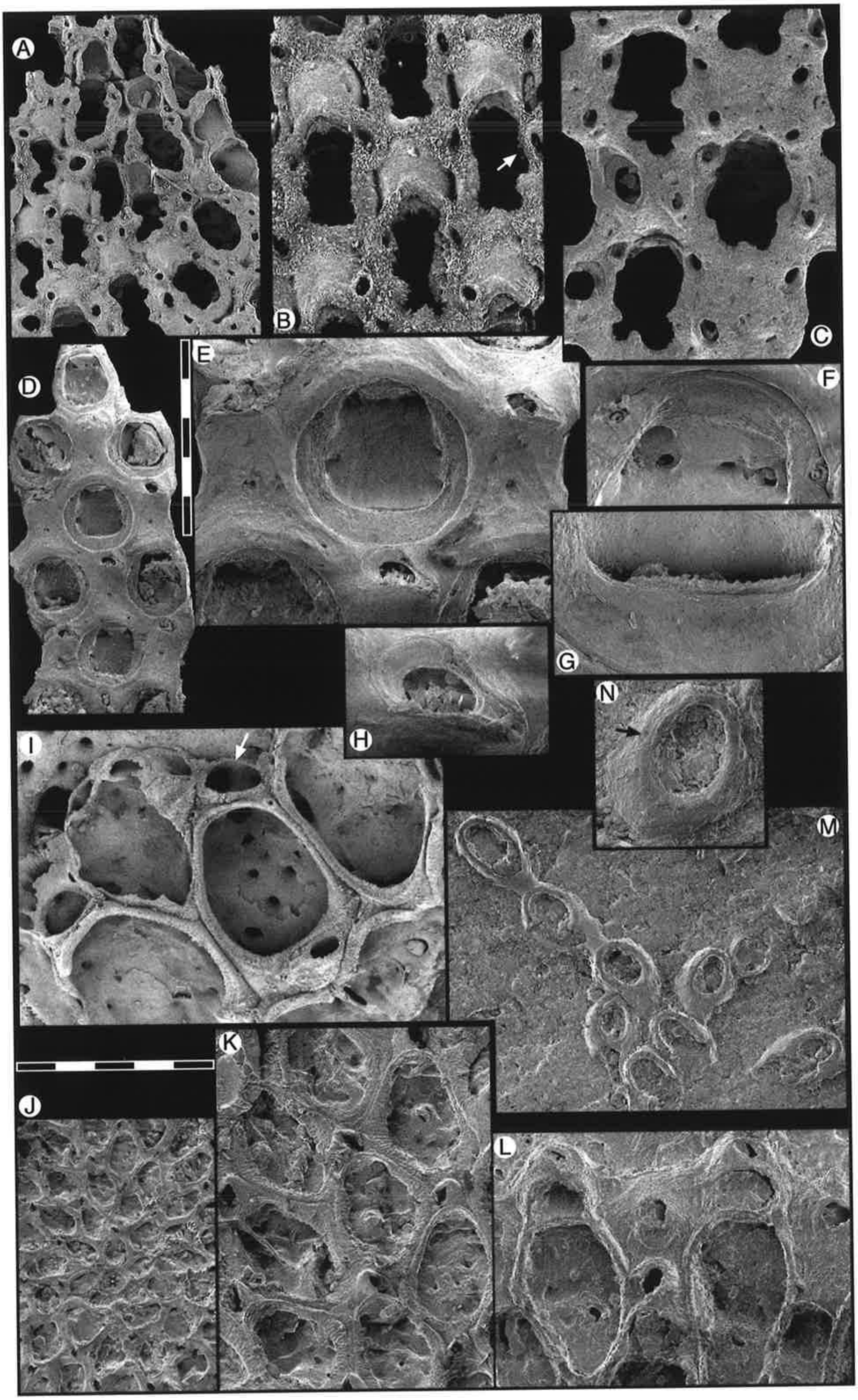

Plate 5

A: ***Crassimarginatella* sp. nov. a**, zooids encrusting on interior of echinoid shell [0.10] (SAM P39341)

B: ***Crassimarginatella* sp. nov. a**, ovicelled zooids [0.10] (SAM P39343)

C: ***Crassimarginatella* sp. nov. a**, zooids encrusting on *Syphonicytara* [0.10] (SAM P39342)

D: ***Crassimarginatella sculpta***, fragment of colony [0.25] (SAM P39344)

E: ***Crassimarginatella sculpta***, ovicelled zooid and vicarious avicularium [0.10] (SAM P39344)

F: ***Crassimarginatella* sp. nov. b**, colony encrusting on shell, including three ovicelled zooids (arrow indicates proximal angular projection on ovicell) [0.10] (SAM P39346)

G: ***Amphiblestrum* sp.**, zooids [0.10] (SAM P39347)

H: ***Copidozoum* sp. nov. a**, autozooids and interzooidal avicularia [0.10] (SAM P39348)

I: ***Copidozoum* sp. nov. a**, ovicelled zooids [0.10] (SAM P39348)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

Plate 5

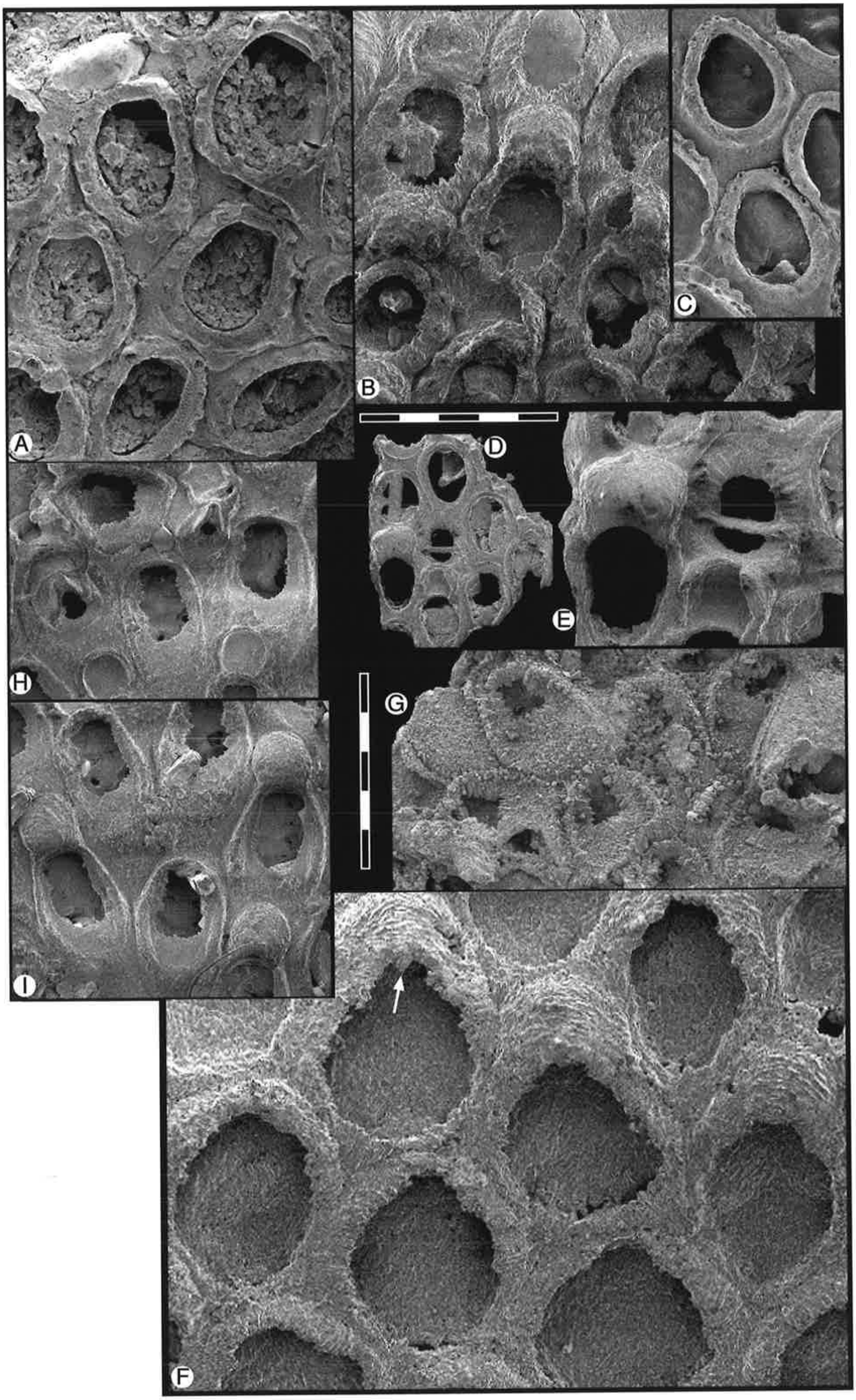

Plate 6

A: '*Lunulites*' sp. nov. a, basal surface of colony (composite SEM) [0.50]
(SAM P39319)

B: '*Lunulites*' sp. nov. a, frontal surface of colony (composite SEM) [0.50]
(SAM P39319)

C: '*Lunulites*' sp. nov. a, autozooids and interzooidal avicularia (opesial spine bases arrowed) [0.10]
(SAM P39319)

D: '*Lunulites*' sp. nov. a, autozooids and interzooidal avicularia (adventitious avicularium arrowed) [0.10]
(SAM P39319)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

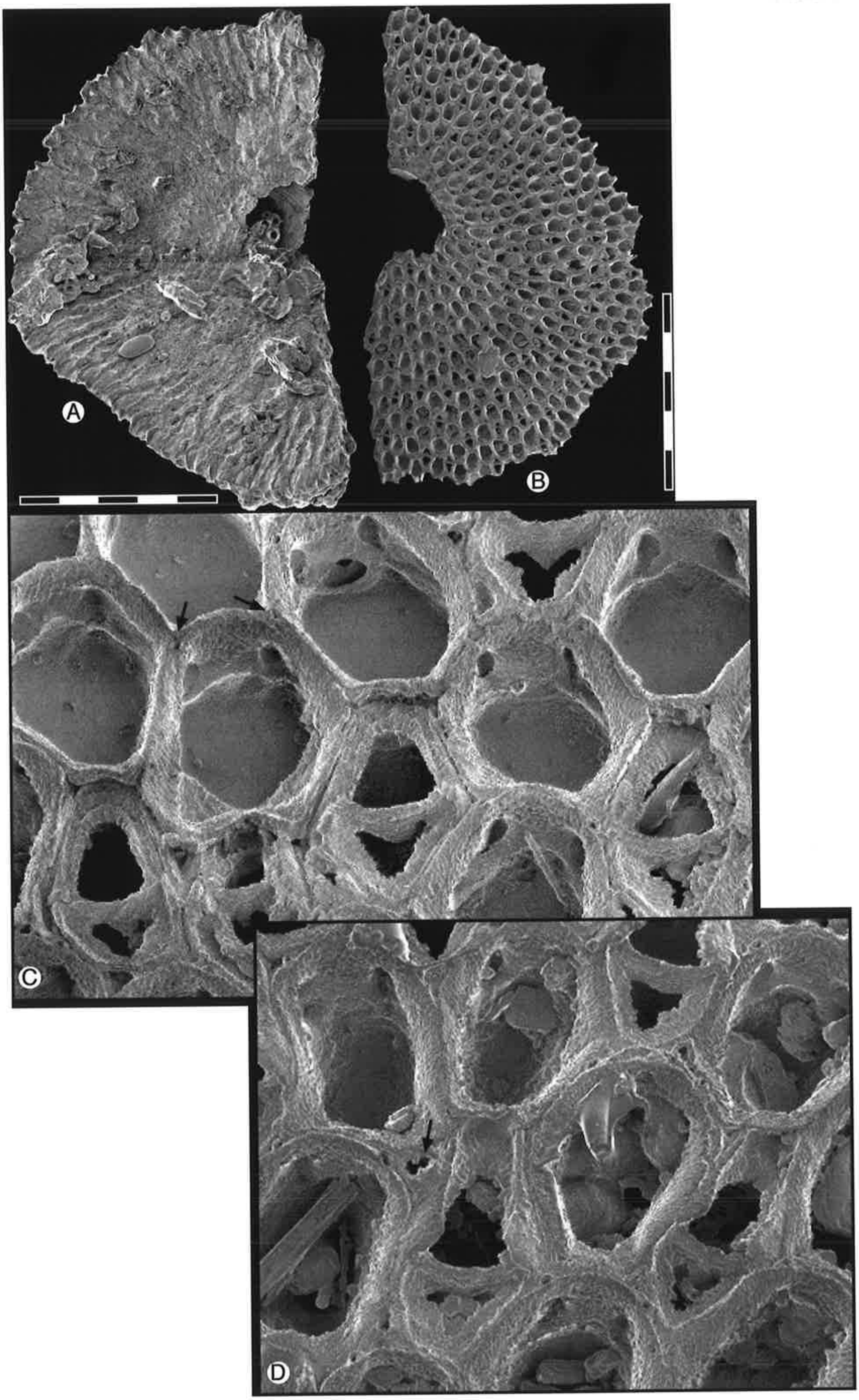
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Plate 7

A: **'*Lunulites*' sp. nov. b**, colony [0.50]
(SAM P39320)

B: **'*Lunulites*' sp. nov. b**, zooids at colony edge, note incomplete distal adventitious avicularia and spine bases [0.25]
(SAM P39320)

C: **'*Lunulites*' sp. nov. b**, zooids at colony edge [0.25]
(SAM P39320)

D: **'*Lunulites*' sp. nov. b**, ancestrular region (*= probable ancestrula; otherwise it may be the zooid to the right) [0.25]
(SAM P39320)

E: **'*Lunulites*' sp. nov. b**, Zooids and interzooidal avicularium [0.10]
(SAM P39320)

F: ***Chaperiopsis* cf. *columnella***, colony fragment (* = ancestrula) [0.25]
(SAM P39353)

G: ***Chaperiopsis* cf. *columnella***, autozooids [0.10]
(SAM P39354)

H: ***Chaperiopsis* cf. ?*columnella***, ovicelled zooids[0.10]
(SAM P39355)

I: ***Chaperiopsis* cf. *columnella***, autozooid [0.10]
(SAM P39353)

J: ***Chaperiopsis* sp. nov. b**, [0.10]
(SAM P39356)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

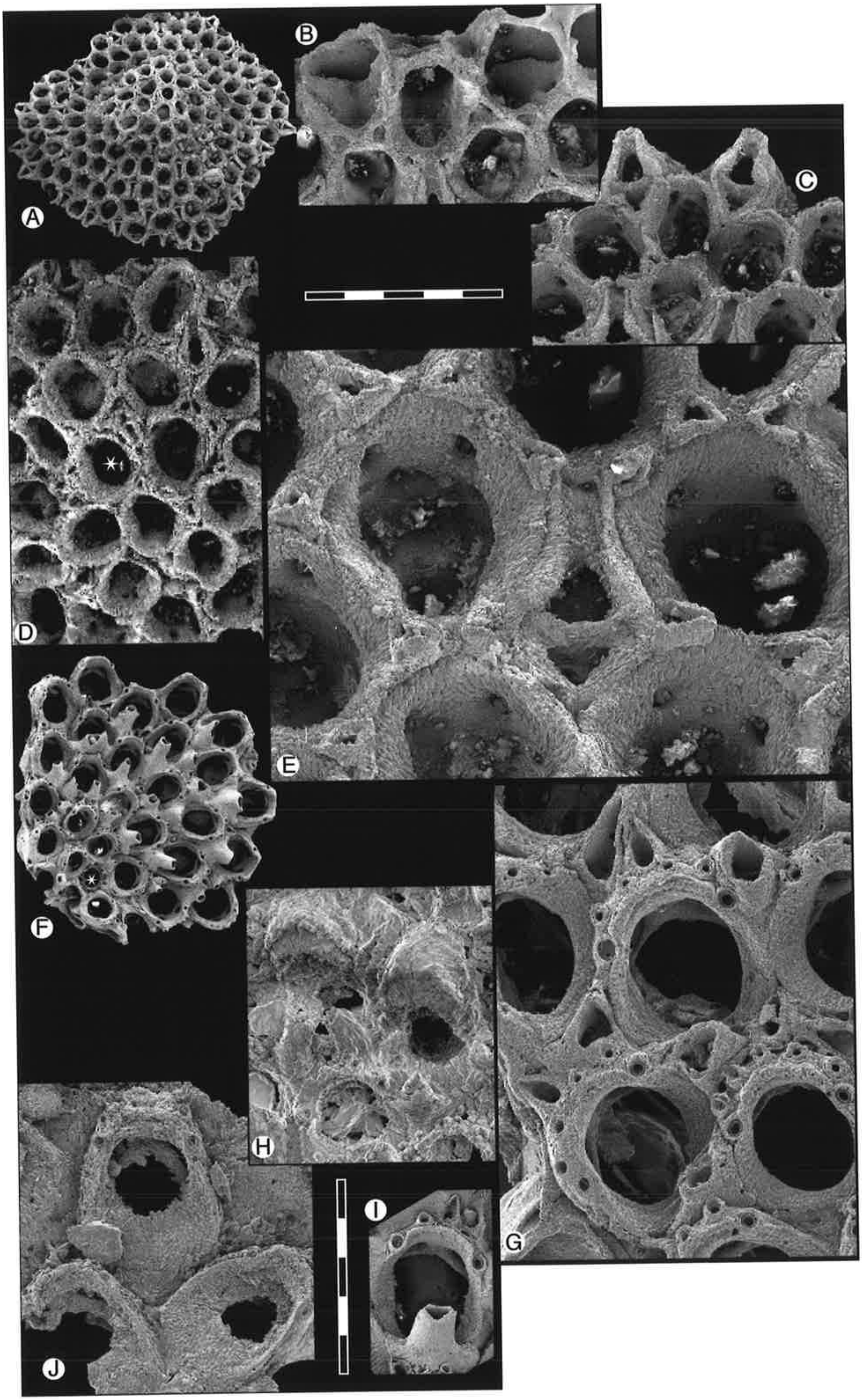
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Plate 8

A: ***Pseudothyracella?* sp. nov. a**, branch segment [0.10]
(SAM P39358)
B: ***Pseudothyracella?* sp. nov. a**, view of serrated proximal opesial margin [0.05]
(SAM P39358)
C: ***Pseudothyracella?* sp. nov. a**, branch segment of a 'bifoliate' colony, with ?bipolar growth possibly due to breakage (possible interzooidal arrowed) [0.25]
(SAM P39359)
D: **Bryopastoridae gen. indet. A sp. nov. a**, branch fragment with autozooids [0.10]
(SAM P39360)
F: **Bryopastoridae gen. indet. B sp. nov. a**, colony with three large dimorphic fertile zooids; left margin is the colony edge [0.25]
(SAM P39361)
G: **Bryopastoridae gen. indet. B sp. nov. a** , cross-section through colony [0.10]
(SAM P39361)
E: **Bryopastoridae gen. indet. B sp. nov. a** , autozooids [0.10]
(SAM P39361)
H: ***Nellia* sp. nov. a**, branch fragment with autozooids [0.25]
(SAM P39362)
I: ***Nellia* sp. nov. a**, zooid [0.10]
(SAM P39362)
J: ***Quadricellaria* sp. nov. a**, branch fragment [0.25]
(SAM P39363)
K: ***Quadricellaria* sp. nov. a**, zooids (opesial denticle arrowed) [0.10]
(SAM P39363)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

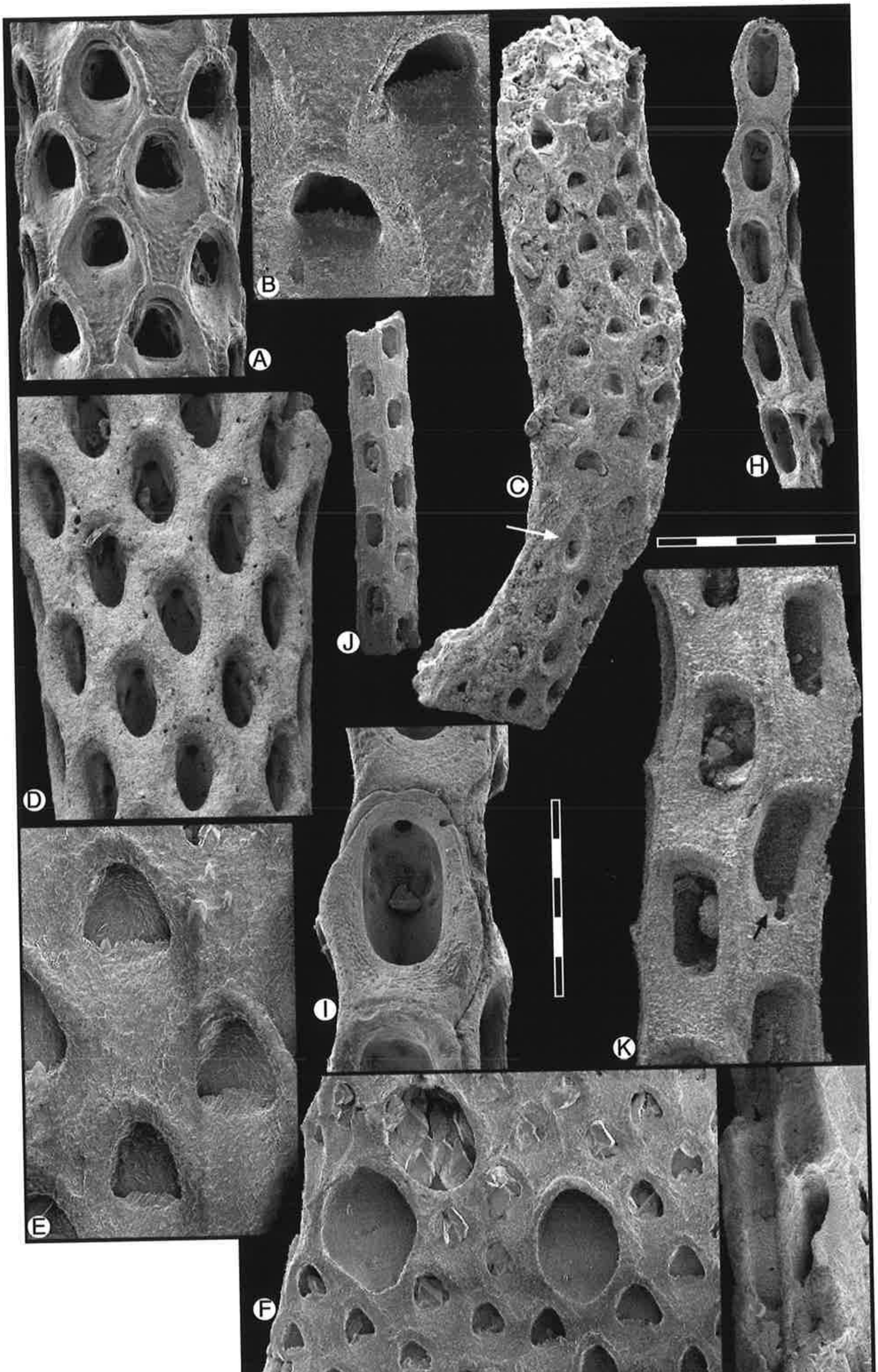
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Plate 9

A: ***Hiantopora* cf. *quadricornis***, autozooids and ovicelled zooid [0.10]
(SAM P39365)

B: ***Hiantopora* cf. *quadricornis***, colony encrusting internal surface of echinoid fragment and overgrowing other bryozoans (*Ellisina* at top, *Smittoidea* sp. nov. at right, ?*Disporella* at bottom of picture) [0.10]
(SAM P39365)

C: ***Caberea* sp. nov. a**, branch segment frontal surface [0.10]
(SAM P39366)

D: ***Caberea* sp. nov. a**, branch segment basal surface [0.10]
(SAM P39366)

E: ***Caberea* sp. nov. b**, branch segment frontal surface [0.25]
(SAM P39367)

F: ***Caberea* sp. nov. b**, branch segment basal surface [0.25]
(SAM P39367)

G: ***Caberea* sp. nov. b**, ovicelled zooid [0.10]
(SAM P39367)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

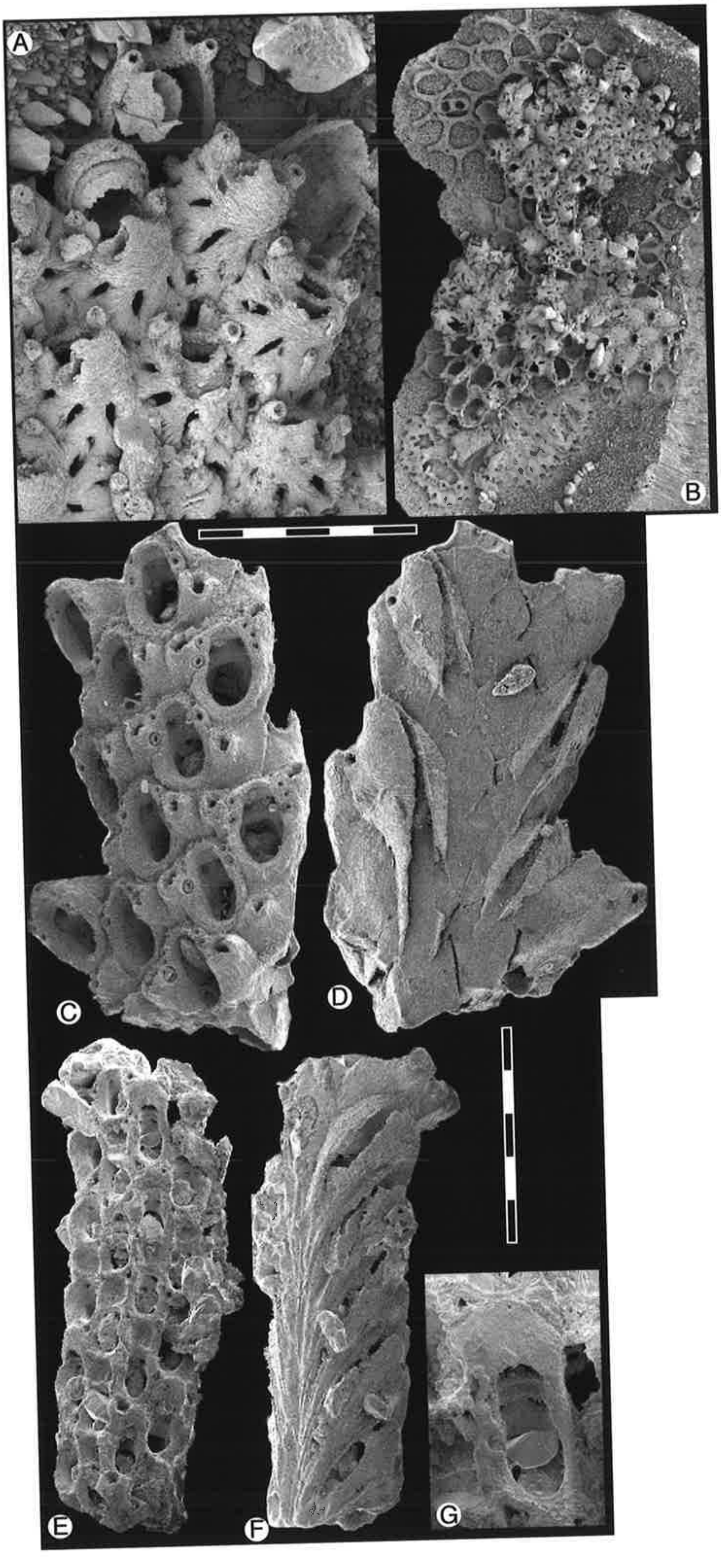

Plate 10

A: ***Scrupocellaria* sp. nov. a**, branch segment frontal surface [0.25] (SAM P39368)

B: ***Scrupocellaria* sp. nov. a**, branch segment basal surface [0.10] (SAM P39368)

C: ***Scrupocellaria* sp. nov. a**, zooids [0.10] (SAM P39368)

D: ***Micropora* cf. *elegans***, ovicelled zooids [0.10] (SAM P39369)

E: ***Micropora* cf. *elegans***, autozooids [0.10] (SAM P39369)

F: ***Larvapora* sp. nov. a**, colony fragment [0.10] (SAM P39370)

G: ***Larvapora* sp. nov. a**, autozooids, ovicelled zooids, kenozooid, interzooidal avicularium [0.25] (SAM P39370)

H: ***Larvapora* sp. nov. a**, view into autozooidal orifice showing condyles [0.10] (SAM P39371)

I: ***Larvapora* sp. nov. a**, zooids at branch bifurcation [0.50] (SAM P39372)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

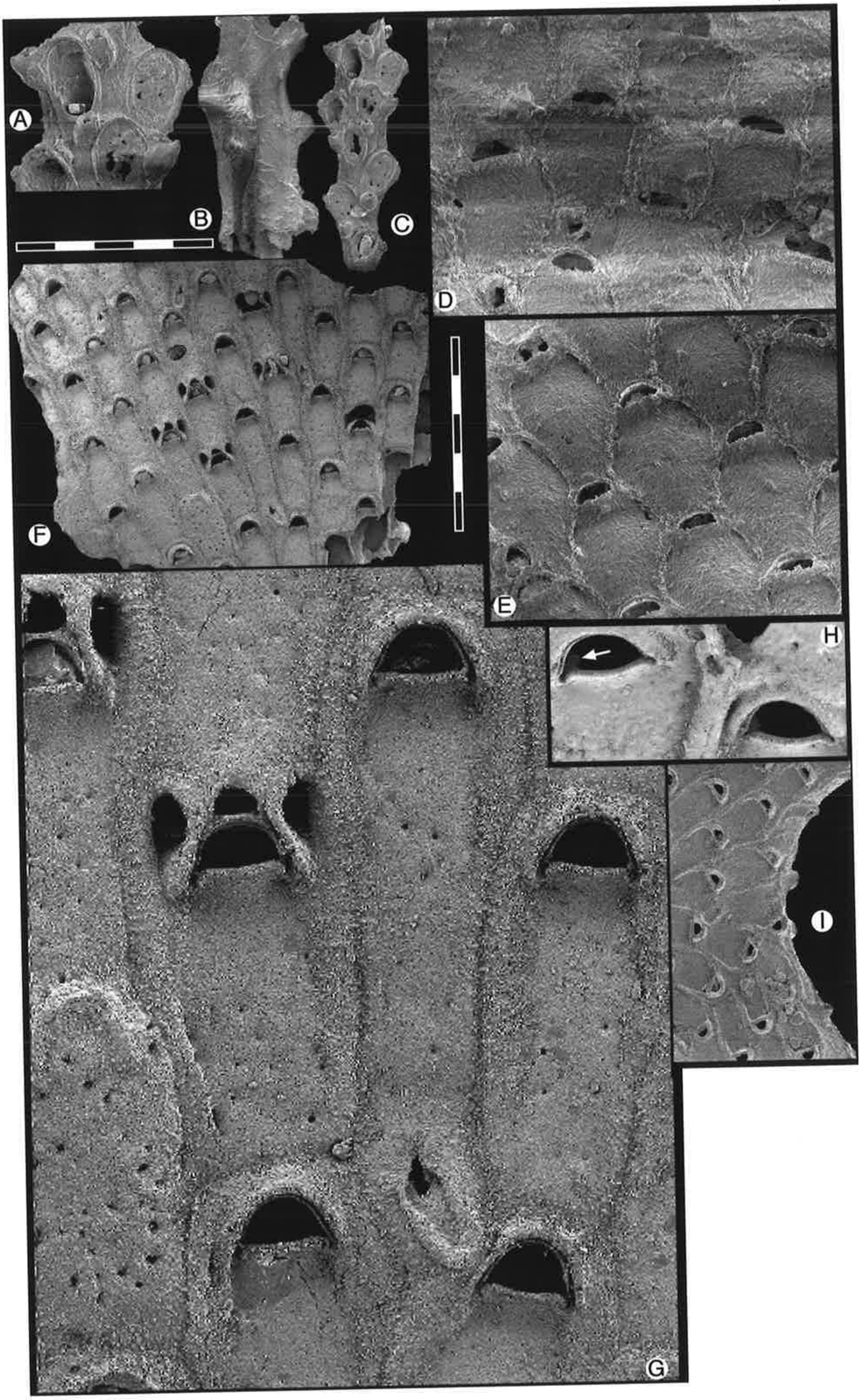
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Plate 11

A: ***Tretosina?* sp. nov. a**, autozooids [0.10]
(SAM P39374)

B: ***Tretosina?* sp. nov. a**, colony fragment [0.25]
(SAM P39374)

C: ***Crateropora* sp.** [0.10]
(SAM P39377)

D: ***Ogiva* sp. nov. a**, colony fragment, possible interzooidal avicularium arrowed (right side of colony broken) [0.25]
(SAM P39378)

E: ***Ogiva* sp. nov. a**, view of distal zooidal wall [0.10]
(SAM P39378)

F: ***Ogiva* sp. nov. a**, autozooids and interzooidal avicularium (at right) [0.10]
(SAM P39379)

G: ***Ogivalia* sp. nov. a**, bifurcating branch segment (possible interzooidal avicularium arrowed) [0.25]
(SAM P39380)

H: ***Ogivalia* sp. nov. a**, branch segment [0.25]
(SAM P39382)

I: ***Ogivalia* sp. nov. a**, autozooid [0.05]
(SAM P39381)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

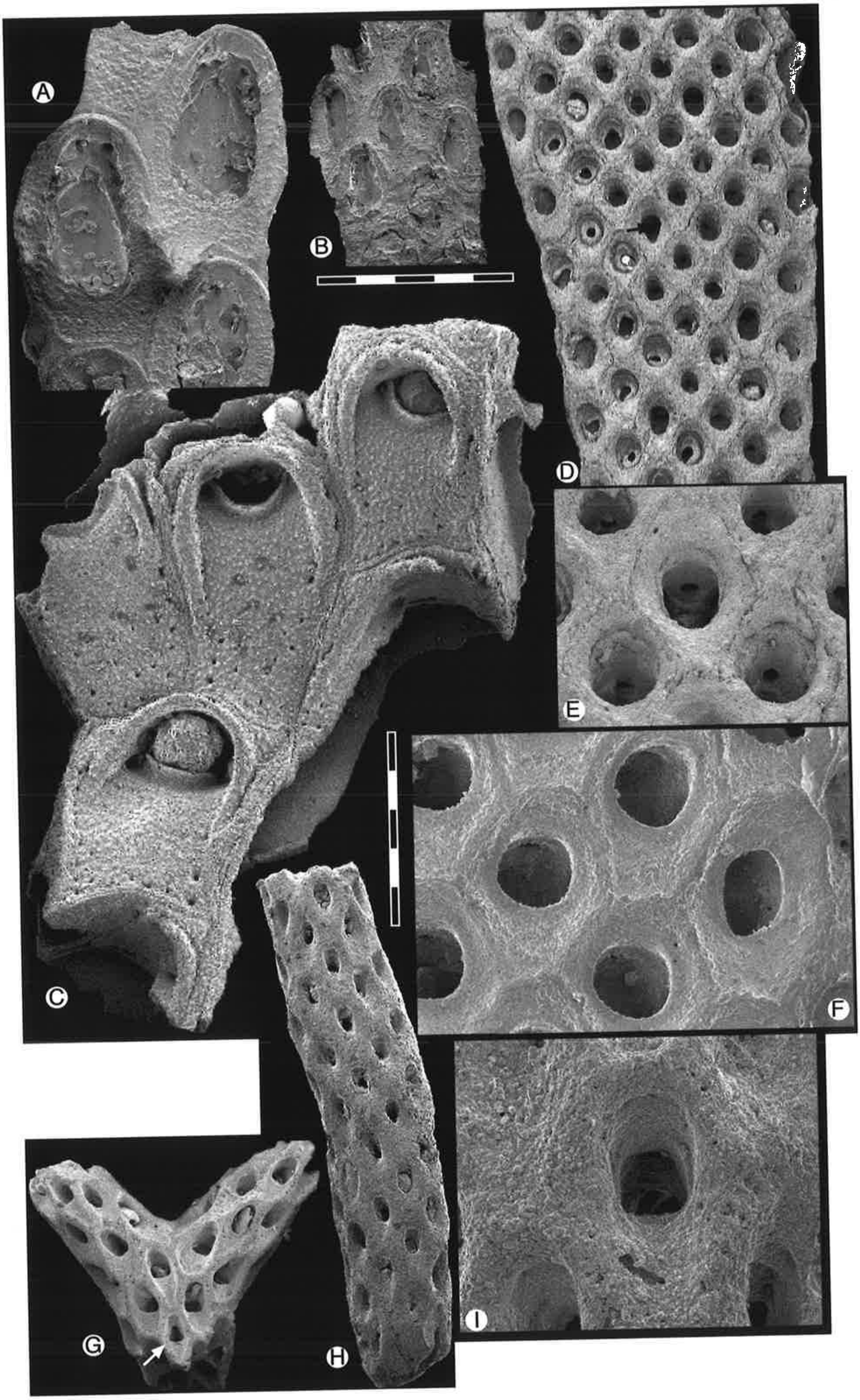
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Plate 12

A: ***'Onychocella'* sp. nov. b**, autozooids [0.10]
(SAM P39305)
B: ***'Onychocella'* sp. nov. b**, autozooids lateral view [0.25]
(SAM P39306)
C: ***'Onychocella'* sp. nov. b**, basal portion of frontally budded sheet [1.00]
(SAM P39306)
D: ***'Onychocella'* sp. nov. b**, avicularium with torqued zooids [0.25]
(SAM P39305)
E: ***'Onychocella'* sp. nov. b**, ovicelled zooids, one with unbroken frontal wall (arrow) [0.25]
(SAM P39306)
F: ***'Onychocella'* sp. nov. b**, internal view of ovicelled zooids [0.25]
(SAM P39304)
G: ***'Onychocella'* sp. nov. a**, autozooids [0.10]
(SAM P39307)
H: ***'Onychocella'* sp. nov. a**, autozooids lateral view [0.25]
(SAM P39307)
I: ***'Onychocella'* sp. nov. a**, avicularium [0.10]
(SAM P39308)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

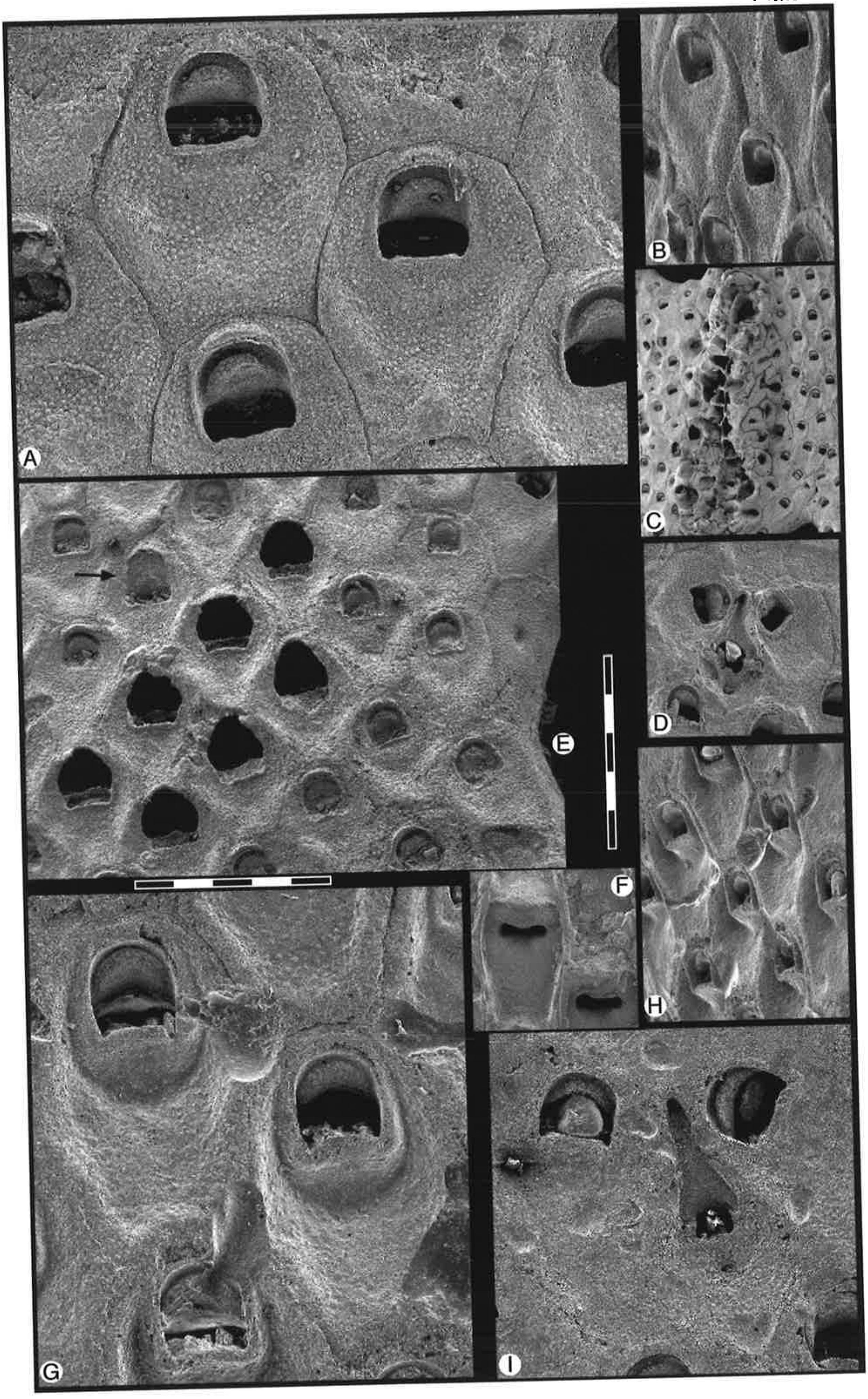
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Plate 13

A: **'*Onychocella*' sp. nov. c**, section of branch [0.25]
(SAM P39312)
B: **'*Onychocella*' sp. nov. c**, bifurcating section of branch [0.50]
(SAM P39313)
C: **'*Onychocella*' sp. nov. c**, autozooids near bifurcation point [0.10]
(SAM P39314)
D: **'*Onychocella*' sp. nov. c**, cross section of branch [0.25]
(SAM P39314)
E: **'*Onychocella*' sp. nov. b**, cribrate colony fragment [0.50]
(SAM P39305)
F: ***Macropora* sp. nov. a**, encrusting colony [0.50]
(SAM P39383)
G: ***Macropora* sp. nov. a**, oposite surface of same encrusting colony [0.50]
(SAM P39383)
H: ***Macropora* sp. nov. a**, autozooids [0.10]
(SAM P39383)
I: ***Macropora* sp. nov. a**, autozooid orifice with calcified operculum [0.10]
(SAM P39383)
J: ***Macropora* sp. nov. a**, aperture of vicarious avicularium [0.10]
(SAM P39383)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

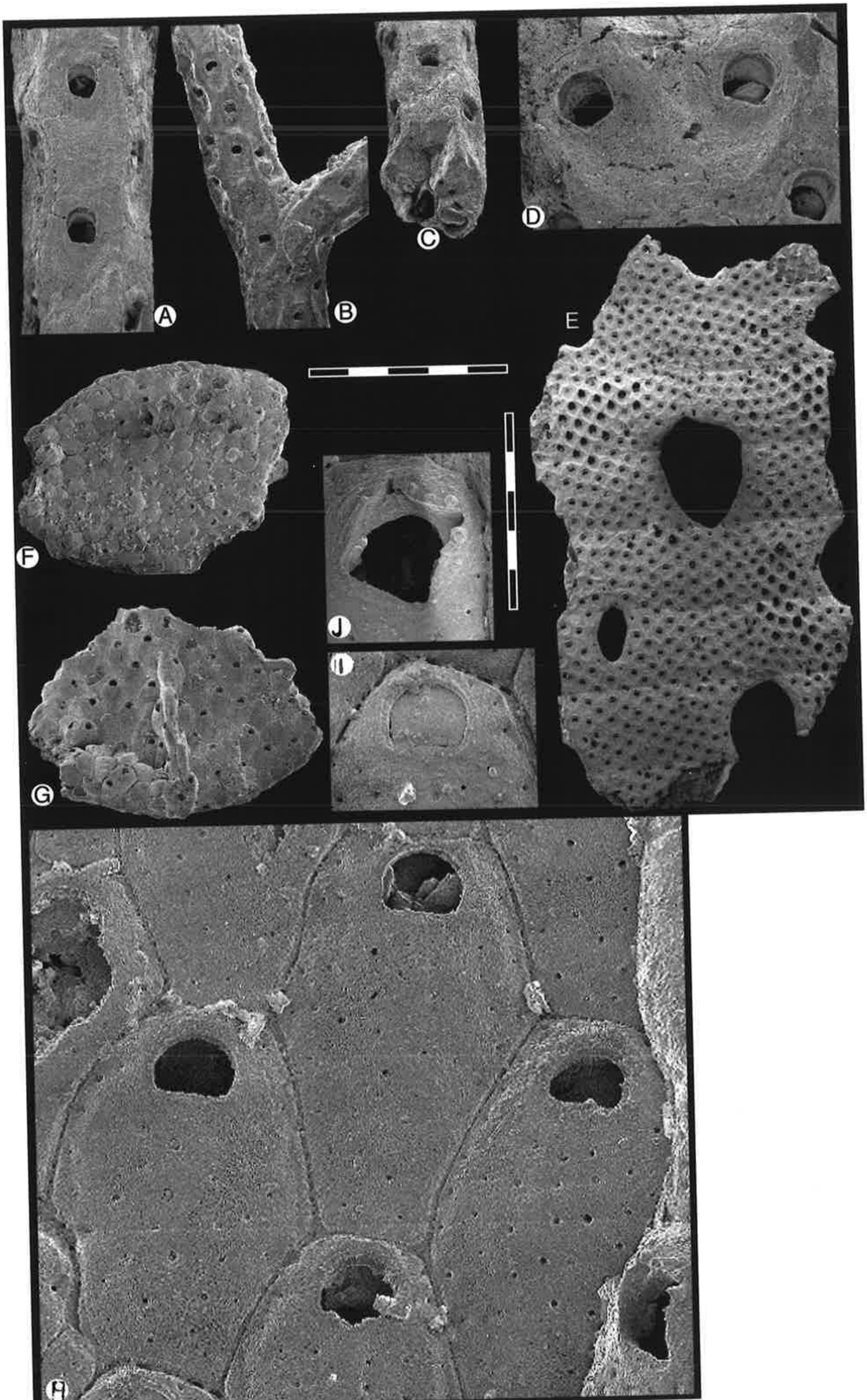
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Plate 14

A: ***Otionellina* cf. *exigua***, colony fragment including ancestrula at lower left (arrow) [0.10]
(SAM P39327)
B: ***Otionellina* cf. *exigua*** , ancestrular region [0.10]
(SAM P39330)
C: ***Otionellina* cf. *exigua*** , interzooidal avicularium [0.05]
(SAM P39328)
D: ***Otionellina* cf. *exigua*** , colony fragment [0.25]
(SAM P39328)
E: ***Otionellina* cf. *exigua*** , basal view of colony fragment [0.25]
(SAM P39329)
F: ***Otionellina* cf. *cupola*** , colony fragment [0.25]
(SAM P39323)
G: ***Otionellina* cf. *cupola*** , autizooids and interzooidal avicularia [0.10]
(SAM P39323)
H: ***Melicerita* cf. *angustiloba***, autozooids and interzooidal avicularium near colony edge [0.10]
(SAM P39389)
I: ***Melicerita* cf. *angustiloba***, one half of colony segment including avicularia [0.25]
(SAM P39389)
J: ***Melicerita* cf. *angustiloba***, one half of colony segment without avicularia [0.25]
(SAM P39390)
K: ***Melicerita* cf. *angustiloba***, cross-section view of colony [0.25]
(SAM P39389)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

Plate 14

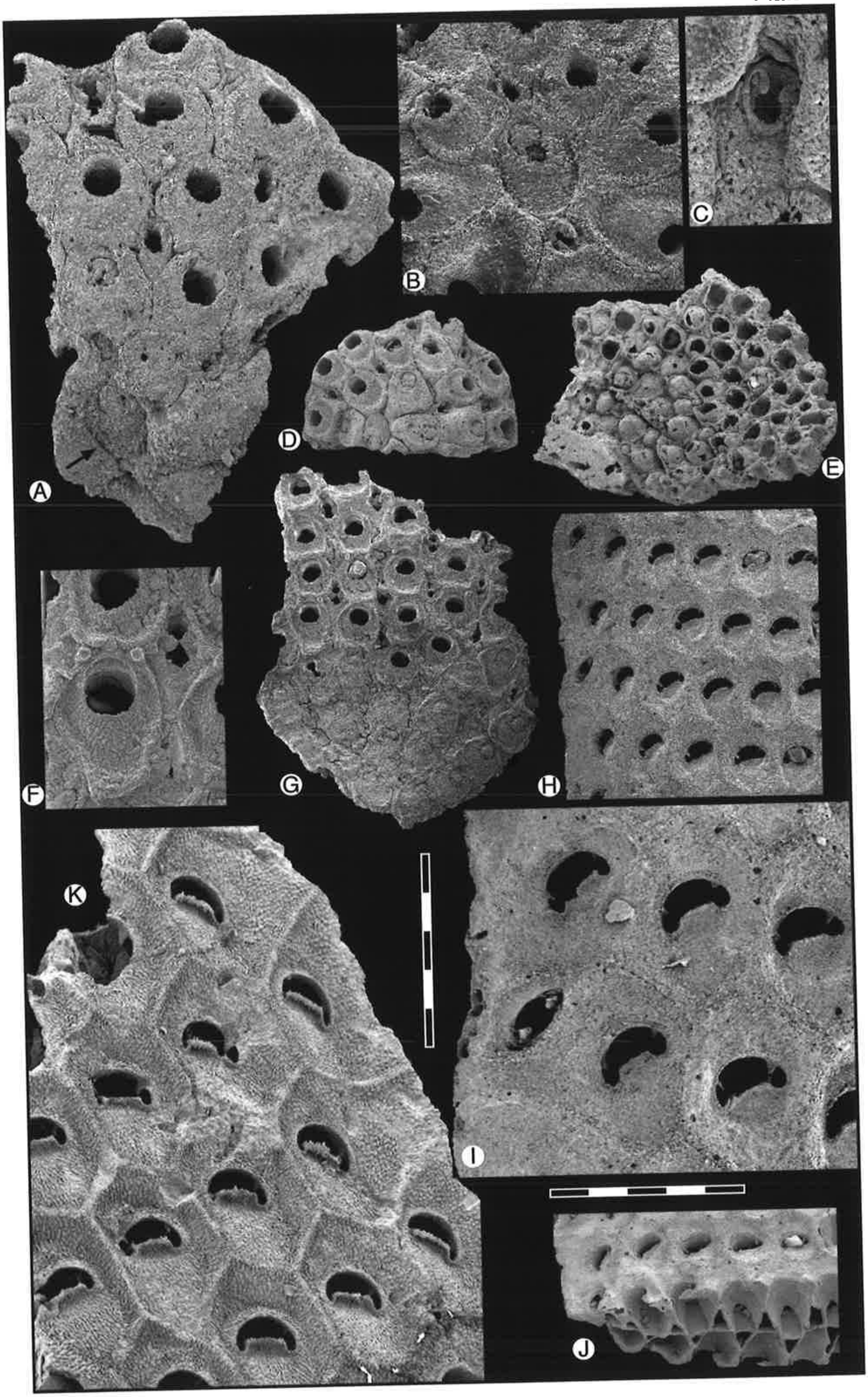

Plate 15

A: ***Cellaria* sp. nov. a**, branch segment [0.25] (SAM P39391)
B: ***Cellaria* sp. nov. a**, autozooids and ovicelled zooids [0.10] (SAM P39391)
C: ***Cellaria* sp. nov. a**, view of denticles on distal opesial margin [0.10] (SAM P39391)
D: ***Cellaria* sp. nov. b**, branch segment [0.10] (SAM P39392)
E: ***Cellaria* sp. nov. b**, branch segment with ovicelled zooids [0.10] (SAM P39393)
F: ***Cellaria* sp. nov. c**, branch segment [0.25] (SAM P39337)
G: ***Cellaria* sp. nov. c**, ovicelled zooids and interzooidal avicularium [0.10] (SAM P39337)
H: ***Cellaria* sp. nov. c**, cross section of branch [0.10] (SAM P39337)
I: ***Cellaria* sp. nov. c**, view into proximal margins of opesia and avicularium [0.10] (SAM P39337)
J: ***Cellaria* sp. nov. d**, branch segment [0.25] (SAM P39396)
K: ***Cellaria* sp. nov. d**, autozooids and interzooidal avicularia [0.10] (SAM P39396)
L: ***Cellaria* sp. nov. e**, branch segment [0.25] (SAM P39397)
M: ***Cellaria* sp. nov. e**, autozooid [0.10] (SAM P39397)
N: ***Cellaria* sp. nov. e**, autozooid [0.10] (SAM P39397)
O: ***Cellaria* sp. nov. f**, autozooids [0.10] (SAM P39398)
P: ***Cellaria* sp. nov. f**, branch segment [0.25] (SAM P39399)
Q: ***Cellaria* sp. nov. g**, branch segment [0.25] (SAM P39400)
R: ***Cellaria* sp. nov. g**, autozooids [0.10] (SAM P39400)
S: ***Cellaria* sp. nov. g**, view of proximal opesial margins [0.10] (SAM P39400)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

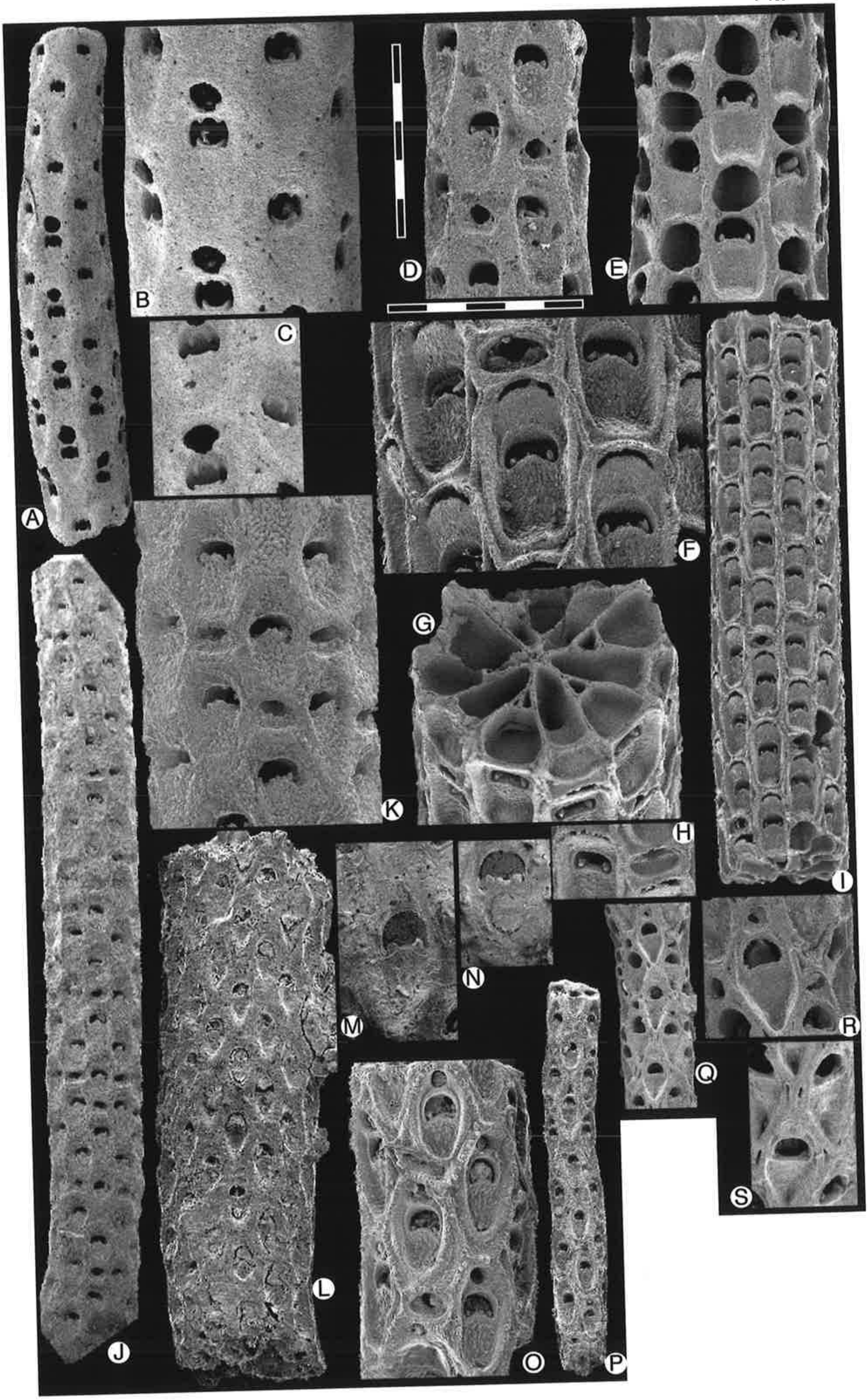
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Plate 16

A: ***Cellaria* sp. nov. h**, branch segment [0.25] (SAM P39401)
B: ***Cellaria* sp. nov. h**, autozooids [0.10] (SAM P39401)
C: ***Cellaria* sp. nov. i**, branch segment [0.25] (SAM P39338)
D: ***Cellaria* sp. nov. i**, autozooids [0.10] (SAM P39338)
E: ***Cellaria* sp. nov. j**, branch segment [0.25] (SAM P39403)
F: ***Cellaria* sp. nov. j**, autozooids [0.10] (SAM P39403)
G: ***Cellaria* sp. nov. j**, view into proximal margin of opesia showing small denticles [0.05] (SAM P39403)
H: ***Cellaria* sp. nov. k**, branch segment (polymorph arrowed) [0.25] (SAM P39404)
I: ***Cellaria* sp. nov. k**, autozooids [0.10] (SAM P39404)
J: ***Cellaria* sp. nov. k**, basal attachment structure [0.10] (SAM P39406)
K: ***Cellaria* sp. nov. k**, autozooids [0.10] (SAM P39406)
L: ***Cellaria* sp. nov. l**, branch segment [0.25] (SAM P39336)
M: ***Cellaria* sp. nov. l**, autozooids [0.10] (SAM P39336)
N: ***Cellaria* sp. nov. m**, autozooids [0.10] (SAM P39335)
O: ***Cellaria* sp. nov. m**, branch segment [0.25] (SAM P39335)
P: ***Cellaria* sp. nov. m**, branch segment [0.25] (SAM P39340)
Q: ***Cellaria* sp. nov. m**, autozooids [0.10] (SAM P39340)
R: ***Cellaria* sp, nov. n**, autozooids [0.10] (SAM P39410)
S: ***Cellaria* sp. nov. n**, bifurcating branch segment [0.25] (SAM P39410)
T: ***Cellaria* sp. nov. o**, branch segment [0.25] (SAM P39411)
U: ***Cellaria* sp. nov. o**, autozooids [0.10] (SAM P39411)
V: ***Cellaria* sp. nov. o**, ?ovicelled zooid [0.10] (SAM P39411)
W: ***Cellaria* sp. nov. p**, autozooids [0.10] (SAM P39412)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

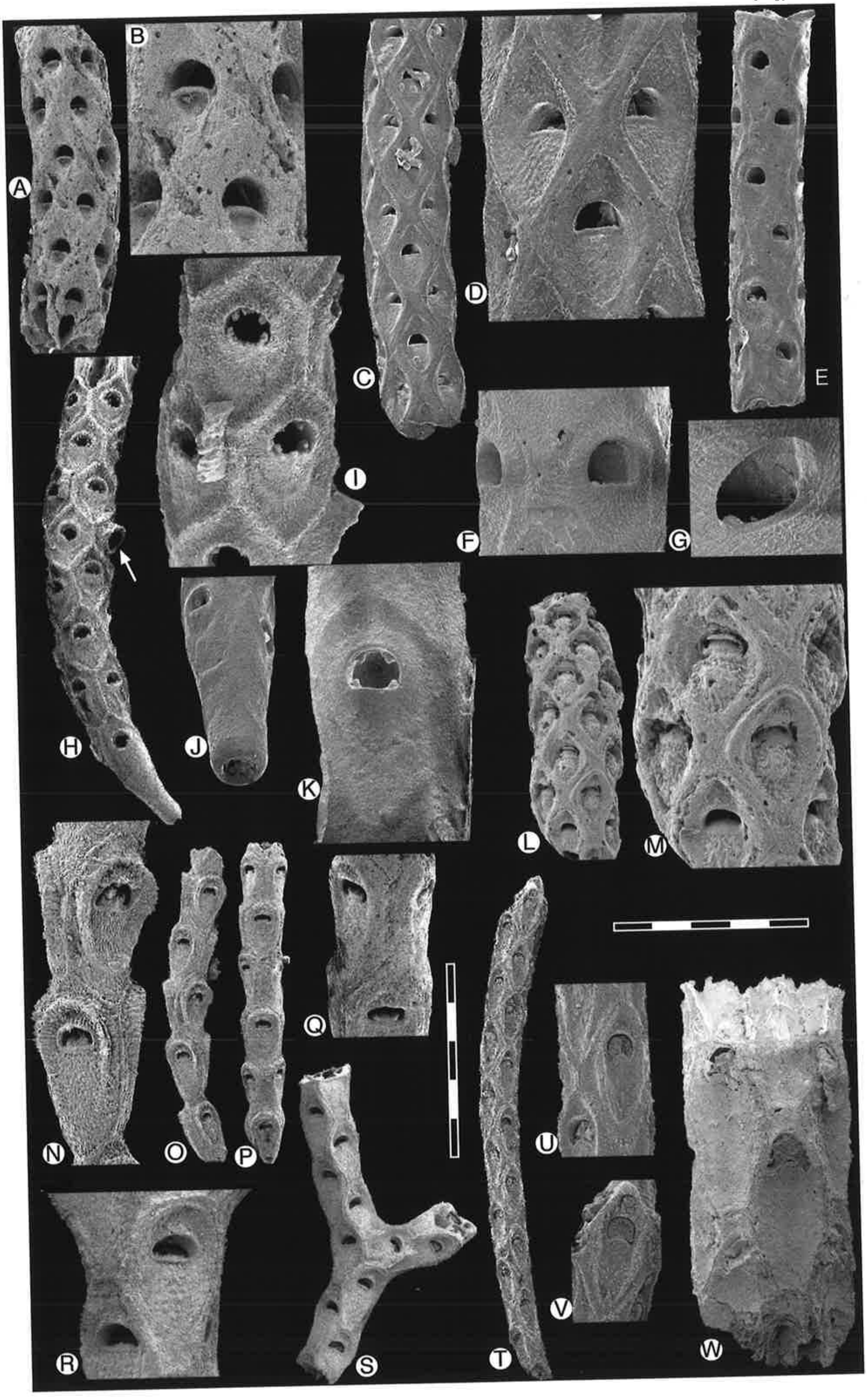
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Plate 17

A: ***Acerinucleus* sp. nov. a**, branch segment [0.25]
(SAM P39413)
B: ***Acerinucleus* sp. nov. a**, autozooids [0.10]
(SAM P39413)
C: ***Acerinucleus* sp. nov. a**, branch segment [0.25]
(SAM P39413)
D: ***Acerinucleus* sp. nov. a**, ovicelled zooids [0.10]
(SAM P39413)
E: ***Acerinucleus* sp. nov. a**, branch segment with regenerated opesia at bottom and and possible rootlet structure on proximal cryptocyst of central two zooids [0.25]
(SAM P39414)
F: ***Acerinucleus* sp. nov. a**, autozooids [0.10]
(SAM P39415)
H: ***Acerinucleus* sp. nov. b**, branch segment [0.25]
(SAM P39416)
G: ***Acerinucleus* sp. nov. b**, ovicelled zooids [0.10]
(SAM P39416)
I: **Cribrilinidae *Gen. indet.* sp. nov. a**, colony fragment [0.25]
(SAM P39420)
J: **Cribrilinidae *Gen. indet.* sp. nov. a**, autozooid and adventitious avicularium [0.10]
(SAM P39420)
K: **Cribrilinidae *Gen. indet.* sp. nov. a**, autozooid without costae [0.10]
(SAM P39420)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

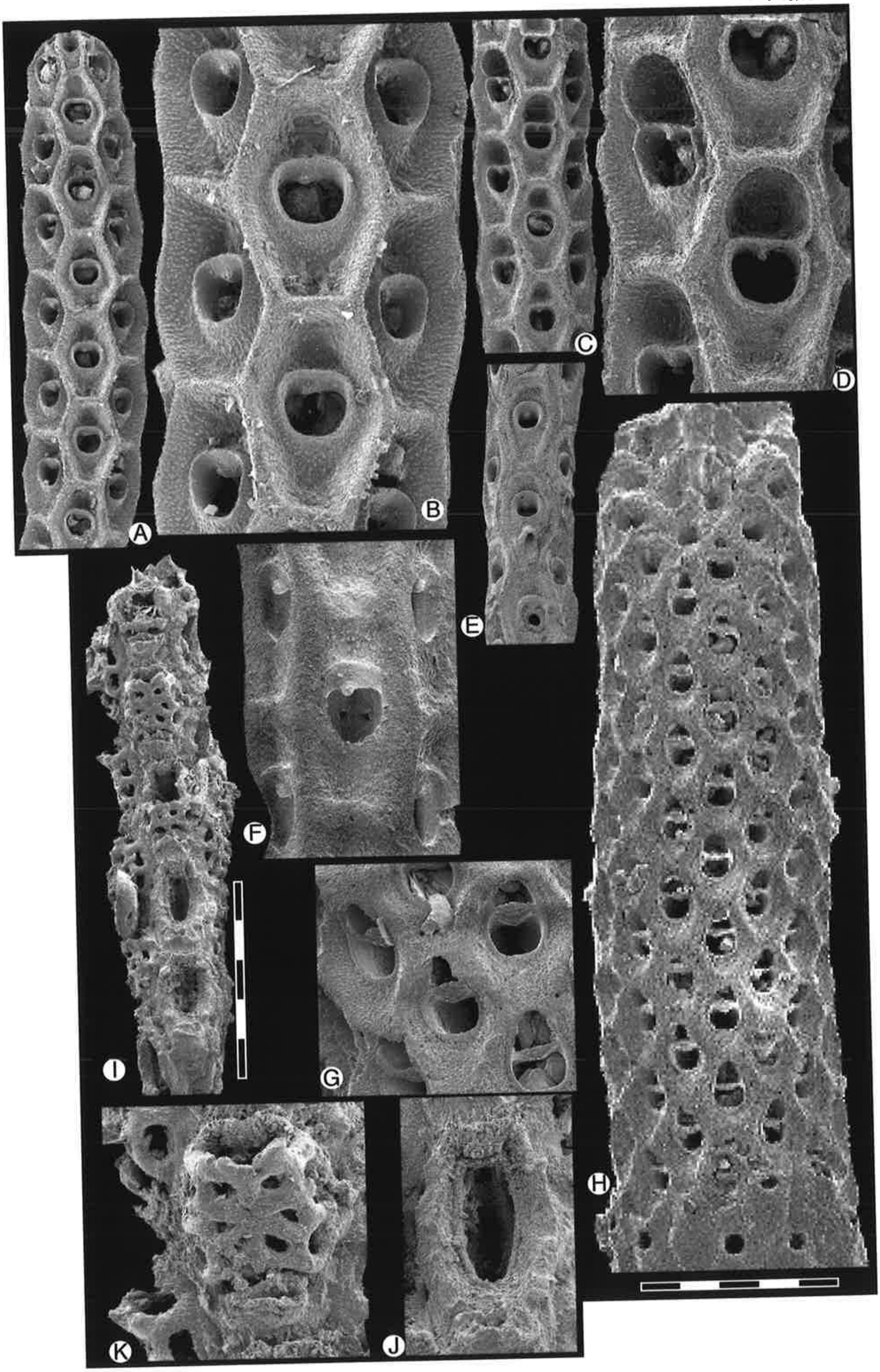
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Plate 18

A: ***Anaskopora* sp. nov. a**, bilaminar colony fragment [0.25] (SAM P39417)

B: ***Anaskopora* sp. nov. a**, autozooids [0.10] (SAM P39417)

C: ***Figularia rugosa***, colony fragment [0.25] (SAM P39421)

D: ***Figularia rugosa***, autozooid and ovicell [0.10] (SAM P39421)

E: ***Figularia rugosa***, autozooids, note small lumen pores [0.10] (SAM P39421)

F: ***Figularia rugosa***, colony encrusting [0.50] (SAM P39422)

G: ***Figularia rugosa***, autozooids [0.10] (SAM P39422)

H: ***Figularia rugosa***, ovicell, note paired ectooecial fenestrae [0.10] (SAM P39422)

I: ***Figularia rugosa***, view into ovicell opening [0.10] (SAM P39421)

J: ***Concatenella airensis***, autozooids [0.10] (SAM P39423)

K: ***Concatenella airensis***, close-up of costal area [0.05] (SAM P39423)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

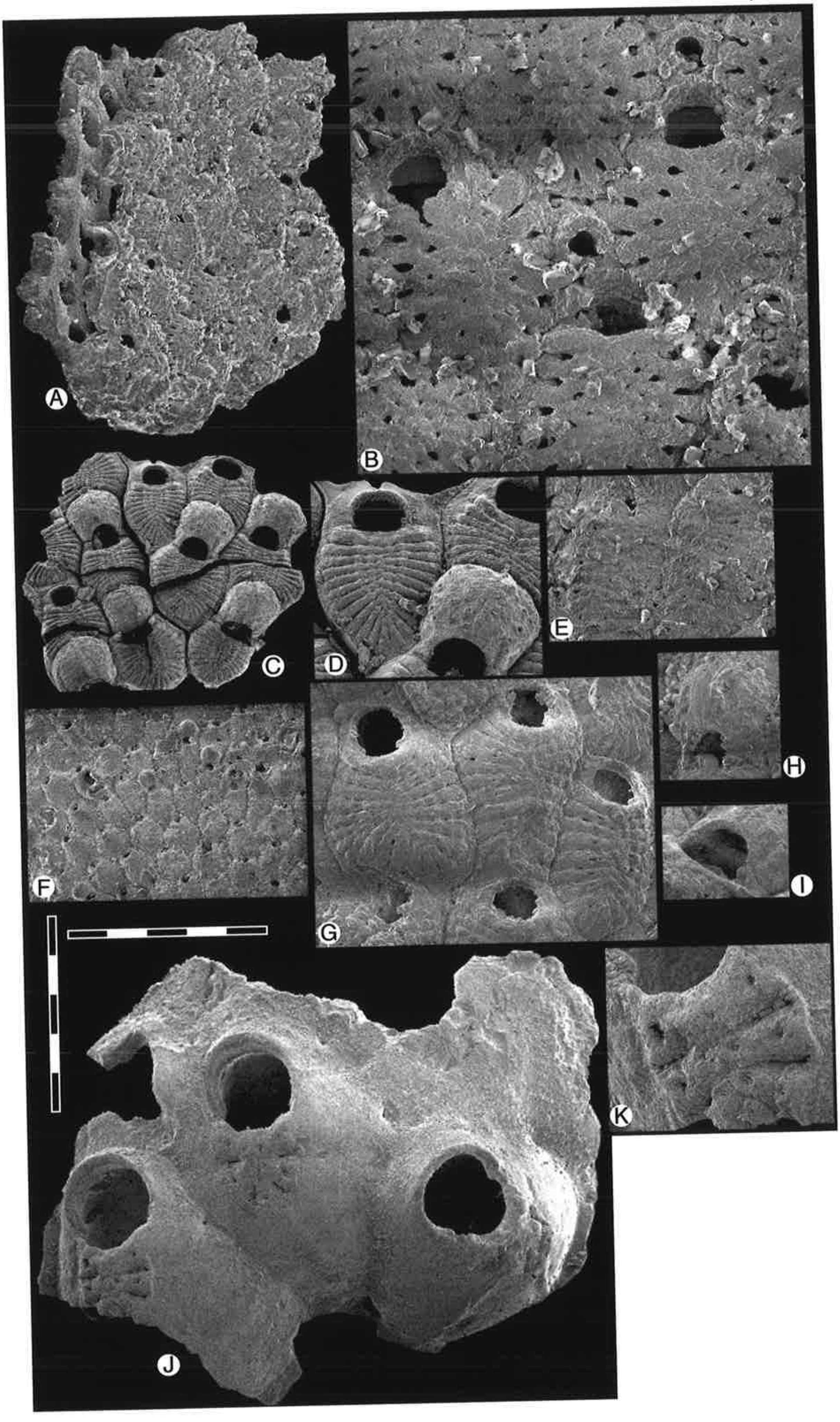
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Plate 19

A: ***Stenostomaria* sp. nov. a**, lateral view of same zoid as B [0.10] (SAM P39424)
B: ***Stenostomaria* sp. nov. a**, singlet [0.10] (SAM P39424)
C: ***Stenostomaria* sp. nov. a**, doublet [0.10] (SAM P39425)
D: ***Stenostomaria* sp. nov. a**, basal view [0.10] (SAM P39426)
E: ***Stenostomaria* sp. nov. a**, ovicelled doublet [0.10] (SAM P39427)
F: ***Strophipora* sp. nov. a**, doublet [0.10] (SAM P39429)
G: ***Strophipora* sp. nov. a**, close-up of suboral structure [0.10] (SAM P39429)
H: ***Catenicellidae Gen. indet.* sp. nov. a**, singlet [0.10] (SAM P39435)
I: ***Stenostomaria* sp. nov. b**, lateral view [0.10] (SAM P39435)
J: ***Catenicellidae Gen. indet.* sp. nov. a**, view into orifice showing condyles [0.10] (SAM P39435)
K: ***Caloporella* sp. nov. a**, singlet [0.10] (SAM P39438)
L: ***Caloporella* cf. *speciosa***, singlet [0.10] (SAM P39439)
M: ***Costaticella* sp. nov. b**, singlet with broken costal area [0.10] (SAM P39433)
N: ***Costaticella* sp. nov. a**, singlet [0.10] (SAM P39431)
O: ***Costaticella* sp. nov. a**, singlet [0.10] (SAM P39432)
P: ***Catenicellidae Gen. nov. A* sp. nov. a**, one zooid of broken doublet [0.10] (SAM P39437)
Q: ***Caloporella* cf. *speciosa***, doublet [0.10] (SAM P39434)
R: ***Caberoides?* sp. nov. a**, view into orifice and avicularia [0.10] (SAM P39440)
S: ***Caberoides?* sp. nov. a**, internode branch [0.10] (SAM P39440)
T: ***Caberoides?* sp. nov. a**, basal colony surface [0.10] (SAM P39440)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

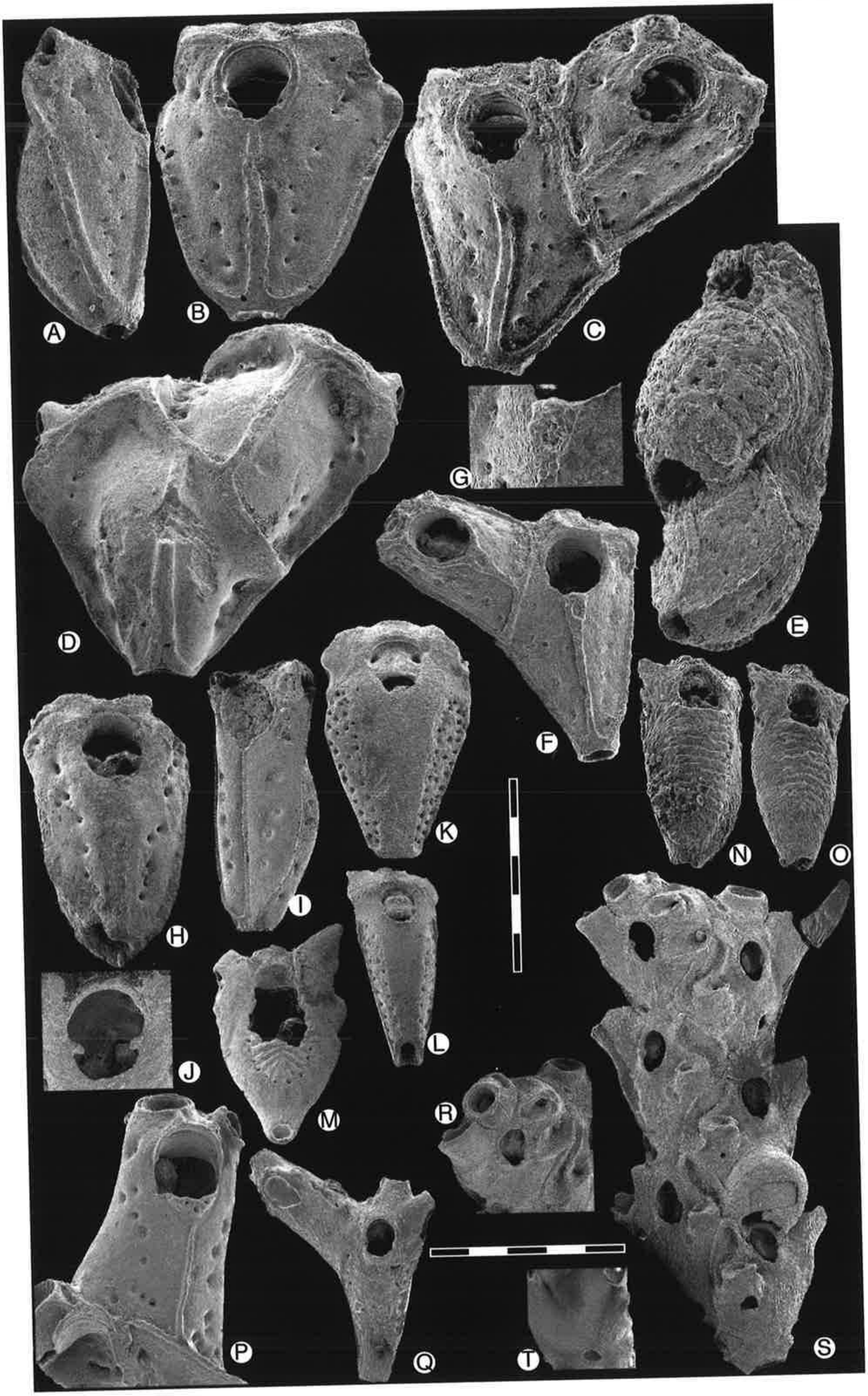
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Plate 20

A: ***Hippothoa* sp. nov.? a**, colony encrusting on shell [0.50] (SAM P39441)
B: ***Hippothoa* sp. nov.? a**, colony encrusting on shell [0.25] (SAM P39441)
C: ***Hippothoa* sp. nov.? a**, autozooid [0.10] (SAM P39441)
D: ***Hippothoa* sp. nov.? a**, ovicelled zooid [0.10] (SAM P39441)
E: ***Celleporella?* sp. nov. a**, colony encrusting on shell [0.50] (SAM P39442)
F: ***Celleporella?* sp. nov. a**, autozooids [0.10] (SAM P39442)
G: ***Arachnopusia* sp. nov. a**, ovicelled zooid [0.10] (SAM P39445)
H: ***Arachnopusia* sp. nov. a**, basal colony surface [0.25] (SAM P39445)
I: ***Arachnopusia* sp. nov. a**, autozooids [0.10] (SAM P39445)
J: ***Arachnopusia* sp. nov. a**, autozooids [0.10] (SAM P39445)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

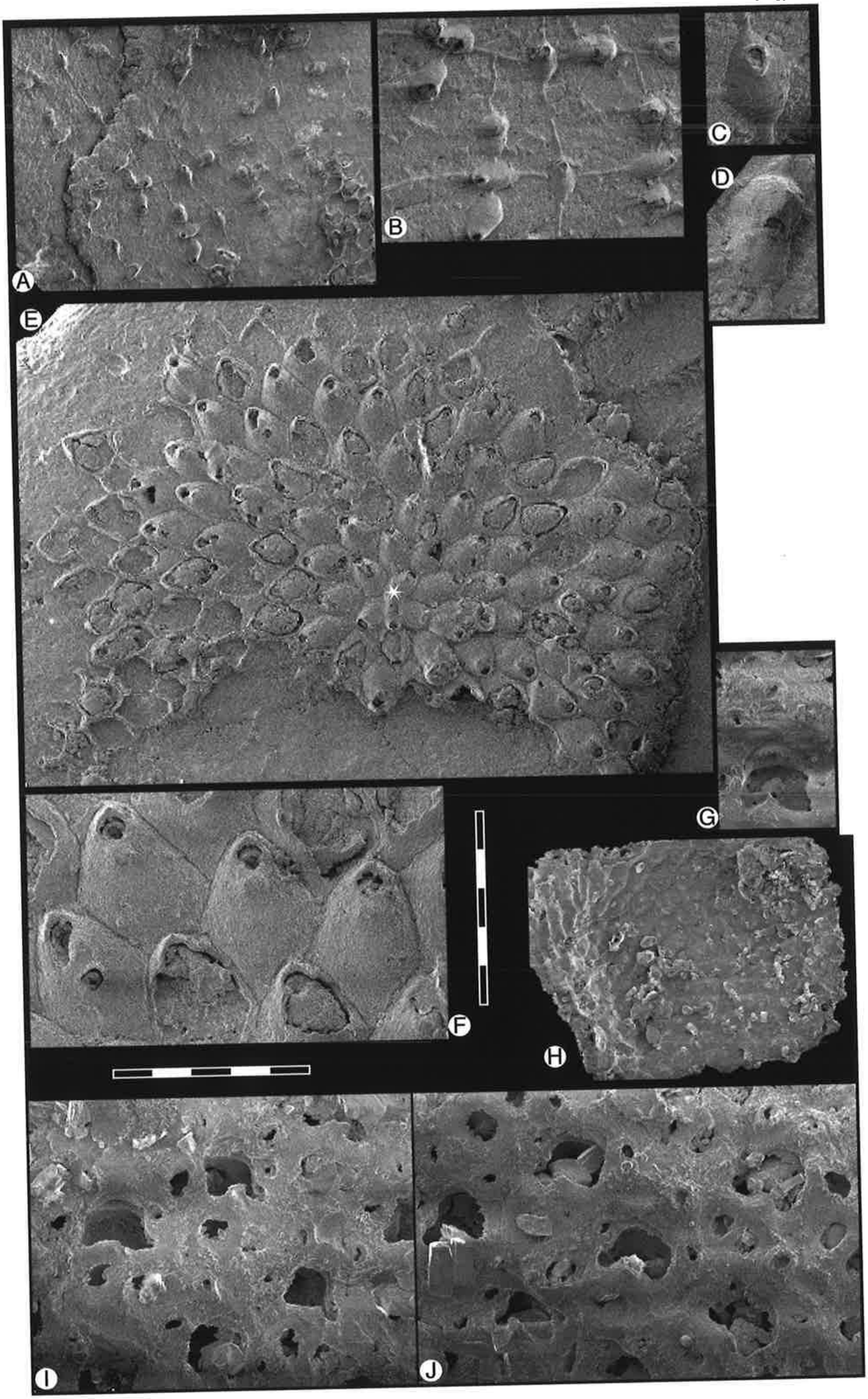
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Plate 21

A: ***Arachnopusia* sp. nov. b**, ovicelled zooids [0.10]
(SAM P39444)

B: ***Arachnopusia* sp. nov. b**, autozooids, arrow indicates orificial spine base [0.10]
(SAM P39444)

C: ***Arachnopusia* sp. nov. b**, autozooids showing proximal margin or orifice [0.10]
(SAM P39444)

D: ***Arachnopusia* sp. nov. b**, section of bilaminar colony showing basal surface [0.25]
(SAM P39444)

E: ***Arachnopusia* cf. *unicornis***, autozooids near colony margin [0.10]
(SAM P39447)

F: ***Arachnopusia* cf. *unicornis***, view into autozooid orifices [0.10]
(SAM P39447)

G: ***Arachnopusia* cf. *unicornis***, encrusting colony [0.50]
(SAM P39447)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

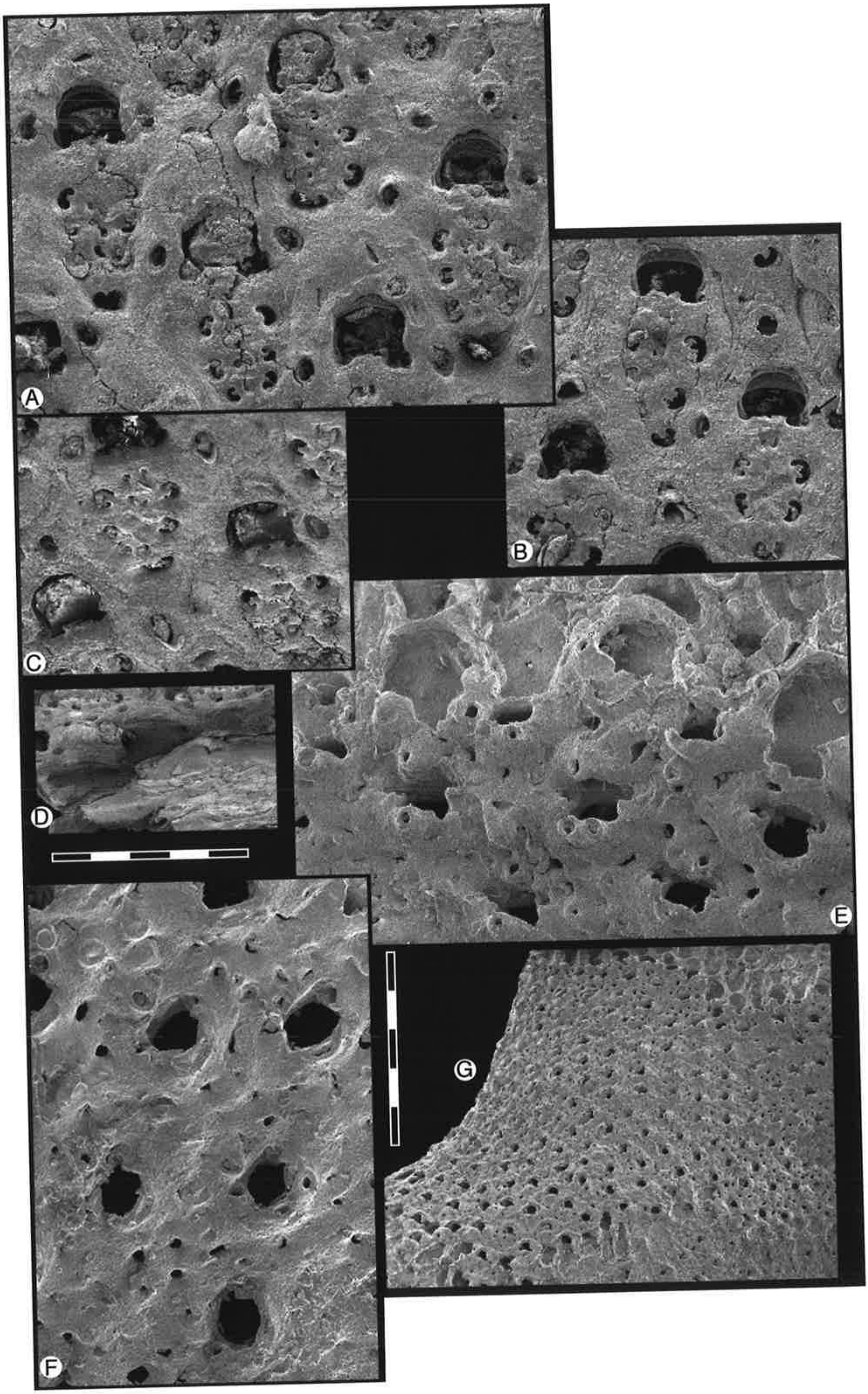
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Plate 22

A: ***Exechonella?* sp. nov. a**, colony bifurcation [0.50] (SAM P39448)

B: ***Exechonella?* sp. nov. a**, autozooids [0.10] (SAM P39448)

C: ***Exechonella?* sp. nov. a**, cross-section of colony branch [0.50] (SAM P39448)

D: ***Exechonella?* sp. nov. a**, autozooids [0.25] (SAM P39448)

E: ***Anarthropora* sp. nov. a**, autozooids [0.10] (SAM P39457)

F: ***Anarthropora* sp. nov. a**, colony fragment [0.25] (SAM P39458)

G: ***Anarthropora* sp. nov. a**, colony fragment [0.25] (SAM P39457)

H: ***Anarthropora* sp. nov. a**, lateral view of colony fragment [0.25] (SAM P39457)

I: ***Inversiula* cf. *airensis***, autozooids [0.10] (SAM P39460)

J: ***Inversiula* cf. *airensis***, colony fragment [0.25] (SAM P39460)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

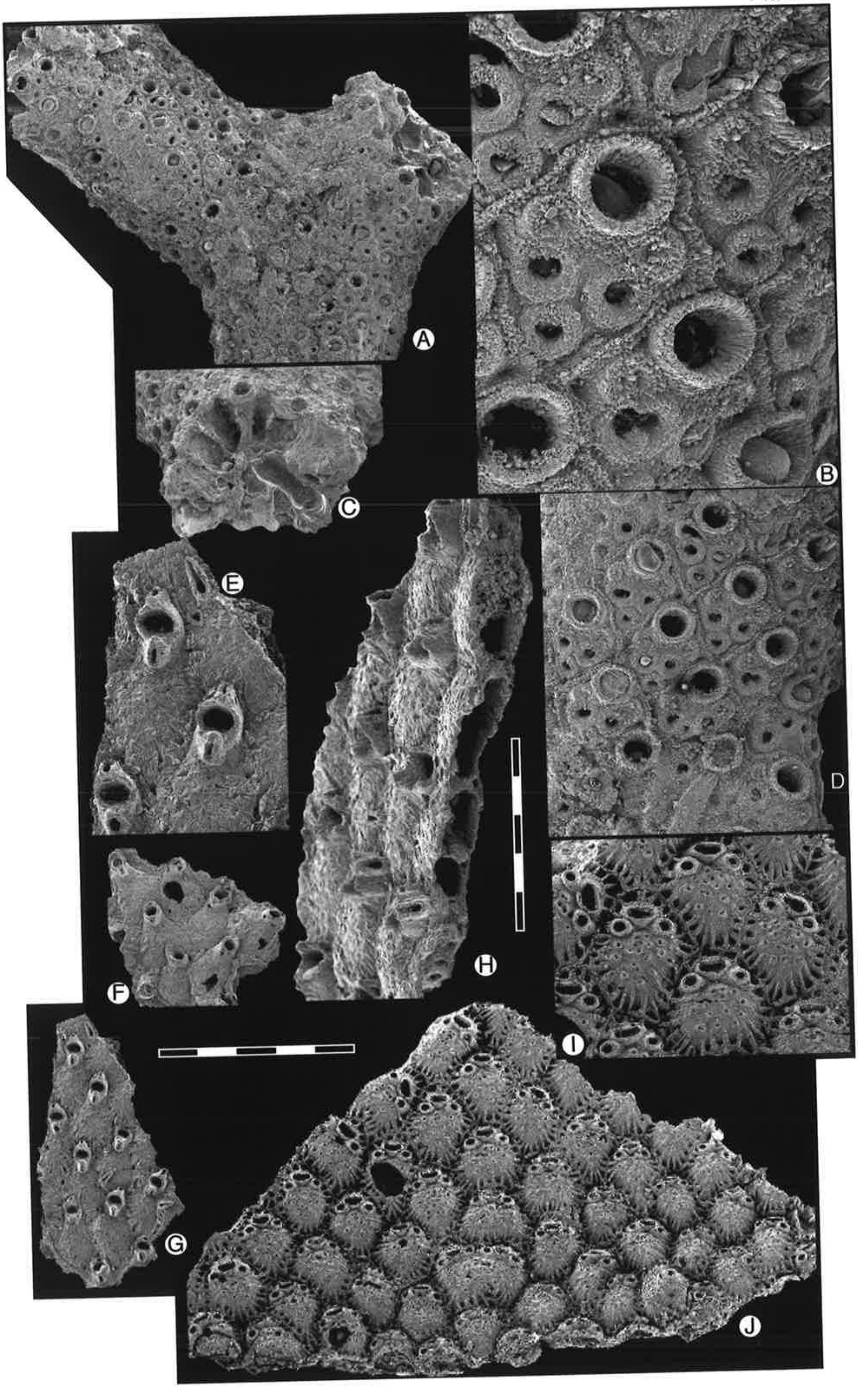
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Plate 23

A: ***Adeonellopsis* sp. nov. a**, section of bilaminar colony branch (lateral polymorph arrowed) [0.10] (SAM P39450)

B: ***Adeonellopsis* sp. nov. a**, section of bilaminar colony branch (lateral polymorph arrowed) [0.10] (SAM P39450)

C: ***Adeonellopsis* ?sp. nov. a**, section of bilaminar colony branch [0.10] (SAM P39451)

D: ***Adeonellopsis* sp.**, view of lateral walls with frontal walls removed, showing dietellae [0.25] (SAM P39455)

E: ***Adeonellopsis symmetrica***, autozooids [0.10] (SAM P39452)

F: ***Adeonellopsis symmetrica***, colony fragment [0.25] (SAM P39452)

G: ***Adeonellopsis* cf. *yarraensis***, colony fragment [0.25] (SAM P39454)

H: ***Adeonellopsis* cf. *yarraensis***, autozooids [0.10] (SAM P39454)

I: ***Adeonellopsis* cf. *yarraensis***, colony fragment [0.25] (SAM P39453)

J: ***Adeonellopsis* cf. *yarraensis***, colony fragment [0.25] (SAM P39453)

K: ***Adeonellopsis* sp. nov. b**, autozooids [0.10] (SAM P39456)

L: ***Adeonellopsis* sp. nov. b**, detail of spiramina [0.05] (SAM P39456)

M: ***Adeonellopsis* sp. nov. b**, bifurcating colony fragment [0.25] (SAM P39456)

N: ***Adeonellopsis* sp. nov. b**, autozooids, the two larger central zooids may be ovicelled [0.10] (SAM P39456)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

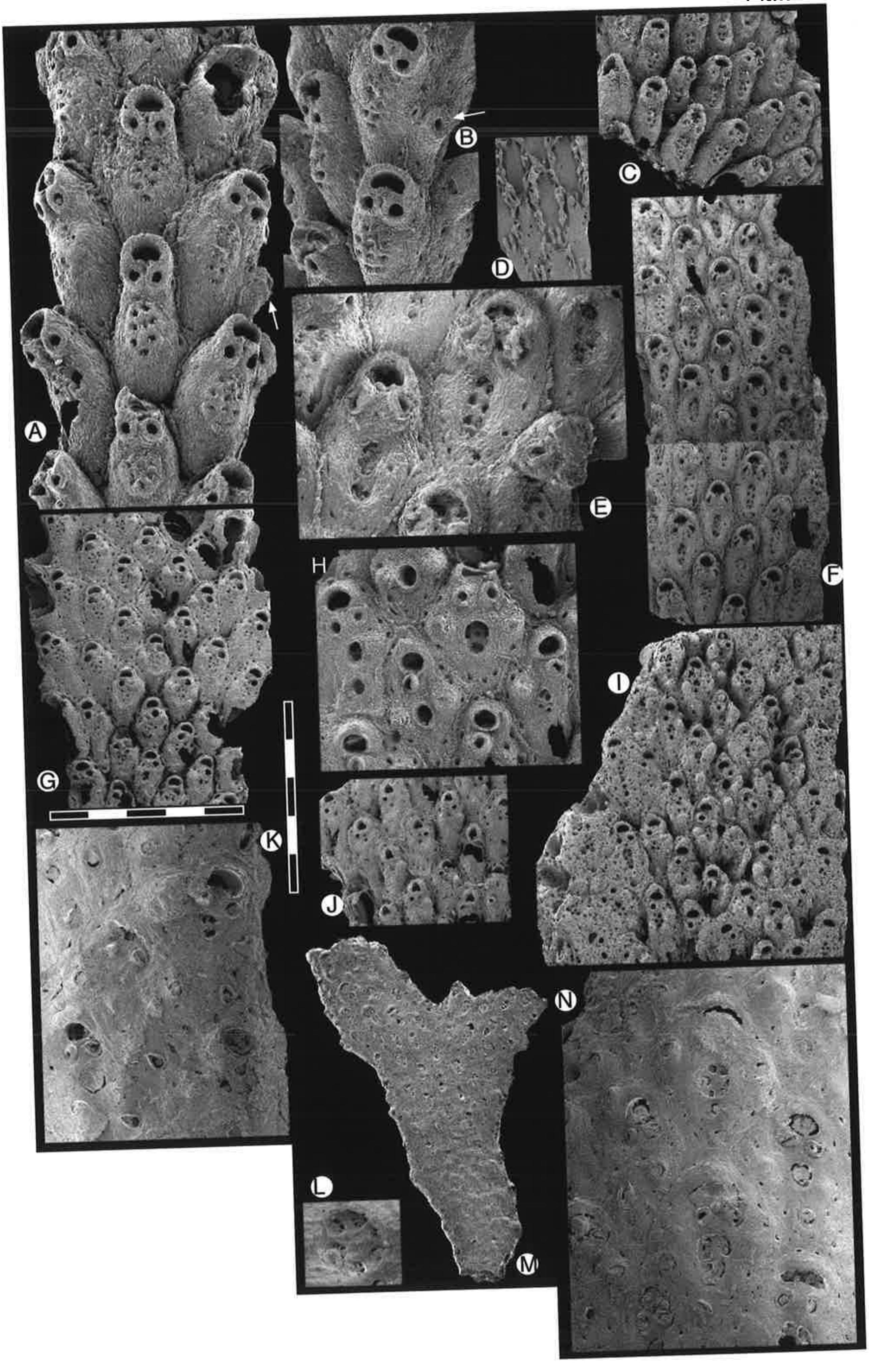
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Plate 24

A: ***Dimorphocella* sp. nov. a**, colony fragment [0.50]
(SAM P39462)
B: ***Dimorphocella* sp. nov. a**, detail of autozooid orifice showing condyles [0.05]
(SAM P39462)
C: ***Dimorphocella* sp. nov. a**, autozooids and large dimorphic brooding zooids [0.10]
(SAM P39462)
D: ***Dimorphocella* sp. nov. a**, autozooid with proximal adventitious avicularium [0.10]
(SAM P39464)
E: ***Dimorphocella* sp. nov. a**, 'cross-section' of colony fragment [0.25]
(SAM P39462)
F: ***Dimorphocella* sp. nov. a**, autozooids [0.10]
(SAM P39463)
G: ***Dimorphocella?* sp. nov. b**, colony fragment [0.25]
(SAM P39465)
H: ***Dimorphocella?* sp. nov. b**, autozooid [0.10]
(SAM P39465)
I: ***Dimorphocella?* sp. nov. b**, autozooids, the upper left-hand one showing the sinus without a large peristomial spiramen [0.10]
(SAM P39465)
J: ***Lepraliella* sp. nov. a**, colony encrusting on internal echinoid shell, ancestrular region [0.25]
(SAM P39479)
K: ***Lepraliella* sp. nov. a**, autozooid [0.10]
(SAM P39479)
L: ***Lepraliella* sp. nov. a**, view into orifice of autozooid [0.10]
(SAM P39480)
M: ***Celleporaria?* sp. nov. a**, view into orifice of autozooids [0.10]
(SAM P39475)
N: ***Celleporaria?* sp. nov. a**, autozooids [0.10]
(SAM P39476)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

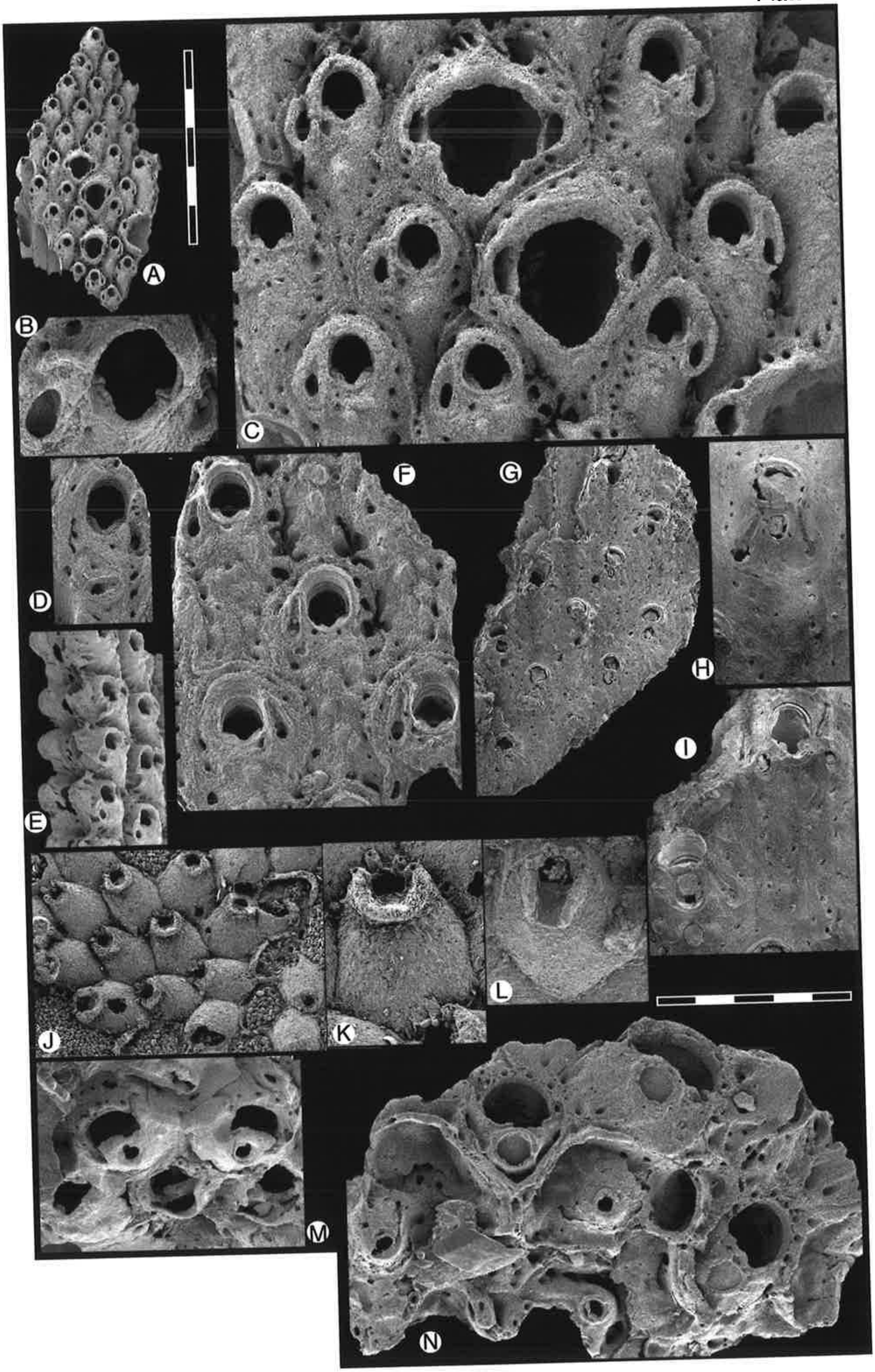
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Plate 25

A: ***Sphaeropora?* sp. nov.? a**, nodular colony [0.25] (SAM P39477)

B: ***Sphaeropora?* sp. nov.? a**, frontally budded zooids [0.10] (SAM P39477)

C: ***Sphaeropora?* sp. nov.? a**, basal attachment area of nodular colony, substrate lost [0.25] (SAM P39477)

D: ***Sphaeropora?* sp. nov.? b**, discoid nodular colony [0.50] (SAM P39478)

E: ***Sphaeropora?* sp. nov.? b**, frontally budded zooids [0.10] (SAM P39478)

F: ***Celleporaria* cf. *'gambierensis'?***, cross-section of arborescent multilaminar colony [0.25] (SAM P39474)

G: ***Celleporaria* cf. *'gambierensis'?***, frontally budded zooids [0.10] (SAM P39474)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

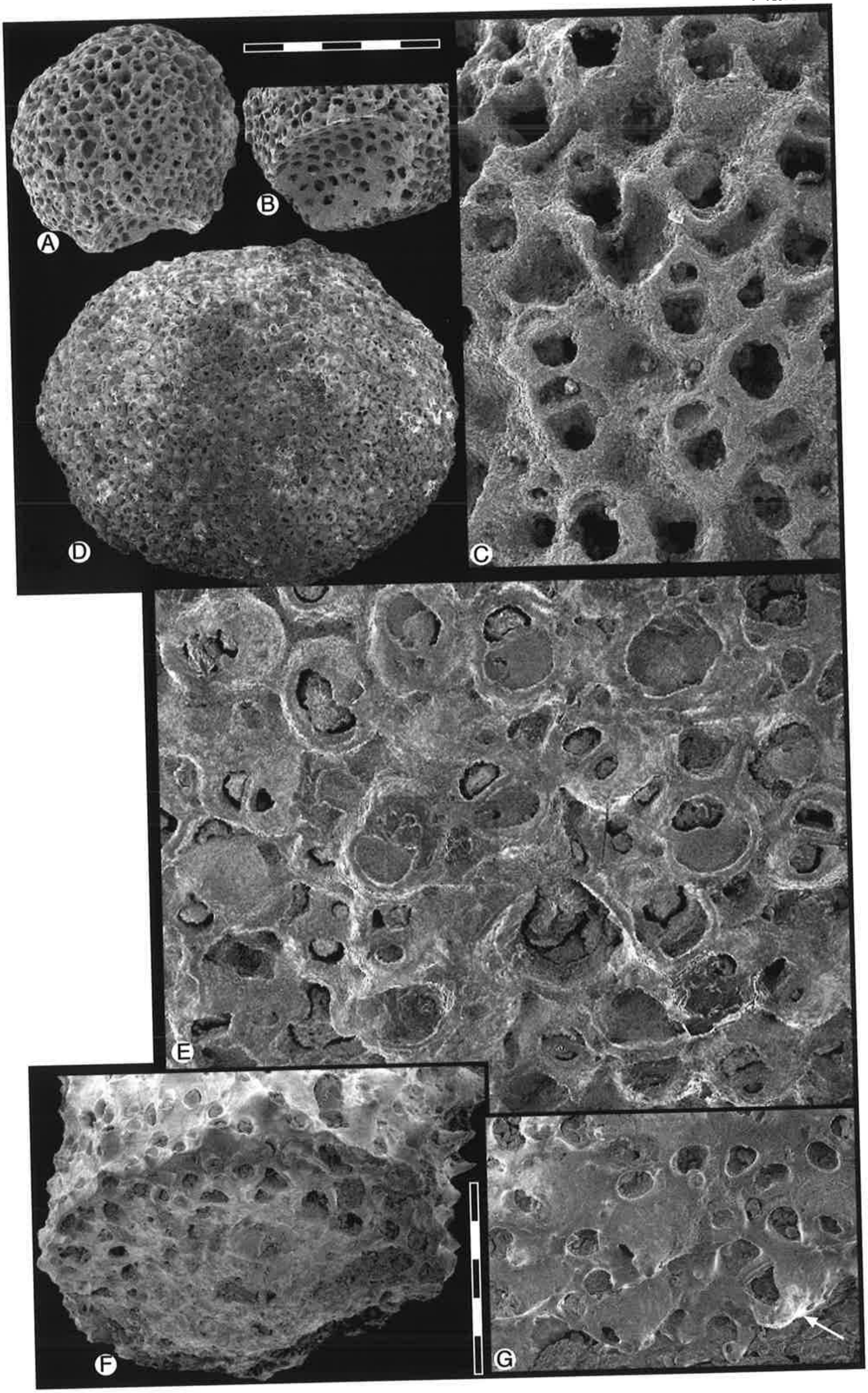
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Plate 26

A: ***Celleporaria* 'gambierensis'**, encrusting colony with frontal budding in central area [0.50] (SAM P39470)
B: ***Celleporaria* 'gambierensis'**, multilaminar colony fragment [0.25] (SAM P39471)
C: ***Celleporaria* 'gambierensis'**, autozooids [0.10] (SAM P39470)
D: ***Celleporaria* 'gambierensis'**, autozooidal orifice [0.10] (SAM P39471)
E: ***Celleporaria* 'gambierensis'**, autozooidal orifice with spine bases[0.10] (SAM P39472)
F: ***Celleporaria* 'gambierensis'**, vicarious avicularium [0.10] (SAM P39472)
G: ***Celleporaria* 'gambierensis'**, autozooid with adventitous and vicarious avicularia [0.25] (SAM P39472)
H: ***Celleporaria* 'gambierensis'**, autozooid with adventitous avicularia [0.25] (SAM P39472)
I: ***Celleporaria nummularia***, basal surface of lunulitiform colony showing mould of foraminiferan substrate [0.25] (SAM P39331)
J: ***Celleporaria nummularia***, autozooid [0.10] (SAM P39331)
K: ***Celleporaria nummularia***, autozooid [0.10] (SAM P39331)
L: ***Celleporaria nummularia***, lunulitiform colonies showing various sizes (large colony on left with encrusting serpulids) [0.10] (SAM P39332, P39333, P39334; clockwise from left)
M: ***Aulopocella*? sp. nov. a**, nodular colony [0.25] (SAM P39481)
N: ***Aulopocella*? sp. nov. a**, autozooids [0.10] (SAM P39481)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

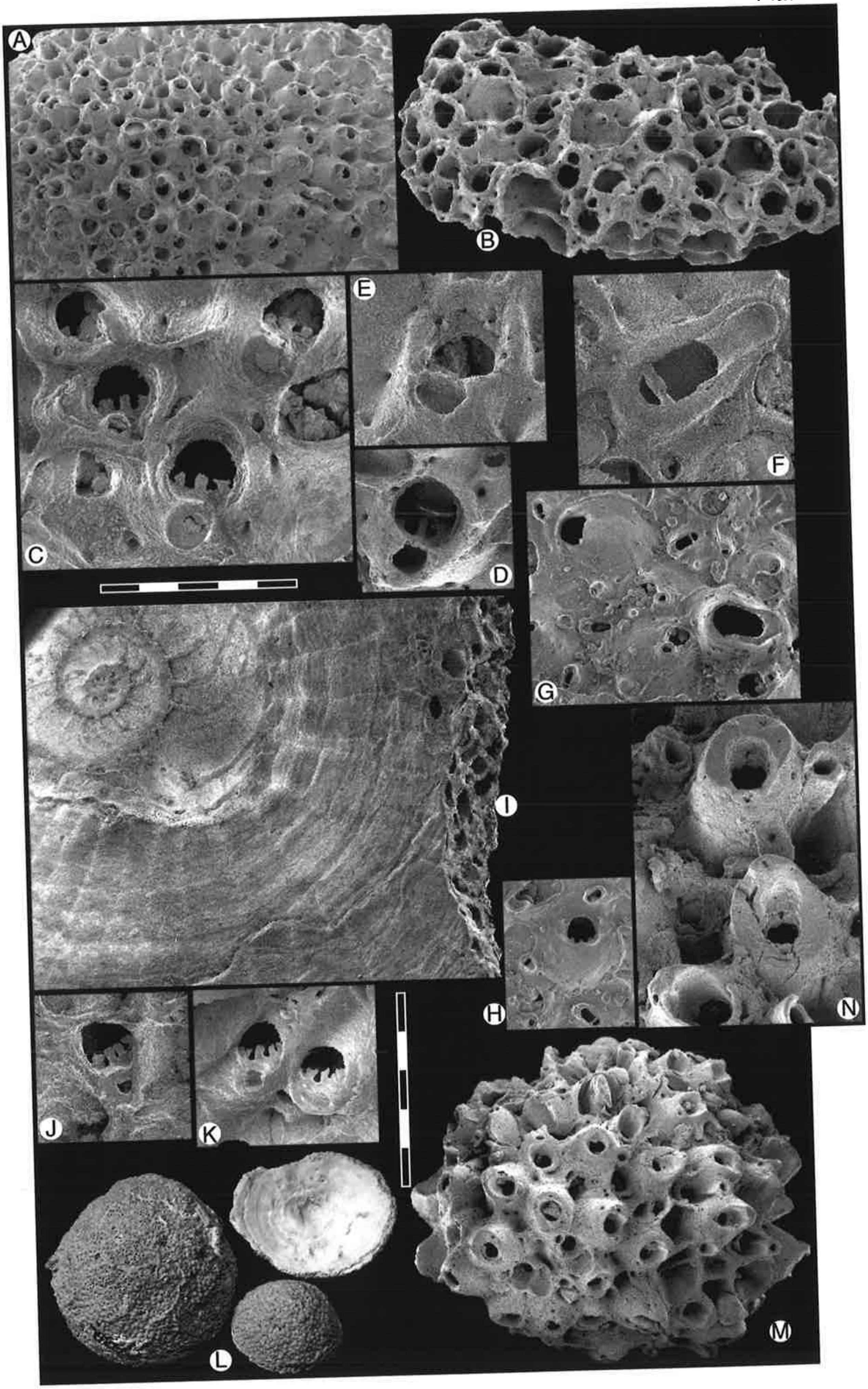
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Plate 27

A: '***Escharoides***' **sp. nov. a**, colony fragment [0.25] (SAM P39482)

B: '***Escharoides***' **sp. nov. a**, basal surface of colony fragment [0.50] (SAM P39482)

C: '***Escharoides***' **sp. nov. a**, view into opening of ovicell [0.10] (SAM P39482)

D: '***Escharoides***' **sp. nov. a**, view into autozooid orifice [0.10] (SAM P39482)

E: '***Escharoides***' **sp. nov. a**, view into ovicelled zooid orifice [3 (SAM P39482)

F: '***Escharoides***' **sp. nov. b**, autozooid [0.10] (SAM P39483)

G: '***Escharoides***' **sp. nov. b**, colony fragment [0.25] (SAM P39483)

H: '***Escharoides***' **sp. nov. b**, view into autozooid orifice [0.10] (SAM P39483)

I: '***Escharoides***' **sp. nov. b**, view into orifices of ovicelled zooids [0.10] (SAM P39483)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

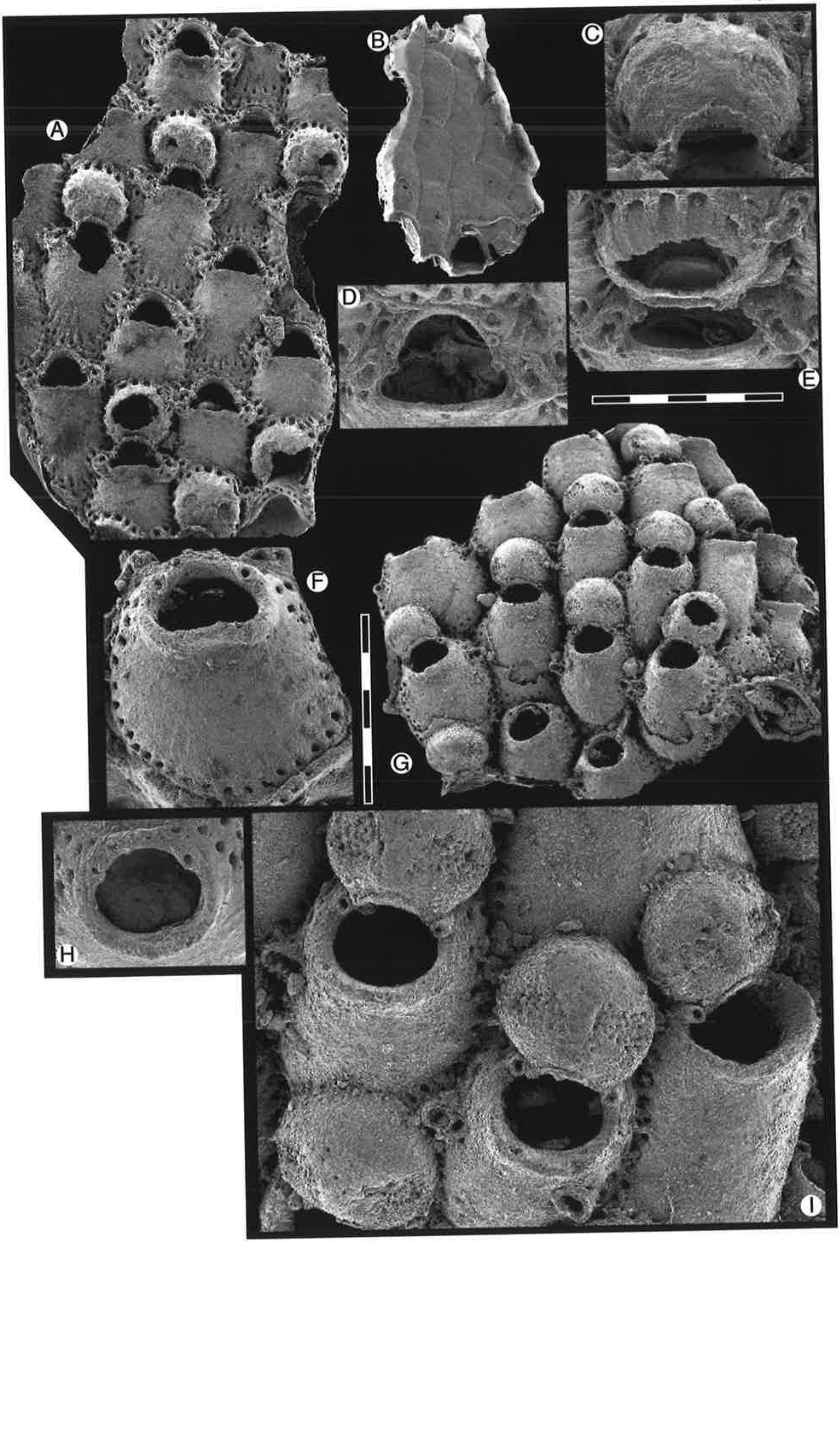
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Plate 28

A: ***Trigonopora* aff. *personata***, autozooids and ovicelled zooids [0.10] (SAM P39485)
B: ***Trigonopora* aff. *personata***, autozooids [0.10] (SAM P39485)
C: ***Trigonopora* aff. *personata***, view into orifices of autozooids [0.10] (SAM P39485)
D: ***Trigonopora* aff. *personata***, view into orifice of autozooid [0.10] (SAM P39485)
E: ***Trigonopora* aff. *personata***, view into opening of ovicell [0.10] (SAM P39488)
F: ***Trigonopora?* sp. nov. a**, autozooids [0.10] (SAM P39490)
G: ***Rhamphosmittina* cf. *lateralis***, view into orifice of ovicelled zooid [0.10] (SAM P39491)
H: ***Rhamphosmittina* cf. *lateralis***, colony fragment [0.25] (SAM P39491)
I: ***Rhamphosmittina* cf. *lateralis***, ovicelled zooids and autozooid [0.10] (SAM P39491)
J: ***Rhamphosmittina* sp. nov. a**, view into autozooid [0.10] (SAM P39492)
K: ***Rhamphosmittina* sp. nov. a**, colony fragment [0.10] (SAM P39492)
L: ***Rhamphosmittina* sp. nov. a**, colony fragment, with possible frontally budded zooids [0.50] (SAM P39492)
M: ***Rhamphosmittina* sp. nov. a**, view into orifice of autozooids (white arrow indicates lyrula, black arrow indicates condyle) [0.10] (SAM P39492)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

Plate 28

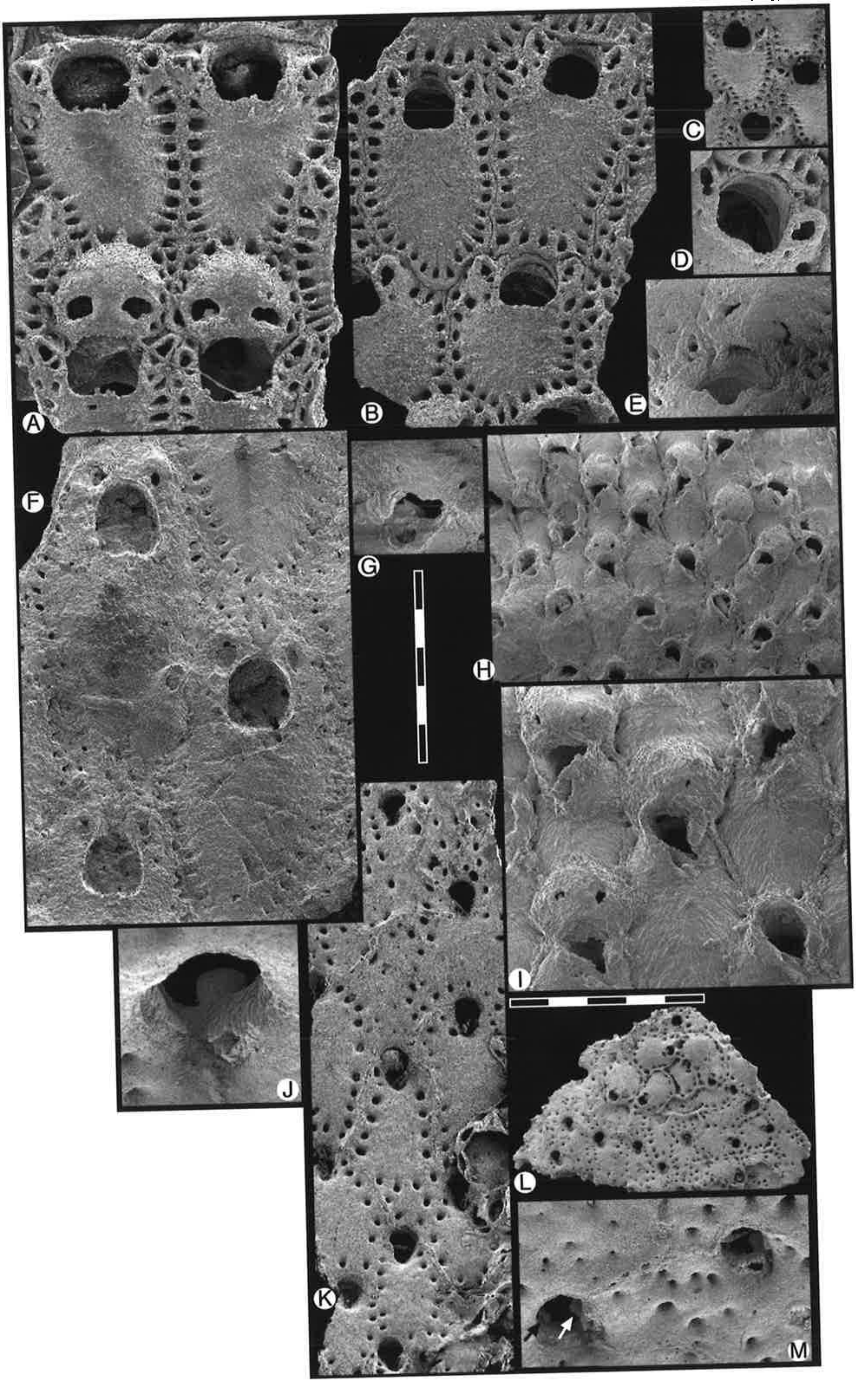

Plate 29

A: ***Exochella* sp. nov. a**, colony fragment [0.25]
(SAM P39493)
B: ***Exochella* sp. nov. a**, view into orifice of autozooid [0.10]
(SAM P39493)
C: ***Exochella* sp. nov. b**, view into orifice of autozooid [0.10]
(SAM P39494)
D: ***Exochella* sp. nov. b**, colony fragment [0.10]
(SAM P39494)
E: ***Exochella* sp. nov. c**, colony fragment [0.25]
(SAM P39495)
F: ***Exochella* sp. nov. c**, autozooid orifice [0.10]
(SAM P39495)
G: ***Exochella* sp. nov. c**, autozooid orifice [0.10]
(SAM P39495)
H: ***Romancheinidae Gen. indet.* sp. nov. a**, view into orifices of autozooids and ovicelled zooids [0.10]
(SAM P39497)
I: ***Romancheinidae Gen. indet.* sp. nov. a**, autozooid and ovicelled zooid [0.10]2
(SAM P39497)
J: ***Romancheinidae Gen. indet.* sp. nov. a**, "*Onychocella*" sp. nov. a [0.25]
(SAM P39497)
K: ***Porella* cf. *angustata***, colony fragment [0.25]
(SAM P39498)
L: ***Porella* cf. *angustata***, autozooid orifice [0.10]
(SAM P39498)
M: ***Porella* cf. *angustata***, view of proximal margin of orifices [0.10]
(SAM P39498)
N: ***Porelloides?* sp. nov. a**, autozooid orifice [0.10]
(SAM P39523)
O: ***Porelloides?* sp. nov. a**, autozooid orifice [0.25]
(SAM P39523)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

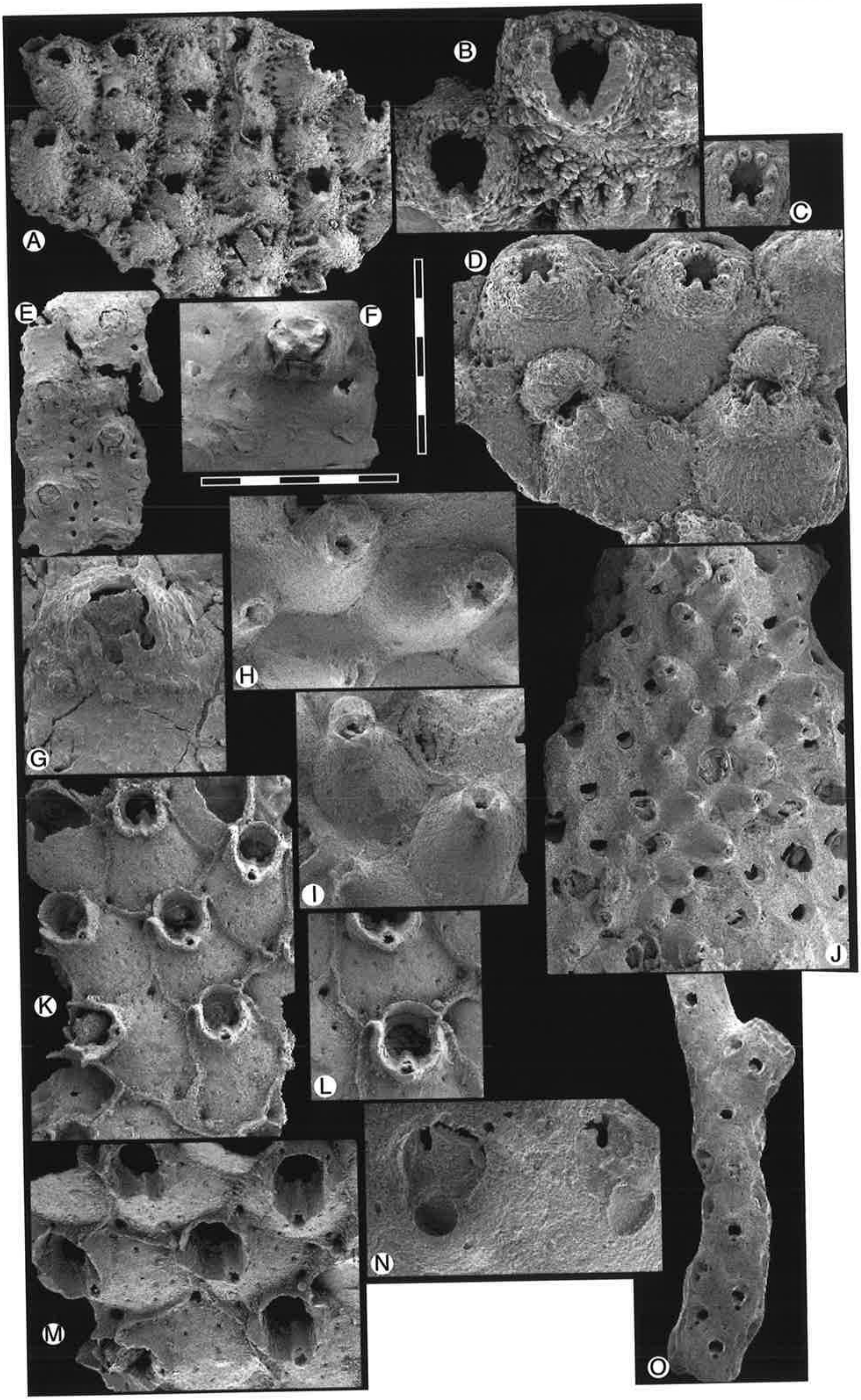
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Plate 30

A: ***'Lekythopora'* sp. nov. a**, branching colony fragment (orificial sinuses directed toward bottom of page) [0.50]
(SAM P39563)

B: ***'Lekythopora'* sp. nov. a**, branching colony fragment (orificial sinuses directed toward bottom of page) [0.50]
(SAM P39564)

C: ***'Lekythopora'* sp. nov. a**, autozooids [0.10]
(SAM P39563)

D: ***'Lekythopora'* sp. nov. a**, view into proximal margin of autozooidal orifice [0.10]
(SAM P39563)

E: ***'Lekythopora'* sp. nov. a**, view into proximal margin of autozooidal orifice [0.10]
(SAM P39563)

F: ***'Lekythopora'* sp. nov. a**, autozooid with adventitious avicularium [0.10]
(SAM P39564)

G: ***'Lekythopora'* sp. nov. a**, cross-section though branch [0.25]
(SAM P39564)

H: ***'Lekythopora'* sp. nov. a**, ?ovicelled zooids [0.10]
(SAM P39563)

I: ***'Lekythopora'* sp. nov. a**, cross-section though branch [0.25]
(SAM P39563)

J: ***'Lekythopora'* sp. nov. a**, view of bifurcation point [0.25]
(SAM P39563)

K: ***'Lekythopora'* sp. nov. a**, view into proximal margin of autozooidal orifice, showing condyles and oral avicularium (arrow) [0.05]
(SAM P39563)

L: ***Gen. indet. B* sp. nov. a**, unilaminar encrustnig colony fragment [0.50]
(SAM P39566)

M: ***Gen. indet. B* sp. nov. a**, autozooids [0.25]
(SAM P39566)

N: ***Gen. indet. B* sp. nov. a**, autozooids [0.10]
(SAM P39566)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

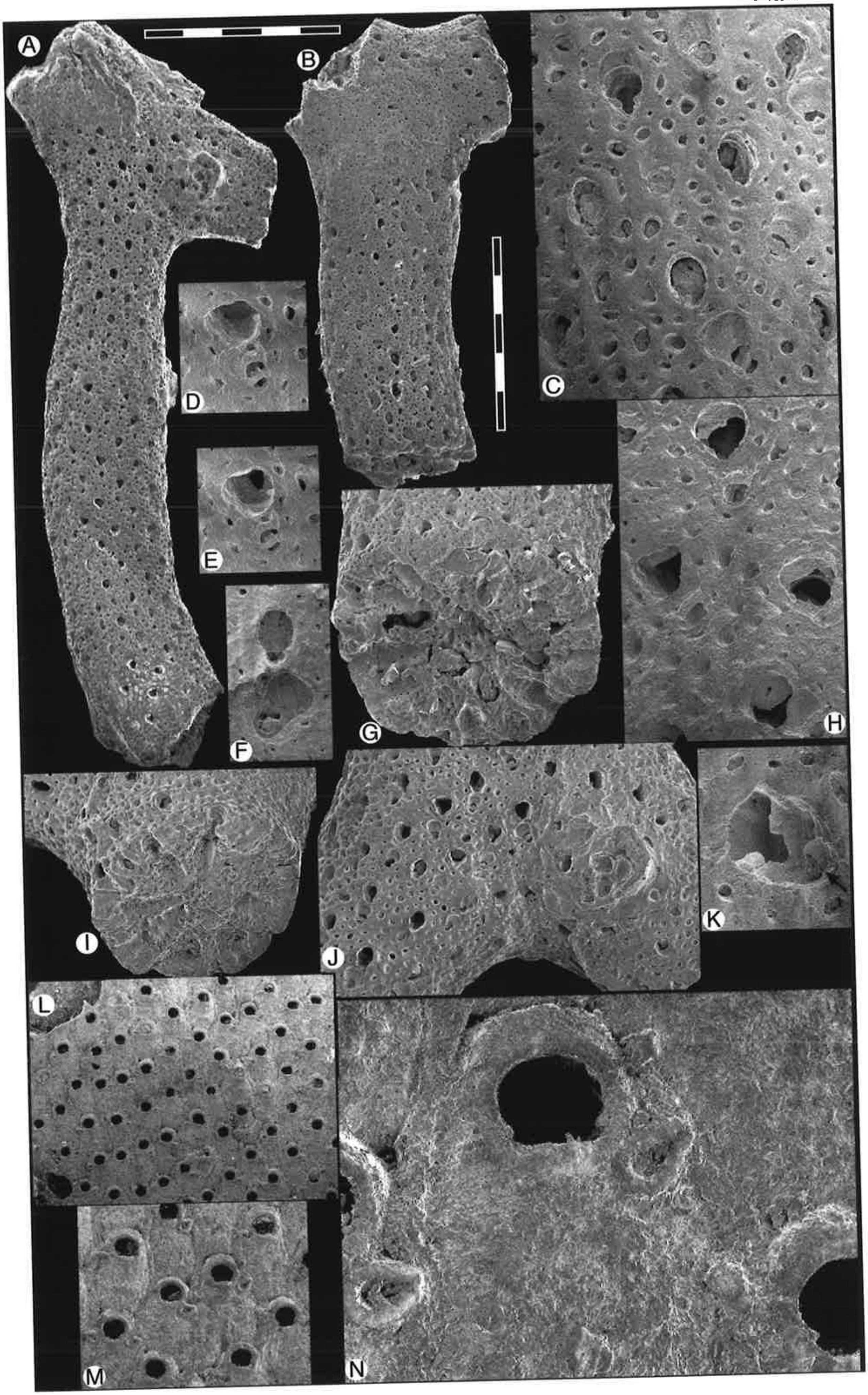
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Plate 31

A: ***Smittoidea* sp. nov. b**, autozooids [0.10]
(SAM P39500)

B: ***Smittoidea* sp. nov. a**, colony encrusting internal echinoid shell, includes ancestrular area (strat indicates probable ancestrula) [0.25]
(SAM P39499)

C: ***Smittoidea* sp. nov. a**, autozooids in ancestrular area [0.10]
(SAM P39499)

D: ***Smittoidea* cf. *dennanti***, autozooids [0.10]
(SAM P39502)

E: ***Smittoidea* cf. *dennanti***, view into orifices of autozooids [0.10]
(SAM P39502)

F: ***Smittoidea* cf. *dennanti***, autozooids [0.10]
(SAM P39502)

G: ***Smittoidea* sp. nov. d**, autozooids [0.10]
(SAM P39503)

H: ***Smittoidea* sp. nov. d**, autozooids [0.10]
(SAM P39503)

I: ***Smittoidea* sp. nov. c**, autozooids [0.10]
(SAM P39503)

J: ***Smittoidea* sp. nov. c**, view into orifice of autozooid [0.05]
(SAM P39503)

K: ***Smittoidea* sp. nov. c**, view into orifice of autozooid [0.05]
(SAM P39503)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

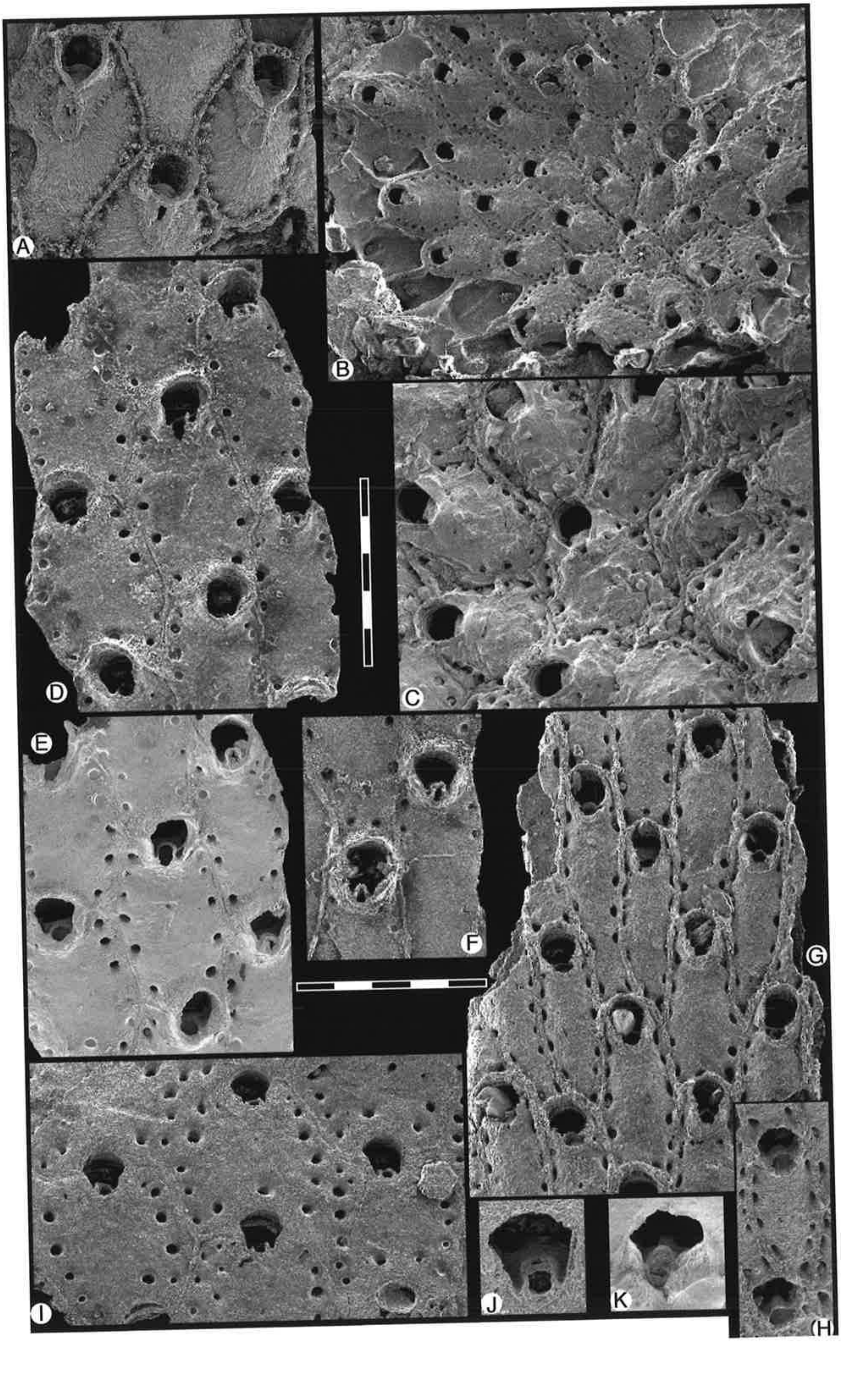
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Plate 32

A: ***Smittoidea* sp. nov. e**, colony fragment [0.25]
(SAM P39511)
B: ***Smittoidea* sp. nov. e**, view into orifices of autozooids [0.10]
(SAM P39511)
C: ***Smittoidea* sp. nov. f**, colony fragment [0.25]
(SAM P39507)
D: ***Smittoidea* sp. nov. f**, view into orifices of autozooids [0.10]
(SAM P39507)
E: ***Smittoidea* sp. nov. g**, view into orifice of autozooid [0.05]
(SAM P39508)
F: ***Smittoidea* sp. nov. g**, autozooids [0.10]
(SAM P39508)
G: ***Smittoidea* sp. nov. h**, colony fragment with ovicelled zooids [0.10]
(SAM P39513)
H: ***Smittoidea* sp. nov. h**, autozooids showing spine bases immersed in secondary calcification[0.10]
(SAM P39513)
I: ***Smittoidea* sp. nov. h**, view into orifice of ovicelled zooid [0.05]
(SAM P39513)
J: ***Smittoidea* sp. nov. i**, close-up of complete ovicell[0.05]
(SAM P39506)
K: ***Smittoidea* sp. nov. i**, ovicelled zooid with broken ovicell, showing spine bases[0.10]
(SAM P39506)
L: ***Smittoidea* sp. nov. i**, ovicelled zooid with broken ovicell, showing spine bases[0.10]
(SAM P39506)
M: ***Smittina* sp. nov. a**, colony fragment [0.25]
(SAM P39512)
N: ***Smittina* sp. nov. a**, autozooids and one ovicelled zooids (lower right) [0.10]
(SAM P39512)
O: ***Smittina* sp. nov. a**, view into openings of ovicelled zooids [0.10]
(SAM P39512)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

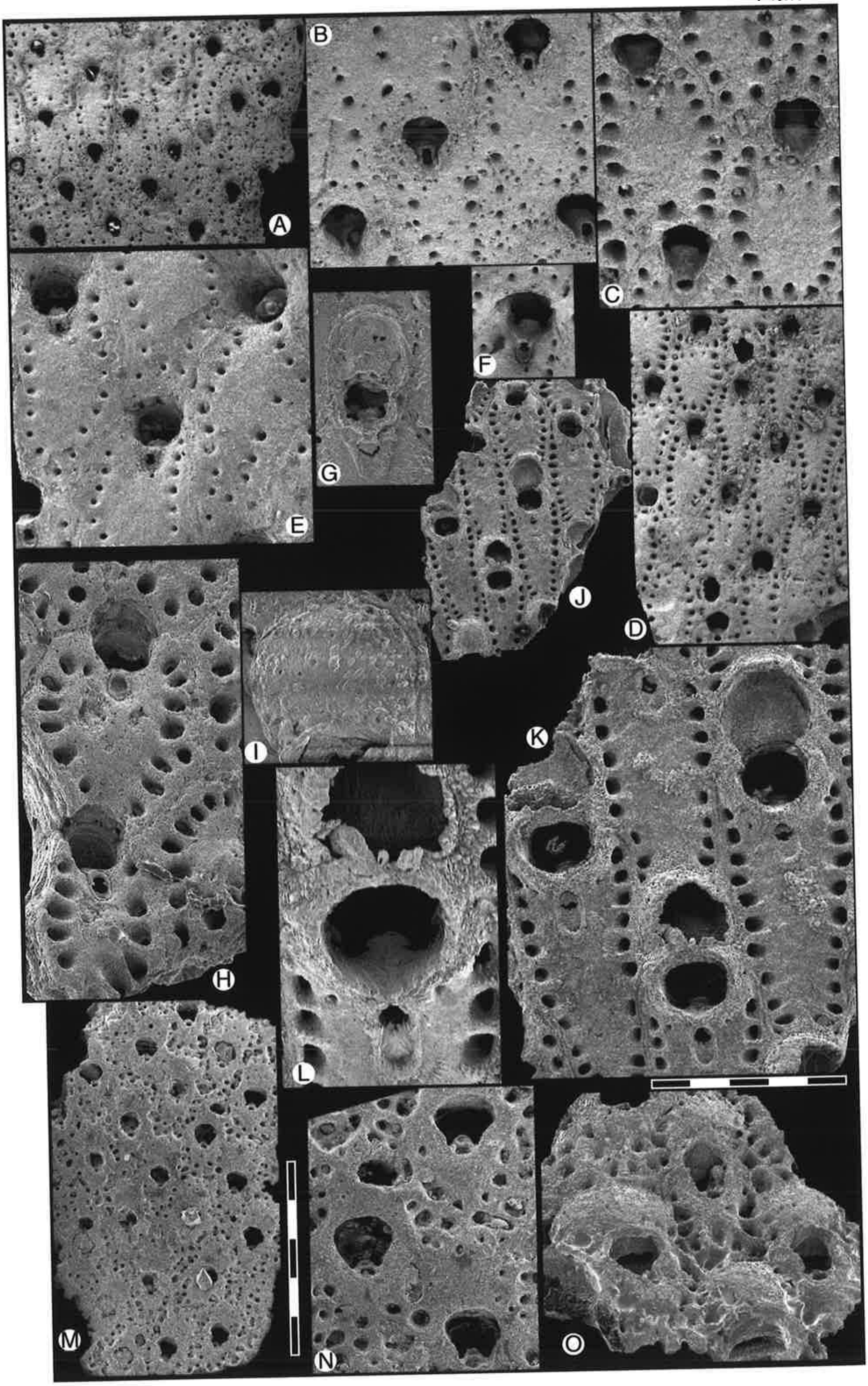
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Plate 33

A: ***Smittina* sp. nov. b**, colony fragment [0.10] (SAM P39514)
B: ***Smittina* sp. nov. b**, view into orifices of autozooids [0.10] (SAM P39514)
C: ***Smittina* sp. nov. c**, view into orifice of autozooid [0.05] (SAM P39515)
D: ***Smittina* sp. nov. c**, autozooids and ovicelled zooids [0.10] (SAM P39515)
E: ***Smittina* sp. nov. d**, view into orifices of autozooids (adventitious avicularium arrowed) [0.10] (SAM P39517)
F: ***Smittina* sp. nov. d**, colony fragment [0.25] (SAM P39517)
G: ***Smittina* sp. nov. e**, view into orifice of autozooids [0.10] (SAM P39518)
H: ***Smittina* sp. nov. e**, autozooids [0.10] (SAM P39518)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

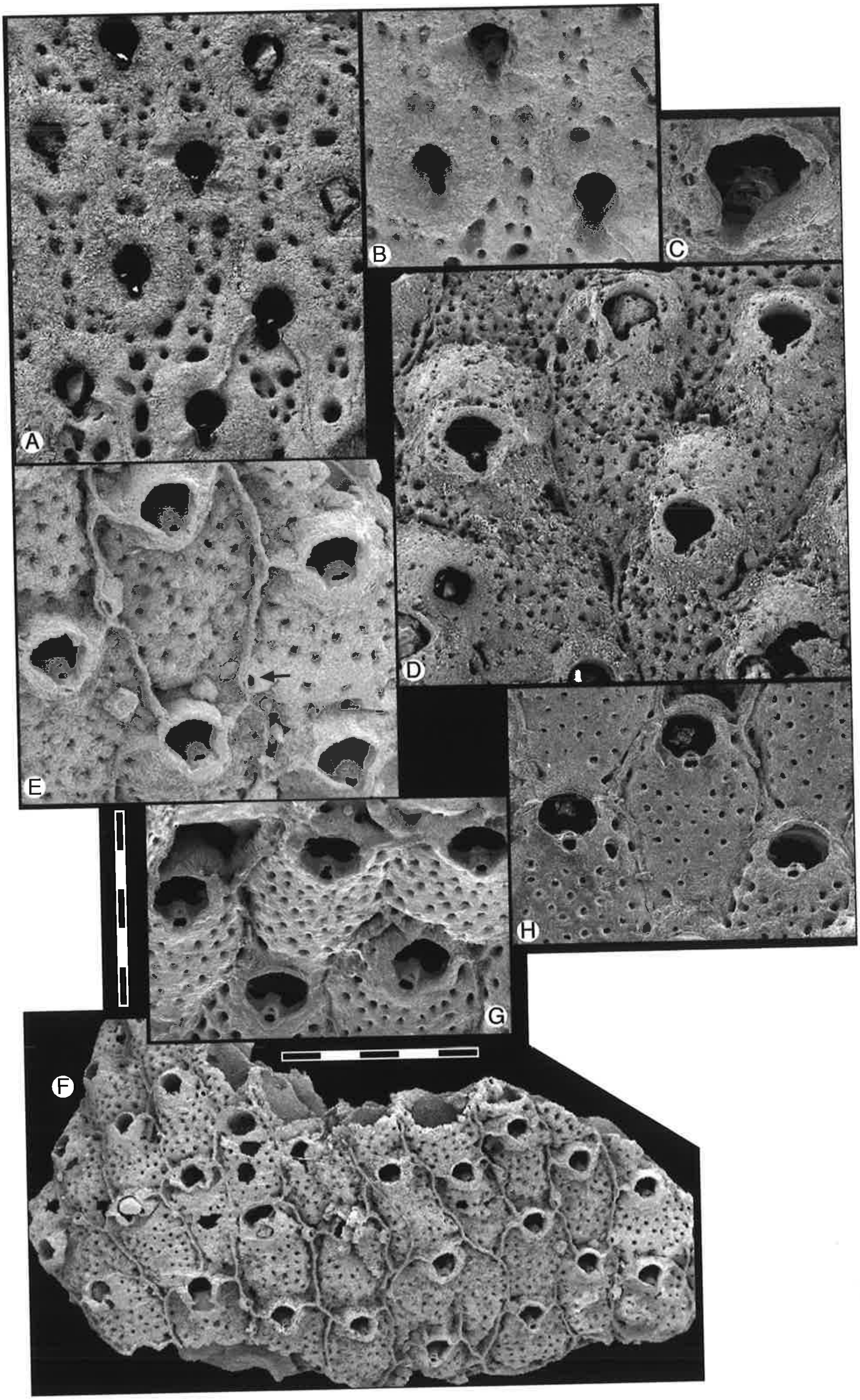
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Plate 34

A: ***Smittina*** **sp. nov. f**, autozooids [0.10]
(SAM P39519)
B: ***Smittina*** **sp. nov. f**, autozooids [0.10]
(SAM P39519)
C: ***Smittina*** **sp. nov. f**, view into orifice of autozooid [0.05]
(SAM P39519)
D: ***Smittina*** **sp. nov. g**, view into orifice of autozooid [0.05]
(SAM P39520)
E: ***Smittina*** **sp. nov. g**, branching colony fragment [0.50]
(SAM P39520)
F: ***Smittina*** **sp. nov. g**, autozooids and possible ovicelled zooid [0.10]
(SAM P39520)
G: ***Smittina*?** **sp. nov. h**, autozooids (arrow indicates occluded orifice) [0.10]
(SAM P39521)
H: ***Smittina*?** **sp. nov. h**, orifice [0.10]
(SAM P39521)
I: ***Smittina*?** **sp. nov. h**, colony fragment [0.50]
(SAM P39521)
J: ***Prenantia*** **sp. nov. a**, autozooids [0.10]
(SAM P39522)
K: ***Prenantia*** **sp. nov. a**, view into orifice of autozooid [0.05]
(SAM P39522)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

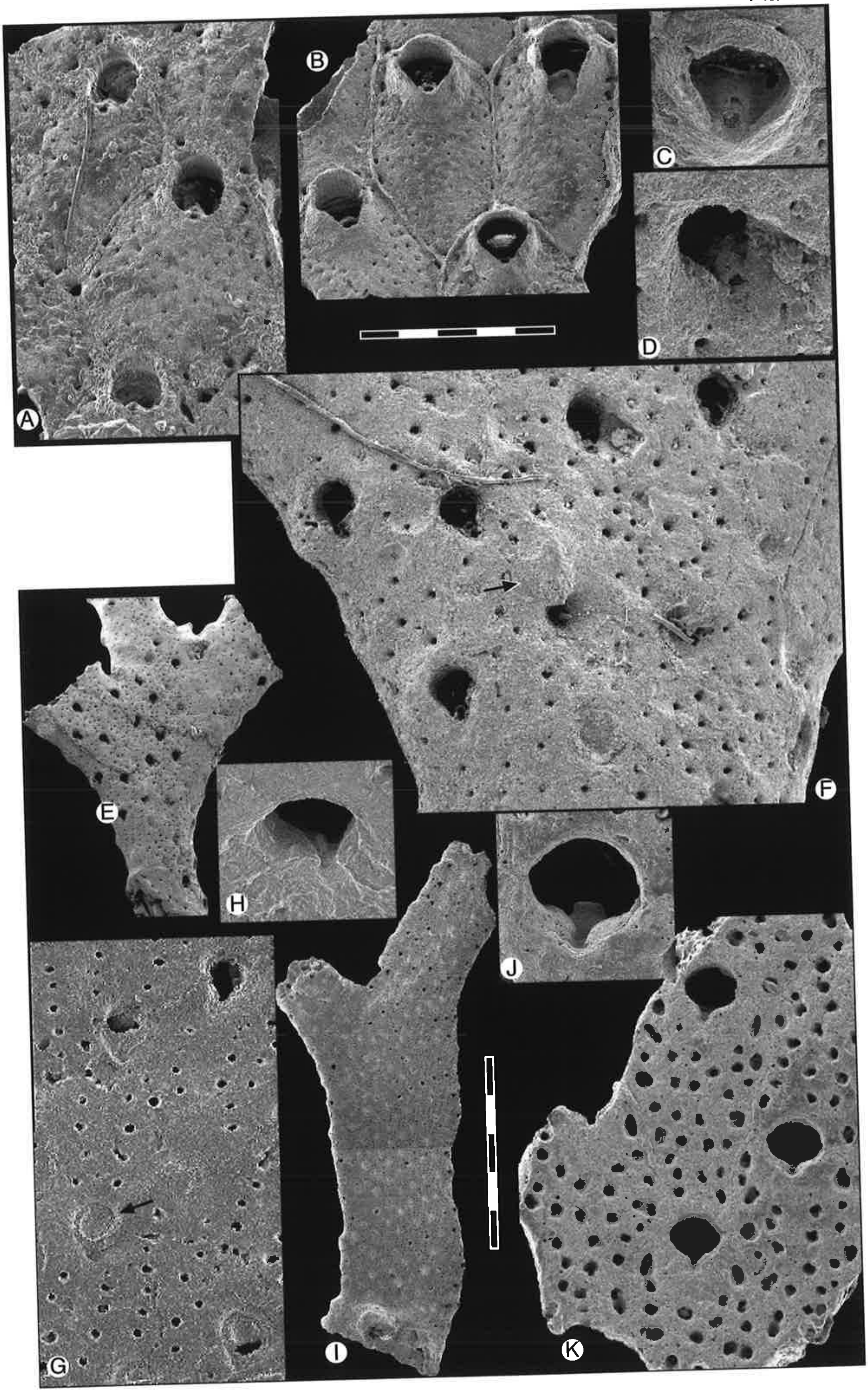
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Plate 35

A: ***Gigantopoidae Gen. indet. B* sp. nov. a**, colony branch fragment [0.50] (SAM P39524)

B: ***Gigantopoidae Gen. indet. B* sp. nov. a**, autozooids [0.25] (SAM P39524)

C: ***Gigantopoidae Gen. indet. B* sp. nov. a**, autozooid with adventitious avicularium [0.10] (SAM P39525)

D: ***Gigantopoidae Gen. indet. B* sp. nov. a**, view into autozooid orifice [0.10] (SAM P39524)

E: ***Gigantopoidae Gen. indet. B* sp. nov. a**, ovicelled zooids zooids [0.25] (SAM P39526)

F: ***Gigantopoidae Gen. indet. A* sp. nov. a**, encrusting colony with ancestrular area at bottom [0.25] (SAM P39528)

G: ***Gigantopoidae Gen. indet. A* sp. nov. a**, autozooids [0.10] (SAM P39528)

H: ***Cosciniopsis* sp. nov. a**, colony with two layers of self-overgrowth [0.50] (SAM P39527)

I: ***Cosciniopsis* sp. nov. a**, autozooids [0.25] (SAM P39527)

J: ***Cosciniopsis* sp. nov. a**, autozooid orifice [0.10] (SAM P39527)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

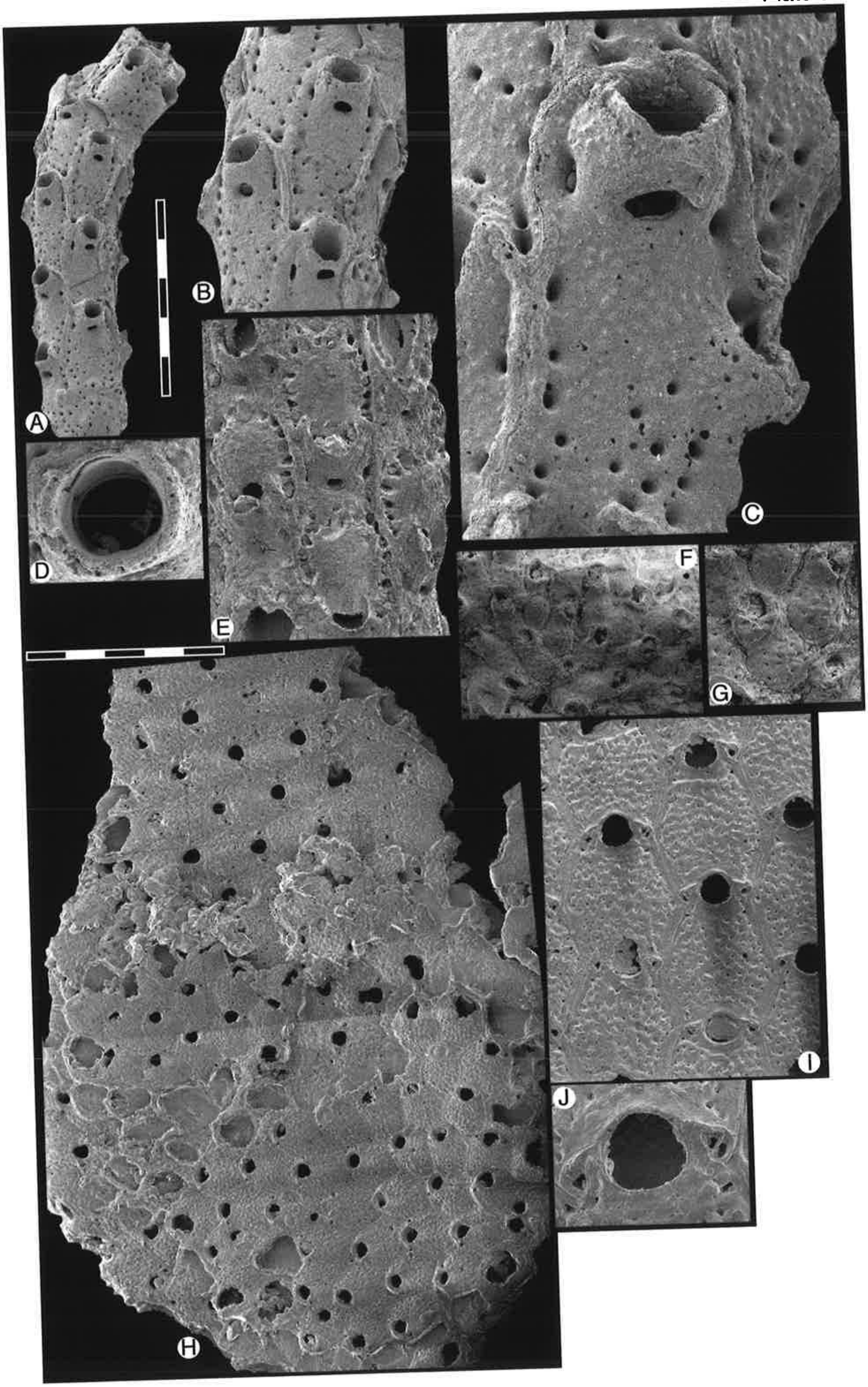
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Plate 36

A: ***Porina* cf. *spongiosa***, colony fragment [0.25]
(SAM P39529)
B: ***Porina* cf. *spongiosa***, autozooids [0.10]
(SAM P39529)
C: ***Porina* cf. *spongiosa***, cylindrical colony fragment [0.25]
(SAM P39531)
D: ***Porina* cf. *spongiosa***, lobate colony [0.50]
(SAM P39530)
E: ***Porina* cf. *spongiosa***, basal attachment of colony, showing bioimmured substrate structure (possibly a pectinid bivalve) [0.50]
(SAM P39532)
F: ***Porina* sp. nov. a**, internal view of frontal zooid wall, zooids in cross-section near lateral margins [0.05] a = avicularian chamber, o = primary orifice, s = spiramen.
(SAM P39534)
G: ***Porina* cf. *spongiosa***, autozooid with view into peristome [0.10]
(SAM P39529)
H: ***Porina* cf. *spongiosa***, autozooid [0.10]
(SAM P39532)
I: ***Porina* sp. nov. b**, autozooids [0.10]
(SAM P39534)
J: ***Porina* sp. nov. b**, bifurcating cylindrical colony fragment [0.25]
(SAM P39534)
K: ***Porina* sp. nov. a**, autozooid [0.10]
(SAM P39533)
L: ***Porina* sp. nov. a**, autozooids [0.25]
(SAM P39533)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

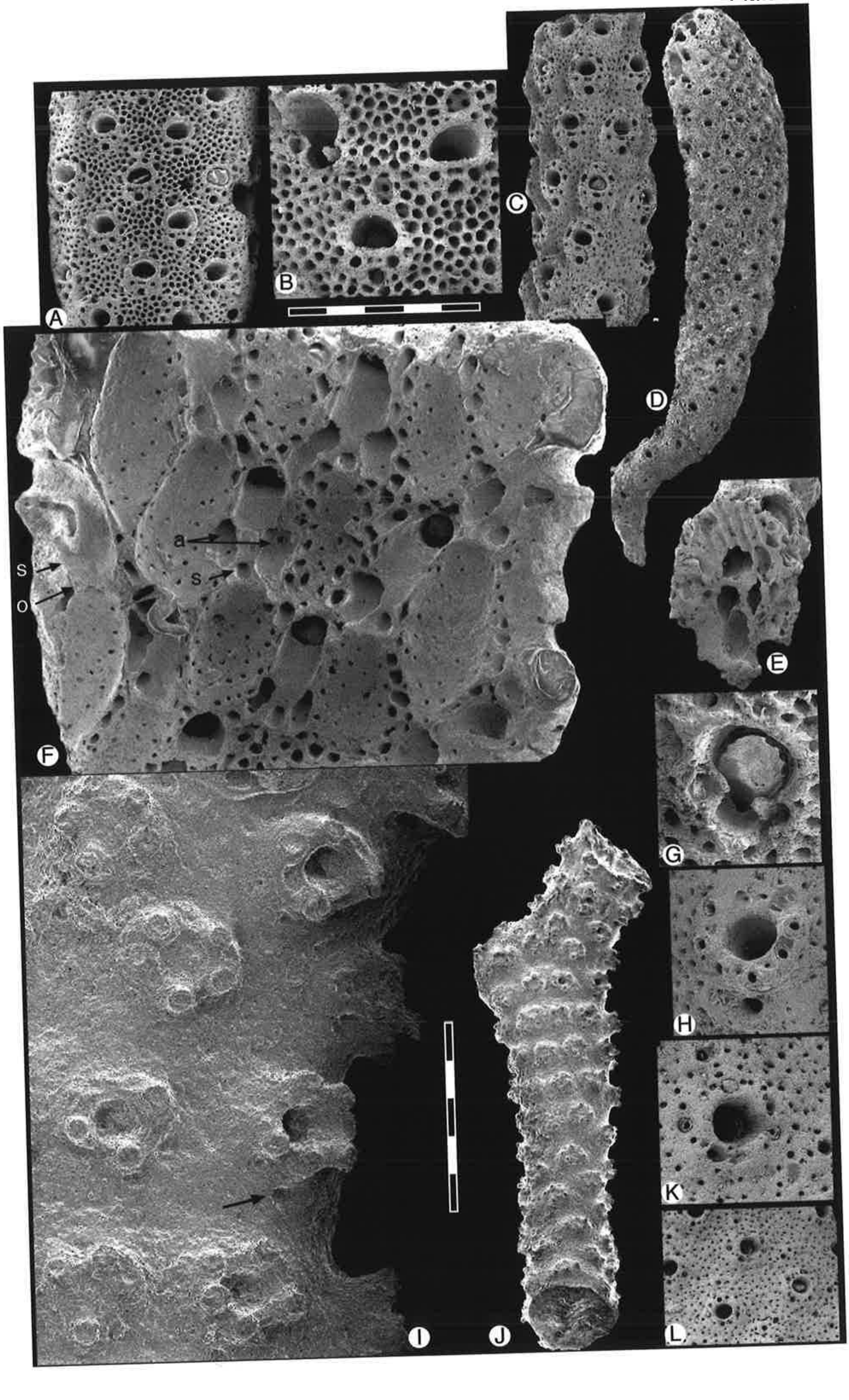
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Plate 37

A: ***Mucropetralia* sp. nov. a**, colony fragment with occluded orifices in lower left [0.25] (SAM P39538)
B: ***Mucropetralia* sp. nov. a**, ovicelled zooids [0.10] (SAM P39538)
C: ***Mucropetralia* sp. nov. a**, view of internal frontal walls [0.25] (SAM P39538)
D: ***Mucropetralia* sp. nov. a**, ovicelled zooid [0.10] (SAM P39538)
E: ***Mucropetralia* sp. nov. a**, view of proximal umbo and avicularia [0.10] (SAM P39538)
F: ***Mucropetralia* sp. nov. a**, colony fragment [0.25] (SAM P39539)
G: ***Mucropetralia* sp. nov. a**, autozooids [0.10] (SAM P39539)
H: ***Hippomenella magna***, autozooids [0.10] (SAM P39540)
I: ***Hippomenella ?magna***, ovicelled zooids [0.10] (SAM P39490)
J: ***Hippomenella magna***, colony fragment [0.50] (SAM P39540)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

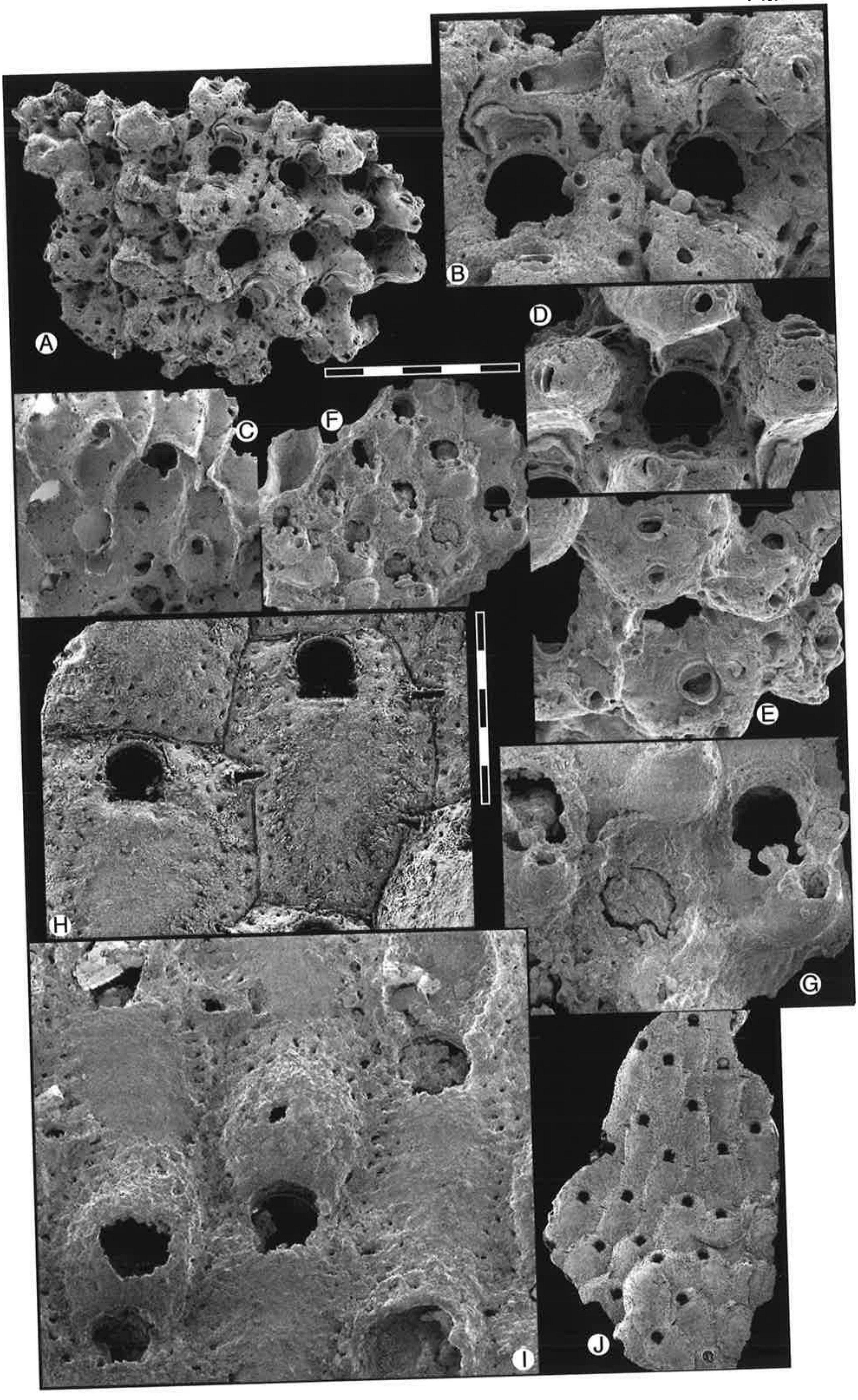
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Plate 38

A: ***Hippoporina* sp. nov. b**, colony fragment with numerous occluded orifices (maculae?) [1.00]
(SAM P39561)

B: ***Hippoporina* sp. nov. b**, oblique view (viewed from proximal direction) of broken colony edge, showing zooid chambers underneath extensive secondary calcification [0.50]
(SAM P39559)

C: ***Hippoporina* sp. nov. b**, colony fragment [0.50]
(SAM P39559)

D: ***Hippoporina* sp. nov. b**, view of intenal frontal wall [0.25]
(SAM P39562)

E: ***Hippoporina* sp. nov. b**, autozooids and occluded orifices [0.25]
(SAM P39560)

F: ***Hippoporina* sp. nov. b**, autozooids [0.10]
(SAM P39559)

G: ***Hippoporina* sp. nov. b**, autozooids [0.10]
(SAM P39559)

H: ***Hippoporina* sp. nov. b**, kenozooidal secondary calcification (white arrow indicates adventitious avicularium similar to normally occurring ones, black arrow indicates possible lingulate adventitious avicularium only occurring within secondary calcification) [0.10]
(SAM P39559)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

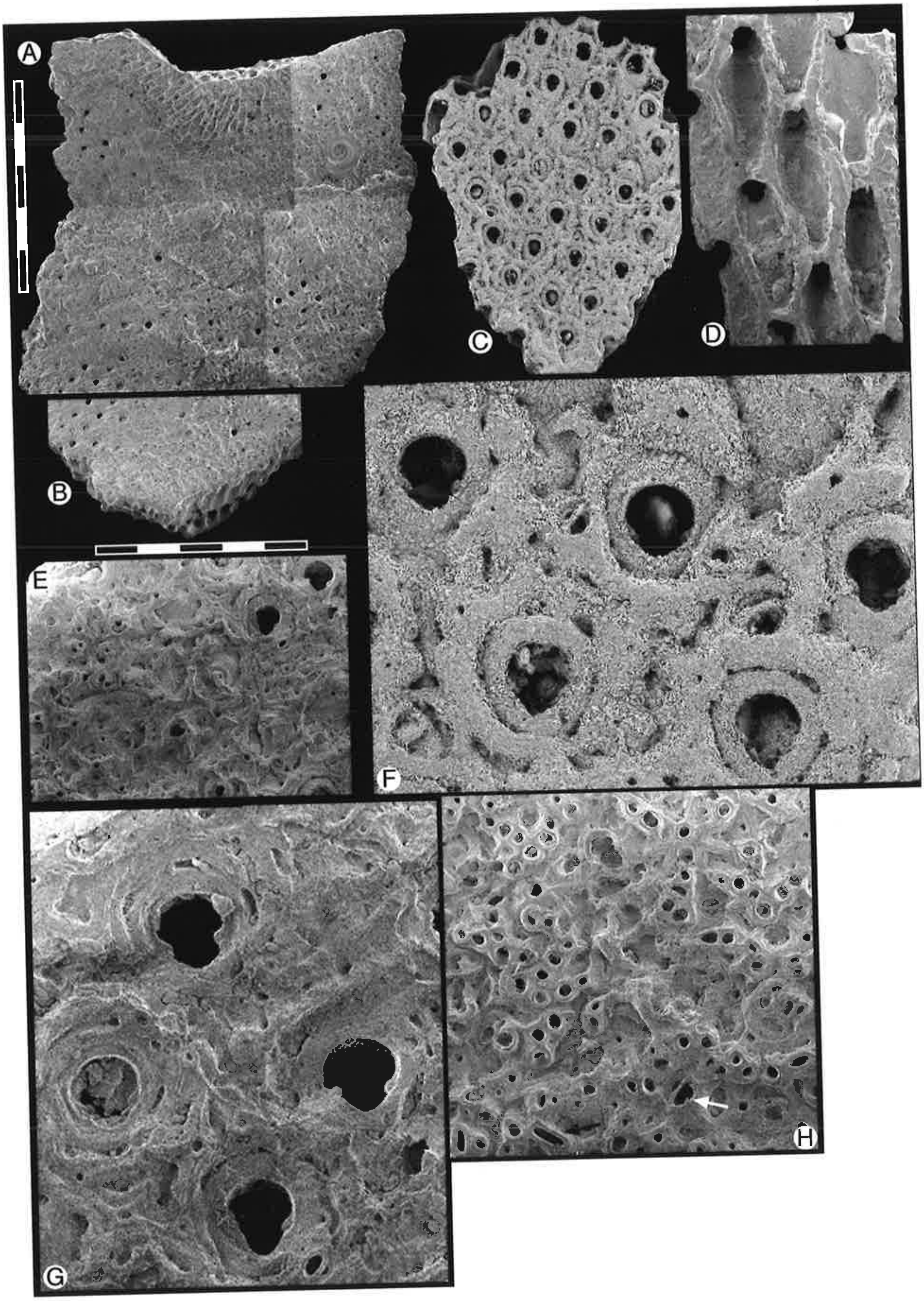
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Plate 39

A: ***Escharina?* cf. *nitidissima***, autozooids and ovicelled zooids [0.10] (SAM P39543)
B: ***Escharina?* cf. *nitidissima***, ancestrular region [0.10] (SAM P39542)
C: ***Escharina?* cf. *nitidissima***, autozooid orifice [0.05] (SAM P39543)
D: ***Escharina?* cf. *granulata***, colony fragment [0.50] (SAM P39544)
E: ***Escharina?* cf. *granulata***, autozooids [0.10] (SAM P39544)
F: ***Escharina?* cf. *granulata***, ovicelled zooid orifice [0.10] (SAM P39544)
G: ***Escharina?* cf. *granulata***, autozooid orifice [0.05] (SAM P39544)
H: **'*Schizoporella*' sp. nov. a**, bifurcation colony fragment [0.10] (SAM P39545)
I: **'*Schizoporella*' sp. nov. a**, view into orifices [0.25] (SAM P39545)
J: ***Hippoporina* sp. nov. a**, colony branch [0.50] (SAM P39541)
K: ***Hippoporina* sp. nov. a**, autozooids [0.10] (SAM P39541)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

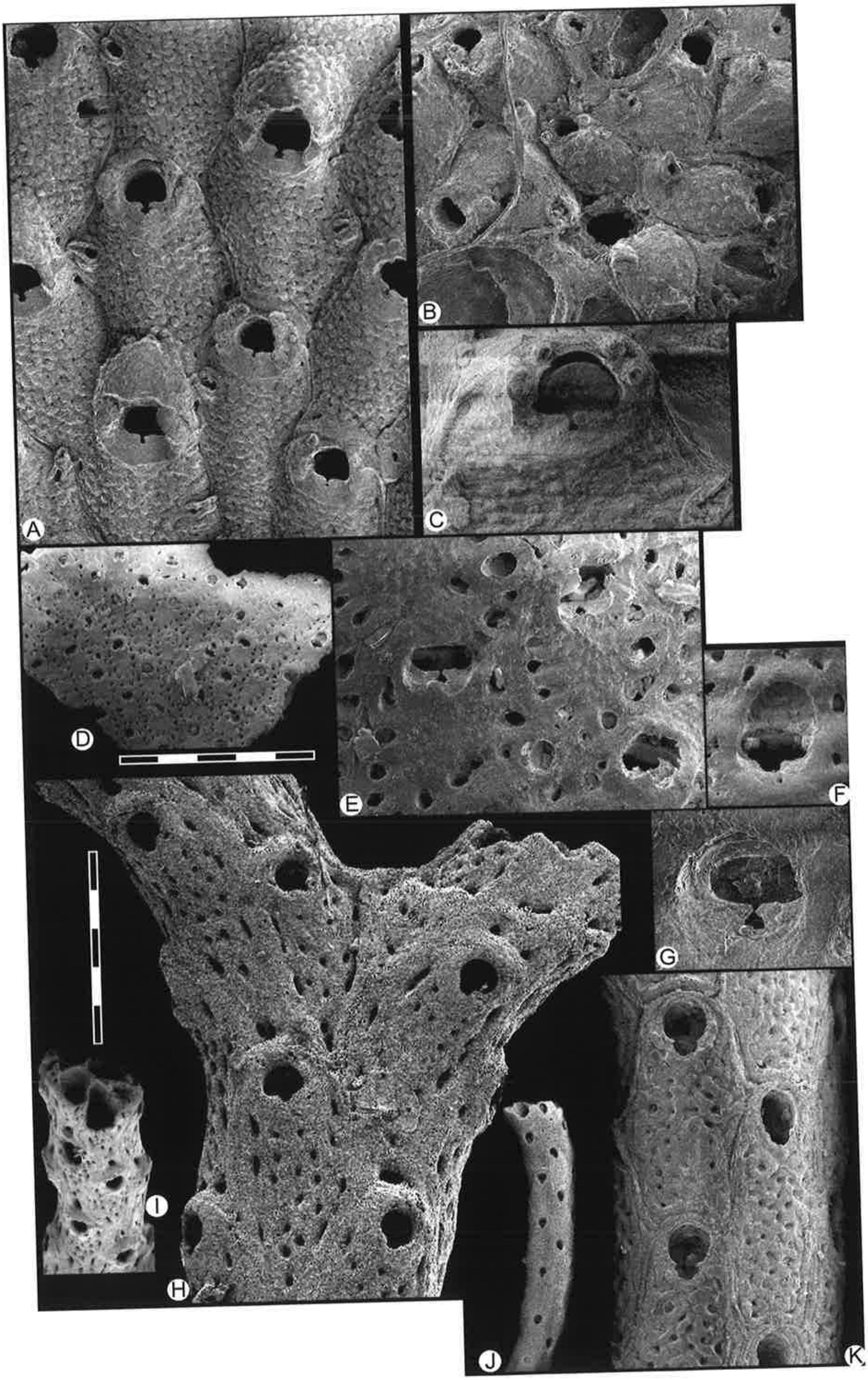
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Plate 40

A: ***Chiastosella* sp. nov. a**, autozooids, [0.10]
(SAM P39546)
B: ***Chiastosella* sp. nov. a**, autozooid lateral view showing suboral projection, [0.10]
(SAM P39546)
C: ***Chiastosella* sp. nov. a**, ovicelled zooids, [0.10]
(SAM P39546)
D: ***Chiastosella* sp. nov. b**, autozooids [0.10]
(SAM P39547)
E: ***Chiastosella* sp. nov. b**, ovicelled zooids, distal view [0.10]
(SAM P39547)
F: ***Chiastosella* sp. nov. b**, ovicelled zooid, proximal view [0.10]
(SAM P39547)
G: ***Chiastosella* sp. nov. c**, erect branching colony fragment [0.50]
(SAM P39548)
H: ***Chiastosella* sp. nov. c**, erect branching colony fragment, abfrontal view [0.50]
(SAM P39548)
I: ***Chiastosella* sp. nov. c**, view of abfrontal surface [0.25]
(SAM P39548)
J: ***Chiastosella* sp. nov. c**, autozooids [0.10]
(SAM P39548)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

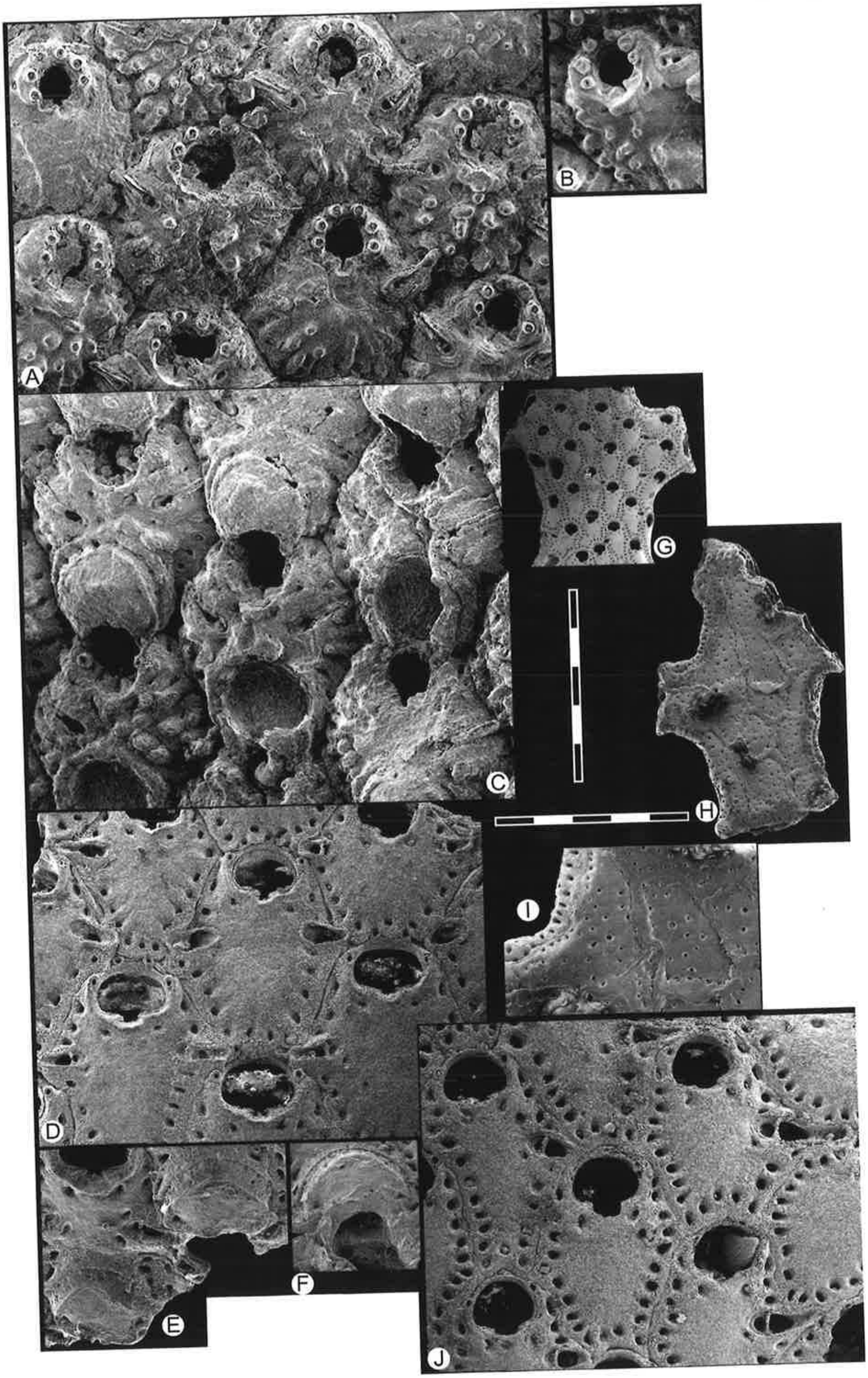
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Plate 41

A: ***Macrocamera robusta***, autozooids [0.10]
(SAM P39549)
B: ***Macrocamera robusta***, colony branch [0.50]
(SAM P39549)
C: ***Macrocamera robusta***, colony branch [0.50]
(SAM P39550)
D: ***Macrocamera robusta***, autozooids [0.10]
(SAM P39552)
E: ***Macrocamera robusta***, branch section with zooids growing in either direstion [0.25]
(SAM P39550)
F: ***Macrocamera robusta***, bifurcating colony branch [0.25]
(SAM P39551)
G: ***Macrocamera robusta***, autozooid without adventitious avicularium [0.10]
(SAM P39553)
H: ***Macrocamera*? sp. nov. a**, colony [0.50]
(SAM P39554)
I: ***Macrocamera*? sp. nov. a**, ovicelled zooid [0.05]
(SAM P39554)
J: ***Macrocamera*? sp. nov. a**, view into proximal margin of autozooids showing peristomial sinus [0.10]
(SAM P39555)
K: ***Macrocamera*? sp. nov. a**, autozooids with granulated frontal wall [0.10]
(SAM P39555)
L: ***Macrocamera*? sp. nov. a**, autozooids and ovicelled zooids [0.10]
(SAM P39555)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

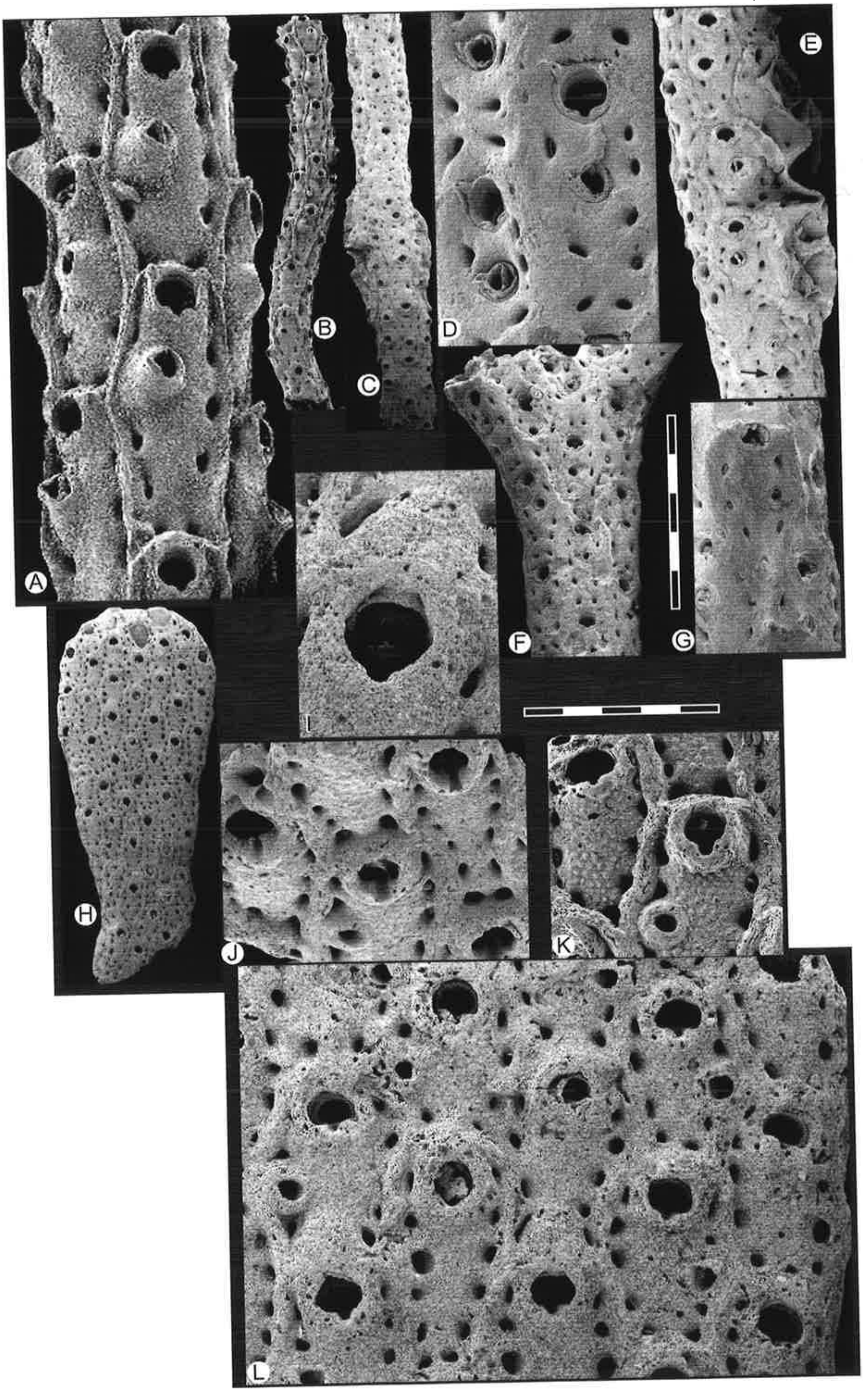
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Plate 42

A: ***Siphonicytara irregularis***, autozooids without extensive secondary calcification (star indicates secondary orifice, arrow indicates ascopore) [0.10]
(SAM P39574)

B: ***Siphonicytara irregularis***, interzooidal avicularia at colony margin [0.10]
(SAM P39574)

C: ***Siphonicytara irregularis***, autozooids with secondary calcification [0.25]
(SAM P39573)

D: ***Siphonicytara irregularis***, autozooidal orifice showing proximal projection into peristome [0.10]
(SAM P39574)

E: ***Siphonicytara irregularis***, view of distal colony margin [0.25]
(SAM P39573)

F: ***Siphonicytara irregularis***, colony fragment [0.50]
(SAM P39574)

G: ***Siphonicytara irregularis***, autozooids with secondary calcification [0.25]
(SAM P39575)

H: ***Siphonicytara irregularis***, autozooids with secondary calcification [0.25]
(SAM P39576)

I: ***Siphonicytara irregularis***, cross section through colony showing primary orifices and ascopores [0.25]
(SAM P39574)

J: ***Siphonicytara irregularis***, view of internal frontal walls showing peristomes and ascopores [0.25]
(SAM P39577)

K: ***Siphonicytara irregularis***, cross section through colony [0.50]
(SAM P39574)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

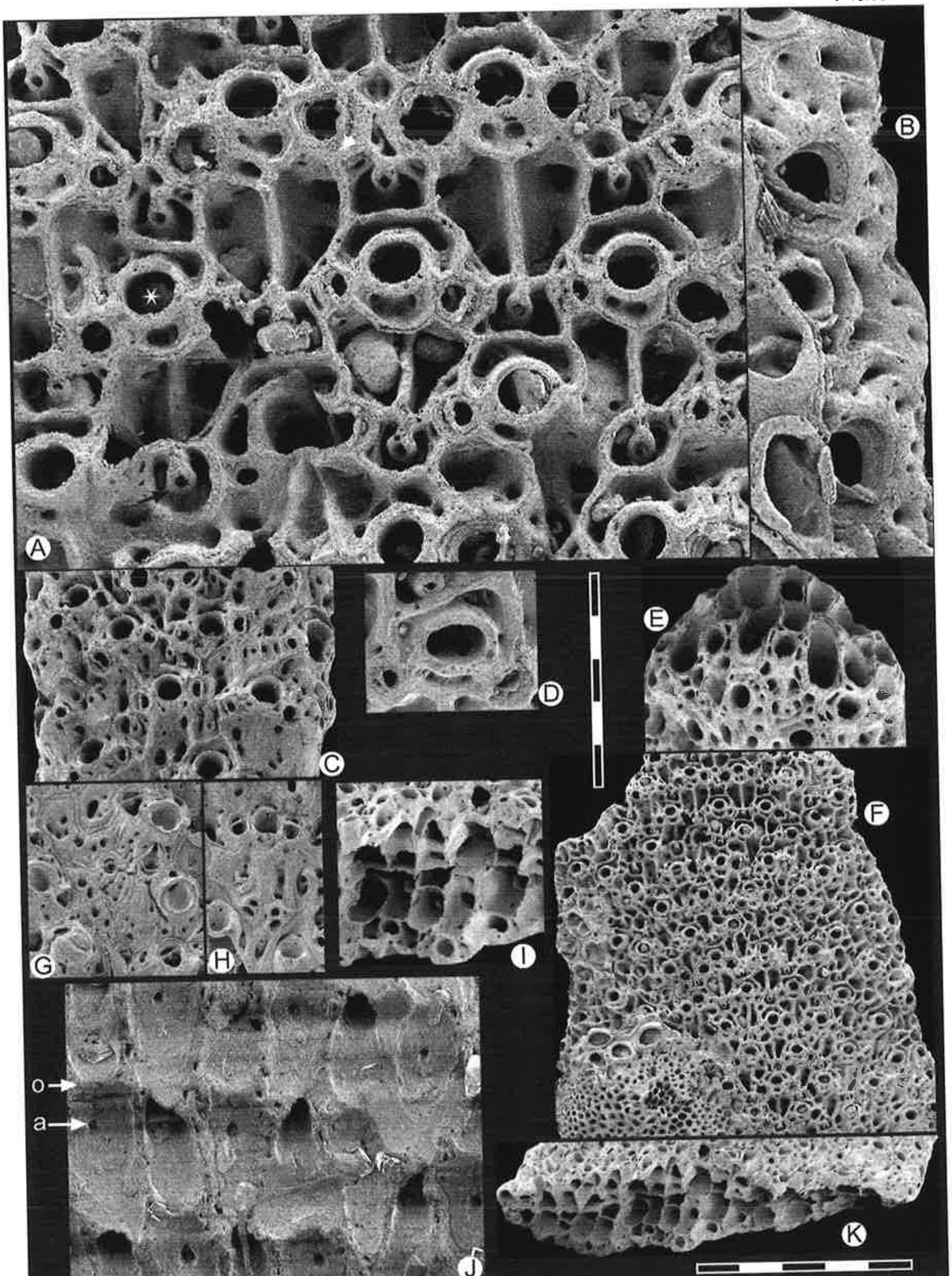
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Plate 43

A: ***Siphonicytara* sp. nov. a**, colony [0.50]
(SAM P39578)
B: ***Siphonicytara* sp. nov. a**, autozooids [0.10]
(SAM P39578)
C: ***Siphonicytara* sp. nov. b**, autozooids [0.10]
(SAM P39579)
D: ***Siphonicytara* sp. nov. b**, autozooids [0.10]
(SAM P39579)
E: ***Siphonicytara* sp. nov. b**, colony [0.50]
(SAM P39579)
F: ***Siphonicytara* sp. nov. c**, colony [0.25]
(SAM P39580)
G: ***Siphonicytara* sp. nov. c**, autozooids [0.10]
(SAM P39580)
H: ***Siphonicytara* sp. nov. c**, autozooid orifice [0.10]
(SAM P39580)
I: ***Siphonicytara* sp. nov. d**, autozooid orifice [0.10]
(SAM P39581)
J: ***Siphonicytara* sp. nov. d**, autozooids [0.10]
(SAM P39581)
K: ***Siphonicytara* sp. nov. d**, colony [0.25]
(SAM P39581)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

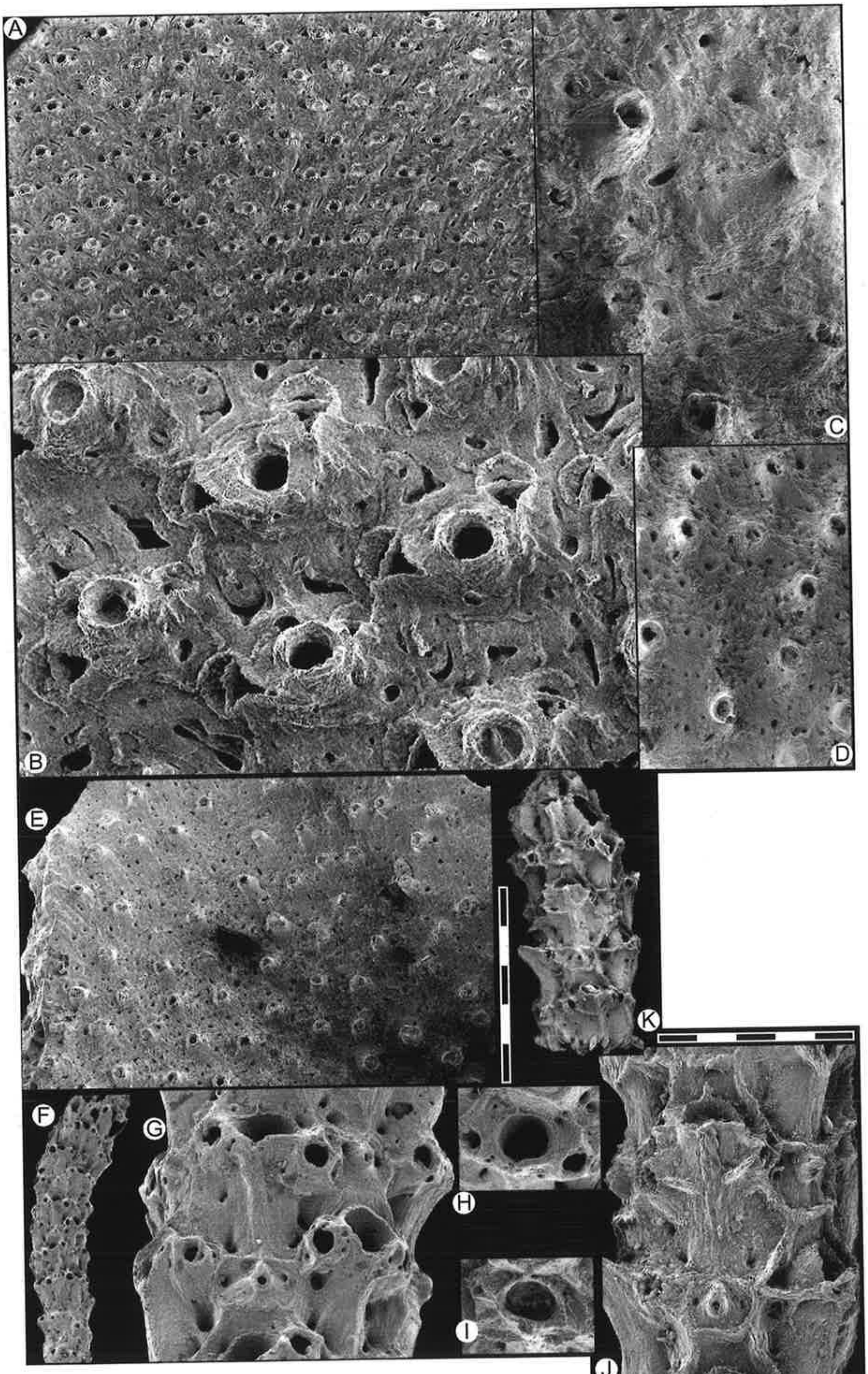
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Plate 44

A: ***Tubiporella magna***, autozooids [0.50]
(SAM P39326)

B: ***Tubiporella magna***, autozooids with frontal walls removed showing avicularian chambers [0.25]
(SAM P39326)

C: ***Tubiporella magna***, autozooids [0.10]
(SAM P39326)

D: ***Tubiporella magna***, autozooids base of lateral wall showing pore chambers [0.25]
(SAM P39326)

E: ***Tubiporella magna***, autozooids [0.25]
(SAM P39326)

F: ***Tubiporella magna***, ovicelled zooids [0.25]
(SAM P39325)

G: ***Tubiporella*? sp.**, mould of basal surface of lunulitiform bryozoan [1.00]
(SAM P39584)

H: ***Tubiporella*? sp.**, detail of mould of basal surface of lunulitiform bryozoan, showing impressions of basal 'pores' [0.10]
(SAM P39584)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

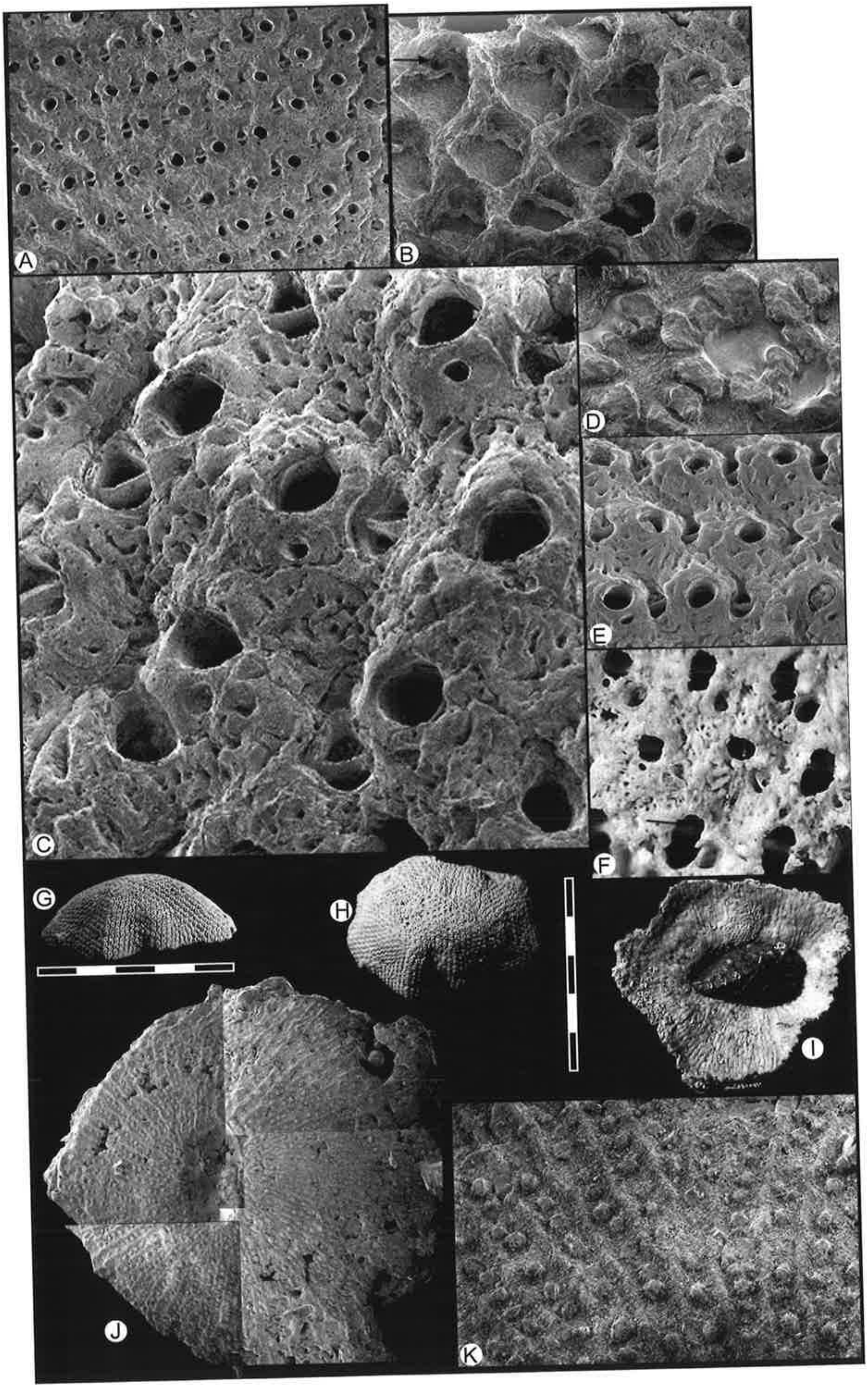
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Plate 45

A: ***Gen. indet. C* sp. nov. a**, autozooids [0.10] (SAM P39567)

B: ***Gen. indet. C* sp. nov. a**, bifurcating branch [0.25] (SAM P39567)

C: ***Gen. indet. C* sp. nov. a**, view into orifices of autozooids [0.10] (SAM P39567)

D: ***Gen. indet. C* sp. nov. a**, autozooid with currugated peristome [0.10] (SAM P39568)

E: ***Gen. indet. C* sp. nov. b**, branch fragment [0.25] (SAM P39569)

F: ***Gen. indet. C* sp. nov. b**, autozooids [0.10] (SAM P39569)

G: ***Gen. indet. C* sp. nov. b**, view into orifices of autozooids [0.10] (SAM P39569)

H: ***Gen. indet. C* sp. nov. b**, ovicelled zooids [0.10] (SAM P39570)

I: ***Gen. indet. A* sp. nov. a**, bifurcation branch [0.50] (SAM P39565)

J: ***Gen. indet. A* sp. nov. a**, autozooid [0.10] (SAM P39565)

K: ***Gen. indet. A* sp. nov. a**, autozooid, lateral view of orifice showing condyle (arrowed) [0.10] (SAM P39565)

L: ***Gen. indet. A* sp. nov. a**, view into orifices of autozooids [0.10] (SAM P39565)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

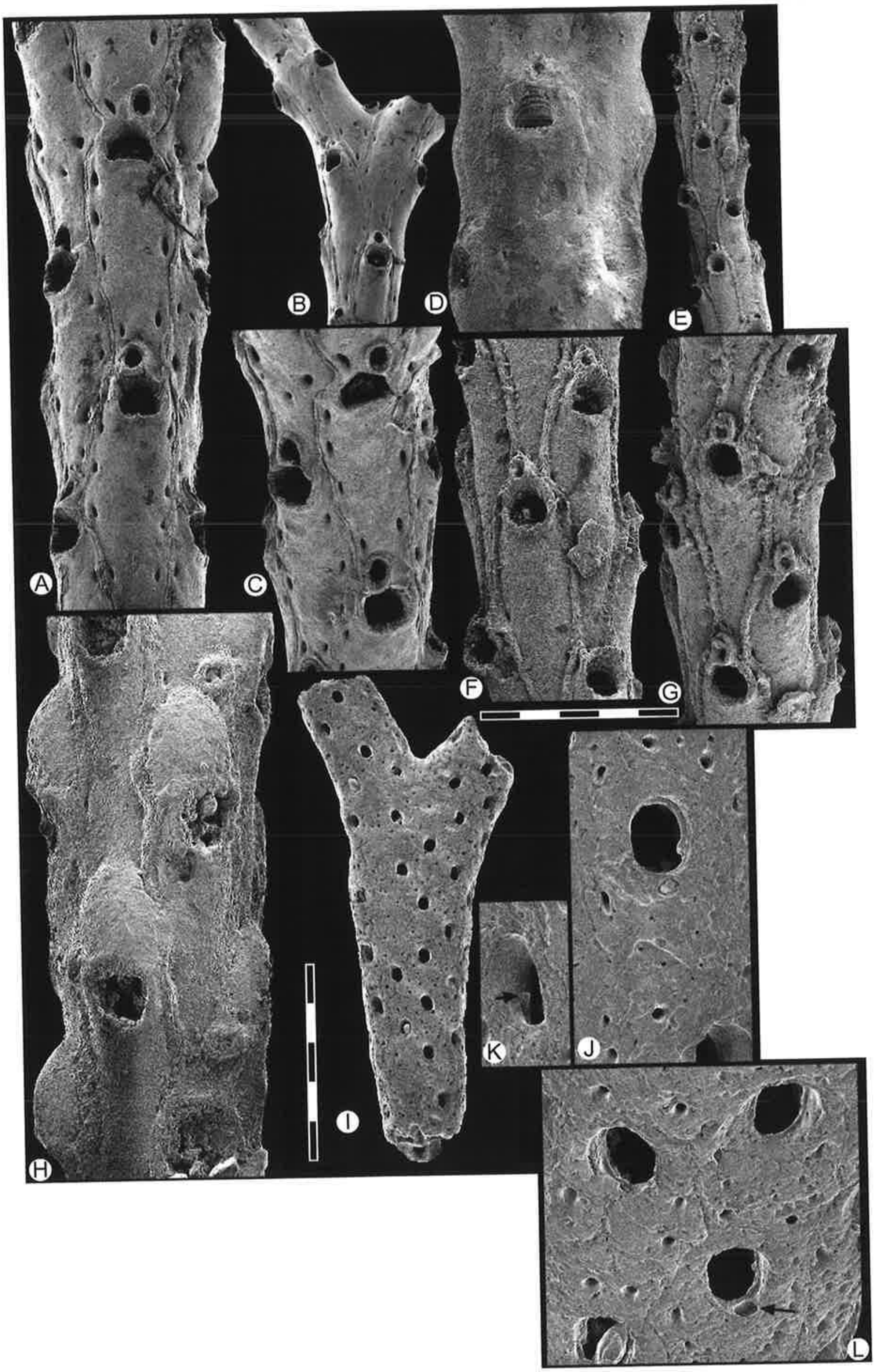
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Plate 46

A: ***Celleporina?* sp. nov. a**, colony fragment, showing maculae [0.50] (SAM P39536)
B: ***Celleporina?* sp. nov. a**, ovicelled zooids [0.25] (SAM P39536)
C: ***Celleporina?* sp. nov. a**, view into opening of ovicelled zooids [0.25] (SAM P39536)
D: ***Celleporina?* sp. nov. a**, ovicelled zooids without frontal thickening [0.25] (SAM P39537)
E: ***Celleporina?* sp. nov. a**, view into proximal autozooid margins showing avicularia [0.25] (SAM P39535)
F: ***Celleporina?* sp. nov. a**, cross-section of colony showing ovicelled zooids [0.25] (SAM P39537)
G: ***Celleporina?* sp. nov. a**, ovicell [0.10] (SAM P39537)
H: ***Celleporina?* sp. nov. a**, adventitious avicularium [0.10] (SAM P39536)
I: ***Celleporina?* sp. nov. a**, autozooids [0.10] (SAM P39536)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

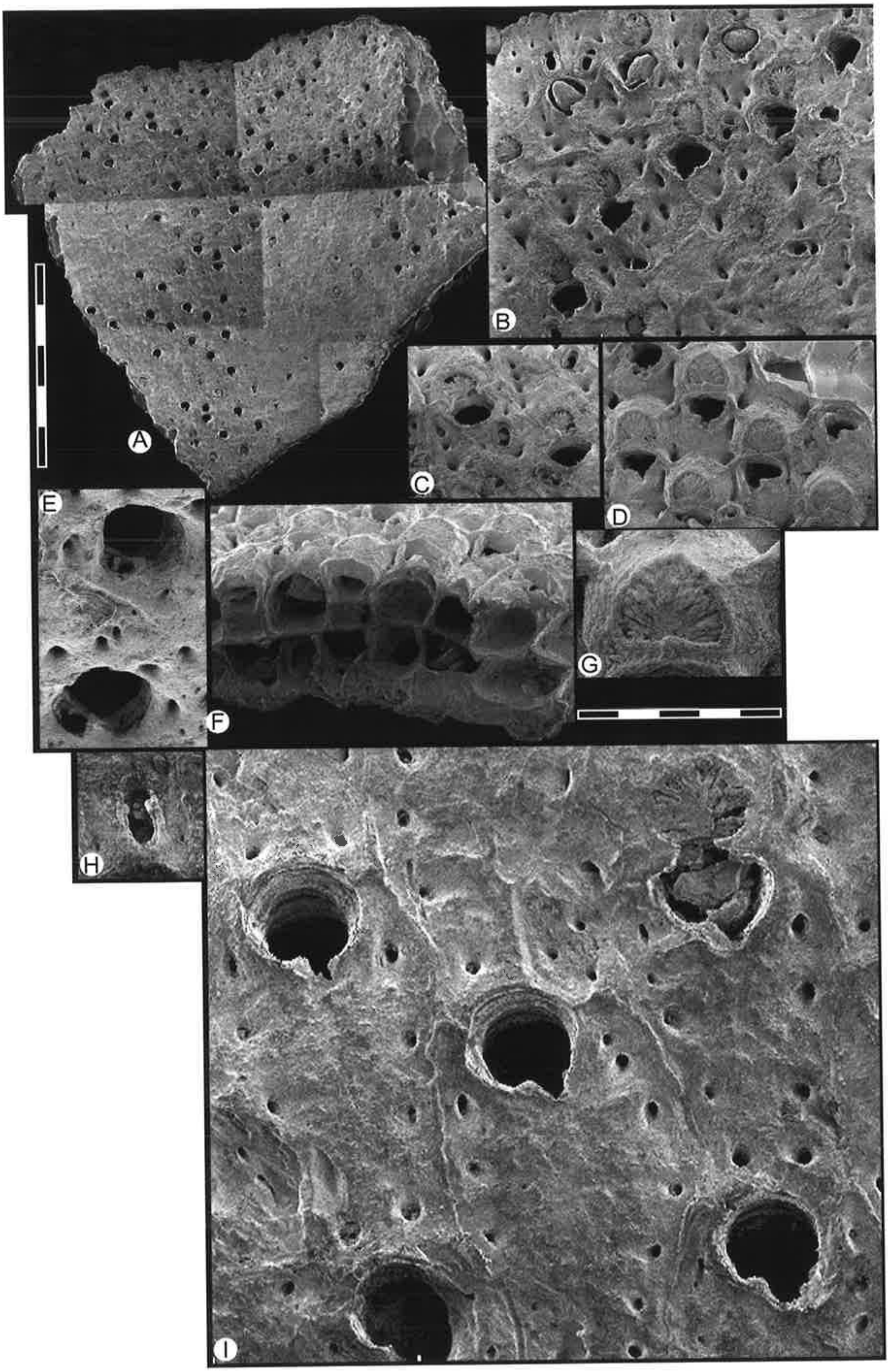
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Plate 47

A: ***Buffonellaria? roberti***, autozooids [0.10]
(SAM P39556)
B: ***Buffonellaria? roberti***, view into orifice of autozooid [0.05]
(SAM P39556)
C: ***Buffonellaria? roberti***, autozooids [0.25]
(SAM P39556)
D: ***Buffonellaria? roberti***, ovicelled zooids [0.10]
(SAM P39557)
E: ***Buffonellaria? roberti***, ovicelled zooids with interzooidal avicularium[0.10]
(SAM P39558)
F: ***Buffonellaria? roberti***, ovicelled zooids [0.10]
(SAM P39557)
G: ***Osthimosia?* sp. nov. a**, colony fragment [0.25]
(SAM P39571)
H: ***Osthimosia?* sp. nov. a**, colony fragment [0.25]
(SAM P39571)
I: ***Osthimosia?* sp. nov. a**, autozooids [0.10]
(SAM P39571)
J: ***Osthimosia?* sp. nov. a**, view into procimal area of autozooids [0.10]
(SAM P39571)
K: ***Palmicellaria* sp. nov. a**, view into orifice [0.10]
(SAM P39572)
L: ***Palmicellaria* sp. nov. a**, colony fragment [0.10]
(SAM P39572)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

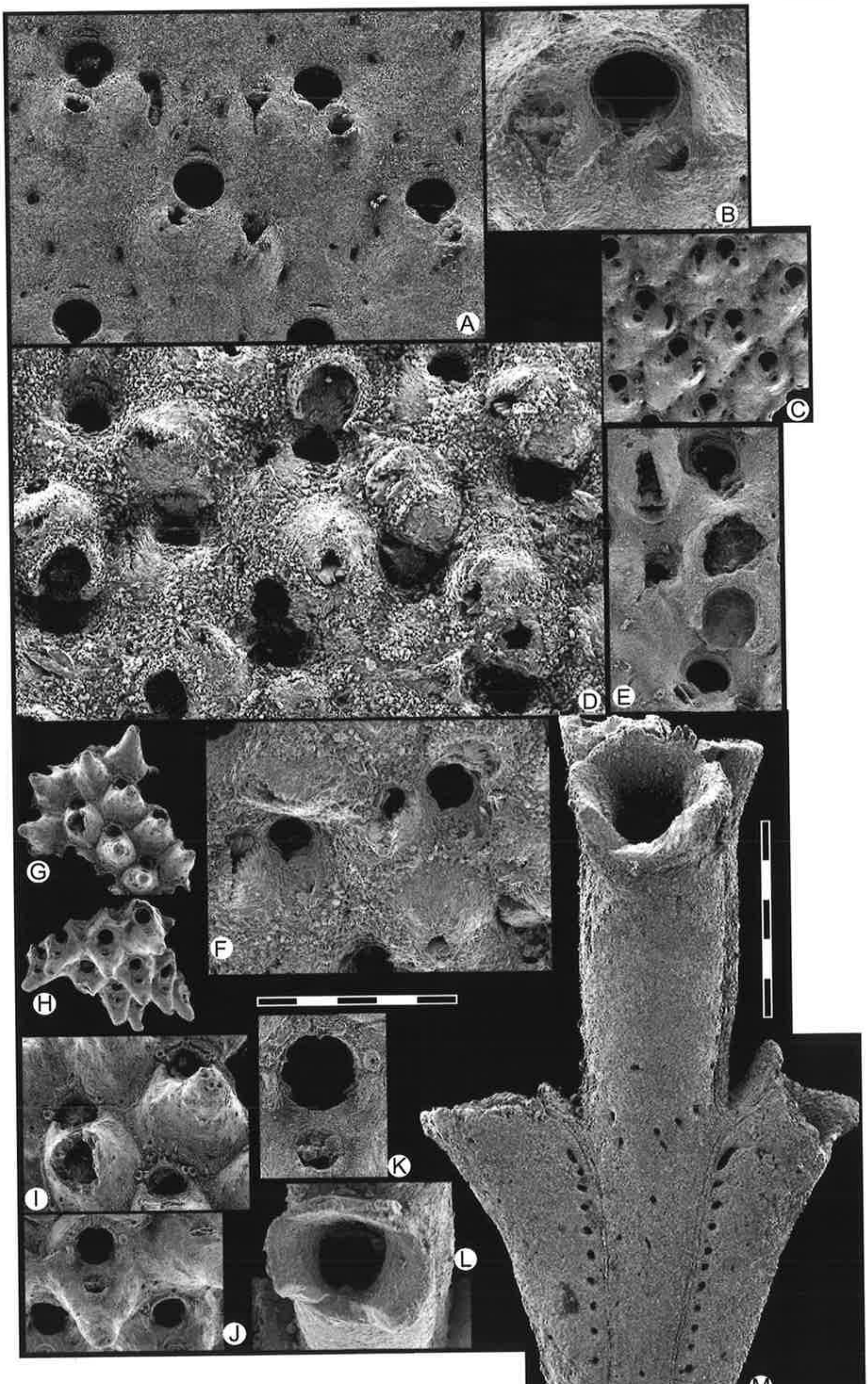
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Plate 48

A: ***Reteporella* aff. *rimata***, colony fragment [0.25] (SAM P39585)

B: ***Reteporella* aff. *rimata***, autozooids [0.10] (SAM P39585)

C: ***Reteporella* aff. *rimata***, autozooid orifice [0.05] (SAM P39585)

D: ***Reteporella* aff. *rimata***, autozooid orifice [0.05] (SAM P39585)

E: ***Reteporella* aff. *rimata***, basal surface of colony fragment [0.25] (SAM P39586)

F: ***Reteporella* aff. *rimata***, lateral view of colony [0.10] (SAM P39586)

G: ***Reteporella* sp. nov. a**, autozooids and ovicelled zooids [0.10] (SAM P39588)

H: ***Reteporella* sp. nov. a**, colony fragment [0.25] (SAM P39588)

I: ***Reteporella* sp. nov. a**, autozooids [0.10] (SAM P39588)

J: ***Reteporella* sp. nov. a**, ovicelled zooids [0.10] (SAM P39589)

K: ***Reteporella* sp. nov. a**, view into orifices of autozooids and ovicelled zooids [0.10] (SAM P39588)

L: ***Reteporella* sp. nov. a**, basal surface of colony fragment [0.25] (SAM P39590)

M: ***Reteporella* sp. nov. b**, autozooids and ovicelled zooids [0.10] (SAM P39591)

N: ***Reteporella* sp. nov. b**, colony fragment [0.25] (SAM P39591)

O: ***Reteporella* sp. nov. b**, view into orifices of autozooids [0.10] (SAM P39591)

P: **phidoloporid sp. nov. a**, autozooids [0.10] (SAM P39829)

Q: ***Phidoloporidae Gen. indet. A* sp. nov. a**, colony fragment [0.50] (SAM P39829)

R: ***Phidoloporidae Gen. indet. A* sp. nov. a**, basal surface of colony fragment [0.25] (SAM P39829)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

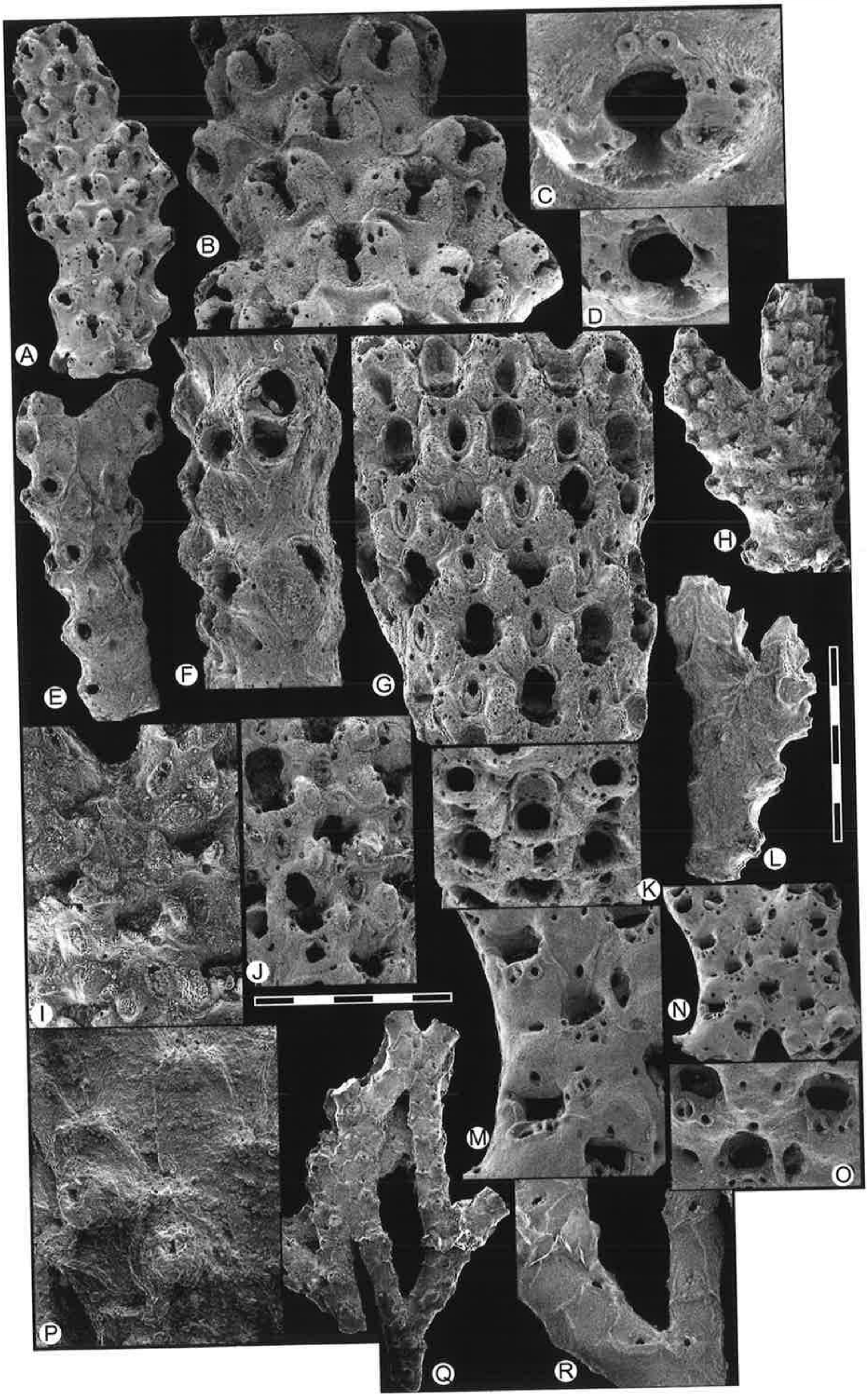
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Plate 49

A: ***Reteporella?* sp. nov. c**, colony fragment [0.25] (SAM P39592)
B: ***Reteporella?* sp. nov. c**, colony fragment [0.25] (SAM P39593)
C: ***Reteporella?* sp. nov. c**, autozooids [0.10] (SAM P39592)
D: ***Reteporella?* sp. nov. c**, autozooids [0.10] (SAM P39593)
E: ***Reteporella?* sp. nov. c**, view into orifices of autozooids [0.05] (SAM P39593)
F: ***Reteporella?* sp. nov. c**, autozooids and ovicelled zooids [0.10] (SAM P39593)
G: ***Reteporella?* sp. nov. c**, basal surface of colony fragment [0.25] (SAM P39592)
H: ***Reteporella?* sp. nov. d**, autozooids and ovicelled zooids [0.10] (SAM P39594)
I: ***Reteporella?* sp. nov. d**, ovicelled zooids [0.10] (SAM P39594)
J: ***Reteporella?* sp. nov. d**, view into orifices of autozooids and ovicelled zooids [0.10] (SAM P39594)
K: ***Iodictyum?* sp. nov. a**, basal surface of colony fragment [0.25] (SAM P39596)
L: ***Iodictyum?* sp. nov. a**, autozooids [0.10] (SAM P39596)
M: ***Iodictyum?* sp. nov. a**, colony fragment [0.25] (SAM P39596)
N: ***Iodictyum?* sp. nov. a**, basal surface of colony fragment [0.10] (SAM P39596)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

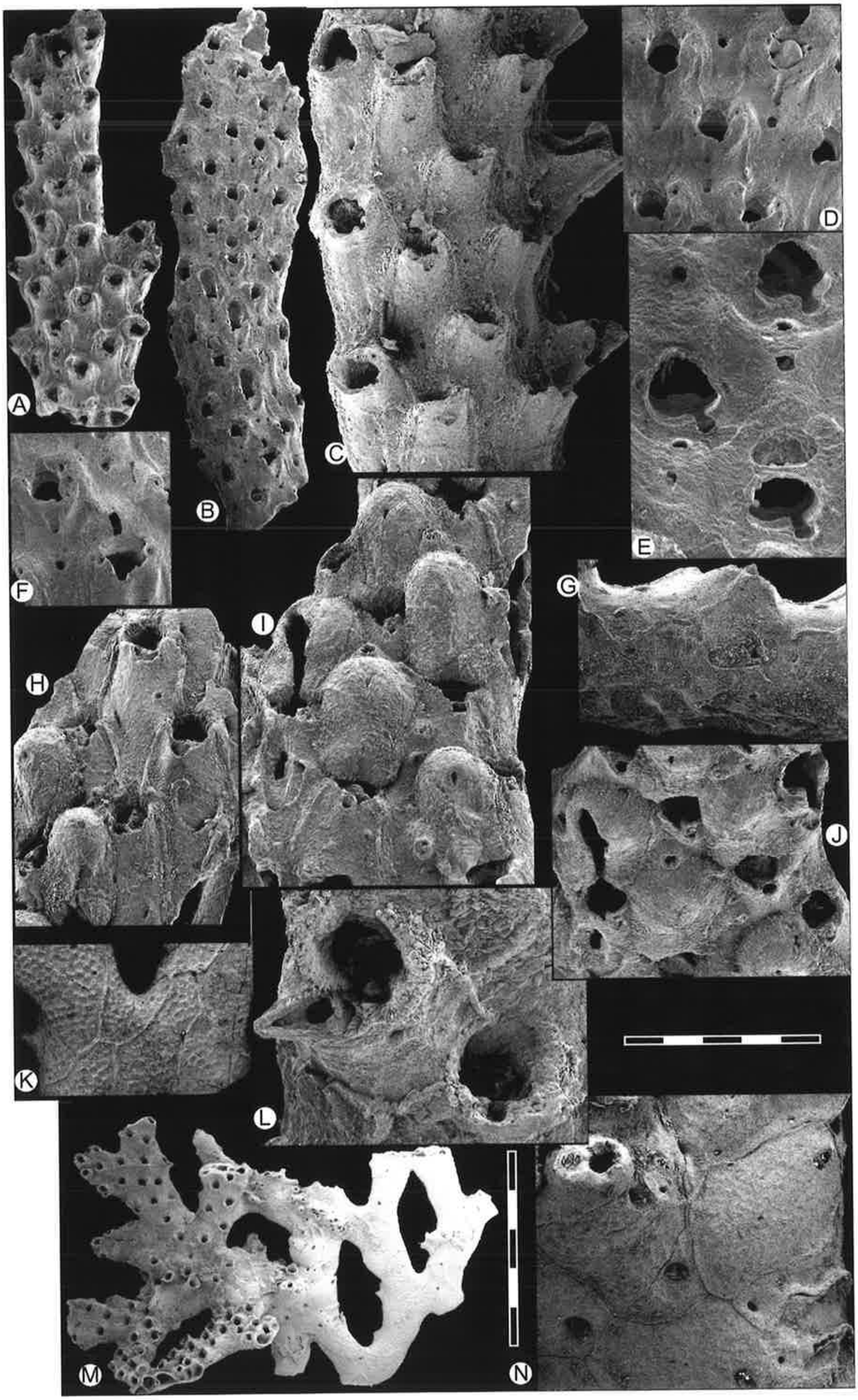
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Plate 50

A: ***Reteporellina* sp. nov. a**, colony fragment [0.25]
(SAM P39597)
B: ***Reteporellina* sp. nov. a**, view into orifices of autozooids [0.25]
(SAM P39597)
C: ***Reteporellina* sp. nov. a**, view into orifice of autozooid showing suboral avicularium [0.05]
(SAM P39597)
D: ***Reteporellina* sp. nov. a,** view into orifice of autozooid [0.10]
(SAM P39598)
E: ***Reteporellina* sp. nov. a**, ovicelled zooids [0.10]
(SAM P39598)
F: ***Reteporellina?* sp. nov. b**, colony fragment [0.25]
(SAM P39599)
G: ***Reteporellina?* sp. nov. b**, basal surface of colony fragment [0.25]
(SAM P39600)
H: ***Reteporellina?* sp. nov. b**, basal surface of colony fragment [0.10]
(SAM P39599)
I: ***Reteporellina?* sp. nov. b**, ovicelled zooids [0.10]
(SAM P39599)
J: ***Reteporellina?* sp. nov. b**, ovicelled zooids [0.10]
(SAM P39600)
K: ***Reteporella?* sp. nov. f**, view into orifices of autozooids [0.10]
(SAM P39595)
L: ***Reteporella?* sp. nov. f**, colony fragment [0.10]
(SAM P39595)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

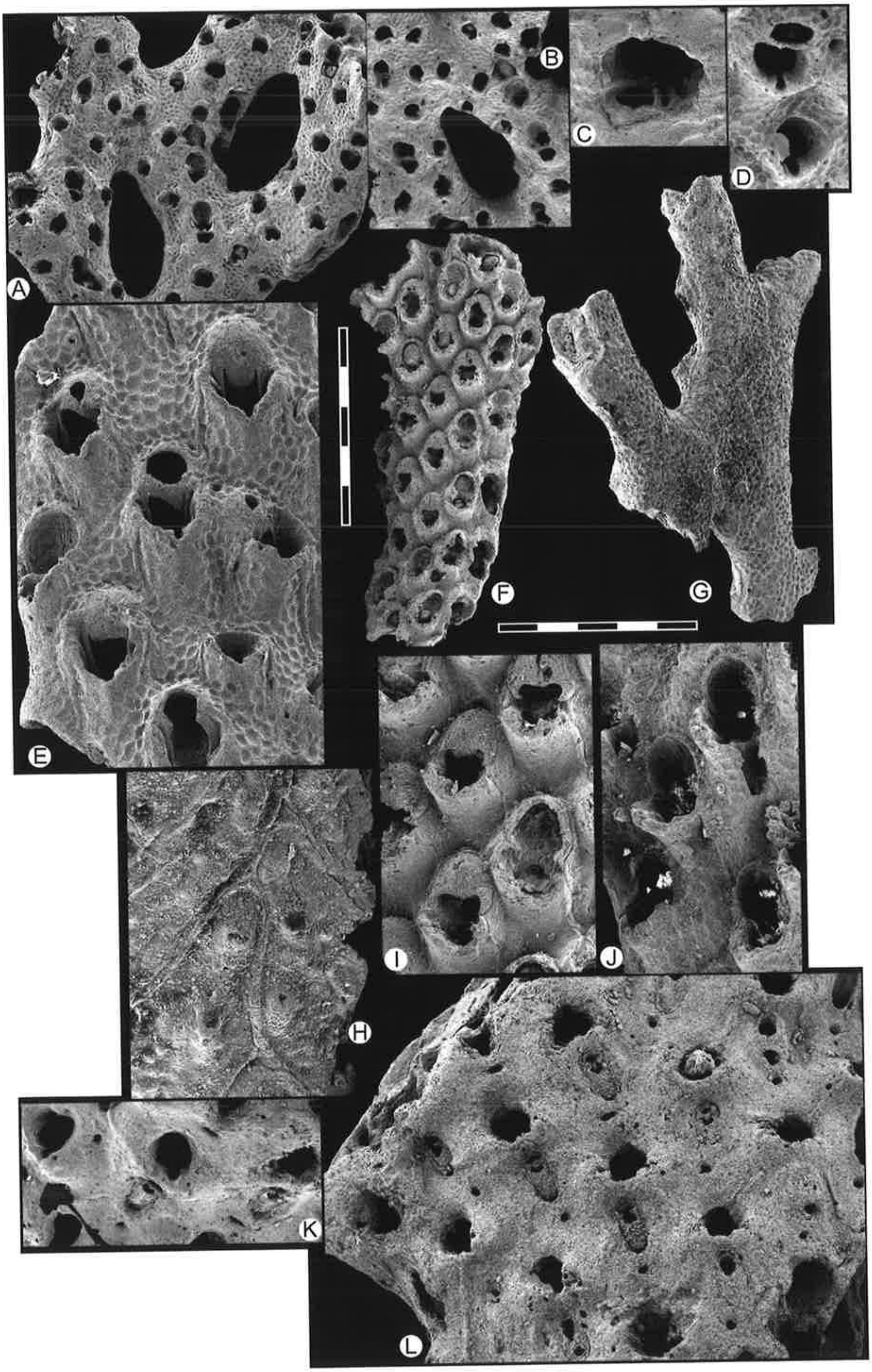
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Plate 51

A: ***'Triphylozoon'?* sp. nov. a**, colony fragment [1.00] (SAM P39601)
B: ***'Triphylozoon'?*sp. nov. a**, colony fragment [0.25] (SAM P39602)
C: ***'Triphylozoon'?*sp. nov. a**, basal surface of colony fragment [0.50] (SAM P39602)
D: ***'Triphylozoon'?*sp. nov. a**, ovicelled zooids [0.10] (SAM P39602)
E: ***'Triphylozoon'?*sp. nov. a**, autozooids [0.10] (SAM P39601)
F: ***'Triphylozoon'?* sp. nov. a**, autozooids and ovicelled zooids [0.10] (SAM P39601)
G: ***'Triphylozoon'?*sp. nov. a**, ovicelled zooid [0.10] (SAM P39602)
H: ***'Triphylozoon'?*sp. nov. a**, autozooids [0.25] (SAM P39947)
I: ***'Triphylozoon'?*sp. nov. a**, ovicelled zooids with broken ovicells [0.25] (SAM P39948)
J: ***'Triphylozoon'?*sp. nov. a**, basal surface of colony with adventitious avicularia [0.10] (SAM P39601)
K: ***'Triphylozoon'?*sp. nov. a**, orifice of autozooid [0.05] (SAM P39948)
L: ***'Triphylozoon'?*sp. nov. b**, colony fragment [0.25] (SAM P39949)
M: ***'Triphylozoon'?*sp. nov. b**, autozooids [0.10] (SAM P39949)
N: ***'Triphylozoon'?*sp. nov. b**, view into orifices of autozooids [0.10] (SAM P39949)
O: ***Phidoloporidae Gen. indet. B* sp. nov. a**, colony fragment [0.25] (SAM P39951)
P: ***Phidoloporidae Gen. indet. B* sp. nov. a**, basal surface of colony fragment [0.25] (SAM P39952)
Q: ***Phidoloporidae Gen. indet. B* sp. nov. a**, view into orifices of autozooids [0.10] (SAM P39952)
R: ***Phidoloporidae Gen. indet. B* sp. nov. a**, avicularia on basal surface of colony fragment [0.10] (SAM P39951)
S: ***Phidoloporidae Gen. indet. B* sp. nov. b**, colony fragment [0.25] (SAM P39953)
T: ***Phidoloporidae Gen. indet. B* sp. nov. b**, ovicelled zooid [0.10] (SAM P39953)
U: ***Phidoloporidae Gen. indet. B* sp. nov. b**, orifice of autozooid [0.05] (SAM P39953)
V: ***Phidoloporidae Gen. indet. B* sp. nov. b**, orifice of autozooid [0.05] (SAM P39953)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

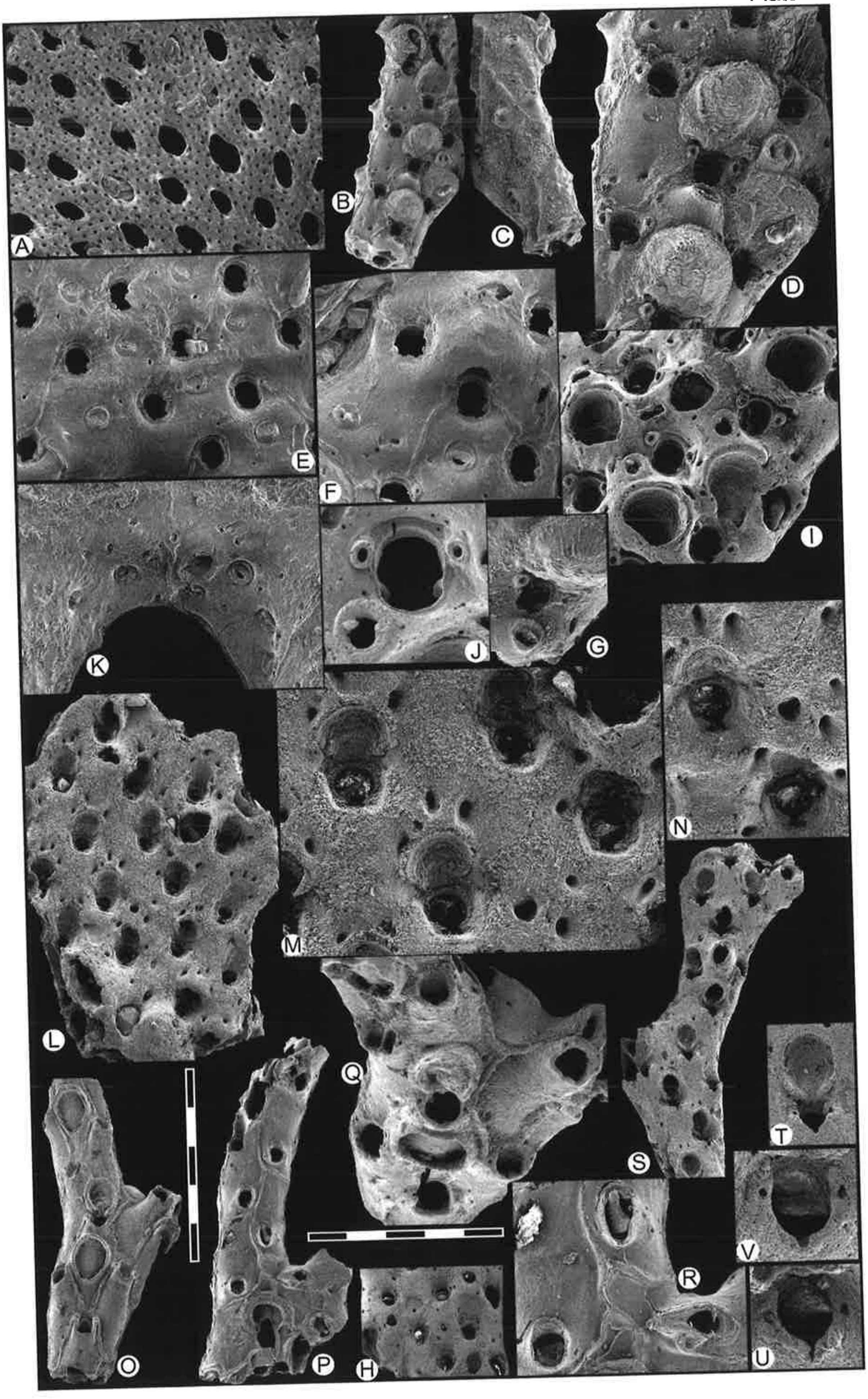
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Plate 52

A: ***Nevianipora* sp. nov. a**, colony fragment [0.50] (SAM P39954)

B: ***Nevianipora* sp. nov. a**, basal colony surface [0.25] (SAM P39954)

C: ***Nevianipora* sp. nov. a**, zooids [0.10] (SAM P39955)

D: ***Diaperoecia* sp. nov. b**, colony fragment [0.25] (SAM P39958)

E: ***Diaperoecia* sp. nov. b**, zooids [0.10] (SAM P39958)

F: **Tervia sp. nov. a**, colony fragment [0.25] (SAM P39960)

G: **Tervia sp. nov. a**, basal surface [0.25] (SAM P39960)

H: ***Diaperoecia* sp. nov. a**, zooids [0.10] (SAM P39957)

I: ***Diaperoecia* sp. nov. a**, colony fragment, with possible gonozooid at top [0.25] (SAM P39957)

J: ***Entalophoroecia* sp. nov. a**, [0.10] (SAM P39959)

K: ***Terviidae? Gen. indet.* sp. nov. a**, colony fragment [0.25] (SAM P39961)

L: ***Terviidae? Gen. indet.* sp. nov. a**, bifurcating colony fragment [0.25] (SAM P39961)

M: ***Terviidae? Gen. indet.* sp. nov. a**, zooids [0.10] (SAM P39961)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

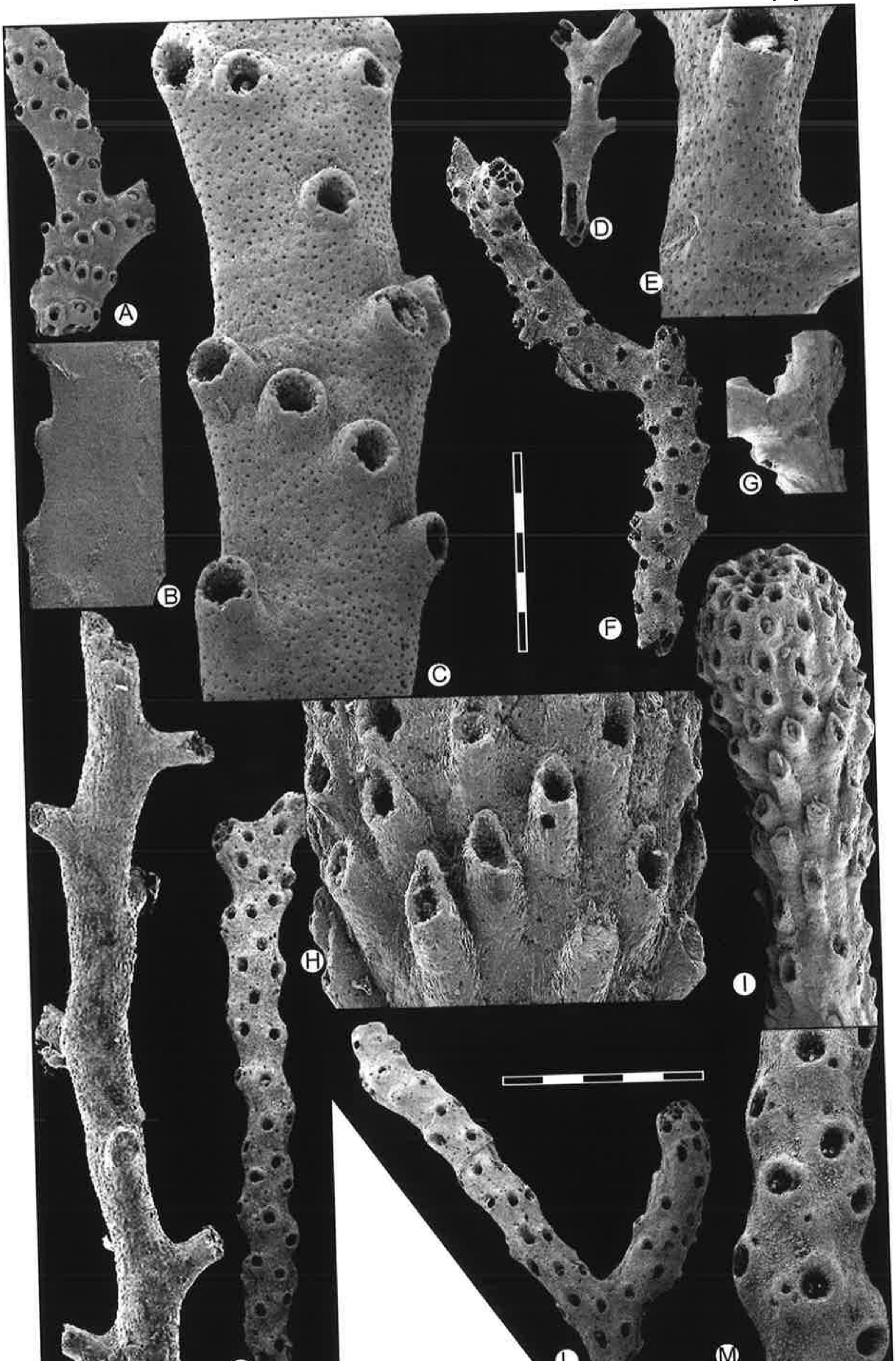
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Plate 53

A: ***Stomatopora* sp. nov. a**, colony encrusting on '*Onychocella'* sp. nov. b [0.25] (SAM P39964)

B: ***Stomatopora* sp. nov. a**, zooids [0.10] (SAM P39964)

C: ***Stomatopora* cf. *geminata***, colony encrusting *Larvapora*' zooid [0.10] (SAM P39963)

D: **'*Stomatopora'* sp. nov. b**, uniserial encruster (arrow indicates ancestrula enlarged in E) [0.25] (SAM P39993)

E: **'*Stomatopora'* sp. nov. b**, uniserial encruster ancestrula [0.10] (SAM P39993)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

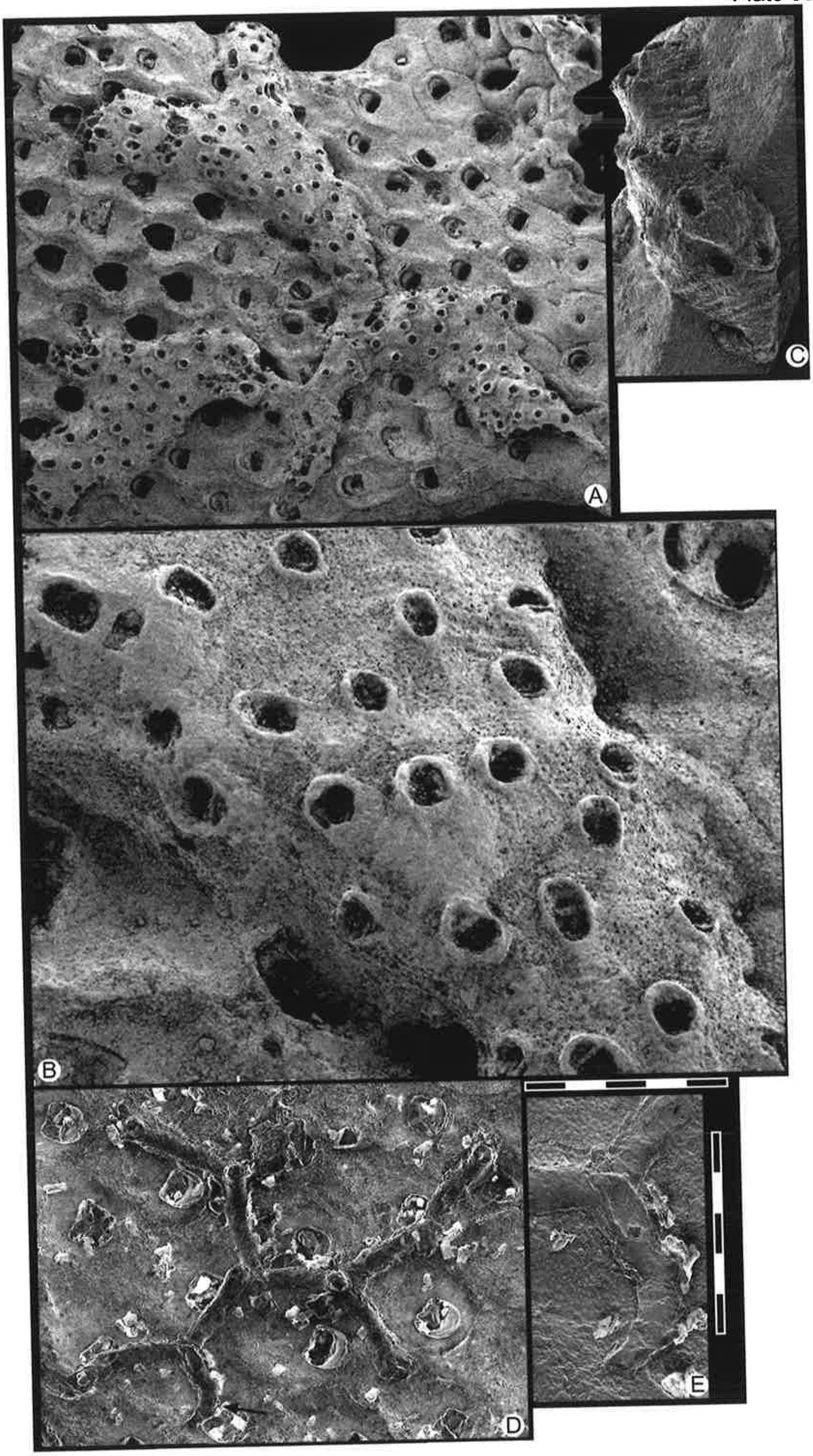
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Plate 54

A: ***Exidmonea?* sp. nov. a**, colony branch with gonozooid [0.10] (SAM P39965)

B: ***Exidmonea?* sp. nov. a**, colony branch [0.10] (SAM P39965)

C: ***Exidmonea?* sp. nov. a**, basal colony surface [0.25] (SAM P39967)

D: ***Exidmonea?* sp. nov. b**, colony branch [0.25] (SAM P39968)

E: ***Exidmonea?* sp. nov. c**, colony attachment [0.10] (SAM P39969)

F: ***Exidmonea?* sp. nov. c**, basal colony surface [0.25] (SAM P39969)

G: ***Exidmonea?* sp. nov. c**, lateral view of colony branch [0.25] (SAM P39969)

H: ***Exidmonea?* sp. nov. c**, colony branch [0.10] (SAM P39969)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

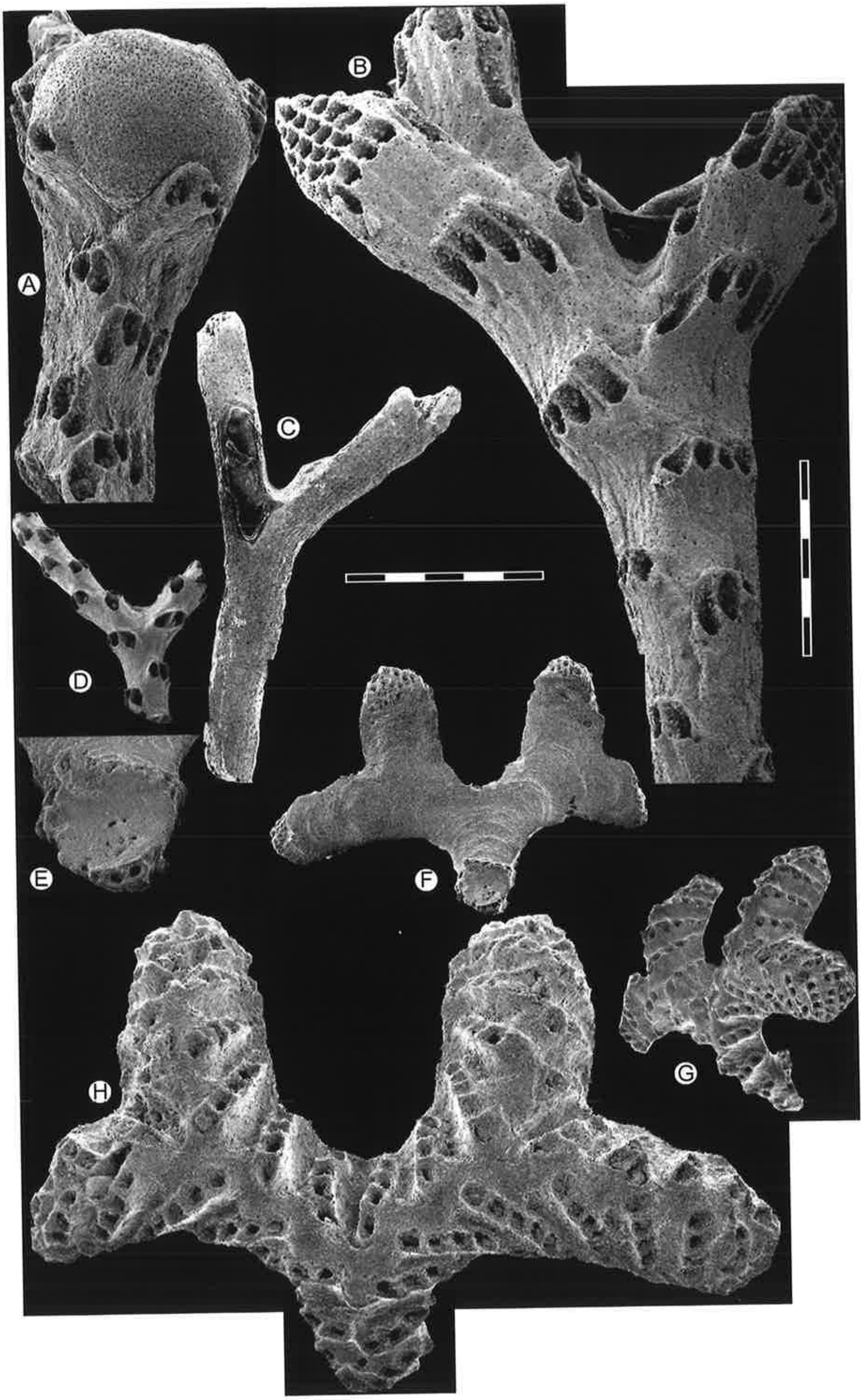
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Plate 55

A: ***Hornera* cf. *robusta***, colony fragment [0.10]
(SAM P39971)

B: ***Hornera* sp. nov. a**, colony fragment [0.10]
(SAM P39970)

C: ***Hornera* cf. *frondiculata***, colony fragment [0.10]
(SAM P39972)

D: ***Hornera* sp. nov. b**, basal colony surface [0.10]
(SAM P39973)

E: ***Hornera* sp. nov. b**, zooids and branch connections [0.10]
(SAM P39973)

F: ***Hornera* sp. nov. b**, colony fragment [0.50]
(SAM P39973)

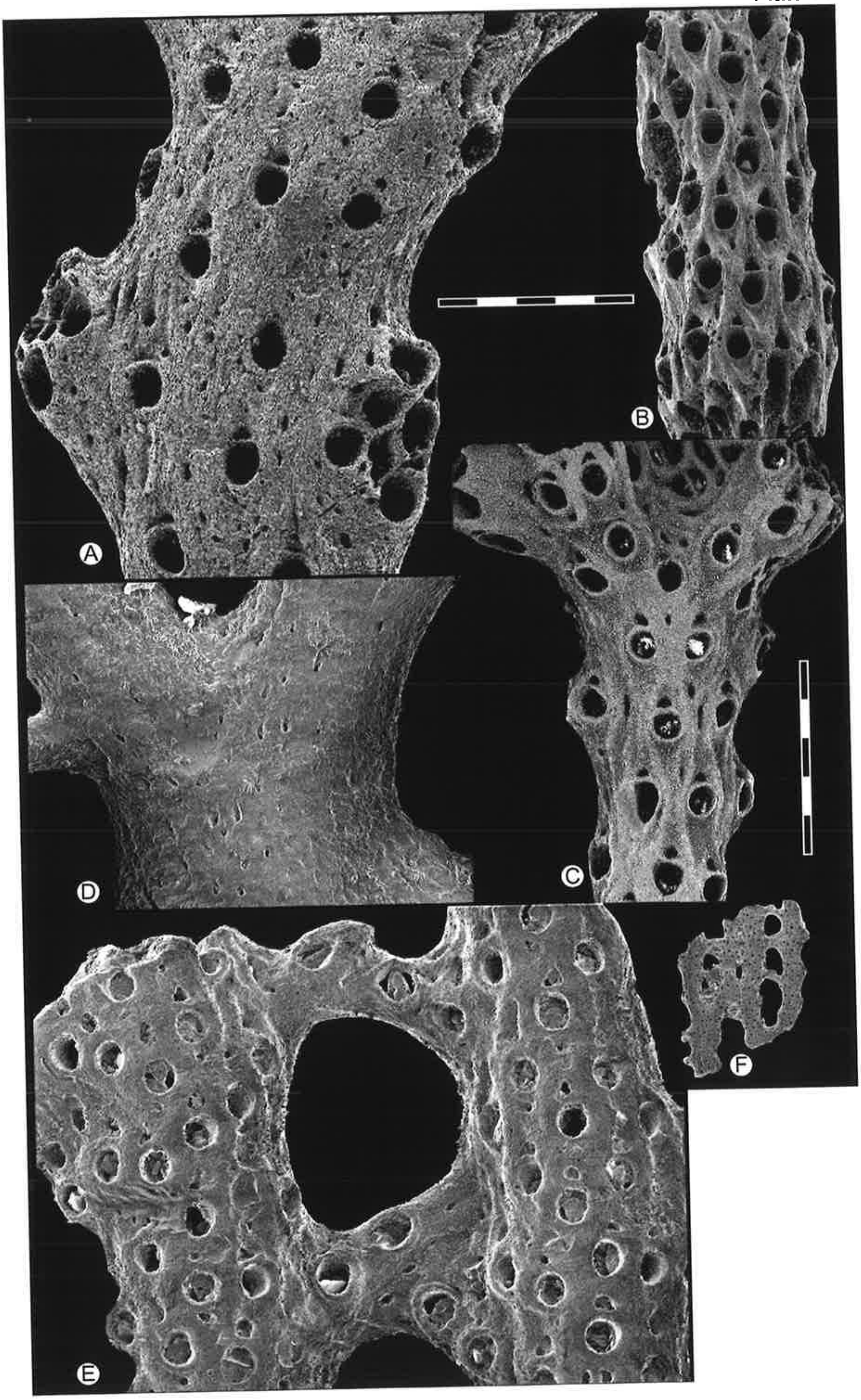
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Plate 56

A: ***Crisina* sp. nov. a**, colony fragment [0.50]
(SAM P39974)
B: ***Crisina* sp. nov. a**, zooids [0.10]
(SAM P39974)
C: ***Crisina* sp. nov. a**, basal surface of ooecium [0.25]
(SAM P39974)
D: ***Crisina* sp. nov. a**, lateral surface of ooecium [0.25]
(SAM P39974)
E: ***Crisina* sp. nov. a**, frontal surface of ooecium [0.25]
(SAM P39974)
F: ***Polyascosoeciella* sp. nov. a**, colony fragment [0.10]
(SAM P39975)
G: ***Heteropora pisiformis***, colony [0.10]
(SAM P39978)
H: ***Crisia* sp. nov. a**, internode [0.10]
(SAM P39976)
I: ***Crisia* sp. nov. b**, internode with ooecium [0.25]
(SAM P39977)
J: ***Crisia* sp. nov. b**, ooecium [0.10]
(SAM P39977)
K: ***Attinopora* sp. nov. a**, colony fragment [0.10]
(SAM P39991)
L: **Cyclosomata *Gen. indet. B* sp. a**, colony fragment [0.25]
(SAM P39994)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

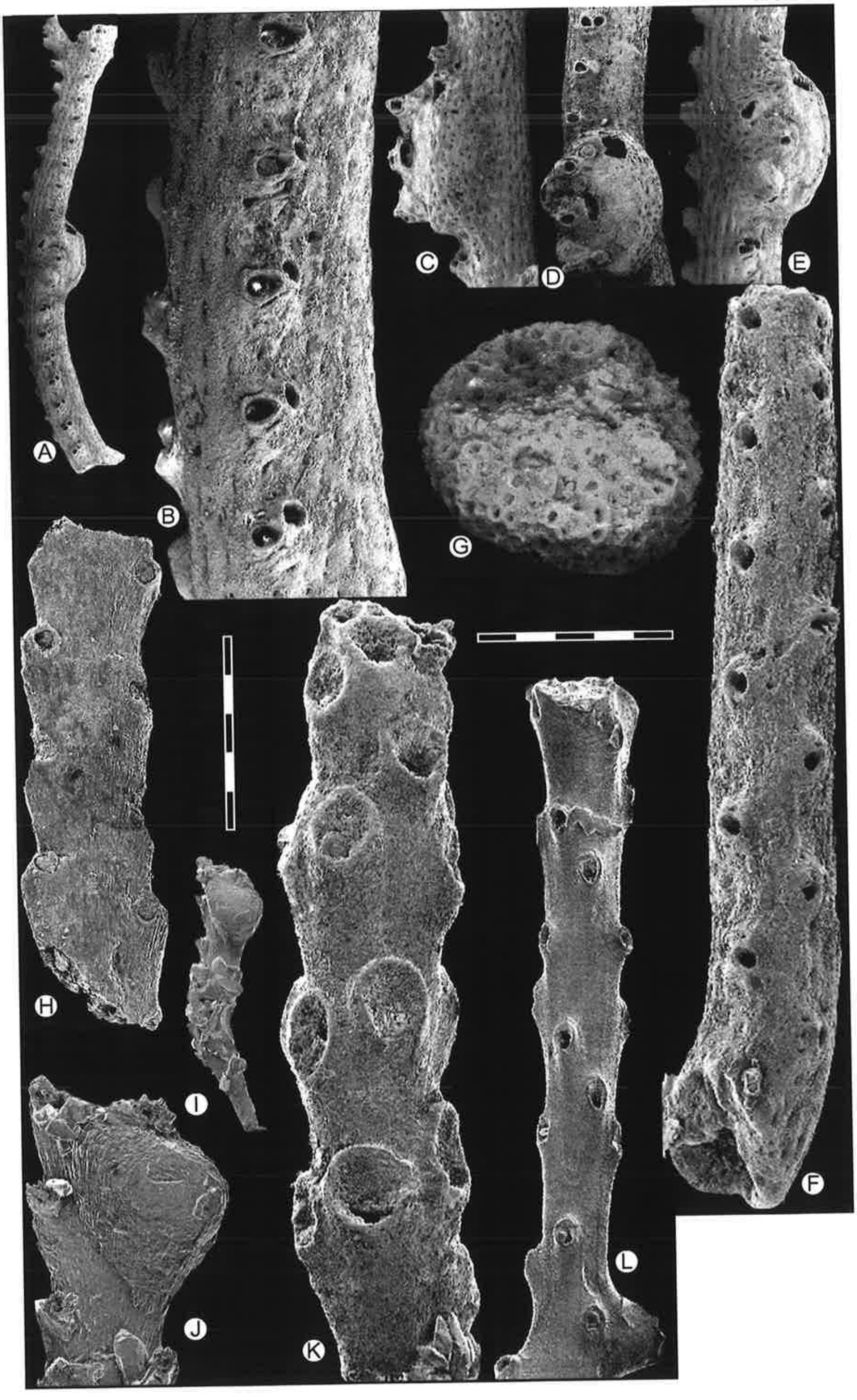
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Plate 57

A: ***Reticrescis* cf. *transennata***, colony fragment [0.50] (SAM P39979)
B: ***Reticrescis* cf. *transennata***, lateral view of colony fragment [0.50] (SAM P39979)
C: ***Reticrescis* cf. *transennata***, zooids [0.25] (SAM P39979)
D: ***Reticrescis* cf. *transennata***, basal colony surface [0.10] (SAM P39980)
E: ***Reticrescis* cf. *transennata***, zooids [0.10] (SAM P39980)
F: ***Reticrescis* sp. nov. a**, colony fragment [0.50] (SAM P39981)
G: ***Reticrescis* sp. nov. a**, lateral view of colony fragment [0.50] (SAM P39981)
H: ***Reticrescis* sp. nov. a**, zooids [0.25] (SAM P39981)
I: ***Reticrescis* sp. nov. a**, basal colony surface [0.25] (SAM P39981)
J: ***Reticrescis* sp. nov. a**, zooids [0.10] (SAM P39981)
K: **Cyclosomata *Gen. indet. C* sp. a**, colony fragment [0.25] (SAM P39994)
L: **Cyclosomata *Gen. indet. A* sp. a**, colony fragment [0.25] (SAM P39992)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

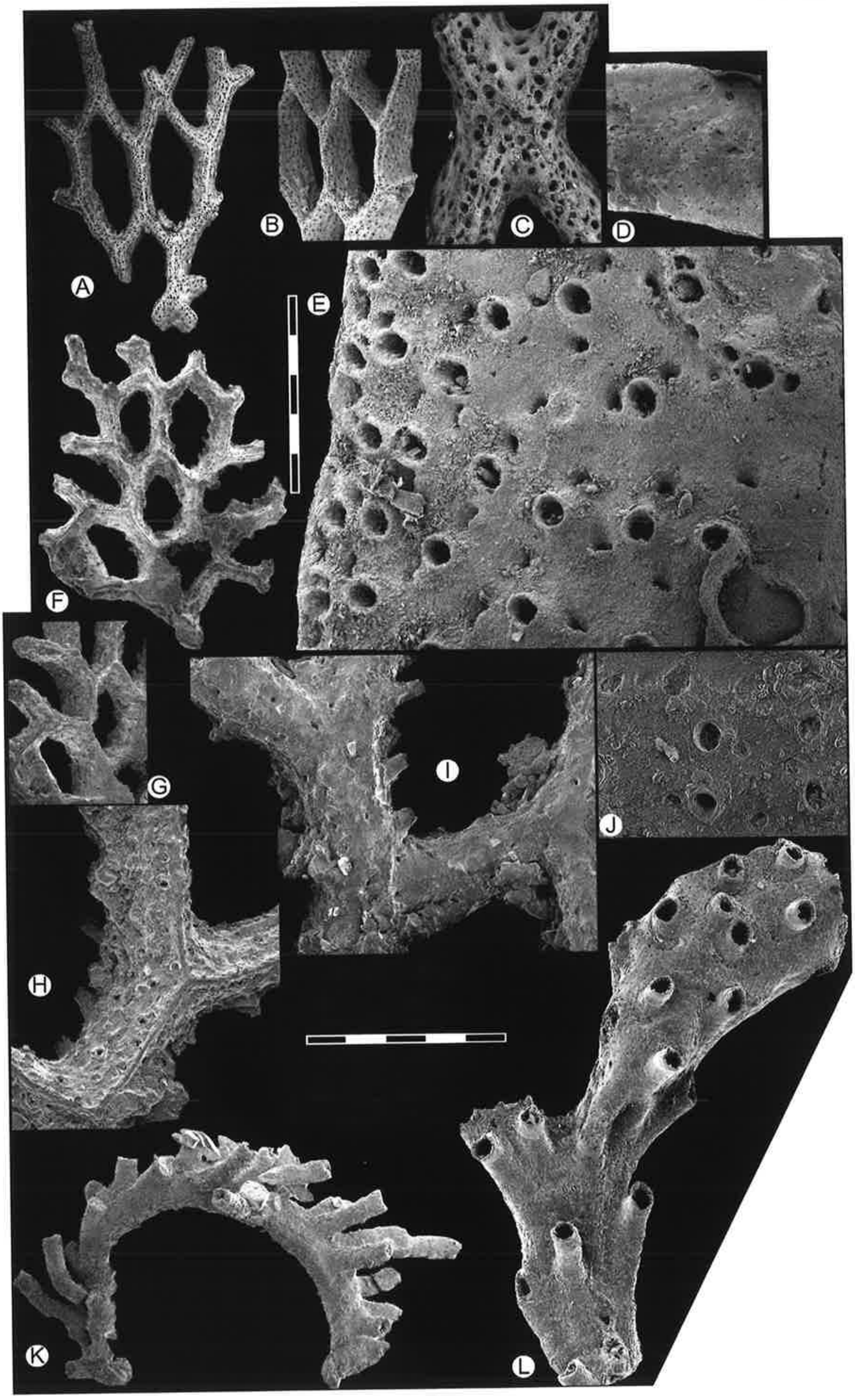
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Plate 58

A: ***Disporella* sp. nov. a**, colony encrusting on *Siphonicytara* sp. nov. a [0.10] (SAM P39982)
B: ***Disporella* sp. nov. a**, colony encrusting on echinoid plate[0.10] (SAM P39982)
C: ***Disporella* sp. nov. b**, colony [0.10] (SAM P39985)
D: ***Disporella* sp. nov. b**, lateral view of colony [0.10] (SAM P39985)
E: ***Lichenoporidae Gen. indet. C* sp. nov. a**, frontal colony surface [0.10] (SAM P39987)
F: ***Lichenoporidae Gen. indet. C* sp. nov. a**, lateral view of colony [0.10] (SAM P39987)
G: ***Lichenoporidae Gen. indet. C* sp. nov. b**, fungiform colony [0.25] (SAM P40002)
H: ***Lichenoporidae Gen. indet. C* sp. nov. b**, basalcolony surface [0.10] (SAM P40002)
I: ***Lichenoporidae Gen. indet. B* sp. nov. a**, colony fragment [0.25] (SAM P39986)
J: ***Lichenoporidae Gen. indet. D* sp. nov. a**, colony fragment [0.25] (SAM P39988)
K: **'*Berenicea*' sp. nov. a**, encrusting colony [0.25] (SAM P39990)
L: **Cyclostomata *Gen. indet. D* sp. nov. a**, encrusting colony [0.10] (SAM P39989)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

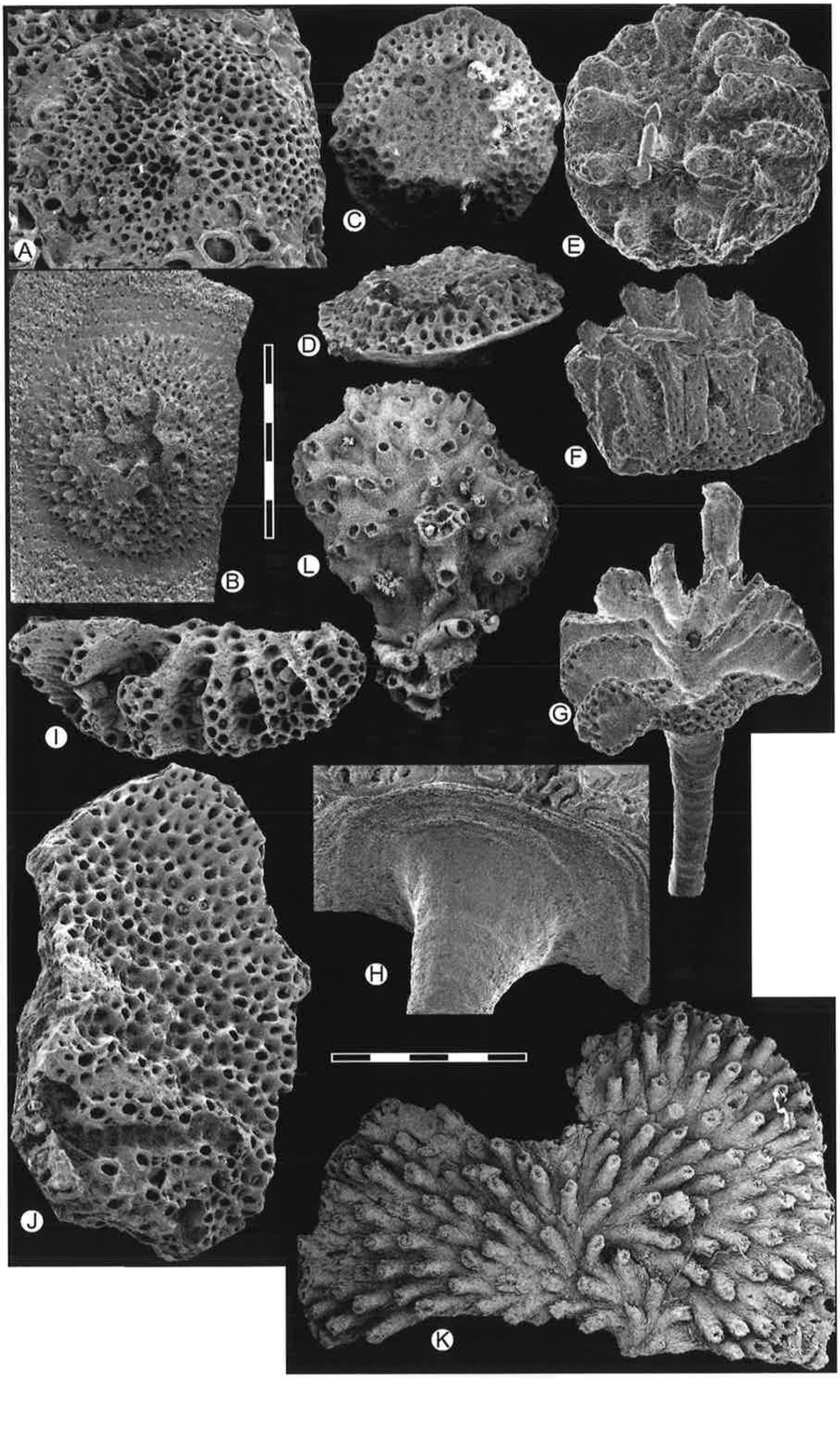
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Plate 59

A: South Maslin Sand, Tortachilla Limestone and Tukeja Member of Blanche Point Formation (outcrop at Maslin Beach stairway, section M2a; measuring stick increments = 10cm)

B: upper Tortachilla Limestone, Tukeja and lower Gull Rock Members of Blanche Point Formation (shore platform just north of Blanche Point, section M5a; measuring stick increments = 10cm)

C: Tortachilla Limestone (outcrop north of Maslin Beach stairway, section M1c)

D: Gull Rock and Perkana Members of Blanche Point Formation (just north of Onkaparinga Mouth)

E: Gull Rock and Perkana Members of Blanche Point Formation (shore platform just south of Blanche Point, section M6a)

[1.00]=1mm(5mm); [0.50]=0.5mm(2.5mm); [0.25]=0.25mm(1.25mm); [0.10]=0.1mm(0.5mm); [0.05]=0.05mm(0.25mm).

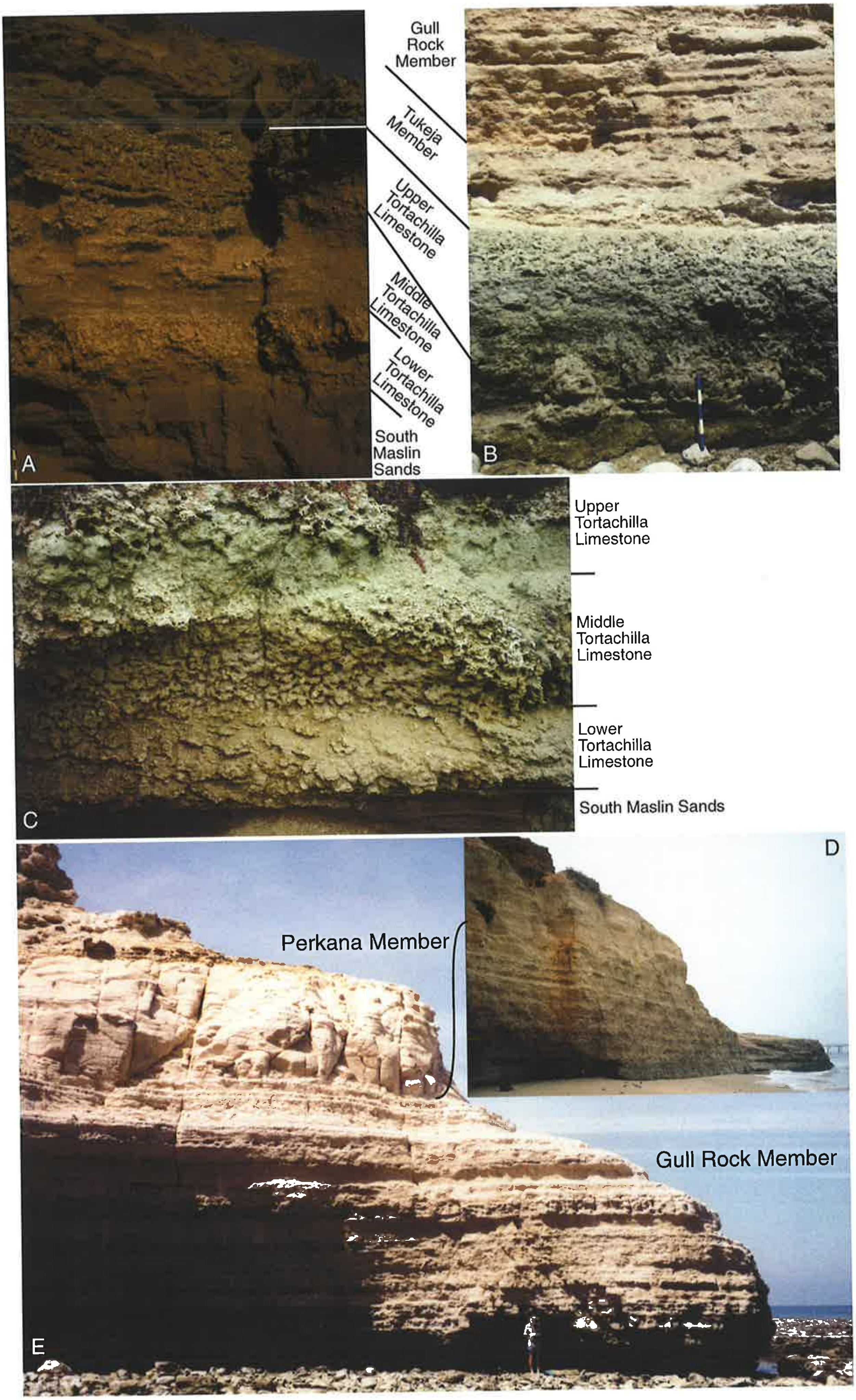

Gull Rock Member
Tukeja Member
Upper Tortachilla Limestone
Middle Tortachilla Limestone
Lower Tortachilla Limestone
South Maslin Sands
A
B
Upper Tortachilla Limestone
Middle Tortachilla Limestone
Lower Tortachilla Limestone
South Maslin Sands
C
D
Perkana Member
Gull Rock Member
E

Plate 60

A: Basal Mulloowurtie Formation overlying Cambrian basement high (just north of Harts Mine, Yorke Peninsula, cliff is ca. 11m high)

B: Close up of basal Mulloowurtie Formation overlying Cambrian basement high (just north of Harts Mine, Yorke Peninsula)

C: Mulloowurtie Formation (north of Mulloowurtie Point; measuring stick increments = 10cm)

D: Basal Mulloowurtie Formation with coarse lag and cross beds (at Sliding Rocks; hammer ca. 28cm long)

E: Port Julia Greensand of the Rogue Formation (Sheoak Flat; measuring stick increments = 10cm)

F: Rogue Formation with unconformably overlying poorly bedded Pleistocene silts and clays (near Port Julia; cliff is ca. 70m high)

G: Silicified layers of Rogue Formation (at Rogue Point; hammer ca. 28cm long)

Plate 60

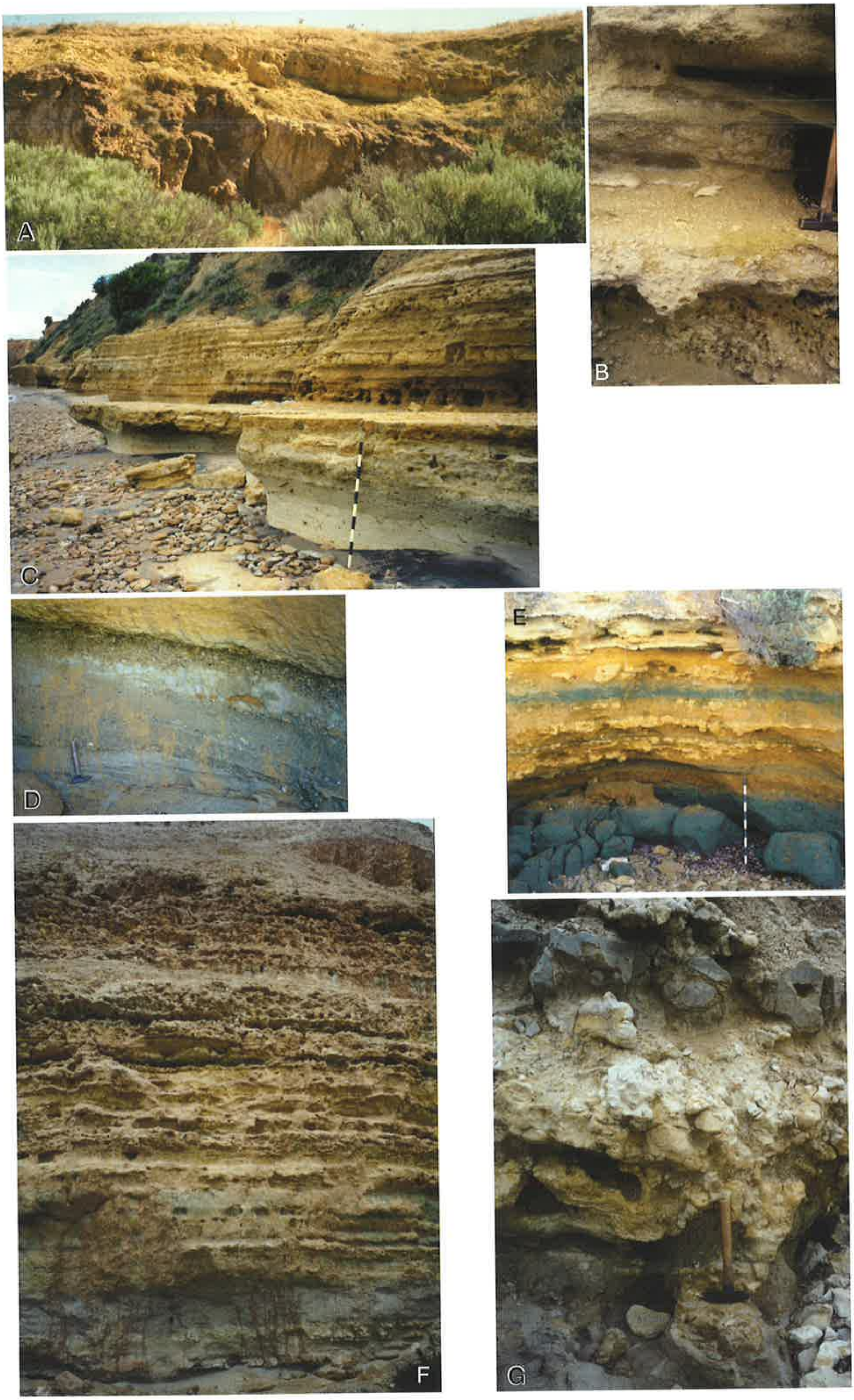


Plate 61

A: Kingscote Limestone type section (section KI2; measuring stick increments = 10cm)

B: Lower Kingscote Limestone *Fibularia* coquina (section KI1)

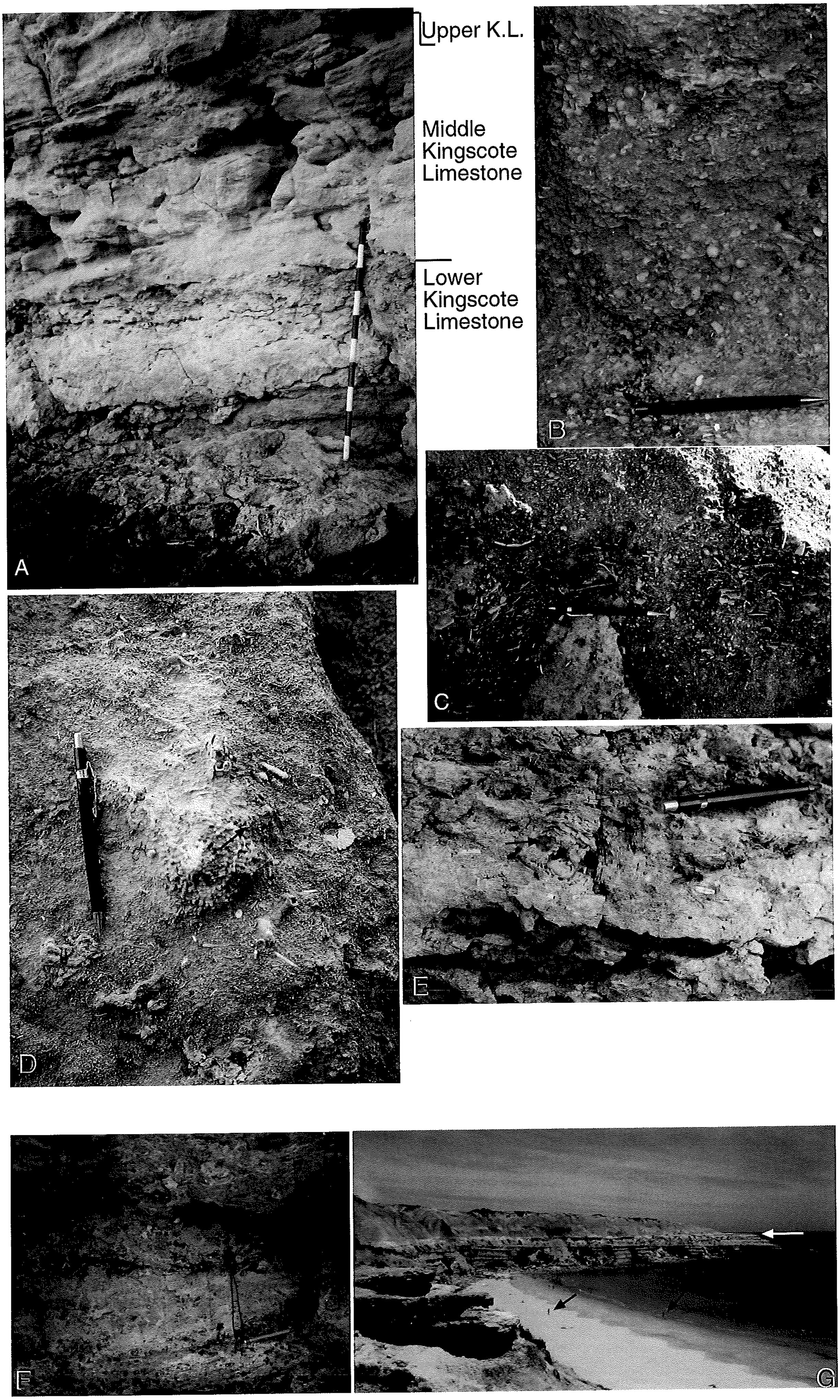
C: Lower Kingscote Limestone echinoid and serpulid lag (section KI3)

D: Multilaminar *Lichenopora* colony arrowed (section KI2)

E: Multilaminar *Lichenopora* colony arrowed (section KI2)

F: Tuketja Member of Blanche Point Formation (shore platform just north of Blanche Point, section M5a)

G: Panoramic view of Blanche Point, white arrow indicates angular unconformity between tilted (2°) Late Eocene Blanche Point Formation and horizontal Pleistocene clays, black arrows indicate nudists.


Upper K.L.
Middle Kingscote Limestone
Lower Kingscote Limestone
A
B
C
D
E
F
G