Miocene Bryozoa from East Kalimantan, Indonesia. Part I: Cyclostomata and 'Anascan' Cheilostomata

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The Cenozoic bryozoan fauna of Indonesia has been neglected in the past. In this pioneering study, based on new material collected during the two field seasons of the Throughflow project, we describe a total of 51 bryozoan species, comprising 15 cyclostomes and 36 anascan-grade cheilostomes, ranging in age from Early to Late Miocene (late Burdigalian to Messinian), collected from 17 sections located in the vicinities of Samarinda, Bontang and Sangkulirang in East Kalimantan, Indonesian Borneo. Eleven of these species are new: *Microeciella nadiae* sp. nov., *Pseudidmonea johnsoni* sp. nov., *Cranosina rubeni* sp. nov., *Parellisina mirellae* sp. nov., *Vincularia berningi* sp. nov., *Vincularia semarai* sp. nov., *Vincularia tjaki* sp. nov., *Vincularia manchanui* sp. nov., *Gontarella*? *sendinoae* sp. nov., *Canda giorgioi* sp. nov. and *Canda federicae* sp. nov. Ten species show affinities with Recent taxa from the Indo-Pacific. Bryozoans are found mainly encrusting the undersides of platy corals from low- and high-relief build-ups, and coral carpets in mixed carbonate-siliciclastic environments.

Contents

Introduction

Bryozoans are colonial marine invertebrates with a rich fossil record ranging from Ordovician to Holocene. They are found particularly in shelf sedimentary rocks deposited at all palaeolatitudes. However, few fossil bryozoans have been recorded from the Cenozoic of the entire Indonesian Archipelago. Braga (2001) reviewed all previous bibliographical references, and ascribed the lack of bryozoans to the difficulty in locating good outcrops and stratigraphical sections owing to the structural and tectonic complexity of the entire area, as well as the intense weathering of the rocks in the humid and rainy climate.

The first report of Cenozoic bryozoans from Indonesia dates from 1929. The palaeontology chapter of Oppenoorth & Gerth's (1929) paper briefly cites bryozoans as being part of "the rich fauna of Nanggoelen beds", along with other taxa such as molluscs, foraminifera, corals, echinoids and crustaceans (Braga, 2001). Lagaaij (1968a, b) indicated in the Miocene of the Indonesian Archipelago the presence of four significant bryozoan genera – *Chlidonia*, *Crepis*, *Savignyella* (= *Vasignyella*) and *Synnotum* – as the first fossil finds of these genera, and a further five genera – *Gemellipora*, *Nellia*, *Poricellaria*, *Vincularia* and *Catenicella* – already known in the fossil record. As seen in other fossil tropical sites (e.g., Tanzania; B. Berning, research in progress), articulated, rooted species are common and abundant.

Keij (1973), in his monograph on the enigmatic genus *Skylonia*, described two new species found in Malaysian Borneo and on Madura Island. The first, *S. sarawakensis*, is represented by 170 specimens collected from the Nyalau Formation of Early Miocene age (*Globorotalia klugeri* Zone) in Sarawak State, Malaysian Borneo. The second species, *S. thomasi*, containing two subspecies (*S. thomasi thomasi* and *S. thomasi madurensis*) came from sedimentary rocks of Late Miocene age in Sabah (Malaysian Borneo) and Middle Miocene age on Madura (Indonesia), respectively. Keij added some preliminary information about characteristic assemblages of other bryozoans occurring together with *Skylonia*. These mainly consisted of specimens of *Nellia*, *Vincularia*, *Margaretta*, *Crisia* and *Poricellaria*, "all cellariiform genera, having erect, branching, flexible jointed colonies, which are attached to their substratum of rock, indurated sediment, plants etc. by rootlets" (Keij, 1973, p. 220), adapted for life in the littoral zone, suggesting that *Skylonia* lived in shallow, tropical waters at depths of up to 50 m. In these assemblages rare specimens belonging to other genera were also found, such as *Canda*, *Cellaria*, *Idmonea*, *Lichenopora*, *Pasythea*, *Savignyella*, *Scrupocellaria*, *Sertella*, *Steginoporella*, *Thalamoporella* and *Vittaticella*.

In their monograph on conescharelliniform Bryozoa, Cook and Lagaaij (1976) described three new Miocene species of *Lacrimula* from the *Globigerinatella insueta* Zone of Madura Island: *L. asymmetrica* and *L. similis* from Kombangan in West Madura, and *L. grunaui* from Batu Putih in East Madura. They also reported in their Appendix 3 a record of *Conescharellina* sp. from the same locality. The most recent work on Indonesian Cenozoic bryozoans is the systematic paper of Pouyet & Braga (1993) describing a new species, *Thalamoporella sulawesiensis*, from the Eocene of Sulawesi. The samples consisted of Tertiary mudrocks interbedded with coarse-grained sandstones. Some samples were quite barren, while others contained reworked Cretaceous fossil molluscs. Only one sample was fairly rich in bryozoans, almost exclusively belonging to the new species, although there were also rare specimens of badly preserved, encrusting membraniporiform bryozoan colonies.

The small number of papers that cite Cenozoic bryozoans from Indonesia and their seemingly sparse occurrence has led to the mistaken belief that they are rare and of low diversity. If true, this would contrast with the high diversity of bryozoans living in the same area at the present day (e.g., Harmer, 1915, 1923, 1926, 1957; Winston, 1986; Winston & Heimberg, 1986). The most obvious reason for this misconception is the paucity of previous research on the Indonesian fossil bryozoan fauna, and that most of the species present are encrusting forms, which tend to be less conspicuous than erect forms. Encrusted surfaces are seldom favourably exposed and, in addition, the combined effects of aragonite dissolution and cementation limit the opportunities for observing encrusting bryozoans in hand specimens. However, burial of reefs in some mixed carbonate-siliciclastic environments by muddy sediment may ameliorate the negative effects of carbonate diagenesis. If this mud is weathered away, or can be washed off, then surfaces with identifiable encrusting bryozoans may become visible. Just such a situation exists in the Miocene of the Kutai Basin, East Kalimantan, where urban development and coal mining has recently exposed easily accessible sections in the Miocene sedimentary rocks. Here, moderately well-preserved bryozoans are found mainly encrusting the undersides of platy corals, providing important insights into the composition of Miocene reef-associated bryozoan communities in the Indo-Pacific region, which is a major diversity hotspot at the present-day.

This paper represents a pioneering study that aims to revise bryozoan diversity in the Miocene of East Kalimantan (Indonesian Borneo), describing bryozoans from new collections obtained during fieldwork undertaken under the auspices of the European Project Throughflow. The description of the bryozoan fauna will be split into two parts. This first part contains the geological and stratigraphical descriptions of the studied sections, and systematic descriptions of bryozoan species from the orders Cyclostomata and Cheilostomata of anascan grade. The second part will include systematic descriptions of Cheilostomata of ascophoran grade.

Geological setting

The research area is located in the Kutai Basin, the largest sedimentary basin in Borneo, which was formed during the Middle to Late Eocene as a consequence of rifting of the Makassar Strait. High rates of Neogene uplift and associated erosion of the central ranges of the Borneo landmass resulted in the progradation of large deltas and significant siliciclastic input into basinal areas to the north and east (Wilson & Moss, 1999). Early Miocene to Middle Miocene deltas prograded rapidly eastwards, contributing to the infilling of the Kutai Basin (Hall & Nichols, 2002). Within this depositional regime, carbonate production took place in proximal delta-front settings contemporaneously with the rapid and near-constant siliciclastic input (Lokier *et al.*, 2009). Miocene carbonates formed as low- and high-relief build-ups and coral carpets on delta-front mouth bars, and on the more distal shelf along the seaward margin of the Mahakam Delta where they are strongly influenced by siliciclastic input throughout their evolution (Wilson, 2005). These carbonates have been interpreted as transitional shelf sediments deposited between deltaic and deep-marine facies (Allen & Chambers, 1998).

The stratigraphy around Samarinda is much better documented than the other areas because of active hydrocarbon exploration on land and offshore of the Mahakam Delta, and because of the greater number of exposures. Explanations and names of the formations differ depending on the authors. In the simplified stratigraphical columns from Allen & Chambers (1998, *loc. cit*. Wilson, 2005, p. 4, fig. 5) and Moss & Chambers (1999, fig. 12), the formations are somewhat diachronous. The Batu Putih Limestone or Batu Putih Formation is a transitional shelf deposit that accumulated contemporaneously between deep marine deposits (Loa Duri Formation) and deltaics (Loa Kulu Formation). The age is N8 in the Neogene planktonic foraminiferan classification scheme, corresponding to Middle Miocene. Alluvial flood-plain facies are represented by the Middle to Upper Miocene Prangat (N9-N16) and Kambola (or Samboja) (N16-N17) formations. According to the Indonesian geological map (Supriatna Sukardi & Rustandi, 1995), the Pulau Balang and Balikpapan formations are exposed around Samarinda.

The Pulau Balang Formation, dated as Middle Miocene based on larger benthic foraminifera, is described as alternating greywacke and quartz sandstone intercalated with limestone, claystone, coal and dacitic tuff. It is overlain by the Balikpapan Formation of late Middle to early Late Miocene age, consisting of an alternation of sandstones and claystones intercalated with siltstones, shale, limestone and coal, 1000-1500 m in thickness, and interpreted as the regressive stage of a delta front to delta plain.

The Lower to Middle Miocene shallow marine Bebluh Formation, which is a reef limestone, possibly recrystallized, with intercalations of sandy limestone and shale, 300 m thick, outcrops around Bontang. It is overlain by the Balikpapan and Kampungbaru formations which are regarded as Late Miocene to Plio-Pleistocene (Supriatna Sukardi & Rustandi, 1995). The Kampungbaru Formation is a quartz sandstone intercalated with claystone, siltstone and lignite, 500 m thick, and interpreted as a deltaic to shallow marine deposit. Further north around Sangatta, Bengalon and Sangkulirang, the Lower Miocene Pamaluan Formation outcrops, consisting of claystone with intercalations of thinly bedded marlstone, sandstone and coal deposited in deep to shallow neritic environments. Overlying the Pamaluan Formation are the above-mentioned Bebluh, Balikpapan and the Kampungbaru formations. However, it is generally agreed that the formations need to be better defined.

Material and methods

Material used for this study was sampled from 17 sections, ranging in age from Early to Late Miocene (late Burdigalian to Messinian), located in the vicinities of Samarinda, Bontang and Sangkulirang (East Kalimantan, Indonesia) (Fig. 1; see below for a more detailed description of localities). Collections were made during the two field seasons of the Throughflow Project in November-December 2010 and June-July 2011. Bryozoans were obtained from a mixture of: bulk samples, weighing 10 kg on average and collected randomly directly from the outcrops; float samples collected as hand specimens (mainly encrusted surfaces of fossil corals weathering out of the rocks); and *in situ* hard substrates with visible encrusting bryozoans picked directly from the exposures. Samples were washed, including scrubbing of hand specimens under running water with a soft toothbrush, sieved and air-dried. Bryozoans were recovered either encrusting the undersides of platy corals and branches of ramose corals or as colony fragments picked from sieved sediment fractions larger than 500 μm.

Scanning electron microscopy (SEM) was carried out on the best-preserved specimens, most of which were first soaked in a dilute solution of the detergent Quaternary-O to remove clay particles and subsequently cleaned ultrasonically. SEM observations were made on uncoated specimens using a low-vacuum scanning electron microscope (LEO VP-1455) at the NHMUK. Zooidal measurements were taken from SEM images using the image-processing program ImageJ. Each measurement is given in the text as the mean value plus or minus standard deviation, observed range, number of specimens used and total number of measurements made (the latter two values enclosed in parentheses).

Measurements on cyclostomes use the following abbreviations: AD, diameter of equidimensional apertures; ADmin, minimum diameter of apertures; ADmax, maximum diameter of apertures; FWL, frontal wall length of single zooid; FWW, frontal wall

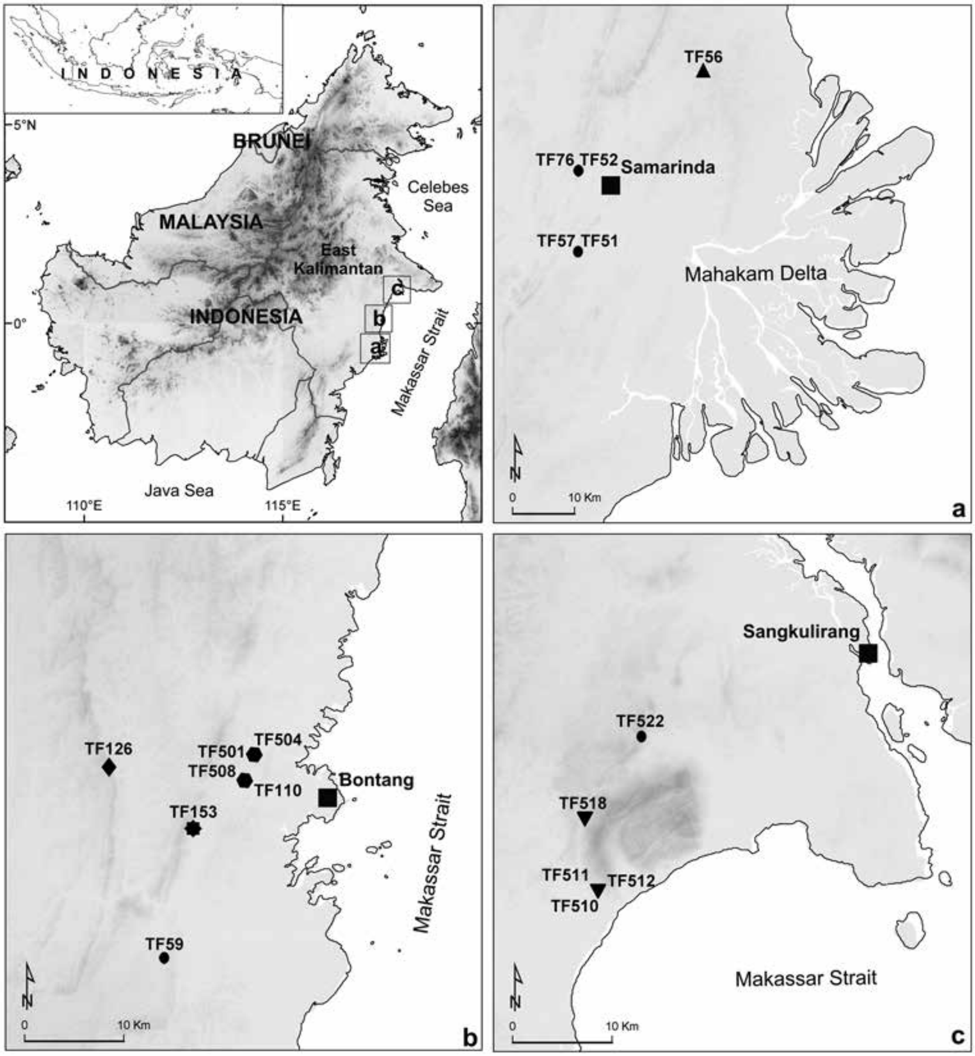

Fig. 1. Map of Borneo with close-ups of sampled areas. (a) Samarinda. (b) Bontang. (c) Sangkulirang. Outcrops are indicated with different symbols according to the age: diamond, late Burdigalian; eight point star, Burdigalian-Langhian boundary; triangle, Langhian; circle, Serravallian; hexagon, early Tortonian; upside down triangle, Messinian.

width of single zooid; GL, gonozooid length; GW, gonozooid width; OD, ooeciopore diameter; OL, ooeciopore length; OW, ooeciopore width; PL, peristome length; PD, peristome diameter; KAD, kenozooid aperture diameter; KL, kenozooid length; KW, kenozooid width.

Measurements on cheilostomes use the following abbreviations: AL, avicularium length; AW, avicularium width; CrL, cryptocyst length; CrW, cryptocyst width; KL, kenozooid length; KW, kenozooid width; OL, orifice length; OW, orifice width; OD, orifice diameter; OvL, ovicell length; OvW, ovicell width; VL, vibraculum length; ZL, autozooid length; ZW, autozooid width. The cheilostome bryozoan classification used here follows D. P. Gordon's provisional listing of genera for the *Treatise on Invertebrate Paleontology* (Gordon, 2011).

The present paper describes 51 bryozoan species, comprising 15 cyclostomes and 36 anascan-grade cheilostomes. Seven of these are described as new species, the remainder being either established species or identifiable only to genus or family level owing to preservational deficiencies. All figured and type specimens are registered in the palaeontological collections of the Natural History Museum, London (NHMUK).

Sampled localities

Sampling sites are designated with a TF (Throughflow) number and often with a colloquial name given during the fieldwork. Ages are provisional, except where noted, mainly based on field observations, and preliminary magnetostratigraphical and biostratigraphical analyses based on nannoplankton and larger benthic foraminifera (Willem Renema, unpublished data, revised 02/01/13); they need to be refined by further research. Individual sections are grouped based on region from south to north (Fig. 1). Within each group they are listed based on their provisional age. For each section a lithological description of the units containing bryozoans is given.

Samarinda

TF56 - Known colloquially as 'Badak South' (GPS location 0.322028˚ S; 117.297500˚ E), this is an active quarry heavily disturbed by bulldozing. The provisional estimated age is Langhian. Encrusting bryozoans were found associated with platy and branching corals in two layers at the top of the section, comprising marlstone and floatstone, respectively, containing very abundant corals above a bed of coal. In addition, many fragments of erect species, mainly *Vincularia* spp., were found in bulk samples from a layer of grey shale located immediately below the coal.

TF76 and TF52 - Known colloquially as 'Batu Putih 1' (GPS location 0.466260˚ S; 117.121830˚ E) and 'Batu Putih 2' (GPS location 0.468910˚ S; 117.121270˚ E), respectively, these sections are located inside an active hand-hammer quarry on either side of the main road. Palaeomagnetic data constrained by nannoplankton and larger benthic foraminifera suggest a Serravallian (13.6-13.7 Ma) age (Marshall *et al.*, in review). In 'Batu Putih 1' bryozoans were collected from a layer consisting of dark grey siltstones interdigitating with the margins of a patch-reef and have a rich content of bioclasts, including corals, molluscs and echinoids. Bryozoans mainly consist of fragments of erect and free-living species. In 'Batu Putih 2' a few specimens of encrusting bryozoans were obtained from two carbonate levels containing laminated platy corals (very much recrystallized), foraminiferans and echinoids.

TF51 and TF57 - Colloquially known as 'Stadion Reef 1' (GPS location 0.585730˚ S; 117.119000˚ E) and 'Stadion Reef 2' (GPS location 0.584670˚ S; 117.119830˚ E) respectively. A patch-reef is exposed in these two sites, 150 m apart, at the crossroad between the stadium road and a coal mine road of the infrastructure company KTC Group. The two studied sections were approximately 10-15 m wide and exposed 8-10 m of beds oriented with a strike of 50° and a dip of 55° E (see Santodomingo *et al.*, in review).

Palaeomagnetic data constrained by nannoplankton and larger benthic foraminifera suggest a Serravallian (11.6 Ma) age for the Stadion localities (Marshall *et al.*, in review). Six main lithological units were identified, corresponding with six sedimentary facies. Bryozoans were found in a coral sheetstone dominated by thin-platy corals.

Bontang

TF126 - Known colloquially as the '3D Reef' (GPS location 0.151300˚ N; 117.304380˚ E), is a road cut in an active coal mine. The exposure is approximately 80 m wide and 25 m thick, with beds dipping west-south-west at an angle of about 25°. Larger benthic foraminifera in combination with calcareous nannoplankton occurrences allow inference of a late Tf1 stage in the East Indian Letter Classification, which equates to a late Burdigalian age (Novak *et al.*, 2013). The section has been interpreted as a patch reef. Nine sedimentary units grouped into five different facies types can be distinguished. Bryozoa were found only in a mixed siliciclastic-carbonate facies with a thin floatstone of platy corals, occasional branching coral fragments and isolated larger foraminiferal tests in a marly matrix. Bryozoans encrust the bases of various platy scleractinian corals such as agariciids, *Cyathoseris*, *Echinopora*, *Podabacia* and *Porites*.

TF153 - The 'Rainy Section' (GPS location 0.096440° N; 117.380370° E) is represented by muddy carbonate deposits exposed in a road cut. Based on larger benthic foraminifera, this section has been dated at the Burdigalian-Langhian boundary, within zones Tf1/2 (Di Martino & Taylor, 2012a). Bryozoans were obtained from bulk samples, collected directly from the outcrop from a framestone containing thin platy and branching corals in a clay matrix, and float samples collected as hand specimens from a pile of platy corals lying adjacent to the exposure. They were associated with scleractinian corals, both platy genera such as *Echinopora*, *Pachyseris* and *Fungophyllia*, and less often branching genera of Acroporidae.

TF59 - Known colloquially as the 'Southern Hemisphere' (GPS location 0.018194˚ S; 117.353490˚ E), which is located inside an active hand-hammer quarry. Provisionally, it is dated as Serravallian. Bryozoans were collected from a marly siltstone containing very thin platy and small branching corals.

TF110 - The 'Seagrass Section' (GPS location 0.140460˚ N; 117.426930˚ E) is a temporary section exposed in a construction site. Samples were collected during the first field season in 2010, but, by the time of the second field season in 2011 the section was no longer visible. The provisional estimated age is early Tortonian. Bryozoans were found in a dark grey, fining upward, silty claystone with branching corals fragments and a highly diverse mollusc fauna. The bryozoan assemblage is monogeneric, consisting of numerous fragments of *Vincularia* spp. The presence of the seagrass-indicative gastropod *Smaragdia*, represented by two species (*S. semari, S. gelingsehensis*) and numerous individuals, and branching coral fragments, allows the palaeoenvironment to be interpreted as a seagrass meadow with intergrowing corals (Reich *et al.*, in review).

TF501 - Known colloquially as the 'Powerplant' (GPS location 0.161500˚ N; 117.434480˚ E), it was briefly accessible during the construction of housing. Provisionally, the age is estimated as early Tortonian. *Vincularia* spp. fragments were collected from a yellowish marl to limestone bed on top of a dark grey claystone containing seagrass moulds.

TF504 (GPS location 0.172180˚ N; 117.437707˚ E) and TF508 (GPS location 0.148924˚ N;

117.428191° E) – These sites are exposed in a small hand-hammer quarry and a construction site, respectively, in the vicinity of the Bontang Garden Hotel. The provisional estimated age is early Tortonian. In TF504, a few specimens of encrusting bryozoans were found on the undersides of thin platy corals, as well as some fragments of *Vincularia* spp. incidentally adhering to the same corals. In TF508, a few fragments of well preserved encrusting colonies were found in samples collected for molluscs.

Sangkulirang

TF522 - Known colloquially as the 'Coalindo Haulage Road 1' (GPS location 0.911674°N; 117.773866°E), this is a road cut in the Kari Orang area. The provisional estimated age is Serravallian. Bryozoans were collected from a layer of very thin platy corals.

TF518 - Known colloquially as 'Kampung Narut' (GPS location 0.835280° N; 117.723510° E), this is a natural exposure along the riverbank. The provisional estimated age is Messinian. Bryozoans were collected from a platy coral layer.

TF510 - The 'Sekarat 3D Reef' (GPS location 0.770835° N; 117.735564° E) is a road cut inside an active coal mine that exposes the lower part of a patch reef. The provisional estimated age is Messinian. Only a few fragments of *Vincularia* spp. were found in samples from this site.

TF511 - Known colloquially as the 'Sekarat Top Reef' (GPS location 0.771791° N; 117.735610° E), represents the top of the patch reef exposed in TF510. It outcrops on the opposite side of the road cut and it is located inside a quarry. The provisional estimated age is Messinian. Bryozoans were found associated with platy corals forming the framework of the reef and also encrusting thickly branched *Porites* colonies overlying the platy coral layer.

TF512 - 'PIK-hauling Road 1' (GPS location 0.773221° N; 117.731559° E) is a road cut inside an active coal mine. The provisional estimated age is Messinian. A few encrusting bryozoans specimens were collected associated with moderately thick platy corals very much recrystallized.

Systematic palaeontology

Order Cyclostomata Busk, 1852
Suborder Tubuliporina Milne Edwards, 1838
Family Stomatoporidae Pergens & Meunier, 1886
Genus *Stomatopora* Bronn, 1825

Stomatopora sp.
Pl. 1, fig. 1a-d.

Figured material – NHMUK PI BZ 6830, late Burdigalian, TF126, '3D Reef', Bontang.

Description – Colony encrusting, uniserial, new branches originating solely by dichotomous bifurcation at approximately 70° (Pl. 1, fig. 1a). Ancestrula not seen. Autozooids large, slender, parallel-sided (Pl. 1, fig. 1b, c). Preserved peristomes short, terminating in a circular aperture. Autozooidal walls containing abundant circular pseudopores, on average 16 μm in diameter (Pl. 1, fig. 1d).

Measurements – FWL 1245±35, 1220-1270 (2, 20); FWW 582±50, 514-630 (2, 20); AD 202±10, 193-217 (2, 10).

Remarks – This species, abundant in the late Burdigalian material, has been attributed to *Stomatopora* because of the uniserial colony-form and dichotomous branching. It differs from the *Voigtopora* specimens found in the same material and described below in the lack of lateral branching, the much larger zooid size, and the frontal walls characterized by more numerous and larger pseudopores, and lacking wrinkles.

The paucity of characters in *Stomatopora* makes the taxonomy of this genus particularly difficult and the absence of the early astogenetic stages in the Kalimantan species militates against its description as a new species. In common with *Voigtopora*, basal gonozooids, which are a major source of morphological characters in cyclostomes, are lacking in *Stomatopora*.

Genus *Voigtopora* Bassler, 1952

Voigtopora sp.

Pl. 1, fig. 2a-d.

Figured material – NHMUK PI BZ 6831, late Burdigalian, TF126, '3D Reef', Bontang.

Description – Colony encrusting, uniserial, new branches originating solely by lateral ramification at approximately 90° to the parent branch (Pl. 1, fig. 2a, b). Ancestrula not seen. Autozooids elliptical, elongated, very variable in length, broadening distally (on average 250 μm and 340 μm wide in the proximal and mid-distal parts, respectively), and sinous proximally (Pl. 1, fig. 2c). Peristomes long, orientated almost perpendicularly to the substrate, terminating in a circular aperture. Autozooidal walls faintly wrinkled transversely and containing abundant circular pseudopores (on average 12 μm in diameter) (Pl. 1, fig. 2d).

Measurements – FWL 600±114, 480-706 (2, 20); FWW 343±9, 333-350 (2, 20); PL 365±7, 360-370 (2, 6); AD 196±1, 195-197 (2, 6).

Remarks – The runner-like cyclostome *Voigtopora* sp. is one of the commonest bryozoans found encrusting the undersides of platy corals in the late Burdigalian TF126 section, along with *Stomatopora* sp. and *Oncousoecia* sp. Unfortunately, the preservation is poor, the ancestrula has not been observed and often the peristomes are broken. However, the paucity of morphological characters, even when better preserved material is available for study, makes species-level taxonomy very difficult in this genus.

Voigtopora sp. differs from the Kalimantan *Stomatopora* sp. in the presence of lateral branching, and in having smaller zooids with long, narrow and sinous proximal parts, smaller and much widely spaced pseudopores, and longer preserved peristomes. Illies (1976) noted that the type species of *Voigtopora* differs from typical *Stomatopora* in having both dichotomous and lateral branching. Dichotomous bifurcations have not been observed in the Kalimantan species, and its attribution to *Voigtopora* is based on Taylor (2002) who included some species that entirely lack dichotomous branching and ramify by lateral branching only in the genus.

Family Oncousoeciidae Canu, 1918
Genus *Filisparsa* d'Orbigny, 1853

Filisparsa sp.
Pl. 2, fig. 1a-d.

Figured material – NHMUK PI BZ 6832, BZ 6833, late Burdigalian, TF126, '3D Reef', Bontang; NHMUK PI BZ 6834, Serravallian, TF76, 'Batu Putih 1', Samarinda.

Description – Colony erect, filiform, dichotomously branched at an acute angle of about 30˚. Branches generally narrow (430-470 µm), straight or sinous, slightly compressed, flat frontally and convex dorsally; proximal portion of daughter branches following bifurcations narrower (200-370 µm). Frontal side (Pl. 2, fig. 1a-b) with zooids arranged irregularly in three longitudinal rows, two lateral and one medial, at variable distance. Autozooecia slender, boundaries obscure; frontal walls finely striated transversally and evenly pseudoporous. Distance between midpoints of two median or lateral apertures within a longitudinal row measuring 400-670 µm. Peristomes short and thin, circular, slightly curved at their extremities. Dorsal surface finely striated transversely and pseudoporous (Pl. 2, fig. 1c). Pseudopores small, about 10 µm in diameter, teardrop-shaped, pointed distally (Pl. 2, fig. 1d). Gonozooid not observed.

Measurements – PL 146±50, 105-200 (2, 3); AD 130±13, 107-157 (3, 12).

Remarks – Five fragments, none of which has a gonozooid, are tentatively referred to *Filisparsa* based on the erect colony-form with dichotomously ramifying, filiform branches having zooids opening only on the frontal surface and not aligned in rows.
The most similar species is *F. gracilis* Canu & Bassler, 1920, from the Eocene of North America, which has similarly slender and straight branches bifurcating at very acute angles, compressed and with three longitudinal rows of zooids, short and thin peristomes, and more or less the same distance between the peristomes as size of the apertures.

Genus *Microeciella* Taylor & Sequeiros, 1982

Microeciella nadiae sp. nov.
Pl. 2, fig. 2a-d.

Figured material – Holotype: NHMUK PI BZ 6835, late Burdigalian, TF126, '3D Reef', Bontang.

Etymology – Named after Nadia Santodomingo (Department of Earth Sciences, Natural History Museum, London) who helped to collect the samples.

Diagnosis – Colony encrusting, sheet-like. Ancestrula with a large protooecium and short distal tube, budding two distal autozooids. Autozooids elongate, finely striated and pseudoporous; pseudopores circular. Apertures longitudinally elongate, arranged more or less in longitudinal parallel rows; preserved peristomes short. Secondary nanozooids occasionally present. Gonozooid ovoidal, wider than long, lateral edges indented slightly by apertures of neighbouring autozooids; ooeciopore not observed.

Description – Colony encrusting, multiserial, unilamellar, sheet-like, flabellate. Ancestrula with large protoecium (Pl. 2, fig. 2b), about 0.17 mm in diameter; distal tube short, 0.10 mm long, straight, aperture 40 μm in diameter; two distal autozooids budded from the ancestrula. Growing edge low; basal and vertical lamina of one generation of zooids visible at budding zone (Pl. 2, fig. 2d). Autozooids elongate, frontal walls flat proximally, gently convex distally, finely striated transversely and evenly pseudoporous; pseudopores small and circular, 8 μm in diameter. Apertures longitudinally elongate, size variability probably due to the preservation of the peristomes, arranged more or less in longitudinal rows; preserved peristomes short, tapering distally. Secondary nanozooids occasionally present, formed within a normal autozooid partly occluded by a terminal diaphragm with a short tubule of 20 μm diameter in the centre (Pl. 2, fig. 2c). Gonozooid represented by a single poorly preserved example; brood chamber roof crushed, seemingly densely pseudoporous, transversely ovoidal, 0.40 mm long by 0.55 mm wide, lateral edges slightly indented by apertures of neighbouring autozooids (Pl. 2, fig. 2c); ooeciostome not preserved.

Measurements – FWL 236±31, 188-273 (1, 12); FWW 117±16, 86-153 (1, 16); ADmax 85±7, 75-97 (1, 18); ADmin 62±8, 50-75 (1, 18).

Remarks – Three specimens of *Microeciella nadiae* sp. nov. have been found encrusting bases of the platy scleractinian coral *Podabacia*. Although only one of these shows a poorly preserved gonozooid with the brood chamber roof crushed and the ooeciostome not recognizable, the overall morphology is sufficiently different from other species of *Microeciella* to justify the creation of a new species. The two colonies without gonozooids are included in this species on the basis of their similar autozooidal characteristics.

Attribution to the genus *Microeciella* rather than *Oncousoecia* is mainly based on the sheet-like colony-form, even though the flabellate holotype colony of this new species is in some respects intermediate between the subcircular colonies typical of the former and the oligoserial, ramifying colonies of the latter (see Taylor & Zatoń, 2008).

The genus *Microeciella* was introduced by Taylor & Sequeiros (1982) for two Spanish Early Jurassic species with subcircular, bereniciform colonies and simple ovoidal gonozooids, of the kind previously incorrectly assigned to *Microecia*. Other Jurassic and Cretaceous species from Poland and North America were assigned to the genus before Taylor & Zatoń (2008) argued that the Recent species *Diastopora suborbicularis* Hincks, 1880, made the type species of the new genus *Eurystrotos* by Hayward & Ryland, 1985, actually belonged to *Microeciella.* The main features that allow distinction between *Microeciella nadiae* sp. nov., and previously described species of *Microeciella*, are the wider than long shape of the brood chamber and the occurrence of secondary nanozooids. Nanozooids have been detected previously in only one species of *Microeciella, M. kuklinskii* Zatoń & Taylor, 2009, from the Jurassic of Poland. However, the nanozooids of *M. kuklinskii* are primary nanozooids unlike the secondary nanozooids of *M. nadiae* sp. nov. which occupy an autozooid. In addition, these two species differ in the width of the autozooidal frontal walls (> 200 μm in *M. kuklinskii* vs. 117 μm in *M. nadiae* sp. nov.) and in the shape of the pseudopores, narrow and circular in *M. nadiae* sp. nov. but large and teardrop-shaped in *M. kuklinskii*. Similar secondary nanozooids occur in *Plagioecia sarniensis* (Norman, 1864), but this extant species has large gonozooids with wide brood chambers penetrated by autozooidal peristomes. Even though the single known gonozooid of *M. nadiae* sp. nov. has a crushed brood chamber roof, it is clear that autozooids only indent its edges and do not penetrate the centre of the chamber.

Genus *Oncousoecia* Canu, 1918

Oncousoecia sp.

Pl. 3, fig. 1a-f.

Figured material – NHMUK PI BZ 6836, BZ 6837, BZ 6838, late Burdigalian, TF126, '3D Reef', Bontang.

Description – Colony small, encrusting, oligoserial, fan-shaped with autozooids slightly diverging from the colony axis, sometimes bifurcating. Ancestrula with rounded polygonal protoecium, 0.15 mm long by 0.17 mm wide, distal tube short, aperture about 70 μm in diameter, budding a single distal autozooid, 0.28 mm long and 0.17 mm wide with an aperture of about 60 μm in diameter (Pl. 3, fig. 1d). Autozooids elongate, frontal wall flat, more convex distally, marked by thick undulose wrinkles and with sparse small and circular pseudopores (Pl. 3, fig. 1f). Apertures subcircular, distributed more or less quicuncially. Preserved peristomes short, with a thick apertural rim; presence of terminal diaphragms uncertain owing to imperfect preservation. Gonozooid small, the transversely ovoidal brood chamber roof (Pl. 3, fig. 1b, c) slightly bulbous around the edges and flat in the centre, marked by thin, undulating parallel wrinkles; pseudopores circular, regularly spaced, more numerous and readily visible than those of the autozooids. Gonozooid margins indented by two neighbouring distolateral autozooids. Ooeciopore terminal, subcircular, slightly smaller than an autozooidal aperture; ooeciostome simple, short. Two rows of polygonal kenozooids developed along the sloping branch edges.

Measurements – FWL 211±32, 155-259 (2, 20); FWW 156±21, 132-188 (2, 20); AD 103±13, 81-130 (2, 16); GL 247±60, 204-289 (1, 2); GW 368±54, 330-406 (1, 2); OD 88±2, 86-89 (1, 2).

Remarks – This species is very abundant in the late Burdigalian '3-D Reef' section at Bontang, forming small colonies, a few developing gonozooids and encrusting the undersides of platy scleractinian corals. Diagnostic features are the surface covered with large overlapping concentric wrinkles and the ovoidal, transverse gonozooids.

Oncousoecia coarctata (Canu & Bassler, 1926) from the Cretaceous (Aptian) of southern England shows the same overlapping concentric wrinkles, but the gonozooid has not been described. Among European Cenozoic species attributed to *Oncousoecia*, *O. biloba* (Reuss, 1847) from the Miocene of Europe has a large, circular gonozooid perforated by autozooecial tubes, not matching the morphology typical for *Oncousoecia* based on Taylor & Zatoń's (2008) revision of the genus. The type species of *Oncousoecia* grows as encrusting colonies that have small, elongated gonozooids not perforated by autozooecial tubes, while *O. varians* has a pyriform gonozooid and transverse wrinkles mainly visible on the dorsal side. Guha & Gopikrishna (2007a) described a species from the Eocene of India, *O. narediensis,* which is slender, biserial or triserial, with distinct pseudopores and a sac-like gonozooid. The gonozooid of *Oncousoecia* sp. from East Kalimantan is similar to that described for the Recent *O. occulta* (Harmelin, 1976).

Family Tubuliporidae Johnston, 1838
Genus *Exidmonea* David, Mongereau & Pouyet, 1972

Exidmonea sp.
Pl. 4, fig. 1a-e.

Figured material – NHMUK PI BZ 6839, late Burdigalian, TF126, '3D Reef', Bontang.

Description – Colony erect, branches narrow, 0.3 mm in diameter, triangular in transverse section, angle between frontal sides acute. Autozooecia arranged in rows of three alternating on either side of the branch midline, diverging from the branch axis and with slightly protuberant, connate, circular apertures (Pl. 4, fig. 1d, e). Frontal surface with fine transverse striae; pseudopores small and circular, evenly distributed. Gonozooid situated on the frontal side (Pl. 4, fig. 1a, b), occupying almost the length of two autozooecial rows, proximally recumbent on the protruding autozooidal peristomes, rhomboidal, 0.64 mm long by 0.55 mm wide; frontal wall undulose, densely pseudoporous, pseudopores teardrop-shaped, on average 12 μm long, pointed distally. Ooeciostome short, preserved length 80 μm, terminal, slightly displaced laterally; ooeciopore small, oval, transversely elongate, 45 μm long by 90 μm wide. Dorsal sides of branches flat (Fig. 1c), perforated by circular or teardrop-shaped pseudopores; transverse growth lines sometimes visible.

Measurements – FWL 408±63, 317-480 (1, 6); FWW 121±17, 103-145 (1, 6); AD 70±13, 57-88 (1, 5).

Remarks – A single fertile branch fragment of *Exidmonea* sp. has been found. This genus differs from *Idmonea* Lamouroux, 1821, in being primarily erect instead of encrusting (although erect branches with ovate cross-sections can be found in the Jurassic type species of *Idmonea*, *I. triquetra* Lamouroux, 1821) and from *Idmidronea* (Johnston, 1847) in the lack of kenozooids on the basal (dorsal) surfaces of the branches. The scarcity of available material from East Kalimantan prohibits assessment of intracolonial variability, for example, in the number of autozoecial tubes present per row.

Among known fossil species of *Exidmonea* rather few are characterised by a low number of autozooecial tubes per row, for example, *E. carantina* and *E. filiformis* (d'Orbigny, 1853) from the Cretaceous of France; *E. incurvata* (Canu, 1911) from the Eocene of France; *E. undata* (Reuss, 1851) from the Cenozoic of Germany; and *E. villaltae* (Reguant, 1961) from the Pliocene of Spain. Although the small rhomboidal gonozooid is very distinctive in the Kalimantan species, absence of gonozooids in the original descriptions of these European species makes comparisons difficult.

Family Entalophoridae Reuss, 1869
Genus *Mecynoecia* Canu, 1918

?*Mecynoecia* sp.
Pl. 4, fig. 2a, b.

Figured material – NHMUK PI BZ 6840, Serravallian, TF76, 'Batu Putih 1', Samarinda.

Description – Very small branch fragment, erect, cylindrical (vincularian) and thin at the base, about 0.37 mm in diameter, broader and more triangular in cross section distally, about 0.6 mm wide. Sporadic, elongate autozooecial tubes arranged irregularly around the branch on all sides, widely separated except for three closely spaced apertures seemingly forming a small fascicle. Frontal wall convex, densely perforated by circular pseudopores, about 14 µm in diameter (Pl. 4, fig. 2b). Peristomes short, terminating in a circular aperture. Gonozooid not present on the single available branch.

Measurements – FWL 577±16, 566-588 (1, 2); PL 235±23, 218-261 (1, 3); AD 176±6, 170-187 (1, 7).

Remarks – This infertile fragmentary specimen is very tentatively assigned to *Mecynoecia* because of the circumferential, distantly spaced and irregularly arranged apertures. A low number of autozooecial tubes (3-5) around the branch is typical of *M. proboscidea* (Milne Edwards, 1838), the most commonly recorded species of this genus in the Eocene of Europe.

Suborder Cancellata Gregory, 1896
Family Horneridae Smitt, 1867
Genus *Hornera* Lamouroux, 1821

***Hornera* sp. 1**
Pl. 5, fig. 1a-d.

Figured material – NHMUK PI BZ 6841, Serravallian, TF 76, 'Batu Putih 1', Samarinda.

Description – Colony erect, dendroid with bifurcating branches. Branches irregularly cylindrical in transverse section, about 500 µm in diameter. Frontal side almost flat; autozooecial tubes long and narrow (Pl. 5, fig. 1a, b). Apertures circular or oval, alternating, not connate or forming well-defined rows but in vague distolaterally oriented rows of 4-5 apertures. Peristomes with undulose inner margins, thick, slightly protruberant, those of outer zooids more so than median zooids. Nervi on frontal side very pronounced, numerous, sinuous between the apertures, delimiting narrow sulci; abundant large cancelli, circular or oval, scattered over the entire frontal surface. Dorsal side convex, with pronounced longitudinal nervi, sometimes meandering and transversely ribbed, not anastomosing; sulci larger and deeper than those on the frontal side (Pl. 5, fig. 1c, d). Gonozooid not observed.

Measurements – FWL 330±60, 252-412 (1, 9); FWW 147±13, 128-172 (1, 9); AD 69±12, 52-90 (1, 10).

Remarks – Only a single, infertile, broken branch of *Hornera* sp. 1 has been found, the broken distal tip of the fragment showing the beginnings of a dichotomous bifurcation. The frontal side of *Hornera* sp. 1 resembles *H. frondiculata* Lamouroux, 1821, one of the most commonly recorded species of *Hornera* in the Cenozoic of Europe and which is still extant, even though, as stated by Zágoršek (2010, p. 36), "better preserved gonozooecia in fossil material are needed to prove they are conspecific". The dorsal side differs in having longitudinal, sometimes meandering nervi without anastomoses. The apparent absence of dorsal cancelli may be due to infilling by sediment or diagenetic cement. Unfortunately, the paucity of material and the absence of a gonozooid precludes a more exact identification.

Hornera sp. 2

Pl. 5, fig. 2a-d.

Figured material – NHMUK PI BZ 6842, Serravallian, TF 76, 'Batu Putih 1', Samarinda.

Description – Colony erect, dendroid with bifurcating branches. Branches subcylindrical, narrow, about 300 μm in diameter. Autozooecia opening only on frontal side (Pl. 5, fig. 2b). Apertures circular, arranged in transverse connate groups diverging from opposite sides of the branch midline, slightly protruberant. Peristomes thick and short. Nervi on frontal side indistinct medially, but forming prominent longitudinal ornament laterally; abundant cancelli, circular or oval, scattered over the entire frontal surface between the nervi. Dorsal side convex, with straight longitudinal nervi, pronounced, not anastomosing, and oval cancelli, on average 30 μm long by 10 μm wide (Pl. 5, fig. 2c, d). Gonozooid not observed.

Measurements – FWL 152±42, 111-220 (1, 7); FWW 94±11, 80-110 (1, 7); AD 73±11, 59-93 (1, 6).

Remarks – One small, infertile, broken branch of *Hornera* sp. 2 has been found, broken distally through one of the two daughter branches of a bifurcation. This species is similar to *H. subannulata* Philippi, 1844, from the Paleogene-Neogene of Europe in having strongly protruberant peristomes with openings facing laterally, but differs in having distinct cancelli on the dorsal side (although this difference could be a preservational artifact).

Family Pseudidmoneidae Borg, 1944
Genus *Pseudidmonea* Borg, 1944

Pseudidmonea johnsoni sp. nov.

Pl. 6, fig. 1a-g.

Figured material – Holotype: NHMUK PI BZ 6843, Serravallian, TF 76, 'Batu Putih 1', Samarinda. Paratypes: NHMUK PI BZ 6844, BZ 6845, BZ 6846, BZ 6847, BZ 6848, same details as holotype.

Etymology – Named after Kenneth G. Johnson (Department of Earth Sciences, NHMUK), coordinator of the Throughflow Project.

Diagnosis – Colony erect, vincularian, with dichotomously bifurcating branches. Median keel well developed, the remainder of the frontal surface sloping steeply away on either side. Autozooidal apertures connate, arranged in transverse rows of 3-4 apertures on each side of the keel. Zooidal boundaries delineated by rows of pores (cancelli). Peristomes prominent, long, increasing in length outwards from the keel towards the lateral edges of the branches giving them a jagged appearance. Apertures oval, flattened. Dorsal side convex, with small cancelli between granular ridges. Gonozooid dorsal, globular; ?ooeciostome prominent; ?ooeciopore circular.

Description – Colony erect, attached to the substrate by a circular basal disc, small, 1.2 mm in diameter. Primary stem short, robust, cylindrical, 0.6 mm in diameter, with autozooidal apertures not visible (?overgrown by secondary calcification). Branches formed by dichotomous bifurcations at an angle of about 50º, slender, 0.3-0.4 wide, rounded triangular in cross section. Median line of the frontal surface bearing a pronounced keel separating two steeply sloping lateral sectors. Autozooecial tubes long and narrow, forming two oblique rows of 3-4 zooids each (Pl. 6, fig. 1b), one median and three lateral zooids or one median and two lateral zooids per rows, on the lateral slopes of the frontal surface. Zooidal boundaries marked by parallel lines of elongated cancelli. Peristomes prominent, long, increasing in length away from the keel, giving the lateral edges of branches a serrated appearance. Apertures oval, compressed transversely relative to the zooidal axis. Dorsal side convex, with small circular cancelli separated by granular walls (Pl. 6, fig. 1d). Gonozooid located on the dorsal side, large and globular, occupying the equivalent length of two rows of autozooids (Pl. 6, fig. 1e-g). Gonozooidal surface showing secondary calcification, with narrow anastomosing ridges surrounding large polygonal pits with pores (cancelli) in the centres. ?Ooeciostome prominent, about 180 μm long, distally directed, protruding laterally (Pl. 6, fig. 1g, see arrow); ?ooeciopore circular, larger than an autozooidal aperture, about 130 μm in diameter.

Measurements – FWL 346±44, 253-391 (2, 8); FWW 89±12, 74-106 (2, 8); PL 141±24, 105-175 (2, 9); ADmin 66±15, 52-97 (2, 7); ADmax 50±13, 37-76 (2, 7); GL 702±67, 620-800 (3, 3).

Remarks – Our material consists of eight broken branches, three of which are fertile, but none of the gonozooids exhibit an unequivocal ooeciostome, although there is one questionable example. One of the branches preserves a colony base, detached from its original substrate (Pl. 6, fig. 1c).

Borg (1944) erected a new family (Pseudidmonidae) and genus (*Pseudidmonea*) for species resembling *Hornera* in the general appearance of the dorsal side and gonozooid, but with a serial arrangement of autozooids recalling '*Idmonea*' (i.e., *Idmidronea* and *Exidmonea*) and *Crisina*. Two Recent species have been attributed to *Pseudidmonea, P. fissurata* (Busk, 1886) and *P. gracilis* Androsova, 1968, both from the South Atlantic, Antarctic and Sub-Antarctic. The new species differs in having 3-4 zooids per series, instead of 4-6 or 5-7 as in *P. fissurata* and *P. gracilis,* respectively, and a smaller gonozooid. It differs from *P. gracilis* also in having shorter peristomes without pronounced frontal and dorsal spines on the outer margins. *Pseudidmonea* has not been formally described before as a fossil, although an un-named species occurs in the Miocene of New Zealand (PDT, pers. obs.).

Suborder Rectangulata Waters, 1887a
Family Lichenoporidae Smitt, 1867
Genus *Disporella* Gray, 1847

***Disporella* sp. 1**
Pl. 7, fig. 1a-d.

Figured material – NHMUK PI BZ 6849, BZ 6850, BZ 6851, late Burdigalian, TF126, '3D Reef', Bontang.

Description – Colony encrusting, simple, circular in outline, low domal, with entire basal surface affixed to the substrate, small in size, up to 2 mm in diameter including marginal lamina, which is sometimes visible, narrow and smooth. Autozooids arranged quincuncially or in ill-defined radial series of 3 to 5 autozooecial tubes; apertures isolated, separated by one or two kenozooids (Pl. 7, fig. 1b), circular; peristomes short, protruding slightly above the colony surface, simple or with inconspicuous spines. Two rows of polygonal kenozooids between adjacent autozooid rows; kenozooid apertures oval, variable in size. Infertile colonies with a flat central part occupied by kenozooids. Brood chambers developed very early in astogeny, prominent, globular or oval, occupying almost the entire central part of the colony with a porous frontal wall covered by irregular ridges (Pl. 7, fig. 1b-d). Ooeciopore situated at the margin of the gonozooid, adnate to an autozooecial peristome, small, oval.

Measurements – GL 339±60, 288-405 (3, 3); GW 411±87, 348-510 (3, 3); OL 65±22, 49-80 (2, 2); OW 82±33, 59-105 (2, 2); AD 68±9, 59-95 (3, 20); KA 56±10, 37-72 (3, 22).

Remarks – A large number of *Disporella* sp. 1 colonies were found encrusting the undersides of platy corals in the late Burdigalian '3D Reef' section at Bontang. Unfortunately, only one specimen showed a fully developed gonozooid, so the attribution of the other colonies to this species is mainly based on general appearance of the colony and measurements. The densely porous roof of the brood chamber covered by irregular ridges of *Disporella* sp. 1 is similar to that in the Recent *Disporella buski* (Harmer, 1915). The two species also share a quincuncial arrangement of isolated autozooids separated by one or two kenozooids, sometimes showing a tendency to assume a radial arrangement.

Species-level taxonomy of lichenoporids is particularly problematical, owing to the substantial changes in the appearance of the skeleton between young and old colonies, and infertile and fertile colonies. As the degree of such variation has never been described in a population of an exemplar species, it is difficult to know which differences in fossil material are interspecific and which intraspecific.

Disporella sp. 2

Pl. 8, fig. 1a, b.

Figured material – NHMUK PI BZ 6852, late Burdigalian, TF126, '3D Reef', Bontang.

Description – Colony encrusting, compound, circular (on average 3 mm in diameter) or oval (on average 3 by 2 mm) in outline, low domal, with the free distal edges of the basal lamina upturned, 0.25 mm wide. Autozooids arranged in radial uniserial rows, forming fascicles of 4 to 7 autozooecial tubes (Pl. 8, fig. 1b), diverging obliquely from the centre of the colony, protruding slightly above the colony surface, separated by one or two rows of kenozooids. Autozooidal apertures small, oval; peristomes rounded rectangular in section, simple, decreasing in height towards the edge of the colony. Centre of the colony flat, occupied by three rows of kenozooids. Kenozooids polygonal, characterized by oval apertures variable in size, but usually larger than autozooidal apertures. Gonozooid not seen. Subcolonies developing marginally, overgrowing 25-50% of the edge of the parent colony.

Measurements – ADmax 80±7, 66-95 (2, 20); ADmin 58±6, 47-64 (2, 20); KA 88±28, 50-170 (2, 32).

Remarks – A significant number of colonies of *Disporella* sp. 2 encrust the undersides of platy corals from the late Burdigalian, along with *Disporella* sp. 1. All specimens attributed to this species have subcolonies developed marginally and partly overgrowing the parent colony but unfortunately none are fertile.

Disporella sp. 2 differs from *Disporella* sp. 1 mainly in the arrangement of the autozooids which are connate and aligned in clear radial rows in the former, but isolated in ill-defined rows or quincuncially arranged in the latter. *Disporella* sp. 2 shows similarities with the Recent *D. boutani* Álvarez, 1995, known from the Red Sea to the Indonesian Archipelago. Both species have a well-developed peripheral basal lamina and autozooids with similar-sized apertures arranged in uniserial rows with a single or double series of kenozooids between adjacent autozooidal rows. *Disporella boutani* has star-shaped spines projecting inside the kenozooidal apertures and a very distinctive lobate gonozooid, but does not seem to produce subcolonies. Unfortunately, the Kalimantan colonies are infertile and the presence of spines in the kenozooids cannot be ascertained because of sediment infilling the chambers.

Another Recent species resembling *Disporella* sp. 2 in having well-marked radial rows of uniserial connate autozooids is *Disporella novaehollandiae* (d'Orbigny, 1853), which has a broad Indian Ocean distribution and was redescribed by Harmer (1915, p. 155, pl. 12, figs. 6-11) as *Lichenopora novaezelandiae* from the Makassar Strait. As Harmer pointed out (1915, p. 159), "the Siboga specimens show distinct indications of regeneration…a smaller disc is produced from one side of the older part of the colony in such way that it is not in the least concentric with it, but leaves part of the old surface exposed…" This regeneration probably corresponds to the overgrowing marginal subcolonies seen in the Kalimantan fossil specimens. Usually *Disporella novaehollandiae* develops much larger colonies than *Disporella* sp. 2, with simple colonies up to 5 mm in diameter and compound colonies up to 15 mm including laminae (Gordon & Taylor, 2001). Distinctive features include pinhead spinules and the internal ledge inside the ooeciostome opening (Gordon & Taylor, 2001), but both characters are missing or not observable in the fossil specimens.

Disporella sp. 3
Pl. 8, fig. 2a-c.

Figured material – NHMUK PI BZ 6853, late Burdigalian, TF126, '3D Reef', Bontang.

Description – Colony encrusting, simple, circular in outline, about 4 mm in diameter, flat, with smooth basal lamina extending slightly beyond budding zone; central area without a distinct region of kenozooids. Autozooids isolated, never connate, separated by one or two kenozooids, arranged in well-defined radial rows diverging from the centre of the colony, protruding above the colony surface. Radial rows quite closely spaced, apparently separated only by a single row of kenozooids, which are generally difficult to observe due to sediment infills and overgrowth by foraminifera. Autozooidal apertures small, oval. Peristome rim acuminate, with two lateral spinose processes (Pl. 8, fig. 2b, c). Kenozooid apertures oval, variable in size. Gonozooid not seen.

Measurements – PD 98±6, 87-107 (1, 30); KA 79±16, 53-96 (1, 10).

Remarks – A single specimen of *Disporella* sp. 3 has been found in the Kalimantan material. This species is distinguished from all other Kalimantan species of the genus in its flatness, the large number of autozooidal rows radiating from the centre of the colony, which is not occupied only by kenozooids, and the spinose lateral processes of the peristome.

Disporella sp. 4
Pl. 8, fig. 3a, b.

Figured material – NHMUK PI BZ 6854, Serravallian, TF522, 'Coalindo Haulage Road 1', Sangkulirang.

Description – Colony encrusting, simple, in outline circular, average diameter 1.2 mm, low domal, with the basal lamina sometimes slightly developed. Autozooids isolated, separated by a single kenozooid, arranged in ill-defined radial rows (Pl. 8, fig. 3b); autozooidal apertures circular. Centre of the colony flat, occupied by a small number of kenozooids. Calcification granular-tubercular. Peristomes short, slightly protruberant above the colony surface; peristomial rim denticulate. Kenozooids polygonal, with circular apertures slightly increasing in size towards the margin of the colony. Gonozooid not seen.

Measurements –AD 73±10, 50-90 (3, 30); KA 46±8, 34-56 (3, 24).

Remarks – *Disporella* sp. 4 is distinguishable from all other species of *Disporella* described here because of its granular-tuberculate frontal wall. Similar granulation is seen in several Recent species, including *D. minicamera* Gordon & Taylor, 2010, from New Zealand and *D. zurigneae* Álvarez, 1992, from Spain.

Incertae familiae
Genus *'Berenicea'* Lamouroux, 1821

'Berenicea' sp.
Pl. 9, fig. 1a-d.

Figured material – NHMUK PI BZ 6855, late Burdigalian, TF126, '3D Reef', Bontang.

Description – Colony encrusting, unilamellar, circular in outline (bereniciform), 3-5 mm in diameter. Ancestrula apparently overgrown by budded zooids. Autozooids elongate, narrow (Pl. 9, fig. 1c); frontal walls convex, especially distally, marked by conspicuous concentric growth lines; apertures arranged quincuncially, subcircular; peristomes short and finely pseudoporous. Gonozooid not seen.

Measurements – FWL 266±36, 193-325 (2, 24); FWW 121±18, 95-150 (1, 24); AD 70±9, 56-84 (2, 24).

Remarks – *Berenicea* is a *nomen dubium* and the name is here used in open nomenclature as a form-genus, following the recommendation of Taylor & Sequeiros (1982). Recent species previously placed in '*Berenicea*' have been mainly reassigned to five genera, *Diplosolen*, *Plagioecia*, *Hyporosopora*, *Mesonopora* and *Microeciella*, depending on the morphology of the gonozooid. *Diplosolen* is easily distinguishable by the presence of numerous primary nanozooids; *Plagioecia* has a very broad gonozooid penetrated by autozoecial peristomes; *Hyporosopora* and *Mesonopora* have subtriangular to crescent-shaped gonozooids, the outline ragged and indented by autozooidal peristomes in the latter; and *Microeciella* has small ovoidal gonozooids.

The Kalimantan specimens lack the gonozooids necessary to allow a more precise generic assignment. However, a swollen broad structure, which has the appearance of a *Plagioecia*-type gonozooid, is visible on the colony surface, but, as it is positioned very close to the centre of the colony, it may not be a gonozooid, but instead a patch of adherent sediment (Pl. 9, fig. 1b).

Order Cheilostomata Busk, 1852
Suborder Neocheilostomina d'Hondt, 1985
Infraorder Flustrina Smitt, 1868
Superfamily Calloporoidea Norman, 1903
Family Calloporidae Norman, 1903
Genus *Cranosina* Canu & Bassler, 1933

Cranosina cf. *coronata* (Hincks, 1881)
Pl. 10, fig. 1a-d.

cf. *Membranipora coronata* Hincks, 1881, p. 147, pl. 10, fig. 1.
cf. *Setosellina coronata*: Harmer, 1926, p. 265, pl. 16, figs 2-4.
cf. *Cranosina coronata*: Fransen, 1986, p. 17, figs 5a-e; Winston & Heimberg, 1986, p. 6, figs 3-6; Chimonides & Cook, 1994, p. 44, fig. 1a; Tilbrook, Hayward & Gordon, 2001, p. 44, fig. 3E; Tilbrook, 2006, p. 25, pl. 2, fig. E.

Figured material – NHMUK PI BZ 6856, Serravallian, TF522, 'Coalindo Haulage Road 1', Sangkulirang.

Description – Colony encrusting, multiserial, unilaminar. Pore chambers not seen. Ancestrula and early astogeny not seen. Autozooids arranged quincuncially, lozenge-shaped with a broad, straight or convex distal margin, slightly longer than broad (mean L/W = 1.14), distinct, separated by thin grooves in depressions. Gymnocyst absent. Cryptocyst sloping gently inwardly, broader laterally, tapering proximally, extremely reduced distally; surrounded by a finely crenulate margin, tending to be coarsely granular with granules aligned radially. Opesia elongate, occupying almost the entire length of the frontal wall, oval or rhomboidal. Presence of ovicells uncertain; some autozooids with a more arched and raised distal margin might be brooding zooids. Avicularium transversely ovoidal, situated at the distal end of each autozooid, asymmetrical, rounded (Pl. 10, fig. 1d); gymnocyst absent, cryptocyst smooth; rostrum laterally directed, spout-like (Pl. 10, fig. 1c); condyles or pivotal bar not visible.

Measurements – ZL 560±54, 482-664 (2, 20); ZW 489±54, 410-571 (2, 20); OL 463±62, 381-553 (2, 20); OW 220±20, 197-245 (2, 20); AL 243±19, 212-267 (2, 20); AW 130±19, 102-152 (2, 20).

Remarks – The uncertainty in the attribution of the Kalimantan specimens to *Cranosina coronata* is due mainly from the impossibility of observing features such as brood chambers or avicularian condyles because of their obliteration by sedimentary rocks. Another difference appears to be the orientation of the avicularia, which are proximolaterally directed in *C. coronate*, but laterally directed in *C.* cf. *coronata*.

A distal avicularium directed laterally is described for the Recent *Cranosina spiralis* Chimonides & Cook, 1994, from Hawaii. However, this species encrusts minute substrates and shows a very characteristic spiral budding pattern not observed in the Kalimantan specimens.

Autozooidal size reported by Fransen (1986) and Chimonides & Cook (1994) in *C. coronata* matches that of the Kalimantan fossils, except for the length of the avicularium which is slightly smaller in this material, while measurements reported by Winston & Heimberg (1986) show narrower autozooids and even smaller avicularia. *Cranosina coronata* is particularly common in the Indo-West Pacific region in shallow waters encrusting corals. In the Kalimantan samples only a few small colonies have been found encrusting the bases of platy scleractinian corals. Better-preserved material is needed to prove that these specimens are conspecific with the Recent *C. coronata*. However, if the attribution is correct, they represent the oldest record of this species.

***Cranosina rubeni* sp. nov.**
Pl. 11, fig. 1a-d.

Figured material – Holotype: NHMUK PI BZ 6857, Serravallian, TF522, 'Coalindo Haulage Road 1', Sangkulirang.

Etymology – Named in honour of the first author's son, Ruben Amata.

Diagnosis – Colony encrusting. Autozooids large, hexagonal or pentagonal in outline, pointed, separated by thick raised margins. Gymnocyst absent. Cryptocyst immersed, flat, finely granular, broad proximally and laterally, reduced distally. Opesia subcircular, denticulate. Ovicells lacking. Avicularia oval, situated at the distal end of each autozooid; rostrum subacute, laterally directed with two small condyles.

Description – Colony encrusting, multiserial, unilaminar, heavily calcified, thick, usually of moderate size. Pore chambers absent. Ancestrula and early astogeny not seen. Autozooids chaotically arranged, large, hexagonal or pentagonal in outline, pointed, equidimensional or slightly broader than long (mean L/W = 0.93), distinct, separated by thick raised margins with a medial groove. Gymnocyst absent. Cryptocyst immersed, flat, broad proximally and laterally, reduced distally; finely granular, thin rim of granules all around the opesia aligned radially, denticulations projecting inwards. Opesia subcircular, almost occupying half of the frontal wall (Pl. 11, fig. 1d). Ovicells lacking. Avicularia transversely oval, situated at the distal end of each autozooid, asymmetrical; gymnocyst absent, cryptocyst granular, broader proximally and distally, reduced laterally; rostrum laterally directed, subpointed; two small pointed condyles (Pl. 11, fig. 1b).

Measurements – ZL 803±132, 600-1200 (10, 50); ZW 868±141, 635-1175 (10, 50); OD 527±54, 419-653 (10, 50); AL 422±34, 347-483 (10, 50); AW 205±20, 159-236 (10, 50).

Remarks – This species is the commonest and most abundant bryozoan in all of the Serravallian sections, forming moderate to large, thick colonies on the bases of platy and branching scleratinian corals, often along with *Reptadeonella* spp. and *Steginoporella* spp. *Cranosina rubeni* differs from *C.* cf. *coronata* as well as all other species belonging to this genus in having much larger autozooids and avicularia, raised instead of depressed zooidal boundaries, zooids acutely polygonal in outline and not lozenge-shaped or oval, and round denticulate instead of elongate oval opesia. Similarities are apparent with some species belonging to the Cretaceous genus *Semiflustrella* d'Orbigny, 1853, such as *S. saratogaensis* (Shaw, 1967) and *S. bifoliata* Taylor & McKinney, 2006.

Genus *Crassimarginatella* Canu, 1900

?*Crassimarginatella* sp.

Pl. 12, fig. 1a-d.

Figured material – NHMUK PI BZ 6858, late Burdigalian, TF126, '3D Reef', Bontang.

Description – Colony encrusting, multiserial, unilaminar. Pore chambers absent. Ancestrula and early astogeny not observed. Autozooids distinct, separated by deep grooves, oval or rounded polygonal in outline, slightly longer than broad (mean L/W = 1.17), sometimes broader proximally, arranged quincuncially. Gymnocyst usually narrow, sometimes well developed proximally and laterally, smooth, convex and inclined at the margins of the zooid. Cryptocyst narrow, tapering distally, striated, inwardly sloping. Opesia oval, usually longer than broad (Pl. 12, fig. 1c), sometimes plectrum-shaped broadening proximally (Pl. 12, fig. 1d), occupying almost the entire frontal surface. Ovicell hyperstomial, crescent-shaped, moderately small, ooecium partly immersed in the gymnocyst of the next distal zooid and rimmed by its cryptocyst; ectooecium completely calcified, smooth, with a median carina (Pl. 12, fig. 1b). ?Kenozooids rare (Pl. 12, fig. 1b), interzooidal, oval, longer than broad (L = 417 μm, W = 145 μm); gymnocyst developed proximally, smooth; cryptocyst narrow, striated; opesia occupying half of the length. Intramural buds present (Pl. 12, fig. 1d). Spines absent. Avicularia not observed.

Measurements – ZL 537±42, 470-636 (4, 60); ZW 460±42, 379-527 (4, 60); OL 478±44, 434-520 (4, 60); OW 345±55, 268-444 (4, 60); OvL 136±5, 132-142 (2, 3); OvW 301±32, 264-321 (2, 3).

Remarks – This species, encrusting the base of platy corals in late Burdigalian and Serravallian sections, is tentatively assigned to the genus *Crassimarginatella* Canu, 1900, mainly on account of autozooidal morphology and the lack of spines. However, Hayward & Ryland (1998, p.170), in their revision of this genus, described an ectooecial window in the ovicell, missing in the Kalimantan species, which also lacks vicarious avicularia, although avicularia are usually rare in *Crassimarginatella* and the paucity of well-preserved material might have biased against the finding of these polymorphs in the Kalimantan species.

Two species of *Crassimarginatella* have been described from Gujarat (India) – *C. blanfordi* and *C. ukirensis* Guha & Gopikrishna, 2007b – from Middle Eocene (Lutetian) and Early Miocene (Aquitanian) strata, respectively. ?*Crassimarginatella* sp. differs from these in the size of the zooids (larger in *C. blanfordi* and smaller in *C. ukirensis*), and in the lack of the distinctive mural septulae. Nevertheless, they show some similarities, such as the lack of avicularia and the presence of kenozooids. In contrast, the Recent Indonesian *C. spatulifera* (Harmer, 1926) has large, vicarious avicularia and vestigial ovicells.

Some Cretaceous species of *Wilbertopora* resemble the Kalimantan species. For example, the North American Maastrichtian species *Wilbertopora ovicarinata* Taylor & McKinney, 2006, has similar hyperstomial ovicells with a completely calcified ectooecium and a median carina. However, it remains uncertain whether *Wilbertopora* ranges upwards into the Miocene, or if the Kalimantan species is a homeomorph of this predominantly Cretaceous genus.

Genus *Flustrellaria* d'Orbigny, 1853

?*Flustrellaria* sp.
Pl. 13, fig. 1a-e.

Figured material – NHMUK PI BZ 6859, Serravallian, TF76, 'Batu Putih 1', Samarinda; BZ 6860, Serravallian, TF522, 'Coalindo Haulage Road 1', Sangkulirang.

Description – Colony encrusting, multiserial with somewhat linear, directional growth, unilaminar. Ancestrula similar to autozooids, almost the same length, but narrower (L =

395 μm; W = 180 μm) with a thinner cryptocyst, budding a single autozooid distally (L = 370 μm; W = 215 μm) (Pl. 13, fig. 1a). Autozooids distinct, separated by thin grooves in depressions, ovoidal in outline, longer than broad (mean L/W = 1.72), chaotically arranged. Gymnocyst well developed proximally, tapering laterally and distally, smooth, convex. Cryptocyst narrow, tapering distally, granular, inwardly sloping. Opesia oval, longer than broad, occupying almost the entire frontal surface. Oral spine bases numerous, but of uncertain number, encircling the opesia and indenting the cryptocyst (Pl. 13, fig. 1c). Ovicell hyperstomial (Pl. 13, fig. 1e), crescent-shaped, small, ooecium partly immersed in the gymnocyst of the next distal zooid; ectooecium fully calcified, smooth. Intramural buds present (Pl. 13, fig. 1d). Pore chambers, kenozooids and avicularia absent.

Measurements – ZL 470±47, 360-571 (3, 40); ZW 274±29, 219-333 (3, 40); OL 316±32, 261-384 (4, 60); OW 194±21, 160-259 (4, 60); OvL 104±11, 89-122 (2, 6); OvW 208±23, 180-236 (2, 6).

Remarks – A few small-sized, fertile colonies of ?*Flustrellaria* sp. encrust the bases of platy corals from two Serravallian sections. This species appears to conform to the characters of *Flustrellaria*, notably the circumopesial distribution of spines and the hyperstomial ovicell with fully calcified ectooecium. However, as for *Wilbertopora*, the upper range of this mainly Cretaceous genus is uncertain, although one species – *F. australis* Gordon & Taylor, 1999 – has been described from the Eocene of Chatham Island, New Zealand. Also, some species assigned to the extant genus *Callopora* show a circumopesial distribution of spines and lack avicularia while the ovicell has a thinly calcified frontal area.

Genus *Parellisina* Osburn, 1940

Parellisina cf. *tenuissima* (Canu & Bassler, 1928)

Pl. 14, fig. 1a-c.

Figured material – NHMUK PI BZ 6861, Serravallian, TF57, 'Stadion Reef 2', Samarinda.

Description – Colony encrusting, multiserial, unilaminar. Ancestrula not seen. Pore chambers not observed. Autozooidal boundaries seemingly corresponding to the cryptocystal rim. Autozooids large, oval or pear-shaped, longer than broad (mean L/W = 1.61), arranged more or less quincuncially. Gymnocyst lacking. Cryptocyst very narrow, smooth. Opesia oval or pear-shaped, corresponding to autozooid outline, elongate, occupying almost the entire frontal surface. Oral spines absent. Ovicells not observed. Avicularia asymmetrical, located along distolateral margins of almost every autozooid; about half the length of an autozooid, narrow, rounded proximally, pointed and curved distally; gymnocyst minimal proximally, smooth; cryptocyst developed distally, smooth; rostrum hook-shaped, distolaterally directed, indenting the cryptocystal mural rim of the distal autozooid; condyles small, pointed (Pl. 14, fig. 1c). Kenozooids vestigial, located along distolateral edge of each avicularium, triangular, with small oval opesia; complex formed by the avicularium and its associated kenozooid trapezoidal in outline shape (mean L = 310 μm, mean W = 112 μm).

Measurements – ZL 545±49, 451-656 (2, 30); ZW 338±28, 280-389 (2, 30); OL 490±28, 467-529 (2, 30); OW 282±22, 259-319 (3, 30); AvL 294±27, 260-327 (2, 20); AvW 73±18, 49-99 (2, 20).

Remarks – Two small poorly preserved colonies of *Parellisina* cf. *tenuissima* encrust the undersides of platy corals. The Kalimantan material closely resembles the Recent *Parellina tenuissima* (Canu & Bassler, 1928) from the Gulf of Mexico, sharing with it a very thin, delicate and smooth cryptocystal mural rim, similarly sized autozooids and the shape of the avicularium. On the other hand the size of the kenozooids reported by Canu & Bassler (1928), even if they refer to the complex consisting of avicularium plus kenozooid, is almost double that of the Kalimantan specimens.

***Parellisina mirellae* sp. nov.**
Pl. 14, fig. 2a-d.

Figured material – Holotype: NHMUK PI BZ 6862, Serravallian, TF522, 'Coalindo Haulage Road 1', Sangkulirang.

Etymology – Named in honour of the first author's mother, Mirella Bordonaro.

Diagnosis – Colony encrusting. One distal and two distolateral pore chamber windows facing frontally. Autozooids polygonal. Gymnocyst smooth, better developed proximally and laterally, minimal distally. Cryptocyst finely granular, narrow. Opesia ovoidal. Oral spines absent. Ovicell globular with a semielliptical opening. Avicularia asymmetrical, rounded proximally, pointed and slightly curved distally, distolaterally directed. Kenozooids located distal to avicularium, subtriangular.

Description – Colony encrusting, multiserial, unilaminar. Ancestrula not seen. One distal pore chamber window facing frontally, large and oval, plus two distolateral slot-like, narrow pore chamber windows, visible at the colony growing edge (Pl. 14, fig. 2d, bottom left). Autozooids distinct, boundaries marked by very narrow furrows, variably polygonal in outline shape, longer than broad (mean L/W = 1.31), arranged more or less quincuncially. Gymnocyst broad to moderately broad proximally and laterally, minimal distally, slightly convex, smooth. Cryptocyst narrow, rather thick, forming a raised mural rim around the opesia, finely granular. Opesia ovoidal, elongate, occupying almost the entire frontal surface. Oral spines absent. Ovicell small, prominent, globular with a semielliptical opening, slightly broader than long, resting on the gymnocyst of the next distal autozooid and indenting its cryptocyst (Pl. 14, fig. 2b); ectooecium uncalcified, endooecial surface finely granular. Avicularia frequent, asymmetrical, placed distolaterally to autozooids (Pl. 14, fig. 2c), about half the length of an autozooid, narrow, rounded proximally, pointed and slightly curved distally; gymnocyst moderately developed proximally, smooth; cryptocyst narrow proximally, better developed distally, finely granular; rostrum acute, distolaterally directed, pointing towards the ovicell of the lateral autozooid or the proximal cryptocyst of the next distal autozooid; condyles small, pointed. Kenozooids located distal to avicularium, triangular, with similarly shaped opesia (Pl. 14, fig. 2c); complex formed by the avicularium and its associated kenozooid rectangular in outline shape (mean L = 396 μm, mean W = 187 μm). Intramural buds common (Pl. 14, fig. 2b, d).

Measurements – ZL 569±68, 460-725 (1, 50); ZW 435±66, 338-631 (1, 50); OL 410±40, 335-505 (1, 50); OW 313±35, 267-360 (1, 50); AvL 320±18, 304-346 (1, 15); AvW 118±6, 109-125 (1, 15); OvL 143±14, 125-159 (1, 10); OvW 235±24, 210-271 (1, 10).

Remarks – One large and well-preserved colony of *Parellisina mirellae* sp. nov. has been found encrusting the base of a very thin platy coral. It differs from *Parellisina* cf. *tenuissima* in the presence of a distinct gymnocyst, the thicker and much more raised cryptocystal mural rim, the larger size of the kenozooids and the different shape of the avicularium rostrum.

This new species can be readily distinguished from the most similar described species of *Parellisina*, such as *P. albida* (Hincks, 1880) recorded from the Recent of Australia and *P. subalbida* (Canu & Bassler, 1929) from the Philippines, by the greater development of the gymnocyst and the much less curved avicularium rostrum. It also differs from *P. albida* in having a prominent rather than a shallow ovicell and in the much more slender avicularium-kenozooid complex. The larger lengths of the autozooids and the avicularium-kenozooid complex are additional differences from *P. subalbida*.

Family Antroporidae Vigneaux, 1949
Genus *Antropora* Norman, 1903

***Antropora granulifera* (Hincks, 1880)**
Pl. 15, fig. 1a, b.

Membranipora granulifera Hincks, 1880, p. 72, pl. 9, fig. 4.
Dacryonella trapezoides Canu & Bassler, 1929, p. 133, pl. 14, figs 2-3.
Antropora granulifera: Harmer, 1926, p. 232, pl. 14, figs 11-14; Cook, 1968, p.138, fig. 9; Tilbrook, 1998, p. 27, fig. 1A; Tilbrook, 2006, p. 30, pl. 4, fig. A.

Figured material – NHMUK PI BZ 6863, Burdigalian-Langhian boundary, TF153, 'Rainy Section', Bontang.

Description – Colony encrusting, multiserial, unilaminar. Ancestrula and pore chambers not seen. Autozooids separated by distinct furrows, arranged in alternating longitudinal rows, rounded hexagonal or rhomboidal, longer than broad (mean L/W = 1.54). Gymnocyst vestigial. Mural rim crenulated, more raised laterodistally and distally. Cryptocyst moderately developed, occupying less than half of the frontal surface, flat, coarsely granular. Opesia rounded triangular, elongate or sometimes broader proximally with a straight proximal edge. Oral spines absent. A pair of small triangular interzooidal avicularia distal to each autozooid; rostra raised, pointed, directed medially, often touching each other. Vicarious avicularia absent. Ovicell small, endozooidal, indistinct.

Measurements – ZL 568±46, 478-644 (2, 60); ZW 369±39, 298-464 (2, 60); OL 323±16, 284-341 (2, 60); OW 254±31, 214-314 (2, 60); AvL 112±13, 99-128 (2, 60).

Remarks – In his revision of the genus *Antropora*, Tilbrook (1998) regarded the interzooidal avicularia placed at the distal corner of each autozooid, with rostra directed medially and almost touching at their distal tips, as the most distinctive feature of the Recent species *Antropora granulifera*. The Kalimantan specimens show this diagnostic character, as well as the roughly triangular opesia occupying more than half of the frontal surface. In addition, the size of autozooids, opesia and avicularia fall within the range of measurements given by different authors for *A. granulifera* (e.g., Canu & Bassler, 1929; Cook, 1968; Tilbrook, 1998).

Antropora granulifera at the present day shows a global distribution in warm and tropical waters. The Kalimantan specimens encrust the base of platy corals from the late Burdigalian to Langhian. They appear to represent the first fossil record of *A. granulifera*.

Antropora cf. _subvespertilio_ (Canu & Bassler, 1929)
Pl. 15, fig. 2a-e.

cf. *Dacryonella subvespertilio* Canu & Bassler, 1929, p. 134, pl. 14, fig. 1.
cf. *Antropora subvespertilio*: Tilbrook, 1998, p. 30, fig. 1B-C; Tilbrook, 2006, p. 32, pl. 4, fig. C.

Figured material – NHMUK PI BZ 6864, late Burdigalian, TF126, '3D Reef', Bontang.

Description – Colony encrusting, multiserial, unilaminar, large and lobate. Ancestrula damaged, similar to later autozooids, smaller, seemingly budding a single zooid distally, surrounded by seven zooids of intermediate size between the ancestrula and later autozooids. Pore chamber windows visible at the growing edge (Pl. 15, fig. 2c): distal pore chamber window large (mean L = 85 μm, mean W = 50 μm), oval, bordered by a thin rim, facing frontally; two pairs of distolateral and proximolateral pore chamber windows, small (mean L = 40 μm, mean W = 30 μm), oval or subcircular, bordered by a thicker rim. Autozooids distinct, separated by shallow furrows, arranged quincuncially, oval or subcircular, slightly longer than broad (mean L/W = 1.22). Gymnocyst reduced proximally, thinning laterally. Mural rim very thin, smooth, raised laterodistally and distally. Cryptocyst extensive, occupying more than half of the frontal surface, flat, finely granular. Opesia trifoliate (Pl. 15, fig. 2e), broad, with two lateral rounded opesiular identations and convex proximal edge along which granules of the cryptocyst tend to be aligned in parallel rows. Oral spines absent. A pair of small triangular interzooidal avicularia distal to each autozooid; rostra raised, pointed, directed medially, often touching each other or distomedially directed in ovicellate zooids; two small acute condyles. Vicarious avicularia absent. Ovicell small, endozooidal, ooecium caplike, smooth surfaced (Pl. 15, fig. 2d).

Measurements – ZL 419±29, 350-480 (2, 50); ZW 341±22, 311-369 (2, 50); OL 168±16, 152-195 (2, 50); OW 188±12, 163-202 (2, 50); AvL 90±8, 71-98 (2, 30).

Remarks – *Antropora* cf. *subvespertilio* differs from *A. granulifera* mainly in the smaller size of the autozooids and adventitious avicularia, and in having a trifoliate instead of rounded triangular opesia. The Kalimantan specimens are also smaller in size than the Recent material at the NHMUK from Puerto Rico studied by Tilbrook (1998), while in Canu & Bassler's material from the Philippines the zooids show a slightly different proportion of length vs. width, being shorter but broader.

Antropora cf. *subvespertilio* is abundant in the late Burdigalian of Kalimantan and often well-preserved, forming large encrustations on the undersides of platy corals. It co-occurs with *Antropora granulifera*. Recent specimens of *A. subvespertilio* have been found at 37 fathoms (about 68 m) in the Philippines and at 124-142 fathoms (about 227-260 m) at Grapples Bank, south-east Puerto Rico, while *A. granulifera* shows a shallower distributional range, extending from 0 to 109 m.

Genus *Parantropora* Tilbrook, 1998

Parantropora laguncula (Canu & Bassler, 1929)

Pl. 16, fig. 1a-e.

Parantropora laguncula Tilbrook, 2006, p. 31, fig. E.

Figured material – NHMUK PI BZ 6865, early Tortonian, TF508, Bontang.

Description – Colony encrusting, multiserial, unilaminar. Ancestrula not seen. Pore chambers absent. Autozooids distinct, boundaries marked by deep grooves, arranged in alternating longitudinal rows, oval, broad (mean L/W = 1.36). Gymnocyst reduced, best developed proximally, minimal laterally and distally, convex, showing concentric growth lines. Cryptocyst narrow, slightly broader proximally, tapering laterally, disappearing distally, coarsely granular with granules aligned in radial rows, projecting into opesia as denticulations. Opesia oval, broad, occupying almost the entire length of the frontal surface. Oral spines absent. One or two small pear-shaped interzooidal avicularia (Pl. 16, fig. 1c), present close to the distolateral corners of each autozooid; palate with a narrow granular cryptocyst; rostrum slightly narrower than palate, rounded, raised, distally directed; condyles inconspicuous. Vicarious avicularia absent. Ovicell endozooidal, small, ooecium raised, cap-like (Pl. 16, fig. 1e), involving the distal edge of the maternal zooid and the proximal edge of the next distal zooid in the series. Intramural buds common (Pl. 16, fig. 1d).

Measurements – ZL 357±16, 337-386 (3, 70); ZW 262±30, 227-310 (3, 70); OL 258±33, 214-313 (3, 70); OW 177±17, 151-211 (3, 70); AvL 65±5, 57-72 (3, 30); AvW 42±6, 32-49 (3, 30).

Remarks – Several colonies of *Parantropora laguncula* form large flat sheets on the bases of platy corals from the Serravallian, while in the early Tortonian they were found encrusting small coral fragments and are very well preserved. This species seems to be conspecific with the Recent *Parantropora laguncula* as described by Tilbrook (2006) from the Solomon Islands. In particular, it closely resembles the specimen figured by Tilbrook (2006, p. 31, fig. E), which lacks large vicarious avicularia and differs from the Miocene material only in the more variable orientation of the interzooidal avicularia.

On the other hand, compared to the Recent type specimen of *Parantropora laguncula* from the Philippines, and to material from the Great Barrier Reef, both figured by Tilbrook (1998, p. 38, fig. E; p. 42, fig. A), the Kalimantan material differs in: having a broader proximal gymnocyst; the variable presence of small interzooidal avicularia; absence of spatulate vicarious avicularia; and having larger autozooids. Some similarities are evident with *Retevirgula aggregata* Gordon, 1984 but this Recent species from New Zealand has a narrower cryptocyst and a prominent hyperstomial ovicell.

The generic attribution of all of the material, both Recent and fossil, assigned to *Parantropora laguncula* can be questioned as the type species of this genus (*P. penelope* Tilbrook, 1998) has a minimal gymnocyst, a cryptocyst occupying slightly less than half the frontal surface and triangular opesia.

The Recent *Antropora typica* (Canu & Bassler, 1928) as well as some of the species belonging to the mainly Cretaceous calloporid genus *Marginaria* Roemer, 1841, reported also from the Aquitanian of Gujarat by Guha & Gopikrishna (2007b), show similar extensions of both gymnocyst and cryptocyst. *Antropora typica* differs in having teardrop-shaped interzooidal avicularia with acute rostra and large spatulate vicarious avicularia, whereas *Marginaria* has a prominent hyperstomial ovicell, oral spines and kenozooids.

At the present day *Parantropora laguncula* is known from the Indo-Malaysian region and Australia. Prior to this occurrence in the Miocene of Kalimantan, it had no known fossil record.

***Parantropora* aff. *laguncula* (Canu & Bassler, 1929)**
Pl. 17, fig. 1a-e.

aff. *Antropora marginella* Harmer, 1926, p. 234, pl. 14, fig. 15.
aff. *Membrendoecium laguncululm* Canu & Bassler, 1929, p. 95, pl. 6, figs 6-11.
aff. *Parantropora laguncula* Tilbrook, 1998, p. 41, figs 3F, 4A-B.

Figured material – NHMUK PI BZ 6865, BZ 6899, Serravallian, TF522, 'Coalindo Haulage Road 1', Sangkulirang.

Description – Colony encrusting, multiserial, unilaminar, large. Ancestrula not seen. Pore chambers absent. Autozooids distinct, boundaries marked by thin furrows, arranged in alternating longitudinal rows, oval, elongate (mean L/W = 1.56). Gymnocyst broadest proximally, narrowing along lateral and distal edges. Cryptocyst encircling the opesia, narrow, slightly broader proximally, tapering distally, coarsely granular, with granules aligned in radial rows. Opesia oval, occupying most of the frontal surface. Oral spines absent. Two small triangular interzooidal avicularia (Pl. 17, fig. 1c) present at the distolateral corners of each autozooid, rounded proximally; rostrum pointed, raised, distomedially directed; condyles not seen. Vicarious spatulate avicularia present (Pl. 17, fig. 1b, d), same size as the autozooids or slightly larger; lateral walls raised and curved inwards, distal edge raised. Ovicell endozooidal, ooecium small, raised, cap-like (Pl. 17, fig. 1e). Intramural buds not seen.

Measurements – ZL 412±43, 349-489 (2, 60); ZW 263±20, 217-296 (2, 60); OL 338±42, 279-399 (2, 60); OW 204±19, 165-238 (2, 60); AvL 521±38, 480-548 (2, 10); AvW 237±6, 233-241 (2, 10).

Remarks – Two large colonies of *Parantropora* aff. *laguncula* have been found encrusting platy corals in one of the Serravallian sections. However, the two specimens show some differences in the length of the zooids, with means of 390 μm and 442 μm, while the vicarious avicularia are slightly longer in the colony with the smaller zooids, averaging 520 µm and 480 µm. The Kalimantan specimens differ in size from the Recent *P. laguncula*, having slightly larger zooids, but smaller vicarious avicularia.

Parantropora cf. *penelope* Tilbrook, 1998
Pl. 18, fig. 1a-d.

cf. *Parantropora penelope*: Tilbrook, 1998, p. 40, fig. 3D-E; Tilbrook, 2006, p. 31, pl. 4, fig. D.

Figured material – NHMUK PI BZ 6867, Serravallian, TF52, 'Batu Putih 2', Samarinda.

Description – Colony encrusting, multiserial unilaminar, small. Ancestrula and early astogeny partially obliterated by rock; ancestrula seemingly smaller than later autozooids, oval, 170 µm long by 140 µm wide, with irregularly oval opesia encircled by a narrow cryptocyst that slopes steeply inwards and is finely granular; first generation of autozooids smaller than later autozooids. Pore chambers absent. Autozooids distinct, separated by shallow furrows, oval to rhomboidal in outline, longer than broad (mean L/W = 1.58). Gymnocyst absent. Cryptocyst broad proximally, occupying slightly less than half frontal surface, tapering distally, encircling the opesia, laterally gently sloping, medially flat or slightly concave, coarsely granular. Opesia rounded triangular. Oral spines absent. One or two small teardrop-shaped interzooidal avicularia located at the distal corners of each autozooid; rostrum acute, raised, distally or distomedially directed. Vicarious avicularia not seen. Ovicell endozooidal, ooecium small, raised, cap-like (Pl. 18, fig. 1b, top left). Intramural reparative buds common (Pl. 18, fig. 1c).

Measurements – ZL 413±49, 340-478 (1, 20); ZW 261±32, 225-333 (1, 20); OL 219±21, 181-255 (1, 15); OW 177±15, 158-189 (1, 15); AvL 63±4, 59-71 (1, 10); AvW 41±2, 39-43 (1, 10).

Remarks – A single small young colony of *Parantropora* cf. *penelope* has been found on the underside of a platy coral. Although small interzooidal avicularia are present in very early astogeny, spatulate vicarious avicularia, which are known to occur in Recent representatives of the species, are unfortunately missing, probably because of the young age of the colony. However, autozooidal size in this specimen is quite similar to the holotype of *Parantropora penelope* and comparison with this species is warranted.

This species is easily distinguishable from the two other species of *Parantropora* found in the Kalimantan material by the absence of the gymnocyst, the extensive development of the cryptocyst and the reduced, subtriangular opesia. At the present day *Parantropora penelope* is known from the tropical South West Pacific (Tilbrook 1998).

Family Vinculariidae Busk, 1852
Genus *Vincularia* Defrance, 1829

Vincularia berningi sp. nov.
Pl. 19, fig. 1a-d; Pl. 20, fig. 1e.

Figured material – Holotype: NHMUK PI BZ 6043, early Tortonian, TF110, 'Seagrass Section', Bontang.

Etymology – Named after Björn Berning (Oberösterreichisches Landesmuseum, Linz) in recognition of his significant contribution to the study of bryozoans.

Diagnosis – Colony erect, quadrangular in cross-section, quadriserial. Zooids subrectangular, dimorphic with ordinary autozooids symmetrical and avicularian autozooids asymmetrical. Cryptocyst smooth, narrow. Opesia oval with two proximolateral septula and two large oval median communication pores. Interzooidal avicularia small, triangular, located between proximo- and distolateral corners of zooids.

Description – Colony erect, articulated; internodes straight, quadrangular in cross-section, quadriserial, beginning with short kenozooids and connected by a tripartite articulation (Pl. 20, fig. 1e, bottom). First zooid budded after the kenozooids is usually shorter than succeeding zooids. Rhizoidal pores not observed. Zooids arranged in alternating series, dimorphic, with similar zooids occurring in two adjacent series, distinct, separated by shallow grooves between slightly raised ridges. Ordinary autozooids symmetrical ('c-zooecia' *sensu* Canu, 1907) (Pl. 19, fig. 1a, b), subrectangular with slightly convex distal and concave proximal margins, elongate (mean L/W = 2.38), slightly broader at about half-length. Cryptocyst smooth, proximally variably developed, narrower but approximately constant in width laterally and along the distolateral margin adjacent to a different polymorph type (here called the outer margin), narrowing in distal third and merging with the sloping median shelf along the distolateral margin adjacent to the same polymorph type (here called the inner margin). Distal cryptocystal shelf broad and sloping gently inwards. Opesia oval, elongate, occupying five-sixths of zooidal length, revealing two small circular proximolateral septula, a large median oval communication pore placed distally connecting zooids from the same row and another large oval communication pore in the distolateral outer corner connecting zooids from adjacent rows. Calcification proceeds throughout ontogeny, resulting in thicker internodes and reduced opesiae. Avicularian autozooids ('D-zooecia' *sensu* Canu, 1907) (Pl. 19, fig. 1c, d) asymmetrical, subrectangular, elongate, larger than ordinary autozooids, but squatter (mean L/W = 1.82), with slightly convex distal and concave proximal margins, diverging from the same type of zooid in the adjacent series and curving towards the adjacent series of ordinary autozooids. Cryptocyst smooth, broadest proximolaterally, narrower and of constant width along the inner margin, tapering distally, merging with immersed distal shelf at about half-length along the outer margin. Distal cryptocystal shelf broad, sloping gently inwards. Opesia oval, elongate, occupying about three-quarters of zooidal length, asymmetrical broadening towards the distolateral outer margin, with two small, circular proximolateral septula more widely spaced than in ordinary autozooids, a large oval median communication pore placed distally connecting zooids from the same row and another large oval median communication pore situated at the distolateral inner corner connecting zooids from two adjacent rows. Interzooidal avicularia common, small, triangular, located between proximo- and distolateral corners of both types of zooids, facing laterally, corresponding to the distal half of the adjacent zooid. Cryptocyst proximally narrow and sloping steeply, distally extensive and sloping gently; rostrum acute, distally directed; opesia oval, crossbar and condyles not seen. Ovicellate zooids absent.

Measurements – 'c-zooecia': ZL 616± 21, 588-652 (10, 40); ZW 258±15, 239-284 (10, 40); OL 486±13, 474-500 (10, 40); OW 162±10, 152-176 (10, 40). 'D-zooecia': ZL 650±37, 603-711 (10, 40); ZW 356±19, 322-388 (10, 40); OL 512±35, 465-563 (10, 40); OW 220±23, 192-258 (10, 40). AL 199±15, 178-224 (5, 15).

Remarks – *Vincularia berningi* sp. nov. is the commonest species in the Kalimantan material, found in all the sections from late Burdigalian to Messinian. It is especially abundant in beds interpreted as having been deposited in seagrass palaeoenvironments where bryozoan assemblages are monogeneric and represented by one or more species of *Vincularia*.

Vincularia berningi sp. nov. is similar to the type species of *Vincularia*, *V. fragilis* Defrance, 1829, from the Eocene of France (see Cheetham, 1973, p. 391, pl. 1, figs 1, 2), in being quadriserial, having dimorphic zooids ('c-zooecia' and 'D-zooecia') and small interzooidal triangular avicularia, but lacking ovicellate zooids. It differs in the absence of a pivotal bar, which has not been observed in any specimens from Kalimantan despite the great abundance and good preservation of the available material.

The genus *Vincularia* apparently ranges from the Middle Eocene to Late Miocene. However, many Cretaceous or Miocene species identified as *Vincularia* or *Vincularia sensu lato* using single quotation marks (e.g., *V. excavata* d'Orbigny, 1851, and *V. prismatica* (von Hagenow, 1839) from Europe, and *'V.' ramwaraensis* Guha & Gopikrishna, 2005, from Gujarat, India) possess more than four sides and do not appear to have the avicularian or 'D-zooecia' characteristic of the genus. *Vincularia berningi* sp. nov. shows some similarities with *Nellia kutchensis* Tewari & Srivastava, 1967, from India, figured by Guha & Gopikrishna (2005, p. 141, pl. 2, figs. 4-5). This species seems to be a true Miocene (Burdigalian) representative of *Vincularia* with dimorphic zooids and asymmetry, even though the description (p. 142) reports that "the back to back placed paired rows of zooids have similar dimensions and differ much from those of the other paired rows", while in *Vincularia* two adjacent rows have similar zooids; the asymmetry may be due to oblique opening of the autozooids and the obliquely placed opesia. The Kalimantan species and *Nellia kutchensis* share also the presence of similar-sized triangular avicularia with undivided opesia, but the zooids in *N. kutchensis* show a greater range of size variation, even taking into account that the measurements of the 'c-zooecia' and 'D-zooecia' were not separated. Specimens closely resembling *Vincularia berningi* sp. nov., but with remnants of a crossbar in the interzooidal avicularia have been also found in the Miocene of Tanzania (B. Berning, research in progress).

Vincularia semarai **sp. nov.**
Pl. 19, fig. 2a-d.

Figured material – Holotype: NHMUK PI BZ 6868, late Burdigalian, TF126, '3D Reef', Bontang.

Etymology – Named after the south-east Asian mythological god Semara.

Diagnosis – Colony erect, quadrangular in cross-section, quadriserial. Zooids dimorphic. Ordinary autozooids symmetrical, rectangular with a pointed distal margin.

Avicularian autozooids slightly asymmetrical with rounded distal margin. Cryptocyst smooth, moderately developed. Opesia oval with two median lateral septula.

Description – Colony erect, articulated; internodes straight, rounded quadrangular in cross-section, quadriserial. Articulating ends of internodes and rhizoidal pores not observed. Zooids arranged in alternating series, dimorphic, with similar zooids occurring in two adjacent series, distinct, separated by shallow grooves between slightly raised ridges. Ordinary autozooids symmetrical (Pl. 19, fig. 2a, b), elongate (mean L/W = 2.1), rectangular with straight or slightly curved lateral walls and a distal margin in the shape of a pointed arch that indents the proximal margin of the next distal zooid. Cryptocyst smooth, moderately developed, constant in width proximally and laterally, slightly broader distally, surrounding a small, oval, elongate, centrally placed opesia, broader distally, probably reduced due to secondary calcification. Avicularian autozooids only slightly asymmetrical (Pl. 19, fig. 2c, d), curving just perceptibly away from the same polymorphs in the adjacent series, little different in shape and size from the ordinary autozooids, except for the distal margin which is more round-arched. Cryptocyst the same as in ordinary autozooids. Opesia oval, nearly symmetrical, reduced. Two small, circular, median lateral septulae; communication pores not seen. Interzooidal avicularia and ovicells absent.

Measurements – ZL 790±36, 735-853 (3, 15); ZW 382±27, 358-417 (3, 15); OL 404±32, 388-441 (3, 15); OW 123±25, 99-158 (3, 15).

Remarks – *Vincularia semarai* sp. nov. is very rare, a few fragments having been found only in the late Burdigalian. This species differs from *Vincularia berningi* sp. nov. in having much longer ordinary autozooids with a very characteristic pointed arched distal margin only slightly different from avicularian zooids and in the lack of interzooidal avicularia. Compared with the Cenozoic species placed unequivocally in *Vincularia* by Cheetham (1966, p. 54), *Vincularia semarai* sp. nov. shares some similarities with *V. davisi* Cheetham, 1966, from the Eocene of Sussex and *V. subsymmetrica* (Canu, 1907) from the Lutetian of France. These similarities include the barely perceptible difference in morphology between ordinary and avicularian zooids, and the lack of interzooidal avicularia and ovicellate zooids. They differ in the size of zooids, the shape of the distal margin – pointed arched in *Vincularia semarai* sp. nov. and straight in the two Eocene species – and the development of the proximal cryptocyst, which is much more extensive in *V. davisi* and *V. subsymmetrica.*

Vincularia tjaki sp. nov.

Pl. 20, fig. 1a-e.

Figured material – Holotype: NHMUK PI BZ 6869, late Burdigalian, TF126, '3D Reef', Bontang.

Etymology – Named after the south-east Asian mythological god Tjak.

Diagnosis – Colony erect, quadrangular in cross-section, quadriserial. Rhizoidal pores large. Zooids rounded rectangular, slightly dimorphic. Ordinary autozooids symmetrical. Avicularian autozooids slightly asymmetrical with narrower distolateral cryptocyst. Cryptocyst smooth. Opesia oval with two small, lateral septula and a distal communication pore. Interzooidal avicularia small, triangular, located at one of the proximolateral zooidal corners.

Description – Colony erect, articulated; internodes straight, quadrangular in cross-section, quadriserial. Articulating ends of internodes with four connecting tubes (Pl. 20, fig. 1e, top), starting with two shorter kenozooids located back-to-back. Rhizoidal pores large, circular, sparse, located on the proximal cryptocyst beneath the opesia, encircled by a raised rim. Zooids arranged in alternating series, slightly dimorphic, with similar polymorphs occurring in two adjacent series, distinct, separated by shallow grooves between slightly raised ridges. Ordinary autozooids symmetrical (Pl. 20, fig. 1a, b), rounded rectangular, elongate (mean L/W = 2.31). Cryptocyst smooth, convex proximally and laterally, slightly depressed distally, narrow, similar in width all around the opesia. Opesia oval, elongate, centrally placed. Avicularian autozooids only slightly asymmetrical (Pl. 20, fig. 1c,d), curving just perceptibly away from the same type of polymorph in the adjacent series, little different in shape and size from the ordinary autozooids, except for the much narrower distolateral cryptocyst merging with immersed distal shelf and the longer opesia. Inner cryptocystal shelf acutely angled with two small, circular, widely spaced, lateral septula mid-length, and a larger, oval distal communication pore. Interzooidal avicularia common, located at one of the proximolateral corners of either an ordinary autozooid or an avicularian autozooid, small, triangular, facing frontally; cryptocyst broader proximally, narrower laterally and distally; rostrum pointed, distally directed; opesia oval, undivided. Ovicellate zooids not observed; a small cap-like swollen calcification seen at the distal end of one zooid is considered unlikely to be an ovicell, but probably a result of secondary calcification owing to reparative budding.

Measurements – ZL 858±26, 819-902 (4, 30); ZW 372±13, 349-397 (4, 30); 'c-zooecia': OL 563±23, 525-594 (4, 15); 'D-zooecia': OL 640±29, 600-680 (4, 15); OW 226±17, 200-237 (4, 30); AL 183±11, 166-196 (4, 30).

Remarks – Fragments of *Vincularia tjaki* sp. nov. are scarce in the late Burdigalian. This species differs from *Vincularia berningi* sp. nov. in having larger zooids and less pronounced dimorphism. It differs from *Vincularia semarai* sp. nov. in having autozooids with straight distal margins, instead of pointed arched margins, and in the presence of interzooidal avicularia.

***Vincularia manchanui* sp. nov.**

Pl. 20, fig. 2a-c.

Figured material – Holotype: NHMUK PI BZ 6042, late Burdigalian, TF126, '3D Reef', Bontang.

Etymology – Named after the south-east Asian mythological god Manchanu.

Diagnosis – Colony erect, quadrangular in cross-section, quadriserial. Zooids club-shaped, dimorphic. Ordinary autozooids symmetrical. Avicularian autozooids slightly asymmetrical. Cryptocyst granular. Opesia claviform. Interzooidal avicularia small, oval, located at one of the proximolateral corners of either polymorph.

Description – Colony erect, articulated; internodes straight, quadrangular in cross-section, quadriserial. Articulating ends of internodes not preserved. Rhizoidal pores not observed. Zooids arranged in alternating series, dimorphic, with similar polymorphs occurring in two adjacent series, distinct, separated by shallow grooves between slightly raised ridges. Ordinary autozooids symmetrical (Pl. 20, fig. 2a, b), club-shaped, elongate (mean L/W = 3), narrower proximally. Cryptocyst granular, broader proximally and distally, narrower laterally, sloping gently inwards. Opesia claviform, elongate, centrally placed, reduced by concentric rings of secondary calcification. Avicularian autozooids slightly asymmetrical (Pl. 20, fig. 2c), curving away from the equivalent polymorph in the adjacent series, with cryptocyst and opesia of similar size and shape as ordinary zooids. Septula and communication pores not visible. Interzooidal avicularia comm0on, located at one of the proximolateral corners of either polymorph, very small, about 120 μm long, oval, facing frontally; cryptocyst broader proximally, narrower laterally and distally; rostrum rounded, distally directed; opesia oval, undivided. Ovicells not observed.

Measurements – ZL 590±14, 580-600 (10, 40); ZW 197±8, 190-205 (10, 40); OL 316±12, 304-327 (10, 40).

Remarks – Together with *Vincularia berningi* sp. nov., *Vincularia manchanui* sp. nov. is one of the most abundant species in all sections from the late Burdigalian to the Messinian. This species differs from all other species of *Vincularia* described here in having much narrower, club-shaped zooids, a granular, inwardly sloping cryptocyst and smaller interzooidal avicularia facing frontally. It resembles the Eocene *V. davisi* Cheetham, 1966, in the shape and size of the zooids and their length/width proportion, but differs in having interzooidal avicularia and in the absence of a size difference between ordinary and avicularian zooids.

***Vincularia* sp. 1**

Pl. 21, fig. 1a-f.

Figured material – NHMUK PI BZ 6870, late Burdigalian, TF126, '3D Reef', Bontang.

Description – Colony erect, articulated; internodes slightly curved, cylindrical, quadriserial. Internode starting with two short, back-to-back kenozooids (Pl. 21, fig. 1a, b, d). Articulating ends of internodes with four connecting tubes. Sparse, large, circular rhizoidal pores perforating the proximal cryptocyst of the zooids immediately beneath the opesia (Pl. 21, fig. 1d, e). Autozooids monomorphic, arranged in four alternating series, distinct, separated by deep grooves between slightly raised ridges, elongate (mean L/W = 1.91), hexagonal in outline with sinuous curved lateral walls, straight or slightly concave proximal margin and straight or slightly convex distal margin. Cryptocyst smooth, convex, broader proximally, narrower, but constant laterally and distally, depressed in distolateral corners, surrounding a small, oval, elongate, centrally placed opesia, broader distally, probably reduced by secondary calcification. Two small, circular, proximal to median lateral septula and one large, oval, median communication pore (Pl. 21, fig. 1d). Interzooidal avicularia infrequent, oval, small, about 140 μm long and 55 μm wide, facing frontally (Pl. 21, fig. 1c); cryptocyst smooth, narrow and steeply sloping proximally and laterally, broader and gently sloping distally; rostrum distally directed; opesia teardrop-shaped undivided. Ovicellate zooids not recognized.

Measurements – ZL 688±7, 676-697 (2, 20); ZW 361±13, 351-380 (2, 20); OL 329±22, 303-358 (2, 20); OW 166±14, 151-179 (2, 20).

Remarks – *Vincularia* sp. 1 is very rare and is restricted to the late Burdigalian. It differs from the previous species of *Vincularia* described herein in having monomorphic zooids and cylindrical internodes. For the present, this species is assigned in open nomenclature to *Vincularia* although it most closely resembles a species recently described from the Middle Eocene of India as *Planicellaria kharaiensis* Guha & Gopikrishna, 2007b. Differences between the morphological similar genera *Vincularia*, *Planicellaria* and *Quadricellaria* need to be fully investigated through revision of type and other material.

'*Vincularia*' sp.

Pl. 21, fig. 2a-c.

Figured material – NHMUK PI BZ 6871, Serravallian, TF76, 'Batu Putih 1', Samarinda.

Description – Colony erect, non-articulated, branches bifurcating at an angle of about 60°, cylindrical, on average 1 mm in diameter, well calcified. Autozooids alternating in regular longitudinal rows, polygonal, rounded distally, longer than broad (mean L/W= 1.6), distinct, separated by a thin smooth mural rim raised distally (Pl. 21, fig. 2b). Autozooids at bifurcations obliquely tilted (Pl. 21, fig. 2c). Gymnocyst absent. Cryptocyst finely granular, depressed, well developed proximally, decreasing laterally and distally. Opesia large, oval, placed distally. Spines, avicularia and ovicells not observed.

Measurements – ZL 900±8, 739-1083 (10, 50); ZW 536±8, 439-732 (10, 50); OL 573±7, 463-742 (10, 50); OW 325±3, 277-348 (10, 50); CrL 252±52, 176-316 (10, 50).

Remarks – '*Vincularia*' sp. is one of the commonest species in the Serravallian section at 'Batu Putih 1', where it occurs as abundant branch fragments scattered in silty sediments. More than a thousand specimens have been collected, none showing avicularia or ovicells; a single zooid at a branch bifurcation has a semielliptical structure in its distal part, but this is interpreted as an unusual thickening of the mural rim rather than an avicularium or ovicell.

Some similarities in the colony form and zooidal morphology are apparent with Cretaceous specimens provisionally assigned to *Vincularia fragilis* Defrance, 1829, from the F. Canu Collection at the Muséum National d'Histoire Naturelle (MNHN) in Paris, the Miocene species *'Vincularia' anceps* Brown, 1952, from New Zealand, and *'Vincularia' ramwaraensis* Guha & Gopikrishna, 2005, from the Aquitanian (Early Miocene) of Gujarat, India. Guha & Gopikrishna (2005, p. 146) also remarked on similarities between their species and many Cretaceous taxa assigned to *Vincularia* (e.g., *V. excavata* d'Orbigny, 1851, *V. prismatica* (Hagenow, 1839)). However, all this material appears to belong to a different, presumably un-named genus when compared to the Eocene type species of *Vincularia*. The genus *Pseudothyracella* Labracherie, 1975, has a similar colony form and arrangement of zooids, but differs in having avicularia larger than its autozooids and squared opesiae more distally placed than in the Kalimantan fossils.

Family Heliodomidae Vigneaux, 1949
Genus *Setosellina* Calvet, 1906

***Setosellina* cf. *constricta* Harmer, 1926**
Pl. 22, fig. 1a-e.

cf. *Setosellina constricta* Harmer, 1926, p. 264, pl. 16, fig. 1.

Figured material – NHMUK PI BZ 6872, BZ 6873, Serravallian, TF76, 'Batu Putih 1', Samarinda.

Description – Colony encrusting small bioclastic sediment grains such as coral and erect bryozoan fragments, foraminifera, gastropod or crab shells, 2 to 4 mm in diameter, frequently enveloping the substrate (Pl. 22, fig. 1d, e). Ancestrula with the same characters as later autozooids, but smaller, on average 250 μm long by 160 μm wide, budding daughter zooids in a clockwise spiral pattern (Pl. 22, fig. 1a). First budded generation of autozooids on average 320 μm long by 200 μm wide. Pore chambers absent. Autozooids distinct, separated by deep grooves, oval, elongate (mean L/W = 1.68). Gymnocyst reduced proximally, minimal laterally and distally, smooth, convex. Cryptocyst very thin proximally and laterally, disappearing distally, sloping steeply inwards, transversely crenulate. Opesia oval or often pear-shaped with the narrower distal third separated from the broader proximal two-thirds by a lateral constriction of cryptocyst, occupying almost the entire frontal surface (Pl. 22, fig. 1b). Avicularia (vibracula) globular to oval, present distally of each autozooid (Pl. 22, fig. 1c); opesia occupying almost the entire frontal surface, constricted in the middle by two small rounded teeth. Ovicells not seen.

Measurements – ZL 400±19, 389-436 (5, 50); ZW 237±25, 204-281 (5, 50); OL 300±22, 268-329 (5, 50); OW 168±11, 154-186 (5, 50); AvL 100±13, 78-123 (5, 30).

Remarks – *Setosellina* cf. *constricta* has been found only in a silty bioclastic layer of one of the Serravallian sections where it appears to be abundant. It encrusts several different types of small bioclastic grains exhibiting different development. For example, when the substrate is rounded or tubular, such as a gastropod, foraminifera or erect bryozoan, the colony tends to envelop it completely, whereas if the substrate is flat, such as a sediment grain or platy coral fragment, the colony is usually present only on one surface.

Despite the large number of specimens found, none has ovicells, which seem also to be lacking in the types of *Setosellina constricta*. That part of Harmer's type material housed in the zoological collection of NHMUK is, unfortunately, unhelpful in the identification because it is a small colony formed by a few periancestrular autozooids. However, additional material available at the NHMUK from the Siboga expedition identified as *S. constricta* has been used to compare zooid sizes. The Recent colonies were found to have shorter autozooids (335 μm vs 400 μm) and consequently shorter opesiae (216 μm vs 300 μm) but very similar autozooidal width and vibraculum size.

Setosellina cf. *constricta* is easily distinguished from all the other species of *Setosellina* in the absence of pore chambers, the very thin lateral cryptocyst and the lack of closing laminae, which usually develop very early in astogeny, in the older, central zooids. At the present day *S. constricta* is reported from the Borneo Bank in the Makassar Strait, New Guinea and the Celebes Sea at depths of 0-59 m.

Setosellina cf. *roulei* Calvet, 1906

Pl. 22, fig. 2a, b.

cf. *Setosellina roulei* Calvet, 1906, p. 157; Calvet, 1907, p. 395, pl. 26, figs 5-6; Hayward & Cook, 1979, p. 48, figs 1A, 17B, 18B.

Figured material – NHMUK PI BZ 6874, Serravallian, TF59, 'Southern Hemisphere', Bontang.

Description – Colony encrusting, small, circular in outline. Ancestrula with the same characters as later autozooids, but smaller, on average 200 μm long by 155 μm wide, and less developed gymnocyst, surrounded by six autozooids budded spirally (Pl. 22, fig. 2a). First budded generation of autozooids on average 270 μm long by 180 μm wide. Pore chambers absent. Autozooids distinct, separated by deep grooves, oval, elongate (mean L/W = 1.56). Gymnocyst moderately developed proximally, tapering laterally, and smooth and convex distally. Cryptocyst reduced to an inconspicuous row of small granules. Opesia oval, sometimes enlarged proximally. Vibracula globular, distal to each autozooid; opesia circular. Ovicells not seen.

Measurements – ZL 389±18, 358-412 (2, 20); ZW 250±22, 227-289 (2, 20); OL 250±34, 225-274 (2, 20); OW 162±3, 159-165 (2, 20); AvL 103±11, 90-122 (2, 20).

Remarks – A few, small, infertile colonies of *Setosellina* cf. *roulei* have been found encrusting the undersides of very thin platy corals from the late Burdigalian and the Serravallian. This species differs from *Setosellina* cf. *constricta* in having a more developed gymnocyst and less developed cryptocyst, and in the lack of lateral opesial constriction. This species is similar to the Recent *Setosellina roulei*, recorded from the east Atlantic and South Africa, in the size of the autozooids (given by Cook, 1965) and opesiae, and in the development of gymnocyst and cryptocyst. However, no ovicells or closure laminae in the ancestrular area were found, although the small size of the colonies may have biased against their presence. *Setosellina roulei* is usually associated with sand-grain substrates and deep waters at 1900-2330 m (Cook, 1965), but the Kalimantan specimens of *Setosellina* cf. *roulei* encrust fairly large platy corals from a shallow water deposit.

Family Cupuladriidae Lagaaij, 1952
Genus *Reussirella* Bałuk & Radwanski, 1984
***Reussirella* sp.**
Pl. 23, fig. 1a-f.

Figured material – NHMUK PI BZ 6875, BZ 6876, BZ 6877, Serravallian, TF76, 'Batu Putih 1', Samarinda.

Description – Colony free, small, diameter up to 7 mm, flattened, discoidal, subcircular (Pl. 23, fig. 1a, e). Autozooids arranged in alternating radial rows, rhomboidal. Cryptocyst developed proximally and laterally, reduced distally, sloping steeply inwards, tuberculate, denticles on the lateral and proximal inner edges numerous, variable in size and shape, pointed or rounded. Vestibular arch with straight or slightly divergent sides. Opesia irregularly oval, occupying two-thirds of the zooidal frontal surface. Vibracula asymmetrical, triangular (Pl. 23, fig. 1d), proximolaterally directed, oriented alternatively to left and right. Dorsal side tuberculate with radial sector boundaries (Pl. 23, fig. 1f).

Measurements – ZL 504±54, 437-601 (2, 50); ZW 346±22, 297-362 (2, 50); OL 372±41, 302-465 (2, 50); OW 197±14, 177-232 (2, 50); AvL 198±17, 183-225 (2, 30).

Remarks – A few complete colonies and some fragments of *Reussirella* sp. have been found only in the silty layer of one Serravallian section, along with some other 'sand-fauna' bryozoans such as *Setosellina* and *Mamillopora*. This genus, redefined by Cook & Chimonides (1994), is distinguished from other cupuladriids by the following characters: autozooidal cryptocyst with vestibular arch, with or without lateral denticles; basal calcification with radial sector boundaries, tuberculate or smooth; central region closed by cryptocystal lamina late in ontogeny; and absence of vicarious avicularia. The Kalimantan specimens fit the definition of the genus, although adherent rock prevents confirmation of the presence of closing laminae in the old zooids at the colony centre; also, the number of denticles is uncertain because of abrasion or sediment infills.

Similarities are apparent with two European species, *R. multispinata* (Canu & Bassler, 1923), known from the ?Pliocene to Recent, and *R. haidingeri* (Reuss, 1847), which ranges from Miocene to Pliocene. However, the Kalimantan species differs from *R. multispinata* in: the absence of a distinct pair of distal denticles; having spinules along the proximal oral border; and the smaller size of the autozooids. It differs from *R. haidingeri* in the smaller size of the zooids. Recent cupuladriids are characterized by skeletons composed of aragonite (see Taylor *et al*., 2009; Taylor, 2012). Aragonite is typically leached at Batu Putih, as is evident from the absence of aragonitic gastropods and bivalves. Therefore, the preservation of reasonably well-preserved colonies of *Reussirella* is puzzling and requires further investigation.

Superfamily Flustroidea Fleming, 1828
Family Flustridae Fleming, 1828
Genus *Gontarella* Grischenko, Taylor & Mawatari, 2002

***Gontarella*? *sendinoae* sp. nov.**
Pl. 24, fig. 1a-f.

Figured material – Holotype: NHMUK PI BZ 6878, Serravallian, TF59, 'Southern Hemisphere', Bontang.

Etymology – Named after Consuelo Sendino (Department of Earth Sciences, Natural History Museum, London), curator of the fossil bryozoan collection.

Diagnosis – Colony encrusting. Autozooids rhomboidal or hexagonal, separated by a thick, raised rope-like mural rim. Gymnocyst absent. Cryptocyst granular, forming a sunken variably developed shelf proximally. Opesia ovoidal or subtriangular. Oral spines absent.

Description – Colony encrusting multiserial, unilaminar. Ancestrula and early astogeny not seen. Pore chambers absent. Autozooids arranged quincuncially, distinct, separated by a thick, raised rope-like mural rim, rhomboidal or hexagonal with curved distal margin, slightly longer than broad (mean L/W= 1.18). Gymnocyst absent. Cryptocyst granular, forming a sunken variably developed shelf proximally, tapering distally. Opesia broad, ovoidal or subtriangular, occupying between half and two-third of the frontal wall. Oral spines absent. Avicularia and ovicells not observed.

Measurements – ZL 465±39, 415-572 (1, 30); ZW 395±26, 353-472 (1, 30); OL 307±25, 251-334 (1, 20); OW 249±17, 230-288 (1, 20).

Remarks – Two colonies of *Gontarella*? *sendinoae* sp. nov. have been found encrusting the base of the same very thin platy coral. The two colonies differ slightly from each other, likely owing to preservation, with one having a smoother cryptocyst probably reflecting greater abrasion (Pl. 24, fig. 1e-f). Zooidal characters of this species closely resemble those of *Cranosina* Canu & Bassler, 1933, but the lack of avicularia excludes it from this genus. It fits best within the definition of *Gontarella* Grischenko, Taylor & Mawatari, 2002, in lacking a gymnocyst, oral spines and pore chambers, but differs in having a better developed, granular cryptocyst, which contrasts with the narrow, non-granular cryptocyst in the type species of the genus. Therefore, the new species is assigned questionably to *Gontarella*.

Superfamily Buguloidea Gray, 1848
Family Candidae d'Orbigny, 1851
Genus *Caberea* Lamouroux, 1816

***Caberea* sp.**
Pl. 25, fig. 1a-f.

Figured material – NHMUK PI BZ 6879, BZ 6880, BZ 6881, late Burdigalian, TF126, '3D Reef', Bontang.

Description – Colony erect, branches triserial to quadriserial, relatively narrow (0.35-0.70 mm), non-articulated. Autozooids in alternating longitudinal rows, elongate, distinct, boundaries marked by grooves between their narrow raised mural rims; lateral and central zooids differing slightly in size and shape. Central zooids rounded pentagonal with the vertex upside down (mean L/W = 1.92); marginal zooids rounded hexagonal, broader laterally, constricted distally (mean L/W = 1.69). Gymnocyst absent. Cryptocyst moderately developed, constant all around the opesia in central zooids, broader laterally in marginal zooids, smooth, funnel-shaped, sloping gently inwards. Two small oval or subcircular communication pores visible on the inner distal margins of each autozooid. Opesia immersed, oval, longer than broad, centrally placed. A disto-lateral oral spine base present on the inner side of each autozooid indenting the mural rim, small, about 10-12 μm in diameter. One large lateral spine (scutum) base also present, about 25 μm in diameter. Two small (mean L = 40 μm), triangular suboral avicularia in median zooids, pedunculate, oblique, proximally directed (Pl. 25, fig. 1e); only one in marginal zooids; distally directed aside the ovicell (Pl. 25, fig. 1f). Ovicell subglobular, slightly broader than long; frontal wall not preserved (Pl. 25, fig. 1d, f). Dorsal side occupied by large vibracula, each with a large deep setal groove, diverging distally from median keel (Pl. 25, fig. 1b). Radicular pore small.

Measurements – ZL 306±20, 255-332 (3, 30); ZW 170±21, 130-200 (3, 30); OL 122±10, 113-133 (1, 4); OW 141±4, 137-144 (1, 4).

Remarks – A few small fragments of *Caberea* sp. have been found in silty sedimentary rocks from the late Burdigalian and Serravallian. This species is similar to the Recent *C. brevigaleata* Canu & Bassler, 1929, in being quadriserial, having the two large pore chambers on the distal part of the zooids, and small triangular suboral avicularia, but it differs in its larger, subglobular ovicell.

Genus *Canda* Lamouroux, 1816

Canda giorgioi sp. nov.

Pl. 26, fig. 1a-d.

Figured material – NHMUK PI BZ 6882, BZ 6883, late Burdigalian, TF126, '3D Reef', Bontang.

Etymology – Named in honour of first author's father, Giorgio Di Martino.

Diagnosis – Colony erect, biserial, triangular in cross section. Autozooids rounded rectangular. Gymnocyst absent. Cryptocyst faintly granular, forming a concave shelf proximally, tapering distally. A large circular communication pore at the inner distal corner of each autozooid. Opesia egg-shaped. Scutum lacking. Avicularia absent. Dorsal side occupied by vibracula.

Description – Colony erect, branches biserial, rectilinear or slightly curved, narrow, triangular in cross section; articulating nodes and bifurcations not observed. Autozooids monomorphic, distinct, alternating in two rows on either side of a median keel, rounded rectangular (mean L/W = 1.86), slightly asymmetrical, leaning towards median keel, separated by shallow grooves, distal edge raised (Pl. 26, fig. 1b). Gymnocyst absent. Cryptocyst faintly granular, forming a concave shelf proximally, tapering distally. A large communication pore visible in the inner distal corner of each autozooid, about 40 μm in diameter. Opesia small, egg-shaped, more pointed proximally. Scutum lacking. Avicularia absent. Ovicells not seen. Dorsal side occupied by vibracula with a long, curved, deep setal groove oriented distolaterally (Pl. 26, fig. 1c, d); a shallow sinuous median furrow corresponds to the zooidal boundaries. Radicular pore very large, on average 70 μm in diameter.

Measurements – ZL 379±12, 365-397 (5, 50); ZW 203±7, 196-213 (5, 50); OL 162±8, 154-170 (5, 50); OW 115±2, 113-117 (5, 50); VL 304±11, 291-317 (5, 50).

Remarks – Numerous fragments of *Canda giorgioi* sp. nov. have been found in silty sedimentary rocks in the late Burdigalian and Serravallian, none with avicularia or ovicells. At first sight, the frontal side of this species closely resembles that of *Vincularia* Defrance, 1829, mainly in the asymmetry of the zooids and in the presence of rhizoidal kenozooids along the distal inner margin. However, branches of this species are triangular rather than quadrangular in cross-section, with only two rows of monomorphic zooids. The dorsal side with its vibracular chambers clearly shows that the species belongs to *Canda*.

The Recent *Canda philippinensis* Canu & Bassler, 1929, is the only known species of *Canda* showing branches of triangular cross-section. However, it differs from the Kalimantan species in having a scutum. The lack of scutum in this fossil species is not a function of the preservation as there are no basal structures from which it might have become detached.

***Canda federicae* sp. nov.**

Pl. 26, fig. 2a-d.

Figured material – NHMUK PI BZ 6884, BZ 6885, late Burdigalian, TF126, '3D Reef', Bontang.

Etymology – Named in honour of the first author's sister, Federica Di Martino.

Diagnosis – Colony erect, biserial, triangular in cross section. Autozooids facing distolaterally, in two alternating rows, hexagonal. Gymnocyst absent. Cryptocyst faintly granular, forming a concave shelf proximally, tapering distally. Two large circular communication pores at the inner distal edge of each autozooid. Opesia oval. Scutum lacking. Avicularia absent. Dorsal side occupied by vibracular chambers.

Description – Colony erect, branches biserial, narrow, less than 100 μm in diameter, triangular in cross section, dichotomously branched. Autozooids facing distolaterally, in two alternating rows on either side of a median keel, hexagonal, longer than broad (mean L/W = 1.91), slightly asymmetrical, distinct, separated by thin grooves. Gymnocyst absent. Mural rim thick and raised laterodistally. Cryptocyst faintly granular, forming a concave shelf proximally, tapering distally. Two large circular communication pores visible at the inner distal edge of each autozooid. Opesia elongate, oval, placed distally, occupying half of the frontal surface. Scutum lacking. Avicularia absent. Ovicells not seen. Dorsal side occupied by vibracular chambers, with a short, wide, deep setal groove obliquely oriented (Pl. 26, fig. 2c); zigzag median shallow furrow corresponding to zooidal boundaries (Pl. 26, fig. 2d). Radicular pore large, on average 50 μm in diameter.

Measurements – ZL 363±17, 338-392 (5, 50); ZW 190±13, 163-207 (5, 50); OL 196±10, 185-213 (5, 50); OW 89±11, 75-105 (5, 50); VL 230±10, 222-245 (5, 50).

Remarks – Numerous fragments of *Canda federicae* sp. nov. have been found in silty sedimentary rocks in the late Burdigalian, but none has avicularia or ovicells. This species differs from *Canda giorgioi* sp. nov. in having smaller zooids and vibracula, longer opesia, much thicker and more raised mural rims, and the presence of two communication pores rather than one at the distal edge of each zooid. Some similarities are evident with two Miocene species, *C. inermis* MacGillivray, 1895, from southeastern Australia and *C. rectangulata* Udin, 1964, from Austria and Tunisia, and also with the Recent *C. filifera* Lamarck, 1816, from the Indo-Pacific. However, all of these species have shorter proximal cryptocysts. In addition, in *C. inermis* setal grooves on the dorsal side extend beyond the median line; *C. rectangulata* has larger zooids and a scutum (hypothesized from the existence of a large spine base).

Genus *Scrupocellaria* van Beneden, 1845

Scrupocellaria sp.
Pl. 26, fig. 3a-d.

Figured material – NHMUK PI BZ 6886, BZ 6887, late Burdigalian, TF126, '3D Reef', Bontang.

Description – Colony erect, branches biserial, flat, narrow, about 0.35 mm in width, dichotomously branched. Autozooids alternating, distinct, separated by narrow grooves, semielliptical, elongate (mean L/W = 1.80). Gymnocyst short, convex, smooth. Cryptocyst forming a narrow border around the opesia. Opesia oval, broad, occupying almost two-thirds of the frontal surface. A pair of large circular communication pores visible on the sloping distolateral inner margins of each autozooid; two smaller circular pores sometimes visible on the median part of the opesia. Three spine bases on outer opesial margin and two on inner margin, plus base of scutum medially (Pl. 26, fig. 3b); distalmost pair smaller in diameter (15 μm vs. 30 μm). Ovicells not observed. Prominent, frontal, adventitious avicularium placed proximally to each autozooid, broken. Marginal lateral avicularia extremely small, about 40 μm long, triangular, placed on distolateral corner of opesia at the base of the vibraculum between two outer spine bases, laterally directed (Pl. 26, fig. 3b). Small vibraculum at outer proximal corner of each autozooid. Dorsal side occupied by vibracular chambers situated on the margins with a narrow deep setal groove (Pl. 26, fig. 3c, d); median shallow sinous furrow marking zooidal boundaries. Radicular pore small, about 30 μm in diameter.

Measurements – ZL 355±13, 337-378 (1, 8); ZW 198±12, 180-216 (1, 8); OL 239±11, 226-256 (1, 8); OW 159±12, 138-170 (1, 8); VL 220±15, 209-238 (1, 5).

Remarks – A few small poorly preserved fragments of *Scrupocellaria* sp. have been found in silty sedimentary rocks of late Burdigalian age. The absence of preserved scuta and frontal avicularia, and the lack of ovicells preclude identification to species level.

Among Cenozoic species, *S. cookei* Canu & Bassler, 1920, and *S. milneri* Canu & Bassler, 1920, both from Alabama, USA, are most similar to the Kalimantan species, mainly in the presence of very small lateral and large frontal avicularium. However, they lack oral spine bases. The same similarities are evident with the Recent *S. peltata* Tilbrook & Vieira, 2012, from Queensland, but again this differs from the Kalimantan species in the number of oral spines and also in the size of the zooids and vibracula.

Superfamily Microporoidea Gray, 1848
Family Monoporellidae Hincks, 1882
Genus *Monoporella* Hincks, 1881

Monoporella sp. 1
Pl. 27, fig. 1a-d.

Figured material – NHMUK PI BZ 6888, late Burdigalian, TF126, '3D Reef', Bontang.

Description – Colony encrusting, multiserial, unilaminar, forming a narrow strip, thick. Ancestrula not seen. Pore chamber windows sometimes visible at the colony growing edge, oval, one placed distally and one laterally, on average 80 μm long by 50 μm wide. Autozooids distinct, separated by shallow grooves, arranged quincuncially, rounded hexagonal, slightly longer than wide (mean L/W = 1.12). Mural rim smooth and thick, raised distally and distolaterally. Cryptocyst occupying almost the entire frontal area, faintly granular, flat, slightly convex medially, raised proximal to the orifice, perforated by 30-40 very large circular pores, 30-50 μm in diameter. Two small, round opesiules, about 40 μm in diameter, proximal to the corners of the orifice (Pl. 27, fig. 1d). Median frontal ridge narrow, smooth, starting from the proximal edge of the orifice and usually extending for the distal half part of the frontal wall, sometimes indistinct. Orifice transversely D-shaped with a straight or slightly concave proximal edge and convergent sides (Pl. 27, fig. 1d). Number of oral spine bases variable, seemingly 4 to 6, distantly spaced. Complete ovicells not observed, but a smooth shelf covering the proximal half part of a zooid is probably the floor of the ovicell of the proximal zooid (Pl. 27, fig. 1c). Avicularia not observed.

Measurements – ZL 538±20, 503-554 (1, 20); ZW 481±20, 447-510 (1, 20); OL 88±5, 80-96 (1, 15); 134±15, 112-159 (1, 15).

Remarks – A single colony of *Monoporella* sp. 1 has been found encrusting the underside of a platy coral. The most characteristic feature of this species is the large size of the frontal pores. Compared to the European Neogene *M. venusta* (Eichwald, 1868) it has a more pronounced median ridge, but is otherwise similar.

Monoporella sp. 2

Pl. 28, fig. 1a-d.

Figured material – NHMUK PI BZ 6889, Serravallian, TF76, 'Batu Putih 1', Samarinda.

Description – Colony encrusting, multiserial, unilaminar, thick. Ancestrula morphologically identical to later autozooids, but smaller, about 500 µm long by 350 µm wide, surrounded by six periancestrular zooids (Pl. 28, fig. 1a). Pore chamber windows sometimes visible at the colony growing edge, oval, one placed distally and a pair distolaterally, on average 60 µm long by 20 µm wide (Pl. 28, fig. 1c). Autozooids distinct, separated by shallow grooves, arranged quincuncially, ovoidal or rounded hexagonal, elongate (mean L/W = 1.26). Mural rim rounded, smooth and thick, raised distolaterally. Cryptocyst occupying almost the entire frontal area, granular, flat, raised proximal to the orifice, perforated by 40-50 very large circular pores, 30-40 µm in diameter. Two round small asymmetrical opesiules, about 40 µm in diameter, proximal to the corners of the orifice (Pl. 28, fig. 1d). Median rounded frontal ridge, narrow, smooth, usually occupying the distal half part of the zooid, less pronounced close to the proximal edge of the orifice. Orifice semicircular with a straight proximal edge (Pl. 28, fig. 1d). Number of oral spine bases variable, seemingly 4 to 6, distantly spaced. Ovicells and avicularia not observed.

Measurements – ZL 635±39, 574-708 (1, 15); ZW 505±36, 443-551 (1, 15); OL 136±11, 122-155 (1, 10); OW 156±15, 136-180 (1, 10).

Remarks – A single young colony of *Monoporella* sp. 2 encrusts the base of a very thin platy coral. Despite representing the early astogenetic stages of a colony, the autozooids are much larger than those of *Monoporella* sp. 1, from which it also differs in the shape and proportions of autozooids, the larger orifice with straight instead of convergent sides, the more coarsely granular frontal wall and more steeply sloping cryptocyst proximal to the orifice. In the general appearance, *Monoporella* sp. 2 resembles the Recent *M. fimbriata* Canu & Bassler, 1927, but it differs in having smaller zooids, a greater number of oral spines, and fewer frontal pores. Because the apertures are filled by rock in the Kalimantan specimen it is not possible to ascertain whether the distal border is denticulate as in *M. fimbriata*.

Family Pyrisinellidae Di Martino & Taylor, 2012b
Genus *Setosinella* (Canu & Bassler, 1933)

Setosinella perfluxa Di Martino & Taylor, 2012b

Pl. 29, fig. 1a-d.

Figured material – Holotype: NHMUK PI BZ 5849, late Burdigalian, TF126, '3D Reef', Bontang. Paratype: BZ 5850, details as for holotype.

Description – Colony encrusting, multiserial, unilaminar, usually irregular in outline shape. Growing edge stepped implying intrazooidal budding. Ancestrula resembling a very small autozooid (mean L = 140 µm, mean W = 120 µm), with up to ten spine bases visible around the entire mural rim, possibly with additional spine bases hidden by surrounding autozooids, budding a single distal zooid (Pl. 29, fig. 1b). Oval pore windows (mean 38 µm by 16 µm) exposed along distal, distolateral and proximolateral vertical walls at the colony growing edge. Autozooids small, rounded hexagonal, longer than broad (mean L/W = 1.24), separated by deep furrows. Gymnocyst narrow, more developed proximally and laterally of the orifice, separated from the extensive cryptocyst by a thin, salient mural rim which together with distal rim of the opesia forms a pear-shaped wall around cryptocyst and opesia. Cryptocyst shelf-like, deep, flat and finely granular, perforated by two small reniform opesiules (Pl. 29, fig. 1d). Opesia semicircular, limited distally by the mural rim and proximally by a transverse salient trabeculum attached to the mural rim. Nine oral spine bases in non-ovicellate autozooids, six in ovicellate zooids, forming an arch around, but somewhat distant, on average 28 µm, from the distal edge of the opesia; spine diameters ranging from 10 to 20 µm independently of their position. Ovicell hyperstomial, globular, prominent, slightly broader than long, smooth, the ectooecium completely calcified, resting on the proximal gymnocyst of distal zooid and indenting its mural rim (Pl. 29, fig. 1c). Avicularia absent.

Measurements – ZL 374±39, 330-451 (3, 40); ZW 300±45, 223-382 (3, 40); OL 57±8, 45-69 (3, 40); OW 84±10, 57-132 (3, 40); OvL 159±12, 145-187 (3, 9); OvW 172±15, 147-189 (3, 9); CrL 199±20, 125-167 (3, 40); CrW 222±30, 131-219 (3, 40).

Remarks – The first description of this distinctive species by Di Martino & Taylor (2012b) gave the date of the section in Kalimantan as Langhian, but more detailed biostratigraphical analysis based on larger benthic foraminifera has suggested that a late Burdigalian age is more plausible (Novak *et al.*, 2013). The species is represented by numerous small colonies, usually well preserved, encrusting the undersides of thin platy corals.

Compared with the North American Paleocene type species of *Setosinella*, *S. prolifica* Canu & Bassler, 1933, this Miocene species has slightly more oral spines (9 vs. 7-8), which are placed significantly further from the distal rim of the opesia, and larger autozooids. Furthermore, it lacks avicularia, which also differentiates *S. perfluxa* from another congeneric species, *S. orbiculata* (Canu & Bassler, 1920) from the Eocene of Georgia, USA.

Pyrisinellidae sp.

Pl. 30, fig. 1a-d.

Figured material – NHMUK PI BZ 6890, Serravallian, TF76, 'Batu Putih 1', Samarinda.

Description – Colony encrusting, multiserial, unilaminar. Ancestrula and pore chambers not seen. Autozooids distinct, separated by deep grooves, arranged quincuncially, rounded hexagonal, slightly longer than broad (mean L/W = 1.17). Gymnocyst convex, smooth, moderately broad proximally, narrow laterally and distally. Cryptocyst extensive, granular, depressed, shelf-like, centrally convex, perforated by two small subcircular opesiules located at about mid-length (Pl. 30, fig. 1d). Orifice semicircular, broader than long. Oral spine bases numerous, probably about 8, arranged in a crescent around the distal edge of the orifice. Avicularia not observed. Ovicell hyperstomial, globular, recumbent on the next distal autozooid in the row; roof broken (Pl. 30, fig. 1c).

Measurements – ZL 380±45, 289-413 (1, 7); ZW 326±28, 295-376 (1, 7); OL 63±1, 62-64 (1, 4); OW 112±4, 109-114 (1, 4); OvL 160±11, 149-171 (1, 3); OvW 168±8, 159-176 (1, 3).

Remarks – A single colony of an unidentified pyrisinellid has been found encrusting a high-relief surface on the underside of a platy coral. The small size of the colony and its poor preservation make generic placement difficult. Some of the characters are reminiscent of genera belonging to the family Microporidae, such as the reduced semicircular orifice and the presence of opesiules (e.g., *Micropora* Gray, 1848), oral spines (e.g., *Andreella* Jullien, 1888, or the Antarctic *Micropora notialis* Hayward & Ryland, 1993), convex cryptocyst (e.g., the Cretaceous *Hoplitaechmella* Voigt, 1949). However, this species seems to fit better in Pyrisinellidae, mainly for the presence of the gymnocyst and the somewhat pear-shaped mural rim.

Family Onychocellidae Jullien, 1882
Genus *Smittipora* Jullien, 1882

***Smittipora* aff. *cordiformis* Harmer, 1926**
Pl. 31, fig. 1a-d.

Figured material – NHMUK PI BZ 6891, Serravallian, TF522, 'Coalindo Haulage Road 1', Sangkulirang; BZ 6892, early Tortonian, TF 508, Bontang.

Description – Colony encrusting, multiserial, unilaminar. Ancestrula not seen. Pore chambers absent. Autozooids distinct, separated by raised marginal rim and narrow shallow grooves, quincuncially arranged, hexagonal or irregularly polygonal, elongate (mean L/W = 1.46). Cryptocyst concave, occupying almost the entire frontal area, large, but sparse granules aligned in short parallel rows all around the opesia. Orifice small, D-shaped, almost equidimensional, placed on the distal half of frontal wall surrounded by cryptocyst, distal opesial margin rounded, proximal edge straight or slightly convex with two small rounded indentations at the proximolateral corners. Avicularia interzooidal, lozenge-shaped, almost as long as autozooids, but much narrower, the acuminate rostrum asymmetrical and curved left or right towards a sibling autozooid; cryptocyst granular, concave; opesia centrally located, elongate egg-shaped, wider distally, proximal border denticulate, distal border smooth. Fertile zooids similar in size to autozooids, but with much larger orifice (mean L = 260 μm, mean W = 210 μm), bell-shaped, bordered distally by the cryptocyst of the distal zooid (Pl. 31, fig. 1b-c).

Measurements – ZL 495±25, 460-540 (6; 40); ZW 338±23, 300-363 (6, 40); OL 140±10, 123-155 (6, 40); OW 126±8, 110-138 (6, 40); AL 475±34, 421-529 (6, 40); AW 233±17, 210-251 (6, 40).

Remarks – *Smittipora* aff. *cordiformis* is one of the commonest species in the Kalimantan material, found in all the sections from late Burdigalian to Messinian and forming large encrusting colonies on the undersides of platy corals. It closely resembles the Recent *S. cordiformis* Harmer, 1926 from the Indo-Pacific in respect of autozooidal outline, opesia shape, avicularia with the distal end curved towards a sibling zooid and the dimorphic fertile zooids. However, it differs in the smaller size of the zooids, orifice and avicularia, and in having fertile zooids with orifices formed distally by the cryptocyst of the next zooid in series rather than gymnocystal calcification. The size of *Smittipora* aff. *cordiformis* is similar to *S. harmeriana* (Canu & Bassler, 1929) from the Philippines', but this Recent species lacks fertile zooids with a dimorphic orifice and its avicularia are symmetrical and oriented in the the direction of colony growth.

***Smittipora* sp.**

Pl. 31, fig. 2a-c.

Figured material – NHMUK PI BZ 6893, Burdigalian-Langhian boundary, TF153, 'Rainy Section', Bontang.

Description – Colony encrusting, multiserial, unilaminar. Ancestrula not seen. Pore chambers absent. Autozooids distinct, separated by raised marginal rim and thin shallow sutures, quincuncially arranged, hexagonal or irregularly polygonal, elongate (mean L/W = 1.80). Cryptocyst concave, occupying almost the entire frontal area, granular. Orifice trifoliate, longer than broad, placed distally and surrounded by cryptocyst, distally rounded, proximomedial edge straight with deep, rounded indentations at the proximolateral corners (Pl. 31, fig. 2b, c). Avicularia interzooidal, irregularly polygonal, slightly smaller than autozooids, symmetrical, with a rounded distal end (Pl. 31, fig. 2c); cryptocyst granular, concave; opesia distally located, elongate, rounded triangular, proximally more pointed, border smooth. Fertile zooids not seen.

Measurements – ZL 594±30, 552-644 (1; 30); ZW 338±22, 313-376 (1, 30); OL 150±14, 140-170 (1, 30); OW 122±8, 116-134 (1, 30); AL 503±31, 478-538 (1, 20); AW 235±22, 204-258 (1, 20).

Remarks – A single large colony of *Smittipora* sp. has been found encrusting the base of a platy coral from a Burdigalian-Langhian boundary section at Bontang. This unnamed species differs from *Smittipora* aff. *cordiformis* in having much longer autozooids, a trifoliate orifice with very deep lateral indentations and in the different shape of the interzooidal avicularia which are symmetrical. There are similarities with *S. acutirostris* (Canu & Bassler, 1928) from Brazil in the shape of the orifice, but this Recent species is characterized by an acute distal end of the avicularia.

Family Steginoporellidae Hincks, 1884
Genus *Steginoporella* Smitt, 1873

***Steginoporella* cf. *truncata* Harmer, 1900**

Pl. 32, fig. 1a-d.

Figured material – NHMUK PI BZ 6894, Serravallian, TF57, 'Stadion Reef 1', Samarinda.

Description – Colony encrusting, multiserial, often with self-overgrowth. Zooids large, distinct, separated by shallow grooves, arranged in regular longitudinal rows, subrectangular in outline, dimorphic. A-zooids more numerous and smaller than B-zooids, distal margin concave and rounded M-shaped, proximal margin convex, longer than broad (mean L/W = 1.37) (Pl. 32, fig. 1c). Cryptocyst proximally depressed, forming a flat shelf occupying less than half the length of the frontal surface, densely and minutely porous, pores circular; distally smooth, less depressed than proximal cryptocyst, best developed at the distolateral corners; paired pointed condyles present at junction between proximal and distal cryptocyst. B-zooids sparse, much larger than A-zooids, distal margin arched, proximal margin convex, much longer than broad (mean L/W = 1.88) (Pl. 32, fig. 1b, d). Cryptocyst proximally the same as in the A-zooids; distally smooth, particularly well developed and deep distally, tapering laterally; paired pointed condyles present at junction between proximal and distal cryptocyst. Both polymorphs quite variable in size within the same colony. Orifice semicircular in both polymorphs, distal margin markedly arched, proximal margin prolonged into an anvil-shaped median process (Pl. 32, fig. 1c).

Measurements – (A) ZL 704±59, 601-857 (10, 50); ZW 515±55, 378-698 (10, 50); (B) ZL 1189±126, 912-1512 (10, 50); ZW 633±77, 435-846 (10, 50).

Remarks – This is one of the commonest species among the Kalimantan bryozoans and is especially abundant in the Stadion sections, usually developing large colonies on coral undersides and covering, together with *Reptadeonella* spp., more substrate space than any other species. Unfortunately, the cryptocystal frontal wall is often crushed and the anvil-shaped median process missing, making identification at species level difficult. The main characteristic of this species is the markedly concave, M-shaped, distal edge of the A-zooids, which has been previously observed only in the Recent *S. truncata* Harmer, 1900, from southeastern Australia. *Steginoporella* cf. *truncata* is similar to *S. truncata* also in the morphology of the B-zooids, with the distal margin semicircular, and in having a proximal cryptocyst that is perforated by small pores, and a distal cryptocyst that is less depressed, smooth and imperforate in both polymorphs. The zooidal sizes reported by Harmer (1900) for *S. truncata* (A-zooids: L = 0.90 mm, W = 0.68 mm; B-zooids: L = 1.02, W = 0.72 mm) fall within the range of measurements obtained for *Steginoporella* cf. *truncata*.

***Steginoporella* sp.**

Pl. 32, fig. 2a-b.

Figured material – NHMUK PI BZ 6895, Serravallian, TF57, 'Stadion Reef 1', Samarinda.

Description – Colony encrusting, multiserial, often with self-overgrowth. Zooids distinct, separated by shallow grooves, arranged in regular longitudinal rows, subrectangular in outline, dimorphic. A-zooids smaller than B-zooids, distal margin straight with rounded or slightly convex corners, proximal margin convex, slightly longer than broad (mean L/W = 1.22) (Pl. 32, fig. 2b). Cryptocyst proximally forming a flat shelf occupying less than half the length of the frontal surface, densely and minutely porous, pores circular; distally smooth and narrow, tapering laterally. Condyles indistinct. B-zooids as numerous as A-zooids, larger, distal margin straight or gently arched, proximal margin straight or slightly convex, longer than broad (mean L/W = 1.56) (Pl. 32, fig. 2b). Cryptocyst proximally the same as in A-zooids; distally smooth, much more developed than in A-zooids, tapering laterally. Condyles indistinct. Both polymorphs quite variable in size within a colony. Orifice in both polymorphs semicircular in outline, distal margin gently arched, proximal margin prolonged into an anvil-shaped median process (Pl. 32, fig. 2b).

Measurements – (A) ZL 614±48, 533-717 (8, 40); ZW 504±64, 368-637 (8, 40); (B) ZL 829±74, 685-992 (8, 40); ZW 533±55, 383-687 (8, 40).

Remarks – Although *Steginoporella* sp. is common in the Miocene of East Kalimantan it appears to be much less abundant than *Steginoporella* cf. *truncata*. It is distinguished from *Steginoporella* cf. *truncata* by the straight or slightly convex distal margins of the A-zooids, the much higher proportion of B-zooids, the smaller size of both polymorphs, and the different proportion of length and width in the B-zooids, which look squatter in *Steginoporella* sp. and more elongate in *Steginoporella* cf. *truncata*. The most similar described species are the Burdigalian *S. bhujensis* Guha & Gopikrishna, 2007c, from Gujarat, India, the Recent *S. buskii* Harmer, 1900, which is widespread in the tropics, and *S. haddoni* Harmer, 1900, from the Indo-Pacific and Australia. *Steginoporella* sp. differs from the first of these species in having the distal margin of both polymorphs less arched. It differs from *S. buskii* in having a less developed cryptocyst, larger orifice and smaller polymorphs of both types. Compared with *S. haddoni* it has much shorter B-zooids.

Family Thalamoporellidae Levinsen, 1902
Genus *Thalamoporella* Hincks, 1887

***Thalamoporella* sp.**
Pl. 33, fig. 1a-e.

Figured material – NHMUK PI BZ 6896, Serravallian, TF76, 'Batu Putih 1', Samarinda.

Description – Colony encrusting, initially uniserial, becoming biserial or oligoserial with up to four longitudinal rows of zooids, unilaminar. Ancestrula not seen. Autozooids distinct, separated by shallow grooves, variable in outline from vase-shaped to rounded-hexagonal or rectangular, much longer than broad (mean L/W = 1.85). Gymnocyst reduced, visible only around orifice. Adoral tubercles always present, one on each side of the orifice (Pl. 33, fig. 1d). Cryptocyst granular, convex proximally, concave distally, punctured medially by medium-sized circular pores about 15-20 μm in diameter, surrounded by a thin slightly raised smooth mural rim. Lateral walls smooth. Two round or oval opesiules, equal in size or asymmetrical, large or small depending on the zooid (40-75 μm in diameter), located distally, away from the lateral walls (Pl. 33, fig. 1d). Orifice semicircular with a slightly concave proximal margin. Presence of vicarious avicularia uncertain; a single acutely triangular structure is probably an avicularium, about 320 µm long, half the length of its sibling autozooid, narrow, distally directed (Pl. 33, fig. 1e, bottom left). Ovicells not observed.

Measurements – ZL 552±60, 435-686 (2, 16); ZW 299±29, 245-342 (2, 16); OL 93±9, 81-105 (2, 10); OW 92±16, 64-109 (2, 10).

Remarks – The genus *Thalamoporella* occurs commonly in tropical and warm-temperate waters in both fossil and Recent assemblages. It is often highly diverse, such as in Cenozoic sequences of western Kachchh, Gujarat (India), from which fifteen fossil species have been described (Guha & Gopikrishna, 2004), while Harmer (1926) reported ten species in the Recent Indo-Pacific. Fossil examples, such as *Thalamoporella sulawesiensis* Pouyet & Braga, 1993, from the Eocene of Sulawesi, may be more abundant and better preserved than other bryozoans. Nevertheless, only two small colonies belonging to *Thalamoporella* sp. have been found in the Kalimantan material, both encrusting the base of the same platy scleractinian coral.

The initial uniserial growth of the colony is very characteristic and unusual, having not been described previously in *Thalamoporella*, except for the fully uniserial species *T. linearis* Canu & Bassler, 1929, from the Recent of the Philippines. However, the small size of the colony, absence of ovicellate zooids and uncertainty about the presence of vicarious avicularia make identification at species level difficult. In addition, it is not clear if the variability in the size of the opesiules and their symmetry/asymmetry depends on the preservation of the specimens. Some similarities in the autozooidal characters and in the outline shape of the putative avicularium are evident with two Indian Miocene species, *T. arabiensis* Guha & Gopikrishna, 2004, and *T. wynnei* Guha & Gopikrishna, 2004, and the Recent Indo-Pacific *T. hamata* Harmer, 1926. However, zooid size is different in the Indian fossils, being much larger than the Kalimantan species in *T. arabiensis*, but much smaller in *T. wynnei*, while *T. hamata* has a more developed gymnocyst around the orificial rim and the orifice is horseshoe-shaped rather than semicircular and often almost equidimensional.

Family Poricellaridae Harmer, 1926
Genus *Poricellaria* d'Orbigny, 1854

Poricellaria sp.
Pl. 34, fig. 1a-c.

Figured material – NHMUK PI BZ 6897, Burdigalian-Langhian boundary, TF153, 'Rainy Section', Bontang.

Description – Colony erect, flexible, articulated; branches narrow, about 150 µm in diameter, ?biserial. Autozooids asymmetrical, oval, elongate (mean L/W = 2.11) (Pl. 34, fig. 1b), arranged in longitudinal rows. Gymnocyst well developed proximally, present also distolaterally to the orifice, smooth, convex. Mural rim thin, little raised. Cryptocyst granular, forming a flat shelf moderately developed mediodistally; opesiules not clearly visible, probably a single slit-like opesiule on one side. Orifice subcircular facing laterally, slightly protruding from the branch axis. Adventitious avicularia small, placed proximally on the gymnocyst, very close to the mural rim, salient; rostrum directed proximolaterally, opposite to the orifice, narrow, long, deeply channelled (Pl. 34, fig. 1c). Ovicells not observed.

Measurements – ZL 270±17, 256-289 (1, 3); ZW 128±3, 126-131 (1, 3); OD 51±4, 47-59 (1, 3); CrL 156±18, 137-173 (1, 3); CrW 109±5, 104-114 (1, 3); AL 70±6, 63-76 (1, 3).

Remarks – A single fragment of *Poricellaria* sp. has been found incidentally attached to the surface of a platy coral, allowing the observation of only one side of the branch, which likely seems to be biserial. A species of *Poricellaria*, *P. ratoniensis* (Waters, 1887b), known from the Cenozoic to the Recent of Indo-Pacific, is similar to the Kalimantan fossil in the general appearance of the zooids and avicularia. However, the scarcity of available material and poor preservation of the specimen precludes a detailed comparison.

Incertae familiae
Family Fusicellaridae Canu, 1900
Genus *Encicellaria* Keij, 1969

?*Encicellaria* sp.
Pl. 34, fig. 2a-c.

Figured material – NHMUK PI BZ 6898, late Burdigalian, TF126, '3D Reef', Bontang.

Description – Colony erect, presumably articulated, internodes in the form of short, rounded spindles, about 2 mm long by 0.5 mm broad in the middle, quadriserial, circular in section (Pl. 34, fig. 2a). Proximal end with numerous large circular rhizoidal pores (Pl. 34, fig. 2b). Four to five autozooids arranged in longitudinal rows, alternating; distal zooids smaller. Autozooids distinct, separated by a narrow raised mural rim, hexagonal, with proximal and distal margins slightly curved, slightly longer than broad (mean L/W = 1.38). Gymnocyst absent. Cryptocyst faintly granular, sloping gently inwards, occupying almost the entire frontal surface. Opesia circular or oval, placed centrally, surrounded by a ring of secondary calcification, on average 40 μm thick, reducing the opening appreciably. Avicularia and ovicells not observed.

Measurements – ZL 430±19, 406-450 (1, 10); ZW 311±15, 294-331 (1, 10); OL 142±11, 131-153 (1, 8); OW 64±3, 59-66 (1, 8).

Remarks – A single fragment of ?*Encicellaria* sp. has been found in late Burdigalian silty sedimentary rocks. This specimen was previously assigned to the genus *Skylonia* Thomas, 1961 (Novak *et al.*, 2013), mainly based on the spindle-shaped colony, circular in section, with zooids arranged quadriserially and reduced aperture due to apparent frontal closure. However, *Skylonia* is also characterised by a symmetrical gradient of zooid size decrease towards the tips of the internodes, whereas the Kalimantan specimen shows reduction in size only for the most distal zooids. The bryozoan nature of

Skylonia is still somewhat controversial. More similarities than colony shape and zooidal arrangement can be observed with the Maastrichtian genus *Encicellaria*, such as the hexagonal shape of the autozooids, the cryptocystal nature of the frontal closure and the initial zooid proximally ending in a hollow tube. The genus *Fusicellaria* d'Orbigny, 1851, which belongs to the same family, differs in the complete absence of cryptocyst.

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Plate 1

Stomatopora sp.
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 1. NHMUK PI BZ 6830. a, dichotomous bifurcation; scale bar = 1 mm. b, autozooids; scale bar = 500 μm. c, autozooid; scale bar = 200 μm. d, pseudopores; scale bar = 20 μm.

Voigtopora sp.
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 2. NHMUK PI BZ 6831. a-b, lateral budding; scale bar = 500 μm. c, autozooid; scale bar = 200 μm. d, pseudopores; scale bar = 20 μm.

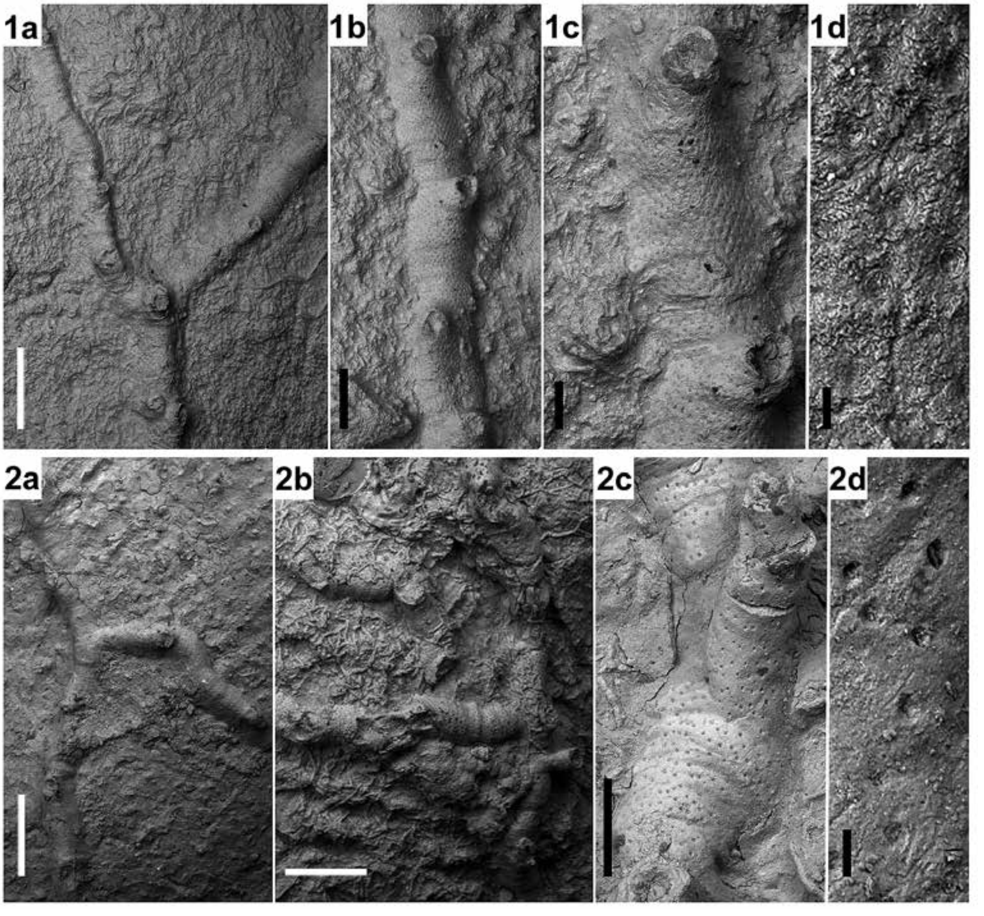
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Plate 2

Filisparsa sp.
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 1. a, NHMUK PI BZ 6832, frontal view of branch fragment; scale bar = 500 μm. b, NHMUK PI BZ 6833, frontal view of branch fragment; scale bar = 500 μm.
Serravallian, TF76, 'Batu Putih 1', Samarinda.
Fig. 1. NHMUK PI BZ 6834. c, dorsal view of branch fragment; scale bar = 500 μm. d, pseudopores; scale bar = 20 μm.

Microeciella nadiae sp. nov.
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 2. Holotype NHMUK PI BZ 6835. a, colony; scale bar = 1 mm. b, ancestrula and early astogeny; scale bar = 200 μm. c, autozooids, some with terminal nanozooids, and broken gonozooid; scale bar = 200 μm. d, colony margin; scale bar = 200 μm.

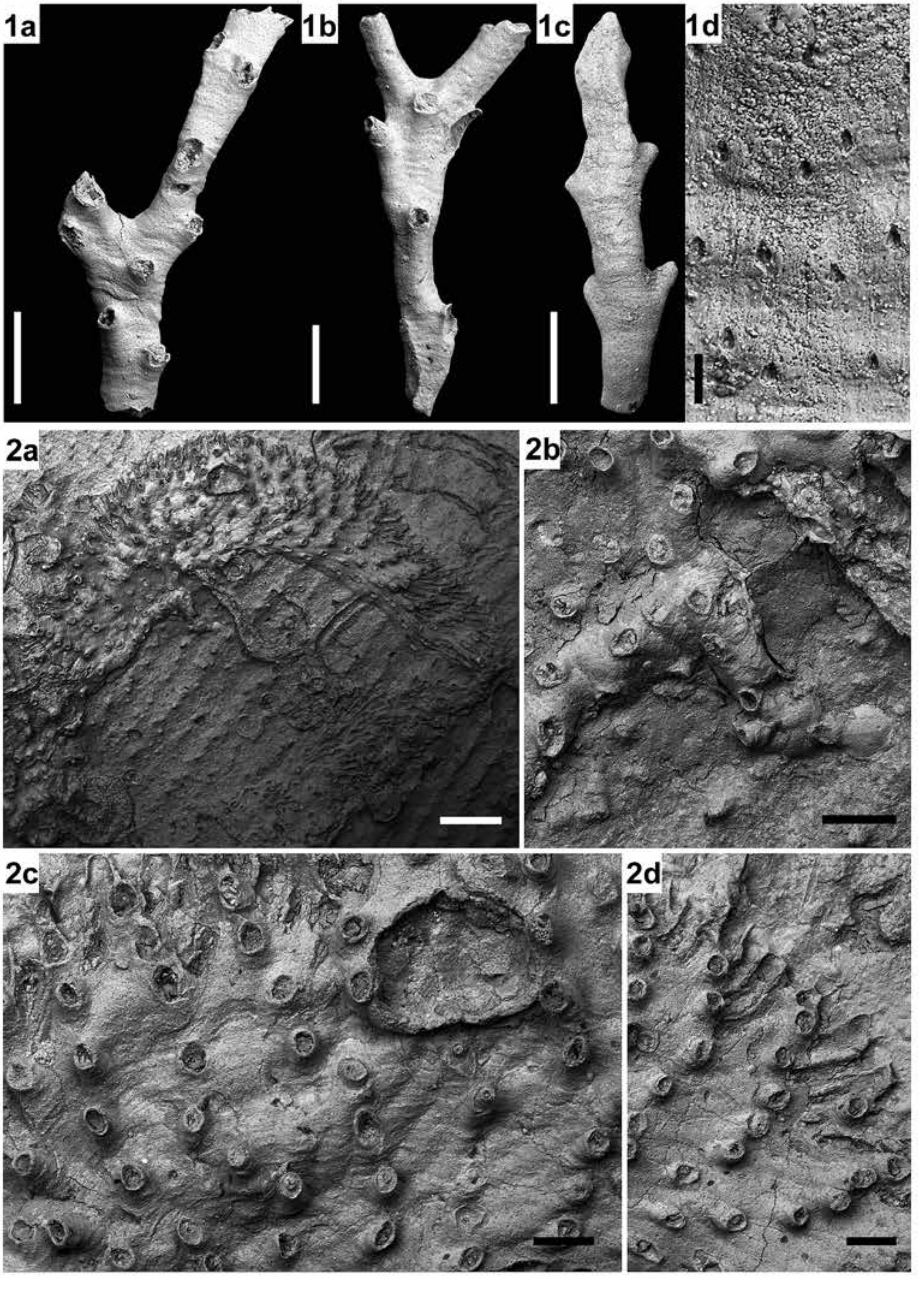
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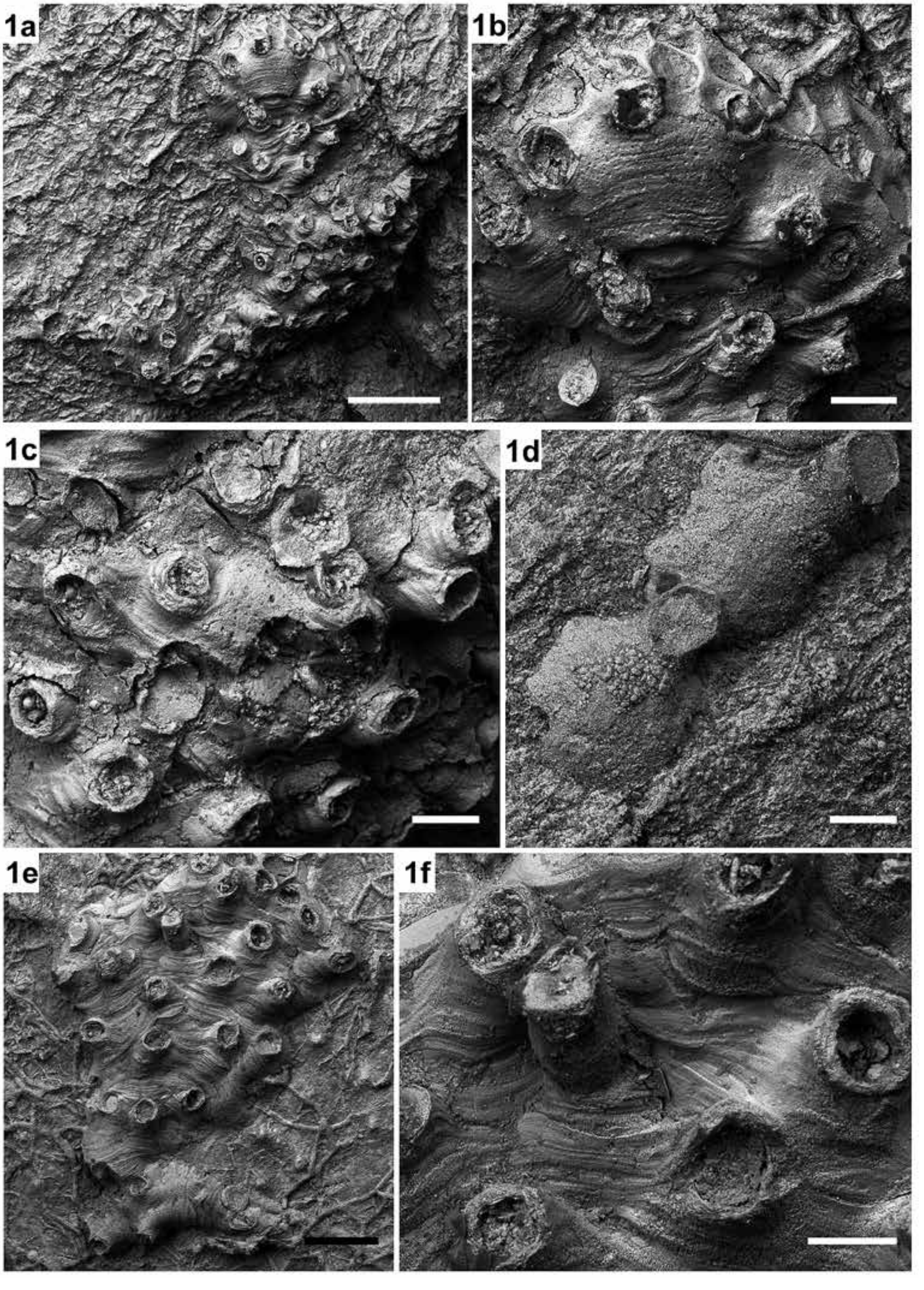
Plate 3

Oncousoecia sp.
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 1. a-c, NHMUK PI BZ 6836. a, colony; scale bar = 500 μm. b-c, gonozooids; scale bar = 100 μm. d, NHMUK PI BZ 6837, ancestrula and first distal budded zooid; scale bar = 150 μm. e-f, NHMUK PI BZ 6838. e, colony; scale bar = 300 μm. f, autozooids and colony surface; scale bar = 100 μm.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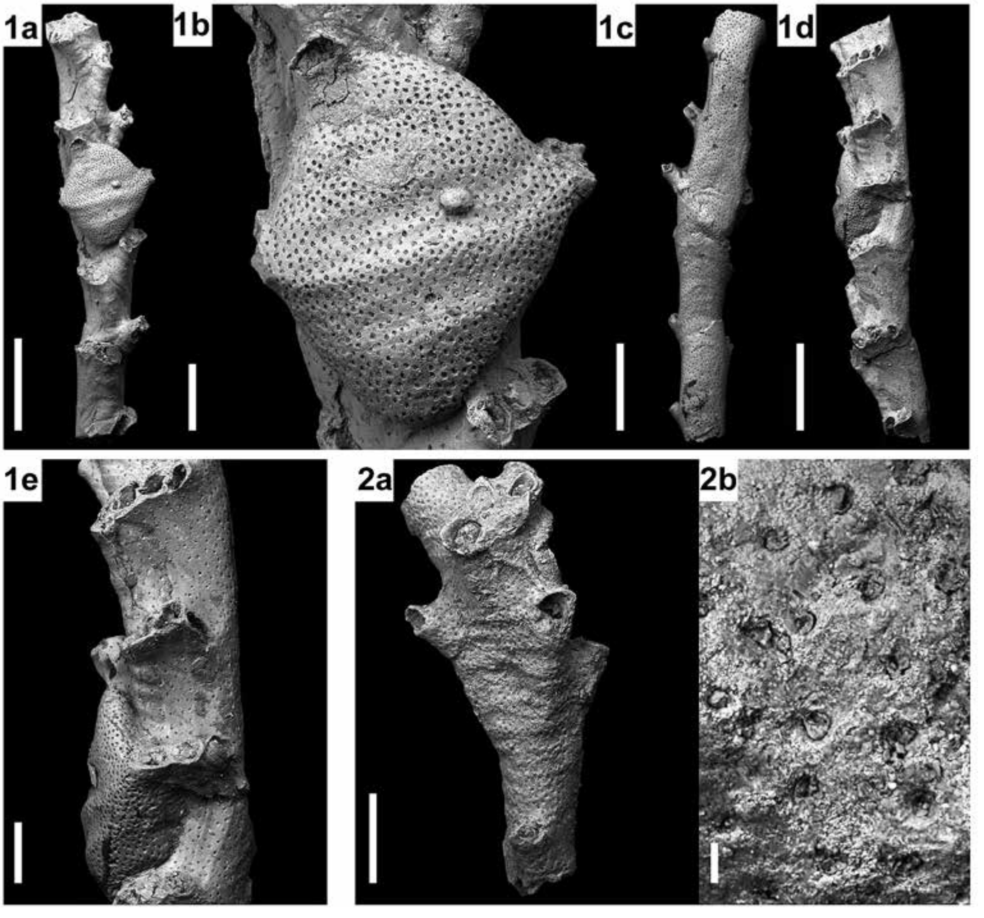


Plate 4

Exidmonea sp.
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 1. NHMUK PI BZ 6839. a, frontal view of branch fragment; scale bar = 500 μm. b, gonozooid; scale bar = 100 μm. c, dorsal view of branch fragment; scale bar = 500 μm. d, lateral view of branch fragment; scale bar = 500 μm. e, autozooecial rows; scale bar = 200 μm.

?*Mecynoecia* sp.
Serravallian, TF76, 'Batu Putih 1', Samarinda.
Fig. 2. NHMUK PI BZ 6840. a, branch fragment; scale bar = 500 μm. b, pseudopores; scale bar = 20 μm.

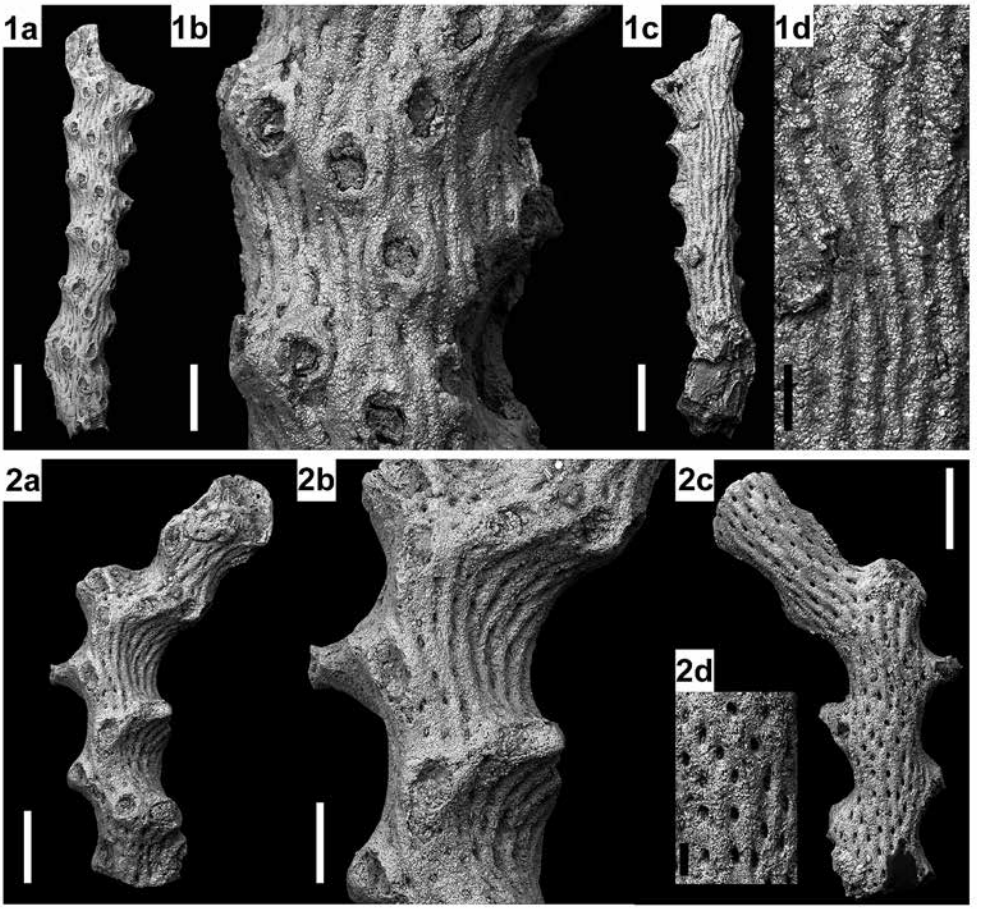


Plate 5

Hornera sp. 1
Serravallian, TF 76, 'Batu Putih 1', Samarinda.
Fig. 1. NHMUK PI BZ 6841. a, frontal view of branch fragment; scale bar = 500 μm. b, autozooids; scale bar = 100 μm. c, dorsal view of branch fragment; scale bar = 500 μm. d, dorsal surface; scale bar = 100 μm.

Hornera sp. 2
Serravallian, TF 76, 'Batu Putih 1', Samarinda.
Fig. 2. NHMUK PI BZ 6842. a, frontal view of branch fragment; scale bar = 200 μm. b, autozooids; scale bar = 100 μm. c, dorsal view of branch fragment; scale bar = 200 μm. d, dorsal surface; scale bar = 50 μm.

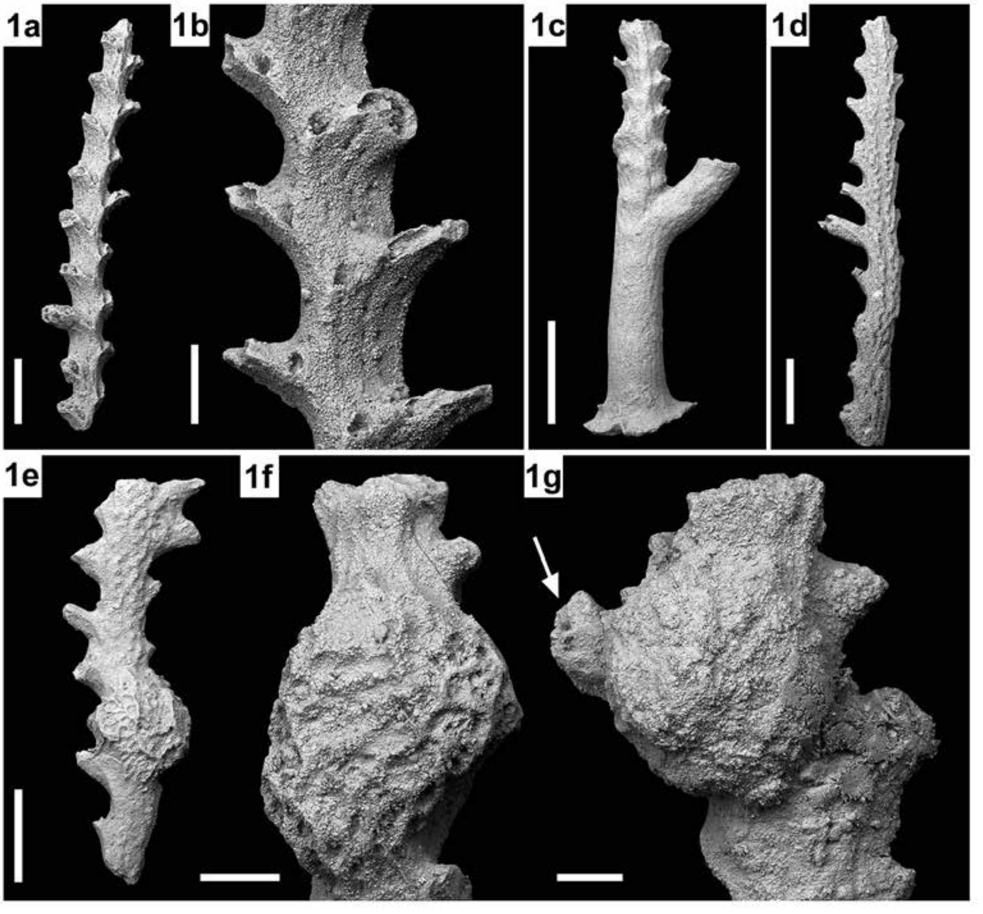


Plate 6

Pseudidmonea johnsoni sp.nov.

Serravallian, TF 76, 'Batu Putih 1', Samarinda.

Fig. 1. a-b, Holotype NHMUK PI BZ 6843. a, branch fragment; scale bar = 500 μm. b, autozooidal fascicles; scale bar = 200 μm. c, Paratype NHMUK PI BZ 6844, basal fragment; scale bar = 1 mm. d, Paratype NHMUK PI BZ 6845, dorsal view of branch fragment; scale bar = 500 μm. e, Paratype NHMUK PI BZ 6846, dorsal view of fertile branch fragment; scale bar = 500 μm. f, Paratype NHMUK PI BZ 6847, gonozooid; scale bar = 200 μm. g, Paratype NHMUK PI BZ 6848, gonozooid and ?ooeciopore (see arrow); scale bar = 200 μm.

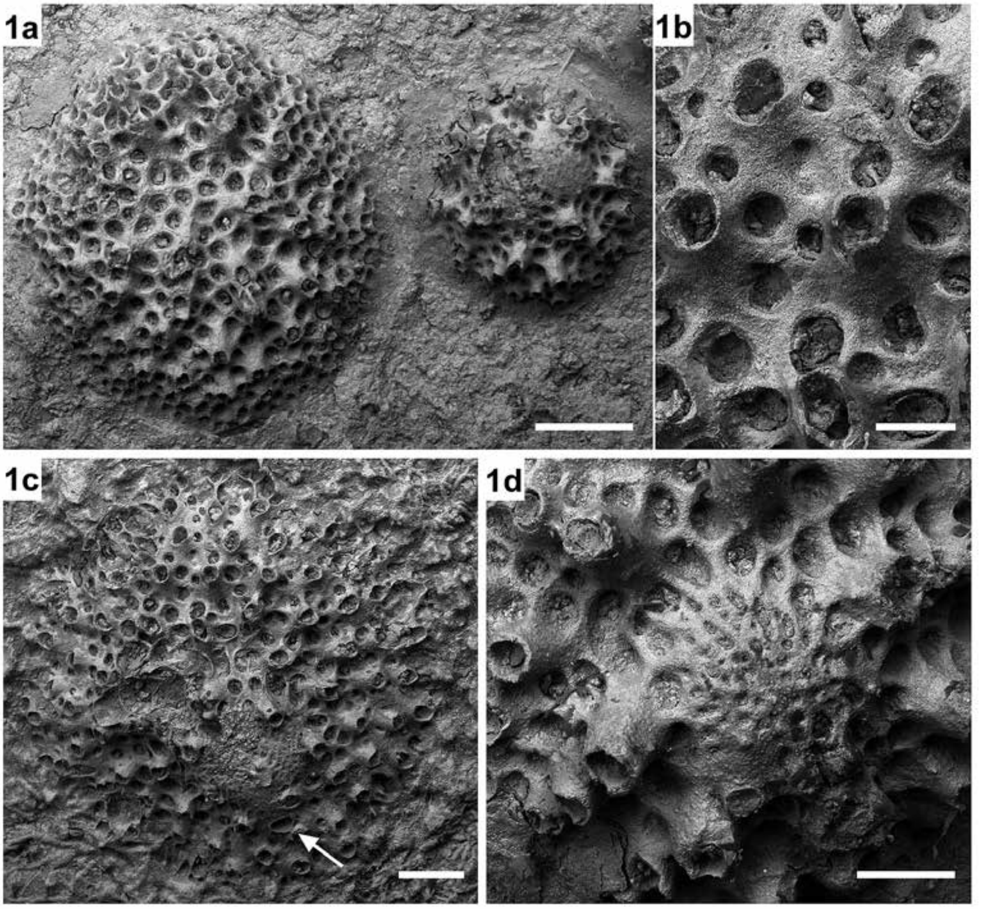


Plate 7

Disporella sp. 1

Late Burdigalian, TF126, '3D Reef', Bontang.

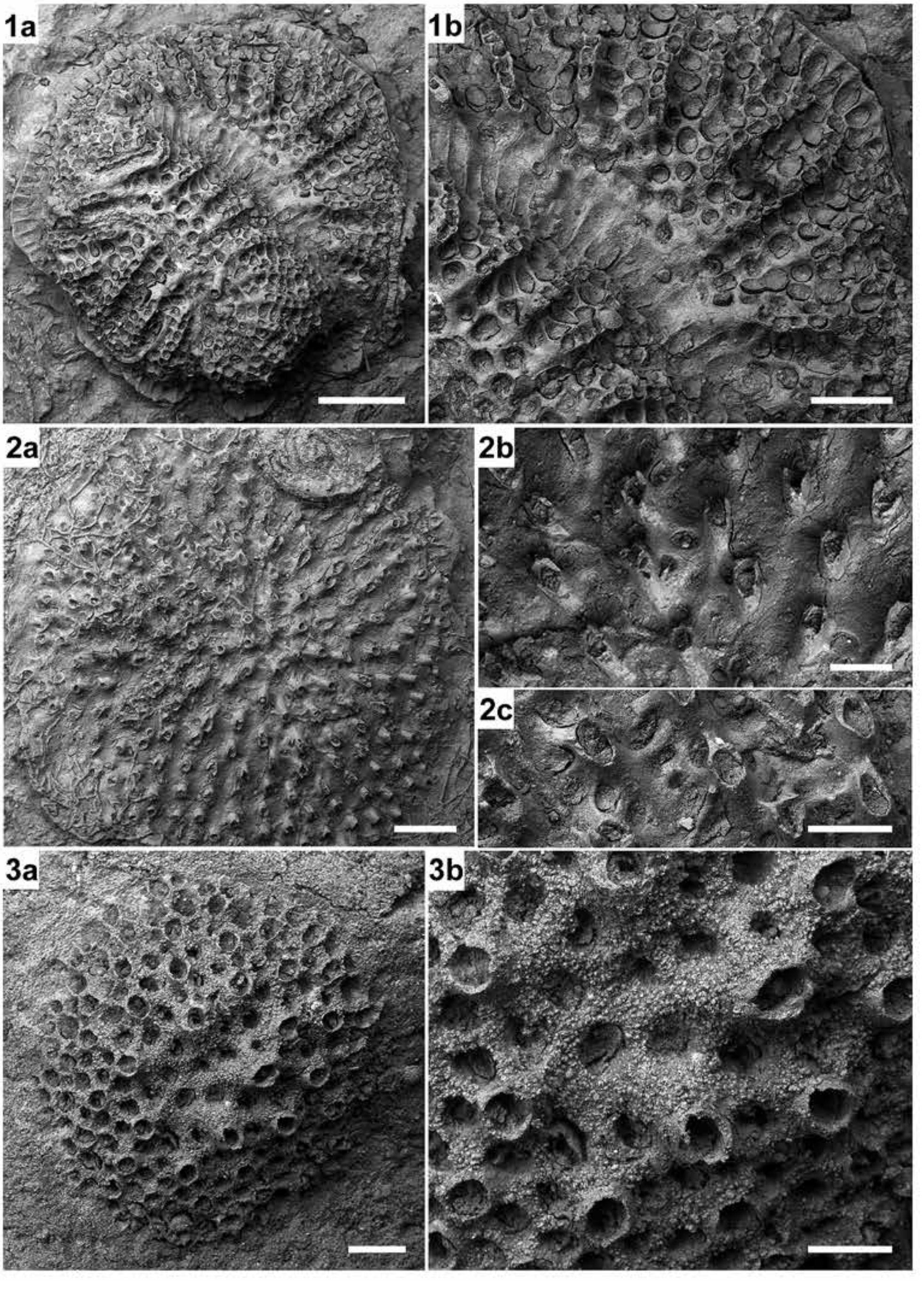
Fig. 1. a-b, NHMUK PI BZ 6849. a, larger, infertile colony (on the left), and a smaller fertile colony (on the right); scale bar = 500 μm. b, autozooids and kenozooids; scale bar = 100 μm. c, NHMUK PI BZ 6850, fertile colony (?ooeciopore arrowed); scale bar = 200 μm. d, NHMUK PI BZ 6851, gonozooid; scale bar = 100 μm.

Plate 8

Disporella sp. 2
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 1. NHMUK PI BZ 6852. a, compound colony; scale bar = 500 μm. b, autozooidal fascicles and marginal lamina; scale bar = 200 μm.

Disporella sp. 3
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 2. NHMUK PI BZ 6853. a, colony; scale bar = 200 μm. b-c, spinose acuminate peristomes; scale bar = 100 μm.

Disporella sp. 4
Serravallian, TF522, 'Coalindo Haulage Road 1', Sangkulirang.
Fig. 3. NHMUK PI BZ 6854. a, colony; scale bar = 500 μm. b, autozooids and kenozooids; scale bar = 200 μm.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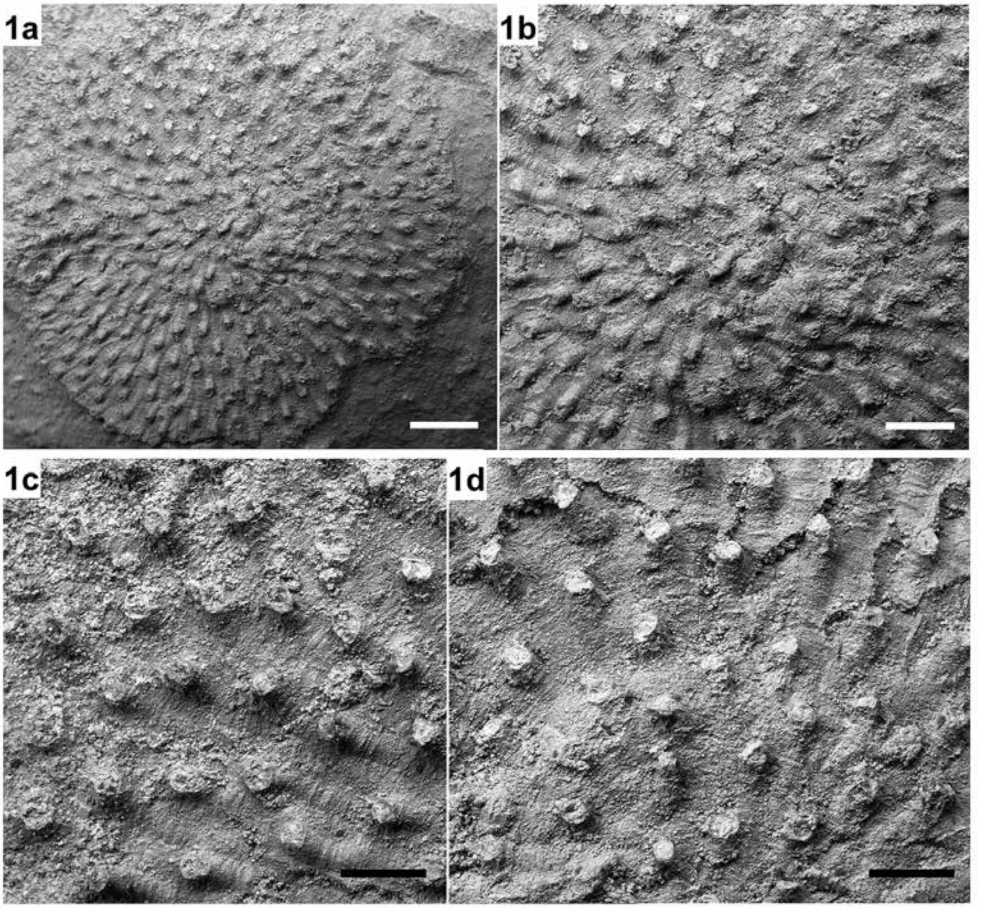

Plate 9

'Berenicea' sp.
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 1. NHMUK PI BZ 6855. a, colony; scale bar = 500 μm. b, colony centre; scale bar = 250 μm. c-d, autozooids; scale bar = 150 μm.

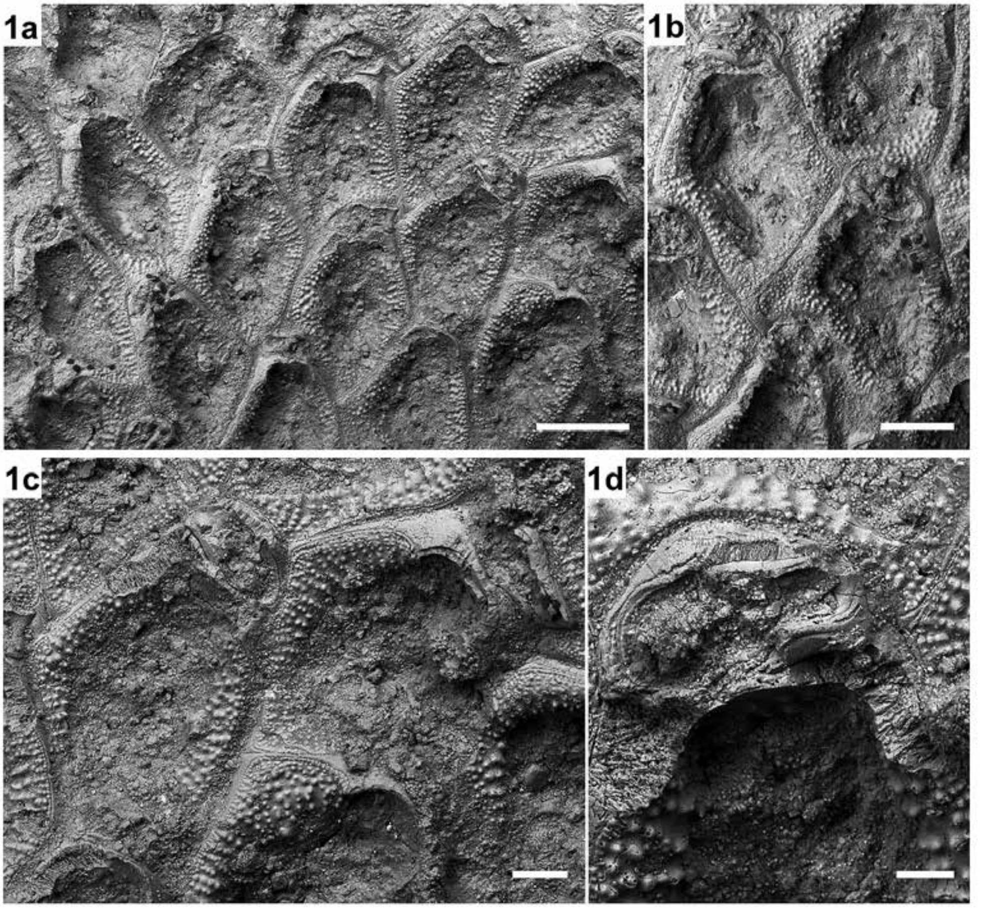

Plate 10

Cranosina cf. *coronata* (Hincks, 1881)
Serravallian, TF522, 'Coalindo Haulage Road 1', Sangkulirang.
Fig. 1. NHMUK PI BZ 6856. a, autozooids; scale bar = 300 μm. b, two autozooids and associated distal avicularia; scale bar = 200 μm. c, two autozooids and associated distal avicularium with spout-like rostrum; scale bar = 100 μm. d, distal avicularium; scale bar = 50 μm.

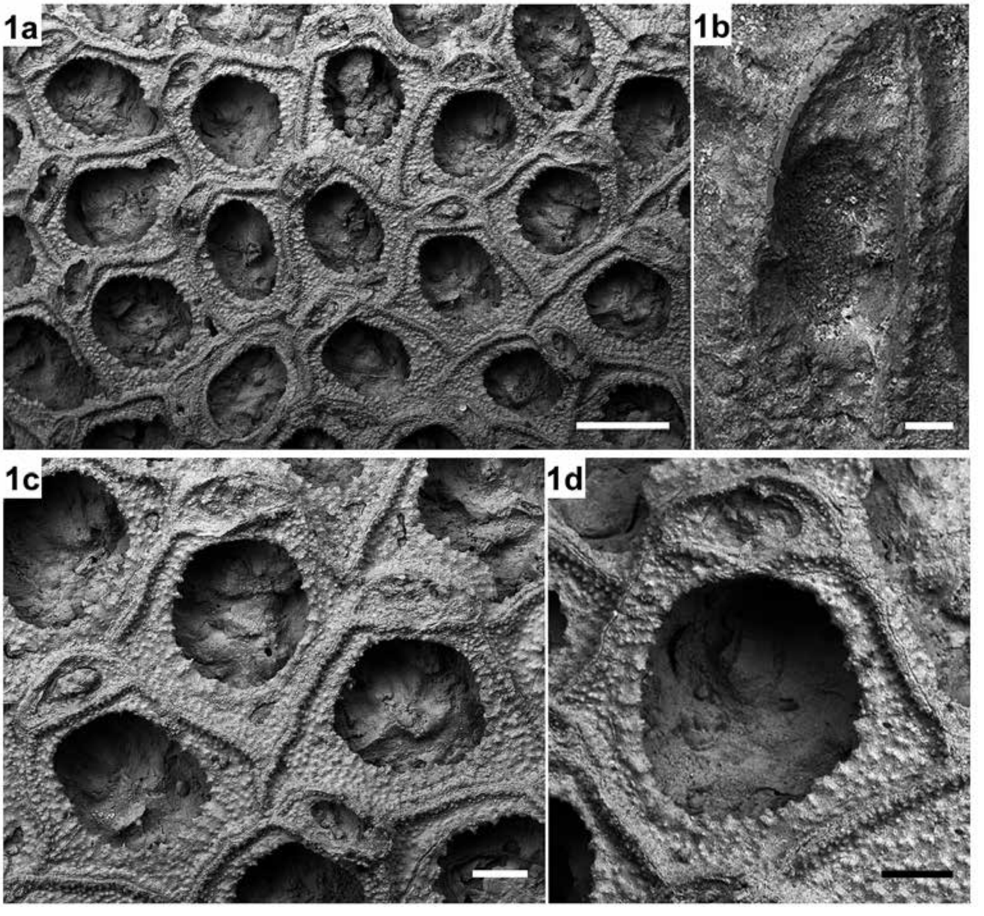

Plate 11

Cranosina rubeni sp. nov.

Serravallian, TF522, 'Coalindo Haulage Road 1', Sangkulirang.

Fig. 1. Holotype NHMUK PI BZ 6857. a, autozooids; scale bar = 500 μm. b, oblique close-up of an avicularium; scale bar = 50 μm. c, three autozooids and associated distal avicularia; scale bar = 200 μm. d, zooid and distal avicularium; scale bar = 150 μm.

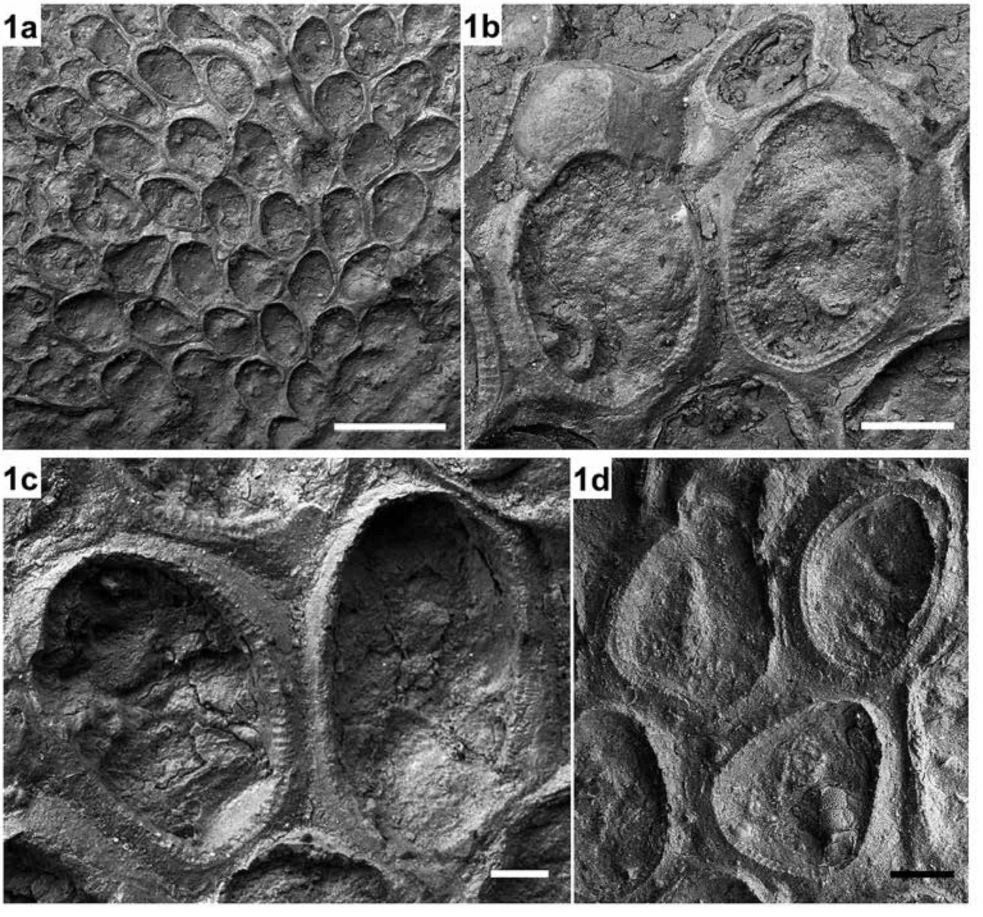

Plate 12

?*Crassimarginatella* sp.
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 1. NHMUK PI BZ 6858. a, colony; scale bar = 1 mm. b, two autozooids, one ovicellate, and ?kenozooid; scale bar = 150 μm. c, two autozooids with oval opesiae; scale bar = 150 μm. d, three autozooids, two with plectrum-shaped opesiae and one with oval opesia and intramural bud; scale bar = 100 μm.

Plate 13

?*Flustrellaria* sp.
Serravallian, TF76, 'Batu Putih 1', Samarinda
Fig. 1a, NHMUK PI BZ 6859, ancestrula and early astogeny; scale bar = 200 μm.

Serravallian, TF522, 'Coalindo Haulage Road 1', Sangkulirang
Fig. 1b-e. NHMUK PI BZ 6860. b, autozooids; scale bar = 200 μm. c, autozooid; scale bar = 50 μm. d, two autozooids with intramural buds; scale bar = 50 μm. e, ovicellate zooid; scale bar = 50 μm.

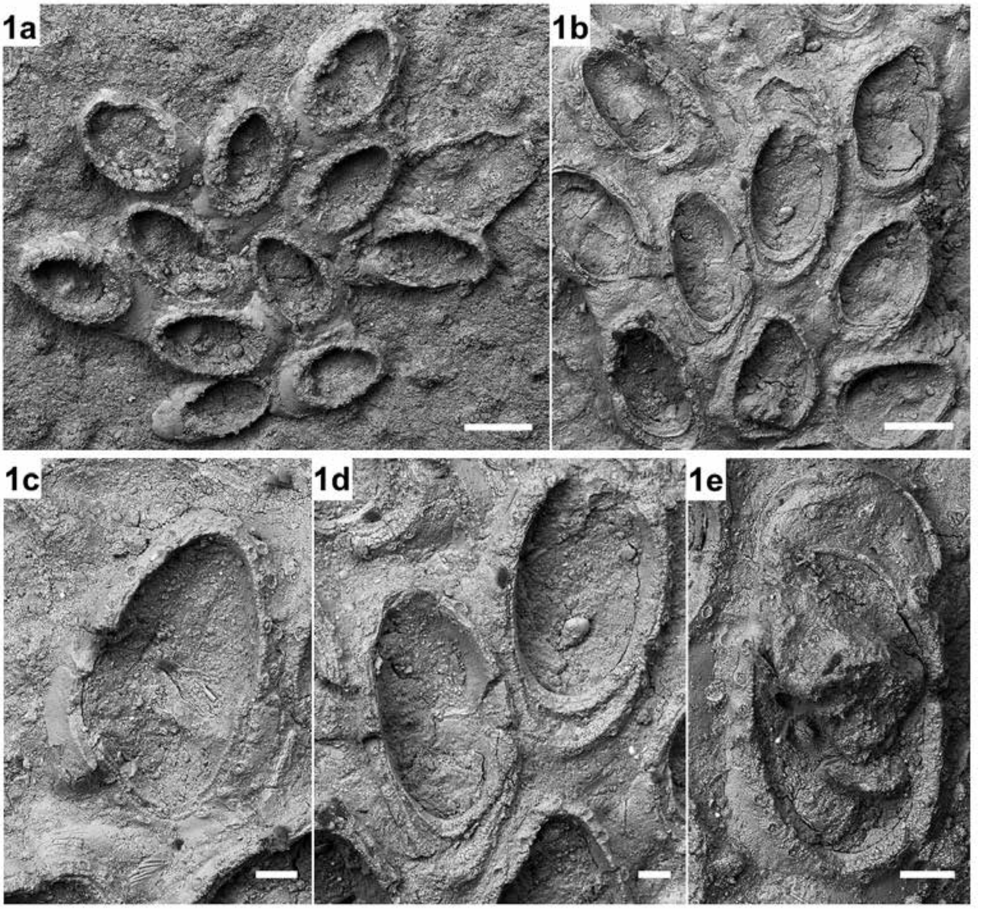
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Plate 14

Parellisina cf. *tenuissima* (Canu & Bassler, 1928)
Serravallian, TF57, 'Stadion Reef 2', Samarinda.
Fig. 1. NHMUK PI BZ 6861. a, autozooids; scale bar = 250 μm. b, two autozooids, associated distolateral avicularia and kenozooids; scale bar = 100 μm. c, avicularium; scale bar = 50 μm.

Parellisina mirellae sp. nov.
Serravallian, TF522, 'Coalindo Haulage Road 1', Sangkulirang.
Fig. 2. Holotype NHMUK PI BZ 6862. a, part of the colony; scale bar = 500 μm. b, ovicellate zooids; scale bar = 200 μm. c, avicularium and distal kenozooid; scale bar = 100 μm. d, autozooids, some with intramural buds (e.g. top right), and pore chambers (bottom left); scale bar = 300 μm.

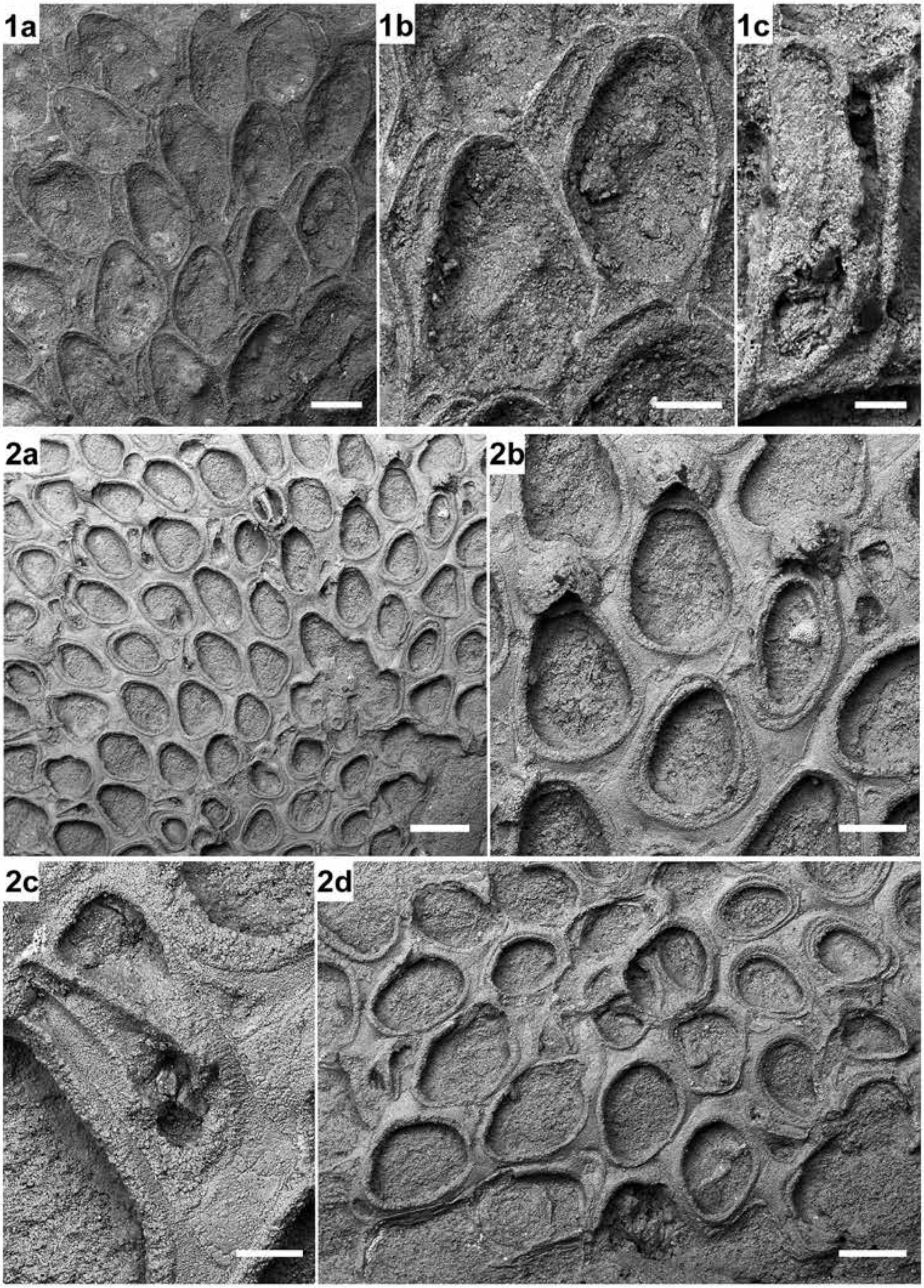
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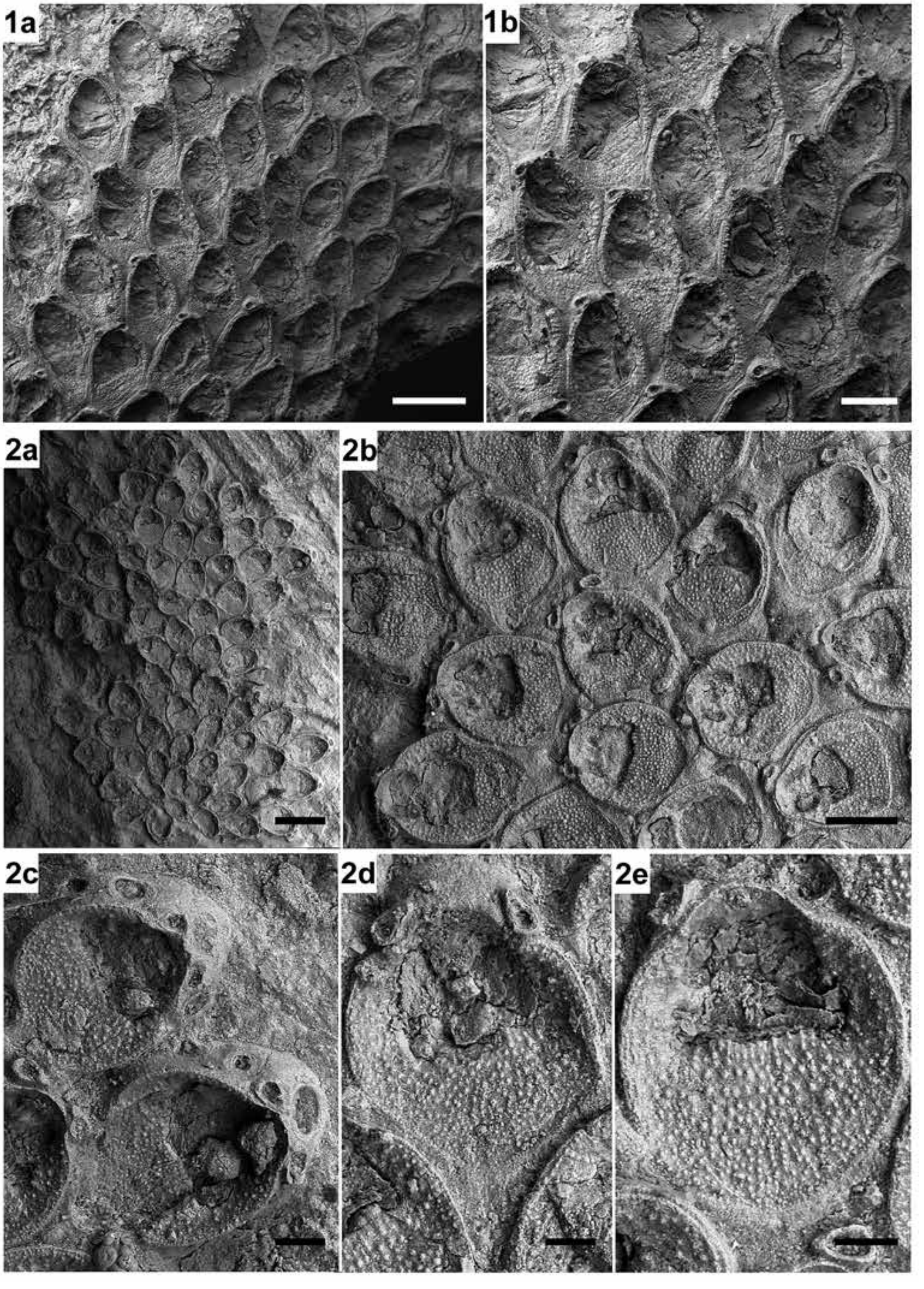
Plate 15

Antropora granulifera (Hincks, 1880)
Burdigalian-Langhian boundary, TF153, 'Rainy Section', Bontang.
Fig. 1. NHMUK PI BZ 6863. a, part of the colony; scale bar = 500 μm. b, autozooids; scale bar = 200 μm.

Antropora cf. *subvespertilio* (Canu & Bassler, 1929)
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 2. NHMUK PI BZ 6864. a, colony; scale bar = 500 μm. b, group of autozooids; scale bar = 200 μm. c, two autozooids at the colony growth margin, showing distal and distolateral pore chamber windows; scale bar = 100 μm. d, ovicellate zooid; scale bar = 50 μm. e, infertile autozooid showing the trifoliate opesia; scale bar = 50 μm.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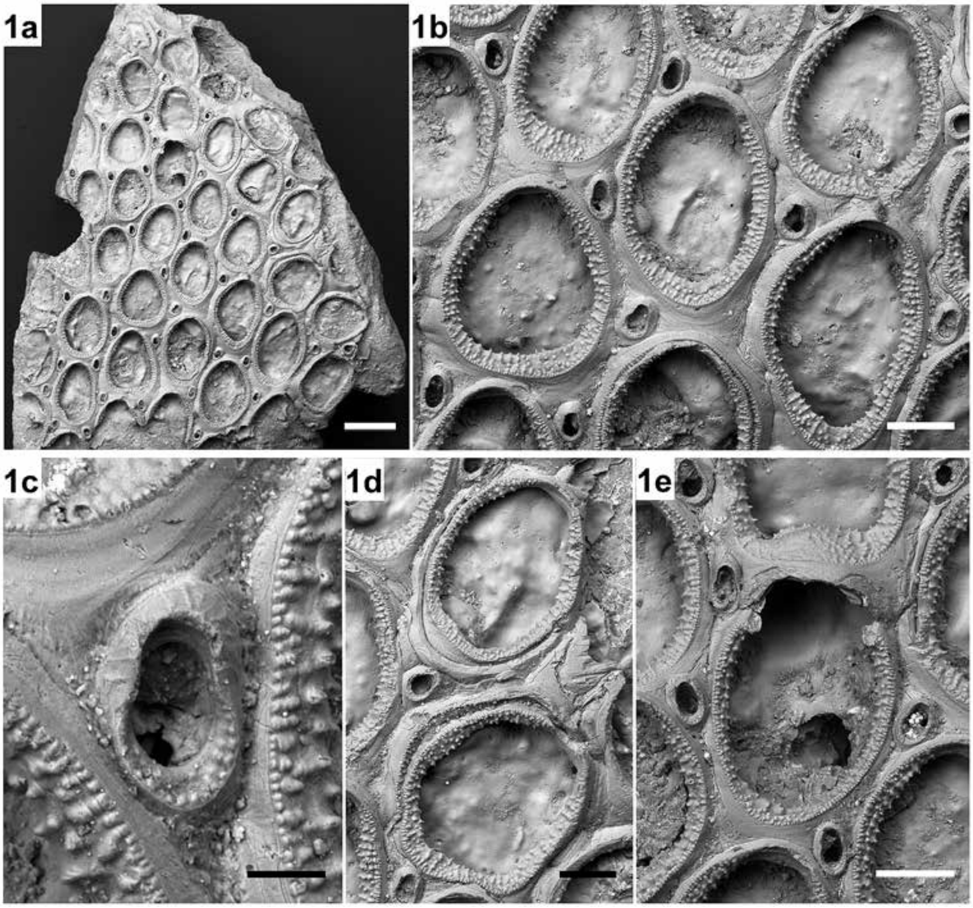

Plate 16

Parantropora laguncula (Canu & Bassler, 1929)
Early Tortonian, TF508, Bontang.
Fig. 1. NHMUK PI BZ 6865. a, colony; scale bar = 250 μm. b, autozooids and interzooidal avicularia; scale bar = 100 μm. c, interzooidal avicularium; scale bar = 20 μm. d, two autozooids with intramural buds; scale bar = 100 μm. e, ovicellate zooid; scale bar = 100 μm.

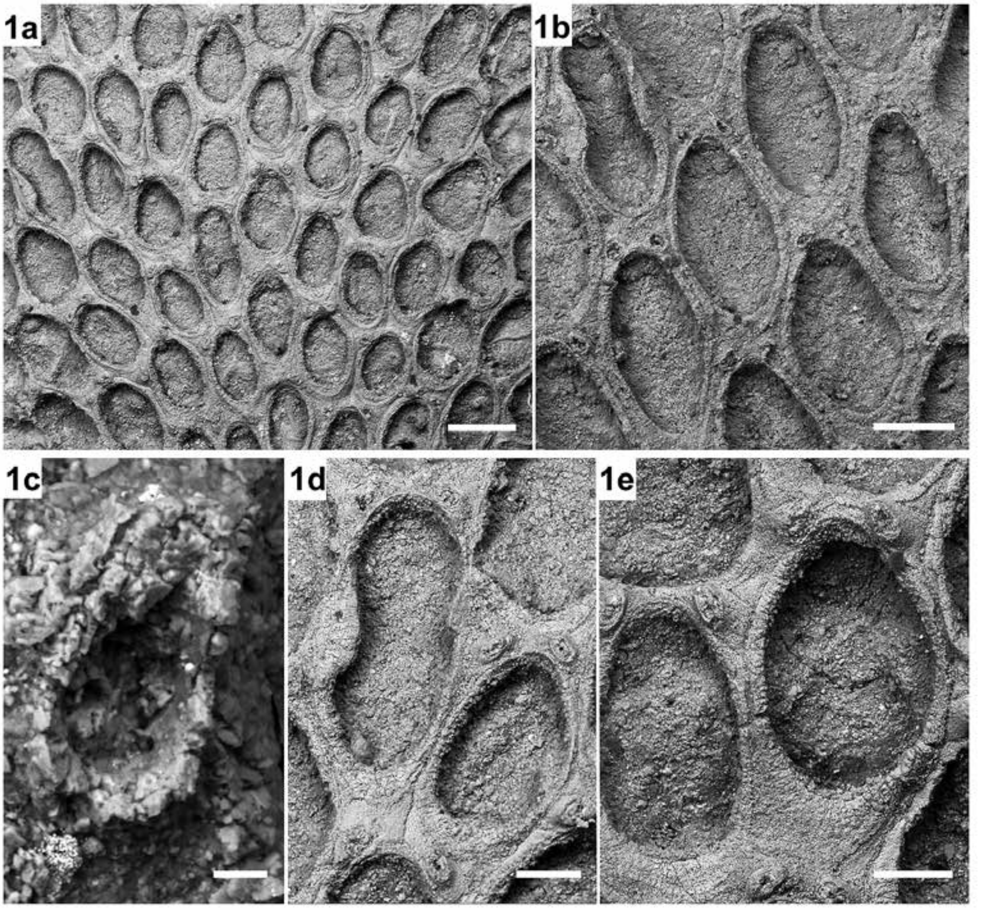

Plate 17

Parantropora aff. *laguncula* (Canu & Bassler, 1929)
Serravallian, TF522, 'Coalindo Haulage Road 1', Sangkulirang.
Fig. 1. a-c, NHMUK PI BZ 6866. a, part of the colony; scale bar = 300 μm. b, group of zooids and vicarious avicularium (top left); scale bar = 150 μm. c, interzooidal avicularium; scale bar = 10 μm. d-e, NHMUK PI BZ 6899. d, vicarious avicularium and autozooid; scale bar = 100 μm. e, ovicellate zooid; scale bar = 100 μm.

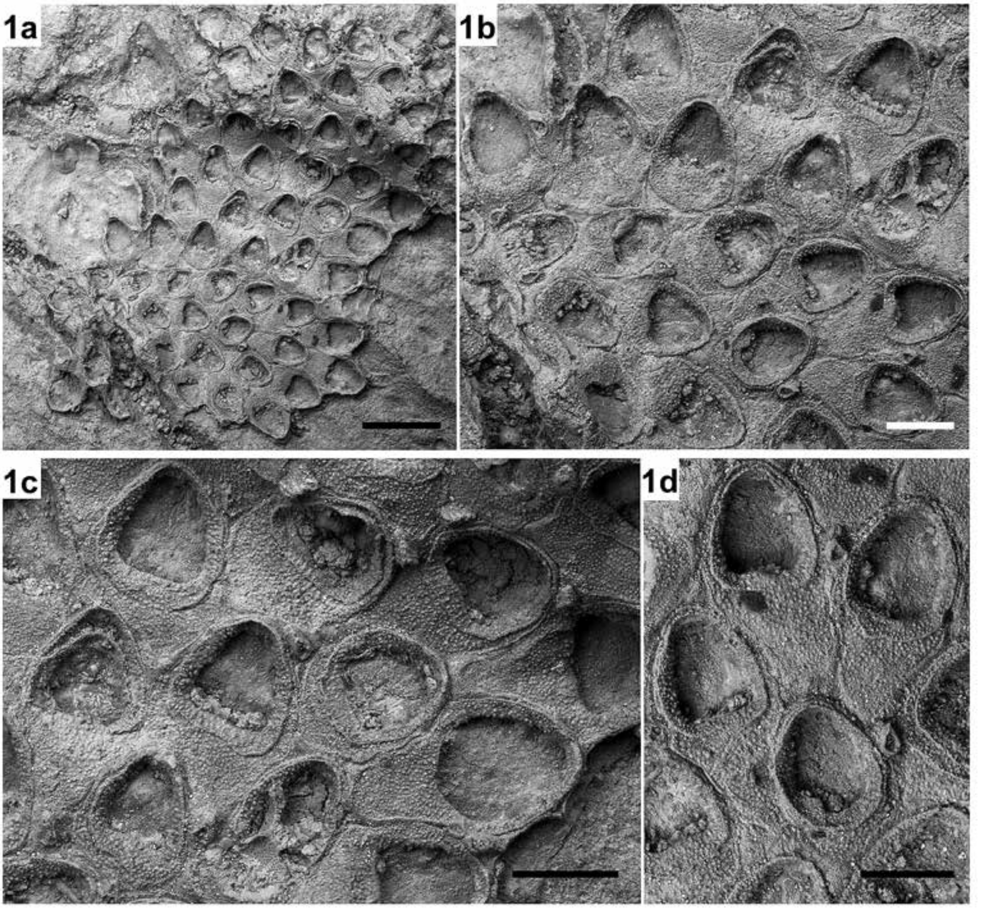

Plate 18

Parantropora cf. *penelope* Tilbrook, 1998
Serravallian, TF52, 'Batu Putih 2', Samarinda.
Fig. 1. NHMUK PI BZ 6867. a, colony with ancestrula; scale bar = 500 μm. b, group of autozooids and ovicellate zooids (top left); scale bar = 200 μm. c, autozooids with intramural buds; scale bar = 200 μm. d, four autozooids; scale bar = 200 μm.

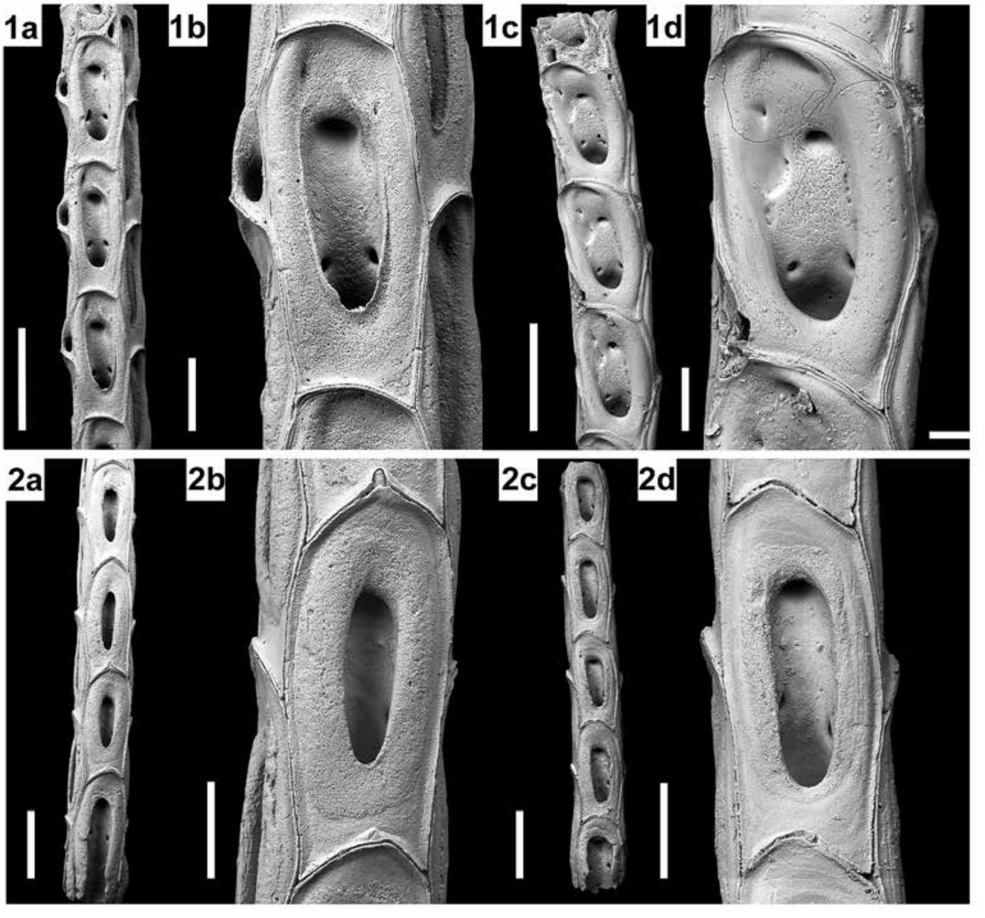

Plate 19

Vincularia berningi sp. nov.
Early Tortonian, TF110, 'Seagrass Section', Bontang.
Fig. 1. Holotype NHMUK PI BZ 6043. a, frontal view of branch fragment with 'ordinary' autozooids ('c-zooecia' *sensu* Canu, 1907); scale bar = 500 μm. b, 'c-zooid' with interzooidal avicularium; scale bar = 100 μm. c, frontal view of branch fragment with 'avicularian' zooids ('D-zooecia' *sensu* Canu, 1907); scale bar = 500 μm. d, 'D-zooid'; scale bar = 100 μm.

Vincularia semarai sp. nov.
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 2. Holotype NHMUK PI BZ 6868. a, frontal view of branch fragment with 'ordinary' autozooids; scale bar = 500 μm. b, 'c-zooid'; scale bar = 250 μm. c, frontal view of branch fragment with 'D-zooids'; scale bar = 500 μm. d, 'D-zooid'; scale bar = 250 μm.

Plate 20

Vincularia tjaki sp. nov.
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 1. Holotype NHMUK PI BZ 6869. a, frontal view of branch fragment with 'ordinary' autozooids; scale bar = 500 μm. b, 'c-zooid' with rhizoidal pore; scale bar = 150 μm. c, frontal view of branch fragment with 'D-zooids' and interzooidal avicularia; scale bar = 500 μm. d, close-up of 'D-zooid'; scale bar = 100 μm. e, quadripartite articulation (top) of *Vincularia tjaki* sp. nov. and tripartite articulation (bottom) of *Vincularia berningi* sp. nov.; scale bar = 50 μm.

Vincularia manchanui sp. nov.
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 2. Holotype NHMUK PI BZ 6042. a, frontal view of branch fragment with 'ordinary' autozooids; scale bar = 500 μm. b, 'c-zooid' with interzooidal avicularium; scale bar = 150 μm. c, close-up of 'D-zooid' and interzooidal avicularium; scale bar = 150 μm.

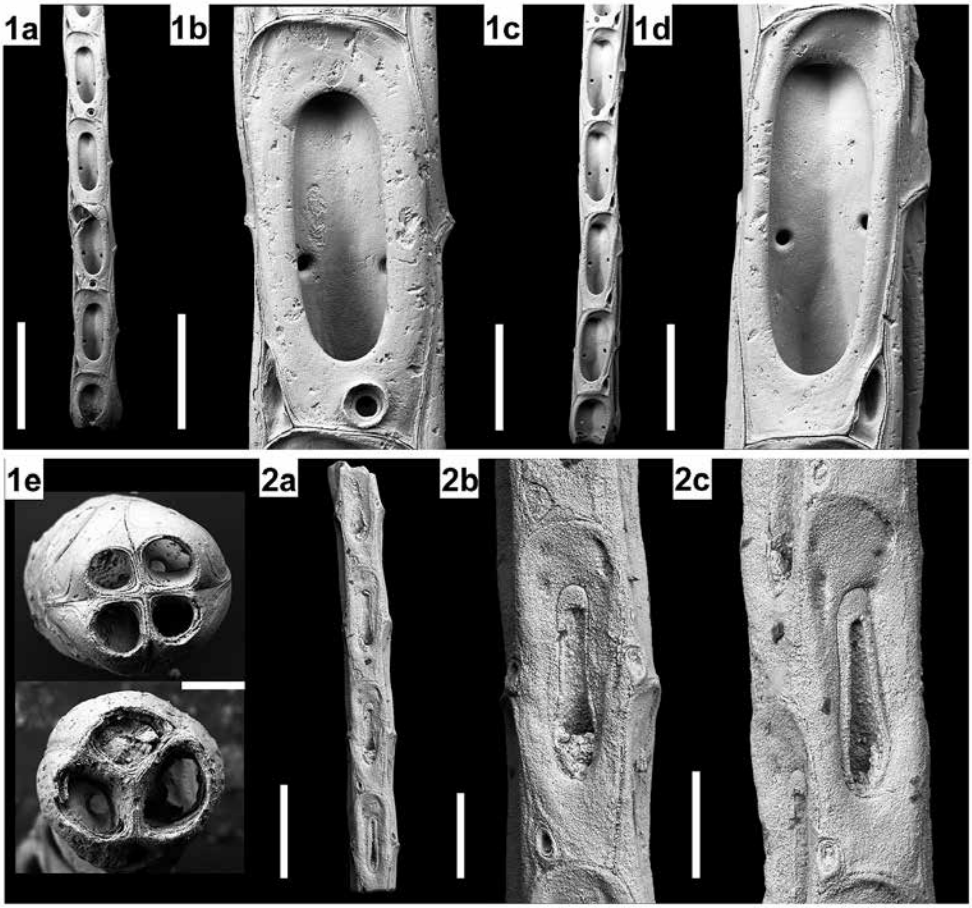
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Plate 21

Vincularia sp. 1
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 1. NHMUK PI BZ 6870. a, frontal view of branch fragment; scale bar = 500 μm. b, lateral view of branch fragment; scale bar = 500 μm. c, interzooidal avicularium; scale bar = 50 μm. d, zooid and kenozooid at the internode articulation; scale bar = 150 μm. e-f, autozooids with rhizoidal pores; scale bar = 200 μm.

'*Vincularia*' sp.
Serravallian, TF76, 'Batu Putih 1', Samarinda.
Fig. 2. NHMUK PI BZ 6871. a, frontal view of a bifurcating branch fragment; scale bar = 1 mm. b, group of autozooids; scale bar = 500 μm. c, zooid at the bifurcation; scale bar = 100 μm.

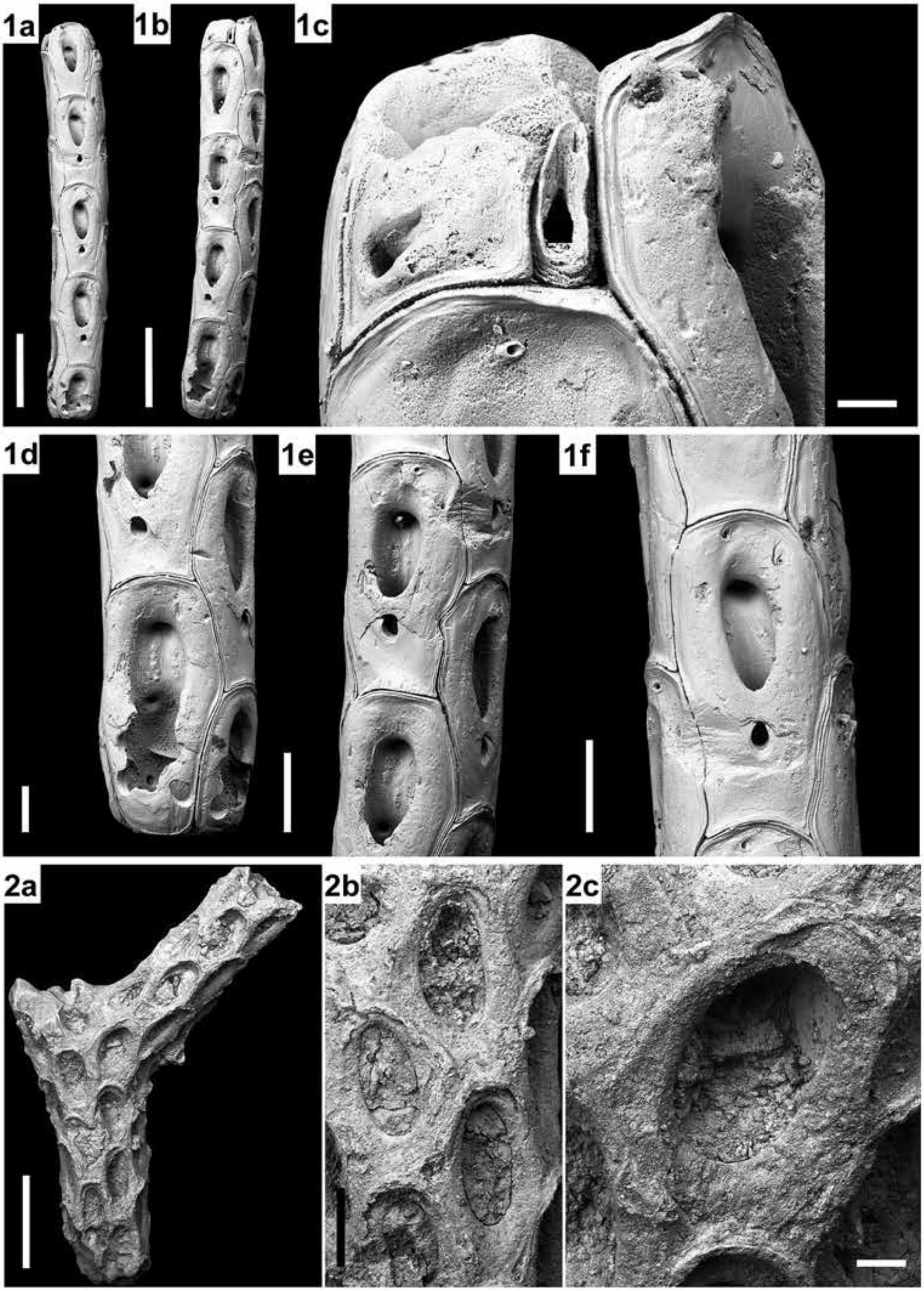
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Plate 22

Setosellina cf. *constricta* Harmer, 1926
Serravallian, TF76, 'Batu Putih 1', Samarinda.
Fig. 1. NHMUK PI BZ 6872. a, ancestrula and early astogeny; scale bar = 500 μm. b, two autozooids and distal vibracula; scale bar = 200 μm. c, autozooids; scale bar = 100 μm. d, colony, encrusting a fragment of crab shell; scale bar = 500 μm. e, NHMUK PI BZ 6873, colony encrusting a gastropod shell; scale bar = 500 μm.

Setosellina cf. *roulei* Calvet, 1906
Serravallian, TF59, 'Southern Hemisphere', Bontang.
Fig. 2. NHMUK PI BZ 6874. a, colony; scale bar = 500 μm. b, autozooids and distal vibracula; scale bar = 150 μm.

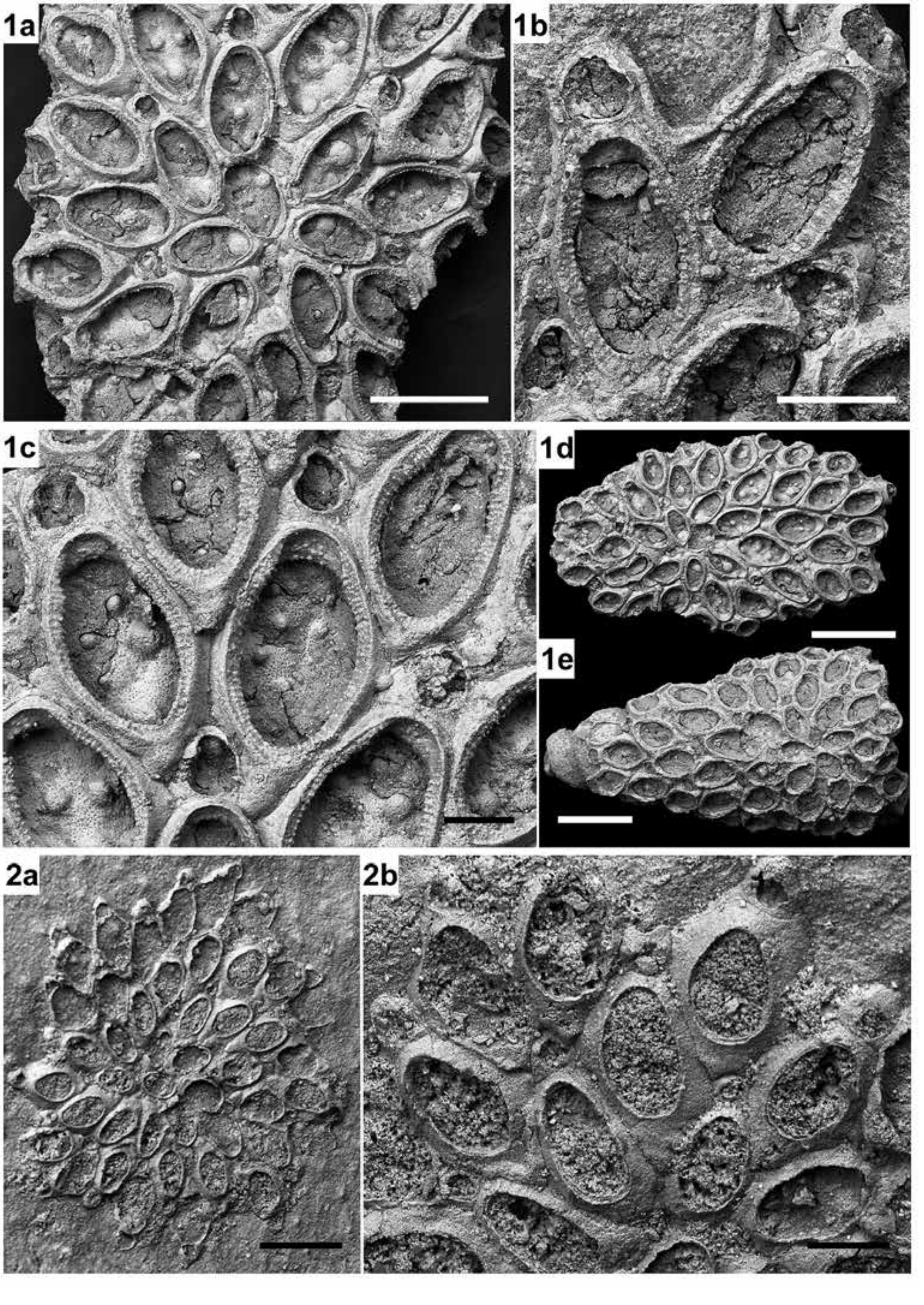
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Plate 23

Reussirella sp.

Serravallian, TF76, 'Batu Putih 1', Samarinda.

Fig. 1. a-d, NHMUK PI BZ 6875. a, subcircular colony; scale bar = 1 mm. b, colony centre; scale bar = 500 μm. c, autozooids; scale bar = 200 μm. d, autozooid and avicularia; scale bar = 100 μm. e, NHMUK PI BZ 6876, discoidal colony; scale bar = 1 mm. f, NHMUK PI BZ 6877, underside; scale bar = 500 μm.

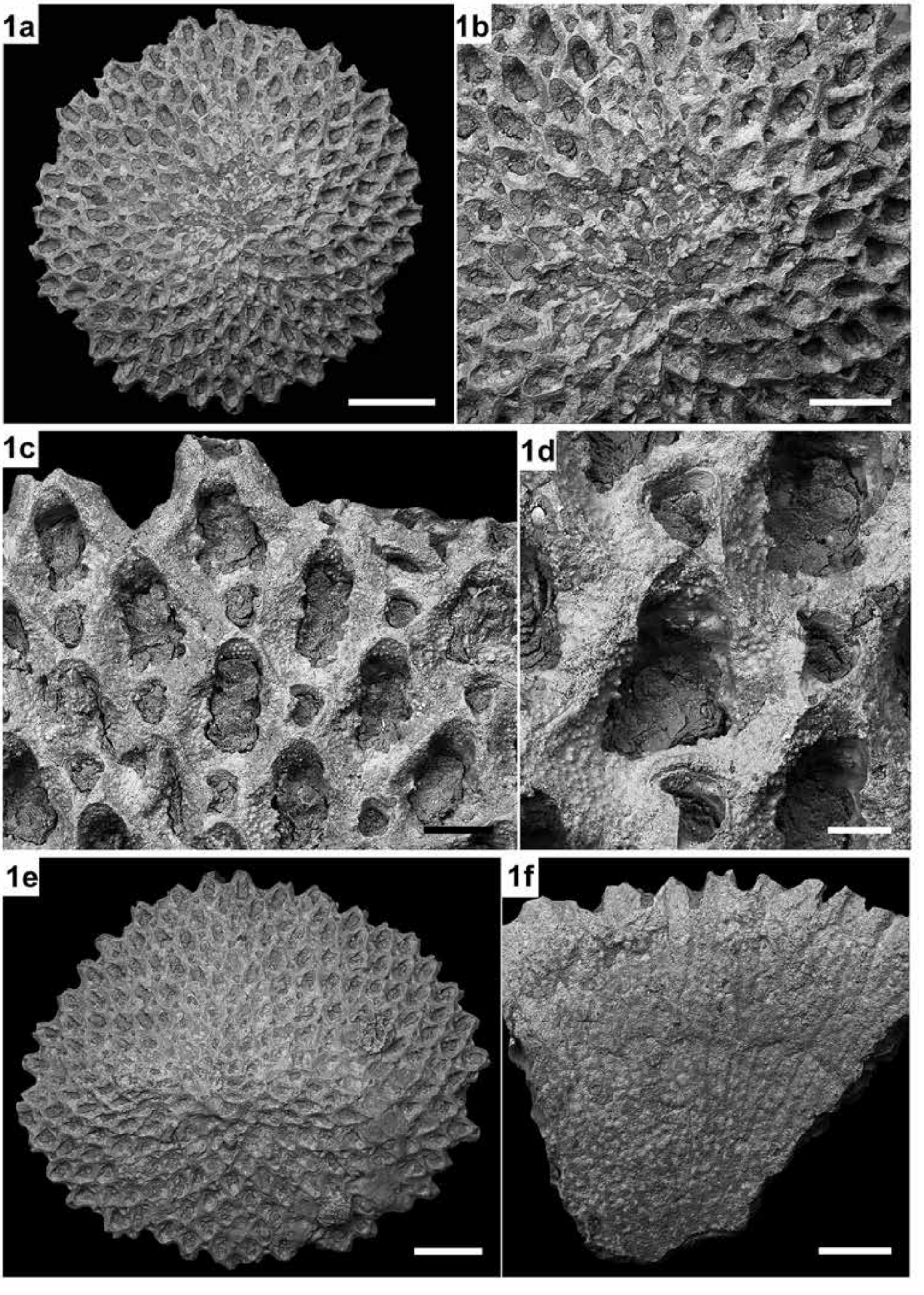
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Plate 24

Gontarella? *sendinoae* sp. nov.
Serravallian, TF59, 'Southern Hemisphere', Bontang.
Fig. 1. Holotype NHMUK PI BZ 6878. a, autozooids with well-preserved granular cryptocyst; scale bar = 200 μm. b, zooid with scarcely developed proximal cryptocyst; scale bar = 100 μm. c, autozooids showing both rounded hexagonal and rhomboidal outline; scale bar = 200 μm. d, zooid showing the subtriangular opesia; scale bar = 100 μm. e, autozooids with abraded frontal wall; scale bar = 200 μm. f, abraded zooid with oval opesia; scale bar = 100 μm.

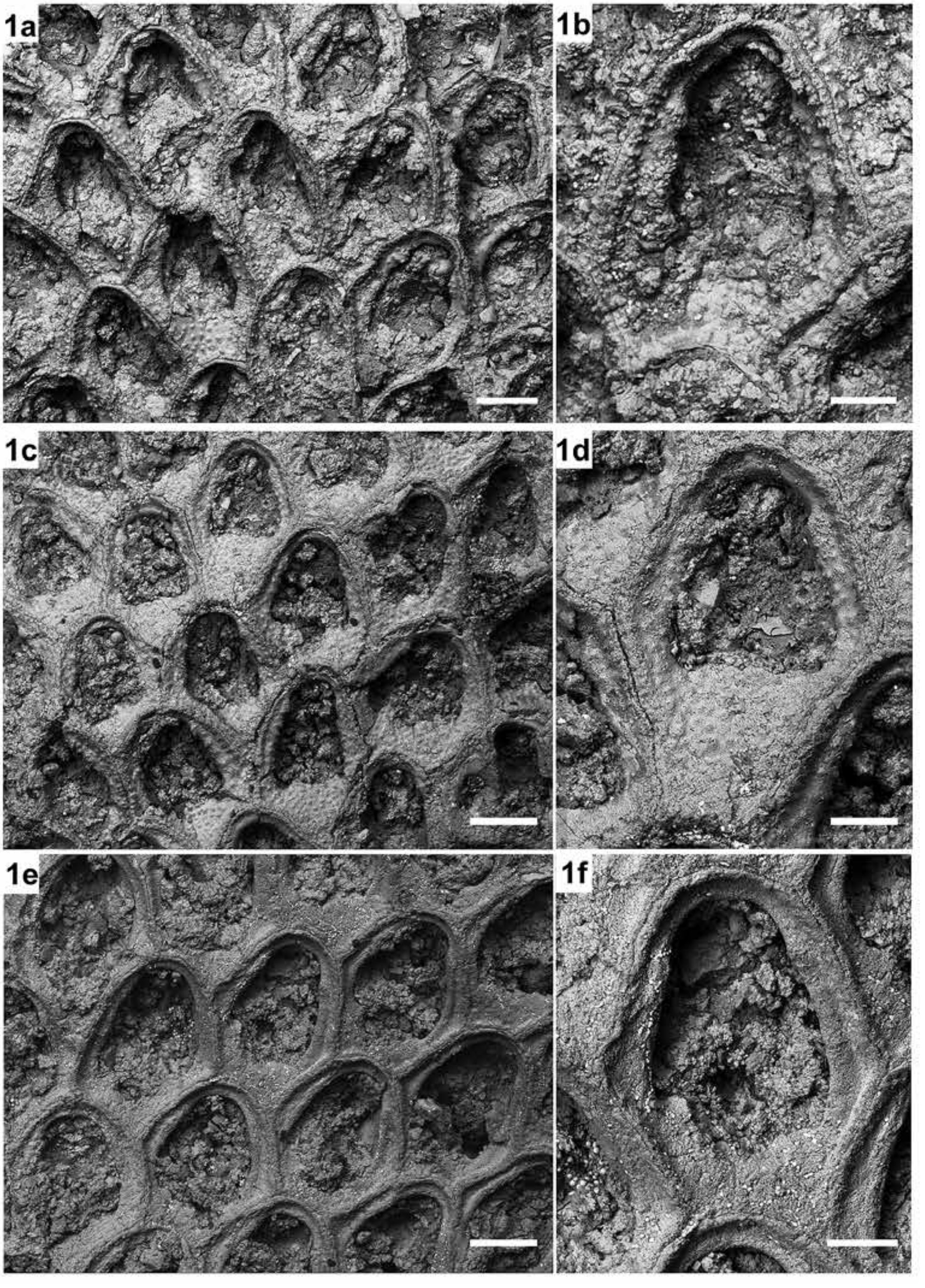
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Plate 25

Caberea sp.
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 1. a, NHMUK PI BZ 6879, frontal view of branch fragment; scale bar = 500 μm. b, NHMUK PI BZ 6880, dorsal view of branch fragment; scale bar = 500 μm. c-f, NHMUK PI BZ 6881. c, autozooids; scale bar = 100 μm. d, ovicellate autozooids; scale bar = 100 μm. e, frontal avicularia; scale bar = 20 μm. f, broken ovicell and lateral avicularia; scale bar = 50 μm.

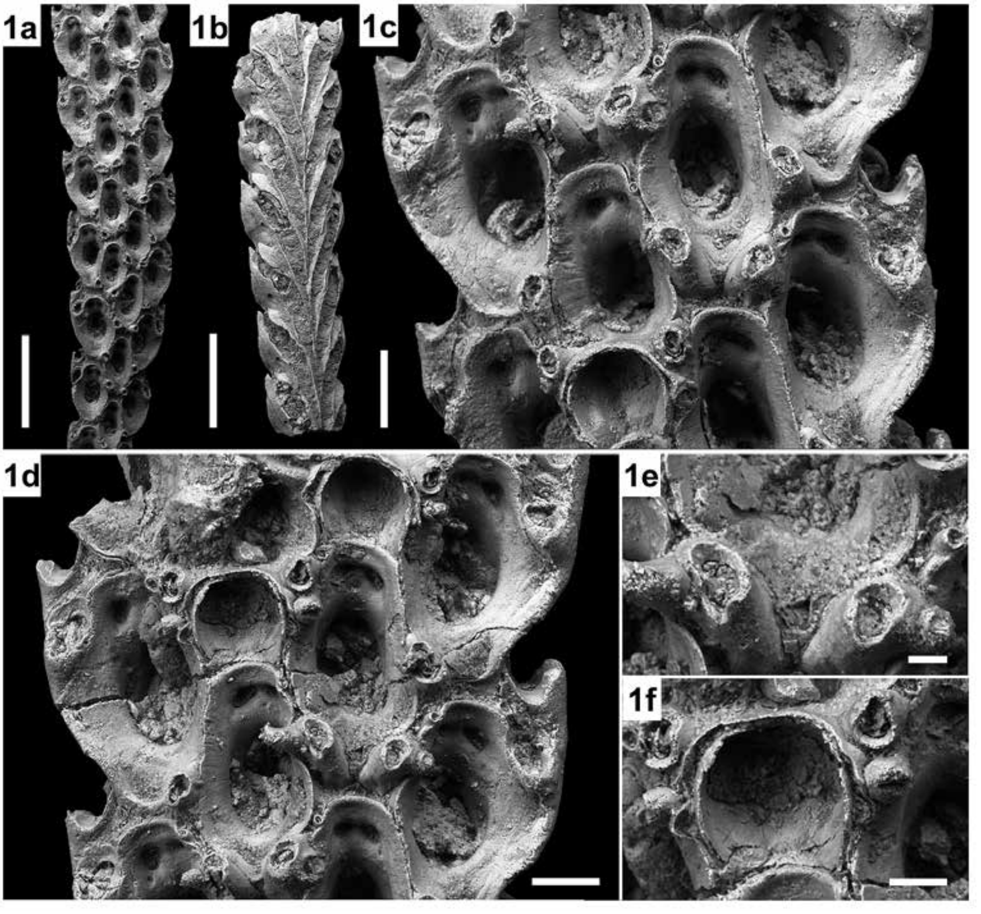
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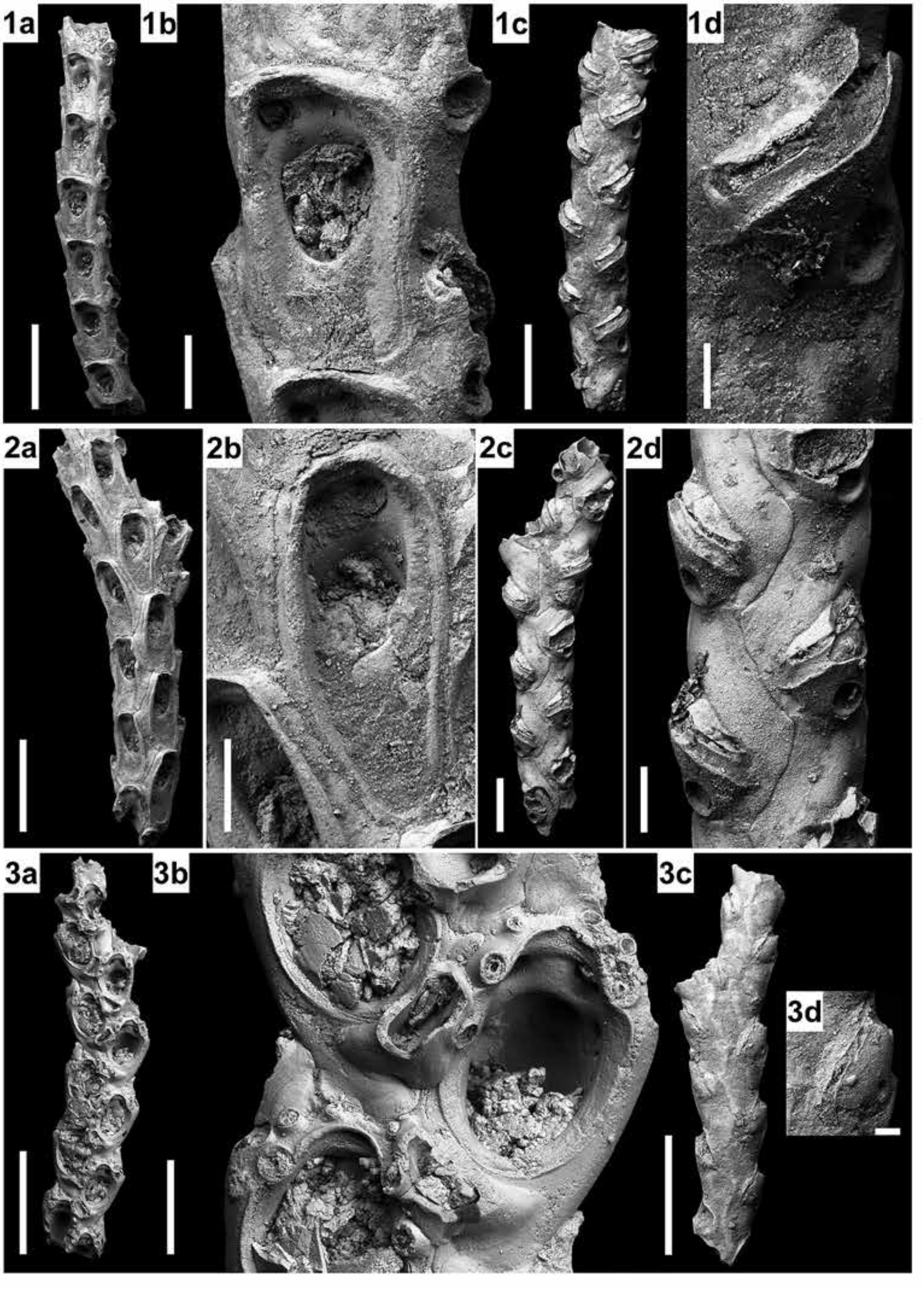
Plate 26

Canda giorgioi sp. nov.
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 1. a-b, NHMUK PI BZ 6882. a, lateral view of branch fragment; scale bar = 500 μm. b, autozooid; scale bar = 100 μm. c-d, NHMUK PI BZ 6883. c, dorsal view of branch fragment; scale bar = 500 μm. d, vibraculum; scale bar = 70 μm.

Canda federicae sp.nov.
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 2. a-b, NHMUK PI BZ 6884. a, frontal view of branch fragment; scale bar = 500 μm. b, autozooid; scale bar = 100 μm. c-d, NHMUK PI BZ 6885. c, dorsal view of branch fragment; scale bar = 250 μm. d, vibracula; scale bar = 50 μm.

Scrupocellaria sp.
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 3. a-b, NHMUK PI BZ 6886. a, frontal view of branch fragment; scale bar = 500 μm. b, autozooid; scale bar = 100 μm. c-d, NHMUK PI BZ 6887. c, dorsal view of branch fragment; scale bar = 500 μm. d, vibraculum; scale bar = 50 μm.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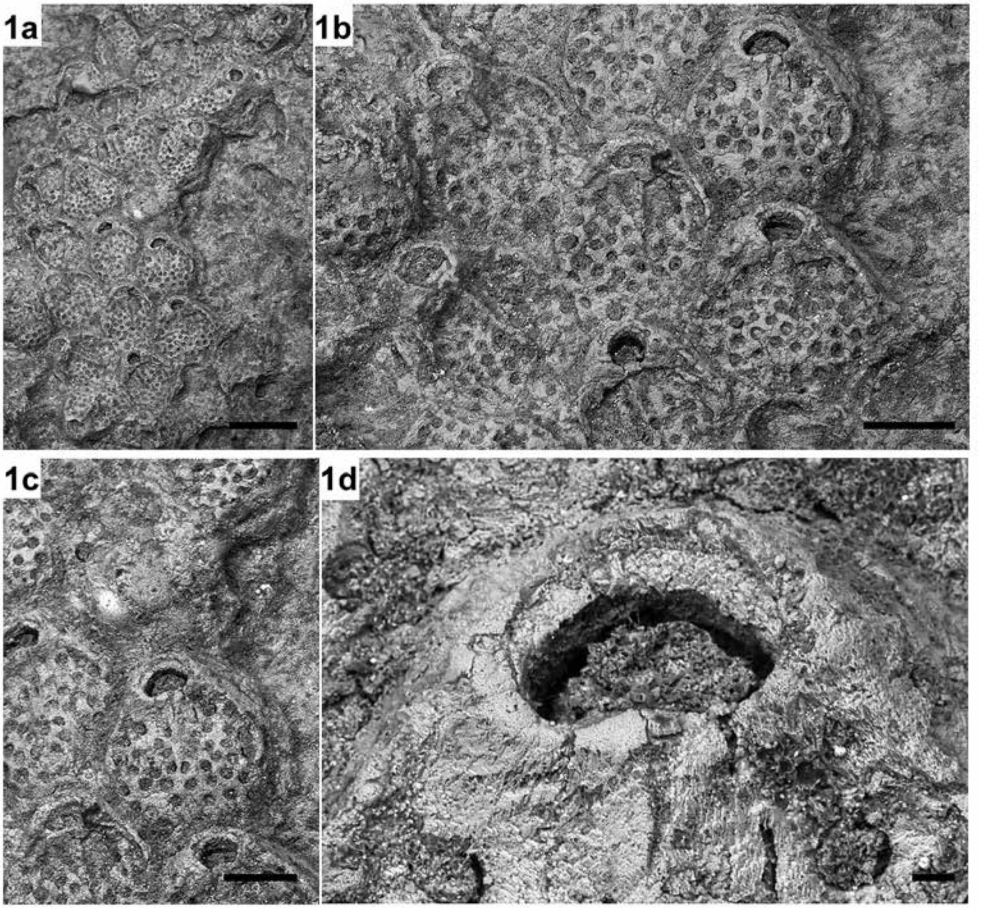

Plate 27

Monoporella sp. 1

Late Burdigalian, TF126, '3D Reef', Bontang.

Fig. 1. NHMUK PI BZ 6888. a, colony; scale bar = 500 μm. b, autozooids; scale bar = 200 μm. c, autozooid and ?ovicell floor; scale bar = 200 μm. d, orifice with four oral spines and two circular suboral opesiules; scale bar = 20 μm.

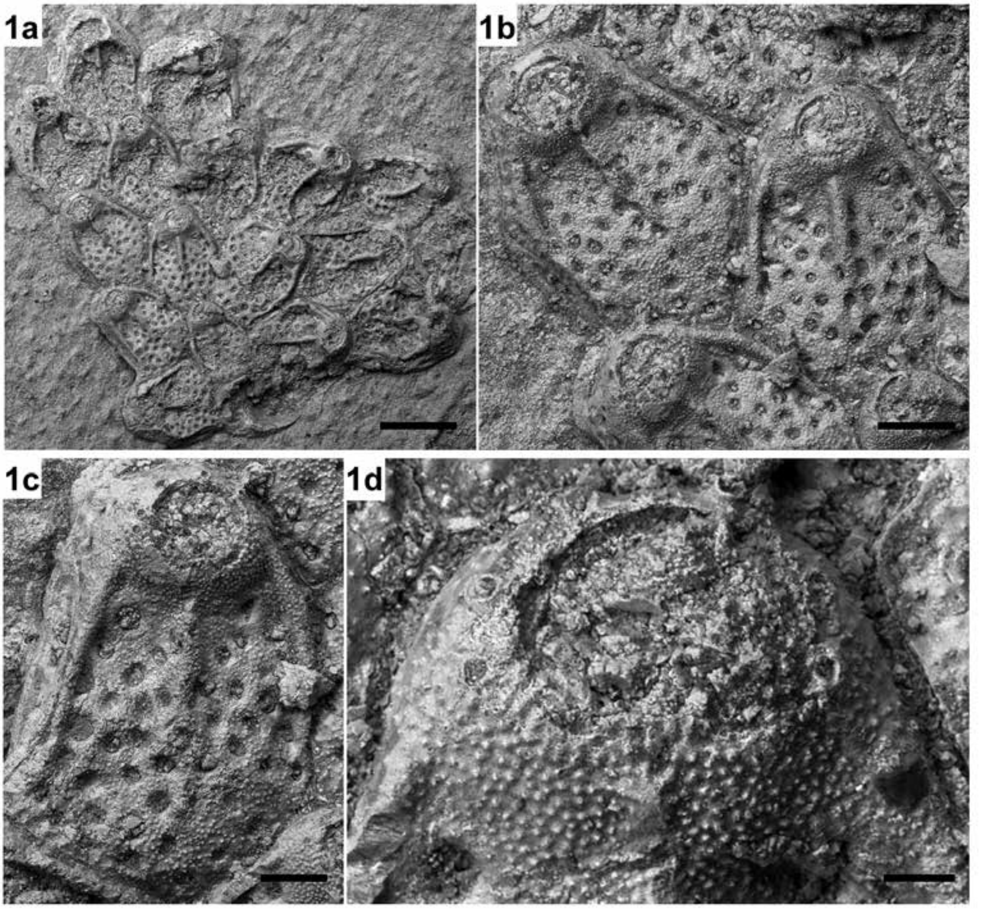

Plate 28

Monoporella sp. 2

Serravallian, TF76, 'Batu Putih 1', Samarinda.

Fig. 1. NHMUK PI BZ 6889. a, colony; scale bar = 500 μm. b, close-up of two autozooids; scale bar = 150 μm. c, autozooid with lateral and distal pore chamber windows; scale bar = 100 μm. d, orifice with six oral spines and two circular suboral opesiules; scale bar = 50 μm.

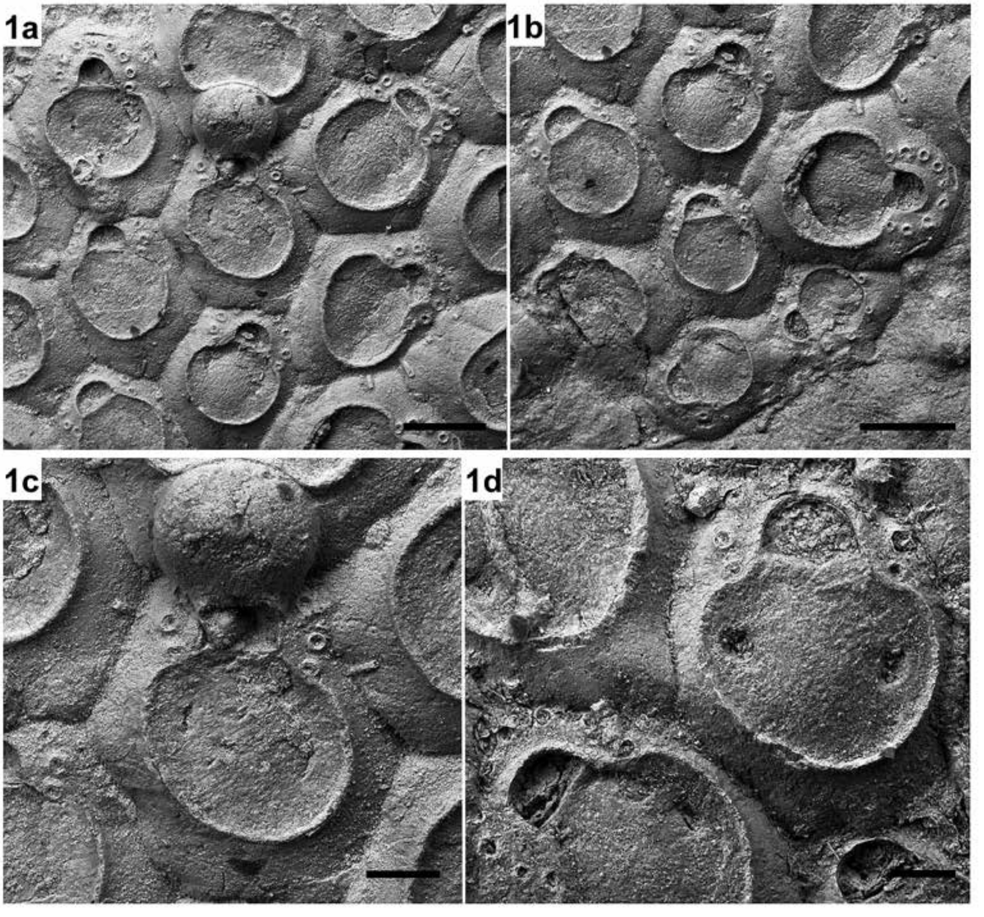

Plate 29

Setosinella perfluxa Di Martino & Taylor, 2012b
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 1. a-c, Holotype NHMUK PI BZ 5849. a, autozooids with ovicellate zooid in the centre; scale bar = 100 μm. b, ancestrula and early astogeny; scale bar = 100 μm. c, close-up of an ovicellate zooid; scale bar = 50 μm. d, Paratype BZ 5850, autozooid showing two subcircular opesiules; scale bar = 50 μm.

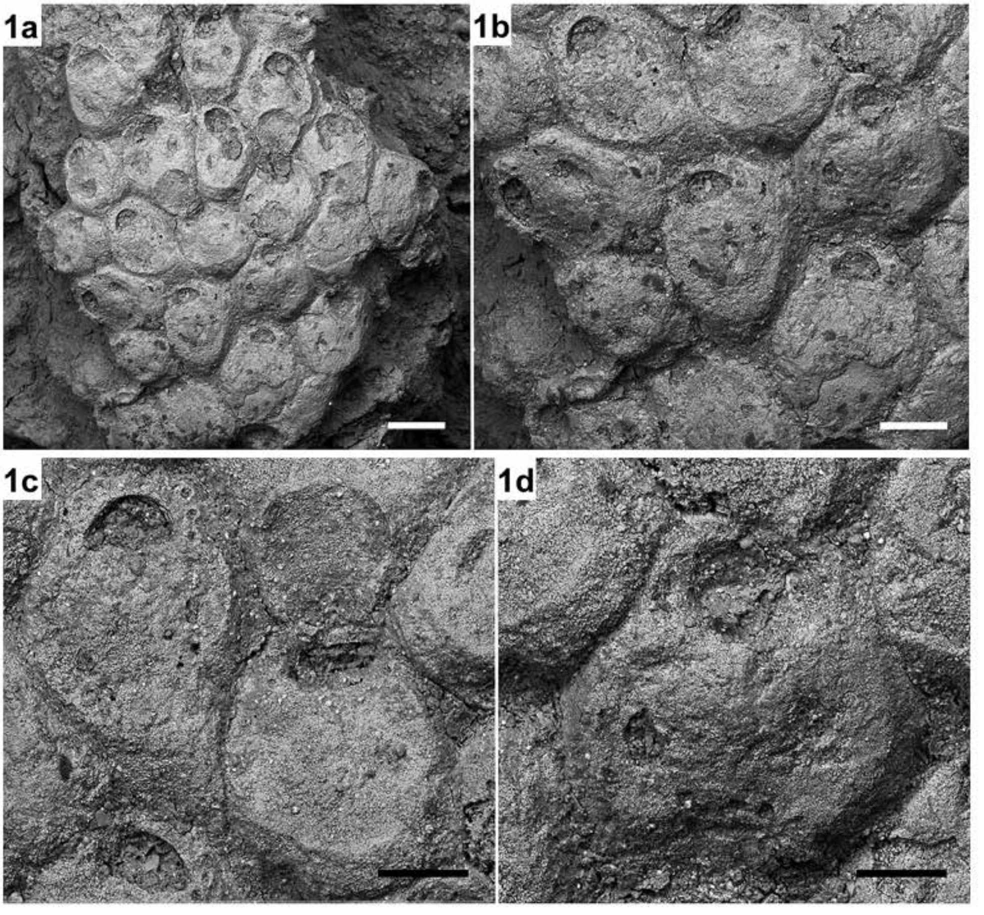

Plate 30

Pyrisinellidae sp.
Serravallian, TF76, 'Batu Putih 1', Samarinda.
Fig. 1. NHMUK PI BZ 6890. a, colony; scale bar = 200 μm. b, autozooids; scale bar = 150 μm. c, two zooids, one with a broken ovicell; scale bar = 150 μm. d, autozooid with opesiules; scale bar = 150 μm.

Plate 31

Smittipora aff. *cordiformis* Harmer, 1926
Serravallian, TF522, 'Coalindo Haulage Road 1', Sangkulirang.
Fig. 1. a-b, NHMUK PI BZ 6891. a, autozooids and vicarious avicularia; scale bar = 200 μm. b, fertile zooid; scale bar = 100 μm.

Early Tortonian, TF 508, Bontang.
Fig. 1. c-d, NHMUK PI BZ 6892. c, fertile zooid and vicarious avicularium; scale bar = 150 μm. d, autozooids and vicarious avicularia; scale bar = 100 μm.

Smittipora sp.
Burdigalian-Langhian boundary, TF153, 'Rainy Section', Bontang.
Fig. 2. NHMUK PI BZ 6893. a, autozooids; scale bar = 150 μm. b, autozooid showing the trifoliate orifice; scale bar = 100 μm. c, autozooid and vicarious avicularium; scale bar = 100 μm.

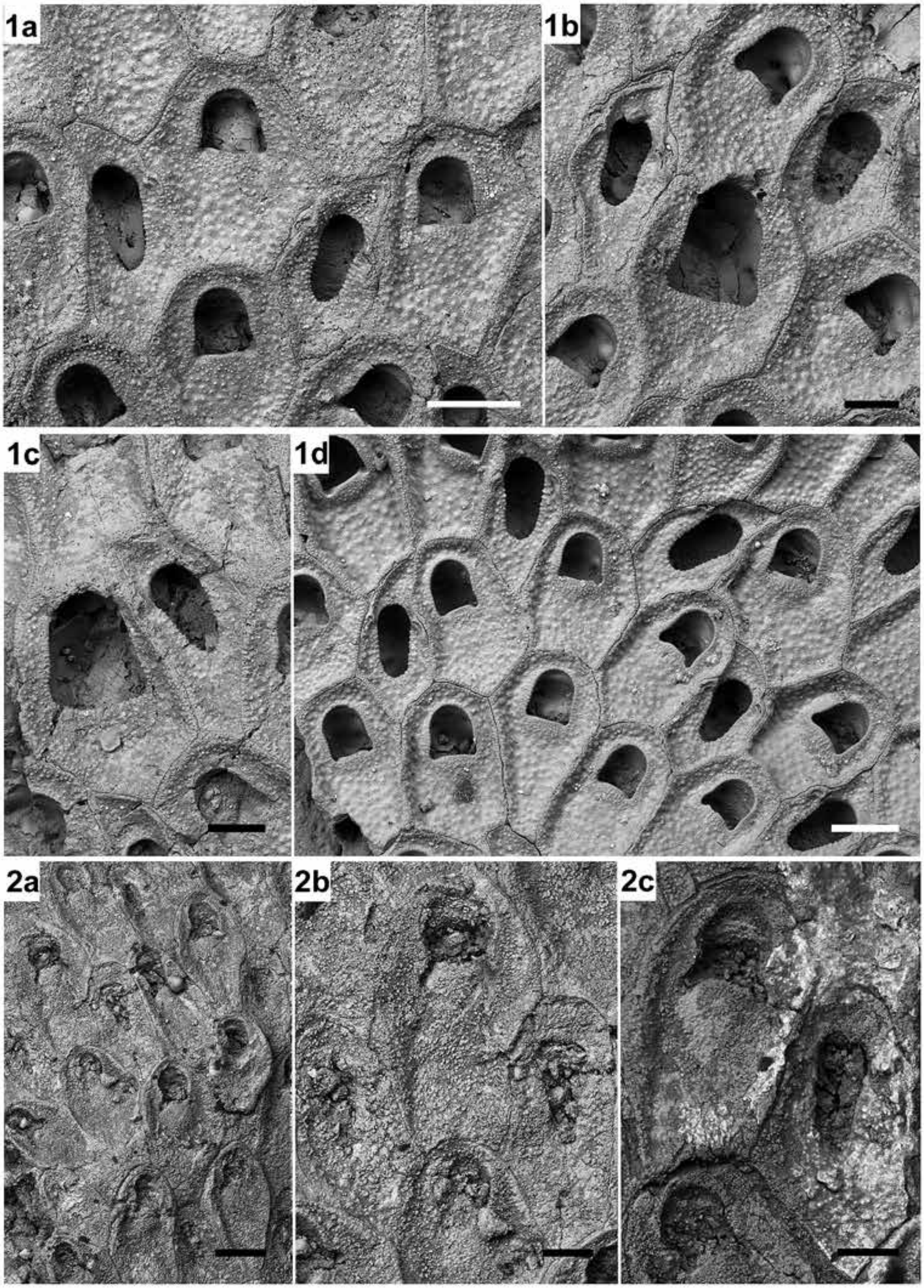
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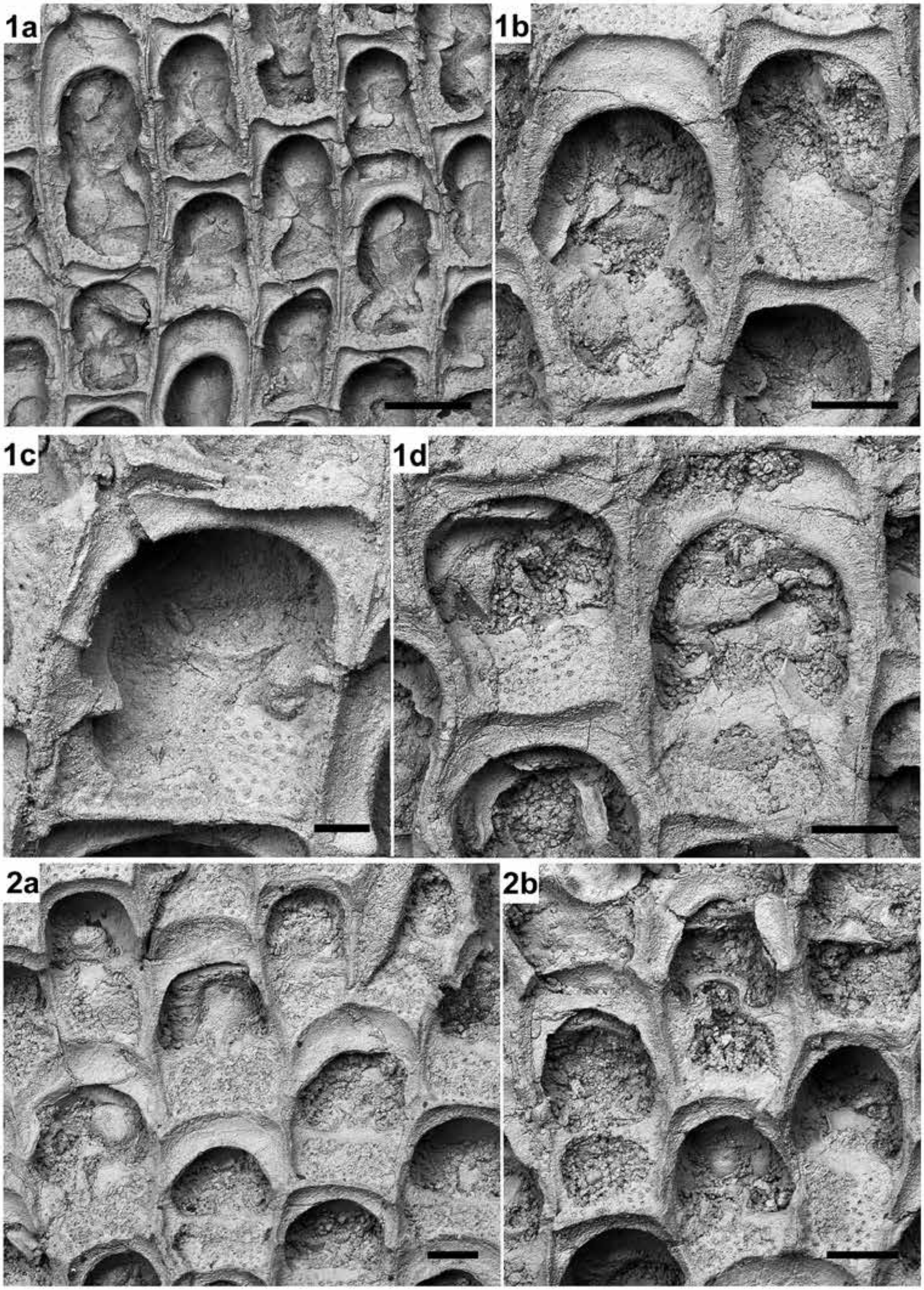
Plate 32

Steginoporella cf. *truncata* Harmer, 1900
Serravallian, TF57, 'Stadion Reef 1', Samarinda.
Fig. 1. NHMUK PI BZ 6894. a, group of zooids; scale bar = 500 μm. b, B- and A-zooids; scale bar = 250 μm. c, A-zooid showing a partially preserved, anvil-shaped median process; scale bar = 100 μm. d, A- and B-zooids; scale bar = 250 μm.

Steginoporella sp.
Serravallian, TF57, 'Stadion Reef 1', Samarinda.
Fig. 2. NHMUK PI BZ 6895. a, group of zooids; scale bar = 200 μm. b, A- and B-zooids; scale bar = 250 μm.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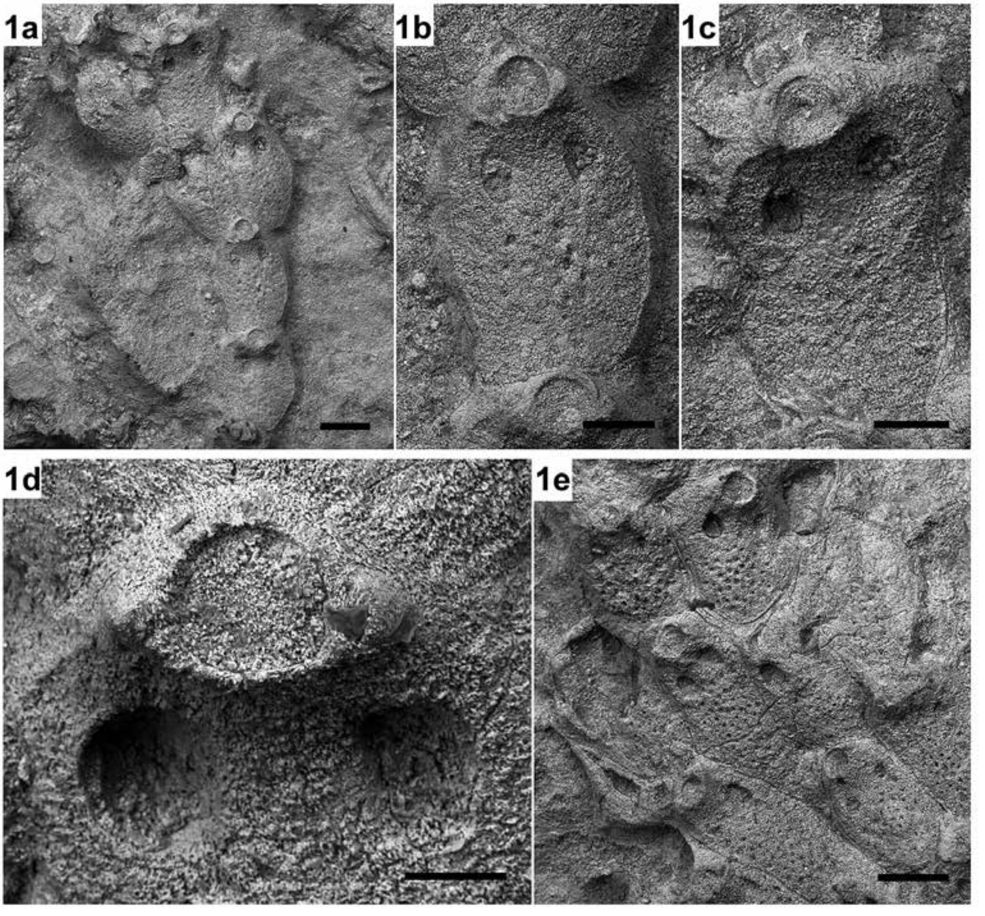

Plate 33

Thalamoporella sp.
Serravallian, TF76, 'Batu Putih 1', Samarinda.
Fig. 1. NHMUK PI BZ 6896. a, uniserial part of the colony; scale bar = 250 μm. b-c, autozooids; scale bar = 100 μm. d, orifice with adoral tubercles and suboral opesiules; scale bar = 40 μm. e, autozooids and ?avicularium (bottom left); scale bar = 250 μm.

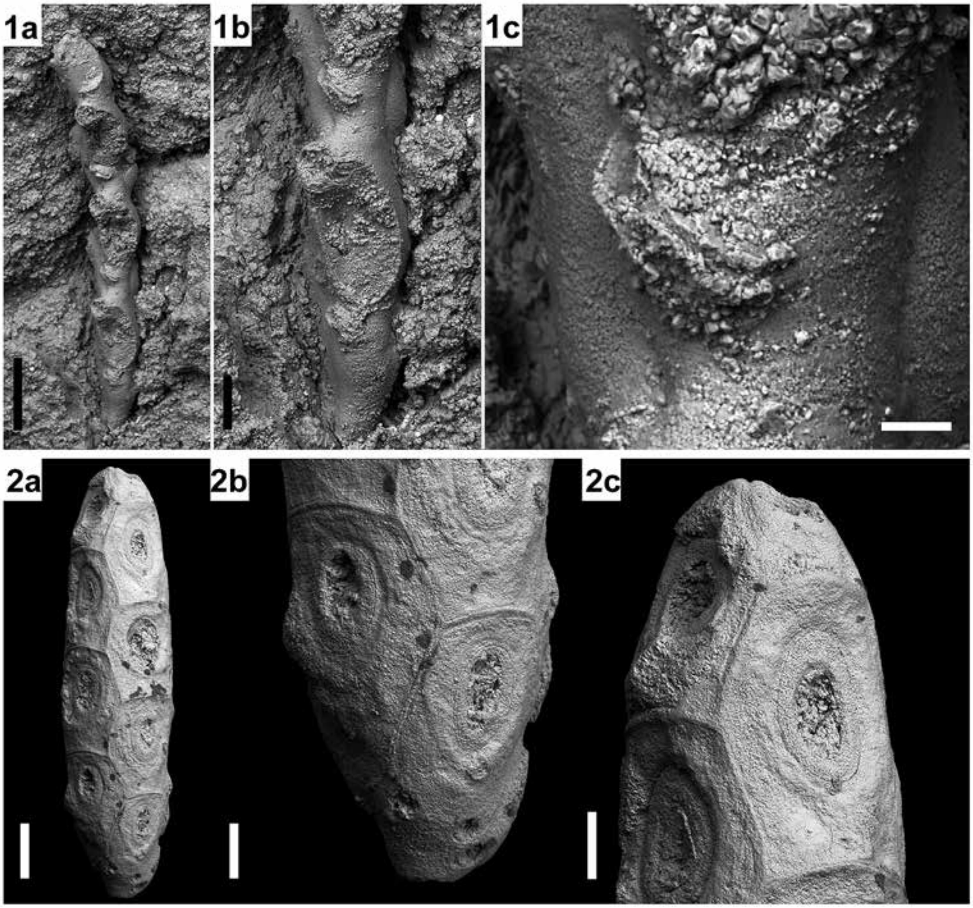

Plate 34

Poricellaria sp.
Burdigalian-Langhian boundary, TF153, 'Rainy Section', Bontang.
Fig. 1. NHMUK PI BZ 6897. a, frontal view of a branch fragment incidentally attached to the surface of a coral; scale bar = 200 μm. b, autozooid and adventitious avicularia; scale bar = 50 μm. c, avicularium; scale bar = 20 μm.

?*Encicellaria* sp.
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 2. NHMUK PI BZ 6898. a, spindle-shaped colony; scale bar = 250 μm. b, proximal tip with rhizoidal pores; scale bar = 100 μm. c, close-up of the distal tip with smaller autozooids; scale bar = 100 μm.

Table 1. Species listing with known range occurrences. OR = Older Range limit (of species or genus); TFR = Miocene range from 'Throughflow' samples (LB = late Burdigalian, B/L = Burdigalian Langhian boundary, L = Langhian, S = Serravallian, T = Tortonian, M = Messinian); YR = Younger Range limit (of species or genus).

Species	**OR**	**TFR**						**YR**
		LB	**B/L**	**L**	**S**	**T**	**M**	
Stomatopora sp.	Triassic	×						Recent
Voigtopora sp.	Cretaceous	×						?Recent
Filisparsa sp.	Cretaceous	×			×			Recent
Microeciella nadiae sp. nov.		×						
Oncousoecia sp.	Jurassic	×			×			Recent
Exidmonea sp.	Cretaceous	×						Recent
?*Mecynoecia* sp.	Jurassic				×			Recent
Hornera sp. 1	?				×			?
Hornera sp. 2	?				×			?
Pseudidmonea johnsoni sp. nov.				×				
Disporella sp. 1	?	×						?
Disporella sp. 2	?	×						?
Disporella sp. 3	?	×						?
Disporella sp. 4	?				×			?
'*Berenicea*' sp.		×			×			
Cranosina cf. *coronata*					×			Recent
Cranosina rubeni sp. nov.		×	×	×	×			
?*Crassimarginatella* sp.	Cretaceous	×			×			Recent
?*Flustrellaria* sp.	Cretaceous				×			Eocene
Parellisina cf. *tenuissima*					×			Recent
Parellisina mirellae sp. nov.					×			
Antropora granulifera			×					Recent
Antropora cf. *subvespertilio*		×			×			Recent
Parantropora laguncula					×			Recent
Parantropora aff. *laguncula*				×	×			Recent
Parantropora cf. *penelope*					×			Recent
Vincularia berningi sp. nov.		×	×	×	×	×	×	?
Vincularia semarai sp. nov.		×						?
Vincularia tjaki sp. nov.		×						?
Vincularia manchanui sp. nov.		×	×	×	×	×	×	?
Vincularia sp. 1		×						
'*Vincularia*' sp.	Cretaceous				×			Miocene
Setosellina cf. *constricta*					×			Recent
Setosellina cf. *roulei*					×			Recent
Reussirella sp.	Eocene				×			Recent
Gontarella? *sendinoae* sp. nov.				×				
Caberea sp.	Miocene	×			×			Recent
Canda giorgioi sp. nov.		×			×			
Canda federicae sp. nov.		×						
Scrupocellaria sp.	Eocene	×						Recent
Monoporella sp. 1	?	×						?
Monoporella sp. 2	?				×			?
Setosinella perfluxa		×						
Pyrisinellidae sp.	Cretaceous				×			Recent
Smittipora aff. *cordiformis*		×	×	×	×	×	×	Recent
Smittipora sp.	Cretaceous		×					Recent
Steginoporella cf. *truncata*					×			Recent
Steginoporella sp.	Eocene				×			Recent
Thalamoporella sp.	Eocene				×			Recent
Poricellaria sp.	Eocene		×					Recent
?*Encicellaria* sp.	Cretaceous	×						