POLISH POLAR RESEARCH
vol. 23, no. 3–4, pp. 213–225, 2002

A new macroporid bryozoan from Eocene of Seymour Island, Antarctic Peninsula

Urszula HARA

Państwowy Instytut Geologiczny, Rakowiecka 4, 00-975 Warszawa, Poland
<uhar@pgi.waw.pl>

ABSTRACT: A few specimens of a macroporid bryozoan were collected, from the Eocene La Meseta Formation from Seymour (Marambio) Island, Antarctic Peninsula. Based on the morphology of the studied specimens *Macropora antarctica* sp. n. has been erected. This is the stratigraphically oldest species of the genus which exhibits a number of similarities with the Tertiary fossils and some Recent macroporids reported from the Southern Hemisphere *i.e.* Australia, New Zealand, and South America.

Key words: Antarctica, La Meseta Formation (Eocene), paleontology (Bryozoa), new species.

Introduction

During the 1993–1994 Argentine-Polish field party to the Antarctic Peninsula, an extensive and superbly preserved bryozoan fauna, including several multilamellar macroporid colonies, were collected by A. Gaździcki from the lowermost facies (Telm1) of the La Meseta Formation of Seymour Island (Fig. 1). The bryozoans, composed mostly of large-sized, massive and multilamellar colonies, are a significant element of the rich La Meseta biota and they represent one of the most diverse and spectacular bryozoan assemblage known from the Eocene, containing 30 genera and 43 species (Hara 1998, 2001).

One interesting genus is *Macropora*, found in Tertiary deposits of Australia and New Zealand as well as in South America (MacGillivray 1895, Maplestone 1901, Canu 1908, Uttley 1949, Brown 1952, 1958). The earliest representatives of *Macropora* were mentioned from the Late Eocene of North America by Canu and Bassler (1920), but it seems doubtful if these two fossil species were appropriately placed in this genus (see also López de la Cuadra and Garcia Gómez 1997). *Macropora* comprises a group of apparently very similar species which has been a subject of controversy due to some anatomical particularies and incompletness of

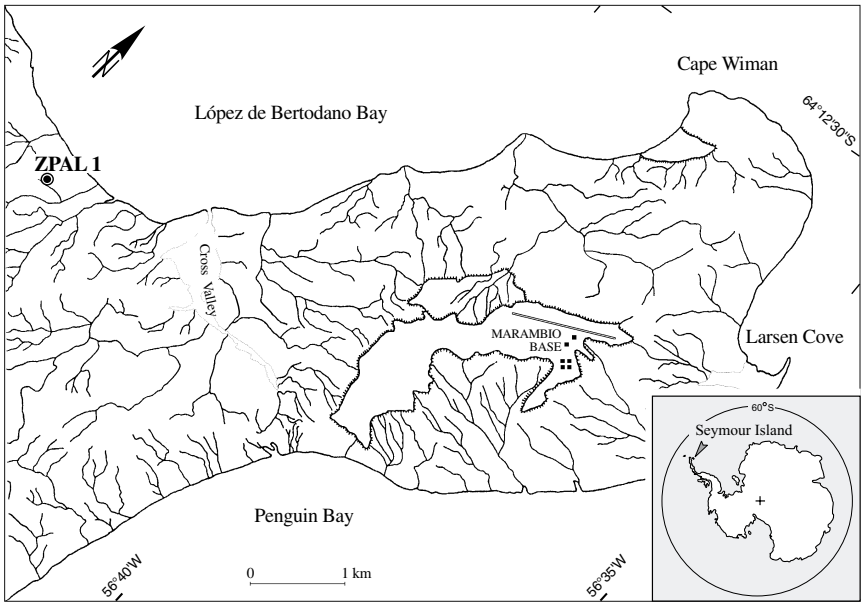


Fig. 1. Morphologic sketch-map of the northern part of Seymour Island showing the locality ZPAL 1 (*Bill Hill*) from which the bryozoan *Macropora antarctica* sp. n. was collected.

the material studied (Gordon 1984, López de la Cuardra and Garcia Gómez 1997). This genus with a long fossil history survives today in the western Pacific region; however, it also occurs in the South Atlantic Ocean, showing its circumtemperate southernmost distribution (López de la Cuadra and Garcia Gómez 1997).

Examination of relatively well-preserved *Macropora* specimens from Eocene of Seymour Island using scanning electron microscopy has revealed some distinctive morphological features which separate the new species from the other described macroporids. The trend in the evolution of *Macropora* to an extreme enlargement of the ovicell at the expanse of the succeeding zooecium which has an operculum, and undivided diatellae, was observed among a few fossil species of *Macropora* such as *M. waimatukuensis, M. cribrilifera* and *M. operculata* from the Tertiary of Australia, New Zealand and South America (Maplestone 1901, Canu 1908, Uttley 1949), as well as occasionally in the Recent New Zealand species *Macropora grandis* Hutton (Gordon 1984). The striking affinity between the fossil macroporid bryozoan from the La Meseta Formation and Recent *Macropora grandis* (Hutton) from New Zealand (Gordon 1984, see also Uttley and Bullivant 1972) and partly with *M. africana* Hayward and Cook (see Hayward and Cook 1983) may prove that a distinctive bryozoan fauna developed in Antarctic waters as early as the late Early Eocene and that evidence of this fauna persisted into Recent times. This is the first and stratigraphically oldest fossil record of *Macropora* from the Lower Eocene of Antarctica which emphasizes a biogeographical link with adjacent Southern Hemisphere regions.

All macroporid specimens described and illustrated in this paper are deposited at the Institute of Paleobiology of the Polish Academy of Sciences, Warszawa (Poland) under the catalogue number ZPAL Br. VIII.

Geological setting

The La Meseta Formation (Rinaldi *et al*. 1978; Elliot and Trautman 1982), exposed in the northern portion of Seymour Island, represents part of an 800 m thick sequence of weakly consolidated marine sandstone, siltstones, and claystones and preserves an exceptional record of Eocene life among which bryozoans are a significant component (Feldmann and Woodburne 1988, Sadler 1988, Stilwell and Zinsmeister 1992, Baumiller and Gaździcki 1996, Bitner 1996, Stolarski 1996, Gaździcki 1998, Hara 2001). The La Meseta Formation is subdivided into seven lithofacies (Telm1–Telm7); see Sadler (1988). The richest bryozoan-bearing horizon, from where the studied specimens of *Macropora* were collected, was recognized in the lowermost unit (Telm1) and crops out south of the Cross Valley (South Section) at locality ZPAL 1 (*Bill Hill*; see Fig. 1). Abundant bryozans in Telm1 occur within a 2 m thick interval of the basal transgressive facies (Gaździcki and Hara 1994, Hara 2001), represented by grey to red-brown limonitic sandy siltstones, sandstones and pebble conglomerates at this locality. The relationship between colony-form, growth pattern, inferred associated biota and sedimentary structure point to a nearshore, shallow-marine-estuarine, wave-dominated environment for the La Meseta Formation (Feldmann and Woodburne 1988, Stilwell and Zinsmeister 1992, 1996; Porębski 1995, 2000; Gaździcki 1996, Marenssi *et al*. 1998, Szczechura 2001, Myrcha *et al.* 2002). The age of the lower part of the formation on the basis of dinoflagellates is late Early Eocene (Wrenn and Hart 1988, Cocozza and Clarke 1992).

Systematic paleontology

Suborder Flustrina Smitt, 1868
Superfamily Microporoidea Gray, 1848
Family Macroporidae Uttley, 1949
Genus *Macropora* MacGillivray, 1895

Type species: *Macropora centralis* MacGillivray, 1895.

Macropora antarctica sp. n.
(Figs 2–5)

2001. *Macropora* sp.; Hara: p. 41.

Holotype: Specimen ZPAL Br.VIII/506, illustrated on Figs 2: 1a–b, 3: 1a–c, 4: 2a–b; 5: 1a–c.

Type horizon: Telm1, La Meseta Formation; Eocene.

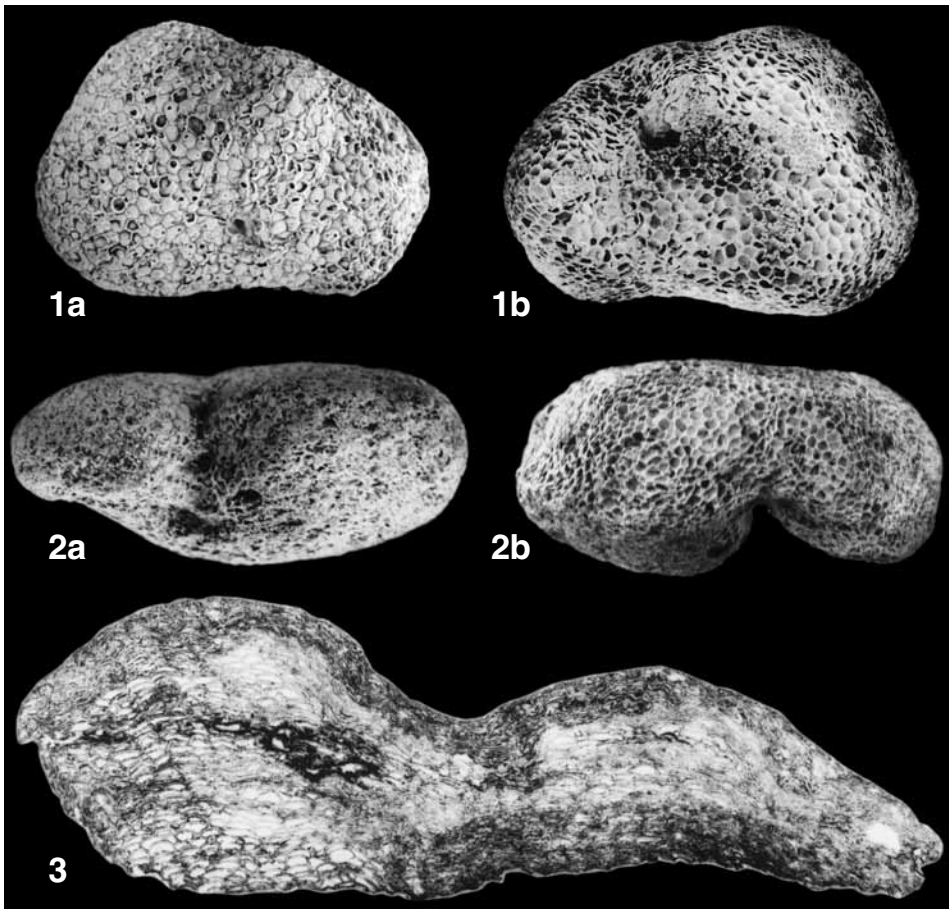
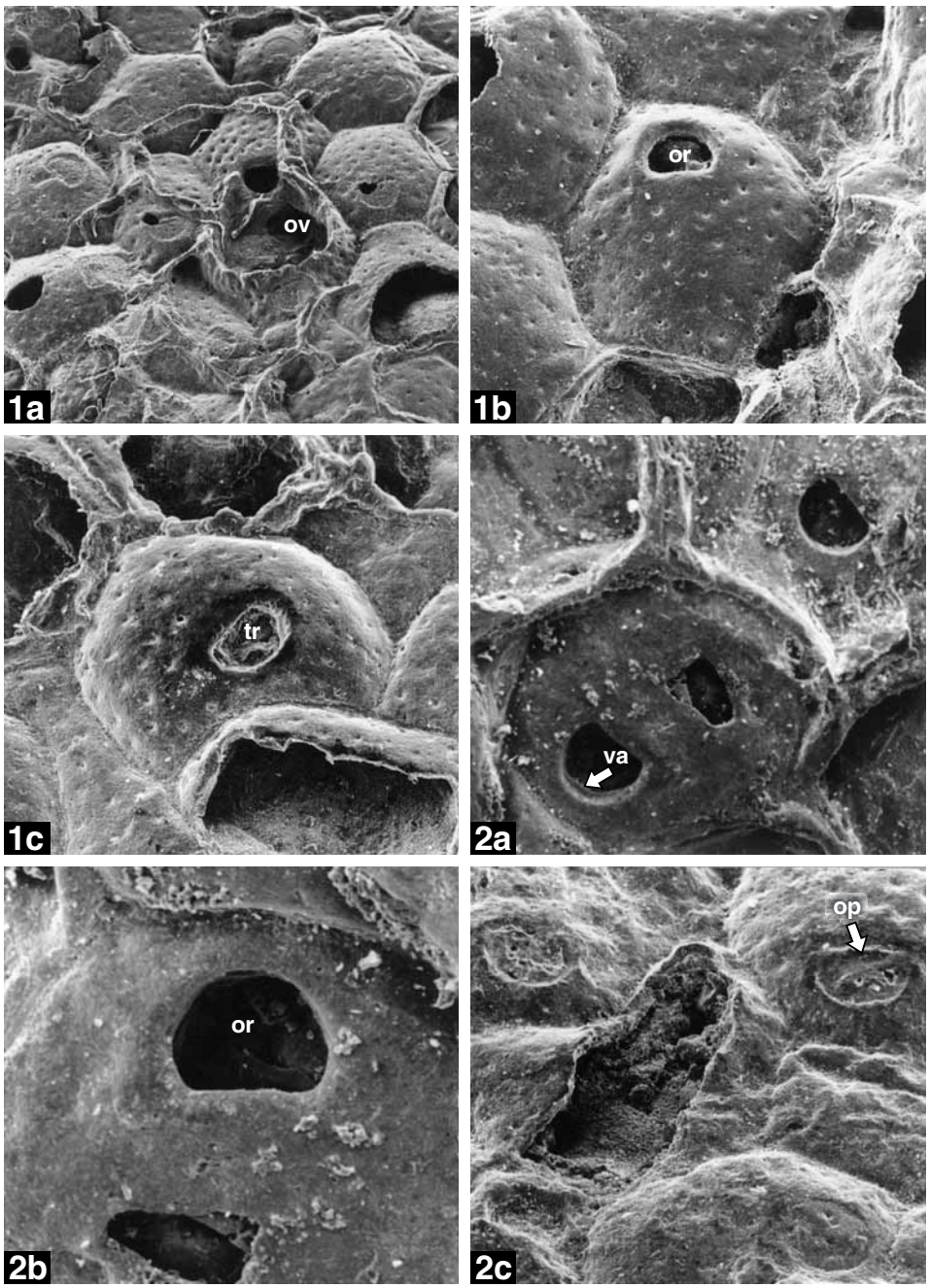


Fig. 2. *Macropora antarctica* sp. n. **1a**. Upper view of the disc-shaped, multilamellar colony, showing chaotically arranged autozooecia, × 2.5. **1b**. Underside of the same colony, slightly concave, showing the inner side of zooecia, × 2.5, ZPAL Br. VIII/506. **2a**. Upper view of the thick, multilamellar colony, × 2. **2b**. Underside of the same colony, × 2, ZPAL Br. VIII/507. **3**. Vertical section through the multilamellar colony, showing the superimposed zooecial layers, × 4, ZPAL Br. VIII/508. ZPAL 1, Telm1, La Meseta Formation (Eocene), Seymour Island.

Type locality: ZPAL 1 (*Bill Hill),* Seymour Island, Antarctic Peninsula.
Derivation of the name: Referring to Antarctica.

Diagnosis. — Colony massive, multilamellar. Autozooecia irregularly hexagonal, possessing semicircular or trapezoidal orifice. Dietellae non-divided, large

Fig. 3. *Macropora antarctica* sp. n. **1a**. General pattern of arrangement of autozooecia, showing some of zooecia with operculum. A broken ovicell (ov) placed in the central part of the colony, showing non-operculate maternal zooecium, × 20. **1b**. Autozooecium with scattered large pores, semicircular orifice (or), surrounded by neighbouring broken zooecia, × 40. **1c**. Zooecium, showing the trape- →



zoidal orifice (tr) surrounded by the broken zooecia, × 50, ZPAL Br. VIII/506. **2a**. Zooecium, showing a very narrow vestibular arch (va) and well-marked zooecial margins, × 50. **2b**. Zooecium showing a non-operculate orifice (or), × 100. **2c**. Group of differently oriented zooecia covered by operculum (op), which are pierced by a few pores, × 54, ZPAL Br. VIII/507. ZPAL 1, Telm1, La Meseta Formation (Eocene), Seymour Island.

and rare, placed laterelly. Ovicell large, recumbent, resting on the succeeding operculated zooecium, an operculum of the maternal zooecium lacking.

Material. — Three nodular, multilamellar colonies of different shape. The zoarial surface is slightly worn. The convex frontal wall of some autozooecia is broken and some of them have holes and fractures of varying morphology.

Dimensions. — Colony length (mean) – 27 mm, colony width (mean) 13 mm; autozooecium length 0.84–1.2 mm, autozooecium width 0.84–1.0 mm; orifice length 0.24–0.32 mm, orifice width 0.16–0.20 mm.

Description. — Colonies are massive, multilamellar, forming a variably shaped zoarium ranging from disc-shaped to more often mushroom-shaped (Fig. 2: 1–2). Autozooecia large, chaotically arranged, irregularly hexagonal in shape, distinctly separated by raised margins (Fig. 3: 1c, 2a). There is also a number of smaller, elongate zooecia interspersed amongst the usual hexagonal forms (Fig. 2: 1a). Frontal wall convex, perforated by numerous large pores (Fig. 3: 1, 2c). Two different shapes of orifice occur among zooecia; the majority possess a D-shaped, semicircular orifice, vestibular arch very narrow or lacking with a straight proximal oral shelf (Fig. 3: 2a). Operculum thick, calcareous, granular, sometimes pierced by a few pores (Fig. 3: 2c), its lower surface with a semicircular ridge and arched, distally placed marginal sclerites (Fig. 5: 1a–b). Autozooecia without oral spines. Zooecia with a trapezoidal shape of orifice are relatively rare. The orifice has a raised distal margin, sinuate and narrower distally, slightly longer than wide (Figs 3: 1c; 4: 1). On the inner side, the operculum of trapezoidal orifice bears two lateral marginal sclerites which are straight and parallel to the side of the operculum (Fig. 5: 1c). Basal pore chambers (dietellae) large, visible in distal part of zooecium, situated laterally at the growing margin, occasionally not divided (Fig. 4: 2b). Ovicell recumbent, large, broken, without its frontal wall, 1.0 mm wide and 0.87 mm long, globular in shape, slightly wider than long, its distal part resting on succeeding zooecium which has an operculum (Fig. 4: 2a). Maternal zooecium without an operculum (Fig. 4: 2a). Zoarium composed of a series of many superimposed zooecial layers, seen in vertical section (Fig. 2: 3).

Remarks. — Based on Gordon's (2001) classification, the genus *Macropora* has been included in the family Macroporidae Uttley, 1949 *incertae sedis* with respect to the superfamily Microporidae in which it is usually included. This uncertainty arises from the unusual frontal wall in *Macropora* in which the apparent pseudopores are actually opesiules transversed by muscles for the operation of the hydrostatic system (Banta *et al.* 1997). One problem concerning *Macropora* has been uncertainty concerning the type species, *M. centralis* MacGillivray, 1895.

Zooecial dimorphism is almost universally present in Recent and Tertiary Macroporidae as a characteristic feature of many New Zealand species (Uttley 1949, Gordon 1984; see also Harmer 1900). The specimens from Seymour Island

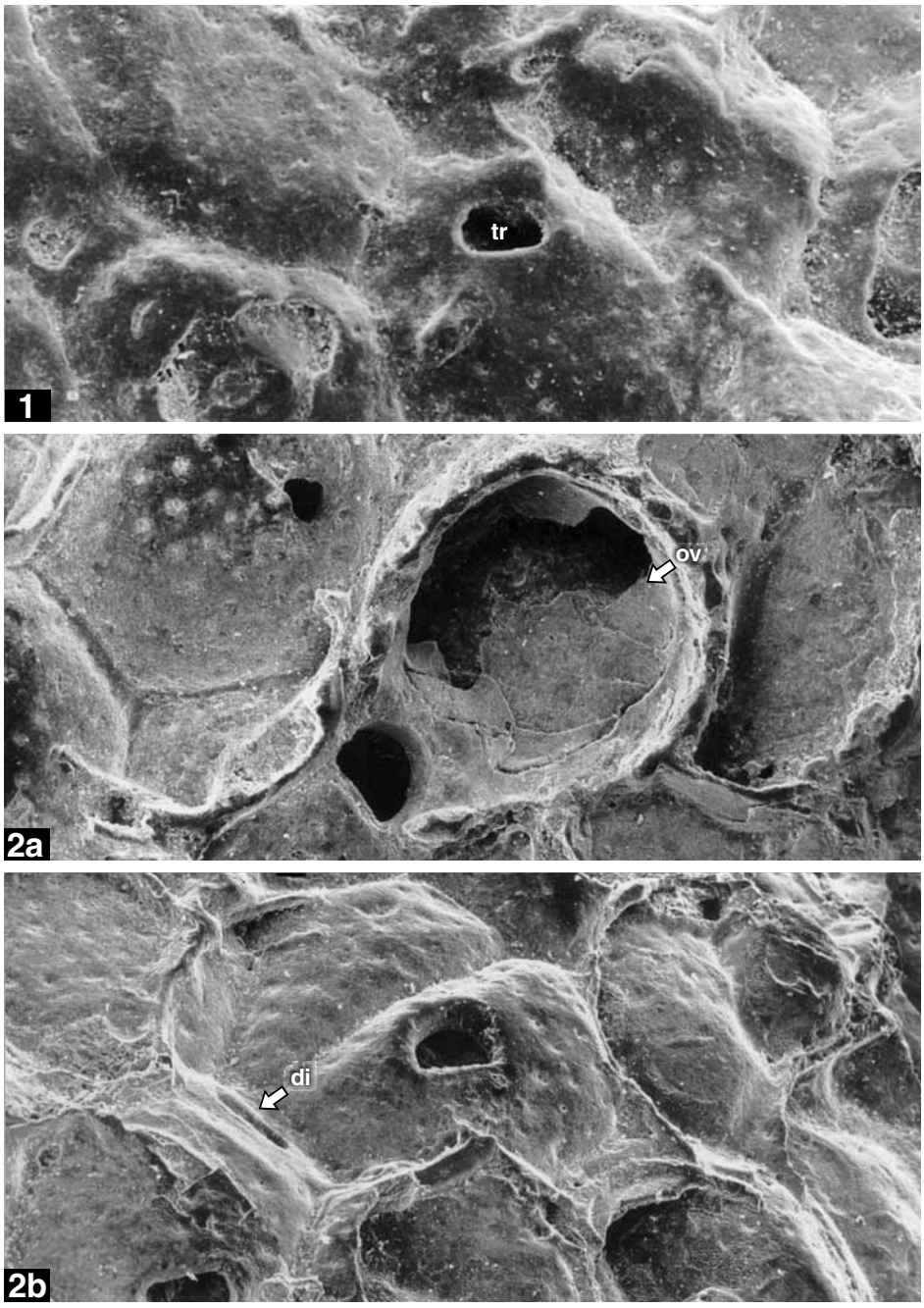


Fig. 4. *Macropora antarctica* sp. n. **1**. Zooecium with trapezoidal-shaped orifice (tr), × 50; ZPAL Br. VIII/507. **2a**. Broken recumbent ovicell (ov) showing, a non-operculated maternal zooecium, resting on the succeeding one, which has an operculum, × 50. **2b**. Zooecium showing not divided dietellae (di) along the growing margin, × 36, ZPAL Br. VIII/506. ZPAL 1, Telm1, La Meseta Formation (Eocene), Seymour Island.

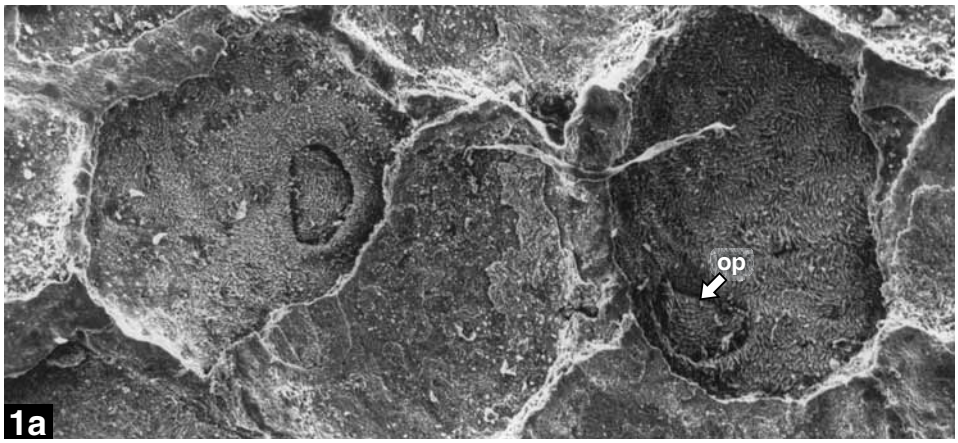
seems to be somewhat polymorphic, especially because the orifices of the zooecia differ in shape, being either semicircular or trapezoidal (see Figs 3: 1b–c; 4: 1a). Trapezoidal zooecia occur in a minority in comparision with semicircular or D-shaped zooecia. Brown (1952) regarded them as avicularia as evidently did Uttley (1949), who called them „B" zooecia, after the terminology of Harmer (1900) with regard to *Steginoporella* (see also Uttley 1949, pl. 39; 1–2; Gordon, 1984, pl. 17: D–F). Hayward and Cook (1983) called them vicarious avicularia.

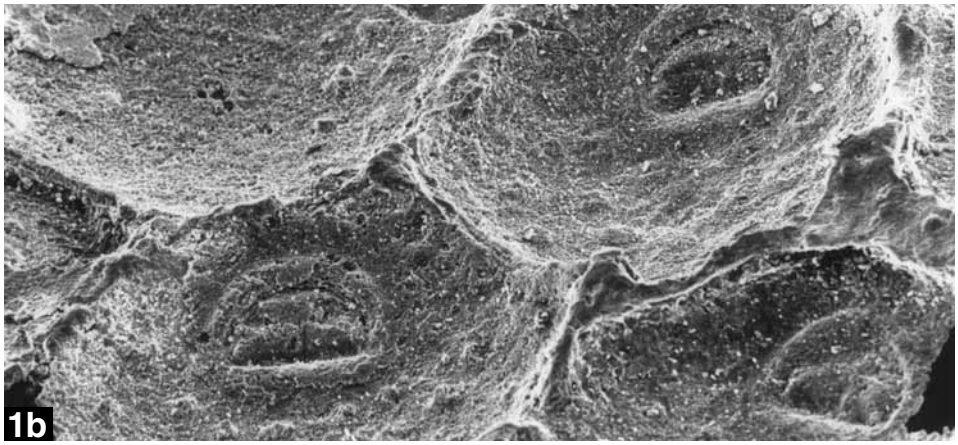
Ovicells are generally scarce in species of *Macropora.* According to Gordon (1984) they should be regarded as a modified recumbent type. Brown (1958) noted that in some other species of *Macropora* the ovicell is actually recumbent, resting on the distal part of zooecium which retains its ovicell. The newly described specimens possess a recumbent ovicell which rests on the succeeding zooecium, but does not occupy all the volume of the succeeding zooecium which has an operculum, however, the operculum in the maternal zooecium is lacking (see Fig. 4: 2a). This feature separates many other species of *Macropora* from *M. antarctica* sp. n. from Seymour Island, however *Macropora grandis* (Hutton) described by Gordon (1984, p. 57, pl. 17: E) shares this feature with the specimen studied (Fig. 4: 2a). Contrary, the same species studied by Brown (1952, p. 135–136) possesses an ovicellular orifice on the proximal slope of the chamber which is closed by the zooecial operculum. Brown (1952) has noted that the operculum in *Macropora grandis* is very stout and thick, and is easily detached without fracture from both fossil and Recent specimens but not all opercula are preserved. For example some zooecia of the specimens studied have an operculum and some are without it (see Fig. 3). In spite of many features which show similarities between *M. grandis* (Hutton) and *M. antarctica* sp. n., the newly described species from Seymour Island shows a different outline of the avicularian orifice as well as a different pattern in the arrangement of the dietellae. The type species, *M. centralis* MacGillivray occurs in the Lower Miocene of Victoria, Australia (see Hayward and Cook 1983).

In some *Macropora* species like *M. operculata* Canu 1908 and *M. africana* Hayward and Cook, 1983 (p. 33–34, fig. 5: C–F), the ovicell is very large and common and supported by a zooecium, but does not occupy all the space of the succeeding zooecium, which has an operculum, as in fossil species like *M. waimatukuensis* Uttley, 1949 (pl. 37, figs 1, 2) and *M. cribrilifera* Maplestone, 1901.

Macropora africana differs from the specimens studied in the different appearance of the avicularia and in possessing an operculum in the maternal zooecium.

The newly described material found on South Georgia Island, *Macropora georgiensis* López de la Cuadra and Garcia Gómez, 1997, is similar to the specimen studied in having dietellae not divided, in the general appearance of the zooecia, a similar outline of the inner operculum sclerites, and in possessing a vestibular arch, which in both species is very narrow and sometimes much reduced. Generally, the vestibular arch is very large in some Pacific species. The basic difference between *M. antarctica* sp. n. and *M. georgiensis* lies in the development of





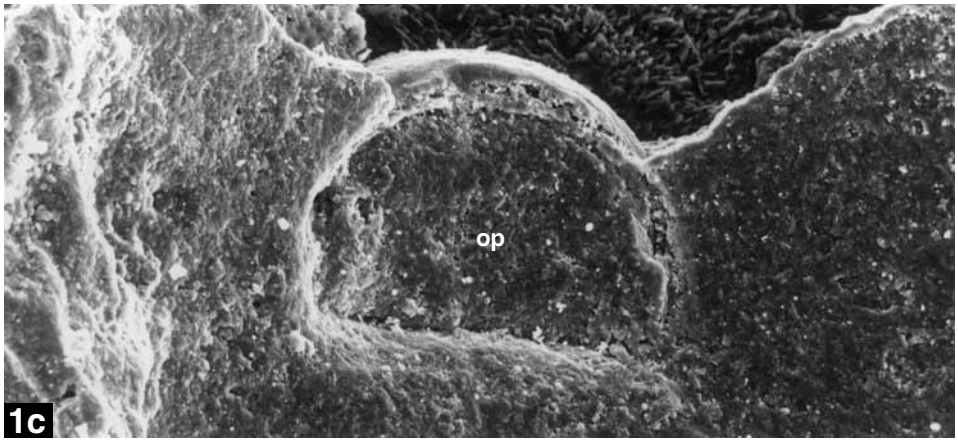


Fig. 5. *Macropora antarctica* sp. n. **1a**. Underside of the zoarium, showing the inner side of the zooecia with operculum (op), × 60. **1b**. Group of zooecia, showing operculate orifices from the inner side, with the slightly marked outline of the arched proximal and distal sclerites, × 75. **1c**. Operculum from the inner side (op), showing two lateral marginal sclerites, × 200, ZPAL Br. VIII/506. ZPAL 1, Telm1, La Meseta Formation (Eocene), Seymour Island.

the ovicell, where the supporting zooecium is fully degenerated into a kenozooecium, and in a different pattern of the distribution of the dietellae. *Macropora operculata* Canu, 1908 (p. 286, pl. 9: 3,4) from the Lower Miocene of Patagonia (Argentina), bears a close resemblance to the La Meseta specimens in having dietellae not divided; however the autozooecial openings and sizes of zooecia of *M. operculata* are much smaller than those of *Macropora antarctica* sp. n.

Occurrence. — Seymour Island, La Meseta Formation: ZPAL 1 (*Bill Hill*), Telm1, (Eocene).

Concluding remarks

The majority of the La Meseta bryozoans including *Macropora antarctica* sp. n. show multilamellar colony growth which appears to have been regularly developed by many different taxa throughout the Tertiary. Most Recent *Macropora* species, however, have a unilamellar colony form. According to Lidgard (1985) and McKinney and Jackson (1989) multilamellar growth represents a more complex colonial type than unilamellar colony form. It may be concluded that the multilamellar colony form of *Macropora antarctica* sp. n. from Seymour Island, which represents the oldest fossil record of the genus, may be an ancestral form related to *Macropora* species from New Zealand and Australia (see also López de la Cuadra and Garcia Gómez 1997).

From a zoogeographical point of view, most Lower Oligocene–Pliocene and Holocene Macroporidae are found in the Western Pacific, mainly in the area of Eastern Australia, New Zealand, the Loyalty and Philippine Islands (MacGillivray 1895, Maplestone 1901, Uttley 1949, Brown 1952, 1958). Comparing past and Holocene distributions, Pacific macroporids seem to have disappeared from Australian coasts, nowadays being distributed in the north of New Zealand, Loyalty Islands and Philippines (Gordon 1984, López de la Cuadra and Garcia Gómez 1997).

Macropora antarctica sp. n, marks the oldest stratigraphical record similar to many other genera of cyclostomes and cheilostomes on Seymour Island, including *Calvetia*, *Borgella*, *Neofungella*, *Paracellaria, Smittina, Smittoidea, Celleporaria, Cellarinella, Metroperiella, Aimulosia, Osthimosia, Reteporella* and *Rhynchozoon* (Hara 2001). The similarity between the bryozoan macroporid from the La Meseta Formation and Recent *Macropora* from the New Zealand, Africa and South America may prove that a distinctive bryozoan fauna developed in Antarctic waters as early as the late Early Eocene and that evidence of this fauna has persisted into Recent times.

The relatively rare fossil record of *Macropora* accentuates the circumtemperate southern distribution showing the biostratigraphical links and a marked faunal affinity between southern South America, Antarctica and the New Zea-

land-Australian realm, also expressed in a number of similarities among Tertiary fossil macroporid faunas.

Most probably the migration of the bryozoan fauna occurred within a distinctive, decidedly temperate, Weddellian Province along the Pacific margins of southermost South America, West Antarctica, New Zealand and south-eastern Australia, persisting until at least the late Eocene epoch. At this time there was no discernible gradient in taxonomic diversity from either southernmost South America or Australasia into Antarctica (Case 1989, Crame 1999).

It is noteworthy that the major Paleocene–Eocene turnover, followed by a rapid increase in generic richness, is marked by a great diversity of new cheilostomes in the bryozoan assemblage of the La Meseta Formation (Hara 2001). The taxonomic composition of the late Early Eocene bryozoans from Seymour Island suggests that the Antarctic region was an important place of origin of many new bryozoan taxa from where they migrated northwards, as has other biota, before the developement of the circum-Antarctic current in the Oligocene (Zinsmeister and Feldmann 1984, Crame 1986, 1992, 1994; Feldmann and Woodburne 1988, Gaździcki 1996, Hara 2001).

Acknowledgements. — Many thanks are due to Professor Dr. Andrzej Gaździcki (Institute of Paleobiology, Warszawa), for giving me an access to the studied bryozoan specimens as well as for useful remarks on the manuscript. This paper has benefited considerably from the reviews of Dr. Dennis P. Gordon (National Institute for Water and Atmospheric Research – NIWA, Wellington) and Professor Dr. Norbert Vávra (Universität, Wien) for which I am very thankful to them. I am also sincerely grateful to Dr. Carlos M. López de la Cuadra (Universidad de Sevilla) for helpful discussion during the preparation of this paper. I should like to thank Dr. Janusz Błaszyk for the kind assistance providing with the scanning electron micrography and Mr. Zbigniew Strąk (both from the Institute of Paleobiology, Warszawa) for making thin-sections. I would like to express my warm thanks to Ms Barbara Ruszkiewicz and Ms Anna Nowicka (Polish Geological Institute, Warszawa) for their effort in preaparing photographs of the specimens.

References

BANTA W.C., GRAY N. and GORDON D.P. 1997. A cryptocystal operculum and a new method of lophophore protrusion in the cheilostome bryozoan *Macropora levinseni*. — Invertebrate Biology, 116: 161–170.

BAUMILLER T. and GAŹDZICKI A. 1996. New crinoids from the Eocene La Meseta Formation of Seymour Island, Antarctic Peninsula. *In*: A. Gaździcki (ed.) *Palaeontological Results of the Polish Antarctic Expeditions. Part II*. — Palaeontologia Polonica, 55: 101–116.

BITNER M.A. 1996. Brachiopods from the Eocene La Meseta Formation of Seymour Island, Antarctic Peninsula. *In*: A. Gaździcki (ed.) *Palaeontological Results of the Polish Antarctic Expeditions. Part II*. — Palaeontologia Polonica, 55: 65–100.

BROWN D.A. 1952. *The Tertiary Cheilostomatous Polyzoa of New Zealand*. Trustees of the British Museum (Natural History), London; 405 pp.

BROWN D.A. 1958. Fossil cheilostomatous Polyzoa from south-west Victoria. — Memoires of the Geological Survey of Victoria, 20: 1–83.

CANU F. 1908. Iconographie des Bryozoaires fossiles de l'Argentine premiere partie. — Annales Museo National Buenos Aires, 3: 245–341.

CANU F. and BASSLER R.S. 1920. North American Early Tertiary Bryozoa. — United States National Museum, Bulletin, 106: 1–879.

CANU F. and BASSLER R.S. 1929. Bryozoa of the Philippine region. — Smithsonian Institut of the United States Natural Museum Bulletin, 100: 1–685.

CASE, J.A. 1989. Antarctica: the effect of high latitude heterochroneity on the origin of the Australian marsupials. *In*: J.A. Crame (ed.) *Origins and Evolution of the Antarctic Biota*. — Geological Society Special Publication, 47: 217–226.

COCOZZA C.D. and CLARKE C.M. 1992. Eocene microplankton from La Meseta Formation, northern Seymour Island. — Antarctic Science, 4: 355–362.

CRAME J.A. 1986. Polar origins of the marine invertebrate faunas. — Palaios, 1: 616–617.

CRAME J.A. 1992. Evolutionary history of the polar regions. — Historical Biology, 6: 37–60.

CRAME J.A. 1994. Evolutionary history of Antarctica. *In*: G. Hempel (ed.) *Antarctic Science Global Concerns*. Springer-Verlag, Berlin-Heidelberg; 188–214.

CRAME J.A. 1999. An evolutionary perspective on marine faunal connections between southernmost South America and Antarctica. *In*: W.E. Arntz and C. Rios (eds). *Magellan-Antarctic Ecosystems that drifted apart*. Scientia Marina, 63 (sup. 1) Institut de Ciencias del Mar, C.S.I.C. Barcelona; 1–14.

ELLIOT D.H. and TRAUTMAN T.A. 1982. Lower Tertiary strata on Seymour Island, Antarctic Peninsula. *In*: C. Craddock (ed.) *Antarctic Geoscience*. The University of Wisconsin Press, Madison; 287–297.

GORDON D.P. 1984. The marine fauna of New Zealand: Bryozoa: Gymnolaemata from the Kermadec Ridge. — New Zealand Oceanographic Institute, Memoir, 91: 1–198.

GORDON D.P. 2001. Genera and subgenera of Cheilostomata. INTERIM Classification (Working Classification for Treatise). Unpublished; pp. 1–13.

FELDMANN R.M. and WOODBURNE M.O. (eds) 1988. *Geology and Paleontology of Seymour Island, Antarctic Peninsula*. — Geological Society of America, Memoir, 169: 1–556.

GAŹDZICKI A. (ed.) 1996. *Palaeontological Results of the Polish Antarctic Expeditions. Part II*. Palaeontologia Polonica, 55: 1–192.

GAŹDZICKI A. 1998. Eocene biota and paleoenvironment of Seymour Island, Antarctica. — Kosmos, 47: 417–424.

GAŹDZICKI A. and HARA U. 1994. Multilamellar bryozoan colonies from the Eocene La Meseta Formation of Seymour Island, Antarctica: a preliminary account. *In*: K. Birkenmajer (ed.) *Geological Results of the Polish Antarctic Expeditions. Part X*. — Studia Geologica Polonica, 104: 105–116.

HARA U. 1998. Cenozoic bryozoans of West Anatrctica. — Kosmos, 47: 431–438.

HARA U. 2001. Bryozoa from the Eocene of Seymour Island, Antarctic Peninsula. *In*: A. Gaździcki (ed.), *Palaeontological Results of the Polish Antarctic Expeditions, Part III*. — Palaeontologia Polonica, 60: 33–156.

HARMER S.F. 1900. A revision of the genus *Steganoporella*. — Quarterly Journal of Microscopical Science (n.s.), 43: 225–297.

HAYWARD P.J. and COOK P.L. 1983. The South African Museum's Meiring Naude Cruises. Part 13. Bryozoa II. — Annales of the South African Museum, 9: 1–161.

MACGILLIVRAY P.H. 1895. A monograph of the Tertiary Polyzoa of Victoria. — Transactions of the Royal Society of Victoria (n.s.), 4: 1–166.

LIDGARD S. 1985. Zooid and colony growth in encrusting cheilostome bryozoans. — Palaeontology, 28: 255–291.

LÓPEZ DE LA CUADRA C.M. and GARCIA GÓMEZ, J.C. 1997. Studies on Recent Macroporidae (Bryozoa: Cheilostomata) with a new taxa and ontogeny of the ovicells. — Journal of the Zoology, London, 242: 605–621.

MAPLESTONE C.M. 1901. Further descriptions of the Tertiary Polyzoa of Victoria, V. — Proceedings of the Royal Society of Victoria (n.s.), 13: 183–219.

MARENSSI S.A., SANTILLANA S.A. and RINALDI C.A. 1998. Stratigraphy of the La Meseta Formation (Eocene), Marambio (Seymour) Island, Antarctica. Asociatión Paleontológica Argentina, Publicación Especial 5. *Paleógeno de América del Sur y de la Península Antártica*; 137–146.

MCKINNEY F.K. and JACKSON J.B.C. 1989. *Bryozoan evolution,* Unwin Hyman, London; 238 pp.

MYRCHA A., JADWISZCZAK P., TAMBUSSI C., NORIEGA J.I., GAŹDZICKI A., TATUR A. and DEL VALLE R. 2002. Taxonomic revision of Eocene Antarctic penguins based on tarsometatarsal morphology. — Polish Polar Research, 23: 5–46.

PORĘBSKI S.J. 1995. Facies architecture in a tectonically-controlled incised-valley estuary: La Meseta Formation (Eocene) of Seymour Island, Antarctic Peninsula. *In*: K. Birkenmajer (ed.) *Geological Results of the Polish Antarctic Expeditions. Part XI*. — Studia Geologica Polonica, 107: 7–97.

PORĘBSKI S.J. 2000. Shelf-valley compound fill produced by fault subsidence and eustatic sea-level changes, Eocene La Meseta Formation, Seymour Island, Antarctica. — Geology, 28: 147–150.

RINALDI C.A., MASSABIE A., MORELLI J., ROSENMAN H.L. and DEL VALLE R. 1978. Geologia de la isla Vicecomodoro Marambio. — Contribuciones Cientificas del Instituto Antártico Argentino, 217: 5–43.

SADLER P. 1988. Geometry and stratification of uppermost Cretaceous and Paleogene units of Seymour Island, northern Antarctic Peninsula. *In*: R.M. Feldmann and M.O. Woodbourne (eds) *Geology and Paleontology of Seymour Island, Antarctic Peninsula.* — Geological Society of America, Memoir, 169: 303–320.

STILWELL J.D. and ZINSMEISTER W.J. 1992. Molluscan systematics and biostratigraphy, Lower Tertiary La Meseta Formation, Seymour Island, Antarctic Peninsula. — Antarctic Research Series, 55: 1–192.

STOLARSKI J. 1996. Paleogene corals from Seymour Island, Antarctic Peninsula. *In*: A. Gaździcki (ed.) *Palaeontological Results of the Polish Antarctic Expeditions. Part II*. — Palaeontologia Polonica, 55: 51–63.

SZCZECHURA J. 2001. Ostracods from the Eocene of Seymour Island, Antarctic Peninsula. *In*: A. Gaździcki (ed.), *Palaeontological Results of the Polish Antarctic Expeditions, Part III*. — Palaeontologia Polonica, 60: 33–156.

UTTLEY G.H. 1949. The Recent and Tertiary Polyzoa (Bryozoa) in the collection of the Canterbury Museum, Christchurch. Part I. — Records of the Canterbury Museum, 5: 167–192.

UTTLEY G.H. and BULLIVANT J.S. 1972. Biological results of the Chatham Islands 1954 Expedition. Part 7. Bryozoa Cheilostomata. — N.Z. Oceanographic Institute Memoir, 57: 61 pp.

WRENN J. H. and HART G. F. 1988. Paleogene dinoflagellate cyst biostratigraphy of Seymour Island, Antarctica. *In*: R.M. Feldmann and M.O. Woodburne (eds) *Geology and Paleontology of Seymour Island, Antarctic Peninsula*. — Geological Society of America, Memoir, 169: 321–447.

ZINSMEISTER W.J. and FELDMANN R.M. 1984. Cenozoic high latitude heterochroneity of Southern Hemisphere marine faunas. — Science, 224: 281–283.

Received March 5, 2002
Accepted May 24, 2002