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Brachiopods from the Chlamys Ledge Member (Polonez Cove Formation, Oligocene) of King George Island, West Antarctica

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Abstract: Brachiopods from the Chlamys Ledge Member, uppermost part of the Polonez Cove Formation (Oligocene), of King George Island, West Antarctica are represented by the undeterminable Rhynchonellida, one short-looped terebratulide *Liothyrella* Thomson, and two long-looped terebratellidines: *Rhizothyris* Thomson and Terebratelloidea gen. et sp. indet. *Liothyrella* is a well known genus in the Cenozoic strata and Recent waters of the Southern Hemisphere, while *Rhizothyris* is noted for the second time in the Antarctic region. This is the first record of brachiopods from the Chlamys Ledge Member.

Key words: Antarctica, Brachiopoda, Polonez Cove Formation (Chlamys Ledge Mb), Oligocene.

Introduction

Brachiopods in the Oligocene–Miocene strata of King George Island, West Antarctica are usually poorly preserved and can rarely be identified more precisely than at a genus level (Bitner and Pisera 1984; Biernat *et al*. 1985; Bitner and Thomson 1999; Bitner and Crame 2002; Quaglio *et al*. 2008). In the lower part of the Oligocene Polonez Cove Fm, namely Low Head Mb the brachiopods are very rare and are represented by 3 genera, a rhynchonellide *Cryptopora* Jeffreys, a short-looped terebratulide *Liothyrella* Thomson, and a long-looped terebratellidine *Neothyris* Douvillé (Bitner and Pisera 1984; Bitner 1997; Quaglio *et al*. 2008). In the upper unit of this formation, the Oberek Cliff Mb brachiopods belonging to the Rhynchonellida were recognized (Bitner 1997; Bitner and Thomson 1999).

Miocene brachiopods are known from two formations, Destruction Bay and Cape Melville, exposed on the Melville Peninsula in the easternmost part of King George Island. The assemblage coming from the Destruction Bay Fm displays the

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greatest diversity among the Neogene brachiopods of King George Island (Biernat *et al*. 1985). One representative of inarticulate brachiopods, *Discinisca* Dall and five genera of long-looped brachiopods, *Neothyris* Douvillé, *Pachymagas* Ihering, *Rhizothyris* Thomson, *Magellania* Bayle and *Magella* Thomson were recognized in this assemblage (Biernat *et al*. 1985). In the Cape Melville Fm, which overlies the Destruction Bay Fm, the brachiopods are very rare and only two genera, *Liothyrella* Thomson and *Paraldingia* Richardson were recorded (Bitner and Crame 2002).

The aim of the present paper is to describe newly collected brachiopods from the uppermost part of the Polonez Cove Fm, *i.e.* Chlamys Ledge Mb (Fig. 1). Part of the collection is determinable to the generic level, with the genera *Liothyrella* and *Rhizothyris* identified, while other specimens are insufficiently preserved to allow precise determination and are represented by the Rhynchonellida and long-looped Terebratelloidea.

Geological and stratigraphical setting

Glaciomarine strata of the Polonez Cove Fm that yielded the studied brachiopods are exposed in the steep cliff between the Low Head and Lions Rump on King George Island, South Shetland Islands (Figs 1, 2).

The Polonez Cove Fm, up to 65 m thick, rests on the Upper Cretaceous–Eocene basalts of the Mazurek Point Fm and is overlain by the mid-Oligocene dacite and andesite lavas and agglomerates of the Boy Point Fm (Birkenmajer 1980, 1982, 2001; Troedson and Smellie 2002). It comprises six lithostratigraphic members of which the lowest, the Krakowiak Glacier Mb consists of continental tillites, while the succeeding ones, the Bayview Mb, the Siklawa Mb, the Oberek Cliff Mb and the Chlamys Ledge Mb are glaciomarine strata formed during the glacial episode – the Polonez Glaciation (see Birkenmajer 1980, 1982, table 3, 1994, 2001; Porębski and Gradziński 1987; Dingle *et al.* 1997; Troedson and Smellie 2002, fig. 3; Jonkers 2003). These strata were initially considered to be the Pliocene in age (Barton 1965; Birkenmajer 1980, 1982; Gaździcki 1984; Gaździcki and Pugaczewska 1984). Later works (Birkenmajer and Gaździcki 1986; Birkenmajer *et al.* 1991; Troedson and Smellie 2002) proved the Oligocene age of this formation.

The Oligocene age of the Polonez Cove Fm is fully supported by stratigraphical studies of calcareous nannoplankton (Gaździcka and Gaździcki 1985), planktonic foraminifera (Gaździcki 1989), K-Ar dating of associated volcanic rocks (Birkenmajer and Gaździcki 1986; Birkenmajer *et al.* 1991), as well as the Sr isotope stratigraphy (Dingle *et al*. 1997; Dingle and Lavelle 1998).

Chlamys Ledge Member. — Troedson and Smellie (2002, figs 1–3) described the Chlamys Ledge Mb, which overlies the Oberek Cliff Mb along a planar ero-

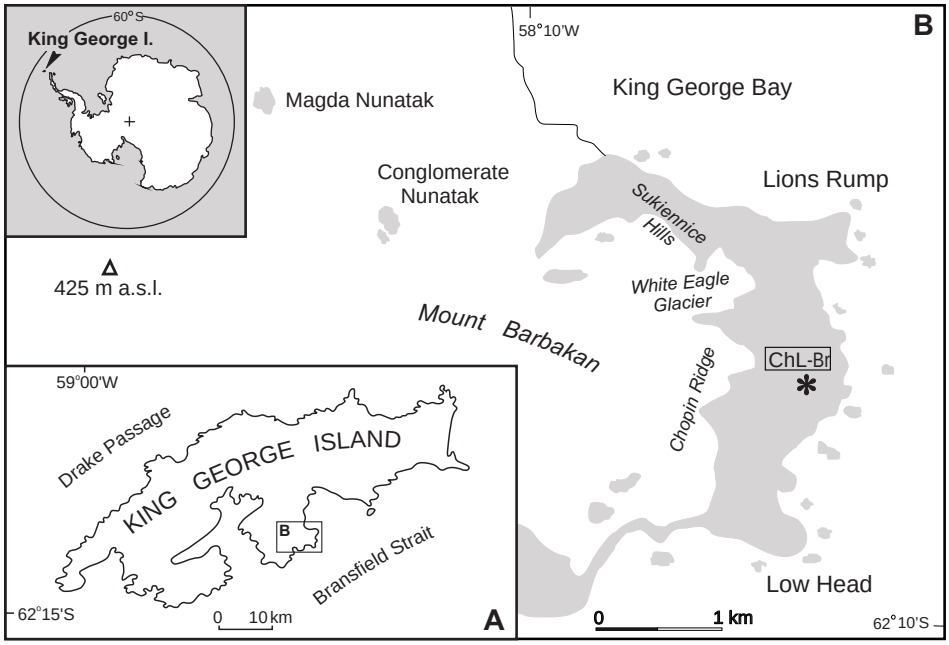

Fig. 1. Map of King George Island (A) and location of the Low Head – Lions Rump area (B). Asterisk indicates location of the brachiopod-bearing strata of the Chlamys Ledge Mb of the Polonez Cove Fm (Oligocene). Shadowed areas are exposed rock.

sional surface in the upper part of the Low Head-Lions Rump cliffs (Fig. 2.1, see also Jonkers 2003, fig. 4.a.), and is overlain by the Boy Point Fm. It is represented by up to 20 m thick sequence of conglomerate and sandstone in the lower part, and sandstone and siltstone in the upper one.

The brachiopod-bearing strata crop out in the upper part of the Chlamys Ledge Mb at the site ChL-Br (GPS position: S 62°08.8', W 58°07.7'; ~100 m above sea level, see Fig. 2.2). It consists of over 3 m thick green sandstone and mudstone beds, from 7 to 25 cm thick (Fig. 2.2). Numerous brachiopod shells form the planar lenses up to 10 cm thick and co-occur with echinoids, solitary corals *Flabellum* (see Gaździcki and Stolarski 1992), bivalves *Austrochlamys* and *Panopea*, benthic foraminifers *Cibicides* and *Globocassidulina* and recycled stromatolites (see Gaździcki 2003, 2008). Most of the studied brachiopods (Figs 3–5) have been collected from this site.

Material

The first 23 brachiopod specimens from the Chlamys Ledge Mb, without the exact locality, were collected by A.L. Troedson (BAS), however, most of the studied material was collected during the austral summers of 2002/2003 and

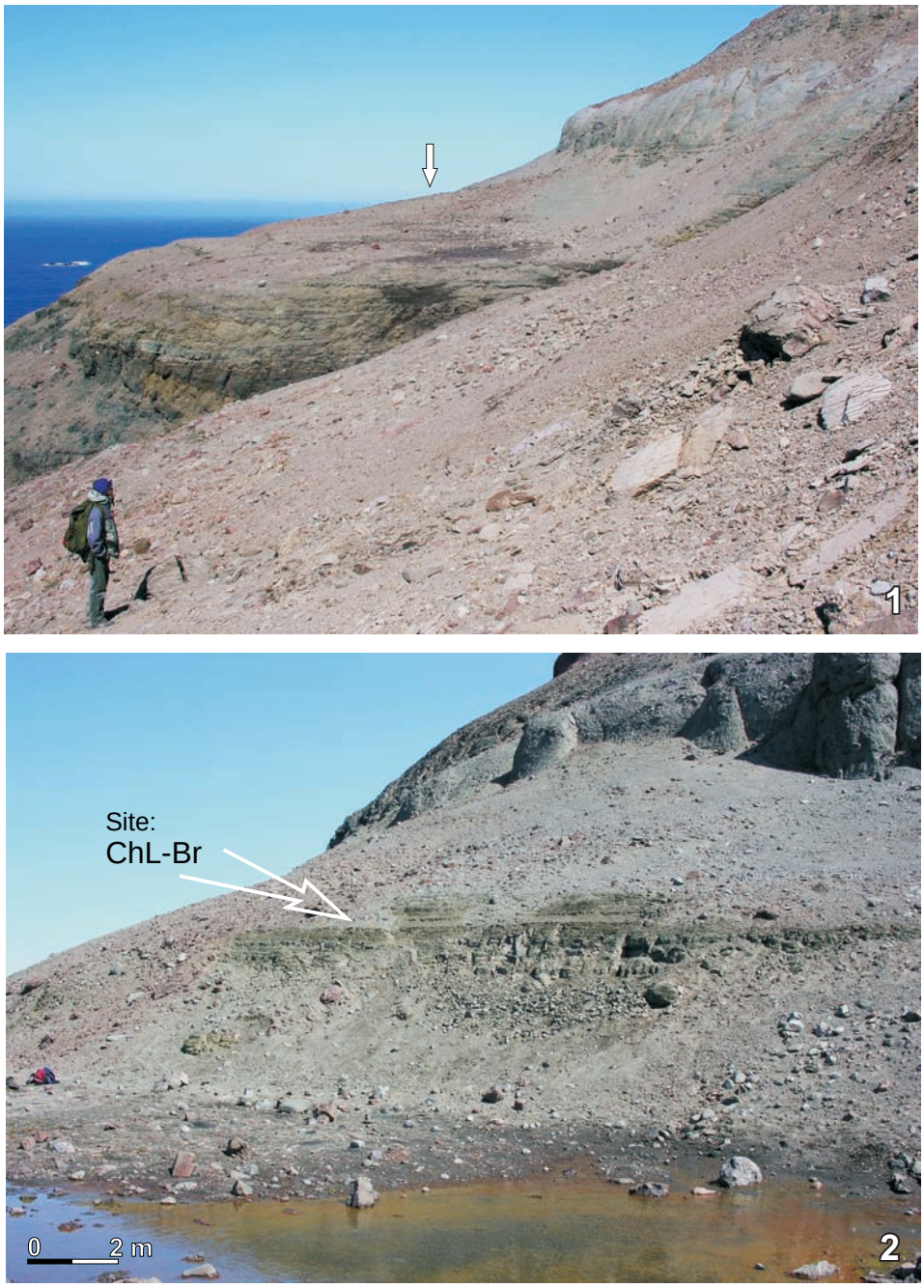

Fig. 2. **1**. View of the upper part of cliff between Low Head – Lions Rump. Arrow indicates location of the brachiopod-bearing strata (ChL-Br) of the Chlamys Ledge Mb. **2**. Exposure (site ChL-Br) of glaciomarine strata of the Chlamys Ledge Mb in which the brachiopods have been collected (arrowed). Photographs by A. Gaździcki, January 2007.

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2006/2007 by A. Gaździcki, and B. Błażejowski and A. Gaździcki, respectively. The whole collection comprises more than 200 specimens but only about 150 of them are determinable, others are too poorly preserved. All thin-shelled brachiopods are preserved as moulds. The shells, including internal structures, are dissolved what precludes precise identifications. Only the shell of *Rhizothyris* is thick enough to be, at least partially, preserved. Additionally many specimens in the collection are broken and/or crushed, although mostly preserved as articulated shells.

The studied brachiopod material is kept in the Institute of Paleobiology, Polish Academy of Sciences, Warszawa (ZPAL Bp.49) and in the collections of the British Antarctic Survey, Cambridge (P.2966.1).

Systematic part

Phylum Brachiopoda Duméril, 1806
Order Rhynchonellida Kuhn, 1949
Rhynchonellida gen. et sp. indet.
(Fig. 3.1–2)

Gen. et sp. indet.; Bitner and Thomson 1999: 85–86, pl. 2, figs 1–3.

Material. — Six specimens preserved as moulds.

Dimensions (in mm):

Specimen no.	Length	Width	Thickness
ZPAL Bp.49/1	37.7	43.2	25.7
P.2966.1	39.5	41.9	17.2

Description. — The shell is large, subtriangular to subpentagonal in outline, wider than long, dorsibiconvex. The ornamentation of coarse, rounded ribs, visible on mould surface suggests that the shell was relatively thin. The number of ribs varies from 15 to 20. The grooves between ribs are narrower than ribs themselves. The beak is moderately low, erect to slightly incurved; foramen seems to be very small. The lateral commissures are straight to ventrally curved, while the anterior commissure is broadly and weakly uniplicate. The internal structures are unknown.

Remarks. — The material is preserved as moulds with dissolved shells precluding investigations of internal structures. The strongly dorsibiconvex and uniplicate shell, however, clearly indicate attribution of the investigated brachiopods to the Rhynchonellida.

In the Southern Hemisphere the only coarsely ribbed rhynchonellide brachiopod is *Notosaria* Cooper, 1959, represented by four species and reported both from the Cenozoic deposits and Recent waters (Foster 1974; Lee 1978; Lee and Wilson 1979; Owen 1980; Wiedman *et al*. 1988; Bitner 1996; MacFarlan *et al*. 2009). This genus differs, however, strongly from the studied specimens in being much smaller, having higher beak with a large foramen and more numerous ribs; in

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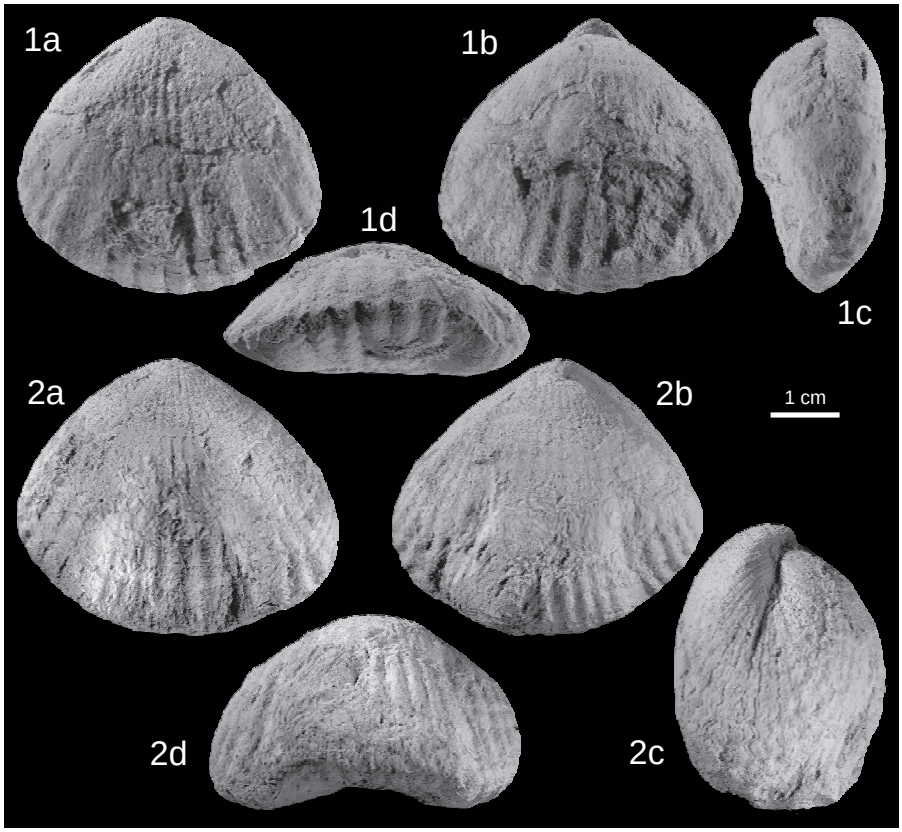

Fig. 3. **1**–**2**. Rhynchonellida gen. et sp. indet., complete specimens; in ventral (a), dorsal (b), lateral (c), and anterior (d) views. **1**. P.2966.1. **2**. ZPAL Bp.49/1. Chlamys Legde Mb of the Polonez Cove Fm (Oligocene), King George Island.

Notosaria the number of ribs varies from 15 to 30 in adults (Lee and Wilson 1979; Owen 1980; Bitner 1996).

Occurrence. — King George Island, upper part of the Oberek Cliff Mb (Bitner and Thomson 1999) and Chlamys Ledge Mb of the Polonez Cove Fm (Oligocene).

Order Terebratulida Waagen, 1883
Superfamily Terebratuloidea Gray, 1840
Family Terebratulidae Gray, 1840
Subfamily Terebratulinae Gray, 1840
Genus *Liothyrella* Thomson, 1916

Type species: *Terebratula uva* Broderip, 1833.

Liothyrella sp.
(Fig. 4.1–2)

Liothyrella sp.; Bitner 1997: fig. 4A–C.

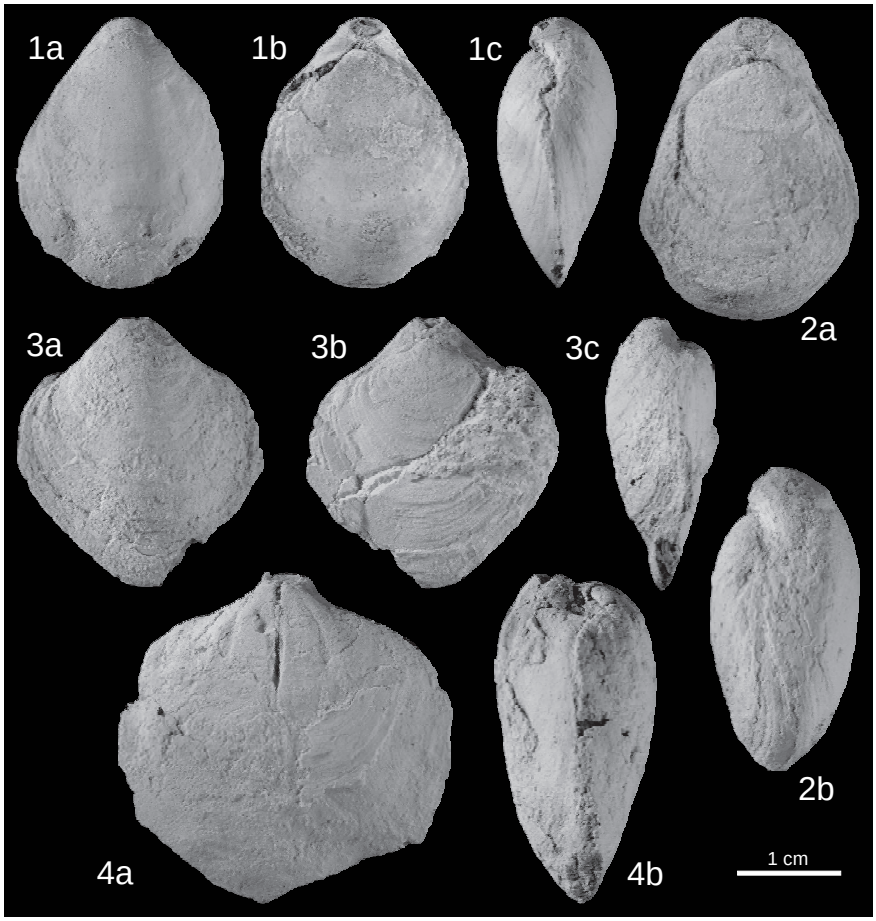

Fig. 4. **1**–**2**. *Liothyrella* sp., complete specimens. **1**. ZPAL Bp.49/2, in ventral (a), dorsal (b) and lateral (c) views. **2**. ZPAL Bp. 49/3, in dorsal (a) and lateral (b) views. **3**–**4**. Terebratelloidea gen. et sp. indet., complete specimens. **3**. ZPAL Bp.49/8, in ventral (a), dorsal (b) and lateral (c) views. **4**. ZPAL Bp.49/9, in dorsal (a) and lateral (b) views. Chlamys Legde Mb of the Polonez Cove Fm (Oligocene), King George Island.

Material. — 45 specimens, mostly preserved as internal moulds, many of them crushed.

Dimensions (in mm):

Specimen no.	Length	Width	Thickness
ZPAL Bp.49/2	25.7	19.72	11.2
ZPAL Bp.49/3	28.1	20.9	14.0
ZPAL Bp.49/11	36.1	24.4	14.8

Description. — The shell is medium to large (maximum observed length is 38.1 mm), strongly elongately oval in outline, smooth with numerous distinct growth lines. The shell is biconvex with ventral valve slightly more convex (Fig.

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4.1c). The beak is suberect to erect with rounded beak ridges; the foramen is large, circular, permesothyrid with partly visible symphytium. The lateral commissures are straight to slightly ventrally curved, while anterior commissure is rectimarginate.

Remarks. — This short-looped genus is very common in the Cenozoic strata of New Zealand (Thomson 1916; Allan 1932; Lee 1978; MacKinnon *et al*. 1993; MacFarlan *et al*. 2009), Australia (Craig 2000, 2001) and Antarctica (Owen 1980; Bitner and Pisera 1984; Wiedman *et al*. 1988; Bitner 1996; Bitner and Crame 2002). It was also reported from the lower part of the Polonez Cove Fm, Low Head Mb (Bitner and Pisera 1984; Bitner 1997; Quaglio *et al*. 2008). In very elongate outline and large, cicular foramen *Liothyrella* sp. described here is very close, although twice as large, to *Liothyrella* sp. from the Low Head Mb at Mazurek Point (Bitner 1997, fig. 4A–C), suggesting conspecifity of those brachiopods. The small size and very large foramen may indicate immaturity of a specimen from the Low Head Mb.

In turn, *Liothyrella* sp. from the Low Head Mb at Vauréal Peak, King George Island, described by Quaglio *et al*. (2008) differs in more rounded shape. The specimen is preserved as an internal mould with broken anterior part.

The representative of genus *Liothyrella* reported from the Lower Miocene Cape Melville Fm on Melville Peninsula, King George Island (Bitner and Crame 2002) is smaller than the specimens described here, differing also in smaller foramen and slightly uniplicate anterior commissure which is rectimarginate in *Liothyrella* sp. from the Chlamys Ledge Mb.

Occurrence. — King George Island, Low Head Mb (Bitner 1997) and Chlamys Ledge Mb of the Polonez Cove Fm (Oligocene).

Superfamily Terebratelloidea King, 1850

Family Terebratellidae King, 1850

Subfamily Stethothyridinae MacKinnon, 1993

Genus *Rhizothyris* Thomson, 1915

Type species: *Bouchardia rhizoida* Hutton, 1905.

Rhizothyris sp.

(Fig. 5.1–4)

Material. — 111 complete specimens, 2 ventral valves and one partly preserved dorsal valve.

Dimensions (in mm):

Specimen no.	Length	Width	Thickness
ZPAL Bp.49/5	24.5	21.0	13.2
ZPAL Bp.49/12	38.3	35.9	21.1
ZPAL Bp.49/13	52.6	39.8	–

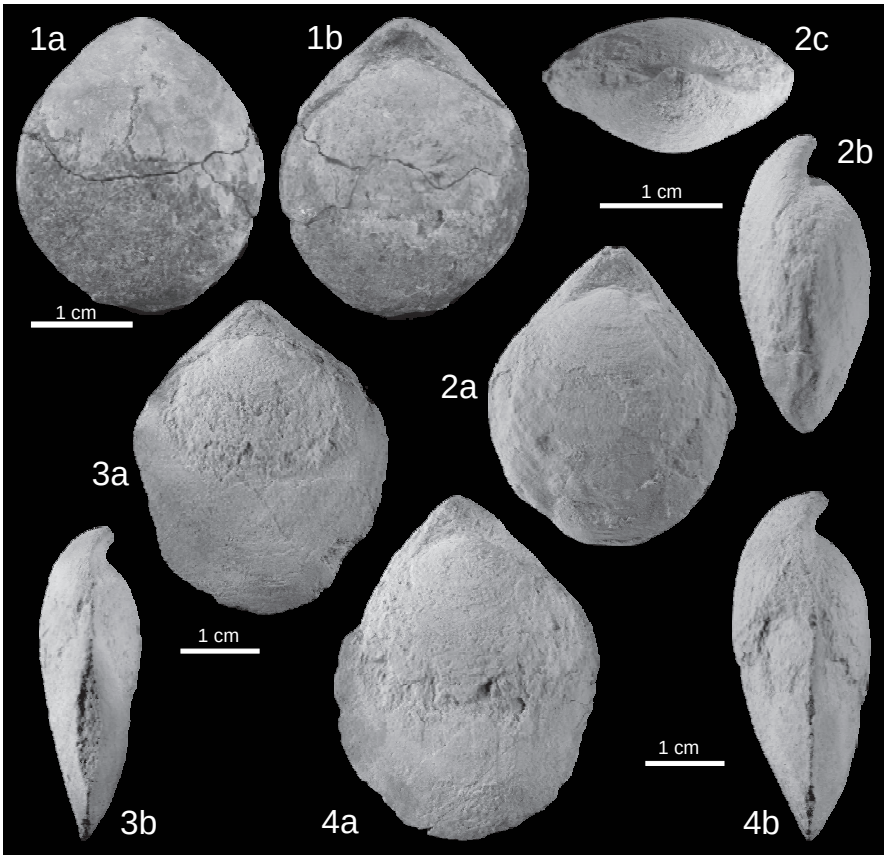

Fig. 5. *Rhizothyris* sp., complete specimens. **1**. ZPAL Bp.49/4, in ventral (a) and dorsal (b) views. **2**. ZPAL Bp.49/5, in dorsal (a), lateral (b) and posterior (c) views. **3**. ZPAL Bp.49/6, in dorsal (a) and lateral (b) views. **4**. ZPAL Bp.49/7, in dorsal (a) and lateral (b) views. Chlamys Legde Mb of the Polonez Cove Fm (Oligocene), King George Island.

Description. — The shell is large to very large, variable in outline from ovally elongate to subpentagonal, very thick posteriorly. The shell is weakly biconvex with ventral valve slightly more convex. The shell surface is smooth, with weakly defined growth lines. The lateral commissures are straight and anterior commissure rectimarginate. The beak is high, suberect, with distinct beak ridges (Fig. 5.2c). The foramen is subcircular, very small, permesothyrid; the deltidial plates are conjunct and form a large, wholly visible symphytium. The hinge line is broad with inclined sides. The cardinalia observed in one dorsal valve are much thickened; swollen inner socket ridges are fused with swollen crural bases to form the cardinal platform.

Remarks. — The name *Rhizothyris* was proposed by Thomson (1915) for the long-looped brachiopods with a permesothyrid foramen and large, wholly visible symphytium. This genus is restricted to the Southern Hemisphere, being long known only from the Oligocene–Miocene strata of New Zealand (Bowen and

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Campbell 1973). Later *Rhizothyris* was recognized in the Lower Miocene Destruction Bay Fm of King George Island by Biernat *et al*. (1985). The present occurrence is the second record from Antarctica. So far only one species, *R. kokoamuensis* Bowen and Campbell, 1973 has been described from the Oligocene of New Zealand (Bowen and Campbell 1973; MacKinnon *et al*. 1993; Hiller and MacKinnon 2000; MacFarlan *et al*. 2009). This species differs from the investigated specimens in much smaller size, lower beak and smaller symphytium; in *Rhizothyris* sp. described here the beak is high with large, wholly visible symphytium. Consequently, most probably it represents a new species which is not proposed because of insufficiently preserved material.

In their revision, Bowen and Campbell (1973) synomized 13 of the 18 previously described species of the genus *Rhizothyris*. Among others, *R. lateralis* Thomson and *R. ovata* Thomson were included into the species *R. rhizoida* (Hutton). Nevertheless Biernat *et al*. (1985) regarded *R. lateralis* and *R. ovata* as valid species and recorded them from the Lower Miocene Destruction Bay Fm of King George Island. Those species differ from *Rhizothyris* sp. described here in having lower beak and smaller symphytium (Biernat *et al*. 1985; Bitner 1998, fig. 3a, c–d).

Occurrence. — King George Island, Polonez Cove Fm, Chlamys Ledge Mb (Oligocene).

Terebratelloidea gen. et sp. indet.
(Fig. 4.3–4)

Material. — Five complete specimens preserved as moulds.

Dimensions (in mm):

Specimen no.	Length	Width	Thickness
ZPAL Bp.49/8	25.5	23.5	10.4
ZPAL Bp.49/9	30.3	30.6	17.2

Descriptions. — The shell is of medium size, subcircular in outline, weakly biconvex with more convex ventral valve. The shell surface is smooth ornamented only by numerous growth lines. The lateral commissures are straight, while anterior commissure is rectimarginate. The beak is low, nearly straight; beak ridges are weakly defined. The foramen is moderately large, circular. The deltidial plates are conjunct. Traces of a dorsal median septum clearly visible on the moulds.

Remarks. — On the basis of the observed characters even a family assignment is impossible, however, the presence of a dorsal median septum clearly indicates a long-looped brachiopod. Although the straight beak makes this brachiopod very different from the hitherto described genera, suggesting a new form, very poor preservation, making impossible to investigate internal structures, precludes a formal description of a new taxon.

In the straight beak the investigated specimens are similar to the Recent genus *Parakinetica* Richardson from off Australia (Richardson 1987) but they differ in

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having conjunct deltidial plates and rectimarginate anterior commissure; *Parakinetica* is strongly sulcate and has disjunct deltidial plates. In rounded outline and smooth surface the specimens from the Chlamys Ledge Mb are also similar to *Iheringithyris* Levy from the Neogene of Patagonia. However, *Iheringithyris* is much larger, has a suberect beak and sharp beak ridges, thus differing strongly from the studied specimens (Levy 1961).

Occurrence. — King George Island, Polonez Cove Fm, Chlamys Ledge Mb (Oligocene).

Discussion

The brachiopod assemblage from the uppermost Polonez Cove Fm is rich in specimens but of low diversity, containing one rhynchonellide and three terebratulide taxa. The fauna is poorly preserved and only two taxa are determinable to the genus level, i.e. *Liothyrella* sp. and *Rhizothyris* sp. Both latter species dominate in the studied assemblage. Rhynchonellides are very rare in the Oligocene strata of King George Island (Bitner and Pisera 1984; Bitner and Thomson 1999), and have not been known from the Lower Miocene deposits cropping out in the easternmost part of King George Island (see Biernat *et al*. 1985; Bitner and Crame 2002). Although being also very rare in the Recent Antarctic waters (Foster 1974), the rhynchonellides are common in the Eocene clastic deposits of the La Meseta Fm from Seymour Island (Owen 1980; Wiedman *et al*. 1988; Bitner 1996). The rhynchonellide brachiopod was also found in the Eocene erratics in the McMurdo Sound region, East Antarctica (Lee and Stilwell 2000).

The genus *Liothyrella* was already reported from the Polonez Cove Fm (Bitner and Pisera 1984; Bitner 1997; Quaglio *et al*. 2008). This genus was also recognized in the material from the Lower Miocene Cape Melville Fm (Bitner and Crame 2002), being, however, absent in the underlying Destruction Bay Fm of the same age (Biernat *et al*. 1985). It is worth mentioning that two species of *Liothyrella* were described from the Eocene of Seymour and Cockburn islands (Owen 1980; Wiedman *et al*. 1988; Bitner 1996). It is a very common genus in the Cenozoic of the Southern Hemisphere (MacFarlan *et al*. 2009). Today *Liothyrella* is represented by 9 species and lives in the Southern Hemisphere from the South Atlantic, Antarctica through the southern Indian Ocean to the southwestern Pacific at the depth from 7 to 2273 m (Logan 2007).

The genus *Rhizothyris* is recorded for the first time from the Polonez Cove Fm, however, it has been already reported from the Lower Miocene Destruction Bay Fm (Biernat *et al*. 1985). *Rhizothyris* is mostly known from the Late Oligocene–Middle Miocene strata of New Zealand (Bowen and Campbell 1973; MacKinnon *et al.* 1993; Hiller and MacKinnon 2000; MacFarlan *et al*. 2009), where six species have been recognized.

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