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Cyclostomatous Bryozoa from the Polonez Cove Formation (Oligocene) of King George Island, West Antarctica

ABSTRACT: An additional account on the Oligocene cyclostome Bryozoa has been made from the glaciomarine sediments of the Low Head Member (= *Pecten* conglomerate of Barton 1965) of the Polonez Cove Formation on King George Island (South Shetland Island, West Antarctica). The following genera have been recognized for the first time in Paleogene of Antarctica: *Crisia, Bicrisia, Exidmonea, Filisparsa* and *Mecynoecia.* Paleoecological interpretation of the bryozoan assemblage implies that the fauna lived in shallow water at a depth of around 50 m.

Key words: Antarctica, King George Island, Oligocene, paleontology, paleoecology, Bryozoa (Cyclostomata).

Introduction

A cyclostomatous bryozoan fauna has recently been found in the glaciomarine sediments of the Low Head Member (= *Pecten* conglomerate of Barton 1965) of the Polonez Cove Formation of King George Island which crop out at the northwest margin of the White Eagle Glacier (Fig. 1, *see also* Smellie *et al.* 1984, Fig. 39; Birkenmajer 1987, Fig. 3).

Samples were collected by A. Gaździcki during the 4th Geodynamic Expedition to West Antarctica, austral summer 1990–1991, organized by the Polish Academy of Sciences (leader Professor Dr. A. Guterch) *see* Gaździcki (*In:* Birkenmajer 1991).

Knowledge of fossil Antarctic Bryozoa is extremely limited until now. Therefore, the recovery of new fossil material from this part of the world deserves attention. There are only a few published papers concerning

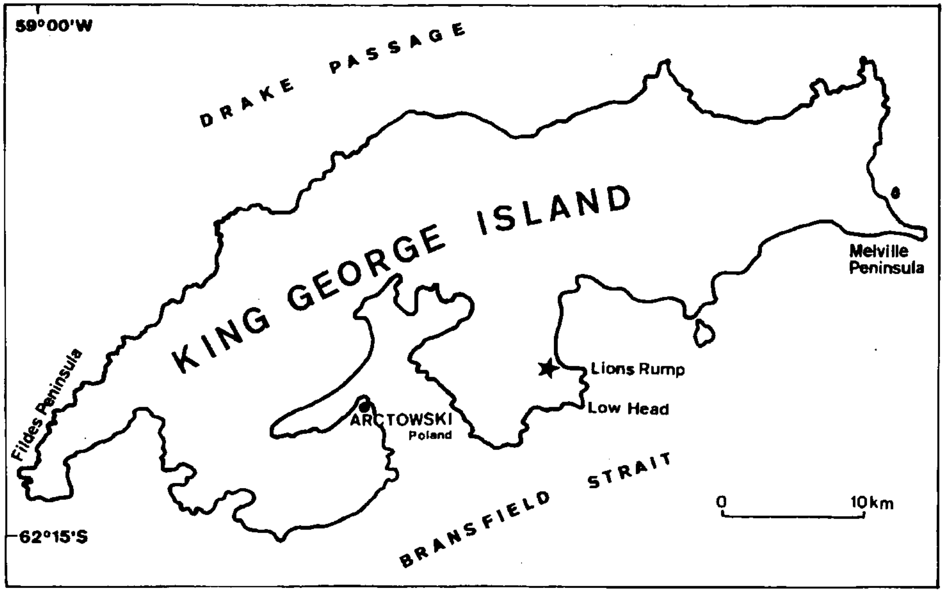


Fig. 1. Map showing location of bryozoan—bearing strata at the northwest margin of the White Eagle Glacier (asterisk) in King George Island.

descriptions of fossil Bryozoa from the Antarctic (*see* Henning 1911, Gaździcki and Pugaczewska 1984, Hayward and Taylor 1984).

Geological setting

The succession of glacial and glaciomarine deposits of the Polonez Cove Formation (up to 90 m thick) attributed to the Polonez Glaciation, is best exposed between Low Head and Lions Rump on King George Island (Fig. 1) *see also* Porębski and Gradziński (1987, Figs 1, 3). The Low Head Member (= *Pecten* conglomerate of Barton 1965, Fig. 3D) is the richest fossil—bearing unit of the Polonez Cove Formation. It consists of fossiliferous conglomerates with *Chlamys* coquinas and iceberg—rafted dropstones, as well as siltstones, sandstones and shales (Birkenmajer 1982, Gaździcki 1984, Gaździcki and Pugaczewska 1984, Porębski and Gradziński 1987). On the basis of the coccolith and foraminifer assemblages recovered from glaciomarine strata of the formation (Gaździcka and Gaździcki 1985; Birkenmajer, Dudziak and Tokarski 1988; Gaździcki 1989), and on the basis of K—Ar dating of the associated volcanic rocks (Birkenmajer, Soliani and Kawashita 1989), an Early Oligocene age has been accepted for the Polonez Cove Formation and the Polonez Glaciation (*see* Birkenmajer and Gaździcki 1991, Birkenmajer 1992, Fig. 3).

Material and methods

The bryozoan fauna from the locality of the White Eagle Glacier has been found during the routine procedure in the preparation of samples for micropaleontological analysis. The maceration of about 4 kg of glaciomarine sediments in Glauber's salt provided about 250 fragments of erect bryozoan colonies (Pls 1 – 5). All samples were washed over a set of sieves and specimens or fragments of Bryozoa were picked from the $<500\mu$ to $<100\mu$ residue fraction. The fauna consists of many broken fragments of colonies which exhibit a rather poor state of preservation. About 34 specimens from this assemblage occur in better state of preservation and were used for preparation on SEM photographs (Pls 1 – 5).
All specimens studied are kept in the paleontological collection of the Institute of Paleobiology of the Polish Academy of Sciences, Warszawa under the catalogue numbers ZPAL Br. VII/1 – 250.

Bryozoan assemblage

An abundant bryozoan fauna from the Low Head Member of the Polonez Cove Formation had been described for the first time by Pugaczewska (*In:* Gaździcki and Pugaczewska 1984) from Low Head – Lions Rump area (profiles I – III, *see* Gaździcki and Pugaczewska 1984, Pl. 1). The rich bryozoan assemblage including 48 species occurs together with other marine micro- and macrofossils: coccolithophorids, both planktonic and benthic foraminifers, brachiopods, gastropods, crinoids and echinoids (Gaździcki 1984, Gaździcki and Pugaczewska 1984, Bitner and Pisera 1984, Jesionek – Szymańska 1984, Gaździcka and Gaździcki 1985, Błaszyk 1987, Birkenmajer, Dudziak and Tokarski 1988, Gaździcki 1989). Twenty-eight of the 48 bryozoan species were ascophoran Cheilostomata, 10 were anascan Cheilostomata and 10 belonged to the cyclostome Bryozoa. The characteristic feature of the bryozoan assemblage as described by Pugaczewska (*In:* Gaździcki and Pugaczewska 1984) is the dominance of the incrusting forms of colonies.

The cyclostome Bryozoa which are subject of the present study have been found in the *Chlamys*-bearing conglomerate (= Low Head Member) of the Polonez Cove Formation in the profile at the northwest margin of the White Eagle Glacier (Fig. 1). The material is composed chiefly of delicate, small, joined, erect tuft-like colonies belonging to the genus *Crisia* and branched colonies including the genera *Exidmonea, Filisparsa* and *Mecynoecia* (Pls 1 – 5). The material also includes a few scattered zooecia of *Pasythea* cf. *tulipifera* and loose fragments of articulated colonies of the genus *Cellaria*, which both belong to Cheilostomata (*see* Gaździcki and Pugaczewska 1984). The material from this site is very fragmentated. The crisiids being the most common in the material studied show only sterile internodes. None of the specimens has gonozooids or any traces of them.

Apart from bryozoans samples are rich in macro- and microfossils such as benthic foraminifers, ostracods, terebratulid brachiopods as well as tube worms (*Spirorbis*). The bryozoan fauna discussed here shows a low diversity in genera and species in comparision with a bryozoan assemblage from profiles I – III *see* Pugaczewska (*In:* Gaździcki and Pugaczewska 1984).

List of Bryozoa

The classification of the taxa determined has been based on Bassler (1953) with modification by Brood (1972) and by David, Mongereau and Pouyet (1972).
The bryozoan assemblage from the White Eagle Glacier locality comprises the following taxa:

Order **Cyclostomata** Busk, 1852
Suborder **Articulata** Busk, 1859
Family **Crisiidae** Johnston, 1847
Genus *Crisia* Lamouroux, 1812
    Crisia cf. *denticulata* Lamarck, 1816 – Pl. 2, Figs 5, 7
    Crisia cf. *eburnea* (Linnaeus, 1758) – Pl. 1, Figs 5–6
    Crisia cf. *elongata* Milne–Edwards, 1838 – Pl. 1, Fig. 4
    Crisia sp., – Pl. 2, Figs 1–4, 6; Pl. 3, Figs 1–4
Genus *Bicrisia* d'Orbigny, 1853
    Bicrisia sp., – Pl. 1, Figs 1–3
Suborder **Tubuliporina** Milne–Edwards, 1838
Family **Tubuliporidae** Johnston, 1838
Genus *Exidmonea* David, Mongreau and Pouyet, 1972
    Exidmonea sp. – Pl. 4, Figs 1, 5
Family **Filisparsidae** Brood, 1972
Genus *Filisparsa* d'Orbigny, 1853
    Filisparsa cf. *typica* Manzoni – Pl. 5, Figs 1–5
Genus *Mecynoecia* Canu, 1918
    Mecynoecia sp., – Pl. 4, Figs 2–4
Order **Cheilostomata** Busk, 1852
Suborder **Anasca** Levinsen, 1909
Division **Pseudostega** Levinsen, 1909
Family **Cellariidae** Hincks, 1880
Genus *Cellaria* Ellis and Solander, 1786
    Cellaria sp.
Suborder **Ascophora** Levinsen, 1909

Family **Pasytheidae** Davis, 1934
Genus *Pasythea* Lamouroux, 1812
Pasythea cf. *tulipifera* (Ellis and Solander, 1786)

The material studied is characterized by a low diversity of taxa. The richest forms in this assemblage belong to the genus *Crisia*, which presents the highest diversity. The following species have been determined: *Crisia* cf. *denticulata* Lamarck, 1816, *Crisia* cf. *eburnea* (Linnaeus, 1758) and *Crisia* cf. *elongata* Milne–Edwards, 1838. At the present stage of investigations the rest of specimens from this assemblage had to be summarized as *Crisia* sp. (*see* Pl. 2, Figs 1–4, 6; Pl. 3, Figs 1–4).

Paleoecology

The relationship between patterns of sedimentation and distribution patterns of bryozoan zoarial forms are a major center of interest in modern research. There are many scientific papers concerning these topics, *e.g.* Stach (1936), Lagaaij and Gautier (1965), Schopf (1969), Brood (1972, 1976), Cuffey (1985), Cuffey *et al.* (1977), McKinney F.K., McKinney M.J. and Listokin (1987), Reguant *et al.* (1991).

The bryozoan fauna from the White Eagle Glacier locality of the Low Head Member is composed chiefly of the internodes of the delicate, jointed, erectly growing zoaria of the genus *Crisia*. In the modern seas, the crisiid growth-form is typical for the littoral zone where wave action is strong. The substrata are mainly algae, but stones, shells and other firm substrata are very common too (Borg 1930, Harmelin 1974, Ryland 1967). Crisiids are abundant components of shallow subtidal communities (*see* Harmelin 1990). They may develop dense and extensive plurispecific populations on sheltered rocky substrata, just beneath the surface („crisiid turf", Hayward and Ryland 1985). Their non-rigid, erect growth form, characterized by jointed internodes, is obviously adapted to life in turbulent water but does not preclude them from living in quieter environments too (Harmelin 1990). Moreover, crisiids can be assumed to occur mainly in the upper shelf area (Harmelin 1990).

According to Bobies (1958) sediments containing the genus *Crisia* have been deposited probably near a coast or close to masses of floating plants. It should be noted that the occurrence of crisiid forms is said to be indicative of rich submarine plant growth and is regarded as a hint for strong wave movement.

The idmidronid growth-form occurs on firm substrata such as stones, shells or bryozoans. In the assemblage studied here, this type of growth-form is represented by the genera *Exidmonea* and *Filisparsa*. This form is characteristic of moderately deep water with little wave action (Borg 1930, 1944; Harmelin 1974).

Fragments of cheilostomatous bryozoan colonies are represented by two genera, *Cellaria* and *Pasythea*. The „finger-shaped" colonies *Cellaria* belong to cellariform-type of growth-form and according to Stach (1936), this type of zoaria suggests a facies subjected to currents at about 35 m. In the material described here, as well as, in the profiles I–III (*see* Gaździcki and Pugaczewska 1984), scattered zooecia of colonies of *Pasythea* cf. *tulipifera* have been found, representing catenicelliform growth-form. It is known that catenicelliform zoaria abound at depths of 20 to 40 m and occur very rarely outside the bathymetric limits (*see* Lagaaij 1973). Catenicelliform zoaria are adapted for life in the littoral zone where wave action is strong (Stach 1936).

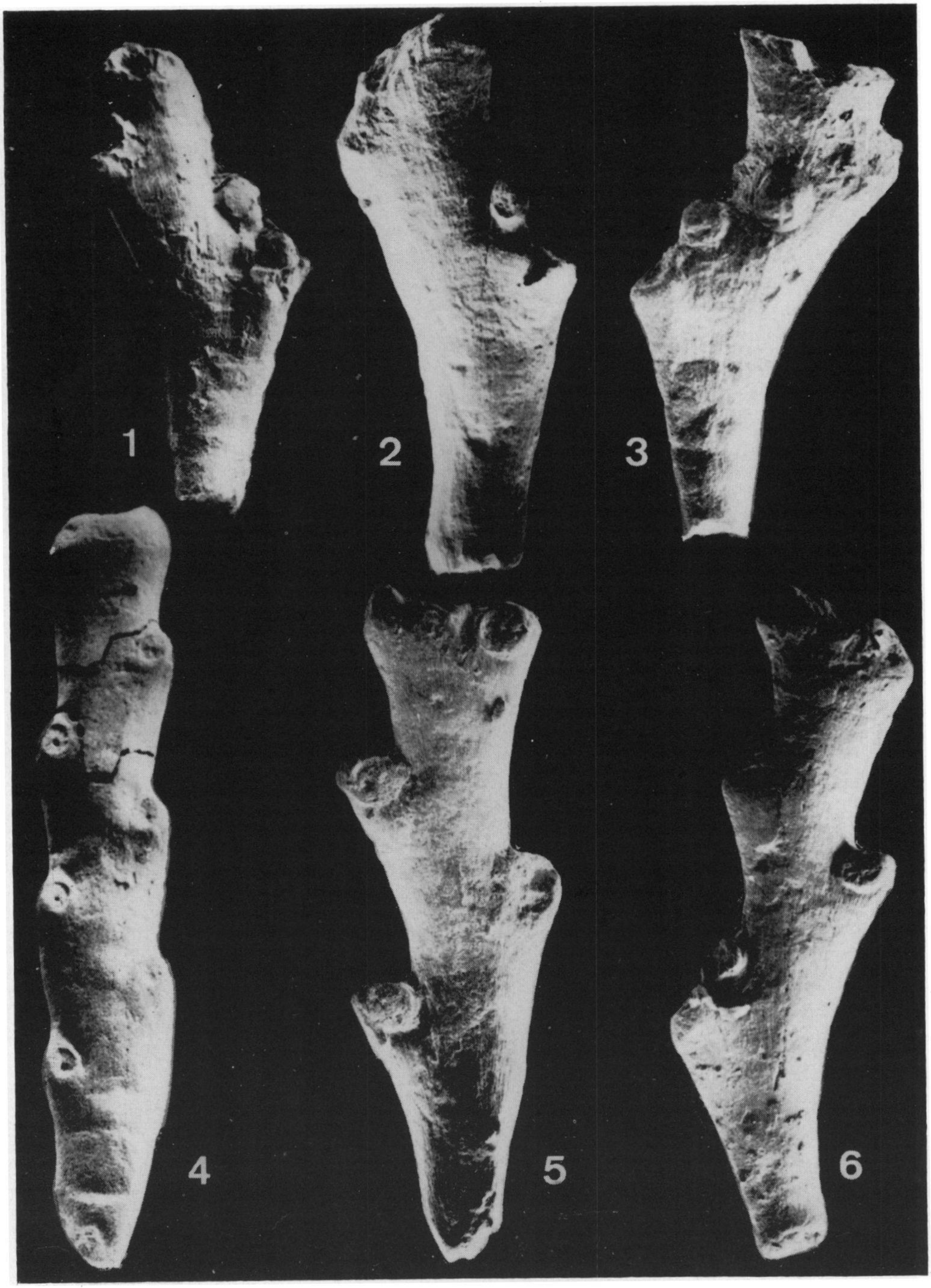
The accompanying micro- and macrofauna is associated with benthic foraminifers specimens of the genus *Pyrgo* being the most common among them. As it was shown by Murray (1973) this genus is abundant in the depth between 0–50 m in the inner shelf–zone.

The bryozoan fauna described from the locality of the White Eagle Glacier seems to be poor in genera in comparison with the fauna from profiles I–III at Polonez Cove between Low Head and Lions Rump (*see* Gaździcki and Pugaczewska 1984).

According to Brood (1972, 1976), the presence of diastoporids, a high number of massive cerioporids and many hornerid colonies may indicate that the bryozoan fauna has been growing in agitated waters.

Among anascan Cheilostomata from profiles I–III colonies of the genus *Cellaria* are the most common. According to Stach (1936) this type is adapted for life in the littoral zone where algae usually form the basis of attachment and the effect of wave action is overcome by the articulation of the long, narrow internodes. The second very abundant growth-form belongs to the membraniporiform type (B), incrusting soft substrata (*see* Lagaaij and Gautier 1965). According to Stach (1936) this type of colony is adapted for life in the littoral and sublittoral zones, and is numerically unimportant in deeper waters. The 28 species from profiles I–III (*cf.* Gaździcki and Pugaczewska 1984) belong to ascophoran Cheilostomata which constitute the majority of species in most shallow waters. The dominant growth-form among ascophoran bryozoans belongs to membraniporiform (A) zoaria. According to Stach (1936) this type of zoarium is adopted for life in the littoral and sublittoral zone.

The rest of species–except for the most common membraniporiform colonies–belong to reteporiform and catenicelliform zoarial growth types. Reteporiform zoarial-growth is adapted for life in regions where currents and wave action are strong, these factors being overcome by rigidity and fenestration of the colony. This type of zoarium is most prolific in sublittoral regions (*see* Stach 1936). As it had been mentioned above the characteristic feature of the bryozoan assemblage described by Pugaczewska (*In*: Gaździcki and Pugaczewska 1984) is the dominance of incrusting forms. It may be related to the plentiful occurrence of *Chlamys*, the shells of which are favoured as a substratum by incrusting Bryozoa (*see* Ryland 1967, Ryland and Hayward 1977, Hayward 1980).

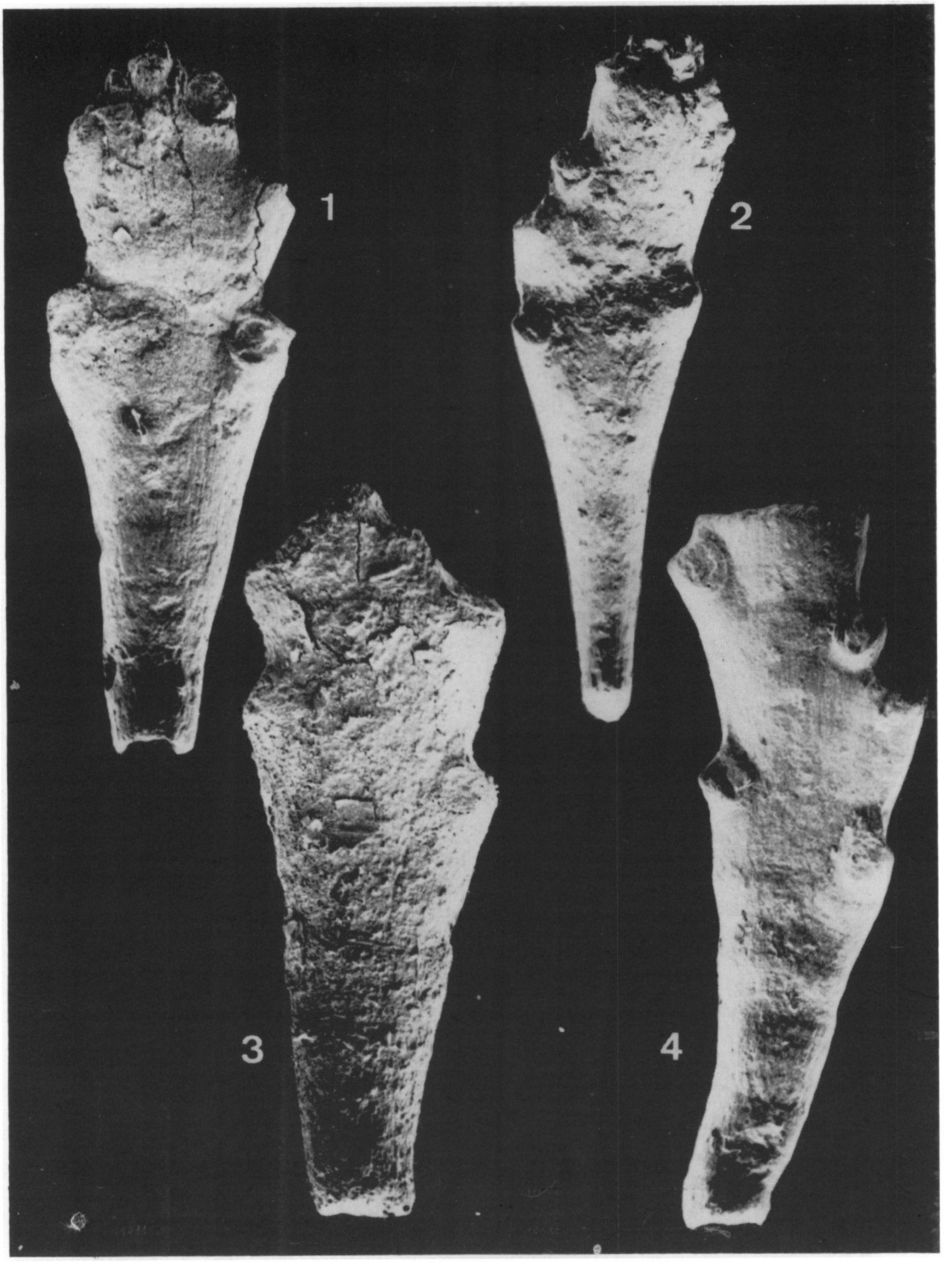


1–3. *Bicrisia* sp., (ZPAL Br. VII/1–3), portions of colony, (1 × 75, 2 × 80, 3 × 70)
4. *Crisia* cf. *elongata* Milne–Edwards, 1838 (ZPAL Br. VII/4), sterile internode, × 55
5–6. *Crisia* cf. *eburnea* (Linnaeus, 1758) (ZPAL Br. VII/5–6), internode of colony, (5 × 80,6 × 75)

King George Island, White Eagle Glacier locality
Polonez Cove Formation (Lower Oligocene)

1–4. *Crisia* sp., (ZPAL Br. VII/7–10), internodes of colony, (1–3 × 65, 4 × 60)
5, 7. *Crisia* cf. *denticulata* Lamarck, 1816 (ZPAL Br. VII/11–12), fragments of internode, (5 × 55, 7 × 45)
6. *Crisia* sp., (ZPAL Br. VII/13) fragment of internode, × 55

King George Island, White Eagle Glacier locality
Polonez Cove Formation (Lower Oligocene)



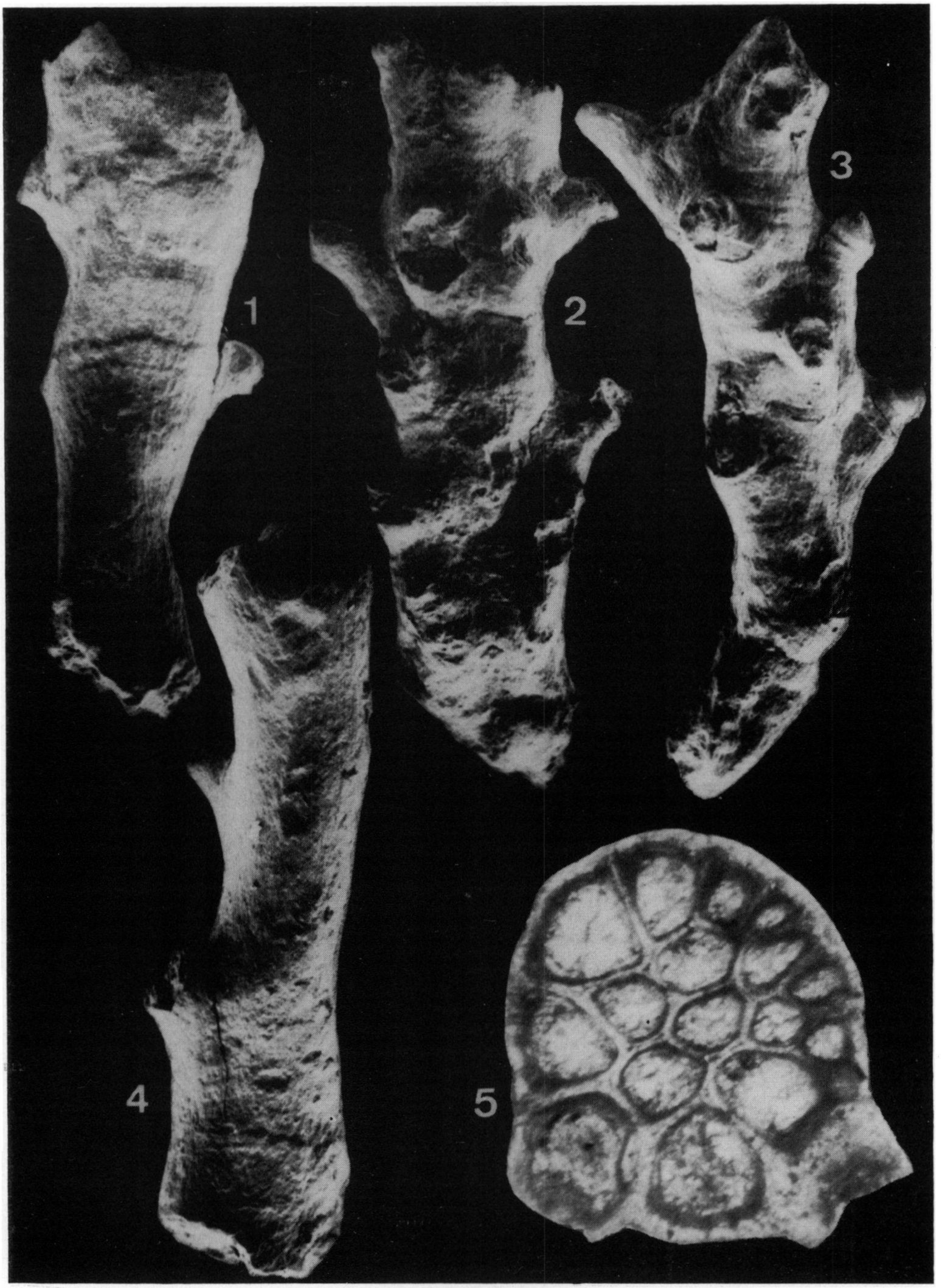
1–4. *Crisia* sp., (ZPAL Br. VII/14–17), fragments of colony, 1–3 × 75, 4 × 65)

King George Island, White Eagle Glacier locality
Polonez Cove Formation (Lower Oligocene)

1, 5. *Exidmonea* sp., (ZPAL Br. VII/18 – 19), 1 – frontal side of branch, 5 – dorsal side of branch, (1 × 35, 5 × 45)

2 – 4. *Mecynoecia* sp., (ZPAL Br. VII/20 – 22) fragments of colony, (2 – 4 × 50)

King George Island, White Eagle Glacier locality
Polonez Cove Formation (Lower Oligocene)



1—5. *Filisparsa* cf. *typica* Manzoni (ZPAL Br. VII/23—27), 1 — dorsal side of branch, 2—3 — frontal side of branch, 4 — lateral view of branch, 5 — cross section of branch, (1—2 × 45, 3 × 55, 4 × 65, 5 × 125)

King George Island, White Eagle Glacier locality
Polonez Cove Formation (Lower Oligocene)

Considering Recent Antarctic bryozoan faunas it should be noted that Bryozoa are one of the essential groups of bottom communities. Powerful bottom currents carry plentiful nutrients thereby nourishing bryozoan species. This is way the Antarctic continent is often called the „Kingdom of Bryozoa and Spongies" (Androsova 1973).

Catenicelliform zoaria are also numerous in samples from Low Head and Lions Rump area, as well as, from the White Eagle Glacier locality. As has been mentioned before, this type of colony was adapted for life in the littoral zone where wave action is strong. All types of the zoarial-growth in the fossil bryozoan material studied led to the conclusion that the fauna represents shallow water biota. Moreover, it may be concluded that the bryozoan fauna settled the marine environment at depth which did not exeeded 50 m. The shallow—water character of fauna from the Polonez Cove Formation was pointed out earlier (*see* Gaździcki 1984, Porębski and Gradziński 1987). The pectinid-bearing strata have been interpreted as nearshore deposits of the high-energy wave dominated coast (Birkenmajer *et al.* 1991).

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Streszczenie

W oligoceńskich utworach morsko-lodowcowych formacji Polonez Cove (ogniwo Low Head), odsłaniających się w północno-zachodniej części Lodowca White Eagle na Wyspie King George w Antarktyce Zachodniej (fig. 1), stwierdzono obecność mszywiołów z rzędu Cyclostomata. Rozpoznany zespół obejmuje: *Crisia* cf. *eburnea* (Linnaeus, 1758) (pl. 1, fig. 5—6), *Crisia* cf. *elongata* Milne—Edwards, 1838 (pl. 1, fig. 4), *Crisia* cf. *denticulata* Lamarck, 1816 (pl. 2, fig. 5, 7), *Crisia* sp. (pl. 2, fig. 1—4, 6; pl. 3, fig. 1—4), *Bicrisia* sp. (pl. 1, fig. 1—3), *Exidmonea* sp. (pl. 4, fig. 1, 5), *Filisparsa* cf. *typica* Manzoni (pl. 5, fig. 1—5), *Mecynoecia* sp. (pl. 4, fig. 2—4). W zespole tym dominuje rodzaj *Crisia*. Rozpoznane tutaj oligoceńskie taksony mszywiołów są po raz pierwszy sygnalizowane z Antarktyki. Analiza paleoekologiczna zespołu mszywiołowego potwierdza wcześniej wysunięte wnioski o płytkowodnym charakterze fauny formacji Polonez Cove.