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Encrusters and borers of brachiopods from the La Meseta Formation (Eocene) of Seymour Island, Antarctica

ABSTRACT: Epifaunal organisms (bryozoans, foraminifera, serpulid polychaetes, cirripeds, octocorals), scratch marks, and borings (brachiopod pedicle attachment traces, and gastropod, phoronid, sponge and algal boreholes) were recognized on the brachiopod shells from the Eocene La Meseta Formation of Seymour Island, Antarctic Peninsula. They are rare and occur only on about 10% of shells. It is probable that environmental conditions were not suitable for epibionts whose requirements were to be higher than those of brachiopods. The rarity of epifauna on the dead shells can be explained by their rapid burial.

Key words: Antarctica, Paleogene, Brachiopoda, epibionts, borers.

Introduction

Brachiopods are common fossils in the Paleogene deposits of the La Meseta Formation of Seymour Island, Antarctic Peninsula and have been the subject of study of several authors (Buckman 1910; Owen 1980; Wiedman *et al.* 1988; Bitner 1991, 1996). However, they have never been examined in detail for the presence of encrusting organisms. Only gastropod borings on *Lingula antarctica* Buckman have been noted previously (Wiedman *et al.* 1988). In some cases encrusters may be very helpful in paleoecological studies, as they provide information about life orientation of the host shell and may have some sedimentological implications as well (compare Cuffey *et al.* 1995).

The studied material is housed in the Institute of Paleobiology of the Polish Academy of Sciences, Warszawa under the collection number ZPAL Bp.XXXVII.

Geological setting

The brachiopod-bearing deposits of the La Meseta Formation crop out in the northern part of Seymour Island, Antarctic Peninsula (Fig. 1) and consist of loosely consolidated sandstones, sandy siltstones, claystones, pebbly sandstones and shell beds with an abundant marine fauna (Sadler 1988, Stilwell and Zinsmeister 1992). They are interpreted, based on associated biota and sedimentary structures, to have been deposited in warm-temperate conditions of a nearshore, tidally influenced, shallow-marine environment (Stilwell and Zinsmeister 1992). Recently Porębski (1995) interpreted them to have been deposited under estuarine conditions, which is difficult to accept in the light of the faunal contents (Bitner 1996). Brachiopods and other stenohaline fauna, such as corals, marine molluscs, crinoids, asteroids, echinoids clearly indicate normal marine conditions. The La Meseta Formation was divided into three lithostratigraphical units (I–III) of Elliot and Trautman (1982) and into seven lithofacies units (Telm1–Telm7) of Sadler (1988).

The age of the La Meseta Formation is considered to be early?–middle Eocene to possible early Oligocene (Wrenn and Hart 1988, Cocozza and Clarke 1992, Stilwell and Zinsmeister 1992, Tambussi *et al.* 1994).

Material

More than 620 specimens of brachiopods collected in the La Meseta Formation were examined for epibionts and boring structures. Only about 10% of the shells (67 specimens) were encrusted by epifaunal organisms. Few carried more than one specimen of encrusters. Scratchings and borings are even less common and occur on about 3% of the shells.

Encrusters

Among the encrusting organisms are bryozoans (Pl. 1, Fig. 3), foraminifera (Pl. 3, Figs 1–3) and serpulids, including *Spirorbis* Daudin, and probably *Galeolaria* Lamarck and *Serpula* Linnaeus (Pl. 1, Figs 1a, 2; Pl. 2, Figs 2–4). Bryozoans and foraminifera dominate. It is worth noting that a diverse cyclostome and cheilostome bryozoan fauna is present in the La Meseta Formation (Gaździcki and Hara 1994, Hara 1995). One brachiopod specimen bore a barnacle (Pl. 1, Fig. 1b). Locally, barnacles are fairly abundant in the La Meseta Formation (Zullo *et al.* 1988). Also one specimen carried an octocoral holdfast.

The epifauna was not found on the surface of *Lingula antarctica* Buckman, ?*Plicirhynchia* sp., *Terebratulina buckmani* Owen, and *Bouchardia antarctica*

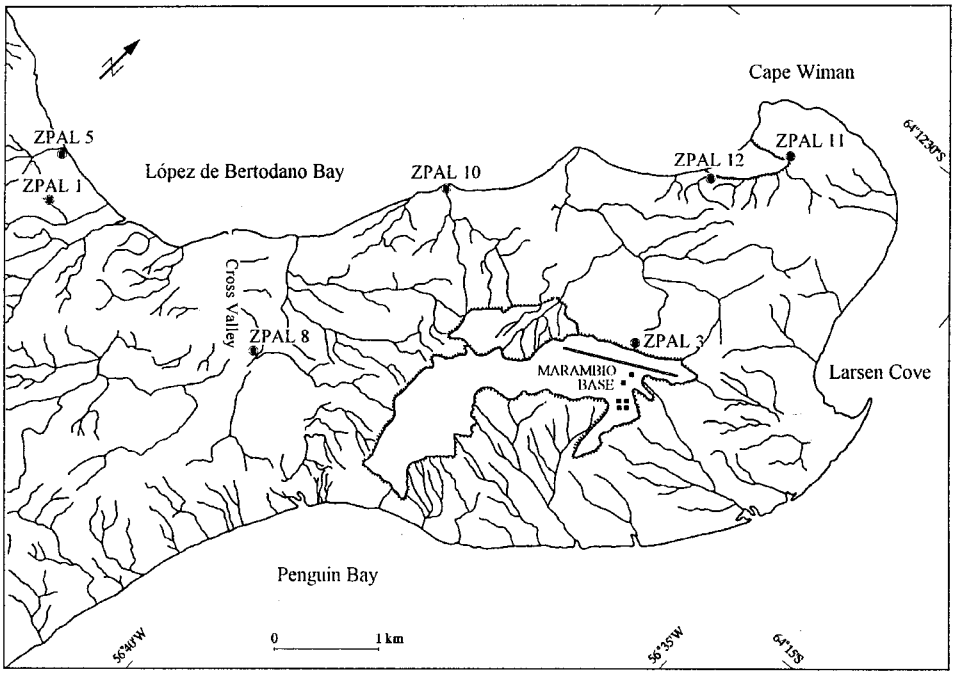

Fig. 1. Map of the northern part of Seymour Island showing the localities where brachiopods were collected.

Buckman. In the case of *L. antarctica* it is clear as *Lingula* lives burrowed in the sediment (Paine 1970). *Bouchardia* also lives partially buried in the sediment (Richardson 1981, Manceñido and Griffin 1988). Therefore, those genera are not favourable sites for epibionts. In the case of *T. buckmani* absence of epibionts may be the result of its small size; Rudwick (1962) observed epifauna associated generally with larger brachiopod shells. Also, Lee (1987) noticed in the assemblage of Recent *Neocrania huttoni* (Thomson) that the majority of valves free from epibionts are juveniles, *i.e.* less than 8 mm. Another explanation of the absence of epifauna can be the analogy with Recent species of *Terebratulina*, *T. retusa* (Linnaeus) and *T. septentrionalis* (Couthouy) which are very often covered by a thick layer of encrusting sponge (Dall 1920, Logan and Noble 1971, Surlyk 1972) that disintegrates after death leaving no traces in the fossil record.

The genus *Tegulorhynchia* Chapman and Crespin very rarely carried epibionts. Those found in the investigated material occur on abraded surfaces, suggesting that they may have attached after the brachiopod death. *Tegulorhynchia*, because of its spinose ribbing, seems not to be a very suitable substrate for encrusting organisms. Encrusters clearly prefer brachiopod species with smooth shell, as they are relatively common on *Liothyrella* species and *Macandrevia*

cooperi Bitner. This was observed previously by Lee (1978a, 1980). As was also noted by Barnes and Clarke (1995), the Recent Antarctic species *Liothyrella uva* (Broderip) frequently bears epibiotic organisms and the proportion of the shell covered by epibionts may vary from 20% to 55%.

The flattened *Cibicides*-like foraminifera (Pl. 3, Figs 1–3), often adhering to a growth line, are found primarily on the smooth surface of *Macandrevia cooperi*.

Serpulid tubes are commonly attached near the region of the anterior commissure (see Pl. 2, Fig. 4) which seems to be the preferred orientation to benefit from the feeding currents of the brachiopod (see also Schumann 1967; Lee 1978b, 1980). Serpulids have been reported from the La Meseta Formation previously (Wiedman and Feldmann 1988) but none has been associated with brachiopods.

The epifaunal distributions seem to indicate that the epifauna was associated with living, rather than dead, brachiopods. Nevertheless, in a few cases the encrusters must have grown after the death of the brachiopod. Some bryozoans (Pl. 1, Fig. 3) and serpulids (Pl. 2, Figs 2–3) have been found growing across the anterior commissure or on the inner surface of separated valves. The rarity of brachiopods encrusted after death could be explained by a high sedimentation rate which resulted in rapid burial of the dead shells.

Borers and grazers

Gastropod boreholes are found solely in the shells of 6 specimens, *i.e.* three in *Lingula antarctica* Buckman (Pl. 2, Fig. 1), one in *Liothyrella* sp. and two in *Macandrevia cooperi* Bitner. There are two types of boreholes. The first type, which occurs on the shells of *L. antarctica*, is very regular, widely conical in shape with a diameter of 1.8–2.0 mm. These boreholes were first noted and illustrated by Wiedman *et al.* (1988). This type of boreholes is similar to that described by Carriker and Yochelson (1968) and Hoffman *et al.* (1974) as being made by naticid gastropods. The Naticacea belong to infauna and attack prey only in the bottom sediment.

The second type of borehole occurs on the shells of *Liothyrella* sp. and *M. cooperi*. It is smaller (0.6–1.4 mm in diameter) and cylindrical in shape. This type may have been made by muricid gastropods which commonly prey on epifauna (see Carriker and Yochelson 1968, Hoffman *et al.* 1974).

The traces of pedicle attachments of brachiopods are fairly common on the shells of the collected brachiopods. Those characteristic etching traces consist of a group of pits or holes which correspond to the hold-fast papillae, and, in *Terebratulina*, to rootlets. Bromley and Surlyk (1973) described a few types of such structures on the Cretaceous and Recent brachiopods under the ichnogenus *Podichnus*. In the material from Seymour Island, several types of *Podichnus*

have been found (Pl. 4, Figs 1–4), suggesting that they may have been produced by various brachiopod species or genera. The pits can be closely spaced (Pl. 4, Figs 1–2) or loosely arranged (Pl. 4, Figs 3–4), and are both symmetrical or asymmetrical. *Podichnus* may be produced by brachiopods with a thick, unbranched pedicle with hold-fast papillae. In the studied material *Hemithiris antarctica* Buckman, *Notosaria* species, *Liothyrella* species, *Terebratulina buckmani* Owen, *Murravia fosteri* Bitner, *Magellania antarctica* (Buckman), and *Macandrevia cooperi* Bitner may be responsible for it, as their Recent congeneric descendants have this type of pedicle (Schumann 1969; Bromley and Surlyk 1973; Lee 1978b, 1991; Richardson 1979, 1981; Curry 1981). Very similar pedicle boring traces were described by Małkowski (1975) on the brachiopod species *Coenothyris vulgaris* (Schlotheim) from the Triassic of Poland. It is noteworthy that *Podichnus* ichnospecies have been also found on the shells of Paleozoic brachiopods (Alexander 1994).

There are also other types of borings; one long, regularly branching, horizontal boring (Pl. 3, Fig 5), assigned to the ichnogenus *Talpina* produced by Phoronida (Voigt 1975, Bromley and Hanken 1981); horizontal microborings (Pl. 3, Fig. 6), probably made by fungi or algae; and irregular, interconnected chambers which may be of sponge origin (Pl. 3, Fig. 4).

Some specimens display scratch marks commonly concentrated around apertures of borings (see Pl. 4, Figs 5–6). Similar grooves, but much more regular, were interpreted by Bromley (1975) as produced by regular echinoids; regular echinoids were recognized in the investigated assemblage (see Radwańska 1996) and thus could be responsible for these scratching marks.

Concluding remarks

Epifaunal organisms and boreholes of various types were recognized only on about 10% of the brachiopod shells collected in the La Meseta Formation deposits from Seymour Island. Encrusting organisms are usually common on both fossil and Recent brachiopod shells (compare Rudwick 1962; Lee 1978a, b, 1987; Heliasz and Racki 1980; Brunton and Hiller 1990; Barnes and Clarke 1995); 80% specimens of Recent *Neocrania huttoni* carried epibionts (Lee 1987). In effect, one may suppose that environmental conditions were not suitable for epibionts. Brachiopods having low metabolic rate are probably more efficient and their requirements were lower than those of epibionts. However, Brookfield (1973) pointed out that the absence of epifauna on fossil shells cannot signify the lack of attached epifauna during life. The shells could have been covered with soft-bodied organisms, such as ascidians, sponges, algae, which disappear without trace soon after death. On the other hand, among the Recent brachiopods, even from the same locality, there are species almost covered by

epifauna and others completely free (Surlyk 1972) which is also difficult to explain. It is possible that the rarity of epifauna on the dead material can be explained by the rapid burial of shells. The character of sediments and sedimentary structures in the La Meseta Formation support this interpretation.

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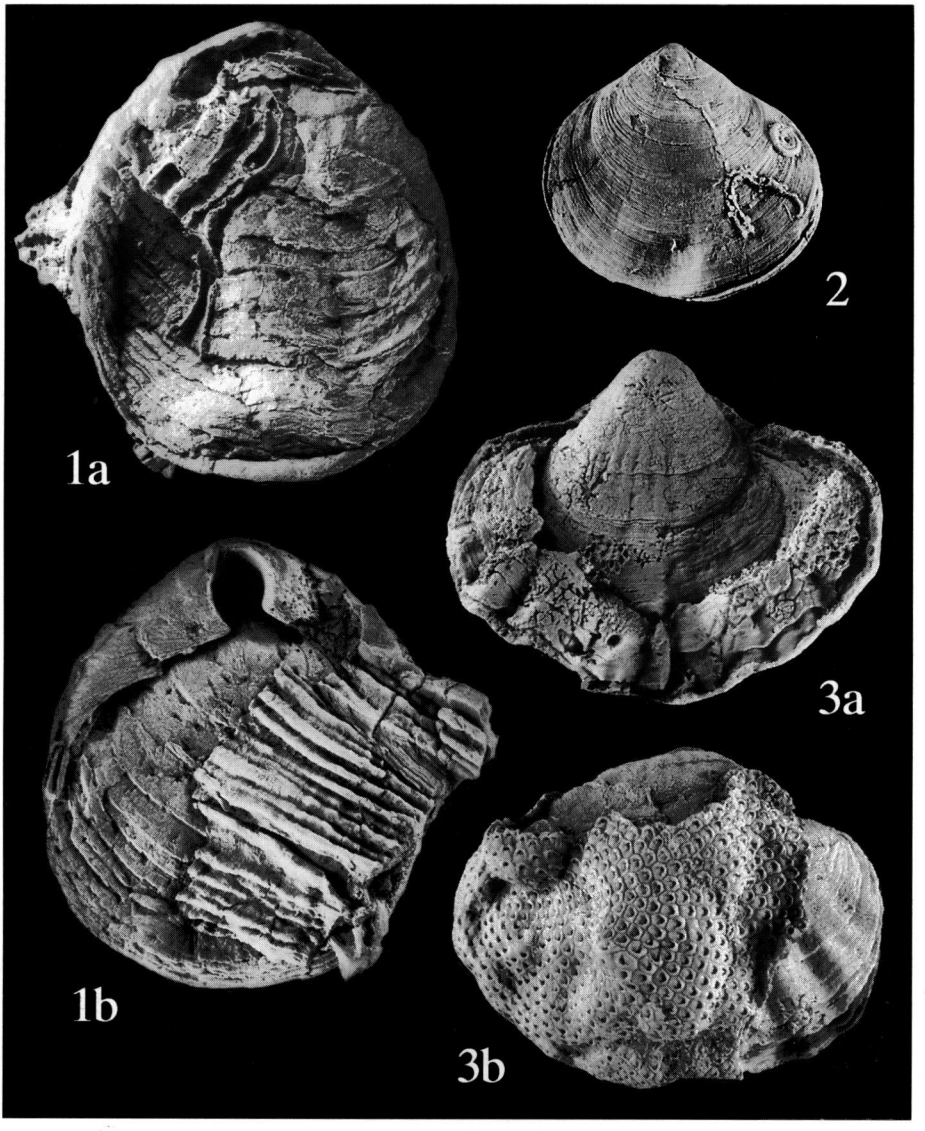
Streszczenie

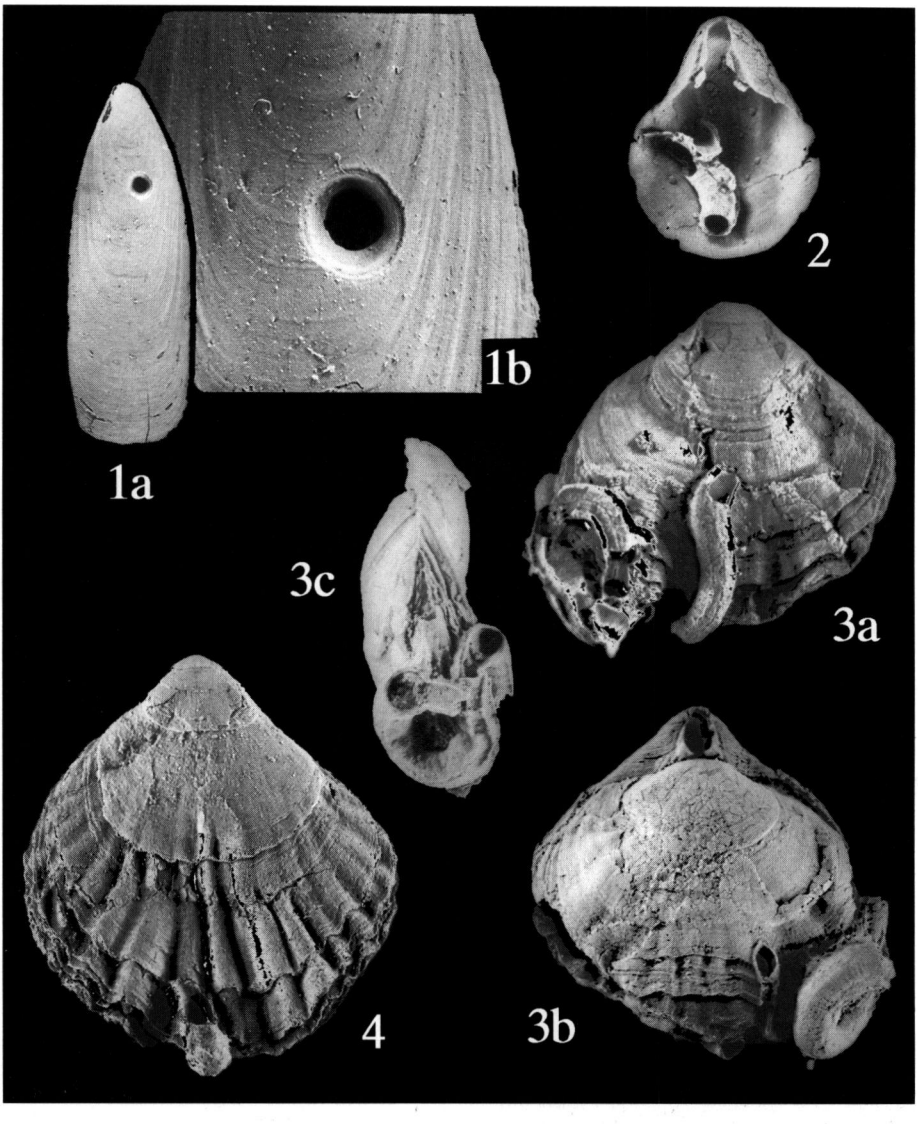
Eoceńskie ramienionogi z formacji La Meseta z Wyspy Seymour, Antarktyka (fig. 1) wykazują na powierzchni obecność organizmów inkrustujących oraz ślady organizmów wiercących i zdrapujących. Wśród inkrustujących dominują mszywioły (pl. 1, fig. 3) oraz otwornice (pl. 3, fig. 1–3), ale stwierdzono także rurki serpul (pl. 1, fig. 1a, 2; pl. 2, fig. 2–4), pąkle (pl. 1, fig. 1b) oraz przyczepy oktokorali. Wśród drążeń stosunkowo częste są struktury będące śladami przyczepu nóżki ramienionogów (pl. 4, fig. 1–4), opisane pod nazwą ichnorodzajową *Podichnus*, natomiast ślady drążeń ślimaków (pl. 2, fig. 1), foronidów (ichnogenus *Talpina*) i gąbek (pl. 3, fig. 4–6) są bardzo rzadkie. Również ślady zdrapywania (pl. 4, fig. 5–6) należą do rzadkich.

Jedynie 10% okazów wykazuje obecność organizmów inkrustujących oraz/lub ślady drążenia. Jest to niezwykle niska frekwencja w porównaniu z innych zespołami ramienionogów, zarówno kopalnymi jak i współczesnymi. Zjawisko to można wytłumaczyć najprawdopodobniej warunkami środowiska niekorzystnymi dla epibiontów — ramienionogi wykazują bardzo dużą tolerancję środowiskową. Brak porastania na martwych muszlach może wynikać z ich szybkiego pogrzebania.



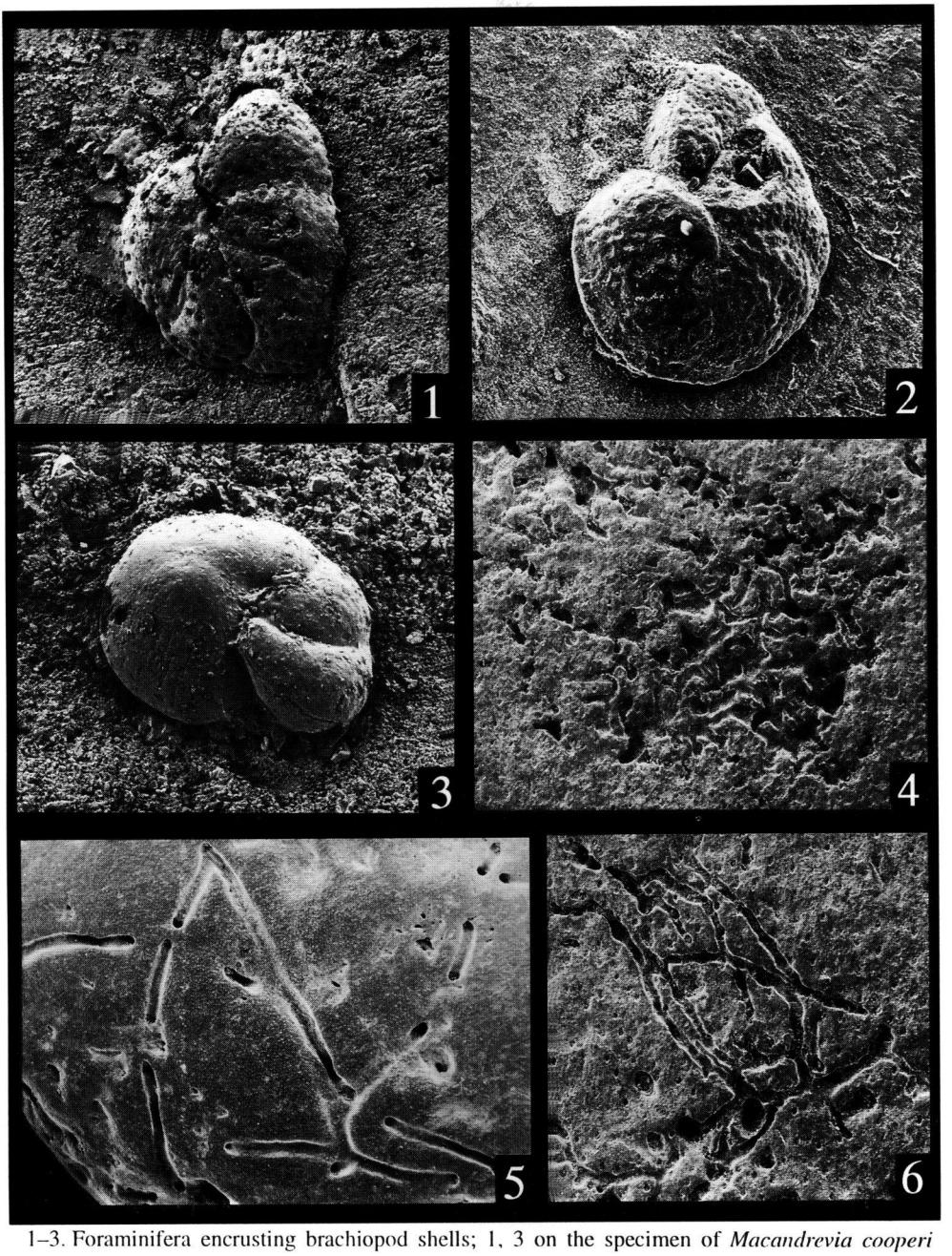
1. Ventral and dorsal views of undetermined specimen encrusted by a serpulid (1a) and barnacle (1b), ZPAL 8, Telm2, × 2.
2. Ventral view of complete specimen of *Basiliola minuta* Bitner encrusted by serpulids (including *Spirorbis*), ZPAL Bp.XXXVII/46, ZPAL 1, Telm1, × 3.
3. Ventral and dorsal views of an anascan cheilostome bryozoan-encrusted specimen of *Paraplicirhynchia gazdzickii* Bitner, ZPAL Bp.XXXVII/573, ZPAL 1, Telm1, × 3.

La Meseta Formation (Eocene), Seymour Island



1. Outer view of ventral valve of *Lingula antarctica* Buckman with naticid borehole, ZPAL Bp.XXXVII/1, Telm7; 1a × 1.5; 1b enlarged fragment to show details, × 7.
2. Inner view of pedicle valve of *Macandrevia cooperi* Bitner encrusted by a serpulid, ZPAL Bp.XXXVII/570, ZPAL 1, Telm1, × 2.
3. Ventral (3a), dorsal (3b) and lateral (3c) views of a serpulid (*?Galeolaria*) encrusted specimen of *Paraplicirhynchia gazdzickii* Bitner, ZPAL Bp.XXXVII/109, ZPAL 1, Telm1, × 3.
4. Ventral view of *Paraplicirhynchia gazdzickii* Bitner encrusted by a serpulid, ZPAL Bp.XXXVII/108, ZPAL 1, Telm1, × 3.

La Meseta Formation (Eocene), Seymour Island



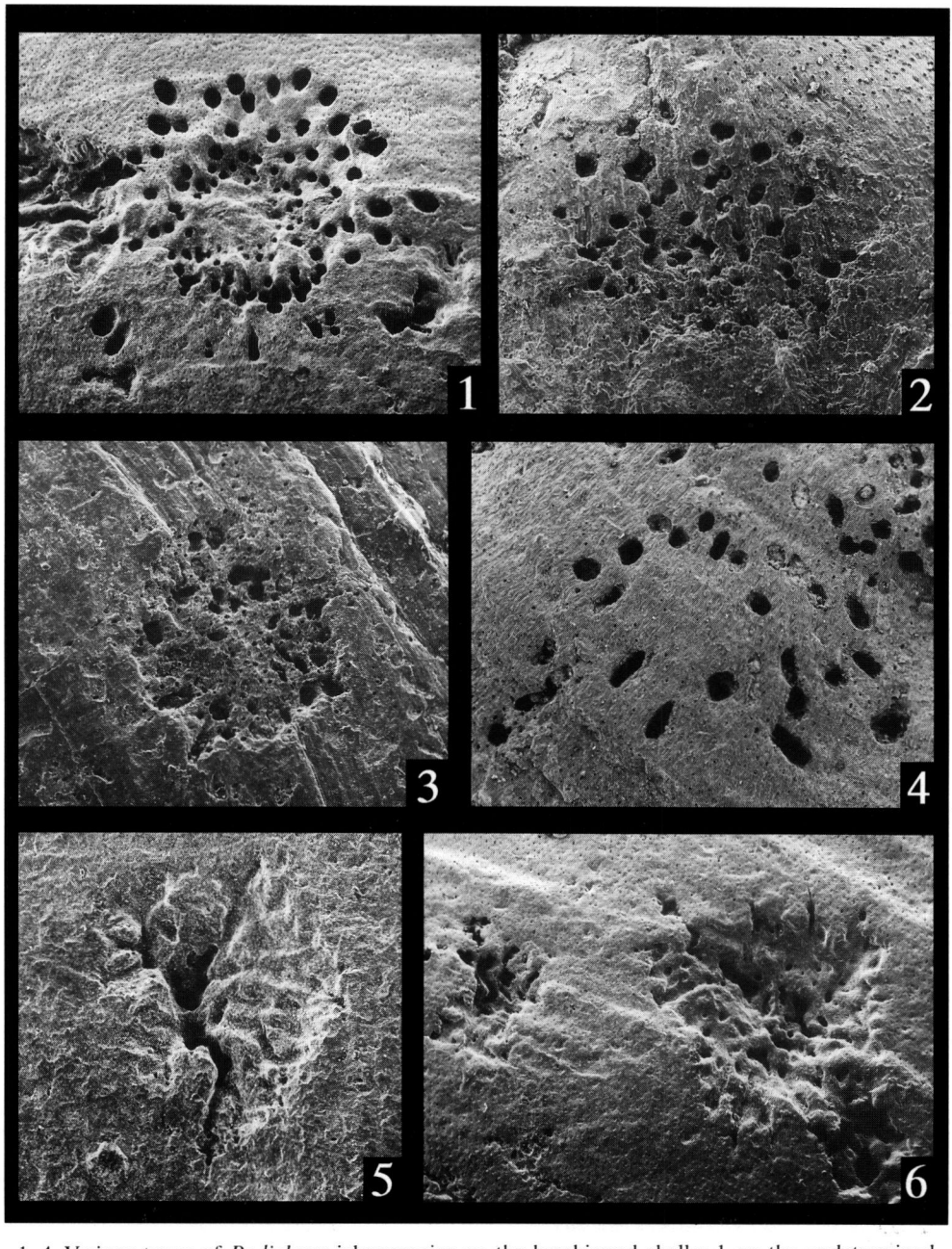
1–3. Foraminifera encrusting brachiopod shells; 1, 3 on the specimen of *Macandrevia cooperi* Bitner, ZPAL Bp.XXXVII/536, ZPAL 8, Telm2, × 110 and × 225, respectively; 2 on *Stethothyris* sp., ZPAL Bp.XXXVII/572, ZPAL 8, Telm2, × 57.

4. Borings probably of sponge origin on the undetermined specimen, ZPAL 1, Telm1, × 27.

5. Borings produced by Phoronida, *Talpina* isp. on *Liothyrella* sp., ZPAL Bp.XXXVII/126, ZPAL 1, Telm1, × 8.

6. Probably algoid microborings on the undetermined specimen, ZPAL 1, Telm1, × 40.

La Meseta Formation (Eocene), Seymour Island



1–4. Various types of *Podichnus* ichnospecies on the brachiopod shells; 1 on the undetermined specimen, ZPAL 1, Telm1, × 12; 2 on *Macandrevia cooperi* Bitner, ZPAL Bp.XXXVII/537, ZPAL 8, Telm2, × 30; 3 on *M. cooperi*, ZPAL Bp.XXXVII/538, ZPAL 8, Telm2, × 27; 4 on *Magella australis* (Buckman), ZPAL Bp.XXXVII/479, ZPAL 8, Telm2, × 18.

5–6. Scratch marks, slightly similar to those produced by regular echinoids, situated around the apertures of small borings on brachiopod shells, undetermined specimens, ZPAL 1, Telm1; 5 × 18; 6 × 15.

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