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CAMBRIAN MICROFOSSIL *HADIMOPANELLA* GEDIK FROM GLACIAL ERRATICS IN WEST ANTARCTICA

(Plates 5—8)

WRONA, R.: Cambrian microfossil *Hadimopanella* GEDIK from glacial erratics in West Antarctica. Palaeontologia Polonica, 49, 37—48, 1987.

A discoidal phosphatic microfossil, *H. antarctica* sp. n., is described from Antarctic limestones occurring within erratic boulders (dropstones) in glacio-marine rocks of the Lower Miocene Cape Melville Formation at King George Island (South Shetland Islands, West Antarctica). The erratics are dated as Early Cambrian on the basis of the co-occurrence of small shelly fossils such as tommotiids, lapworthellids, *Chancelloria*, *Halkieria* and *Mongolitubulus*. The first natural association of a dozen sclerites of the genus *Hadimopanella* is reported. These are arranged one next to the other in a single layer representing a fragment of the skeletal armour of an unknown animal body. There is erected a new family, Utahphosphidae fam. nov., comprising the two genera *Utahphospha* MÜLLER and MILLER, and *Hadimopanella* GEDIK. The new microfossils are compared with similar problematic ones known from the Lower Palaeozoic of other regions.

Key words: Phosphatic microfossils, *Hadimopanella*, *Utahphospha*, Utahphosphidae, Cambrian, Cape Melville Formation, Lower Miocene, Antarctica.

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KAMBRYJSKA MIKROSKAMIENIAŁOŚĆ *HADIMOPANELLA* GEDIK Z TRZECIORZĘDOWYCH GŁAZÓW NARZUTOWYCH ANTARKTYKI ZACHODNIEJ

Streszczenie. — Opisano nowy gatunek dyskoidalnych mikroskamieniałości fosforanowych *H. antarctica* sp. n., znalezionych w wapiennych głazach narzutowych, pochodzących z kontynentu antarktycznego. Występują one w lodowcowo-morskich osadach dolnomioceńskiej formacji Cape Melville na Wyspie Króla Jerzego w Antarktyce Zachodniej. Na podstawie współwystępujących z *H. antarctica* sp. n. skamieniałości, należących do rodzajów: *Chancelloria*, *Hakielria* i *Mongolitubulus*, oraz tommotiidów i lapworthellidów określono wiek eratyków jako kambr dolny. Po raz pierwszy opisano grupę kilkunastu sklerytów z rodzaju *Hadimopanella* ułożonych w sposób naturalny jeden obok drugiego, w jednej warstwie, która stanowiła fragment zewnętrznej okrywy szkieletowej organizmu. Ustanowiono nową rodzinę Utahphosphidae fam. n., obejmującą dwa rodzaje: *Utahphospha* MÜLLER et MILLER oraz *Hadimopanella* GEDIK. Opisane mikroskamieniałości porównano z podobnymi problematycznymi mikroskamieniałościami z wczesnego paleozoiku innych regionów.

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INTRODUCTION

Intense studies on small shelly fossils of the Early Paleozoic with recognition of their great potential for biostratigraphy and correlations, has resulted in discoveries of several new species of enigmatic phosphatic microfossils. Of special interest are button-shaped sclerites, found in strata ranging in age from the Cambrian to Ordovician in Asia, Europe, North America, Svalbard and Greenland. I report here, for the first time, such microfossils from the Antarctic region.

The described microfossils, the first examples from the Southern Hemisphere, come from Antarctic erratics, gathered during field work led by K. BIRKENMAJER of the Fifth Polish Antarctic Expedition 1980—1981 on King George Island. This study has been carried out within the frame of the Research Project MR. I. 29. of the Polish Academy of Sciences.

SEM micrographs were taken at the Electron Microscopy Laboratory of the Nencki's Institute of Experimental Biology, Warsaw.

The collections of erratic boulders and microfossils are housed in the Institute of Paleobiology, Polish Academy of Sciences, Warsaw (abbreviated as ZPAL).

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ERRATIC BOULDERS: AGE AND PROVENANCE

Erratic boulders are scattered in glacio-marine sediments of the Cape Melville Formation in the Melville Peninsula, the easternmost part of the King George Island (fig. 1). The formation comprises a sequence of shales with intercalations of siltstones, marls and sandstones, up to 200 m in thickness (BIRKENMAJER 1982*a*, 1984, 1987 this volume, GAŹDZICKI and WRONA 1982, BIRKENMAJER *et al.* 1983). It is cut by numerous basalt and andesite dykes. Two of these dykes have been recently dated with the use of the K-Ar method at about 20 Ma, i. e. Early Miocene, which shows that the glacio-marine sequence has to be older (BIRKENMAJER *et al.* 1985).

Rocks of the Cape Melville Formation are rich in marine micro- and macrofossils. The microfossil assemblage is comprised of coccolithophorinales, diatoms, chrysomonad cysts, silicoflagellates, calcareous and arenaceous foraminifers and polychaete jaws (GAŹDZICKI and WRONA 1982, BIRKENMAJER *et al.* 1983, SZANIAWSKI and WRONA 1987, this volume), solitary corals (RONIEWICZ and MORYCOWA 1987, this volume), decapods (FÖRSTER *et al.* 1985, 1987, this volume), bivalves and gastropods (KARCZEWSKI 1987, this volume), echinoids (JESIONEK-SZYMAŃSKA 1987, this volume), asteroids, bryozoans and fish remains (GAŹDZICKI and WRONA 1982, BIRKENMAJER *et al.* 1983).

The Cape Melville Formation is characterized by the presence of ice-rafted Cretaceous belemnites (BIRKENMAJER *et al.* 1987, this volume) and blocks of rocks completely extraneous

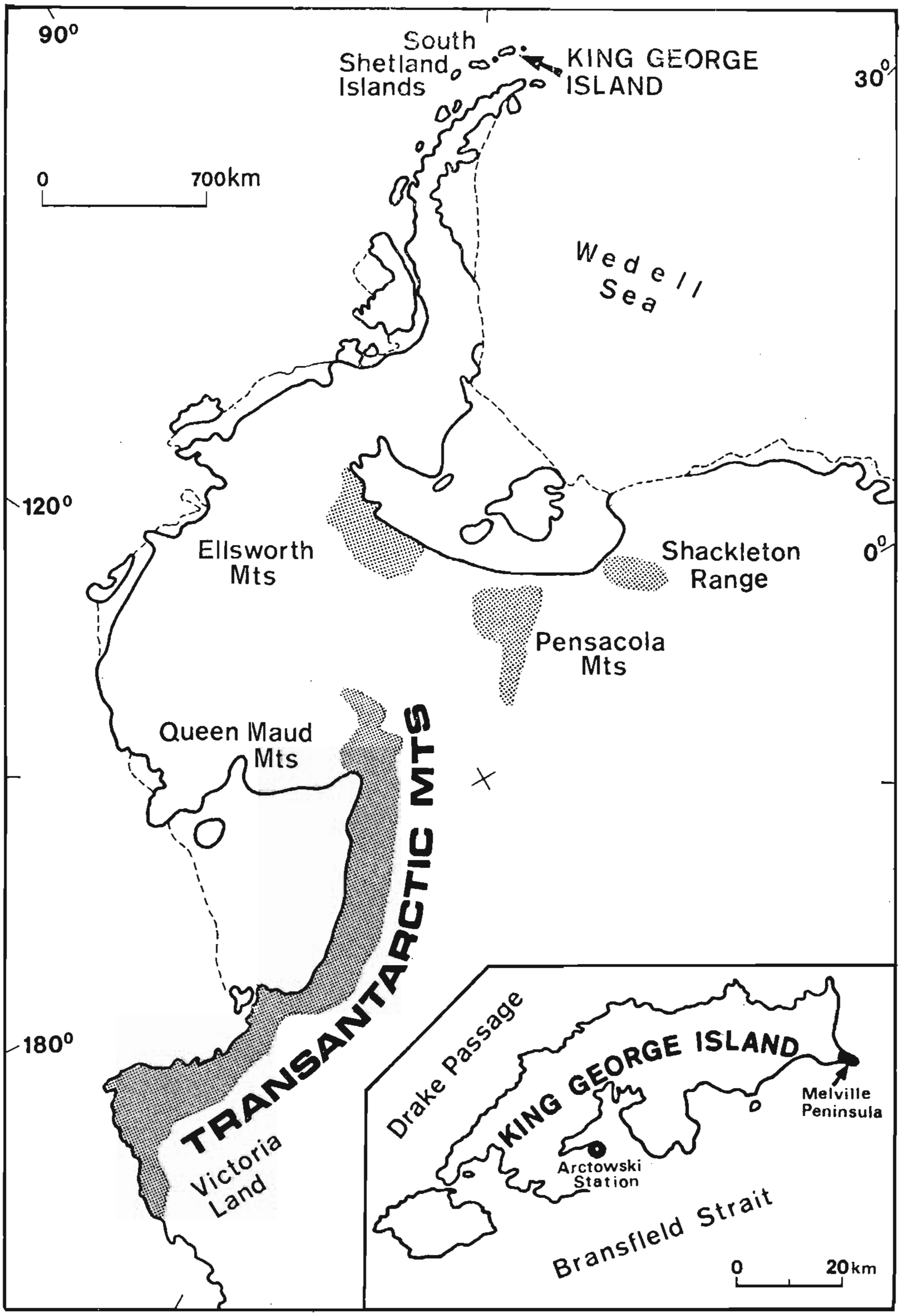

Fig. 1
Map of West Antarctica showing location of the South Shetlands archipelago and distribution of fossiliferous Cambrian rocks (stippled); arrowhead shows locality of glacial erratics in the Cape Melville Formation, King George Island.

for King George Island. The latter are interpreted as dropstones — exotic blocks brought to that area from the Antarctic continent by icebergs during the Early Miocene glacial epoch, named as the Melville Glaciation (BIRKENMAJER 1982*a*, 1982*c*, 1984; BIRKENMAJER *et al.* 1983). The blocks, usually angular and up to 50 cm in diameter (but sometimes even up to 2 m in diameter), represent fragments of metamorphic igneous and sedimentary rocks, sometimes with well preserved glacial striae at polished surfaces. They have been gathered at erosional surface in the Melville Peninsula, where they are exposed and concentrated due to resistance to erosion higher than that of surrounding sediments (shales). For paleontological studies over a hundred fragments of sedimentary rocks, mainly potentially fossiliferous limestones have been collected. For petrographic studies (carried out by K. BIRKENMAJER) — fragments of rocks of other types were collected. Limestone blocks were at first studied in thin sections and, subsequently, by etching (WRONA 1983). Most characteristic types of these rocks include light-coloured archaeocyathan-algal and black limestones rich in small shelly fossils. Button--shaped sclerites of *H. antarctica* sp. n. and other microfossils have been found in thin sections and residues from three boulders briefly described below:

Boulder Me. 33. Fairly well rounded block of black limestone, about 10 cm × 10 cm in size and about 1 kg in weight. Thin section studies showed that the rock is rich in hyolithid shells infilled with sediment darker than the surrounding one. The block yielded a variety of fossils: archaeocyathan, poriferan, inarticulate brachiopods *Lingulella* sp., monoplacophorans, gastropods *Anabarella* sp. and *Helcionella* sp., hyoliths, trilobites, ostracods *Hipponicharion* sp., and *Indiana* sp., and representatives of enigmatic microfossil groups such as *Chancelloria* sp., *Halkieria* sp., and tommotiids, lapworthellids, and hyolithelminths.

Boulder Me. 40. Angular block of slightly bituminous, finecristalline limestone, black on fresh surfaces and gray on the weathered one, about 1 kg in weight. It yielded inarticulate brachiopods *Lingulella* sp.

Boulder Me. 66. Somewhat angular boulder 30 m × 20 cm in size, about 5 kg in weight, and similar in lithology to boulder No. Me. 33. It yielded a variety of fossils including archaeocyathan, inarticulate brachiopods *Lingulella* sp., monoplacophorans, gastropods *Anabarella* sp. and *Helcionella* sp., hyoliths, trilobites, ostracods *Hipponicharion* sp., and *Indiana* sp., and representatives of enigmatic microfossil groups such as *Chancelloria* sp., *Halkieria* sp., *Mongolitubulus* sp., tommotiids and hyolithelminths.

Lithology and paleontological record of the boulders Me. 33 and Me. 66 show that they possibly represent fragments of the same limestone package and the boulder Me. 40 — limestone of the same or similar age as the above but from a deeper facies. Although the majority of fossils extracted from these boulders are known from the Lower to Upper Cambrian, the cooccurrence and high frequency of the taxa appear typical of the Lower Cambrian Atdabanian (see MATTHEWS and MISSARZHEVSKY 1975, MISSARZHEVSKY and MAMBETOV 1981, BENGTSON 1983, LANDING 1984, CONWAY MORRIS and FRITZ 1984). This seems to be supported by the fact that microfossils of the genera *Mongolitubulus* and *Halkieria*, recorded in the studied boulders, are known from the Lower Cambrian only (MISSARZHEVSKY and MAMBETOV 1981, BENGTSON and CONWAY MORRIS 1984). The presence of these fossils along with inarticulate brachiopods make it possible to date precisely the age of limestones with *H. antarctica* sp. n. as Early Cambrian (MATTHEWS and MISSARZHEVSKY 1975). It should be also noted that the above listed microfossils were until now unknown from the Antarctic region. The majority of them include forms widely distributed in the Cambrian of North America, Europe, Asia and Australia, whereas the record of sclerites *Mongolitubulus* makes the assemblage closer to the Lower Cambrian assemblages of Asia. This is in agreement with affinities indicated by earlier records of Middle and Late Cambrian fauna of brachiopods, mollusca and trilobites from Antarctica (WEBERS 1972, YOCHELSON *et al.* 1973, SHERGOLD *et al.* 1976).

Fossiliferous Cambrian rocks are known from some parts of the Antarctic continent: Ellsworth Mountains, Pensacola Mountains and Transantarctic Mountains (for summary see SHERGOLD *et al.* 1976, MORYCOWA *et al.* 1982). Lower Cambrian rocks are almost exclusively known on the basis of morainic blocks of light coloured archaeocyathan-algal limestones from the Transantarctic Mountains (*op. cit.*). Black limestones yielding the above described assemblage of fossil remain unknown from that continent covered by ice. However, general lithological composition of the whole spectrum of erratics from the Cape Melville Formation and its similarity to that of erratics brought to King George Island in times of the Polonez Glaciation (BIRKENMAJER 1980, 1982*b*, 1983; MORYCOWA *et al.* 1982, BIRKENMAJER and WIESER 1985) suggest that outcrops of Lower Cambrian rocks stretching around the Weddell Sea (Ellsworth Mts, Pensacola Mts and northern Transantarctic Mts) acted as source areas of the boulders.

MATERIAL

After etching about seven kg of rocks in 10% acetic acid, over 500 phosphatic sclerites of *H. antarctica* sp. n. have been collected from the residuum. However, it should be noted that the number of sclerites present in the residuum is at least three times larger. There were also found three fragments of armours displaying natural arrangements of sclerites. Detailed SEM studies covered some dozens of isolated sclerites and one fragment of armour. Attempts to make thin and polished sections for analysis of internal structure of sclerites failed to give positive results possibly because of poor preservation and very small dimensions of the fossils.

SYSTEMATIC DESCRIPTION

Phylum, class and order — *incertae sedis*
Family **Utahphosphidae** fam. n.

Type genus: *Utahphospha* MÜLLER and MILLER, 1976

Diagnosis. — Skeletal armour formed of more or less densely spaced microscopic phosphatic sclerites, usually discoidal in shape and more or less flat, unornamented but rough at one side and clearly ornamented with one or more nodes and/or circular rims at the opposite one, and with fine, bilayered structure. In coherent armour, sclerites are circular to polygonal in outline and embeded in intersclerite plate material which forms a third layer.

Remarks. — The new family comprises two genera: *Utahphospha* MÜLLER and MILLER, 1976 and *Hadimopanella* GEDIK, 1977. Similarity of the two genera was noted previously by REPETSKI (1981), who even assumed that *Hadimopanella* may be a junior synonym of *Utahphospha*. Similarly DZIK 1986 placed the two genera in a single *Hadimopanella-Utahphospha* group, suggesting that along with sclerites of the genus *Milaculum* MÜLLER, 1973, they could represent an evolutionary line of dermal skeleton in primitive chordates.

Common morphological, structural and functional features, indicating homology of sclerites of the genera *Utahphospha* and *Hadimopanella*, from the basis for recognition of a monophyletic taxonomic family group.

The homology of sclerites within the two genera is unquestionable, but they are not congengeneric and display marked differences. Sclerites of *Utahphospha*, connected by mineralized infilling layer, were forming a coherent armour in which individual sclerites were varying from circular to polygonal in outline (MÜLLER and MILLER 1976, REPETSKI 1981), whereas those of *Hadimopanella* were not connected with mineralized layer but are loosely arranged one next to the other, retaining a circular outline and always preserved as isolated fossil specimens.

Sclerite of the genus *Milaculum* could have similar functions as those of the family Utahphosphidae fam n. but they differ from the latter in lacking a hyaline outer layer that would clearly differ from the porous internal (basal) core, and markedly larger size, an elongate subovate outline, and a complex system of large channels in internal structure. It seems that hyaline outer part of sclerites of the family Utahphosphidae fam. n. was formed from the outside and that the basal core formed from the inside (see MÜLLER and MILLER 1976, BENGTSON 1977, DZIK 1986), so the above mentioned differences in structure of *Milaculum* sclerites do not indicate homology but rather analogy with the newly proposed family.

Genus *Hadimopanella* GEDIK, 1977

Type species: *Hadimopanella oezgueli* GEDIK, 1977

Remarks. — The genus comprises four species: *H. oezgueli* GEDIK — known from the Middle Cambrian of Turkey (GEDIK 1977), Spain (van der BOOGAARD 1983) and as a redeposited material in Lower Ordovician sandstones of the Ladozskaya suite in Estonia (Kaisa Mens, personal information); *H. knappologica* (BENGTSON) — known from the Lower Cambrian of Siberia (BENGTSON 1977); *H. apicata* WRONA — from the Lower Cambrian of Svalbard (WRONA 1982) and Greenland (Peel and Larsen 1985); and *H. antarctica* sp. n. — from the inferred Lower Cambrian of Antarctica.

Hadimopanella antarctica sp. n.
(pls. 5—8; figs 2—4)

Holotype: Specimen shown in pl. 8 : 2; ZPAL V. VI/28S3.
Type horizon: The inferred mid part of the Lower Cambrian.
Type locality: Erratic boulders of Antarctic origin, No. Me. 66. in glacio-marine Cape Melville Formation (Lower Miocene), King George Island, South Shetland Islands, West Antarctica.
Derivation of the name: *antarctica* — found in Antarctica.

Diagnosis. — Discoidal, microscopic sclerite, with lower surface smooth and flat to shallowly convex, and the upper — strongly convex, with a pointed central apex, which is surrounded by a crown of regulary spaced minute nodes. Internal structure bilayered: thick inner core covered with a thin denser layer.

Dimensions (in μm):

		Diameter
ZPAL V. VI/28S3.	Holotype	91
	Range	55—93
	Mode	75

Description. — Sclerites very small, usually circular to subcircular in outline, up to 42 μm high and with diameter 2.5 to 4 time larger than the height (pl. 7 : 4). Lower (inner) surface unornamented, rough, passing through rounded margin into strongly convex upper (outer) surface with conical apex (pl. 6 : 2, 3; pl. 7 : 4; fig. 2). The apex surrounded by 9 to 13 minute nodes. The nodes arranged in a form of regular rim spaced closer to sclerite margin than the center, are 3—4 times smaller than central conical apex (fig. 2). These nodes are of the same size in a given rim and are spaced regularly at a different distances: from a small (pl. 5 : 1;

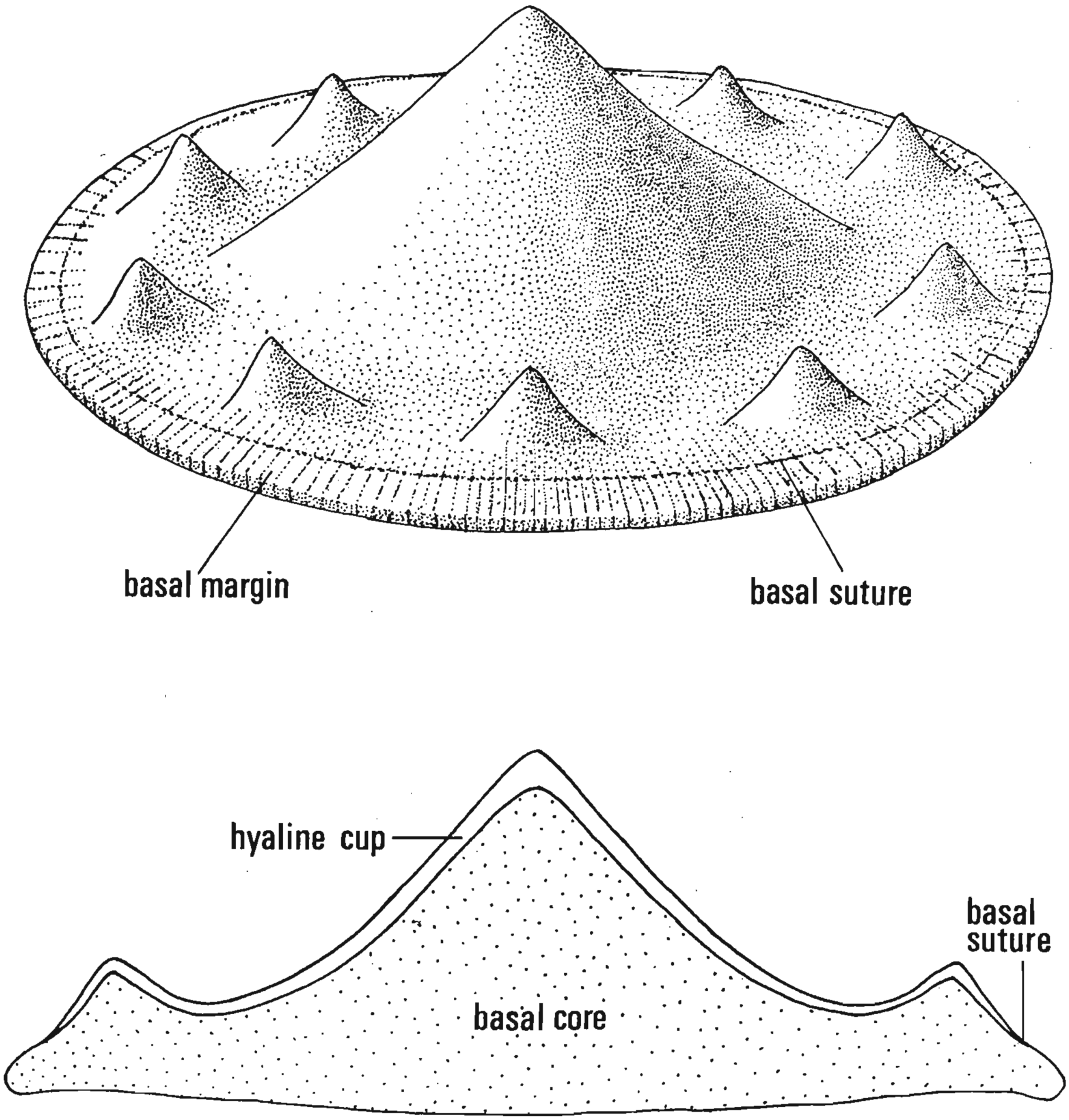

Fig. 2
Diagramatic morphology and cross section of a sclerite.

fig. 3c) to a large (pl. 5 : 6; pl. 6 : 3, fig. 3a). When large nodes are situated very close to the margin of sclerite, the margin becomes uneven, wavy (pl. 5 : 1, 3, 4, 5; fig. 3a, c, d). Basal margin sometimes displays a suture of outer and inner layers (pl. 5 : 4, 6) and radial striae, sometimes continuing from basal core to a dense layer covering it (pl. 5 : 4, 6; pl. 7 : 1, 3; pl. 8 : 1). Outer layer often almost completely covers basal core, obscuring basal margin at the upper surface. The majority of sclerites are characterized by surface displaying traces of intense mechanical corrosion (pl. 5 : 3; pl. 6 : 4) or etching in the course of processing of samples (pl. 6 : 2, 3, 4; pl. 7 : 3). Sclerites are often fractured or with broken-off margins (pl. 5 : 2, 4; pl. 7 : 2, 3; pl. 8) and more or less strongly coated with mineral matter and crystals pressed into their surface (pl. 5 : 4, 5; pl. 8 : 1). Such mineral coating protected natural arrangement of sclerites loosely spaced in relation to one another in a single layer. In that case all the sclerites are oriented with nodular face in the same direction — upwards (see pl. 8 : 1; fig. 4).

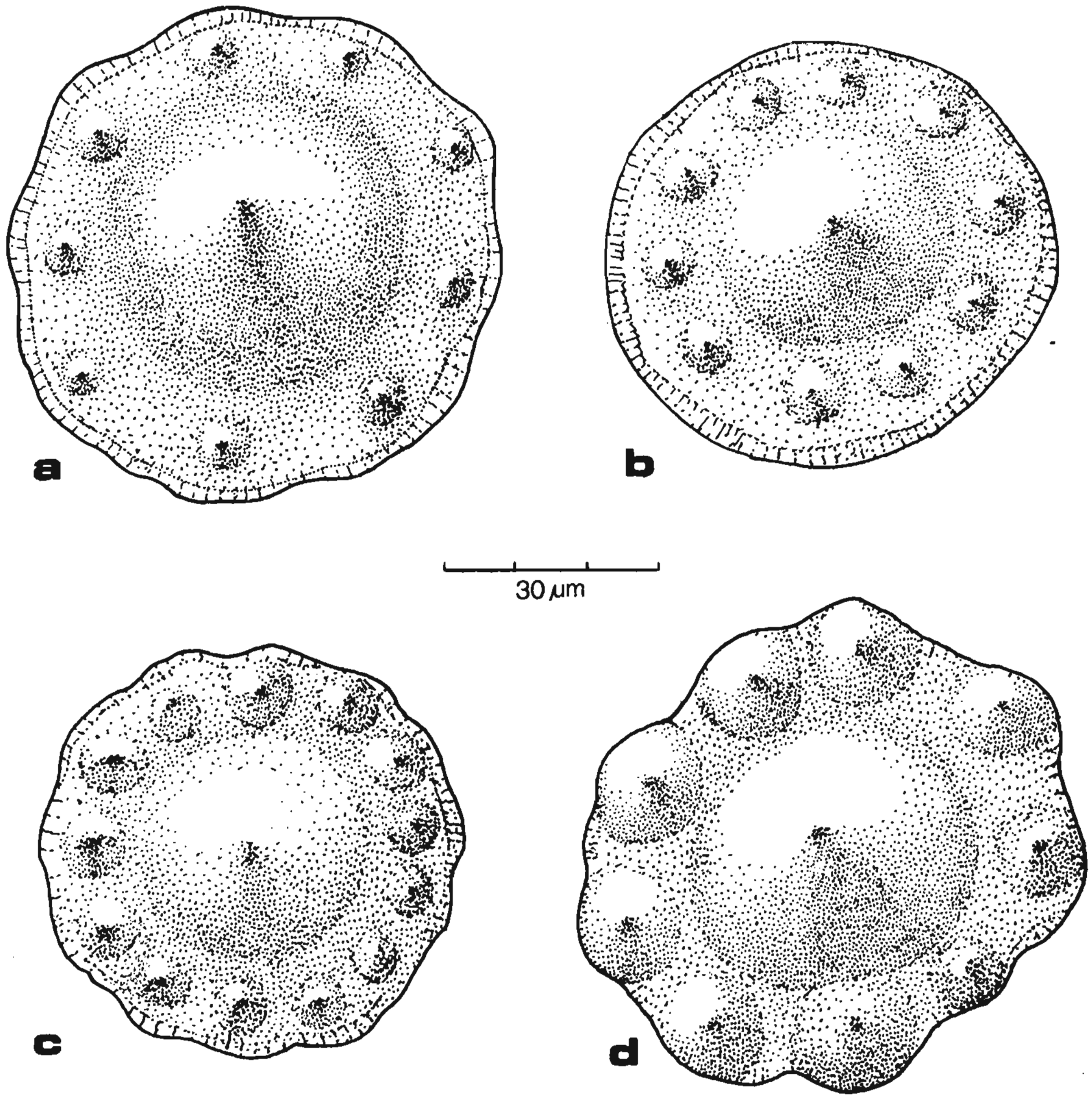

Fig. 3
Variability in size and morphology of sclerites.

There have been found three such groups, comprising from a few to about a dozen sclerites, and representing fragments of a large armour. Moreover, there were found aggregates of two to three sclerites, juxtaposed back to back. These aggregates are similar to those described by Repetski (1983, pl. 1 : 9).

Remarks. — Sclerites assigned to *H. antarctica* sp. n. are markedly smaller than those hitherto allocated in this genus (Gedik 1977, Bengtson 1977, Wrona 1982, van der Boogaard 1983, Peel and Larsen 1985).

Sclerites of the new species markedly differ in morphology of upper surface from those allocated in other species of that genus. They appear most similar to those of *H. apicata* Wrona in general shape, differing in surface ornamented with both central apex and a number of minor nodes arranged in a rim in proximity of basal margin. Some sclerites of other species, e. g. *H. oezgueli* or *H. knappologica*, may be ornamented with numerous nodes in a similar arrangement: one situated in the center and others around it in rim-like way (BENGTSON 1977, fig. 1b; van der BOOGAARD 1983, fig. 4a). However, in the latter case the nodes are uniform in size and always concentrated close to the center of sclerite.

Sclerites of *H. antarctica* sp. n. are also similar to single Ordovician representatives of *Utahphospha cassiniana* REPETSKI, which in comparison with them, form coherent armour consolidated with intersclerite plate material, are ornamented with nodes almost uniform in size, and sometimes merge with one another in the form of a single smooth rim (REPETSKI 1983, pl. 1 : 9, 10, 11).

It should be noted that the findings of sclerites of *H. antarctica* sp. n. in natural arrangements support very well BENGTSON's interpretation and hypothetic reconstruction of dermal armour composed with sclerites (BENGTSON 1977, fig. 7). Simultaneously, these

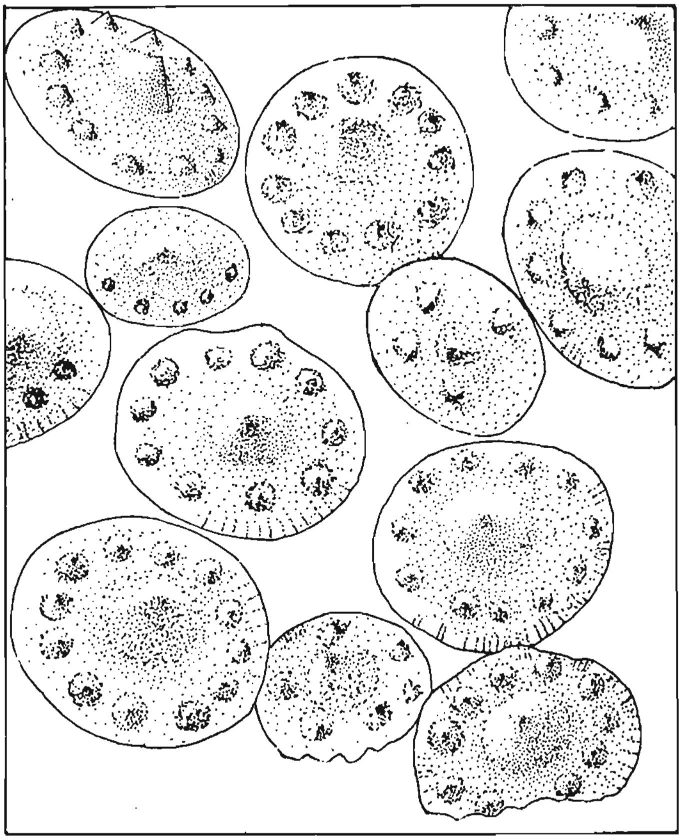

Fig. 4
A fragment of natural assemblage of sclerites (armour) *Hcdimopanella antarctica* sp. n.; drawing based on SEM micro graph from pl. 8 : 1*a*.

findings are an excellent argument for invallidation again an alternative and discarded explanation *op. cit.* which suggests that sclerites may represent opercula of tube-dwelling animals. The shape and size of the armour remain difficult to reconstruct, but the common findings of sclerites juxtaposed back to back implicates that the armour was circular in cross--section or, perhaps, tubular or conoidal, like the armour of the genus *Utahphospha* (see MÜLLER and MILLER 1976). Armour of such shape, when flattened by compaction, may form bilayered aggregates juxtaposed back to back.

Occurrence. — Antarctica (South Shetland Islands, King George Island): upper Lower Cambrian, erratic boulders in glacio-marine Cape Melville Formation (Lower Miocene).

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EXPLANATIONS OF THE PLATES 5—8

All specimens come from Cambrian glacial erratcs found in the Cape Melville Formation (Lower Miocene) at Melville Peninsula, King George Island, West Antarctica. All figures (except that shown in pl. 5 : 2 taken under ordinary light microscope) are SEM micrographs.

PLATE 5

Hadimopanella antarctica sp. n.

1. Coated sclerite in top view; Erratic boulder Me. 33; ZPAL V. VI/25S27, × 1000.
2. Sclerite under transmitted, ordinary light microscope; Erratic boulder Me. 40; ZPAL V. VI/26S11, × c. 500.
3. Coated and corroded sclerite in top view; Erratic boulder Me. 66; ZPAL V. VI/26S2, × 800.
4. Sclerite in top view, central part considerably coated with mineral grains pressed into the surface; note basal suture and striae (arrowed); Erratic boulder Me. 66; ZPAL V. VI/26S9, × 1000.
5. Considerably coated sclerite in top view; Erratic boulder Me. 33; ZPAL V. VI/25S7, × 1000.
6. Partly coated sclerite in top view; note striae and irregular contact line of two layer; Erratic boulder Me. 33; ZPAL V. VI/25S8, × 1000.

PLATE 6

Hadimopanella antarctica sp. n.

1. Considerably coated sclerite in top view; Erratic boulder Me. 33; ZPAL V. VI/25S22, × 1000.
2. Coated central apex of sclerite; Erratic boulder Me. 33; ZPAL V. VI/25S9, × 3000.
3. *a*, coated sclerite in top view; Erratic boulder Me. 33; ZPAL V. VI/25S18, × 1000; *b*, central apex of the same sclerite, × 3000.
4. *a*, coated and corroded sclerite in top view; Erratic boulder Me. 40; ZPAL V. VI/25S32, × 1000; *b*, central apex of the same sclerite, × 3000.

PLATE 7

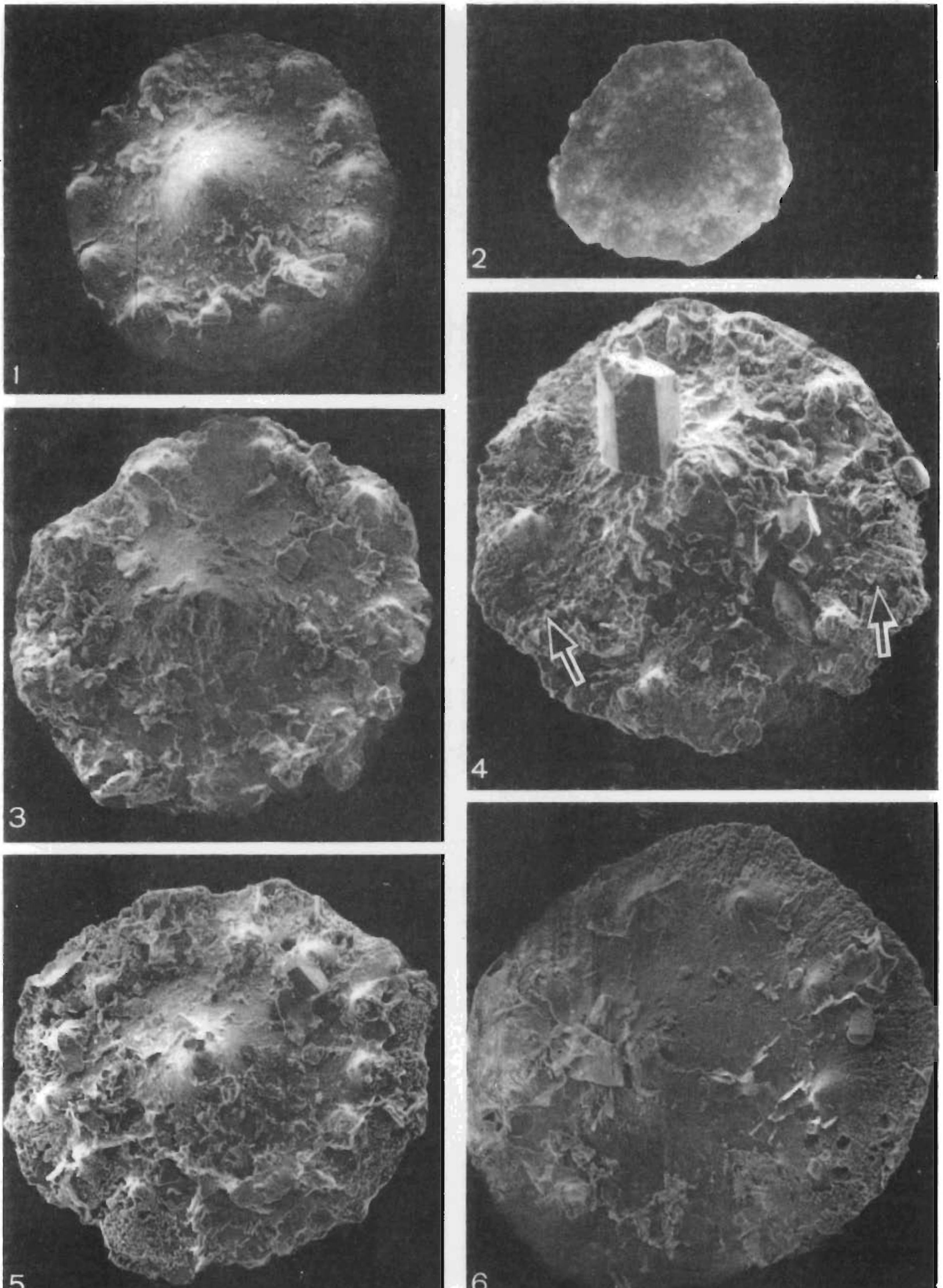
Hadimopanella antarctica sp. n.

1. Considerably coated sclerite in top view; Erratic boulder Me. 40; ZPAL V. VI/26S11, × 800.
2. Sclerite in bottom view; Erratic boulder Me. 40; ZPAL V. VI/25S15, × 1000.
3. *a*, markedly corroded sclerite; Erratic boulder Me. 66; ZPAL V. VI/26S35, × 1000; *b*, corroded or etched fibrous basal margin (rim) of the same sclerite, × 3000; *c*, corroded or etched central apex of the same sclerite, × 2000.
4. Coated sclerite in oblique lateral view; Erratic boulder Me. 66; ZPAL V. VI/28S8, × 1500.

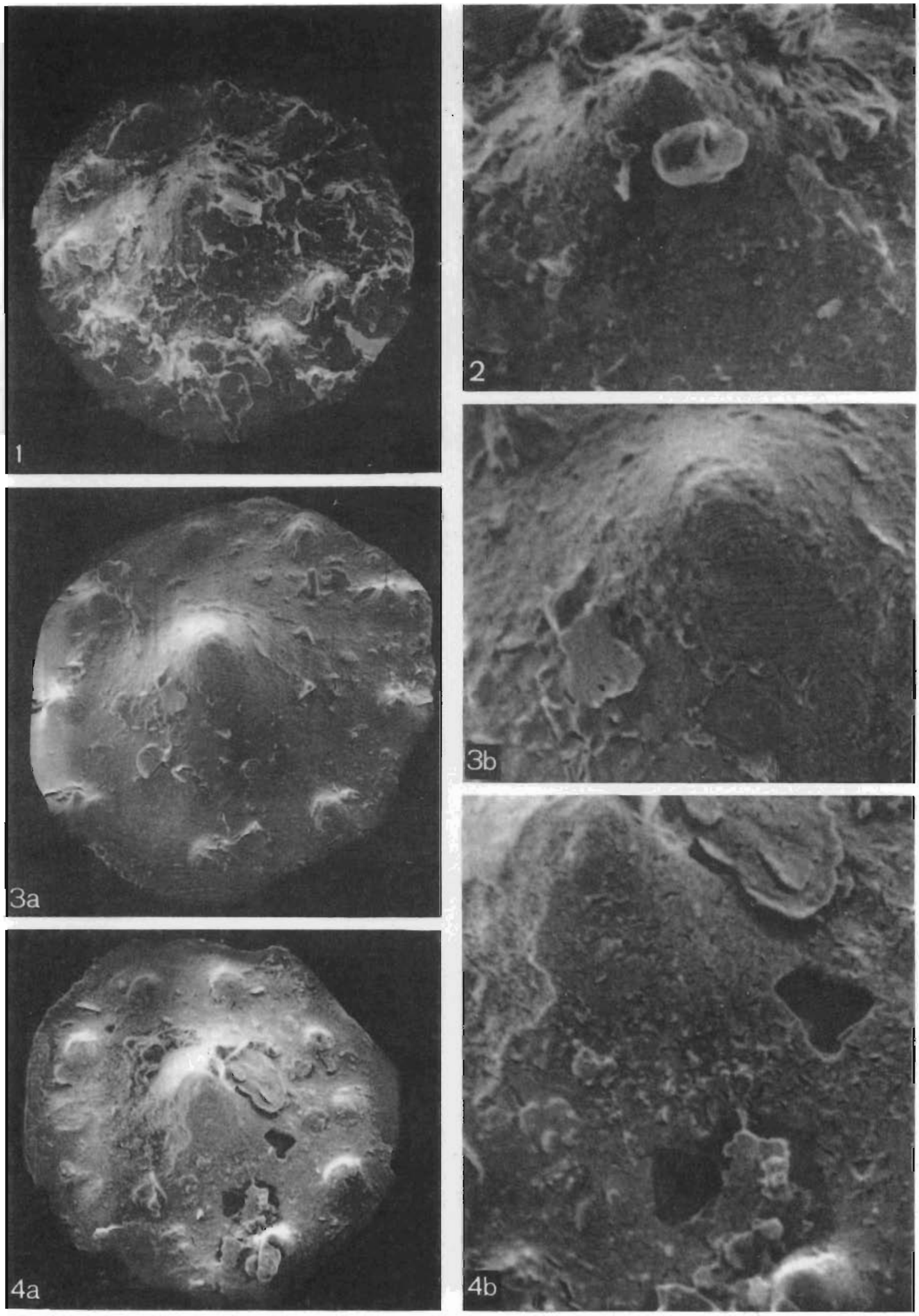
PLATE 8

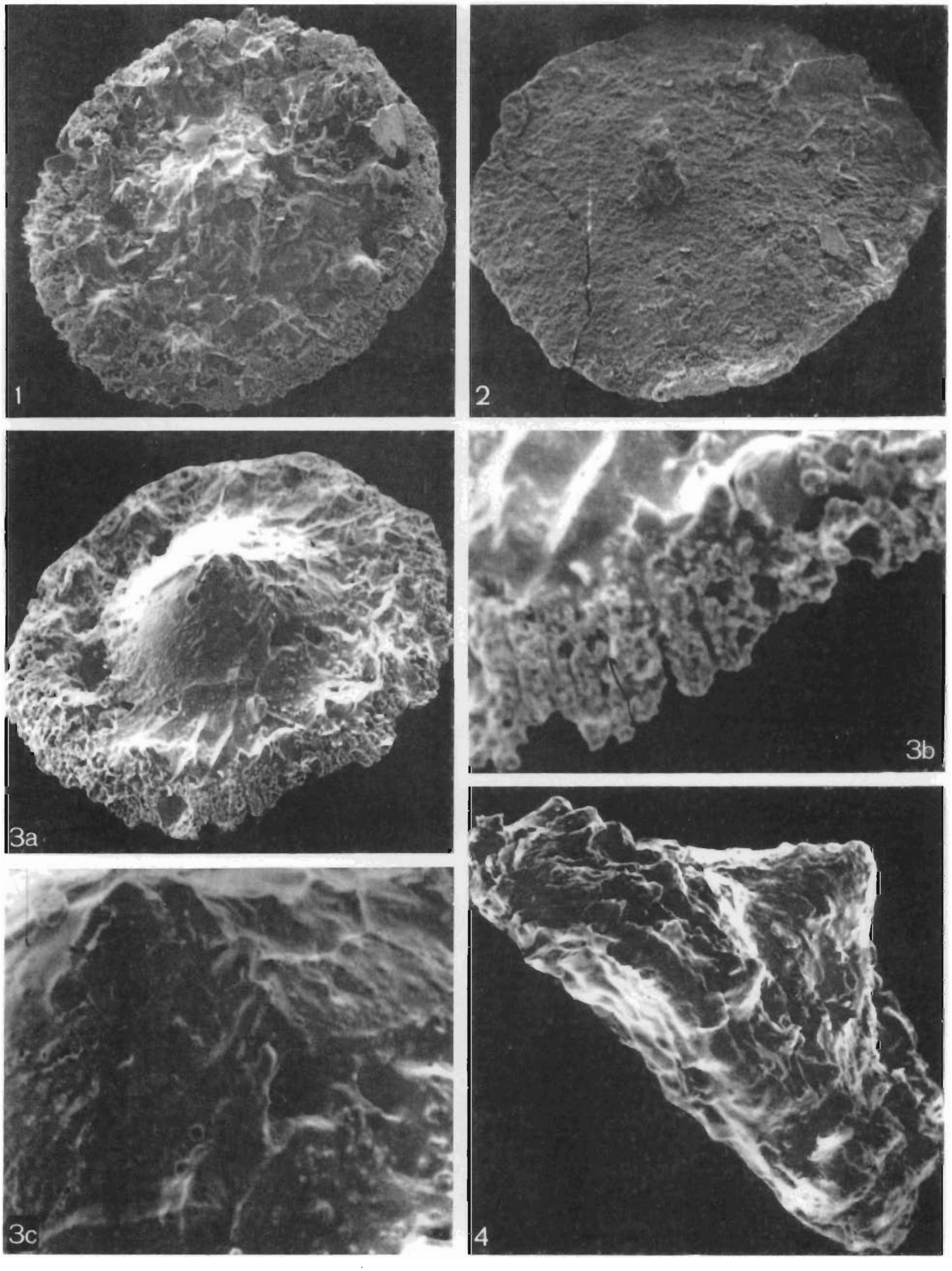
Hadimopanella antarctica sp. n.

1. *a*, natural association of several sclerites in top view, partly obscured by mineral coating; arrowed — sclerite shown in figs. *b* and *c* (cf. also p. 45, fig. 4); Erratic boulder Me. 33; ZPAL V. VI/25S10, × 500; *b*, considerably coated sclerite from the natural association, × 5000; *c*, detail of fig. *b*; note basal margin and striae; × 3000.
2. Slightly coated sclerite in top view, holotype; Erratic boulder Me. 66; ZPAL V. VI/28S3, × 950.



R. WRONA: CAMBRIAN MICROFOSSIL *Hadimopanella*


1
2
3a
3b
4a
4b


1
2
3a
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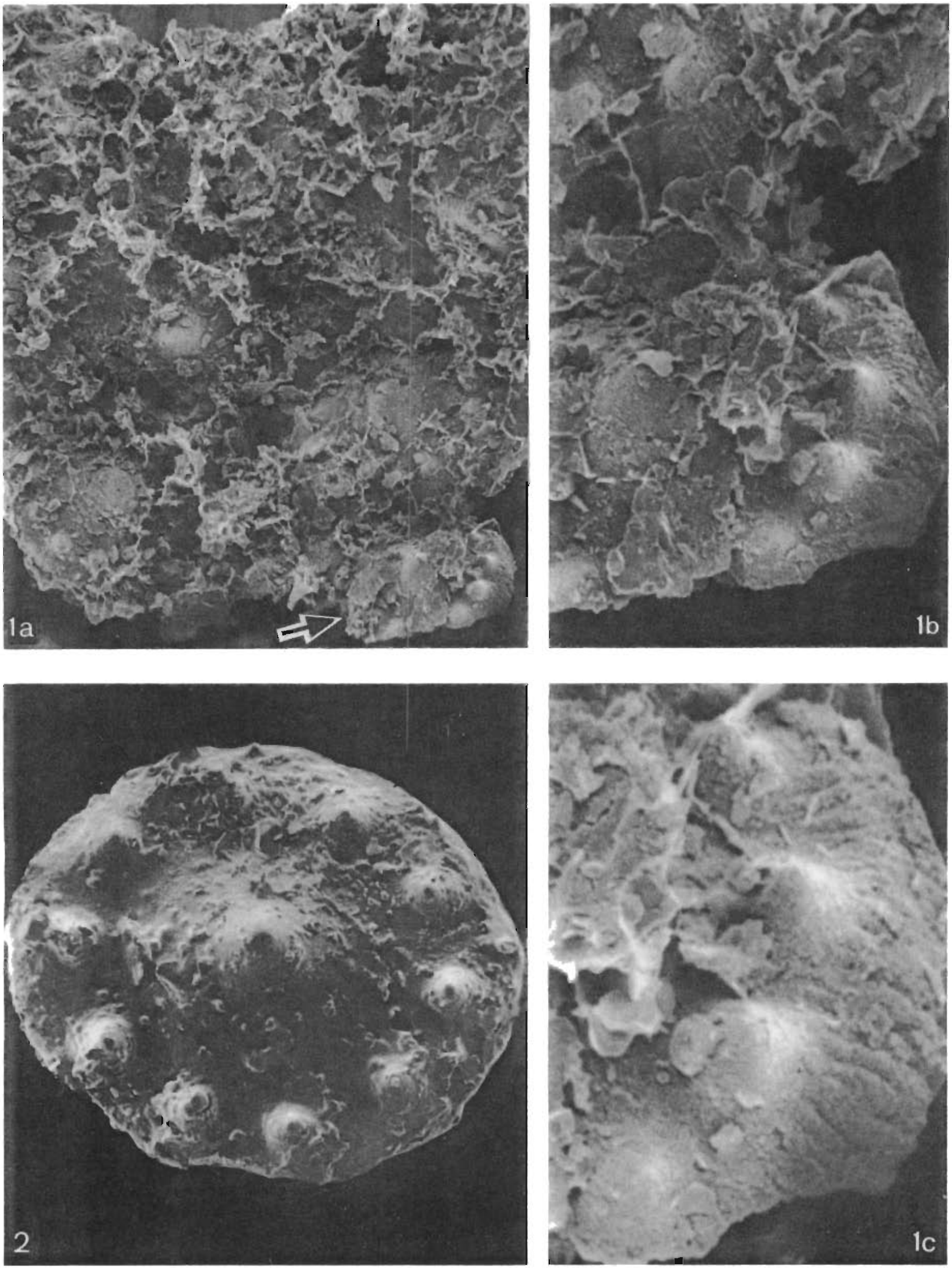
3c
4


1a
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2
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