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Cambrian Ostracodes Mainly from Baltoscandia and Morocco

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A b s t r a c t: Lower to Upper Cambrian ostracodes from Baltoscandia are described or revised on the basis of discoveries from outcrops in Scandinavia and from glacial erratics from Northern Germany. Additionally, five Cambrian taxa from different localities and stratigraphic levels in the Anti-Atlas Mountains of Morocco are introduced. A total of 26 species and subspecies (14 new) representing 17 genera (six new) is described. The suborder Phosphatocopina MÜLLER is revised and three new families and subfamilies are established on the basis of previously published data. The families Beyrichonidae, Bradoriidae, Hipponicharionidae and Svealutidae of the suborder Bradorina RAYMOND are discussed. Three Australian representatives of *Eremos* (= *Svealuta*) are described. The mode of life of Archaeocopa and possible palaeogeographic relations are discussed.

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Zusammenfassung

Ostrakoden sind kleine Krebstiere, die ihren Körper durch ein zweiklappiges Gehäuse schützen. Dieses ist i.a. kalkig, aber es gibt auch Taxa mit chitinigen Gehäusen. Dabei ist die verkalkte Schicht zwischen innerer und äußerer Lamelle sehr stark reduziert. Solche Gehäuse findet man vorzugsweise bei den planktisch lebenden Myodocopa, für die die Gewichtsreduktion des Carapaxes entscheidende Bedeutung hat.

Im Kambrium ist dagegen organisches bzw. phosphatisches Baumaterial für die Ostrakodengehäuse vorherrschend. Es handelt sich hierbei nicht um eine Reduktion des Carapaxes wie bei den Myodocopa, sondern es ist ein Primärmerkmal. Die frühesten archaeocopen Ostrakoden hatten vermutlich nur unvollständig mineralisierte Gehäuse, bei denen die organische Wandung durch Apatitkristalle verstärkt wurde. Allmählich bildeten sich härtere, d.h. voll mineralisierte Gehäuse aus. An der Wende Kambrium/Ordovizium trat ein Wechsel der Bausubstanz von phosphatisch nach kalkig auf. Dieses Phänomen ist auch bei anderen Tiergruppen, wie zum Beispiel den Brachiopoda, zu beobachten.

Die kambrischen Archaeocopa sind die ältesten Repräsentanten der Unterklasse Ostracoda. Ihre Hauptentwicklung liegt im Kambrium. Sie unterscheiden sich von den sog. 'echten' Ostrakoden in ihrer Schalensubstanz, der Entwicklung der Dorsal- und Ventralskulpturen, der Muskelanheftung, der Lobation etc. Diese Unterschiede führten in der Vergangenheit zu erheblichen Zweifeln über ihre Zugehörigkeit zur Gruppe der Ostracoda. Seit sich herausgestellt hat, daß diese Unterschiede jedoch keine hochrangigen taxonomischen Merkmale darstellen, sondern phylogenetischer Natur sind (z.B. HINZ 1991b, 1993, HINZ-SCHALLREUTER 1993a), erfahren die Archaeocopa zunehmend Akzeptanz als Ostrakoden.

Postkambrische Ostrakoden sind bisher weltweit in großem Umfang untersucht worden. Sie haben eine große Zahl wertvoller Leitfossilien und ökologischer Indikatoren geliefert. Für das Kambrium gibt es zwar Ostrakodennachweise auf allen Kontinenten, aber ihre biologische Vielfalt ist nur sehr unzureichend erfaßt. Darüberhinaus stammt die überwiegende Zahl der Taxa aus China, wobei

der Vergleich mit chinesischen Formen z.T. durch die Unzugänglichkeit des Materials und teilweise auch der Publikationen stark behindert, wenn nicht gar unmöglich gemacht, wird.

Das hier vorliegende Material stammt aus Baltoskandien, Marokko und untergeordnet auch aus Australien. Die Untersuchungen haben ergeben, daß die Unterordnung Phosphatocopina MÜLLER vollständig in die Gruppe der interdorsumtragenden Formen einzuordnen ist. Im Mittelkambrium ist diese Skulptur noch bei allen Vertretern ausgebildet und kann sich allerdings im Oberkambrium bis hin zur Unkenntlichkeit reduzieren. Die Gattungen *Cyclotron*, *Falites* und *Vestrogothia* bilden eindrucksvolle Beispiele.

Von den sechs Familien der Phosphatocopina werden drei neu eingeführt. Die Ulopsidae sind durch ihre typische Lobation charakterisiert, während die Schallreuterinidae durch ihr konvexes Interdorsum auffallen. Bei *Schallreuterina* ist es hochgewölbt, während es bei der vorläufig auch zu dieser Familie gestellten *Comleyopsis* lateral konvex ist. Gemeinsam ist beiden Taxa eine dadurch erheblich verminderte seitliche Bewegungsfreiheit der Klappen. Die von MÜLLER 1964 aufgestellte Familie Hesslandonidae wird hier auf die Typusgattung *Hesslandona* beschränkt. Der Holotypus der von MÜLLER aufgestellten Typusart ist eine kleine Larve mit schwacher Lobation. Wie Beispiele innerhalb der Vestrogothiiden zeigen, ist auch bei der Gattung *Hesslandona* davon auszugehen, daß sich die Lobation im Laufe der Ontogenese noch verstärkt. Mit *Falites*, *Vestrogothia* und *Cyclotron* sind nun drei Gattungen bekannt, die den von HINZ 1993 postulierten Trend der interdorsalen Reduktion vom Unter- zum Oberkambrium belegen.

Die für die Familie namengebende Gattung *Bradoria* basiert auf einer unvollständigen Klappe. Der ventrale freie Rand des Exemplares ist abgebrochen. Der Erhaltungszustand legt nahe, *Bradoria* als nomen dubium zu betrachten. Dies hätte jedoch weitreichende nomenklatorische Konsequenzen für die Gültigkeit der supragenerischen Taxa Bradoriidae und Bradorina. Alternativ wird daher vorgeschlagen, bis zu einer Revision der Typusart der Gattung *Bradoria* an topotypischem Material, sich bei vergleichenden Studien an dem besser erhaltenen Material der von BOLTON & COPELAND 1963 beschriebenen *Bradoria* sp. zu orientieren.

An Hand des vorliegenden Holotypus der Typusart wird auch die Familie Beyrichonidae neu definiert. Die von MELNIKOVA 1992 als eine Klappe von *Uskutchiella sulcata* n.gen. n.sp. beschriebene Form wird als aufgeklapptes beyrichonides Gehäuse identifiziert und ebenfalls neu abgebildet. Die zum Teil sehr flachen und hohen beyrichoniden Gehäuse legen nahe, daß diese Tiere solche Carapaxe wahrscheinlich - zumindest zum Teil - nicht oder nicht vollständig schließen konnten und als weitgeöffneten, dachartigen Schutz trugen.

Die Hipponicharioniden werden revidiert, ergänzt und in ihrem Gesamtumfang stark erweitert. Charakteristisches Merkmal dieser Gruppe ist eine randparallele Lobation. Innerhalb dieser Familie lassen sich eine ganz undeutliche Lobation (*Parahoulongdongella*) bis hin zu sehr differenzierten Skulpturen (*Andresia*, *Vojbokalina*) nachweisen.

Die Svealutidae werden auf Grund ihrer äußeren Morphologie, d.h. einem dünnwändigen, globulären Gehäuse, in Verbindung mit ihrer Verbreitung als pelagische Ostrakoden gedeutet. Eine genaue Untersuchung des Holotypus von *Eremos* MOBERG & SEGERBERG, 1906 ergab, daß die Gattung *Svealuta* OPIK, 1961 als jüngeres Synonym anzusehen ist, ebenso wie die Gattung *Anabarochilina* ABUSHIK, 1960.

Im Rahmen der taxonomischen Beschreibungen werden 6 neue Gattungen und 14 neue Arten und Unterarten aufgestellt, vor allem aus Baltoskandien und - erstmals - aus Marokko sowie aus Australien. Von den Typen der Typusarten der MATTHEW'schen Gattungen *Hipponicharion* M., 1886, *Beyrichona* M., 1886, *Bradoria* M., 1899, *Bradorona* M., 1902 und *Escasona* M., 1902 sowie der Gattungen *Sellula* WIMAN, 1903, *Eremos* und *Anabarochilina* werden neue, stereoskopische Abbildungen geliefert.

Introduction

Ostracodes are small crustaceans which protect their body by a bivalved carapace. The latter is generally made of calcareous matter, but in some forms it is chitinous. In these ostracodes the mineralised layer between the outer and inner lamella is considerably reduced or almost lacking. Such a shell composition is characteristic for myodocopes with a planktonic mode of life. However, in the Cambrian, phosphatic or organic-walled ostracodes prevail. Contrary to the above mentioned Myodocopa this is a primary feature and not due to secondary reduction of the carapace wall. Early archaeocopes may have had incompletely mineralised carapaces, i.e., organic-walled shells reinforced by apatite crystallites. Gradually the archaeocopes achieved, however, fully mineralised carapaces built of phosphate. A sudden change in shell composition from phosphate to calcareous matter at the Cambrian/Ordovician boundary is not unique for ostracodes but is also known among other groups, e.g., the Brachiopoda.

The Cambrian Archaeocopa are the oldest representatives of the Subclass Ostracoda and their main development was in the Cambrian. They are distinct from 'true' ostracodes by several features such as shell substance, development of dorsal and ventral sculptures, muscle attachment, lobation etc. which previously led to considerable doubts about their assignment to the Ostracoda. Recently, Cambrian archaeocopes have received increasing acceptance as Ostracoda. HINZ (1991b, 1993) and HINZ-SCHALLREUTER (1993a) have shown that the differences between Cambrian archaeocopes and other ostracodes are of a phylogenetic rather than of a high rank taxonomic nature.

Whereas Post-Cambrian ostracodes have been well investigated and a great deal is known about ecology, distribution and diversity, the diversity of Cambrian ostracodes is still poorly known.

Cambrian ostracodes have been reported from all continents but most of them have been described from China. Because access to the latter material is very limited, comparison of other material with taxa described from China is difficult or impossible. Cambrian ostracodes from other localities are mostly known only from brief reports or from largely outdated literature.

The published data clearly indicate the need of further research on Cambrian ostracodes. The recognition of taxonomically relevant features and phylogenetic links requires further emphasis on the detailed worldwide documentation of different ostracode faunas. With the revision of some Baltoscandian ostracodes, new Middle Cambrian taxa from the same region, from Morocco, and subordinatedly also from Australia the present paper contributes to this purpose.

The material comprises representatives of the two archaeocope suborders Phosphatocopina and Bradorina. For a better understanding of the described taxa, the holotypes of the type genera are also included in certain cases.

Previous work

GEOGRAPHIC OCCURRENCE - The following list of the various regional investigations is not comprehensive. It concentrates on areas which are relevant for the faunas described herein.

Baltoscandia (Fig. 2)

C e n t r a l S w e d e n: Pioneer work was done by LINNARSSON (1869) who described the first archaeocope under the name *Leperditia primordialis*. BARRANDE (1872) introduced the name *Beyrichia angelini* for an ostracode figured already by ANGELIN (1855) in an unpublished paper. WIMAN (1903) described nine species from glacial erratics of the Lower Cambrian *Olenellus* sandstone from the south Bothnian area and MÜLLER (1964,1982) published 11 nominal species with partially preserved integument from the Upper Cambrian of the same area.

Ø l a n d: Ostracodes were mentioned already by LINNARSSON (1876). KUMMEROW (1931) described the new species *Aristozoe ? minima* and ANDRES (1969) two additional new species from the same region.

S c a n i a: Cambrian ostracodes are known from the Lower Cambrian Gislöv Formation (BERGSTROM & AHLBERG 1981) and from the lower Upper Cambrian *Agnostus pisiformis* and *Beyrichia angelini* Zones (TULLBERG 1880: 5,7,9, 9 Bihang; REMELÉ 1883: 82; WESTERGARD 1944: 33). HINZ-SCHALLREUTER (1993a) described an upper Middle Cambrian ostracode from a glacial erratic of Gislövshammar.

B o r n h o l m: Middle and Upper Cambrian ostracodes were described or mentioned by GRÖNWALL (1902), POULSEN (1923), KOZUR (1974), GRÜNDEL (in GRÜNDEL & BUCHHOLZ 1981) and BERG-MADSEN (1981, 1985a-c).

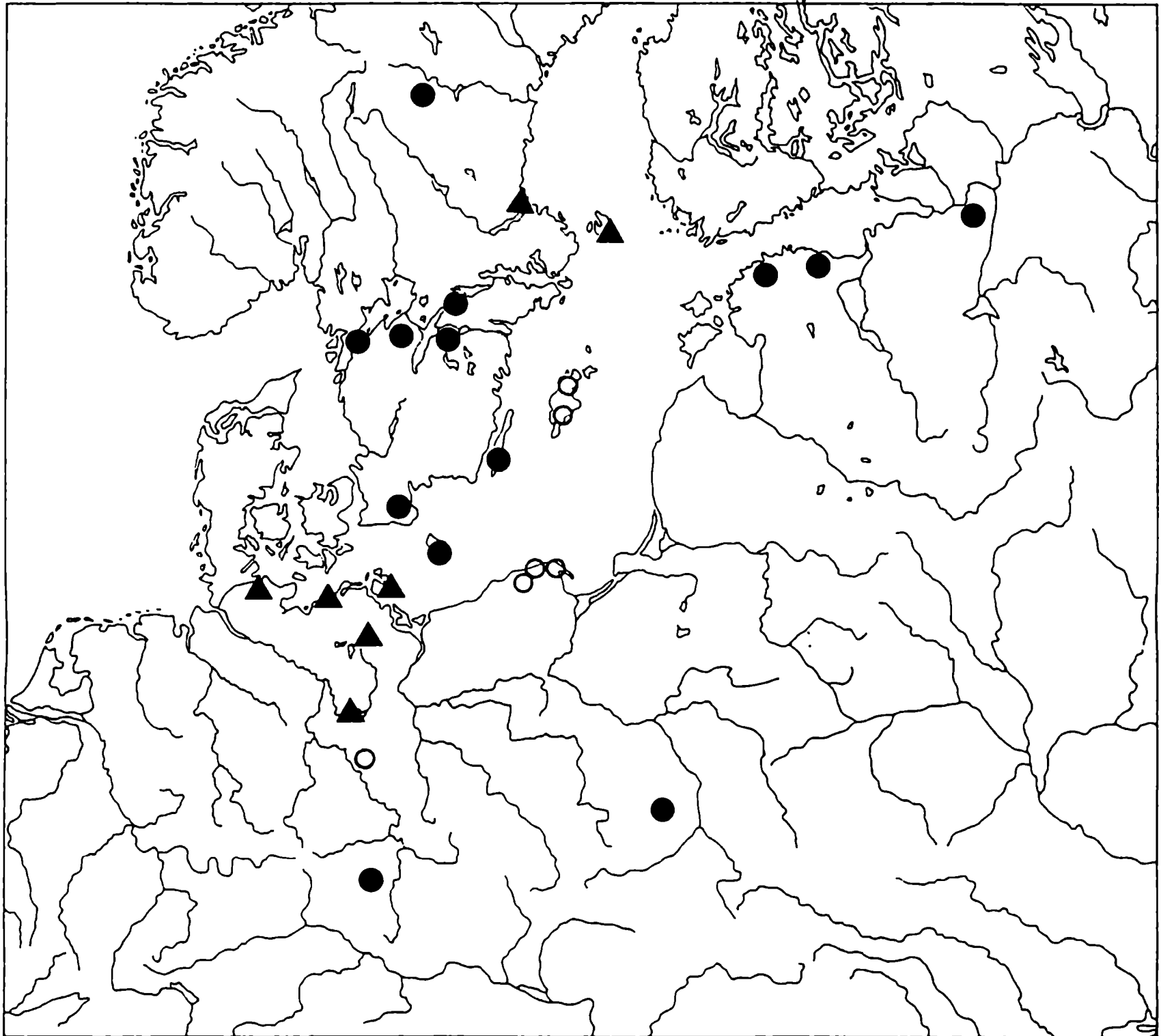


Fig. 2: Locality map of Baltoscandia and Central Europe with ostracode discoveries. Black spots: material from profiles; triangles: material from glacial erratics; circles: material from drillings.

- | | | |
|-----------------|------------------------|--------------------------|
| ● ostracods | ∇ hyoliths | ⊗ <i>Mobergella</i> |
| ☀ acritarchs | ▲ phosphatic sclerites | ◻ conglomerate/arkose |
| 🪨 stromatolites | 👉 conodonts | ◻ sandstone/siltstone |
| 🌀 gastropods | 👛 <i>Volborthella</i> | ◻ claystone & al. |
| 👒 trilobites | 👉 sabelliditids | ◻ limestone/dolomite |
| 👒 brachiopods | 👉 platysolenitids | ◻ black shale, siltstone |

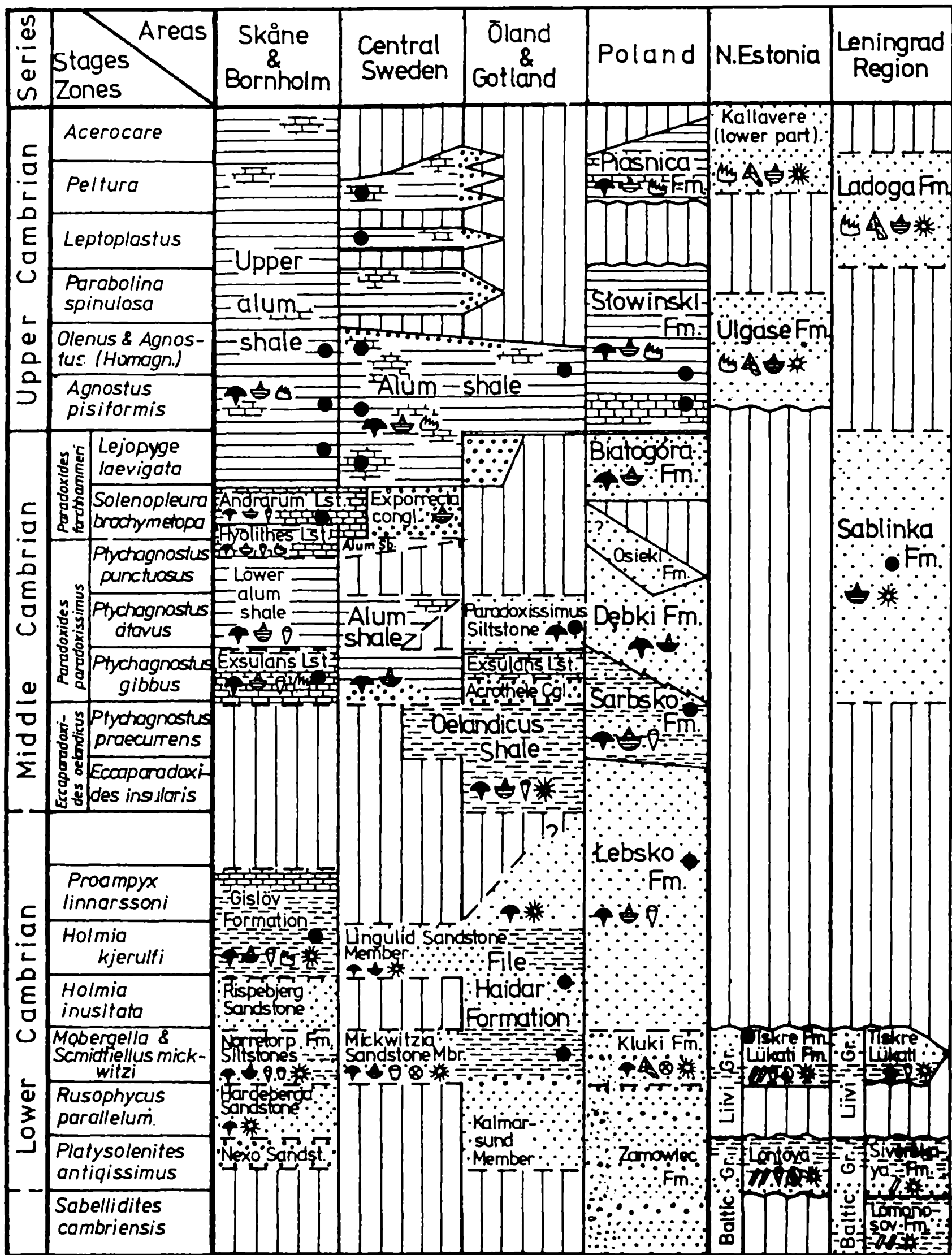


Fig. 3: Stratigraphic distribution of archaeocope ostracodes in the Cambrian of Baltoscandia (after AHLBERG 1989, ANDRES 1969, BEDNARCZYK 1979, BEDNARCZYK & PRZYBYLOWICZ 1980, BERG-MADSEN 1981, 1985, BERGSTRÖM & AHLBERG 1981, KUMMEROW 1931, LINNARSSON 1869, 1876, MELNIKOVA 1987, MELNIKOVA in KHAZANOVITCH et al. 1984, MÜLLER 1964, REMELÉ 1883, THORSLUND & WESTERGARD 1938). [Correlation chart with fossil indices other than ostracodes after MENS et al. 1987. Explanation of the indices on p. 388].

J ä m t l a n d: Ostracodes occur in the Upper Cambrian zone 2 (WESTERGARD 1922: 90).

G o t l a n d: The record of archaeocope ostracodes started with THORSLUND & WESTERGARD (1938) who described a single valve from the File Haidar core drilling. AHLBERG (1989) mentioned *Indiana*? sp. from the Lower Cambrian File Haidar Formation of the När 1 core drilling.

E s t o n i a: First reports date back to the end of the last century when SCHMIDT (1888) discovered an indistinct "*Primitia*" from the *Olenellus* Zone but not before a century later MELNIKOVA 1987 documented the two species *Bradoria*? *estonica* and *Konicekion kundaensis*.

I n g e r m a n l a n d (St. Petersburg region): MELNIKOVA (in KHAZANOVITCH et al. 1984) described *Vojbokalina magnifica*.

N o r t h e r n P o l a n d: BEDNARCZYK (1979) and BEDNARCZYK & PRZYBYLOWICZ (1980) recorded Lower and lower Middle Cambrian and two Upper Cambrian ostracodes from core drillings.

N o r t h e r n G e r m a n y: A number of different ostracode taxa was established from discoveries in glacial erratics. STEUSLOFF (1895) described some phosphatic valves from a stinkstone glacial erratic of Neu-Brandenburg under the name *Bythocypris polita*. SCHRANK (1973) recorded *Cyclotron nodomarginatum*, and GRÜNDEL (in GRÜNDEL & BUCHHOLZ 1981) published 12 taxa of which eight were new from different upper Middle and mainly Upper Cambrian glacial erratics. Ostracodes from glacial erratics of Northern Germany were also mentioned by KUMMEROW (1923,1924,1925,1927,1928).

Africa

From this continent, Cambrian ostracodes have not been described so far. In the frame of his detailed stratigraphical and palaeontological study of the Atlas Mountains, Morocco, GEYER (1990: 50) mentioned archaeocopes for the first time from rocks with *Kingaspidoides obliquorulops* and *K. brevifrons*. Specimens from different localities (Fig.4) are introduced in this paper.

North America

Except for a few short reports on archaeocopes by BOLTON & COPELAND (1963), COPELAND (1986), LANDING (1980) and LOCHMAN & HU (1960) the investigations date back to ULRICH & BASSLER (1931) who also redescribed MATTHEW's (1886-1902) ostracode faunas. Some type material from North America has been refigured herein for comparative purposes.

Australia

Investigations on the Cambrian ostracodes initiated by CHAPMAN (1918), OPIK (1961,1967,1968), FLEMING (1973) and JONES & MCKENZIE (1979,1980) have been continued by the author (e.g., HINZ 1992, HINZ-SCHALLREUTER 1993b). A monographic description of the Georgina Basin fauna is under way.

China

The vast majority of Cambrian ostracodes has been described from several Chinese provinces, e.g., Guizhou, Henan, Hunan, Shaanxi and Zhejiang. HUO et al. (1989: fig. 1) provided a detailed locality map.

STRATIGRAPHIC OCCURRENCE - In Baltoscandia ostracodes occur throughout the Cambrian stratigraphic sequence (Fig. 3). The same applies to North American faunas. Also African taxa were discovered from Lower, Middle and Upper Cambrian strata. Descriptions from Australia refer to Lower and Middle Cambrian strata. Chinese archaeocopes are known from the entire Cambrian to the Lower Ordovician.

TAXONOMY - The Phosphatocopina are characterized by an interdorsum. The latter is particularly well-developed in Lower and Middle Cambrian taxa, whereas the same genus may have hardly recognizable interdorsal borders in the Upper Cambrian. Within the Phosphatocopina there is a consequent development of carapaces with broad interdorsa to carapaces with simple dorsal separations. The distinction of families is based on gross morphological features such as outer shape and lobation.

Until now the *Phosphatocopina* were only represented by the three families Hesslandonidae MULLER, Falitidae MULLER and Vestrogothiidae KOZUR. They are supplemented by two further families: the Ulopsidae, marked by their typical lobation, and the Schallreuterinidae. The latter is characterized by a convex interdorsum or convex dorsal area which permits only very limited mobility of the valves.

The *Bradorina* is comprised of the families Beyrichonidae, Bradoriidae, Hipponicharionidae and Svealutidae. The *Beyrichonidae* are a group with mostly rather short, but very high carapaces, sometimes higher than long. The family is newly defined herein on the basis of the holotype of the type species, *B. papilio*. Flat and high carapace shapes, such as in *B. papilio* suggest that those ostracodes were unable to close their carapaces, they probably used it as a shield-like protection of the body.

The family *Bradoriidae* was given its name by the type genus *Bradoria* MATTHEW. The holotype of the type species is, however, a fragmentary specimen with a broken free margin. The state of preservation would suggest its consideration as a nomen dubium. However, as a consequence, not only the genus *Bradoria*, but also the suprageneric taxa Bradoriidae and Bradorina would lose their validity. Alternatively it is suggested to refer to the better preserved specimen of *Bradoria* sp. described by BOLTON & COPELAND (1963).

The family *Hipponicharionidae* was expanded by MELNIKOVA (in ABUSHIK et al. 1990) since its introduction by SYLVESTER-BRADLEY (1961). However, she included also taxa such as *Cyclotron* which are definitely phosphatocopines. Therefore I do not completely follow her concept. *Ushkarella* may be a haoiid (SHU 1990a: 42). Characteristic features are a marginal lobation which may be also rather weak to completely lacking. This family exemplifies the stratigraphically supported development from indistinct lobes to highly differentiated sculptures.

The *Svealutidae* have been recorded from Australia, Baltoscandia, Canada, Great Britain and Siberia. Their wide distribution combined with their globose, thin-walled carapaces suggest a pelagic mode of life as was proposed by SIVETER et al. 1991 for Silurian myodocopes. A detailed analysis of the holotype of the genus *Eremos* revealed that the genera *Svealuta* and *Anabaroichilina* have to be regarded as junior synonyms.

Material and Methods

The *Baltoscandic* material described and/or figured herein came mainly from glacial erratics of both Northern Germany and Southern Sweden. One sample came from the Andrarum Limestone at the rivulet Läså, Bornholm.

Lower Cambrian:

1. Glacial erratic RUD-2: *Strenuella* sandstone.

Locality (Loc.): Kreuzfeld, Schleswig-Holstein; collected (coll.) 1986;

Collection (Coll.): F.RUDOLPH, Wankendorf.

Lithology: Yellow to white-grey, finely lamellar quartzitic sandstone with recrystallised quartz grains and finely distributed grains of probably manganese or ferruginous particles. Larger spots make the rock resemble the so-called leopard sandstone.

Fossils: Only some questionable fragments of brachiopods and trilobites and two ostracode valves of *Parahoulongdongella rudolphi* n.sp.(Fig.1).

2. Glacial erratic RUD-3: *Strenuella* sandstone.

Locality: Kreuzfeld; coll. 1990; Coll.: F.RUDOLPH.

Lithology: Same as preceding.

Fossils: Several specimens of *Parahoulongdongella rudolphi* n.sp.(Figs. 16-17).

M i d d l e C a m b r i a n:

1. Glacial erratic RUD-6: *Tessini* sandstone.

Locality: Kreuzfeld, gravel pit Schult; coll. 1985; Coll.: F.RUDOLPH.

Lithology: Grey or yellow-grey, hard, quartzitic sandstone with recrystallised quartz grains.

Fossils: Many trilobite fragments, some brachiopods; steinkern and external mould of *Andresia loculata* (ANDRES,1969).

2. Glacial erratic RUD-7: *Tessini* sandstone.

Locality: Kreuzfeld, gravel pit Wandhoff; coll. 1986; Coll.: F.RUDOLPH.

Lithology: Same as preceding.

Fossils: Few trilobite fragments mainly on a bedding plane, few specimens of *Andresia loculata* (ANDRES, 1969).

3. Glacial erratic no. AGH 128-1/9.

Locality: Gislövshammar, SE-Scania, Sweden (local glacial erratic); coll. by K.EICHBAUM; Coll. AGH (no test sample, microfossils only).

Fossils: inarticulate brachiopods, gastropods, ?hyolithids, phosphatic spheres. Ostracodes: *Hesslandona reichi* n.sp., *Bidimorpha inversa* n.sp., *Aparchona klafacki* n.sp. and others (Figs. 6.1-3, 7.2-4, 10).

4. Andrarum Limestone, sample no. 6507.

Locality: Outcrops at rivulet Læså near Kalby, Bornholm.

A piece of rock given to K.J.MÜLLER (Bonn) by courtesy of V.BERG-MADSEN several years ago.

The limestone was etched with 15 per cent acetic acid, screened and sorted for microfossils.

Fossils: sponge spicules, echinoderms, inarticulate brachiopods, gastropods, hyolithids, hyolithelminthes, *Microdictyon*, conodonts (*Furnishina*, *Gapparodus*, *Phakelodus*, *Proacodus*, *Problematoconites*, *Protohertzina*, *Westergaardodina*), trilobites (*Hypagnostus* or *Cotalagnostus*, det. SHERGOLD), phosphatic spheres, ?egg cases, fecal pellets. Ostracodes: *Vestrogothia longispinosa* and others.

5. Glacial erratic KLA-1: Black limestone of the *Lejopyge laevigata* zone, uppermost Middle Cambrian.

Locality: Cliff of Stoltera, west of Rostock-Warnemünde,

Mecklenburg; coll. by J.KOPPKA 1988; Coll.: AGH (leg. R.KLAFACK).

Lithology: Dark, reddish-brown to grey-black, bituminous limestone. Surface weathered into light-grey. Except for a test sample (66.5 g) the boulder was split into small pieces in the search for further fossils.

Fossils: Several specimens of *Lejopyge laevigata* (DALMAN,1828), few inarticulate brachiopods and ostracodes (among them the figured specimen of *Falites unisulcatus*: Fig.7.1).

6. Glacial erratic RUD-5: Black stink-limestone.

Locality: unknown; coll. F.RUDOLPH; Coll.: AGH

Lithology: Black lustreless stink-limestone, micritic matrix with larger, irregular sparry particles, the latter may be enriched in some layers.

Fossils: Few specimens of *Eremos primordialis* (Fig.18.1), few trilobite fragments and some undetermined microfossils.

U p p e r C a m b r i a n:

1. Glacial erratic RUD-4: Stink-limestone (zone 2).

Locality: Gravel pit Damsdorf, Schleswig-Holstein; coll. 1985 by F.RUDOLPH; Coll.: AGH.

Lithology: Dark, rather coarse-crystalline, bituminous limestone.

Fossils: A great number of valves and carapaces of *Veldotron bratteforsa* on a bedding surface together with *Homagnostus* sp. and *Olenus* sp.

2. Glacial erratic AGH-128-14: dark stink-limestone.

Loc.: cliff near Dwasieden, Isle of Rügen (Baltic Sea); coll. by M.REICH 1993; Coll.: AGH.

Fossils: Figured specimen of *Cyclotron furcatocostatum* (Fig.9.4). Only the small piece with the ostracode is preserved.

3. Glacial erratic SS-1: dark stink-limestone (zone 2).

Loc.: Bralitz/Oderberg, Mark Brandenburg; Coll.: S.SCHNEIDER.

Lithology: Dark, red-brownish to black sparry stink-limestone. Small rounded phosphorite particles and larger, irregular phosphorite pebbles. Irregular pyrite aggregates, enriched in some parts of the rock.

Fossils: Many trilobites (in some parts enriched), few inarticulate brachiopods, conodonts (*Westergaardodina* sp. and others) and ostracodes (among them: *Cyclotron ventrocurvatum* and *Vestrogothia steffenschneideri* n.sp.: Figs.6.4, 9.3).

The ostracode specimens from M o r o c c o were kindly handed over to me by PD Dr. G. GEYER, Würzburg. He sorted the fossils from etched residues processed for his extensive research on Middle Cambrian trilobites and molluscs. The ostracodes came from different localities in the Anti-Atlas Mountains (Fig. 4) covering the Lower Cambrian *Sectigena* and the Middle Cambrian *Ornamentaspis frequens* and *Bailiella* zones. The respective lithologies were described by GEYER 1990 as follows (translated from German): Western Anti-Atlas:

- Taidalt: Greenish-grey, calcareous, fine-grained sandstones to fine-grained sandy, ferruginous coquina (bioclastic wacke-/packstone). Fossils chloitised and slightly silicified; abundant hyoliths cone-in-cone. Issafen-Formation; *Sectigena* Zone ?

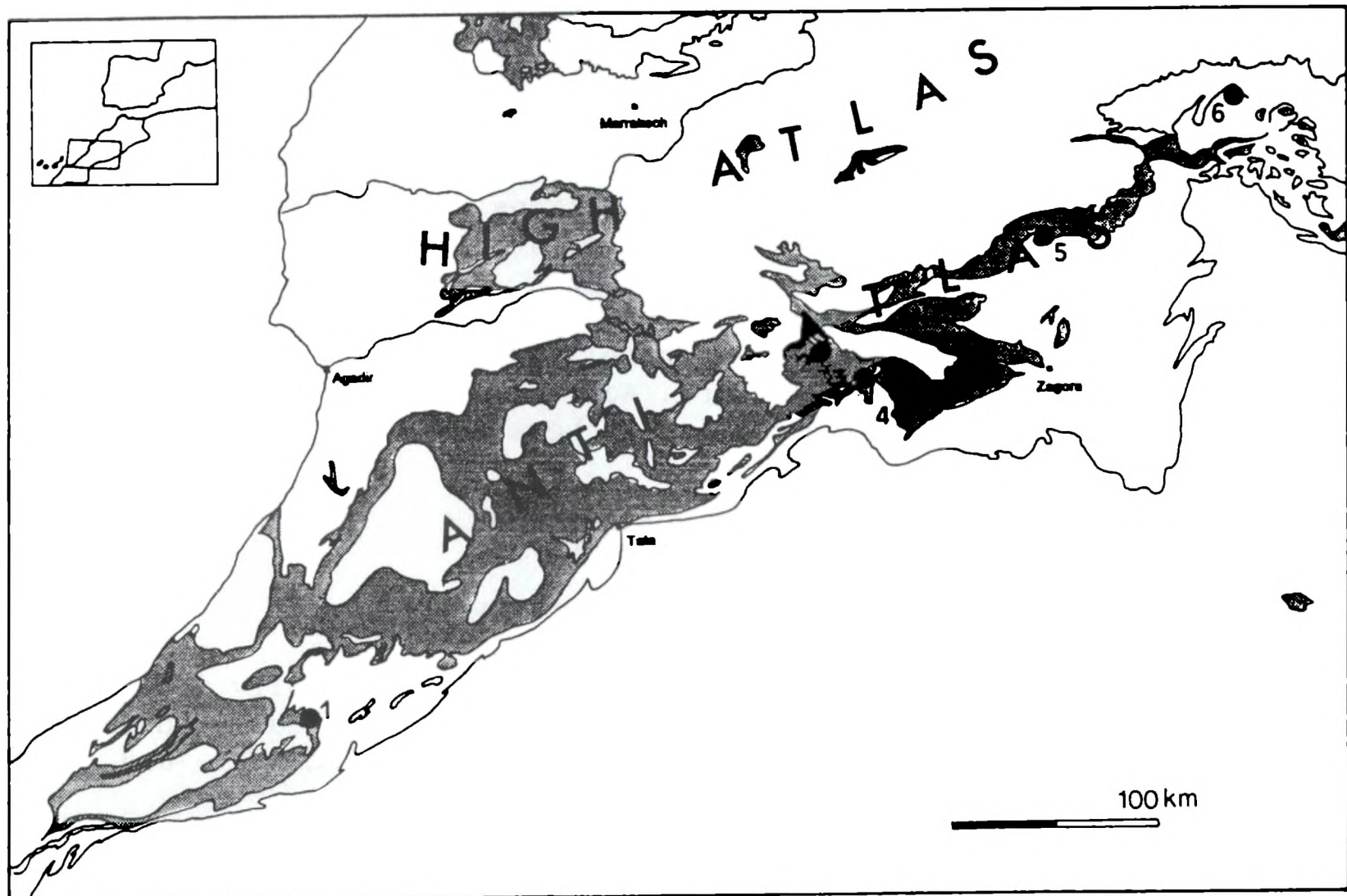


Fig. 4: Locality map of the Atlas Mountains, Morocco (after GEYER 1990) with ostracode localities: 1) Taidalt (Lower Cambrian), 2) Tagrara Syncline, 3) Jbel Azgza, 4) Jbel bou Ifersikt, 5) Aït Mersid, 6) Tizi n'Izem.

Central Anti-Atlas:

- Tagrara-Syncline: Limonitic brecciated coquina with large bioclasts. Horizon 0.4 m thick and about 240 m above basis of Ibe Wawrmast Formation. Top of Brèche a *Micmacca* Member. *Ornamentaspis frequens* Zone [equivalent to *Paradoxides insularis* Zone in Baltoscandia (GEYER, written comm. 1993)].
- Jbel bou Ifersikt: Light yellow to yellow-brownish or dark grey, limonitic coquina. Fossils partly phosphatised (bioclastic wacke-/packstone); about 35 m above basis of Jbel Afraou Formation. *Ornamentaspis frequens* Zone?, *Ornamentaspis destomebesi* Biofacies Zone ?
- Jbel Azgza: Grey to dark grey limonitic and fine-grained sparry limestones or fine-grained calcareous sandstones (bioclastic wacke-/packstone). Fossils partly phosphatised. Jbel Afraou Formation. *Ornamentaspis frequens* Zone ?
- Ait Mersid: Ochre to grey ferruginous fine-grained sparry limestones (bioclastic packstone), often dolomitic. Fossils partly phosphatised or ferruginised. *Bailiella* Formation with *B. cf. levyi* [equivalent to *P. paradoxissimus* Zone in Baltoscandia (GEYER, written comm. 1993)].

Eastern Anti-Atlas:

- Tizi n'Izem: Greyish-yellow to blackish-grey, sandy dolomitic limestones, slightly sparry (bioclastic packstone). Fossils phosphatised and partly slightly ferruginised; intercalated in series of greenish, clayey, fine-grained sandstones. Jbel Wawrmast Formation, about 45 m above top of Tazlaft Formation and 15 m below conglomerate bed at the basis of Jbel Afraou Formation. *Ornamentaspis frequens* Zone ?, *O. destomebesi* Biofacies Zone.

Etched ostracode specimens and those situated on sufficiently small pieces of rock were examined by SEM stereo-photography. They were mounted on aluminium stubs with carbon-coated adhesive tabs (Leit-tabs) or conductive C (Leit-C) and coated with an alloy of gold and palladium. The holotype of *Parahoulongdongella rudolphi* n.sp. is illustrated by light photography in order not to affect the differently coloured areas.

The illustrated material is housed in the following institutions:

- AGH = *Archiv für Geschiebekunde*, Geologisch-Paläontologisches Institut und Museum der Universität Hamburg
- UB = Paläontologisches Institut der Universität Bonn
- PIW = Paläontologisches Institut der Universität Würzburg
- BB = Bundesanstalt für Geowissenschaften und Rohstoffe Berlin (former Zentrales Probenarchiv des Zentralen Geologischen Institutes)
- CPC = Commonwealth Palaeontological Collections, Australian Geological Survey Organisation, Canberra, A.C.T., Australia
- ROM = Royal Ontario Museum, Toronto, Canada
- PIN = Paleontologicheskii Institut, Rossiiskaia Akademiia nauk, Moskva
and in the private collections of
- FR = Frank RUDOLPH, 24601 Wankendorf, Achtern Höven 6
- SS = Steffen SCHNEIDER, 13156 Berlin, Eichenstr. 42

Systematic part

Subclass Ostracoda LATREILLE, 1806

O r i e n t a t i o n: In the living animal orientation usually does not cause any difficulties because anterior and posterior ends are clearly indicated by the positions of mouth and anus. Also the definition of dorsal and ventral sides is unproblematical.

In fossil ostracodes orientation may be rather difficult, because the integument is generally not preserved. The specimens occur as isolated valves or carapaces so that the orientation has to be deduced from carapace features that can also be recognized in extant ostracodes. The dorsal side of a valve or carapace comprises the hinge or an incipient sculpture. Many Paleozoic ostracodes have a straight dorsal margin, the ventral side is generally

convex. For precise recognition of the valve outline, the latter is studied with the hinge orientated horizontally. By contrast, post-Paleozoic ostracodes which are characterized by a centroventral concavity are orientated with both ventral projections on a horizontal or so-called base-line. In this respect, the dorsal margin may be inclined.

A distinction between the anterior and posterior ends is usually facilitated by the presence of muscle scars. The adductor muscle is located in the same segment as the maxillule, thus leaving scars in the anterior portion of the valve. Another aid for orientation are directed processes*, which are mostly posteriorly directed.

The orientation in archaeocope ostracodes generally follows the same principles as in post-Cambrian ostracodes. Directed processes can be observed, e.g., in *Vestrogothia* (Fig. 8.1-3). Muscle scars, however, have not yet been demonstrated reliably for any archaeocope taxon. By contrast, muscle activity is documented in a number of bradorine taxa with an apparently swimming mode of life. For this purpose the antennular muscle had to be strongly developed and its position and strain resulted in a triangular sulcal depression in the anterodorsal field of, e.g., *Zepaera*, *Parahoulongdongella*, *Flemingopsis*. Lobation is another significant characteristic. The main lobes are generally situated in the anterior part of the valve (e.g., *Bidimorpha*, *Bradorona*, *Ulopsis*, *Veldotron*).

A number of ostracode taxa may lack some of the characteristics mentioned above. In these cases, the general outline appears to be an additional aid for orientation. Most of the yet known phosphatocopine ostracodes are preplete to subamplete, whereas bradorines are generally postplete. Marginal sculptures such as rostral or caudal projections may serve as further indication of anterior and posterior.

Order Archaeocopa SYLVESTER-BRADLEY in BENSON et al., 1961
Suborder Phosphatocopina MÜLLER, 1964

Synonyms: *Hesslandonina* MÜLLER, 1982
Vestrogothiina MÜLLER, 1982
Vestrogothicopina MÜLLER, 1982 emend. MCKENZIE, MÜLLER & GRAMM, 1983
Hesslandonocopina MÜLLER, 1982 emend. MCKENZIE, MÜLLER & GRAMM, 1983
Type genus: *Hesslandona* MÜLLER, 1964 (here designated).

D i a g n o s i s: Archaeocopes with an interdorsum which may be rudimentary or missing. Outline distinctly preplete to subamplete. Shape (L:H ratio) elongate to high. Free margin with doublure along inner side. Lobation consisting of nodes or spines in dorsal half and often also in ventral half.

R e m a r k s: Originally the taxonomically significant characteristic of the family Hesslandonidae was the presence of an interdorsum (MÜLLER 1964). This feature was known from the genus *Hesslandona* only. Meanwhile it has been recorded from many other genera among which are also non-hesslandonid phosphatocopes sensu MÜLLER** (*Vestrogothia*, HINZ-SCHALLREUTER 1993a: 330; *Falites*, see below). Therefore the Phosphatocopina sensu MÜLLER completely falls into

* In overemphasizing the significance of the curved ventral spine, HINZ-SCHALLREUTER (1993b: 320, 321, fig. 4.1) regarded the spine in *Flemingopsis ventrospinata* as anteroventral, pointing posteriorly. However, it is now clear that the triangular dorsal depression, a common characteristic in bradorines, is apparently related to a strong antennular muscle, and thus precisely marks the anterior and posterior ends. The sulcal depression is therefore in this special case more important than the directed process and accordingly the specimen illustrated in the paper cited above is a left valve. [see also p. 424].

** According to MÜLLER (pers. comm.) *Reticulocambria* MÜLLER, 1964 is only a special preservational state. The taxonomic position of this taxon is presently uncertain. Therefore the genus is considered herein as a *nomen dubium*.

the category of interdorsum-bearing ostracodes, i.e., it is identical with the family Hesslandonidae. HINZ-SCHALLREUTER (1993b) pointed out that there is a continuous development from broad, laterally convex interdorsa in the Lower Cambrian to smaller, parallel-bordered sculptures in the Upper Cambrian. They may even become so narrow that they are hardly recognizable any more, a fact exemplified by the Upper Cambrian *Vestrogothia spinata*. Originally the latter was established as a taxon with a simple asolenic hinge (HINZ-SCHALLREUTER 1993a). This stratigraphically supported tendency further suggests that the family Hesslandonidae also comprises taxa with simple asolenic hinges. In this respect, the interdorsum loses its importance as a suprageneric taxonomic characteristic within the group, it rather represents a phylogenetic feature. Outer shape and lobation seem to be more significant for taxonomic assignments within the Phosphatocopina.

The 12 genera described so far were mostly assigned to the family Hesslandonidae. With regard to their gross morphological features, an assignment to six families is suggested: Falitidae, Hesslandonidae, Schallreuterinidae, Tubupestidae, Ulopsidae and Vestrogothiidae (Fig. 5). Taxa such as Monasteriidae and Oepikalutidae which were referred to the Vestrogothiina by MÜLLER (1982) are secondarily phosphatised and have gross morphological features which are very much distinct from phosphatocopines.

According to the new concept for the phosphatocopines, representatives of the group were already described in the last century. However, the characteristic interdorsum was not discovered before 1964. *Cyclotron angelini* seems to be the first species illustrated (ANGELIN 1855)* and described (BARRANDE 1872).

MÜLLER (1964) considered the shell substance of the Phosphatocopina as primary phosphatic while KOZUR (1974) regarded it as secondarily phosphatised. Borings observed in the shell of *Vestrogothia longispinosa* (Fig. 8.1) suggest a primary nature of the shell substance similar to the later ostracodes [compare SCHALLREUTER 1983: pl. 26(12), fig. 5; 1986: pl. 3, fig. 3].

O c c u r r e n c e: Lower to Upper Cambrian of North America, Europe and Australia.

Family Hesslandonidae MÜLLER, 1964

D i a g n o s i s: Medium-sized (to large ?)**. Elongate. Shape usually rather long to very long. Lobation consists of three flat nodes close to dorsal border.

R e m a r k s: This family is presently restricted to the genus *Hesslandona* MÜLLER, 1964. The type species of that genus was established on the basis of relatively small specimens (L_{max} 1.18 mm, holotype smaller). The gradual development of the lobation during ontogeny was already documented by HINZ-SCHALLREUTER (1993a) in the larger *Bidimorpha bidimorpha*. It suggests that MÜLLER's material contained juvenile specimens only and that also *Hesslandona* may have developed additional nodes during ontogeny. A revision of *Hesslandona* is urgently needed.

Genus *Hesslandona* MÜLLER, 1964

T y p e s p e c i e s: *Hesslandona necopina* MÜLLER, 1964.

D i a g n o s i s: As for family.

F u r t h e r s p e c i e s: *Bythocypris polita* STEUSLOFF, 1895

Hesslandona kinnekullensis MÜLLER, 1964

Dielymella ? trituberculata LOCHMAN & HU, 1960

Hesslandona reichi n.sp.

O c c u r r e n c e: Upper Middle and Upper Cambrian; Baltoscandia, Wyoming.

* see remarks on p.402.

** length (L): < 0.5 mm: very small, 0.5 - 1 mm: small, 1 - 2 mm: medium-sized, 2 - 5 mm: large, 5 - 10 mm: very large.

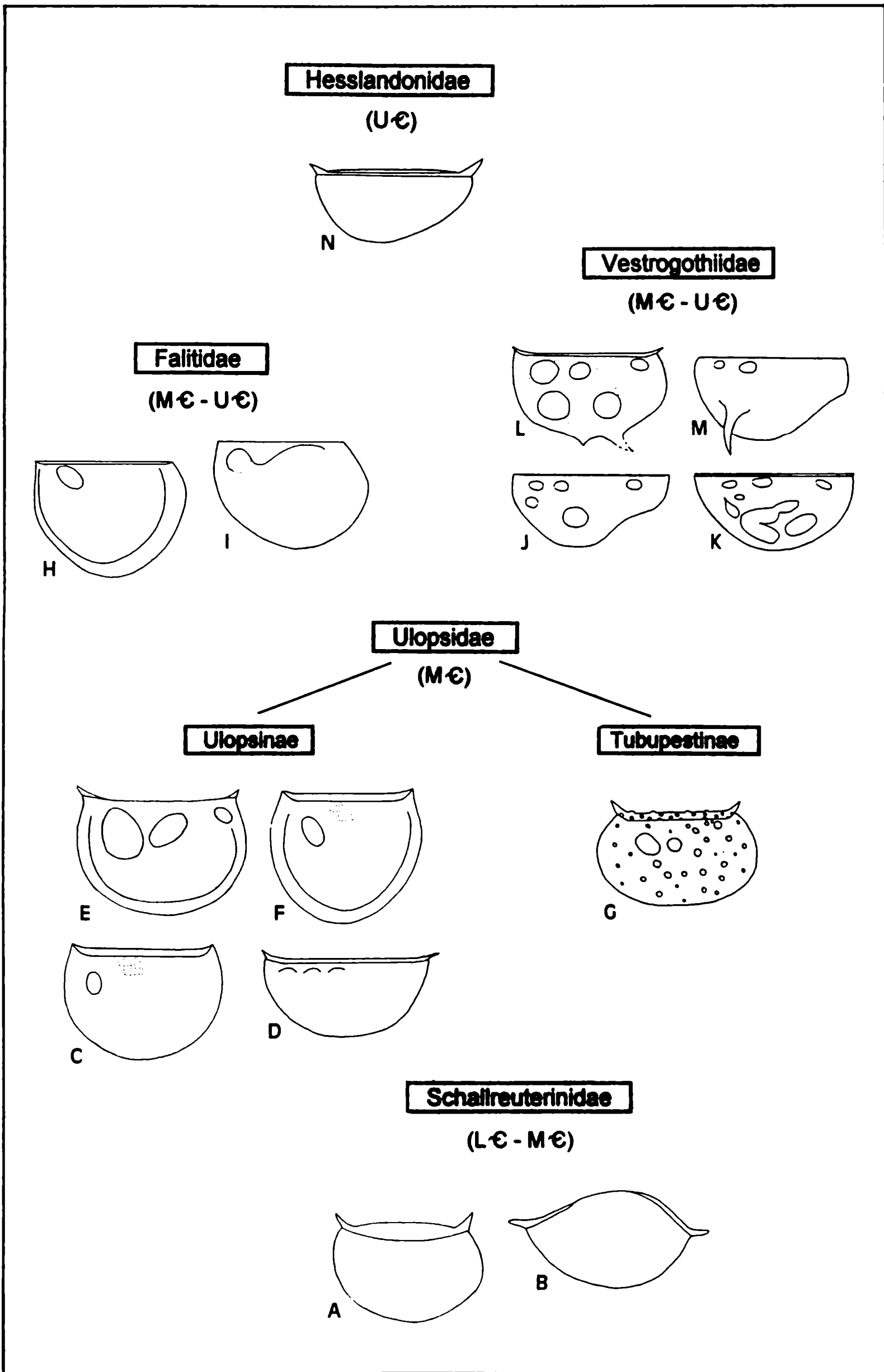
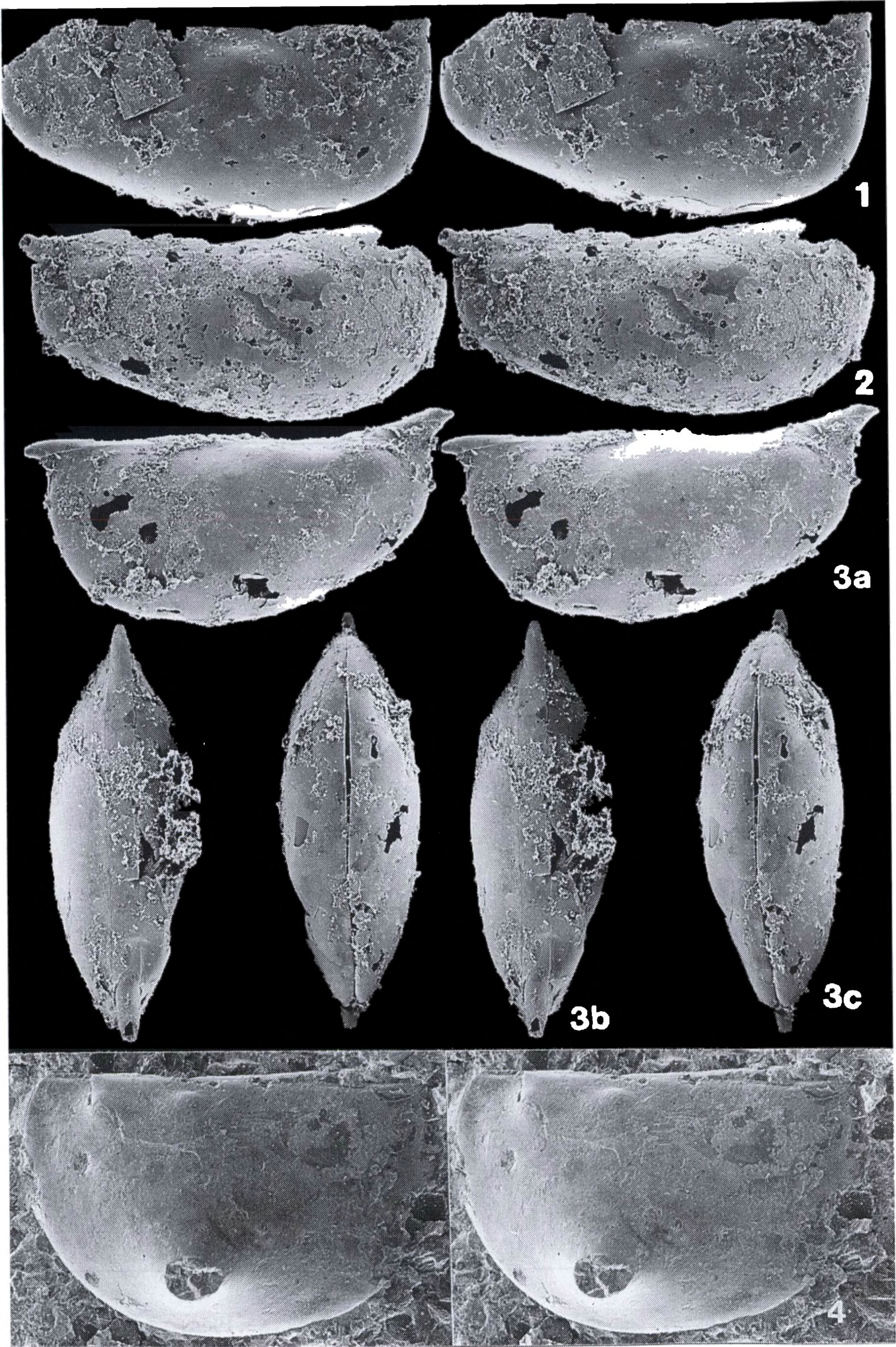


Fig. 5: Families of the Suborder Phosphatocopina MULLER, 1964, and their yet known stratigraphic occurrence.



Hesslandona reichi n.sp.

Figs. 6.1-3

D e r i v a t i o n o f n a m e: In honour of cand.geol. M. REICH, Greifswald, for having supplied material for the present research.

H o l o t y p e: Carapace, AGH no. 128-9: Figs. 6.3a-c.

T y p e l o c a l i t y: Gislövshammar, SE Scania, Sweden; local glacial erratic.

T y p e h o r i z o n: Andrarum Limestone (*Solenopleura brachymetopa* zone), upper Middle Cambrian.

M a t e r i a l: 2 single valves, 1 carapace.

D i a g n o s i s: Centrodorsal node stronger than antero- and posterodorsal nodes. Free margin without spines.

D e s c r i p t i o n: Equivalved. Shape very long. Outline distinctly preplete. Cardinal angles exceed only slightly 90°, ends weakly rounded. Distinct, parallel-bordered interdorsum with slightly converging ends that terminate in spines. Anterior spine horizontally directed, posterior spine posterodorsally directed. Broad, flat but distinct node in centrodorsal field, slightly shifted anteriorly. Additional nodes in dorsal half only weakly developed. Surface smooth.

S i z e: Holotype: L 0.565 mm, H 0.29 mm, L:H 1.95; paratype (AGH no.128-7): L 0.86 mm, H 0.39 mm, L:H 2.20.

R e m a r k s: The hesslandonid ostracode mentioned and illustrated by BERGMADSEN (1985c: 140; fig.5A-D) from the Andrarum Limestone of Bornholm is very similar to *H. reichi* with its prominent mid-dorsal node. In her specimen the position of the node is slightly more anterior, the shape is higher (L 0.62, L:H 2.05) and the cardinal corners appear larger due to the more rounded ends (= *H. reichi* ssp.n. A).

O c c u r r e n c e: Known only from type locality and type horizon.

Family Falitidae MULLER, 1964

D i a g n o s i s: Medium-sized. Shape very high. Outline subamplete or slightly postplete. Interdorsum may be reduced or missing. Valves flattened along free margin. Lobation consists mainly of a distinct antero- or centrodorsal node. Outer surface smooth or tuberculate.

G e n e r a: *Falites* MULLER, 1964

Trapezilites n.gen.

R e m a r k s: This family is distinguished from hesslandonids by both shape and lobation.

Originally MULLER (1964) also included the genus *Vestrogothia* in the family Falitidae. The respective diagnosis thus also comprised taxa with strong spines and sexually dimorphic carapaces. In 1982 MULLER established the suborder Vestrogothiina with the families Vestrogothiidae and Falitidae, but he did not provide a revised diagnosis of the family Falitidae.

O c c u r r e n c e: Middle to Upper Cambrian, Europe.

Fig. 6 (p. 398): ■1-3 *Hesslandona reichi* n.sp. Gislövshammar, SE Scania, local glacial erratic; Andrarum Limestone, upper Middle Cambrian: ■1 Paratype (AGH 128-7), right valve, posterocardinal corner missing. Lateral view; L 0.86 mm. ■2 Paratype (AGH 128-8), right valve, anterocardinal corner missing. Lateral view; L 0.86 mm. ■3 Holotype (AGH 128-9), carapace, (a) left lateral, (b) dorsal and (c) ventral views (anterior: up). ■4 *Vestrogothia steffenschneideri* n.sp., holotype (SS no.SS-1-1), left valve with broken spine and preserved interdorsum. Lateral view; L 1.44 mm; glacial erratic from Bralitz/Oderberg, Mark Brandenburg; Upper Cambrian zone 2. All stereo-pairs.

Genus *Falites* MÜLLER, 1964

Type species: *Falites fala* MÜLLER, 1964.

Diagnosis: Outline slightly postplete. Prominent anterodorsal node. One or two further but weaker nodes may occur near dorsal margin in larger larvae and adults.

Further species: *Falites cycloides* MÜLLER, 1964
Falites angustiduplicatus MÜLLER, 1964*
? *Falites pateli* LANDING, 1980
Hesslandona unisulcata MÜLLER, 1982

Occurrence: Uppermost Middle and Upper Cambrian, Baltoscandia, England, ?? China (SHU 1990a: 66).

Falites unisulcatus (MÜLLER, 1982)

Fig. 7.1

1978 *Falites fala* Müller, 1964 - RUSHTON: 276-277, pl.26, fig.12

1982 *Hesslandona unisulcata* sp. nov. - MÜLLER: 276-303, pls.1-8, figs.1-5.

Holotype: A juvenile carapace, UB no. 674 - MÜLLER 1982: pl.6, figs. 5a-b.

Type locality: Gum, Kinnekulle, Västergötland, Sweden.

Type horizon: *Agnostus pisiformis* Zone, lowermost Upper Cambrian.

Material: Figured specimen.

Diagnosis: Prominent anterodorsal node obliquely elongate. Without any further nodes. 'Loop-like thickenings' at dorsal marginal ends. Lateral surface weakly tuberculate.

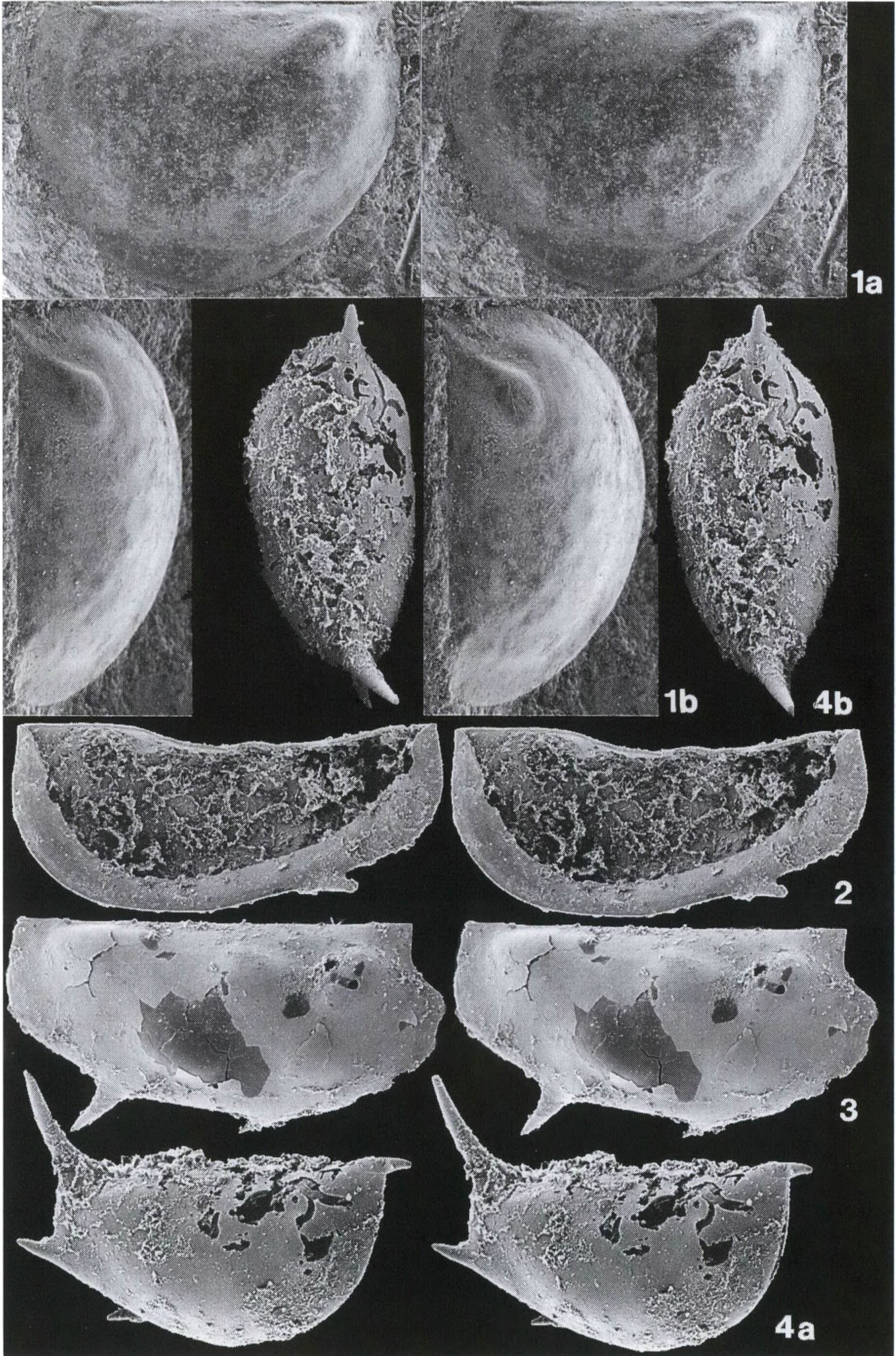
Description: Single right valve embedded in rock; hinge-line straight, an interdorsum not recognizable in this specimen. Outline of carapace asymmetrically semicircular, slightly postplete. Maximum length in the dorsal portion, maximum convexity in the anterior region, distinctly flattening towards the free margin. The latter is evenly convex without any marginal sculpture. Inner side of free margin with broad doublure. Doublure broadest ventrally and posteroventrally. Shape and extension of doublure well recognizable on the outer surface of uncoated specimen by its yellow colour contrary to the dark rest of the valve. Outer side of carapace with distinct, spindle-like node in anterodorsal field. Long axis of spindle posteroventrally directed. Sulcus behind node only very weak. Outer surface of carapace tuberculate except for yellow area and a shallow triangular depression taking the entire subdorsal region.

Size: L 1.366 mm, H 1.012 mm; L:H 1.35. MÜLLER's holotype (L 0.94 mm) is apparently a juvenile specimen. The specimen described by RUSHTON (1978: 276) is 1.85 mm long.

Remarks: *F. unisulcatus* differs from the Upper Cambrian species described by MÜLLER mainly by virtue of its distinct interdorsum, development of only the anterodorsal node, the tuberculation and the less distinct postplete outline.

* Names ending in *-ites* are masculine: ICZN Article 30b (RIDE & al. 1985: 59).

Fig. 7 (p. 401): ■1 *Falites unisulcatus* (MÜLLER, 1982), (AGH 128-1), right valve embedded in rock. (a) Lateral and (b) dorsal views; L 1.37 mm; cliff of Stoltera, W of Warnemünde, Mecklenburg (Baltic Sea); glacial erratic (no. KLA-1); *Lejopyge laevigata* Zone, uppermost Middle Cambrian. ■2-4 *Bidimorpha inversa* n.sp., same sample as Figs. 6.1-3: ■2 Paratype (AGH 128-3), right tecomorphic valve. Interior view; L 0.78 mm. ■3 Holotype (AGH 128-2), right heteromorphic valve. Lateral view; L 0.99 mm. ■4 Paratype (AGH 128-4), juvenile carapace. (a) right lateral and (b) dorsal views; L 0.44 mm (without spines). All stereo-pairs.



Originally *Falites* was regarded as a non-hesslandonid due to the missing (or unobserved) interdorsum. Consequently the interdorsum-bearing *F. unisulcata* was described by MÜLLER as the third representative of the genus *Hesslandona* which was defined by the presence of an interdorsum.

The genus *Vestrogothia* with broad interdorsum in the Middle Cambrian and extremely narrow interdorsum in the Upper Cambrian serves as a good example for the fact that presence or absence of an interdorsum cannot be regarded as a generic characteristic. *H. unisulcata* is therefore assigned to the genus *Falites*. Both outer shape and lobation of this taxon agree much more with the genus *Falites* than with the more slender and elongate *Hesslandona*.

The species of *Falites* described by MÜLLER in 1964 came from the upper Upper Cambrian whereas *F. unisulcata* occurs in older stratigraphic horizons (uppermost Middle and lowermost Upper Cambrian). *Falites* thus is an example for the phylogenetic reduction of the interdorsum even within the same genus.
O c c u r r e n c e: Uppermost Middle Cambrian (*Lejopyge laevigata* Zone) to lowermost Upper Cambrian (*Agnostus pisiformis* Zone), Baltoscandia, England.

Trapezilites n.gen.

T y p e s p e c i e s: *Aristozoe ? minima* KUMMEROW, 1931.

D e r i v a t i o n o f n a m e: After the characteristic outline.

D i a g n o s i s: Outline trapezoidal with rounded ventral corners, subamplete. Distinct node in centrodorsal field just in front of mid-height.

R e m a r k s: The genus differs from *Falites* by the outline and the main node which seems to correspond to the centrodorsal node of *Falites* (MÜLLER 1964: pl.5, fig.5a-6). An interdorsum has not yet been recorded, but it seems that the type species has similar 'loop-like thickenings' as *Falites unisulcata* (comp. MÜLLER 1964: pl.4, fig.8a and 1982: pl.6, figs.5a-b).

O c c u r r e n c e: Upper Cambrian, Baltoscandia, England.

Family Vestrogothiidae KOZUR, 1974

= Cyclotronidae GRÜNDEL in GRÜNDEL & BUCHHOLZ, 1981; = ? Hesslandonidae

D i a g n o s i s: Equivalved or unequivalved. Carapace with distinct lobation, consisting of three subdorsal and another two or three ventral nodes. Valve and sexual dimorphisms occur.

G e n e r a: *Polyphyma* GROOM, 1902 non JAKOVLEV, 1877 non HAMM, 1881

Vestrogothia MÜLLER, 1964

Cyclotron RUSHTON, 1969 (nom.nov. pro *Polyphyma*)

Veldotron GRÜNDEL in GRÜNDEL & BUCHHOLZ, 1981

Bidimorpha HINZ-SCHALLREUTER, 1993 (1993a)

R e m a r k s: Originally this taxon was established by KOZUR 1974 for taxa with strong lateral spines similar to the Tricorninidae. However, it turned out that they also have an interdorsum. Vestrogothiid taxa can be distinguished from hesslandonids by their typical lobation which occupies also the ventral portion of the valve. For this reason, the family name Vestrogothiidae has been kept, but is newly defined herein.

The genus *Cyclotron* was already regarded as being related to *Bidimorpha bidimorpha* by HINZ-SCHALLREUTER (1993a). An interdorsum of the Upper Cambrian type species has, however, not yet been recorded. By contrast, a Middle Cambrian representative proved to have an interdorsum. The possible absence of an interdorsum in the Upper Cambrian might be the result of the same phylogenetic trend as observed in *Vestrogothia* and *Falites*.

Hesslandonidae are assumed to be an older synonym of Vestrogothiidae. It is possible that the known hesslandonids are not adult and that the adults are eventually characterized by more and stronger lobes or nodes.

Genus *Vestrogothia* MÜLLER, 1964

Type species: *Vestrogothia spinata* MÜLLER, 1964.

Diagnosis: Interdorsum broad to very small or (?) missing. Cardinal corners may have spines, of which the posterior one is stronger. Both valves with a ventrocentral, posteriorly curved spine. Heteromorphs may have another posteriorly directed spine in the centroventral field.

Further species: *Vestrogothia hastata* MÜLLER, 1964

Vestrogothia longispinosa KOZUR, 1974

Vestrogothia steffenschneideri sp.n.

Remarks: Originally this genus was described without having an interdorsum. Some of the specimens illustrated by MÜLLER (1964: pl.2, figs. 4a-b, 5a-b, 7a-b) show a posterior cardinal spine on either isolated valves or carapaces. This spine is presumably part of the interdorsum.

Occurrence: Middle to Upper Cambrian, Baltoscandia.

Vestrogothia longispinosa KOZUR, 1974

Figs. 8.1-3

1974 *Vestrogothia longispinosa* n.sp. - KOZUR: 827-828; Abb.1-2

1986a VESTROGOTHIA LONGISPINOSA KOZUR, 1974 D - KEMPF: 747

1986b - dto. - KEMPF: 341

1987 - dto. - KEMPF: 605

Holotype: Left valve no. XXVI/1, Staatliche Museen Meiningen Schloß Elisabethenburg (?) - KOZUR 1974: fig.1.

Type locality: Sellin, Isle of Rügen (Baltic Sea); glacial erratic.

Type horizon: Middle Cambrian (without further details).

Original diagnosis (translated): "Maximum height of valve in anterior third. Dorsal margin long, straight, with distinct cardinal corners. End margins blunt; anterior margin higher than posterior one (= anterior height of valve greater than posterior height). Ventral margin convex, posteriorly strongly converging towards dorsal rim. Both valves with a long centroventral spine, that is obliquely posteriorly directed; outer surface of shell smooth. Hinge adont".

Material: 3 valves, 5 carapaces from Kalby, Bornholm (samples # 6507; AND-3).

Diagnosis: Interdorsum broad. Lateral spine in posterior ventrocentral region.

Size: Holotype: L o.695 mm, H o.38 mm, L:H 1.83.

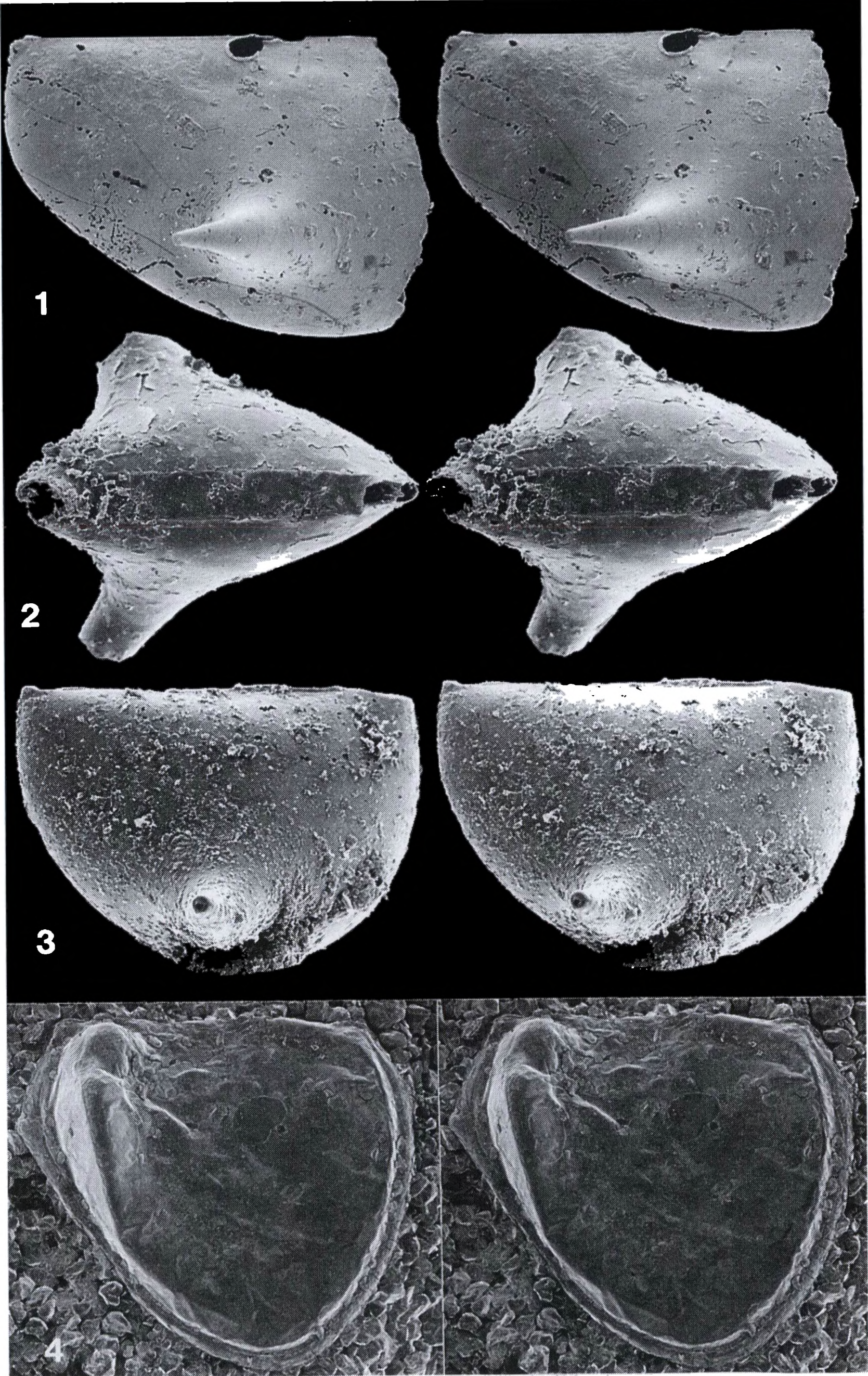
Remarks: KOZUR 1974 apparently had only single valves at hand. Material from Kalby (Bornholm) including carapaces and single valves revealed a distinct broad interdorsum (Fig. 8.2). A very small interdorsum was already observed in specimens of the Upper Cambrian type species (HINZ-SCHALLREUTER, 1993a). The general trend of reducing the interdorsal width in hesslandonid ostracodes during phylogeny was already postulated by HINZ-SCHALLREUTER (1993a: 347). Like *Falites*, the genus *Vestrogothia* seems to be an example for the evolutionary reduction of the interdorsum even within the same genus.

Occurrence: Middle Cambrian, Bornholm (KOZUR 1974), Andrarum Limestone, Kalby (herein), and Middle Cambrian glacial erratics from Sellin, Isle of Rügen (KOZUR 1974).

Vestrogothia steffenschneideri n.sp.

Fig. 6.4

Derivation of name: In honour of Steffen SCHNEIDER, Berlin, for his kind loan of the material.



H o l o t y p e: Left valve with broken spine - collection Steffen SCHNEIDER, Berlin, no. SS-1-1: Fig.6.4.

T y p e l o c a l i t y: Bralitz, Oderberg, Brandenburg.

T y p e h o r i z o n: Upper Cambrian zone 2 (det. S.SCHNEIDER).

M a t e r i a l: Figured specimen.

D i a g n o s i s: Interdorsum distinct, relatively broad. Lateral spine in anterior ventrocentral position, being colinear with the second anterodorsal node.

S i z e: Holotype: L 1.44 mm, H 0.915 mm, L:H 1.57.

R e l a t i o n s: The spine has a more posterior position than in the younger type species (MULLER 1964: pl.5, figs.1b,7), but is situated more anteriorly than in the Middle Cambrian *V. longispinosa* (Fig. 8.1). The anteriorly directed shift of the spine seems to be a phylogenetic trend.

O c c u r r e n c e: Known only from type locality and type horizon.

Genus *Veldotron* GRUNDEL in GRUNDEL & BUCHHOLZ,1981

T y p e s p e c i e s: *Veldotron kutscheri* GRUNDEL in GRUNDEL & BUCHHOLZ, 1981 = *Vestrogothia bratteforsa* MULLER,1964.

D i a g n o s i s: Large. With small interdorsum. Lobation as in *Bidimorpha*. Free margin concave posteroventrally.

R e m a r k s: As can be documented with the new material *Veldotron* is characterized by a small interdorsum (Fig. 9.1). It is distinguished from both *Bidimorpha* and *Cyclotron* (GRUNDEL in GRUNDEL & BUCHHOLZ 1981: 66) mainly by the posteroventral concavity of the free margin.

According to GRUNDEL (l.c.) *Vestrogothia bratteforsa* MULLER,1964 possibly belongs to the genus *Veldotron*. MULLER described the species without interdorsum and with a lobation of only three nodes (N_1-N_3). The holotype is only 0.92 mm, and similar larvae of *Bidimorpha* also show three dorsal nodes only. The other nodes appear during further growth. Comparable to *Bidimorpha Veldotron kutscheri* exceeds 2 mm in length. Therefore, it is likely that MULLER had only small larvae at his disposal (2 carapaces, 1 valve) with still incomplete lobation. Concerning the presence of an interdorsum, reinvestigation of the holotype of *V. bratteforsa* showed that this species also has such a sculpture. Originally *Veldotron bratteforsa* was recorded from zone 2. The zone of which the holotype of *V. kutscheri* came from is unknown, but the material described herein also came from zone 2. Therefore, the species *V. bratteforsa* is an older synonym of *V. kutscheri*. The generic name *Veldotron* keeps its validity.

O c c u r r e n c e: Upper Cambrian zone 2; Sweden, glacial erratics from Northern Germany.

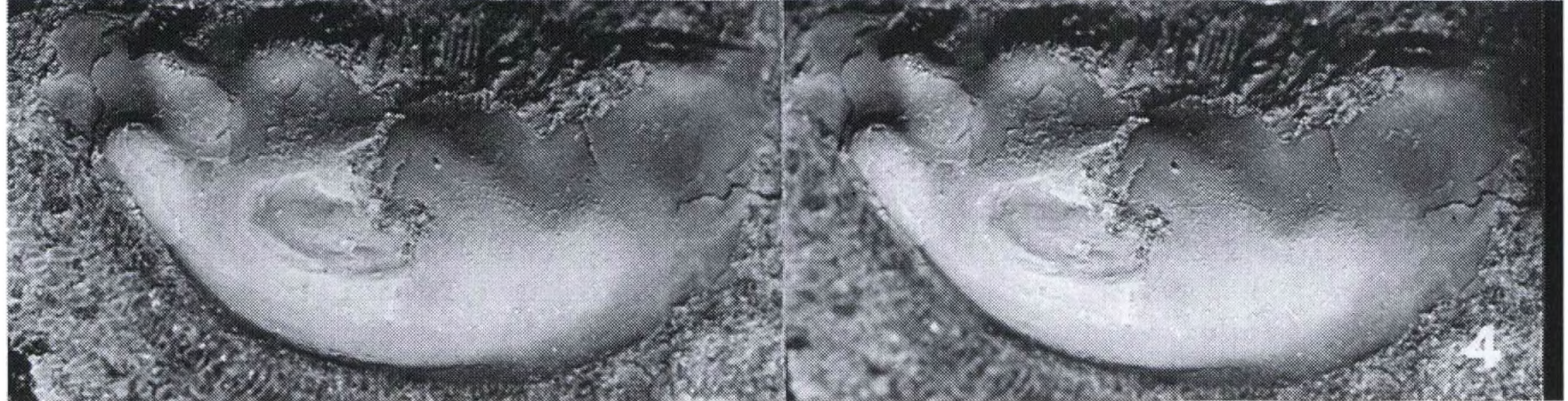
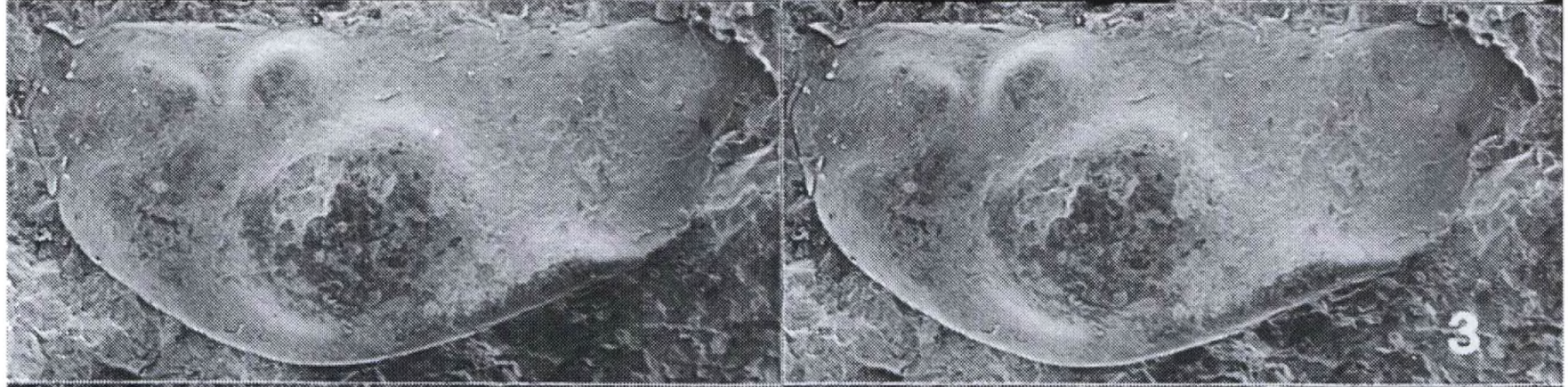
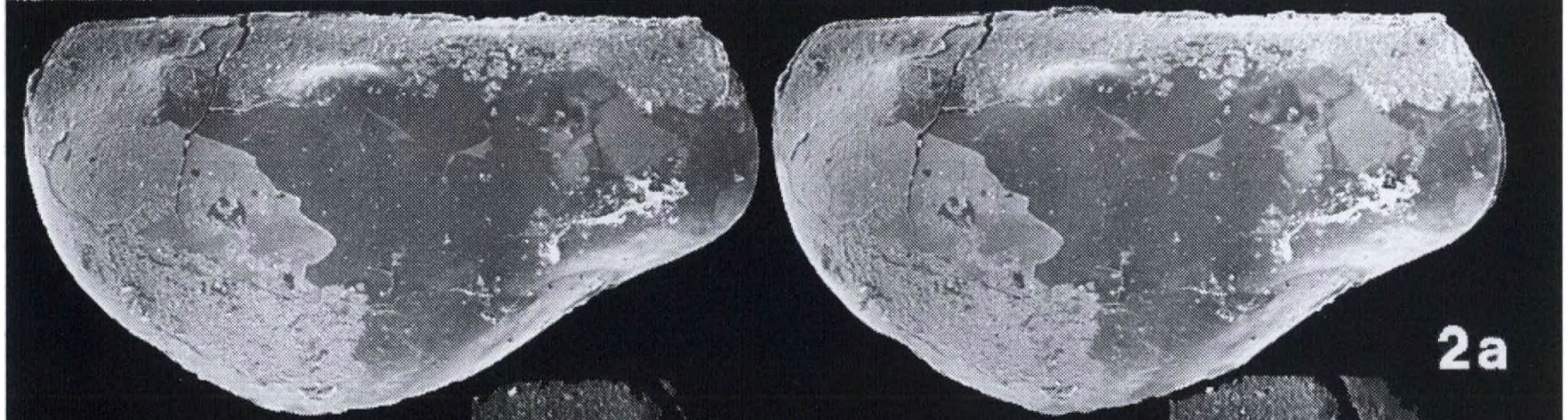
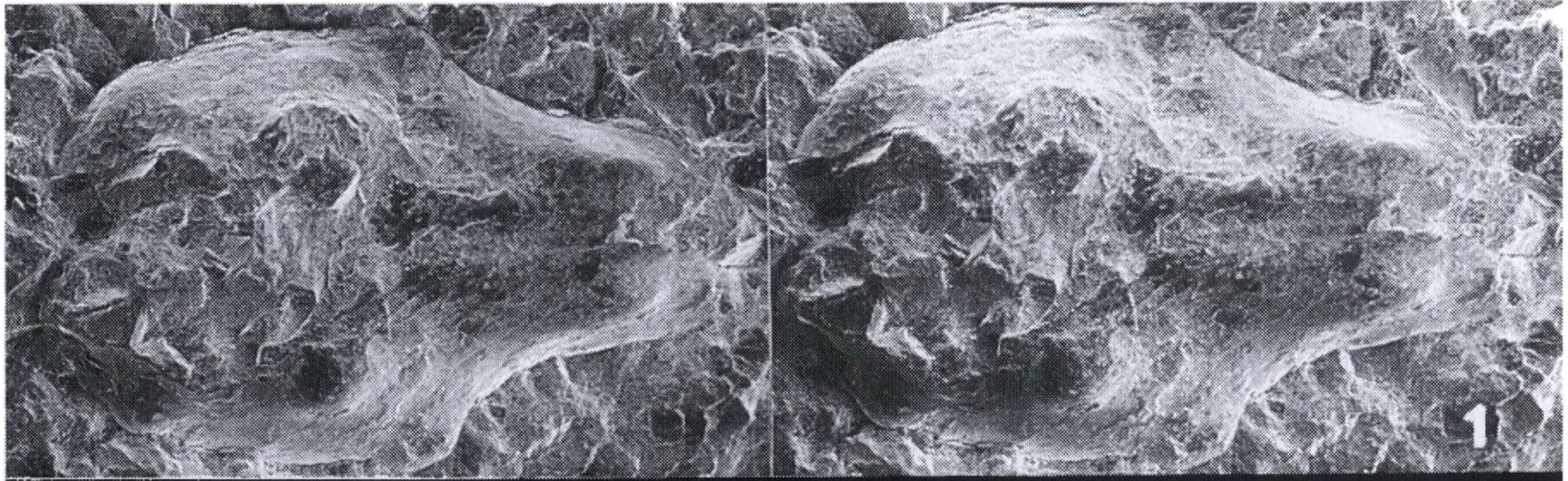
Veldotron bratteforsa (MULLER,1964)

Figs. 9.1-2

1964 *Vestrogothia bratteforsa* n.sp. - MULLER: 34-35,38; table 3; pl.3, figs. 1-2

1981 *Veldotron kutscheri* n.g.,n.sp. - GRUNDEL in GRUNDEL & BUCHHOLZ: 66; pl.3, figs.11-12,15

Fig. 8 (p. 404): ■1-3 *Vestrogothia longispinosa* KOZUR,1972. Kalby, Læså rivulet, Bornholm; Andrarum Lst., Upper Middle Cambrian. ■1 Anteriorly incomplete right valve (AGH 128-10). Lateral view; H 0.35 mm. Note borings in the shell. ■2 (AGH 128-11), juvenile carapace with spines more or less broken away, dorsal view, L 0.39 mm. ■3 Juvenile right valve. Lateral view; L 0.37 mm. ■4 *Sellula fallax* WIMAN,1903, holotype (UM), left valve embedded in rock. Lateral view, L 1.95 mm. Biludden, N Uppland, Sweden; glacial erratic (no.14 of WIMAN) of *Olenellus* sandstone, Lower Cambrian. All stereo-pairs.



- 1981 *Vestrogothia bratteforsa* (K.J.MÜLLER = possibly *Veldotron* - GRÜNDEL in GRÜNDEL & BUCHHOLZ: 66
 1986 *Vestrogothia bratteforsa* - HUO et al.: fig.3:1 (after MÜLLER 1964: pl.3, fig.2b
 1986a *VELDOTRON KUTSCHERI* GRÜNDEL, 1981 B; *VESTROGOTHIA BRATTEFORSA* MÜLLER, 1964 A - KEMPF: 745,747
 1986b - dto. - KEMPF: 316,101
 1987 - dto. - KEMPF: 710,436
 1987 *Vestrogothia bratteforsa* Müller - TONG: 433
 1993a *Veldotron kutscheri* GRÜNDEL & BUCHHOLZ, 1982 - HINZ-SCHALLREUTER: 334; fig.1C

H o l o t y p e: A juvenile carapace, UB no.27: Fig. 9.2; (see also MÜLLER 1964: pl.2, figs.2a-b; HUO, SHU & ZHAO 1986: fig.3.1).

Holotype of *V. kutscheri*: Right valve, embedded in rock, BB no.X7860, GRÜNDEL & BUCHHOLZ: pl.3, fig.12. - Paratype (presumably): BB no. X7863, left valve, embedded in rock, l.c.: fig.15. L.c.: fig.11 (X7859) is not a paratype (HINZ-SCHALLREUTER 1993a: 334, footnote).

T y p e l o c a l i t y: Brattefors, Kinnekulle, Västergötland, Sweden; great quarry south of the village.

Type locality of *V. kutscheri*: Mukran, Isle of Rügen; glacial erratic.

T y p e h o r i z o n: Zone 2 (MÜLLER's sample 995).

Type horizon of *V. kutscheri*: Presumably Upper Cambrian (glacial erratic without associated trilobite fauna).

M a t e r i a l: A piece of rock with >70 specimens (mostly valves); glacial erratic from Damsdorf, coll. F.RUDOLPH 1985.

O r i g i n a l d i a g n o s i s (after MÜLLER 1964: 34; translated): "A representative of *Vestrogothia* with three flat nodes. Left valve larger than right valve, without spines and tubercles."

Original diagnosis of *V. kutscheri* (after GRÜNDEL in GRÜNDEL & BUCHHOLZ 1981: 67; translated): "N₅ indistinctly delimited with distinct N₆ on its posterior slope. The rounded N₂ is larger than N₁. N₄ is situated below N₁ and is smaller. Posterior end flattened. Posterior border straight and steeply descending ventrally and posteriorly".

D i a g n o s i s: As for the genus.

S i z e: Holotype: L 0.92 mm, H 0.51 mm, L:H 1.80; holotype of *V. kutscheri*: L 1.50 mm (after GRÜNDEL: o.c.: 67), H 0.70 (according to GRÜNDEL: o.c.: pl.3, fig.12), L:H 2.14; AGH 128-13: L ~ 2.94 mm.

R e m a r k s: *Veldotron bratteforsa* is characterized by a small epicline dorsum at each valve and a small interdorsum between the dorsa (Fig. 9.1).

O c c u r r e n c e: Upper Cambrian zone 2; Sweden, glacial erratics from Northern Germany (Mukran, Pommern; Damsdorf, Schleswig-Holstein).

 Fig. 9 (p. 406): ■1-2 *Veldotron bratteforsa* (MÜLLER, 1964): ■1 (AGH 128-13), anteriorly damaged carapace embedded in rock. Dorsal view (anterior: left); L ~ 2.94 mm. Stink-stone glacial erratic (no. RUD-4) from the gravel pit Damsdorf, Schleswig-Holstein, coll. by F.RUDOPH 1985. ■2 Holotype (UB27), carapace. (a) Left lateral and (b-c) dorsal views, (anterior: up); L 0.92 mm; Brattefors (great quarry south of the village), Kinnekulle, Västergötland, Sweden; Upper Cambrian zone 2. ■3 *Cyclotron ventrocurvatum* GRÜNDEL in GRÜNDEL & BUCHHOLZ, 1981, (no. SS-1,2), left valve embedded in rock, dorsally damaged. Lateral view; L 2.42 mm; same glacial erratic as in Fig. 6.4. ■4 *Cyclotron furcatocostatum* GRÜNDEL in GRÜNDEL & BUCHHOLZ, 1981, (AGH 128-14), dorsally damaged left valve embedded in rock. Lateral view, whitened with ammonium chlorid; L 9.3 mm. Glacial erratic of black non-bituminous limestone, cliff near Dwasieden, S Saßnitz, Isle of Rügen (Baltic Sea), Pommern; leg. M.REICH May 1993. All stereo-pairs.

Genus *Cyclotron* RUSHTON, 1969

= nom.nov. pro *Polyphyma* GROOM, 1902 non JAKOVLEV, 1877 non HAMM, 1881

Type species: *Polyphyma Lapworthi* GROOM, 1902.

Diagnosis: Large to very large. Subamplete. Three nodes ($N_1 - N_3$) in dorsal half near dorsal margin, N_1 and N_2 near anterior end (N_2 closer to dorsal margin than N_1), N_3 in posterodorsal region. Another node (N_4) in anteroventral region. Large ventrocentral lobe which may split posteriorly into two branches (N_5 and N_6).

Further species: *Beyrichia Angelini* BARRANDE, 1872

Cyclotron nodomarginatum SCHRANK, 1973

Cyclotron cambricum GRÜNDEL in GRÜNDEL & BUCHHOLZ, 1981

Cyclotron furcatocostatum GRÜNDEL in GRÜNDEL & BUCHHOLZ, 1981

Cyclotron poulsenii GRÜNDEL in GRÜNDEL & BUCHHOLZ, 1981

Cyclotron ventrocurvatum GRÜNDEL in GRÜNDEL & BUCHHOLZ, 1981

Remarks: *Beyrichia Angelini* var. *lunula*, *B. Holsti* and *B. cornigera* MOBERG in MUNTHER, 1906 are *nomina nuda*.

Beyrichia angelini was established by BARRANDE (1872: 485) for a species illustrated by N.P. ANGELIN on his 'Tabula A' (figs. 36a-b). The latter was printed for the planned fasciculus III of *Palaeontologia Scandinavica*, which was, however, only distributed to colleagues abroad, but was never published (WESTERGARD 1947: 19; MARTINSSON 1961: 15, 17). Since ANGELIN's original is probably lost WESTERGARD regarded the specimen illustrated by LINNARSSON (1875: pl. 5, fig. 11) and himself as (neo-)type (WESTERGARD 1947: 19; pl. 1, fig. 15). *Beyrichia angelini* was recorded from several Swedish localities by many authors, and received acceptance as zonal index fossil (e.g.: REMELÉ 1883: 82, 110). Later WESTERGARD (1947: 18-19) selected the species as one of the index fossils for the uppermost subzone of the *Olenus* Zone (Upper Cambrian zone 2). From the Upper Cambrian zone 2, several species of *Cyclotron* were described by GRÜNDEL (o.c.). It is likely that the many mentionings of *Beyrichia angelini* comprise several *Cyclotron* species.

Relations: *Cyclotron* differs from *Bidimorpha* mainly by lobation as well as by sexual dimorphism. *Cyclotron* is distinct from *Veldotron* by its special outline.

Occurrence: Upper Cambrian, Britain; Upper Middle and Upper Cambrian, Baltoscandia.

Cyclotron furcatocostatum GRÜNDEL in GRÜNDEL & BUCHHOLZ, 1981

Fig. 9.4

1979 *Cyclotron nodomarginatum* SCHRANK 1973 - BEDNARCZYK: 217, pl., fig. 1a-b, ? 2-4, 7-8

1981 *Cyclotron furcatocostatum* n.sp. - GRÜNDEL in GRÜNDEL & BUCHHOLZ: 64-65; pl. 2, figs. 11-12

1986a CYCLOTRON FURCATOCOSTATUM GRÜNDEL, 1981 B - KEMPF: 203

1986b - dto. - KEMPF: 233

1987 - dto. - KEMPF: 710

Holotype: Right valve (Steinkern and external mould), BB no. X 7844, GRÜNDEL & BUCHHOLZ: pl. 2, figs. 11-12.

Type locality: Mukran, Isle of Rügen (Baltic Sea); glacial erratic.

Type horizon: *Olenus* Zone.

Original diagnosis (translated): Outline of valve subrectangular (ventral margin slightly convex). Ventral branch of furcated N_5 with N_6 being attached. N_1 and N_2 connected, N_4 rounded. Without marginal ridge.

Material: 1 valve embedded in rock.

D i a g n o s i s: Very large. Anteriormost nodes (N_1 , N_4) elongate, dorsal branch of furcated ventrocentral lobe (N_5) shorter than ventral branch (= N_6).

S i z e: Holotype: L 3.7 mm (after GRÜNDEL: o.c.: 64), H 2.04 mm (after GRÜNDEL's figure), L:H 1.82; AGH 128-14: L 9.3 mm, H ~ 4.4 mm, L:H ~ 2.10.

O c c u r r e n c e: Leba High (borehole Debki-2), local *Agnostus pisiformis* & *A. (Homagnostus) obesus* Zone (BEDNARCZYK 1979), Northern Germany (glacial erratics), probably Upper Cambrian zone 2 (without associated trilobite fauna; comp. also GRÜNDEL: o.c: 65).

Cyclotron ventrocurvatum GRÜNDEL in GRÜNDEL & BUCHHOLZ, 1981

Fig. 9.3

1981 *Cyclotron ventrocurvatum* n.sp. - GRÜNDEL in GRÜNDEL & BUCHHOLZ: 66; pl. 3, fig.6

1986a CYCLOTRON VENTROCURVATUM GRUENDEL, 1981 B - KEMPF: 203

1986b - dto. - KEMPF: 634

1987 - dto. - KEMPF: 710

H o l o t y p e: Right valve, BB X 7854, GRÜNDEL & BUCHHOLZ: pl.3, fig.6.

T y p e l o c a l i t y: Dwasieden, Isle of Rügen (Baltic Sea); glacial erratic.

T y p e h o r i z o n: *Olenus* Zone.

O r i g i n a l d i a g n o s i s (translated): "Small species with rounded N_5 which is distinctly set off from ventral margin. N_4 large, directly at margin of valve. From there a bend (Umbiegungskante) forms the valve border which is seen in lateral view. Posteroventrally the border is distinctly arched upward and bulge-like thickened".

M a t e r i a l: Figured specimen.

D i a g n o s i s: Medium-sized to large. $N_{5/6}$ as a large and broad, flat, undivided lobe. Posteroventral border typically arched upwards in order to form a bulge-like thickening, which is separated from $N_{5/6}$ by a weak and narrow furrow.

S i z e: Holotype: L 1.95 mm (after GRÜNDEL: o.c.: p.66), H 1.07 mm (after GRÜNDEL: o.c.: pl.3, fig.6), L:H 1.81; SS-1-2: L 2.42 mm, H 1.13 mm, L:H 2.14.

R e m a r k s: The ventrally arched area probably led to an unequal development of the valves similar to that in *Vestrogothia* (MÜLLER 1964: pl.2, figs.8a-b).

O c c u r r e n c e: Upper Cambrian zone 2, glacial erratics from Dwasieden, Pommern, and Bralitz/Oderberg, Mark Brandenburg.

Genus *Bidimorpha* HINZ-SCHALLREUTER, 1993

T y p e s p e c i e s: *Bidimorpha bidimorpha* HINZ-SCHALLREUTER, 1993 (1993a).

D i a g n o s i s: Large. Shape moderately high to rather elongate. Distinctly preplete. Carapace with parallel-bordered interdorsum, borders only slightly converging at either end. Short cardinal spines may be developed. Free margin without marginal rim. Doublure along inner side of free margin. Lobation consists of four more or less distinct, flat nodes (N_1, N_2, N_4, N_6) in anterior-most two thirds of valve. Nodes are part of a larger elevation. N_3 dorsally in flattened posterior third of valve. Carapace without lateral spines. Valve and sexual dimorphism observed: left or right valves with one (tecnomorphs?) or two ventral spines (heteromorphs?), the respective opposite valves without or with one ventral spine. Outer surface of valve smooth.

Bidimorpha inversa sp.n.

Figs. 7.2-4; 10.1

D e r i v a t i o n o f n a m e: *inversus*, Latin - vice versa, after the two spines at the right valve contrary to the type species with two spines on the left valve in heteromorphs.

H o l o t y p e: Posterodorsally incomplete right valve, AGH no. 128-2: Fig. 7.3.

T y p e l o c a l i t y: Gislövshammar, SE Scania, Sweden; local glacial erratic.

T y p e h o r i z o n: Presumably Andrarum Limestone, upper Middle Cambrian.

M a t e r i a l: 2 right valves, 1 carapace.

D i a g n o s i s: N_3 broad, taking half of the posterior height of valve. Right valve with one ventral spine in tecnomorphs or two ventral spines in heteromorphs. Distance between both spines takes about one third of total length of valve. In heteromorphs the stronger posterior spine is colinear with the posterior end of N_6 and the anterior end of N_3 . Left valve with one spine that is in a more anterior position than the spine in a tecnomorphic right valve.

S i z e: Holotype: L 0.99 mm, H 0.445 mm, L:H 2.22; paratype (AGH 128-4): L 0.44 mm, H 0.255, L:H 1.73.

R e m a r k s: The largest herein recorded specimen is probably not an adult. The smallest instar shows weaker lobation and the spines are in a more posterior position. This characteristic has not been observed in *B. bidimorpha*.

R e l a t i o n s: *B. inversa* differs from the type species mainly by the stronger N_3 , by general gross morphological characteristics of the heteromorphs which have two spines on the right valve instead on the left one, and by the greater distance between these spines.

O c c u r r e n c e: Only from type locality and type horizon.

Family Schallreuterinidae n.fam.

Fig. 5

D i a g n o s i s: Equivalved. Interdorsum with strongly convex borders.

G e n e r a: *Schallreuterina* HINZ-SCHALLREUTER, 1993 (1993b)

Comleyopsis HINZ, 1993

R e m a r k s: The genera assigned to this family are somewhat different: *Schallreuterina* is characterized by a strongly arched interdorsum, while *Comleyopsis* has a flat but laterally convexly-bordered interdorsum. In both cases its function as a hinge, i.e., opening and closure of the carapace is rather problematical. The taxa are assumed to have had very limited lateral mobility of the valves.

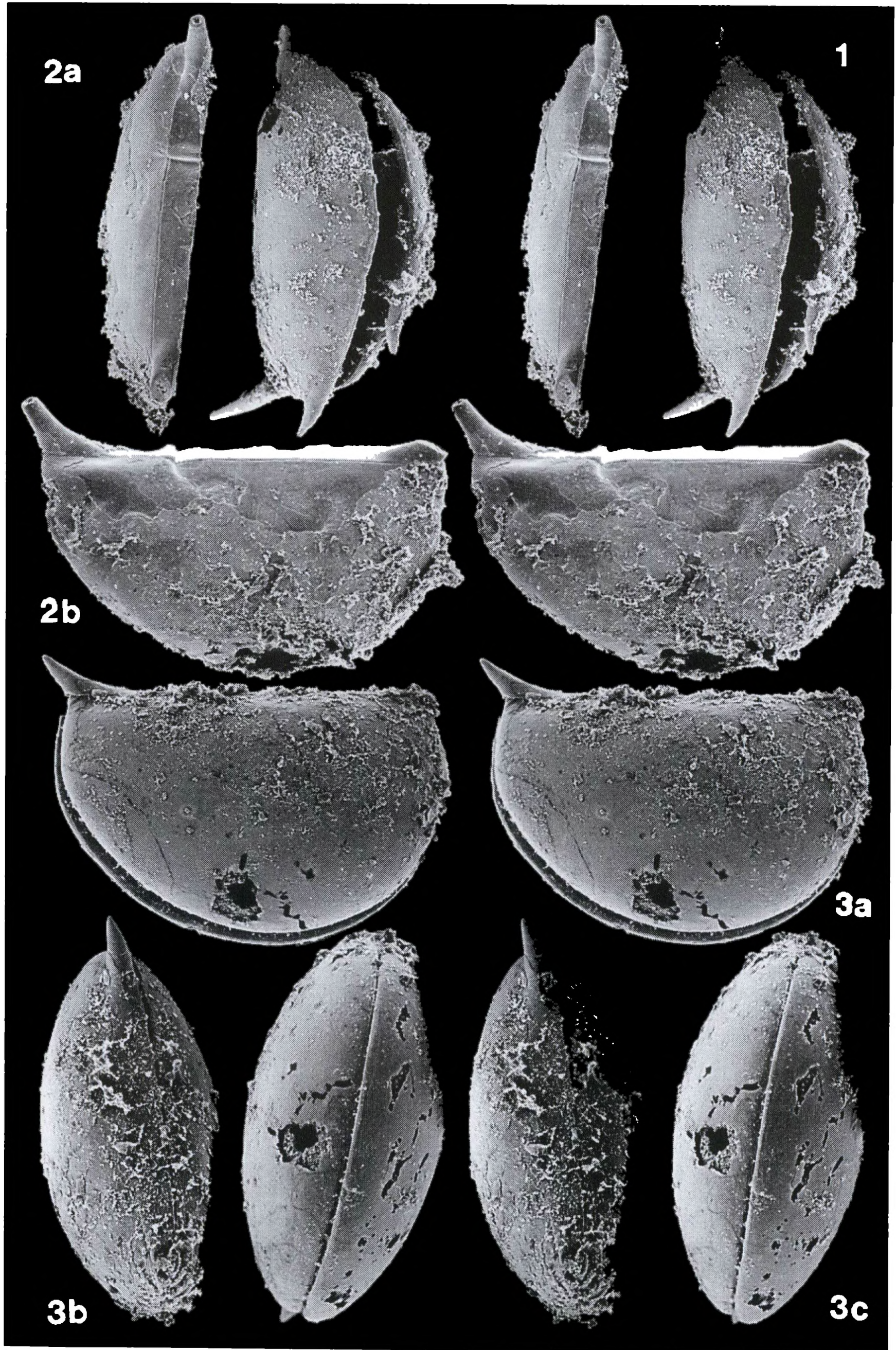
O c c u r r e n c e: Lower Cambrian, England (*Comleyopsis*); Middle Cambrian, Australia (*Schallreuterina*).

Family Ulopsidae n.fam.

Fig. 5

D i a g n o s i s: Equivalved. Shape relatively high. Two distinct lobes in anterodorsal quarter of the valve.

Fig. 10 (p. 411): ■1 *Bidimorpha inversa* n.sp., same specimen as in Fig. 7.4. Ventral view. ■ 2-3 *Aparchona klafacki* n.gen.n.sp., from same sample as Figs. 6.1-3. ■2 Paratype (AGH 128-5), slightly distorted right valve with interdorsum. (a) Dorsal and (b) lateral views; L 0.46 mm. ■3 Holotype (AGH 128-6), carapace. (a) Right lateral, (b) dorsal and (c) ventral views; L 0.32 mm. All stereo-pairs.



Subfamily Ulopsinae n.sf.

D i a g n o s i s: Centrodorsal node close to dorsal margin. Interdorsum smooth.

G e n e r a: *Ulopsis* HINZ, 1991

Parashergoldopsis HINZ-SCHALLREUTER, 1993 (1993b)

Shergoldopsis HINZ-SCHALLREUTER, 1993 (1993b)

O c c u r r e n c e: Middle Cambrian, Australia.

Subfamily Tubupestinae n.sf.

D i a g n o s i s: Centrodorsal node in some distance from dorsal border. Interdorsum sculptured like the lateral surfaces.

G e n u s: *Tubupestis* HINZ & JONES, 1992.

O c c u r r e n c e: Middle Cambrian, Australia.

Fam.inc.

The families distinguished above were defined mainly on the basis of outline and lobation. The nearly non-lobate taxon *Semillia* HINZ, 1992 resembles *Hesslandona* but this genus is based on larvae and the according adults may possess a vestrogothiid lobation. By contrast, *Semillia* is rather large and its lobation strongly differs from that of Vestrogothiidae. It is distinguished from ulopsids by its outer shape.

The new genus *Aparchona* is based on a juvenile carapace which does not show any traces of lobation. It thus differs from the smallest vestrogothiid larvae which have lobes developed already at an early ontogenetic stage. The characteristics of the above mentioned taxa do not seem to justify the establishment of monotypic families. A suprageneric classification is only sensible on the basis of more material and better knowledge of the ontogeny.

Genus *Aparchona* n.gen.

T y p e s p e c i e s: *Aparchona klafacki* n.sp.

D e r i v a t i o n o f n a m e: Artificial combination made of the morphological similar Ordovician genus *Aparchites* and the Cambrian *Beyrichona*.

F u r t h e r s p e c i e s: ? *Vestrogothia granulata* MÜLLER, 1964.

D i a g n o s i s: Small. Slightly preplete. Left valve slightly larger than right valve. Without any lobation. Surface smooth (or granulate?).

R e m a r k s: The genus differs from most other phosphatocopine genera mainly by its lack of any lobation. It thus resembles *Comleyopsis* which, however, has an interdorsum with strongly convex lateral borders. The interdorsum in *Aparchona* is parallel-bordered.

O c c u r r e n c e: Uppermost Middle Cambrian, ? Lower Upper Cambrian (zone 2), Baltoscandia.

Aparchona klafacki n.sp.

Figs. 10.2-3

D e r i v a t i o n o f n a m e: In honour of R. KLAFAK (Rostock) for having supplied material for this paper.

H o l o t y p e: A presumably juvenile carapace, AGH no.128-6: Figs.10.3a-c.

T y p e l o c a l i t y: Gislövshammar, SE Scania, glacial erratic.

T y p e h o r i z o n: Andrarum Limestone (~ *Solenopleura brachymetopa* Zone), upper Middle Cambrian.

M a t e r i a l: 1 valve, 1 carapace.

D i a g n o s i s: As for the genus.

S i z e: Holotype: L 0.32 mm, H 0.21 mm, L:H 1.52; paratype (AGH 128-5): L 0.46 mm, H 0.24 mm, L:H 1.89.

O c c u r r e n c e: Known only from type locality and type horizon.

Suborder Bradorina RAYMOND, 1935

D i a g n o s i s: Large to very large. Carapace with simple dorsal hinge.

Family Bradoriidae MATTHEW, 1902

D i a g n o s i s: Large. Subamplete to distinctly postplete. Without prominent lobation. Sometimes presence of an anterodorsal 'eye' tubercle and a weak triangular sulcal depression behind the latter. Shell punctate.

Genus *Bradoria* MATTHEW, 1899

T y p e s p e c i e s: *Bradoria scrutator* MATTHEW, 1899.

R e m a r k s: According to ULRICH & BASSLER (1931: 15) MATTHEW based *Bradoria scrutator* on three specimens. However, ULRICH & BASSLER (l.c.) who "found it necessary to restrict his [MATTHEW's] types to the figured specimens in practically all cases" considered two of his specimens to be conspecific. Both specimens are refigured herein in Fig. 11.4 (lectotype) and Fig. 13.2. They are both incomplete. ULRICH & BASSLER (l.c.) wrote about the lectotype: "Matthew's figure of the left valve of this specimen gives a false impression of the outline, the ventral portion of the specimen being somewhat obscured by matrix and the whole carapace crushed so as to straighten this side a trifle and to expose the cardinal edge of the opposite right valve".

The paralectotype is a single valve broken out of the rock. It was subsequently glued to another place or piece of rock again. This manipulation probably affected the free margin which seems at least to be partly broken away. Despite this fact the specimen apparently differs from the lectotype by its outline and the presence of a distinct 'eye tubercle'. Therefore, it is rather doubtful whether or not both specimens are conspecific. Here, *B. scrutator* is restricted to the lectotype. Its fragmentary state of preservation may suggest its classification as a *nomen dubium* which would, however, infer great nomenclatural consequences.

Alternatively it is referred herein to an ostracode carapace described and illustrated by BOLTON & COPELAND as *Bradoria* sp. (1963: 1070, pl.143, fig.5-7). Their specimen closely resembles the lectotype of *B. scrutator*. Its dorsal half has the same outline as the visible part of the lectotype, a similar punctation, and it also lacks an 'eye tubercle'. This specimen is considered here as typical representative of the genus *Bradoria*.

Until now more than 40 species were described or assigned to *Bradoria* (see KEMPF 1986a: 135). A revision of the genus is beyond the scope of the present paper. *Bradoria* species with a distinct 'eye tubercle' such as *B. robusta* and the paralectotype of the type species are presently better assigned to *Bradorona* MATTHEW, 1902. Originally this genus was established as a subgenus of *Bradoria* and subsequently considered as junior synonym of *Bradoria* by ULRICH & BASSLER 1931. The type species, *Bradorona perspicator* (MATTHEW, 1902) has a distinct 'eye' tubercle (Fig. 13.1) like the paralectotype of *Bradoria scrutator* (see above). The tubercle of the lectotype of *B. scrutator* shown in MATTHEW's drawing (see also ULRICH & BASSLER 1931: pl.1, fig.11) proved to be relics of the matrix (Fig.11.4). *Bradorona* is thus regarded as a valid genus.

O c c u r r e n c e: Lower to Middle Cambrian, North America, Morocco.

Bradoria mapora n.sp.

Fig. 11.3

D e r i v a t i o n o f n a m e: After the large pores on the outer surface (*macroporata*).

H o l o t y p e: Posterodorsally incomplete right valve, PIW 94-III-7: Fig.11.3.

T y p e l o c a l i t y: Jbel Azgza, Central Anti-Atlas, Morocco.

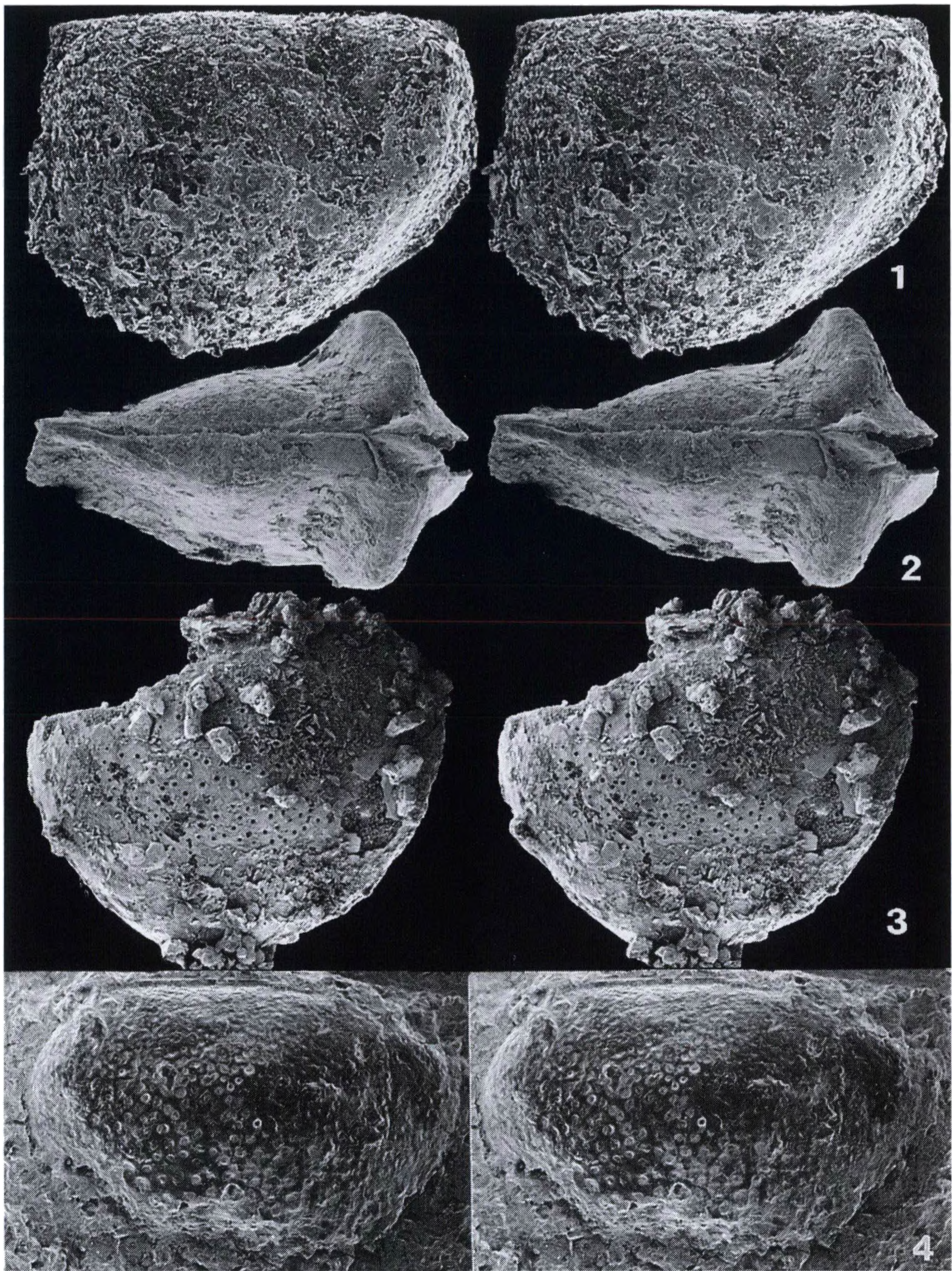


Fig. 11: ■1 *Tagra koppkai* n.gen.n.sp., holotype (PIW 94-III-5), right valve. Lateral view; L 0.82 mm. Tagragera syncline, central Anti-Atlas, Morocco; *Ornamentaspis frequens* Zone ? (~ *Paradoxides insularis* Zone) (coll. by GEYER, sample # TA/MC40). ■2 *Albrunnicola oelandicus maroccanus* n.ssp., paratype (PIW 94-III-6), ventrally and posteriorly incomplete carapace, anteriorly slightly distorted. Dorsal view; L 1.63 mm. Aït Mersid, Central Anti-Atlas, Morocco; *Bailiella* Formation with *B. cf.levyi* (~ *Paradoxides paradoxissimus* Zone) (coll. by GEYER, sample # D 2077) ■3 *Bradoria mapora* n.sp., holotype (PIW 94-III-7), right valve, posterodorsally incomplete. Lateral view; L 2.07 mm; Jbel Azgza, central Anti-Atlas, Morocco; Jbel Afraou Formation, *Ornamentaspis*

Type horizon: Jbel Afraou Formation, *Ornamentaspis frequens* Zone ? (~ *Paradoxides insularis* zone), Middle Cambrian (GEYER sample # D2058).

Material: 1 incomplete right valve.

Diagnosis: Outline more or less semicircular, slightly postplete. Outer surface porous.

Description: Outline approximately semicircular, postplete. Hinge-line partly broken off, but appears to be straight. Maximum length of valve at about mid-height, maximum convexity in the central field, slightly shifted posteriorly. Free margin without marginal rim. Without lobation. Outer surface of valve with pores, mainly in the central field.

Size: Holotype: L 2.07 mm, H ~1.66 mm, L:H ~1.25.

Relations: *B. mapora* is similar to *Bradoria* sp. recorded by BOLTON & COPELAND (1963) from the Middle Cambrian of western Canada. Both taxa have a porous outer surface, but otherwise lack any distinctive features. In *Bradoria* sp. the anterior side appears to be more receding than in *B. mapora*, and the latter is also more convex in the central field. The punctate outer surface apparently is of variable taxonomic significance. It occurs in many different archaeocope ostracodes, e.g., *Hipponicharion geyeri*, *Cedocamia* and *Biaurina*. They strongly differ from *B. mapora* mainly by lobation and the presence of a marginal rim. *Pengshuiella hemicyclica* HUO et al. (1991, pl. 17, figs. 1-7) shows pores underneath a net-like surface sculpture, it also has a marginal rim and a marginal furrow. A lobation is not recognizable. *Zhexiella venusta* SHU, 1990 lacks major lobation but has a broad centrodorsal bulb-like inflation (SHU 1990a: pl. 4, fig. 3a; text-fig. 19). *Euzepaera* SHU, 1990 is another perforate taxon. It is longer than *B. mapora*, has a marginal rim and a weak anterodorsal depression (o.c.: pl. 2, fig. 5; text-fig. 20).

Occurrence: Known only from type locality and type horizon.

Genus *Ifersiktia* n.gen.

Type species: *Ifersiktia mipora* n.sp.

Derivation of name: After its occurrence at Jbel Ifersikt, Anti-Atlas, Morocco.

Diagnosis: Medium-sized to large (?). Broadest centrally. Shape very high, nearly as high as long. Distinctly postplete with clear retral swing. Typical representatives with weak anterodorsal sulcal depression and flat ('eye') node in the anterodorsal region in front of the depression. Shell finely porate.

Further species: ? *Bradoria tontoensis* ULRICH & BASSLER, 1931.

Remarks: *Ifersiktia* differs from *Bradoria* by the presence of a weak anterior sulcal depression and by the anterodorsal node.

ULRICH & BASSLER 1931 described *Bradoria tontoensis* which is very similar to *Ifersiktia* in its general outline. The latter appears to be a typical feature, and suggests an assignment of *B. tontoensis* to the new genus. However, *B. tontoensis* lacks both sulcal depression and 'eye' tubercle so that its present assignment can only be tentative.

Occurrence: Middle Cambrian, Morocco and ? Arizona.

Ifersiktia mipora n.sp.

Fig. 12.4

Derivation of name: After the small surface pores (*microporata*).

Fig. 11 (cont. from p. 414):

frequens Zone ? (coll. by GEYER, sample # D 2058). ■4 *Bradoria scrutator* MATTHEW, 1899, lectotype (ROM Cat.No. 142 CM), left valve, ventrally corroded. Lateral view; L 3.05. Dugald Brook, Cape Breton, Nova Scotia, Canada; Upper Etcheminian (division E3e), Lower Cambrian. All stereo-pairs.

H o l o t y p e: Anteriorly incomplete carapace, PIW no.94-III-4, Fig. 12.4.
T y p e l o c a l i t y: Jbel bou Ifersikt, central Anti-Atlas, Morocco.
T y p e h o r i z o n: Afraou Formation, *Ornamentaspis frequens* Zone ? (~ *Paradoxides insularis* Zone), Middle Cambrian (GEYER sample # 2094).
M a t e r i a l: 1 incomplete carapace.
D i a g n o s i s: Anterodorsal field with small node and a weak triangular sulcal depression.
D e s c r i p t i o n: Shape very high, postplete with slight retral swing. Hinge-line straight. Maximum length of valve in dorsal half, maximum convexity in central field, but carapace generally rather flat. Free margin without marginal rim. Anterior side slightly receding. Anterior part of valve rather flat and partly compressed, anterodorsal depression indicated. Lobation consists of a rather flat, anterior lobe. Outer surface finely porate.
S i z e: Holotype: L 1.61 mm, H 1.655 mm, L:H slightly >0.97.
R e l a t i o n s: *I. ? tontoenesis* has the same outline and shape but lacks completely both sulcal depression and 'eye' tubercle.
O c c u r r e n c e: Known only from type locality and type horizon.

Family Beyrichonidae ULRICH & BASSLER, 1931

D i a g n o s i s: Small to large. Shape very high or higher than long. Postplete with distinct retral swing. Lateral surface with two more or less distinct sulci mainly in dorsal part. They separate three flat lobes of which the median lobe usually is the broadest. Anterior lobe may form a small node close to dorsal margin. Free margin with or without marginal rim.
R e m a r k s: ULRICH & BASSLER originally distinguished only the two families Bradoriidae and Beyrichonidae. The latter also comprised those taxa which were later assigned to the family Hipponicharionidae by SYLVESTER-BRADLEY (in BENSON et al. 1961). Most of the remaining beyrichonids have been eventually referred to other suprageneric taxa (see also herein). From all beyrichonid genera of ULRICH & BASSLER only the type genus and *Escasona* remain in the family. *Uskutchiella* MELNIKOVA, 1992 is also assigned herein to the family Beyrichonidae. A reinvestigation of the holotype of the type species - the only known specimen - revealed a misinterpretation by the author. The holotype is not a right valve but a widely opened carapace with both valves in juxtaposition (Fig. 14.1). The 'sulcus' thus is part of the hinge-line. *Uskutchiella* resembles *Beyrichona* in the presence of an anterior 'eye' tubercle and in the broad centrodorsal lobe. It differs from *Beyrichona* in its straight posterior sides which extend perpendicularly to the straight dorsal margin. The long, straight posterior margins of both valves led MELNIKOVA to misinterpret them as straight hinge-line.

Carapaces of Beyrichonidae generally appear rather flat. A typical feature is the anterior lobe which almost reaches the dorsal margin. Except for that elevation, the other lobal sculptures appear as sulcation rather than as proper lobation, which is a feature distinctive to hipponicharionids with their bulgy, marginal lobation. For this reason, taxa such as *Beyrichona chinensis* SHU, 1990 and *Pseudobeyrichona longquanxiensis* SHU, 1990 seem to be hipponicharionids rather than beyrichonids.

Presently more than 14 species and subspecies have been assigned to *Beyrichona* (see KEMPF 1986a: 120-121; SHU 1990a). A revision of this group is absolutely necessary, but is beyond the scope of this paper.

O c c u r r e n c e: Lower and Middle Cambrian, North America, Morocco, China.

Genus *Tagra* n.gen.

T y p e s p e c i e s: *Tagra koppkai* n.sp.

D e r i v a t i o n o f n a m e: Artificial letter combination.

D i a g n o s i s: Shape lower than in other beyrichonids, postplete with distinct retral swing. Hinge-line straight. Free margin convex, with small marginal rim anteroventrally. Two shallow sulci in dorsal half separate three lobes; medium lobe broader than anterior and posterior lobes.

R e l a t i o n s: The new genus resembles *Beyrichona* MATTHEW, 1886 in its lobation but has a distinctly different outline and shape. Furthermore, the anterior lobe is not node-like at dorsal margin as in *Beyrichona*.

Beyrichona rotunda SHU, 1990 is similar in shape and outline but differs by the presence of a V-shaped anterodorsal sulcus and the distinct entire marginal rim (SHU 1990a: fig. 23; pl. 7, figs. 1-7). SHU's taxon might represent a new genus.

Tagra koppkai n.sp.

Fig. 10.1

D e r i v a t i o n o f n a m e: In honour of J. KOPPKA (Rostock) for his kind delivery of ostracode material.

H o l o t y p e: Right valve PIW 94-III-5, Fig. 11.1.

T y p e l o c a l i t y: Tagrara-syncline, central Anti-Atlas, Morocco.

T y p e h o r i z o n: *Ornamentaspis frequens* zone? (~ *Paradoxides insularis* zone), Middle Cambrian (GEYER sample # TA/MC40).

M a t e r i a l: 1 valve.

D i a g n o s i s: As for the genus.

D e s c r i p t i o n: Single right valve, postplete, but without retral swing. Hinge-line straight. Anterior side gently angular, posterior side almost straight. Dorsal (dorsum) and marginal surfaces rather steep, forming an indistinct bend with the flat lateral surfaces. Marginal part of anteroventral region and utmost part of distinct cardinal areas flattened, forming narrow marginal rim. Otherwise free margin without marginal rim. Valve more or less evenly convex except for subdorsal sulcation. Maximum length of valve at about mid-height, maximum convexity in anterior portion. Lobation consists of marginal anterior lobe which disappears at mid-height of the valve. Anterodorsal and posterodorsal fields with shallow vertical sulcation. Outer surface of valve may have been pitted, but is beyond proper identification due to diagenetic alteration.

S i z e: L 0.82 mm, H 0.615 mm, L:H 1.34.

R e m a r k s: ULRICH & BASSLER (1931: pl. 6, figs. 12, 12¹) figured two specimens which they assigned to *Beyrichona rotundata* MATTHEW. General comparison with the type specimen likewise illustrated casted some doubt on that particular assignment. Comparison of the type species of the genus *Beyrichona* (Fig. 13.3) and ULRICH & BASSLER's illustrations of *B. rotundata* suggest that the latter do not belong to the genus *Beyrichona*. They are assigned to *Tagra* n.gen.

O c c u r r e n c e: Known only from type locality and type horizon.

Family Hipponicharionidae SYLVESTER-BRADLEY in BENSON et al., 1961

D i a g n o s i s: Small to large, shape usually very high. Outline subtriangular, generally slightly postplete. Posterior half of free margin generally a little more convex than anterior one which may be partly straight. Anterodorsal field sometimes with a small projection ('protorostrum'*). Lobation consists usually of two lobes paralleling anterior and posterior borders. One or even both lobes may be reduced, in other cases additional lobes, nodes, ribs or pits ('loculi') etc. appear between outer marginal lobes. A very persistent feature is a flat node or an inflation near the dorsal margin. A small to relatively broad marginal rim is close to the free margin.

* see Figs. 8.4 or 16.1; very distinct, e.g., in *Parahoulongdongella* (SHU 1990a: pl. 7, fig. 13) or *Albrunnicola* (o.c: pl. 6, fig. 10).

G e n e r a: *Hipponicharion* MATTHEW, 1886
Sellula WIMAN, 1903
Longispina ANDRES, 1969 non COOPER, 1942
Konicekion SNAJDR, 1975
Albrunnicola MARTINSSON, 1979 (n.nom. pro *Longispina*)
Vojbokalina MELNIKOVA in KHAZANOVITCH, POPOV & MELNIKOVA, 1984
Pseudobeyrichona SHU, 1990 (1990a)
Parahoulongdongella SHU, 1990 (1990a)
Wimanicharion n.gen.
Andresia n.gen.

R e m a r k s: Typical Hipponicharionidae are characterized by two strong lobes paralleling anterior and posterior margins. These lobes may be partly weak (e.g., the posterior lobe in *Albrunnicola*), or totally to nearly totally reduced (e.g., the posterior lobe in *Sellula* or *Parahoulongdongella* in which the anterior lobe is also strongly reduced). Furthermore, the lobes are quite variable in length. They are rather long in *Hipponicharion*, in *Wimanicharion*, *Andresia* and *Vojbokalina* they are ventrally fused, and in *Konicekion* and *Albrunnicola* they are restricted mainly to the dorsal half.

Beyrichona - the type of the family Beyrichonidae ULRICH & BASSLER, 1931 - has two marginal lobes restricted to the dorsal half (Fig. 13.3), like, e.g., in *Albrunnicola*, but *Beyrichona* lacks a marginal rim. However, it should be noted that also the marginal rim varies in hipponicharionids from broad to small sculptures (comp., e.g., *Sellula* and *Albrunnicola*).

Among Cambrian ostracodes there are several forms which resemble hipponicharionids in the development of two marginal lobes, but their assignment to this family is questionable. *Australopsis* HINZ-SCHALLREUTER, 1993b, e.g., is similar to *Konicekion* in lobation, but differs mainly by its outline. It further differs by the lack of a distinct marginal rim. *Cambraechmina* HINZ-SCHALLREUTER, 1993b is also distinct from typical hipponicharionids by both outline and shape. *Biaurina* HINZ-SCHALLREUTER, 1993b with its relatively high shape is distinct by virtue of its outline and the strong dorsocentral, bulb-like lobe which also occurs in *Cedocamia* HINZ-SCHALLREUTER, 1993b. All these taxa are presumably homeomorphs and belong to other families.

Hipponicharionidae are among the oldest representatives of archaeocope ostracodes. They have been recorded from all continents (Fig. 22). Their possible mode of life is discussed below.

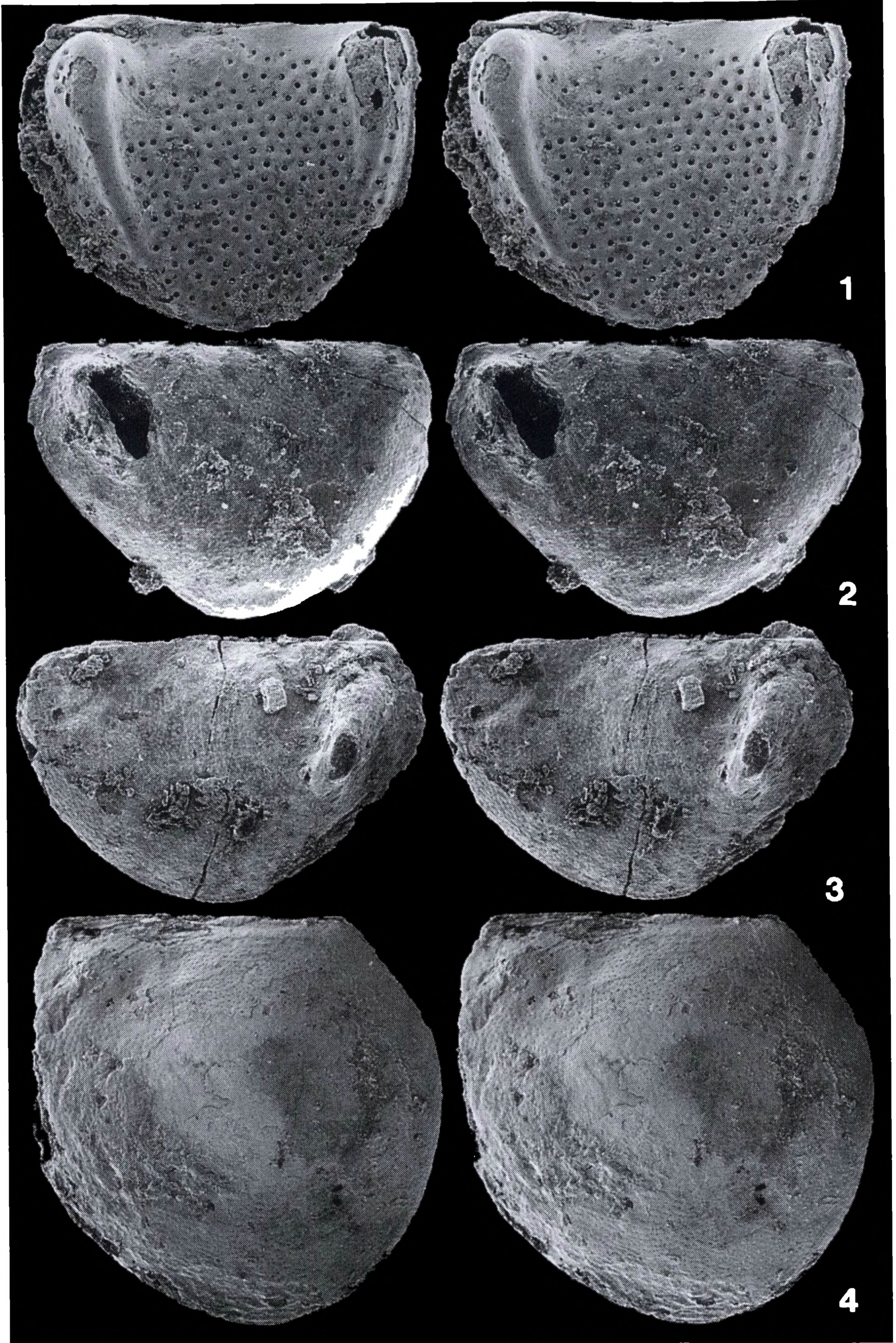
O c c u r r e n c e: Lower and Middle Cambrian, worldwide.

Genus *Hipponicharion* MATTHEW, 1886

T y p e s p e c i e s: *Hipponicharion eos* MATTHEW, 1886 [type by monotypy and not SD by MILLER (1889: 550) as was stated by SYLVESTER-BRADLEY in BENSON et al. (1961: Q102)].

D i a g n o s i s: Large. Two strong lobes in anterior and posterior part of valve parallel and close to free margin. Low node in anterior part of centrodorsal region. Free margin with narrow, flattened marginal rim.

 Fig. 12 (p. 419): ■1 *Hipponicharion geyeri* n.sp., holotype (PIW 94-III-1), carapace, ventrally partly incomplete. Left lateral view; L 1.07 mm. Tizi n' Izem, eastern Anti-Atlas; *Ornamentaspis frequens* Zone ? (~ *Paradoxides insularis* Zone) (coll. by GEYER, sample # N2). ■2-3 *Albrunnicola oelandicus maroccanus* n.ssp., Ait Mersid, central Anti-Atlas; *Bailiella* Formation with *B.* cf. *levyi* (~ *Paradoxides paradoxissimus* Zone) (coll. by GEYER, sample # D 2077): ■2 paratype (PIW 94-III-2), left valve. Lateral view; L 1.65 mm. ■3 Holotype (PIW 94-III-3). Right lateral view; L 1.75 mm. ■4 *Ifersiktia mipora* n.gen.n.sp., holotype (PIW 94-III-4), carapace, anterior incomplete. Left lateral view; L 1.61 mm. Jbel bou Ifersikt, central Anti-Atlas; Jbel Afraou Formation, *Ornamentaspis frequens* Zone ? (coll. by GEYER, sample # 2094). All stereo-pairs.



F u r t h e r s p e c i e s: *Hipponicharion cavatum* MATTHEW, 1894
Hipponicharion minus MATTHEW, 1894
Hipponicharion confluens ULRICH & BASSLER, 1931
Konicekion kundaensis MELNIKOVA, 1987
Hipponicharion geyeri n.sp.

R e m a r k s: Typical *Hipponicharion* representatives have their lobes ventrally separated (e.g., *H. eos*: Fig. 15.3). In accordance with MELNIKOVA (in KHAZANOVITCH et al., 1984: 36) *H. plicatum* ULRICH & BASSLER, 1931 and *H. parvum* ULRICH & BASSLER, 1931 are excluded from the genus *Hipponicharion*. However, her assignment of the taxa to *Vojbokalina* is not followed completely. *H. parvum* appears to be more closely related to *Ushkarella* KONEVA, 1978 than to *Vojbokalina*. The proper relationship of *H. plicatum* is also not quite clear. It may turn out to be a new genus.

Konicekion kundaensis MELNIKOVA, 1987 is based on an incomplete valve which appears dorsally broken. Taking this into account, the specimen probably represents a right rather than left valve contrary to MELNIKOVA's suggestion. In this respect, the outline of the valve accords more with *Hipponicharion* than with *Konicekion* and the lobation thus is equally distant from the dorsal margin.

O c c u r r e n c e: Lower and Middle Cambrian, North America; Europe (CZARNOCKI 1926, ELICKI 1992); Morocco; Antarctica (GAZDZICKI & WRONA 1987).

Hipponicharion geyeri n.sp.

Fig. 12.1

D e r i v a t i o n o f n a m e: In honour of G. GEYER, Würzburg.

H o l o t y p e: Ventrally slightly incomplete carapace, no. PIW 94-III-1, Fig. 12.1

T y p e l o c a l i t y: Tizi n' Izem, eastern Anti-Atlas, Morocco.

T y p e h o r i z o n: *Ornamentaspis frequens* zone? (~ *Paradoxides insularis* zone), Middle Cambrian (GEYER sample # N2).

M a t e r i a l: Figured specimen.

D i a g n o s i s: Shape very high. Lateral surface between lobes very flat. Lobes broadest and highest dorsally, gradually disappearing in ventral part of the valve. Anterior lobe longer than posterior one. Posterior lobe nearly perpendicular to straight dorsal margin, anterior lobe slightly oblique. Flat, indistinct node in centrodorsal field, slightly shifted anteriorly. Surface distinctly punctate with punctation being reduced along borders of valve.

S i z e: Holotype: L 1.07 mm, H 0.81 mm, L:H slightly <1.32.

R e l a t i o n s: The new species is distinguished from all other *H.* representatives by its characteristic porous surface. Furthermore, the marginal lobes are longer in the Lower Cambrian *H. eos* MATTHEW, 1886 (type species), *H. cavatum* and *H. minus* MATTHEW, 1894, all from North America.

Konicekion has similarly short lobes but the latter extent more obliquely from the straight dorsal margin. The shape of typical specimens is elongate rather than high, and the shell is not punctate (SNAJDR 1975: pl.1-2; PRIBYL & VANEK 1965: pl.1).

O c c u r r e n c e: Known only from type locality and type horizon.

A similar species (*H.* aff. *geyeri*) occurs in the Lower Cambrian of Taidalt [size of *H.* aff. *geyeri*: largest valve (PIW 94-III-8): L 2.75 mm].

Fig. 13 (cont. from p. 421): Dugald Brook, Cape Breton, Escasonie, Nova Scotia; Lower Cambrian (Lower Etcheminian, Eld). ■2 *Bradorona* sp. [paralectotype (ROM cat.No. 142 CM) of *Bradoria scrutator* MATTHEW, 1899], right valve. Lateral view; L 2.77 mm. Same locality as Fig. 13.1; Lower Cambrian [Upper Etcheminian (≈ *Callavia* zone, E3c-f)]. ■3 *Beyrichona papilio* MATTHEW, 1886, holotype (ROM cat.No. 114 CM), opened carapace with valves in juxtaposition (anterior: left); L 3.05 mm. Hanford Brook, New Brunswick; Lower Cambrian (Hanfordian, C1b3). All lateral views and stereo-pairs.



Fig. 13: ■1 *Bradorona perspicator* (MATTHEW, 1902), lectotype (ROM Cat.No. 93 CM), left valve, posterodorsally slightly distorted. Lateral view; L 4.47 mm.

Genus *Wimanicharion* n.gen.

Type species: *Hipponicharion matthewi* WIMAN, 1903*

Derivation of name: After Carl WIMAN who described the type species.

Diagnosis: Large. Marginal anterior- and posteriormost lobes fused ventrally, thus forming an uninterrupted bulge.

Further species: *Hipponicharion confluens* ULRICH & BASSLER, 1931.

Remarks: *Hipponicharion* has anterior and posterior lobes of variable length which, however, are not fused ventrally. In *Andresia* the corresponding sculpture forms an uninterrupted lobe. *Pseudobeyrichona* SHU, 1990 also has an uninterrupted marginal ridge along the entire free margin (SHU 1990a: fig.24; pl.6, figs. 1a-b, 2, 4; 1990b: pl.2, figs.25-26). Since the ridge is weaker ventrally, the genus appears to be a transitional form to *Albrunnicola*.

As the type species of *Pseudobeyrichona* n.gen. SHU (1990a: 47) quoted "*Pseudobeyrichona longquanxiensis* CUI gen. et sp. nov.". He designated the right valve no. D44505 (l.c.: pl.6, fig.1a-b) as holotype. By contrast, CUI (in CUI, ZHANG, TONG & HUO 1987) had already established *Beyrichona longquanxiensis* [as "Cui sp. nov." (p.75) and "Cui et Huo, sp. nov." (p.77)]. CUI designated the right valve no. S84022 (l.c.: fig.22) as holotype. The species is very similar and may be conspecific to *Pseudobeyrichona longquanxiensis*. However, nomenclaturally they represent two different species. In the holotype of *Beyrichona longquanxiensis* the marginal ridge seems to be missing or is at least extremely weak centroventrally. Together with the strong anterior lobe which is spine-like, the species is very similar to *Albrunnicola* and thus assigned to the latter genus. SHU (o.c.: pl.6, fig.6) assigned a similar specimen to his *P. longquanxiensis*. If the two nomenclatural species are conspecific, *Pseudobeyrichona* is probably a junior synonym of *Albrunnicola*.
Occurrence: Lower (?) to Middle Cambrian of Baltoscandia and Nova Scotia, Canada.

Genus *Albrunnicola* MARTINSSON, 1979

= nom. nov. pro *Longispina* ANDRES, 1969 non COOPER, 1942 (Brachiopoda)

Type species: *Longispina oelandica* ANDRES, 1969.

Diagnosis: Medium-sized. Marginal anterior and posterior lobes restricted to dorsal half. Anterior lobe strong, may be spine-like. Posterior lobe weaker than anterior lobe, may be reduced to a node. Valve broadly inflated dorsally. Inflation somewhat shifted towards anterior cardinal corner. Marginal rim small.

Further species & subspecies:

Beyrichona chinensis SHU, 1990

Albrunnicola oelandicus maroccanus n.ssp.

Albrunnicola bengtsoni n.sp.

Remarks: *Albrunnicola* differs from *Hipponicharion* and *Konicekion* mainly by its weak posterior lobe. *Albrunnicola* and *Sellula* both have strong anterior lobes and weak to lacking posterior lobes. Contrary to *Albrunnicola*, *Sellula* lacks the centrodorsal elevation, but has a more distinct marginal rim.

Relations: see remarks to *Wimanicharion*.

Occurrence: Middle Cambrian of Baltoscandia, Morocco, China and Australia.

Albrunnicola oelandicus (ANDRES, 1969)

1977 *Longispina oelandica* ANDRES 1969 - HELMDACH: 20, Abb.1 (after ANDRES 1969: fig.11)

* During a visit in Uppsala in summer 1993, it was not possible to borrow the types for reinvestigation, because the material was reserved for two other colleagues.

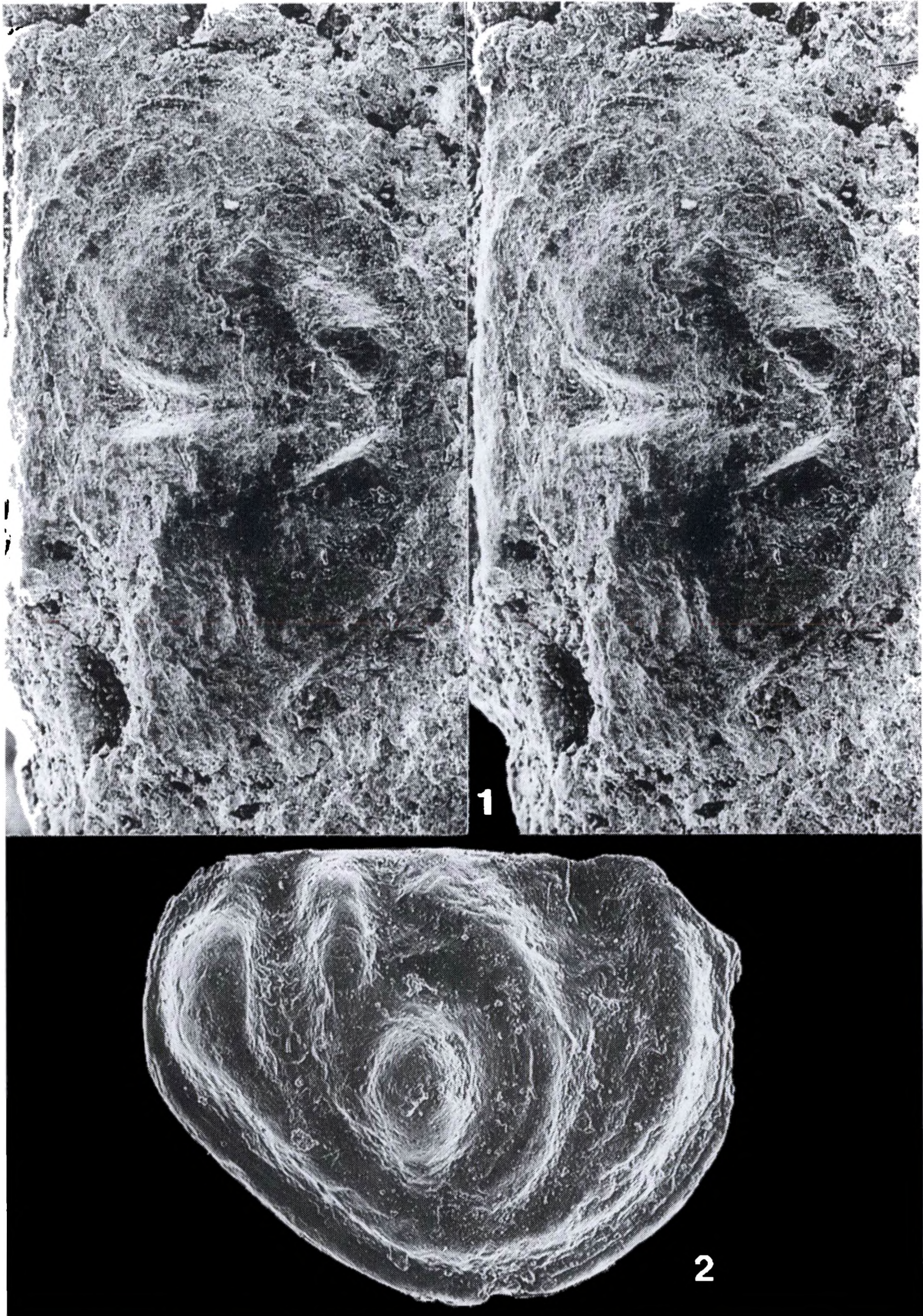


Fig. 14: ■1 *Uskutchiella sulcata* MELNIKOVA, 1992, holotype (PIN no. 4346/25), widely opened carapace. Lateral view; L 0.80 mm, stereo-pair. Gornyi Altai, left bank of Uskuch River, three km from its confluence with Bol'shaia Isha River; Tandoshka Formation, Saksian stage, Upper Cambrian. ■2 *Vojbokalina magnifica* MELNIKOVA, 1984, holotype (PIN no. 3465/6), carapace. Left lateral view; L 1.37 mm. Ingermanland (St. Petersburg region), Saria River, left bank 800 m downstream from Voibokalo settlement; Gertovo unit, upper Sablinskaia member, Middle Cambrian.

1991a *Albrunnicola oelandicus* (ANDRES,1969) - HINZ: 232 (q.v.further synonymy)

H o l o t y p e and taxonomic description: see HINZ 1991: 232.

Albrunnicola oelandicus maroccanus n.ssp.

Figs. 11.2; 12.2-3

D e r i v a t i o n o f n a m e: After its occurrence in Morocco.

H o l o t y p e: Carapace PIW 94-III-3, Fig. 12.3.

T y p e l o c a l i t y: Ait Mersid, central Anti-Atlas, Morocco.

T y p e h o r i z o n: *Bailiella* Formation with *Bailiella* cf. *levyi* (~ *Paradoxides paradoxissimus* Zone), Middle Cambrian (GEYER sample # D 2077).

M a t e r i a l: 10 carapaces and single valves.

D i a g n o s i s: Anterior lobe rounded (not spine-like as in the nominate subspecies).

S i z e: Holotype: L 1.75 mm, H 1.18 mm, L:H 1.48; largest carapace (PIW 94-III-9) L 2.04 mm, H 1.27 mm, L:H 1.60.

R e l a t i o n s: The new subspecies is very similar to the nominate subspecies published by ANDRES (1969). Both taxa differ only in the development of the anterodorsal lobe. ANDRES (1969) described this lobe as spine, but the holotype as the only photographically documented specimen merely shows a laterally compressed and distally broken lobe. Reinvestigation of ANDRES' type material revealed only very few specimens with an anterodorsal spine. The latter is flattened and lies outwardly directed on the bedding plane. For this reason ANDRES considered the spine as 'directed process' similar to those in post-Cambrian ostracodes, and accordingly regarded its position as posterodorsal. With regard to the closely related *Sellula* which has a similar outline, *Albrunnicola* must be oriented vice versa.

R e m a r k s: *Albrunnicola oelandicus maroccanus* occurs in about the same stratigraphic level as *A. oelandicus oelandicus*. The designation of a new subspecies takes the differently developed anterodorsal lobe and the different regional occurrence into account.

O c c u r r e n c e: Known only from type locality and type horizon.

Albrunnicola bengtsoni n.sp.

1990 *Hipponicharion* sp. - BENGTON in BENGTON et al.: 325; fig.5 (log), 207A

H o l o t y p e: Right valve SAMP30925 from 6529RS110 - BENGTON in BENGTON et al.: fig.207A.

T y p e l o c a l i t y: Kulpara Road section, Yorke Peninsula, South Australia (BENGTON et al: fig.1).

T y p e h o r i z o n: Parara Limestone, Lower Cambrian.

D i a g n o s i s: Medium-sized. Shape very high, slightly postplete. Hinge-line straight, free marginal area with narrow, bulgy marginal rim which is set off from the rest of the valve by a small marginal furrow. Lobation with strong anterior lobe extending over about half height of valve, and shorter, more node-like posterior lobe. Weak, relatively small, centrodorsal inflation.

S i z e: L 1.26 mm, H 0.96 mm, L:H 1.31.

R e m a r k s: *A. bengtsoni* differs from *A. oelandicus* mainly by the distinct but smaller, node-like posterior lobe and the smaller centrodorsal inflation. With its more distinct posterior lobe the species is intermediate between typical species of *Hipponicharion* and *Albrunnicola*.

O c c u r r e n c e: Lower Cambrian (Parara Limestone), South Australia.

Genus *Andresia* n.gen.

T y p e s p e c i e s: *Hipponicharion loculatum* ANDRES,1969.

D e r i v a t i o n o f n a m e: In honour of Dr. D. ANDRES, Berlin, who was the first to describe the species.

D i a g n o s i s: Medium-sized to large. With ridge-like lobe close to and parallel to entire free margin. A second weaker ridge is between marginal lobe and free margin, paralleling the latter. An additional ridge-like anterior lobe forms a broad platform-like elevation in ventrocentral region. Platform with several grooves or pits. Number, size and arrangement of grooves ('loculi' of ANDRES) variable.

R e m a r k s: The new genus was established on the basis of features which are definitely hipponicharionid, but atypical for the type genus. *Andresia* is characterized by a subcentral elevation with a variable number of loculi which is yet unique among Hipponicharionidae. The large, subcentral elevation of *Vojbokalina magnifica* (Fig. 14.2) might be regarded as comparative feature.

The marginal polygonal depressions in *Haoia* SHU,1990 resemble the 'loculi' in *Andresia*, but it is yet uncertain whether or not they demonstrate any closer relationships between these taxa (SHU 1990a: pl.1, figs.1-3,4-6,9). SHU established for *Haoia* the family Haoidae [= Ushkarellidae SHU,1990 (SHU 1990a: 42)] within the superfamily Hipponicharionacea or Haoiacea (o.c.: 42,79).

O c c u r r e n c e: Middle Cambrian, Baltoscandia.

Andresia loculata (ANDRES,1969)

Figs. 15.1-2

- 1969 *Hipponicharion loculatum* n.sp.- ANDRES: 165, 170-173; figs. 6-9
1974 *Hipponicharion loculatum* - MARTINSSON: 204
1977 *Hipponicharion loculatum* ANDRES 1969 - HELMDACH: 22; fig.2 (after ANDRES 1969: fig.7A)
1978 *Hipponicharion loculatum* Andres - POKORNÝ: fig.32A (= ANDRES 1969:fig.6)
1981 *Hipponicharion loculatum* ANDRES 1969 - GRÜNDEL in GRÜNDEL & BUCHHOLZ: 67; pl.3, fig.14
1983 *Hipponicharion loculatum* - HUO & SHU: 84,88
1985 *Hipponicharion loculatum* - HUO & SHU: 24
1986a HIPPONICHARION LOCULATUM ANDRES ,1969 A - KEMPF: 401
1986b - dto. - KEMPF: 337
1987 - dto. - KEMPF: 511
1991 *Hipponicharion loculatum* Andres - HUO, SHU & CUI: 18, figs. 2-9 (after ANDRES 1969: Fig. 6), pl. 5, figs. 1-3 (= ANDRES 1969: Fig. 7A,B,D).
1993a *Hipponicharion loculatum* - HINZ-SCHALLREUTER: 346

H o l o t y p e: Juvenile right valve, no. B6, ANDRES 1969: fig.7A.

T y p e l o c a l i t y: Cliff of Albrunna, SW Isle of Öland, Baltic Sea.

T y p e h o r i z o n: *Paradoxissimus* sandstone (middle Middle Cambrian).

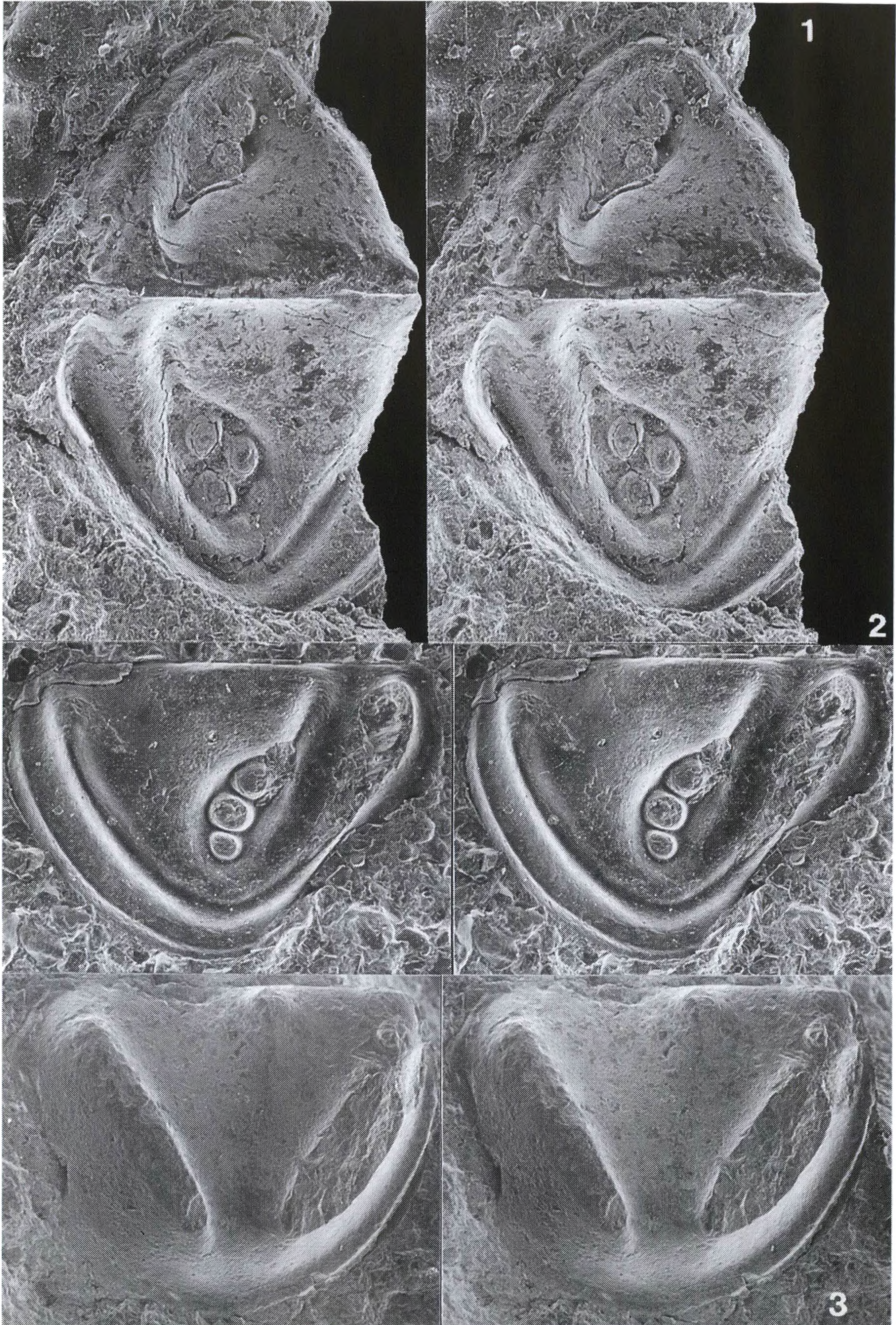
M a t e r i a l: Few paratypes from the collection D.ANDRES, Berlin and few valves embedded in rock from two *Tessini* sandstone glacial erratics of the collection F.RUDOLPH, Wankendorf (no. 2162, 2381, 2382, 2382A).

D i a g n o s i s: As for the genus.

D e s c r i p t i o n: Outline subamplete to slightly postplete, but without retral swing. Posterior margin a little more convex than anterior margin which is partly straight. Hinge-line straight. Narrow marginal rim close to free margin. Lobation consists of three lobes and a subcentral elevation with two to ten pits of various sizes. Anterior lobe broad in anterodorsal field, becomes very narrow subsequently and forms a continuous band together with the marginal posterior lobe. Another slender, sickle-shaped lobe paralleling the anteriormost lobe is in contact with the circular elevation.

S i z e: Up to 2.1 mm (ANDRES 1969: fig.9), holotype 1.25 mm.

O c c u r r e n c e: *Paradoxissimus* sandstone (Middle Cambrian), Isle of Öland, Sweden. *Tessini* sandstone (Middle Cambrian), Northern Germany (Schleswig-Holstein, Mecklenburg-Vorpommern: glacial erratics).



Genus *Sellula* WIMAN, 1903

Type species: *Sellula fallax* WIMAN, 1903.

Diagnosis: Medium-sized. Shape very high, slightly postplete with distinct retral swing. Hinge-line straight. Posterior margin slightly more convex than the anterior one. Anterior side partly straight and forming a short rostrum-like protuberance (protorostrum) in the anterodorsal region. Lobation consists of an anterior marginal lobe that decreases in width ventrally and terminates in the ventral third of the valve. Lobes sharp and crest-like rather than bulgy.

Remarks: *Sellula* is distinguished from typical Hipponicharionidae by the lacking posterior lobe-like protuberance or marginal rib respectively.

Occurrence: Lower Cambrian, Baltoscandia.

Sellula fallax WIMAN, 1903

Fig. 8.4

- 1903 *Sellula fallax* n.sp. - WIMAN: 48; table between p.56/57; pl.1, figs. 31-32
1931 *Sellula fallax* WIM. - KUMMEROW: 252
1931 *Sellula fallax* Wiman - ULRICH & BASSLER: 11,49,118; pl.7, figs.18-19 (after WIMAN 1902: pl.1, figs.31-32)
1961 *Sellula fallax* WIMAN, 1902 - SYLVESTER-BRADLEY in BENSON et al.: Q102; fig. 38.3 (after WIMAN 1902: pl.1, Fig.31)
1975 *Sellula fallax* Wiman - LI: p.43, pl.3, fig.11 (after SYLVESTER-BRADLEY in BENSON et al. 1961: fig.38.3)
1986a SELLULA FALLAX WIMAN, 1905 A - KEMPF: 685
1986b - dto. - KEMPF: 217
1987 - dto. - KEMPF: 124
1990 *Sellula* Wiman, 1902 - ABUSHIK et al.: 10,44
1993 *Sellula fallax* Wiman 1905 - HINZ: 8; Fig.4C

Holotype: Left valve embedded in rock, Palaeontological Institution of the University of Uppsala (UM), WIMAN (1903: pl.1, figs.31-32); ULRICH & BASSLER (1931: pl.7, figs.18-19); BENSON et al. (1961: fig.38,3); LI (1975: pl.3, fig.11); HINZ (1993: fig.4C); this paper Fig. 8.4.

Type locality: Biludden, Northern Uppland, Sweden; WIMAN's glacial erratic no. 14.

Type horizon: Bituminous *Olenellus* sandstone, Lower Cambrian.

Material: Holotype.

Diagnosis: As for genus which is currently monotypic.

Size: Holotype: L 1.95 mm, H 1.78 mm, L:H 1.10.

Occurrence: Known only from type locality and type horizon.

Genus *Parahoulongdongella* SHU, 1990

Type species: *Parahoulongdongella bashanensis* SHU, 1990.

Diagnosis: Medium-sized to large. Without distinct lobation, but

Fig. 15 (p. 426): ■1-2 *Andresia loculata* (ANDRES, 1969), cliff at Albrunna, SW coast of the Isle of Öland (Baltic Sea); *Paradoxissimus* sandstone, middle Middle Cambrian: ■1 Paratype (AGH 128-16; coll. by ANDRES, Berlin), widely opened carapace embedded in rock (anterior: left); L 0.96 mm. ■2 Paratype Coll. ANDRES, Berlin, no. B4), right valve embedded in rock; L 1.36 mm. ■3 *Hipponicharion eos* MATTHEW, 1886, lectotype (ROM Cat.No. 267 CM), carapace. Right lateral view; L 5.7 mm. Hanford Brook, St. Martins, New Brunswick; Lower Cambrian (Hanfordian, C1b1). All stereo-pairs.

anteriorly more convex than posteriorly, mainly in dorsal half of valve. Free margin with marginal rim and weak protorostrum in anterodorsal region. Outer surface porate.

F u r t h e r s p e c i e s: *Bradoria ? estonica* MELNIKOVA, 1987

Parahoulongdongella rudolphi n.sp.

R e l a t i o n s: *Parahoulongdongella* closely resembles *Sellula* in its outer shape, the flattened marginal rim and in the presence of a protorostrum. Like *Sellula*, *Parahoulongdongella* is broadest and most convex anteriorly. From there it gently descends towards the posterior and ventral sides. However, in *Sellula* the anterior area is even more convex, forming a distinct ridge-like lobe similar to *Hipponicharion*. Morphologically, *Parahoulongdongella* is thus a primitive hipponicharionid.

Due to the lack of a prominent lobation it might resemble more those taxa that were united under the generic name *Bradoria* by several authors. However, in transverse section *Bradoria* is more equally convex than *Parahoulongdongella*. *Bradorona* is distinguished from *Parahoulongdongella* by its 'eye' tubercle, which is considered herein as a generic characteristic.

Escasona MATTHEW, 1902 shows a similar anterodorsal inflation like *Parahoulongdongella rudolphi*. However, a marginal rim is not observable. The holotype (Fig. 17.3), apparently the only representative of the type species, is higher than long but seems to be compressed transversally. This has led to a deformation of the left side of the valve and may have also caused or strengthened the dorsal sulcation.

O c c u r r e n c e: Lower Cambrian, Baltoscandia, China.

Parahoulongdongella rudolphi n.sp.

Figs. 1, 16.1-3

D e r i v a t i o n o f n a m e: In honour of Frank RUDOLPH, Wankendorf.

H o l o t y p e: Left valve embedded in rock, Coll. F.RUDOLPH (Wankendorf) no.3430, Fig. 1.

T y p e l o c a l i t y: Kreuzfeld, gravel pit Wandhoff, Schleswig-Holstein. Glacial erratic, coll. by F.RUDOLPH 1986.

T y p e h o r i z o n: *Strenuella* sandstone, Lower Cambrian (det. F. RUDOLPH).

M a t e r i a l: 2 valves from glacial erratic RUD-2, 12 valves from glacial erratic RUD-3 (Coll. F.RUDOLPH, Wankendorf).

D i a g n o s i s: As for the genus.

D e s c r i p t i o n: Outline rounded-triangular, slightly postplete. Carapace shape very high (L:H ratio 1.02-1.20; holotype 1.11). Hinge-line straight. Maximum length in dorsal half of valve, maximum width in centro-anterior region (brownish part in Fig.1). In transverse section more convex anterodorsally than posterodorsally. Specific lobation not recognizable. Free margin with distinct marginal rim and weak anterodorsal protorostrum. Outer surface of valve with fine pores. Small circular area slightly dorsal and anterior to center with fine granulation.

S i z e: Holotype: L 2.3 mm, H 2.03 mm, L:H 1.13; right valve no.6471 (Fig.16.3): L 2.05 mm, H 2.01 mm, L:H 1.02; left valve no. 6473 (Fig.16.1): L 2.08 mm, H ~1.95 mm, L:H 1.07; largest valve (no.6466) L 2.79 mm, H 2.32 mm, L:H 1.20.

R e m a r k s: In the holotype (Fig.1) the area slightly dorsal and anterior to center appears granular and brownish-stained contrary to the rest of the valve. The different colour might be the result of diagenetic processes in an area of muscle attachment. A translucent bluish colour appears in the anterodorsal corner, in the dorsocentral and the central fields which might originate from inner features rather than from accidental staining.

P. rudolphi is very similar to *P. bashanensis* but lacks the weak V-shaped sulcus in the anterodorsal field (comp. SHU 1990a: pl.7, figs. 8-16; 1990b: pl.2, fig.19). According to the measurements given by MELNIKOVA 1987, *P. estonica* differs from *P. rudolphi* by its smaller size (L max. 1.70 mm) and a

more slender shape (L:H 1.18 - 1.29, mean 1.24). Its outline is also more rounded and the marginal rim is smaller.

Bradorona nitida WIMAN, 1903 is very similar but its shape is less high and more rounded [L:H 1.26 according to WIMAN's figure (1903: pl.1, fig. 34)]. Furthermore, *B. nitida* is more symmetrical in transverse section than the new species with its more convex anterior portion (l.c.: fig. 36). Although the

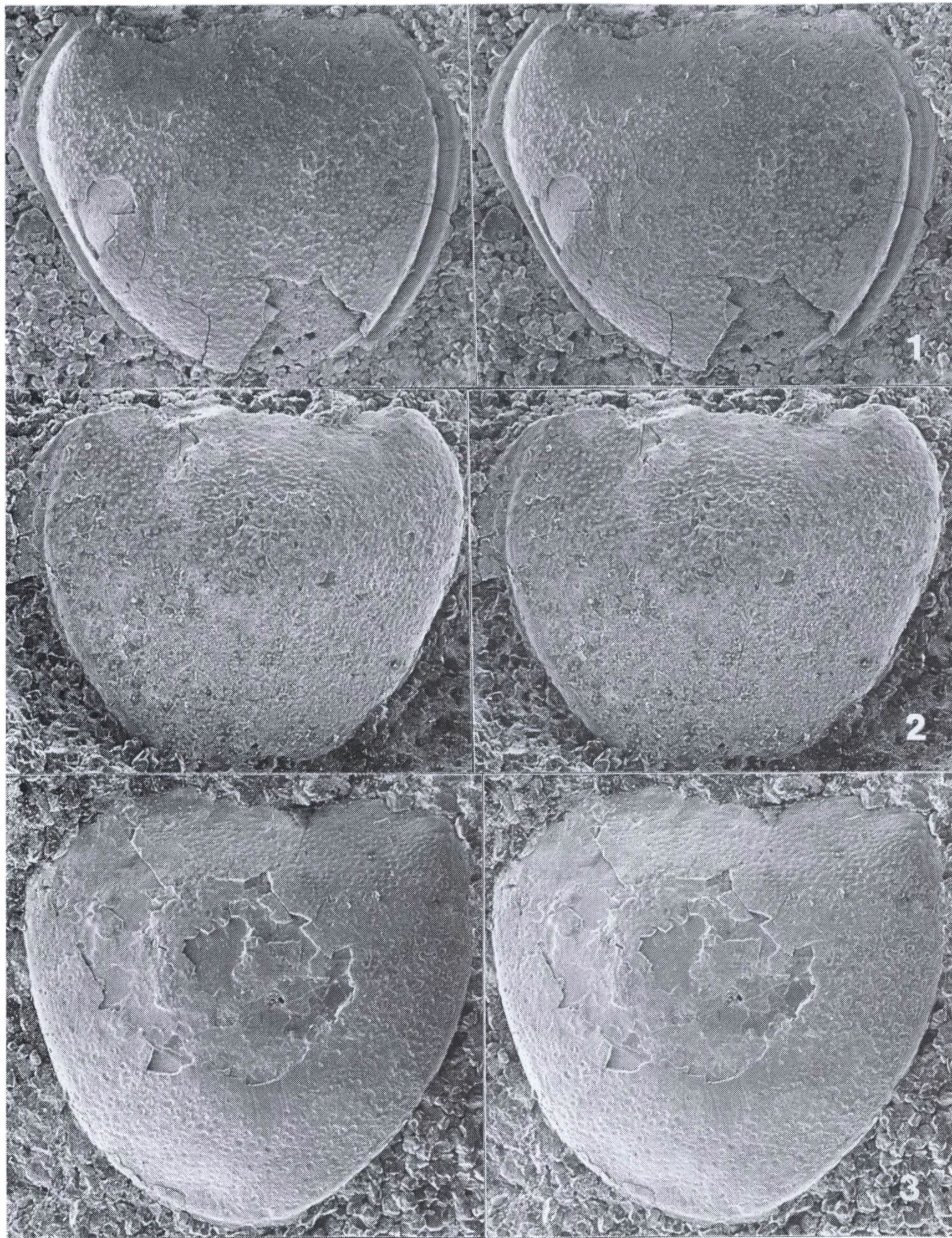
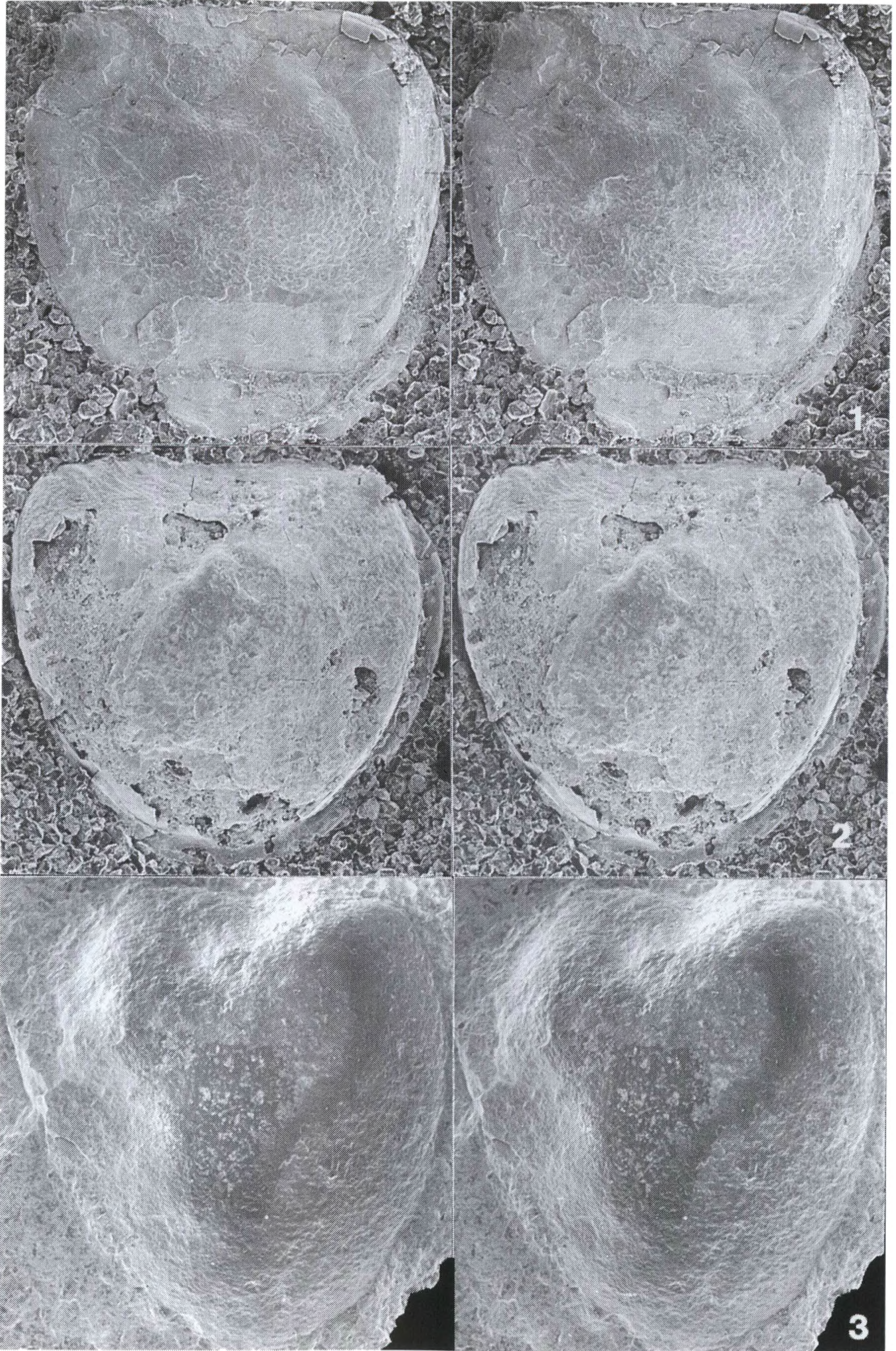


Fig. 16: *Parahoulongdongella rudolphi* n.sp., Kreuzfeld, Schleswig-Holstein, glacial erratic (RUD-3); Lower Cambrian *Strenuella* sandstone. ■1 (FR no. 6466), left valve embedded in rock; L 2.86 mm. ■2 (FR no. 6469), right valve embedded in rock L 2.24 mm. ■3 (FR no. 6471), right valve embedded in rock, L 2.05 mm. All lateral view and stereo-pairs.



anterodorsal part of *P. rudolphi* is slightly inflated it does not form a distinct tubercle like in *B. nitida* (l.c.: fig.34)*.

O c c u r r e n c e: *Strenuella* sandstone glacial erratics, Northern Germany.

Family Svealutidae ØPIK, 1961

The first representative of this family was already described by LINNARSSON (1869). However, only in the last 35 years additional material was recovered from several sites all over the world (Siberia: 1960, Australia: 1961, England: 1972, North America: 1986, Kazakstan: 1990). Presently, four nominal genera with nine species are known. The family is considered to have been pelagic (comp. p. 442).

D i a g n o s i s: Large to very large. Outline more or less postplete. Valve moderately to strongly convex. A prominent node or flat lobe in anterocentral or anteroventral region. It is separated from the rest of the valve by a weak to distinct furrow. Furrow passing into a semisulcus which borders a distinct dorsal marginal rim. Rim broadest anterodorsally. Globose node may overreach anterior border. Distinct narrow, marginal rim parallels free margin. Shell in typical members very thin and black.

G e n e r a: *Eremos* MOBERG & SEGERBERG, 1906

Anabaroichilina ABUSHIK, 1960

Svealuta ØPIK, 1961

Bullaluta COPELAND, 1986

R e m a r k s: *Svealuta* is considered herein as a synonym of *Eremos*. MELNIKOVA (in ABUSHIK et al. 1990: 42) regarded *Svealuta* as a synonym of *Anabaroichilina*. Apart from the type genus ØPIK (1968: 31) assigned two further genera to the family, *Carnavonia* and *Alutella*. Both genera are excluded from the Svealutidae herein. JONES & MCKENZIE (1980: 207) referred *Anabaroichilina* ABUSHIK, 1960 to the Svealutidae. MELNIKOVA (l.c.) considered the Svealutidae as a synonym of the Alutidae HOU, 1956 in which the latter author placed mainly Chinese taxa of the subfamilies Alutinae, Houlongdongellinae and Tsunyiellinae. The type species of *Aluta* MATTHEW, 1896 is, however, based on an incomplete, distorted valve and has to be regarded as *nomen dubium* until it can be redescribed on the basis of sufficient topotype material. The Houlongdongellinae HUO & SHU, 1985 have been regarded as the family Houlongdongellidae by HUO, SHU & CUI (1991: 91) to which the latter authors also assigned *Alutella*.

O c c u r r e n c e: Middle Cambrian of Europe and Australia, Middle to Upper Cambrian of Asia, Upper Cambrian of North America.

Genus *Eremos* MOBERG & SEGERBERG, 1906

Synonyms: *Anabaroichilina* ABUSHIK, 1960

Svealuta ØPIK, 1968

T y p e s p e c i e s: *Eremos bryograptorum* MOBERG & SEGERBERG, 1906.

D i a g n o s i s: Large to very large. Anterocentral field with more or less distinct oval node. Valves flattened admarginally and along dorsum. Dorsum

* See footnote on p. 421.

Fig. 17 (p. 430): ■1-2 *Parahoulongdongella rudolphi* n.sp., same glacial erratic as Fig.16: ■1 Paratype (FR no. 6467), laterally compressed right valve embedded in rock. Lateral view; L 1.89 mm. ■2 Paratype (FR no. 6473), right valve embedded in rock. Lateral view; L 2.07 mm. ■3 *Escasona rutellum* MATTHEW, 1902, holotype (ROM Cat. No. 155 CM), right valve, slightly compressed transversally; L 3.00 mm. Gillis' Indian Brook, Cape Breton, Nova Scotia; Upper Etcheminian (division E3f), Lower Cambrian.

separated from lateral surface by a sulcus or semisulcus. Rim broadest anterodorsally, passing into an indistinct, broad, very flat node or indistinct elevation.

F u r t h e r s p e c i e s: *Leperditia primordialis* LINNARSSON, 1869
(type species of *Svealuta*)
Anabaroichilina ventriangulosa ABUSHIK, 1960
(type species of *Anabaroichilina*)
Anabaroichilina ventriarcuata ABUSHIK, 1960
Anabaroichilina ? konevae MELNIKOVA, 1990
Eremos australis n.sp.
Eremos burkensis n.sp.
Eremos chummyensis n.sp.

R e m a r k s: The holotype of the type species is poorly preserved. Nevertheless its relation to *Svealuta* is clearly recognizable. Both *Leperditia primordialis* which is the type species of *Svealuta*, and *E. bryograptorum* are characterized by a distinct anterior node. A similar very distinct node is present also in *Bullaluta* COPELAND, 1986. In that particular genus the node is positioned in some distance from the anterior border. A dorsum is missing or only weakly developed.

O c c u r r e n c e: Middle Cambrian to Lower Ordovician of Scandinavia, Britain, Siberia, Kazakstan and Australia.

Eremos bryograptorum MOBERG & SEGERBERG, 1906
Figs. 18.2-3

- 1906 *Eremos bryograptorum* WESTERGARD mscr.n.g.n.sp. - MOBERG & SEGERBERG: 75, 109; pl.3, fig.24
1909 *Eremos bryograptorum* n.g. et n.sp. - WESTERGARD: 21,55,75; pl.2, fig.12 (= MOBERG & SEGERBERG 1906: pl.3, fig.24)
1931 *Eremos bryograptorum* Westergaard - ULRICH & BASSLER: 9,61-62,121; pl.8, fig.32 (= MOBERG & SEGERBERG 1906: pl.3, fig.24)
1961 *Eremos bryograptorum* MOBERG & SEGERBERG, 1906 - SYLVESTER-BRADLEY in BENSON & al. 1961: Q102; fig.38.2
1975 *Eremos* Moberg et Segerberg, 1906; *Eremos bryograptorum* (Westergaard) Moberg & Segerberg, 1906 - LI: 41,44,70,175; pl.3, fig.3 (after ULRICH & BASSLER 1931: pl.8, fig.24)
1986 *Eremos bryograptorum* Moberg and Segerberg, 1906 - COPELAND: 400
1986a EREMOS BRYOGRAPTUM WESTERGAARD, 1906 A - KEMPF: 339
1986b - dto. - KEMPF: 105
1987 - dto. - KEMPF: 127

H o l o t y p e: Steinkern and external mould of a dorsally and posteriorly incomplete, slightly compressed left valve, Lunds Universitet Geologiska Institutionen (LM) no. LO 1803 T: Fig.18.2-3; MOBERG & SEGERBERG 1906: pl.3, fig.24; WESTERGARD 1909: pl.2, fig.12 (= MOBERG & SEGERBERG 1906: pl.3, fig.24); ULRICH & BASSLER 1931: pl.8, fig.32; SYLVESTER-BRADLEY in BENSON et al. 1961: Fig.38.2 (after MOBERG & SEGERBERG 1906); LI 1975: pl.3, fig.3.

T y p e l o c a l i t y: Fågelsång (Loc. E 18a), Scania.

T y p e h o r i z o n: 'Bryograptus zon, Dictyograptus sviten' (Tremadoc): border beds between zone b (Zone with *Clonograptus*) and c (*Dictyograptus flabelliformis norvegica*) (WESTERGARD 1909).

M a t e r i a l: Holotype.

D i a g n o s i s: Oval node in anteroventral part of valve, distinctly set off from the rest of the valve.

S i z e: Holotype: L (without missing posterior end) 3.6 mm.

R e l a t i o n s: *Eremos bryograptorum* resembles *E. primordialis* in the globose anterior lobe which, however, seems to be located more ventrally than in *E. primordialis*.

O c c u r r e n c e: Known only from type locality and type horizon.

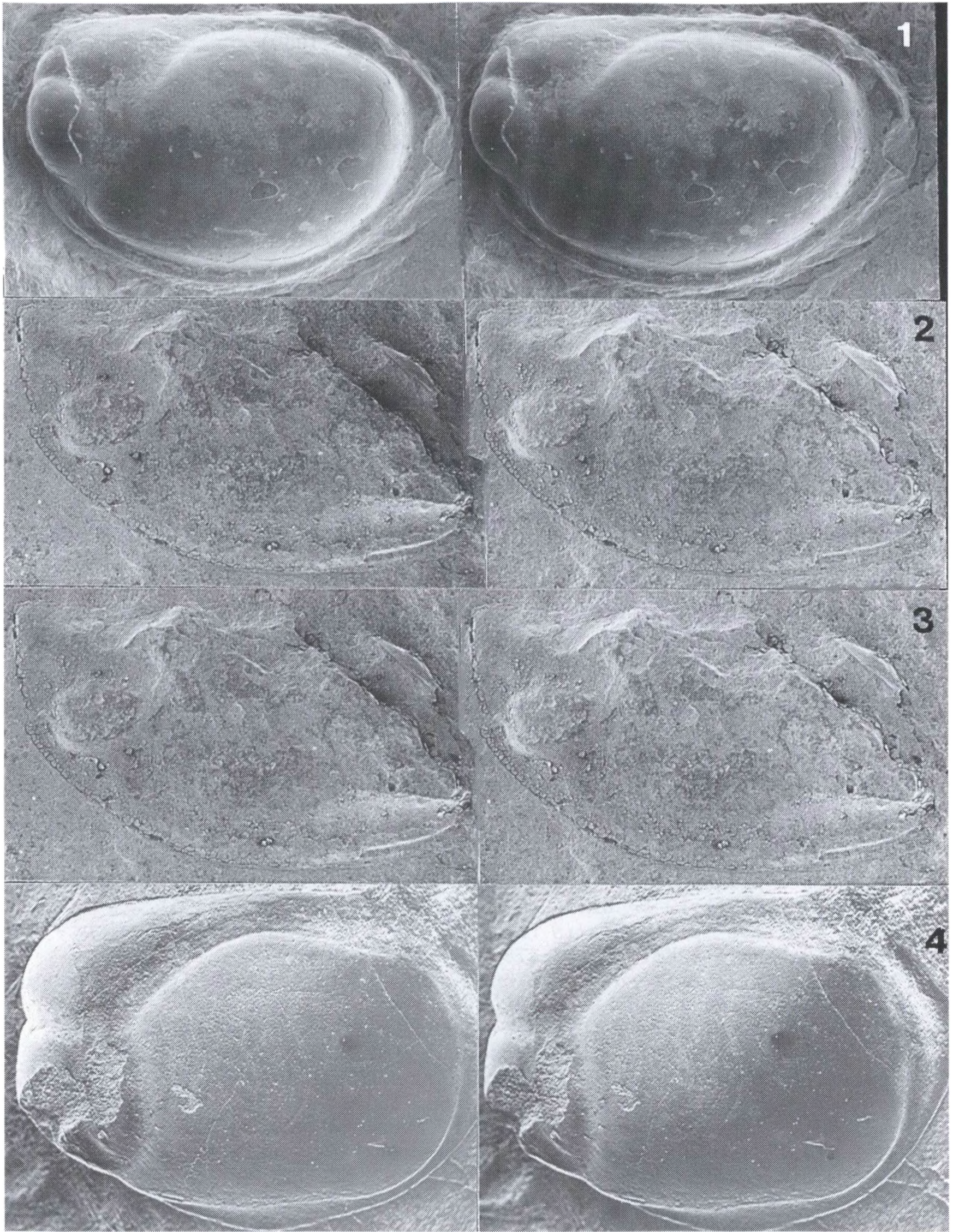


Fig. 18: ■1 *Eremos primordialis* (LINNARSSON, 1869). Left valve (AGH 128-15) in lateral view; L 8.1 mm. Black limestone glacial erratic (no. RUD-5), Kreuzfeld, Schleswig-Holstein; presumably *Lejopyge laevigata* Zone. ■2-3 *Eremos bryograptorum* MOBERG & SEGERBERG, 1906, holotype (LM LO 1803 T), dorsally and posteriorly incomplete, slightly compressed left valve. Lateral view, stereo tilt = 20° (2) and stereo tilt = 10° (3); L 3.6 mm. Fogelsång (Loc. E 18a), Scania; A. NILSON-WESTERGÅRD leg.; 'Bryograptus zon, *Dictyograptus sviten*', Lower Ordovician (Tremadoc). ■4 *Anabarochilina ventriangulosa* ABUSHIK, 1960, holotype (St. Peterburg University no. 3), left valve embedded in rock. Lateral view (valve slightly tilted posterodorsally). Kotui River, Eastern Siberia; upper Middle Cambrian, L 8.1 mm; (see also Fig. 19.4). All stereo-pairs.

Eremos primordialis (LINNARSSON, 1869)

Fig. 18.1

- 1866 *Leperditia* - LINNARSSON: 6
1869a *Leperditia (Isochilina) primordialis* LINRS. - LINNARSSON: 196
1869b *Leperditia primordialis* n.sp. - LINNARSSON: 40,41,84,88,89; pl. 2, figs. 65-66
1875 *Leperditia primordialis* LINNARSSON - LINNARSSON: 15,18,33,34,37,45
1880 *Leperditia primordialis* - TULLBERG: 37
1883 *Leperditia primordialis* LINRS. - REMELÉ: XLIV,CX,CXXXIII
1888 *Leperditia primordialis* Lns. - LINDSTRÖM: 5
non 1893 »*Leperditia primordialis*» LINRS. - HOLM. 110 (footnote)
[= *Polyphyma angelini*; l.c.]
1895 "*Leperditia*" *primordialis* LINRS. - WALLERIUS: 62-63;70,72(tables)
1901 »*Leperditia*» *primordialis* LINRS. - HOLM: 30, fig.21 (= LINNARSSON 1869b: pl.2, figs.65-66)
1902 "*Leperditia*" *primordialis* LINRS. - GRÖNWALL: 17,27,162-163,169
1906 "*Leperditia*" *primordialis* LINRS. - MUNTHE: 32,34
1911 *Leperditia primordialis* - MOBERG: 184,185
1916 »*Leperditia*« *primordialis* LNRS. - GRÖNWALL in GRÖNWALL & MILTHERS: 65
1922 "*Leperditia*" *primordialis*, LINRS. - WESTERGARD: 45,61,68,85
1923 »*Leperditia*« *primordialis*, LINRS. - POULSEN: 17
1923 *Leperditia primordialis* LNRS. - KUMMEROW: 766
1924 *Aristozoë primordialis* LINNSS.sp. - KUMMEROW. 406,414,445-446
1925 *Aristozoë primordialis* - KUMMEROW: 189
1927b *Aristozoë primordialis* LINNRSS. sp. - KUMMEROW: 43
[non *Aristozoë* cf. *primordialis* LINNRSS. sp. - KUMMEROW: 42-43; pl. 2, fig.19 = *Aristozoe ? minima* KUMMEROW,1931: 255]
1929 "*Leperditia*" resp. *Polyphyma primordialis* LIN. - GÜRICH: 43,44: text-pl. 2, fig. 5.
1931 *Aristozoe* (= "*Leperditia*") *primordialis* LINN. (1869) sp. - KUMMEROW: 243,244,245,247-248,249,253-254,256; fig. 15.
1931 *Aluta primordialis* (Linnarsson) - ULRICH & BASSLER: 7,10,59,120; pl. 8, figs. 11-12 (= LINNARSSON 1869b: pl. 2, figs. 65-66).
1934 "*Callizoe*" *primordialis* (LINNARSSON),1869; "*Callizoe*" *megalops* - van STRAELEN & SCHMITZ: 177-178,209,228,236,244
1934 *Leperditia primordialis* Linnarsson = *Aluta primordialis*, a Cambrian branchiopod - BASSLER & KELLETT: 398
1940 *Aluta primordialis* (LINRS.) - WESTERGARD: 12,14,26,49,66
1944 *Aluta primordialis* (Linnarsson) - WESTERGARD: 33
1958 "*Leperditia*" [*Aluta*] *primordialis* - BEXEL in MAGNUSSON et al.: 187
1961 *Svealuta primordialis* (Linnarsson, 1863) - ØPIK: 6,174,175,176; fig. 58 [non *Svealuta* sp. M. aff. *Svealuta primordialis* (Linnarsson): 174-175; pl.24, figs.1a-e = *Eremos burkensis* sp.n.]
1964 *Aluta primordialis* (LINNARSSON,1869) - MULLER: 4
1967 *Svealuta primordialis* - ØPIK: 394 [non *Svealuta* cf. *primordialis* (Linnarsson): (1):394; (2):9; pl.2,fig.2 = *Eremos chummyensis* sp.n.]
1968 *Svealuta (Leperditia; Aluta) primordialis* (Linnarsson) - ØPIK: 10,26
1969 *Aluta primordialis* - ANDRES: 179
1972 *Svealuta primordialis* (Linnarsson) - TAYLOR & RUSHTON: 8, pl.4 (Log)
1978 *Svealuta primordialis* (Linnarsson, 1869) - RUSHTON: 278-279; pl.26, fig.8
1979 *Aluta (Leperditia) primordialis* (LINNARSSON 1883) - NEBEN & KRUEGER: pl.117 (p.16), figs.6-9
1985a *Svealuta primordialis* - BERG-MADSEN: 30; fig.5H
1985c *Svealuta primordialis* or *primordialis* - BERG-MADSEN: 141
1986 *Svealuta primordialis* (Linnarsson,1863) - COPELAND: 402

- 1986 *Svealuta primordialis* - BERG-MADSEN: 10
 1986a ALUTA PRIMORDIALIS (LINNAR.1869A)ULRICH&BASSLER,1931 A; LEPERDITIA
 PRIMORDIALIS LINNARSSON, 1869 A; SVEALUTA PRIMORDIALIS * (LINNARS-
 SON,1869A)OEPIK, 1961 A - KEMPF: 45,457,707
 1986b - dto. - KEMPF: 467
 1987 - dto. - KEMPF: 59,167,381
 1991 *Leperditia primordialis* - HINZ: 231
 1993 *Svealuta primordialis* - RUDOLPH: 117,121,127

L e c t o t y p e: Not yet designated.

T y p e l o c a l i t y: Not yet fixed. LINNARSSON (1869a,b) mentioned several localities (see below).

T y p e h o r i z o n: Olenidskiffer, afd.3 (LINNARSSON 1869b: 84) = *Agnostus laevigatus* Zone (see WESTERGARD 1922: 8).

O r i g i n a l d i a g n o s i s (LINNARSSON 1869a: 196, 1869b: 84): "Testa equivalvis, valve convexa, oblonga, medio latissima, limbo depresso, in parte anteriore dorsali evanescente. Margo dorsalis rectus, 3/4 longitudinis occupans, cum posteriore angulum efficiens; ventralis regulariter curvatus, cum anteriore sine angulo confluens. Valva utraque impressionibus obsoletis in tres partes gibbas divisa, posteriorem magnam ovatam, anteriores parvas, superiorem subtriangularem, inferiorem globoso-inflatam, ultra marginem prominentem. Tuberculum oculare haud discernendum. Long.8, lat. 5 mm".

M a t e r i a l: Several dissociated valves embedded in rock from various glacial erratics of Northern Germany and Sweden.

D i a g n o s i s: Prominent antero-central node relatively small and well-bordered. Dorsal area broad and flattened, anterior part forms a flat, node-like elevation.

D e s c r i p t i o n: Equivalved, hinge-line straight, amplete. Maximum length of carapace at about mid-height, maximum convexity in antero-central region. Valves strongly inflated. Free margin evenly convex except for angular posterior end. Bulgy marginal rim set off from the rest of the valve by a marginal furrow that also follows the dorsal margin. Lobation restricted to the anterior part of the valve and consists of a weak anterodorsal node and a strong, subglobose, antero-central node that may overreach the anterior margin, and may be deflected anteriorly. The lobes are separated from each other by shallow sulci. Shell very thin, black, mostly broken.

S i z e: L up to 9 mm (BERG-MADSEN 1985c: 141).

O c c u r r e n c e: Baltoscandia - Olenidskiffer afd.3 (Middle Cambrian), Sweden (LINNARSSON 1869); Bornholm: upper alum shale (= *Lejopyge laevitata* zone) [POULSEN (1923), GRÖNWALL in GRÖNWALL & MILTHERS (1916), POULSEN (1923), BERG-MADSEN (1985a: 30; 1985b: 141)].

WALLERIUS (1895) distinguished two beds in the subzone of *Agnostus laevigatus* of Västergötland, the basal Exsculptus bed and the overlying Primordialis bed. The latter is comprised of an upper part (with *Leperditia primordialis*) and a lower part (without *L. primordialis*). MOBERG (1911: 184) stated: "As *Leperditia primordialis* is also found in the Exsculptus beds and is said to be missing in the lower part of the Primordialis beds, the denominations ... are quite unreasonable".

Britain: Nuneaton District - Lower part of the Mancetter Fm. (= *L. laevigata* Zone, Merevale No.3 Borehole (213.36 m, 194.82 m) (RUSHTON 1978).

Northern Germany - Middle Cambrian (*L. laevigata* Zone): Jeserig near Brandenburg (KUMMEROW 1924); Mark Brandenburg: Schlagenthin, Paretz, Brandenburg (KUMMEROW 1923), Hohensaaten (NEBEN & KRUEGER 1979); Kreuzfeld, Schleswig-Holstein (glacial erratic RUD-5); near Dala, Västergötland (leg. Ulrich HENKYS, Mönchengladbach) [AGH 128-17]. Glacial erratics mostly without associated trilobite fauna except for KUMMEROW's (1924) sample.

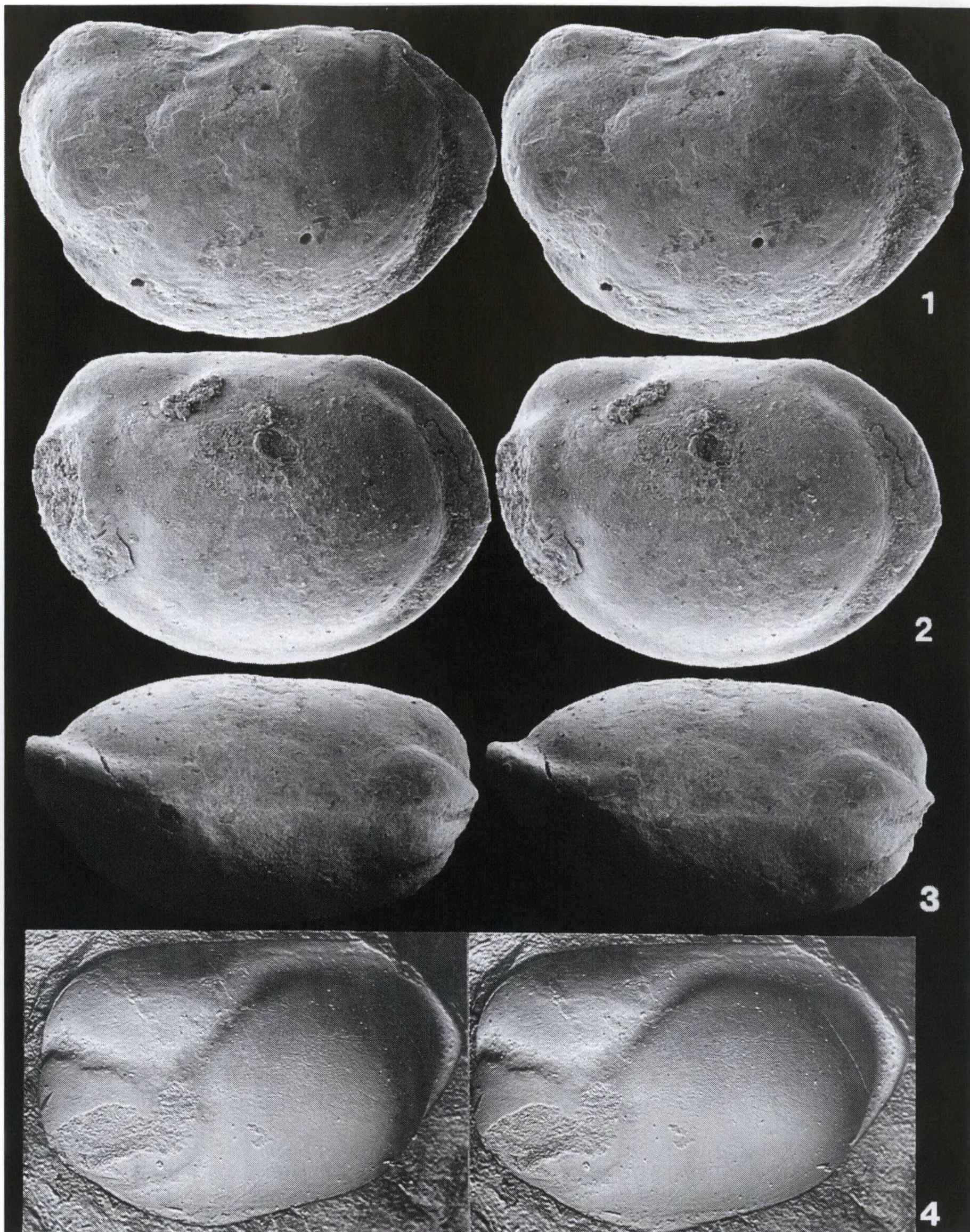


Fig. 19: ■ 1-3 *Eremos australis* n.sp.; locality Phosrep 14 (= D640), 1 km N' of Mt. Murray, Queensland, Australia; *Triplagnostus gibbus* Zone, middle Middle Cambrian. ■1 Paratype (CPC 23589), left valve, dorsally slightly compressed. Lateral view; L 2.70 mm. ■2 Holotype (CPC 23590), left valve, anterior node incomplete. Lateral view, L 2.20 mm. ■3 Paratype (CPC 23591), carapace, ventrally damaged. Dorsal view (anterior: right); L 4.16 mm. Note the 'hinge' line. ■4 *Anabaroichilina ventriangulosa* ABUSHIK, 1960, holotype, left valve, anterior node slightly damaged. Lateral view (anterodorsal portion slightly tilted upward); L 8.1 mm. River Malaia Kounamka (river Anabar basin), eastern Siberia; lower Amginskian Fm., Middle Cambrian (see also Fig.18.4).

Eremos australis n.sp.

Figs. 19.1-3

1980 *Svealuta* sp. A. - JONES & MCKENZIE: 207-209, fig.2

1993 *Svealuta* sp. A - ZHANG & PRATT: 94

D e r i v a t i o n o f n a m e: After its occurrence in Australia.

H o l o t y p e: Left valve, CPC 23590, Fig. 19.2.

T y p e l o c a l i t y: Locality Phosrep 14 (= D640): 1 km N' of Mt. Murray [139° 58' 27.6" E, 21° 48' 25.8" S].

T y p e h o r i z o n: *Triplagnostus gibbus* Zone, Templetonian, Middle Cambrian.

M a t e r i a l: 5 specimens (valves and carapaces).

D i a g n o s i s: Anterior node low and very broad, not very much set off from rest of the valve. Bulgy dorsal rim relatively small.

S i z e: Largest specimen: L 5.28 mm, H 3.85 mm, L:H 1.37.

R e m a r k s: *E. primordialis* is laterally more convex than *E. australis*, the dorsal area is broader, and its anterior node is smaller but higher and much more distinct than in *E. australis*. *E. bryograptorum* also has a smaller and more distinct node. Apart from that, the node seems to have a slightly more ventral position than in *E. australis*. With its flat and broad node *E. australis* resembles more *Anabarochilina* than the Baltoscandian species of *Eremos*. The similar position of the main lobe in both the Middle Cambrian *E. australis* and the Upper Cambrian *Anabarochilina ventriangulosa* suggests that *Anabarochilina* originated from the Australian branch of *Eremos*.

JONES & MCKENZIE (1980: fig.2) had only a single carapace of *Eremos* in which they did not observe a hinge-line. Their conclusion that *Eremos* is univalved, a conclusion which was adopted by ZHANG & PRATT (1993: 94), cannot be maintained on the basis of the present material. The Australian fauna is partly heavily phosphatised, and, e.g., in *Zepaera rete* or in *Flemingopsis dua* the coating proved to conceal not only the asolenic hinges but all of the lateral sculpture. The carapace figured on Fig.19.3 exhibits a distinct simple hinge-line. The record of a univalved carapace probably resulted from a misinterpretation caused by secondary phosphatisation.

JONES & MCKENZIE described *E. australis* as a taxon with a gaping carapace. As can be documented by the available material (Fig.19.3) *Eremos* has, without doubt, tightly closing valves.

O c c u r r e n c e: Middle Cambrian (*Triplagnostus gibbus* Zone, Templetonian), Queensland: type locality and Qld. Museum locality L113 (JONES & MCKENZIE 1980).

Eremos burkensis n.sp.

1961 *Svealuta* sp. M. aff. *Svealuta primordialis* (Linnarsson) - ØPIK: 174-175, 182; pl.24, fig.1a-e

1978 *Svealuta* sp.M aff. *Svealuta primordialis* (Linnarsson, 1863), Øpik, 1961 - JONES in de DECKKER & JONES: 30

D e r i v a t i o n o f n a m e: After the type locality.

H o l o t y p e: Anterodorsally incomplete right valve, CPC no. 3640, ØPIK 1961: pl.24, figs.1a-e.

T y p e l o c a l i t y: Devoncourt Lst. at locality D13A (21° 22' S, 139° 57' E), Headwaters, Burke River, Qld. (ØPIK 1961: fig.2).

T y p e h o r i z o n: Zone of *Proampyx agra* (ØPIK 1961) = *L. laevigata* II of ØPIK, Boomerangian, upper Middle Cambrian (SHERGOLD 1989: 10).

D i a g n o s i s (mainly after ØPIK 1961: 175): The flat border fades out on the anteroventral margin, but is continuous along dorsum. Marginal rim distinctly angular ventrocentrally and posterolaterally. Surface smooth.

S i z e: Length at least up to 7 mm.

R e m a r k s: *E. oepiki* differs from *E. australis* mainly by the characteristic posteroventral angularity of the free margin and the disappearance of the flat border in the anteroventral region (ØPIK 1961: pl.24, figs.1a,1c).

O c c u r r e n c e: Known only from type locality and type horizon.

Eremos chummyensis n.sp.

1967 *Svealuta* cf. *primordialis* (Linnarsson) - ØPIK (1):394; (2):9; pl.2,fig.2

1978 *Svealuta* cf. *primordialis* (Linnarsson, 1863); Øpik 1967 - JONES in de DECKKER & JONES: 30

1989 *Svealuta* cf. *primordialis* (Linnarsson,1869) - SHERGOLD: 12

D e r i v a t i o n o f n a m e: After the type locality.

H o l o t y p e: Ventrally incomplete left valve, CPC no. 5362, ØPIK 1967: pl.2, fig.2.

T y p e l o c a l i t y: Locality G131, about 3 km NW of Chummy, Mungerebar-Mindyalla Area, NW Queensland (22° 16' S, 139° 01' E) [ØPIK 1967: (1) fig.3].

T y p e h o r i z o n: Mungerebar Limestone, zone of *Cyclagnostus quasivespa*, Mindyallan, lower Upper Cambrian.

D i a g n o s i s (partly after ØPIK 1967: 294): Anterior node large and broad, posteriorly surrounded by a distinct sulcus. Posterodorsal field with characteristic swelling at the posterior cardinal angle.

S i z e: Length at least up to 6.4 mm.

R e m a r k s: This species is the only Upper Cambrian representative yet known. It is distinguished from the other species of *Eremos* mainly by the posterodorsal swelling, and from *E. australis* as well by the distinct sulcal separation of the anterior node from the lateral surface (ØPIK 1967: pl.2, fig.2).

O c c u r r e n c e: Known only from type locality and type horizon.

Mode of life

Among extant ostracodes, two large groups can be distinguished: primarily swimming taxa, i.e., benthic and pelagic animals and primarily creeping taxa. Although the specific development of the individual appendages is a significant characteristic, both groups can generally be recognized on the basis of their carapace morphology. Primary creepers, such as bairdiids and cytherids have straight to concave ventral margins, whereas swimmers have distinctly convex ventral margins. The only yet known exception are the Cyprididae with the carapace shape of creepers but a swimming mode of life which they acquired secondarily.

A primarily swimming mode of life does not infer no bottom contact. On the contrary, those taxa rest on the bottom or even burrow, but they are able to swim for short distances above the substrate, too. Some taxa swim considerable distances. For the purpose of swimming, the respective taxa have developed strong antennae which usually serve for this type of locomotion. Accordingly, the antennular muscle has to be well developed.

With few exceptions, e.g., from the Upper Cambrian of Sweden, the Middle Cambrian of Australia and from the Devonian of the Carnic Alps, the record of integument in Palaeozoic ostracodes is very limited, and ecological interpretations are mainly based on carapace morphology and occurrence, i.e., the distributional pattern of the respective taxa. SIVETER et al. (1987: 784) suggested both their morphology and pattern of distribution indicates a pelagic mode of life for Silurian myodocope ostracodes.

Archaeocope ostracodes are assumed to have been primary swimmers. This assumption is based on both carapace morphology and the development of the

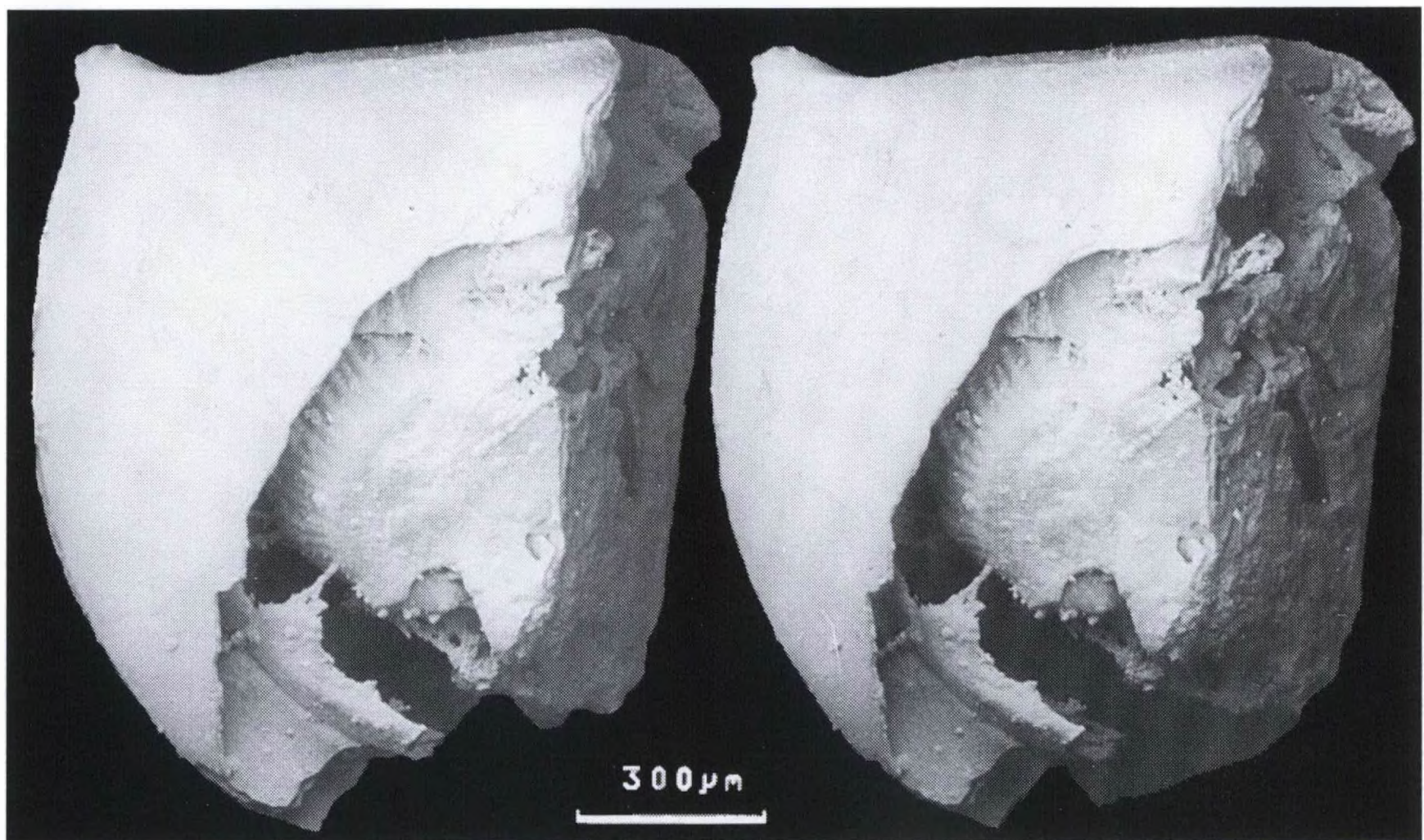
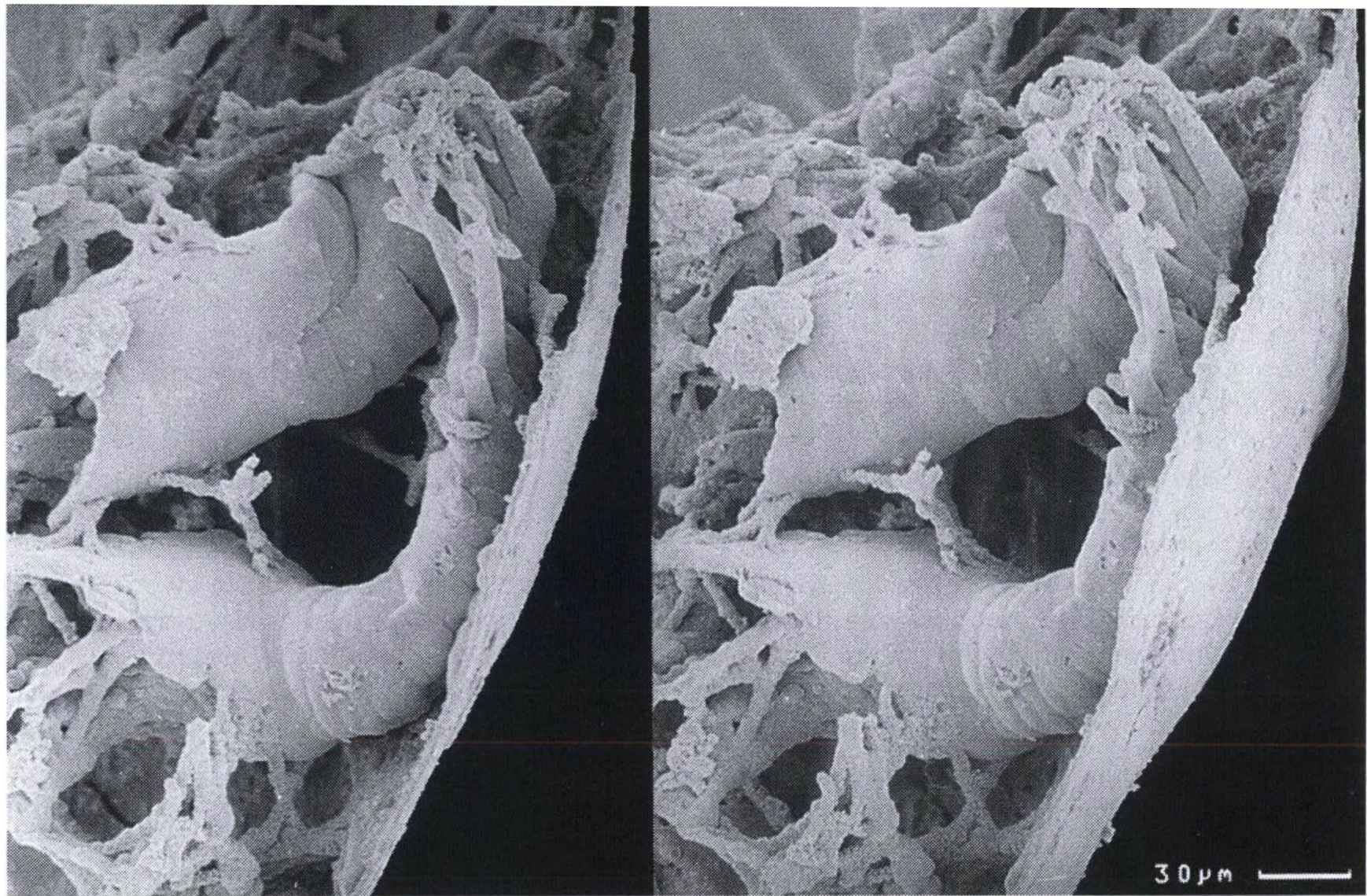


Fig. 20: ■1 Fragmentary oepikalutid carapace (CPC 23591) with anteriormost two pairs of appendages preserved. The long setae indicate a swimming mode of life. ■2 *Parashergoldopsis levis* HINZ-SCHALLREUTER, 1993. Broken carapace (CPC 23590) permitting view onto curved posterior portion of trunk. Body wall with densely set 'chitinous' bars similar to extant myodocopes. appendages. Archaeocopes generally have a distinctly convex ventral margin

similar to mydocopes and a subtriangular anterodorsal depression which is recognizable in many taxa such as *Zepaera*, *Flemingopsis*, *Cedocamia* etc. This depression is well in accord with the position and strain of the antennular muscle in extant swimming mydocopes. Taxa with the respective anterodorsal depression probably had extremely strong antennular muscles which would infer fairly good swimming capability.

Additionally, the first two pairs of appendages in a possible oepikalutid from Australia show well-developed long setae (Fig. 20.1) which are a typical feature in extant primarily swimming ostracodes.

MULLER & WALOSSEK (1991: 283-284) were the first to present a model for the mode of life of Upper Cambrian ostracodes from Sweden. They suggested that the animals had lived in a so-called flocculent zone which may occur only up to a few centimeters above the bottom sediment. In a comparative study of Ørsten and Australian ostracode appendages WALOSSEK et al. (1993: 11) noted that the recorded Australian appendages (2nd antenna, mandible and postmandibular limb) are uniramous in contrast to the biramous Ørsten appendages. He therefore assumed a distinctly "...different life strategy particularly concerning locomotory and feeding habits" of these two ostracode faunas.

However, a different development of appendages is not necessarily significant to whether the respective ostracode was a primary creeper or swimmer, as is well-documented in the Cyprididae. The latter are swimmers despite their uniramous appendages. Their carapace morphology is also that of primary creepers, and the swimming habit is a secondary achievement.

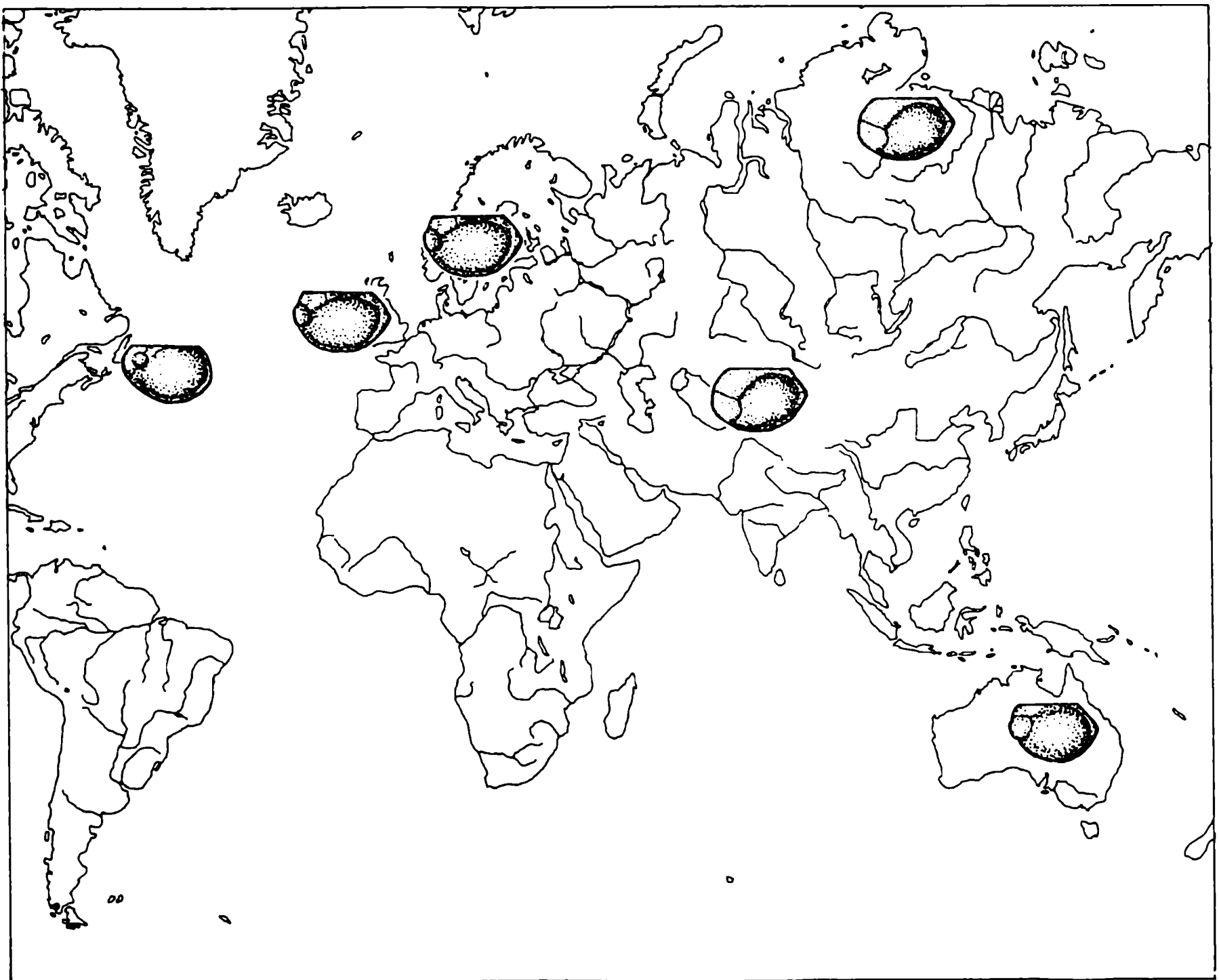


Fig. 21: Distribution of the Svealutidae.

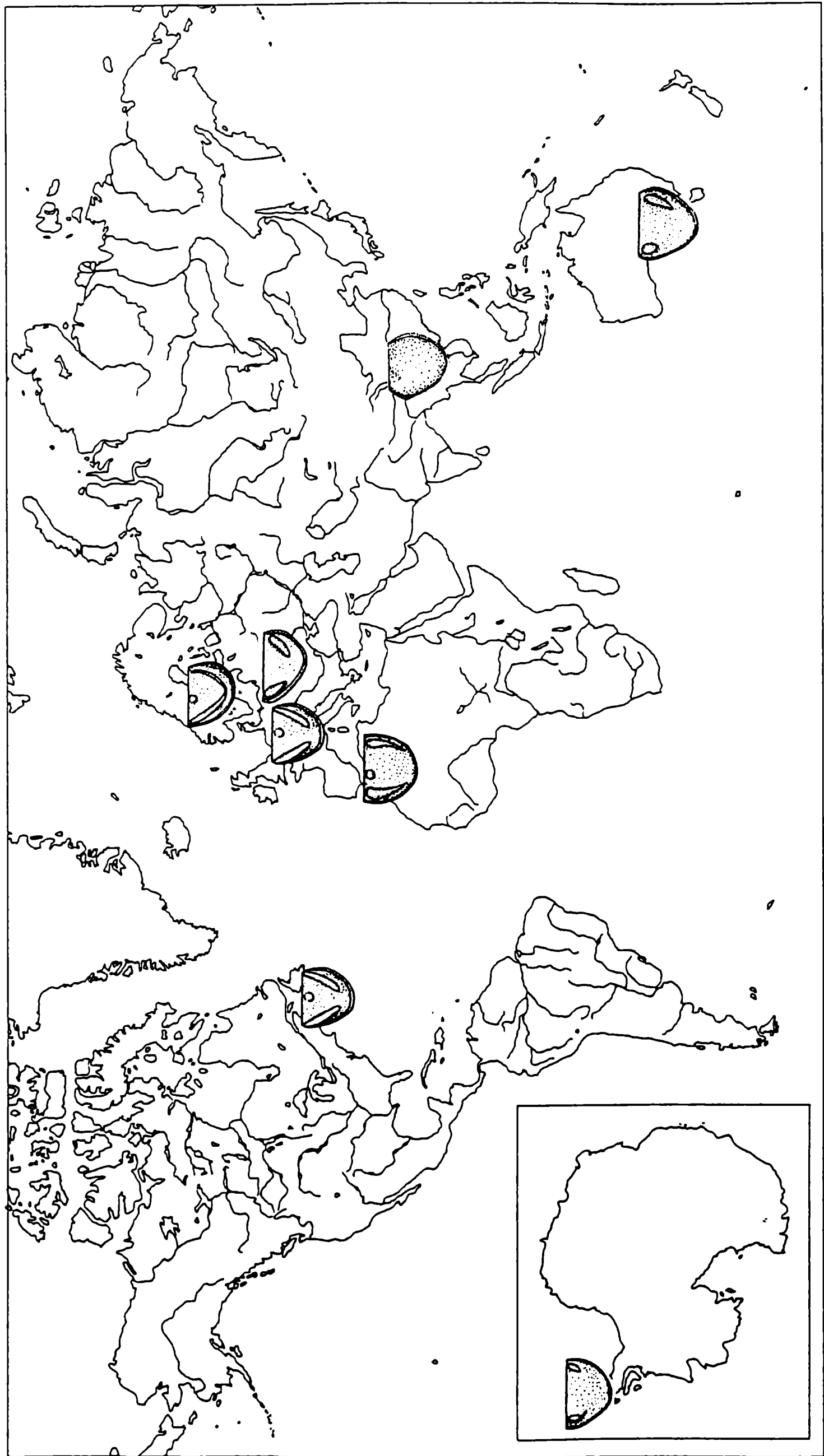


Fig. 22: Distribution of the Hipponicharionidae.

Another feature which is very similar to extant myodocopes is a fluted body wall at the posterior end (Fig. 20.2), the region where the trunk is anteriorly incurved. This portion consists of chitinous bars which support the trunk on one hand and guarantee mobility on the other hand (HARTMANN, pers. comm. 1993, compare also HARTMANN 1989: fig. 533).

The genus *Schallreuterina* has a strongly convex dorsal area, characterized by an interdorsum. This constellation does not seem to favour lateral mobility of the valves. The same refers to the extant *Gigantocypris* with its univalved and dorsally convex carapace. The latter has only a very narrow anterior slit in order to release the antennae for feeding. *Gigantocypris* is known as a pelagic ostracode whereas *Schallreuterina* probably was benthic. The latter is assumed to have had a permanently opened carapace and was thus able to swim, contrary to the floating *Gigantocypris*.

Benthic ostracodes are known from the Early Cambrian but the first appearance of pelagic ostracodes is still under discussion. SIVETER et al. (1991: 151) regarded the Silurian myodocope ostracodes as the pioneer colonisers of pelagic habitats. In his paper on *Bullaluta* COPELAND (1986: 400) speculated: "...could a branch of the Archaeocopida have given rise to the Myodocopida at about the same time" (the Late Cambrian)? It seems that a pelagic mode of life among ostracodes was realized already in the Cambrian. Both morphology and distributional pattern favour this conclusion. Among the Archaeocopa svealutids appear to be the earliest yet known pelagic ostracodes. The genus *Eremos* which has yet been recorded from Sweden, England, Australia, Kazakstan and Siberia (Fig. 21) is a large archaeocope with a globose, but rather thin-walled carapace. Its strongly globose anterodorsal lobe together with the inflated carapace is comparable to certain bolbozoid myodocopes from the Silurian for which SIVETER et al. (1991) suggested a pelagic mode of life. The authors based their statement mainly on the distributional pattern of these myodocopes in combination with their carapace characteristics, i.e., thin-walled and globose. The same arguments apply to the genus *Eremos* and it might be the oldest pelagic ostracode taxon. However, to support this conclusion more records of the genus are required.

Also the hipponicharionids are distributed worldwide (Fig. 22) and a pelagic mode of life is also possible for that group. Especially their high triangular shape makes a benthonic life very problematical. In his remarks on the mode of life of his new hipponicharionid genus *Konicekion* SNAJDR (1975: 154-155) suggested algal accumulations as "a host substrate serving as a shelter during animals life".

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References

- ABUSHIK AF 1960 Pervye nakhodki leperditatsei v kembrii Sibirskoi platformy - Vestnik Leningradskogo univ. (ser. geol. geogr.) 6 (1): 93-98, 6 figs.
- ABUSHIK AF & al. 1990 Prakticheskoe rukovodstvo po mikrofaune SSSR 4 [Ostrakody paleozoya] - 356 pp., 78 pls., 12 figs., 8 tables, Leningrad.
- AHLBERG P 1989 Cambrian stratigraphy of the När 1 deep well, Gotland - Geol. Fören. Förh. 111 (2): 137-148, 10 figs., Stockholm.
- ANDRES D 1969 Ostracoden aus dem mittleren Kambrium von Öland - Lethaia 2 (3): 165-180, 12 figs., Oslo.
- BARRANDE J 1872 Système Silurien du centre de la Bohême Ière Partie: Recherches Paléontologiques. Supplément au Vol. I. Trilobires, Crustacés divers et Poissons. - XXX+647 pp., 35 pls., Prague/Paris.
- BASSLER RS & KELLETT B 1934 Bibliographic Index of Paleozoic Ostracoda - Spec. Pap. Geol. Soc. Amer. 1: XIII+500 pp., 24 figs., (6 tables), Washington, D.C.
- BEDNARZCYK W 1979 On the Occurrence of *Bradiorina Raymond* 1935 Ostracods in the Upper Cambrian of NW Poland - Bull. Acad. Polon. Sci. (Sci. Terre) 26 (3/4): 215-219, 1 pl., 2 figs.
- BEDNARCZYK W & PRZYBYŁOWICZ T 1980 On development of Middle Cambrian sediments in the Gdansk Bay area - acta geol. polonica 30 (4): 391-415, 24 pls., 6 figs. (fig.6: sep.), 4 tables, Warszawa.
- BENGTSON & al. 1990 Early Cambrian fossils from South Australia - Mem. Assoc. Australasian Palaeontologists 9: (IV)+364 pp., 218 figs., Brisbane.
- BENSON RH & al. 1961 Systematic Descriptions - MOORE RC & PITRAT CW Treatise on Invertebrate Paleontology Q: 99-421, figs.36-334, Lawrence, Kan./New York (Univ. Kans. Press/Geol. Soc. Amer.).
- BERG-MADSEN V 1981 The Middle Cambrian Kalby and Borregård Members of Bornholm, Denmark - Geol. Fören. Förh. 103 (2): 215-231, 8 figs., 1 table, Stockholm.
- 1985a Middle Cambrian Biostratigraphy, Fauna and Facies in Southern Baltoscandia - Acta Univ. Upsaliensis 781: (II+)37 p., 5 figs., Uppsala.
 - 1985b The Middle Cambrian of Bornholm, Denmark: A stratigraphical revision of the lower alum shale and associated anthraconites - Geol. Fören. Förh. 106 [1984] (4 = 585): 357-376, 10 figs., Stockholm.
 - 1985c A review of the Andrarum Limestone and the upper alum shale (Middle Cambrian) of Bornholm, Denmark - Bull. geol. Soc. Denmark 34 (3/4): 133-143, 5 figs., 2 tables, Copenhagen.
 - 1986 Oversigt over det reviderede Mellem Kambrium på Bornholm - Dansk geol. Foren. Arsskr. 1985: 1-13, 3 figs., København.
- BERGSTROM J & AHLBERG P 1981 Uppermost Lower Cambrian biostratigraphy in Scania - Geol. Fören. Förh. 103 (2 = 585): 193-214, 14 figs., 1 table, Stockholm.
- BOLTON TE & COPELAND MJ 1963 *Cambrotrypa* and *Bradoria* from the Middle Cambrian of Western Canada - J. Paleont. 37 (5): 1069-1070, pl.143, Tulsa, Okla.
- CHAPMAN F 1918 Ostracoda from the Upper Cambrian Limestone of South Australia - Proc. Roy. Soc. Victoria (n.s.) 31 (1): 108-112, pl.9, 5 figs.
- COPELAND MJ 1986 *Bullaluta kindlei* n.gen., n.sp. (Ostracoda, Archaeocopida) from Zone 5 (Late Cambrian, *Cedaria* - *Crepicephalus*) of the Cow Head Group, western Newfoundland - Pap. Geol. Surv. Canada 86 (1B) [Current Research B]: 399-403, 1 pl., Ottawa.
- CUI Zhilin, ZHANG Xiguang, TONG Haowen & HUO Shicheng 1987 Ontogeny of some Cambrian *Bradoriids* from China - J. Northwest Univ. 17 (3 = 56): 68-77, 1 pl., 8 figs., Xian.
- CZARNOCKI J 1926 Stratygrafia i fauna kambru w części środkowej gór Świętokrzyskich [Sur la stratigraphie et la faune du Cambrien dans la partie moyenne du Massif de Swiety Krzyz] - Posiedzenia naukowe Panstwowego Inst. Geol. [Comptes-Rendus Séances Serv. Géol. Pologne] 14: 7-9, Warszawa.
- DECKKER P de & JONES PJ 1978 Check List of Ostracoda recorded from Australia and Papua New Guinea 1845 - 1973 - Rep. Bur. Miner. Resources Geol. Geophys. 195: (II+)184 pp., 5 figs., 2 tables, Canberra.

- ELICKI O 1992 Faziesanalyse der unterkambrischen Karbonate Deutschlands - Diss. Bergakad. Freiberg: 121(+10) p., 14 pls., 31 figs., Freiberg (ms).
- GAŹDZICKI A & WRONA R 1987 Polskie badania paleontologiczne w Antarktyce Zachodniej (1986) - przegląd geol. 34 (11 = 403): 607(?)–609–617,674(?), 9 + 2 figs.(on covers of no.), Warszawa.
- GEYER G 1990 Die marokkanischen Ellipsocephalidae (Trilobita: Redlichiida) - Beringeria 3: 363 pp., 56 pls., 69 figs., 9 tables, Würzburg.
- GRÖNWALL KA 1902 Bornholms Paradoxideslag og deres Fauna. - Danmarks geol. Undersøgelse (2) 13: XI+231 p., 5 pls., 7 figs., Kjøbenhavn.
- GRÖNWALL KA & MILTHERS V 1916 Beskrivelse til Geologisk Kort over Danmark (i Maalestok 1 : 100,000). - Danmarks geol. Undersøgelse (1) 13 (Tekst.): (IV+) 281 pp., 13 figs., Kjøbenhavn.
- GROOM T 1902 On *Polyphyma*, a new genus belonging to the Leperditiidae, from the Cambrian Shales of Malvern - Quart. J. Geol. Soc. 57: 83–88, pl.3, 1 fig., London.
- GRÜNDEL J & BUCHHOLZ A 1981 Bradoriida aus kambrischen Geschieben vom Gebiet der nördlichen DDR - Freiburger Forsch.-h. (C) 363: 57–73, 3 pls., 5 figs., Leipzig.
- GURICH E 1929 Silesicaris von Leipe und die Phyllokariden überhaupt. - Mitt. Miner.-Geol. Staatsinst. Hamburg 11: 21–90, 1 pl., 5 figs., 10 text-pls., Hamburg.
- HARTMANN G 1989 Dr.H.G.BRONNs Klassen und Ordnungen des Tierreichs Fünfter Band: Arthropoda I.Abteilung: Crustacea 2.Buch, IV.Teil 5.Lieferung: (IV+) pp.787–1067, 8 pls., figs.475–534, Jena.
- HELMDACH F-F 1977 Leitfaden zur Bestimmung fossiler und rezenter Ostrakoden - 264 p., 6 pls., 245 figs., Berlin/New York (de Gruyter).
- HINZ I 1991a On *Ulopsis ulula* HINZ gen. et sp. nov. - Stereo-Atlas Ostracod Shells 18 (2) 17: 69–72, 2 pls., London.
- 1991b Ostrakoden aus kambrischen Geschieben - Arch. Geschiebekde. 1 (3/4): 231–234, 1 fig., Hamburg.
- 1992 On *Semillia pauper* HINZ gen. et sp. nov. - Stereo-Atlas Ostracod Shells 19 (1) 4: 13–16, 2 pls., London.
- 1993 Evolutionary trends in archaeocopid ostracods - MCKENZIE KG & JONES PJ (eds.) Ostracoda in the Earth and Life Sciences (Proc. 11th internat. Symp. Ostracoda Warrnambool, Victoria, Australia 1971): 3–12, 4 figs., Rotterdam/Brookfield (Balkema).
- HINZ-SCHALLREUTER I 1993a Ein mittelkambrischer hesslandonider Ostrakod sowie zur Morphologie und systematischen Stellung der Archaeocopa - Arch. Geschiebekde. 1 (6): 329–350, 6 figs., Hamburg.
- 1993b Ostracodes from the Middle Cambrian of Australia - N. Jb. Geol. Paläont. (Abh.) 188 (3): 305–326, 5 figs., Stuttgart.
- HINZ I & JONES PJ 1992 On *Tubupestis tuber* HINZ & JONES gen. et sp. nov. - Stereo-Atlas Ostracod Shells 19 (1) 3: 9–12, 2 pls., London.
- HOLM G 1893 Sveriges kambrisk-siluriska Hyolithidæ och Conulariidæ - Sver. Geol. Undersökning (C) 112: IX+173 pp., 6 pls., 2 figs., Stockholm.
- 1901 Kinnekulles berggrund - Ibid. 172 [Kinnekulle dess geologi och den tekniska användningen af dess bergarter]: 1–76, pls.1–2, figs.1–59, ibid.
- HUO Shicheng & SHU Degan 1983 On the Phylogeny and Ontogeny of Bradoriida with Discussions of the Origin of Crustacea - J. Northwest Univ. 1983 (3 = 38): 82–88, 3+1 fig.
- 1985 Cambrian Bradoriida of South China - (V+)251 pp. (except pp.179–186), 37 pls. (except pl.36, figs. 1–9), 124 figs., Xian.
- HUO Shicheng, SHU Degan & CUI Zhilin 1991 Cambrian Bradoriida of China - (2+) VII+249 pp., 46 pls., 173 figs., 2 tables, Beijing.
- HUO Shicheng, SHU Degan & ZHAO Jingzhou 1986 Researches on Cambrian Bradoriids - Acta Geol. Sinica 60 (1): 18–30, 2 pls., 4 figs., 1 table, Beijing.
- JONES PJ & MCKENZIE KG 1980 Queensland Middle Cambrian Bradoriida (Crustacea): new taxa, palaeobiogeography and biological affinities - Alcheringa 4 (3/4): 203–225, 8 figs., 5 tables.

- KHAZANOVITCH KK, POPOV LE & MELNIKOVA LM 1984 Bezzamkovye brachiopody, ostrakody (bradoriidy) i khiolitel'minty iz sablinskoj svity Leningradskoj oblasti - Paleont. zh. 1984 (4): 33-47, pl.3, 6 figs., Moskva.
{engl. transl.: KHAZANOVICH KK, POPOV LYE & MEL'NIKOVA LM 1985 Inarticulate Brachiopods, Ostracodes (Bradoriids), and Hyolithelminthes from the Sablinskaya Formation in the Leningrad Region - Paleont. J. 18 [1984] (4): 31-45, pl.3, 6 figs., Silver Spring, MD}.
- KEMPF EK 1986a Index and Bibliography of Marine Ostracoda 1 Index A - S.-Veröff. Geol. Inst. Univ. Köln 50: 766 pp., Köln.
-- 1986b Index and Bibliography of Marine Ostracoda 2 Index B - Ibid. 51: 712 pp., Köln.
-- 1987 Index and Bibliography of Marine Ostracoda 3 Index C - Ibid. 52: 774 pp., Köln.
-- 1988 Index and Bibliography of Marine Ostracoda 4 Bibliography A - Ibid. 53: 454 pp., Köln.
- KONEVA SP 1978 O pervoj nakhodke ostrakod v nizhnem kembrii Kazakhstana [First discovery of ostracodes in Lower Cambrian of Kazakhstan] - Paleont. zh. 1978 (1): 150-152, 1 fig., Moskva.
{engl. transl.: KONEVA SP 1979 The First-Record of Ostracodes in the Lower Cambrian of Kazakhstan - Paleont. J. 12 [1978] (1): 137-138, 1 fig., Washington, D.C.}.
- KOZUR H 1974 Die Bedeutung der Bradoriida als Vorläufer der postkambrischen Ostracoden - Z. geol. Wiss. 2 (7): 823-830, 2 figs., Berlin.
- KUMMEROW E 1923 Über neue und wenig bekannte Diluvialgeschiebe - Jb. Preuß. Geol. Landesanstalt 42 [1921] (2): 765-768, Berlin.
-- 1924 Beiträge zur Kenntnis der Ostracoden und Phyllocariden aus nordischen Diluvialgeschieben - Ibid. 44 [1923]: 405-448, pls.20-21, 1 fig., (1 table), ibid.
-- 1925 Besprechung: KUMMEROW 1924 - Z. Geschiebeforsch. 1 (4): 186-189, Berlin.
-- 1927a Über einige neue und seltene Geschiebearten und die Heimatbestimmung der Geschiebe. - Cbl. Miner. etc. (B) 1927 (1): 9-17, Stuttgart.
-- 1927b Beiträge zur Kenntnis der Fauna und der Herkunft der Diluvialgeschiebe - Jb. Preuß. Geol. Landesanstalt 48 [1927] (1): 1-59, pl.1-2, 1 fig., Berlin (vol.: 1928).
-- 1931 Über die Unterschiede zwischen Phyllocariden und Ostracoden. - Cbl. Miner., Geol. Paläont. (B) 1931 (5): 242-257, 18 figs., Stuttgart.
- LANDING E 1980 Late Cambrian-Early Ordovician Macrofaunas and Phosphatic Microfaunas, St. John Group, New Brunswick - J. Paleont. 54 (4): 752-761, 4 figs., 1 table, Tulsa, Okla.
- LI (LEE) Yu-wen 1975 Cambrian Ostracoda and Other New Descriptions from Sichuan, Yunnan, and Shaanxi - DI-ceng, Gu-sheng-wi & LU-wen-zhi Professional papers of stratigraphy and palaeontology 2: 37-72, 173-177, 5 pls., 1 fig., Beijing. [Title cited after KEMPF 1988: 220].
- LINDSTRÖM G 1888 List of the Fossil Faunas of Sweden. I. Cambrian and Lower Silurian. - 24 pp., Stockholm.
- LINNARSSON JGO 1866 Om de Siluriska Bildningarne i Mellersta Westergötland. I. - Akad. Afh.: 23 pp., 2 pls., Stockholm.
-- 1869a Diagnoses specierum novarum e classe Crustaceorum in depositis Cambricis et Siluricis Vestrogotiæ Sueciæ repertarum. - Öfv. Kongl. Vet.-Akad. Förh. 26 [1869] (2): 191-196, Stockholm.
-- 1869b Om Vestergötlands Cambriska och Siluriska Aflagringar. - K. Svenska Vet.-Akad. Handl. 8 (2): 89 pp., 2 pls., (1 table), Stockholm.
-- 1875 Öfversigt af Nerikes öfvergångsbildningar. - Öfversigt Kongl. Vet.-Akad. Förh. 32 (5): 3-47, pls.4-5, Stockholm.
-- 1876 Geologiska iakttagelser under en resa på Öland. - Geol. Fören. Förh. 3 (2 = 30): 71-86, Stockholm.
- LOCHMAN C & HU CH 1960 Upper Cambrian Faunas from the Northwest Wind River Mountains, Wyoming. Part I - J. Paleont. 34 (5): 793-834, pls.95-100, 4 figs., Tulsa, Okla.

- MAGNUSSON NH 1958 Lexique stratigraphique international Europe 2c Suède - Sweden - Sverige - 499 pp., (3 maps, 2 sep. tables), Paris.
- MARTINSSON A 1962 Ostracodes of the Family Beyrichiidae from the Silurian of Gotland - Bull. Geol. Inst. Univ. Uppsala 41: 1-369, 203 figs., 2 tables (= Publ. Palaeont. Inst. Univ. Uppsala 41; = Akad. avh. fil. doktorsgrad), Uppsala.
- 1974 The Cambrian of Norden - Lower Palaeozoic Rocks of the World 2 [HOLLAND CH (Ed.) Cambrian of the British Isles, Norden, and Spitsbergen (with an Introduction to the Lower Palaeozoic Systems and an essay on the Pre-Cambrian-Cambrian Boundary): 185-283, 16 figs., London &c. (Wiley).
- 1979 *Albrunnicola*, a new name for the Cambrian ostracode genus *Longispina* Andres 1969 - Lethaia 12 (1): 27, Oslo.
- MATTHEW GF 1886 Illustrations of the Fauna of the St. John Group continued. No. III.- Descriptions of new Genera and Species, (including a description of a new Species of Solenopleura by J.F.Whiteaves.) - Mém. Comptes Rendus Soc. roy. Canada [Proc. Trans. Roy. Soc. Canada] (4) 3 [1885]: 60-84, pl. 6-7, Montréal.
- 1894 Illustrations of the Fauna of the St. John Group No. 8. - Proc. Trans. Roy. Soc. Canada (1) 11 [1893] (4) 8: 85-129.
- 1896 Faunas of the Paradoxides Beds in Eastern North America, No. 1. - Trans. New York Acad. Sci. 15: 192-247, 4 pls., 1 fig.
- 1899 Preliminary notice of the Etcheminian Fauna of Cape Breton - Bull. Nat. Hist. Soc. New Brunswick 4 (3) 18: 198-208.
- 1902 Ostracoda of the Basal Cambrian Rocks in Cape Breton - Canadian Rec. Sci. 8 [1899-1902.] (7): 437-470, 2 pls., (1 table), Montreal.
- McKENZIE KG, MÜLLER KJ & GRAMM MN 1983 Phylogeny of Ostracoda - SCHRAM FR (Ed.) Crustacean Phylogeny: 29-46, 6 figs., 4 tables, Rotterdam (Balkema).
- MELNIKOVA LM 1987 Bradoriidy iz tiskreskoj svity (nizhnij kembrii) Estonii - Paleont. zh. 1987 (1): 128-131, 1 fig., Moskva.
- {Engl. transl.: MEL'NIKOVA LM 1988 Bradoriids from the Tiskres Formation (Lower Cambrian) in Estonia - Paleont. j. 21 [1987] (1): 142-145, 1 fig., New York}.
- 1990 Ranne- i pozdnekembriiskie Bradoriida (ostrakody) severo-vostoka Tsentral'nogo Kazakhstana - Trudy inst. geol. geofiz. 765: 170-174, 188, 219-220, 2 pls., Novosibirsk.
- 1992 Pervye pozdnekambriiskie bradoriidy (ostrakody) Gornogo Altaia [Some Bradoriids (Ostracoda) from the Late Cambrian of Gornyy Altay] - Paleont. zh. 1992 (4): 80-82, 1 fig., Moskva.
- {engl.transl.: The first Late Cambrian Bradoriids (Ostracoda) from Gornyy Altay - Paleont. J. 26 [1992] (4): 104-107, 1 fig., New York 1993}.
- MENS K, BERGSTROM J & LENDZION K 1987 Kembrii vostochno-Evropeskoj platformy (korreliatsionnaia skhema i ob'iashitel'naia zapiska) [The Cambrian System on the East European platform (Correlation Chart and Explanatory Notes) - 118 pp., 1 chart, 1 map, Tallin(n) (Valgus).
- MILLER SA 1889 North American Geology and Palaeontology for the Use of Amateurs, Students, and Scientists - 664 pp., 1194 figs., Cincinnati, O.
- MOBERG JC 1911 Historical-Stratigraphical Review of the Silurian of Sweden - Sver. Geol. Undersökning (C) 229 {Arsbok 4 [1910] (1)}: 210 pp., (several tables), Stockholm.
- MOBERG JC & SEGERBERG CO 1906 Bidrad till kännedomen om Ceratopygeregionen med särskild hänsyn till dess utveckling i Fogelsångstrakten - Lunds Univ. Arsskr. N.F. (2) 2 (.) = Kongl. Fysiograf. Sällskapetets Handl. (N.F.) 17 (7) = Medd. Lunds Geol. Fältklubb (B) 2: 117 pp., 7 pls., 1 fig., Lund.
- MÜLLER KJ 1964 Ostracoda (Bradorina) mit phosphatischen Gehäusen aus dem Oberkambrium von Schweden - N. Jb. Geol. Paläont. (Abh.) 121 (1): 1-46, pl. 1-5, 3 tables (table 1: appendix), Stuttgart.
- 1979 Phosphatocopine ostracodes with preserved appendages from the Cambrian of Sweden - Lethaia 12 (1): 1-27, 38 figs., Oslo.
- 1982 *Hesslandona unisulcata* sp.nov. with phosphatised appendages from Up-

- per Cambrian "Orsten" of Sweden - BATE RH & al. (eds.) Fossil and Recent Ostracods (Brit. Micropalaeont. Soc. Ser.): 276-304, 8 pls., 6 figs., Chichester (E.Horwood).
- MULLER KJ & WALOSSEK D 1991 Ein Blick durch das <Orsten>-Fenster in die Arthropodenwelt vor 500 Millionen Jahren - Vergh. Dt. Zool. Ges. 84: 281-294, 15 figs., Stuttgart/Jena/New York.
- MUNTHE H 1906 Beskrifning till kartbladet Tidaholm - Sver. Geol. Undersökning (Aa) 125: 156 pp., 21 figs., 1 map, Stockholm.
- NEBEN W & KRUEGER HH 1979 Fossilien kambrischer, ordovizischer und silurischer Geschiebe - Staringia 5 [= Bijvoegsel Grondboor en Hamer 1]: 63 pp., pls. 110-164, Münster.
- ØPIK AA 1961 The Geology and Palaeontology of the Headwaters of the Burke River, Queensland - Bull. Bur. Miner. Resources, Geol. Geophys. 53: (I)+249 pp., 24 pls., 59 figs., (Canberra, A.C.T.).
- 1967 The Mindyallan Fauna of North-Western Queensland - Ibid. 74 (1): XVI + 404 p., 149 figs., 4 (+ 2 unnumbered) tables (1 sep.); (2): V+107 pp., 67 pls., Anberra, A.C.T..
- 1968 Ordian (Cambrian) Crustacea Bradoriida of Australia - Ibid. 103: (V) + 45 pp., 4 pls., 11 figs., ibid.
- POKORNÝ V 1978 Ostracodes - HAQ BU & BOERSMA A (eds.) Introduction to Marine Micropaleontology: 109-149, 61 figs., 2 tables, New York/Oxford (Elsevier).
- POULSEN C 1923 Bornholms Olenuslag og deres Fauna. - Danmarks geol. Undersøgelse (2) 40: 84 pp., 3 pls., 22 figs., (3 tables). København.
- PŘIBYL A & VANĚK J 1965 O rodu Hipponicharion MATTHEW, 1886 (Ostracoda) z českého středního kambria [Zur Gattung Hipponicharion MATTHEW, 1886 (Ostracoda) aus dem böhmischen Mittelkambrium] - Časopis národního muzea přírodovědeckého muz. (oddíl přírodovědný) 134 (3): 153-154, 1 pl., Praha.
- RAYMOND PE 1935 Leancoilia and Other Mid-Cambrian Arthropoda - Bull. Mus. Comp. Zool. 76 (6): 205-230, 3 figs., Cambridge, Mass.
- REMELE A 1883 Untersuchungen über die versteinерungsführenden Diluvialgeschiebe des norddeutschen Flachlandes mit besonderer Berücksichtigung der Mark Brandenburg. I. Stück. Allgemeine Einleitung nebst Uebersicht der älteren baltischen Sedimentgebilde. Untersilurische gekrümmte Cephalopoden. 1. Lieferung. - 153 pp., 1 fig., 1 map, Berlin.
- RIDE WDL & al. 1985 International Code of Zoological Nomenclature (Third Edition) - XX+339 pp., Berkely/Los Angeles (U Cal.Press). [ICZN].
- RUDOLPH F 1993 Die mittelkambrischen Sedimente Baltoskandiens - Der Geschiebesammler 26 (3): 107-138, 1 table, Wankendorf.
- RUSHTON RWA 1969 *Cyclotron*, a New Name for *Polyphyma* Groom - Geol. Mag. 106: 216-217, Hertford, Herts.
- 1978 Fossils from the Middle-Upper Cambrian Transition in the Nuneaton District - Palaeont. 21 (1): 245-283, pls.24-26, 2 figs., London.
- SCHALLREUTER R 1983 Glossomorphytinae und Sylthinae (Tetradellidae, Palaeocopa, Ostracoda) aus Backsteinkalk-Geschieben (Mittelordoviz) Norddeutschlands - Palaeontographica (A) 180 (4/6): 126-191, pls.15-29, 4 figs., 16 tables, Stuttgart.
- 1986 Ostrakoden aus Öjlemyrflint-Geschieben von Sylt - U von HACHT (ed.) Fossilien von Sylt 2: 203-232, 8 pls., Hamburg (I-M von HACHT) 1987 (preprint: 32 pp., 1986).
- SCHMIDT F 1888 Über eine neuentdeckte untercambrische Fauna in Estland. - Mém. Acad. Imp. Sci. St.-Petersbourg (7) 36 (2): 29 p., 2 pls., 2 figs., St.-Petersbourg.
- SCHRANK E 1973 fauna und Kontakt Mittelkambrium/Oberkambrium in einem Geschiebe - Z. geol. Wiss. 1 (1): 85-99, 3 pls., Berlin.
- SHERGOLD JH & al. 1989 Australian Phanerozoic Timescales 1. Cambrian Biostratigraphic Chart and Explanatory Notes - Rec. Bur. Miner. Resources, Geol. Geophys. 1989/31: VI+25 pp., 1 table, Canberra, A.C.T.
- SHU Degan 1990a Cambrian and Lower Ordovician Bradoriida from Zhejiang, Hunan and Shaanxi Provinces: 95 pp., 20 pls., 45 figs., 18 tables, Xian

- (Northwest Univ.)
- 1990b Cambrian and Early Ordovician "Ostracoda" (Bradoriida) in China - Cour. Forsch.-Inst. Senckenberg 123: 315-330, 3 pls., 1 fig., 1 table, Frankfurt a.M.
- SIVETER DJ, VANNIER JMC & PALMER D 1987 Silurian Myodocopid Ostracodes: Their Depositional Environments and the Origin of Their Shell Microstructures - Palaeont. 30 (4): 783-813, pls.83-88, 10 figs., London.
- 1991 Silurian Myodocopes: Pioneer pelagic ostracods and the chronology of an ecological shift - J. micropalaeont. 10 (2): 151-173, 3 pls., 5 figs., London.
- ŠNAJDR M 1975 Konicekion nov. gen. from the Middle Cambrian of Bohemia (Ostracoda) - Věstník Ústředního ústavu geol. (Bull. Geol. Surv. Prague) 50 (3): 153-156, 2 pls., Praha.
- STEUSLOFF A 1895 Neue Ostrakoden aus Diluvialgeschieben von Neu-Brandenburg - Z. Dt. geol. Ges. 46 [1894] (4): 775-787, pl.58, Berlin.
- STRAELEN V van & SCHMITZ G 1934 Crustacea Phyllocarida (= Archaeostraca). - Fossilium Catalogus (I : Animalia) 64: 246 pp., Berlin.
- TAYLOR K & RUSHTON AWA 1972 The pre-Westphalian geology of the Warwickshire Coalfield with a description of three boreholes in the Merevale area - Bull. Geol. Surv. Great Britain 35: VII+152 pp., 12 pls., 11 figs., 4 tables, London (dated 1971).
- THORSLUND P & WESTERGARD AH 1938 Deep Boring through the Cambro-Silurian at File Haidar, Gotland - Sver. Geol. Undersökning (C) 415 {Arsbok 32 [1938] (5)}: 57 pp., 4 pls., 2 tables, 7(+ 2) figs., 1 diagr., Stockholm.
- TONG Hao-wen 1987 Fossil Phosphatocopida from Lower Cambrian of China - Acta Micropalaeont. Sinica 4 (4): 427-437, 2 pls., 4 figs., 1 table, Beijing.
- TULLBERG SA 1880 Om Agnostus-arterna i de kambriska aflagringarne vid Andrarum.- Sver. Geol. Undersökning (C) 42: (I)+38 pp., 2 pls., 1 map, Stockholm.
- ULRICH EO & BASSLER RS 1931 Cambrian Bivalved Crustacea of the Order Conchostraca - Proc. U. S. Nat. Mus. 78 (4 = 2847): 130 pp., 10 pls., Washington, D.C.
- WALLERIUS ID 1895 Undersökningar öfver zonen med Agnostus lævigatus i Västergötland. Jämte en inledande öfversikt af Västergötlands samtliga Paradoxideslager. - Akademisk afhandling: (2)+II+73 pp., 1 pl., 12 figs., Lund 1895 (H.Möller).
- WALOSSEK D, HINZ-SCHALLREUTER I, SHERGOLD JH & MÜLLER KJ 1993 Three-dimensional preservation of arthropod integument from the Middle Cambrian of Australia - Lethaia 26 (1): 9-15, 5 figs., Oslo.
- WESTERGARD AH 1909 Studier öfver dictyograptusskiffern och dess gränslager med särskild hänsyn till i Skåne förekommande bildningar - Lunds Univ. Arsskr. (N.F.) 5 (3) = Kongl. Fysiograf. Sällskapets Handl. (N.F.) 20 (3): 79 pp., 5 pls., (3 figs., 3 tables), Lund.
- 1922 Sveriges olenidskiffer I. Utbredning och lagerföljd II. Fauna. 1. Trilobita - Sver. Geol. Undersökning (Ca) 18: VI+205 pp., 16 pls., 39 figs., Stockholm.
- 1940 Nya djupborrningar genom äldsta ordovicium och kambrium i Östergötland och Närke [New Deep Borings through the Lowest Ordovician and Cambrian of Östergötland and Närke (Sweden).] - Ibid. (C) 437 {Arsbok 34 [1940] (7)}: 72 pp., 9 figs., 6 diagr., Stockholm.
- 1944 Borrningar genom Skånes alunskiffer 1941-42 - Ibid. 459: 45 pp., 6 pls., ibid.
- 1947 Supplementary Notes on the Upper Cambrian Trilobites of Sweden - Sver. Geol. Undersökning (C) 489 {Arsbok 41 [1947] (8)}: 35 pp., 3 pls., (2 tables), Stockholm.
- WIMAN C 1903 Studien über das Nordbaltische Silurgebiet. I. Olenellussandstein, Obolussandstein und Ceratopygeschiefer. - Bull. Geol. Inst. Univ. Upsala 6 [1902-1903.] (1 = 11)[1902]: 36-76, pls.1-4, 2 figs., (2 tables), Upsala.
- ZHANG X-g & PRATT BR 1993 Early Cambrian Ostracode Larvae with a Univalved Carapace - Science 262 (5130): 93-94, 3 figs., Washington, D.C. 1.10.1993.