

Late Ordovician Ostracodes from Sardinia and Perigondwanan Ostracode Palaeobiogeography

Oberordovizische Ostrakoden aus Sardinien und Ostrakoden-Paläobiogeographie Perigondwanas

Ostracodi dell'Ordoviciano Superiore della Sardegna e paleobiogeografia ad ostracodi nell'area perigondwaniana



ROGER SCHALLREUTER (Greifswald), INGELORE HINZ-SCHALLREUTER (Greifswald), ANNALISA FERRETTI (Modena) & ENRICO SERPAGLI (Modena)

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Abstract

A Late Ordovician ostracode fauna from Sardinia comprises more than 45 species of beyrichiocopes and podocopes. There is a total of 13 named new species of the genera *Grammolomatella*, *Pseudulrichia*, *Antiaechmina*, *Postceratia*, *Arpaschmidtella*, *Bairdiocypridella*, *Prorectella*, *Dornbuschia*, *Velapezoides*, *Bairdia* as well as of the new genus *Sardicornina*. The podocopes constitute about two thirds of all species, the binodicopes take three fourth of the beyrichiocopes. The fauna shows close relationships to faunas from both Thuringia and Central Iran (Yazd Block). The closest relations exist to Iran and the fauna of the so-called *Bairdiocypridella* clasts of the Thuringian Lederschiefer. Therefore, Thuringia, Sardinia and Central Iran can be regarded as a palaeobiogeographic ostracode province, here called the Thuringian province. Within Gondwana/Perigondwana two further ostracode provinces, the Armorican and Australian provinces can be distinguished.

Zusammenfassung

Von Sardinien wird eine oberordovizische Ostrakodenfauna beschrieben, die aus über 45 Arten der Beyrichiocopa und Podocopa besteht. 13 Arten der Gattungen *Grammolomatella*, *Pseudulrichia*, *Antiaechmina*, *Postceratia*, *Arpaschmidtella*, *Bairdiocypridella*, *Prorectella*, *Dornbuschia*, *Velapezoides*, *Bairdia* und *Sardicornina* gen. n. sind neu. Die podocopen Arten machen zwei Drittel aller Arten aus, bei den Beyrichiocopa sind drei Viertel der Arten Binodicopa. Die Fauna zeigt enge Beziehungen zu Zentral-Iran (Yazd Block) und zu Thüringen, dort besonders zu der Fauna der *Bairdiocypridella*-Klasten des Lederschiefers. Innerhalb von Peri-Gondwana/Gondwana bildeten Thüringen, Sardinien und Zentral-Iran eine eigene paläobiogeographische Provinz neben der australischen und der armorikanischen Provinz.

Riassunto

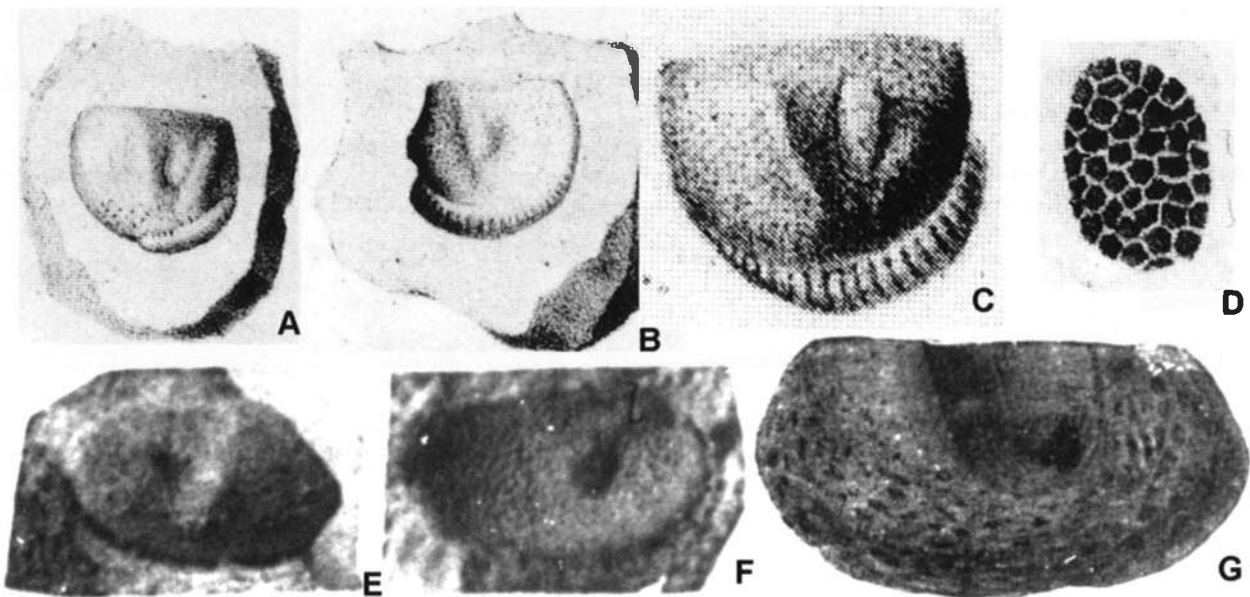
Una fauna ad ostracodi dell'Ordoviciano Superiore della Sardegna è costituita da oltre 45 specie di beyrichiocopi e podocopi. Vengono proposte 13 nuove specie appartenenti ai generi *Grammolomatella*, *Pseudulrichia*, *Antiaechmina*, *Postceratia*, *Arpaschmidtella*, *Bairdiocypridella*, *Prorectella*, *Dornbuschia*, *Velapezoides*, *Bairdia* ed al nuovo genere *Sardicornina*. I podocopi rappresentano circa i due terzi di tutte le specie, e i binodicopi costituiscono a loro volta circa i tre quarti dei beyrichiocopi. La fauna descritta mostra chiare analogie con le faune sia della Turingia che dell'Iran Centrale (Yazd Block). Le relazioni più strette esistono con l'Iran e con la fauna dei cosiddetti clasti a *Bairdiocypridella* della unità Lederschiefer della Turingia. Quindi, la Turingia, la Sardegna e l'Iran Centrale possono essere considerate come una unica provincia paleogeografica ad ostracodi: la provincia Turingiana. Due altre province faunistiche ad ostracodi, la provincia Armoricana e quella Australiana, possono essere riconosciute all'interno del Gondwana/Perigondwana.

Introduction

Ordovician ostracodes have been known from Sardinia for nearly 150 years, but only a few species have been described or mentioned until now. The first ostracodes from this region were described by BORNEMANN (in MENEGHINI 1860: 8) who established *Beyrichia reticulata* (Text-fig. 1A–D) and mentioned *Beyrichia simplex* JONES and *Beyrichia* sp. from Perdass de Fogu, near Fluminimaggiore, in the Province of Cagliari (JONES 1890b: 539), Upper Ordovician (HAMMANN & LEONE 1997: 12). *Beyrichia reticulata* was refigured by JONES (1890b: pl. 20 figs.14a-b). The entire plate of MENEGHINI was refigured

by HAMMANN & LEONE (1997: text-fig. 2). Another species (*Primitia ? caputaquae*) from Caput aquas was established by VINASSA DE REGNY (1927: 444) (Text-fig. 1E–G).

The fauna described herein came from the Late Ordovician of Cannamenda, SW Sardinia. The outcrop is located about 2.5 km east of the village Bacu Abis (text-fig. 3). According to FERRETTI, SERPAGLI, HAMMANN & LEONE (1998: 178) the thin (4–4.5 cm thick), fossiliferous horizon has no lateral continuity and is poorly exposed in the field in the form of small pieces of rock. During the course of conodont investigations, a rich ostracode fauna was discovered in the light fractions of limestone samples



Text-fig. 1 A – D: *Beyrichia reticulata* BORNEMANN in MENEGHINI in DE LA MARMORA, 1860 (after the copy of the original plate in HAMMANN & LEONE 1997: text-fig. 2): steinkern (A) and external mould (B) of a female right valve, cast of the external mould (C), and enlargement of the reticulation (D), length 2,14 mm (fig. A). Late Ordovician of Fluminimaggiore, southern Sardinia.

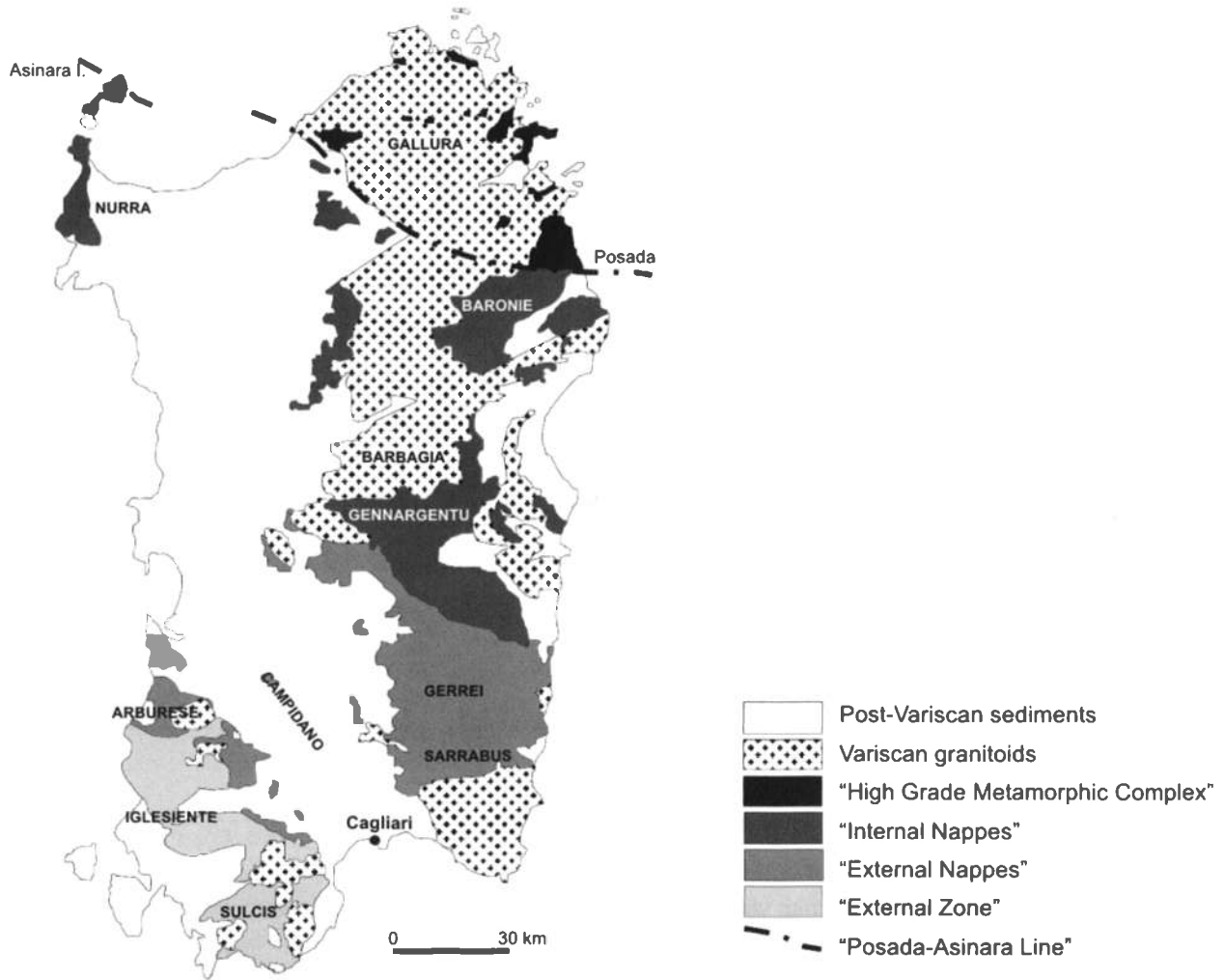
E – G: *Primitia ? caputaquae* VINASSA DE REGNY, 1927: holotype, left valve: steinkern (anterodorsally and posterodorsally incomplete) (E), external mould (F), and cast of the external mould (G), length 2.5 mm. Late Ordovician (presumably Portixeddu Formation), Caput aquas, Sardinia.

VINASSA DE REGNY (1927: 444) mentioned only one valve and figured (pl. 1 figs. 9-10) a steinkern and an external mould of a left valve. The figured cast of the external mould (pl. 1 fig. 11) is figured as a right valve, apparently erroneously inverted.

Abb. 1 A – D: *Beyrichia reticulata* BORNEMANN in MENEGHINI in DE LA MARMORA, 1860 (nach der Kopie der Originaltafel in HAMMANN & LEONE 1997: text-fig. 2): Steinkern (A) und Außen-Abdruck (B) einer ? Klappe, Abguß des Abdruckes (C) und Vergrößerung der Retikulation (D), Länge 2,14 mm (Fig. A). Oberordoviz von Fluminimaggiore, Süd-Sardinien.

E – G: *Primitia ? caputaquae* VINASSA DE REGNY, 1927: Holotypus, linke Klappe: Steinkern (antero- und posterodorsal unvollständig) (E), Außenabdruck (F) und Abguß des Außenabdrucks (G), Länge 2,5 mm. Oberordoviz (wahrscheinlich Portixeddu Formation), Caput aquas, Sardinien.

VINASSA DE REGNY (1927: 444) erwähnt nur eine Klappe und bildet (Taf. 1 Fig. 9-10) einen Steinkern und den Außen-Abdruck einer linken Klappe ab. Der abgebildete Abdruck des Außen-Abdrucks (Taf. 1 Fig. 11) ist als rechte Klappe dargestellt, d.h. offensichtlich irrtümlicherweise seitenverkehrt abgebildet.



Text-fig. 2: Simplified structural map of Sardinia (modified after CARMIGNANI et al. 1992)

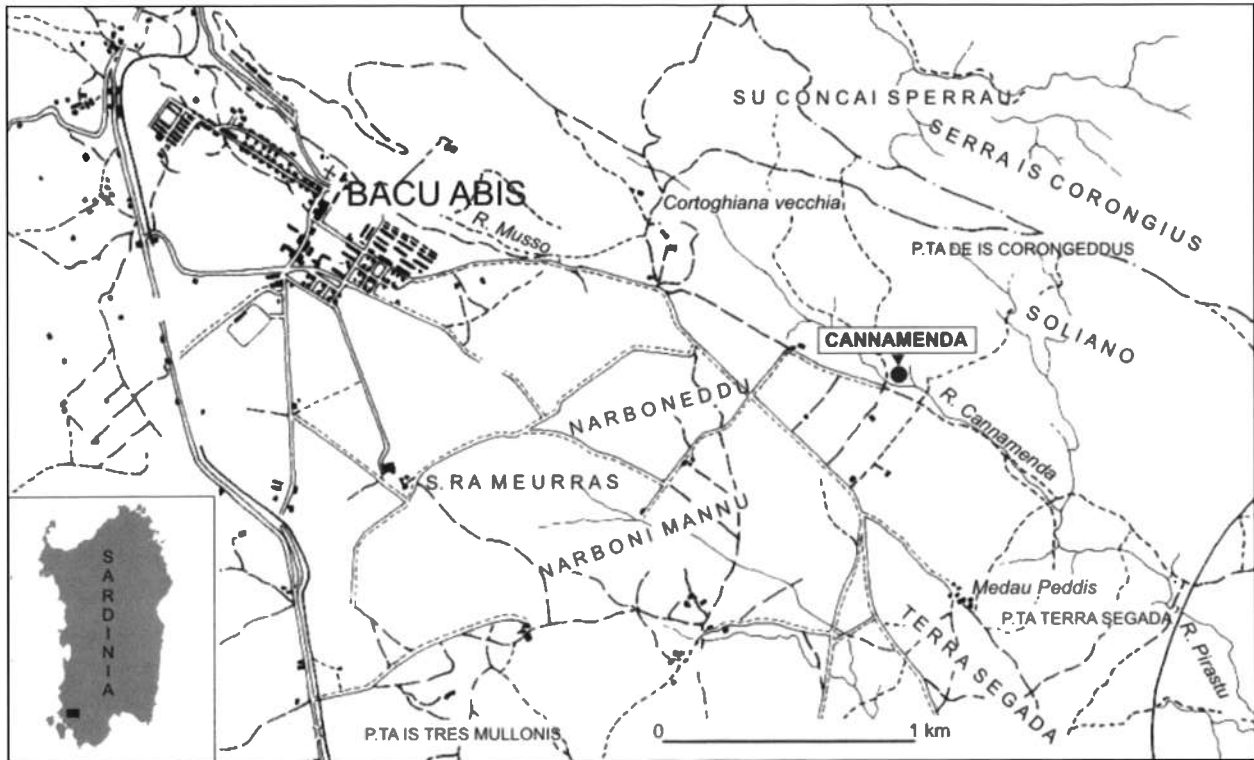
Abb. 2: Vereinfachte Strukturkarte Sardiniens (nach CARMIGNANI et al. 1992, verändert)

(FERRETTI, SERPAGLI, HAMMANN & LEONE 1998: 186). The fauna is characterized by a large quantity of podocopes similar to other Late Ordovician ostracode faunas. Many podocopes are difficult to determine because they are poor in characteristic features and exhibit wide morphologic variation. Among the determined ostracodes, binodicopes and tricorninoides dominate.

Material and methods

The ostracodes were discovered some years ago in the light fractions of samples prepared for conodonts (the previous authors generally used sieves of 0.14 mm diameter, or occasionally 0.10–1.00 mm). The ostracodes

described here came from sample CDA Fine Sotto AL 6. Among all samples, it was richest in ostracodes. About 5,000 specimens (carapaces and mainly single valves) were picked from the residues. Generally, the specimens are rather coarsely silicified. Due to diagenesis, they are sometimes slightly compressed, which often alters the original shape (L:H ratio) (e.g., Pl. 13 fig. 12) and may suggest false transitions between certain species in addition to the natural variation, as for example, between species with a ventral spine (*Tricornina haebneli*, *T. compacta*, and *Margoplanitia brevispina*). This makes the determination of podocopes with their minimal features and great natural variation even more difficult. The situation is best characterized by Sherlock Holmes's statement: "The more featureless a crime is, the more difficult is it to bring it



Text-fig. 3: Location map of the Cannamenda outcrop

Abb. 3: Lage der Aufschlüsse von Cannamenda bei Bacu Abis, SW-Sardinien

home". Since the sieve fraction >1.00 mm was not available for this study, some of the described species may exceed the largest specimens at hand.

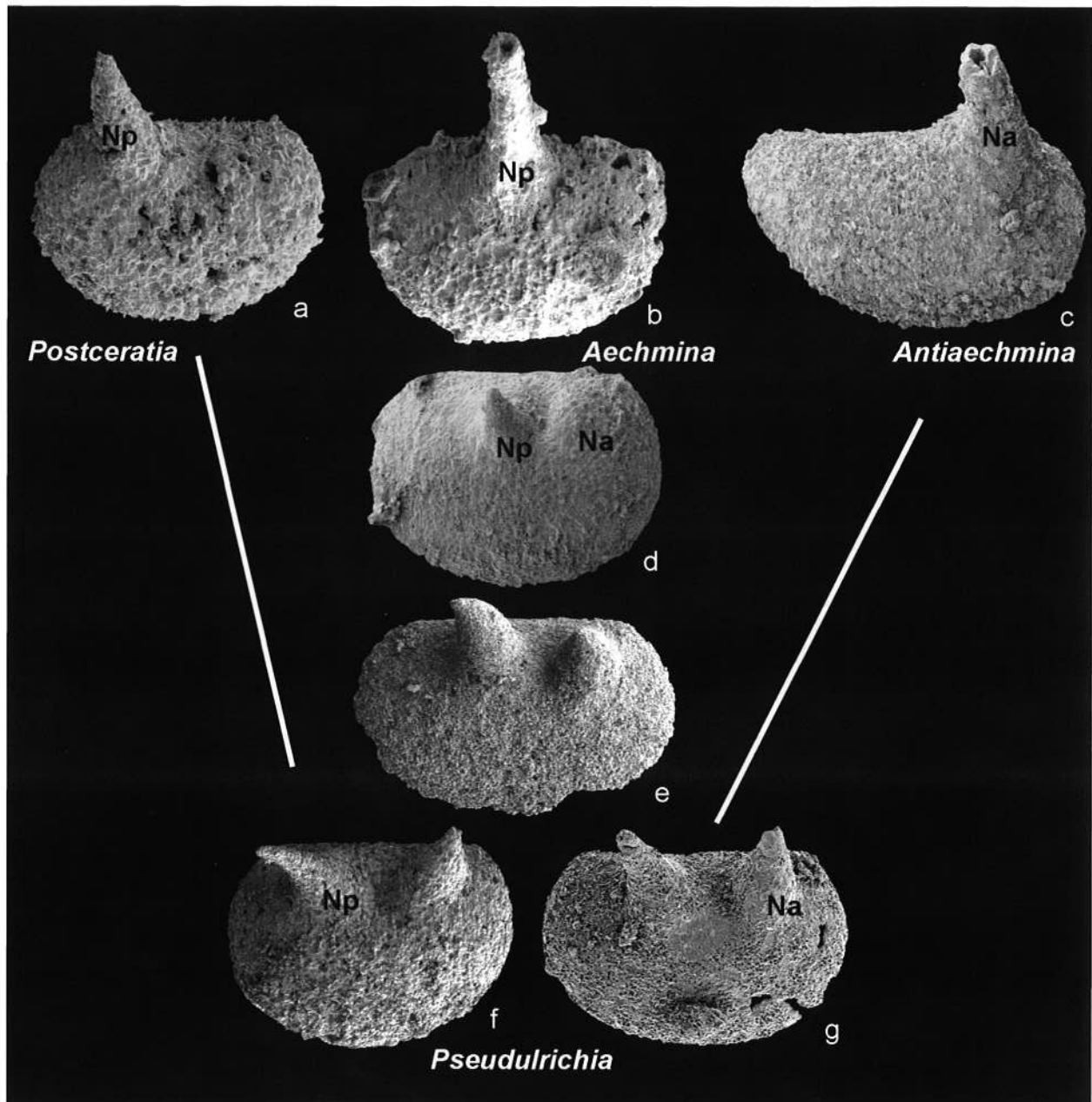
In some cases, the silicification and the preparation process may produce a pseudo-duplicature: BECKER & ADAMCZAK (2001: 155) as, for example, in *Cryptophyllus* sp. A: BECKER & SÁNCHEZ DE POSADA, 1977 [BECKER & ADAMCZAK 2001: text-fig. 4 fig.4 (in the explanation 3) = BECKER & SÁNCHEZ DE POSADA 1977: pl. 14 fig.10]. The pseudo-duplicature is not produced by "partial silicification" (partieller Verkieselung, BECKER & ADAMCZAK 2001: 155). The median parts of the siliceous cover of the inner side of the valve are broken away. Therefore the retention furrows of the inner side of the outer silica cover can be seen. By the silicification – as also in the case of phosphatisation (see for example HINZ-SCHALLREUTER 1995: text-fig. 4 fig.1a) – often both sides of the calcareous shell are covered by a siliceous cover, which is very thin and delicate (as recognized previously by ADAMCZAK, see BECKER & SÁNCHEZ DE POSADA 1977: 188) and, therefore, often broken away by the processing and rough handling. The space between outer and inner siliceous covers is often empty after dissolution of the calcareous shell in the course of the preparation process.

Parts of the cover sometimes break away or the two covers may completely split apart (SCHALLREUTER 1996a: 140–141). Stronger silicification, however, filled the space between inner and outer covers more or less completely with larger quartz crystals (SCHALLREUTER 1994c: pl. 21, 4 figs.1–2).

All illustrated specimens on the plates are figured as stereo-pairs mounted according to the *method of parallel axes* (SCHALLREUTER 2004). The material is housed under the numbers 27977–28130 in the *Dipartimento del Museo di Paleobiologia e dell'Orto Botanico, Università di Modena e Reggio Emilia, Via Università 4, 41100 Modena, Italy* (IPUM).

Geological setting

Sardinia represents one of the few places in Italy in which Palaeozoic sequences, ranging in age from the Early Cambrian to the earliest Carboniferous, occur abundantly. They represent a significant part of the South European Variscan Chain. The Variscan Orogeny affected the whole Palaeozoic Basement with various degrees of deformation and metamorphism followed



Text-fig. 4: Morphogenetic relations between *Pseudulrichia* and *Antiaechmina*, *Aechmina*, and *Postceratia* as possible phylogenetic lineages. All right valves (except of fig. e which is flipped horizontally). All Late Ordovician.

Abb. 4: Morphogenetische Beziehungen zwischen *Pseudulrichia* und *Antiaechmina*, *Aechmina*, und *Postceratia* als mögliche phylogenetische Abkömmlinge. Alles rechte Klappen (außer Fig. e, die horizontal gespiegelt wurde). Alle Oberordoviz.

a – *Postceratia posterocerata* (BLUMENSTENGEL, 1965) (SCHALLREUTER 2005: pl. 5 fig. 2); b – *Aechmina gracilis* BLUMENSTENGEL, 1965 (Pl. 5 fig. 4); c – *Antiaechmina insula* sp. n. (Pl. 5 fig. 7); d – *Pseudulrichia sardinica* sp. n. (Pl. 4 fig. 1); e – *Pseudulrichia bucera* (NECKAJA, 1966) (SCHALLREUTER 1990: pl. 5 fig. 8); f – *Pseudulrichia bobemica norvegica* HENNINGSMOEN, 1954 (SCHALLREUTER 2005: pl. 4 fig. 8); g – *Pseudulrichia fuga* SCHALLREUTER, 1999 (SCHALLREUTER 1999: pl. 1 fig. 3)

by important and extended post-collisional magmatism. On the basis of the grade of regional metamorphism, a “nappe” zone may be recognized as separating a Metamorphic High Grade Complex in the NE from an autochthonous External Zone in the SW (Text-fig. 2). Within the “nappe” zone, external nappes (including the Sarrabus Unit, Gerrei Unit, and Arburese Unit) and internal nappes (Nurra Unit, Baronie Unit, and Gennargentu Unit) have been described. In the External Zone and the External Nappe Zone, the original lithological features and the palaeontologic content have been preserved, thanks to only weak tectonic deformations and a low-grade metamorphism.

Ordovician sediments are common in Sardinia mostly in the south, where two different situations characterize the southeastern and southwestern part of the island. The two areas, physically separated by the Pliocene to mid-Pleistocene tectonic depression of the Campidano, have been attributed to different sedimentary basins, also on the basis of a markedly diverse zircon typology and geochemical signature (LOI & DABARD 1997). Nevertheless, the similar tectono-sedimentary evolution of both basins, the presence of a complete Cambrian to Lower Ordovician succession as well as the existence of a Middle Ordovician stratigraphic gap (respectively known as “Sardic unconformity” in SW Sardinia and “Sarrabese unconformity” in SE Sardinia) suggest a close palaeogeographical origin and indicate, furthermore, a strong similarity with other northern Gondwana areas (HAMMANN 1992; HAMMANN & LEONE 1997).

Palaeontological and sedimentological studies have mostly dealt with these two areas individually. In SW Sardinia, the Iglesias-Sulcis sequence represents the most important post-Sardic Ordovician autochthonous unit. Here some 1000 m of terrigenous deposits are covered by typical marine sediments and are capped by a thick Hirnantian glaciomarine cover. LEONE et al. (1991) and LASKE et al. (1994) described five Formations in the Upper Ordovician which, in stratigraphic order, are the Monte Argentu Fm., the Monte Orri Fm., the Portixeddu Fm., the Domusnovas Fm. and the Rio San Marco Fm. These units have provided for a long time a rich and well preserved fossil fauna of brachiopods, bryozoans and echinoderms, associated with trilobites, conodonts, ostracodes, gastropods, bivalves, cephalopods, cornulitids, conularids, corals, hyolithids, sponges, chitinozoans, acritarchs, algae and graptolites. Most of the fauna comes from the dark-gray sandstones, siltstones and shales (having pyritic, phosphatic or siliceous nodules at the top) of the Portixeddu Fm. and from the arenaceous (lower) and shaley-marly (upper) sediments of the Domusnovas Fm. More recent data can be found in LEONE et al. (2002).

In SE Sardinia, the post-Sarrabese succession bears a lower Middle Ordovician volcanic and volcanoclastic complex overlain by an Upper Ordovician mainly terrigenous sequence with extremely subordinate limestones (LEONE 1998). Late Ordovician brachiopods, trilobites, bryozoans, crinoids, cystoids, gastropods, solitary corals and rare orthocone cephalopods were recovered in the Sarrabus and in the Gerrei.

Sample locality

The ostracode fauna described in the present study comes from conodont residues of material collected in the Cannamenda outcrop of SW Sardinia, close to the village of Bacu Abis (Text-fig. 3). Sampling was there concentrated in the Punta S'Argiola Member at the top of the Domusnovas Formation. LEONE et al. (1991) described two brachiopod and trilobite associations within this unit. The lower one was assigned to the *Nicolella* Community. The younger association bears trilobites dominated by Cyclopygid members and brachiopods attributed to the *Folliomena* Fauna but also with members of the Proboscisambon Community. In the Rio Cannamenda Section, brachiopod and trilobite fauna of the latter level indicate a shallower environment. Here the Domusnovas Fm. is represented by a thin barren interval of green claystones, followed above by red claystones intercalated with green to pink-red calcareous horizons, which are locally enriched by crinoid fragments. Limestones consist of wackestones to packstones, whose main constituents are echinoderm fragments, associated with trilobites, bryozoans, sponges and sponge spicules, brachiopods, gastropods, ostracodes and very rare small cephalopods. Within these calcareous horizons, only a 4–4.5 cm unit of fine-grained pink limestone, exposed in the field in the form of scattered blocks, produced a rich conodont fauna attributed to the *A. ordovicicus* Zone (FERRETTI, SERPAGLI, HAMMANN & LEONE 1998; FERRETTI & SERPAGLI 1999). Pure encrinitic limestones as well as bryozoan packstones proved to be completely barren for conodonts.

Systematic Palaeontology

(R. SCHALLREUTER & I. HINZ-SCHALLREUTER)

Remarks: The terminology used herein conforms with SCHALLREUTER et al. (2006, p. 299). Additionally, the term *lappet* of BERDAN (1976: text-fig. 3) (= *Lappen*: SCHALLREUTER 1968d: Fig. 15) is preferred to “bow-shaped projection” (comp. HESSLAND & ADAMCZAK 1974: 60 and ADAMCZAK 1976: 300). The term *glacial*

erratic boulder is replaced by the shorter German term *geschiebe* (SCHALLREUTER 1994b; SCHALLREUTER et al. 2006: 299).

Abbreviations used: OD original designation, SD subsequent designation

GG Institute of Geography and Geology, Ernst Moritz Arndt University Greifswald

Type locality for all new species (except of *Prorectella erratica*) is Cannamenda about 2.5 km SE of the Bacu Abis village. *Stratum typicum* is the Punta S'Argiola Member of the Domusnovas Formation, Late Ordovician, *A. ordovicicus* Zone (FERRETTI, SERPAGLI, HAMMANN & LEONE 1998: 178). The occurrence is given only when the species occurs elsewhere. Under *Material* only the specimens are given that have been closely investigated. It is very possible that in the material picked, more specimens, primarily of the podocope species, would be present. The Shirgesht Formation at Anarak (Central Iran) is called *Anarak Formation* herein, because it is presently uncertain whether it really represents the upper part of the Shirgesht Formation, which has its type section in another Block of Central Iran and exhibits relations to Armorica instead.

Order BEYRICHIOCOPA POKORNÝ, 1954 emend.
SCHALLREUTER, 1980a

Suborder PALAEOCOPA HENNINGSMOEN, 1953
emend. MARTINSSON, 1956 (?1955)

Infraorder HOLLINOMORPHA HENNINGSMOEN,
1965

Superfamily Hollinoidea SWARTZ, 1936

Family Hollinidae SWARTZ, 1936

Subfamily Triemilomatellinae SCHALLREUTER, 1974

Genus *Grammolomatella* JAANUSSON, 1957

Synonyms: *Australomatella* SCHALLREUTER, 1974; *Rozmaniella* MELNIKOVA, 1978; *Xystista* SIVETER, 1985

Type-species: *Biflabellum vestrogothicum* HENNINGSMOEN, 1948 (OD JAANUSSON 1957: 410), Late Ordovician of Baltica; holotype of the type-species: HENNINGSMOEN 1948: pl. 25 fig. 12; JAANUSSON 1957: pl. 12 fig. 23.

Definition: Medium-sized. Unisulcate, with long and sigmoidal S2. Broad indistinct bulb-like preadductorial node, and distinct posteroventral lobe. Dorsal part of L3 missing to distinctly bulb-like. Tecnomorphs with two velar spurs. In adults and larger instars spurs are fused ventrally of S2, with posterior spur being separated from posteroventral lobe. Female velum ridge-like anterodorsally to flange-like ventrally, and terminating spur-like in the anterior posteroventral region. Antrum dolonal to admarginal and botulate. Marginal sculpture ridge-like, may be dimorphic by forming the inner antral fence.

Ordovician species

Biflabellum vestrogothicum HENNINGSMOEN, 1948

Grammolomatella valdari IVANOVA & MELNIKOVA, 1977

Grammolomatella mesosibirica IVANOVA & MELNIKOVA, 1977

Rozmaniella tersa MELNIKOVA, 1978 (type-species of *Rozmaniella*; OD MELNIKOVA 1978: 72; Late Ordovician, Mongolia)

Grammolomatella norvegica Qvale, 1980

Grammolomatella pustulosa MELNIKOVA, 1986

? *Thuringobolbina* ? *sibirica* MELNIKOVA, 2000

Silurian species.

Bollia auricularis JONES, 1887 (type-species of *Xystista*; OD SIVETER 1985: 77; Wenlock, Welsh Borderland)

Ctenentoma ? *dubitabilis* ÖPIK, 1953 (type-species of *Australomatella*; OD SCHALLREUTER 1974: 166; Silurian, Victoria)

Ctenentoma ? *unguiculata* ÖPIK, 1953

Grammolomatella graffhami LUNDIN, 1965

In his genus JAANUSSON (1957: 410) included also the Silurian species *Ctenobolbina diensti* KUMMEROW, 1924 and *Ctenentoma* ? *dubitabilis* ÖPIK, 1953 (which he considered to be the other sex of *C.* ? *unguiculata* ÖPIK, 1953). However, *Ctenobolbina diensti* later became the type-species of *Diceratobolbina* SETHI, 1979 and *Ctenentoma* ? *dubitabilis* the type-species of *Australomatella* SCHALLREUTER, 1974. In addition, SCHALLREUTER (1974: 166) assigned *Grammolomatella graffhami* LUNDIN, 1965 to *Australomatella*. QVALE (1980: 107) considered *Australomatella* as a synonym of *Grammolomatella*. *Grammolomatella graffhami* has been placed in *Xystista* SIVETER, 1985 by SIVETER (1985: 77) and SIVETER & LUNDIN (1985: 81).

QVALE (1980: 106, 107) included *Sigmobolbina bucera* KANYGIN, 1971 and *S. decurvata* KANYGIN, 1971 in *Grammolomatella*, and considered both as the possible dimorphs of one species since both species came from the same bed. However, the holotype of *G.* ? *bucera* (a tecnomorph and possibly not an adult) is larger (1.02 mm) than the holotype of *G.* ? *decurvata* (considered to be a female by QVALE; 0.75 mm). Furthermore, the posteroventral lobe is developed to a different degree in the two species (KANYGIN 1971: pl. 5 figs. 5, 7).

Grammolomatella veterrima SCHALLREUTER, 1967 became the type-species of *Eolomatella* SCHALLREUTER, 1974.

Grammolomatella ? *plana* MELNIKOVA, 1981 is, however, excluded from the genus. Its systematic position is still unclear. It resembles both *Vittella* and *Oepikiium* in part and therefore may represent a new genus.

Comparison: *Rozmaniella* MELNIKOVA, 1978 (type-species: *R. tersa* MELNIKOVA, 1978; late Ordovician, Mongolia) is considered to be a synonym of *Grammolomatella*. The holotype of *Rozmaniella tersa* (MELNIKOVA 1978: 70; pl. 9 fig. 4)

does seem not to be a female contrary to MELNIKOVA's assumption. The velar dolonal flange is not interrupted below the sulcus in typical *Grammolomatella* species with two ventral spurs in tecnomorphs (JAANUSSON 1957: pl. 12 figs. 23–25; QVALE 1980: fig. 17).

Tecnomorphs of the Silurian *Semibolbina* JORDAN, 1964 [= *Winchellia* JORDAN, 1964: 54 (type-species: *W. bispinosa* JORDAN, 1964, p. 55); = *Valetudinis* WANG, 1989], which is represented in the Late Ordovician by *S. ordoviciana* SCHALLREUTER, 1977a also have two ventral spurs, but the posterior spur is part of the posteroventral lobe. Only anteriorly the velum is developed as a spine, but as a ridge between posteroventral lobe and free margin (SCHALLREUTER 1977a: pl. 5 figs. 7–9) – a typical feature of the Tetrasacculinae (SCHALLREUTER 1974: 166; SCHALLREUTER & al. 1999: pl. 4 fig. 1). By contrast, in *Grammolomatella* the posterior velar spine is located between the posteroventral lobe and free margin and is a velar sculpture.

The Silurian *Xystista* SIVETER, 1985 (type-species from the Wenlock, England) is very similar and considered to be a junior synonym. According to SIVETER (1985: 77–79) *Xystista* “May be derived from stock ancestral to the Ordovician hollinine” [recte hollinine] “*Grammolomatella* ... which differs in S2 morphology (dorsally), in having a much shorter female velum and males with two unconnected velar spurs and possibly in antral morphology”. The type-species of *Grammolomatella* is not very well known, but larger tecnomorphs of *Grammolomatella gondwanica* show that the two velar spurs are connected as in *Xystista* (Pl. 1 fig. 1, 5). The ventral part of the L3 (posteroventral lobe) is distinctly separated from the posterior ventral spur in both *Grammolomatella* and *Xystista*, but the dorsal portion of the L3 is differently developed. It is completely missing in *Grammolomatella*, but weak (*X. auricularis*; SIVETER 1985: pl. 12, 78 fig. 1; pl. 12, 80 fig. 3) to distinct in adults and larger instars (*X. graffhami*; LUNDIN & SIVETER 1985: pl. 12, 82 fig. 2, pl. 12, 84 fig. 1) of *Xystista*. In smaller instars it is missing, as in *Grammolomatella* (LUNDIN & SIVETER 1985: pl. 12, 84 fig. 5, 7). According to LUNDIN & SIVETER (1985: 83) the more pronounced L3 in *X. graffhami* is, phylogenetically, what might be expected from its younger age. Differences in the length of the female velum are only minor (JAANUSSON 1957: pl. 12 fig. 23; MEIDLA 1996: pl. 14 fig. 11). The antral morphology of the type-species of *Grammolomatella* is unknown, but similar to other genera it may vary between the different species of a genus. *Grammolomatella*, as is the case with *Semibolbina*, represents one of the few ostracode genera that survived the Ordovician/Silurian boundary.

In many hollinoides the tecnomorphs are characterized by two ventral spines (spurs), and a precise taxonomic

assignment can often be made if females are known. Several genera were established on the base of tecnomorphic valves only. Two examples are *Thuringobolbina* ZAGORA, 1967 (type-species: *T. thuringica* ZAGORA, 1967, lower Devonian, Thuringia), and *Spinobolbina* ABUSHIK, 1968 (type-species: *S. bispina* ABUSHIK, 1968, Llandoverly, W Siberia). According to SIVETER (1985: 77) *Spinobolbina* is a *nomen dubium*.

Thuringobolbina ZAGORA, 1967 resembles *Semibolbina* in the posteroventral lobe that terminates in a strong spine (ZAGORA 1967: pl. 6 figs. 1–2). ZAGORA considered the holotype (l.c.: fig. 1) as female, but the anterior spine-like flange does not seem to be a dolon. The “dolon” of the holotype is steeply inclined, which is contrary to the normal orientation more or less parallel to the contact plane. Therefore, the exact systematic position of *Thuringobolbina* remains questionable as *Thuringobolbina sibirica* MELNIKOVA, 2000 from Northern Taimyr, from which only tecnomorphic valves are known.

Occurrence: Late Ordovician – Ludlow; Baltoscandia, Siberia, Kazakhstan, Oklahoma, Victoria

Grammolomatella gondwanica sp. n.

Pl. 1 figs. 1–7

Derivation of name: After the ancient supercontinent Gondwana

Holotype: Tecnomorphic left valve IPUM 27981 – Pl. 1 fig. 5. Paratypes: IPUM 27977–27980, 27982–27983

Definition: At least up to 1.30 mm. Larger tecnomorphs with velum developed as two flanges terminating in spines in the anteroventral and posteroventral regions. In smaller instars the spines are more isolated and ventrally directed. Anterior flange starting in anterodorsal region.

Material: More than 10 tecnomorphic valves (seven on stubs); two fragmentary, questionable female valves.

Comparisons: The tecnomorphic left valve of the type-species *Biflabellum vestrogothicum* HENNINGSMOEN, 1948, is very similar to smaller valves of the species (JAANUSSON 1957: pl. 12 figs. 24–25) in having the velum restricted to the spines. However, in the largest tecnomorphic valve of *Grammolomatella gondwanica* sp. n. the spines continue anteriorly in flanges that reach the anterodorsal region. By contrast, the velum of *G. vestrogothica* ends anteriorly in the anteroventral region (JAANUSSON 1957: pl. 12 fig. 23; MEIDLA 1996: pl. 14 fig. 11).

G. pustulosa MELNIKOVA, 1986 from the upper Ordovician of Kazakhstan is very similar to *G. gondwanica*, but distinctly smaller (1.00 mm; holotype, a female left valve 0.95 mm). Compared with the tecnomorphic left valve PIN no. 3810/34 (MELNIKOVA 1986: pl. 10 fig. 4) the

preadductorial node of *G. gondwanica* seems to be more bulbous (Pl. 1 fig. 5). In specimens of about the same size the spines are more ventrally directed in *G. gondwanica* (Pl. 1 fig. 6; MELNIKOVA 1986: pl. 10 figs. 4–5).

Grammolomatella valdari IVANOVA & MELNIKOVA, 1977 (Mangazeya Fm., Middle Ordovician; Siberian Platform) and *Grammolomatella mesosibirica* IVANOVA & MELNIKOVA, 1977 (Dolbor Fm., upper Ordovician; Siberian Platform) differ from the new species mainly by the narrower and less sigmoidal sulcus (IVANOVA & MELNIKOVA 1977: pl. 9, figs. 10–14).

G. ? sibirica (MELNIKOVA, 2000) from the Late Ordovician of the Northern Taimyr differs from *G. gondwanica* by a weaker sulcus and its stronger spinosity (longer spurs, acroidal spines). Both species are known so far only from tecnomorphs. In *G. ? sibirica* it is unclear whether the posterior spine is part of the posteroventral lobe (MELNIKOVA 2000: pl. 6 fig. 14) or part of the velum (l.c. fig. 16). In *G. gondwanica* the ventral spur is not distinctly separated from the posteroventral lobe in all valves (distinct: Pl. 1 figs. 1, 5; indistinct: Pl. 1 figs. 3, 7).

Occurrence: Known only from the stratum typicum of the type locality

Family Euprimitiidae HESSLAND, 1949

Subfamily Gryphiswaldensiinae SCHALLREUTER, 1968b

Genus *Geshirtia* SCHALLREUTER, HINZ-SCHALLREUTER, BALINI & FERRETTI, 2006

Type-species: *Geshirtia ventrocostata* SCHALLREUTER et al., 2006 [OD SCHALLREUTER et al. 2006: 302]; Late Ordovician (Anarak Formation), Central Iran (Yazd Block); holotype of the type-species: SCHALLREUTER et al., 2006: pl. 2 fig. 2.

Geshirtia ? sp. n. A
Pl. 3 fig. 1

Material: A single valve (on stub)

Remarks: The species differs from *Geshirtia ventrocostata* by its weak preadductorial node and the adventral sculpture

developed only as a bend (comp. SCHALLREUTER et al. 2006: pl. 2 figs. 2–3).

Superfamily Tetradelloidea SWARTZ, 1936

Family Ctenonotellidae SCHMIDT, 1941

Subfamily Tallinnellinae SCHALLREUTER, 1976

Genus *Quadritia* SCHALLREUTER, 1966a

Type-species: *Entomis (Bursulella ?) quadrispina* KRAUSE, 1892 (OD SCHALLREUTER 1966: 204), Late Ordovician of Baltica; lectotype of the type-species: KRAUSE 1892: pl. 22 fig. 6.

Subgenus *Quadritia (Krutatia)* SCHALLREUTER, 1981

Type-species: *Quadritia (Krutatia) innior* SCHALLREUTER, 1981 (OD SCHALLREUTER 1981: 125), Late Ordovician, Baltica; holotype of the type-species: SCHALLREUTER 1981: pl. 8, 126 fig. 1.

Remarks: Species and occurrences: Table 1. *Q. (K.) aperta* MELNIKOVA, 1986 does not belong to this subgenus. *Quadritia (Krutatia)* is characterized by only four ventral spines, while *Q. (K.) aperta* has five conical ventral nodes. Additionally, there is one longer spine posterocentrally, and the remaining lateral surface has larger tubercles (MELNIKOVA 1986: pl. 9 figs. 5–6). Presently the species might be better placed in *Nabanniopsis* COPELAND, 1982 (comp. COPELAND 1982: pl. 5 figs. 4–16).

Quadritia (Krutatia) krausei SCHALLREUTER, 1976
Pl. 2 figs. 1–6

Holotype: Left tecnomorphic valve – GG-33-82 – SCHALLREUTER 1976: pl. 3 (= 36) figs. 4–6.

Type locality: Teschenhagen near Stralsund, Pomerania; geschiebe

Stratum typicum: Backsteinkalk 14B2 type (age: Haljala Stage of Estonia; origin: eastern part of central Sweden or middle Baltic Sea (north of Isle of Gotland, south of the Åland Is.).

Table 1. Species of *Quadritia (Krutatia)*

Tab. 1. Arten von *Quadritia (Krutatia)*

Species	age	occurrence	size [mm]
<i>Q. (K.) blidseleensis</i> SCHALLREUTER, 1987	Ashgill (Upper Harjuan)	Baltica (Öjlemyrflint geschiebes)	0.71
<i>Q. (K.) innior</i> SCHALLREUTER, 1981	Ashgill (Upper Harjuan)	Baltica (Öjlemyrflint geschiebes)	1.05
<i>Q. (K.) krausei</i> SCHALLREUTER, 1976	Caradoc (Upper Viruan)	Baltica (Backsteinkalk geschiebes)	0.92
<i>Q. (K.) tromelini</i> VANNIER & SCHALLREUTER, 1983	Llandeilo	Ibero-Armorica Perunica	1.59

Definition: Adults more than 1.10 mm in length. Unisulcate. Preadductorial node developed as cone-like node. Anterodorsal spine as strong as the other spines. Spines distally with many secondary spines. Outer surface smooth to granulose reticulate.

Material: Seven valves, most incomplete (six on stubs)

Comparison: The Sardinian representatives of the species are strongly silicified, which disguised a possible existing granulose-reticulate ornament of the outer surface documented from Baltoscandian specimens out of geschiebes (SCHALLREUTER 1983: pl. 11 fig. 1; VANNIER, SIVETER & SCHALLREUTER 1985: pl. 30 fig. 9), but agree in all other characters (SCHALLREUTER 1976: pl. 3 figs. 4–6). The largest Sardinian specimens are incomplete, but with a length of 1.10 mm and a height of 0.80 mm they are larger than the largest specimen hitherto known.

The oldest known species, *Q. (K.) tromelini* from the Llandeilo, has a stronger, more ancestral condition, i.e. quadrilobate lobation and shorter nodes (VANNIER & SCHALLREUTER 1983: pl. 1; SCHALLREUTER, KRŮTA & MAREK 1996: figs. 2.1–2).

The early Late Ordovician type-species, *K. (Q.) iunior*, exhibits conical spines with less significant secondary spines and the anterodorsal spine is weak (SCHALLREUTER 1981: pls. 8, 126 and 8, 128). *Q. (K.) blidseleensis* has only short spines developed (SCHALLREUTER 1987: fig. 3.2).

Remarks: *Q. (K.) krausei* has been described from early Late Ordovician Backsteinkalk geschiebes of Northern Germany and the Isle of Gotland but has not been found in outcrops of the Baltic area so far. These geschiebes correspond to the Haljala Stage (former Idavere + Jõhvi stages, C3/D1) in Estonia.

Occurrence: Late Ordovician of Baltoscandia. Sardinia: Late Ordovician of Cannamenda

Family Tetradellidae SWARTZ, 1936
Subfamily Dilobellinae KAY, 1940

Genus *Bohuckea* SCHALLREUTER & KRŮTA, 2001a

Type-species: *Bohuckea bohémica* SCHALLREUTER & KRŮTA, 2001a (OD SCHALLREUTER & KRŮTA 2001a: 88); Letná Formation, Bohemia; holotype of the type-species: SCHALLREUTER & KRŮTA 2001a: pl. 3 fig. 8

Bohuckea ? sp. n. A
Pl. 3 fig. 2

Material: A single valve (on stub)

Remarks. The species is similar to the type-species *B. bohémica* SCHALLREUTER & KRŮTA, 2001 (2001a: pl. 3 figs. 7–8) except for the postplete outline and the nonsulcate lateral surface. Both species agree in the posterior raise of the velum. By contrast, *Bolbarakia* SCHALLREUTER et al., 2006 has a velum that is separated from the free margin about the same distance over its entire length, but otherwise resembles *Bohuckea* (SCHALLREUTER et al. 2006: pl. 3 figs. 6–9).

Bohuckea ? sp. n. A resembles Gen. n. sp. n. B SCHALLREUTER et al., 2006 in its special convexity. The main difference is the missing adventral sculpture in the latter species (SCHALLREUTER et al. 2006: pl. 11 fig. 4).

Suborder BINODICOPA SCHALLREUTER, 1972b emend.
SCHALLREUTER, 1978a

Superfamily Drepanelloidea ULRICH & BASSLER, 1923
[ZANINA & POLENOVA, 1960]

Family Aechminidae BOUČEK, 1936 [SCOTT & WAIN-
WRIGHT in BENSON et al., 1961]

= Richinidae SCOTT in BENSON et al., 1961 = Circul-
nidae NECKAJA, 1966

Remarks. As can be demonstrated with *Pseudulrichia* and possible derivatives (Text-fig. 4) a precise taxonomic assignment of many binodicope genera is rather difficult because of the transitional nature of nearly all morphological features. Therefore, the distinction of many families is perhaps pragmatic but artificial and unnatural.

Genus *Pseudulrichia* SCHMIDT, 1941

Synonym: *Bucerella* NECKAJA, 1966 (SCHALLREUTER 1968c: 250)

Type species: *Pseudulrichia pseudobivertex* PŘIBYL, 1979 [*P. bivertex* (ULRICH, 1879) sensu SCHMIDT, 1941; SD SCHALLREUTER 2000: 834; Late Ordovician, Bohemia]; holotype of the type-species: SCHMIDT 1941: pl. 4 fig. 33 = PŘIBYL 1979: text-fig. 4 figs. 5–6, text-fig. 15 figs. 4–5, pl. 7 figs. 4–5.

Further species: SCHALLREUTER 2005: 293. *Ps. albraca* SCHALLREUTER & LEHNERT, 1993, which has been assigned to *Postceratia* (SCHALLREUTER & HINZ-SCHALLREUTER 1998: 351), is replaced in the original genus for reasons outlined below.

Definition: SCHALLREUTER 1968c: 251

Occurrence: Baltoscandia, Podolia, Bohemia, England, Wales, ? Massif Armoricaïn, Sardinia, North America, Argentina.

Pseudulrichia sardinica sp. n.

Pl. 4 figs. 1–4

Derivation of name: After Sardinia*Holotype:* Right valve IUPM 28004 – Pl. 4 fig. 1. *Paratypes:* IUPM 28005–28007*Definition:* At least up to 0.98 mm in length. Shape very high to high. Outline amplete. Anterior node small and indistinct. Posterior spine relatively short, not projecting beyond the hinge-line.*Material:* More than 100 valves (six on stubs)*Comparison:* *Ps. albraca* SCHALLREUTER & LEHNERT, 1993 from the Darriwillian of Argentina is generally smaller (–0.75 mm; SALAS 2000a: 56) than *Ps. sardinica*, more elongate and slightly preplete; its spine is stronger and projects beyond the hinge-line (SCHALLREUTER & LEHNERT 1993: pls. 20, 110 and 112; SALAS 2002a: fig.9 D–E, G–H, J).Typical *Pseudulrichia* species have two equally strong nodes or spines similar to those of *Ps. fuga* (SCHALLREUTER 1999, pl. 1 figs. 3–4). Because of the very weak anterior node developed as a low conical node rather than as spines, *Ps. albraca* has been assigned to *Postceratia* (SCHALLREUTER & HINZ-SCHALLREUTER 1998: 351). However, the more posterior position of the posterior spine and the development of an anterior bulb in the new material of the type-species of *Postceratia* and *Po. anteropspinata* sp. n. suggest that *Ps. albraca* should be retained in its original genus.Genus ***Antiaechmina*** SCHALLREUTER, 1968c*Type species:* *Aechmina cuspidata* JONES & HOLL, 1869; Wenlock, England; holotype (monotypy?) of the type-species: JONES & HOLL 1869: fig. 2, pl. 14 fig. 8; LEVINSON in BENSON et al. 1961: fig. 61.1.SCHMIDT (1941: 63) wrote that the subsequent designation of the type-species of *Aechmina* was done by ULRICH & BASSLER (1913: 521) which was taken by SCHALLREUTER (2005: 289). However, a subsequent check of ULRICH & BASSLER's 1913 paper evidenced, that the authors did not designate *A. cuspidata* as the type-species but described only North American material under this name. The designation of the type-species according to ICZN Art. 69.1 was done by BASSLER & KELLETT (1934: 146) though they mentioned in the same paper (1934: 19) still *Aechmina bovina* JONES, 1887 as the type-species.*Remarks:* *Antiaechmina* SCHALLREUTER, 1968c is acknowledged as a valid genus by some authors (PŘIBYL 1979: 87). Others consider it as a junior synonym of *Aechmina* (MEIDLA 1996: 84), or assign certain *Antiaechmina* speciesto the genus *Aechmina* (WILLIAMS et al. 2001: 596). However, as is shown in text-fig. 4, *Antiaechmina* and at least Ordovician species of *Aechmina* possibly evolved from forms like *Pseudulrichia* SCHMIDT, 1941. Typical *Pseudulrichia* species have two spines in the dorsal half of the valve. In the *Antiaechmina* line the posterior spine disappeared, whereas it is the anterior spine that is reduced in other lines (*Postceratia*, *Aechmina*). In species having developed a S2 the systematic placement is clear. Species that have a huge spine but lack a S2 – as in the Silurian type species of *Aechmina* – make a designation problematic (SCHALLREUTER 2005: 289–290).

The development of a single strong spine at the dorsal margin must probably be regarded as a polyphyletic feature.

Antiaechmina insula sp. n.

Pl. 5 figs. 6–7

2006 *Antiaechmina* sp. n. – SCHALLREUTER et al.: 306, 324; table 5; pl. 1 fig.12*Derivation of name:* After the occurrence on the Isle of Sardinia*Holotype:* Left valve with spines broken at its end, IUMP 28019 – Pl. 5 fig. 6. *Paratype:* left valve IUMP 28020*Definition:* At least up to 1.02 mm in length. Shape moderately to rather long (L:H mostly 1,80–1,90). Anterodorsal corner field with long and slender, posteriorly curved spine.*Material:* More than 10 valves (three on stubs)*Comparisons:* The type-species of *Antiaechmina*, *Aechmina kolibai* SCHMIDT, 1941 from the Bohdalec Formation (upper Caradoc) of Bohemia also exceeds 1.00 mm in length, but seems to have a weak sulcus behind the much shorter spine [SCHMIDT 1941: pl. 3 fig. 25 (= PŘIBYL 1979: pl. 2 figs.5a–c, text-figs.5.14–16)].*A. blumenstengeli* PŘIBYL, 1979 from a Lederschiefer clast (Ashgill) is smaller (0.71 mm), but relatively higher (L:H 1, 62) than *A. insula*, and has only a short spine that does not overreach the straight hinge-line (SCHALLREUTER 2005: pl. 5 figs. 5–6).*A. groenwalli* (TROEDSSON, 1918) from the uppermost Ordovician of Scania differs from *A. insula* in having its long spine located more distantly from the anterodorsal corner (TROEDSSON 1918: pl. 2 figs. 14–15). MEIDLA (1996: 84) considers *Aechmina ciecerensis* GAILĪTE, 1970 from the Late Ordovician of Latvia as a synonym of *Ae. groenwalli*, but the spine in the Baltic specimens seems to be more voluminous (GAILĪTE 1970: pl. 1 fig. 1; MEIDLA 1996: pl. 16 fig. 2).*A. pseudovelata* SCHALLREUTER, 1977b from an Öjlemyrflint geschiebe (Ashgill) of the Isle of Gotland differs

from the new species mainly by its distinct pseudovelum, the reticulation of the lateral surface and the location of the spine at some distance behind the anterodorsal corner (SCHALLREUTER 1977b: pls. 4, 30, 4, 32).

A. ? libyensis SCHALLREUTER & HINZ-SCHALLREUTER, 1998 from the Ashgill of Libya differs in having a distinct sulcus and a bulb-like (rather than a spine-like) anterior node, which is placed antero-centrally instead of anterodorsally (SCHALLREUTER & HINZ-SCHALLREUTER 1998: fig. 4). Because of these strong differences the species can be only tentatively assigned to *Antiaechmina*.

Baldiscella ? anterobulbosa from the same sample differs by having a node rather than a long spine, which is located further from the anterodorsal cardinal corner.

Genus *Baldiscella* DE GARCÍA, 1975

Type-species: Baldiscella originalis DE GARCÍA, 1975 (OD DE GARCÍA 1975: 74 by monotypy; Mid Ordovician, Argentina); holotype of the type-species: DE GARCÍA 1975: fig. p. 74.

Further species

? *Aechminaria anterobulbosa* BLUMENSTENGEL, 1965a
? *Euprimitia ? anterionoda* KNÜPFER, 1968

B. ? anterionoda is considered here as a synonym of *B. ? anterobulbosa*.

Definition: See SCHALLREUTER 1996a: 142

Remarks: As with the genus *Antiaechmina*, *Baldiscella* is characterized by the presence of only an anterior spine or node. The latter is, however, more centrally located than *Antiaechmina*.

Occurrence: Llandeilo/Caradoc of Argentina; Late Ordovician of Sardinia and ? Thuringia

Baldiscella ? anterobulbosa (BLUMENSTENGEL, 1965a) Pl. 4 figs. 5–8

2005 *Antiaechmina ? anterobulbosa* (BLUMENSTENGEL, 1965) SCHALLREUTER, 1977 – SCHALLREUTER: 290, 291–292, 330; table 1; pl. 6 (p. 331) figs. 6, 8 (q.v. p. 291 for further synonymy)

2006 *Baldiscella anterionoda* (KNÜPFER, 1968) – SCHALLREUTER et al.: 306, 315, 334; tab. 5; pl. 6 figs. 1–10

2006 *Antiaechmina ? anterobulbosa* (BLUMENSTENGEL, 1965) – SCHALLREUTER et al.: 306

Holotype: Left valve – BLUMENSTENGEL 1965a: pl. 1 fig. 10; SCHALLREUTER 2005: pl. 6 (p. 331) fig. 8. (Not mentioned in the catalogue of KEYSER & SCHÖNING 1996).

Type locality: Former Wismut dump at the open-air swimming pool of Saalfeld.

Stratum typicum: Late Ordovician limestone clast from the Lederschiefer (no. 692 of BLUMENSTENGEL)

Material: Six valves (four on stubs)

Remarks: The material from Sardinia shows all transitions between the two nominal species, *Aechminaria ? anterobulbosa* BLUMENSTENGEL, 1965a and *Euprimitia ? anterionoda* KNÜPFER, 1968 and confirms the previous assumption (SCHALLREUTER et al. 2006: 306) that both species are synonymous. The specimen figured on Pl. fig. 6 is very similar to the holotype of *B. ? anterionoda* (KNÜPFER 1968: pl. 4 fig. 2a), while the valve figured on Pl. fig. 8 very much resembles the holotype of *B. anterobulbosa* (BLUMENSTENGEL 1965a: pl. 1 fig. 10; SCHALLREUTER 2005: pl. 6 fig. 8). The specimens of Pl. 4 figs. 5 and 7 are transitional between these two extremes.

B. ? anterionoda differs from the type-species by the relatively steep marginal surface and the presence of a weak, more or less distinct bend-like pseudovelum. By these features it resembles more certain bollids, e.g. *Klimphores* SCHALLREUTER, 1966b or *Lardeuxella* VANNIER, 1986a. The anterior node might be a homeomorphic feature.

Occurrence: Thuringia: Kalkbank; Iran (Yazd Block): Anarak Fm.; Sardinia: Cannamenda

Baldiscella ? sp. n.

Pl. 6 fig. 6

Material: One valve (on stub)

Remarks: This species resembles *B. ? anterobulbosa*, but differs in having a very weak preadductorial node only. This is not an ontogenetic feature since specimens of the same size of *B. ? anterobulbosa* have a strong node already. Therefore, the respective valve may probably represent a new species.

Genus *Aechmina* JONES & HOLL, 1869

Type species: Aechmina cuspidata JONES & HOLL, 1869 (LEVINSON in BENSON et al. 1961: Q127); Wenlock, England; holotype (monotypy ?) of the type-species: JONES & HOLL 1869: fig. 2, pl. 14 fig. 8; LEVINSON in BENSON et al. 1961: fig. 61.1.

Ordovician species: SCHALLREUTER 2005: 289.

Definition: At present difficult because of the insufficient knowledge of the type-species. See remarks in SCHALLREUTER 2005: 289–290.

Aechmina gracilis BLUMENSTENGEL, 1965a
Pl. 5 figs. 3–4

2005 *Aechmina gracilis* BLUMENSTENGEL 1965 – BLUMENSTENGEL: tab. 3 (p. 132)

2005 *Aechmina gracilis* BLUMENSTENGEL, 1965 – SCHALLREUTER: 290, 328; table 1; pl. 5 figs. 7–8 (p. 290 further synonymy)

Holotype: Left valve – BLUMENSTENGEL 1965a: pl. 1 fig. 6; SCHALLREUTER 2005: pl. 5 fig. 7. (Not mentioned in the catalogue of KEYSER & SCHÖNING 1996).

Type locality: Former Wismut dump at the open-air swimming pool of Saalfeld

Stratum typicum: Limestone clast from the Lederschiefer (no. 692 of BLUMENSTENGEL)

Material: More than 20 valves (two on stub)

Definition: SCHALLREUTER 2005: 290

Occurrence: Thuringia: Lederschiefer clasts. Sardinia: Cannamenda

Genus *Postceratia* SCHALLREUTER & HINZ-SCHALLREUTER, 1998

Synonym: *Vannieria* SCHALLREUTER, 1999

Type species: *Pseudulrichia posterocerata* BLUMENSTENGEL, 1965a (OD SCHALLREUTER & HINZ-SCHALLREUTER 1998: 351; Late Ordovician, Thuringia); holotype of the type-species: BLUMENSTENGEL 1965a: pl. 1 fig. 11, SCHALLREUTER 2005: pl. 5 fig. 3.

Further species

Dicranella ? *simplex* ULRICH, 1894

Parulrichia tubulata NECKAJA, 1966

Copelandia kerformei VANNIER, 1986a

? *Aechmina* ? *ventadorni* VANNIER, 1986a

Copelandia confluentis SCHALLREUTER & KRŪTA in SCHALLREUTER et al., 1996

Vannieria gladius SCHALLREUTER, 1999 (type-species of *Vannieria*; OD SCHALLREUTER 1999: 56; Late Ordovician, Argentina; holotype: SCHALLREUTER 1999: pl. 1 fig. 6)

Pseudulrichia sp. B WILLIAMS et al., 2001

Parulrichia tubulata is a synonym of the type-species (SCHALLREUTER et al. 2006: 307).

Definition: See SCHALLREUTER et al. 2006: 306

Remarks: Some specimens of the new material of *P. posterocerata* recently described from Iran (SCHALLREUTER et al. 2006) are so extremely similar to *Vannieria gladius* (comp. SCHALLREUTER et al. 2006: pl. 6 figs. 1–2 and SCHALLREUTER 1999: pl. 1 figs. 5–7) that the latter

genus should be considered as a junior synonym of *Postceratia*.

Copelandia melmerbyensis JONES, 1987, which was erroneously assigned to *Vannieria* (SCHALLREUTER 1999: 56) belongs in fact to *Herrigia* (op. cit.: 57) being transitional between *Herrigia* and *Postceratia*.

Occurrence: Thuringia (Lederschiefer erratics), Baltoscandia, England, Massif Armoricaïn, Sardinia, Iran, Argentina.

Postceratia posterocerata (BLUMENSTENGEL, 1965a) SCHALLREUTER & HINZ-SCHALLREUTER, 1998
Pl. 5 figs. 1–2

1999 *Pseudulrichia posterocerata* BLUMENSTENGEL 1965) – SCHALLREUTER: 57

2001a *Pseudulrichia posterocerata* BLUMENSTENGEL, 1965) – SCHALLREUTER & KRŪTA: 90

2001a *Pseudulrichia tubulata* (NECKAJA, 1966) – SCHALLREUTER & KRŪTA: 90

2005 *Postceratia posterocerata* (BLUMENSTENGEL 1965) SCHALLREUTER & HINZ-SCHALLREUTER 1998 – BLUMENSTENGEL: tab. 3 (p. 139)

2006 *Postceratia posterocerata* (BLUMENSTENGEL, 1965) – SCHALLREUTER et al.: 294, 307, 314, 315, 324, 334; tab. 5; pl. 1 figs. 5–7, pl. 6 figs. 1–3; (q.v. p. 307 for further synonymy)

Holotype: Right valve – BLUMENSTENGEL 1965a: pl. 1 fig. 11; SCHALLREUTER 2005: pl. 5 fig. 3. (Not mentioned in the catalogue of KEYSER & SCHÖNING 1996).

Type locality: Former Wismut dump at the open-air swimming pool of Saalfeld

Stratum typicum: Late Ordovician limestone clast from the Lederschiefer (no. 692 of BLUMENSTENGEL)

Material: More than 30 valves (two on stub)

Remarks: As in the material from Iran the anterior bulb is indistinct in smaller instars (Pl. 5 fig. 2) but becomes distinct in larger specimens (Pl. 5 fig. 1).

Occurrence: Thuringia: Lederschiefer clasts; Baltic: Estonia: Oandu – Nabala, Lithuania: Keila – Vormsi, East Prussia: Oandu – Pirgu; Iran: Anarak Fm.; Sardinia: Cannamenda.

Postceratia anterospinata sp. n.
Pl. 5 fig. 8

Derivation of name: After the (broken) anterior spine

Holotype: Left valve IUPM 28021 – Pl. 5 fig. 8.

Definition: At least up to 0.90 mm in length. Shape moderately to rather long. Posterodorsal spine very long, extending beyond the valve proper. Anteroventrally another strong spine is developed. Weak preadductorial

node in front of a weak sulcus. A low but distinct bulb developed anterodorsally.

Material: 2 valves (one on stub)

Comparison: The new species differs from all other representatives of the genus by the strong anteroventral spine. In *Postceratia gladius* (SCHALLREUTER, 1999) the posterior spine is shorter, the preadductor node stronger and additionally, there is a high ridge developed anteriorly that terminates dorsally in a spine (SCHALLREUTER 1999: pl. 1 figs. 5–7).

Genus *Vogdesella* BAKER, 1924

Synonyms: *Melanella* WADE, 1911 (non BORY, 1824; non BOWDITCH, 1827; non SWAINSON, 1840; BAKER 1924: 187), *Parapyxion* JAANUSSON, 1957

Type species: *Jonesella obscura* ULRICH, 1894 (OD BAKER 1924: 188); Galena shale, Minnesota; figured specimens of the type-series of the type-species: ULRICH 1894: pl. 44 figs. 17–19 (fig. 19 anterior view, not interior view as mentioned in the explanation); this paper: Text-fig. 5A.

Remarks: Originally, WADE described *Melanella hemidiscus* “gen. et sp. nov.” and stated also that *Jonesella obscura* Ulrich “should be placed in the new genus” (WADE 1911: 451). In replacing the genus name *Melanella* WADE by *Vogdesella*, BAKER (1924) did not use *Melanella hemidiscus* as type-species but rather used *Jonesella obscura* ULRICH (1894: 668). Before this background, *Vogdesella* has to be regarded as newly erected genus and not as a *nomen novum*. No replacement name is necessary for *Melanella* WADE because it is still considered synonymous to *Vogdesella*.

SCHALLREUTER (1967: 627; 1980a: 14) considered *Vogdesella* as a synonym of *Parapyxion*, a genus established by JAANUSSON (1957) with *Primitia subovata* THORSLUND, 1948 as type-species (Text-fig. 5B). Most authors agreed with the synonymy (JONES 1987: 97; OLEMPKA 1994: 193; MEIDLA 1996: 86), although others continued in using *Parapyxion* [GAILITE 1975: 62; GAILITE in ULST et al. 1982: table 8, 9(pp.121, 126); SIDARAVIČIENĖ 1992: 172].

MEIDLA (1996: 86) questioned the validity of *Pariconchoprimitia* SCHALLREUTER, 1980a and considered it tentatively as a synonym of *Vogdesella* BAKER, 1924. *Pariconchoprimitia* was erected by SCHALLREUTER (1980a: 10) with *Primitia conchoides* HADDING, 1913 as type-species, which had been tentatively assigned to *Conchoprimitia* by JAANUSSON (1957: 423), e.g. not in his genus *Parapyxion* established in the same paper.

Various authors consider *Pariconchoprimitia* and *Vogdesella* as different genera (e.g., VANNIER 1986a: 124, 130; JONES 1987; VANNIER & VASLET 1988; WILLIAMS et al.

2003: 209, Fig.1). But in WILLIAMS et al. (in GHOBADI POUR et al. 2006: 556) both genera were treated as synonyms because the authors considered them as “end members of a range of morphological variation”. This means, if both genera are synonymous, then the type-species of *Pariconchoprimitia* and *Parapyxion* (= *Vogdesella*) have to be considered as synonyms also, especially since both occur in the same sample. SCHALLREUTER 1980a described them from a local geschiebe (Gis-29) of Sularp Shale from Gislövshammer in SE Scania.

The type-species of *Parapyxion* and *Pariconchoprimitia* are very similar because they have only a few distinctive features (JONES 1987: 92). Some of these features may represent “end members of a range of morphological variation” but definitely not all. A careful investigation of the two species utilizing both morphological and statistical methods permits a clear differentiation of the two taxa.

Morphologically, both species differ in lobation, which is more distinct in typical specimens of *Vogdesella* (e.g., SCHALLREUTER 1980a: pl. 5 fig. 4 and pl. 6 fig. 6). Since the distinctness of the lobes is rather variable the latter may appear transitional to *Pariconchoprimitia*. However, differentiation is still possible as illustrated in the diagrams of text-figs. 6 and 7. Both species reach the same maximum size, but in a common L:H diagram both species are distinctly separated because *V. subovata* has a slightly higher shape.

Morphological similarity does not necessarily mean a close relationship. This fact was illustrated by COHEN & MORIN (1990: 381) on extant bioluminescent ostracods from the Caribbean Sea that all have the diagnostic morphological characters of the genus “*Vargula*” but that belong to a number of different genera based on their bioluminescent signals. Systematic assignments of fossil material, particularly when rather featureless, requires much more effort. That effort, however, should be invested in order to avoid errors and misinterpretations. Therefore, we agree with MADDOCKS (1969: 2) who stated: “*Certainly, the taxonomist with the whole animal before him has a very real advantage over the one confronted by fragmentary skeletal remains. ..., yet an equivalent amount of equally significant and entirely congruent information is embodied in the carapace morphology. It is true that in some forms ... carapace shape may be difficult to define, evaluate, and communicate, but this is a problem of technique rather than of inherent information, and it is a difficulty that will be reduced in future by application of geometric and statistical techniques of description and analysis*”.

In this respect also, the two Iranian ostracod species described by SCHALLREUTER et al. (2006), *Herrigia asiatica* and *Pariconchoprimitia iranica*, which might be considered as “end members of a range of morphological variation” (comp. Pl. 6 fig. 1 and SCHALLREUTER et al. 2006: pl. 5 figs. 1–2), could have been differentiated by high-resol-

Text-fig. 5 A: *Jonesella obscura* ULRICH, 1894, type-species of *Vogdesella* BAKER, 1924, left valve, length 0.68 mm (ULRICH 1894: pl. 44 fig. 18). **B** *Primitia subovata* THORSLUND, 1948, type-species of *Parapyxion* JAANUSSON, 1957 (= *Vogdesella*), left valve, length 1.19 mm (JAANUSSON 1957: fig. 46A)

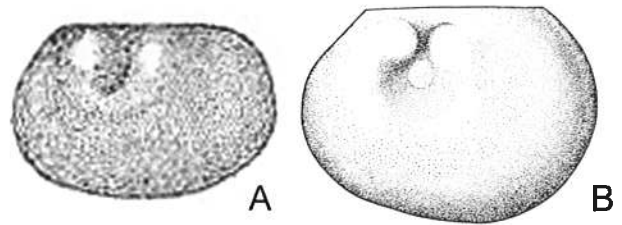


Abb. 5 A: *Jonesella obscura* ULRICH, 1894, Typusart von *Vogdesella* BAKER, 1924, linke Klappe, Länge 0,68 mm (ULRICH 1894: Taf. 44 Fig. 18). **B** *Primitia subovata* THORSLUND, 1948, Typusart von *Parapyxion* JAANUSSON, 1957 (= *Vogdesella*), linke Klappe, Länge 1,19 mm (JAANUSSON 1957: Abb. 46A)

ution morphological investigation. It is the only way to deal with the homoeomorph, the “persistent joker in the taxonomic pack” (MCKENZIE 1982), which lurks everywhere and adds to the problem outlined above.

Morphologically and maybe phylogenetically *Vogdesella* could be considered as a *Pseudulrichia* with both spines reduced (comp. figs. 4–6). *P. raguenezensis* VANNIER, 1986a forms a transition between both genera (VANNIER 1986a: pl. 5 fig. 2), but is better placed in *Vogdesella*.

Species

Parapyxion [*Discina*] ? *dubium* (BARRANDE, 1879) PŘIBYL, 1979

? *Primitia mundula cambrica* JONES, 1890a (? senior synonym of *V. hemidiscus*, JONES 1987: 97, 98)

Jonesella obscura ULRICH, 1894

Melanella hemidiscus WADE, 1911 (type-species of *Melanella* WADE, 1911) (JONES 1987)

Primitia subovata THORSLUND, 1948 (type-species of *Parapyxion* JAANUSSON, 1957; OD JAANUSSON 1957: 423; Late Ordovician, Baltica; SCHALLREUTER, 1980: *V.*; holotype: THORSLUND 1948: pl. 20 fig. 5, JAANUSSON 1957; pl. 15 figs. 18–19)

Primitia obesa THORSLUND, 1948 (JAANUSSON, 1957: *P.*; SCHALLREUTER, 1980: *V.*)

Parapyxion pragense PŘIBYL, 1979 (JONES 1987)

Pseudulrichia raguenezensis VANNIER, 1986a

Vogdesella ngakoi VANNIER, 1986a

Vogdesella aequa OLEMPSKA, 1994

Vogdesella sp. n. MEIDLA, 1996

Primitia mundula cambrica may be a senior synonym of *V. hemidiscus* (JONES 1987: 97, 98).

Parapyxion [*Primitia*] ? *fugax* (BARRANDE, 1872) HAVLÍČEK & VANĚK, 1966 has been placed in *Cytherellina* by PŘIBYL (1979: 101). *Parapyxion* [*Primitia*] *prunella* (BARRANDE, 1872) JAANUSSON, 1957 became the typespecies of *Parapyxionella* PŘIBYL, 1979. *Parapyxion* [*Primitia*] ? *transiens* (BARRANDE, 1872) HAVLÍČEK &

VANĚK, 1966 belongs to *Conchoprimitia* (SCHALLREUTER & KRŮTA 2001b: 100). *Vogdesella* sp. WILLIAMS et al. in GHOBADI POUR et al. (2006: fig.3G) is a *Pariconchoprimitia*.

Parapyxion abnormis SIDARAVICHIEHNE, 1975 became type-species of *Arpaschmidtella* (see below).

Parapyxion dizungensis GAILĪTE, 1975 seems to be better placed in *Pedomphalella*, and *Parapyxion bernatiensis* GAILĪTE, 1975 belongs in *Orechina* (SCHALLREUTER 1980a: 17; SCHALLREUTER & KRŮTA 1987: 61).

Parapyxion melvillensis COPELAND, 1977 has valves “rising from all margins, slightly flattened medially” (COPELAND 1977: 82) and therefore, does not belong to *Vogdesella* but is placed in *Pedomphalella*. JONES (1987: 94) assigned *Pedomphalella germanica* SCHALLREUTER, 1972b to *Vogdesella*, but the presence of an umbo excludes this species from *Vogdesella*.

Vogdesella minorbicularis (SCHALLREUTER, 2005) comb. nov.

Pl. 6 figs. 1–4

2005 *Easchmidtella minorbicularis* SCHALLREUTER 2005 – BLUMENSTENGEL: table 3 (p. 135) [*nomen nudum*]

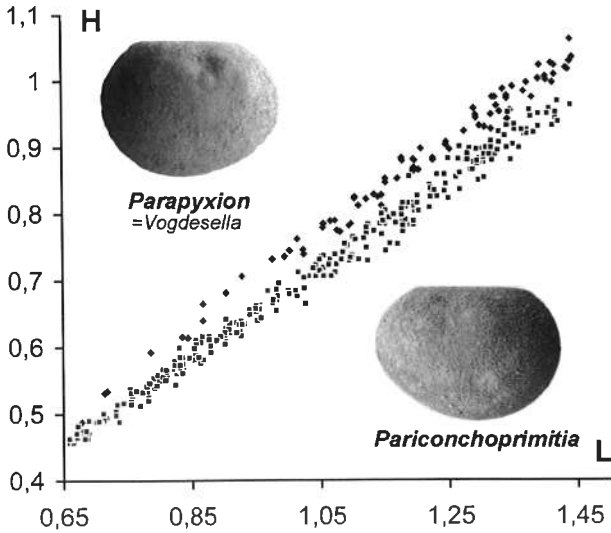
2005 *Easchmidtella minorbicularis* sp. n. – SCHALLREUTER: 296, 338; table 5 (*minorbicularis*); pl. 10 (p. 339) figs. 8–9

Holotype: Left valve, Thüringer Landesamt für Geologie Weimar – SCHALLREUTER 2005: pl. 10 (p. 339) fig. 8

Material: More than 20 valves (13 on stubs)

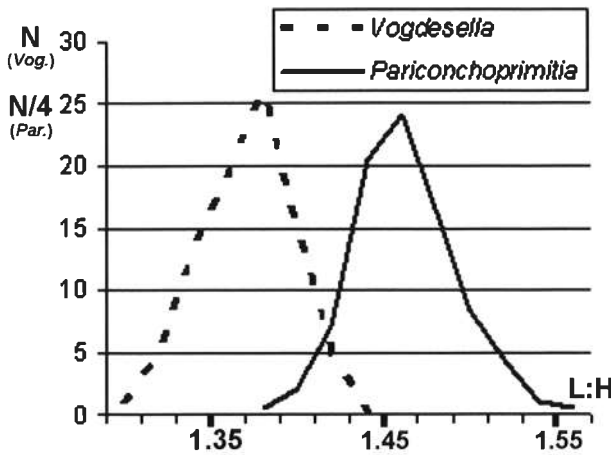
Definition: At least up to 0.95 mm in length. Shape very high, outline subcomplete. Posterior dorsal cardinal angle slightly larger than anterior cardinal angle. Nodes indistinct and rounded, posterior node not extending into the posterior third of the valve.

Comparisons: Originally the species was assigned to *Easchmidtella*, but the respective specimens in the material from



Text-fig. 6: Length-height diagram of the type-species of *Parapyxion* (*P. subovata*) and the type-species of *Pariconchoprimitia* (*P. conchoidea*)

Abb. 6: Längen-Höhen-Diagramm der Typusarten von *Parapyxion* (*P. subovata*) und *Pariconchoprimitia* (*P. conchoidea*)



Text-fig. 7: Distribution curves of the shape (L:H ratio) of valves >0.67 mm of the type-species of *Parapyxion* (*P. subovata*) and the type-species of *Pariconchoprimitia* (*P. conchoidea*)

Qualitatively there exists a continuous transition between both species but quantitatively (in number of specimens/class) there are two normal curves that overlap only at one end showing that there are two different species and (because they are type-species) of two different genera.

Abb. 7: Verteilungskurven der Gestalt (L:H-Verhältnis) von Klappen >0.67 mm der Typusarten von *Parapyxion* (*P. subovata*) und *Pariconchoprimitia* (*P. conchoidea*)

Qualitativ besteht zwischen beiden Arten ein kontinuierlicher Übergang, quantitativ (in der Anzahl der Klappen/Klasse) existieren jedoch zwei sich nur randlich überlappende Normalverteilungen, die zeigen, daß zwei verschiedene Arten und – da es sich um Typusarten handelt – zweier verschiedener Gattungen vorliegen.

Sardinia often show two nodes in the anterodorsal quarter of the valve. Although the nodes are very weak an assignment to *Vogdesella* is more likely due to a similarly developed convexity. Typical *Easchmidtella* species are broadest in the central regions and not anterodorsally. Furthermore, they are characterized by a more or less distinct umbo, which is strongest centrodorsally (text-fig. 8B).

Contrary to *Vogdesella minorbicularis*, *V. ngakoi* (Llandeilo, Massif Armoricaine) has relatively voluminous, broad, rounded nodes and a distinct sulcus between them (VANNIER 1986a: pl. 9 figs. 1–4).

The nodes in *V. aequae* (Mójcza Lst., *Pygodus serra* Zone, Holy Cross Mountains) are rather flat and indistinct and situated relatively far from the straight dorsal margin; the

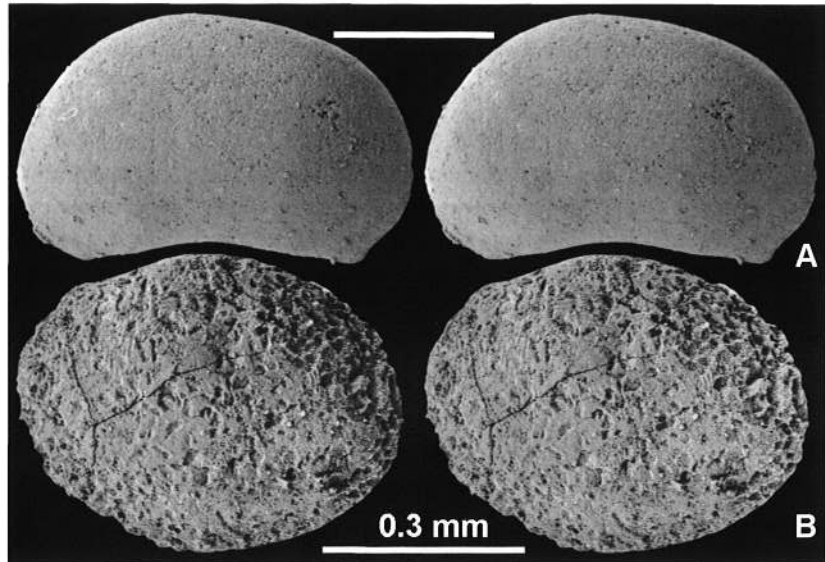
posterior node is elongate and “continuous along posterior margin as weak bend between lateral and marginal surface” (OLEMPKA 1994: 193; text-fig. 21; pl. 44 figs. 10–12).

Vogdesella sp. n. MEIDLA, 1996 (Pirgu or Porkuni Stage, Estonia) possesses distinct, long, elongate nodes with the posterior node reaching the posterior quarter of the valve (MEIDLA 1996: pl.16 figs.11–12).

In *V. subovata* the posterior node is more or less distinct and elongate and parallels the straight dorsal margin (SCHALLREUTER 1980a: pl. 5 figs. 4–5, pl. 7 fig. 7). The specimens of *V. hemidiscus* figured by WADE (1911: fig.9a–b) are characterized by a horseshoe-shaped ridge in the anterodorsal quarter of the valve. They do not agree very well with the specimens described by JONES (1987:

Text-fig. 8 A: *Utboernia lunata* SCHALLREUTER, 1986, holotype, left valve in lateral view, length 0.76 mm, geschiebe Sy-115 (Pirgu/Porkuni, Late Ordovician). **B:** *Easchmidtella crassiumbonata* SCHALLREUTER, 1967, paratype, right valve in lateral view, length 0.56 mm, geschiebe 12B9 (Oandu, Late Ordovician).

Abb. 8 A: *Utboernia lunata* SCHALLREUTER, 1986, Holotypus, linke Klappe in Lateralansicht, Länge 0,76 mm, Geschiebe Sy-115 (Pirgu/Porkuni, Oberordoviz); **B:** *Easchmidtella crassiumbonata* SCHALLREUTER, 1967, Paratypus, rechte Klappe in Lateralansicht, Länge 0,56 mm, Geschiebe 12B9 (Oandu, Oberordoviz).



pl. 29 figs. 2–4, 6–9, 12) who did not locate WADE's material. In JONES' specimens the posterior node is also "... elongated posteriorly", but "is more posteriorly extended" in *V. subovata* (JONES 1987: 98). In the new species the posterior node is rounded and not extended posteriorly. Also, the valves's outline is more symmetrical than in the specimens of *V. bemidiscus* figured by JONES.

V. pragensis and *V. dubia* differ mainly by their large size (>2.00 mm) and the distinct sulcus (PØIBYL 1979: text-figs. 6.2–4, 13.1–6).

Occurrence: Thuringia: Lederschiefer clasts; Sardinia: Canamenda

Genus *Easchmidtella* SCHALLREUTER, 1967

Type species: *Easchmidtella crassiumbonata* SCHALLREUTER, 1967 (OD SCHALLREUTER 1967: 626; Late Ordovician, Baltica); holotype of the type-species: SCHALLREUTER 1967: fig. 7

Easchmidtella ? sp. n. A
Pl. 9 fig. 11

Material: A single valve on stub

Remarks: The species is characterized by the strong and broad umbo. The dorsal corners are indistinctly developed. It resembles *E. orbicularis* MEIDLA, 1996, which is, however, more rounded (MEIDLA 1996. pl. 17 figs. 8–10).

Genus *Arpaschmidtella* MEIDLA, 1996

= *Paraschmidtella* SIDARAVIČIENĖ, 1992 non SWARTZ, 1936
= *Ledanina* SIDARAVIČIENĖ, 2001

Remarks: Although SIDARAVIČIENĖ had been informed about the homonymy of her new generic names *Nida* and *Paraschmidtella* by the first author in July 1992, she did not supply new names before 2001 after replacements had already been introduced by other authors.

Type-species: *Parapyxion abnormis* SIDARAVIČIENĖ, 1975 (OD SIDARAVIČIENĖ 1992: 174; Late Ordovician, Baltica); holotype of the type-species: SIDARAVIČIENĖ 1975: pl. 5 fig. 2; 1992: pl. 43 fig. 10.

Remarks: *Easchmidtella* SCHALLREUTER, 1967 (type-species: *E. crassiumbonata* SCHALLREUTER, 1967) is fairly similar to *Arpaschmidtella*, but the latter differs according to SIDARAVIČIENĖ (1992: 174–175) by its larger size, the character of the dorsal protuberance and the adductor sculpture (Text-fig. 8B; SIDARAVIČIENĖ 1975: pl. 5 figs. 2–3; 1992: pl. 43 figs. 6–10, pl. 56 fig. 8; MEIDLA 1996: pl. 17 fig. 1).

Arpaschmidtella ? *decentralis* sp. n.
Pl. 3 figs. 6–7

Derivation of name: After the umbo in the anterior two thirds of the valve

Holotype: Left valve IUPM 27999 – Pl. 3 fig. 6

Material: Two left valves on stubs

Definition: At least up to 0.87 mm long. Outline sub-

amplet to distinctly postplete. Valves strongly convex with strong umbo in anterodorsal and centrodorsal regions.

Comparisons: In the holotype the umbo is situated more centrally and the posterior margin is narrower rounded (SIDARAVIČIENĖ 1975: pl. 5 fig.2–3; MEIDLA 1996: pl. 17 fig. 1). Since only two left valves are known from the new species it is presently unknown whether or not the right valves are also umbonate like the type-species. A genus with only one umbonate valve is, for example, *Hemiaechninoides* SCHALLREUTER, 1971. There, the respective bulb is situated in the posterior part of the left valve and is missing in the right valve (SCHALLREUTER 1971: fig. 5, 1986b: pl. 6 fig. 10; MEIDLA 1996: pl. 19 fig. 7–9).

Occurrence: Sardinia: Cannamenda

Genus *Byrsolopsina* SWAIN & CORNELL in SWAIN, CORNELL & HANSEN, 1961

Type species: *Paraschmidella planilateralis* KAY, 1940 (OD SWAIN & CORNELL in SWAIN, CORNELL & HANSEN 1961: 363), Late Ordovician, Wisconsin; holotype of the type-species: KAY 1940: pl. 30 figs. 11–13).

Byrsolopsina ? sp. n. A
Pl. 3 fig. 3

Remarks: The only available incomplete valve differs from the type-species and other *Byrsolopsina* members mainly by the weak sulcus (SWAIN et al. 1961: pl. 49 figs. 1–5).

Suborder LEIOCOPA SCHALLREUTER, 1973a
Family Aparchitidae JONES in CHAPMAN, 1901

Genus *Baltonotella* SARV, 1959

Type species: *Macronotella kuokersiana* BONNEMA, 1909 (OD SARV 1959: 161; Late Ordovician, Baltica); lectotype of the type-species: SARV 1959: pl. 32 fig. 17, ? BONNEMA 1909: pl. 3 figs. 1–4.

Remarks: For reasons outlined below, a definition of *Baltonotella* is presently difficult and should be accompanied with a revision of the similar, possible synonymous genera *Hyperchilarina* HARRIS, 1957, *Libumella* ROZHDESTVENSKAJA, 1959, *Eblersia* KESLING, CRAFTS, DARBY, SHUBAK & SMITH, 1960, *Brevidorsa* NECKAJA, 1973, and *Aekermites* MELNIKOVA, 1980 (see remarks in SCHALLREUTER 1996c: 69; 1997: 162, 164–165; 2005: 298–299).

In their review of Middle Ordovician Aparchitidae and Schmidtellidae WILLIAMS & VANNIER (1995) considered *Hyperchilarina* and *Baltonotella* as different genera. Figures of a carapace of the type-species of *Hyperchilarina*, *H. ovata* HARRIS, 1957, exhibit weak puncta (WILLIAMS &

VANNIER 1995: pl. 2 figs. 2, 3, 8), so that there is no principal difference between both genera with regard to punctation. However, the type-species of *Baltonotella* may also possess a row of marginal spines in the smaller valve (SCHALLREUTER 1996c: pl. 23, 72 fig. 1). By contrast, the type-species of *Hyperchilarina* shows, unlike *Baltonotella*, a small lappet in the larger valve, as well as a row of antero-ventral spines while the smaller left valve is characterized by a narrow ridge located posteriorly close to the free margin instead of a row of spines (WILLIAMS & VANNIER 1995: pl. 2 figs. 2, 3, 8). However, in *Hyperchilarina nodosimarginata* HARRIS, 1957 the posterior ridge is replaced by a row of spines and the larger valve lacks a distinct lappet but has a row of spines, too. To decide whether or not this feature is matter of variation or a taxonomically distinctive feature requires further investigations of different species.

Baltonotella angustovelata (BLUMENSTENGEL, 1965a)
BLUMENSTENGEL, 2005
Pl. 7 figs. 6–10

2005 *Baltonotella angustovelata* (BLUMENSTENGEL 1965)
SCHALLREUTER 2005 •n. – BLUMENSTENGEL: tab. 3 (p. 133)

2006 *Baltonotella angustovelata* (BLUMENSTENGEL, 1965a) –
SCHALLREUTER et al.: 294, 308, 315, 330; tab. 5;
pl. 4 figs.2–3 (q.v. p. 308 for further synonymy)

Holotype: Left valve – BLUMENSTENGEL 1965a: pl. 1 fig. 7; SCHALLREUTER 2005: pl. 7 figs. 1a–b. (Not mentioned in the catalogue of KEYSER & SCHÖNING 1996)

Type locality: Former Wismut dump at the open-air swimming pool of Saalfeld

Stratum typicum: Limestone clast from the Lederschiefer (no. 692 of BLUMENSTENGEL)

Material: 5 carapaces and more than 20 valves (seven on stubs)

Definition: SCHALLREUTER 2005: 299. Supplementation: Right valve may have a bend- or ridge-like admarginal ridge.

Remarks: Some specimens from Sardinia show a marginal ridge on both valves (Pl. 7 fig. 8). Along the contact margin the right valve overlaps the left valve up to the marginal stop-ridge of the latter, which thus has a marginal position. Another ridge on the right valve is some distance but parallel to the stop-ridge and has an admarginal position with regard to the free margin (Pl. 7 figs. 7–8; SCHALLREUTER et al. 2006: pl. 4 fig. 2). The distance between the two ridges of the valves corresponds to the width of the contact lists of both valves.

Occurrence: Thuringia: Lederschiefer clasts. Sardinia: Cannamenda. Iran: Anarak Fm

Order PODOCOPA SARS, 1866

Remarks: Because podocopes most often have only a few characteristic features with variable morphology, the determination of species is often difficult. This is especially true if surficial sculpturing is lacking. Species having characteristic sculpture, for example, *Morphohealdia wiefeli* often exhibit a significant variation of other features, such as shape and outline (see Pl. 8 figs. 7–11). Therefore, podocopes are often neglected in the descriptions of whole faunas and their investigation is restricted to comparably strongly featured species. To recognize a species with its range of variation leading to transitions between the taxa requires special studies (e.g., MEIDLA 1996: 119).

Suborder METACOPA SYLVESTER-BRADLEY in BENSON et al., 1961 emend. ADAMCZAK, 1967
Superfamily Healdioidea HARLTON, 1933
Family Healdiidae HARLTON, 1933

Genus *Morphohealdia* KNÜPFER, 1968

Type-species: *Thrallella (Morphohealdia) inornata* KNÜPFER, 1968 (OD KNÜPFER 1968: 13; Late Ordovician, Thuringia); holotype of the type-species: KNÜPFER 1968: pl. 1 figs. 6a–c.

Further species, subspecies

Morphohealdia wiefeli BLUMENSTENGEL & SCHALLREUTER, 1997

Morphohealdia wiefeli restricta SCHALLREUTER, HINZ-SCHALLREUTER, BALINI & FERRETTI, 2006

? *Rectella explanata* MEIDLA, 1996

Definition: Small. Outline kidney-like with summit in anterior half; hinge-line converging with basis line in posterior direction, may be hidden in lateral view by a more or less distinct epicline umbo. Anterior end broadly rounded, posterior end narrower rounded forming with the hinge line a more or less distinct rounded corner. Vecon distinct to missing. At the border between lateral and posterior surfaces a ridge runs parallel to free margin. A similar but weaker ridge may occur also at the border between lateral and anterior surfaces. Outer surface smooth or punctate.

Remarks: *Rectella explanata* may belong to *Morphohealdia*. This species has not only the same outline but also a flattened lateral surface. A weak rounded ridge at its

border to the marginal surface may be present at least anteriorly (comp. MEIDLA 1996: pl. 31 figs. 6–8 and SCHALLREUTER et al. 2006: pl. 9 figs. 1–6, and this paper: Pl. 8 figs. 7–11).

Morphohealdia is easily distinguishable from other podocopes by the ridge at the posterior valve end and the punctuation. Most podocopes in the Sardinian material (as well as in the material from Thuringia and Iran) do not have such characteristic features.

Occurrence: Late Ordovician of Thuringia (Kalkbank, Upper Ore Horizon), Sardinia, and Iran (Anarak Fm.)

Morphohealdia wiefeli wiefeli BLUMENSTENGEL & SCHALLREUTER, 1997

Pl. 8 figs. 7–11

1997 *Morphohealdia wiefeli* sp. n. – BLUMENSTENGEL & SCHALLREUTER: 17–19; text-fig. 1 figs. 6–8, text-fig. 2 figs. 1–2

2005 *Morphohealdia wiefeli* Blumenstengel & Schallreuter 1998 – BLUMENSTENGEL: tab. 3 (p.138), fig. 13 (p.126; = BLUMENSTENGEL & SCHALLREUTER 1997: text-fig. 2 figs. 1–2)

2006 nominal subspecies, *Morphohealdia wiefeli wiefeli* – SCHALLREUTER et al.: 313; tab.5

Holotype. Right valve, Thüringer Landesanstalt für Geologie; BLUMENSTENGEL & SCHALLREUTER 1997: text-fig. 1; BLUMENSTENGEL 2005: text-fig. 2 fig. 1.

Type locality: Boring Mötzelbach 4 NE Rudolstadt, Thuringia

Stratum typicum: Upper Iron-Ore Horizon

Definition. BLUMENSTENGEL & SCHALLREUTER 1997: 17

Material: More than 10 valves (7 on stubs)

Comparison. Very similar to *Criboconcha ordoviciana* (BLUMENSTENGEL, 1965a) from a limestone clast of the Lederschiefer, which differs by the more rounded outline and especially by the development of two posterior spines instead of a lateromarginal ridge (SCHALLREUTER 2005: pl. 9 figs. 7–11).

Occurrence: Thuringia: upper Iron-Ore Horizon; Sardinia: Cannamenda

Superfamily Bairdiocypridoidea SHAVER in BENSON et al., 1961

Family Longisculidae NECKAJA, 1966

Remarks: ADAMCZAK (1967: 462) was the first to describe two inner stop-ridges (stop-pegs) in the larger left valve

of two Silurian metacope ostracodes from Gotland and subsequently on Devonian species of *Bairdiocypris*, but he was the opinion that “its role in evolution of *Bairdiocypris* was limited” (ADAMCZAK 1976: 319).

However, after the discovery of such stop-ridges in *Kroemmelbeinia* by SCHALLREUTER (1969: 211: “balkonartige Vorsprünge”) this feature was observed worldwide in many Ordovician and Silurian podocopes, which was considered to be a sign of the important systematic significance of this feature (SCHALLREUTER 1979, SCHALLREUTER & HINZ-SCHALLREUTER 1999: 230).

Apart from the list of genera and species possessing stop-pegs given by SCHALLREUTER & HINZ-SCHALLREUTER (1999: table 1) this feature was mentioned and/or figured also in the genera and species listed in tab. 2.

ADAMCZAK (1976: 319) assigned *Longiscula* to Bairdiocyprididae and SCHALLREUTER found stop-ridges in *Longiscula* sp. (SCHALLREUTER 1979: pl. 2 fig. 5) when he referred all genera with stop-ridges (op. cit.: 27–28) to the superfamily Bairdiocypridacea, regarding the Longisculidae and ? Krausellidae (= Rectellidae) as synonyms of the Bairdiocyprididae. MEIDLA (1993: 291) questioned SCHALLREUTER's (1979) assignment of *Longiscula* sp. to the respective genus without giving any explanation. Three years later, MEIDLA (1996: 115) mentioned the occurrence of “two interior stop-ridges in the antero- and posteroventral parts of the left valve” in the diagnosis of the Longisculidae. Although still regarding Longisculidae and Bairdiocyprididae as separate taxa, MEIDLA (1996: 116) stated in the same paper that “Longisculidae may be a junior synonym of Bairdiocyprididae”.

Until now, the synonymy of Longisculidae and Bairdiocyprididae is still under debate (see ABUSHIK in ABUSHIK, GUSSEVA et al. 1990, MEIDLA 1996) and we will regard them as separate families (SCHALLREUTER & HINZ-SCHALLREUTER 1999: 234) as long as the contrary is not proved.

SCHALLREUTER (1972c: 259, 1979: 27) considered the Rectellidae as synonym of the Krausellidae and both as possible synonyms of Longisculidae. SCHALLREUTER (1988: 574) listed the Rectellidae as a synonym of the Krausellidae. MEIDLA (1996: 134, 143) still considered both as separate families apart from the Longisculidae. The maintenance of Krausellidae as a separate taxon although outer stop-ridges (the posterior as spine) are present was not explained by the latter author.

In addition, his *Krausella* sp. n. (MEIDLA 1996: 135) seems to not belong to the genus *Krausella* ULRICH, 1894. In the holotype of the type-species *Krausella inaequalis* ULRICH, 1894 the left valve strongly overlaps the right valve, particularly along dorsal and ventral margins. Only at the posterior end is the left valve overlapped by the posterior

spine of the right valve (BERDAN in BENSON et al. 1961: fig. 293, 1a). By contrast, *Krausella* sp. n. MEIDLA, 1996 is nearly equivalved (MEIDLA 1996: pl. 29 figs. 1–3), and thus resembles more the type-species of *Rayella* TEICHERT, 1939 (TEICHERT 1937: pl. 23 figs. 11–15). In the type-species of the latter genus, *Basslerites hansenii* TEICHERT, 1937, the margins of both valves carry a posteroventral spine – similar to *Kroemmelbeinia ala* SCHALLREUTER, 1969. The spines of both valves are inequally developed. However, in *Kroemmelbeinia ala* the left valve carries the larger spine (SCHALLREUTER 1969: fig. 3.1), while in *Rayella hansenii* the larger spine is that of the right valve.

Most species of *Rectella* have their smaller right valve characterized by two outer stop-ridges of which the posterior one may be spine-like. The stop-ridges insert into more or less distinct depressions flanking the lappet of the left valve (SCHALLREUTER & HINZ-SCHALLREUTER 1999: fig. 2). A similar development can be found in other genera such as *Stenuloffina* ? *lintra* SCHALLREUTER 1972a or *Rempesgrinella* ? *posterolatissima* (SCHALLREUTER, 1972c) [= *Microbeilinella* ? *lubrica* (STUMBUR, 1956), MEIDLA 1996: 129, 130] (SCHALLREUTER 1979: pl. 1 fig. 4–5). These taxa additionally have inner stop-ridges.

However, the co-existence of inner and outer stopridges in one species (see ADAMCZAK 1976: pl. 3 figs. 10b, 12) clearly demonstrates that one character alone, i.e. the outer stop-ridges, is insufficient for defining the Rectellidae. ABUSHIK (in ABUSHIK, GUSSEVA et al. 1990: 51: pl. 64 fig. 7a), for example, assigned *Turiella* ZENKOVA, 1969, a genus with outer stop-ridges, to the Longisculidae and erected the superfamily Longisculoacea (Longisculoidea) in which she tentatively included the Rectellidae. This evidences once more the rather confused situation on the suprageneric level. Until a revision and re-definition of the Rectellidae, the family is considered as a synonym of the Longisculidae.

MEIDLA (1966: 116) referred the following genera to Longisculidae: *Longiscula*, *Pullvillites* ÖPIK, 1937, *Arcuaria* NECKAJA, 1958 and *Trapezisyllthere* SCHALLREUTER, 1986b. *Arcuaria* he considered as a synonym of *Pullvillites*. SCHALLREUTER & HINZ-SCHALLREUTER (1999: 234) additionally included the following genera with stop-ridges to the family: *Kroemmelbeinia* SCHALLREUTER, 1969 (= *Beecherellita* NECKAJA, 1973), *Pachydomelloides* SWAIN, 1962, *Revisyllthere* SCHALLREUTER, 1986b, *Medianella* NECKAJA, 1966, *Cytherellina* (sensu BONNEMA 1909), and *Uthoernia*. *Trianguloschmidtella* SARV, 1963 is also placed within the Longisculidae.

Among the longisculids described below are genera with unknown inner stop-ridges. Their assignment to Longisculidae is tentative and based on similarities of the outer carapace morphology. The valve with two inner

Table 2: Further lower Palaeozoic podocope ostracodes with stop-pegs (Continuation to SCHALLREUTER & HINZ-SCHALLREUTER 1999: table 1)**Tab. 2:** Weitere altpaläozoische podocope Ostrakoden mit Stoppern (Fortsetzung zu SCHALLREUTER & HINZ-SCHALLREUTER 1999: Tab. 1)

species	occurrence	Figures/mentioned
<i>Trianguloschmidella triangulata</i> SARV, 1963	Oandu Stage, Late Ordovician, Estonia	SARV 1963: pl. 7 fig.11; SCHALLREUTER 1988: 576
<i>Uthoernia lunata</i> SCHALLREUTER, 1986b	Late Ordovician, Baltica	SCHALLREUTER 1986b: 11 bzw. 1987: 211
<i>Phelobothocypris cylindrica</i> (HALL, 1871)	Ordovician, North America	WARSHAUER & BERDAN 1982: H 68; pl. 18 fig. 13
<i>Elliptocyprites ? magna</i> SALAS, 2002b	Caradoc, Precordillera, Argentina	SALAS 2002b: 132; fig. 2P
<i>Bulbosohnia bolboformis</i> BECKER & WANG, 1992	Silurian, Mongolia	BECKER & WANG 1993: pl. 20, 92 fig. 2
<i>Bairdiocypris marginata</i> ADAMCZAK, 1976	Middle Devonian, Holy Cross Mountains	ADAMCZAK 1976: pl. 3 figs.10a–b

stop-ridges is generally considered as the left valve. In species of genera with unknown inner features the larger overlapping valve is considered as the left valve if no other features demonstrate the contrary.

Genus *Longiscula* NECKAJA, 1958

Type-species: *Longiscula arcuaris* NECKAJA, 1958 (OD NECKAJA 1958: 364); holotype of the type-species: NECKAJA 1958: pl. 3 fig. 1; ABUSHIK, GUSSEVA et al. 1990: pl. 64 fig. 1; MEIDLA 1993: figs. 1.1–2.

Definition: MEIDLA 1993: 290. Elongate subtriangular. Summit central. Anterior end more narrowly rounded than the posterior end. Weak vecon in anterior half.

Remarks: After a new figure had been published by ABUSHIK (in ABUSHIK, GUSSEVA et al. 1990: pl. 64 fig. 1) MEIDLA (1993) revised the genus and published new figures of the holotype of the type-species. In the type-species the distinct summit is situated in the centrodorsal region. In lateral view the valves are nearly symmetrical, but the anterior margin is slightly more narrowly rounded than the posterior margin. The maximum extension of anterior and posterior sides (d-line) is situated at some distance from the basis-line and diverges from the basis-line in the posterior direction. The vecon is located in the anterior half. It is distinct in the right and weak in the left valve (MEIDLA 1993: fig. 1.1–2). The vecon is generally more pronounced in the overlapped right valve.

In *Arcuaria* and *Pulvillites* the d-line runs (nearly) parallel and is placed closer to the basis-line. *Pulvillites* differs from *Arcuaria* by the knob-like summit.

Longiscula aff. *arcuaris* NECKAJA, 1958

Pl. 9 fig. 7

Material: One valve (on stub)

Definition: MEIDLA 1993: 292

Remarks: In the nature of the shape and outline (i.e. central summit, narrower rounded anterior margin than posterior margin, vecon in anterior half) the species resembles very much the type-species, which occurs in Baltica in the uppermost Middle Ordovician. The Sardinian specimen is more elongate than the typical specimens.

Longiscula ventroconvexa SCHALLREUTER, HINZ-SCHALLREUTER, BALINI & FERRETTI, 2006

Pl. 1 figs. 8–9

2006 *Longiscula ventroconvexa* sp. n. – SCHALLREUTER et al.: 310, 338 ; pl. 8 (p. 339) figs. 1–3

Holotype: Right valve, GG-341-38b – SCHALLREUTER et al. 2006: pl. 8 fig. 1

Type locality: Site IR12, section 5-6756 of SHARKOVSKI et al. 1984 east of Anarak, central Iran

Stratum typicum: Anarak Formation (= Shirgesht Formation at Anarak)

Definition: SCHALLREUTER et al. 2006: 310

Material: Two valves (on stubs)

Occurrence: Iran (Yazd Block): Anarak Fm., Sardinia: Late Ordovician of Cannamenda

Genus *Arcuaria* NECKAJA, 1958

Type-species: *Arcuaria sineclivula* NECKAJA, 1958 (OD NECKAJA 1958: 367); Late Ordovician, Baltica; holotype of the type-species: NECKAJA 1958: pl. 3 fig. 7.

Definition: Outline rounded triangular. Summit central with summit area broadly rounded. Anterior end slightly more narrowly rounded than posterior end. Rounded ventral corners close to basis line. Vecon centrally located.

Remarks: *Arcuaria* resembles *Longiscula* but is more shortly rounded triangular. The rounded ventral corners are

located close to the basis line and the vecon is more centrally orientated.

Arcuaria ? sp. n. A

Pl. 14 figs. 10–11

Material: Two valves (on stubs)

Description: At least up to 1.12 mm in length. Outline rounded-rectangular, summit in centre or slightly in front it. Dorsal margin forms indistinct rounded corners (shoulders) with anterior and posterior margins of which the posterior is more distinct. D-line slightly converging towards the basis-line in posterior direction. Maximum convexity in dorsal half; ventrally a distinct vecon is developed, which is even more distinct in the right valve.

Remarks: The type-species is more rounded-triangular than rounded-rectangular and lacks the rounded anterodorsal and posterodorsal shoulders of this species, which is therefore only referred tentatively to the genus.

Particularly the right valve figured on Pl. 14 fig. 10 resembles *Olbianella* ? sp. B SCHALLREUTER et al., 2006 in its asymmetry, but differs with regard to convexity and by the distinct vecon. *Olbianella* ? sp. B has its strongest convexity in the half with the greatest height and lacks a vecon (SCHALLREUTER et al., 2006: pl. 10 fig. 7).

Genus *Pullvillites* ÖPIK, 1937

Type-species: *Pullvillites triangulum* ÖPIK, 1937 (OD ÖPIK 1937: 55 or 119; Late Ordovician, Baltica); holotype of the type-species: ÖPIK 1937: pl. 13 figs. 25–26

Definition: Outline rounded triangular. Summit central, summit area narrow, sometimes knob-like. Anterior end slightly more narrowly rounded than posterior end and sometimes with an indistinct anterodorsal shoulder. Ventral corners rounded and close to basis line. Vecon, if present, located centrally or in anterior half.

Remarks. In the systematic assignment, we follow ABUSHIK (in ABUSHIK, GUSSEVA et al. 1990: 151) who regarded *Arcuaria* NECKAJA, 1958 and *Pullvillites* as different genera of the Longisculidae. By contrast, MEIDLA (1996: 119) considered them to be synonymous. He mentioned a very wide range of variation in *Pullvillites laevis* ABUSHIK & SARV, 1983, which had been determined as *Arcuaria sineclivula* NECKAJA, 1958 by PRANSKEVIČIUS (1972: 145).

However, both *Arcuaria* and *Pullvillites* are distinct from each other mainly in the development of summit region, which is short and knob-like in the holotype of the typespecies of *Pullvillites* and broader in the holotype of the type-species of *Arcuaria* (ÖPIK 1937: pl. 13 fig. 25,

NECKAJA 1958: pl. 3 fig. 7). Transitions between both genera certainly exist, and for the problems arising from such constellations see remarks of the order.

Pullvillites sp. n. A

Pl. 3 fig. 9

Material: One valve (on stub)

Description: At least up to 0.78 mm in length. Outline heart-shaped, with summit centrally located. The anterior is considered to be more broadly rounded with a rounded anterodorsal corner (shoulder); the posterior margin more narrowly rounded. D-line parallel to basis-line. Vecon very distinct.

Remarks. The species differs from the type-species mainly in having a very distinct vecon. The type-species has a posterior margin that is more broadly rounded than the anterior one. The latter exhibits an anterodorsal shoulder (ÖPIK 1937: pl. 13 fig. 25) similar to *Pullvillites* n.sp. A.

Pullvillites rostratus (KRAUSE, 1891b) has a distinct but less distinct vecon in the anterior half of the valve (MEIDLA 1996: pl. 24 figs. 9–10).

Genus *Olbianella* MEIDLA, 1996

Synonym: *Olbia* PRANSKEVIČIUS, 1972 (non STÅL, 1862, non MARCUSEN, 1867; MEIDLA 1996: 111).

PRANSKEVIČIUS was informed by the senior author of the homonymy in 1973 but he did not change the name.

Type-species: *Olbia fabacea* PRANSKEVIČIUS, 1972 (OD PRANSKEVIČIUS 1972: 99; Late Ordovician, Baltica); holotype of the type-species: PRANSKEVIČIUS 1972: pl. 16 figs. 4a–b.

Definition: Outline of left valve horizontally ovate with dorsal side being more convex than ventral side. Outline of right valve rounded subtriangular. Summit central. Anterior and posterior ends equally rounded, d-line nearly parallel to basis line. Vecon either missing or weakly developed.

Remarks. *Olbianella* was referred to Thlipsuriidae (recte Thlipsuridae), Thlipsuroidea (MEIDLA 1996: 111). Since *Pachydomelloides braderupensis* SCHALLREUTER, 1980b, which was assigned to *Olbianella* by MEIDLA (1996: 111) does have inner stop-ridges (SCHALLREUTER 1980b: pl. 7, 80 figs. 1–2), the genus is suggested to belong to Longisculidae, Bairdiocypridoidea.

Olbianella ? sp. B SCHALLREUTER et al., 2006 (pl. 10 fig. 7) is very similar to *B. ? brevis* MEIDLA, 1996 (pl. 32 figs. 9–12). However, both species differ from the type-species of *Brevantia* MEIDLA, 1996, *B. antis* MEIDLA, 1996,

in having a distinct posterodorsal corner so that they possibly represent a different genus (*Olbianella* ? sp. B = *B.* ? aff. *brevis*).

Olbianella cf. sp. A SCHALLREUTER, HINZ-SCHALLREUTER, BALINI & FERRETTI, 2006

Pl. 9 figs. 10, ? 8

2006 *Olbianella* sp. A – SCHALLREUTER et al.: 311, 338; pl. 8 (p. 339) fig. 4

Material: Four valves (on stubs)

Description. SCHALLREUTER et al. 2006: 311 (remarks)

Remarks. The figured specimens resemble *Olbianella* sp. A SCHALLREUTER et al., 2006 in having the greatest convexity in the dorsal half, but they differ slightly in shape and/or outline.

Olbianella sp. C

Pl. 6 fig. 9

Remarks: The figured specimen (Pl. 6 fig. 9) has a outline similar to *Olbianella* sp. A (SCHALLREUTER et al. 2006: pl. 8 fig. 4), but differs in having maximum convexity developed in the ventral half rather than in the dorsal half of the valve.

Genus *Uthoernia* SCHALLREUTER, 1986b

Species

Uthoernia lunata SCHALLREUTER, 1986b [OD SCHALLREUTER 1986b: 11 (1987: 211), monotypy; Late Ordovician, Baltica]; holotype of the type-species: SCHALLREUTER 1986b: pl. 7 fig. 13

Uthoernia longofrenatorum SCHALLREUTER, 1990

Definition: Outline kidney-shaped. Summit in front of centre. Both valves with distinct centroventral vecon. Anteroventral and posteroventral corners developed as spine-like, sometimes rounded projections. Left valve with two inner stop-ridges.

Remarks: The carapace figured by MEIDLA (1996: pl. 23 fig. 9) shows on both valves a distinct vecon.

Uthoernia ? sp. A

Pl. 10 fig. 9

Material: One valve (on stub)

Remarks: The outline of the type-species *U. lunata* is more asymmetrical (text-fig. 8A) with the summit placed in the anterior half, whereas *Uthoernia* ? sp. A has a more centrally positioned summit. *U.* ? sp. A is more strongly

convex than *U. lunata*, but resembles the latter in having its maximum convexity in the posterodorsal quarter. In *U. lunata* the free margin of the left valve has weak anteroventral and distinct posteroventral spine-like tops, which are missing in the figured specimen of *U.* ? sp. A. It therefore might be a right valve.

The outline of *Uthoernia* sp. SCHALLREUTER, 2005 is also more asymmetrical than in *U.* ? sp. A, but more equally convex.

Genus *Rectella* NECKAJA, 1958

Synonym: *Mica* NECKAJA, 1952 (non BUDDA-LUND, 1908; ABUSHIK, GUSSEVA et al. 1990: 152)

Type-species: *Mica inaequalis* NECKAJA, 1952 (OD NECKAJA 1958: 353); Late Ordovician, Baltica; holotype of the type-species: NECKAJA 1952; pl. 3 figs. 5–6

Definition: Outline rounded-rectangular. Summit located centrally or in anterior half. Vecon weak to distinct. Right valve anteroventrally and posteroventrally with more or less distinct exterior stop-ridges of which the posterior may be spine-like.

Remarks: MEIDLA (1996: 143) characterized the family Rectellidae by the lack of interior stop-ridges and the development of outer stop-ridges on the right valve. But the development of outer stop-ridges varies between the species and are very weakly developed in some species, for example, in *R. romboformis* NECKAJA, 1966 (SCHALLREUTER 1986b: pl. 7 fig. 8; MEIDLA 1996: pl. 30 figs. 9–11). Such representatives of *Rectella* resemble more closely the genus *Parasclerites* (SWAIN 1962: pl. 111 fig. 6) and may be better referred to that genus.

Some species of *Rectella* with a posterior spine resemble *Krausella* ULRICH, 1894, which may suggest synonymy of both genera. The carapace of *R. carinaspinta* figured by SCHALLREUTER (1986b: pl. 7 fig. 3), for example, is very similar to the holotype of *Krausella inaequalis* ULRICH, 1894 (see BENSON et al.: fig. 293.1a). In both carapaces the left valve strongly overlaps the right valve in nearly all regions and the right valve has a distinct spine posteriorly.

Rectella ? sp. A

Pl. 9 figs. 2–3

Remarks: In its trapezoidal outline the species resembles certain species of *Rectella*, e.g., *R. thomasi* SCHALLREUTER, 1972c (op.cit.: fig. 1–2) or *R. nais* NECKAJA, 1958 (MEIDLA 1996: pl. 31 figs. 12–14).

Genus *Parasclerites* SWAIN, 1962

Type-species: *Parasclerites elongatus* SWAIN, 1962 (OD SWAIN 1962: 741); Mid Ordovician, New York; holotype of the

type-species: SWAIN 1962: pl. 111 fig. 5b

Remarks. Following SWAIN the higher part of the valve including the summit is considered to be the anterior half. This agrees with the orientation of the carapace figured on Pl. 10 fig. 6 with L/R-overlap.

The differences between *Parasclerites* and *Elliptocyprites* are distinct in some specimens assigned to these genera (comp. SWAIN 1962: pl. 111 figs. 6 and 9a, 10) contrary to the holotypes of both type-species (comp. SWAIN 1962: pl. 111 figs. 5b and 9b). Therefore both genera may be synonymous.

In comparison with *Parasclerites*, the genera *Longiscula*, *Pullwillites* and *Arcuaria* have a more pronounced summit in the centrodorsal region (most distinct in *Pullwillites*) and are more symmetrical in lateral view. In *Longiscula* the anterior margin is narrower rounded than the posterior margin contrary to *Parasclerites*.

***Parasclerites* sp. B**
Pl. 10 figs. 6–7, ?8

Material: One carapace and three valves (on stubs)

Remarks: This species is characterized by a rather long, straight hinge obliquely orientated to the basis-line. The hinge has rounded corners at both ends, anteriorly at the summit and posteriorly close to the posterior end of the valve. The summit is situated at about the middle of the anterior two thirds.

The hinge-line in the specimen figured on Pl. 10 fig. 8 is shorter and less raised. It is presently unclear whether this feature falls within variation or is a specific one.

In *Parasclerites* sp. aff. *lamellosus*: SCHALLREUTER et al., 2006 the summit is located more anteriorly and the straight hinge-line is correspondingly longer (SCHALLREUTER et al. 2006: pl. 10 figs. 8–9).

***Parasclerites* sp. C**
Pl. 3 fig. 4

Material: One valve (on stub)

Description. At least up to 1.02 mm in length. Straight dorsal margin nearly parallel to the basis line. Anterior and posterior margin equally rounded. D-line parallel to basis line. Vecon distinct.

Remarks: The specimen resembles *Parasclerites* cf. sp. B, but in that species the straight dorsal margin is shorter and obliquely directed towards the basis line (Pl. 10 fig. 8).

Genus ***Elliptocyprites*** SWAIN, 1962

Type-species: *Elliptocyprites parallela* SWAIN, 1962 (OD SWAIN 1962: 742); Mid Ordovician, New York; holotype of the

type-species: SWAIN 1962: pl. 111 fig. 9b. (genus name feminine according to ICZN art. 30.1.4.4.)

Definition: SWAIN 1962: 741–742

Remarks: *Elliptocyprites* was established for elongate forms with “dorsal and ventral margin nearly straight, long and subparallel” and rounded ends (SWAIN 1962: 741). Therefore, the summit in the anterior half is nearly indistinct if the specimens are orientated after the basis-line (SWAIN 1962: pl. 111 fig.9b).

The genus was referred within “Family Uncertain” by SWAIN (not Pachydomellidae as given erroneously by SCHALLREUTER 2005: 309) and tentatively assigned to Bairdiocyprididae by SCHALLREUTER (1979: 27–28).

SALAS (2002b: 132) described inner stop-ridges in *Elliptocyprites* ? *magna* SALAS, 2002.

Shenandoia KRAFT, 1962 is very similar to *Elliptocyprites*, but differs by its unequally rounded anterior and posterior margins (KRAFT 1962: pl. 19 figs. 8a,c, 9a–b). In *Elliptocyprites* both margins are rather equally rounded.

Elliptocyprites nesowa SCHALLREUTER, 1988
Pl. 9 figs. 4–6

1965a *Elliptocypris* Swain ? – BLUMENSTENGEL: 76

1988 *Elliptocyprites nesowa* n. sp. – SCHALLREUTER: 574, 576; text-fig.1 (p. 575) fig.7

1995a ELLIPTOCYPRITES NESOWA SCHALLREUTER, 1988 C – KEMPF: 96

1995b – dto. – KEMPF: 120

1995c – dto. – KEMPF: 140

2002b *Elliptocyprites nesowa* Schallreuter (1988) – SALAS: 134

2005 *Elliptocyprites* sp., *Elliptocyprites* ? sp. – SCHALLREUTER : 309, 342 ; table 1 (p. 312) ; pl. 12 (p. 343) fig. 5

Holotype: Carapace – SCHALLREUTER 1988: fig.1.7 (from right side, not left as mentioned on p. 574)

Type locality: Fossil Hill, New South Wales, Australia

Stratum typicum: Gleasons Limestone Member, Fossil Hill Limestone, Late Ordovician

Material: Three valves (on stubs)

Definition: Length up to 1.22 mm in length (holotype 1.05 mm). Shape very long (L:H greater than 2.22, holotype 2.35). Dorsal and ventral margins nearly parallel to each other. Summit indistinct. Anterior end slightly more broadly rounded than posterior end, d-line gently converging with basis-line in posterior direction. Vecon indistinct to missing.

Remarks: Generally the dorsal cardinal corners are more distinct in the Sardinian material.

The species is very similar to the type-species, *E. parallela* from the Crown Point Fm., Valcour Is., New York, which has a slightly higher shape (L:H of holotype 1.97).

Elliptocyprites sp. A SCHALLREUTER et al., 2006 from the Anarak Fm. has a more elliptical outline because of the more strongly convex dorsal margin with a distinct summit in the centrodorsal region (SCHALLREUTER et al. 2006: pl. 8 figs.11–12, pl. 11 fig. 9).

E. paracylindrica SWAIN & CORNELL, 1987 from the Decorah Shale of Minnesota also has a more elliptical outline and an anterior end that is more narrowly rounded than the posterior end (op. cit.: pl. 10 figs.3a, e).

Occurrence: Limestone clasts of the Thuringian Lederschiefer, Late Ordovician of Sardinia and New South Wales

Elliptocyprites ? sp. n. B
Pl. 9 fig. 9

Material: Two specimens (on stubs)

Remarks: The species is characterized by its low convexity. In the figured specimen, which is considered to be a right valve, the anterior margin is more narrowly rounded than the posterior margin. The straight dorsal margin is overreached more by the anterior end than by the posterior end.

Elliptocyprites sp. C
Pl. 10 fig. 10

Material: One valve (on stub)

Remarks: *Elliptocyprites* sp. A from the Anarak Fm. is more spindle-like (SCHALLREUTER et al. 2006: pl. 8 figs. 11–12, pl. 11 fig. 9)

Elliptocyprites sp. C somewhat resembles *Parasclerites* in having a very slightly raised hinge-line anteriorwards and demonstrates the difficulty in distinguishing both genera from each other. The summit is less distinct in *Elliptocyprites* sp. C in comparison with *Parasclerites* sp. B, and the d-line runs more parallel to the basis-line in the former.

Genus *Bairdiocypridella* BLUMENSTENGEL, 1965a

Synonym: ? *Macrocyproides* SPIVEY, 1939 (SCHALLREUTER et al. 2006: 309)

Type-species: *Bairdiocypridella bairdiaformis* BLUMENSTENGEL, 1965a (OD BLUMENSTENGEL 1965a: 73; Late Ordovician, Thuringia); holotype of the type-species: BLUMENSTENGEL 1965a: pl. 2 figs. 29–30.

Further species

Aparchites minutissimus trentonensis ULRICH, 1894

? *Macrocyproides clermontensis* SPIVEY, 1939 (type-species of *Macrocyproides*)

Bairdiocypridella anterosecata sp. n.

Bairdiocypridella ? *libratogutta* sp. n.

M. trentonensis has been assigned to *Bairdiocypridella* by SCHALLREUTER et al. (2006: 309) based on figures published by SWAIN et al. 1961 and BURR & SWAIN 1965.

Definition: Small (?), medium-sized to large. Asymmetrically heart-shaped; summit somewhat in front of the mid-line. Anterior margin broadly rounded, posterior margin more narrowly rounded to weakly pointed. Anterior end at or below mid-height; pointed posterior end distinctly below mid-height (i.e., d-line converges with the basis line posteriorwards). Interiorly a more or less distinct sulcament (interior adductorial ridge) may occur. Stop-ridges unknown.

Remarks: As discussed previously (SCHALLREUTER 2005: 309), *Macrocyproides* may be an older synonym of *Bairdiocypridella*.

Occurrence: Late Ordovician of Thuringia, Sardinia, Iran (Yazd Block), and North America

Bairdiocypridella bairdiaformis BLUMENSTENGEL, 1965a
Pl. 10 figs. 1–5

2005 *Bairdiocypridella bairdiaformis* BLUMENSTENGEL 1965 – BLUMENSTENGEL: tab. 3 (p. 133)

2005 *Bairdiocypridella bairdiaformis* BLUMENSTENGEL, 1965; *Bairdiocypridella bairdiaformis* BLUMENSTENGEL, 1965 – SCHALLREUTER: 306–307, 340, 342; table 1 (p. 312); pl. 11 (p. 341) figs. 1–5; pl. 12 (p. 343) fig. 6 (p. 306 further synonymy)

2006 *Bairdiocypridella bairdiaformis* BLUMENSTENGEL, 1965a – SCHALLREUTER et al.: 309, 310, 315, 336; tab. 5; pl. 7 (p.337) figs. 1–10

Holotype: Left valve – BLUMENSTENGEL 1965a: pl. 2 figs. 29–30 and ? text-fig. 23. (Not mentioned in the catalogue of KEYSER & SCHÖNING 1996).

Type locality: Former Wismut dump at the open-air swimming pool of Saalfeld

Stratum typicum: Late Ordovician limestone clast from the Lederschiefer (no. 692 of BLUMENSTENGEL)

Definition: SCHALLREUTER et al. 2006: 309

Material: More than 50 valves (nine on stubs)

Remarks: In the material of *Bairdiocypridella bairdiaformis* from Sardinia a sulcament was not observed. It is presently unclear whether the sulcament is primarily lacking

or not preserved in the course of silicification. SCHALLREUTER (2005: 306) noted that inner stop-ridges were preserved in only two valves out of many silicified specimens of *Trispinatia rusconii* from Argentina.

Comparisons: The holotype of the type-species of *Bairdiocypridella*, a fairly large specimen (1.79 mm in length), differs from *Macrocyproides trentonensis* figured by BURR & SWAIN (1965: pl. 6 fig. 33) by the position of the summit in relation to the sulcament. In the holotype of *Bairdiocypridella bairdiaformis* the sulcament is placed only slightly behind the summit; the figured valve of *Bairdiocypridella trentonensis* displays a great distance between sulcament and summit. BURR & SWAIN (1965: 40) considered the figured valve as a left valve, but according to its outline it should be a right valve in with the sulcament located behind mid-line. Considering the outline and its small size (0.60 mm) it is possibly a very young instar, but variations in outline and the positions of summit and sulcament, which SCHALLREUTER et al. (2006: pl. 7 figs. 6–10) documented for *Bairdiocypridella bairdiaformis*, may be also the reason for this development in *Bairdiocypridella trentonensis*.

Occurrence: Late Ordovician of Thuringia (limestone clasts of the Lederschiefer), Iran (Anarak Fm.), and Sardinia (Cannamenda)

***Bairdiocypridella anterosecata* sp. n.**
Pl. 2 figs. 7–8, Pl. 14 fig. 6–8

Derivation of name: Secatus, Latin – cut; after the anterodorsal part of the valve appearing to be cut

Holotype: Carapace IPUM 28117 – Pl. 14 fig. 8

Material: One carapace, three right valves and one left valve (all on stubs)

Definition. At least up to 1.29 mm long. Summit centro-dorsal. Anterodorsal margin straight and obliquely directed to basis-line, posterodorsal margin bow-shaped and continuous with posterior margin. The latter forming an acute posteroventral corner. Anterior margin narrowly rounded. Ventral margin convex or with very weak vecon in posterior half. Left valve posteroventrally spine-like, right valve with an acute posteroventral corner.

Remarks: In *Bairdiocypridella bairdiaformis* the summit is located somewhat in front of the centre unlike the new species. Additionally, the latter has a anterodorsal margin obliquely directed towards the ventral margin. Therefore, the anterior margin is narrowly rounded while it is broadly rounded in *B. bairdiaformis*. The posteroventral corner is acute and spine-like, but in *B. bairdiaformis* posterior and ventral margins form an acute but rounded angle.

The new species also resembles *B. ? libratogutta* sp. n. but differs by a more elongate shape and the more ventrally located greatest convexity.

In the possibly congeneric *Cadmea* ? sp. MEIDLA, 1996 (Vormsi – Porkuni Stage, Estonia) the ventral margin is less convex, and the right valve is developed spine-like posteroventrally (MEIDLA 1996: pl. 29 fig. 12). The Silurian type-species of *Cadmea* PRANSKEVICHUS, 1970, *C. inexplorata* PRANSKEVICHUS, 1970 has a more *Bairdia*-like outline (PRANSKEVICHUS 1970: pl. 16).

The new species is also similar to both *Longiscula ventroconvexa* and *L. posteroangulata*, but differs by the more narrowly rounded anterior margin and the acute posteroventral angle.

***Bairdiocypridella ? libratogutta* sp. n.**
Pl. 14 figs. 4–5

Derivation of name: Libratus, lat. horizontally, gutta, latin – drop, after the drop-like shape in lateral view

Holotype: Left valve IPUM 28113 – Pl. 14 fig. 4

Material: Two left valves (on stubs)

Definition: Length at least up to 0.73 mm. Outline longitudinally symmetrical if posterior pointed end is orientated at mid-height. Greatest convexity centrally.

Remarks: In comparison with the type-species this species is more symmetrical along the horizontal axis and the maximum convexity is developed more ventrally.

***Bairdiocypridella ?* sp. n. A**
Pl. 14 fig. 9

Remarks: This species (length at least 0.71 mm), represented by a single left valve only, resembles *B. ? libratogutta* sp. n., but differs by a more elongate shape, a more centrally located summit, and the maximum convexity developed in the ventral half of the valve.

Genus ***Prorectella*** MELNIKOVA, 1982

Type-species: *Prorectella longula* MELNIKOVA, 1982 (OD MELNIKOVA 1982: 74; Mid Ordovician, Kazakhstan); holotype of the type-species: MELNIKOVA 1982: pl. 7 figs. 5a–b

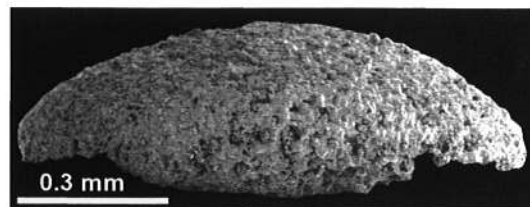
***Prorectella erratica* sp. n.**
Text-fig. 9, Pl. 15 figs. 1–9, ?10

1965a *aparchites*-ähnliche Form, Ostracode sp. A – BLUMENSTENGEL: 76, 78; pl. 2 figs. 23–25, 32

2005 *Rempesgrinella* ? sp. SCHALLREUTER 2005 (=Ostracode sp. A, *aparchites*-ähnlich BLUMENSTENGEL 1965) – BLUMENSTENGEL: table 3 (p.140)

Text-fig. 9: *Prorectella erratica* sp. n. Holotype, right (?) valve in ventral view, length 1.00 mm.

Abb. 9: *Prorectella erratica* sp. n. Holotypus, rechte (?) Klappe in Ventralansicht, Länge 1,00 mm



2005 *Rempesgrinella* ? sp.; Gen. et sp. n. – SCHALLREUTER: 307–308, 340; table 1 (p. 312); pl. 11 (p. 341) fig. 10

Derivation of name: After the occurrence in an erratic boulder from the Lederschiefer

Holotype: Right (?) valve, Thüringer Landesamt für Geologie Weimar – BLUMENSTENGEL 1965a: pl. 2 fig. 24; SCHALLREUTER 2005: pl. 11 fig. 10

Type locality: Former Wismut dump at the open-air swimming pool of Saalfeld.

Stratum typicum: Late Ordovician limestone clast from the Lederschiefer (no. 692 of BLUMENSTENGEL)

Definition: At least up to 1.17 mm in length (holotype 1.00 mm). Shape varying between rather high and long. Dorsal margin rather long and straight or only slightly convex. Anterior margin generally more broadly rounded than posterior one, leading to a preplete outline. Both anterior and posterior end overreaching the straight dorsal margin by about the same amount. Centroventral margin convex. Lappet (“bow-shaped projection”) strongly developed.

Material: More than 30 valves (11 on stubs)

Comparison: The type-species from the Middle Ordovician of Kazakhstan is larger (1.90 mm long) and has a more elongate shape. Its centroventral margin is straight or only slightly convex and parallel to the straight dorsal margin. The anterior margin is more narrowly rounded than the posterior one and overreaches the straight dorsal margin more than the posterior one. The d-line converges with the basis-line towards the anterior [MELNIKOVA 1982: pl. 7 fig. 5a, 1983: pl. 7 fig. 5a, 1986: pl. 12 fig.6b; orientation: not given in 1982 and 1983 but according to the description (1982: 75; 1983: 75): left valve, 1986 (p. 99): right valve; here considered as left valve].

Occurrence: Late Ordovician of Thuringia (Lederschiefer clasts) and Sardinia

Superfamily Tricorninoidea BLUMENSTENGEL, 1965b [KOZUR, 1972]

Family Tricorninidae BLUMENSTENGEL, 1965b emend. SCHALLREUTER, 1966b

Genus *Tricornina* BOUČEK, 1936

Type-species: *Tricornina navicula* BOUČEK, 1936 (OD BOUČEK 1936: 50); Devonian, Bohemia); holotype of the type-species: BOUČEK 1936: pl. 3 fig. 3

Tricornina haehneli BLUMENSTENGEL, 1965a Pl. 5 fig. 5, Pl. 11 figs. 7–11

2005 *Tricornina (Tricornina) haehneli* BLUMENSTENGEL 1965, (SCHALLREUTER 2005) – BLUMENSTENGEL: tab. 3 (p. 142)

2005 *Tricornina haehneli* BLUMENSTENGEL, 1965 – SCHALLREUTER: 301–302, 311, 334, 342; text-fig.3; table 1 (p.312); pl. 8 (p.335) figs.10–12, pl. 12 (p.343) fig.7 (p.301 further synonymy)

2006 *Tricornina haehneli* BLUMENSTENGEL, 1965 – SCHALLREUTER et al.: 294, 311, 315, 332; tab. 5; pl. 1 fig. 10, pl. 5 fig. 10; (q.v. p. 311 for further synonymy)

Holotype: Right valve (spine later broken away) – BLUMENSTENGEL 1965a: pl. 1 figs. 15–16, SCHALLREUTER 2005: pl. 8 fig. 10. (Not mentioned in the catalogue of KEYSER & SCHÖNING 1996)

Type locality: Former Wismut dump at the open-air swimming pool of Saalfeld

Stratum typicum: Limestone clast from the Lederschiefer (no. 692 of BLUMENSTENGEL)

Definition: SCHALLREUTER 2005: 301

Material: More than 200 valves (eight on stubs)

Remarks: Many specimens have slightly flattened anterior and posterior margins (Pl. 11 figs. 8, 10–11), which was the reason for KNÜPFER (1968: 8) to refer the species to *Margoplanitia*. However, SCHALLREUTER (2005: 302) considered the flattened margins of only subordinate generic significance. This feature occurs also in the new genus *Sardicornina* (see below).

Occurrence: Iran: Anarak Fm., Thuringia (Kalkbank, Lederschiefer clasts). Sardinia: Cannamenda; ? England/Wales: Cautley Mudstone Fm.

Tricornina compacta (KNÜPFER, 1968) comb. n.
Pl. 3 fig. 10, Pl. 11 figs. 1–6

- 1968 *Ovornina (Margoplanitia) compacta* n. sp. – KNÜPFER: 8, 20; pl. 2 figs. 2a–c
1986a OVORNINA (MARGOPLANIT COMPACTA) KNUEPFER, 1968 A – KEMPF: 550
1986b – dto. – KEMPF: 135
1987 – dto. – KEMPF: 501
1996b *Ovornina (Margoplanitia) compacta* KNÜPFER, 1968 – SCHALLREUTER: 62
1996 *Ovornina (Margoplanitia) compacta* KNÜPFER, 1968 – KEYSER & SCHÖNING: 66
1997 *Ovornina (Margoplanitia) compacta* KNÜPFER, 1968 – BLUMENSTENGEL & SCHALLREUTER: 14
2005 *Ovornina (Margoplanitia) compacta* KNÜPFER 1968 – BLUMENSTENGEL: tab. 3 (p. 138)

Holotype: Juvenile right valve, Bergakademie Freiberg, Saxony, coll. No. 45/1021 – KNÜPFER: pl. 2 figs. 2a–c. Catalogue of KEYSER & SCHÖNING 1996: no. 2457
Type locality: Former Iron Ore Mine Gebersdorf, middle adit; Thuringia

Stratum typicum: Kalkbank (limestone layer) of the Upper Iron-Ore Horizon (Schmiedefelder Folge) between the Upper Iron-Ore Layer and the “Hangende Leitschichten”

Definition: At least up to 1.61 mm in length (holotype 0.63 mm). Ventrolateral spine rather long with very broad longitudinal base and continuing ridge in anterior direction.

Material. More than 50 valves (13 on stubs)

Remarks: The largest specimen from Sardinia is much bigger than the holotype, so that the latter is a rather young instar.

KNÜPFER (1968: 8) assigned the species to his new subgenus *Ovornina (Margoplanitia)*, which was given genus rank by SCHALLREUTER (1984b: 29, 30). However, the two other species which KNÜPFER referred to the subgenus, *Tricornina haebneli* BLUMENSTENGEL, 1965a and *O. (M.) compacta*, were not included in *Margoplanitia* by SCHALLREUTER (2005, p. 302).

Margoplanitia brevispina is similar but has a smaller spine. It is unlikely that *M. brevispina* represents a younger instar of *T. compacta* because spines are usually stronger in young instars than in adults and larger instars as, for example, in *Bolbibithis abdominalis* (SCHALLREUTER 1986c: pl.13, 146 figs.1 and 4), *Uhakiella jaanussoni skageni* (SCHALLREUTER 1973b: pl.18 figs.8–9, pl.19 figs.7–9), or *Bromidella sarvi* (SCHALLREUTER 1973b: pl. 20 figs. 4–6).

Occurrence: Thuringia: Kalkbank. Sardinia: Cannamenda

Genus *Margoplanitia* KNÜPFER, 1968

Type-species: *Ovornina (Margoplanitia) brevispina* KNÜPFER, 1968 (OD KNÜPFER 1968: 7; Late Ordovician, Thuringia); holotype of the type-species: KNÜPFER 1968: pl. 3 fig. 1

Further species: *Budnianella ventrocosta* BLUMENSTENGEL, 1965a

Definition: SCHALLREUTER 2005: 302

Occurrence: Late Ordovician of Thuringia and Sardinia.

Margoplanitia brevispina (KNÜPFER, 1968) SCHALLREUTER, 2005

Pl. 12 figs. 1–10

1968 *Ovornina (Margoplanitia) brevispina* n. subgen. n. sp. – KNÜPFER: 7–8, 22; pl. 3 (p. 23) figs. 1a–b, 2a–b

1970 *Ovornina (Margoplanitia) brevispina* KNÜPFER 1968 – JORDAN: 8

1986a OVORNINA(MARGOPLANIT BREVISPINA) KNUEPFER, 1968 A – KEMPF: 550

1986b – dto. – KEMPF: 104

1987 – dto. – KEMPF: 501

1996b *Ovornina (Margoplanitia) brevispina* KNÜPFER, 1968 – SCHALLREUTER: 62

1996 *Ovornina (Margoplanitia) brevispina* KNÜPFER, 1968 – KEYSER & SCHÖNING: 66, 102

1997 *Ovornina (Margoplanitia) brevispina* KNÜPFER, 1968; *Margoplanitia* cf. *brevispina*; *Budnianella*? sp. – BLUMENSTENGEL & SCHALLREUTER: 14, 15; fig.1 3a–c

2001 *Budnianella*? sp. BLUMENSTENGEL & SCHALLREUTER, 1997; *Budnianella*? sp. sensu BECKER, BLUMENSTENGEL & SCHALLREUTER 1997 – BECKER: 399, 402; fig. 2.9 (~ BLUMENSTENGEL & SCHALLREUTER 1997: fig.1.3a) [Because BECKER delivered the SEM monographs for the text-fig. 1 in that paper he cites himself (2001: 412) irregularly as the first author of the paper but with wrong title].

2005 *Margoplanitia* cf. *brevispina* BLUMENSTENGEL & SCHALLREUTER 1998; *Ovornina (Margoplanitia) brevispina* KNÜPFER 1968 – BLUMENSTENGEL: tab. 3 (p. 137, 138)

2005 *Margoplanitia brevispina* KNÜPFER, 1968 – SCHALLREUTER: 302

2006 *Margoplanitia brevispina* – SCHALLREUTER et al.: 312

Holotype: Right valve, Bergakademie Freiberg, Saxony, coll.-no. 45/1018 – KNÜPFER: pl. 2 figs. 1a–b. Catalogue of KEYSER & SCHÖNING 1996: no. 2456

Type locality: Former Iron Ore Mine Gebersdorf, middle adit; Thuringia. Kalkbank of the upper ore horizon

Definition: At least up to 1.10 mm in length (holotype 0.72 mm). Lateral surface slightly convex above ventrolateral ridge or bend

Material: More than 180 valves (10 on stubs)

Remarks. *Margoplanitia brevispina* differs from *Tricornina compacta* and *T. haebneli* by having a smaller spine, which is directed more horizontally and posteriorwards. In addition it usually does not project beyond the free margin in lateral view. Furthermore, the lateral surface above of the spine is more convex than in *T. compacta*, where it is rather flat. In comparison to the latter species anterior and posterior ends are relatively distinctly flattened

Occurrence: Thuringia: Kalkbank, Upper Ore Horizon; Sardinia: Cannamenda

Genus *Brevicornina* GRÜNDEL & KOZUR, 1972

Type-species: *Budnianella brevis* BLUMENSTENGEL, 1965a (OD GRÜNDEL & KOZUR 1972: 910; Late Ordovician, Thuringia); holotype of the type-species: BLUMENSTENGEL 1965a: pl. 1 fig. 19; SCHALLREUTER 2005: pl. 8 fig. 7

Further species and subspecies

Budnianella shenandoabense SWAIN, 1962 (July)

Budnianella ellipticalis SWAIN, 1962

? *Monoceratina* ? *plattsburgensis* SWAIN, 1962

Budnianella shenandoense KRAFT, 1962 (September, SOHN 1968: 441)

Steusloffina ? *caudica* NECKAJA, 1966

Margoplanitia wittmannsgereuthensis SCHALLREUTER, 2005 (subspecies of *B. brevis*)

M. shenandoabense and *M. shenandoense* are synonyms. They are placed, as was *Margoplanitia wittmannsgereuthensis* SCHALLREUTER, 2005 (SCHALLREUTER et al. 2006: 312), in *Brevicornina* because of the missing ventral spine. It is considered here as a subspecies of the type-species (see below). On the other hand, the assignment of *Monoceratina* ? *plattsburgensis* to *Brevicornina* (SCHALLREUTER 2005: 304) is questionable because the valve's ends are not flattened; for that reason the species should remain in *Pseudobrevicornina* (SCHALLREUTER 1999: 61).

Definition: SCHALLREUTER et al. 2006: 311

Remarks: In general, *Brevicornina* and *Margoplanitia* are very similar. They occur together in the samples from Sardinia and differ principally only by the ventrolateral spine developed in *Margoplanitia*. The occurrence of a similar spine in instars of *M. ventrocosta* could be considered as proterogenesis and may suggest that *Brevicornina* originated from *Margoplanitia*

Occurrence: Middle Ordovician of New York and Virginia; Late Ordovician of Thuringia, the Baltic, Iran and Sardinia.

Brevicornina brevis (BLUMENSTENGEL, 1965a) GRÜNDEL & KOZUR, 1972

Pl. 3 fig. 5, Pl. 13 figs. 1–12

2005 *Brevicornina brevis* (BLUMENSTENGEL, 1965) GRÜNDEL & KOZUR, 1972 – SCHALLREUTER: 304, 311, 334; table 1 (p. 312); pl. 8 (p. 335) figs. 7–9 (p. 304 further synonymy)

2005 *Margoplanitia wittmannsgereuthensis* sp. n. – SCHALLREUTER: 302, 303; text-fig. 4 figs. 1–3

2006 *Brevicornina brevis* (BLUMENSTENGEL, 1965a) – SCHALLREUTER et al.: 312, 315, 324, 332, 342; table 5 (p. 314); pl. 1 (p. 325) fig. 9, pl. 5 (p. 333) fig. 5, pl. 10 (p. 343) figs. 1–6

Holotype: Right valve – SCHALLREUTER 2005: pl. 8 (p. 335) fig. 7; BLUMENSTENGEL 1965a: pl. 1 fig. 19. (Not mentioned in the catalogue of KEYSER & SCHÖNING 1996).

Type locality: Former Wismut dump at the open-air swimming pool of Saalfeld.

Stratum typicum: Limestone clast from the Lederschiefer (no. 692 of BLUMENSTENGEL)

Material: More than 50 valves (12 on stubs)

Comparisons. The specimen figured on Pl. 13 fig. 1 is very similar to the holotype (SCHALLREUTER 2005: pl. 8 fig. 7), while other specimens resemble more *Brevicornina wittmannsgereuthensis*. In typical specimens of *Brevicornina brevis* the lateral surface is so strongly convex that the valve is centrally higher than the ventral ridge (SCHALLREUTER 2005: pl. 8 figs. 7–9). By contrast, in *Brevicornina wittmannsgereuthensis* the ridge is the highest position (SCHALLREUTER 2005: text-fig. 4 figs. 1–3). In the present material both varieties occur together (comp. Pl. 13 figs. 9, and 11), and the difference between both species, e.g. the plane lateral surface in *B. wittmannsgereuthensis* may be relevant only on the subspecies level if at all.

By preservation and/or natural variation there are transitions between *Brevicornina brevis* and *Margoplanitia brevispina*, which make the assignment of some specimens difficult.

Occurrence: Thuringia: limestone clasts of the Lederschiefer, Kalkbank (subspecies *wittmannsgereuthensis*); Sardinia: Cannamenda

Genus *Neoscaphina* MELNIKOVA, 1982

Type-species: *Neoscaphina kazachstanica* MELNIKOVA, 1982 (OD MELNIKOVA 1982: 76; Mid Ordovician, Kazakhstan);

holotype of the type-species: MELNIKOVA 1982: pl. 7 figs. 10a–v.

Further species

Acanthoscapha pennae SCHALLREUTER, 1996 (SCHALLREUTER & HINZ-SCHALLREUTER 2006: 163)

Neoscaphina pseudopennae SCHALLREUTER, HINZ-SCHALLREUTER, BALINI & FERRETTI, 2006

Definition.: Small to medium-sized. Outline preplete to postplete. Main part of the valve strongly convex; both ends flattened, with posterior one being more distinct. Without ventrolateral ridge or bend.

Comparisons.: *N.* differs from *Brevicornina* by the total lack of a ventrolateral sculpture.

Occurrence.: Llanvirn of Kazakhstan, Llanvirn/Llandeilo of Argentina, Late Ordovician of Iran (Yazd Block) and Sardinia

Neoscaphina pseudopennae SCHALLREUTER, HINZ-SCHALLREUTER, BALINI & FERRETTI, 2006

Pl. 12 figs. 11–12

2006 *Neoscaphina pseudopennae* sp. n. – SCHALLREUTER et al.: 312, 332; pl. 5 (p. 333) fig. 4

Holotype.: Left valve, GG-341-29 – SCHALLREUTER et al. 2006: pl. 5 fig. 4

Type locality.: Site IR12, section 5-6756 of SHARKOVSKI et al. 1984 east of Anarak, central Iran

Stratum typicum.: Anarak Formation (= Shirgesht Formation at Anarak)

Definition.: SCHALLREUTER et al. 2006: 312

Material.: More than 10 valves (four on stubs)

Remarks.: As shown by the figured specimen (Pl. 12 figs. 11–12), the outline may be also subamplete or slightly preplete.

Occurrence.: Iran (Yazd Block): Anarak Fm., Sardinia: Late Ordovician of Cannamenda

Genus *Sardicornina* gen. n.

Derivation of name.: After Sardinia and the similarity with *Brevicornina*

Species.: *Echinoprimitia* ? *spinosa* COPELAND, 1982; *Barrosina italica* sp. n. (type-species)

Definition.: Small, elongate. Without sulcus or weak sulcal depression only. Anterior and posterior ends more or less distinctly flattened. Surface irregularly covered with

spines, which may be arranged in rows dorsally and anteroventrally.

Comparisons.: The similar *Barrosina* SCHALLREUTER, 1988 from the Late Ordovician of Australia differs mainly by the two saw-blade-like ridges near anterior and posterior margins (SCHALLREUTER 1988: text-fig. 1 fig.3).

Echinoprimitia HARRIS, 1957 from the Ordovician of Oklahoma differs from *Sardicornina* mainly by the distinct sulcus and the antero-jacent spine, as well as by the presence of a vecon and the narrow flattened stripe at the free margin, which is broadest anteroventrally (HARRIS 1957: pl. 6 figs. 5a–b).

The anteriorly and posteriorly flattened margins, the convexity of the domicilium, and the weak bow-shaped projection observed in the type-species demonstrate the similarity with *Brevicornina* and *Margoplanitia* and a close systematic relationships to that group. *Barrosina* was originally referred to the Spinigeritidae (SCHALLREUTER 1988: 573), but is now assigned to the same group as *Sardicornina*.

Occurrence.: Middle Ordovician of the District of Mackenzie, Late Ordovician of Sardinia

Sardicornina italica sp. n.

Pl. 8 figs. 1–5

Derivation of name.: After the country of occurrence

Holotype.: Left valve IPUM 28043 – Pl. 6 fig. 2

Material.: More than 100 valves (five on stub)

Definition.: Up to 0.99 mm in length. Anterior and posterior ends flattened. Surface covered by irregularly distributed spines that are arranged in rows near the free margin anteroventrally and posteriorly.

Comparison.: *S. spinosa* from the Esbataottine Fm., early Middle Ordovician (Chazy), of the District of Mackenzie, is fairly similar to the new species but is smaller (0.70 mm) with a more rounded-rectangular outline and more pronounced dorsal spines (COPELAND 1982: pl. 1 figs. 30–33).

Genus *Kozuriscapha* SCHALLREUTER, 1996a

Species

Acanthoscapha prima DE GARCÍA, 1975 (type-species; OD SCHALLREUTER 1996a: 150; Mid Ordovician, Argentina); holotype (or lectotype) of the type-species: DE GARCÍA 1975: fig. p. 75.

Vltavina ? *dorsospinata* BLUMENSTENGEL, 1965a

Ceratinella brevicerata KNÜPFER, 1968

Vltavina ? *insulcata* KNÜPFER, 1968

Kozuriscapha rectangulata SALAS, 2002b

- K. brevicerata* and *K. insulcata* are considered as synonyms of *K. dorsospinata*.
Definition: SCHALLREUTER 1996a: 150
Remarks: *Kozuriscapha* is herein considered to be a *Tricornina* lacking the lateral spine and is, therefore, assigned to the family Tricorninidae.
Occurrence: Argentina: Llanvirn/Llandeilo; Late Ordovician of Thuringia, and Sardinia
- Kozuriscapha dorsospinata*** (BLUMENSTENGEL, 1965a) SCHALLREUTER, 1996
 Pl. 7 figs. 1–5
- 1968 *Ceratinella brevicerata* n. sp. – KNÜPFER: 9, 26; pl. 5 (p. 27) fig. 6
 1968 *Vltavina ? insulcata* n. sp. – KNÜPFER: 12–13, 26; pl. 5 (p. 27) figs. 4–5
 1970 *Ceratinella brevicerata* KNÜPFER 1968 = *Ceritta brevicerata* (KN.) – JORDAN: 8
 1970 *Vltavina ? insulcata* KNÜPFER 1968 – JORDAN: 8
 1986a CERATINELLA BREVICERATA KNÜEPFER, 1968 A
 CERITTA BREVICERATA (KNUEPFER, 1968A) JORDAN, 1970 B
 VLTAVINA ? INSULCATA KNUEPFER, 1968 A – KEMPF: 166, 167, 748
 1986b – dto. – KEMPF: 102, 290
 1987 – dto. – KEMPF: 501, 534
 1996b *Ceratinella brevicerata* KNÜPFER, 1968 – SCHALLREUTER: 62
 1996b *Vltavina ? insulcata* KNÜPFER, 1968 – SCHALLREUTER: 62
 1996 *Ceratinella brevicerata* KNÜPFER, 1968 – KEYSER & SCHÖNING: 22
 1996 *Vltavina insulcata* KNÜPFER, 1968 – KEYSER & SCHÖNING: 95
 1996a *Kozuriscapha insulcata* (KNÜPFER, 1968) – SCHALLREUTER: 150
 1997 *Ceratinella brevicerata* KNÜPFER, 1968 – BLUMENSTENGEL & SCHALLREUTER: 14
 1997 *Vltavina ? insulcata* KNÜPFER, 1968 – BLUMENSTENGEL & SCHALLREUTER: 14
 2002b *Kozuriscapha dorsospinata* (Blumenstengel, 1965) – SALAS: 132
 2002b *Kozuriscapha insulcata* (Knüpfer, 1968) – SALAS: 132
 2005 *Kozuriscapha dorsospinata* (BLUMENSTENGEL 1965) – BLUMENSTENGEL: tab. 3 (p. 137)
 2005 *Ceretta brevicerata* KNÜPFER 1968 – BLUMENSTENGEL: tab. 3 (p. 134)
 2005 *Vltavina ? insculpta* KNÜPFER 1968 – BLUMENSTENGEL: tab. 3 (p. 143)
 2005 *Kozuriscapha dorsospinata* (BLUMENSTENGEL, 1965) SCHALLREUTER, 1996 – SCHALLREUTER: 308; tab. 1; pl. 9 figs. 1–6 (p.308 further synonymy)
- 2005 *Kozuriscapha insulcata* (KNÜPFER, 1968) – SCHALLREUTER: 308
- Holotype*: Left valve – BLUMENSTENGEL 1965a: pl. 1 fig. 13. Catalogue of KEYSER & SCHÖNING 1996: no. 3637
Type locality: Former Wismut dump at the open-air swimming pool of Saalfeld
Stratum typicum: Late Ordovician limestone clast from the Lederschiefer (no. 692 of BLUMENSTENGEL)
Material: One carapace, more than 20 valves (six on stubs)
Definition: SCHALLREUTER 2005: 308
Remarks. According to KNÜPFER (1968: 12, 13), *Vltavina ? insulcata* KNÜPFER, 1968 from the Kalkbank should be distinguished from *K. dorsospinata* by its lack of a centro-dorsal sulcus. JORDAN (1970: 8) noted the missing sulcus. Since such a sulcus could not be verified in *K. dorsospinata*, *Vltavina ? insulcata* is considered here as a younger synonym. Also, *Ceratinella brevicerata* KNÜPFER, 1968 is regarded as a synonym of *K. dorsospinata*.
- Suborder CYPRIDOCOPA JONES in CHAPMAN, 1901 emend. SCHALLREUTER, 1978b [SCHALLREUTER, 1968d]
 = Bairdiocopina GRÜNDEL, 1967 (SCHALLREUTER 1968a: 83); Bairdiomorpha KOZUR, 1972; Cuyanocopina DE GARCÍA, 1975 (SCHALLREUTER & HINZ-SCHALLREUTER 2006: 162)
 Infraorder BAIRDIOMORPHA KOZUR, 1972 [SCHALLREUTER, 1988]
 Superfamily Bairdioidea SARS, 1887 [SYLVESTER-BRADLEY, 1948]
 Family Beecherellidae ULRICH, 1894
- Genus ***Dornbuschia*** SCHALLREUTER, 1968a
- Synonym*: *Berdanoscaptha* KNÜPFER, 1968 (SCHALLREUTER 1975b: 284, 285)
- Type-species*: *Dornbuschia biddenseensis* SCHALLREUTER, 1968a (OD SCHALLREUTER 1968a: 91; Late Ordovician, Baltica); holotype of the type-species: SCHALLREUTER 1968a: pl. 9 figs. 4–5.
- Further species*
Dornbuschia ostseensis SCHALLREUTER, 1968a
Berdanoscaptha germanica KNÜPFER, 1968 (type-species of *Berdanoscaptha*; OD KNÜPFER 1968: 12; Late Ordovician, Thuringia)
Dornbuschia timmermanni SCHALLREUTER, 1975b
Dornbuschia longissima SCHALLREUTER, 1975b
Dornbuschia vecon SCHALLREUTER, 2001 (Silurian)
Dornbuschia dynamica SCHALLREUTER, HINZ-SCHALLREUTER, BALINI & FERRETTI, 2006

Dornbuschia aposymmetrica sp. n.

Dornbuschia bornemanni sp. n.

Definition: Very small to small. Elongate, shape very long. Dorsal margin long and straight. Maximum height in posterior half. Anterior margin more broadly rounded than posterior one. The latter terminates posteroventrally in an acute extremity or short spine. Vecon mostly missing. Broad duplicature with vestibules antero- and posteroventrally.

Comparisons: *Berdanoscapba* has been considered as a synonym of *Dornbuschia* (SCHALLREUTER 1975: 285). The type-species of *Berdanoscapba* is very similar to *D. ostseensis* (SCHALLREUTER 1968a: pl. 9 fig. 1; KNÜPFER 1968: pl. 5 fig. 1c). Both species differ from the type-species of *Dornbuschia* mainly in having a longer straight part of the dorsal margin and thus a more broadly rounded anterior margin (SCHALLREUTER 1968a: pl. 9 fig. 5).

Estoniosylthère MEIDLA, 1996 differs by its convex dorsal margin (MEIDLA 1996: pl. 32 fig. 13), but it is unknown whether or not this genus has a duplicature like *Dornbuschia* or *Inisylthère*, which indicates the degree of relation.

Occurrence: Late Ordovician: Baltic, Iran and Sardinia; Wenlock/Ludlow of the Lindener Mark near Gießen, Hesse.

Dornbuschia dynamica SCHALLREUTER, HINZ-SCHALLREUTER, BALINI & FERRETTI, 2006
Pl. 6 fig. 5

2006 *Dornbuschia dynamica* sp. n. – SCHALLREUTER et al.: 313, 326, 334; table 5; pl. 2 (p. 327) fig. 5, pl. 6 (p. 335) figs. 4–5

Holotype: Right valve GG-341-7b – SCHALLREUTER et al. 2006: pl. 6 fig. 4

Type locality: Site IR12, section 5-6756 of SHARKOVSKI et al., 1984 east of Anarak, central Iran (Yazd Block)

Stratum typicum: Anarak Formation (= Shirgesht Formation at Anarak)

Definition: At least up to 0.76 mm long. Straight part of dorsal margin relatively short. Correspondingly, the anterior margin is rather narrowly rounded. The posterior margin descends gently and terminates posteroventrally in an acute extremity

Material: One valve (on stub)

Remarks: The specimen from Sardinia is nearly double the size of the type material from Iran.

Comparisons: *D. dynamica* is generally more elongate than *D. germanica*. The latter has a longer straight dorsal margin

and together with its greater relative height, the posterior margin appears steeper than in *D. dynamica*. Also, the anterior margin is more broadly rounded.

Occurrence: Iran: Anarak Fm.; Sardinia: Cannamenda

Dornbuschia ventroconvexa sp. n.

Pl. 6 fig. 10

Derivation of name: After the convex ventral margin of the valve

Holotype: Right valve IPUM 28032 – Pl. 6 fig. 10

Definition: Adults as much as 0.76 mm in length. Shape very long (L:H 2.34). Dorsal margin long and straight. Ventral margin convex and forming an obtuse angle with the posterior margin.

Material: Holotype (on stub)

Remarks: *D. ventroconvexa* differs from *D. germanica* by the more narrowly rounded anterior margin and the more convex ventral margin (KNÜPFER 1968: pl. 5 fig. 1c).

D. timmermanni also has a convex ventral margin like *D. ventroconvexa*, but its ends are less symmetrical to each other (SCHALLREUTER 1975b: fig. 10).

Dornbuschia ventroconcava sp. n.

Pl. 3 fig. 8, pl. 14 fig. 1

Derivation of name: After the weak vecon

Holotype: Carapace IPUM 28001 – Pl. 3 fig. 8

Definition: Adults as much as 0.79 mm. Shape very long (L:H around 2.36–2.41). Greatest length in ventral half, greatest height in posterior half. Posterior end more narrowly rounded than anterior end. Vecon weak.

Material: One carapace and one right valve (on stubs)

Remarks: The species is very similar to *D. longissima* which also has a weak vecon. However, *D. longissima* is more elongate (L:H ~3.00) and its ends are located closer to the basis-line (SCHALLREUTER 1975b: fig. 9).

Dornbuschia bornemanni sp. n.

Pl. 14 fig. 3

Derivation of name: After Johan Georg Bornemann, formerly professor in Halle/Saale (not Thuringia as mentioned by HAMMANN & LEONE 1997: 13) who described the first Ordovician ostracode from Sardinia (text-fig. 1).

Holotype: Carapace, IPUM 28112 – Pl. 14 fig. 3

Material: Holotype

Definition: Length at least up to 0.62 mm. Shape moderately long (L:H of holotype 1.82). Dorsal and ventral margins convex. Anterior margin broadly rounded, posterior margin ventrally pointed.

Remarks: *D. bornemanni* differs from the other species of the genus mainly by its relatively high shape. It is additionally distinct from *D. dynamica* and *D. ventroconvexa* by the rounded anterior and pointed posterior margins.

***Dornbuschia* ? sp. A**

Pl. 14 fig. 2

Remarks: The species is characterized by its spindle-like outline, with its nearly equally developed ends it differs from all other species of the genus.

Genus ***Velapezoides*** MCGILL, 1966

Synonym: *Zenkovaelina* MELNIKOVA, 1986 (SCHALLREUTER 1988: 577)

Type-species: *Velapezoides shaveri* MCGILL, 1966 (OD MCGILL 1966: 123; Givetian, Alberta); holotype of the type-species: MCGILL 1966: pl. 6 figs. 9–11

Orientation: The holotype of the type-species is a carapace and MCGILL (1966: 128; pl. 6 figs. 9–11) considered its smaller end to be anterior. However, with this orientation the right valve is larger than the left one (MCGILL 1966: 123). The same orientation (smaller end anterior) was used by SCHALLREUTER 1968 for the Ordovician species of *Velapezoides* as well as for *Dornbuschia* (SCHALLREUTER 1968a: pl. 10 fig. 3; compare with pl. 9 fig. 1). *Zenkovaelina costulata* (MELNIKOVA 1986: 101, pl. 22 figs. 5b, 6) was also orientated in the same way, but here the left valve overlaps the right one (MELNIKOVA 1986: 84).

Further species

Velapezoides ? *rotundus* SCHALLREUTER, 1968a

Velapezoides angulatus SCHALLREUTER, 1968a

Zenkovaelina costulata MELNIKOVA, 1986 (type-species, OD MELNIKOVA 1986: 84; Mid Ordovician, Kazakhstan)

Velapezoides australiensis SCHALLREUTER, 1988

Velapezoides varicostata SCHALLREUTER, 1996a

Velapezoides pinna sp. n.

As shown by the list of species, the genus is relatively common in the Ordovician. *Zenkovaelina elata* MELNIKOVA, 1986 (Upper Ordovician, Kazakhstan) is excluded from the genus.

Remarks: *Zenkovaelina* is considered as a synonym of *Velapezoides* (SCHALLREUTER 1988: 577, 1996a: 152).

***Velapezoides pinna* sp. n.**

Pl. 4 figs. 9–10, Pl. 5 fig. 9, Pl. 8 fig. 6

Derivation of name: After the similarity with *Pinna*

Holotype: Right valve IPUM 28013 – Pl. 4 fig. 10

Definition: Length at least up to 1.12 mm. Shape very long and distinctly postplete. Maximum height near posterior end, maximum width in posterior half. Anterior and posterior ends slightly flattened. Distinct lappet, which forms a ridge-like bend with the lateral surface.

Material: More than 20 valves (four on stubs)

Comparison: *V. angulatus* SCHALLREUTER, 1968a (Late Ordovician, Baltica) has very distinctly flattened ends, and the anterior and posterior margins form distinct corners with the ventral margin (SCHALLREUTER 1968a: pl. 10 fig. 3).

Due to preservational reasons *V. australiensis* SCHALLREUTER, 1988 (Late Ordovician, New South Wales) exhibits only one ventral corner and a distinct ventrolateral ridge (SCHALLREUTER 1988: text-fig. 1 fig. 4).

V. costulata (MELNIKOVA, 1986) (Mid Ordovician, Kazakhstan) has distinct dorsal and ventral ridges (MELNIKOVA 1986: pl. 22 figs. 5–6).

Family Bairdiidae Sars, 1887

Genus ***Bairdia*** MCCOY, 1844

Type-species: *Bairdia curta* MCCOY, 1844, Carboniferous, Ireland (SD ULRICH & BASSLER 1923: 320); according to SOHN (1960: 25) an inadequately defined species. Type material apparently lost (BECKER et al. 1989: 29). A recollection to get new material for designation of a neotype was unsuccessful (BECKER et al. 1989: 30, 33).

***Bairdia wutzkei* sp. n.**

Pl. 9 fig. 1

Derivation of name: In honour of Ulrich Wutzke for his engagement in geological publishing.

Holotype: Right valve IPUM 28054 – Pl. 9 fig. 1

Material: One valve (on stub)

Definition: Length at least up to 1.00 mm. Summit centrally located. Dorsal margin forms round antero- and posterodorsal shoulders, of which the anterior one is closer to the anterior margin than the posterior one is to the posterior margin. Posterior end more pointed than anterior one. D-line in ventral half, and paralleling basis-line. Without vecon.

Remarks: Of all of the few Ordovician species originally assigned to *Bairdia* the new species is most similar to typical *Bairdia* mainly by its characteristic shape and outline. All other respective Ordovician species do not belong to *Bairdia* and remain only tentatively in that genus. *Bairdia* ? *iocus* SCHALLREUTER, 1987 probably represents a new genus (MEIDLA 1996: 148; SCHALL-

REUTER & HINZ-SCHALLREUTER 2006: 164), and *Bairdia* ? *ordoviciana* SCHALLREUTER, 1999 differs mainly from typical bairdiids (SHAVER in BENSON et al. 1961: fig. 140) by its more elongate shape, the d-line parallel to the basis-line, and the valve ends being closer to the basis-line. Antero- and posterodorsal margins of *ordoviciana* are straight to slightly convex (SCHALLREUTER 1999: pl. 2 fig. 9). Its gross morphological characters suggest an assignment to *Bairdiocypridella* rather than to *Bairdia*.

Suborder CYTHEROCOPA GRÜNDEL, 1967 emend.
SCHALLREUTER, 1979
? Superfamily inc.

Family Conodomyridae SCHALLREUTER, 1977

Genus *Conodomyra* SCHALLREUTER, 1968d

Type-species: *Conodomyra brevinodata* SCHALLREUTER, 1968d (OD SCHALLREUTER 1968d: 146; Late Ordovician, Baltica); holotype of the type-species: SCHALLREUTER 1968d: figs.22.4–5.

Species, definition, occurrence: SCHALLREUTER 2005: 300

Conodomyra conocerata (BLUMENSTENGEL, 1965a) SCHALLREUTER, 1968d
Pl. 6 figs. 7–8

2005 *Conodomyra conocerata* (BLUMENSTENGEL 1965) SCHALLREUTER 1968, 2005 – BLUMENSTENGEL: table 3 (p. 134)

2005 *Conodomyra conocerata* (BLUMENSTENGEL, 1965) SCHALLREUTER, 1968 – SCHALLREUTER: 300, 330; table 1 (p. 312); pl. 6 (p. 331) fig. 7 (p. 300 further synonymy)

2006 *Conodomyra conocerata* (BLUMENSTENGEL, 1965a) – SCHALLREUTER et al.: 294, 313, 315, 342; tab. 5; pl. 10 fig. 11

Holotype. Right valve – BLUMENSTENGEL 1965a: text-fig. 11; SCHALLREUTER 2005: pl. 6 fig. 7

Type locality: Former Wismut dump at the open-air swimming pool of Saalfeld

Stratum typicum: Late Ordovician limestone clast from the Lederschiefer (no. 692 of BLUMENSTENGEL)

Definition: SCHALLREUTER 2005: 300

Material: More than 30 valves (four on stubs)

Occurrence: Thuringia: limestone clasts in the Lederschiefer (Ashgill); Sardinia: Cannamenda; Iran (Yazd Block): Anarak Fm.

Palaeobiogeographical significance of the ostracod fauna

Analysis of the ostracode fauna from Sardinia

The fauna is represented by more than 45 beyrichiocopec and podocope species. Taxonomically and quantitatively the fauna is dominated by podocopes, which account for about two thirds of the total species. Among the beyrichiocopecs the binodicopecs represent two thirds of all beyrichiocopec species. The high percentage of podocope species is typical for many Late Ordovician ostracode faunas, but the high percentage of binodicopecs is characteristic for the higher Perigondwanan latitudes.

The fauna shows close relations to faunas from Thuringia. From the latter region Late Ordovician ostracode faunas are known from

- 1) the Upper Iron-Ore Layer of the Upper Iron-Ore Horizon [BLUMENSTENGEL & SCHALLREUTER 1997]
- 2) the so-called Kalkbank (limestone layer) of the Upper Iron-Ore Horizon (Schmiedefelder Folge) between the Upper Iron-Ore Layer and the “Hangende Leitschichten” (FALK & WIEFEL in SEIDEL 2003: 116; text-fig. 4. 3.2–4) [KNÜPFER 1968; SCHALLREUTER 1984a, 1986a, 2005; SCHALLREUTER et al. 2006],
- 3) limestone clasts of the Lederschiefer [BLUMENSTENGEL 1965a, SCHALLREUTER 2005]
- 4) quartzite clasts of the Lederschiefer [SCHALLREUTER & HINZ-SCHALLREUTER 1998].

The fauna from Sardinia comprises elements from both the Kalkbank fauna and the limestone clasts of the Lederschiefer.

Species from both the Kalkbank and Upper Iron-Ore layer that occur also in Sardinia, are:

Baldiscella ? *anterionoda* (KNÜPFER, 1968) = *B.* ? *anterobulbosa* (BLUMENSTENGEL, 1965)

Tricornina haebneli BLUMENSTENGEL, 1965

Tricornina compacta (KNÜPFER, 1968)

Margoplanitia brevispina (KNÜPFER, 1968)

Brevicornina brevis (BLUMENSTENGEL, 1965)

Kozuriscapha insulcata (KNÜPFER, 1968) = *K dorsospinata* (BLUMENSTENGEL, 1965)

Morphobealdia wiefeli BLUMENSTENGEL & SCHALLREUTER, 1997

Species that limestone clasts of the Lederschiefer have in common with Sardinia are:

Aechmina gracilis BLUMENSTENGEL, 1965

Baldiscella ? *anterobulbosa* (BLUMENSTENGEL, 1965)

Postceratia posterocerata (BLUMENSTENGEL, 1965)

Vogesella miniorbicularis (SCHALLREUTER, 2005)

Baltonotella angustovelata (BLUMENSTENGEL, 1965)

Bairdiocypridella bairdiaformis BLUMENSTENGEL, 1965

Prorectella erratica sp. n.

Brevicornina brevis (BLUMENSTENGEL, 1965)
Tricornina baehneli BLUMENSTENGEL, 1965
Kozuriscapha dorsospinata (BLUMENSTENGEL, 1965)
Conodomyra conocerata (BLUMENSTENGEL, 1965)

In addition the fauna also shows close relations to the late Ordovician fauna from Anarak, Yazd Block, Central Iran recently described by SCHALLREUTER et al. (2006). Species from Sardinia, which correspond to the Anarak fauna are:

Antiaechmina insula sp. n.
Baldiscella ? *anterobulbosa* (BLUMENSTENGEL, 1965)
Postceratia posterocerata (BLUMENSTENGEL, 1965)
Baltonotella angustovelata (BLUMENSTENGEL, 1965)
Morphohealdia wiefeli BLUMENSTENGEL & SCHALLREUTER, 1997
Bairdiocypridella bairdiaformis BLUMENSTENGEL, 1965
Longiscula ventroconcava SCHALLREUTER, HINZ-SCHALLREUTER, BALINI & FERRETTI, 2006
Tricornina baehneli BLUMENSTENGEL, 1965
Brevicornina brevis (BLUMENSTENGEL, 1965)
Neoscaphina pseudopennae SCHALLREUTER, HINZ-SCHALLREUTER, BALINI & FERRETTI, 2006
Dornbuschia dynamica SCHALLREUTER, HINZ-SCHALLREUTER, BALINI & FERRETTI, 2006
Conodomyra conocerata (BLUMENSTENGEL, 1965)

Gondwanan Ordovician ostracode biogeography

Reconstructions of the former palaeogeography cannot be based alone on palaeomagnetic data. These data allow determination of the palaeolatitude, but offer no information of the palaeolongitude. Only palaeontological studies deliver palaeogeographic information regarding the relative longitude. Therefore, it is of utmost importance to combine faunal data with palaeomagnetic data. This has been previously demonstrated by COCKS & TORSVIK (2002), who used palaeomagnetic data in combination with the distribution of trilobites, brachiopods and fishes.

Because of their mostly benthic lifestyle ostracodes are an excellent tool for the determination of palaeobiogeographic connections. This applies particularly for Ordovician ostracodes, because only a few species are known to have had a pelagic lifestyle (SCHALLREUTER & KOCH 1999, GABBOTT & al. 2003).

In the following, an analysis is given of the present knowledge of ostracode faunas in the different parts of Gondwana and Peri-Gondwana. In this paper no distinction has been made between continents, microcontinents, microplates, superterranes, terranes, subterraneans and probably microterraneans, because their status

is not clear and exact definitions are lacking. COCKS & TORSVIK (2002: table 1), for example, considered Perunica as a continent and in another paper as a terrane (COCKS & TORSVIK 2004: 65). The existence of terranes had been assumed previously by ÖPIK (1939: 50) who called them "Scherben" (potsherds, fragments) of continents.

Faunal provinces of Gondwana/Perigondwana indicated by ostracodes

Comparisons between ostracode faunas from different parts of Perigondwana and Gondwana are difficult and can be only preliminary due to the very different state of ostracod knowledge in the respective regions. Species, which were thought originally to be endemic to a region may turn out to be not. Despite these circumstances some general features are already recognizable and permit some generalisations with regard to faunal relations and palaeobiogeographic connections.

In the Ordovician the following three faunal provinces can be distinguished in Gondwana and Perigondwana on the basis of ostracodes:

1. Thuringian province

The similarity of Late Ordovician ostracode faunas from Thuringia, Central Iran (Yazd Block) and SW Sardinia (Table 3) suggests that these regions belonged to the same province of the Perigondwanan realm, here called Thuringian province (TP).

The closest relations existed between Sardinia and Iran but the relations between Sardinia and clasts of the Lederschiefer were of about the same order.

Species occurring in Sardinia, Iran and the limestones clasts of the Thuringian Lederschiefer are: *Postceratia posterocerata*, *Baltonotella angustovelata*, *Bairdiocypridella bairdiaformis*, *Conodomyra conocerata*, *Baldiscella* ? *anterobulbosa*, *Brevicornina brevis*, and *Tricornina baehneli* (all established by BLUMENSTENGEL 1965a). Of these species the last three were recorded also from autochthonous beds of Thuringia.

The relations between Sardinia and autochthonous Thuringian deposits (seven species common, see above) are more distinct than the relations between Iran and Thuringia (species in common apart from the three mentioned above are *Doringia spinosa* and *Morphohealdia wiefeli*).

With *Postceratia posterocerata* only a single species occurs also in regions outside the TP.

According to ostracodes known from the Late Ordovician faunas, TP comprises Thuringia, Sardinia and

Table 3: Late Ordovician ostracodes of the Thuringian province of Perigondwana

[Thuringia: KNÜPFER 1968, BLUMENSTENGEL & SCHALLREUTER 1997, SCHALLREUTER 2005; Lederschiefer clasts (Thuringia): SCHALLREUTER 2005; Iran: SCHALLREUTER et al. 2006; Sardinia: this paper]; Thuringia: × – Kalkbank, O – Upper Ore Horizon, *wittm.* = *wittmannsgereuthensis*

Tab. 3: Oberordovizische Ostrakoden der Thüringer Provinz Perigondwanas

Thüringen: KNÜPFER 1968, BLUMENSTENGEL & SCHALLREUTER 1997, SCHALLREUTER 2005; Lederschiefer- Klasten (Thüringen): SCHALLREUTER 2005; Iran: SCHALLREUTER et al. 2006; Sardinien: diese Arbeit; Thüringen: × – Kalkbank, O – Oberer Eisenerzhorizont, *wittm.* = *wittmannsgereuthensis*

	Thuringia	Clasts	Sardinia	Iran
<i>Acanthoscapha</i> sp. BLUMENSTENGEL & SCHALLREUTER, 1997	O			
<i>Aechmina gracilis</i> BLUMENSTENGEL, 1965		×	×	
<i>Ampletocbilina</i> ? sp. n. SCHALLREUTER et al.,2006				×
<i>Amsdenia</i> ? <i>postnodus</i> (BLUMENSTENGEL, 1965)		×		
<i>Antiaechmina blumenstengeli</i> PRIBYL, 1979		×		
<i>Antiaechmina insula</i> sp. n.			×	×
<i>Aparchites dotthi</i> KNÜPFER, 1968	×			
<i>Arcuaria</i> ? sp. n. A			×	
<i>Arpaschmidtella</i> ? <i>decentralis</i> sp. n.			×	
<i>Bairdia wutzkei</i> sp. n.			×	
<i>Bairdiocypridella</i> ? <i>libratogutta</i> sp. n.			×	
<i>Bairdiocypridella</i> ? sp. n. A			×	
<i>Bairdiocypridella anterosecata</i> sp. n.			×	
<i>Bairdiocypridella bairdiaformis</i> BLUMENSTENGEL, 1965		×	×	×
<i>Baldiscella</i> ? <i>anterobulbosa</i> (BLUMENSTENGEL, 1965)		×	×	×
= <i>Baldiscella</i> ? <i>anteronoda</i> (KNÜPFER, 1968)	×	×	×	×
<i>Baldiscella</i> ? sp. n.			×	
<i>Baltonotella angustovelata</i> (BLUMENSTENGEL, 1965)		×	×	×
<i>Bichilinoides interrupta</i> SCHALLREUTER et al.,2006				×
<i>Bobuckea</i> ? sp. n. A			×	
<i>Bolbarakia obliqua</i> SCHALLREUTER et al.,2006				×
<i>Bollita anarakensis</i> SCHALLREUTER et al.,2006				×
<i>Brevicornina brevis</i> (BLUMENSTENGEL, 1965)	<i>wittm.</i>	<i>b.</i>	<i>b.</i>	<i>b.</i>
<i>Bulbosclerites longa</i> KNÜPFER, 1968	×			
<i>Bulbosclerites</i> n. sp. KNÜPFER, 1968	×			
<i>Bullaferum granodus</i> SCHALLREUTER et al.,2006				×
<i>Byrsolopsina</i> ? sp. n. A			×	
<i>Conchoprimitiella discriminata</i> SCHALLREUTER et al.,2006				×
<i>Conodomyra</i> ? <i>ventronoda</i> (BLUMENSTENGEL, 1965)		×		
<i>Conodomyra conocerata</i> (BLUMENSTENGEL, 1965)		×	×	×
<i>Crescentilla</i> ? sp. KNÜPFER, 1968	×			
<i>Criboconcha ordoviciana</i> (BLUMENSTENGEL, 1965)		×		
<i>Dornbuschia</i> ? sp. A			×	
<i>Dornbuschia ventroconvexa</i> sp. n.			×	
<i>Dornbuschia ventroconcava</i> sp. n.			×	
<i>Dornbuschia bornemanni</i> sp. n.			×	
<i>Dornbuschia dinamica</i> SCHALLREUTER et al.,2006			×	×
<i>Dornbuschia germanica</i> (KNÜPFER, 1968)	×			
<i>Duringia spinosa</i> (KNÜPFER, 1968)	×			×
<i>Easchmidtella</i> ? sp. n. A			×	
<i>Elliptocyprites</i> ? sp. n. B			×	
<i>Elliptocyprites nesowa</i> SCHALLREUTER, 1988			×	
<i>Elliptocyprites</i> sp. A SCHALLREUTER et al.,2006				×
<i>Elliptocyprites</i> sp. C			×	
<i>Elliptocyprites</i> sp. SCHALLREUTER,2005		×		
<i>Eoaquapulex</i> ? sp. n. BLUMENSTENGEL & SCHALLREUTER, 1997	O			
<i>Eographiodactylus</i> ? sp. n. BLUMENSTENGEL & SCHALLR., 1997	O			
<i>Foveaprimitiella</i> ? sp. n. A SCHALLREUTER et al.,2006				×
<i>Garciana asulcata</i> SCHALLREUTER & HINZ-SCHALLREUTER, 1998		×		
<i>Geshirtia</i> ? sp. n. A			×	
<i>Geshirtia ventrocostata</i> SCHALLREUTER et al.,2006				×
<i>Grammolomatella gondwanica</i> sp. n.			×	
<i>Herrigia asiatica</i> SCHALLREUTER et al.,2006				×

<i>Hippula (Hippula)</i> sp. (BLUMENSTENGEL, 1965)		×			
<i>Iranomita cecus</i> SCHALLREUTER et al.,2006					×
<i>Klimphores</i> cf. <i>minimus</i> (SARV, 1956): KNÜPFER, 1968	×				
<i>Klimphores granterionodus</i> SCHALLREUTER et al.,2006					×
<i>Klimphores levis</i> KNÜPFER, 1968	×				
<i>Kozuriscapha dorsospinata</i> (BLUMENSTENGEL, 1965)					
= <i>Vltavina</i> ? <i>insulcata</i> KNÜPFER, 1968					
= <i>Ceratinella brevicerata</i> KNÜPFER, 1968		×		×	
<i>Kransella brevicornis</i> : KNÜPFER, 1968		×			
<i>Leperditella</i> sp. aff. <i>rex</i> : KNÜPFER, 1968	×				
<i>Levisulculus</i> ? sp. (BLUMENSTENGEL, 1965)			×		
<i>Longiscula</i> aff. <i>arcuaria</i> NECKAJA, 1958				×	
<i>Longiscula posteroangulata</i> SCHALLREUTER et al.,2006					×
<i>Longiscula</i> sp. A SCHALLREUTER et al.,2006					×
<i>Longiscula</i> sp. D SCHALLREUTER et al.,2006					×
<i>Longiscula</i> sp. E SCHALLREUTER et al.,2006					×
<i>Longiscula</i> sp. SCHALLREUTER,2005	?	×			
<i>Longiscula ventroconvexa</i> SCHALLREUTER et al.,2006				×	×
<i>Margoplanitia brevispina</i> (KNÜPFER, 1968)	×			×	
<i>Margoplanitia ventrocosta</i> (BLUMENSTENGEL, 1965)		×			
<i>Morphobealdia inornata</i> (KNÜPFER, 1968)	×				
<i>Morphobealdia wiefeli</i> BLUMENSTENGEL & SCHALLREUTER, 1997	○ w.			w.	<i>restricta</i>
<i>Neoscaphina pseudopennae</i> SCHALLREUTER et al.,2006				×	×
<i>Olbianella</i> ? sp. B SCHALLREUTER et al.,2006					×
<i>Olbianella</i> sp. A SCHALLREUTER et al.,2006				cf.	×
<i>Olbianella</i> sp. C				×	
<i>Opisthoblax anarakensis</i> SCHALLREUTER et al.,2006					×
<i>Parasclerites</i> sp. A SCHALLREUTER et al.,2006					×
<i>Parasclerites</i> sp. aff. <i>elongatus</i> SWAIN, 1962	×				×
<i>Parasclerites</i> sp. aff. <i>lamellosus</i> SWAIN, 1962	×				×
<i>Parasclerites</i> sp. B				×	
<i>Parasclerites</i> sp. C				×	
<i>Pariconchoprimitia iranica</i> SCHALLREUTER et al.,2006					×
<i>Pinnatulites</i> sp. aff. <i>microrugosa</i> : KNÜPFER, 1968	×				
<i>Platyrbomboides</i> ? sp. KNÜPFER, 1968	×				
<i>Platyrbomboides</i> sp. A SCHALLREUTER et al.,2006					×
<i>Postceratia anterospinata</i> sp. n.				×	
<i>Postceratia posteroerata</i> (BLUMENSTENGEL, 1965)		×		×	×
<i>Prorectella erratica</i> sp. n.		×		×	
<i>Pseudbollia egregoides</i> SCHALLREUTER et al.,2006					×
<i>Pseudulrichia bohémica norvegica</i> HENNINGSMOEN, 1954		×			
<i>Pseudulrichia sardinica</i> sp. n.				×	
<i>Pullvillites</i> sp. n. A				×	
<i>Quadrilia (Krutalia) krausei</i> SCHALLREUTER, 1976				×	
<i>Rectella</i> ? sp. A				×	
<i>Rectella</i> sp. SCHALLREUTER,2005	?	×			
<i>Rempesgrinella hemiventrocosta</i> KNÜPFER, 1968	×				
<i>Retinoda varionoda</i> (BLUMENSTENGEL, 1965)			×		
<i>Retinoda varionoda sulcata</i> (KNÜPFER, 1968)	×				
<i>Sardicornina italica</i> sp. n.				×	
<i>Spinidiphores</i> ? sp. n.? SCHALLREUTER,2005		×			
<i>Stensloffina nudaplex</i> SCHALLREUTER et al.,2006					×
<i>Thuratia reticulata</i> (BLUMENSTENGEL, 1965)		×			
<i>Thuringobliqua thuringensis</i> (BLUMENSTENGEL, 1965)		×			
<i>Tricornina</i> ? n. sp. KNÜPFER, 1968	×				
<i>Tricornina compacta</i> (KNÜPFER, 1968)	×			×	
<i>Tricornina baehneli</i> BLUMENSTENGEL, 1965	×	×		×	×
<i>Uthoernia</i> ? sp. A				×	
<i>Uthoernia</i> sp. SCHALLREUTER,2005		×			
<i>Velapezoides pinna</i> sp. n.				×	
<i>Vittella pana</i> SCHALLREUTER et al.,2006					×
<i>Vogdesella miniorbicularis</i> (SCHALLREUTER,2005)		×		×	
	112	30	28	50	40

Central Iran (Yazd Block). East Central Iran (Tabas Block) has not been included contrary to other reconstructions where both blocks are united (e.g.: VON RAUMER et al. 2003: fig. 2).

Sardinia was regarded as part of Iberia by COCKS (2000: 3) or of Ibero-Armorica by WILLIAMS et al. (2003: 201). However, according to the Late Ordovician ostracode fauna described in this paper, at least the south-western part of Sardinia belongs to the Thuringian province. The Ashgill ostracode faunas of Ibero-Armorica are undescribed (WILLIAMS et al. 2003: 202) and Middle Ordovician ostracode faunas from Thuringia are unknown.

2. Armorican province

Armorica, Iberia, North Africa, Perunica, east Central Iran (Tabas Block) and questionably also the Carnic Alps constitute the Armorican province.

The knowledge of the respective ostracode faunas is very variable and comparisons are, therefore, preliminary. Presently, there is no taxon common to all regions. Only one genus (*Quadridigitalis*) occurs in the three main regions (Armorica, Perunica, east Central Iran).

Cerninella aaryana WILLIAMS, VANNIER & MEIDLA in GHOBADI POUR et al. 2006 is very similar to *Ogmoopsis arcadelti* VANNIER, 1986b, which was assigned to *Cerninella* PŘIBYL, 1966 by WILLIAMS, VANNIER & MEIDLA in GHOBADI POUR et al. (2006: 553). Both species are certainly congeneric, but their assignment to *Cerninella* is rather doubtful. Both species have lobes that are more or less parallel to each other and joined by a connecting ridge. The latter extends ventrally as wide as the tecnomorphic velar ridge. That's not the case in the Bohemian type-species of *Cerninella*. The species in question seem to be more closely related to the Bohemian *Brepbocharieis ? ctiradi* SCHALLREUTER & KRŮTA, 1988 from the Šárka Formation (Darriwillian), which has similarly developed ridge-like lobes that are not so closely spaced to each other. The L1 agrees in being slightly expanded at its dorsal end, but is node-like rather than hook-shaped. As in *C. aaryana* and *O. arcadelti* the connecting ridge also reaches the ventral margin in lateral view (comp. GHOBADI POUR et al. 2006 fig.3 A–B, D–F and SCHALLREUTER & KRŮTA 1988: pl. 3 figs.1L, 3L). The species mentioned above are assigned to the genus *Quadridigitalis* JONES, 1986. The type-species of the latter genus, *Ogmoopsis (Quadridigitalis) siveteri* JONES, 1986 is very similar to *Q. ctiradi* and differs mainly by the less ridge-like lobes only (JONES 1986: pl. 12 figs.1–15).

Unlike most other areas, which have been tentatively referred to the Armorican province, Perunica and

Armorica could be compared in more detail. In the Šárka stage the first common genus occurs (*Quadridigitalis*), but in the Dobrotivá the two regions share four common genera – among them two typical Armorican genera (*Jeanlousiella* VANNIER, 1986b, *Reuentalina* VANNIER, 1986b) – and one species (*Quadritia tromelini*). “The ostracode fauna of the Dobrotivá clearly confirms the close relations to Armorica and the relative proximity of Perunica and Armorica. However, some of the ostracodes also indicate connections to Baltica” (SCHALLREUTER, KRŮTA & MAREK 1996: 458). These connections increase in the later Ordovician and the “relationships of the ostracode fauna to Armorica on one side and Baltica on the other, demonstrates the displacement of Perunica to Armorica on one side and a approaching toward Baltica in the Ordovician on the other side” (SCHALLREUTER & KRŮTA 2001a: 85). The close connections between Perunica and Baltica and also the Carnic Alps in the Late Ordovician are expressed by common species (*Scanipisthia rectangularis*, *Harpabollia harparum*). The Ashgill ostracode faunas of Armorica and Iberia are not very well known. Therefore, it is unknown whether or not these species occur also in Armorica and Iberia.

Biogeographical links at the generic level (*Quadridigitalis*), and possibly also at species-level (*Postceratia ? ventadorni*), of a small Mid-Ordovician ostracode fauna from east Central Iran (Tabas Block) with the Travesout Formation of western France have been postulated by GHOBADI POUR et al. (2006: 551).

COCKS & TORSVIK (2002: table 1) positioned Avalonia, Armorica and Perunica as part of NW Gondwana – apparently in today's sense because in Ordovician time (due to the position of the South pole in Gondwana itself) alloverall directions in Gondwana were to the north. (That would be valid also for the “north-Gondwanan margin” of RAUMER et al. 2001).

A distinction between, for example, NW and NE cannot be made.

3. Australian province

A third faunal province is constituted in the Late Ordovician by Australia, Argentina (Precordillera terrane, Cordillera Oriental) and the Himalaya (Spiti region). This province is characterized mainly by members of the binodicope subfamily Pillinae (SCHALLREUTER in WEBBY et al. 2000: 86). The only genus occurring (represented by different species) in all three regions is *Pilla*. *Webbylla* and *Dominina* are presently known only from Australia/Tasmania, *Pinpilla* from Himalaya only. *Eodominina* occurs in Australia and Argentina, in Australia already in the lower Arenig. *Bolliaphores*, from a Mid-Ordovician

geschiebe of Scania, is the only known member of the subfamily outside of this province. If *Sinoprimitia* is accepted as a member of the subfamily, then the subfamily occurs also in China.

Members of typical (e.g., velar dimorphic Palaeocopa) occur only in the Himalaya (Late Ordovician).

Most other ostracodes show relations to other regions. Endemic elements are known mainly from Argentina (*Cribobolbina*, *Jachalipisthia* et al.)

WILLIAMS et al. (2003: 202) concluded, that the Precordillera terrane did “exhibit Gondwana affinities ... only later in the Ordovician” but in the same paper (p. 211) the authors stated that “During the late Arenig-early Llanvirn there were two migrations from Australia to the Argentine Precordillera, involving the binodicopes *Eodominina* and *Pilla*”.

As documented by the two non-dimorphic palaeocopes of the family Soanellidae, *Eopilla* (Australia) and *Saltite* (Argentina), relations between Australia and the Northwestern basin (Cordillera Oriental) existed already in the Upper Tremadoc/Lower Arenig (SCHALLREUTER & HINZ-SCHALLREUTER 2007).

Relations of the Thuringian province to other faunal provinces and regions north of Gondwana

A common feature of all Gondwanan/Perigondwanan ostracod faunas is the high percentage of binodicope ostracodes, which are non-dimorphic. Dimorphic palaeocopes, which are very common in lower latitudes (Baltica, Laurentia), are extremely rare.

All single parts of the Thuringian province (TP) show relationships with Baltica, partly by taxa occurring in more than one of the different parts (*Postceratia posterocerata*, *Baltonotella*, *Klimphores*, *Conodomyra*, *Morphobealdia*, *Dornbuschia*, for example), and partly by taxa occurring only in one of the single regions of the TP:

Sardinia: *Grammolomatella*, *Quadritia*, *Bullaeferum*, *Velapezoides*

Thuringia (clasts): *Hippula*, *Pseudulrichia norvegica*

Thuringia (autochthonous): *Bulbosclerites*, ? *Eoaquapulex*, ? *Eographiodactylus*

Iran: *Vittella*, *Bollita*, *Steusloffina*, *Pariconchoprimitia*, *Herrigia*

These constellations suggest that the relations between Baltica and all the single parts of the TP have been about the same. The occurrence of species common to Perunica and Baltica demonstrates that at least this part of the Armorican province must have had a closer position to Baltica than the TP. Since the Lederschiefer contains dropstones of presumably of Armorican origin, Thuringia

must have taken a more northerly position than Armorica (SCHALLREUTER & HINZ-SCHALLREUTER 1998: fig. 2; SCHALLREUTER et al. 2006: fig. 6). These facts show that the Armorican province must have had a longer south-north extension than the TP.

Quadritia (Krutatia), which has been found in the TP only in Sardinia, exhibits closer relations and maybe indicates a closer position of Sardinia to Armorica than Thuringia and Central Iran.

WILLIAMS et al. (2003: 211) assumed a possible migration of *Quadritia* from Baltica to Ibero-Armorica, a reverse migration is more likely, because the oldest known species, the Armorican *Q. (Krutatia) tromelini* VANNIER & SCHALLREUTER, shows the most ancient features of all respective species.

Some relations exist also to Laurentia. The presence of *Sardicornina* indicates Sardinia had a connection to the District of Mackenzie, whereas *Pseudbollia* indicates a connection between Central Iran and Central North America and Avalonia.

Appendix

Remarks on *Beyrichia reticulata* and *Primitia ? caputaquae*

Beyrichia reticulata BORNEMANN in MENEGHINI in DE LA MARMORA, 1860 certainly is a palaeocope, but its exact systematic position is unknown. On one hand it resembles the type-species of *Ctenentoma* SCHMIDT, 1941, *Entomis umbonata* STEUSLOFF, 1895 (see SCHALLREUTER 1994a: pl. 17 fig. 3), on the other hand it is similar to eurychilinoidea, especially *Piretella* ÖPIK, 1937 by the lobal and sulcal sculptures, the apparently tubulate velum and the similar reticulation (see SCHALLREUTER 1975a: pl. 6 fig. 1, pl. 5 fig. 7).

Primitia? caputaquae VINASSA DE REGNY, 1927 seems to belong to *Piretella* and is probably a younger synonym of *Beyrichia reticulata*.

Piretella caputaquae (= *Primitia ? caputaquae*) came from the Iglesias-Sulcis Autochthonous of SW-Sardinia like the fauna described herein from Cannamanda near Bacu Abis, while *Piretella ? reticulata* (= *Beyrichia reticulata*) was found in the Fluminimaggiore area, which belongs to the Arburese Nappe north of the Iglesias-Sulcis Autochthonous (HAMMAN & LEONE 1997: text-fig. 1).

Piretella indicates not only relations to Baltica but also to Turkey from where the Late Ordovician *Piretella bithynia* SAYAR & SCHALLREUTER, 1989 has been described.

Note: If *Beyrichia reticulata* belonged to *Piretella*, *Strepula reticulata* KRAUSE, 1891, which was assigned to *Piretella* by ÖPIK (1937: 112 or 48) would be a younger secondary

homonym. The name *reticulata* was used by KRAUSE only in the plate explanation. Therefore, in accordance with SZTÉJN (1985: 60 or 8), the second species name used by KRAUSE (1891b: 498) in the description of the species, *limbata*, is used here (*Piretella limbata*). This name is given priority, because KRAUSE (1891a: 11, footnote) had used the name *limbata* exclusively in a preceding paper. ÖPIK (1937) mentioned both names but favoured *reticulata*. KEMPF (1986a: 592, 702, 704; 1986b: 332, 501; 1987: 99, 151, 205–206) cited both names (original version and later combinations). The use of *reticulata* instead of *limbata* goes back to ULRICH & BASSLER (1908: 298) who copied the figure of KRAUSE and used the name of KRAUSE's plate explanation.

Conclusions

Based on ostracode studies three biogeographic provinces can be distinguished in the Late Ordovician for the Perigondwana/Gondwana region – the Thuringian, Australian and Armorican Provinces.

Faunistically, Sardinia and Central Iran have more than 10 ostracode species in common, of which at least seven also occur in Thuringia. This suggests they belonged to one biogeographic province, the Thuringian Province.

A detailed faunal comparison showed that ostracodes from Central Iran and Sardinia are more closely related to ostracodes from clasts of the Thuringian Lederschiefer than to ostracodes from autochthonous beds of Thuringia, i.e. the Kalkbank and to the Upper Ore Horizon. Therefore, the place of origin of these clasts was relatively closer to Sardinia and Iran than to the Thuringian terrane proper.

Australia, Argentina and the Himalaya constitute another biogeographic province (Australian Province) of the Perigondwana/Gondwana region. Characteristic ostracodes are representatives of the subfamily Pillinae.

The third biogeographic province (Armorican province) comprises Armorica, Iberia, and Perunica as well as the Tabas Block of eastern Central Iran. The Late Ordovician ostracodes of this province are, however, fairly well known from Perunica only.

All three palaeobiogeographic provinces have certain relations to Baltica. But unlike the latter, a common feature of all Perigondwanan ostracode faunas is the reduction of palaeocopes and the dominance of binodicopes within the Beyrichiocopa. However, in both Perigondwana/Gondwana provinces and Baltica the Podocopa constitute about 50% of Late Ordovician ostracode faunas.

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Addresses of the authors:

PD Dr. Roger Schallreuter, Prof. Dr. Ingelore Hinz-Schallreuter, Institut für Geographie und Geologie, Ernst Moritz Arndt-Universität, Friedrich Ludwig Jahn-Str. 17a, D-17489 Greifswald
 Roger.Schallreuter@uni-greifswald.de
 ihinz-s@uni-greifswald.de

Prof. Dr. Annalisa Ferretti, Dipartimento del Museo di Paleobiologia e dell'Orto Botanico, Via Università 4, I-41100 Modena

ferretti@unimore.it

Enrico Serpagli, Dipartimento del Museo di Paleobiologia e dell'Orto Botanico, Università degli Studi di Modena e Reggio Emilia, Via Università 4, I-41100 Modena
 serpagli@unimore.it

Corrections to SCHALLREUTER 2005

p.	column	line	
306	right	5 th	<i>Bairdiocypridella</i> (instead of <i>Baidiocypridella</i>)
340		2 nd , 10 th	<i>bairdiaformis</i> (instead of <i>baidiaformis</i>)
342		5 th , 15 th	<i>bairdiaformis</i> (instead of <i>baidiaformis</i>)

Corrections to SCHALLREUTER et al. 2006

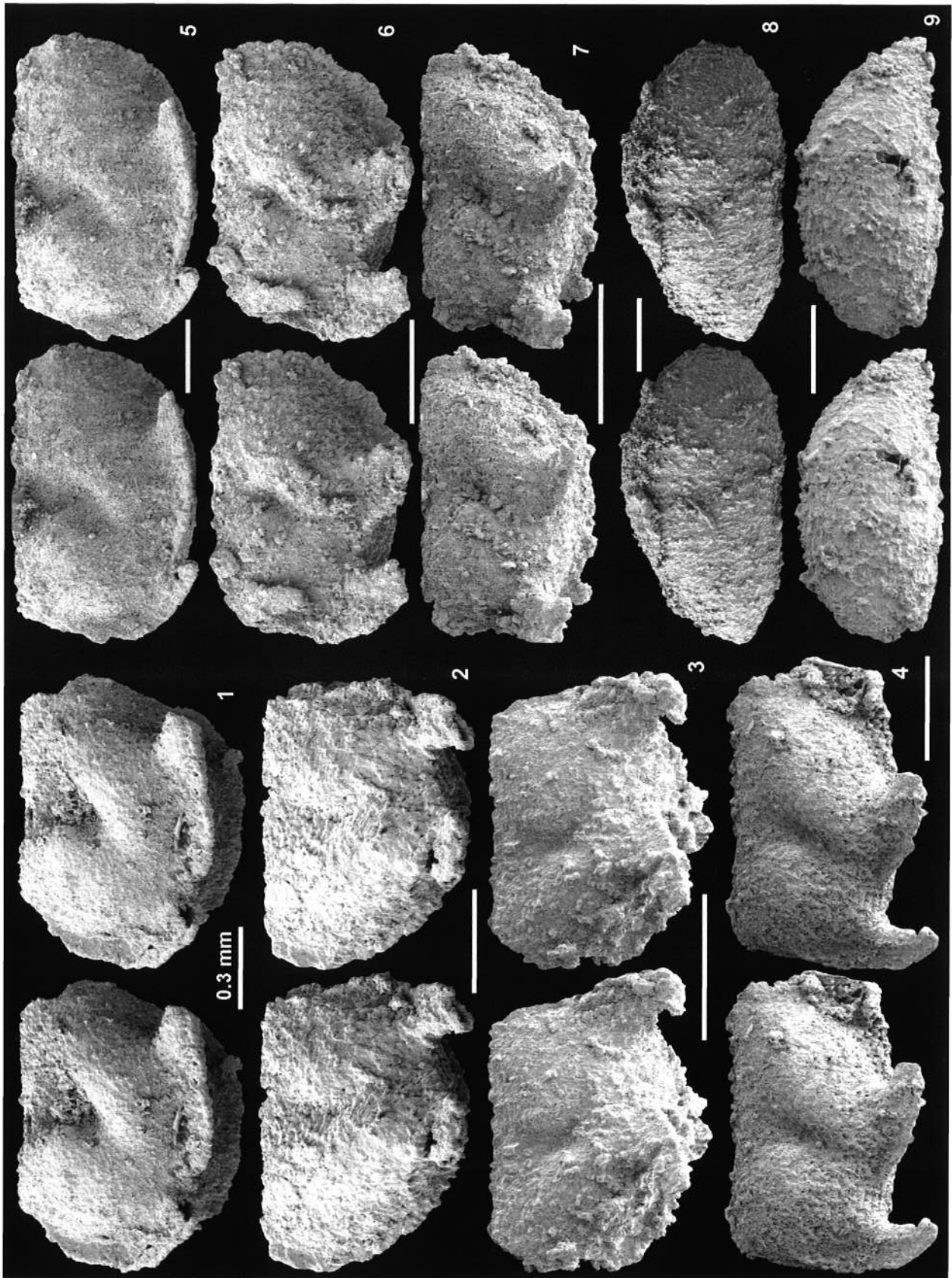
p.	column	line	
293		12 th	18 (instead of 17)
310	right	5 th	figs. 9–10 (instead of 10–11)
311	left	38 th	figs. 8–9 (instead of 8–10)
314		Table 5	<i>Pariconchoprimitia</i> (instead of <i>Piconchoprimitia</i>)
			<i>improba</i> (instead of <i>Improba</i>)
299		29 th	Tables 3–4 (instead of 1–2)

Correction to HINZ-SCHALLREUTER & SCHALLREUTER 2007a

17th line: delete „to“

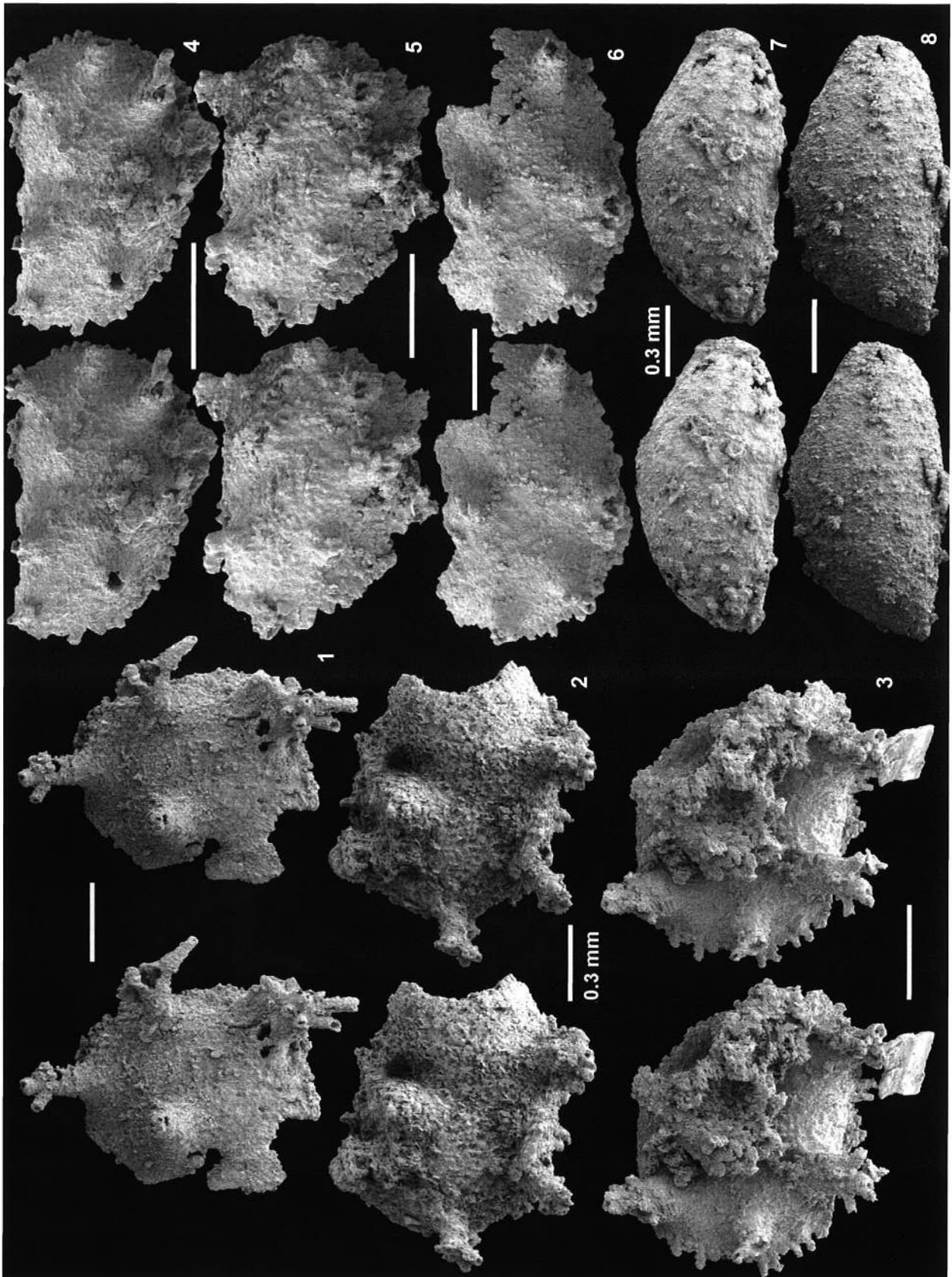
TAFEL 1 / PLATE 1

- 1 – 7 *Grammolomatella gondwanica* sp. n. 1 Posteriorly incomplete left valve (IPUM 27977) in lateral view, height 0.78 mm; 2 juvenile right valve (IPUM 27978) in lateral view, length 0.87 mm; 3 posteriorly incomplete right valve (IPUM 27979) in lateral view, length 0.88 mm; 4–7 left valves (IPUM 27980–27983) in lateral views, length 0.58, 1.30, 0.90, and 0.61 mm; holotype (5), and paratypes
- 8 – 9 *Longiscula ventroconvexa* SCHALLREUTER, HINZ-SCHALLREUTER, BALINI & FERRETTI, 2006. Right (IPUM 27984) and left valves (IPUM 27985) in lateral views, length 1.28, and 1.01 mm
- 1 – 7 *Grammolomatella gondwanica* sp. n. 1 Hinten unvollständige linke Klappe (IPUM 27977) in Lateralansicht, Höhe 0,78 mm; 2 juvenile rechte Klappe (IPUM 27978) in Lateralansicht, Länge 0,87 mm; 3 hinten unvollständige rechte Klappe (IPUM 27979) in Lateralansicht, Länge 0,88 mm; 4–7 linke Klappen (IPUM 27980–27983) in Lateralansicht, Länge 0,58, 1,20, 0,90 bzw. 0,61 mm; Holotypus (5) und Paratypen
- 8 – 9 *Longiscula ventroconvexa* SCHALLREUTER, HINZ-SCHALLREUTER, BALINI & FERRETTI, 2006. Rechte (IPUM 27984) und linke Klappe (IPUM 27985) in Lateralansicht, Länge 1,28 bzw. 1,01 mm



TAFEL 2 / PLATE 2

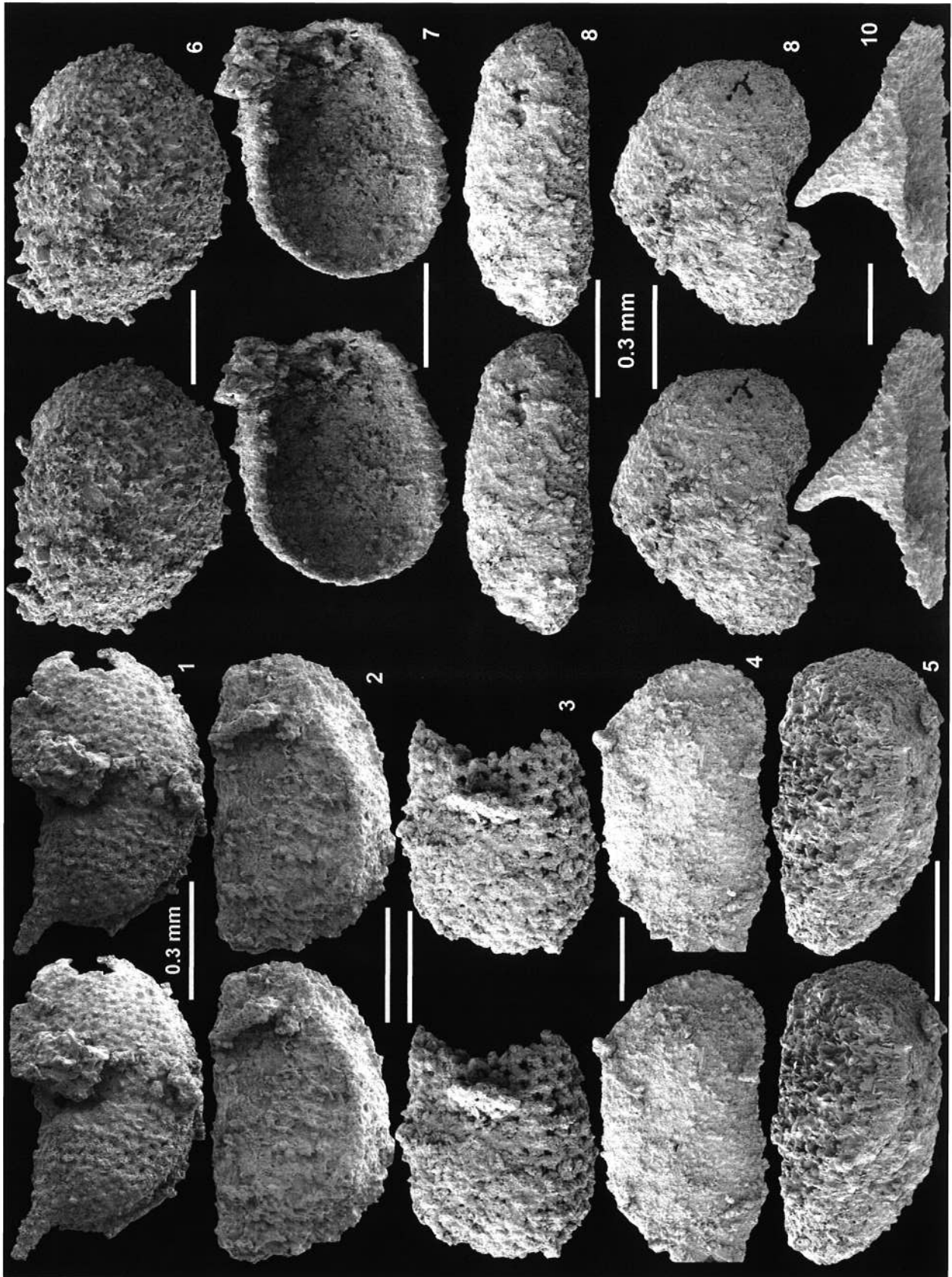
- 1 – 6 *Quadritia (Krutatia) krausei* SCHALLREUTER, 1976. 1 Posteriorly incomplete right valve (IPUM 27986) in lateral view, height 0.65 mm; 2–3 incomplete left valves (IPUM 27987–27988) in lateral views, height 0.80, and 0.64 mm; 4–5 juvenile right valves (IPUM 27989–27990) in lateral views, length 0.69, and 0.83 mm; 6 dorsally incomplete left valve (IPUM 27991) in lateral view, length 1.10 mm
- 7 – 8 *Bairdiocypridella anterosecata* sp. n. Two right valves (IPUM 27992–27993), paratypes, in lateral views, length 1.29, and 1.28 mm
- 1 – 6 *Quadritia (Krutatia) krausei* SCHALLREUTER, 1976. 1 Hinten unvollständige rechte Klappe (IPUM 27986) in Lateralansicht, Höhe 0,65 mm; 2–3 unvollständige rechte Klappen (IPUM 27987–27988) in Lateralansicht, Höhe 0,80 bzw. 0,64 mm; 4–5 juvenile rechte Klappen (IPUM 27989–27990) in Lateralansicht, Länge 0,69 bzw. 0,83 mm; 6 dorsal unvollständige linke Klappe (IPUM 27991), Länge 1,10 mm
- 7 – 8 *Bairdiocypridella anterosecata* sp. n. Zwei rechte Klappen (IPUM 27992–27993), Paratypen, in Lateralansicht, Länge 1,29 bzw. 1,28 mm



TAFEL 3 / PLATE 3

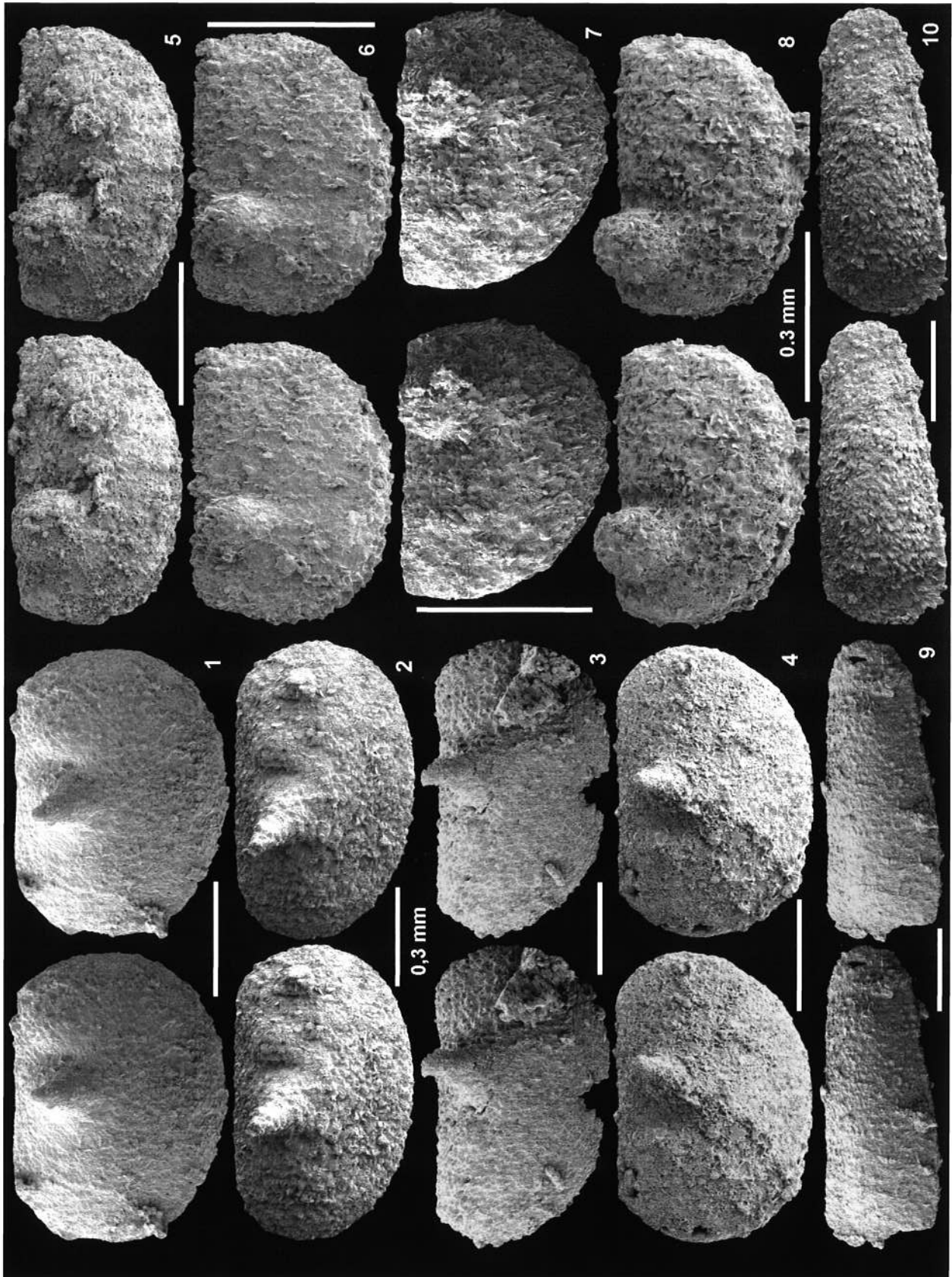
- 1 *Gesbirtia* ? sp. n. A, left valve (IPUM 27994) in lateral view, length 0.72 mm
- 2 *Bobuckea* ? sp. n. A, right valve (IPUM 27995) in lateral view, length 0.78 mm
- 3 *Byrsolopsina* ? sp. A, posteriorly incomplete left valve (IPUM 27996) in lateral view, length >0.49 mm
- 4 *Parasclerites* sp. C, right valve (IPUM 27997) in lateral view, length 1.02 mm
- 5 *Brevicornina brevis* (BLUMENSTENGEL, 1965), right valve (IPUM 27998) with a retained valve (?), length 0.66 mm
- 6 – 7 *Arpaschmidtella* ? *decentralis* sp. n. Holotype, left valve (IPUM 27999) in lateral view, length 0.87 mm, and paratype, left valve (IPUM 28000) in interior view, length 0.75 mm
- 8 *Dornbuschia ventroconcava* sp. n. Holotype, carapace (IPUM 28001) from left, length 0.68 mm
- 9 *Pullvillites* sp. n. A, right valve (IPUM 28002) in lateral view, length 0.78 mm
- 10 *Tricornina compacta* KNÜPFER, 1968, right valve (IPUM 28003) in ventral view showing the bow-shaped projection, length 1.07 mm

- 1 *Gesbirtia* ? sp. n. A, linke Klappe (IPUM 27994) in Lateralansicht, Länge 0,72 mm
- 2 *Bobuckea* ? sp. n. A, rechte Klappe (IPUM 27995) in Lateralansicht, Länge 0,78 mm
- 3 *Byrsolopsina* ? sp. A, hinten unvollständige linke Klappe (IPUM 27996) in Lateralansicht, Länge >0.49 mm
- 4 *Parasclerites* sp. C, rechte Klappe (IPUM 27997) in Lateralansicht, Länge 1,02 mm
- 5 *Brevicornina brevis* (BLUMENSTENGEL, 1965), rechte Klappe (IPUM 27998) mit retendierter Klappe (?), Länge 0,66 mm
- 6 – 7 *Arpaschmidtella* ? *decentralis* sp. n. Holotypus, linke Klappe (IPUM 27999 in Lateralansicht, Länge 0,87 mm, und Paratypus, linke Klappe (IPUM 28000) in Innenansicht, Länge 0,75 mm
- 8 *Dornbuschia ventroconcava* sp. n. Holotypus, Gehäuse (IPUM 28001) von links, Länge 0,68 mm
- 9 *Pullvillites* sp. n. A, rechte Klappe (IPUM 28002) in Lateralansicht, Länge 0,78 mm
- 10 *Tricornina compacta* KNÜPFER, 1968, rechte Klappe (IPUM 28003) in Ventralansicht den ventralen Lappen (bow-shaped projection) zeigend, Länge length 1,07 mm



TAFEL 4 / PLATE 4

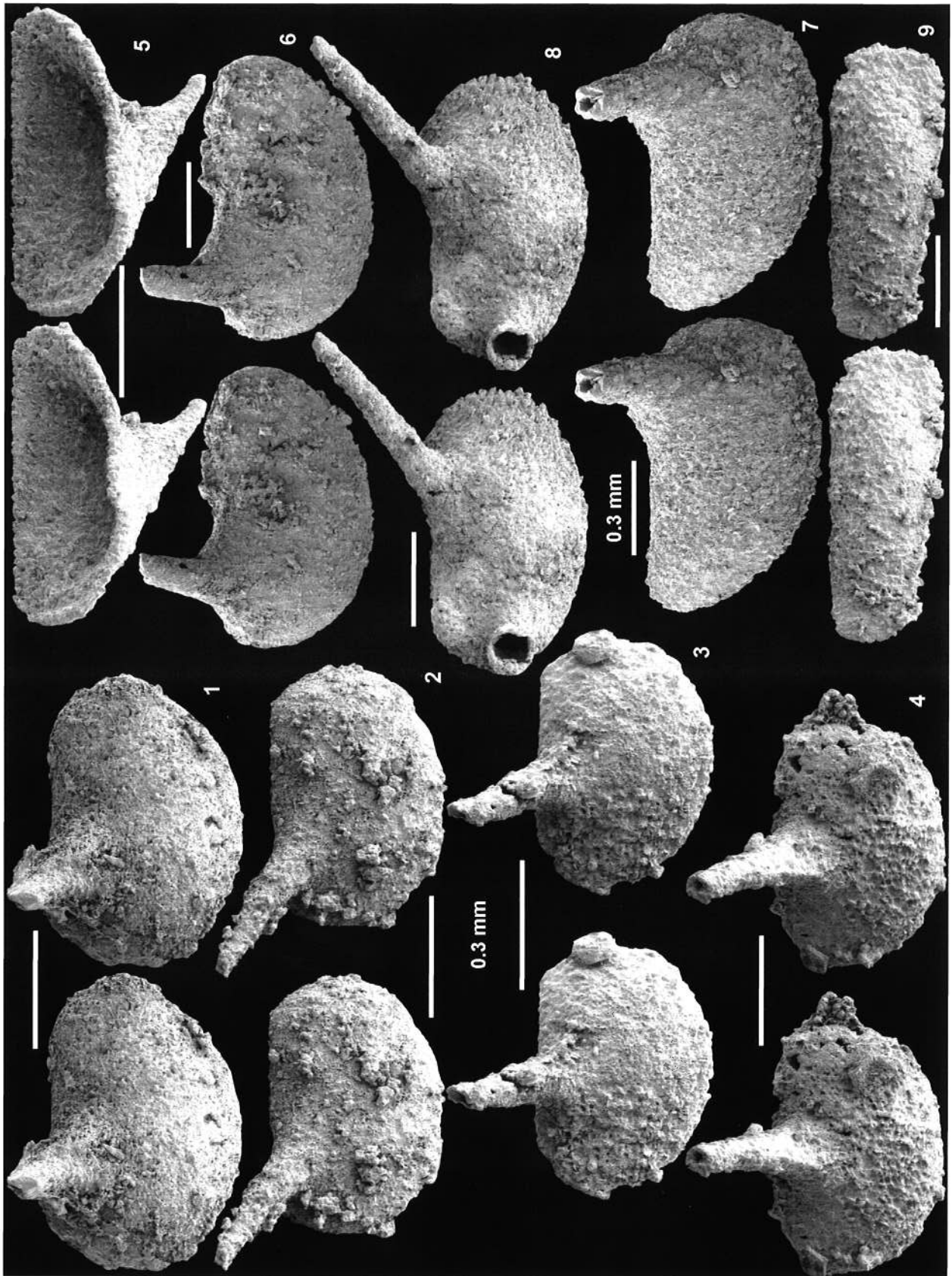
- 1 – 4 *Pseudulrichia sardinica* sp. n. 1–2 Right valves (IPUM 28004–28005) in lateral views, length 0.76, and 0.92 mm;
3–4 left valves (IPUM 28006–28007) in lateral views, length 0.98, and 0.79 mm; holotype (1) and paratypes
- 5 – 8 *Baldiscella ? anterobulbosa* (BLUMENSTENGEL, 1965). 5–6, 8 left valves (IPUM 28008–28010) in lateral views, length
0.64, 0.51, and 0.51 mm; 7 right valve (IPUM 28011) in lateral view, length 0.49 mm
- 9 – 10 *Velapezoides pinna* sp. n. Right valves in lateral views (IPUM 28012–28013), paratype (9) and holotype, length
0.96, and 0.95 mm
- 1 – 4 *Pseudulrichia sardinica* sp. n. 1–2 Rechte Klappen (IPUM 28004–28005) in Lateralansicht, Länge 0,76 bzw. 0,92 mm;
3–4 linke Klappen (IPUM 28006–28007) in Lateralansicht, Länge 0,98 bzw. 0,79 mm, Holotypus (1) und Paratypen
- 5 – 8 *Baldiscella ? anterobulbosa* (BLUMENSTENGEL, 1965). 5–6, 8 linke Klappen (IPUM 28008–28010) in Lateralansicht,
Länge 0,64, 0,51 bzw. 0,51 mm; 7 rechte Klappe (IPUM 28011) in Lateralansicht, Länge 0,49 mm
- 9 – 10 *Velapezoides pinna* sp. n. Rechte Klappen (IPUM 28012–28013) in Lateralansicht, Länge 0,96 bzw. 0,95 mm,
Paratypus (9) und Holotypus



TAFEL 5 / PLATE 5

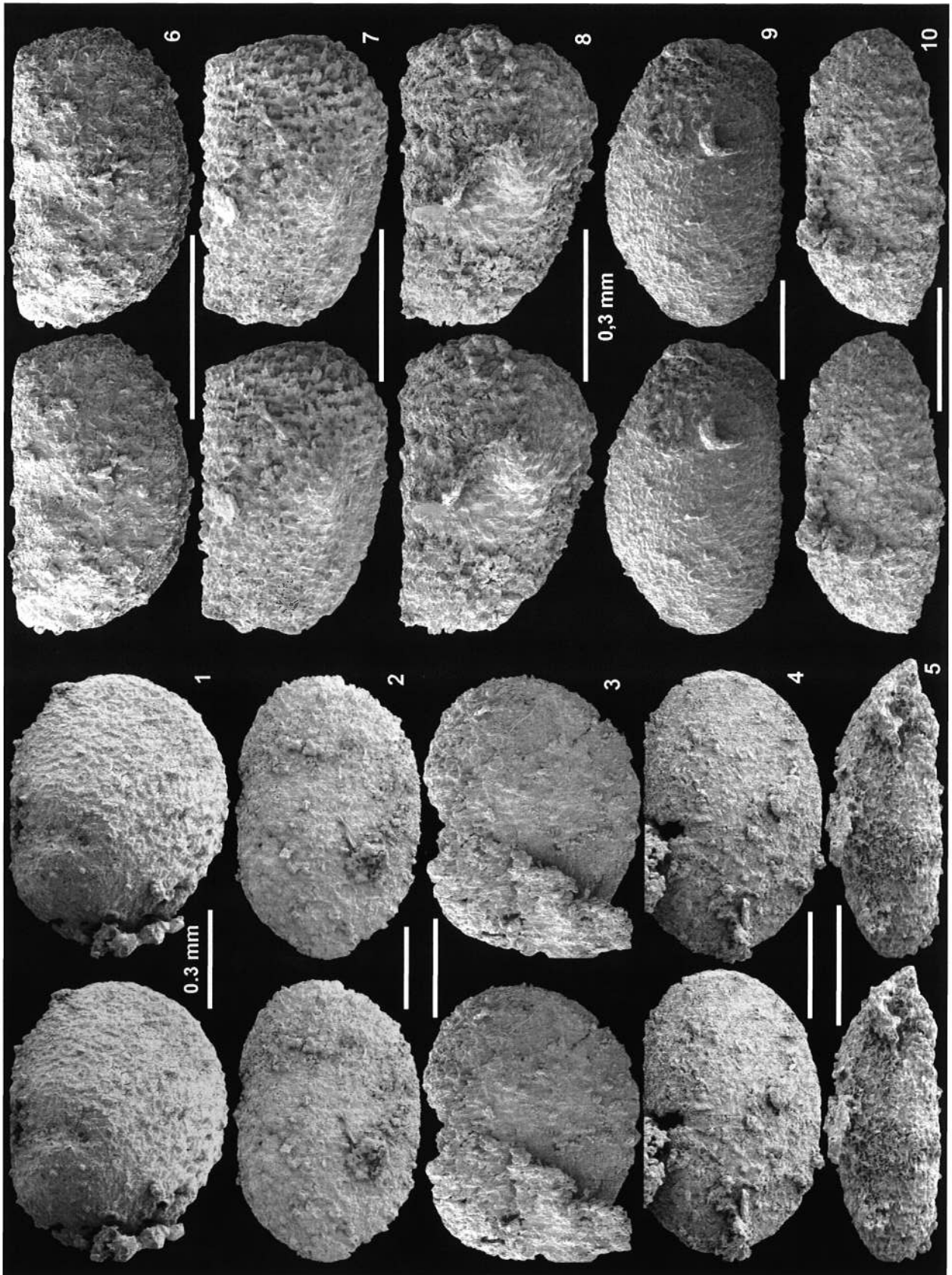
- 1 – 2 *Postceratia posterocerata* (BLUMENSTENGEL, 1965), left valves (IPUM 28014–28015) in lateral views, length 0,73, and 0,63 mm
- 3 – 4 *Aechmina gracilis* BLUMENSTENGEL, 1965, right valves (IPUM 28016–28017) in lateral views, length 0.59, and 0.64 mm
- 5 *Tricornina baehneli* BLUMENSTENGEL, 1965, right valve (IPUM 28018) in ventro-interior view, length 0.81 mm
- 6 – 7 *Antiaechmina insula* sp. n. Holotype, right valve (IPUM 28019) in lateral view (6), and paratype, left valve (IPUM 28020) in lateral view (7), length 0.98, and 1.02 mm (6)
- 8 *Postceratia anterospinata* sp. n. Holotype, left valve (IPUM 28021) in lateral view, length 0.90 mm
- 9 *Velapezoides pinna* sp. n. Paratype, left valve (IPUM 28022) in lateral view, length 0.96 mm

- 1 – 2 *Postceratia posterocerata* (BLUMENSTENGEL, 1965), linke Klappen (IPUM 28014–28015) in Lateralansicht, Länge 0,73 bzw. 0,63 mm
- 3 – 4 *Aechmina gracilis* BLUMENSTENGEL, 1965, rechte Klappen (IPUM 28016–28017) in Lateralansicht, Länge 0.59, and 0,64 mm
- 5 *Tricornina baehneli* BLUMENSTENGEL, 1965, rechte Klappe (IPUM 28018) von innen (ventral angehoben), Länge 0,81 mm
- 6 – 7 *Antiaechmina insula* sp. n. Holotypus, rechte Klappe (IPUM 28019) in Lateralansicht (6), Länge 0,98, und Paratypus, linke Klappe (IPUM 28020) in Lateralansicht (7), Länge 1,02 mm
- 8 *Postceratia anterospinata* sp. n. Holotypus, linke Klappe (IPUM 28021) in Lateralansicht, Länge 0,90 mm
- 9 *Velapezoides pinna* sp. n. Paratypus, linke Klappe (IPUM 28022) in Lateralansicht, Länge 0,96 mm



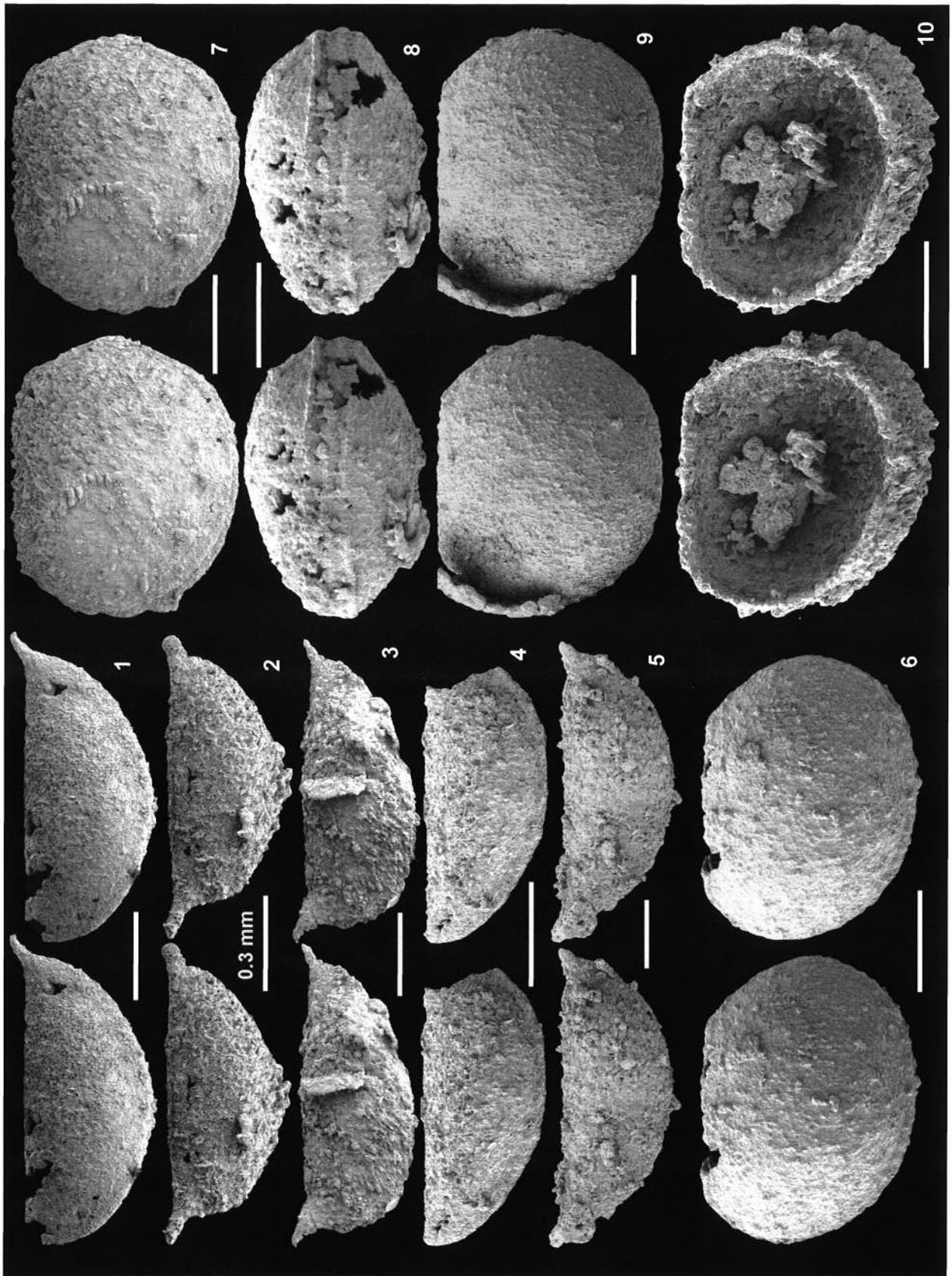
TAFEL 6 / PLATE 6

- 1 – 4 *Vogdesella minorbicularis* (SCHALLREUTER,2005). Left valves (IPUM 28023–28026) in lateral views, length 0.83, 1.05, 0.86, and 0.86 mm
 - 5 *Dornbuschia dinamica* SCHALLREUTER, HINZ-SCHALLREUTER, BALINI & FERRETTI,2006. Left valve (IPUM 28027) in lateral view, length 0.76 mm
 - 6 *Baldiscella* ? sp. n. Left valve (IPUM 28028) in lateral view, length 0.50 mm
 - 7 – 8 *Conodomyra conocerata* (BLUMENSTENGEL, 1965). Right valves (IPUM 28029–28030) in lateral view, length 0.61 mm
 - 9 *Olbianella* sp. C. Left valve (IPUM 28031) in lateral view, length 0.90 mm
 - 10 *Dornbuschia ventroconvexa* sp. n. Holotype, right valve (IPUM 28032) in lateral view, length 0.76 mm
-
- 1 – 4 *Vogdesella minorbicularis* (SCHALLREUTER,2005). Linke Klappen (IPUM 28023–28026) in Lateralansicht, Länge 0,83, 1,05, 0,86, bzw. 0,86 mm
 - 5 *Dornbuschia dinamica* SCHALLREUTER, HINZ-SCHALLREUTER, BALINI & FERRETTI,2006. Linke Klappe (IPUM 28027) in Lateralansicht, Länge 0,76 mm
 - 6 *Baldiscella* ? sp. n. Linke Klappe (IPUM 28028) in Lateralansicht, Länge 0,50 mm
 - 7 – 8 *Conodomyra conocerata* (BLUMENSTENGEL, 1965). Rechte Klappen (IPUM 28029–28030) in Lateralansicht, Länge 0,61 mm
 - 9 *Olbianella* sp. C. Linke Klappe (IPUM 28031) in Lateralansicht, Länge 0,90 mm
 - 10 *Dornbuschia ventroconvexa* sp. n. Holotypus, rechte Klappe (IPUM 28032) in Lateralansicht, Länge 0,76 mm



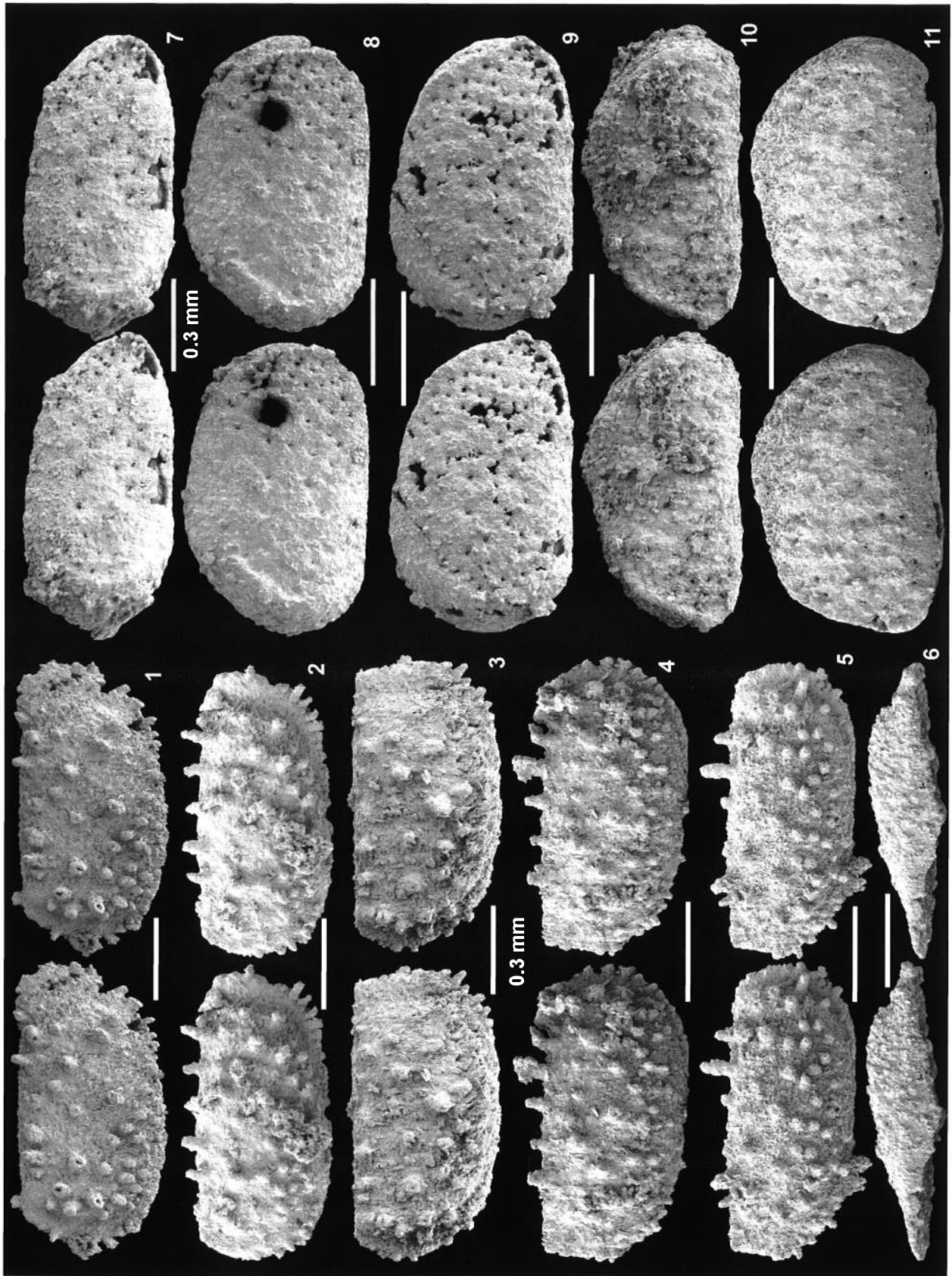
TAFEL 7 / PLATE 7

- 1 – 5 *Kozuriscapha dorsospinata* (BLUMENSTENGEL, 1965). 1,3,5 Left valves (IPUM 28033–28035) in lateral views, length 0.98 (without spine), 0.98 (without spines), and 1.34 mm resp., lateral views; 2 carapace (IPUM 28036) in dorsolateral view, length 0.95 mm; 4 anteriorly incomplete right valve (IPUM 28037) in lateral view, length > 0.81 mm
- 6 – 10 *Baltonotella angustovelata* (BLUMENSTENGEL, 1965). 6 Right valve (IPUM 28038) in lateral view, length 0.88 mm; 7 right valve (IPUM 28039) in lateral view, length 0.84 mm; 8 carapace (IPUM 28040) in ventral view (left valve upper), length 0.81 mm; 9 right valve (IPUM 28041) in lateral view, length 1.02 mm; 10 left valve (IPUM 28042) in interior view, length 0.88 mm
- 1 – 5 *Kozuriscapha dorsospinata* (BLUMENSTENGEL, 1965). 1,3,5 linke Klappen (IPUM 28033–28035) in Lateralansicht, Länge 0,98 (ohne Dorn), 0,98 (ohne Dornen) bzw. 1.34 mm; Lateralansichten; 2 Gehäuse (IPUM 28036) in Dorsolateralansicht, Länge 0,95 mm; 4 vorn unvollständige rechte Klappe (IPUM 28037) in Lateralansicht, Länge > 0,81 mm.
- 6 – 10 *Baltonotella angustovelata* (BLUMENSTENGEL, 1965). 6 Rechte Klappe (IPUM 28038) in Lateralansicht; Länge 0,88 mm; 7 rechte Klappe (IPUM 28039) in Lateralansicht, Länge 0,84 mm; 8 Gehäuse (IPUM 28040) in Ventralansicht (linke Klappe oben), Länge 0,81 mm; 9 rechte Klappe (IPUM 28041) in Lateralansicht, Länge 1,02 mm; 10 linke Klappe (IPUM 28042) von innen, Länge 0,88 mm



TAFEL 8 / PLATE 8

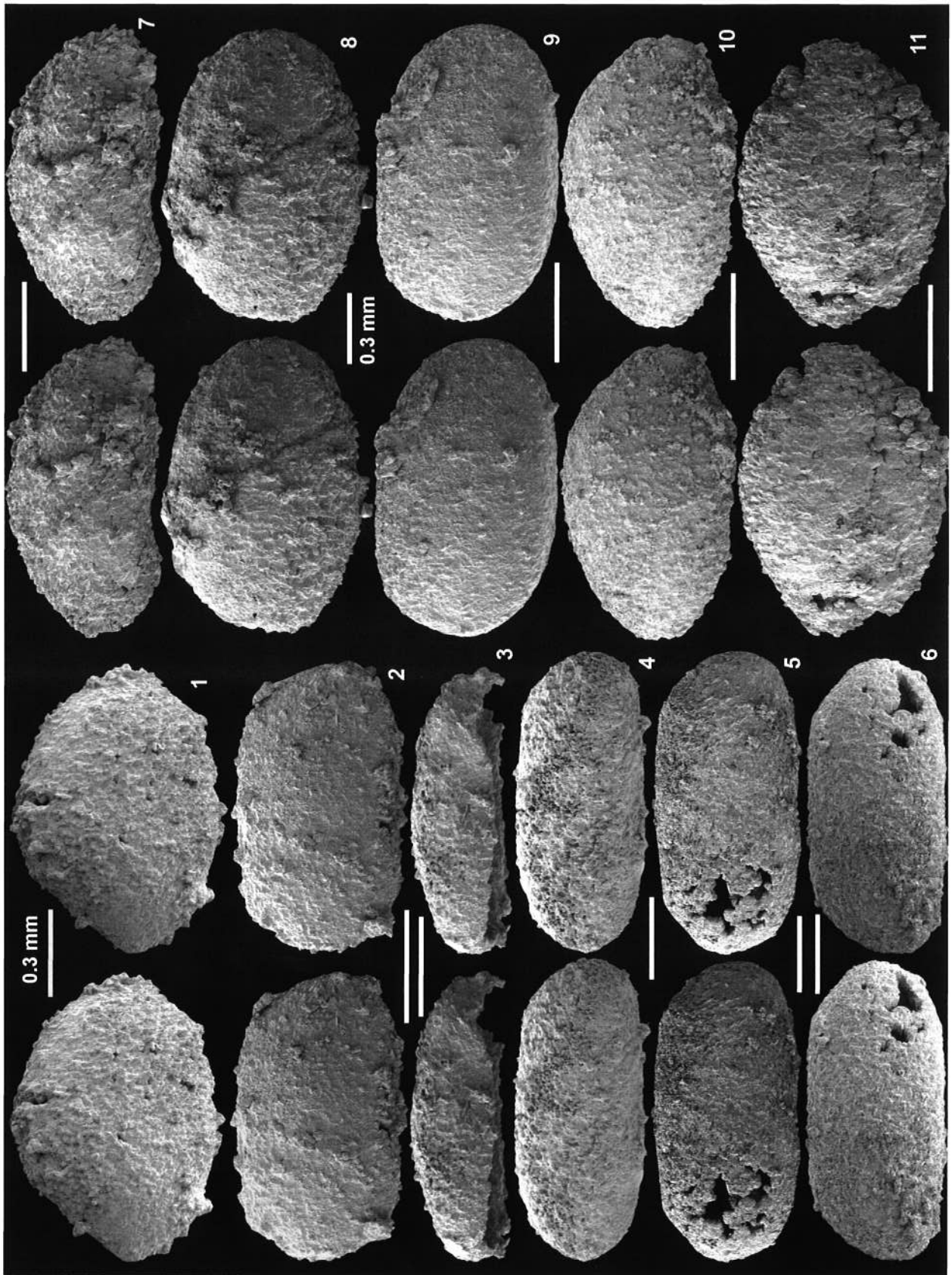
- 1 – 5 *Sardicornina italica* sp. n. 1–3 Left valves (IPUM 28043–28045) in lateral views, 4–5 right valves (IPUM 28046–28047) in lateral views, length 0.99, 0.95, 0.96, 0.86, and 0.90 mm, holotype (2) and paratypes
- 6 *Velapezoides pinna* sp. n. Paratype, left valve (IPUM 28048) in ventral view, length 1.00 mm
- 7 – 11 *Morphobealdia wiefeli wiefeli* BLUMENSTENGEL & SCHALLREUTER, 1997. 7–9 Left valves (IPUM 28049–28051) in lateral views, length 0.98, 0.85, and 0.79 mm; 10–11 right valves (IPUM 28052–28053) in lateral views, length 0.90, and 0.83 mm
- 1 – 5 *Sardicornina italica* sp. n. 1–3 Linke Klappen (IPUM 28043–28045) in Lateralansicht, Länge 0,99, 0,95 bzw. 0,96 mm; 4–5 rechte Klappen (IPUM 28046–28047) in Lateralansicht, Länge 0,86 bzw. 0,90 mm; Holotypus (2) und Paratypen
- 6 *Velapezoides pinna* sp. n. Paratypus, linke Klappe (IPUM 28048) in Ventralansicht, Länge 1.00 mm
- 7 – 11 *Morphobealdia wiefeli wiefeli* BLUMENSTENGEL & SCHALLREUTER, 1997. 7–9 Linke Klappen (IPUM 28049–28051) in Lateralansicht, Länge 0,98, 0,85 bzw. 0,79 mm; 10–11 rechte Klappen (IPUM 28052–28053) in Lateralansicht, Länge 0,90 bzw. 0,83 mm



TAFEL 9 / PLATE 9

- 1 *Bairdia wutzkei* sp. n. Holotype, right valve (IPUM 28054) in lateral view, length 1.00 mm
- 2 – 3 *Rectella* ? sp. A. Left (?) valves (IPUM 28055–28056) in lateral and ventral views, length 0.78, and 0.90 mm
- 4 – 6 *Elliptocyprites nesowa* SCHALLREUTER, 1988. Two left valves (IPUM 28057–28058) and right valve (IPUM 28059) in lateral views, length 1.22, 1.13, and 1.17 mm
- 7 *Longiscula* aff. *arcuaris* NECKAJA, 1958, left valve (IPUM 28060) in lateral view, length 0.98 mm
- 8 *Olbianella* cf. sp. A SCHALLREUTER, HINZ-SCHALLREUTER, BALINI & FERRETTI, 2006 ?, left valve (IPUM 28061) in lateral view, length 1.27 mm
- 9 *Elliptocyprites* ? sp. n. B, right valve (IPUM 28062) in lateral view, length 0.93 mm
- 10 *Olbianella* cf. sp. A SCHALLREUTER, HINZ-SCHALLREUTER, BALINI & FERRETTI, 2006, right valve (IPUM 28063) in lateral view, length 1.10 mm
- 11 *Easchmidtella* ? sp. n. A, right (?) valve (IPUM 28064) in lateral view, length 0.84 mm

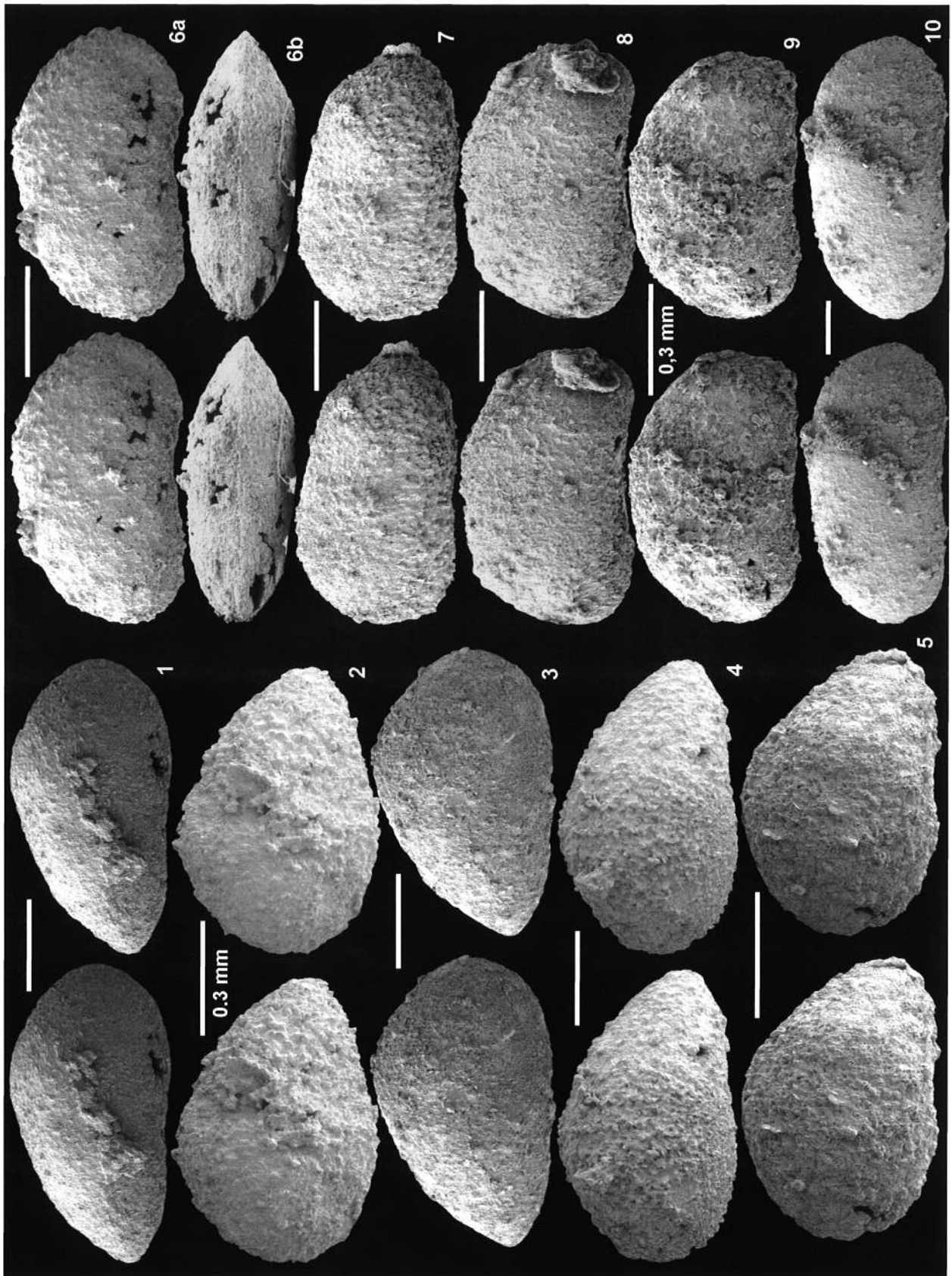
- 1 *Bairdia wutzkei* sp. n. Holotypus, rechte Klappe (IPUM 28054) in Lateralansicht, Länge 1,00 mm
- 2 – 3 *Rectella* ? sp. A. Linke (?) Klappen (IPUM 28055–28056) in Lateral- und Ventralansicht, Länge 0,78 bzw. 0,90 mm
- 4 – 6 *Elliptocyprites nesowa* SCHALLREUTER, 1988. Linke Klappe (IPUM 28057–28058) und rechte Klappe (IPUM 28059) in Lateralansicht, Länge 1,22, 1,13 bzw. 1,17 mm
- 7 *Longiscula* aff. *arcuaris* NECKAJA, 1958, linke Klappe (IPUM 28060) in Lateralansicht, Länge 0,98 mm
- 8 *Olbianella* cf. sp. A SCHALLREUTER, HINZ-SCHALLREUTER, BALINI & FERRETTI, 2006 ?, linke Klappe (IPUM 28061) in Lateralansicht, Länge 1,27 mm
- 9 *Elliptocyprites* ? sp. n. B, rechte Klappe (IPUM 28062) in Lateralansicht, Länge 0,93 mm
- 10 *Olbianella* cf. sp. A SCHALLREUTER, HINZ-SCHALLREUTER, BALINI & FERRETTI, 2006, rechte Klappe (IPUM 28063) in Lateralansicht, Länge 1,10 mm
- 11 *Easchmidtella* ? sp. n. A, rechte (?) Klappe (IPUM 28064) in Lateralansicht, Länge 0,84 mm



TAFEL 10 / PLATE 10

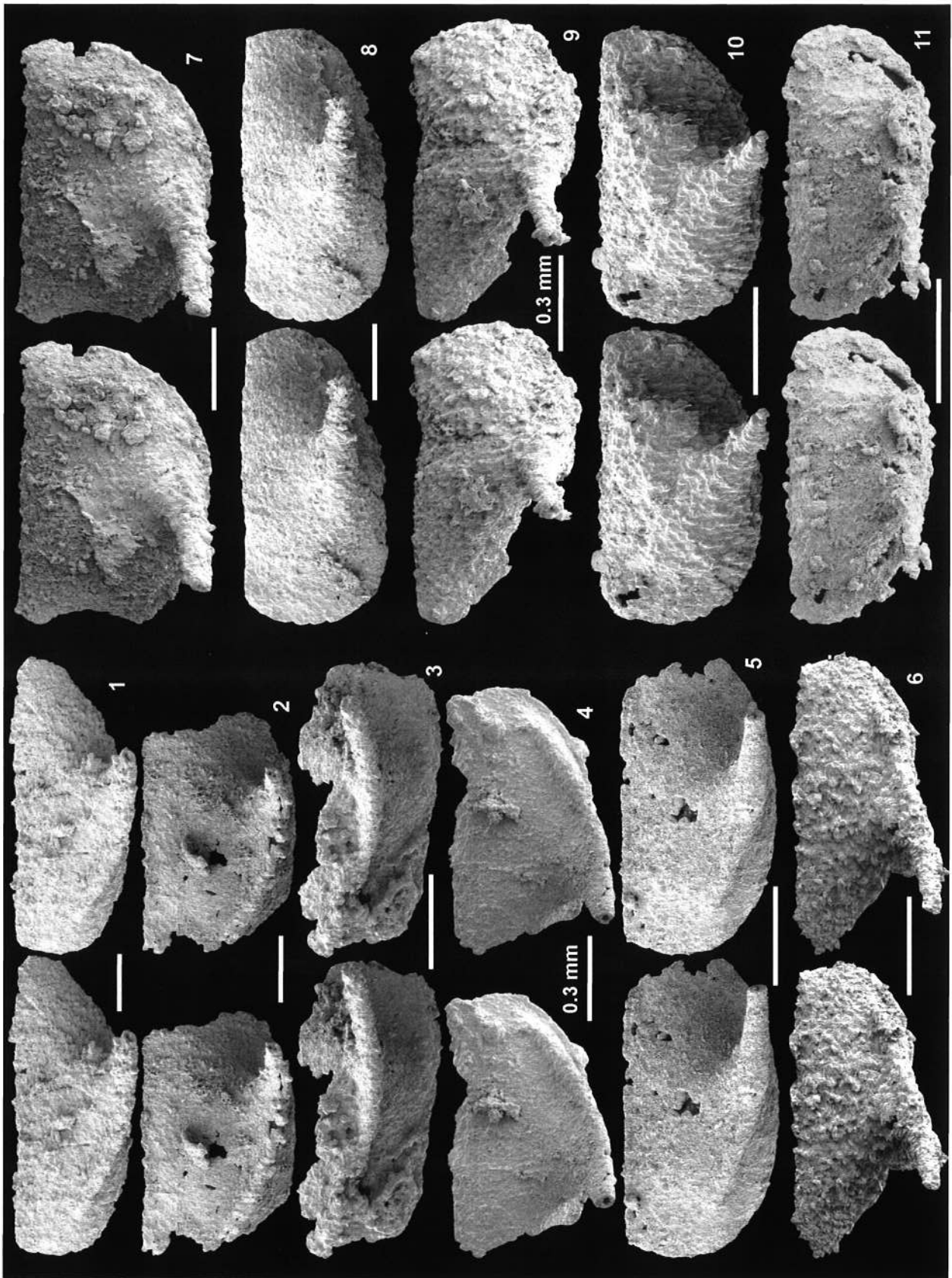
- 1 – 5 *Bairdiocypridella bairdiaformis* BLUMENSTENGEL, 1965. Right valves (1, 3) (IPUM 28065–28066) and left valves (IPUM 28067–28069) in lateral views, length 1.02, 0.78, 0.96, 0.97, and 0.71 mm
- 6 – 7 *Parasclerites* sp. B, carapace (IPUM 28070) from right and in ventral views, length 0.81 mm, and left valve (IPUM 28071) in lateral view, length 0.92 mm
- 8 *Parasclerites* cf. sp. B, right valve (IPUM 28072) in lateral view, length 0.93 mm
- 9 *Uthoernia* ? sp. A, right valve (IPUM 28073) in lateral view, length 0.73 mm
- 10 *Elliptocyprites* sp. C, right valve (IPUM 28074) in lateral view, length 1.63 mm

- 1 – 5 *Bairdiocypridella bairdiaformis* BLUMENSTENGEL, 1965. Rechte Klappen (1, 3) (IPUM 28065–28066) und linke Klappen (IPUM 28067–28069) in Lateralansicht, Länge 1,02, 0,78, 0,96, 0,97 bzw. 0,71 mm
- 6 – 7 *Parasclerites* sp. B, Gehäuse (IPUM 28070) von rechts und ventral, Länge 0,81 mm, und linke Klappe (IPUM 28071) in Lateralansicht, Länge 0,92 mm
- 8 *Parasclerites* cf. sp. B, rechte Klappe (IPUM 28072) in Lateralansicht, Länge 0,93 mm
- 9 *Uthoernia* ? sp. A, rechte Klappe (IPUM 28073) in Lateralansicht, Länge 0,73 mm
- 10 *Elliptocyprites* sp. C, rechte Klappe (IPUM 28074) in Lateralansicht, Länge 1,63 mm



TAFEL 11 / PLATE 11

- 1 – 6 *Tricornina compacta* KNÜPFER, 1968. 1 Left valve (IPUM 28075) in lateral view, length 1.61 mm; 2 anteriorly and posteriorly incomplete left valve (IPUM 28076) in lateral view, length >1.13 mm; 3 fragment of a left valve (IPUM 28077) in lateral view, length 1.00 mm; 4 fragment of a right valve (IPUM 28078) in lateral view, length 0.98 mm; 5 posteriorly incomplete left valve (IPUM 28079) in lateral view, length 0.93 mm; 6 right valve (IPUM 28080), length 0.93 mm
- 7 –11 *Tricornina haebneli* BLUMENSTENGEL, 1965. 7 Posteriorly incomplete right valve (IPUM 28081) in lateral view, length > 1.04 mm; 8 left valve (IPUM 28082) in lateral view, length 1.13 mm; 9 posteroventrally incomplete right valve (IPUM 28083) in lateral view, length 0.94 mm; 10 left valve (IPUM 28084), length 0.81 mm; 11 right valve (IPUM 28085) in lateral view, length 0.73 mm
- 1 – 6 *Tricornina compacta* KNÜPFER, 1968. 1 Linke Klappe (IPUM 28075) in Lateralansicht, Länge 1,61 mm; 2 vorn und hinten unvollständige linke Klappe (IPUM 28076) in Lateralansicht, Länge >1.13 mm; 3 Fragment einer linken Klappe (IPUM 28077) in Lateralansicht, Länge 1,00 mm; 4 Fragment einer rechten Klappe (IPUM 28078) in Lateralansicht, Länge 0,98 mm; 5 hinten unvollständige linke Klappe (IPUM 28079) in Lateralansicht, Länge 0,93 mm; 6 rechte Klappe (IPUM 28080), Länge 0,93 mm
- 7 –11 *Tricornina haebneli* BLUMENSTENGEL, 1965. 7 Hinten unvollständige rechte Klappe (IPUM 28081) in Lateralansicht, Länge > 1,04 mm; 8 linke Klappe (IPUM 28082) in Lateralansicht, Länge 1,13 mm; 9 posteroventral unvollständige rechte Klappe (IPUM 28083) in Lateralansicht, Länge 0,94 mm; 10 linke Klappe (IPUM 28084) in Lateralansicht, Länge 0,81 mm; 11 rechte Klappe (IPUM 28085) in Lateralansicht, Länge 0,73 mm



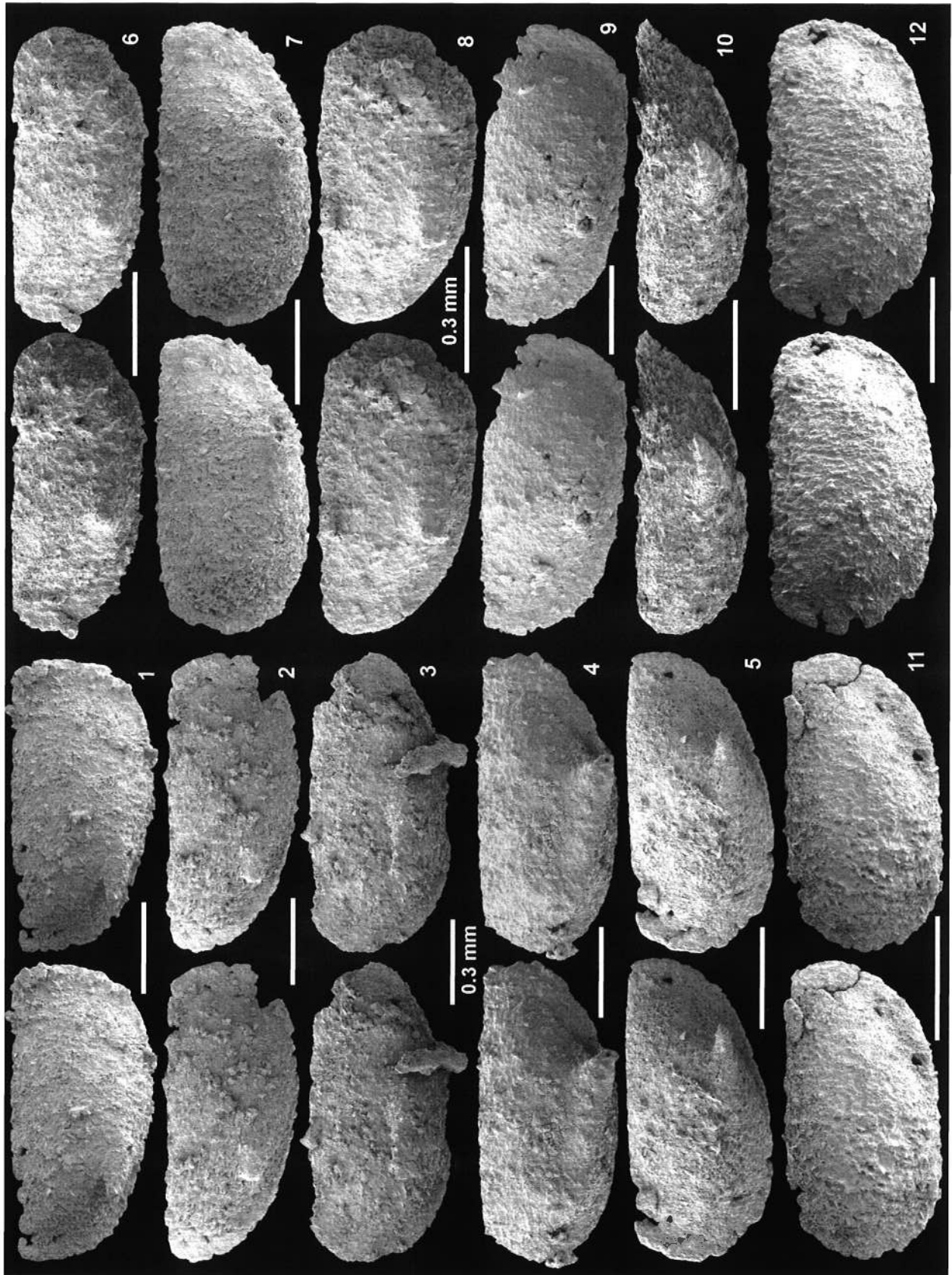
TAFEL 12 / PLATE 12

1 – 10 *Margoplanitia brevispina* (KNÜPFER, 1968). Right (IPUM 28086–28092) and left valves (4–5, 7; IPUM 28093–28095) in lateral views, length 1.10, 1.05, 0.98, 1.01, 0.93, 0.90, 0.91, 0.74, 1.05, and 0.97 mm

11 – 12 *Neoscaphina pseudopennae* SCHALLREUTER, HINZ-SCHALLREUTER, BALINI & FERRETTI, 2006. Left valves (IPUM 28096–28097) in lateral views, length 0.75, and 0.90 mm

1 – 10 *Margoplanitia brevispina* (KNÜPFER, 1968). Rechte (IPUM 28086–28092) und linke Klappen (4–5,7; IPUM 28093–28095) in Lateralansicht, Länge 1,10, 1,05, 0,98, 1,01, 0,93, 0,90, 0,91, 0,74, 1,05 bzw. 0,97 mm

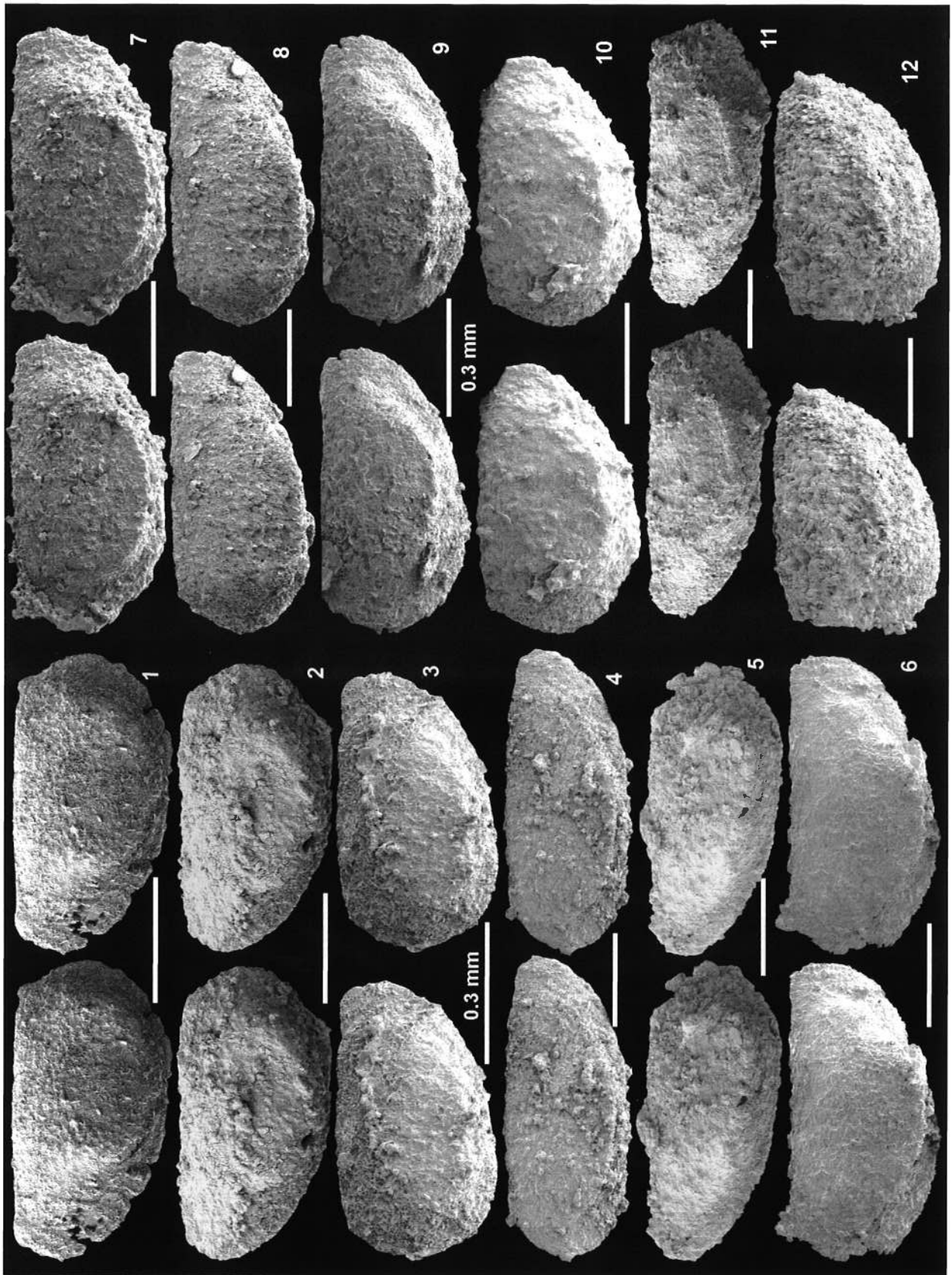
11 – 12 *Neoscaphina pseudopennae* SCHALLREUTER, HINZ-SCHALLREUTER, BALINI & FERRETTI, 2006. Linke Klappen (IPUM 28096–28097) in Lateralansicht, Länge 0.75 bzw. 0.90 mm



TAFEL 13 / PLATE 13

Brevicornina brevis (BLUMENSTENGEL, 1965). 1–2, 5, 11 Right valves (IPUM 28098–28101) in lateral views, length 0.73, 0.79, 0.89, and 1.11 mm; 3–4, 6–10, 12 left valves (IPUM 28102–28109) in lateral views, length 0.62, 1.03, 0.89, 0.78, 0.90, 0.76, 0.68, and 0.76 mm. Specimen of fig. 12 compressed longitudinally

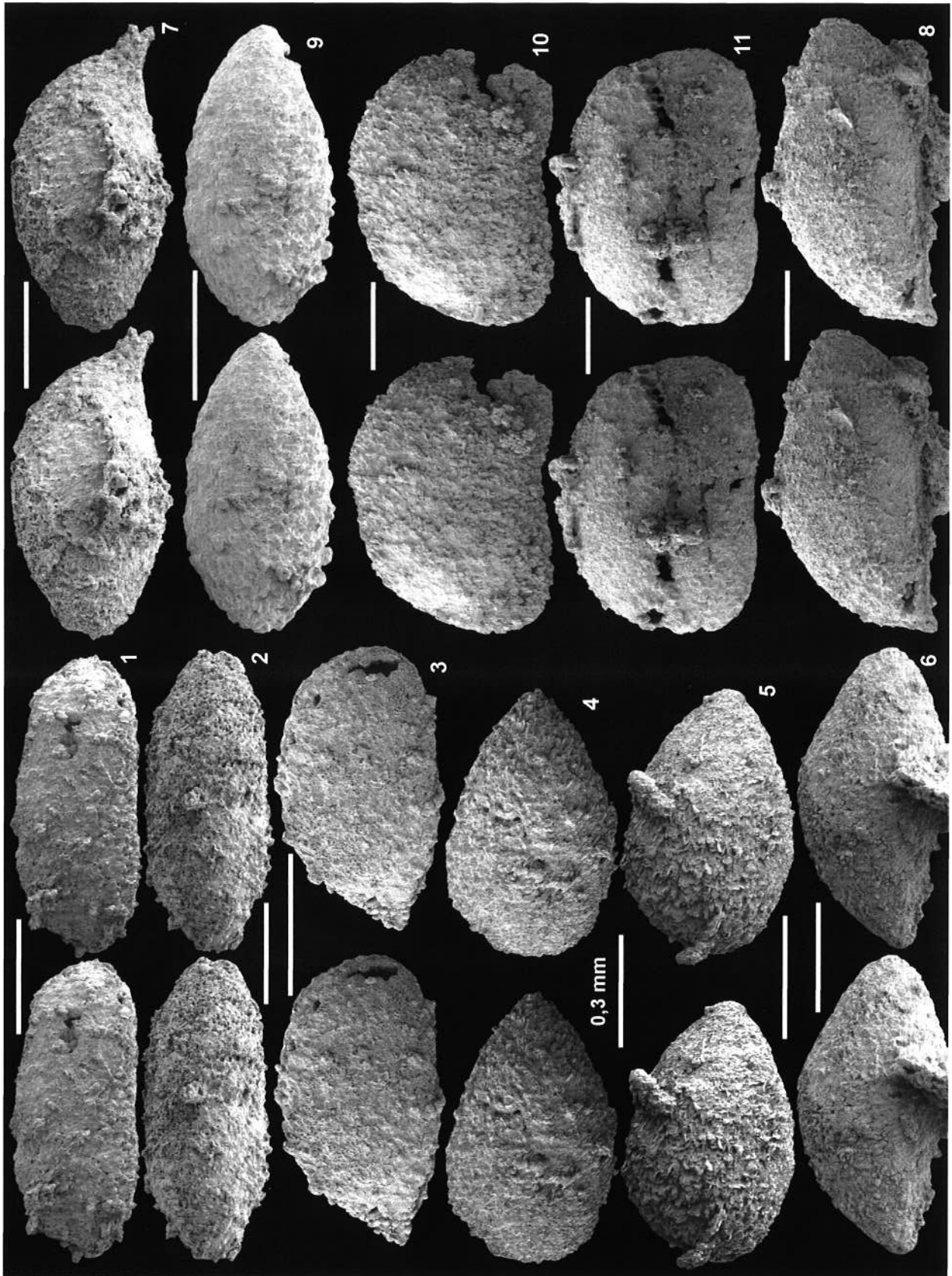
Brevicornina brevis (BLUMENSTENGEL, 1965). 1–2, 5, 11 Rechte Klappen (IPUM 28098–28101) in Lateralansicht, Länge 0,73, 0,79, 0,89, and 1,11 mm; 3–4, 6–10, 12 linke Klappen (IPUM 28102–28109) in Lateralansicht, Länge 0,62, 1,03, 0,89, 0,78, 0,90, 0,76, 0,68 bzw. 0,76 mm. Exemplar von Fig. 12 longitudinal verzerrt



TAFEL 14 / PLATE 14

- 1 *Dornbuschia ventroconcava* sp. n. Paratype, right valve (IPUM 28110) in lateral view, length 0.79 mm
- 2 *Dornbuschia* ? sp. A, right valve (IPUM 28111) in lateral view, length 0.90 mm
- 3 *Dornbuschia bornemanni* sp. n., holotype, carapace (IPUM 28112) from right, length 0.62 mm
- 4 – 5 *Bairdiocypridella* ? *libratogutta* sp. n., left valves (IPUM 28113–28114) in lateral views, length 0.73, and 0.66 mm, holotype (4), and paratype
- 6 – 8 *Bairdiocypridella anterosecata* sp. n. Paratypes, left valve (IPUM 28115) and right valve (IPUM 28116) in lateral views, and holotype (8), carapace (IPUM 28117) from right, length 0.85, 0.89 (with spine), and 1.10 mm
- 9 *Bairdiocypridella* ? sp. n. A, left valve (IPUM 28118) in lateral view, length 0.71 mm
- 10 – 11 *Arcuaria* ? sp. n. A, right valve (IPUM 28119) and left valve (IPUM 28120) in lateral views, length 0.95, and 1.12 mm

- 1 *Dornbuschia ventroconcava* sp. n. Paratypus, rechte Klappe (IPUM 28110) in Lateralansicht, Länge 0,79 mm
- 2 *Dornbuschia* ? sp. A, rechte Klappe (IPUM 28111) in Lateralansicht, Länge 0,90 mm
- 3 *Dornbuschia bornemanni* sp. n., Holotypus, Gehäuse (IPUM 28112) von rechts, Länge 0,62 mm
- 4 – 5 *Bairdiocypridella* ? *libratogutta* sp. n. Linke Klappen (IPUM 28113–28114) in Lateralansicht, Länge 0,73 bzw. 0,66 mm, Holotypus (4) und Paratypus
- 6 – 8 *Bairdiocypridella anterosecata* sp. n. Paratypen, rechte und linke Klappe (IPUM 28115–28116) in Lateralansicht und Holotypus (8), Gehäuse (IPUM 28117) von rechts, Länge 0,85, 0,89 (ohne Dorn) bzw. 1,10 mm
- 9 *Bairdiocypridella* ? sp. n. A, linke Klappe (IPUM 28118) in Lateralansicht, Länge 0,71 mm
- 10 – 11 *Arcuaria* ? sp. n. A, rechte (IPUM 28119) und linke Klappe (IPUM 28120) in Lateralansicht, Länge 0,95 bzw. 1,12 mm



TAFEL 15 / PLATE 15

1 – 9 *Prorectella erratica* sp. n. Right and left valves (IPUM 28121–28129) in lateral views or interior view (9), length 1.08, 0.95, 0.88, 0.78, 0.75, 0.95, 0.78, 1.17, and 0.78 mm. Fig. 8 valve with SCOTT retention?

10 *Prorectella erratica* sp. n.?, left (?) valve (IPUM 28130), interior view, length 0.68 mm

1 – 9 *Prorectella erratica* sp. n. Rechte und linke Klappen (IPUM 28121–28129) in Lateral- und Innenansicht (9), Länge 1,08, 0,95, 0,88, 0,78, 0,75, 0,95, 0,78, 1,17 bzw. 0,78 mm. Fig. 8 Klappe mit SCOTT'scher Retention?

10 *Prorectella erratica* sp. n.?, linke (?) Klappe (IPUM 28130) in Innenansicht, Länge 0,68 mm

