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LINGULIFORMEAN AND CRANIIFORMEAN BRACHIOPODS OF THE ORDOVICIAN (TŘENICE TO DOBROTIVÁ FORMATIONS) OF THE BARRANDIAN, BOHEMIA

MICHAL MERGL
Department of Biology, University of West Bohemia, Klatovská 51, 306 19 Plzeň, Czech Republic

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Abstract. A revision of linguliformean and craniiformean brachiopods of the Třenice, Mílina, Klabava, Šárka and Dobrotivá Formations confirms the presence of 61 species of the order Lingulida, twelve species of the order Acrotretida, ten species of Siphonotretida, four species of Paterinida and two species of Craniida. In total, 89 species have been recognized, 16 of them newly described and 15 determined only in generic level. Three new genera have been established: *Mytoella, Wosekella*, and *Eoschizotreta*. Three main community groups are recognized in the early Ordovician of the Barrandian having limited stratigraphical significance. The *Obolus* C. G. (*Hyperobolus* Community and westoniid communities) characterizes a transgressive, coarse siliciclastic base of the Ordovician, which was followed by the *Leptembolon* Community and the *Acrotreta*-elkaniid Community of the *Acrotreta* C. G. in the latest Tremadocian and the early Arenigian times. Both community groups were in the middle Arenigian followed by a new lingulate fauna of the *Paterula* assemblage in the deeper environment, but by mixed orthid-lingulate faunas in shallower environments. The Barrandian early Ordovician brachiopod fauna is closely related to the early Ordovician linguliformean brachiopod fauna of the Scandinavia and east European platform. This indicates a common interchange of the planctotrophic linguliformean brachiopods between the distant palaeocontinents, namely Baltica and North Gondwana in early Ordovician times.

■ Brachiopoda, Lingulata, Paterinata, Craniata, taxonomy, palaeoecology, Ordovician, Barrandian, Bohemia

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Introduction

Organophosphatic brachiopods are, along with trilobites and orthid brachiopods, the most significant macrofossils in the Lower and Middle Ordovician marine sediments. They have been intensively studied in the last two decades. New technical facilities, such as scanning electron microscope, microprobes, EDX and molecular studies make possible the study of morphological details, shell structure and biochemistry that is reflected in the new conception of the organophosphatic brachiopod phylogeny. The new phylogeny introduced in *Treatise on Invertebrate Paleontology, part H, Brachiopoda* (Williams et al. 1997, 2000) is accepted by the present author. However, many questions of the linguliformean brachiopod phylogeny remain uncovered, and a systematic study will have to be inevitable done at some time.

The Lower and Middle Ordovician sequence of the Barrandian is remarkably rich in the organophosphatic brachiopods. This was evident already since the pioneer work of Joachim Barrande (1879) and the essential study of Vladimír Havlíček (1982b). New methods and S.E.M. facility uncovered high diversity and excellent preservation of microbrachiopods also in the Barrandian. Their diversity and morphological disparity are comparable to the rich lingulate brachiopod faunas in terraines with the lime sedimentation in the Ordovician period (Baltic area, Kazakhstan, Laurentian platform) despite the almost exclusively siliciclastic sedimentation in the Barrandian during Ordovician time.

The systematic part describes or presents 87 linguliformean species, some of them only at generic level. A few additional species including the species present in the studied material and the giant obolid *Thysanobolus giganteus* (KOLIHA) have not been incorporated into the paper. This ensues from rarity of material, less favourable preservation and problems with the taxonomic placement. Nevertheless, other but rare finds often indicate a longer stratigraphical range of particular taxon and despite their imperfect knowledge, the presented data may be significant for the brachiopod phylogeny. Rare low-conical shells from the late Tremadocian sediments may be referred to craniiform brachiopods, and thus represent their earliest known occurrence yet recorded.

Historical overlook

The first linguliformean brachiopods were described from the Barrandian area by Joachim Barrande in 1879. In his earlier brachiopod work published in 1848 (Barrande 1848) he noted the presence of *Lingulella attenuata* from quartzites of Quartzit-Etage (D) (= Letná Formation, Drabov Quartzites in current stratigraphy) but without any detailed stratigraphical or locality data.

Thirty years later, Barrande (1879) assigned 53 species from the Ordovician period to the lingulate and craniiformean brachiopods, 28 of them from the Třenice, Mílina, Klabava, Šárka, and Dobrotivá Formations of current stratigraphical sense. He established the new genus *Paterula* BARRANDE, the remaining species were referred by him

to genera *Lingula* BRUGUIÈRE, *Obolus* EICHWALD and *Discina* LAMARCK. He did not present species descriptions or diagnoses and only fine lithographic drawings define the new species. Substantial part of his collection, the type specimens and other topotypic material currently are stored in the National Museum, Prague and are accessible for study.

Some comments on the stratigraphic position of the early Ordovical linguliformean brachiopods were given by Jaroslav J. Jahn (1904). His field observations and critical study of Barrande's originals resulted in the compilation of the species list with valuable locality and stratigraphical data.

Between 1915 and 1925, Prof. Celda Klouček, an excellent fossil collector of the early 20th century, presented several papers about fossils from the Lower Ordovician of the Barrandian. Apart from the faunal lists including brachiopods from several localities (Klouček 1915, 1917a, 1917b, 1919, 1924a, 1925), he described the acrotretid *Acrotreta minima* var. *grandis* KLOU. n. sp. (Klouček 1919) from the Třenice Formation and *Obolus complexus* var. *punctatus*, n. var., and *Paterula* ? *prima* n. sp. (Klouček 1924a) from the Klabava Formation. Unfortunately, he did not select any type specimens and presented only diagrammatic drawings; therefore, his types cannot be recognized in his collection which is currently kept in the National Museum, Prague and the neotypes have been selected (Havlíček 1980b, Mergl 1999b). The extensive Klouček's collection has been used in the current study.

In a preliminary work, Jan Koliha (1918) discussed differences between the genera *Lingula* BRUGUIÈRE, *Lingulella* SALTER, and *Obolella* BILLINGS, and described eleven species from the Lower Ordovician of the Barrandian, three of them as new [*Obolus Kloučeki* n. sp., *Obolus Nováki* (KLOUČEK) n. sp., *Lingulella libečovensis* n. sp]. He discussed the presence of genera *Orbiculoidea* ORBIGNY and *Acrotreta* KUTORGA. Several varietes [*Obolus* (*Lingulobolus*) *Feistmanteli* (BARR.) var. *acicutirostris* n. var., *O.* (*L.*) *Feistmanteli* (BARR.) var. *tenuilamellosa* n. var., *Obolus* (*Westonia*?) *lamellosus* (BARR.) var. *elongata* n. var.] defined by Koliha (1918) were by later revisions (Koliha 1924, Havlíček 1982b) recognized as invalid taxa. In 1924, Koliha revised "atrematid" brachiopods from the Krušná hora Beds (Třenice Formation, Mílina Formation and Olešná Beds Member of the Klabava Formation). He described twelve species and subspecies, among them *Obolus* (*Lingulobolus*) *Feistmanteli* (BARR.) var. *Barrandei prima* n. var., *Lingulella insons* (BARR.) var. *lata* n. var. and *Lingulella Bukovensis* n. sp. All the described species he refered to the genera *Obolus* and *Lingulella*, although his material comprised also siphonotretids and elkaniids. Apart from the descriptions, he also presented important locality and stratigraphical data. The latter have been very usefull recently, but illustrations of the described species are poor. Two years later, Koliha (1926) described the stratigraphy and the brachiopod fauna from the quarry "Na Chrástnici" in Břežany II east of Prague. He discussed the morphology and stratigraphical significance of the species *Obolus barrandei* (KLOUČEK) and noted its identity with *Thysanotos siluricus* (EICHWALD). He also noted the presence of other small brachiopods, referred by him to *Obolus*, *Lingulella*, *Acrotreta,* and *Orbiculoidea*, but without any other data. In his last paper, Koliha (1938) discussed the stratigraphical significance of lingulate brachiopods for the stratigraphy of Bohemia, and named, omitting the formal description, a giant obolid *Obolus giganteus* n. sp. from the quarry "Na Chrástnici" in Břežany II.

The third author studying the Lower Ordovician brachiopods between the World Wars was Robert Růžička. He described remarkable rich fauna from haematite lens discovered in an abandoned iron ore mine near Holoubkov (V Ouzkém), including the lingulate and paterinate brachiopods. In his second work (1927) he determined twelve linguliformean brachiopods. Of these, he described newly the species *Micromitra* (*Iphidella*) *Walcotti* n. sp., *Kutorgina Kolihai* n. sp., *Siphonotreta Krafti* n. sp., and *Siphonotreta simulans* n. sp. and presented the first formal description of the species *Acrotreta grandis* KLOUČEK. His drawings are highly diagrammatic but descriptions and generic determinations are remarkably accurate. Other lingulate brachiopods from the clayey shale of the Klabava Formation were studied between the wars by J. V. Želízko. In 1921, he described and well-illustrated six lingulate brachiopods and defined *Lingulella amygdala* ŽEL. and *Lingulella pusilla* ŽEL. as new species. In 1943, Ferdinand Prantl described the unique find of a large siphonotretid which he referred to the species *Siphonotreta verrucosa* (EICHWALD) known only from the Baltic area till that time. The specimens were found by G. Měska in a core of borehole in Krušná hora, in volcanoclastic sediments of the upper part of the Klabava Formation. All the specimens of these authors are currently stored in the palaeontological collections of the National Museum, Prague.

After the Second World War, the study of lingulate brachiopods in the Barrandian ceased. In 1972, Vladimír Havlíček shortly described and illustrated the species *Ptychopeltis* sp. n. from the siliceous nodule of the Dobrotivá Formation and in the paper about inarticulate brachiopods from the Montagne Noire (1980a) he defined a new genus *Rafanoglossa* g. n., based on the Bohemian species *Lingula impar* BARRANDE. His paper about acrotretid brachiopods (1980b) contains redescription of *Conotreta grandis* (KLOUČEK) and descriptions of two new acrotretid species *Conotreta turricula* sp. n. and *C. obesa* sp. n. from the Olešná Beds Member of the Klabava Formation, and the Třenice Formation, respectively. A short paper describing six species of the genus *Orbithele* SDZUY appeared shortly later (Mergl 1981).

In 1982, Havlíček presented a new approach to the linguliformean brachiopods. He recognized 40 species in the Třenice, Mílina, Klabava, Šárka, and Dobrotivá Formations which he referred to 22 genera, of which thirteen were established as new. Besides this, he established a new subfamily Schizamboninae subfam. n. In this paper, the author totally omitted the order Acrotretida KUHN, which had

been described earlier (Havlíček 1980b). The extensive Havlíček's brachiopod collection is currently housed in the regional Museum of Dr. Bohuslav Horák at Rokycany and is accessible for study.

The outstanding works of Holmer (1989) and especially of Popov and Holmer (1994) that presented revision of many Baltoscandinavian Lower Ordovician lingulate brachiopods, make a modern reevaluation of the Bohemian taxa possible. The first revision (Mergl 1994) about elkanids has been followed by short papers about lingulates of the Třenice, Mílina and Klabava Formations (Mergl 1995, 1996, 1997a, 1997b, 1997d, and 1999b). Havlíček and Vaněk (1996) in their analysis of Dobrotivian/Berounian boundary interval noted the occurrences of *Paterula circina transiens* n. subsp., *Paldiskites subditivus* (WILLIAMS) and *Ptychopeltis salopiensis* (WILLIAMS) in the Dobrotivá Formation (early Middle Ordovician).

Text-fig. 1: The Bohemian Massif with the Ordovician of the Barrandian (1); the position of fossiliferous Tremadocian in Bavaria is indicated, with the Leimitz-Schiefer near Hof (2) and the Vogtendorf-Schichten near Vogtendorf (3). The territory of the Czech Republic is grey.

Material

The lingulate brachiopods were collected from all common sedimentary rocks in the Barrandian. Unlike other extensive and described material of linguliformean brachiopods (Cooper 1956, Holmer 1989, Popov and Holmer 1994), the Czech material is preserved in siliciclastic rocks. Limestones are exceptional and currently uknown in natural outcrops. Thus, the quality of brachiopod preservation tightly depends on the particular rock type. Five taphonomic groups of brachiopods can be differentiated, each of them has been studied by particular method.

The coarse sandstone, greywacke, and sandy matrix in conglomerate and breccia yielded poorly preserved and often fragmentary shells, with the original shell preserved by weathered whittish mineral (probably collophanite). Natural internal and external moulds commonly lack fine morphological details. The preparation of artificial moulds did not offer satisfactory results. It is quite common that sand grains intersect and penetrate the original shell wall and deform it. Brachiopod shells from chert of the Mílina Formation and chert lenses of the Třenice Formation are also poorly preserved, with the original phosphatic shells removed and replaced by secondary silica film. The valves display only general shell morphology. Siltstones and shales, and rarely also some chert beds yielded well preserved internal and external moulds, with shell already lacking or substituted by white soft mineral (collophanite by former authors; Kettner 1916, Koliha 1924). The shells are often fragmentary, with numerous cracks, indicating fragility and breakage inside unconsolidated sediment. The evidence of post-mortal dissolvement is lacking in contrast to the comparatively poorly preserved calcareous shells. This mode of preservation is characteristic for coarse to medium grained, often red-coloured siliciclastic sediments (fine-grained greywackes, siltstones and shales) of the Třenice, Mílina. and Klabava Formations (Olešná Beds Member). The removal of rests of the shells in fine sediments by means of hydrochloric acid resulted in obtaining preserved internal and external moulds suitable for study and preparation of latex casts, sometimes of an excellent quality.

Grey-green shales, black shales, and thin beds of highly calcareous hyaloclastites bear grey, dark-brown to black-coloured shells, sometimes heavily carbonised. In contrast to the brachiopod shells derived from siliceous nodules and bioclastic limestones (often silicified), the shells show flexible deformation and sometimes also partial etching. This mode of preservation is typical for the deeper lithofacies of the Šárka and Dobrotivá Formations, and it is locally present also in dark clayey shales, massive hyaloclastites, oolite ferolites and bioclastic limestones of the Klabava Formation.

In rocks rich in haematite, the original organophosphatic shell material may be partially or wholly substituted by quartz with thin haematite film covering outer and inner shell surfaces. This mode of preservation is generally rare and is restricted to a few localities with haematite lenses near the base of the Ordovician sequence. Similar preservation is less common in tuffaceous rocks and sandstones with haematite cement. The finest morphological details, especially of the outer shell surface, are sometimes preserved on the external moulds covered by thin haematite film.

The unusual mode of preservation has been observed in clay-phosphatic clasts embedded in fine-grained siltstone and greywacke near the base of the Olešná Beds Member of the Klabava Formation. The organophosphatic shells were partially and mostly superficially substituted by resistant phosphate mineral and left empty spaces inside the shell wall.

The last mode of preservation has been observed in translucent red-grey cherts in the upper part of the Třenice Formation. The classic hammering of chert yielded only poorly preserved internal and external moulds. The cutting of chert layers (often less than 1 cm in thickness) into several mm thick sheets, and polishing of their surface made possible the study of excellently three-dimensionally pre-

served micromorphous brachiopods (acrotretids) inside the rock. However, these shells cannot be satisfactorily illustrated.

Methods

Substantial part of the fossil material, mainly of large-to medium-sized shells, was obtained by hammering and observed by a binocular microscope. A dissolution of the sediment by the means of three acids was successfully used in three different rock types.

The acetic acid was successfully used for dissolution of thin, mm to cm thick, intercalations of white and grey bioclastic and in some parts silicified limestones which occur locally and are restricted to the upper part of the Klabava Formation (Upper Arenig). After the dissolution of calcite by the means of 10 % acetic acid, the resulting porous and fragile rock pieces remained in the solution. They were washed, mechanically broken and the residues were sieved. Dried and often intact shells and shell fragments were sorted out under the binocular microscope.

The hydrochloric acid in 15 % solution has been used for the etching of clay-phosphatic clasts, which were previously separated by hammering from the particular greywacke bed near the base of the Klabava Formation (Olešná Beds Member). The residues were washed, sieved, and dried. The very fragile, often corroded tiny shells and small shell fragments shells were sorted out under the binocular microscope.

The hydrofluoric acid dissolution was used in a limited amount. That is because most of fossilized shells were destroyed together with the sediment. Only the siliceous nodules of the Šárka Formation (Llanvirnian) rarely yielded very fragile remains of phosphatic shells. However, as the lingulate brachiopods are generally rare and heavily carbonised in siliceous nodules and the volume of etched rock was limited, only a small amount of specimens was gathered by this method. The small rock pieces (about 2–3 g) were, after the previous removing of carbonate content by acetic acid solution, treated by 10 % hydrofluoric acid, washed and dried. Generally very small and fragile shells and their fragments were sorted out under the binocular microscope.

The released brachiopod shell material was mounted to stabs, covered by gold and studied in S. E. M.

External moulds, mostly artificially prepared after removing the shell by the means of hydrochloric acid, were used for preparation of the latex casts. The latex casts of some selected specimens were prepared and studied also in S. E. M. under low magnification.

Repositories

All specimens figured or mentioned in the text are stored in the public collections, with a code for the repository followed by an institution registration number for the specimens. The specimens of Vladimír Havlíček‘s collection, currently stored in Museum of Dr. Bohuslav Horák, Rokycany are noted with the catalogue number of the museum along with the original VH collection numbers to avoid confusion with the original works of V. Havlíček.

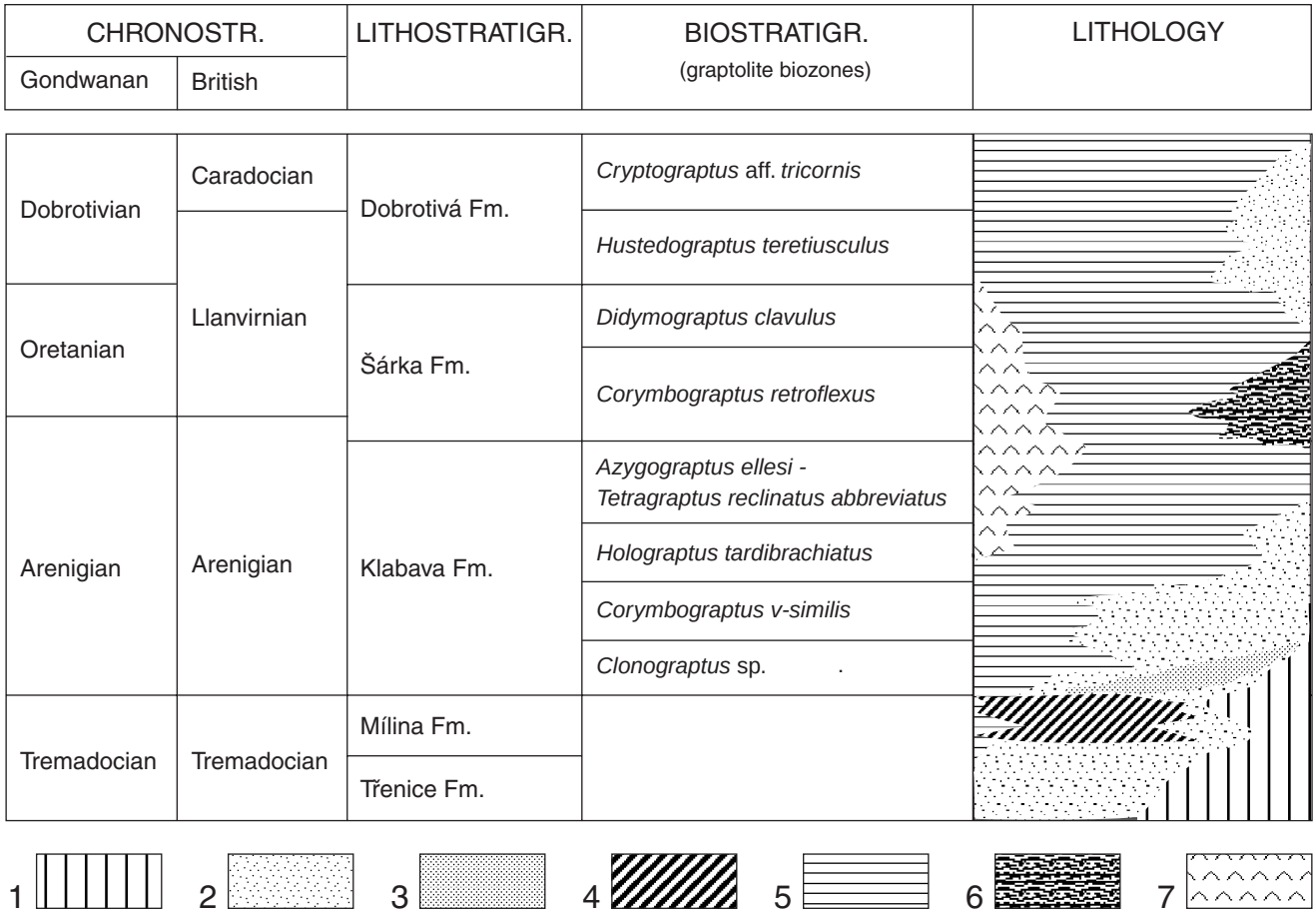
The institution codes used in this study are as follows:
ČGÚ MM – Czech Geological Survey, Prague (collection of the author).
MBHR – Museum of Dr. Bohuslav Horák, Rokycany (mainly collections of V. Havlíček, J. Kraft, and P. Kraft).
NM L – National Museum, Prague (mainly collections of J. Barrande, J. Koliha, C. Klouček, J. V. Želízko, and R. Růžička).
PCZCU – University of West Bohemia in Plzeň, Plzeň (collection of the author).
TJ – Uppsala University, Uppsala, Sweden.
ZČM S – Museum of West Bohemia, Plzeň.

Geological and stratigraphical setting

The Palaeozoic of the Barradian area comprises the Cambrian to Middle Devonian sequence, located in the central part of the Bohemian Massif (Chlupáč et al. 1998). It extends from Starý Plzenec near Plzeň in SW to Břežany II in NE (Text-fig. 1). The area was affected by Variscan folding and faulting, followed by erosion, and from the Upper Carboniferous also by platform fluvio-lacustrine and marine sedimentation, mainly of the Westfalian, Upper Cretaceous and Neogene ages.

Two units bounded by a marked unconformity have been recognized in the Barrandian area. The Middle Cambrian marine sedimentation was in the upper Cambrian followed by an uplift and erosion with a local terrestrial and lacustrine sedimentation and extensive subaeric volcanism. The early Ordovician transgression over the unevenly eroded land in the new, tectonically predisposed Prague Basin was heterochronnous and resulted in marked facies differentiation. Local sources gave origin to various conglomerates, breccias, coarse to fine grained greywackes, shales, chert beds and lenses of ferolites. The culmination of the transgression, extension of the basin from the Arenigian time and high sea-level stand in Llanvirnian and Dobrotivian brought more uniform sedimentation into the later preserved part of the basin. The new volcanic centre of the Komárov volcanogenic komplex affected the sedimentation by a supply of volcanic ashes and hyaloclastites from the early Arenigian time.

The problems of international correlation between particular terraines and general acceptance of the British stratigraphical scheme resulted in the establishment of regional chronostratigraphical units by Havlíček and Marek (1973) for the Middle and Upper Ordovician in the Barrandian (Dobrotivian, Berounian, Královdvorian, and Kosovian Series). The British scale has been retained only for the Lower Ordovician in the Barrandian. This scheme has not been accepted for the entire North Gondwanan area and new local series have been introduced (e. g. Oretanian). Until the new formal stratigraphical correlation of the Barrandian units with a new chronographical standard is accepted,



Text-fig. 2: Stratigraphy of the Lower, Middle and early Upper Ordovician of the Barrandian (after Chlupáč et al. 1998, and Kraft and Kraft 1999, modified). 1 – land (hiatus), 2 – conglomerates, sandstones, greywackes, siltstones, 3 – red siltstones and shales (Olešná Beds Member), 4 – cherts, 5 – grey-green and black clayey shales, 6 – ferolites, 7 – volcanic rocks.

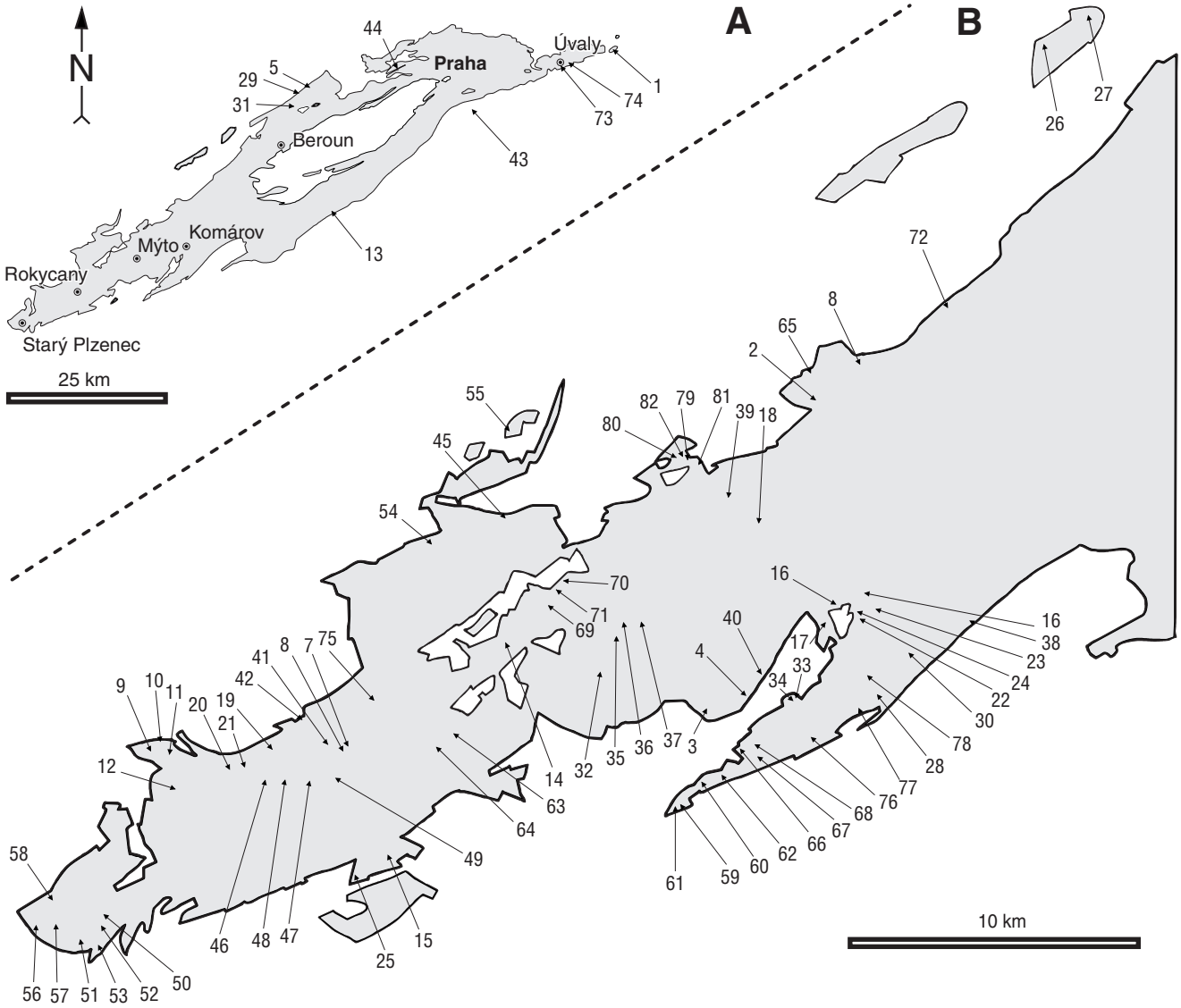
the Havlíček and Marek (1973) scheme, presented lastly in 1998 (Chlupáč et al. 1998) is with changes according to Kraft and Kraft (1993a) adopted herein (Text-fig. 2).

The earliest transgressive Ordovician units, the Třenice and Mílina Formations, are referred to the Upper Tremadocian; the Klabava Formation, including the Olešná Beds Member (generally confined to the lower part of the formation), and the boundary interval between the Klabava and Šárka Formations are referred to the Arenigian; the Šárka Formation is referred to the Llanvirnian; the Dobrotivá Formation is referred to the Dobrotivian. The biostratigraphical subdivision based on graptolite of the Klabava and Šárka Formations has been accepted after Kraft and Kraft (1999). The detailed lithostratigraphy of the Mílina and Klabava Formations boundary beds in the Komárov area is figured in Text-fig. 4, to illustrate particular levels noted in the text.

Localities

Details of fossil sites concerning the specimens cited and figured in the text and plates are given below. At present, there exists no any standard list of palaeontological localities of the Ordovician units of the Barrandian. Many localities have ambiguous names or are referred to by the names of the nearby but different villages or towns. Numerous fossils, especially in the old institutional collections (the National Museum, Geological Survey) come from old, recently abandoned mines, small and presently fild quarries and destroyed dumps, temporary road and highway cuts, building excavations, wells, core boreholes, and other temporary exposures. References to many Lower and Middle Ordovician fossil sites can be found in Kettner (1916), Koliha (1924), Mergl (1984, 1986, 1992, 1997d), Kraft (1977), Kraft and Kraft (1990, 1992, 1993b, 1994). The following list of the most significant fossil sites includes the commonly used names (local name in Czech followed by English translation), the rock type, geographical location and stratigraphical age; the localitions of sites are given in Text-fig. 3.

1. Březany II (lom "Na Chrástnici" – "Na Chrástnici"quarry): Sandstones and grey cherts intercalations and nodules in the large abandoned quarry "Na Chrástnici" near Březany II village E of Prague; Upper Tremadocian, Třenice and Mílina Formations.
2. Cerhovice (Cerhovská hora – Cerhovská hora Hill): Greywackes, cherts and red siltstones in large old quar-



Text-fig. 3: Map of the Barrandian, showing key localities and outcrops of Ordovician rocks (A) and detail of the SW part of the same area (B). Numbers refer the list of localities in text.

ries (currently partly destroyed) on E slope of the Cerhovská hora Hill and small natural outcrops on E and SE slope of the Cerhovská hora Hill near Cerhovice village; Upper Tremadocian to Lower Arenigian, Třenice, Mílina and lower part of the Klabava Formations (Olešná Beds Member). Type locality of the Třenice Formation.

3. Cheznovice (Janovky): Greywackes and massive haematites in wooded dumps of old iron ore mine in the forest Janovky SW to Cheznovice village; Upper Tremadocian, Třenice Formation.
4. Cheznovice (Žlebec): Greywackes, microconglomerates and cherts in wooden dumps of old small iron ore mine in the forest Žlebec S of Cheznovice village; Upper Tremadocian, Třenice and Mílina Formations.
5. Chrbina (štola – gallery): Greywackes and tuffites from the dump of the Chrbina gallery in Chyňava creek valley; Upper Tremadocian and Arenigian, Třenice and Klabava Formations.
6. Díly (jih – south): Tuffaceous shales nad phosphorite greywacke in a temporary highway cut and rock debris in close vinicity of the highway near Díly lonely house (part of Volduchy village); Arenigian, Klabava Formation, the uppermost part (*Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone).
7. Díly (pole – field): Siliceous nodules in soil in fields S of the Díly lonely house (part of Volduchy village); Llanvirnian, Šárka Formation (*Corymbograptus retroflexus* Biozone).
8. Drozdov (Holý vrch a Obiš – Holý vrch and Obiš Hills): Greywackes in small abandoned quarries in S slope of the Holý vrch Hill and Obiš Hill near Drozdov village; Upper Tremadocian, Třenice Formation.
9. Ejpovice (vrty – borings): Various sediments in core boreholes in the area between Klabava, Ejpovice and Kyšice villages; Arenigian, Klabava Formation, upper part (*Azygograptus ellesi – Tetragraptus reclinatus ab-*

breviatus Biozone) and Dobrotivian, Dobrotivá Formation.

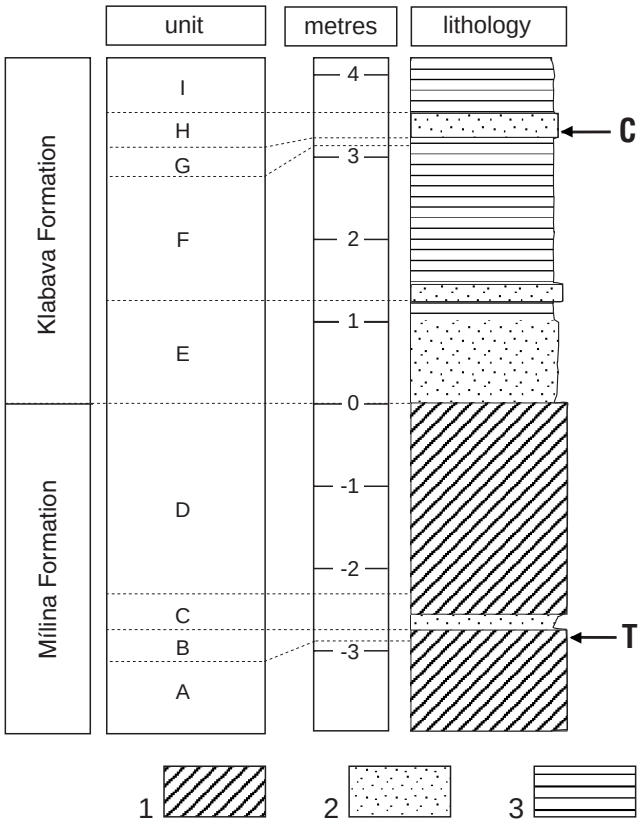
10. Ejpovice (lom, severovýchodní část – quarry, NE part): Tuffites, tuffaceous shales and oolithic iron ores in numerous small exposures along N and E banks of the flooded large iron ore quarry near Ejpovice village; Arenigian, Klabava Formation, upper part (*Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone).
11. Ejpovice (lom, jižní část – quarry, S part): Black clayey shales in small outcrops in S bank of the flooded large iron ore quarry near Ejpovice village; Dobrotivian, Dobrotivá Formation (*Cryptograptus* aff. *tricornis* Biozone).
12. Ejpovice (zářez dálnice – highway cut): Black shales in temporary outcrops in a highway cut along the foot of the Čilina Hill SE to Ejpovice village; Dobrotivian, Dobrotivá Formation (*Hustedograptus teretiusculus* Biozone).
13. Hatě (Vrahův potok – Vrahův potok creek): Red siltstones, tuffaceous shales and tuffites in small exposures in the left bank of a small pond on the Vrahův potok creek S to Hatě village; Arenigian, Klabava Formation, Olešná Beds Member.
14. Holoubkov (V Ouzkém): Massive quartzose haematites in wooded old dumps of an abandoned mine "V Ouzkém" NW to Holoubkov village; Upper Tremadocian, Třenice Formation.
15. Hrádek (gorge): Brown-violet siltstones and greywackes in natural outcrops in a deep gorge in NW margin of Hrádek town; Arenigian, Klabava Formation, lower part.
16. Jivina (staré lomy – old quarries): Greywackes, cherts and red siltstones in old quarries along the way from the Jivina village to Komárov town; Upper Tremadocian to lower Arenigian, Třenice and Mílina Formations, and the Olešná Beds Member of the Klabava Formation.
17. Jivina (Jivina Hill): Greywackes, cherts and red siltstones in natural exposures and rock debris on slopes and top of the Jivina Hill near Komárov town; Upper Tremadocian to lower Arenigian, Třenice and Mílina Formations, and the Olešná Beds Member of the Klabava Formation.
18. Kařízek (důl Veronika – Veronika mine): Siderite oolithic iron ores in old dumps of an abandoned mine Veronika near Kařízek village; Dobrotivian, Dobrotivá Formation.
19. Klabava (Klabavská přehrada – Klabava dam): Natural small outcrops of clayey shales in NE bank of the Klabava dam near Klabava village; Arenigian, Klabava Formation, middle part (*Hologratus tardibrachiatus* Biozone).
20. Klabava (štola Kristiánka – Kristiánka gallery): Tuffites in old dump in front of the Kristiánka gallery near Klabava village; Arenigian, Klabava Formation, upper part.
21. Klabava (U Starého hradu – Old Castle): Natural outcrops of clayey shales located in the eastern wooded slope of a deep erosive furrow, about 350 m ESE from the Klabava railroad station near Klabava village; Arenigian, Klabava Formation, upper part (*Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone). The type locality of the Klabava Formation.
22. Kleštěnice (důl Stanislav – Stanislav mine): Tuffites, tuffaceous shales and oolithic iron ores in an old dump on high right bank of Jalový potok creek near Kleštěnice village; Arenigian, Klabava Formation, upper part.
23. Kleštěnice (stará halda – old dump): Tuffites, tuffaceous greywackes, red shales, and oolithic iron ores in a large dump on right bank of Jalový potok creek near Kleštěnice village; Arenigian, Klabava Formation, upper part.
24. Kleštěnice (profil podél Jalového potoka – section along the Jalový potok creek): Natural outcrops of greywackes, cherts, red siltstones, tuffites, and tuffaceous shales in steep slope on the right bank of the Jalový potok creek near Kleštěnice village; Upper Tremadocian to Arenigian, the Třenice, Mílina and Klabava Formations.
25. Kotel (Kotel Hill): Red siltstones in dumps of old test pits in the N slope of Kotel Hill S of Rokycany town; Arenigian, Klabava Formation, Olešná Beds Member.
26. Krušná hora (důl Gabriela – Gabriela mine): Greywackes, shales, tuffites and iron ores in dumps of an abandoned iron ore mine Gabriela in the SW slope of Krušná hora Hill near Hudlice village; Upper Tremadocian to Arenigian, the Třenice and Klabava Formations (*Hologratus tardibrachiatus* Biozone).
27. Krušná hora (štola – gallery): Greywackes in dumps of old mines in Nový Jáchymov in the E and N slopes of Krušná hora Hill near Hudlice village; Upper Tremadocian, Třenice Formation.
28. Kváň (pole – field): Cherts and red siltstones in stony debris at field located along a low ridge near the S margin of Kváň village near Zaječov village; Tremadocian to Lower Arenigian, Mílina and Klabava Formations (Olešná Beds Member).
29. Libečov (Na Močidle): Fine sandstones and siltstones in natural outcrops in the valley of Chyňava potok creek near Libečov village; Upper Tremadocian, Třenice Formation.
30. Malá Víska (důl Hlava – Hlava mine): Siderite iron ores and silicites intercalations in tuffs in wooded dumps in abandoned iron ore mine Hlava N of Malá Víska village; Arenigian, Klabava Formation.
31. Malé Přílepy (pole – field): Siliceous nodules in soil in fields near Malé Přílepy village; Dobrotivian, Dobrotivá Formation.
32. Medový Újezd (lom – quarry): Greywackes and red siltstones in the old quarry in Medový Újezd village; Upper Tremadocian and Lower Arenigian, Třenice Formation and lower part of the Klabava Formation (Olešná Beds Member).
33. Mílina (Mílina Hill): Greywackes, cherts and siltstones

in old quarries in the NW slope of the Mílina hill near Olešná village; Upper Tremadocian to lower Arenigian, Třenice, Mílina and lower part of the Klabava Formations (Olešná Beds Member). The type locality of the Mílina Formation.

34. Mílina (štola – gallery): Tuffites and tuffaceous shales in front of the old gallery in meadows W of the Mílina hill near Olešná village; Arenigian, Klabava Formation, upper part.
35. Mýto (pole – fields): Siliceous nodules in soil in fields NW of Mýto town; Llanvirnian, Šárka Formation.
36. Mýto (zářez dálnice – highway cut): Tuffaceous and clayey shales and siliceous nodules in the N slope of a higway cut near Mýto town; Upper Arenigian to Dobrotivian, upper part of the Klabava Formation, Šárka and Dobrotivá Formations.
37. Mýto (Štěpánský rybník – St. Stephen pond): Tuffites, tuffaceous and clayey shales and siliceous nodules along the NW margin of the Štěpánský rybník pond near Mýto town and in an old quarry and fields N of the railway; Arenigian to Llanvirnian, upper part of the Klabava Formation and the Šárka Formation.
38. Neřežín (Jedová hora – Jedová hora Hill): Haematite and tuffaceous shales in wooded dumps of an abandoned iron and quicksilver ore mine near Neřežín village; Arenigian, upper part of the Klabava Formation.
39. Pětidomky: Siliceous nodules in soil in the fields east of Pětidomky (part of Kařez village); Llanvirnian, Šárka Formation.
40. Olešná (lom – quarry): Cherts and red siltstones in an old quarry 500 m NE from Olešná village; Upper Tremadocian and Lower Arenigian, Mílina and Klabava Formations. The type locality of the Olešná Beds Member of the Klabava Formation.
41. Osek (pole – field): Siliceous nodules in soil in the fields between Osek and a highway cut N of Rokycany; Llanvirnian, Šárka Formation and much rare material of Dobrotivian, Dobrotivá Formation.
42. Osek (stará halda – old dump): Tuffites and tuffaceous shales in an old, now destroyed dump in the field SW of Osek village; Arenigian, upper part of the Klabava Formation.
43. Praha – Kunratický hrádek: Tuffaceous shales and silty shales in small exposures in the E margin of ruins of Kunratice Castle in the S part of Prague; Arenigian, Klabava Formation.
44. Praha – Motol: Black clayey shales and nodules in a railroad cut in Praha – Motol; Dobrotivian, upper part of the Dobrotivá Formation.
45. Rač: Tuffites in small old dumps on the N foot of the Rač Hill near Skomelno village; Arenigian, upper part of the Klabava Formation.
46. Rokycany (Drahouš): Clayey shales in natural outcrops in slope and a small quarry N of the highway in the Klabava river valley and temporary outcrops during the highway built between Rokycany town and Klabava village; Arenigian to Llanvirnian, upper part of the Klabava Formation (*Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* and *Corymbograptus retroflexus* Biozones) and the Šárka Formation.
47. Rokycany (Stráň): Entensive natural and temporary artificial outcrops of clayey shales on the N margin of Rokycany town, with many local sites (see Kraft and Kraft 1977, 1992, 1993, 1994); Arenigian, lower to upper part of the Klabava Formation (*Corymbograptus v-similis* to *Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozones).
48. Rokycany (zářez dálnice – highway cut): Temporary outcrops of clayey shales in a highway cut N of Rokycany town; Arenigian, Klabava Formation (*Hologaptus tardibrachiatus* Biozone).
49. Rokycany (Husinec): Clayey shales in small exposures and temporary excavations on the S margin of Rokycany town; Lower Arenigian, lower part of the Klabava Formation (*Corymbograptus v-similis* Biozone).
50. Sedlec (Sutice): Black clayey shales in natural outcrops in the W slope of the Sutice Hill near Sedlec village; Dobrotivian, Dobrotivá Formation.
51. Sedlec (obec – village): Natural and temporary outcrops (mainly excavations of wells) of clayey shales in the N part of the Sedlec village; Arenigian, Klabava Formation (*Corymbograptus v-similis* to *Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozones), Llanvirnian, Šárka Formation (*Corymbograptus retroflexus* Biozone) and Dobrotivian, Dobrotivá Formation (*Cryptograptus* aff. *tricornis* Biozone).
52. Sedlec (jih Sutice – Sutice, south): Grey-green and black clayey shales in natural outcrops in the S and W slopes of the Sutice Hill NE of Sedlec village; Lower Arenigian, Klabava Formation (lower part, *Corymbograptus v-similis* Biozone).
53. Sedlec (strž – gorge): Siltstones and sandstones in natural outcrops in a short erosive furrow near the junction of Tymákovský potok and Lhůtský potok creeks and temporary excavations in a field above the gorge near Sedlec village; latest Tremadocian to lower Arenigian, Klabava Formation (horizon with *Clonograptus* and *Corymbograptus v-similis* Biozone).
54. Sklenná Huť (vrty – boreholes): Tuffites and tuffaceous limestone in core boreholes near Sklenná Huť village; Arenigian, Klabava Formation, upper part.
55. Skomelno (Na Solích): Greywackes in old dumps in forest Na Solích near Skomelno village; Upper Tremadocian, Třenice Formation.
56. Starý Plzenec (U Blažeje): Natural outcrops of shales in the slope above the alluvial plain of the Úslava river, some 1 km W from the centre of Starý Plzenec town; Arenigian, middle part of the Klabava Formation (*Hologaptus tardibrachiatus* Biozone).
57. Starý Plzenec (Černá stráň): Natural outcrops of black clayey shales in the steep S slope of the Hůrka Hill NE of Starý Plzenec town; Dobrotivian, middle and upper part of the Dobrotivá Formation.
58. Starý Plzenec (Kocanda): Massive and oolithic

pelosiderites in dumps of an old iron mine in Kocanda N of Starý Plzenec town; Arenigian, lower part of the Klabava Formation (probably *Corymbograptus v-similis* Biozone).

59. Strašice (pole u sv. Vojtěcha – field near St. Vojtěch): Red-brown siltstones from temporary excavations in a fied and along the field way between Strašice town and near the cemetery with the St. Vojtěch Church; Arenigian and Lower Llanvirnian, the Klabava and Šárka Formations.
60. Strašice (východ – east): Red-brown siltstones in a road cut in the fields E from Strašice town; Arenigian, lower part of the Klabava Formation (Olešná beds Member).
61. Strašice (východní okraj obce – E margin): Red-brown siltstones in temporary excavations in the centre and along the E margin of the Strašice town; Arenigian, lower part of the Klabava Formation (Olešná Beds Member).
62. Strašice (u silnice – near road): Tuffites, red-brown siltstones, and oolite ferolites in a temporary exposure near the road from Strašice town to Těně village; Upper Arenigian, the top of the Klabava Formation.
63. Svojkovice (Závírka): Clayey shales in natural outcrops E of Svojkovice village; Arenigian, lower part of the Klabava Formation.
64. Svojkovice (silniční zářez – road cut): Siltstones and clayey shales in a road cut W of Svojkovice village; Arenigian, lower part of the Klabava Formation.
65. Tejček: Greywackes in an old quarry "Na Čihadle" near Tejček village; Upper Tremadocian, Třenice Formation.
66. Těně (západ – west): Greywackes, siltstones and cherts from the top of a low smooth hill near the road from Strašice to Těně, 700 m W of Těně village; Upper Tremadocian and lower Arenigian, Mílina and lower part of the Klabava Formations (Olešná beds Member) (Text-fig. 4).
67. Těně (obec – village): Greywackes and siltstones from temporary excavations in the N margin of Těne village; Arenigian, Klabava Formation (Olešná Beds Member).
68. Těně (silniční zářez – road cut): Greywackes and siltstones in aroad cut N of Těně village; Lower Arenigian, lower part of the Klabava Formation (Olešná Beds Member).
69. Těškov (pole – field): Siliceous nodules in soil in the fields SW of Těškov village; Llanvirnian, Šárka Formation (*Corymbograptus retroflexus* Biozone).
70. Těškov (Kněžský vrch – Kněžský vrch Hill): Breccias and coarse greywackes in upper level of a large quarry at Kněžský vrch Hill NE of Těně village; Upper Tremadocian, Třenice Formation.
71. Těškov (obec – village): Excavations in clayey shales and siltstones in Těškov village; Arenigian, Klabava Formation (*Hologroptus tardibrachiatus* and *Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozones).
72. Točník: Natural outcrops of red siltstones in a ridge west of Točník Castle; Arenigian, lower part of the Klabava Formation (Olešná Beds Member).



Text-fig. 4: Lithology of the upper Mílina Formation and the lower Klabava Formation in the Komárov area of the W part of the Barrandian. The units refer paper of Mergl (1986). The greywacke with clay clasts used for hydrochloric acid etchig method is indicated by C, the bed with *Thysanotos siluricus* (EICHWALD) is indicated by T. 1 – chert, 2 – greywacke, 3 – siltstone.

73. Úvaly (stará halda – old dump): The sandstones and siltstones in old dumps of the W margin of Úvaly town; Třenice and Mílina Formations.
74. Úvaly (Vinice): Small natural outcrops in slope Na Vinici on the NE margin of Úvaly town; the Mílina Formation.
75. Volduchy (Kašparův vrch – Kašparův vrch Hill): Small outcrops of clayey shales on the E side of the road from Volduchy to Rokycany, about 100 m SW of the bridge above the Voldušský potok creek; Arenigian, Klabava Formation (*Hologroptus tardibrachiatus* Biozone).
76. Zaječov (Hrbek): Greywackes and siltstones in stony debris in a field and wooded low ridge called "Hrbek" 750 m SWS of Zaječov village; Lower Arenigian, Klabava Formation (Olešná Beds Member).
77. Zaječov (lom u školy – quarry near the school building): Red greywackes, siltstones and cherts in a small quarry and a cut of the road near the scholl building in Zaječov village; Tremadocian to lower Arenigian, Mílina Formation and lower part of the Klabava Formation (Olešná Beds Member). The locality was named St. Benigna (Svatá Dobrotivá) by J. Barrande (1879).
78. Zaječov (Svatá Dobrotivá): Black clayey shales from the

Kozojedy gallery near Zaječov; Dobrotivian, Dobrotivá Formation. The type locality of the Dobrotivá Formation.

79. Zbiroh (Bukov – Bukov Hill): Tuffaceous shales, bioclastic limestones and tuffites in wooded dumps at the top and on the N slope of the Bukov Hill near Zbiroh town; Arenigian, upper part of the Klabava Formation.
80. Zbiroh (Bukov, stará halda – Bukov, old dump): Conglomerate with haematite cement in an old dump in the NW slope of the Bukov Hill near Zbiroh town; Upper Tremadocian, the base of the Třenice Formation.
81. Zbiroh (staré lomy – old quarries): Greywackes, sometimes with haematite cement in the S slope of the Bukov Hill near Zbiroh town; Upper Tremadocian, the base and lower part of the Třenice Formation.
82. Zbiroh (Bukov, Josefská štola – Bukov, Joseph gallery): Tuffaceous shales, bioclastic limestones and tuffites in a dump in front of the Joseph gallery in the N slope of Bukov Hill near Zbiroh town; Arenigian, upper part of the Klabava Formation.

Linguliformean brachiopod communities and biostratigraphy

The discrete brachiopods fossil assemblages that comprise lingulate and orthid brachiopods have been used by former authors (Jahn 1904, Koliha 1938) for biostratigraphical subdivision of the Třenice, Mílina, and lower part of the Klabava Formations (Olešná Beds Member) (= the Krušná hora Beds in the original stratigraphical scheme of Kettner and Kodym 1919). In the new scheme, Havlíček and Vaněk (1966) accepted some biostratigraphical importance of the orthid brachiopod *Jivinella*, but unlike Koliha (1938), they omitted the lingulate brachiopods.

There is little doubt that the lithofacies is the main factor controlling the spatial distribution of the linguliformean brachiopods. The extant burrowing lingulides prefer clayey sand, fine sand or coarse sand with fine-grained sandy matrix while discinids are epifaunal on a hard substrate (Emig 1997). A similar dependence may be inferred for their extinct relatives. Consequently, being the classical facies-related invertebrate group, the linguliformean brachiopods have a limited biostratigraphic significance. Being often the only skeletal fossils in sediments, the brachiopods can be used for the palaeoenvironmental reconstruction and approximate biostratigraphic correlation in the basin.

Several discrete brachiopod communities (named assemblages or associations by other authors; e. g. Popov and Holmer 1994) can be determined in the Třenice, Mílina, Klabava, Šárka, and Dobrotivá Formations (Text-fig. 5). Three linguliformean community groups (C. G.) in sense of Boucot (1975) may be distinguished in the basin in the early Ordovician (Havlíček 1982a, 1989, Mergl 1999c): The *Obolus* C. G., *Acrotreta* C. G., and *Paterula* C. G.

Obolus Community Group

Transgressive siliciclastic sediments near the base of the Ordovician sequence comprise distinct low-diversity palaeocommunities with dominance of large and generally thick-shelled obolids and zhanatellids. They are referred to the *Obolus* C. G. which may be considered as the Gondwannan counterpart of the *Ungula-Schmidtites* and *Obolus-Helmersenia* assemblages of Baltoscandinavia (Puura 1996).

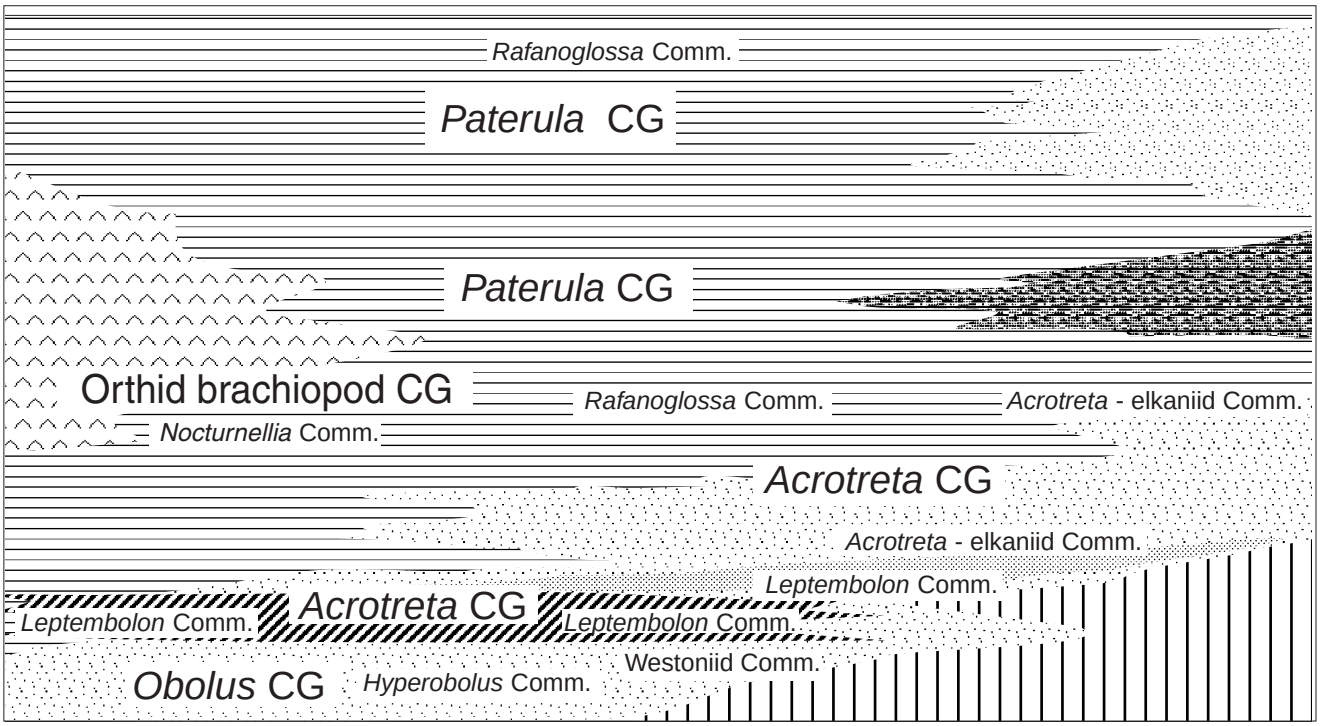
Hyperobolus Community

The *Hyperobolus* Community is characterized by large and moderate- to thick-walled brachiopods, with dominant *Hyperobolus feistmanteli, Expellobolus expulsus*, and *Orbithele secedens* associated by less common to rare acrotretid *Acrotreta grandis* and obolid *Teneobolus bukovensis*. However, the taxonomic composition can significantly fluctuate, and sometimes the large acrotretid *Acrotreta grandis* is the dominant element and *Hyperobolus feistmanteli* is rare. The characteristic species *Hyperobolus feistmanteli* may be associated or substituted by other large zhanatellid species *Rosobolus magnus*. The epibenthic (*Orbithele, Acrotreta*) to semiendobenthic (*Hyperobolus, Rosobolus*) elements are common, with the strictly endobenthic *Expellobolus* being present locally. The community occupied unconsolidate sandy bottom along the NW margin of the basin, covering continuously the area between the Krušná hora tectonic islet and Zbiroh. It has only patchy presence in the westward extremes of the Prague Basin (Medový Újezd, Těškov, Cheznovice, Holoubkov). The community is restricted to the Třenice Formation, especially to its lower, transgressive part and is sometimes followed by the *Leptembolon* Community in the upward deepenig sequence.

Westoniid communities

The different large lingulate brachiopod communities are represented by obolids with well-defined terrace lines which occur in the low-diversity *Westonisca* and *Libecoviella* Communities. The brachiopod fauna of the *Westonisca* Community is represented exclusively by *Westonisca lamellosa*. The *Libecoviella* Community yields two different species, *Libecoviella arache* and *L. ovata*, respectively. In both communities, the brachiopod shells are moderate to large sized, thick-walled, with surface bearing divaricate terrace lines indicating good adaptation to the burrowing mode of life in a dynamic marine environment (Savazzi 1986). The taphonomy and stratigraphical data of fossil-bearing beds indicate spatial and probably also stratigraphical separation of these communities. However, the chronostratigraphical level of the beds with these communities is not well proved. The *Westonisca* and *Libecoviella* Communities are known in the Třenice Formation in the area between Libečov and Svárov villages north of Beroun, and in the Bukov Hill near Zbiroh.

The low-diversity westoniid communities are widely known from the middle and upper Cambrian strata where they commonly constitute monospecific shell accumulations in shallow water near-shore siliciclastic lithofacies (Walcott 1912, Legrand 1969, Mergl and Linan 1996). Their presence in the early Ordovician of the Barrandian in-



Text-fig. 5: Distribution of the brachiopod benthic communities and the community groups in the Lower, Middle and early Upper Ordovician of the Barrandian. Stratigraphy and lithology same as in Text-fig. 2.

dicates persistence of this low-diversity Cambrian type of communities to the Lower Ordovician.

Acrotreta Community Group

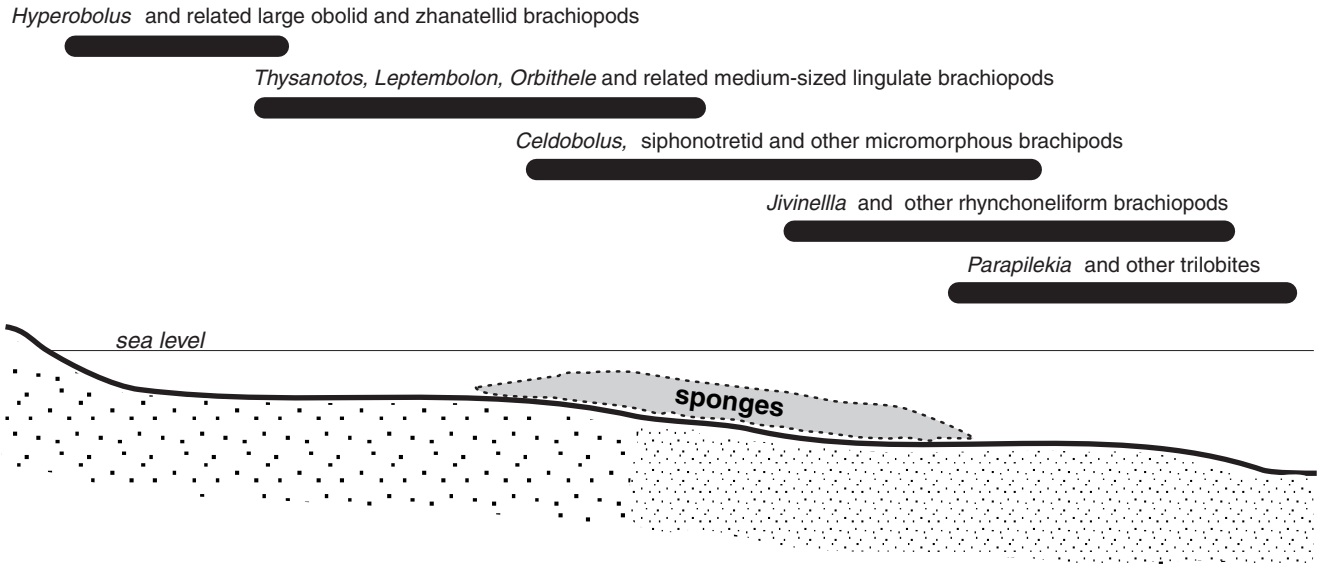
Medium to fine-grained siliciclastic littoral sediments, often with large amounts of haematite in matrix, or various chemogenic sediments (haematites, cherts) generally contain medium-sized to micromorphous brachiopod fauna. This fauna changes significantly with the particular stratigraphic level and is closely related to various microhabitats and other benthic animals (sponges, trilobites, rhynchonelliform brachiopods). The fauna is never authochtonnous in sediments which yielded graptolite fauna but may be present in the intercalations with allochthonnous material (quartz grains, hyaloclastites, phosphatic clasts) that originated by slumps or represent distal storm deposits. Two communities may be recognized in the basin. The first is related to the *Leptembolon-Thysanotos* assemblage, the second has no direct counterpart in Baltoscandinavia.

Leptembolon Community

The *Leptembolon* Community is the commonest community in the Třenice, Mílina, and lower part of the Klabava Formations. Its is rather a heterogeneous mix of medium (macromorphous) to minute (micromorphous) linguliformean brachiopods, commonly associated with the other benthic fauna. Apart from the organophosphatic brachiopods, orthid brachiopods of the genera *Poramborthis* and *Jivinella*, siliceous sponges and in favourable environmental conditions also the cystoids and trilobites can be associatied with the linguliformean brachiopods. The linguliformean brachiopods, at least locally, show a high diversity, with obolids, zhanatellids, elkaniids, acrothelids, acrotretids, siphonotretids, and paterinids. Apart from the giant genus *Thysanotos* that is generally rare and restricted to the upper part of the Třenice Formation and several chert beds in the upper Mílina Formation, all other brachiopods are small to medium sized. The acrotretid *Dactylotreta*, obolid *Leptembolon*, acrothelid *Orbithele*, and a siphonotretid *Celdobolus* are the commonest elements of the community. The taxonomic richness, diversity and morphological disparity among the particular fossil sites and the stratigraphical levels fluctuate significantly, but this is surely affected also by the taphonomic processes. The selective etching of skeletal fossils in the sediment must be taken into account (Mergl 1997c). Under favourable circumstances, the fossil diversity is remarkably high; two cases are noted herein.

The quartzose haematites referred to the Třenice Formation, apart from the diversified orthid, trilobite, and cystoid fauna (Růžička 1926, 1927, Havlíček 1977, Mergl 1994) yielded the linguliformean taxa *Leptembolon insons, Rosobolus robertinus, Elkanisca obesa, Broeggeria ferraria, Ferrobolus catharinus, Orbithele discontinua, Acrotreta grandis, Eosiphonotreta krafti, Siphonobolus simulans, Celdobolus* cf. *mirandus, Kolihium kolihai*, and *Lacunites walcotti*; the earliest craniid *Petrocrania* sp. is also present.

The second case represents fossils yielded by the etching of clay-phosphatic clasts embedded inside a fine



Text-fig. 6: Diagrammatic model of distribution of main genera and faunistic groups with the depth gradient in the upper Mílina Formation (Upper Tremadocian). Based on data from the Komárov area in the SW part of the Barrandian.

greywacke near the base of the Klabava Formation (Olešná Beds Member, level H in Mergl 1986; Text-fig. 4). The yet known most diversified fauna of the linguliformeans from the Barrandian was ascertained there, with *Leptembolon testis, Teneobolus gracilis, Elliptoglossa celdai, Pidiobolus minimus, Rosobolus* cf. *robertinus, Rowellella distincta, Elkanisca obesa, Orbithele undulosa, Acrotreta foetida, Dactylotreta prisca, Mamatia retracta, Pomeraniotreta holmeri*, a new acrotretid, *Eoconulus gemmatus, Celdobolus mirandus, Eosiphonotreta krafti, Siphonotretella filipi,* and *Kolihium* sp., with other two or three micromorphous brachiopod species known by minute shell fragments (these are not included in the current paper). The brachiopod fossil assemblages are commonly associated with hexactinellid and rarely also with the demospogian sponge spicules.

The fossils assemblages of macromorphous brachiopods commonly found in the cherts of the Třenice and Mílina Formations, and the Olešná Beds Member are poorer, with genera *Leptembolon, Orbithele*, undeterminable acrotretids and in the Olešná Beds Member also with the siphonotretid *Celdobolus*. The fauna is strictly lithofacial dependent, being exclusively present in red-coloured cherts, fine greywackes and sandstones, siltstones and silty shales. The fossil sites marginal to the area of the red-brown coloured sediments (Olešná Beds Member) yielded slightly different assemblage of brachiopod fauna in the lower part of the Klabava Formation. The typical elements (*Leptembolon, Celdobolus, Orbithele*) are rare or even missing and instead of them the new taxa appear (*Lingulella lata, Collarotretela, Eoschizotreta*, minute and poorly known zhanatellids). These fossil sites indicate a periphery of the area occupied by the *Leptembolon* Community and its mixed with other benthic linguliformean-brachiopod rich communities. These different beds also mark the *Leptembolon* Community vertical stratigraphical range. The colour of this marginal sediments is darker, e. g. dark brown-violet to grey-brown, and thin intercalations of coarse unsorted sandstones are common.

Poorly diversified macromorphous brachiopods of the Mílina Formation and Olešná Beds Member led some authors (Havlíček 1982, Mergl 1996) to the consideration that *Leptembolon* Community represents low-diversity, shallow marine lingulid community in a restricted marine environment. Currently, the opposite seems to be probable: The *Leptembolon* Community is, at least locally and at least in some periods of its evolution, a highly diversified and wholly marine benthic community, which under favourable preservation was composed of various linguliformean brachiopods (endobenthic, semiendobenthic, epibenthic, epizoic on or in sponges), epibenthic orthid brachiopods, trilobites, fixosessile and rarely also stalked echinoderms, and common (?) floating conodontophorids. This distinguishes the *Leptembolon* Community in the Barrandian from its analogues in the Baltic area, where the *Leptembolon-Thysanotos* assemblage represents the low-diversity community on an unconsolidated sandy bottom (Puura 1996).

Taxonomic differences and spatial distribution of the *Leptembolon* Community in the upper part of the Mílina Formation and new data about the related communities (Sdzuy et al. 2001) enable the proposition of an energy and depth–related distributional model of the selected taxa (Text-fig. 6). The *Leptembolon* Community was generally located shoreward to the *Hyperobolus* Community. That is evident from the geological and stratigraphical position of their known occurrence. The *Hyperobolus* Community which lies below the *Leptembolon* Community bearing-beds in the known transgressive sequences is associated with coarser rock (sometimes conglomerates or breccias). It consists of "thick-walled"and "large-sized" brachiopods,

has lower taxonomic diversity and disparity than the *Leptembolon* Community, and lacks other shelly invertebrate groups.

Unlike the *Hyperobolus* Community, the large, thick-walled burrowing or semiinfaunal lingulates and obolids with terrace lines were totally absent in the *Leptembolon* Community in most of the Barrandian area. The exception is the area east of Prague; there, the community yields abundant large and thick walled lingulates, mainly *Thysanotos primus* associated with the large clitambonitid *Protambonites* and much rarely small lingulates *Leptembolon* and *Orbithele*. This modified *Leptembolon* Community is known, but not so well as in other parts of the basin, from several localities near Úvaly and Břežany II E of Prague.

Elkania-Acrotreta Community

A similar, but taxonomicaly different community has appeared in the early Arenigian Klabava Formation (Lower Arenigian) and roughly copied the spread of aleuropelitic sedimentation. The linguliformean brachiopod assemblage, named the *Elkania-Acrotreta* Community (Mergl 1999c) has the genera *Orbithele* and *Acrotreta* in common with the *Leptembolon* Community. The new genera appeared while *Thysanotos, Leptembolon, Teneobolus*, *Pidiobolus* and *Dactylotreta* were completely missing. As novelties appeared the genera *Elkania, Spondyglossella, Sedlecilingula, Wosekella, Mytoella, Lithobolus, Rafanoglossa,* and *Paldiskites*. The new genera indicate the appearance of a deeper environment with less firm aleuropelitic or muddy bottom. The taxonomic composition of the *Elkania-Acrotreta* Community changes with the stratigraphical level and bathymetry of the basin.

The lower part of the Klabava Formation (*Corymbograptus v-similis* Biozone) is characterized by the species *Acrotreta scabra*, *Spondyglossella spondylifera, Elkania praelineola*, *Orbithele undulosa* and rarer *Paldiskites sulcatus.* Higher parts of the Klabava Formation (*Hologaptus tardibrachiatus* Biozone) have common *Acrotreta scabra, Orbithele rimosa* which are associated with more deep-water and almost ubiquist elements *Paldiskites sulcatus, Rafanoglossa platyglossa,* and *Mytoella pusilla.* The latter genera indicate a transition to even deeper *Paterula* Community Group. The upper part of the formation (*Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone) is characterized by *Elkania lineola, Fagusella indelibata*, *Orbithele rimosa, Lithobolus plebeius*, rarely also the early paterulid *Paterula prima* is accociated. Acrotretids became extraordinarily abundant, with prevalent and ubiquist *Numericoma vulcanogena* and only local *Eoconulus commutabilis.* The distribution of siphonotretids was much more facies related. On the shallower, coarser and often volcanogenic sediments commonly dwelt the thick-walled *Celdobolus complexus*. This species continues to the earliest oolithic ferolites that are already referred to the Šárka Formation (= transition Arenigian-Llanvirnian). The deeper muddy bottom in the deeper parts of the basin was characterized by a minute siphonotretid *Acanthambonia klabavensis* accompanied by glosselline *Rafanoglossa platyglossa*, *Paldiskites sulcatus,* genera *Mytoella* and *Wosekella.* These genera indicate the transition to the deeper, dysaerobic *Rafanoglossa* Community which became much spread in the basin in the early Middle Ordovician. Other species of the *Elkania-Acrotreta* Community were less common and had patchy and often only local distributions. The species *Eosiphonotreta verrucosa, Josephobolus regificus, Sedlecilingula sulcata*, undescribed minute and poorly known lingulellines, *Lacunites*, and *Kolihium* belong there.

Paterula Community Group

Drastic changes in sedimentation (beginning of the extensive ferolite sedimentation, dysaeroby and sedimentation of black shales) and the appearance of a new and highly diversified atheloptic trilobite fauna with abundant calcichordates, molluscs, and hyoliths near the boundary between the Klabava and Šárka Formations rapidly influenced the composition of the lingulate fauna. These benthic communities of the black-shales lithofacies have been repeatedly studied (Havlíček 1982, Havlíček and Vaněk 1990, Havlíček et al. 1993; *Euorthisina-Placoparia* Community*, Placoparia* C., *Paterula circina* C.). Some elements continued from the upper part of the Klabava Formation, namely the genera *Paldiskites*, *Mytoella* and *Wosekella*, but represented by different species. The acrotretids became rare and, surprisingly, also the glossellines disappeared. Many genera, e. g. *Orbithele, Acrotreta, Lithobolus, Eosiphonotreta*, and *Celdobolus* vanished completely. Only a minute *Paterula incognita* became abundant and an epizoic trematid *Schizocrania salopiensis* appeared as novelties among the lingulate fauna. The last two genera directly indicate the continuous deepening of the basin and transition to a new, depth related outer shelf and basinal slope benthic communities.

The composition of the lingulate fauna in the Dobrotivá Formation significantly differs from the Šárka Formation, although occurs in similar sediments and is associated with similar shelly fauna. The taxa adapted to the deeper and maybe disaerobic basinal environment flourished, being represented by the large *Paterula circina*, an infaunal glosselline *Rafanoglossa platyglossa* and an epizoic *Schizocrania salopiensis.* Other lingulate taxa are very rare and poorly known: *Pseudolingula* (?) *trimera*, *Wosekella senilis*, rare discinids and minute obolids. The associated shelly fauna with atheloptic trilobites and mesopelagic cyclopygids indicates the depth of a few hundred meters. The sessile benthic animals constituted the low-diversity *Rafanoglossa* Community in the Dobrotivá Formation, which evolved from the Upper Arenigian deep water ancestors.

In general, three informal morphological groups of linguliformean brachiopods can be recognized in the Lower and early Middle Ordovician in the Barrandian. The first "large lingulates" group comprises low-diversity communities with dominant large, thick-shelled lingulates (*Obolus* C. G.). The *Hyperobolus*, *Westonisca*, and *Libecoviella* Communities are the typical representatives. They occur near the

base of the Ordovician sequence, in a shallow littoral environment with coarse unconsolidated sediments.

The second "medium-sized lingulates" group is represented by taxonomically diversified and morphologically various medium-sized to micromorphous lingulate and paterinate brachiopods. The taxonomic diversity of brachiopods is medium to high, in particular sites and levels with abundant and diversified trilobites, rhynchonelliform brachiopods, sponges, echinoderms and less commonly also other invertebrate groups. The *Leptembolon* and *Elkania-Acrotreta* Communities are heterogeneous, successive representatives of this group. In the upper Klabava Formation these communities were shoreward bordered or intermixed by the rhynchonelliform brachiopod dominated *Nocturnellia* Community. This community belongs to the rapidly evolving Orthid brachiopod Community Group of the shallow subtidal environment during the late Lower – early Middle Ordovician.

The third "thin-walled lingulate" group is represented by the *Rafanoglossa* Community. The brachiopods of this group are medium to small-sized, thin-walled and the associations show low diversity. These brachiopods also indicate oxygen deficient bottom waters and depletion of food supplies. The density of brachiopod population is low but brachiopods are commonly complete with both valves attached, sometimes in vertical attitude indicating the original life position.

Autoecology of linguliformean brachiopods

A very broad range of the shell size, shape and ornamentation of linguliformean brachiopod shells indicates various life strategies and habitats. Unlike the extant lingulids and discinids, which are exclusively endobentic (*Lingula, Glottidia*) or fixosesile (*Discinina, Discinisca, Pelagodiscus*), much broader range of adaptations was common in the Lower Paleozoic.

Two main ecological groups of linguliformean brachiopods can be distinguished: an endobenthic to semiendobenthic group, and an epibenthic to supraepibenthic group (Text-fig. 7). A hypothetical pseudoplanctonic style is omitted because of a lack of direct evidence.

Burrowing endobenthic linguliformeans

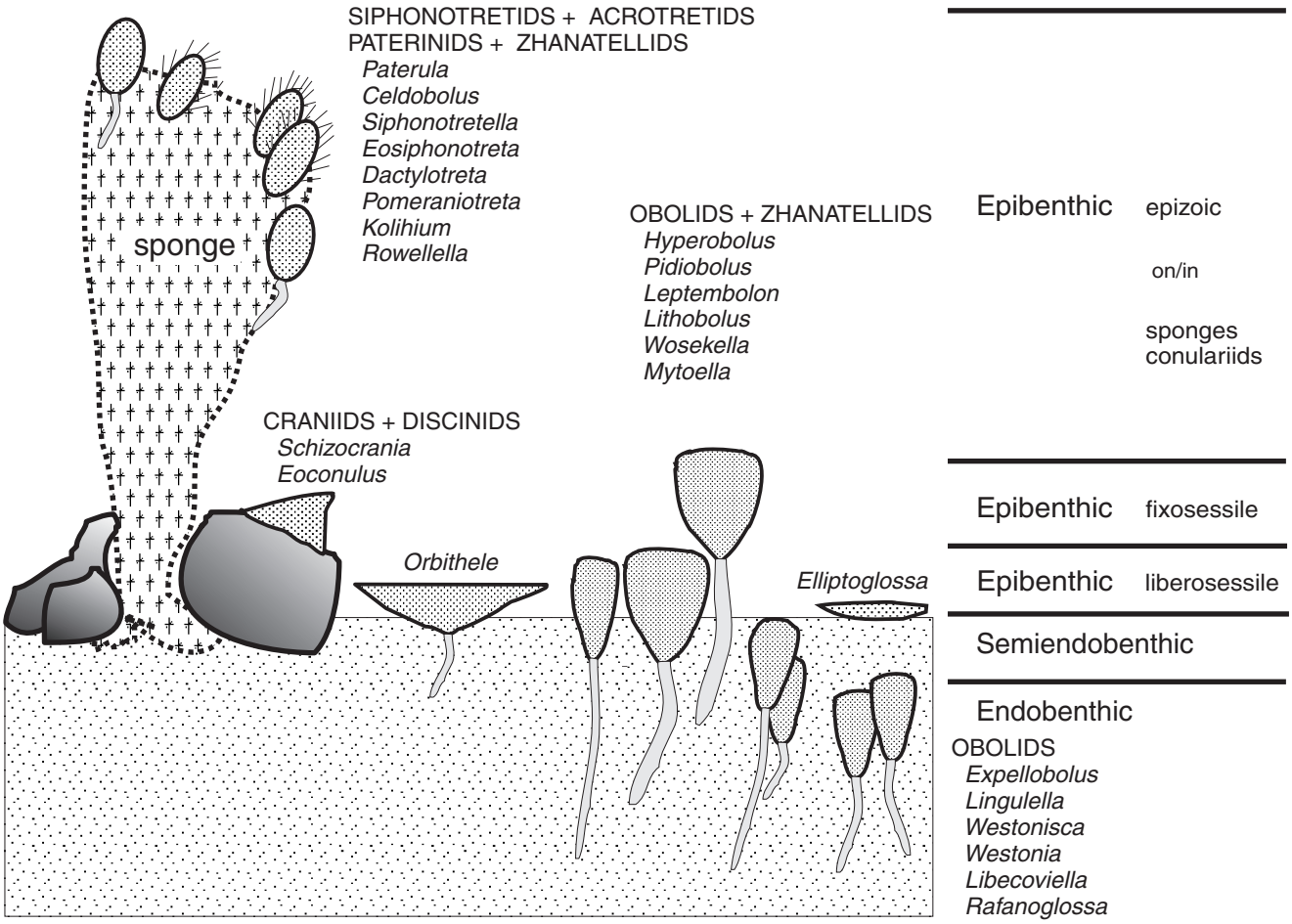
In the Barrandian, the endobenthic and semiendobenthic brachiopods were represented by medium to large-sized obolids, pseudolingulids, glossellines and zhanatellids. They burrowed as their extant relatives (Thayer and Steele-Petrovic 1975, Emig 1997) to unconsolidated substrate by the means of long and functional pedicle and a scissors-like movement of the valves. Two shell morphologies can be distinguished.

The shells of the first group of the endobenthic linguliformeans are entirely or at least partially, and mostly on the posterolateral surface, covered with prominent terrace lines, arranged sometimes in a divaricate pattern. The pedicle was probably very long as presented in the middle Cambrian finds of the related linguliformeans (Jin et al. 1993) and was significant during the burrowing action. The presence of terrace lines does not have reflect any real phylogenetical affinity: the divaricate terrace lines or transverse terraces are known in some obolids (*Westonia, Westonisca, Libecoviella, Josephobolus*) but similar superficial structures are present also in some other obolids, pseudolingulids and glossellines (e.g. *Kacakiella*, *Pseudolingula*, *Spinilingula*). The prominent terrace lines are associated with thick-walled shells, a moderate convexity and rather wide shell anterior but tapering the shell posterior which forms an acuminate outline. The marginal setae were densely arranged along anterior and anterolateral periphery and normal to the shell margin. This can be inferred from the prominent intervascular ridges on the shell interior. Sometimes, the anteriorly weakly trilobed commissure indicates a distinct separation of the inhalant and exhalant currents in a feeding position. After the withdrawal from the burrow by the currents, the specimens were able to reburrow rapidly into the unconsolidate substrate. The terrace lines do not help directly in the burrowing phase, when the animal reburrows by the shell anterior because of their steep anterior slopes. The lines may help to scape away sand grains laterally by a scissors-like movements of one valve when the opposite valve was in a fixed contact with the sediment. The terrace lines may also protect the animal against the upward sliding during the downward motion in the dwelling burrow. Linguliformeans with terrace lines are present in fine-grained sandstones and siltstones in monospecific postmortal accumulations, which probably represent fatal disturbations of the live populations in a shallow littoral environment. The species *Libecoviella arachne, L. ovata, Westonisca lamellosa, Westonia* sp. A, *W.* sp. B, and *Josephobolus regificus* belong to this group.

The endobenthic linguliformeans of the second group have a nearly smooth and thinner shell, with poor convexity and a low filtration chamber. The shell sides are nearly parallel. The medium to small shell size, reduced or depressed pseudointerareas are characteristic. The animals burrowed into silty to firm muddy substrate in a low-energy deeper environments. Species *Rafanoglossa platyglossa, R. impar* and *Pseudolingula* (?) *trimera* belong to this group. The in situ lingulids in vertical attitude are moderately common from the Cambrian to later times. The overview of Palaeozoic cases has been given by Pickerill et al. (1984). The deep-water, outer shelf and upper slope burrowing lingulids are less frequent and are known from Middle Ordovician (Pickerill et al. 1984).

The species *Expellobolus expulsus* is larger than the other taxa of the second group, being similarly shaped with very low convexity. It dwelt in coarse sandy bottom, unlike the other genera of shallow littoral environment. This is the only species among the Lower and early Middle Ordovician linguliformenas in the Barrandian which can be directly compared by a size and shape with the extant *Lingula*.

The semiendobenthic group contains brachiopods living



Text-fig. 7: Diagrammatic scheme of main ecological groups of linguliformean and craniid brachiopods known in the Lower and Middle Ordovician of the Barrandian. Not in the scale.

near the sediment-water interface, being partly or only shallowly buried into substrate. The many medium to large sized genera from the Barrandian are referred to this group. Transverse subpentagonal and large shell of zhanatellids enabled only shallow penetration into sediment (genera *Hyperobolus, Thysanotos, Rosobolus*). They have smooth to finely rugellate surface, prominent convexity and their posterior is only gently extended. Medium to small obolids and zhanatellids probably lived near sediment surface, being weakly buried and anchored by the pedicle (genera *Leptembolon, Teneobolus, Wosekella, Mytoella*). Their small limited size in black shales may reflect oxygen deficient bottom waters.

Epibenthic linguliformeans

Epibenthic brachiopods utilized two main strategies. The first was used by large and strongly convex elkaniid genera *Elkanisca* and *Elkania*. The stability on firm bottom was achieved by greatly thickened umbonal region of the shell, with heavier dorsal valves and thin anterior part, and by prominent rugellae. The same mechanism was used in many other brachiopod groups, but was quite common in trimerellids and pentamerids (Webby and Percival 1983, Johnson 1977). The pedicle of elkaniids has only a subsidiary function. The correlation can be demonstrated by spatial distribution of genera. While the rugellate genus *Elkanisca* occupied sandy sediments of shallow and turbulent waters, the nearly smooth genus *Elkania* lived at the muddy bottom of the deeper environment. The genus *Orbithele* has a broadly conical shell, with ventral apex shallowly buried into substrate, and stabilized by prominent concentric rugellae. The pedicle extended from the centre of gravity and fixed the specimen to sand grains inside substrate. Setae encircled almost entire shell margin as demonstrated by radially arranged intervascular ridges. The flat dorsal valve minimalized a vertical drag produced by bottom currents. Similarly shaped discinids (*Schizotreta, Orbiculoidea*) are present in much softer sediments and were probably epibenthic, fixed by a pedicle to solid substrate.

The absence of micromorphous brachiopods in coarse-grained sediments (greywackes, sandstones) is probably secondary and is produced by taphonomic processes. Occasional thin intercalations of finer sediments or fine haematite cement indicate presence of micromorphous brachiopods associated by sponge spicules. The spicules

(mostly hexactinellid and rarely also lythistid sponges) and micromorphous brachiopods form recurrent fossil associations. It is worth to note that, even in the siliceous nodules of the Šárka Formation, the rare finds of micromorphous brachiopods are associated by the otherwise very rare hexactinellid spicules. Characteristic taxa represent acrotretoids *Pomeraniotreta, Dactylotreta, Mamatia, Numericoma, Cyrbasiotreta,* minute *Rowellella, Eoconulus*, siphonotretids *Siphonotretella* and *Celdobolus*. These brachiopods may be interpreted as epizoic, attached to surface or living inside the sponges.

The similar commensalism is common in extant sponges by various invertebrate groups, but mostly by the barnacles. They may be completely embedded in sponge tissues during life, living in their own chamber with only tips of cover plates extended during feeding. The recent species *Acasta spongites* (POLI, 1795) from the Mediterranean and SW Europe seas is a typical example. It has smaller size than its freely-living recent relatives (*Chthamalus* RANZANI, 1817*, Balanus* DA COSTA, 1778, *Chelonibia* LEACH, 1877 etc.) and occurs frequently in great number in a large demospongian *Dysidea fragilis* (MONTAGU, 1812). Convergences between small linguliformean brachiopods and balanids (swimming larval stage but fixosessile adults, pedicle or stalk for fixation, diminution of the shell size, subglobose shell shape, feeding by filtration) support the conception of the epizoic habitat of the microbrachiopods. The brachiopods developed various structures for fixation and protection against the sponge overgrowth. The long and thin hollow spines of *Siphonotretella* and *Eosiphonotreta* may penetrate deeply into tissues of a sponge for fixation but left the shell free on the sponge surface. Dense cover of spines of *Celdobolus* may have similarly stabilized this genus below the surface of a sponge and left its commissure free and distant from the sponge tissues. High and irregular lamellae of *Rowellella* probably had the same function as numerous spines. Acrotretoids were fixed by long pedicle and their ventral conical valves were attached to the surface or partly penetrated into the sponge wall. Extended pedicle structures, such as long pedicle tubes or very high conical ventral valve made an elevation of shell commissure above the surface of the sponge possible.

Rich diversity and abundant occurrence of micromorphous brachiopods may be closely related to the abundance of sponges. The latter presented larger surface for shell fixation than bare and unconsolidate bottom. The water currents produced by feeding sponges aided the feedings of attached micromorphous brachiopods. The direct evidence of fixation of paterinid *Micromitra* to sponge *Pirania* is known from Burgess Shale, Middle Cambrian (Morris and Whittington 1985).

A similar strategy was utilized by genus *Paterula*, and its ecology based on data from the Barrandian has been discussed by Havlíček and Vaněk (1990), Havlíček et al. (1993) and Mergl (1999b). This genus was found directly attached to sponge surface near the oscular opening in the Ludlow of Arctic Canada (Lenz 1993). In the Dobrotivá Formation, the shells are commonly associated with conulariids, sometimes encrusted by shells of *Schizocrania*. The mode of feeding of conulariids is essentially unknown, but they probably were sessile filter feeders and not carnivores (Harland and Pickerill 1987). Their shells were suitable as otherwise rare solid substrate for attachment of the larvae in the soft muddy bottom of the deeper environment. Epizoic brachiopods, e. g. trematids and craniids, fixed to the conulariid skeleton are abundant in Middle and Upper Ordovician of the Barrandian, sometimes associated by encrusting bryozoans (Havlíček 1994).

Palaeogeography of lingulate assemblages

Lingulate brachiopods have been rarely used in palaeogeographic reconstructions. Havlíček (1982a, 1989) reviews of the Bohemian and Mediterranean type brachiopod communities, including several distinct linguliformean communities is an exception. His papers were followed by numerous, but more local and less extensive papers of other authors, mainly about lingulate communities in NE and SW Europe (Cocks and Lockley 1981, Emig and Gutierrez-Marco 1997). Especially, as the distinctive element near the Tremadocian-Arenigian interval, the *Leptembolon-Thysanotos* assemblage was extensively studied in the last decade (Popov and Holmer 1994, Mergl 1997a, Bednarczyk 1999, Bassett et al. 1999, Popov et al. 1999).

Shallow littoral communities, consisting of large obolids and zhanatellids (*Obolus* C. G.) some of them bearing burrowing sculptures, were highly endemic and restricted to small areals. Particular genera and species flourished in different palaeocontinents, adapted to similar habitat reflected by high morphological convergency. Only a careful study may uncover their high endemism (e. g. Popov et al. 1989, Puura 1996).

The *Leptembolon-Thysanotos* assemblage (= *Leptembolon* Fauna herein) represents a different case. This low to medium diversified fauna became widespread around the late Tremadocian and early Arenigian in Central Europe (Barrandian, Thuringia, Holy Cross Mountains), Estonia, the South Urals and Iran. The significance of this fauna has already been recognized by Koliha (1926). The extension of the *Leptembolon* fauna reflects the existence of fine sand sea floor under special, maybe stagnant environment with a low sedimentation rate as reflected by the chert beds formations in Bohemia and Poland. This indicates lithofacially dependent fauna with limited significance for the biostratigraphical purposes.

In Baltoscandinavia, its stratigraphical range extends from the *Paroistodus proteus* conodont Biozone as the lower limit, with the upper limit defined by the rich fauna of clitambonitacean and plectambonitacean brachiopods in Estonia; the *Thysanotos siluricus* Biozone is restricted to the Leetse Formation. Its range covers only the Hunneberg Stage, and this led Popov and Holmer (1994) to the conclusion that all the other known occurrences of this fauna must be of early Arenigian age (regional Hunneberg Stage of Baltoscandi-

navia). In Poland, the age of the *Leptembolon* Fauna was extensively discussed for many years (Bednarzyk 1999; he reviewed older papers). The most recent evaluation based on the conodont fauna suggests an older age than in Estonia, corresponding to the Varangu Stage (approximately to the *Ceratopyge* fauna of south Scandinavia; Bednarzyk 1999).

In Bohemia, the fauna with *Thysanotos siluricus* occurs below the early Arenigian fauna as proved by graptolite fauna (Kraft and Mergl 1979) and chitinozoa (Paris and Mergl 1984) in SW part of the Barrandian. The evidences of the Late Tremadocian age of the Třenice and Mílina Formations are indirect. The fauna above *Thysanotos primus* and *T. siluricus* yielded microbrachiopods both the late Tremadocian type, with many forms closely related to fauna of the Bjørkåsholmen Limestone (*Elliptoglossa, Pomeraniotreta, Dactylotreta, Orbithele, Siphonotretela*), and some other having the younger aspect (*Mammatia, Eoconulus*, *Leptembolon*).

Consequently, only approximate correlations of the Barrandian and Baltoscandinavian fauna can be done without a study of conodonts or other microfossils. Mergl (1997a) proposed a model of the expansion of the *Leptembolon* Fauna from the Central European terraines (Perunica, Malopolska Massif) to the nearby margin of the Baltica in the late Tremadocian to early Arenigian times (Varangu and Hunneberg regional stages of Scandinavia). Bednarzyk (1999) repeated the same suggestion, supported by the conodont data. It seems likely that planctotrophic lingulate brachiopod larvae could have easily crossed the Törnquist Sea, while the other benthic fauna remained more endemic. However, it is worth to note that similarities in late Tremadocian and early Arenigian Baltoscandinavian and Central European faunas have been discussed for the last two decades by more authors in different fossil groups (trilobites: Mergl 1984, trilobites, brachiopods: Havlíček et al. 1994) and a current description of shelly fauna from Frankenwald (Sdzuy et al. 2001) supports this idea by new data.

The deeper *Broeggeria* assemblage (late Cambrian to Tremadocian) is unknown in the Barrandian area. This represents low-diversity mix of eurytopic organisms, adapted to dysaerobic environment. This assemblage in unknown in the Barrandian in early Ordovician, but similar environment was occupied by the *Paterula* Community Group.

The deepenig of the basin as a result of the early Arenigian transgressive event brought deep water environment into the Prague basin. The increase of the sea level and extension of the oceanic barrier ceased the interchange of lingulate larvae between the palaeocontinents. The lingulate brachiopods became more endemic, with migration only along the slopes of the peri-Gondwannan shelf. The resulting composition of lingulate fauna in the Arenigian, Llanvinian and Dobrotivian became taxonomically poorer, with minute, depth-related and widespread genera *Paterula, Schizocrania*, minute lingulellines, glossellines and elkanids (*Mytoella, Wosekella, Rafanoglossa,* and *Elkania*). The Gondwannan aspect of these deep-related faunas is strenghtened by common genera of SW Europe (SW France) where the same genera as in coeval beds in the Barrandian appeared (*Spondyglossella*, *Rafanoglossa*; Havlíček 1980a). Unlike in SW Europe, the shallow water lingulate fauna with *Ectenoglossa, Lingulobolus, Lingulepis, Tomasina* did not appear in the Barrandian in Arenigian and Llanvirnian times but this was due to the lack of corresponding lithofacies.

Abbreviations

Following abbreviations are used in the text:

KMFB – boundary between the Mílina and Klabava Formations; SKFB – boundary between the Klabava and Šárka Formations.

Systematic part

Class ***Lingulata*** GORJANSKY et POPOV, 1985

Order **Lingulida** WAAGEN, 1885

Superfamily **Linguloidea** MENKE, 1828

Family **Pseudolingulidae** HOLMER, 1991

Genus ***Pseudolingula*** MICKWITZ, 1909

Type species: *Crania quadrata* EICHWALD, 1829; Ordovician, Ashgillian; north-western Russia.

Pseudolingula (?) ***trimera*** (BARRANDE, 1879)

Pl. 1, figs 1–6, 8

1879 *Lingula trimera* BARR.: Barrande, pl. 104, case I, figs 1–3.
1982b *Rafanoglossa trimera* (BARRANDE, 1879): Havlíček, p. 46, pl. 8, figs 10–12.

Lectotype: Designated by Havlíček (1982b), ventral valve figured by Barrande on pl. 104, case I, fig. 2, and by Havlíček (1982b) on pl. 8, fig. 11, stored in the palaeontological collection of the National Museum, Prague (NM L 18220).

Paralectotypes: Dorsal valve figured by Barrande on pl. 104, case I, fig. 1 (NM L 18219), and ventral valve figured by Barrande on pl. 104, case I, fig. 3 (NM L 18218) stored in the palaeontological collection of the National Museum, Prague.

Type horizon and locality: Dobrotivian, Dobrotivá Formation, black-shale; Barrandian, Zaječov (Svatá Dobrotivá; Sta. Benigna in original spelling).

Material: Eight valves and several fragments.

Description: Shell biconvex, thin-shelled, elongate-oval, with length nearly 10 mm in large specimens.

The dorsal valve has a subquadrate outline, with angular posterior and subtruncate anterior margins. The valve is almost flat in lateral profile, highest at the apex, with a flat median sector and sloping flanks in a transverse profile. This narrowly triangular depressed sector extends from the apex and occupies about 50–70 % of the valve width at the

anterior margin. The dorsal pseudointerarea is minute, developed as a broad and short, deeply concave plate near the dorsal apex. The dorsal valve interior shows weak median septum from one third to the midlength of the valve. Its anterior part is laterally bounded by a narrowly triangular and weakly impressed muscle platform.

The ventral valve is elongate-oval, 160–180 % as long as wide, with the extended apex. Posterolateral margins subtend 70° angle. The valve is weakly convex posteriorly becoming almost flat anteriorly in a lateral profile. Posterior half of the valve is weakly but evenly convex, but the anterior partition has a depressed median sector in transverse profile. Two lateral plications border the depressed median sector which anteriorly bears the third one, less distinct axial plication in large shells. The interior of the ventral valve shows no distinct traces of the visceral area. The ventral pseudointerarea is imperfectly known; it is minute, with shallow and broad pedicle groove.

Ornamentation consists of fine, high, uniformly sized and densely spaced concentric fila that are less distinct in the depressed median sector of the shell.

Remarks: This species was based by Barrande (1879) on three flattened and carbonised valves (lectotype NM L 18220, pl. 104, case I, fig. 2; paralectotypes NM L 18218 and NM L 18219, pl. 104, case I, figs 3 and 1, respectively) preserved in black shale. New material from siliceous nodules is rare and mostly fragmentary, but unlike the genus *Rafanoglossa* HAVLÍČEK, 1980, to which the species was formerly referred (Havlíček 1982b), the distinct dorsal pseudointerarea is discernible in one valve (Pl. 1, fig. 2). The generic position of the species in not clear, because of small size, restricted material and lack of any data about the ventral pseudointerarea, shape of visceral area and pallial margins. The shell is externally similar to *Bicarinatina* BATRUKOVA, 1969. However, this genus is much younger, being known from the Middle Devonian to the Lower Carboniferous. The genus *Pseudolingula* MICKWITZ, 1909 to which the species is tentatively referred, comprises much larger species which have well impressed ventral muscle platform. The genus *Meristopacha* SUTTON, BASSETT et CHERNS, 1999 (Sutton et al. 1999) is larger, with prominent concentric ornamentation and distinct ventral muscle platform.

Occurrence: The species is uncommon in black shale and siliceous nodules of the Dobrotivá Formation (Dobrotivian). The valves commonly occur in monospecific clusters of a similarly sized specimens, a probably original life association.

Localities: Barrandian; Zaječov (Svatá Dobrotivá), Malé Přílepy (field), Ejpovice (borings).

Genus ***Sedlecilingula*** MERGL, 1997

Type species: *Sedlecilingula sulcata* MERGL, 1997; Ordovician, Arenigian, Klabava Formation; Bohemia.

Remarks: When established, the genus was monospecific, with only species *Sedlecilingula sulcata* MERGL, 1997 from the Lower Arenigian of the Barrandian. Sutton et al. (1999) defined a new genus *Meristopacha* SUTTON, BASSETT et CHERNS, 1999 based on *Lingula granulata* PHILLIPS, 1848 from the Llandeilo Series of Wales. Some internal features of *M. granulata* were not sufficiently known until the study of Sutton et al. (1999), especially the nature of the dorsal pseudointerarea. In comparison with *Sedlecilingula*, the genus *Meristopacha* has a clearly defined dorsal median septum and lacks the sulcus which forms a shallow emargination at the front margin of the shells of *Sedlecilingula*. Common features of *Sedlecilingula* and *Meristopacha* which distinguish these genera from the Upper Ordovician *Pseudolingula* MICKWITZ, 1909 are distinct dorsal pseudointerareas with a median depression, complex ventral pseudointerarea with flexure lines, and muscle scars and mantle canals being only weakly impressed. These features indicate a derivation of *Sedlecilingula* and *Meristopacha*, as the earliest pseudolingulides, from the late Cambrian or the early Ordovician obolides. The genus *Sedlecilingula* (Lower to Middle Arenigian) is probable an evolutionary ancestor of *Meristopacha* (Lower Llanvirnian to Upper Llandeilian). The latter already has the dorsal median septum which is the characteristic feature of *Pseudolingula.*

Sedlecilingula sulcata MERGL, 1997

Pl. 1, figs 7, 9, 10, 12–14

1997d *Sedlecilingula sulcata* sp. n.: Mergl, p. 99, figs 4, 5.

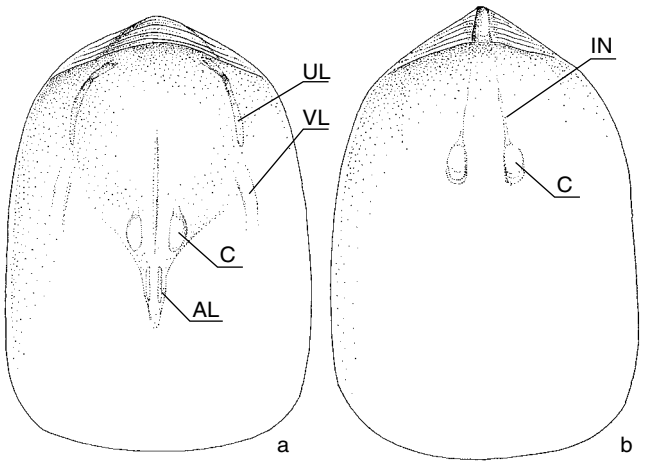
Holotype: Ventral valve (internal and external moulds) figured by Mergl (1997d) on figs 4: A, B, I, stored in the palaeontological collections of Museum of Dr B. Horák in Rokycany (MBHR 66837), refigured herein on pl. 1, figs 10, 14.

Type horizon and locality: Lower Arenigian, Klabava Formation, *Corymbograptus v-similis* Biozone, lower part; Barrandian, Sedlec (gorge, temporary excavations).

Description: Mergl (1997d).

Remarks: This species is uncommon in the lower and middle part of the Klabava Formation. The rich material comes from the type locality, where the species was quite common in fossiliferous violet-brown clayey shale with sand admixture. In other localities the species is very rare. The shells are highly fragmentary and often deformed by a compaction, which obscures the important morphological features. The typical specimens lack any radial ornamentation on flanks of the shell. However, single ventral valve from the highest part of the Klabava Formation has similar size and shape with distinct sulcus, but unlike the typical shells, the flanks bear weak radial plications and concentric lines are less distinct. This may represent another but closely related species derived from *S. sulcata* but additional material is necessary for its safe determination.

Occurrence: This species is rare in the lower part and middle part of the Klabava Formation (Lower and Middle Arenigian; *Corymbograptus v-similis* to *Hologratus tardibrachiatus* Biozones). One valve from the topmost part of the same formation (the top of the *Azygograptus ellesi – Te-*



Text-fig. 8: ***Expellobolus expulsus*** **(BARRANDE, 1879). Dorsal (a) and ventral (b) valve interiors. AL – anterior lateral muscle scars, C – central muscle scars, IN – impression of pedicle nerve, UL – undivided lateral muscles scars, VL – vascula lateralia.**

tragraptus reclinatus abbreviatus Biozone) may be referred to the species. The species is confined to clayey shales bearing high admixture of coarsely-grained angular quartz grains, phosphatic clasts and hyaloclasts.

Localities: Barrandian; Klabava (Klabava dam), Rokycany (Drahouš), Sedlec (gorge), Starý Plzenec (U Blažeje).

Family **Obolidae** KING, 1846

Subfamily **Obolinae** KING, 1846

Genus ***Expellobolus*** HAVLÍČEK, 1982

Type species: *Lingula expulsa* BARRANDE 1879; Ordovician, Tremadocian, Třenice Formation; Bohemia.

Expellobolus expulsus (BARRANDE, 1879)

Pl. 2, figs 1–7; text-fig. 8.

1879 *Lingula expuls*a BARR.: Barrande, pl. 110, case IX, figs 1–4.
1879 *Lingula Feistmanteli* BARR. (partim): Barrande, pl. 106, case IV, figs 8, 14, pl. 110, case VIII, fig. 4.
1918 *Lingulella* ? *expulsa* (BARR.): Koliha, p. 10.
1924 *Lingulella expulsa* (BARR.): Koliha, p. 33 and 59, text-figs 7, 8.
1982b *Expellobolus expulsus* (BARRANDE, 1879): Havlíček, p. 26, pl. 4, figs 2–8, text-fig. 6.

Lectotype: Designated by Havlíček (1982b), dorsal valve figured by Barrande (1879) on pl. 110, case IX, fig. 2, and by Havlíček (1982b) on pl. 4, fig. 7, stored in the palaeontological collection of the National Museum, Prague (NM L 18167).

Paralectotypes: Dorsal valves figured by Barrande (1879) on pl. 110, case IX, figs 1, 3, 4, stored in the palaeontological collection of the National Museum, Prague (NM L 18166, NM L 18168, NM L 18169).

Type horizon and locality: Upper Tremadocian, Třenice Formation; Barrandian, Krušná hora (Kruschna Hora in original spelling).

Material: Twenty specimens.

Description: Havlíček (1982b). A diagrammatic drawing of the interior with muscle scars is newly given herein.

Remarks: This species was first determined by Barrande (1879). Koliha (1918) noted the lack of data about interior including the shape of the pseudointerarea. The first formal description was given by Koliha (1924) with diagrammatic illustrations of interiors. Havlíček (1982b) illustrated seven specimens and selected the lectotype. He established the new genus *Expellobolus* to accommodate the species *Lingula expulsa* BARRANDE.

Apart the type species, subrectangular shell of *Lingulella tetragona* GORJANSKY, 1969 may belong to *Expellobolus* (Puura 1996). The species *E. tetragonus* is known from the lower Leetse Formation (Gorjansky 1969, Puura 1996) but belongs to rare species. Both species have truncate anterior margin, prominent radial striation of the shell wall and a low, thin pseudointerarea. Puura (1996) notes the presence of another species *E.* ? sp. in the Türisalu Formation of Estonia. Other specimens of the same species were tentatively referred to *E.* aff. *tetragonus* by Popov and Khazanovich (1989) from the Varangu Formation of Estonia.

Occurrence: The species is generally uncommon in coarse greywackes of the Třenice Formation (Upper Tremadocian), but locally occurred frequently as may be inferred from several specimens on common bedding plane in old material from Krušná hora.

Localities: Barrandian; Krušná hora (gallery), Kvásek Hill, Drozdov (Obiš Hill), Zbiroh (Bukov, old quarries).

Genus ***Josephobolus*** MERGL, 1997

Type species: *Josephobolus regificus* MERGL, 1997; Ordovician, Arenigian, Klabava Formation; Bohemia.

Josephobolus regificus MERGL, 1997

Pl. 2, fig. 1, pl. 8, figs 7–10

? 1879 *Lingula distincta* BARR.: Barrande, pl. 104, case V, figs 1, 2.
1996 *Westonia* sp.: Mergl, p. 44, pl. 4, figs 1–3.
1997b *Josephobolus regificus* sp. n.: Mergl, p. 137, fig. 8.

Holotype: Ventral valve (internal and external moulds) figured by Mergl (1997b) on figs 8: B, G, stored in the palaeontological collections of Museum of Dr. B. Horák in Rokycany (MBHR 66892), refigured herein on pl. 8, fig. 9.

Type horizon and locality: Upper Arenigian, Klabava Formation, upper part, *Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone; Barrandian, Zbiroh (Bukov, Joseph gallery, old dump).

Description: Mergl (1996, 1997b).

Remarks: Barrande (1879) established the species *Lingula distincta* BARRANDE on two minute and poorly preserved shell. One of them, figured on. pl. 104, case V (specimen NM L 18192; refigured herein on pl. 2, fig. 1) is

a poorly preserved internal mould in dark-grey shale, probably derived from the upper part of the Klabava Formation (there are scattered black ooids in clay matrix). The fragment shows poorly preserved terrace lines similar to lines of *Josephobolus regificus* MERGL, but no other details are discernible. Unlike *J. regificus*, the shell of *L. distincta* was probably much thinner.

Occurrence: The species occurs rarely and only in fragments in tuffaceous shales in the upper part of the Klabava Formation, above the clayey shales of the *Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone. Shell fragments are easily recognizable among broken brachiopod shells and, despite its rarity, the species may be used as a good index fossil of the upper part of the Klabava Formation.

Localities: Barrandian; Zbiroh (Bukov, Joseph gallery), Rokycany (highway cut), Krušná hora (?).

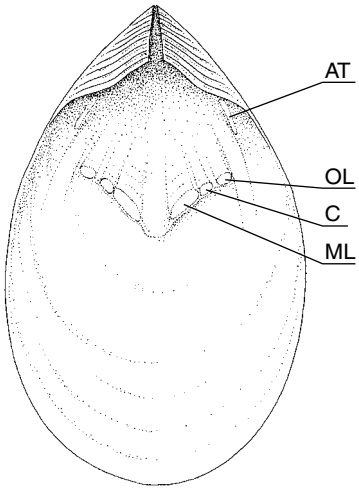
Genus ***Leptembolon*** MICKWITZ, 1896

Type species: *Obolus* (*Leptembolon*) *lingulaeformis* MICKWITZ, 1896; Ordovician, Arenigian, Leetse Formation; Estonia.

Remarks: Recent reviews to the genus have been given by Gorjansky (1969), Havlíček (1982b) and Popov and Holmer (1994). The genus has very wide geographic distribution; it is reported from Poland, Estonia, the South Urals, Bohemia, Germany, and Serbia. Popov and Holmer (1994) suggested a great morphologic variability in populations. They included the known species, especially described from Poland (Bednarczyk 1962, 1964) and Estonia (Gorjansky 1969), into *Leptembolon lingulaeformis* (MICKWITZ). The species has wide, subtriangular shell outline in large specimens. The much narrower and almost parallel-sided shells, distinguished by Gorjansky (1969) as *Leptembolon recta* GORJANSKY, 1969 were also synonymised with *L. lingulaeformis* by Popov and Holmer (1994), because they fall within the variation range of the latter.

In Bohemia, Barrande (1879) differentiated two species *Lingulella insons* BARRANDE, 1879 and *L. testis* BARRANDE, 1879. Havlíček (1982b) formally described them as two subspecies, the older *Leptembolon insons insons* (BARRANDE) from the Mílina Formation and the younger *L. insons testis* (BARRANDE) from the Klabava Formation. The currently collected material indicates presence of *Leptembolon insons* in the Třenice Formation, at least in the higher part of this unit. The stratigraphically earliest specimens are less favourably preserved and cannot be surely differentiated from the subspecies *Leptembolon insons insons*. The presence of *Leptembolon* in the basal sediments of the Třenice Formation is significant for stratigraphic correlations between the palaeocontinents, because Popov and Holmer's (1994) suggestions about the non-existence of the records older than early Arenigian (Hunneberg) contradict the data from the Barrandian.

The acceptance of a very broad morphological variation (in sense of Popov and Holmer 1994, Puura 1996) within species of *Leptembolon* and synonymization of other species including *L. insons* and *L testis* with *L. lingulaeformis* would result in significant perturbations of the nomenclature. The species *Leptembolon insons* was described by Barrande in 1879. It has a priority as it was described seventeen years earlier than Mickwitz (1896) established the species *Obolus* (*Leptembolon*) *lingulaeformis* sp. nov. which is the type species of the genus *Leptembolon.* The acceptance of the identity of *L. insons* and *L. lingulaeformis* would result in invalidity of the genus *Leptembolon*. However, this procedure is not accepted here. I consider the differences between *L. insons* and *L. lingulaeformis* significant enough to maintain them as separate species.



Text-fig. 9: *Leptembolon insons* (BARRANDE, 1879). Ventral valve interior. AT – transmedian and anterior lateral muscle scars, C – central muscle scars, ML – middle lateral muscle scars, OL – outside lateral muscle scars.

Leptembolon insons (BARRANDE, 1879)

Pl. 2, figs 8–16, pl. 3, figs 1–6; text-fig. 9

1879 *Lingula insons* BARR.: Barrande, pl. 105, case X, figs 5, 6.
1918 *Lingulella insons* (BARR.): Koliha, p. 9.
1924 *Lingulella insons* (BARR.): Koliha, p. 25 and 54, text-figs 5, 6.
1927 *Lingulella insons* (BARR.): Růžička, p. 5.
1927 *Lingulella Bukovensis* KOL.: Růžička, p. 5.
1964 *Lingulella insons* (BARRANDE, 1879): Bednarczyk, p. 40, pl. 3, figs 1–13, pl. 4, figs 1–6, 9, 10, p. 7, fig. 15, text-figs 5, 6.
1982b *Leptembolon insons insons* (BARRANDE, 1879): Havlíček, p. 39, pl. 6, figs 10–15, text-fig. 8a.

Lectotype: Designated by Walcott (1912), ventral valve figured by Barrande on pl. 105, case X, fig. 6, and by Havlíček (1982b), pl. 6, fig. 10, stored in the palaeontological collection of the National Museum, Prague (NM L 18241).

Paralectotype: Ventral valve figured by Barrande on pl. 105, case X, fig. 5, stored in the palaeontological collection of the National Museum, Prague (NM L 18242).

Type horizon and locality: Upper Tremadocian, Mílina

Formation; Barrandian, Zaječov (Svatá Dobrotivá; Sta. Benigna in original spelling).

Material: Thirty specimens in various state of preservations.

Description: Havlíček (1982b) did not present data about the visceral area and muscle scars of dorsal valve and only noted the presence of widely rhomboidal visceral platform with central muscle scars in the ventral valve. The muscle impressions are sufficiently preserved in the new material. The dorsal valve has the visceral area faintly impressed with a very long and narrow median tongue which extends to anterior 60–70 % of the valve length and has small elongate impressions of the anterior lateral muscles. A weak median ridge is present. Oblique, crescentic central muscle scars lie slightly posterior to the midlength. Posterolateral muscle scars are weakly impressed, undivided, the umbonal scars are obscure. The dorsal pseudointerarea is weakly but clearly raised above the valve floor and it is deeply undercut in its anterior edge. It is differentiated into inner, broadly triangular and deeply concave median groove and wider inner and narrower outer propareas, which are separated from each other by flexures of growth lines but the real flexure lines are absent. Pallial markings are not discernible apart the proximal part of the vascula lateralia.

The ventral valve has broadly rhomboidal visceral area, slightly raised anteriorly extending nearby the midlength. There are three pairs of oblique and rather minute scars along the anterior edge of the visceral area. They may be referred to small middle lateral, larger central and distant and small outside lateral muscle scars. Posterolateral muscle scars are not differentiated and are situated closely to the posterolateral margin. Umbonal muscle scars are obscure as well as pedicle nerve impressions. The ventral pseudointerarea is low, anteriorly undercut without flexure lines or clearly defined inner and outer propareas. The pedicle groove tapers posteriorly, having wide anterior opening. Its bottom in almost smooth, without distinct growth lines and is not raised above the valve floor. Growth lines on the surface of propareas are curved backward near the pedicle groove and anteriorly near the posterior margin.

The posterior of the visceral area bears numerous, large and often grouped davisate pits. Concentric rows of smaller davisate pits copy the external growth lamellae.

Shell exterior bears fine concentric growth lines, and a few concentric low lamellae.

Remarks: The outline of *Leptembolon insons* (BARRANDE) slightly varies; the maximum width lies at midlength to immediately anterior to that. However, no specimen *L. insons* has a subtriangular outline, although the large specimens attain the size comparable with the specimens figured by Popov and Holmer (1994). The species *Leptembolon insons* has always the acute ventral beak (with an angle between 63–93°; Havlíček 1982b), while the beak of *Leptembolon testis* (BARRANDE, 1879) is less acute. Stratigraphically the earliest specimens from the Třenice Formation have sometimes an elongate-elliptical outline, especially in small and medium-sized specimens.

Occurrence: The species *Leptembolon insons* (BARRANDE) was originally described from reddish cherts and intercalated siltstones of the Mílina Formation (Upper Tremadocian), where it is one of the commoner brachiopods. New collecting proved its abundant occurrence also in greywackes and haematites near the transgressive base, and in chert intercalations in the upper part of the Třenice Formation. These beds are probably heterochronous, and they are probably younger than greywackes bearing large *Hyperobolus feistmanteli* (BARRANDE, 1979) and *Expellobolus expulsus* (BARRANDE, 1879), from which any specimen of *Leptembolon* is known. Less favourably preserved specimens that may be referred to *L. insons* are known from sandstones with nodules of grey cherts in Břežany II (Na Chrástnici quarry) east of Prague. The upper stratigraphic range of the species extends into the basal Klabava Formation, and it probably does not completely follow the facies change. The specimens from greywackes 0.5 m above the highest chert bed in the Komárov area (unit E; Mergl 1986) are better accommodated in *L. insons* because of the curved growth lines on the ventral pseudointerarea. The specimens immediately above this level (unit F; Mergl 1986) have the growth lines almost straight and indicate the transition to *L. testis*.

Localities: Barrandian; Břežany II (Na Chrástnici quarry), Cerhovice (Cerhovská hora Hill), Cheznovice (Janovky; Žlebec), Hatě (Vrahův potok creek), Holoubkov (V Ouzkém), Jivina (old quarries; Jivina Hill), Kleštěnice (section along the Jalový potok creek), Kváň (field), Mílina Hill, Olešná (quarry), Skomelno (Na Solích), Těně (west), Točník, Zaječov (Hrbek; quarry near the school building).

Leptembolon testis (BARRANDE, 1879)

Pl. 3, figs 7–14, pl. 14, fig. 2

1879 *Lingula testis* BARR.: Barrande, pl. 111, case VII, figs 1, 2.
1879 *Lingula transiens* BARR.: Barrande, pl. 111, case II, figs 1, 2.
1924 *Lingulella insons* (BARR.): Koliha, p. 25 and 54, pl. 2, fig. 5.
1982b *Leptembolon insons testis* (BARRANDE, 1879): Havlíček, p. 40, pl. 6, figs 1–9, text-fig. 8b.

Lectotype: Designated by Havlíček (1982b), ventral valve figured by Barrande on pl. 111, case VII, fig. 1, and by Havlíček (1982b) on pl. 6, fig. 1, stored in the palaeontological collection of the National Museum, Prague (NM L 18240).

Paralectotype: Ventral valve figured by Barrande on pl. 111, case VII, fig. 2, stored in the palaeontological collection of the National Museum, Prague (NM L 18239).

Type horizon and locality: Lower Arenigian, Klabava Formation, the Olešná Beds Member; Barrandian, Medový Újezd (Hradiště; Hradischt in original spelling).

Description: See Havlíček (1982b).

Remarks: The species does not significantly differ from *Leptembolon insons* (BARRANDE, 1879) apart from the ventral pseudointerarea. In *Leptembolon testis* that bears nearly straight growth lines, the pedicle groove is narrower and anteriorly less expanding than in *L. insons.* Nevertheless, although the outline variation is also great, the large

shells of *L. testis* are generally broader, with an apical angle of about 90° or even more in the ventral valve. Its outline slightly recalls the broadly triangular outline of *L. lingulaeformis* (MICKWITZ, 1896). Several large specimens from the unit H (Mergl 1986) have unusually broadly triangular outline compared to the other specimens of *L. testis* (Pl. 3, figs 7, 11) and follow the outline of large adult specimens of *L. lingulaeformis*. The latter differs by even bigger size, wider shells with maximum width in the anterior third (in *L. testis* the maximum width is at midlength but there is an overlap of extreme specimens of *L. testis*). The species *L. lingulaeformis* has longer dorsal and more clearly defined median septum than *L. testis*. The species *L. testis* and *L. lingulaeformis* are approximately coeval as the latter is restricted to the Lower Arenigian (Leetse Formation, Hunneberg Stage) in Estonia.

Free valves of *L. testis* show almost circular larval shell, which is moderately convex having slightly depressed margins. The larval shell is 700 µm wide and 600–650 µm long, with evenly curved margins and it is bordered by thin and shallow groove from the postlarval shell. The ornamentation of the postlarval shell consists of low concentric rugellae. A pitted microornamentation is not preserved and was probably originally absent.

Occurrence: The species is abundant and strictly restricted to red shales, siltstones and greywackes of the lower part of the Klabava Formation (Olešná Beds Member). It is an evolutionary offspring of *L. insons* and it is associated with the other similar lingulate brachiopods. The species is unknown from the brown-violet and grey shales in the W part of the Barrandian which are probably of the same age.

Localities: Barrandian; Cerhovice (Cerhovská hora Hill), Hatě (Vrahův potok creek), Hrádek (gorge), Jivina (old quarries), Jivina Hill, Kotel Hill, Kleštěnice (section along the Jalový potok creek), Kváň (field), Medový Újezd (quarry), Mílina Hill, Olešná (quarry), Praha-Kunratický hrádek, Svárov, Těně (road cut; village; west), Točník, Zaječov (Hrbek; quarry near the school building).

Genus ***Libecoviella*** MERGL, 1997

Type species: *Lingula arachne* BARRANDE, 1879; Ordovician, Tremadocian, Třenice Formation; Bohemia.

Remarks: The genus *Libecoviella* MERGL is closely allied to the genus *Westonia* WALCOTT, 1901, with the type species *Westonia aurora* (HALL, 1861) from the Upper Cambrian of Wisconsin, U. S. A. The genus *Westonia* clearly differs in the clearly zig-zig terrace lines in the posterior part of the shell, while *Libecoviella* has only divaricate terrace lines, with uncommon zig-zag lines restricted to the narrow median sector in the anterior part of the shell. In addition, *Westonia* has terrace lines only in the posterior part of the shell, while in *Libecoviella* the terrace lines cover the entire shell surface.

Other differences can be seen in the shell interior. In *Westonia* the median projection in the dorsal valve is developed while this is absent in *Libecoviella* and as noted by Mergl (1997b), the pseudointerareas of *Libecoviella* are much smaller than in *Westonia*.

Libecoviella arachne (BARRANDE, 1879)

Pl. 4, figs 1–6

1879 *Lingula Arachne* BARR.: Barrande, pl. 111, case III, figs 1, 2.
1879 *Lingula variolata* BARR.: Barrande, pl. 111, case VIII.
1879 *Lingula eximia* BARR.: Barrande, pl. 105, case I.
1918 *Lingulella libečovensis* n. sp.: Koliha, p. 11, text-fig. 5.
1924 *Lingulella Arachne* (BARR.): Koliha, p. 31 and 58, pl. 2, figs 1–4. non 1941 *Lingulella arachne* (BARRANDE): Prantl and Růžička, p.12.
1982b *Westonisca arachne* (BARRANDE, 1879): Havlíček, p. 32. pl. 5, fig. 13, pl. 15, figs 12–15.
1997b *Libecoviella arachne* (BARRANDE, 1879): Mergl, p. 133, figs 2: E, 5.

Lectotype: Designated by Havlíček (1982b), deformed valve figured by Barrande (1879) on pl. 111, case III, fig. 1, and by Havlíček (1982b) on pl. 15, fig. 15, stored in the palaeontological collection of the National Museum, Prague (NM L 18165).

Type horizon and locality: Tremadocian, Třenice Formation; Barrandian, Libečov (Na Močidle locality) (Libetschov in original spelling).

Material: Twenty, mostly incomplete valves and numerous fragments, often with the original phosphatic shell.

Diagnosis and description: Emended diagnosis was presented by Mergl (1997b). The first description was given by Koliha (1924). Havlíček (1982b) only briefly commented on the size of the species and compared it to the species *Westonisca lamellosa* (BARRANDE), but the shell morphology of the latter species is quite different as noted by Mergl (1997b).

Occurrence: The species is known only from about several metres thick sequence of grey greywackes and fine grey-violet sandstones of the Třenice Formation (Upper Tremadocian). It commonly occurs in monospecific aggregations, and although fairly frequent, the shells are generally fragmentary.

Locality: Barrandian; Libečov (Na Močidle).

Libecoviella ovata (HAVLÍČEK, 1982)

Pl. 4, figs 7–11

1924b *Obolus lamellosus* BARR.: Klouček, p. 1.
1924b *Lingulella arachne* BARR.: Klouček, p. 2.
1982b *Westonisca ovata* sp. n.: Havlíček, p. 33, pl. 4, figs 10–12.
1997b *Libecoviella ovata* (HAVLÍČEK, 1982): Mergl, p. 133, figs 2: D, C, 6.

Holotype: Ventral valve (internal and external mould) figured by Havlíček (1982b) on pl. 4, fig. 10, stored in the palaeontological collections of Museum of Dr. B. Horák in Rokycany (MBHR 21854; coll. V. Havlíček, VH 3086).

Type horizon and locality: Upper Tremadocian, Třenice Formation; Bohemia, Barrandian, Zbiroh (Bukov, old dump).

Material: Twelve, mostly incomplete valves and numerous fragments, often with original shell.

Description: Havlíček (1982b) and Mergl (1997b).

Remarks: The species *Libecoviella ovata* (HAVLÍČEK) has morphology similar to *L. arachne* (BARRANDE, 1879). Both occur in coarse siliciclastic sediments of the littoral environment. In addition to the differences of the shell shape noted by Mergl (1997b), the shell of *L. ovata* has a three-lobed anterior shell margin. This is always undivided and evenly curved in *L. arachne*.

The type locality of the species *L. ovata* is the old dump on the N slope of the Bukov Hill, which was discovered by Klouček (1924b). This author noted the presence of *Obolus lamellosus* BARR. [= *Westonisca lamellosa* (BARRANDE, 1879)] and *Lingulella arachne* BARR. [= *Libecoviella ovata* (HAVLÍČEK)]. In consideration of lingulate brachiopods, he referred the fossil-bearing conglomerates to the lower part of the Krušná hora Beds (= the Třenice Formation). Among the available fossils from this locality, including the original collection of C. Klouček, the presence of *Westonisca lamellosa* was not confirmed. It seems probable that Klouček (1924b) referred the shell fragments with terrace lines which actually belong to *Libecoviella ovata* to the species *Westonisca lamellosa,* and the smooth, exfoliated shells of *L. ovata* he referred to *L. arachne*. The type localities of *Libecoviella arachne* and *L. ovata* were referred to the Třenice Formation on the basis of geological setting. The material of *Libecoviella ovata* was collected in the basal Ordovician conglomerate, the species *L. arachne* occurs in the upper part of the sandstone and siltstone sequence some 20 meters above the base of the Ordovician sequence. Other faunistic and stratigraphical data are missing in both localities. The general morphological similarity and minor but clear differences confirm similar habitat but heterochronity of both species. It is not excluded that *L. ovata* came from the stratigraphically higher level and the fossil-bearing conglomerates at the Bukov Hill locality actually form the base of the transgressive Klabava Formation (Lower Arenigian). It is worth noting that the near basal greywackes of the Třenice Formation yielded characteristic but totally different lingulate fauna with *Hyperobolus feistmanteli* (BARRANDE, 1879), *Expellobolus expulsus* (BARRANDE, 1879), *Orbithele secedens* (BARRANDE, 1879), *Acrotreta grandis* KLOUČEK, 1919, and *Teneobolus bukovensis* (KOLIHA, 1924) but no shell fragment with divaricate terrace lines was collected there.

Occurrence: The species is common in finer sandy matrix of coarse conglomerate at the base of the Ordovician sequence. Although the conglomerate is referred to the Třenice Formation, a younger age (Arenigian, lower part of the Klabava Formation) is not excluded.

Locality: Barrandian; Zbiroh (Bukov, old dump).

Genus ***Lingulella*** SALTER, 1866

Type species: *Lingula davisii* M`COY, 1851; Upper Cambrian, the Ffestiniog Flags Formation (Merioneth Series); North Wales.

Lingulella lata KOLIHA, 1924

Pl. 5, figs 1–7

1924 *Lingulella insons* BARR. var. *lata* n. var.: Koliha, p. 39 and 56, pl. 2, figs 10, 11.

1982b *Lingulella lata* KOLIHA, 1924: Havlíček, p. 42, pl. 3, figs 10–12.

1996 *Lingulella lata* KOLIHA, 1924: Mergl, p. 96, fig. 2: H-M.

Holotype: Disarticulated shell (internal and external moulds) figured by Koliha (1924) on pl. 2, figs 10, 11, and by Havlíček (1982b) on pl. 3, figs 11, 12 and refigured herein on pl. 5, fig. 6, stored in the palaeontological collection of the National Museum, Prague (NM L 18190).

Type horizon and locality: Lower Arenigian, Klabava Formation, Olešná Beds Member; Barrandian, Cerhovice (Cerhovská hora Hill).

Material: Apart from the holotype, one complete shell, five ventral and four dorsal valves.

Description: Havlíček (1982b) and Mergl (1997b).

Remarks: The species *Lingulella lata* KOLIHA significantly differs from the typical specimens of *Lingulella davisii* M`COY as redefined currently by Sutton et al. (2000). Unlike *Lingulella davisii*, the species *L. lata* has very long and broad dorsal pseudointerarea, much narrower pedicle groove, poorly defined visceral area and the shell is thin, with poorly impressed visceral field. This surely represents a different genus, but paucity of material and absence of information about the microornamentation and shell interior do not justify establishment of a new taxon. The species *L. lata* differs from all other thin-shelled and medium-sized lingulellines in the Barrandian in very large pseudointerareas and comparatively narrow pedicle groove. The species *Rebrovia chernetskae* KHAZANOVICH et POPOV, 1989 from the Ladoga Formation of the Upper Cambrian of Ingria, Russia has similar interior but its exterior, unlike smooth shell of *L. lata*, is covered with fine undulating rugae.

Occurrence: The species is a good index species despite its general rarity in red-brown siltstones of the lower part of the Klabava Formation (Olešná Beds Member) in SW part of the Barrandian.

Localities: Barrandian; Cerhovice (Cerhovská hora Hill), Hrádek (gorge), Kotel Hill, Olešná (quarry), Strašice (field).

Genus ***Lithobolus*** MERGL, 1996

Type species: *Lithobolus plebeius* MERGL, 1996; Ordovician, Arenigian, Klabava Formation; Bohemia.

Lithobolus plebeius MERGL, 1996

Pl. 5, figs 8–14

1996 *Lithobolus plebeius* sp. n.: Mergl, p. 45, pl. 1, figs 1–6.

Holotype: Ventral valve figured by Mergl (1996) on pl. I, fig. 3, stored in the palaeontological collections of Museum of Dr. B. Horák in Rokycany (MBHR 66789), refigured herein on pl. 5, fig. 10.

Type horizon and locality: Upper Arenigian, Klabava Formation, the uppermost part, *Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone; Barrandian, Zbiroh (Bukov, Joseph gallery, old dump).

Material: Thirty dorsal and ventral valves, many fragments.

Description: Mergl (1996).

Remarks: Unlike other contemporary lingulellines in the Barrandian, *Lithobolus plebeius* MERGL has broad pedicle groove bearing the coarse growth lines and is also characterized by a poorly defined visceral area. These feature distinguish it from the externally similar genus *Leptembolon* MICKWITZ. The exterior of *Lithobolus* is devoid of any radial elements, with fine concentric lines and several short concentric lamellae. Other obolids of the upper part of the Klabava Formation and sometimes the associated *L. plebeius* differ in common radial elements in the external ornamentation (e. g. *Wosekella* gen. n.).

Occurrence: This species has restricted stratigraphical range, but it is the index taxon of clayey and tuffaceous shales of the upper part of the Klabava Formation (*Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone). It is often associated with other fauna of the *Nocturnellia* Community. Its stratigraphically highest occurrence is in clayey shales with common phosphatic clasts which are present in the SW part of the Barrandian as a boundary bed between the Klabava and Šárka Formations. The specimens from this level are generally smaller, with subquadrate outline and with shorter and anteriorly almost straight transverse edge of the ventral pseudointerarea. Despite these differences, these specimens are referred to *L. plebeius*.

Localities: Barrandian; Díly (south), Ejpovice (quarry, NE part), Ejpovice (borings), Klabava (Old Castle), Kleštěnice (Stanislav mine), Rokycany (Drahouš), Zbiroh (Bukov, Joseph gallery).

Genus ***Apatobolus*** POPOV in NAZAROV et POPOV, 1980

Type species: *Apatobolus plicatus* POPOV in NAZAROV et POPOV, 1980; Ordovician, Lower Caradocian, Bestamak Formation; Kazakhstan.

Remarks: Genera *Apatobolus* POPOV, 1980 and *Paldiskites* HAVLÍČEK, 1982 are closely related and represent one evolutionary lineage extending from the Lower to Upper Ordovician. Several separate species were described from deep-water related sediments in different palaeocontinents (Nazarov and Popov 1980; Havlíček 1982b, Mergl 1998, Sutton et al. 1999). In the Barrandian, one species from the Middle Ordovician can be referred to this genus.

Apatobolus sp.

Pl. 6, figs 5, 8

1996 *Paldiskites subditivus* (WILLIAMS, 1974): Havlíček and Vaněk, p. 233, pl. 1, figs 1–8.

Material: One dorsal valve in a siliceous nodule.

Description: The valve represents a very small specimen which is 3 mm wide, subcircular in an outline, 95 % as long as wide. The beak is rounded, with the apical angle of about 135°, lateral and anterior margins are evenly curved. The dorsal pseudointerarea is very short, with a broadly triangular and gently concave median depression, and a rudimentary, linear and very narrow undivided propareas. The valve bears three coarser and two weaker radial and widely divergent plications crossing fine concentric lines.

Remarks: This specimen probably represents the same species as the valves referred by Havlíček and Vaněk (1996) to *Apatobolus subditivus* (WILLIAMS). The species *A. subditivus* was originally described from the Lower Llanvirnian Hope Shale Formation of Shelve area of Wales, and it was recently revised by Sutton et al. (1999). Typical specimens differ from the described Bohemian valve by less transverse outline and more numerous and unevenly spaced radial plications. The valve probably represents a new species with distinct relationships to the Arenigian-Llanvirnian genus *Paldiskites* HAVLÍČEK.

Occurrence: It is very rare in siliceous nodules released from black shales of the Dobrotivá Formation.

Locality: Barrandian; Malé Přílepy (field).

Genus ***Paldiskites*** HAVLÍČEK, 1982

Type species: *Lingula sulcata* BARRANDE, 1879; Ordovician, Arenigian, Klabava Formation; Bohemia.

Remarks: The type species *Lingula sulcata* BARR. was defined by Barrande (1879), and used for erection of the new genus *Paldiskites* by Havlíček (1982b). Later, the genus *Paldiskites* was considered invalid by Popov and Holmer (2000), being only a junior synonym of the genus *Apatobolus* POPOV in NAZAROV et POPOV. However, this opinion is not followed here. The type species *Apatobolus plicatus* POPOV from the Bestamak Formation (Llandeilian) of Kazakhstan clearly differs by a very short ventral pseudointerarea with undivided propareas and a short pedicle groove. The ventral pseudointerarea of *Paldiskites* is substantially longer, with well defined narrow and almost parallel sided pedicle groove and the propareas divided by distinct flexure lines. The genus *Paldiskia* GORJANSKY, 1969 is externally similar to *Paldiskites* but the pseudointerarea of the former has widely triangular pedicle groove much similar to other zhanatellids (e.g. *Thysanotos* MICKWITZ, 1896). This feature was already used for the discrimination of both genera by Havlíček (1982b). Therefore, the species from the Klabava to Šárka Formations are referred to *Paldiskites.* It remains unclear, whether *Paldiskites* belongs to Obolidae KING or Zhanatellidae KONEVA because no fine external pitted microornamentation was ascertained in *Paldiskites*.

Species referred to *Apatobolus* are generally smaller than those of *Paldiskites*, with the length rarely exceeding 6 mm. The first representatives of *Apatobolus* are known from the Lower Llanvirnian (Williams 1974, Sutton et al. 1999), with other species from the Llandeilian to Lower Caradocian

(Popov 1980) and Ashgillian (Mergl 1998). The genus *Paldiskites* is probably an evolutionary ancestor of *Apatobolus*; the former is known in the Barrandian from the Lower Arenigian to Llanvirnian. The earliest representative of *Paldiskites* occurred in the early Arenigian age and has bigger size, elongate outline, size exceeding 10 mm, and large, unrestricted pseudointerareas. The evolution in a deeper environment probably led to decrease of the shell size and restriction of structures along the posterior margin. This may be related to depletion of nutrient supplies and probably disaeroby of bottom waters as indicated by black colour of the sediment.

Paldiskites sulcatus (BARRANDE, 1879)

Pl. 6, figs 9–18

1879 *Lingula sulcata* BARR.: Barrande, pl. 106, case III, figs 2, 3.
1879 *Lingula rugosa* BARR.: Barrande, pl. 152, case V, figs 2, 3.
1921 *Lingulella sulcata* BARR.: Želízko, p. 16, pl. 4, figs 1–3.
1921 *Lingulella rugosa* BARR.: Želízko, p. 17, pl. 4, fig. 4.
1921 *Lingulella amygdala* ŽEL.: Želízko, p. 17, pl. 4, fig. 5.
1982b *Paldiskites sulcatu*s (BARRANDE): Havlíček, p. 34, pl. 7, figs 1–12.

Lectotype: Designated by Havlíček (1982b), dorsal valve figured by Barrande on pl. 106, case III, fig. 2, and by Havlíček (1982b) on pl. 7, fig. 7, stored in the National Museum, Prague (NM L 18248).

Paralectotype: Probably dorsal valve figured by Barrande on pl. 106, case III, fig. 3, stored in the National Museum, Prague (NM L 18249).

Type horizon and locality: Upper Arenigian, Klabava Formation; Barrandian, Rokycany (Rokitzan in original spelling).

Material: About one hundred specimens.

Description: See Havlíček (1982b).

Remarks: The species *Paldiskites sulcatus* (BARRANDE) is strongly variable in outline and ornamentation; on the other hand, the average shell size and nature of pseudointerareas remain almost constant despite the shell outline variation. The stratigraphically oldest specimens from the *Corymbograptus v-similis* Biozone are generally longer, with reduced radial plication in the mid-sector of the shell but present on the flanks; their concentric growth lines are developed as low rugellae in posterolateral parts of the shell (Pl. 6, fig.11). Specimens from the *Hologratus tardibrachiatus* Biozone were differentiated as a separate species *Lingulella amygdala* ŽEL. by Želízko (1921), but the type specimen does not differ from the typical specimens of *P. sulcatus*. Numerous specimens from this biozone are deformed and their radial plications are exceedingly prominent. The shells from both biozones are generally elongate, with apical angle of the ventral angle 90–100°. The shells of *P. sulcatus* from the *Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone have a different outline. They are much broader, becoming as long as wide or slightly wider than long, with generally bigger apical angle. Median sector bears a few, four to six narrow radial plications, while these are obscure on flanks. The plications are distinct immediately beyond the larval shell, some of them rapidly disappeared. The shape of plications and broad outlines of shells from this biozone are developed already in juvenile specimens (Pl. 6, figs 14–18). Uncommon finds of the species from the topmost beds of the Klabava Formation indicate again a more elongate shell outline. The shell variability is probably connected with the nature of substrate. The elongate specimens occur in levels with silty admixture and sand grains, while the transverse specimens are common in fine claystones.

Occurrence: The species is abundant in clayey shale, siderite and siltstone of a deep water origin of the Klabava Formation (*Corymbograptus v-similis* Biozone, *Hologratus tardibrachiatus* Biozone and *Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone). The stratigraphically earliest occurrence is above the horizon with *Clonograptus*, the youngest occurrence comes from shales bearing common phosphatic clasts and ooids at the Klabava and Šárka Formations boundary beds. The species is often associated with graptolites in fossil associations and may be the only abundant and autochthonous lingulate brachiopod in shales. The shells are often bivalved, buried into muddy bottom, reflecting the dwelling position and not uncommonly are grouped into monospecific clusters of similarly sized specimens on the bedding planes.

Localities: Díly (south), Klabava (Old Castle, Klabava dam), Mýto (excavations near railroad station), Rokycany (Drahouš; Husinec; Stráň), Sedlec (village; Sutice, south), Starý Plzenec (U Blažeje), Strašice (old dumps near Bílá skála), Volduchy (Kašparův vrch Hill).

Paldiskites peracutus sp. n.

Pl. 6, figs 1–8

1996 *Paldiskites subditivus* (WILLIAMS, 1974): Havlíček and Vaněk, p. 233, pl. 1, figs 1–8.

Holotype: Ventral valve (internal mould) figured on pl. 6, fig. 3, stored in the palaeontological collection of the University of West Bohemia in Plzeň (PCZCU 545).

Type horizon: Llanvirnian, Šárka Formation, siliceous nodule.

Type locality: Barrandian, Mýto (field).

Name: Latin, *peracutus*, very acute, referring to shape of the ventral valve.

Material: Five ventral and three dorsal valves.

Diagnosis: *Paldiskites* with acute beak of ventral valve, deep and narrow pedicle groove, large pseudointerarea; dorsal valve with rudimentary propareas, short and broadly triangular median groove and exterior with a few plications

Description: The shell is biconvex, thin-shelled, 7.5 mm long in the largest specimen.

The dorsal valve is elongate-oval, 115 % as long as wide in a single complete valve, weakly convex in a transverse profile, more convex posteriorly than anteriorly in a lateral profile. The maximum depth lies in the posterior one third. The beak is rounded, with apical angle of nearly 90°, lateral and anterior margins are evenly curved. The dorsal pseu-

dointerarea is very short, but distinctly developed, apsacline, with a broadly triangular and gently concave median depression, and linear undivided propareas. Dorsal valve interior bears subparallel vascula media, but the muscle scars and the outline of the visceral area are not well defined.

The ventral valve has tear-drop outline, 105 to 115 % as long as wide, evenly and weakly convex in transverse and lateral profiles. The maximum width lies at the anterior third and the maximum depth at the midlenght. The beak is acute, with apical angle 100–115°, lateral and anterior margins are evenly curved. The ventral pseudointerarea is rather large, almost catacline, with narrowly triangular pedicle groove and undivided propareas. These, which are only gently raised above the valve floor, slope toward the pedicle groove. Their anterior edges are distinctly undercut. The ventral visceral area is obscure, weak central muscle scars are located in the posterior third.

The ornamentation consists of fine growth lines, with one or two coarser concentric growth bands. The weak radial plications are obscure or lacking.

Remarks: New species differs from *Paldiskites sulcatus* (BARRANDE) in a smaller size, narrower shell with more acute beaks and in the lack of any distinct radial plications on the shell exterior. The new species has a similar outline and size as the species *Apatobolus subditivus* (WILLIAMS) from the Llanvirnian of Wales. The species *A. subditivus* is primary known from the Hope Shale Formation of the Lower Llanvirnian age (Williams 1974, Sutton et al. 1999) being of the same age as *P. peracutus*. Another species *Apatobolus micula* (M`COY, 1851) is known from the Lower Llanvirnian to Upper Llandeilian of the Anglo-Wales Basin, but it clearly differs from *P. peracutus* in a very short ventral pseudointerarea.

Occurrence: The species is very rare in siliceous nodules released from the black shales of the Šárka Formation (*Corymbograptus retroflexus* Biozone).

Localities: Barrandian; Mýto (field), Osek (field).

Genus ***Teneobolus*** MERGL, 1995

Type species: *Teneobolus gracilis* MERGL, 1995; Ordovician, Arenigian, Klabava Formation; Bohemia.

Remarks: An examination of new specimens of the type species *Teneobolus gracilis* MERGL indicates the smooth shell surface devoid of any pitted microornamentation. The larval shell is broadly oval, gently convex, without nodes, smooth, with weakly defined borders (Pl. 7, figs 1, 13). The postlarval macroornamentation starts by a fine concentric rugellae 250 µm from the apex, next rugellae are irregularly spaced, distant and attain uneven size. The absence of pitted surface warrants the attribution of the genus to the family Obolidae KING.

Species referred:

Teneobolus bukovensis (KOLIHA, 1924); Upper Tremadocian, Třenice and Mílina Formations; Barrandian.

Teneobolus gracilis MERGL, 1995; Lower Arenigian, Klabava Formation; Barrandian.

Teneobolus bukovensis (KOLIHA, 1924)

Pl. 7, figs 1–6

1924 *Lingulella Bukovensis* n. sp.: Koliha, p. 30 and 57, pl. 2, fig. 8.
1982b *Palaeoglossa bukovensis* (KOLIHA, 1924): Havlíček, p. 37, pl. 8, figs 1–3 (non 4).
1995 *Teneobolus gracilis* sp. n. (partim): Mergl, p. 104, pl. 1, fig. 5.

Holotype: Ventral valve figured by Koliha on. pl. 2, fig. 8, and by Havlíček (1982b) on pl. 8, fig. 2, refigured herein on pl. 7, fig. 2, stored in the palaeontological collection of the National Museum, Prague (NM L 18231).

Type horizon and locality: Upper Tremadocian, Třenice Formation; Barrandian, Zbiroh (Bukov, old quarries).

Material: Five ventral and two dorsal valves preserved as internal moulds, and five external moulds.

Description: Havlíček (1982b).

Remarks: This species was established by Koliha (1924) who, apart a short formal description, figured only a schematic drawing of the ventral valve. Havlíček (1982b) referred this species to genus *Palaeoglossa* COCKERELL, 1911 and figured three specimens from the type locality. Reexamination of these specimens indicates a close relationship to the stratigraphically younger species *Teneobolus gracilis* MERGL which is the characteristic species of the lower part of the Klabava Formation (Olešná Beds Member). *Teneobolus bukovensis* (KOLIHA) differs from *T. gracilis* by a narrower, almost parallel-sided outline, less curved to almost truncated anterior margin, more extended ventral pseudointerarea, more acute apical angle (65° to 80° in *T. bukovensis* and 130° to 140° in *T. gracilis*), and more distinct flexure lines with rapid changes of the growth lines directions between the outer and inner ventral propareas (Pl. 7, fig. 2). The single specimen collected in the upper part of the Mílina Formation and referred to *T. gracilis* (Mergl 1995; pl. 1, fig. 5; refigured herein on pl. 7, fig. 5) shows more acute ventral apex and more curved growth lines in the propareas compared to the holotype and topotypic specimens from the Klabava Formation; therefore, this specimen is referred to the species *T. bukovensis* herein.

The ornamentation of *T. bukovensis* consists of concentric growth fila, regularly and densely spaced over the surface. The lines are slightly less curved in the narrow median sector (Pl. 7, figs 3, 4, 6). In *T. gracilis*, the lines are less regularly spaced and they are more curved in the median sector.

Havlíček (1982b) referred to *T. bukovensis* one specimen from the haematite lens in Holoubkov (V Ouzkém), but the reexamination of this individual and other specimens newly collected do not confirm the attribution to this species. The specimen, figured by Havlíček (1982b) on pl. 8, fig. 4, has elongate-elliptical outline and is strongly convex. It is probably a juvenile of *Leptembolon insons* (BARRANDE) which occurs but rarely in this locality.

Occurrence: The species *T. bukovensis* is uncommon in greywackes with haematite cement near the base of the Třenice Formation (Upper Tremadocian) and rarely occurs in cherts in the upper part of the Mílina Formation (Upper Tremadocian; unit B).

Localities: Barrandian; Zaječov (quarry near the school building, unit B), Zbiroh (Bukov, old quarries).

Teneobolus gracilis MERGL, 1995

Pl. 7, figs 7–15

1995 *Teneobolus gracilis* sp. n.; Mergl, p. 104, pl. 1, figs 6–8.

Holotype: Complete shell figured by Mergl (1995) on pl. 1, fig. 7, refigured herein on pl. 7, figs 7, 8, 10, stored in the palaeontological collection of the Geological Survey, Prague (ČGÚ MM 512),

Type horizon and locality: Lower Arenigian, Klabava Formation, Olešná Beds Member, lower part; Barrandian, Strašice (temporary excavation in a field W to the St. Vojtěch Church).

Material: Fourteen ventral and five dorsal valves.

Description: Mergl (1995).

Occurrence: Apart from the type locality, where the species is abundant, the species *T. gracilis* is generally rare in red-brown and red-violet greywackes, siltstones and shales in the lower part of the Klabava Formation (Lower Arenigian; units E to I; Mergl 1986). The species does not extend into the higher part of the Klabava Formation and is unknown in all the localities defined by graptolite fauna.

Localities: Barrandian; Hatě (Vrahův potok creek), Hrádek (gorge), Olešná (quarry, unit F), Strašice (field near St. Vojtěch), Těně (west, units E, H, I), Zaječov (quarry near the school building, unit E).

Genus *Westonia* WALCOTT, 1901

Type species: *Lingula aurora* HALL, 1861; Upper Cambrian; Wisconsin, U. S. A.

Remarks: The typical species was newly figured by Holmer and Popov (2000). The illustrations indicate fine divaricate terrace lines in the apical part of the shell. Numerous lingulide species of the Cambrian and Ordovician ages were previously referred to this genus simply based only on the presence of the terrace lines, but besides the lines they often display a wholly different internal morphology. Although some new genera bearing the divaricate terrace lines were established in the last decade (*Agalatassia* POPOV et HOLMER, 1994, *Josephobolus* MERGL, 1997, *Kacakiella* MERGL, 2001, *Libecoviella* MERGL, 1997, *Westonisca* HAVLÍČEK, 1982) indicating the polyphyletic origin of the terrace lines, the origin and generic position of many species with terrace lines remain unclear. Two yet unknown species with remarkably shaped terrace lines were discovered in the Barrandian. Their rarity and poor knowledge but presence of the terrace lines led the author to a formal reference to the genus *Westonia*. New and better preserved specimens will surely result in establishing a particular new genus.

Westonia sp. A

Pl. 8, fig. 14

Material: A single dorsal valve.

Remarks: The poorly preserved, moderately-thick shelled valve is 8.5 mm long and 7 mm wide, roughly triangular in the outline with a semicircular anterior margin. The valve is strongly convex in a transverse profile. Anterolateral parts bear broadly divergent terrace lines in regular intervals, but the median sector is smooth.

The external morphology is unique and the only *Josephobolus regificus* MERGL has slightly similar arrangement of the terrace lines. The latter differs in thick-shell wall and less convex shell.

Occurrence: The valve was ascertained in volcaniclastic rocks of the Komárov volcanogenic complex in the upper part of the Klabava Formation (Middle or Upper Arenigian).

Locality: Barrandian; Malá Víska (Hlava mine).

Westonia sp. B

Pl. 8, figs 11–13

Material: One external mould (probably ventral valve) and an internal mould of the dorsal valve.

Description: The species is thin shelled, very small, with the largest valve only 2.5 mm long. The probably ventral valve is moderately convex in transverse and lateral profiles, with a very narrow, depressed sector along the axis. Slopes bear divergent, fine radial lines superimposed onto the growth lines. The radial lines are normal to shell margin, being repeatedly disrupted at the coarser growth lines. The dorsal valve, preserved only as an internal mould and tentatively referred to the same species has a short undivided pseudointerarea and narrowly rhomboidal visceral field with extended anterior projection. The proximal parts of the vascula lateralia run parallelly with the shell margin. Thin vascula media rapidly diverge from long anterior projection.

Remarks: The shell ornamentation cannot be compared to any other described species, except for the much larger *Westonia* sp. A from the Klabava Formation.

Occurrence: The species is very rare in siliceous nodules released from black shales of the Dobrotivá Formation (Dobrotivian).

Locality: Barrandian; Malé Přílepy (field).

Genus *Westonisca* HAVLÍČEK, 1982

Type species: *Lingula lamellosa* BARRANDE, 1879; Ordovician, Tremadocian, Třenice Formation; Bohemia.

Westonisca lamellosa (BARRANDE, 1879)

Pl. 8, figs 1–6

1879 *Lingula lamellosa* BARR.: Barrande, pl. 106, case I, figs 1–5, pl. 111, case IX, figs 1–3.

1912 *Obolus*? (*Westonia*?) *lamellosus* (BARRANDE): Walcott, p. 463, pl. 7.

1918 *Obolus* (*Westonia*?) *lamellosus* (BARR.): Koliha, p. 7.

1918 *Obolus* (*Westonia*?) *lamellosus* (BARR.) var. *elongata* n. var.: Koliha, p. 8.

1924 *Obolus* (*Westonia*) *lamellosus* (BARR.): Koliha, p. 29 and 50, pl. 1, fig. 5, text-figs 3, 4.

1982b *Westonisca lamellosa* (BARRANDE, 1879): Havlíček, p. 31, pl. 5, figs 1–12, text-fig. 7.

non 1941 *Obolus* (*? Westonia*) *lamellosus* (BARRANDE); Prantl and Růžička, p. 11.

Lectotype: Designated by Walcott (1912), deformed valve figured by Barrande (1879) on pl. 106, case I, fig. 1, and by Havlíček (1982b) on pl. 5, fig. 3, stored in the National Museum, Prague (NM L 18171).

Paralectotypes: Valves (probably dorsal) figured by Barrande (1879) on pl. 106, case I, figs 2, 3, 4, 5, stored in the National Museum, Prague (NM L 18170, NM L 18173, NM L 18174, NM L 18172).

Type horizon and locality: Tremadocian, Třenice Formation; Barrandian, Libečov (Na Močidle locality) (Libetschov in original spelling).

Material: Hundreds of specimens, mostly imperfectly preserved in sandstone.

Description: Havlíček (1982b) and Mergl (1997b).

Occurrence: This species is very common in fine-grained greywackes and siltstones referred to the middle to upper part of the Třenice Formation in a restricted area NE of Beroun.

Localities: Barrandian; Chrbina (gallery), Libečov (Na Močidle).

Genus ***Mytoella*** gen. n.

Type species: *Mytoella krafti* sp. n.; Ordovician, Llanvirnian, Šárka Formation; Bohemia.

Name: After Mýto, the town in Barrandian.

Diagnosis: Minute thin-shelled lingulelline with strongly convex and elongate-elliptical shell; ventral pseudointerarea low, with distinct propareas and flexure lines, and a narrow pedicle groove; dorsal pseudointerarea short; pallial markings obscure; shell exterior with fine growth lines, radial ornamentation absent or consisting of very low, and short plication on flanks.

Remarks: The new genus is distinct in the lack of well impressed pallial markings. It differs from the genus *Palaeoglossa* COCKERELL, 1911 by distinct flexure lines, elongate-elliptical outline and prominent convexity of both valves. The genus *Lingulella* SALTER, 1866 is much larger, moderately thick shelled, less convex and its outline is broadly spatulate to subquadrate. The interareas of *Lingulella* are also more raised above the valve floor. *Wosekella* gen. n. differs by elongate spatulate outline, distinct radial plication and microornamentation of oblique fila.

Species referred:

Mytoella pusilla (ŽELÍZKO, 1921); Arenigian, Klabava Formation; Barrandian.

Mytoella krafti sp. n.; Llanvirnian, Šárka Formation; Barrandian.

Mytoella pusilla (ŽELÍZKO, 1921)

Pl. 11, figs 3–5, 8–10

1921 *Lingulella pusilla* ŽEL.: Želízko, p. 17, pl. 1, figs 8, 9.
1982b *Palaeoglossa pusilla* (ŽELÍZKO, 1921): Havlíček, p. 38, pl. 7, figs 13, 14.

Holotype: Dorsal valve figured by Želízko (1921) on pl. 1, figs 8, 9, refigured herein on pl. 11, fig. 10, stored in the palaeontological collection of the National Museum, Prague (NM L 18215).

Type horizon and locality: Arenigian, Klabava Formation, *Hologratpus tardibrachiatus* Biozone; Barrandian, Starý Plzenec (U Blažeje).

Material: Apart from the holotype, one valve from the type locality, and ten valves and numerous fragments from other localities and stratigraphical levels.

Description: Havlíček (1982b).

Remarks: This species is based (Želízko 1921) on a poorly preserved dorsal valve, which lacks fine morphological details and any data about the internal morphology. The shell is elongate-elliptical, 185 % as long as wide (laterally deformed), showing weakly curved lateral margins, semicircular anterior margin and the ornamentation of regularly spaced concentric fila.

There are numerous finds, but mostly unfavourably preserved specimens which have been referred to *Mytoella pusilla* (ŽELÍZKO) (e. g. Havlíček 1982b). However, there are significant fluctuations in outline and shape, moreover complicated by post mortal shell deformations. Stratigraphically older specimens from the lower part of the *Corymbograptus v-similis* Biozone have broader, elongate-oval instead of elongate-elliptical outline, and their ornamentation completely lacks radial elements (Pl. 11, fig. 5). Stratigraphically younger specimens from the *Hologratpus tardibrachiatus* Biozone have elongate-elliptical outline already similar to the outline of *Mytoella krafti* sp. n., but lack any radial ornamentation (Pl. 11, fig. 10). Specimens from *Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone have elongate-elliptical outline, and fine concentric fila, and sometimes very weak radial plications on flanks are discernible (Pl. 11, fig. 3); the latter feature is sometimes present on type species *M. krafti* from the Šárka Formation (Pl. 9, fig. 4). The dorsal pseudointerarea of *M. pusilla* is large relative to the shell size; it is 10–11 % as long as the valve and is longer than the dorsal pseudointerarea of *M. krafti*, which is only 7–8 % long in the valve axis.

The species *M. pusilla* needs a redefinition on rich topotypic material. Taxonomy of this and other coeval and closely related species of the Klabava Formation is complicated and more extensive fossil material is necessary. Likely, the presence of several related species would be confirmed.

Occurrence: The species is known in clayey shales and siltstones of the Klabava Formation (Arenigian), in the *Corymbograptus v-similis*, *Hologratpus tardibrachiatus* and *Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozones.

Localities: Barrandian; Klabava (Klabava dam, Old Castle), Rokycany (Stráň), Starý Plzenec (U Blažeje).

Mytoella krafti sp. n.

Pl. 9, figs 1–20

Holotype: Ventral valve (internal and external moulds) figured on pl. 9, figs 3, 4, 12, 15, 18, stored in the palaeontological collection of the University of West Bohemia in Plzeň (PCZCU 557).

Paratype: Dorsal valve, figured on pl. 9, fig. 2, stored in the palaeontological collection of the University of West Bohemia in Plzeň (PCZCU 556).

Type horizon: Llanvirnian, Šárka Formation, siliceous nodule.

Type locality: Barrandian, Osek (field).

Name: After Jaroslav Kraft from Plzeň, the outstanding Czech palaeontologist.

Material: Several tens of specimens in nodules and numerous fragments released from nodules by hydrofluoric acid.

Diagnosis: *Mytoella* with elongate-elliptical outline, prominently biconvex shell covered by fine concentric fila, on flanks sometimes crossed by sparse, low and disrupted radial plications; ventral pseudointerarea large, low, anacline, with narrow pedicle groove; dorsal pseudointerarea large, with wide median groove.

Description: The shell is biconvex, small, thin-shelled, in maximum 9 mm long.

The dorsal valve is elongate elliptical in outline, 180–188 % as long as wide in adults, with evenly curved anterior and lateral margins. The posterior margin is subangular. The valve is highly convex in the transverse profile, and moderately convex in the lateral profile, with the maximum depth at the midlength. The maximum width is at the midlength or slightly posteriorly. The dorsal pseudointerarea is clearly defined, crescentic, anteriorly undercut, and poorly raised above the valve floor, apsacline in position. The median groove is very wide (Pl. 9, fig. 11), with deeply concave frontal margin. Propareas are small and smooth. The dorsal interior shows obscure borders of the visceral area and muscle fields, an incipient median septum is present near the midlength.

The ventral valve is elongate-elliptical, with acutely angular beak, apical angle 70°. The tip of the umbo is distinct by elongate node (Pl. 9, figs 15, 16, 18). The transverse profile is regularly and highly convex, lateral profile is moderately convex without distinct flattening in the anterior half. The valve margins are regularly curved, with the maximum width at the midlength. The ventral pseudointerarea is anacline, gently raised above the valve floor, divided by a shallow, narrow pedicle groove. Its bottom is divided into three linear sectors, the transverse striation is obscure. The propareas are clearly defined into inner and outer parts, with distinct flexure lines. The ventral visceral area is weakly defined, of a rhomboidal outline. Muscle scars are obscure but their arrangement follows the other lingulellid genera. Pallial markings are not preserved.

The exterior of the shell bears fine concentric growth lines, which are better defined posterolaterally but weaken anteriomedianly. Very low, discontinuous radial plications are sometimes developed in the large shells.

Remarks: In earlier works, the species was not recognized among lingulate brachiopods of the Šárka Formation although it is even the most common lingulate in siliceous nodules. Due to its minute size it was commonly confused with small specimens of the species *Wosekella debilis* (BARRANDE, 1879). The latter differs by a spatulate outline and ornamentation with distinct radial plications on flanks; it is also larger. Stratigraphically preceding species, *Mytoella pusilla* (ŽELÍZKO), is close to the new species. It has the same size, an elongate elliptical outline but its ventral valve is less extended posteriorly and the shell is ornamented by much prominent concentric fila.

Occurrence: *Mytoella krafti* sp. n. is an abundant species in clayey shales and siliceous nodules of the Šárka Formation. It is the most common lingulate taxon in the Šárka Formation and the shells, mostly of juveniles, often form monospecific clusters. Until recently, the species is unknown in the Dobrotivá Formation.

Localities: Barrandian; Díly (field), Mýto (field), Mýto (St. Stephen pond), Osek (field), Sedlec (village), Pětidomky.

Genus ***Wosekella*** gen. n.

Type species: *Lingula debilis* BARRANDE; Ordovician, Llanvirnian, Šárka Formation; Bohemia.

Name: After Wosek, the original Barrande's spelling of the village nearby the type species locality.

Diagnosis: Thin-shelled lingulellid with low pseudointerareas, well-defined ventral propareas with clearly defined flexure lines, large dorsal pseudointerarea, weakly defined visceral areas in both valves; exterior with low and broad radial plications, crossed obliquely by much finer fila; smooth median sector in both valves is present.

Remarks: *Wosekella* gen. n. is much similar to the genera *Palaeoglossa* COCKERELL, 1911 and *Lingulella* SALTER, 1866. These three genera are closely related. The genus *Palaeoglossa* differs by the lack of flexure lines in the ventral pseudointerarea and its exterior bears only growth lines. The genus *Lingulella* has similar ventral pseudointerarea with clearly defined flexure lines, but its shell is more thicker as reflected by well impressed pallial markings, distinct border of the visceral area and muscle scars (Sutton et al. 2000). Unlike this species, *Wosekella* is thin-shelled, with weakly defined visceral area, poor muscle scars and no sign of the pallial marking. Radial plications and fine oblique lines of microornamentation also lack in *Lingulella*. Davisate pits, which are the characteristic feature of *Lingulella*, are less numerous in *Wosekella*. Although of minor taxonomic value, the outline of many *Lingulella* species, e.g. *L. davisii* (M'COY, 1851), *L. nicholsoni* CALLAWAY, 1877, and *L. bella* WALCOTT, 1898, is often subquadrate while *Wosekella* is elongately spatulate.

Species referred:

Wosekella debilis (BARRANDE, 1879); Llanvirnian, Šárka Formation; Barrandian.

Wosekella filiola sp. n.; Arenigian, Klabava Formation; Barrandian.

Wosekella senilis sp. n.; Dobrotivian, Dobrotivá Formation; Barrandian.

Wosekella debilis (BARRANDE, 1879)

Pl. 10, figs 1–15

1879 *Lingula debilis* BARR.: Barrande, pl. 102, case IX, figs 1, 2.
1982b *Palaeoglossa debilis* (BARRANDE, 1879): Havlíček, p. 36, pl. 8, figs 5–9.

Lectotype: Designated by Havlíček (1982b), dorsal valve (internal mould) figured by Barrande (1879) on pl. 102, case IX, fig. 1, and by Havlíček (1982b) on pl. 8, fig. 8, stored in the palaeontological collections of the National Museum, Prague (NM L 18213).

Paralectotype: Dorsal valve (internal mould) figured by Barrande (1879) on pl. 102, case IX, fig. 2, stored in the palaeontological collections of the National Museum, Prague (NM L 18214).

Type horizon and locality: Llanvirnian, Šárka Formation, siliceous nodule; Barrandian, Osek (field) (Wosek in original spelling).

Material: One complete shell, five ventral and seven dorsal valves.

Description: The shell is dorsi-biconvex, thin-shelled, 10 mm long in the largest known specimens.

The dorsal valve is elongately spatulate, widest in the anterior third, about 140–150 % as long as wide, with evenly curved anterior margin and subangular posterior margin. The apical angle is 80–90°. The valve is weakly but clearly subcarinate in the transverse profile, more convex posteriorly than anteriorly, with the maximum depth situated at the posterior third. The dorsal pseudointerarea is clearly defined, gently raised above the valve floor, and its anterior border is clearly undercut. The median groove is very wide, rather long, with concave frontal margin. The propareas are limited laterally by the thin, clearly defined groove from the thickened and flat posterolateral border. The dorsal visceral area is ill defined, of widely rhomboidal outline, with weakly impressed muscle scars (Pl. 10, fig. 4) and narrow, short anterior projection divided by a fine median ridge. Pallial markings are not preserved.

The ventral valve is more acuminate, elongate spatulate in the outline, 150–160 % as long as wide, with distinctly convex to subcarinate posterior part in a transverse profile; anterior half of the valve is less convex. The valve is more convex posteriorly than anteriorly in the lateral profile. The apical angle is 75–80°. The ventral pseudointerarea is divided by the deep and anteriorly weakly expanding pedicle groove. Propareas are clearly defined, with flexure lines and thin lateral groove limiting the posterolateral border of the valve. Anterior edges of propareas are clearly raised above the valve floor. The surface of the propareas and the bottom of the pedicle groove bear distinct and uneven growth lines, but the surface of the lateral border is smooth. The ventral visceral area has ill-defined borders but bears very fine superficial pitting (= epithelian cell moulds). Muscle scars are weakly defined, with short, oblique central muscle scars. Almost parallel paired impressions of pedicle nerve are shallow. Pallial markings are unclear.

The ornamentation consists of fine growth lines, irregularly spaced and extending into a few, short lamellae. On the flanks, there the concentric ornamentation is crossed by low, wide radial plications, extending from the umbones towards the anterolateral margins. A narrowly triangular anteromedian sector is nearly smooth, bearing only concentric lines or rarely few weak radial plications. The microornamentation consists of densely packed oblique striae, clearly defined on flanks and more apparent near the junction of concentric fila with radial plications. The radial plications are also distinct on the interiors of the shell as undulations on anterolateral peripheries. The larval shell is elongate-oval, highly convex, smooth, and distinctly separated from the postlarval shell surface by a growth disjunction.

Remarks: Barrande (1879) described two new species from the locality Osek (Wosek in his original spelling), which is the most famous and rich locality of fossils of the Šárka Formation. The first species *Lingula debilis* BARR. was defined on two dorsal valves (Pl. 102, case IX, figs 1, 2). The second species *Lingula curta* BARR. was by Barrande (1879) defined on a single, poorly preserved valve (specimen NM L 18191), and its relationship remains unclear. *Lingula debilis* was referred to the genus *Palaeoglossa* COCKERELL by Havlíček (1982b), but there are clear flexure lines in the ventral pseudointerarea and therefore the new genus *Wosekella* is established herein to accommodate the species *L. debilis.*

Occurrence: The species is moderately common in siliceous nodules released from the black shales of the Šárka Formation (*Corymbograptus retroflexus* Biozone).

Localities: Mýto (St. Stephen pond), Malé Přílepy (field), Osek (field).

Wosekella filiola sp. n.

Pl. 11, figs 1, 2, 6, 7

1997d *Palaeoglossa* sp.: Mergl, p. 98, fig. 3.

Holotype: Ventral valve (internal and external moulds) figured on pl. 11, figs 1, 6, stored in the palaeontological collection of the University of West Bohemia in Plzeň (PCZCU 578).

Type horizon: Arenigian, Klabava Formation, *Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone.

Type locality: Barrandian, Klabava (Old Castle).

Name: Latin, *filiola,* pretty daughter, referring to nice exterior of the species.

Material: Three ventral valves, numerous fragments.

Diagnosis: Ventral valve elongate-elliptical, with short pedicle groove and raised propareas. Interior with poorly defined visceral area and numerous small davisate pits; exterior with distinct growth concentric fila crossed in anteromedian and anterolateral sectors by radial fila.

Description: The shell is thin-shelled, 8 mm long in the largest specimens. The ventral valve is elongate-elliptical, 60 % as long as wide, with the maximum width at or anterior to the midlength. The anterior and lateral margins are

evenly curved, the posterior margin subtends 70–80° apical angle. The valve is gently convex in the transverse and lateral profiles. The ventral pseudointerarea is short, orthocline, clearly raised above the valve floor and its anterior edge is undercut. The flexure lines are well developed along the outer margins of the pseudointerarea. The pedicle groove is short, deep and broadly triangular in the outline. The ventral interior lacks clearly defined visceral area and pallial markings. Davisate pits are small and arranged in narrow concentric bands.

The shell exterior is covered by low concentric growth fila which are better discernible laterally than medially. The anteromedian and anterolateral sectors of the shell are, apart from the concentric fila, densely covered by radial fila of a uniform size. Their size and distinctness regularly increase anteriorly.

Remarks: The species is closely related to the stratigraphically younger species *W. debilis* (BARRANDE, 1879). The new species distinguishes radial fila covering the entire anterior part of the shell, while the smooth median fold is present in *W. debilis.*

Occurrence: The species is generally rare in dark brown-violet shales in the lower part of the Klabava Formation (lower part of the *Corymbograptus v-similis* Biozone) and in grey-green fine clayey shales in the upper part of the same formation (*Azygograptus ellesi-Tetragraptus reclinatus abbreviatus* Biozone).

Localities: Barrandian; Klabava (Old castle), Sedlec (gorge).

Wosekella senilis sp. n.

Pl. 10, figs 13–15

Holotype: Dorsal valve (internal mould) figured herein on pl. 10, fig. 14, stored in the palaeontological collections of the National Museum, Prague (NM L 36719).

Paratype: Ventral valve (external mould) figured herein on pl. 10, fig. 13, stored in the palaeontological collections of the National Museum, Prague (NM L 36718).

Type horizon: Dobrotivian, Dobrotivá Formation, siliceous nodule.

Type locality: Barrandian, Praha-Vokovice (field).

Name: Latin, *senilis,* old, referring to late stratigraphic level.

Material: Three ventral valves, two dorsal valves and several fragments.

Description: The shell is dorsi-biconvex, thin-shelled, nearly 9 mm long in the largest known specimen.

The dorsal valve is broadly spatulate, widest in the anterior one-fourth, about 125 % as long as wide, with evenly curved anterior and subangular posterior margins. The apical angle is 90°. The valve is moderately convex in the transverse profile, with the maximum depth situated at the midlength. The dorsal pseudointerarea is clearly defined, gently raised above the valve floor, and its anterior border is clearly undercut. The median groove is wide, rather long, with concave frontal margin. The propareas are limited laterally by a thin, clearly defined groove from the thickened and flat posterolateral border. The shape of the dorsal visceral area is unknown.

The ventral valve is acuminate, elongate spatulate in an outline, 130–140 % as long as wide, with a distinctly convex posterior part in the transverse profile; the anterior half of the valve is less convex. The valve is more convex posteriorly than anteriorly in the lateral profile. The apical angle 75–80°. The ventral pseudointerarea is divided by a deep and anteriorly weakly expanding pedicle groove. The propareas are clearly defined, with flexure lines and thin lateral groove limiting the posterolateral border of the valve.

The ornamentation consists of fine growth lines, irregularly spaced and extending into a few, short lamellae. On the flanks, the concentric ornamentation is crossed by a few weak wide radial plications, extending from the umbones towards the anterolateral margins. The widely triangular anteromedian sector is smooth, bearing only concentric fila.

Remarks: The new species is closely related to *Wosekella debilis* (BARRANDE, 1879), but the latter differ by more numerous and better developed radial plications on the shell exterior and more elongate shell outline. The new species is evidently the youngest member of the *W. filiola – W. debilis – W. senilis* evolutionary lineage, which is distinct by gradual reduction of radial ornamentation and decrease of the L/W ratio.

Occurrence: The species is rare in siliceous nodules released from the black shales of the Dobrotivá Formation.

Localities: Barrandian; Malé Přílepy (field), Praha-Vokovice (field).

Subfamily **Glossellinae** COOPER, 1956

Genus ***Ectenoglossa*** SINCLAIR, 1945

Type species: *Lingula lesueuri* ROUAULT, 1850; Ordovician, Arenigian; France.

Ectenoglossa (?) sp.

Pl. 1, fig.11

1982b *Ectenoglossa* sp.: Havlíček, p. 47, pl. 8, fig. 15.

Remarks: The genus *Ectenoglossa* SINCLAIR is characterized by a very elongate, parallel-sided outline (Popov and Holmer, 2000). It is poorly understood, with only the type species *E. lesueri* (ROUAULT) from the Arenigian of SW Europe. The generic assignment of the Bohemian specimen be taken as tentative, because no details on the internal morphology are preserved.

Occurrence: This rare species is known only in a single specimen from sandy shales overlying the Skalka Quartzite.

Locality: Barrandian; Praha-Dubeček.

Genus ***Rafanoglossa*** HAVLÍČEK, 1980

Type species: *Lingula impar* BARRANDE, 1879: Ordovician, Dobrotivian, Dobrotivá Formation; Bohemia.

Rafanoglossa impar (BARRANDE, 1879)

Pl. 12, figs 1–10, 13

1879 *Lingula impar* BARR.: Barrande, pl. 103, case IV, figs 1, 2.
1982b *Rafanoglossa impar* (BARRANDE, 1879): Havlíček, p. 44, pl. 9, figs 9–14, text-fig. 9.

Lectotype: Designated by Havlíček (1982b), ventral valve figured by Barrande (1879) on. pl. 103, case IV, fig. 2, and by Havlíček (1982b) on pl. 9, fig. 14, stored in the palaeontological collection of the National Museum, Prague (NM L 18245).

Paralectotype: Ventral valve figured by Barrande (1879) on. pl. 103, case IV, fig. 1, stored in the palaeontological collection of the National Museum, Prague (NM L 18246).

Type horizon and locality: Dobrotivian, Dobrotivá Formation, black-shales; Barrandian, Zaječov (Svatá Dobrotivá; Sta. Benigna in original spelling).

Material: Some thirty specimens, mostly incomplete.

Description: General characteristics of the species were noted by Havlíček (1982b). The examination of the new material indicates anacline posterior slope of the dorsal valve (Pl. 2, figs 3, 5) but no dorsal pseudointerarea; only thickened posterior shell wall is in contact with the anterior edge of the well developed, nearly orthocline ventral pseudointerarea. The ornamentation differs with position on the shell. Flanks bear rounded, uniform concentric fila which became depressed and less distinct in the median sector of the valve. There are no patterns of radial ornamentation. The larval shell is smooth and poorly separated from the postlarval shell.

Havlíček (1982b) noted the absence of muscle scars in the dorsal valve interior. In a single specimen in the new material, there is a distinctly impressed, large and broadly triangular, unpaired umbonal muscle scar and a set of small impressions posterolaterally on valve interior. The median septum is invariably present and extends over mid-length of all the examined valves.

Occurrence: The species is generally common in black clayey shales and siliceous nodules of the Dobrotivá Formation. It commonly occurs in monospecific clusters of uniformly sized specimens, often of juveniles.

Localities: Barrandian; Březina (borings), Ejpovice (highway cut; quarry, S part), Kařízek (Veronika mine), Malé Přílepy (field), Mýto (highway cut), Praha-Vokovice, Sedlec (Sutice), Starý Plzenec (Černá stráň), Zaječov (Svatá Dobrotivá).

Rafanoglossa platyglossa HAVLÍČEK, 1982

Pl. 12, figs 11–12, 14–16

1982b *Rafanoglossa platyglossa* sp. n.: Havlíček, pl. 9, figs 1–8, pl. 10, fig. 13.

Holotype: Dorsal valve figured by Havlíček (1982b) on pl. 9, fig. 3, stored in the palaeontological collections of Museum of Dr. B. Horák in Rokycany (MBHR 21980, coll. V. Havlíček, VH 3182b).

Type horizon and locality: Arenigian, Klabava Formation, *Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone; Barrandian, Klabava (Old Castle).

Material: About a hundred specimens.

Description: Havlíček (1982b).

Remarks: As noted by Havlíček (1982b), this species is characterized by the truncated anterior margin of the shell and is generally larger, wider and more parallel-sided than *R. impar* (BARRANDE). The original convexity is modified and the posterior margins of all the available specimens are deformed and cannot be exactly compared with the *R. impar* (BARRANDE). Fine details of ornamentation of *R. platyglossa* are unknown, but the growth fila in available specimens are probably less prominent. The dorsal valve interior has similar triangular umbonal muscle impression as noted in remarks of the species *R. impar.*

Occurrence: The species is fairly abundant in the grey-green clayey and tuffaceous shales of the middle and upper part of the Klabava Formation and is the characteristic species of the *Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone.

The earliest specimen which can be referred to this species comes from greywacke of the Olešná Beds Member (unit H) and from clayey shales of the *Corymbograptus v-similis* Biozone. The stratigraphically latest specimen was collected in red-brown tuffaceous shales in the uppermost part of the Klabava Formation above the tuffites with *Nocturnellia* Community.

Localities: Barrandian; Ejpovice (quarry, NE part), Hatě (Vrahův potok creek), Klabava (Klabava dam, Old Castle), Mýto (St. Stephen pond), Rokycany (Stráň), Sedlec (village), Těně (west).

Genus ***Spondyglossella*** HAVLÍČEK, 1980

Type species: *Spondyglossella spondylifera* HAVLÍČEK, 1980; Ordovician, Arenigian; Montagne Noire, France.

Spondyglossella spondylifera HAVLÍČEK, 1980

Pl. 11, figs 11–17

1980a *Spondyglossella spondylifera* sp. n.: Havlíček, p. 5, pl. 1, figs 6, 9, 12, pl. 2, figs 9, 11–14.
1997d *Spondyglossella spondylifera* HAVLÍČEK, 1980: Mergl, p. 101, figs 2: A-G.

Holotype, type horizon and locality: See Havlíček (1980a).

Material: Five dorsal and five ventral valves, and many fragments from the Barrandian localities.

Description: Original description based on the specimens from France was given by Havlíček (1980a). Mergl (1997d) described the material from the Barrandian.

Remarks: This species was established by Havlíček (1980a) on the specimens of the early Arenigian age of the Montagne Noire. Unlike the undeformed specimens from the Montagne Noire, all specimens from the Barrandian are more or less compressed and deformed. Nevertheless, they

show well a short septalium-like structure in the ventral valve interior. The dorsal valve lacks pseudointerarea and has a truncate posterior margin.

Occurrence: The species is known from clayey, red and grey shales with coarse clastic admixture (mostly angular quartz grains). It is restricted to the lower part of the Klabava Formation (Lower Arenigian), and is frequent at the type locality just above the level bearing the *Clonograptus* Assemblage. In addition, it is fairly common in the *Corymbograptus v-similis* Biozone.

Localities: Barrandian; Ejpovice (borehole E-35, depth 61.0 m; collection of V. Havlíček), Sedlec (gorge), Starý Plzenec (Kocanda).

Spondyglossella ? sp.

Pl. 11, fig. 18

Material: Two deformed shells in clayey shales.

Description: The larger shell is 8 mm long, broadly oval, 120 % as long as wide, thin-walled. Beaks of both valves are very short, broadly rounded, anterior and lateral margins are evenly curved. The shell is ornamented by concentric growth lines, with intercalated concentric bands bearing irregular subconcentric growth fila. Interiors are poorly known, with gently divergent impressions of pedicle nerves in the ventral valve and a lack of median ridge in the dorsal valve. Pseudointerareas are undoubtedly vestigial.

Remarks: Both the dorsal valves lack prominent median ridge which os the characteristic feature of the glossellid genus *Rafanoglossa* HAVLÍČEK. The ornamentation of *Spondyglossella* ? sp. clearly differs in irregular growth fila on concentric bands because in *Rafanoglossa* that consists of simple concentric fila with a nearly bald median sector. Both specimens are referred to *Spondyglossella* on the basis of general morphology and ornamentation but there are not any significant data about their interiors.

Occurrence: This species, unknown in all well-known localities of the Šárka Formation, was ascertained only in clayey shales with abundant graptolites and phyllocarid crustaceans in NE part of the Barrandian.

Locality: Barrandian; Praha-Vokovice (temporary excavations).

Subfamily **Elliptoglossinae** POPOV et HOLMER, 1994

Synonymy: Litoperatidae SUTTON, BASSETT et CHERNS, 1999

Remarks: Sutton et al. (1999) defined a new family Litoperatidae that accommodates only the genus *Litoperata* SUTTON, BASSETT et CHERNS. This genus is monospecific, based on *L. agolensis* sp. nov. by the same authors. They distinguished two valve morphotypes, the morphotype A and B, without any certainty which of these two represents the dorsal or ventral valve, respectively. The genus *Litoperata* shows the greatest similarity to *Lingulops* HALL, 1872 and may be considered even synonymous, because it differs only in coarser concentric rugellae and less clearly defined muscle platforms. I agrees with the placement of *Lingulops* to Elliptoglossinae POPOV et HOLMER, and conclude that the family Litoperatidae is synonymous with Elliptoglossinae. The subfamily Elliptoglossinae comprises only three Ordovician genera *Elliptoglossa* COOPER, *Lingulops* HALL, and *Litoperata* SUTTON et al. The earliest members of the subfamily appeared in the Tremadocian and the latest representatives are known from the Silurian (Ludlow).

Genus ***Elliptoglossa*** COOPER, 1956

Type species: *Leptobolus* ? *ovalis* BASSLER, 1919; Ordovician, Caradocian or Ashgillian; Pennsylvania, U. S. A.

Remarks: The genus *Elliptoglossa* COOPER is characterized by equivalved shell with poorly differentiated ventral and dorsal valves. These features, noted by previous authors (Cooper 1956, Percival 1978) sometimes led to confusion of the valves. Unlike the other elliptoglossine genera (*Lingulops* HALL and *Litoperata* SUTTON et al.), the genus *Elliptoglossa* lacks the flattened posterolateral margins of the ventral valve. This flattening is distinct in *Litoperata* of the Llandeilian age from the Anglo-Welsh Basin, and from the Ashgillian of Sweden figured by Sutton et al. (1999) and in *Lingulops* from the Wenlock and Ludlow of the Barrandian (Mergl 1999a, 2001). The genus *Elliptoglossa* also lacks a raised muscle platforms, which are invariably present in *Litoperata* and *Lingulops*, but unlike the latter genera, *Elliptoglossa* preserves the ventral pseudointerarea. Exteriors of *Litoperata, Lingulops* and *Elliptoglossa* lack the pitted microornamentation, which differentiates these genera from the externally similar but more circular genus *Paterula* BARRANDE. In the Barrandian, the genus is represented by a single species having the stratigraphic range restricted to Tremadocian/Arenigian boundary interval.

Elliptoglossa celdai MERGL, 1995

Pl. 13, figs 1–19, pl. 14, figs 1, 2

? 1875 *Obolus minimus* BARR.: Barrande, pl. 95, case II, fig. 2.
1995 *Elliptoglossa celdai* sp. n.: Mergl, p. 104, pl. 2, figs 9–15.

Holotype: Ventral valve, internal mould, figured by Mergl (1995) on pl. 2, fig. 10, stored in the palaeontological collection of Museum of Dr. B. Horák, Rokycany (MBHR 65888), refigured herein on pl. 13, fig. 1.

Type horizon and locality: Lower Arenigian, Klabava Formation, Olešná Beds Member, lower part, unit I (Mergl, 1984); Barrandian, Těně (west).

Material: Thirty specimens.

Description: The shell is equivalved, weakly dorsi-biconvex, thin-shelled, 1.3 mm long in the large specimens.

The dorsal valve is broadly elliptical, 120–130 % as long as wide, with the maximum width slightly posterior to the midlength, with lateral margins less curved than the anterior margin. The posterior margin is evenly rounded. The valve is gently and evenly convex, with maximum depth at the mi-

dlength. The beak is marginal, with a distinctly convex, smooth larval shell raised above the shell surface. The interior of the dorsal valve shows evenly broad limbus along the whole periphery. The pseudointerarea is not differentiated. The visceral field is large, widely rhomboidal in the outline, 60 % as long and 60 % as wide as the valve, with poor muscle impressions. Epithelian cell moulds are distinct on anteromedian surface of the visceral area (Pl. 13, fig. 18). The central and anterior lateral muscle scars are located anteriorly. The narrow muscle scars which correspond to the transmedian, outside and middle lateral muscles are located in the posterior third of the valve. The umbonal muscle scar is paired, located in posterior 20 %. The fine median ridge separates the anterior muscle scars but it is absent in other specimens.

The ventral valve has nearly the same outline as the dorsal valve, with the exception of the posterior margin which is gently extended posteriorly and less rounded. The valve is evenly convex, with the maximum depth posterior to the midlength. The beak is marginal, with distinctly raised larval shell. Interior of the ventral valve has broad and flat limbus along the periphery. The ventral pseudointerarea is poorly differentiated, 80 % as wide as the valve, without the pedicle groove and clearly defined propareas. Its anterior margin forms acute an edge above the umbonal chamber, the sides of pseudointerarea extend anterolaterally, with surface slightly raised above the surface of the limbus. The visceral area is weakly defined, with a small umbonal muscle scar at 15 % of the valve length.

Shell exterior is covered by weak concentric growth lines which become more distinct, and closely spaced anteriorly. A distinct microornamentation is absent.

Remarks: The species *Elliptoglossa celdai* MERGL differs from the Lower Ordovician elliptoglossines from Poland, Scandinavia, Kazakhstan and Great Britain (Bednarczyk 1986, Popov and Holmer 1994, Sutton et al. 1999) by a narrower outline and the absence of a pair of short ridges in the ventral valve interior. The stratigraphically higher species *E. sylvanica* COOPER, 1956 and *E. ovalis* (BASSLER, 1919) have more elongate outline and vestigial ventral pseudointerareas.

Occurrence: The species *E. celdai* is locally abundant in red-coloured siltstones and shales in the lower and middle part of the Klabava Formation (Olešná Beds Member).

Localities: Barrandian, Hrádek (gorge), Kotel Hill, Kváň (field), Mílina Hill, Strašice (east; town), Svárov, Těně (west; units H, I).

Family **Zhanatellidae** KONEVA, 1986

Genus ***Fagusella*** MERGL, 1996

Type species: *Fagusella indelibata* MERGL, 1996; Ordovician, Arenigian, Klabava Formation; Bohemia.

Remarks: The genus *Fagusella* MERGL was established for a single zhanatellid species having unusually thick-walled shell from the upper Arenigian of the Barrandian. A similarly sized and ornamented genus *Rowellella* WRIGHT, 1963 differs in a subrectangular, posteriorly thin-walled shell and highly lamellose external macroornamentation. Both genera display great variation of the shell outline. The new examination of *Fagusella* showed numerous unevenly distributed, very deep and conical davisate pits in the visceral area in the ventral valve (Pl. 15, figs 3, 7). The exteriors of all available free valves of *Fagusella* are always worn and sometimes polished, especially in the posterior of the shell, indicating significant transport and abrasion on the sea floor. Coarse concentric rugellae are preserved anteriorly and on steep slopes of the geniculate valves. Microornamentation is never preserved not even in the deep depressions between the rugellae.

The genus is probably derived from some Late Cambrian to Lower Ordovician ancestor of the *Zhanatella*-like type. *Fagusella* follows the evolutionary trends of contemporaneous zhanatellid *Rowellella*, e. g. formation of the geniculate, dorsi-biconvex to dorsi-planar shell and coarsely rugellate exterior. However, *Fagusella* retained the heavily mineralised posterior of the shell with a very wide and short pedicle groove. In contrast, *Rowellella* has a thick shell wall restricted to later growth stages, and also has much higher lamellose ornamentation. This is probably connected with the very small shell size reflecting a different mode of life.

Fagusella indelibata MERGL, 1996

Pl. 15, figs 1–14

1996 *Fagusella indelibata* sp. n.: Mergl, p. 47, pl. 1, fig. 9, pl. 2, figs 1–11, text-fig. 1.

Holotype: Ventral valve figured by Mergl (1996) on pl. 2, fig. 11, refigured herein on pl. 15, fig. 12, stored in the palaeontological collection of Museum of Dr. B. Horák, Rokycany (MBHR 66790).

Type horizon and locality: Upper Arenigian, Klabava Formation, uppermost part; *Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone; Barrandian, Zbiroh, (Bukov, Joseph gallery, old dump).

Material: About fifty specimens.

Description: Mergl (1996).

Occurrence: The species is abundant in tuffaceous shales and thin beds of organodetritic limestone within the *Nocturnellia* Community in the upper part of the Klabava Formation. It is a characteristic species in littoral area bordering NW margin of the basin. Small fragmentary shells of this species, probably the juveniles, are rare in taphocoenoses present in the graptolite-bearing clayey sequence in the upper part of the formation (*Azygograptus ellesi-Tetragraptus reclinatus abbreviatus* Biozone).

Localities: Ejpovice (quarry, NE part), Klabava (Old Castle), Rač, Rokycany (Stráň), Velíz (borehole), Zbiroh (Bukov, Joseph gallery).

Genus ***Hyperobolus*** HAVLÍČEK, 1982

Type species: *Lingula feistmanteli* BARRANDE, 1879; Ordovician, Tremadocian, Třenice Formation; Bohemia.

Hyperobolus feistmanteli (BARRANDE, 1879).

Pl. 16, figs 1–8, pl. 20, figs 12–14

1879 *Lingula Feistmanteli* BARR.: Barrande, pl. 106, case IV, figs 3–7, 9–13, pl. 110, case VIII, figs 1–3.

non: 1879 *Lingula Feistmanteli* BARR.: Barrande, pl. 106, case IV, figs 8, 14 [= *Expellobolus expulsus* (BARRANDE, 1879)]; pl. 106, case IV, fig. 2 (spec. indet); pl. 110, case VIII, fig. 4 [= *Expellobolus expulsus* (BARRANDE, 1879)].

1912 *Obolus feistmanteli* (BARRANDE): Walcott, p. 391, pl. 12, figs 1, 1a–f, 9, 9a.

1918 *Obolus* (*Lingulobolus*) *Feistmanteli* (BARR.): Koliha, p. 6, text-figs 1a, 1b.

1918 *Obolus* (*Lingulobolus*) *Feistmanteli* (BARR.) var. *acutirostris* n. var.: Koliha, p. 7 (nomen nudum).

1918 *Obolus* (*Lingulobolus*) *Feistmanteli* (BARR.) var. *tenuilamellosa* n. var.: Koliha, p. 7 (nomen nudum).

1924 *Obolus* (*Lingulobolus*) *Feistmanteli* (BARR.): Koliha, p. 12 and 47, figs 1, 2.

1982b *Hyperobolus feistmanteli* (BARRANDE, 1879): Havlíček, p. 16, pl. I, figs 1–8, pl. 14, figs 11, 12, text-fig. 4.

1982b *Thysanobolus pirolus* sp. n.: Havlíček, p. 23, pl. 10, figs 10 and (?) 11.

Lectotype: Designated by Walcott 1912, ventral valve figured by Barrande (1879) on pl. 106, case IV, fig. 4, and by Walcott (1912) on pl. 12, fig. 1d, stored in the palaeontological collection of the National Museum, Prague (NM L 18225).

Paralectotypes: Figured by Barrande (1879) on pl. 106, case IV, fig. 2 (probably ventral valve, NM L 18223), fig. 3 (ventral valve, NM L 18224), fig. 5 (dorsal valve, NM L 18153), fig. 6 (probably dorsal valve, NM L 24470), fig. 7 (ventral valve, NM L 18155), fig. 8 (dorsal valve, NM L 18151), fig. 9 (ventral valve, NM L 18227), fig. 11 (probably ventral valve, NM L 18228), fig. 12 (ventral valve, NM L 18154), and fig. 13 (probably ventral valve, NM L 18152), stored in the palaeontological collection of the National Museum, Prague.

Type horizon and locality: Upper Tremadocian, Třenice Formation; Barrandian, Krušná hora (Kruschna Hora in original spelling).

Material: About a hundred specimens.

Description: Havlíček (1982b).

Remarks: The species was extensively described and discussed by Havlíček (1982b), but without any data about the morphology of juvenile specimens. Well preserved specimens which probably belong to the same species have been ascertained in the greywacke with haematite cement from an old quarry in the Bukov Hill near Zbiroh. The juvenils differ from adults by remarkably long, widely triangular orthocline pseudointerarea with long, deep and rather narrow pedicle groove. The propareas are densely covered with fine growth lines. The juvenile ventral pseudointerarea is only partly preserved in the large specimens. Thinner posterior margin was worn or broken off and the adults display short propareas divided by short, deep and broad pedicle groove. The juvenile valve is gently convex, with weakly defined visceral field, and oblique and with shallow central muscle scars impressed. The juvenile dorsal valve is subtriangular in the outline, with the maximum height in the umbonal chamber. The dorsal pseudointerarea is very short, restricted to linear, strongly thickened posterior shell wall. This posterior thickening is externally covered by coarse growth lines being devoid of well-defined propareas. The dorsal apex is suprapical in its position. The dorsal valve interior has three pairs of deeply impressed scars. There are small, probably umbonal scars in the umbonal chamber, and two larger pairs at the centre of the valve.

The shell ornamentation of *Hyperobolus feistmanteli* (BARRANDE) has been poorly known. The adult specimens, preserved as external moulds in coarse greywackes, display weak concentric growth rugellae, arranged in almost regular intervals. The juvenile shells posses short and regular rounded concentric rugellae over the entire surface, and this ornamentation probably remains in adults. However, the preservation of large shells in coarse sediment is poor and shell surface with rugellate ornamentation was usually worn on the mobile coarse bottom sediment.

The exterior of *H. feistmanteli* is devoid of prominent high rugellae that are present in *Thysanotos* MICKWITZ, 1896 and also lacks rows of marginal spines on the lamellae. Popov and Holmer (1994) noted the presence of the finely pitted microornamentation in the species *Hyperobolus andreevae* POPOV et HOLMER, 1994 but that is not preserved in *H. feistmanteli*. In contrast, the surface of *H. andreevae* does not bear any regular rugellae as those present in *H. feistmanteli*.

Occurrence: The species is abundant, sometimes in small accumulations, on the bedding planes of coarsely grained greywackes of the Třenice Formation (Upper Tremadocian) in the area between Nový Jáchymov (Krušná hora tectonic islet) and Zbiroh. The reported occurrences in more SW situated fossil sites (Cheznovice, Medový Újezd: Havlíček, 1982b) are very rare and some of them were confused with *Thysanotos primus* (KOLIHA,1924) or *Rosobolus magnus* sp. n. The shell fragments that may be referred to the juveniles *H. feistmanteli* are known from haematites in Holoubkov (V Ouzkém). These specimens (Pl. 20, figs 13, 14) have been found in a different type of haematite and indicate other environment and benthic community than the rich brachiopod-trilobite fauna known at this locality.

Localities: Cerhovice (Cerhovská hora and Kvásek Hills), Drozdov (Holý vrch and Obiš Hills), Holoubkov (V Ouzkém), Krušná hora (Gabriela mine; gallery), Medový Újezd (quarry), Tejček, Zbiroh (Bukov, old quarries).

Genus ***Pidiobolus*** MERGL, 1995

Type species: *Pidiobolus minimus* MERGL, 1995; Ordovician, Arenigian, Klabava Formation; Bohemia.

Remarks: When established, the genus was referred to

subfamily Obolinae KING, 1846 on the basis of its general morphology. The new investigation does not support this placement; the examination of the free shells discovered that the external surface bears fine superficial pitting, which is diagnostic for the family Zhanatellidae KONEVA, 1986. The genus *Pidiobolus* MERGL is closely related to the upper Cambrian genus *Tropidoglossa* ROWELL, 1966. The latter has different morphology of the ventral interarea, with well defined and larger propareas.

The genus *Pidiobolus* is present in the Barrandian as one well known species in the Mílina and Klabava Formations, but related, larger and poorly preserved species is known from the Třenice Formation. Only one very small shell with superficial pits that may belong to *Pidiobolus* is known questionably from the Dobrotivá Formation (Pl. 6, fig. 6). This specimen was probably referred to *Leptobolus* HALL, 1871 by Havlíček (1982b) and is not discussed in the present work.

Pidiobolus minimus MERGL, 1995

Pl. 17, figs 1–14

1995 *Pidiobolus minimus* sp. n.: Mergl, p. 103, pl. 1, figs 2–4.

Holotype: Dorsal valve (internal and external moulds) figured by Mergl (1995) on pl. 1, fig. 4, stored in the palaeontological collections of Museum of Dr. B. Horák in Rokycany (MBHR 65878).

Type horizon and locality: Lower Arenigian, Klabava Formation, Olešná Beds Member, level I; Barrandian, Těně (west).

Material: Five ventral valves and three dorsal valves preserved as internal moulds in siltstone and seven ventral and three dorsal free valves yielded by etching of the rock.

Description: The shell is dorsi-biconvex, small, 2 mm long as the maximum. The shell is rather thick-walled, with a rectimarginate commissure.

The dorsal valve is subcircular, 105 % as long as wide, with the maximum width at the midlength. Margins including the posterior one are evenly rounded. The valve is moderately and evenly convex in both profiles, with the maximum depth at the midlength. The dorsal beak has two prominent, divergent and elongate nodes. The dorsal valve interior has very short propareas. The median groove is broad, long and only gently raised above the valve floor. The muscle scars are distinct near the centre of the valve, with large central muscle scars.

The ventral valve is slightly longer than dorsal valve, about 110 % as long as wide, posteriorly less rounded than anteriorly. The valve has weakly convex profiles, gently depressed median sector and the maximum depth located in the posterior third. The ventral beak has a distinct node. The ventral pseudointerarea is large, undercut along the anterior edge, with a large, deep and triangular pedicle grove. Propareas are wide, without distinct flexure lines, gently inclined toward the pedicle groove and their anterior edge is excavated. The visceral area is weakly defined, bearing fine, distant and subparallel impressions of the pedicle nerves and large and obscure impression of the muscle field in the midlength of the valve. Narrow and long, oblique impressions of the transmedian and anterior lateral muscles are situated posterolaterally, close to the internal edge of the wide and flattened brim encircling the shell cavity. The pallial markings are not preserved.

The shell is ornamented by low concentric growth lines of uneven size, more distinct posterolaterally, and sometimes forming low concentric fila. The microornamentation consists of shallow rectangular pits, 7–8 μm in diameter, regularly arranged in radial and oblique rows. The pitting is apparently absent in the larval shell, which has a poorly defined border. The diameter of the larval shell is approximately 100 μm.

Remarks: The species *Pidiobolus minimus* MERGL is reliably known from the Barrandian only, where it occurs in the upper part of the Mílina Formation to the lower part of the Klabava Formation; this interval is generally interpreted as late Tremadocian to early Arenigian (Havlíček and Vaněk 1966). Recently, Bednarczyk and Stupnicka (2000) referred to the species *P. minimus* two valves from the Kleczanów Sandstone Member of the Miedzigorz Sandstone Formation (eastern Holy Cross Mountains, Poland) which is referred to the upper Tremadocian. These valves, named ? *Pidiobolus* cf. *minimus* have a comparatively small size but the ventral valve figured by those authors on fig. 9: I is more elongate, and the valve on fig. 9: J is probably the ventral valve of a siphonotretid. Therefore, the presence of *P. minimus* in the Holy Cross Mountains needs further confirmation.

Occurrence: The species *P. minimus* is rare in red-coloured siliciclastic sediments in the upper part of the Mílina Formation (unit B) and the lower part of the Klabava Formation (units H and I).

Localities: Barrandian; Těně (west), Zaječov (quarry near the school building).

Genus ***Rosobolus*** HAVLÍČEK, 1982

Type species: *Rosobolus robertinus* HAVLÍČEK, 1982; Ordovician, Tremadocian, Třenice Formation; Bohemia.

Remarks: In the generic diagnosis Havlíček (1982b) noted that *Rosobolus* HAVLÍČEK strikingly differs from the otherwise similar *Hyperobolus* HAVLÍČEK by large and subrectangular central muscle scars, which are roughly normal to the midline of the ventral valve. In contrast, the central muscle scars in *Hyperobolus* are shorter and oblique. This difference is also apparent in the new species *Rosobolus magnus* sp. n. which, unlike the type species *R. robertinus* HAVLÍČEK, attains the size characteristic for the specimens of *Hyperobolus feistmanteli* (BARRANDE). Apart from other differences discriminated by Havlíček (1982b), a weak dorsal sulcus which forms less rounded anterior margin of the *Hyperobolus* is totally absent in three known species of *Rosobolus*. The striking difference between *Rosobolus* and *Hyperobolus* is the development of concentric ornamentation. The former has never present

rugellae and instead of them, its exterior is remarkably smooth, with only remarkably regular microornamentation.

The microornamentation of *Rosobolus* was first figured by Holmer and Popov (2000). This consists of shallow transversely rhomboidal pits of an uniform size, 10–12 µm wide and 5–6 µm long, arranged in straight radial rows over the whole external surface (Pl. 18, figs 10, 13). These pits significantly differ from the pits developed in *Hyperobolus* HAVLÍČEK and *Thysanotos* MICKWITZ. The two latter genera have subcircular, concave, chaotically arranged pits of moderate and variable size (Popov and Holmer 1994). The genus *Rosobolus* was referred to family Zhanatellidae KONEVA and this is followed herein, but its pitting resembles the rhomboidal pitting of the families Elkaniidae WALCOTT et SCHUCHERT, 1908 and Paterulidae COOPER, 1956.

The genus *Rosobolus* is known from the Třenice Formation (Upper Tremadocian) to the top of the Klabava Formation (Upper Arenigian). Holmer (1989) tentatively refered to the genus *Rosobolus* any fragmentary valves from the Gullhögen Formation (Llandeilo) of Sweden but this does not seem well justified. Recently, Bednarczyk and Stupnicka (2000) note the presence of the genus in Tremadocian of the Holy Cross Mountains.

Rosobolus robertinus (HAVLÍČEK, 1982)

Pl. 18, figs 1–8, 10, 11, 13

1927 *Obolus* (*Lingulobolus*) cf. *feistmanteli* (BARR.): Růžička, p. 3, pl. 1, figs 1–4.
1982b *Rosobolus robertinus* sp. n.: Havlíček, p. 19, pl. 3, figs 1–9, text-fig. 5.
1995 *Rosobolus* sp.: Mergl, p. 102, pl. 1, fig. 1.
2000 *Rosobolus robertinus*: Holmer and Popov, p. 65, fig. 29, 1a–d.
2000 *Rosobolus robertinus* (HAVLÍČEK, 1982): Bednarczyk and Stupnicka, fig. 9: B, D.

Holotype: Ventral valve (internal and external mould) figured by Havlíček (1982b) on pl. 3, fig. 7, stored in the palaeontological collections of Museum of Dr. B. Horák in Rokycany (MBHR 65878, original signature VH 704b).

Type horizon and locality: Upper Tremadocian, Třenice Formation; Barrandian, Holoubkov (V Ouzkém).

Material: Fourteen ventral and six dorsal valves, several fragments.

Description: Havlíček (1982b).

Remarks: The ventral valve of *Rosobolus* sp. described by Mergl (1995) may be tentatively referred to *R. robertinus* HAVLÍČEK. It differs only by a greater convexity and a little smaller central muscle scars, otherwise it is similar to the topotypic specimens. Shells referred to *R. robertinus* by Bednarczyk and Stupnicka (2000) do not differ from the Bohemian species. The deeply impressed, transverse ventral central scars associated with a subtriangular shell outline are also characteristic for the typical specimens of *R. robertinus*. Their occurrences significantly confirm faunal interchange between the Barrandian and the Baltoscandinavian area.

Occurrence: The species was fairly abundant in quartzite haematites in the old dumps of an abandoned iron ore mine at Holoubkov. The locality is referred to the base of the Třenice Formation (Upper Tremadocian). The stratigraphically youngest, an almost identical specimen is known from fine red-brown greywackes (Olešná Beds Member) in the lowest beds of the Klabava Formation (Lower Arenigian).

Localities: Barrandian; Holoubkov (V Ouzkém), Zaječov (quarry near the school building).

Rosobolus magnus sp. n.

Pl. 15, figs 15–17

Holotype: Ventral valve (internal mould) figured herein on pl. 15, fig. 16 stored in the palaeontological collections of the University of West Bohemia in Plzeň (PCZCU 603b).

Paratype: Dorsal valve (internal mould) figured herein on pl. 15, fig. 17, stored in the palaeontological collections of the University of West Bohemia in Plzeň (PCZCU 604).

Type horizon: Upper Tremadocian, Třenice Formation, upper part.

Type locality: Barrandian, Cheznovice (Žlebec, old dump).

Name: Latin, *magnus*, large, referring to the large size of species.

Material: Four ventral valves and two dorsal valves.

Diagnosis: Large *Rosobolus* with deeply impressed ventral central muscle scars, anterior lateral and central muscle scars of the dorsal valve of similar size, deeply impressed vascula lateralia and subparallel dorsal vascula media.

Description: The shell is biconvex, thick-shelled, large for the genus, with the length 23–25 mm. The dorsal valve is subcircular, 100–104 % as long as wide, with the maximum width in the anterior third. The beak is short, rounded. Posterolateral margin is weakly curved, the anterior and anterolateral margins are evenly curved. The valve is slightly convex, with no sign of sulcus. The dorsal pseudointerarea is formed as a high, orthocline and undivided platform covered by unnumerous coarse growth lines. The umbonal chamber is deep, with well impressed jointed pair of umbonal muscle scars. The visceral area is large, thickened centrally, anteriomedianly limited by two pairs of muscle scars; the anterior one is situated closer to the midline (anterior lateral and central muscle scars). Posterolateral muscle scars are undivided, being deeply impressed into the valve floor. Vascula lateralia are broadly divergent, running almost parallel with the valve margins. Vascula media are almost parallel, deeply impressed proximally but obscure distally.

The ventral valve is roundly triangular in the outline, with an acute beak, 113–118 % as wide as long, widest at the anterior third, with evenly curved margins. The apical angle is 90–100 %. The valve is moderately convex, but the visceral area is shallow due to the thickening of the valve wall. The ventral pseudointerarea is orthocline, short, restricted to the narrow and short strip along the posterolateral margins. The pedicle groove is deep, parallel-sided and rather short. Muscle scars are deeply impressed, with

prominent, transverse subrectangular central muscle scars, narrow and undivided posterolateral scars and small paired umbonal scars. Vascula lateralia are gently curved, moderately divergent. They disappear at two-thirds of the valve. Davisate pits are uncommon and small.

Remarks: The new species is characterized by a large size, which attains 200–250 % the size of *R. robertinus* HAVLÍČEK. Other differences are less significant but fine details in *R. magnus* are unknown due to the preservation in coarse greywackes. Unlike *R. robertinus*, the species *R. magnus* lacks a prominent convexity in the anterior half of the ventral valve. Several specimens of *R. magnus* come from greywackes of the Třenice Formation in quarry at Žlebec near Cheznovice (some 200 m from the type locality). Those specimens were by previous authors (Koliha 1924) confused with *Hyperobolus feistmanteli* (BARRANDE) but this species is actually unknown from the locality.

Occurrence: The species is know only from coarse greenish greywackes in the upper part of the Třenice Formation (Upper Tremadocian). It occurs separately from other brachiopod fauna in the locality, represented by orthids, other medium-sized lingulid brachiopods and trilobites, indicating another, probably more agitated and shallower environment.

Locality: Barrandian; Cheznovice (Žlebec).

Rosobolus sp.

Pl. 18, figs 9, 12.

Material: One ventral valve.

Description: The valve is 4.5 mm long, 90 % as long as wide, thick-shelled posteriorly but thin anteriorly, moderately convex in the transverse and lateral profiles. The shell outline is roundly triangular, with the maximum width at the anterior third. The posterior margin is evenly curved. Transverse and clearly defined central muscle scars lie posteriorly to the midlength, separated from each other by a tongue-like anterior extension of the visceral area.

The shell exterior is almost smooth, without growth lines except for a few concentric lamellae. The microornamentation consists of evenly sized transversely rhomboidal, shallow pits, arranged in regular radial and oblique rows.

Remarks: The species bears the characteristic ornamentation of the genus, with rhomboidal pits in the microornamentation and absence of any concentric or radial elements of the macroornamentation. Its presence in the upper part of the Klabava Formation (Upper Arenigian) indicates a longer stratigraphical range of the genus *Rosobolus* than was suggested by Havlíček (1982b).

Occurrence: The species is very rare in the upper part of the Klabava Formation (Upper Arenigian), where it occurs in the *Nocturnellia* Community.

Locality: Barrandian; Kleštěnice (Stanislav mine).

Genus ***Rowellella*** WRIGHT, 1963

Type species: *Rowellella minuta* WRIGHT, 1963; Ordovician, Ashgillian, Portrane Limestone; Ireland.

Rowellella distincta BEDNARCZYK et BIERNAT, 1978

Pl. 19, figs 1–3, 8–10, 14–20

1978 *Rowellella distincta* sp. n.: Bednarczyk and Biernat, p. 302, pl. 17, figs 1, 2.
1986 *Rowellella* sp.: Mergl, p. 29, pl. 2, fig. 5.
1995 *Rowellella distincta* BEDNARZCYK et BIERNAT, 1978: Mergl, p. 105, pl. 2, figs 1–8.

Holotype: Dorsal valve figured by Bednarczyk and Biernat (1978) on pl. 17, fig. 1, stored in the Polish Academy of Sciences, Warszawa (ZPAL Bp. XXVII/25).

Type horizon and locality: Late Lower Arenigian, *Acontiodus rectus sulcatus* Zone; Poland, Holy Cross Mountains, borehole Bukówka IG-1 at Kielce.

Material: Fifteen dorsal valves preserved in siltstone and about twenty incomplete loose valves, and many fragments from the Barrandian localities.

Description: Mergl (1995).

Remarks: The description of this species was based on several specimens from the late Lower Arenigian of the Holy Cross Mountains by Bednarczyk and Biernat (1978). The new rich material from the Barrandian displays a great variation in the shell morphology and outline as already noted by Mergl (1995). Some specimens are elongate-oval to subrectangular, with slightly to strongly geniculate sides, but specimens with widely trapezoidal outline in the later growth stages are the most frequent. The holotype and paratype from Poland fall to the trapezoidal type. The ornamentation is also uneven, with high to low lamellae, resting under a high angle on the shell surface. The distances among lamellae grow almost regularly toward the anterior margin. The surfaces of rugellae bear irregular wrinkles and drapes, which are more distinct on steeply geniculate lateral slopes than in the median sector. Popov and Holmer (1994) described fragmental valves with similar ornamentation and trapezoidal outline from the Bjørkåsholmen Limestone (Upper Tremadocian) in Sweden. The species *R. distincta* BEDNARCZYK et BIERNAT probably represents species characteristic for the late Tremadoc-early Arenig interval. Stratigraphically younger species of the genus (*R. rugosa* GORJANSKY, 1969, *R. holenensis* HOLMER 1989, *R. margarita* ROWELL et KRAUSE, 1973, *R. minuta* WRIGHT, 1963) are usually more elongate, less geniculate and have finer or, in *R. rugosa* coarser lamellae. As noted by Holmer (1989) and confirmed by the new examination, the genus *Rowellella* is, due to its great intraspecific variability, rarely described or illustrated and it is an, the extraordinary, taxonomically complicated genus.

Occurrence: The species *R. distincta* is really abundant within the short stratigraphical interval in red-coloured siltstones and shales in the lower part of the Klabava Formation (Olešná Beds Member) and its level is probably older than the level of the type specimens in Poland.

Localities: Barrandian; Hatě (Vrahův potok creek), Kváň (field), Těně (west; units H, I).

Rowellella sp. A

Pl. 19, figs 7, 11–13

1997d *Rowellella* sp.: Mergl, p. 101, fig. 6: A-C.

Material: Five fragmentary valves.

Remarks: This species differs from other Bohemian specimens by flat and non-geniculate valves, thinner shell, and more rounded anterior margin. The preservation of the valves also indicates thinner posterior part and a great morphological variability and asymmetry as in the ther species of the genus.

Occurrence: This species occurs rarely in red-brown siltstones in the lower part of the Klabava Formation (Lower Arenigian).

Locality: Barrandian; Hrádek (gorge).

Rowellella sp. B

Pl. 19, figs 4–6

Material: A single dorsal valve (internal and external mould) in siliceous nodule, stored in the palaeontological collections of Museum of Dr. B. Horák in Rokycany (MBHR 15667).

Description: The dorsal valve is 1.8 mm long, elongate subrectangular, parallel-sided, thick-shelled, 65 % as wide as long. Sides and anterior margin are distinctly geniculate. Ornamentation consists of coarse, evenly curved, thin and high lamellae spaced regularly over the shell surface except for the posterior third, where only fine growth lines are developed.

Remarks: The specimen cannot be accommodated in any known species of the genus. Its preservation with posterior part preserved is also unique. The evenly curved concentric lamellae distinguish this species from *R. distincta* BEDNARCZYK et BIERNAT, which has the lamellae less curved in the median sector, while they are rapidly turned on the flanks. The species *R. rugosa* GORJANSKY, 1969 from the Llanvirnian of Russia (Gorjansky 1969) has very thick and fewer concentric lamellae. The rarity of the material does not warrant a formal description, although the specimen probably represents a new species. It is worth to note that the specimen was found in the siliceous nodule in association with abundant spicules of hexactinellid sponges, which are otherwise extremely rare in the Šárka Formation.

Occurrence: Only one specimen has been found in a siliceous nodule released from black shales of the Šárka Formation (Llanvirnian, *Corymbograptus retroflexus* Biozone).

Locality: Barrandian; Osek (field).

Genus ***Thysanotos*** MICKWITZ, 1896

Type species: *Obolus siluricus* EICHWALD, 1840; Ordovician, Arenigian, Leetse Formation; Estonia.

Synonym: *Thysanobolus* HAVLÍČEK, 1982

Thysanotos primus (KOLIHA, 1924)

Pl. 20, figs 10, 11

1924 *Obolus* (*Lingulobolus) Feistmanteli* (BARR.) var. *Barrandei prima* n. var.: Koliha, p. 19, pl. 1, fig. 6.

1982b *Thysanotos primus* (KOLIHA, 1924): Havlíček, p. 24, pl. 2, fig. 8.

1982b *Thysanotos siluricus* (EICHWALD, 1840): Havlíček, p. 24, pl. 2, figs 3, 4, 6.

1982b *Thysanobolus lingulides* sp. n.: Havlíček, p. 21, pl. 2, figs 10–13.

1997a *Thysanotos primus* (KOLIHA, 1924): Mergl, p. 29, pl. 2, figs 5–8, pl. 3, figs 1–4.

Holotype: Ventral valve figured by Koliha on pl. 1, fig. 6, stored in the palaeontological collections of the National Museum, Prague (NM L 18251).

Type horizon and locality: Upper Tremadocian, Třenice Formation; Barrandian, Jivina (old quarries).

Material: About thirty specimens and numerous fragments preserved as moulds in greywackes and cherts.

Description and discussion: Mergl (1997a).

Occurrence: The species is restricted to the Třenice Formation (Upper Tremadocian). It is known from the upper part of the formation in the western part of the Barrandian. The species abundantly occurs in 0.5 m thick bed with thin chert lenses within a sequence of fine-grained grained greywackes in the type locality, and much rarely also in other localities. The stratigraphic position of the localities east of Prague is not wholly clear, but the comparable age was suggested by former authors (Havlíček 1982b, Mergl 1997a).

Localities: Barrandian; Břežany II (Na Chrástnici quarry), Holoubkov (V Ouzkém), Jivina (old quarries), Kleštěnice (section along the Jalový potok creek), Medový Újezd (quarry), Úvaly (old dump).

Thysanotos siluricus (EICHWALD, 1840)

Pl. 20, figs 1–9

1918 *Obolus* (*Lingulobolus* ?) *Barrandei* (KLOUČEK): Koliha, p. 7.

1924 *Obolus* (*Lingulobolus*) *Feistmanteli* (BARR.) var. *Barrandei* (KLOUČEK): Koliha, p. 18, pl. 1, figs 7, 8 and pl. 2, figs 5–7.

1982b *Thysanotos siluricus* (EICHWALD, 1840): Havlíček, p. 24, pl. 2, figs 1, 2, 5.

non 1941 *Obolus (Mickwitzella) barrandei barrandei* (KLOUČEK): Prantl and Růžička, p. 7.

non 1941 *Obolus (Mickwitzella) barrandei primus* KOLIHA: Prantl and Růžička, p. 8.

non 1941 *Obolus (Mickwitzella)* cf. *palliatus* (BARRANDE): Prantl and Růžička, p. 9.

non 1941 *Obolus* (*Lingulobolus) feistmanteli minor* KOLIHA: Prantl and Růžička, p. 10.

[synonymy of the Estonian material see Gorjansky (1969) and Popov and Holmer (1994)].

Lectotype, type horizon and locality: See Gorjansky (1969).

Material: Mostly incomplete, ten ventral and four dorsal valves in chert from the Barrandian localities.

Description of material from Bohemia: Havlíček (1982b), Mergl (1997a).

Remarks: The species *Thysanotos siluricus* (EICHWALD) is a significant index fossil in Central Europe, Baltic

area, Iran and the South Urals. Its morphology, distribution and stratigraphic position were discussed by many authors (Popov and Holmer 1994, Mergl 1997a, Bassett et al. 1999, Bednarczyk 1999). Currently, Bednarzcyk and Stupnicka (2000) discussed the age of *Thysanotos siluricus* in the Holy Cross Mountains. The authors note the presence of a siphonotretid *Celdobolus mirandus* (BARRANDE) between the beds with *Thysanotos siluricus* in the Kleczanów Sandstones Member of the Miedzygórz Formation, referred by them to the Upper Tremadocian. In Bohemia, the siphonotretid *Celdobolus mirandus* is known from the base of the Klabava Formation (Havlíček 1982b, Mergl 1986), which correlates with Lower Arenigian. However, a similar siphonotretid (*Celdobolus* cf. *mirandus*) was currently discovered in thin chert lenses in beds with *T. primus* (KOLIHA) (some 20–30 m below the beds bearing *T. siluricus* and 25–35 m below the abundant occurrence of *C. mirandus* in the Komárov area of the west Barrandian). It indicates much earlier appearance of *Celdobolus* HAVLÍČEK than was suggested by the previous authors (Havlíček 1982b, Mergl 1986) and does not contradict the Tremadocian age of the beds bearing *Thysanotos primus* and *T. siluricus*. The cherts bearing *T. siluricus* (the Mílina Formation), otherwise very rich in lingulate brachiopods, do not contain *Celdobolus*, but this seems to be environmentally based.

Occurrence: The species occurs rarely in the upper part of the Mílina Formation (Upper Tremadocian) associated with the Bohemian equivalent of the Scandinavian *Ceratopyge* fauna. It is known from the cherts 3.5–4.5 m below the KMFB in the Komárov area in the W part of the Barrandian, and from rocks in the old dumps near Úvaly east of Prague.

Localities: Barrandian; Kváň (field), Mílina (quarry), Olešná (quarry), Zaječov (quarry near the school building).

Family **Elkaniidae** WALCOTT et SCHUCHERT, 1908

The family is represented in the Lower Ordovican of the Barrandian by locally abundant, but generally heavily fragmentary species of the genera *Elkania* FORD,1886 and *Elkanisca* HAVLÍČEK, 1982, the latter closely related to the Baltic genus *Lamanskya* MOBERG et SEGERBERG, 1906. The Bohemian representatives, apart from the genus *Broeggeria* WALCOTT, 1902, were revised by Mergl (1994) and only limited new data, mainly concerning distribution of elkaniids in the basin, were gathered.

Genus ***Broeggeria*** WALCOTT, 1902

Type species: *Obolella salteri* HOLL, 1865; Upper Cambrian, White-Leaved-Oak Shales; Malvern Hills, South Wales.

Broeggeria ferraria sp. n.

Pl. 21, figs 9, 12–15

1982b *Broeggeria* sp.: Havlíček, p. 53, pl. 10, fig. 1, pl. 15, figs 8, 11.

Holotype: Dorsal valve (internal mould) figured herein on pl. 21, fig. 14, stored in the palaeontological collections of the National Museum, Prague (NM L 36728).

Type horizon: Upper Tremadocian, Třenice Formation.

Type locality: Barrandian, Holoubkov (V Ouzkém).

Name: Latin, *ferrarius,* made from iron, referring to the rock in which the species occurs.

Material: One incomplete ventral valve and four dorsal valves in haematite.

Description: The dorsal valve is thin-shelled, transversely oval, 77 % as long as wide, widest at the midlength, 7.5 mm wide in the largest known specimen. The valve has evenly curved margins, including the posterior one. The valve is weakly convex in a transverse profile and more convex posteriorly, becoming depressed in the anterior half. The dorsal valve interior shows small pseudointerarea, having a moderately wide median groove and vestigial propareas. The median septum is clearly defined, extending to the midlength of the valve. The visceral area is poorly defined, with obscure muscle impressions. Proximal parts of the vascula lateralia are widely divergent, straight. Vascula media are short, gently divergent, without distinct secondary branches. The radial striation is distinct near the shell periphery.

The ventral valve is poorly known. The visceral area is poorly defined and pallial markings are obscure.

Remarks: This species was shortly commented by Havlíček (1982b) with a short note that the material is not sufficient for a safe comparison with the type species *Broeggeria salteri* (HOLL). Popov and Holmer (1994) discussed widely the morphology and distribution of the type species, and figured it from Kazakhstan, South Wales, Scandinavia, the South Urals, and Nova Scotia. The specimens from the Barrandian do not wholly fall within the variability range, as proposed Popov et Holmer (1994) for the species *Broeggeria salteri*. The clearly defined median ridge, moderately wide dorsal median groove and less divergent dorsal vascula lateralia distinguish *Broeggeria ferraria* from *B. salteri.*

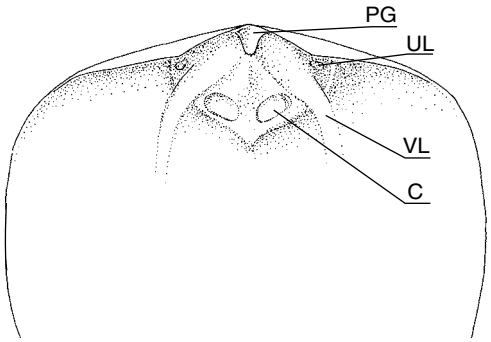
Broeggeria ferraria is the only species of the genus known in the Barrandian. Unlike in other areas, *B. ferraria* is not associated with olenid trilobites and dysaerobic environment. It occurs with the remarkably rich fauna of linguliformean brachiopods, orthides, trilobites and cystoids. As a very rare element in the type locality it represents a tentative presence of the *Broeggeria* Assemblage in the Barrandian and is the only report of this genus in the peri-Gondwanan area during the early Ordovician. Its presence confirms the Tremadocian or, at least, the early Arenigian (Hunneberg) age of the associated fauna.

Occurrence: The species is a rare element in massive quartzose haematite of the Třenice Formation of the Upper Tremadocian age.

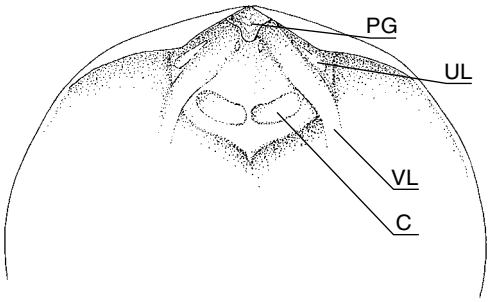
Locality: Barrandian; Holoubkov (V Ouzkém).

Genus ***Elkania*** FORD, 1886

Type species: *Obolella desiderata* BILLINGS, 1862; Ordovician, Levis Shale; Quebec, Canada.



Text-fig. 10: ***Elkania lineola*** **(HAVLÍČEK, 1982). Ventral valve interior. C – central muscle scars, PG – pedicle groove and umbonal muscle scars, UL – undivided lateral muscles scars, VL – vascula lateralia.**



Text-fig. 11: ***Elkania praelineola*** **sp. n. Ventral valve interior. C – central muscle scars, PG – pedicle groove and umbonal muscle scars, UL – undivided lateral muscles scars, VL – vascula lateralia.**

Elkania lineola (HAVLÍČEK, 1982)

Pl. 21, figs 1–3; text-fig. 10

1982b *Elkanisca lineola* sp. n.: Havlíček, p. 52, pl. 1, figs 9, 12, pl. 15, figs 1, 3.
1996 *Elkania lineola* (HAVLÍČEK, 1982): Mergl, p. 46, pl. 1, figs 7, 8.

Holotype: Ventral valve figured by Havlíček (1982b) on pl. 15,, figs 1, 3, stored in the palaeontological collections of Museum of Dr. B. Horák in Rokycany (MBHR 22775; collection of V. Havlíček, VH 3134), refigured herein on pl. 21, fig. 1.

Type horizon and locality: Upper Arenigian, Klabava Formation, upper part, *Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone; Barrandian, Klabava (Old Castle).

Material: Three ventral valves, numerous small fragments.

Emended diagnosis: Posteriorly thick-shelled *Elkania* with subcircular outline and distinctly depresed posterior margin; the maximum width at posterior third; external surface smooth, devoid of rugellae, microornamentation of transverse rhomboidal shallow pits; ventral muscle platform short and high; ventral pseudointerarea very low, with short and narrow pedicle groove.

Description: See Havlíček (1982b).

Remarks: A generic position of this species was commented by Mergl (1994). The external shell surface with rhomboidal pits is the characteristic feature of elkaniids, and this cannot be used as a base for the differentiation of *Elkanisca* HAVLÍČEK from *Elkania* FORD as suggested by Havlíček (1982b). The species diagnosis given by Mergl (1994) is incorrect and refers to the newly established species *E. praelineola* sp. n. The stratigraphicaly younger *E. lineola* (HAVLÍČEK) has thinner shell, depressed posterior margin of the ventral valve, shorter and smaller ventral muscle platform and, as the main difference, the maximum shell width is located in the posterior one-third to one-fourth while the outline of *E. praelineola* is almost circular with the maximum width at the midlength. These features are distinct in all the available specimens of *E. lineola* and *E. praelineola* and justify their separation. Undoubtedly, both species are closely related and represent two successive stages of the same evolutionary lineage.

Occurrence: The species is uncommon in tuffaceous and clayey shales in upper part of the Klabava Formation (Upper Arenigian) (*Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone),

Localities: Barrandian; Díly (south), Ejpovice (quarry, NE part), Klabava (Old Castle), Rokycany (Drahouš).

Elkania praelineola sp. n.

Pl. 21, figs 4–8, 10, 11; text-fig. 11

? 1921 *Acrothele*? nov. sp.: Želízko, p. 17, pl. 3, figs 7, 7a, 7b.
1994 *Elkania lineola* (HAVLÍČEK, 1982): Mergl, p. 51, pl. 2, figs 2–6, text-fig. 3.

Holotype: Ventral valve (internal mould) figured herein on pl. 21, fig. 5, figured by Mergl (1994) on pl. 2, fig. 2, stored in the palaeontological collections of Museum of Dr. B. Horák in Rokycany (MBHR 21946; collection of V. Havlíček, VH 3135).

Type horizon: Lower Arenigian, Klabava Formation, *Corymbograptus v-similis* Biozone.

Type locality: Barrandian, Starý Plzenec (Kocanda, old dumps).

Name: Latin, *prae,* prefix referring to the evolutionary priority of species.

Material: About twenty complete, mostly ventral valves (some juvenile) and numerous fragments.

Diagnosis: Thick-shelled *Elkania* with a circular outline and convex posterior margin; the maximum width at the midlength; external surface smooth, devoid of rugellae, microornamentation of transverse rhomboidal shallow pits; ventral muscle platform high, moderately long; ventral pseudointerarea low, with short and narrow pedicle groove.

Description: The shell is dorsi-biconvex, circular in outline, 13 mm wide in the largest complete specimen. The shell is significantly thick-shelled posteriorly, becoming slightly thinner anteriorly but it always is slightly thicker just near the periphery, creating internally a narrow brim along the margins.

The dorsal valve is less perfectly known, having highly elevated visceral platform with prominent divergent vascula media on its anterior slope.

The ventral valve is moderately convex, with evenly curved margins and fairly large, apsacline and transversely striated pseudointerarea, bisected by the short and clearly defined pedicle groove. The broadly triangular visceral area rests on an elevated platform. The platform is 40 % as wide and 22–25 % as long as the valve and has a highly raised anterior edge. Vascula lateralia are deeply impressed, moderately divergent and distinct to the midlength of the valve. The platform bears comparatively large, triangular central muscle scars and minute umbonal muscle scars.

The shell exterior is smooth, without growth fila or rugellae, but displays several distinct bands reflecting the growth lamellae. The microornamentation consists of uniform, widely rhomboidal, shallow pits arranged in crossed oblique rows.

Remarks: The new species was referred to *Elkania lineola* (HAVLÍČEK) by former authors (Havlíček 1982b, Mergl 1994). The species *Elkania praelineola* sp. n. differs by more circular shell outline, the maximum width located at the midlength instead of the posterior third as in *E. lineola*, higher and less steeply apsacline ventral pseudointerarea, and broader ventral visceral area. The species *E. lineola* can be derived from *E. praelineola* by posterior migration of the visceral area, reduction of the pseudointerarea, and an extension and thinning of the anteromedian part of the shell. The valve described as *Acrothele*? nov. sp. by Želízko (1921) from the *Holograptus tardibrachiatus* Biozone from the Starý Plzenec (U Blažeje) has the size and outline similar to elkaniid dorsal valve and probably is conspecific with *E. praelineola*.

Occurrence: The species is abundant and sometimes even dominant in grey-green shales with coarse sand admixture in the lower and middle parts of the Klabava Formation (*Corymbograptus v-similis* and *Holograptus tardibrachiatus* Biozones), but is absent in red-coloured greywackes and shales.

Localities: Barrandian; Rokycany (Stráň-Valcha), Sedlec (gorge), Starý Plzenec (Kocanda; U Blažeje).

Genus ***Elkanisca*** HAVLÍČEK, 1982

Type species: *Obolus klouceki* KOLIHA, 1918; Ordovician, Arenigian, Klabava Formation; Bohemia.

Synonymy: *Dictyobolus* WILLIAMS et CURRY, 1985.

Remarks: A closely related genus *Lamanskya* MOBERG et SEGERBERG from Tremadocian to Llanvirnian of Scandinavia, Ingria and the Southern Urals differs from *Elkanisca* HAVLÍČEK by a smooth exterior, having only subdued rugellae. On the contrary, the high, lamellar rugellae are a significant external element in *Elkanisca*. Another difference is shown in the ventral pseudointerarea; this is reduced in *Lamanskya* but high in *Elkanisca*. The dorsal visceral area is highly raised in *Lamanskya* and *Elkania* FORD, but it is low in *Elkanisca*. The exterior of *Dictyobolus* WILLIAMS et CURRY is finely rugellate and thus it is better to synonymize it with *Elkanisca* than with *Lamanskya* (Holmer and Popov 2000).

Elkanisca klouceki (KOLIHA, 1918)

Pl. 22, figs 9–14

1918 *Obolus Kloučeki* n. sp.: Koliha, p. 8, text-fig. 2.
1924 *Obolus Klouceki* KOLIHA: Koliha, p. 24 and 53, pl. 1, figs 11, 12.
1982b *Elkanisca klouceki* (KOLIHA, 1918): Havlíček, p. 51, pl. 1, figs 10, 11, pl. 10, fig. 12, and pl. 11, fig. 15.
1994 *Elkanisca klouceki* (KOLIHA, 1918): Mergl, p. 50, text-fig. 2.

Holotype: Dorsal valve (internal and external moulds) figured by Koliha on pl. 1, fig. 11, 12, refigured herein on pl. 22, figs 9, 10, 12, 13, stored in the National Museum, Prague (NM L 18156).

Type horizon and locality: Lower Arenigian, Klabava Formation, Olešná Beds Member; Bohemia, Barrandian, Žebrák, Točník (hillside).

Material: Eight specimens.

Description: Havlíček (1982b) and emended diagnosis Mergl (1994).

Remarks: The species is characterized by densely rugellate exterior and the dorsal visceral area only weakly raised above the valve floor. The species *E. obesa* (HAVLÍČEK) is much coarsely rugellate.

Occurrence: This species is rare and is known only from red-brown siltstones and shales in the lower part of the Klabava Formation (Lower Arenigian).

Localities: Barrandian; Cerhovice (Cerhovický vrch Hill), Točník.

Elkanisca obesa (HAVLÍČEK, 1980)

Pl. 22, figs 1–8

1927 *Obolus siluricus* EICHW.: Růžička, p. 4, pl. 1, fig. 6.
1980b *Conotreta obesa* sp. n. (partim): Havlíček, p. 299, pl. 1, figs 6, 7.
1982b *Elkanisca* sp. A: Havlíček, p. 52, pl. 11, figs 8, 9.
1994 *Elkanisca obesa* (HAVLÍČEK, 1980): Mergl, p. 48, pl. 1, figs 1–6, pl. 2, fig. 2, text-fig. 1.

Holotype: Small dorsal valve, figured by Havlíček (1980b) on pl. 1, figs 6, 7, stored in the palaeontological collections of Museum of Dr. B. Horák in Rokycany (MBHR 23397; coll. V. Havlíček, VH 3311a).

Type horizon and locality: Upper Tremadocian, Třenice Formation; Barrandian, Skomelno (Na Solích).

Material: Ten dorsal and five ventral valves and many fragments.

Description: Mergl (1994). The microornamentation consists of transversely rhomboidal shallow and slightly curved, uniformly sized pits, arranged in crossed oblique rows (Pl. 22, figs 7, 8).

Occurrence: The species is locally abundant in coarsely grained greywackes near the base of the Třenice Formation (Upper Tremadocian) and extends to the lower part of the

Klabava Formation (Lower Arenigian) where its minute fragments are generally rare. These small fragments are referred to *E. obesa* (HAVLÍČEK) on the basis of density of rugellae of the external ornamentation, because the coeval species *E. klouceki* (KOLIHA) has much finer rugellation. The species is unknown from the Mílina Formation.

Localities: Barrandian; the Třenice Formation: Holoubkov (V Ouzkém), Skomelno (Na Solích), Těškov (Kněžský vrch Hill); Klabava Formation: Březina (boreholes), Hrádek (gorge), Kváň (field), Mníšek, Strašice (field near St. Vojtěch), Svojkovice (highway cut), Těně (west), Zaječov (quarry near the school building).

Family **Paterulidae** COOPER, 1956

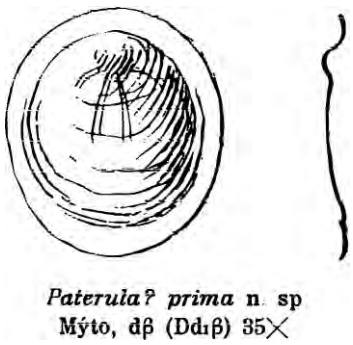
Genus ***Paterula*** BARRANDE, 1879

Type species: *Paterula bohemica* BARRANDE, 1879; Ordovician, Berounian, Vinice Formation; Bohemia.

Paterula prima KLOUČEK, 1924

Pl. 14, figs 3–10; text-fig. 12

1924a *Paterula ? prima* n. sp.: Klouček, p. 201, drawing on p. 202.
1999b *Paterula prima* KLOUČEK, 1924: Mergl, p. 352, fig. 4: 1–10.



Text-fig. 12: Original drawing of the type specimen of *Paterula prima* sp. n. by C. Klouček (1924a).

Neotype: Dorsal valve (internal mould) figured by Mergl (1999b) on fig. 4: 6; refigured herein on pl. 14, fig. 9, stored in the palaeontological collections of Museum of Dr. B. Horák in Rokycany (MBHR 85193).

Type horizon and locality: Upper Arenigian, Klabava Formation, uppermost part, *Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone; Barrandian, Mýto (excavations near St. Stephen pond).

Material, diagnosis and description: Mergl (1999b).

Remarks: Although this species was already distinguished and correctly referred to the genus *Paterula* by Klouček (1924), it was formally described by Mergl (1999b), who selected the neotype because the original shells collected by Klouček (1924a) were not discovered in the palaeontological collections of the National Museum, Prague and were probably lost.

Occurrence: This species is abundant in some clayey shale intercalations marginal to graptolite-bearing beds at the top of the Klabava Formation and range upward to grey shales with the first climacograptid graptolites at the base of the Šárka Formation; its stratigraphical range is restricted to the upper Arenigian.

Localities: Díly (south), Kleštěnice (Stanislav mine), Mýto (St. Stephen pond; highway cut), Rokycany (Drahouš).

Paterula incognita MERGL, 1999

Pl. 14, figs 11–14

1879 *Paterula Bohemica* BARR. (partim): Barrande, pl. 152, case I, fig. 3.
1982b *Paterula* sp. A: Havlíček, p. 50.
1974 *Paterula* cf. *bohemica* BARRANDE: Williams, p. 40, pl. 6, figs 2–11.
1999b *Paterula incognita* sp. n.: Mergl, p. 353, fig. 4: 11–16.

Holotype: Dorsal valve (internal mould) figured by Mergl (1999b) on fig. 4: 15, 16, refigured herein on pl. 14, fig. 13, stored in the palaeontological collections of Museum of Dr. B. Horák in Rokycany (MBHR 8870).

Type horizon and locality: Llanvirnian, Šárka Formation, *Corymbograptus retroflexus* Biozone. Barrandian, Díly (field).

Material, diagnosis and description: Mergl (1999b).

Remarks: This species was by Barrande (1879) referred to the species *P. bohemica* BARRANDE, 1879, which occurs in the Berounian Stage and differs in a larger size, convexity, and more circular outline. Havlíček (1982b) noted a minute size of *Paterula* sp. A and its dissimilarity with *P. bohemica* but did not describe this species formally due to scarcity of his material.

Occurrence: The species is sometimes common in siliceous nodules derived from clayey shales of the Šárka Formation, referred to the *Corymbograptus retroflexus* Biozone; its stratigraphical range is restricted to the Llanvirnian. The specimens referred to *P.* cf. *bohemica* BARRANDE from the Meadowtown Beds and Hope Shales of Shropshire by Williams (1974) are probably conspecific with *P. incognita* and extend the range of the species to the Lower Llandeilian.

Localities: Barrandian; Díly (field), Mýto (highway cut), Osek (field), Rokycany.

Paterula circina HAVLÍČEK, 1982

Pl. 14, figs 15–21

1879 *Paterula Bohemica* BARR.: Barrande, pl. 152, case I, figs 1, 2.
1982b *Paterula circina* sp. n.: Havlíček, p. 48, pl. 8, fig. 14, pl. 10, figs 2–9, text-fig. 10.
? 1982b *Leptobolus* sp.: Havlíček, p. 47, pl. 8, fig. 13.
1996 *Paterula circina transiens* n. subsp.: Havlíček and Vaněk, p. 232, pl. 1, figs 4–8.
1999b *Paterula circina* HAVLÍČEK, 1982b: Mergl, p. 354, figs 5, 6.

Holotype: Ventral valve (internal mould) figured by Havlíček (1982b) on pl. 10, fig. 6, stored in the palaeontological collections of Museum of Dr. B. Horák in Rokycany (MBHR 23135; coll. V. Havlíček, VH 3242a).

Type horizon and locality: Dobrotivian, Dobrotivá Formation, lens of siderite in the upper part of the formation; Barrandian, Kařízek (an abandoned Veronika mine).

Material, diagnosis and description: Havlíček (1982b) and Mergl (1999b).

Remarks: Havlíček (1982b) shortly described species *Leptobolus* sp. and figured an incomplete internal mould on pl. 8, fig. 13. This mould is probably a small fragment of *Paterula circina* HAVLÍČEK and the ridges noted by him are actually the imprints of the pedicle nerves. However, another minute "obolid" used by Havlíček for description is present in the Dobrotivá Formation and this specimen is currently referred to an undescribed species of the genus *Pidiobolus* MERGL.

Occurrence: The species is common and widespread in the black shales of the Dobrotivá Formation (Dobrotivian) and its upper stratigraphical limit reaches the Lower Berounian (Libeň Shales and Řevnice Quartzites of the Libeň Formation.).

Localities: The Dobrotivá Formation: Ejpovice (highway cut; quarry, S part), Kařízek (Veronika mine), Mýto (highway cut), Malé Přílepy (field), Sedlec (Sutice, village), Praha-Motol, Starý Plzenec (Černá Stráň), Strašice (temporary excavations), Praha-Vokovice (field), Zaječov (Svatá Dobrotivá).

The Libeň Formation: Praha-Smíchov, Těně, Kařez (Kařezská hora Hill)

Family **Dysoristidae** POPOV et USHATINSKAYA, 1992

Genus ***Ferrobolus*** HAVLÍČEK, 1982

Type species: *Ferrobolus catharinus* HAVLÍČEK, 1982; Ordovician, Tremadocian, Třenice Formation; Bohemia.

Ferrobolus catharinus HAVLÍČEK, 1982

Pl. 35, figs 14–20

1927 *Obolus* sp.: Růžička, p. 4, pl. 1, fig. 5.
1982b *Ferrobolus catharinus* sp. n.: Havlíček, p. 71, pl. 15, figs 4–7, 9, 10, text-fig. 15.
2000 *Ferrobolus catharinus*; Holmer and Popov, p. 76, figs 36, 2a–c.

Holotype: Ventral valve figured by Havlíček (1982b) on pl. 15, figs 4, 5, refigured herein on pl. 35, fig. 18, stored in the palaeontological collections of the National Museum, Prague (NM L 18125).

Type horizon and locality: Upper Tremadocian, Třenice Formation; Barrandian, Holoubkov (V Ouzkém).

Material: Ten ventral and three dorsal valves.

Description: Havlíček (1982b).

Occurrence: The species is rare in greywackes and haematites of the Třenice Formation.

Localities: Barrandian; Holoubkov (V Ouzkém), Skomelno (Na Solích).

Superfamily **Discinoidea** GRAY, 1840

Family **Trematidae** SCHUCHERT, 1893

Genus ***Schizocrania*** HALL et WHITFIELD, 1875

Type species: *Orbicula filosa* HALL, 1847; Ordovician, Caradocian-Ashgillian; U.S.A.

Remarks: Shell morphology and affinity of genera *Schizocrania* HALL et WHITFIELD and *Ptychopeltis* PERNER, 1903 was discussed by Havlíček (1972). As the main difference between these genera he defined the presence of the narrow and parallel-sided pedicle notch in *Ptychopeltis* in contrast to the broadly triangular pedicle opening in *Schizocrania*. Despite this difference, the genus *Ptychopeltis* was synonymized with *Schizocrania* by Holmer and Popov (2000). It is noteworthy, that *Schizocrania filosa* HALL, the type species of *Schizocrania*, is not sufficiently known. Since its establishing by James Hall (1897), followed by the redescription and illustrations by Hall and Clarke (1892), no new data about the pedicle slit of the ventral valve of the type species has been presented. Hall and Clarke (1892) also noted that flat to concave ventral valve with large broadly triangular opening was deeply inserted inside the convex dorsal valve. This is reflected by a taphonomy of ventral valves, which are commonly preserved inside the dorsal valves in the attached specimens. The ventral valves have apparently smaller diameter of the flat disc and have a concave periphery. Hall and Clarke (1892) inferred the presence of a very strong pedicle which enabled fixo-sessile mode of life on the surface of other shells, *S. filosa* namely on the reclining strophomenid brachiopod *Rafinesquina* HALL et CLARKE, 1892.

Among the described species, the ventral valves are often unknown. Cooper (1956) and Williams (1974) described and figured only the dorsal valves, but Lockley and Williams (1981) figured the entire ventral valve of *S. salopiensis* with the large listrium and widely triangular pedicle opening. Havlíček (1972) figured, apart from the dorsal valves, a single deformed ventral valve of *Ptychopeltis* sp. showing a parallel-sided pedicle slit, but this may be the result of post-mortem deformation. Sutton et al. (1999) figured the ventral valve of *Schizocrania multistriata* (REED, 1905) with a narrowly triangular pedicle slit attached to the shell exterior of the obolid *Apatobolus subditivus* (WILLIAMS). The ventral valve of *Ptychopeltis incola* PERNER, 1903 (the type species of the genus *Ptychopeltis* PERNER) is unknown. New but very scarce material of the ventral valves of this trematid group indicates a narrower pedicle slit in the earliest (Llanvirnian to Dobrotivian) representatives of the genus in the Barrandian. The dorsal valves are also very variable in their outline, profile and convexity and the radial costellation show some but restricted variability. The absence of the clear morphological differences, the obvious variability in shape, convexity and ornamentation with mostly postmortally deformed flexible

shells lead to the acceptance of Holmer and Popov (2000) opinion about the identity of *Schizocrania* and *Ptychopeltis* by the present author. The genus *Orbiculothyris* WOLFART, 1968 was also synonymized by Holmer and Popov (2000) with the genus *Schizocrania*, but the former differs in the oval pedicle opening which does not intersect the posterior margin (Wolfart 1968; pl. 47, fig. 3) and by a filose radial ornamentation on the surface of the ventral valve, which is entirely absent in *Schizocrania*. The dorsal valve of *Orbiculothyris* is remarkably similar to *Schizocrania,* with a submarginal beak, radial filose ornamentation and medium to large size of the shell.

The stratigraphic range of *Schizocrania* is very long with the latest known representatives from the Lower Devonian (Holmer and Popov 2000). The earliest known occurrence of the late Arenigian age (Fennian) was described from the Anglo-Welsh Basin (Sutton et al. 1999), and a single but undoubted shell fragment was collected in the upper part of the Klabava Formation in the Barrandian (*Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone). The peak of the distribution and abundance of *Schizocrania* took place in the Middle Ordovician time. It is remarkable that the distribution of *Schizocrania* does not completely follow the Ordovician palaeogeography. The genus is known from the temperate (Wales; Lockley and Williams 1981, Bohemia; Havlíček 1972) to the tropical climatic zones (Laurentia; Hall 1847, Cooper 1956).

Schizocrania salopiensis (WILLIAMS, 1974)

Pl. 23, figs 1–12

1972 *Ptychopeltis* sp. n.: Havlíček, p. 233, pl. 2, figs 4, 5.
1974 *Schizocrania salopiensis* sp. nov.: Williams, p. 44, pl. 6, figs 22–26.
1981 *Schizocrania* cf. *salopiensis* WILLIAMS: Lockley and Williams, p. 24, figs 60–65.
1996 *Ptychopeltis salopiensis* (WILLIAMS, 1974): Havlíček and Vaněk, 234, pl. 1, figs 1, 2, pl. 2, fig. 1.

Holotype, type horizon and locality: See Williams (1974).

Material: Thirty-two dorsal valves and three ventral valves from the Barrandian localities.

Description of material from the Barrandian: The shell is convexo-concave, thin-walled, with a variable outline ranging from subtriangular, circular to elongate-elliptical. The largest known shell is 18 mm wide, but the available specimens are generally smaller, with a width not exceeding 10 mm.

The dorsal valve is moderately to highly convex, tending to be carinate in small and symmetrical specimens, with the maximum width and height at the midlength. Shell margins are evenly rounded in the symmetrical specimens, but the margins and slopes may be irregularly scalloped reflecting the uneven surface of the substrate. The anterior commissure is rectimarginate. The dorsal beak is submarginal, prominent, and directed posteriorly. The interior of the dorsal valve bears large elliptical central muscle scars near the beak which expands toward one third of the valve. Small oblique pair of muscle scars is located near the centre of the valve and probably accommodate the oblique lateral muscles. A weak median septum lies between both pairs of the scars.

The dorsal valve is ornamented by radially arranged fila, directed laterally to posterolaterally in the posterior half of the valve, always nearly in the normal attitude to the shell margin. The size of fila increases in anteriorly, rare new fila are of the same size and originated exclusively by an implantation. Fila are rounded in a section and are slightly broader than rounded deep interspaces. The earliest fila appear immediately at the dorsal beak, the size and surface of the larval shell is unknown. Number of fila per 1 mm changes with the distance from the beak; 5 mm from the dorsal beak there are 6 to 10 fila per mm, but in the periphery of the large specimens only 4 to 5 fila per mm are developed. The concentric ornamentation is subdued, with several concentric, unevenly spaced growth lines or may be totally absent, and it is sometimes pronounced by the postmortem deformation of the thin and probably rather flexible shell.

The ventral valve is thinner than the dorsal valve, judging from scalloped available shell. The profile of the valve is flat, sometimes with irregular outline and concave periphery in large specimens. The ventral apex is subcentral. Only one complete ventral valve shows a parallel-sided pedicle slit with its margins curved dorsally. Ornamentation is very varied. One valve shows very fine but distinct growth fila near the subcentral apex, later growth stages have the growth fila weaker and replaced by wide and smooth concentric bands. Other valve from the same bed has clearly developed radial, distant fila coarser than the concentric ornamentation. The later growth stages have preserved irregular radial rows of fine, uneven growth drapes. The microornamentation is unknown.

Remarks: The specimens from the Dobrotivá Formation were shortly described by Havlíček and Vaněk (1996) and referred to *Ptychopeltis salopiensis* (WILLIAMS). The specimens from the Šárka Formation cannot be clearly differentiated from the specimens of the Dobrotivá Formation and are referred to the same species. Single shell fragment coming from the upper part of the Klabava Formation has the same number of radial fila as the stratigraphically younger specimens and therefore is also referred to *Schizocrania salopiensis*. The species *S. salopiensis* was established by Williams (1974) on the specimens derived from the early Caradoc (Spy Wood Grit of Shropshire). Williams noted that the stratigraphically older species from the Lower Llanvirnian (Hope Shales) probably have finer radial ornamentation; also the specimens from the Šárka Formation have slightly finer ornamentation than the specimens from the Dobrotivá Formation. Undescribed species from the Upper Berounian of the Barrandian (Bohdalec Formation) has distinctly coarser radial ornamentation. Gradual coarsening of the ornamentation is likely an evolutionary trend of the genus *Schizocrania* and may help to distinguish separate species; that is, however, currently a premature conclusion.

Occurrence: In the Barrandian area, the species is very rare in siliceous nodules released from black shales of the Šárka Formation (Llanvirnian) and slightly more abundant in the clayey shales and nodules of the Dobrotivá Formation (Dobrotivian). One fragment also comes from the Upper Arenigian, Klabava Formation (*Azygograptus ellesi -Tetragraptus reclinatus abbreviatus* Biozone). Fossil specimens, despite their general rarity, occur commonly in small groups, reflecting original natural life clusters attached to common substrate (conulariid tests or unpreserved soft substrate).

Localities: Barrandian; Šárka Formation: Osek (field); Dobrotivá Formation: Ejpovice (highway cut), Kařízek (Veronika mine), Malé Přílepy, Osek (highway cut), Praha-Vokovice (field), Starý Plzenec (Černá Stráň), Sedlec (Sutice; village).

Family **Discinidae** GRAY, 1840

Subfamily **Orbiculoideinae** SCHUCHERT et LE VENE, 1929

Genus ***Orbiculoidea*** D'ORBIGNY, 1847

Orbiculoidea sp.

Pl. 24, fig. 13

Material: A single complete shell.

Description: The shell is almost subcircular, 5.5 mm wide, thin-shelled, with the maximum width located slightly anteriorly to the midlength.

The ventral valve is low conical, with the apex in the posterior one-fifth. The external pedicle opening lies at the posterior end of the short and deep pedicle track. The dorsal valve is depressed conical, with apex at the posterior one-third. The shell exterior is covered by coarse concentric rugellae of a nearly uniform size, only slightly finer in the apical regions of the shell. The rugellae are arranged in regular intervals, with 8–9 rugellae per 1 mm. Radial ornamentation is not discernible.

Remarks: The slightly deformed single specimen does not allow a reliable comparison with the other described species. The occurrence of the undoubted discinid in the Dobrotivá Formation is significant because it represents one of the earliest occurrence of the genus. The shell is externally rather similar to *Schizotreta* sp. from the Mytton Flags (Arenigian) of Shropshire (Williams 1974), except for the less elongate outline of the Bohemian specimen.

Occurrence: The species is very rare in the black shales of the Dobrotivá Formation (Dobrotivian).

Locality: Barrandian; Březina, borehole B3 (depth 44 m) (coll. V. Havlíček).

Genus ***Acrosaccus*** WILLARD, 1928

Type species: *Acrosaccus shuleri* WILLARD, 1928; Ordovician, Caradocian, Rich Valley Formation; Virginia, U. S. A.

Acrosaccus cf. ***posteroconvexus*** (COOPER, 1956)

Pl. 24, figs 16, 17

Material: One dorsal and one ventral valve.

Description: The shell is thin-shelled, circular, small, only 5 mm wide.

The dorsal valve is asymmetrically conical, with the apex located in the posterior one-sixth of the valve. The posterior slope is steep, anterior slope is weaker and the anterior third of the valve becomes nearly flat. The dorsal valve interior shows thin median ridge running from the apex toward the anterior third of the valve. A transverse, narrowly triangular slightly elevated platform is present near the posterior margin of the valve; this area may be homologous with the dorsal pseudointerarea of the lingulates.

The ventral valve is nearly symmetrically conical, with the subcentral apex. The lateral slopes are straight, the posterior slope is gently convex and the anterior slope is slightly concave in the lateral profile. The bottom of a narrowly rhomboidal pedicle track is formed by a shallow listrium. The length of the pedicle track equals to one-third of the posterior slope.

Exterior of the shell bears fine concentric fila, about 15 per 1 mm anteromedianly.

Remarks: Discinids are not common groups in the lower Middle Ordovician and the number of adequately described species is low. The species *Schizotreta transversa* WILLIAMS from the Meadowntown Beds, Llandeilian of Shropshire (Williams 1974) differs from the described taxon in a transverse outline and narrower, slit-like pedicle opening. *Schizotreta elliptica* (KUTORGA, 1846) from the Idavere Beds of the Baltoscandinavia has less circular outline ant its external ornamentation is coarser. Several Ordovician species referred to *Acrosaccus* by Popov (2000) come from the Caradocian and Ashgillian; the type species A. *schuleri* WILLARD has finer ornamentation and a less transverse outline. The species *A. posteroconvexa* COOPER, 1956 (the base of the Athens Formation, early Middle Ordovician, Tennessee, U. S. A.) has a narrower pedicle slit, but Bohemian specimens are otherwise very similar to this species by the lateral profile with convex posterior slope and in the subcircular outline.

Occurrence: The taxon is very rare in black shales of the Dobrotivá Formation.

Localities: Barrandian; Ejpovice (quarry, S part), Kozojedy (gallery).

Genus ***Eoschizotreta*** gen. n.

Type species: *Eoschizotreta veterna* sp. n.; Ordovician, Arenigian, Klabava Formation; Bohemia.

Name: Latin, *Eo,* prefix referring to the evolutionary priority of the species.

Diagnosis: Shell minute, broadly oval, with holoperipheral growth, thin-shelled; ventral valve with short and narrow pedicle notch without any listrium; larval ventral

valve separated from the pedicle notch by brephic shell; exterior with fine concentric rugellae.

Remarks: New genus is one of the earliest members of the family Discinidae GRAY. Its morphology, with the holoperipheral growth, pedicle notch and rugellate ornamentation is wholly consistent with the family concept. The opened pedicle notch and lack of listrium indicate primitive morphology, which in more advanced forms in the Middle and Upper Ordovician times led to the posterior closure of the pedicle slit, bigger shell size and morphological diversification.

The genus *Schizotreta* KUTORGA differs by a posteriorly closed pedicle slit which continues immediately to the ventral apex and the well developed listrium. Unlike *Eoschizotreta* gen. n., one of the earliest discinids, the species *Schizotreta* sp. from Tourmakeady Limestone (Arenigian) of Ireland (Williams and Curry 1985) shows a well developed pedicle slit and more advanced rugellate ornamentation.

Species assigned: *Eoschizotreta veterna* sp. n.; Arenigian, Barrandian, Bohemia.

Eoschizotreta veterna sp. n.

Pl. 24, figs 1–7

Holotype: Ventral valve (internal and external moulds) figured herein on pl. 24, figs 1–3, and 7, stored in the palaeontological collections of the University of West Bohemia in Plzeň (PCZCU 629).

Paratype: Dorsal valve (internal mould) figured herein on pl. 24, fig. 4, stored in the palaeontological collections of the University of West Bohemia in Plzeň (PCZCU 630).

Type horizon: Lower Arenigian, Klabava Formation, brown-violet shale.

Type locality: Barrandian, Hrádek (gorge near the road to Dobřív).

Name: Latin*, veternus,* old, referring to the stratigraphic position.

Material: Two ventral and two dorsal valves.

Diagnosis: Shell minute, subcircular, with short pedicle notch cutting the posterior margin; the notch does not continue to the ventral apex; dorsal valve with apex in the posterior one-fourth.

Description: The shell thin-shelled, subcircular, minute, 3 mm long in the largest specimen, with the maximum width at or slightly posterior to the midlength.

The dorsal valve is subcircular, less curved posteriorly than anteriorly, with the dorsal apex at posterior 25 % of the valve length. The valve is depressed subconical, with gently convex slopes. The visceral area is not clearly impressed.

The ventral valve is asymmetrically conical, with the apex in 18–20 % of the valve length. The pedicle notch is very short, broadly triangular, and does not touch the ventral larval shell. The larval shell is separated from the anterior end of the notch by the brephic shell. The exterior bears regularly spaced and anteriorly expanding concentric rugellae.

Remarks: This species is externally remarkably similar to the early Ordovician paterulids. However, the latter differs by well developed limbus along the shell periphery and by clearly impressed divergent imprints of the pedicle nerves which are not present in *Eoschizotreta veterna* sp. n.

Occurrence: The species is rare in red-brown siltstones in the lower part of the Klabava Formation, associated with other small organophosphatic brachiopods.

Locality: Barrandian; Hrádek (gorge).

Genus ***Schizotreta*** KUTORGA, 1848

Type species: *Orbicula elliptica* KUTORGA, 1846; Ordovician, Upper Arenigian to Lower Llanvirnian; Ingria, Russia.

Schizotreta prilepensis sp. n.

Pl. 24, figs 14, 15, 18

Holotype: Ventral valve (internal and external mould) figured herein on pl. 24, figs 14, 15, 18, stored in the palaeontological collections of Museum of Dr. B. Horák in Rokycany (MBHR 23205; coll. V. Havlíček; VH 5768).

Type horizon: Dobrotivian, Dobrotivá Formation, siliceous nodule.

Type locality: Barrandian, Malé Přílepy (field).

Name: *prilepensis*, referring to the type locality.

Material: One ventral valve.

Diagnosis: *Schizotreta* with a minute shell of broadly oval outline, with a short pedicle slit cutting the posterior margin and vestigial subvertical listrium which extends to the ventral apex.

Description: The shell is minute, thin-shelled, broadly oval, 3.5 mm long, with the maximum width slightly anterior to the midlength. The valve is depressed, asymmetrically conical. The posterior margin is bisected by a short, wide pedicle slit, which is anteriorly closed by subvertical listrial plate. Exterior bears regular, uniformly sized concentric rugellae.

Remarks: There are a few sufficiently described Ordovician species referred to *Schizotreta* KUTORGA. Among them, the species *S. currugata* COOPER, 1956 from the Llandeilian of Alabama, U.S.A. differs in a coarser ornamentation. The species *Schizotreta transversa transversa* WILLIAMS, 1974 and *S. transversa ffairfachensis* LOCKLEY et WILLIAMS, 1981 are poorly known and their ventral apex is more centrally located than that in *S. prilepensis*. The new species is also similar to *Eoschizotreta veterna* sp. n., from which it differs by a larger and broader pedicle slit and a true listrium located immediately posterior to the ventral apex.

Occurrence: The species is very rare in siliceous nodules of the Dobrotivá Formation.

Locality: Barrandian; Malé Přílepy (field).

Schizotreta sp.

Pl. 24, figs 8–12

Material: Two dorsal valves and two incomplete ventral valves.

Description: The shell is minute, subcircular, with a short pedicle slit cutting the posterior margin and vestigial subvertical listrium. The dorsal valve is subcircular, with a marginal beak. The surface is covered by unequally distant filose rugellae, separated by wide and depressed interspaces. The dorsal valve interior has weak but well defined visceral area.

The external microornamentation consists of fine pits arranged in double radial rows (Pl. 24, fig. 12).

Occurrence: The species is very rare in siliceous nodules of the Šárka Formation (Llanvirnian).

Localities: Barrandian; Osek (field), Pětidomky.

Superfamily **Acrotheloidea** WALCOTT et SCHUCHERT, 1908

Family **Acrothelidae** WALCOTT et SCHUCHERT, 1908

Subfamily **Acrothelinae** WALCOTT et SCHUCHERT, 1908

Genus ***Orbithele*** SDZUY, 1955

Type species: *Discina contraria* BARRANDE, 1868; Ordovician, Tremadocian, Leimitz Shales; Bavaria, Germany.

Remarks: The validity of the species referred to the genus *Orbithele* SDZUY has been discussed by Popov and Holmer (1994). They extensively illustrated the morphology of *O. ceratopygarum* (BRØGGER, 1882) from the Upper Tremadocian Bjørkåsholmen Limestone. The authors noted close affinity or identity of other separate species of the genus (*O. bicornis* BIERNAT, 1973, *Acrothele barbata* BRØGGER, 1906, and *A. borgholmensis* WALCOTT, 1908) and discussed the validity of the Bohemian species. In the Barrandian, Mergl (1981) distinguished five species; this concept is followed herein, because the species are separated both morphologically and stratigraphically. Among them, the species *O. discontinua* MERGL is morphologically the closest to *O. ceratopygarum* by irregular and interrupted concentric rows of pustules (those are not preserved in *O. discontinua*). The stratigraphically younger species present in the Barrandian have more regular concentric lines forming distinct, regular to wavy rugellae. The average size of *O. discontinua* is smaller than in other species in the Barrandian and confirms the affinity to *O. ceratopygarum*. Apart from *O. discontinua*, the other species of the genus were described by Mergl (1981) and only their differential diagnoses are presented.

The genus is known from the upper Middle Cambrian to Tremadocian and Arenigian (Holmer and Popov 2000). In the Barrandian, the genus occurs from the base of the Třenice Formation (Upper Tremadocian) to the top of the Klabava Formation (Upper Arenigian).

Orbithele discontinua MERGL, 1981

Pl. 25, figs 1–11, 13, 14

1927 *Orbiculoidea sodalis* var. *undulosa* (BARR.): Růžička, p. 9.
1981 *Orbithele discontinua* sp. n.: Mergl, p. 288, pl. 1, figs 1–8.

Holotype: Ventral valve figured by Mergl (1981) on pl. 1, figs 2, 7, and 8, stored in the palaeontological collections of Museum of Dr. B. Horák in Rokycany (MBHR 21715, original signature VH 2092b, c).

Type horizon and locality: Upper Tremadocian, Třenice Formation; Barrandian, Holoubkov (V Ouzkém).

Material: About fifty ventral and twenty dorsal valves in haematite.

Description: The shell is subcircular, slightly wider than long, with a depressed conical ventral valve and weakly convex dorsal valve. The maximum shell width reaches 7.5 mm, but the average shell size is 6.0–6.5 mm. The posterior margin is weakly curved dorsally.

The dorsal valve is weakly convex, with marginal apex and evenly curved margins. The ventral valve is a depressed cone, with the apex located in the posterior one-third. Slopes are straight, without any concavity near the shell periphery. The external pedicle opening has elongate-oval outline. The foramen obliquely penetrates the shell wall and internally forms a septum-like structure on the valve interior.

The ornamentation is rather complex. The concentric ornamentation consists of concentric rows of pustules, which are at short distances interrupted, forming wavy and irregular pattern lineages. The size of rows and interspaces between the rows regularly increase with the age of the individual, having a more regular concentric pattern along the periphery of the large valves. The posterior slope is covered by coarser and more regular concentric rugellae which sharply define the ventral pseudointerarea. The larval shell is almost circular, extending apically into short spines on the ventral valve and two pairs of spines in the dorsal valve. The brephic shell is 1.4–1.6 mm wide, with a weak median sulcus. Its surface is covered by fine and densely spaced, straight radial fila which disappear at the same distance from the apex. Concentric lamellae are prominent, two or three on each valve, extensively overlapping the shell surface which is below the lamellae smooth, devoid of pustules. The margin of lamellae extends into uniformly sized, triangular flattened acute spines, four to five per mm.

The ventral valve interior is marked by a high, septum-like internal pedicle tube. The internal pedicle opening is situated at the midlength between the apex and the posterior margin. The posterior slope has three distinct pairs of muscle scars, and one poorly impressed pair near the posterior margin. The muscle system can be homologised with that of other obolids. The position of vascula lateralia indicates that the two posterior pairs of large scars are separated anterior lateral and transmedian muscles. The outside lateral, central and middle lateral muscles were attached immediately laterally to the wall of the pedicle tube. The vascula lateralia are divided into two main canals. The proximal part has a prominent secondary branch turned lat-

erally, followed by three secondary canals. The inner branches are undivided and converge at the shell midlength.

Remarks: The species *O. discontinua* MERGL is closely related to *O. ceratopygarum* (BRÈGGER), but the latter differs by radially arranged radial plications along the anterior shell periphery (Popov and Holmer 1994: fig. 114: D, H, J, M, and P). These plication are always absent in *O. discontinua*. The species *O. discontinua* is the smallest of all the species of the genus in the Barrandian, with the width not exceeding 7 mm.

Occurrence: The species is rather abundant in the haematites and fine greywackes of the Třenice Formation.

Localities: Barrandian; Cheznovice (Žlebec), Holoubkov (V Ouzkém), Skomelno (Na Solích).

Orbithele secedens (BARRANDE, 1879)

Pl. 25, figs 12, 15–17

1879 *Discina secedens* BARR.: Barrande, pl. 110, case VII, figs 1–4.
1879 *Discina sodalis* BARR.: Barrande, pl. 102, case III, figs 1, 2.
1879 *Lingula Feistmanteli* BARR.: Barrande, pl. 106, case IV, fig. 1.
1981 *Orbithele secedens* (BARRANDE): Mergl, 289, pl. 1, figs 12, 13.
1981 *Orbithele sodalis* (BARRANDE): Mergl, p. 292.

Lectotype: Designated by Mergl (1981), ventral valve figured by Barrande on pl. 110, case VII, fig. 4, and by Mergl (1981) on pl. 1, fig. 13, stored in the palaeontological collection of the National Museum, Prague (NM L 18162).

Paralectotypes: Ventral valves figured by Barrande on pl. 110, case VII, figs 1–3, stored in the palaeontological collection of the National Museum, Prague (NM L 18160, NM L 18163, NM L 18161).

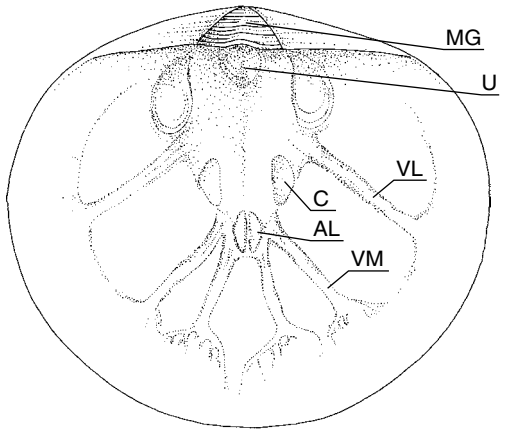
Type horizon and locality: Upper Tremadocian, Třenice Formation; Barrandian, Krušná hora (Kruschna Hora in original spelling).

Material: Eight ventral and one dorsal valves in greywacke.

Diagnosis: Mergl (1981).

Remarks: All the available specimens are preserved in coarse grained greywackes and fine details of the external morphology are unknown. The shell outline is rather transverse, with very low ventral valve. The species is largest from all the so far described species of the genus in the Barrandian, and attains 14 mm of the width. Its exterior is covered by coarse concentric, regular rugellae. These features distinguish the species from *O. discontinua* MERGL which is about half size and has much finer and less regular external ornamentation.

Barrande (1879) described two species from the early Ordovician (Třenice Formation): *Discina sodalis* BARR. and *Discina discontinua* BARR. Both species were defined on ventral valves, poorly preserved in coarse greywackes but with the original shell substance partly preserved; the dorsal valve has been confused with *Hyperobolus feistmanteli* (BARRANDE). During the preparation of the original revision (Mergl 1981), the Barrande's types of *Discina sodalis* were not available, but new careful revision of Barrande's material stored in the palaeontological collections of the National Museum discovered the box with two specimens of *D. sodalis* and a label written by J. Barrande. Therefore, the note of Mergl (1981) that type specimens of *D. sodalis* have been lost is probably incorrect. Nevertheless, because the lectotype of *O. secedens* was selected by Mergl (1981), and both specimens belong actually to the same species, the name *O. sodalis* is considered as a subjective synonym of *O. secedens*.



Text-fig. 13. ***Orbithele maior*** **MERGL, 1981. Dorsal valve interior. AL - anterior lateral muscle scars, C – central muscle scars, MG – median groove, OML – outside lateral and middle lateral muscle scars, U – umbonal muscle scars, VL – vascula lateralia, VM – vascula media.**

Occurrence: The species is uncommon in coarse greywackes in the lower part of the Třenice Formation (Upper Tremadocian).

Localities: Barrandian; Drozdov (Holý vrch Hill), Krušná hora (gallery), Zbiroh (Bukov, old quarries).

Orbithele maior MERGL, 1981

Pl. 26, figs 1–12; text-fig. 13

1981 *Orbithele sodalis* (BARRANDE): Mergl, p. 289, pl. 2, figs 1–5.

Holotype: Ventral valve figured by Mergl (1981) on pl. 2, fig, 5, stored in the palaeontological collection of the Geological Survey, Prague (ČGÚ MM 008).

Type horizon and locality: Upper Tremadocian, Mílina Formation; Barrandian, Kváň (field).

Material: Sixty ventral and dorsal valves in chert.

Description: Mergl (1981).

Remarks: The absence of fine radial fila on the brephic shell is presented in the original description (Mergl 1981) as a diagnostic feature of *O. maior* MERGL. However, several shells display poorly preserved striation on external moulds and the common absence of these fila in the preserved shells is probably caused by taphonomical factors. The species is larger and has more regular concentric rugellae, and the spines on concentric lamellae are finer than in *O. discontinua* MERGL.

One newly collected valve (Pl. 26, fig. 6) displays a distinct concentric, evenly wide marginal band of secondary vascular canals. An arrangement of the muscle scars impressions is newly interpreted in agreement with Holmer and Popov (2000).

Occurrence: The species is abundant in cherts and fine greywackes of the Mílina Formation (Upper Tremadocian). Localities: Barrandian; Březany II (Na Chrástnici quarry), Kváň (field), Jivina Hill, Komárov (section along the Jalový potok creek), Mílina (quarry), Olešná (quarry), Těně (west), Úvaly (Vinice), Zaječov (quarry near the school building; Hrbek).

Orbithele rimosa MERGL, 1981

Pl. 27, figs 13–17

1981 *Orbithele rimosa* sp. n.; Mergl, p. 290, pl. 2, figs 9–11.

Holotype: Ventral valve figured by Mergl (1981) on pl. 2, fig. 11, refigured herein on pl. 27, fig. 14, stored in the palaeontological collection of the Geological Survey, Prague (ČGÚ MM 012a).

Type horizon and locality: Upper Arenigian, Klabava Formation, upper part, *Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone, red-brown shale interbed in oolithic ferolite; Barrandian, Ejpovice (quarry, NE part).

Material: Ten dorsal valves and twelve ventral valves.

Description: Mergl (1981).

Remarks: This species is characterized by a large size and differs from the other species in the Barrandian by the irregular, wavy course of high concentric rugellae. The crests of rugellae are in well preserved specimens wrinkled by radial grooves. Unlike other species of the genus, radial fila on the brephic shell are less numerous, distant and of uneven size. The spines on concentric lamellae are finer than in *O. discontinua* MERGL, being 6 to 8 in number per mm.

Occurrence: The species occurs in the upper part of the Klabava Formation, being common in the coarse grained intercalations within otherwise aleuropelitic sequence. The oldest specimens that may be referred to this species were collected in the *Holograptus tardibrachiatus* Biozone, but the commonest occurrence of the species is at the very top of the Klabava Formation.

Localities: Barrandian; Klabava (Klabava dam), Kleštěnice (old dump; Stanislav mine), Mílina (gallery), Osek (old dump), Rokycany (Drahouš; Stráň), Sedlec (village), Zbiroh (Bukov, Joseph gallery).

Orbithele undulosa (BARRANDE, 1879)

Pl. 27, figs 1–12

1879 *Discina undulosa* BARR.: Barrande, pl. 101, case 7, fig. 1.
1981 *Orbithele undulosa* (BARRANDE): Mergl, p. 289, pl. 2, figs 6–8.

Lectotype: Designated by Mergl (1981), ventral valve figured by Barrande (1879) on pl. 101, case VII, fig. 1, and by Mergl (1981) on pl. 2, fig. 13, stored in the palaeontological collection of the National Museum, Prague (NM L 24499).

Paratype: Fragment of dorsal valve figured by Barrande (1879) on pl. 101, case VII, fig. 2, stored in the palaeontological collection of the National Museum, Prague (NM L 24443).

Type horizon and locality: Lower Arenigian, Klabava Formation, Olešná Beds Member, red-brown shale; Barrandian, Zaječov (Svatá Dobrotivá) (Sta. Benigna in original spelling).

Material: Ten dorsal and ten ventral valves.

Description: Mergl (1981).

Remarks: The species is currently the best known of all the species of the genus in Bohemia, with known details of larval and brephic shell. The dorsal larval shell is transverse in the outline, with two pairs of acute, posterodorsally directed nodes (Pl. 27, figs 5, 6). The ventral larval shell bears two acute nodes directed lateroventrally. The pedicle opening is elliptical, with raised anterior and anterolateral margins. The brephic shell is about double size as in *O. discontinua* MERGL, with distinct sulcus and it is covered by radial fila superimposed onto less prominent concentric, uneven fila. The juvenile shell (Pl. 27, fig. 1) displays very fine marginal spines; the details of spines are illustrated herein (Pl. 27, figs 1, 12). The spines are narrower and smaller than spines of *O. discontinua*, numbering 7 to 9 per mm.

Occurrence: *Orbithele undulosa* (BARRANDE) is moderately common in red-brown and brown-violet shales, siltstones and fine greywackes of the lower part of the Klabava Formation (Olešná Beds Member) and it occurs also in siltstones, shales and siderites of the *Corymbograptus v-similis* Biozone of the same formation. The specimens in younger beds, from the *Holograptus tardibrachiatus* Biozone, display less regular concentric rugellae and are referred to *O. rimosa* MERGL.

Localities: Barrandian; Kváň (field), Jivina Hill, Komárov (section along the Jalový potok creek), Medový Újezd (quarry), Mílina (quarry), Olešná (quarry), Praha-Kunratický Hrádek, Sedlec (gorge), Svojkovice (road cut), Těně (village; west), Zaječov (quarry near the school building; Hrbek).

Order **Acrotretida** KUHN, 1949

Superfamily **Acrotretoidea** SCHUCHERT, 1893

Family **Acrotretidae** SCHUCHERT, 1893

Genus ***Acrotreta*** KUTORGA, 1848

Type species: *Acrotreta subconica* KUTORGA, 1848; Ordovician, Arenigian; environs of St. Petersburg, Russia.

Acrotreta grandis KLOUČEK, 1919

Pl. 28, figs 1–21; text-fig. 14

1919 *Acrotreta minima* var. *grandis* KLOU. n. sp.: Klouček, p. 2.
1927 *Acrotreta grandis* (KLOU.): Růžička, p. 8, pl. 2, figs 1–3, 5.

1980b *Conotreta grandis* (KLOUČEK, 1919): Havlíček, p. 298, pl. 1, figs 8–15.
1980b *Conotreta obesa* sp. n. (partim): Havlíček, p. 299, pl. 1, fig. 5 (non figs 6, 7).

Neotype: Ventral valve figured by Havlíček (1980b) on pl. 1, fig. 8, stored in the palaeontological collection of the National Museum, Prague (NM L 19401).

Type horizon and locality: Upper Tremadocian, Třenice Formation; Barrandian, Zbiroh (Bukov, old quarries).

Material: Forty ventral and ten dorsal valves preserved as internal moulds in greywacke and haematite.

Diagnosis: *Acrotreta* with convex dorsal valve, gently anacline dorsal pseudointerarea, low and basally stout dorsal median septum, highly and acutely conical ventral valve with catacline to steeply procline pseudointerarea, and strongly thickened ventral valve apex.

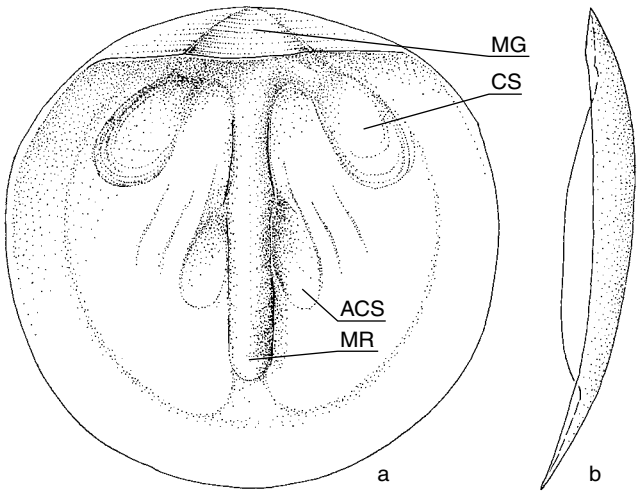
Revised description: Shell large for the family, thick walled and remarkably thickened ventral apex, 4.5 to 5 mm wide.

The dorsal valve is subcircular, slightly wider than long, 80–90 % as long as wide, widest slightly posterior to the midlength. The valve is gently and evenly convex in transverse and lateral profiles, without traces of the sulcus. The dorsal pseudointerarea is large, gently anacline, about 65 % as wide, and 25–30 % as long as the valve. The median groove is broadly triangular, shallow. The anterior edge of the interarea, including the median groove is distinctly undercut. The surface of the propareas are coarsely striated, the striation of the median groove is comparatively finer. The periphery of the valve interior is distinctly bordered from the evenly concave visceral area and it forms a low brim. The dorsal median septum is coarse, with stout base and weak median buttress and extends toward the brim of the valve. The septum is low, almost uniformly high along the whole length. At the midlength of the septum, its sides are depressed by closely located anterocentral muscle scars. The cardinal muscle scars are large, oblique, expanding anterolaterally and deeply impressed, situated posterolaterally. Broad and shallow impressions of the proximal part of vascula lateralia separate them from the anterocentral muscle scars.

The ventral valve was described in detail by Havlíček (1980b).

The ornamentation consists of very fine concentric growth fila, generally 12 to 14, in some places even 16 fila per 0.1 mm. The regular pattern is in some places interrupted by slightly coarser, short concentric lamellae. The radial ornamentation is completely missing.

Remarks: This species was determined but not formally described by Klouček (1919). Havlíček (1980b) described and referred this species to the genus *Conotreta* WALCOTT. The repeated attribution to the genus *Acrotreta* KUTORGA was performed by Holmer and Popov (1994: p. 436). Havlíček described also an other species of the genus *Conotreta* from the same horizon (the Třenice Formation, Upper Tremadocian) but this species (*Conotreta obesa* HAVLÍČEK) was based on an erroneously determined dorsal valve, which belongs to an elkaniid (Mergl 1994).



Text-fig. 14. ***Acrotreta grandis*** **KLOUČEK, 1919. Dorsal valve interior (a) and lateral profile (b). ACS – anterocentral scars, CS – cardinal scars, MG – median groove, MR – median ridge.**

The lateral profile of the species *A. grandis* KLOUČEK falls between the species *A. korynevskii* HOLMER et POPOV, 1994 and *A. subconica* KUTORGA, 1848. The species *A. korynevskii* has also almost catacline ventral pseudointerarea but it is not so highly conical while *A. subconica* has a similarly high ventral valve but its ventral pseudointerarea is apsacline. Holmer and Popov (1994) noted almost identical age of *A. korynevskii* and *A. grandis* but they did not compare them in detail because of poor knowledge of the detailed morphology of *A. grandis*. Another similar Lower Ordovician Baltoscandinavian species is *A. tallinensis* HOLMER et POPOV, 1994 but this clearly differs by poorly developed apical process, by a weakly impressed ventral mantle canal pattern and by its ventral median septum which is lower. Bednarczyk (1959a, 1959b) described from the Lower Ordovician of the Holy Cross Mountains, Poland seven species of the genus *Conotreta* coming from the uppermost Tremadocian. All specimens (ventral valves only) most probably belong to only one species of the genus *Acrotreta* but their preservation as internal moulds without any morphological details makes any closer comparison impossible. However, their deeply impressed ventral valve mantle canals and catacline to procline ventral pseudointerarea indicate affinity of these specimens to *A. korynevskii* or *A. grandis* and indirectly confirm their suggested Tremadocian age (Bednarczyk 1959a, 1959b).

Occurrence: The species *A. grandis* KLOUČEK is known undoubtedly only from the Třenice Formation although several poorly preserved shells that may belong to this species are known from red cherts of the Mílina Formation. The species is abundant in coarse-grained greywackes and haematitic ferolites but almost exclusively only in the western part of the basin. The shells are often fragmentary and constitute a significant part of small phos-

phatic bioclasts in coarser rocks (e.g. sandstone matrix in basal conglomerates and breccias). On the contrary the species is very rare in greywackes with *Hyperobolus feistmanteli* (BARRANDE) and *Expellobolus expulsus* (BARRANDE).

Localities: Barrandian; Cheznovice (Žlebec), Holoubkov (V Ouzkém), Kváň (field), Skomelno (Na Solích), Těškov (Kněžský vrch Hill), Zbiroh (Bukov, old quarries).

Acrotreta foetida sp. n.

Pl. 29, figs 1–7

Holotype: Dorsal valve figured on pl. 29, fig. 2, stored in the palaeontological collections of the University of West Bohemia at Plzeň (PCZCU 716).

Paratype: Ventral valve figured on pl. 29, fig. 6, stored in the palaeontological collections of the University of West Bohemia at Plzeň (PCZCU 720).

Type horizon: Lower Arenigian, Klabava Formation, Olešná Beds Member.

Type locality: Barrandian, Těně (west, bed H: Mergl 1986).

Name: Latin, *foetidus,* pongy, referring to the current unfavourable environment at the type locality.

Material: Four ventral and seven dorsal valves.

Diagnosis: *Acrotreta* with nearly flat dorsal valve, gently anacline dorsal pseudointerarea, low and basally moderate thick dorsal median septum, highly and acutely conical ventral valve with catacline pseudointerarea, exterior with uniform rugellae separated by narrow, deep interspaces.

Description: The shell is closely related to *Acrotreta grandis* KLOUČEK, and differs substantially only in the shape of the dorsal valve. The special features of the ventral valve are described separately.

The dorsal valve is nearly flat, with a tendency to be concave in the transverse and lateral profiles. The outline of the valve is almost circular, with the maximum width at the midlength. The dorsal pseudointerarea is gently anacline, with broad, nearly orthocline median groove. The median septum is prominent, with a weakly thickened base, extending to three-fourths of the valve length. The cardinal muscle scars are large, located posterolaterally.

The ventral valve is highly conical, with a catacline, slightly depressed pseudointerarea. The surface of the pseudointerarea is covered by uneven rugellae turned apically near the borders of a broad interridge. The interridge bears coarse growth lines which are slightly dorsally convex. The surface of the ventral valve is covered by uniformly sized, regular rugellae separated by narrow and deep interspaces. There are 5 to 7 rugellae per 0.1 mm anterolaterally.

The interior the ventral valve bears deeply impressed vascular canals, extending from the prominent apical process. The internal pedicle opening lies near the posterior shell wall and is bordered by small subcircular umbonal muscle scars attached to the posterior shell wall. Large, undivided cardinal muscle scars are impressed posterolaterally.

Remarks: The species is very near to *A. grandis* KLOUČEK from which it is derived. It differs from *A. grandis* in a thinner dorsal median septum, flat dorsal valve and coarser concentric rugellae.

Occurrence: The species is rare in the red-brown siltstones and greywackes of lower part of the Klabava Formation (Olešná Beds Member). Its finds are concentrated to bed H (Mergl 1986) with rare occurrence in other levels.

Localities: Barrandian; Kváň (field), Těně (west), Zaječov (quarry near the school building).

Acrotreta scabra sp. n.

Pl. 29, figs 8–15; text-fig. 15

Holotype: Dorsal valve figured on pl. 29, fig. 12 stored in the palaeontological collections of the National Museum, Prague (NM L 36756).

Paratype: Dorsal valve figured on pl. 29, fig. 14 stored in the palaeontological collections of the University of West Bohemia at Plzeň (PCZCU 726).

Type horizon: Upper Arenigian, Klabava Formation, upper part, *Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone.

Type locality: Barrandian, Osek (old dump in field S of the village).

Name: Latin, *scaber,* rough, referring to the shell surface.

Material: Eight ventral and seven dorsal valves.

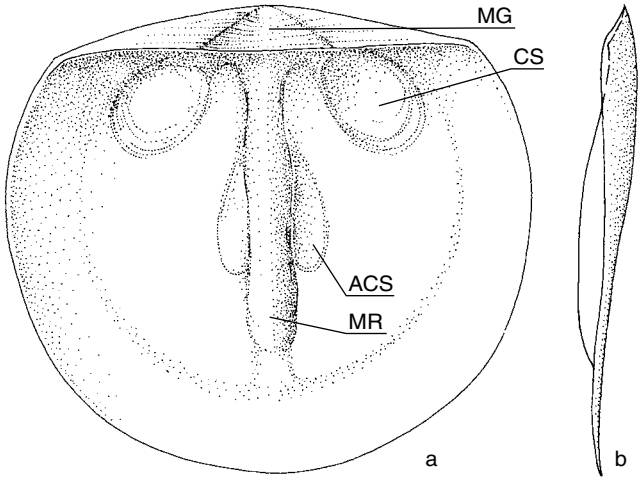
Diagnosis: *Acrotreta* with flat dorsal valve, steeply anacline dorsal pseudointerarea, low and basally massive dorsal median septum, highly and acutely conical ventral valve with catacline pseudointerarea, deep proximal but fine distal vascular canals and distinct although fine intervascular ridges along the periphery; ventral valve covered by uniform coarser rugellae separated by narrow, deep interspaces; dorsal valves with fine growth fila.

Description: The shell is closely related by *Acrotreta grandis* KLOUČEK with only minor differences.

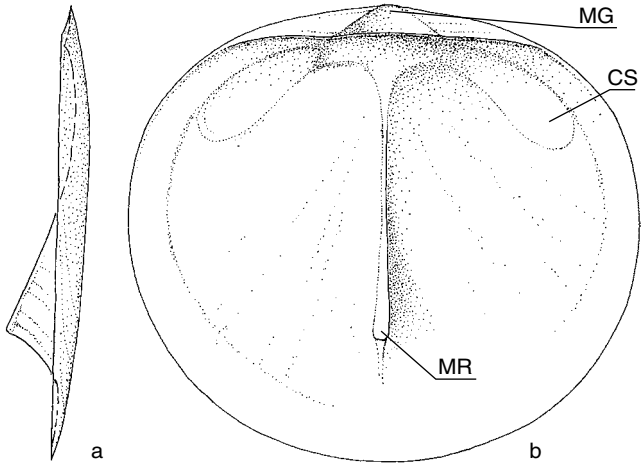
The dorsal valve is flat, with a tendency to concave transverse profile, being almost circular in outline with less curved posterior margin. The maximum width lies at the midlength. The narrow median sulcus is developed from the apex to the anterior margin. The posterolateral parts of the dorsal valve are weakly concave in the transverse profile as a result of the elevated posterior and posterolateral margins. The dorsal pseudointerarea is steeply anacline, with broad, deep and anacline median groove. The median septum is prominent, low, with a strongly thickened base, extending to 70–80 % of the valve length. The cardinal muscle scars are large, deeply impressed, located posterolaterally. A thickened brim is developed along the margin of the valve in large specimens.

The ventral valve is acutely conical, with less prominent apical process, a high median septum and deeply impressed proximal vascular canals. The periphery of the ventral interior bears fine radial fila corresponding to the distal intervascular ridges.

The exterior of the dorsal valve is covered by fine



Text-fig. 15. ***Acrotreta scabra*** **sp. n. Dorsal valve interior (a) and lateral profile (b). ACS – anterocentral scars, CS – cardinal scars, MG – median groove, MR – median ridge.**



Text-fig. 16. ***Cyrtonotreta osekensis*** **sp. n. Dorsal valve lateral profile (a) and interior (b). CS – cardinal scars, MG – median groove, MR – median ridge.**

growth concentric fila. The ventral valve bears much coarser concentric rugellae, numbering only 2–3 per 0.1 mm.

Remarks: The new species differs from the related *A. grandis* KLOUČEK by flat to concave profile of the dorsal valve, anacline dorsal pseudointerarea and much coarser ventral valve ornamentation. The last two features distinguish *A. scabra* sp. n. from *A. foetida* sp. n. The new species is the youngest member of the evolutionary lineage *A. grandis – A. foetida – A. scabra,* present in the Upper Tremadocian to Upper Arenigian of the Barrandian.

Occurrence: The species is locally common in clay and silty shales with sandy admixture in the Klabava Formation (*Corymbograptus v-similis, Hologratus tardibrachiatus* and *Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozones).

Localities: Barrandian; Klabava (Klabava dam), Osek (old dump), Starý Plzenec (Kocanda), Strašice (field near St. Vojtěch), Zbiroh (Bukov, Joseph gallery).

Genus ***Cyrtonotreta*** HOLMER, 1989

Type species: *Conotreta depressa* COOPER, 1956; Ordovician, Llandeilian, Pratt Ferry Formation; Alabama, U. S. A.

Cyrtonotreta osekensis sp. n.

Pl. 29, figs 16–21; text-fig. 16

Holotype: Dorsal valve (internal mould) figured on pl. 29, fig. 18, stored in the palaeontological collection of the National Museum, Prague (NM L 36754c)

Paratype: Ventral valve (external mould) figured on pl. 29, figs 16, 17, 19 stored in the palaeontological collection of the National Museum, Prague (NM L 36754a).

Type horizon: Llanvirnian, Šárka Formation, siliceous nodule.

Type locality: Barrandian, Osek near Rokycany (field).

Name: *osekensis*, referring to the type locality near the village Osek.

Material: Six ventral and four dorsal valves.

Diagnosis: *Cyrtonotreta* with widely conical ventral valve, catacline pseudointerarea with distinct interridge; ventral valve interior with distinct apical process; dorsal valve gently convex, with small pseudointerarea and thin and long median septum.

Description: The shell is minute, 1.5 mm in width, thin-shelled. The outline of the valves broadly oval, gently depressed posteriorly.

The dorsal valve is gently convex, without distinct sulcus, slightly depressed posteriorly. The dorsal pseudointerarea is small, some 40 % as wide as the valve. The median septum is distinct, thin and occupies about 70 % of the valve length. In the lateral profile, the septum is narrowly triangular, with a weak single upper septal rod. The median buttress is distinct. The visceral area is poorly defined, the marginal brim is broad, smooth and weakly defined. Cardinal muscle scars are weakly impressed, being widely separated, with a narrowly oval outline. They diverge anteriorly to reach one-third of the valve.

The ventral valve is widely conical, 60 % as high as wide, with weakly defined and gently depressed catacline pseudointerarea. The larval shell is small, imperfectly known, with short and small pedicle tube directed posteroventrally. The ventral pseudointerarea is weakly separated from the remaining shell surface, with a wide interridge which is covered by straight growth fila. The ventral valve interior is characterized by posterior, circular and minute internal pedicle opening, anteriorly bordered by distinct apical process with a shallow pit. The vascular canals are weakly impressed, with a pair of subparallel anterior canals.

The exterior of both valves is covered by slightly irreg-

ular concentric growth fila of an uniform size. The microornamentation is unknown.

Remarks: Despite the type species *Cyrtonotreta depressa* (COOPER), four other species were described by Holmer (1989) from the Middle Ordovician of Sweden. Out of them, the species *Cyrtonotreta*? sp. B. (Holmer 1989, p. 99, fig. 68) from the Llanvirnian and Llandeilian (Vamb Limestone, Skovde beds, and Gullhogen Formation) is most similar to *C. osekensis* sp. n. The new species has similarly shaped dorsal median septum and widely conical ventral valve, while *C. vestrogothica* HOLMER has strongly apsacline ventral valve and almost lacks the interridge and has a weak apical process. The species *Cyrtonotreta striata* HOLMER differs by procline ventral valve and by faint radial striae on exterior.

Occurrence: The species occurs very rarely in the siliceous nodules released from black shales of the Šárka Formation (Llanvirnian).

Locality: Barrandian; Osek (field).

Genus ***Dactylotreta*** ROWELL et HENDERSON, 1978

Type species: *Dactylotreta reduncta* ROWELL et HENDERSON, 1978; Upper Cambrian, Idamean Stage; western Queensland, Australia.

Dactylotreta prisca sp. n.

Pl. 30, figs 1–16

? 1879 *Obolus minimus* BARR. (partim): Barrande, pl. 95, case II, figs 1, 4.

? 1912 *Acrotreta* ? *minima* (BARRANDE) (partim): Walcott, p. 695, pl. 77, fig. 7a.

? 1918 *Acrotreta minima* (BARR.): Koliha, p. 13, 14.

? 1980b *Conotreta turricula* sp. n. (partim): Havlíček, p. 297, pl. 1, figs 1–4.

Holotype: Ventral valve figured on pl. 30, figs 8, 9, 11, 12, stored in the palaeontological collection of the University of West Bohemia in Plzeň (PCZCU 734).

Paratype: Dorsal valve figured on pl. 30, figs 3, 4, stored in the palaeontological collection of the University of West Bohemia in Plzeň (PCZCU 730).

Type horizon: Lower Arenigian, Klabava Formation, Olešná Beds Member, level H (Mergl 1986).

Type locality: Barrandian, Těně (west).

Name: Latin, *priscus*, former, referring to stratigraphic position of the species.

Material: Some hundred specimens, often fragmentary.

Diagnosis: *Dactylotreta* with subcircular, weakly convex dorsal valve with large pseudointerarea and ventral valve with procline ventral pseudointerarea; ornamentation of concentric rugellae and superimposed radial rows of pustules.

Description: The shell is minute, thin-walled, 1.2–1.3 mm wide in the largest specimens available.

The dorsal valve is circular, with the larval shell distinctly overhanging the convex posterior margin. Anterior and lateral margins are evenly curved. The valve is weakly convex with a narrow and very shallow sulcus. The dorsal larval shell is subcircular, posteriorly having large and moderately convex protegular node. Its periphery is concave and the margins of the larval shell are raised above the surface of the postlarval shell. The dorsal pseudointerarea is large, 50 % as wide as valve, with markedly concave anteriorly median groove and anacline, short propareas. The median buttress is massive, large, and extends into the simple median ridge. The ridge has wide base, is obscure in small shells but becomes low, septum like in adults, extending over 75 % of the valve length in the large specimens. The cardinal scars are large, elongate suboval, on half-way between the median ridge and the lateral margins.

The ventral valve is acutely conical, subcircular in outline, with convex but slightly depressed posterior margin. The valve is about as high as long, with a straight commissure. The ventral larval shell is nearly circular, 270–280 μm wide, with a prominent, short but distinct external pedicle tube directed posteroventrally. The pedicle foramen is circular, enclosed within the larval shell, 57–60 μm in external diameter, gently tapering toward the shell interior. The ventral pseudointerarea is procline, narrowly triangular, with narrow and obscure interthrough, about 35 % as wide as the valve. The ventral interior has small, elongate apical process and short pedicle tube attached to the posterior shell wall. The tube opens by a circular foramen and continues by a low elevated pad on the posterior wall of the pseudointerarea.

The exterior of the larval shell is covered by fine and uniformly sized pits. The postlarval shell bears distinct concentric rugellae, separated by much narrower interspaces. There are 9–10 fila per 0.1 mm anteriomedianly. Posterolaterally, the rugellae become finer and less regular. Fine, distinctive pustules are superimposed on crests of rugellae, forming radial arrays that are more distinct along the midsector of the valves and on the sides.

Remarks: The new species is near to *Dactylotreta pharus* POPOV et HOLMER, 1994 from the Bjørkåsholmen Limestone (Upper Tremadocian) of Scandinavia. The Bohemian species shares short external pedicle tube and pustulose ornamentation that distinguish both species from other known species of the genus. In the new species, the pustules are arranged in distinct radial rows, unlike their less scattered distribution in *D. pharus*. The dorsal pseudointerarea of *D. prisca* is longer, with less distinct outline of the larval shell on the contrary to *D. pharus*.

The affinity of *Dactylotreta prisca* and *Conotreta turricula* HAVLÍČEK is difficult to evaluate. Havlíček (1980b) established a new species *Conotreta turricula* on the internal moulds from the red-brown siliciclastic sediments of the Klabava Formation (Olešná Beds Member) near the same stratigraphical level as the type horizon of *D. prisca*. The type specimens of *C. turricula* are about twice the size of *D. prisca* and have a very strong dorsal median ridge. The fig-

ured ventral valve by Havlíček (1980b) shows the pinnate ventral mantle system which is absent in *D. parva*. The species *C. turricula* may be referred to genus *Acrotreta* (Holmer 2000) and may be even the synonym of the usually larger species *Acrotreta grandis* KLOUČEK, known from the older stratigraphic units (the Třenice and Mílina Formations). In addition, the specimen figured by Havlíček (1980b) on pl. I, fig. 4 belongs to species *Numericoma vulcanogena* MERGL,1996.

Occurrence: The species is the commonest acrotretid taxon of the red-brown sediments of the Mílina and Klabava Formations (Olešná Beds Member). The valves that may be referred to the same species are known from thin chert beds of the upper Třenice Formation where they are associated with *Thysanotos primus* (KOLIHA).

Localities: Barrandian; Cerhovice (Cerhovská hora Hill), Hatě (Vrahův potok creek), Kváň (field), Hrádek (gorge), Jivina (old quarries), Jivina Hill, Komárov (section along the Jalový potok creek), Medový Újezd (quarry), Mílina (quarry), Praha-Kunratický hrádek, Olešná (quarry), Svárov, Těně (west), Zaječov (quarry near the school building; Hrbek), Žebrák.

Family **Acrotretidae** gen. et. sp. indet.

Pl. 33, figs 1–4, 6, 7

Material: Five fragmentary ventral valves, and one dorsal valve.

Description: The species is distinct by rather thick ventral apex, with a poorly defined border of the larval shell. The pedicle foramen is circular, piercing the top of the extremely extended, posteroventrally directed and gradually tapering, thick-walled pedicle tube. The ventral postlarval shell is broadly conical, with procline and weakly depressed pseudointerarea, and moderately convex posterior and straight posterior margins. The interior lacks the apical process. The dorsal valve is transverse, gently convex, with the moderately convex transverse larval shell.

Remarks: The fragments are very similar to unnamed species from the Bjørkåsholmen Limestone (Upper Tremadocian) of Sweden, which was described and figured by Popov and Holmer (1994: p. 125, fig. 94: J-N). The specimens from the Barrandian have an even more extended pedicle tube.

Occurrence: The species is rare in the lower part of the Klabava Formation (Olešná Beds Member; unit H, Mergl 1986).

Locality: Barrandian; Těně (west).

Family **Ephippelasmatidae** ROWELL, 1965

Genus ***Mamatia*** POPOV et HOLMER, 1994

Type species: *Paratreta retracta* POPOV in NAZAROV et POPOV, 1980; Ordovician, Tremadocian, Mamat Formation; Kazakhstan.

Mamatia retracta (POPOV, 1980)

Pl. 33, figs 5, 8–16; pl. 34, fig. 14

1973 *Myotreta* sp.: Biernat, p. 85, pl. 15, figs 6–8.
1980 *Paratreta retracta* sp. nov.: Popov (in Nazarov and Popov), p. 95, pl. 25, figs 1–6.
1994 *Mamatia retracta* POPOV, 1980: Popov and Holmer, p. 128, fig. 102.
1995 *Myotreta* ? sp.: Mergl, p. 107, pl. 1, fig. 9.

Holotype: Ventral valve figured by Popov (1980) in Nazarov and Popov (1980) on pl. 25, figs 1–6.

Type horizon and locality: Lower Ordovician, Mamat Formation; eastern Kazakhstan.

Material: Ten ventral and six dorsal valves, many fragments from the Barrandian localities.

Description: The shell is minute, dorsi-biconvex, 0.6 mm wide, thin-walled.

The dorsal valve is transversely oval, 70–80 % as long as wide, with evenly rounded margins. The larval shell gently overhangs the weakly curved posterior margin. The larval shell is 220 μm wide and 180 μm long, with simple weakly convex surface except for the gently concave posterolateral part. The surface of the larval shell is finely and densely pitted. The dorsal pseudointerarea is small, gently anacline, with a weak median groove. The width of the pseudointerarea equals to some 30 % of the valve. The median ridge is poorly defined, low, more distinct anteriorly, extending over 70 % of the valve length. The cardinal muscle scars are large and weakly defined. The exterior of the dorsal valve is covered by fine, poorly defined concentric fila.

The ventral valve is asymmetrically conical, transversely oval, with a procline posterior slope and a gently convex anterior slope. The pseudointerarea is weakly defined, gently depressed. The ventral larval shell has a poorly defined border, being evenly convex both transversely and longitudinally. The pedicle foramen is circular, small, enclosed within the larval shell, and directed posteroventrally.

Remarks: The genus *Mamatia* POPOV et HOLMER is by Popov and Holmer (1994) characterized by low to moderately high septum with a single septal rod and catacline to apsacline ventral pseudointerarea. The Bohemian specimens, unlike the specimens from Central Kazakhstan, have an obscure dorsal median ridge and a procline ventral pseudointerarea, the features present also in the specimens from the early Ordovician chalcedonites of the Zbilutka Beds in Holy Cross Mountains, Poland (Biernat and Holmer, written communication). Moreover, the specimens from the Barrandian have posteriorly less extended surface of the ventral larval shell. The obvious morphological variability of *M. retracta* (POPOV) was well evidenced by Popov and Holmer on the specimens from Central Kazakhstan and the South Urals (Popov and Holmer, 1994: cf. figs 102: G, O, V). Therefore, this variability warrants the attribution of the specimens from the Barrandian to this species.

Occurrence: The species is moderately common in the lower part of the Klabava Formation (Olešná Beds Member; unit H, Mergl 1986).

Locality: Barrandian; Těně (west).

Genus *Numericoma* POPOV, 1980

Type species: *Numericoma ornata* POPOV in NAZAROV et POPOV, 1980; Ordovician, Llanvirnian; Kazakhstan.

Numericoma vulcanogena MERGL, 1996

Pl. 31, figs 1–16, pl. 32, figs 12, 15

1980b *Conotreta turricula* sp. n. (partim): Havlíček, p. 298, pl. 1, fig. 4.
1996 *Numericoma vulcanogena* sp. n.: Mergl, p. 48, pl. 3, figs 1–5, pl. 4, figs 4–7.

Holotype: Ventral valve figured by Mergl (1996) on pl. 4, fig. 4 stored in the palaeontological collections of Museum of Dr. B. Horák in Rokycany (MBHR 66802).

Type horizon and locality: Upper Arenigian, Klabava Formation, the uppermost part, *Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone; Barrandian, Zbiroh (Bukov Hill, Joseph gallery, old dump).

Material: Twenty dorsal and thirty ventral valves and many fragments of loose shells, and hundreds of specimens preserved on bedding planes of clayey shales.

Description: Mergl (1996).

Occurrence: The species is abundant in the upper part of the Klabava Formation (*Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone). The shells occur in various sediment types (clayey shale, tuffites, ferolite) and sometimes are completely covering bedding planes of the shales. The well preserved but often worn shells are known in bioclastic limestone with other characteristic species of the *Nocturnellia* Community. The stratigraphically youngest occurrence is known from clayey shales above the tuffaceous bed (KSFB beds) in the Mýto area. Rare shells of *N. vulcanogena* MERGL are associated with a climacograptid graptolite fauna [*Undulograptus novaki* (PERNER, 1895)] of the Šárka Formation (Llanvirnian), but these brachiopod shells may be rewashed from older beds together with the volcanogenic material.

Occurrence: Barrandian; Březina (borehole), Díly (south), Ejpovice (quarry, NE part), Klabava (Old Castle; Kristiánka gallery), Mýto (highway cut), Neřežín (Jedová hora Hill), Osek (old dump), Sirá (old dumps), Sklenná Huť (boreholes), Strašice (near road), Těškov (village), Zbiroh (Bukov, Joseph gallery).

Numericoma campanula sp. n.

Pl. 32, figs 1–11, 13, 14

Holotype: Ventral valve figured on pl. 32, figs 10, 11, stored in the palaeontological collections of the University of West Bohemia in Plzeň (PCZCU 755).

Paratype: Dorsal valve, figured on pl. 32, figs 2, 3, stored in the palaeontological collections of the University of West Bohemia in Plzeň (PCZCU 750).

Type horizon: Llanvirnian, Šárka Formation, lower part, siliceous nodule.

Type locality: Barrandian, Mýto (highway cut).

Name: Latin, *campanula,* small bell, referring to the shell shape.

Material: Four ventral and seven dorsal valves from the same siliceous nodule.

Diagnosis: *Numericoma* of small size, with catacline ventral pseudointerarea, coarse rugellate ventral valve ornamentation, and posteroventrally directed pedicle foramen in a low depression of the larval shell; dorsal valve nearly flat, with median septum having simple upper rod at a high and thin median septum; dorsal exterior with lamellose concentric rugellae.

Description: The shell is small, planoconvex, 0.7 mm wide in the largest individual, thin-shelled.

The dorsal valve is transversely elliptical, 80–85 % as long as wide, widest slightly posteriorly to the midlength, with nearly straight posterior margin and evenly curved anterior and lateral margins. The valve is low, with gently convex posterior half and concave anterior, becoming resupinate in adults. The dorsal larval shell is transversely oval, 150 μm wide and 120 μm long, convex, undivided and covered by fine circular pits of 2–3 μm in a diameter. The border of the larval shell is smooth and overlapping the early postlarval shell. The dorsal valve interior has short, almost linear orthocline pseudointerarea, with widely triangular and shallow median groove. The median septum is thin, extending to 80 % of the valve length, with a simple lower rod and a thicker, undivided upper rod. The cardinal muscle scars are very large, raised above the internal surface, located in posterolateral part, other muscle scars are not discernible.

The ventral valve is acutely conical, with the convex apex. The anterior slope is gently convex in the lateral profile, the posterior slope is depressed, with a wide and well defined catacline pseudointerarea. An evenly wide interthrough is well developed. The ventral larval shell is evenly convex in the anterior profile, with a distinct axial depression in its posterior part. The pedicle foramen is situated in the posterior third at the bottom of the depression. The ventral valve interior is unknown.

The shell exterior is covered by comparatively coarse concentric rugellae in the ventral valve, 5–6 in number per 0.1 mm, and by high, lamellose rugellae, evenly increasing in height anteriorly on the dorsal valve. There are about ten rugellae per 0.1 mm anteriomedianly on the large dorsal valves.

Remarks: This species differs from the stratigraphically earlier species *Numericoma vulcanogena* MERGL in a less complex dorsal median septum and mainly in an axial depression in the ventral larval shell with the pedicle foramen at the bottom of this depression. On the contrary, the ventral larval shell of *N. vulcanogena* is completely convex, with the pedicle foramen encircled by the raised surface of the protegular node. The new species is also smaller being only 0.7 mm wide as the maximum (*N. vulcanogena* may be 1.5 mm wide), but this size already represents the adult specimens as it is evident from the thickened cardinal muscle scars (Pl. 32, fig. 2).

Occurrence: The species is rare in siliceous nodules released from the black shales in lower part of the Šárka For-

mation (Llanvirnian), some 8–10 m above the KSFB. The associated fauna contains common macrofauna of this unit (e.g. trilobites *Trinucleoides, Placoparia, Ormathops, Ectillaenus,* hyolithids, calcichcordates etc.).

Locality: Barrandian; Mýto (highway cut).

Genus ***Pomeraniotreta*** BEDNARCZYK, 1986

Type species: *Pomeraniotreta biernatae* BEDNARCZYK, 1986; Ordovician, Arenigian; northern Poland.

Pomeraniotreta holmeri MERGL, 1995

Pl. 34, figs 1–13, 15–17

1995 *Pomeraniotreta holmeri* sp. n.; Mergl, p. 106, pl. 3, figs 1–10, text-fig. 2.

Holotype: Dorsal valve figured by Mergl (1995) on pl. 3, fig. 1, stored in the palaeontological collection of the Geological Survey, Prague (ČGÚ MM 370).

Type horizon and locality: Lower Arenigian, Klabava Formation, Olešná Beds Member, level H (Mergl 1986); Barrandian, Těně (west).

Material: Several dozen specimens, often fragmentary.

Description: Mergl (1995).

Remarks: This species is newly illustrated herein. The main differences between the type specimens of *Pomeraniotreta biernatae* BEDNARCZYK, 1986 and *P. holmeri* MERGL have been summarised by Mergl (1995). The specimens of *P. holmeri* from the Bjørkåsholmen Limestone (Upper Tremadocian) are morphologically very near to the Barrandian species. The only distinct difference is the higher convexity of the anterior slope near the ventral apex and the posterior margin of the dorsal valve less overhanged by the larval shell in the Bohemian species. In addition, the ventral valve of the Baltoscandinavian species is more slender than the Bohemian ones.

Occurrence: The species is moderately common in the lower part of the Klabava Formation (Olešná Beds Member; unit H, Mergl 1986)

Locality: Barrandian; Těně (west).

Family **Eoconulidae** ROWELL, 1965

Genus ***Eoconulus*** COOPER, 1956

Type species: *Eoconulus rectangulatus* COOPER, 1956; Ordovician, Llandeilian, Pratt Ferry Formation; Alabama, U. S. A.

Eoconulus gemmatus MERGL, 1995

Pl. 35, figs 1–5

1995 *Eoconulus gemmatus* sp. n.: Mergl, p. 108, pl. 4, figs 1–5.

Holotype: Ventral valve figured by Mergl (1995), pl. 4, fig. 1, stored in the palaeontological collection of the Geological Survey, Prague (ČGÚ MM 377).

Type horizon and locality: Arenigian, Klabava Formation, lower part, unit H (Mergl 1986); Barrandian, Těně (west).

Material: Ten dorsal valves, numerous fragments.

Description: Mergl (1995).

Remarks: The new diagnosis is given herein to differentiate this taxon from the new species described in this paper: *Eoconulus* with minute, subcircular, depressed conical, thin shell; shell surface coarsely scalloped, with fine and uneven growth fila; dorsal larval shell with two pairs of nodes.

Occurrence: The species is moderately common in greywacke of the lower part of the Klabava Formation (Lower Arenigian), but is known only from the residues of the bed H at the type locality. It is unknown in the surrounding rocks but this may be due to its very small size.

Locality: Barrandian; Těně (west).

Eoconulus commutabilis sp. n.

Pl. 35, figs 6–13

Holotype: Ventral valve (internal mould), figured herein on pl. 35, fig. 12, stored in the palaeontological collections of the University of West Bohemia in Plzeň (PCZCU 784).

Type horizon: Upper Arenigian, Klabava Formation, upper part.

Type locality: Barrandian, Kleštěnice (abandoned Stanislav mine, dump).

Name: Latin, *commutabilis*, varied, reflecting the shell shape variability.

Material: Thirty specimens, mostly ventral valves.

Diagnosis: *Eoconulus* with medium sized, trapezoidal shell, thick-walled; ventral valve with depressed posterior slope and central to anterocentral apex; dorsal valve asymmetrically, moderately conical; exterior with fine growth fila and regularly spaced lamellae; ventral cardinal muscle scars very large.

Description: The shell is trapezoidal to transversely oval, thick-shelled, 2.5 mm wide in the largest specimens.

The dorsal valve is moderately conical, thinner than the opposite valve, with the anterocentral central apex, without distinct muscle scars.

The ventral valve is highly conical, with flattened, widely triangular posterior slope. The maximum width of the valve lies between one-fourth to the midlength of the valve. The outline and commissure of the valve are slightly irregular reflecting the weakly scalloped shell surface, but the posterior margin is always almost straight. The ventral apex is located at the centre or slightly anterocentrally, pierced by a large circular pedicle foramen. Large cardinal muscle scars are located posterolateraly to the apex. The internal surface bears several concentric bands in regular intervals. They reflect short and distinct growth lamellae of the shell exterior.

The exterior of the ventral valve bears fine and densely packed growth fila, arranged in discrete bands by coarse and short concentric lamellae. The larval shell shape is unknown.

Remarks: The new species is similar to *Eoconulus dyminensis* BEDNARCZYK et BIERNAT, 1978 from the late

Lower Arenigian of the Holy Cross Mountains (Bednarczyk and Biernat 1978). The new species differs in the trapezoidal outline and in bigger size. The trapezoidal outline also distinguishes the new species from other early Ordovician described eoconulids (Holmer 1989, Popov and Holmer 1994). Wright (1963) described similarly shaped species *E. transversus* WRIGHT, 1963 from the Upper Ordovician Portrane Limestone of Ireland, but similar convexity and outline refer of dorsal valve opposite to ventral valve of the new species. The stratigraphically preceding species in the Barrandian, the species *Eoconulus gemmatus* MERGL, is much smaller, less conical, thin-shelled and its outline is subcircular to subrectangular.

Occurrence: The species is abundant in tuffaceous shales in the upper part of the Klabava Formation (Upper Arenigian) at the type locality, but is unknown in other localities.

Locality: Barrandian; Kleštěnice (Stanislav mine).

Order **Siphonotretida** KUTORGA, 1848

Superfamily **Siphonotretoidea** KUTORGA, 1848

Family **Siphonotretidae** KUTORGA, 1848

Subfamily **Siphonotretinae** KUTORGA, 1848

Genus ***Acanthambonia*** COOPER, 1956

Type species: *Acanthambonia minutissima* COOPER, 1956; Ordovician, Llandeilian, Pratt Ferry Formation; Alabama, U.S.A.

Acanthambonia klabavensis HAVLÍČEK, 1982

Pl. 39, figs 6–10

1982b *Acanthambonia klabavensis* sp. n.: Havlíček, p. 73, pl. 16, figs 13–17.

Holotype: Disarticulated shell figured by Havlíček (1982b) on pl. 16, figs 14, 15, stored in the palaeontological collections of Museum of Dr. B. Horák in Rokycany (MBHR 21734; coll. V. Havlíček, VH 2188).

Type horizon and locality: Upper Arenigian, Klabava Formation, upper part, *Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone; Barrandian, Klabava (Old Castle).

Material: Three dorsal and two ventral valves.

Description: Havlíček (1982b).

Remarks: This species was established by Havlíček (1982b) on a small siphonotretid valves rarely preserved in clay grey-green shales of the Klabava Formation. The valves are small-sized, thin-shelled with the width not exceeding 3 mm. Their shape and ornamentation strongly recall juvenile specimens of the genus *Celdobolus* HAVLÍČEK. Although new and more numerous material could confirm the identity of these specimens with the juvenile shells of *Celdobolus*, the validity of the species seems to be more probable. Unlike known juvenile shells of *Celdobolus*, the shells of *Acanthambonia klabavensis* HAVLÍČEK invariably bear regularly spaced internal projections of the external hollow spines. This feature is unknown in any species currently referred to *Celdobolus*. Small specimens of *Celdobolus* have a smooth interior, sometimes with a wide marginal band of tubercles. In the medium sized specimens, groups of tubercles may be present on the visceral platform of *Celdobolus complexus* (BARRANDE), but these tubercles are not homologous with the internal openings of hollow spines. Unlike this species, *A. klabavensis* has regularly arranged spine bases on the entire interior (Pl. 30, figs 10, 11).

Havlíček (1982b) briefly described the shell interior of *Acanthambonia klabavensis*. The new material indicates a weakly defined pair of muscle scars in the dorsal valve interior and narrow arcuate vascula lateralia in the ventral interior. A short vertical median ridge is present in the dorsal umbonal chamber. The ridge is also present in the juveniles of *Celdobolus* but is wider and the deposition of the shell embedded this ridge into the shell wall. The clearly defined internal pedicle tube is absent in *A. klabavensis*; however, this feature is present in the stratigraphically younger species of *Acanthambonia* (Popov and Nõlvak 1987).

Occurrence: The species is uncommon in grey-green clayey shales of the Klabava Formation (*Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone).

Localitites: Barrandian; Klabava (Old Castle), Díly (south).

Genus ***Celdobolus*** HAVLÍČEK, 1982

Type species: *Obolus complexus* BARRANDE, 1879; Ordovician, Arenigian, Klabava Formation; Bohemia.

Remarks: This genus was established by Havlíček (1982b) for a medium-sized, biconvex and thick-walled siphonotretine having a minute or even missing pedicle tube. Its surface is densely covered by fine, uniformly-sized, and long hollow spines. Its size and morphology is similar to genera *Acanthambonia* COOPER and *Helmersenia* PANDER, 1861. The former genus differs by thin shell and internal tube attached to the shell wall, the latter genus differs also by thin shell and its surface has scattered spines. Other siphonotretine genera, e. g. *Collarotretella* MERGL, *Eosiphonotreta* HAVLÍČEK, *Gorchakovia* POPOV, 1989, and *Siphonobolus* HAVLÍČEK have larger pedicle openings enlarged by a resorption. *Siphonotretella* POPOV et HOLMER lacks distinct ventral pseudointerarea, and *Alichovia* GORJANSKY, 1969 possesses branched spines. The genus *Quasiambonia* BEDNARCZYK et BIERNAT, 1978 is poorly known, but its morphology is nearest to *Eosiphonotreta*. Unlike *Quasiambonia*, the external surface of *Celdobolus* is more densely covered by spines, it is larger and thick-shelled. The shell of *Quasiambonia* is small, thin-shelled and its spines are sparse.

The absence of marginal sensory setae and their func-

tional substitution by long hollow spines with sensory function was suggested by Wright and Nõlvak (1997) in the related genus *Acanthambonia*. The arrangement of tubercles in concentric rows along the shell periphery in the interior of *Celdobolus* does not follow the suggested radial canals of the vascular system; there are not any pits that may accommodate the setal follicles. However, unlike in these siphonotretids, the internal openings of the hollow and delicate spines were rapidly closed by the deposition of the shell material; thus, all except for the peripheral spines lack the sensory function, being disconnected with the outer epithelium. The lack of functional pedicle during *Celdobolus* phylogeny and the restriction of sensory function of the hollow spines indicates that the spines had another function. They probably fixed the subglobose specimen in the soft surface of sponges and protected the specimen against an entire outgrowth by host tissues.

The genus *Celdobolus* characterizes the sequence of the Arenigian age in the Barrandian. Its maximum distribution is in aleuropelitic red sediments (Olešná Beds Member of the Klabava Formation) in lower part of the Arenigian, but it is also but rarely present in haematites, oolithic ferolites, and tuffaceous shales of upper Tremadocian to late Arenigian ages, respectively. Apart from the Barrandian, the shells that may be referred with some confidence to *Celdobolus* are known from the Kielce region of the Holy Cross Mountains; Bednarczyk (1964) figured several valves identical with the Bohemian specimens. A few valves of *Celdobolus* were collected be the author in glauconitic sandstone above the chalcedonites with *Thysanotos* assemblage in Nove Zalesie locality of the Kielce region. These valves also confirm the presence of the genus outside the Barrandian area.

Celdobolus complexus (BARRANDE, 1879)

Pl. 36, figs 1–20

1879 *Obolus* ? *complexus* BARR.: Barrande, pl. 95, case III, fig. 1.
1879 *Obolus* ? *complexus* BARR.: Barrande, pl. 113, case V.
1879 *Obolus complexus* BARR.: Barrande, pl. 152, case II, fig. 4.
1879 *Obolus* ? *rokitzanensis* BARR.: Barrande, pl. 126, case II, fig. 5.
1918 *Obolus complexus* (BARR.): Koliha, p. 9, text-figs 3a–3e.
? 1918 *Obolus complexus* BARR. var. *grandis* n. var.: Koliha, p. 10 (nomen nudum).
1924 *Obolus complexus* BARRANDE: Koliha, p. 7, pl. 1, figs 1–4.
1924a *Obolus complexus* var. *punctatus* n. var.: Klouček, p. 201.
1982b *Celdobolus complexus* (BARRANDE): Havlíček, p. 67, pl. 13, figs 1, 4–13, text-fig. 14.
1982b *Celdobolus punctatus* (KLOUČEK, 1924): Havlíček, p. 69, pl. 13, figs 3, 14.
1982b *Celdobolus* sp.: Havlíček, p. 70, pl. 13, fig. 2.

Lectotype: Designated by Walcott (1912), ventral valve figured by Barrande (1879) on pl. 152, case II, fig. 4, stored in the palaeontological collection of the National Museum, Prague (NM L 18263).

Paralectotypes: Dorsal valves figured by Barrande (1879) on pl. 95, case III, fig. 1, and pl. 113, case V, stored in the palaeontological collection of the National Museum, Prague (NM L 18164, NM L 18234)

Type horizon and locality: Arenigian, Klabava Formation, red-brown shale with volcaniclastic admixture (probably upper part of the formation); Barrandian, Krušná hora (Kruschna Hora in original spelling).

Material: Fifty specimens.

Description: Havlíček (1982b).

Remarks: The species *C. complexus* (BARRANDE) differs from *C. mirandus* (BARRANDE) by coarse tubercles in a wide belt around the shell margin. The tubercles are variably developed, being arranged into discrete concentric rows (Pl. 36, fig. 2), especially in young and early adult specimens. A dense radially spaced arrangement of tubercles (Pl. 36, fig. 9) is developed in the thick-walled adult specimens. Some large specimens have obscure tubercles, with only wavy radial canals around the shell periphery. The size and shape of tubercles vary; tubercles may be minute and elongate to large and subcircular (Pl. 36, figs 2, 19). Because of the great phenotypic variability, the species *Celdobolus punctatus* (KLOUČEK) is synonymized with *C. complexus* (BARRANDE) herein. Both species have overlapping stratigraphical and geographical ranges. The main difference concerning the tubercles present on the whole inner surface is a variable feature; this may be illustrated by the specimens on pl. 36, where the visceral area is smooth (Figs 1, 2), bears a few tubercles (Fig. 3) or is densely covered by them (Fig. 20).

The shell ornamentation also displays the great variability. There are specimens with finely and densely spinose surface (Pl. 36, fig. 13) to much scattered and coarser spine bases in discrete bands (Pl. 36, fig. 1).

The specimens from the oolithic ferolites of the basal Šárka Formation are significant by their large size, extremely thick shell wall (Pl. 36, figs 17, 19), deep umbonal chambers, very high pseudointerareas and elongate ventral valve posterior. Their marginal belt is clearly defined and bears very coarse tubercles. Because of the great variability, the specimens are referred to *C. complexus*.

The type specimen (dorsal valve) of *Obolus* ? *rokitzanensis* BARR. established by Barrande (1879) belongs to the species *C. complexus*. The type specimen comes from the topmost part of the Klabava Formation as it is evident from the brown-yellow shale with phosphatic clasts. This type of the rock is known from several sites in the neighbourhood of Rokycany (e.g. Drahouš locality). This is consistent with the original data of J. Barrande (in original spelling Environs de Rokitzan is the type locality).

Occurrence: The species is the commonest siphonotretid in the upper part of the Klabava Formation (*Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone). Its lower range is not well known. Its shells are restricted in occurrence to shales with coarser admixture (e. g. hyaloclasts, sandy grains, phosphatic clasts) and occur also in phosphorite greywackes and oolithic ferolites near the KMFB; the latest occurrence is known from the lower oolithic ferolite beds already referred to the Šárka Formation.

Localities: Barrandian; Díly (south), Kváň (field), Kleštěnice (old dump; Stanislav mine), Krušná hora, Mílina (gallery), Mýto (St. Stephen pond), Osek (old dump), Rokycany (Drahouš), Strašice (field near St. Vojtěch), Zbiroh (Bukov, Joseph gallery).

Celdobolus mirandus (BARRANDE, 1879)

Pl. 37, 1–18, pl. 38, figs 1–17, pl. 39, figs 1–5

1879 *Lingula miranda* BARR.: Barrande, pl. 111, case I, figs 1–3.
1879 *Obolus* ? *complexus* BARR. (partim): Barrande, pl. 95, case III, fig. 2.
1879 *Obolus* ? *complexus* BARR.: Barrande, pl. 111, case IV, figs 1, 2.
1879 *Obolus* ? *advena* BARR.: Barrande, pl. 95, case IV, figs 1, 2.
1879 *Lingula ancilla* BARR.: Barrande, pl. 111, case VI, fig. 3.
1879 *Obolus* ? *minimus* BARR. (partim): Barrande, pl. 95, case II, figs 3–5.
1918 *Obolus mirandus* (BARR.): Koliha, p. 9.
1964 *Obolus* (*Obolus*) *complexus* (BARRANDE, 1879): Bednarczyk, p. 32, text-figs 1, 2, pl. 8, figs 7, 8, 10–13, 16, 17.
1982b *Celdobolus mirandus* (BARRANDE, 1879): Havlíček, pl. 12, figs 1–14, text-fig. 13.
2000 *Celdobolus mirandus* (BARRANDE, 1879): Bednarczyk and Stupnicka, fig. 9, G, H.

Lectotype: Designated by Walcott (1912), ventral valve figured by Barrande (1879) on pl. 111, case I, fig. 3, and by Havlíček (1982b) on pl. 12, fig. 5, stored in the palaeontological collection of the National Museum, Prague (NM L 18158).

Type horizon and locality: Lower Arenigian, Klabava Formation, Olešná Beds Member; Barrandian, Medový Újezd (Hradiště; Hradischt in original spelling).

Material: Several hundred specimens.

Description: The species was described in detail by Havlíček (1982b) who also commented on the great morphological variability of the species. The new, etched specimens show some unknown details, especially the shape of the larval and juvenile shells and the ornamentation.

The ventral larval shell is 220 μm long, subcircular, with a large low posterior node, a smaller node anteriorly and two oblique nodes anterolaterally (Pl. 36, figs 5, 10). The posterior node is penetrated by a circular foramen, which is posteroventrally directed. The border of the larval shell is obscure, the postlarval shell is marked by the earliest hollow spines. The dorsal larval shell is weakly convex, with a depressed posterior node, which is anteriorly divided by a shallow concentric depression from two anterolateral nodes.

The shell ornamentation is variable, with fine hollow spines of an uniform size. The spines are scattered in the juvenile shells being more crowded anteriorly in adult specimens. The density of spines strongly varies (Pl. 39, figs 1–5), with denser accumulations immediately before the growth retardation that are marked by narrow and smooth concentric bands. The spines also cover the surface of the pseudointerareas, being more frequent in the ventral than the dorsal pseudointerarea. The shape and direction of spines vary, but the straight, and low-angled, anteriorly directed spines are the commonest. Spines on the surface of the ventral pseudointerarea are less regular, aligned in growth lamellae, deformed by a substrate relief to which the specimen was attached by the pedicle. The shells are usually found worn, but several exceptions indicate dense spinose ornamentation over the whole shell surface, with the length of spines equal to the one-third of valve length (Pl. 37, figs 17, 18). Two unique specimens indicate that spines of the earlier growth stages were not worn significantly during the life. The anterior spines were longer than spines directed laterally and posterolaterally and their length grew progressively with the shell size.

Remarks: The species is the commonest siphonotretid in the Klabava Formation, but occurs almost exclusively in red-brown siltstones of the Olešná Beds Member. It is strongly variable in size, shell thickness, convexity and outline, and the height of pseudointerarea, but the ornamentation of fine densely crowded spines and lack of tubercles around the shell periphery remain the constant features.

Bednarczyk (1964) referred small siphonotretids from the Holy Cross Mountains to the species *O. complexus* BARRANDE. The same species has been collected by present author in Nove Zalesie locality in sandstone above chalcedonites bearing the fauna of the *Leptembolon-Thysanotos* assemblage. The shells are identical as may be inferred from an imperfect preservation, with *Celdobolus mirandus* (BARRANDE) from the Barrandian. In the Barrandian, the former authors (Havlíček 1982b, Mergl 1986) noted the earliest occurrence of *C. mirandus* at the base of the Klabava Formation (Lower Arenigian) above the latest chert bed of the Mílina Formation. New collections indicate much earlier occurrence of the species. The abundant and morphologically similar, only less convex shells were found in chert lenses in the upper part of the Třenice Formation, associated with *Thysanotos primus* (KOLIHA), *Leptembolon insons* (BARRANDE) and minute acrotretids. Two additional specimens were determined in haematites of the Třenice Formation in Holoubkov (V Ouzkém). Consequently, the range of *Celdobolus mirandus* extends down to the Upper Tremadocian and cannot be used for biostratigraphical purposes without a critical revision and an analysis of the associated fauna. The shells figured by Bednarczyk and Stupnicka (2000) and the data from the Kleczanów Sandstone Member in the Międzygórz locality also indicate the extension of the *C. mirandus* to the Upper Tremadocian in the Holy Cross Mountains.

Occurrence: *Celdobolus mirandus* (BARRANDE) is the commonest species of the red-brown siltstones of the Klabava Formation (Olešná Beds Member). It is known from the level 1.0 – 1.5 m above MKFB, but it is unknown in cherts and greywackes of the Mílina Formation. Almost identical specimens were found in the chert intercalations and haematites in the upper part of the Třenice Formation. The upper stratigraphical range is not well known. As single specimen that may be referred to *C. mirandus* was found in clayey shale of the *Corymbograptus v-similis* Biozone, but no other specimens are known from clayey sequence of the Klabava Formation.

Localities: Barrandian; Cerhovice (Cerhovská hora Hill), Hatě (Vrahův potok creek), Kváň (field), Hrádek (gorge), Jivina (old quarries), Jivina Hill, Komárov (section along the Jalový potok creek), Medový Újezd (quarry), Mílina (quarry), Olešná (quarry), Sedlec (Sutice), Strašice (field near St. Vojtěch), Strašice (E margin; east; field near St. Vojtěch), Svárov, Těně (road cut; village; west), Točník, Zaječov (Hrbek; quarry near the school building).

Genus ***Collarotretella*** MERGL, 1997

Type species: *Collarotretella septata* MERGL, 1997; Ordovician, Arenigian, Klabava Formation; Bohemia.

Remarks: This monospecific genus was briefly compared with the genus *Eosiphonotreta* HAVLÍČEK in the original description (Mergl 1997d). The new material of *Eosiphonotreta* from the Barrandian indicates the same shape of the pedicle opening. As in *Collarotretella septata* MERGL, the pedicle tube has developed an internal collar of a smaller diameter than is the diameter of its median part. This is known also in *Eosiphonotreta verrucosa* (EICHWALD). Apart from this similarity, the genus *Eosiphonotreta* has the exterior covered by prominent hollow spines which are absent in *Collarotretella*.

Collarotretella septata MERGL, 1997

Pl. 39, figs 16–19

1997d *Collarotretella septata* sp. n.: Mergl, p. 102, fig. 7.

Holotype: Ventral valve (internal mould) figured by Mergl (1997d) on fig. 7: A, refigured on pl. 39, fig. 17, stored in the palaeontological collections of Museum of Dr. B. Horák, Rokycany (MBHR 66845).

Type horizon and locality: Lower Arenigian, Klabava Formation, red-brown shale; Barrandian, Hrádek (gorge).

Material: Twelve ventral and fifteen dorsal valves.

Description: Mergl (1997d).

Occurrence: The species is rather abundant in brown-violet siltstones of the lower part of the Klabava Formation but only at the type locality.

Locality: Barrandian; Hrádek (gorge).

Genus ***Eosiphonotreta*** HAVLÍČEK, 1982

Type species: *Terebratula verrucosa* EICHWALD, 1840; Ordovician, Arenigian; Estonia.

Eosiphonotreta krafti (RŮŽIČKA, 1927)

Pl. 40, figs 1–11

? 1918 *Obolus Nováki* (KLOUČEK): Koliha, p. 9.

? 1924 *Obolus Nováki* (KLOUČEK): Koliha, p. 24, pl. 1, figs 9, 10.

1927 *Siphonotreta Krafti* n. sp.: Růžička, p. 6, pl. 1, figs 7–9.

1982b *Eosiphonotreta krafti* (RŮŽIČKA, 1927): Havlíček, pl. 59, pl. 11, figs 10–14.

1995 *Eosiphonotreta* sp.: Mergl, p. 108, pl. 4, fig. 6.

Lectotype: Designated by Havlíček (1982b), ventral valve figured by Růžička (1927) on pl. 1, fig. 7, and by Havlíček (1982b) on pl. 11, fig. 10, stored in the palaeontological collections of the National Museum, Prague (NM L 18130).

Paralectotypes: Dorsal valve and shell fragment figured by Růžička (1927) on pl. 1, figs 8, 9, stored in the palaeontological collections of the National Museum, Prague (NM L 18146, NM L 18124).

Type horizon and locality: Upper Tremadocian, Třenice Formation; Barrandian, Holoubkov (V Ouzkém).

Material: Five ventral and three dorsal valves, several shell fragments

Description: Havlíček (1982b).

Remarks: *Eosiphonotreta krafti* (RŮŽIČKA) is a rare species and the material from haematite is not well preserved (Havlíček 1982b). The new collection on the type locality and the examination of the not-catalogued material in the National Museum offer new data about the external morphology. Moreover, the rare but well preserved fragments from the lower part of the Klabava Formations, which probably belong to the same species exhibit new morphological details.

The shell is thick-walled, with numerous concentric lamellae which were only weakly expressed on the shell exterior. This is covered by evenly scattered, erect hollow spines. The latex cast of a juvenile shell (Pl. 40, fig. 1) from the type locality shows subcircular outline of the dorsal valve, weakly defined larval shell and concentric rows of evenly sized macrospines. The macrospines also cover the posterolateral shell margins, being directed laterally and posterolaterally and under high angle to shell surface (Pl. 40, figs 9, 11). The macrospines are evenly spaced in large shells (Pl. 40, fig. 5). Well preserved shell fragments show concentric rows (those correspond to lamellose preservation in haematitized internal moulds) of very small and densely packed microspines, followed by smooth surface only with macrospines (Pl. 40, fig. 10). The pedicle opening is large, almost circular, located immediately anterior to the ventral apex. The external opening is posteriorly bordered by a shortly triangular pedicle track. Unlike the species *E. verrucosa* (EICHWALD), the diameter of internal opening is not diminished by a thick collar. The ventral pseudointerarea is very low, almost catacline, broadly triangular and arched posteriorly. Its boundary is weakly defined, with the surface covered by growth lines but without any spines.

Klouček (1918) named, and Koliha (1918, 1924) briefly defined the species *Obolus Nováki* (KLOUČEK). This species is based on a poorly preserved dorsal valve. It shows concentric bands and ornamentation characteristic for a siphonotretid. The find came from red-brown greywacke of the lower part of the Olešná Beds Member of the Klabava Formation, and probably belongs to the same species which is known as a fragment from the coeval sediments. However, this Klouček`s specimen has not been discovered in the collections stored in the National Museum, Prague and has probably been lost; therefore its definite identification is impossible.

Occurrence: The species is rare in haematites of the Třenice Formation (Upper Tremadocian) and the fragments of probably the same species are known but rarely from the lower part of the Klabava Formation (Olešná Beds Member; level H, Mergl 1986). Poorly preserved internal mould, collected by C. Klouček, which may belong to this siphonotretid is known from red-coloured, coarse greywacke intercalation between cherts of the Mílina Formation in Cerhovská Hora Hill.

Localities: Barrandian; Cerhovice (Cerhovská hora Hill), Holoubkov (V Ouzkém), Olešná (quarry), Těně (west).

Eosiphonotreta verrucosa (EICHWALD, 1840)

Pl. 40, figs 12–17, text-fig. 17

1879 *Lingula sulcata* BARR. (partim): Barrande, pl. 106, case III, fig. 1.
1943 *Siphonotreta verrucosa* (EICHWALD): Prantl, p. 3, pl. 1, figs 1, 2.
1969 *Siphonotreta verrucosa* (EICHWALD, 1840): Gorjansky, p. 87, pl. 15, figs 1, 2 (here see quotations of older references).
1982b *Eosiphonotreta verrucosa* (EICHWALD, 1840): Havlíček, p. 58, pl. 14, figs 1–6, text-fig. 11.

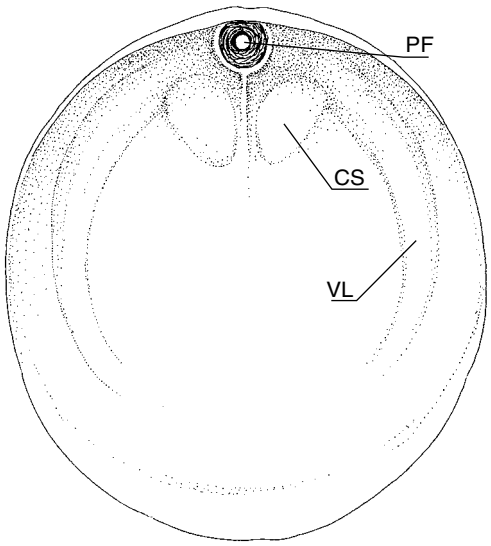
Neotype, type horizon and locality: See Gorjansky (1969).

Material: Twenty valves, mostly incomplete in various states of preservation from the Barrandian localitites.

Description: Havlíček (1982b). This species was ascertained in the Barrandian area by Prantl (1943). Havlíček (1982b) described the Bohemian material but some details of the shell morphology were noted only briefly; some additional data are presented herein.

The ventral valve interior (Pl. 40, figs 13, 15) is characterized by a large circular pedicle foramen having a thick collar around its internal opening. Muscle scars are poorly preserved, with two scars situated posteriorly and divided by a distinct median ridge. Long vascula lateralia run parallelly with the valve margin and extend almost to the anterior margin, but without any distinct secondary branches. The shell exterior is evenly covered by rather distant large and straight, unbranched spines, which are directed anteriorly and laterally, being normal to concentric growth lines. The internal openings of the hollow macrospines are sometimes impressed on the surface of internal moulds, but as seen in better preserved specimens with the original shell, the inner shell surface is otherwise smooth. The concentric lamellae, numbering four to six in the adult shells are externally marked by concentric bands of densely packed minute spines. These spines are negatively impressed on the adjacent shell surface (Pl. 40, fig. 17).

Remarks: The original description of this species is based on specimens from the Petersburg area and although it has been redescribed and figured by several authors (Gorjansky 1969, Holmer and Popov 2000), the finest details of its morphology are not sufficiently known. Therefore, the comparison of the type material and specimens from the Barrandian is difficult. There are some differences between the populations, concerning the more densely spinose surface of the specimens from Russia and a nearly smooth shell surface among the macrospines in the specimens from the Barrandian.



Text-fig. 17. ***Eosiphonotreta verrucosa*** **(EICHWALD, 1840). Ventral valve interior. CS – central muscle scars, PF – pedicle foramen, VL – vascula lateralia.**

Occurrence: The species is locally common in the upper part of the Klabava Formation (Arenigian), but it has a patchy distribution. It was frequently found in tuffaceous shales with coarse sand and hyaloclast admixture from the *Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone. The poorly preserved shells were rarely collected from silty shales of the *Hologratpus tardibrachiatus* Biozone. Generally abraded crescentic fragments of the shells are commonly scattered in the tuffaceous rocks of the upper Arenigian age in the periphery of the Komárov volcanogenic complex (probably the *Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone).

The original specimens of Prantl (1943) occur in calcareous, massive grey tuffites with abundant large hyaloclasts. This rock was found in the borehole made during the prospecting of iron ores in the Krušná hora tectonic islet and is kept in the palaeontological collection of the National Museum, Prague.

Localities: Barrandian; Kleštěnice (old dump; Stanislav mine), Krušná hora (Gabriela mine), Rokycany (Stráň), Zbiroh (Bukov, Joseph gallery).

Genus ***Siphonobolus*** HAVLÍČEK, 1982

Type species: *Siphonotreta simulans* RŮŽIČKA, 1927; Ordovician, Tremadocian, Třenice Formation; Bohemia.

Siphonobolus simulans (RŮŽIČKA, 1927)

Pl. 39, figs 11–15

1927 *Siphonotreta simulans* n. sp.: Růžička, p. 7, pl. 1, figs 10–12.
1927 *Obolus complexus* BARR.: Růžička, p. 4.
1982b *Siphonobolus simulans* (RŮŽIČKA, 1927): Havlíček, p. 62, pl. 11, figs 1–7, text-fig. 12.

Lectotype: Designated by Havlíček (1982b), ventral valve figured by Růžička on pl. 1, fig. 11, and by Havlíček (1982b) on pl. 11, fig. 3, stored in the palaeontological collections of the National Museum, Prague (NM L 18128).

Paralectotypes: Ventral and dorsal valves, figured by Růžička (1927) on pl. 1, figs 10, 12, stored in the palaeontological collections of the National Museum, Prague (NM L 18131, NM L 37008).

Type horizon and locality: Upper Tremadocian, Třenice Formation; Barrandian, Holoubkov (V Ouzkém).

Material: Ten ventral and three dorsal valves.

Description: Havlíček (1982b).

Remarks: Two latex casts of the external moulds are figured to show the spinose ornamentation which was only briefly noted by Havlíček (1982b). The spines are short, directed anteriorly, with broad bases and tapering rapidly. Smooth concentric bands are intercalated with spinose bands which have densely crowded spines.

Occurrence: The species is moderately common in greywackes and haematites of the Třenice Formation.

Localities: Barrandian; Cheznovice (Žlebec), Holoubkov (V Ouzkém).

Genus ***Siphonotretella*** POPOV et HOLMER, 1994

Type species: *Siphonotretella jani* POPOV et HOLMER, 1994; Ordovician, Tremadocian, Bjørkåsholmen Limestone; Sweden.

Siphonotretella filipi sp. n.

Pl. 41, figs 1–14

1995 *Siphonotretella* sp.: Mergl, pl. 107, pl. 4, figs 7–11.

Holotype: Ventral valve figured on pl. 41, figs 1–3, stored in the palaeontological collection of the University of West Bohemia in Plzeň (PCZCU 697).

Paratype: Dorsal valve figured on pl. 41, figs 5, 6, 9, stored in the palaeontological collection of the University of West Bohemia in Plzeň (PCZCU 698).

Type horizon: Lower Arenigian, Klabava Formation, Olešná Beds Member, level H (Mergl 1986).

Type locality: Barrandian, Těně (west).

Name: In honour of RNDr. Filip Lederer, CSc. from the University of West Bohemia, tragically deceased in March, 2001.

Material: Ten ventral and five dorsal valves, several fragments.

Diagnose: *Siphonotretella* with subconical ventral valve, with procline and gently convex ventral pseudointerarea; dorsal valve convex, with reduced pseudointerarea.

Description: The shell is ventri-biconvex, thin-shelled, 1.2–1.3 mm wide in large specimens.

The dorsal valve is subcircular, strongly convex, with maximum height in the posterior third, slightly depressed along the axis. The dorsal pseudointerarea is very low, catacline. The dorsal larval shell is subcircular, less curved in the posterior border, gently convex, with higher central node and two smaller and lower nodes situated anterolaterally. The dorsal interior is poorly known, without the median septum.

The ventral valve is subconical, with maximum depth in the posterior third, with gently convex slopes. The ventral pseudointerarea is steeply procline, with surface devoid of spines, arched axially and ventral edge curved dorsally. The ventral larval shell is subconical, with conical median node apically penetrated by the circular, posteroventrally directed foramen. The anterior half of the larval shell is depressed, and its border is poorly divided from the postlarval shell. The ventral interior is marked by a short and thick internal tube.

The shell exterior is covered by erect, thin, straight hollow spines of an uniform size, spaced in irregular concentric rows. The spines are radially directed onto the shell including the shell posterior and appear immediately after the early secretion of the postlarval shell.

Remarks: The species *Siphonotretella filipi* sp. n. is very similar to *S. jani* POPOV et HOLMER from the Bjørkåsholmen Limestone of the Upper Tremadocian age of Scandinavia. The new species differs by procline ventral pseudointerarea instead of its apsacline position in *S. jani* and its shell has a less transverse outline. Species *Siphonotreta acrotretomorpha* GORJANSKY, 1969 from the Leetse Formation, Estonia has been recently (Puura 1996) referred to the genus *Eosiphonotreta* HAVLÍČEK. This Estonian species differs mainly by a bigger size and by an elongate pedicle foramen enlarged by resorption. Biernat (1973) referred some specimens from the Holy Cross Mountains of Poland to *Siphonotreta acrotretomorpha* but this material needs a revision.

Occurrence: The species is rarely known from the cherts in the upper part of the Mílina Formation and from the red-brown siltstones and shales near the base of the Klabava Formation (Olešná Beds Member). Its preservation, due to its minute size, is generally poor without fine details of exterior. The internal moulds are marked by low-conical shape and a prominent, long internal pedicle tube.

Localities: Barrandian; Kváň (field), Strašice (field near St. Vojtěch), Těně (west), Zaječov (quarry near the school building).

Subfamily **Schizamboninae** HAVLÍČEK, 1982

Genus ***Schizambon*** WALCOTT, 1884

Type species: *Schizambon typicalis* WALCOTT, 1884; Ordovician, Pogonip Limestone; Nevada, U. S. A.

Schizambon (?) sp.

Pl. 41, figs 15–17

Material: One dorsal valve.

Remarks: The only available valve is transversely oval, thin-shelled, 2.5 mm wide, strongly convex in both profiles with a distinct narrow sulcus extending from the apex. The

surface is covered by densely packed shallow, overlapping pits (Pl. 41, fig. 17). The concentric ornamentation is suppressed, with a few weak lines. The valve is strongly different from the other known linguliformean brachiopods from the Ordovician of the Barrandian. Its morphology with a distinct sulcus is similar to schizambonines but the spinose ornamentation is not preserved and the systematic placement is unclear.

Occurrence: The species is very rare in the siliceous nodules of the Šárka Formation (Llanvirnian).

Locality: Barrandian; Mýto (field).

Class **Paterinata** WILLIAMS et others, 1996

Order **Paterinida** ROWELL, 1965

Superfamily **Paterinoidea** SCHUCHERT, 1893

Family **Paterinidae** SCHUCHERT, 1893

Remarks: The paterinid brachiopods are rare in the Ordovician of the Barrandian. There are two distinct species of the Upper Tremadocian age that have already been described by Růžička (1927) and revised and illustrated by Havlíček (1982b). Apart these species, the finds of other specimens of this brachiopod group are known from the Lower Arenigian (Klabava Formation), but, being poorly preserved, these shells are determined in the generic level only.

Genus ***Kolihium*** HAVLÍČEK, 1982

Type species: *Kutorgina kolihai* RŮŽIČKA, 1927; Ordovician, Tremadocian, Třenice Formation; Bohemia.

Kolihium kolihai (RŮŽIČKA, 1927)

Pl. 42, figs 1–10

1927 *Kutorgina kolihai* n. sp.: Růžička, p. 5, pl. 1, figs 13, 14.
1982b *Kolihium kolihai* (RŮŽIČKA, 1927): Havlíček, p. 55, pl. 16, figs 5–11.
2000 *Kolihium kolihai*: Laurie, p. 153, figs 84, 3a–c.

Lectotype: Designated by Havlíček (1982b), ventral valve (internal and external moulds) figured by Růžička (1927) on pl. 1, fig. 13, and by Havlíček (1982b) on pl. 14, fig. 8, stored in the palaeontological collection of the National Museum, Prague (NM L 18127).

Paralectotype: Dorsal valve (internal and external moulds) figured by Růžička (1927) on pl. 1, fig. 14, and by Havlíček (1982b) on pl. 11, figs 5, 9, stored in the palaeontological collection of the National Museum, Prague (NM L 18129).

Type horizon and locality: Upper Tremadocian, Třenice Formation; Barrandian, Holoubkov (V Ouzkém).

Material: Five ventral valves, three dorsal valves and a few fragments.

Description: Havlíček (1982b).

Remarks: Havlíček (1982b) described the shell morphology, but some notes to his descriptions may be added. There is evidently a high variation in the development of concentric bands. As may be seen in pl. 42, fig. 8, some ventral valves may have external surface smooth while other specimens show very prominent concentric rugae (Pl. 42, figs 3, 5). The same variations are distinct in the dorsal valves (Pl. 42, figs 2–4). The dorsal valve interior shows two muscle scars in the umbonal chamber in a similar arrangement as in the other paterinid genera (Laurie 2000). The ventral valve of *K. kolihai* (RŮŽIČKA) does not show any muscle impressions but the divergent and branched vascula media are well impressed in two internal moulds (Pl. 42, figs 9, 10).

Occurrence: The species is rare and generally fragmentary in haematite of the Třenice Formation (Upper Tremadocian).

Locality: Barrandian; Holoubkov (V Ouzkém).

Kolihium sp.

Pl. 42, fig. 16

1995 *Kolihium* sp.: Mergl, p. 108, pl. 1, figs 10, 11.

Material: Several fragments.

Remarks: The available fragments display subcircular to transversely elongate pits with flat bottom, arranged in oblique rows in bands between the weak concentric lamellae. The shell wall in never perforated. The ornamentation is consistent with the superficial pitting of *Kolihium kolihai* (RŮŽIČKA) but the pits of *K*. sp. are separated by wider interspaces as may be inferred from otherwise totally different mode of the preservation. The Ordovician genus *Dictyonites* COOPER, 1956 differs in the weakly mineralised shell at the bottom of the pits with the large subcircular perforations developed (Williams et al. 1998).

Havlíček (1982b) described a ventral valve of *Kolihium* sp. from shale of the Klabava Formation (Arenigian), which is remarkable by densely arranged concentric rugae which evenly enlarge anteriorly. The superficial ornamentation consists of minute and rarely preserved pits. This specimen was not available for the present study, but its concentric rugellae distinguish it from the type species as well as from the fragments described herein.

Occurrence: Rare minute fragments with a characteristic sculpture have been rarely ascertained in the lower part of the Klabava Formation (Lower Arenigian) (level H: Mergl 1986).

Locality: Barrandian; Těně (west).

Genus ***Lacunites*** GORJANSKY, 1969

Type species: *Lacunites balaschovae* GORJANSKY, 1969; Ordovician, Arenigian, Leetse Formation; Ingria, Russia.

Lacunites walcotti (RŮŽIČKA, 1927)

Pl. 42, figs 13–15, 18; text-fig. 18

1927 *Micromitra* (*Iphidella*) *Walcotti* n. sp.; Růžička, p. 2, pl. 2, figs 6, 7.

1982b *Lacunites walcotti* (RŮŽIČKA, 1927): Havlíček, p. 54, pl. 16, figs 1–4.

Holotype: Ventral valve (internal and external moulds) figured by Růžička (1927) on pl. 2, figs 6, 7, and by Havlíček (1982b) on pl. 15, fig. 3, stored in the palaeontological collection of the National Museum, Prague (NM L 18123).

Type horizon and locality: Upper Tremadocian, Třenice Formation; Barrandian, Holoubkov (V Ouzkém).

Material: Four ventral valves and one dorsal valve.

Description: Havlíček (1982b).

Remarks: The species *Lacunites walcotti* (RŮŽIČKA) was based only on a ventral valve and only some internal characters were noted by Havlíček (1982b). A single dorsal valve that can be referred to this species was recognized among the not catalogized material of the National Museum, Prague (Pl. 42, fig. 18). The valve was collected by R. Růžička as it is evident from the attached label. The dorsal valve is flat, transverse, widest in the posterior third with rounded extremities. Shallow and large triangular anterior muscle impressions are located at the centre of the valve, with raised transverse anterior borders. Another pair of large triangular and divergent muscle scars occupies the posterolateral sector of the valve. The dorsal musculature is remarkably similar to that illustrated by Laurie (2000) in the early Cambrian genus *Askepasma toddense* LAURIE, 1986 and significantly differs from the musculature of the advanced paterinids, in which the dorsal muscle scars are smaller. The ventral valve interior has strong, widely divergent ridges on lateral internal slopes of the delthyrium and less divergent pair bordering an elevated triangular platform in the posterior part of the visceral area.

All the known species of the genus *Lacunites* GORJANSKY are rare, based on external morphology; internal structures of the dorsal valve are unknown (Gorjansky 1969). *Lacunites walcotti* (RŮŽIČKA) differs from other species by high ventral valve and very rapidly growing, large superficial pits (Pl. 42, fig. 14).

Occurrence: The species is very rare in haematite of the Třenice Formation (Upper Tremadocian).

Locality: Barrandian; Holoubkov (V Ouzkém).

Lacunites sp.

Pl. 42, figs 11, 12

Material: One valve, probably the dorsal one.

The shell is very small and probably represents a juvenile specimen. Although flattened, the valve displays dense superficial pitting in a divaricate pattern, with the size regularly and rapidly growing anteriorly. The pits are broadly oval and shallow. A concentric ornamentation of broad rugae is distinct along the shell periphery,.

Remarks: The rapidly growing size of pits is different from the uniformly sized, much smaller pits of *Kolihium* HAVLÍČEK, and the specimen may be referred to *Lacunites* GORJANSKY. It is the stratigraphically younger occurrence of the genus, comparable with the age of *L. alimbeticus* (ANDREEVA, 1962) from the Kuragan Formation (Arenigian) of the Ural Mountains (Andreeva 1962) and *L. balaschovae* GORJANSKY from the upper part of the Leetse Formation (Lower Arenigian) of NW Russia. Another known species is known from older strata of the Tremadocian age (Růžička, 1927).

Occurrence: The only specimen was found in red-brown shale of the lower part of the Klabava Formation (Lower Arenigian, *Corymbograptus v-similis* Biozone).

Locality: Sedlec (excavation above the gorge).

Class **Craniata** WILLIAMS et others, 1996

Order **Craniida** WAAGEN, 1885

Superfamily **Cranioidea** MENKE, 1828

Family **Craniidae** MENKE, 1828

Genus *Petrocrania* RAYMOND, 1911

Type species: *Craniella meduanensis* OEHLERT, 1888; Devonian; France.

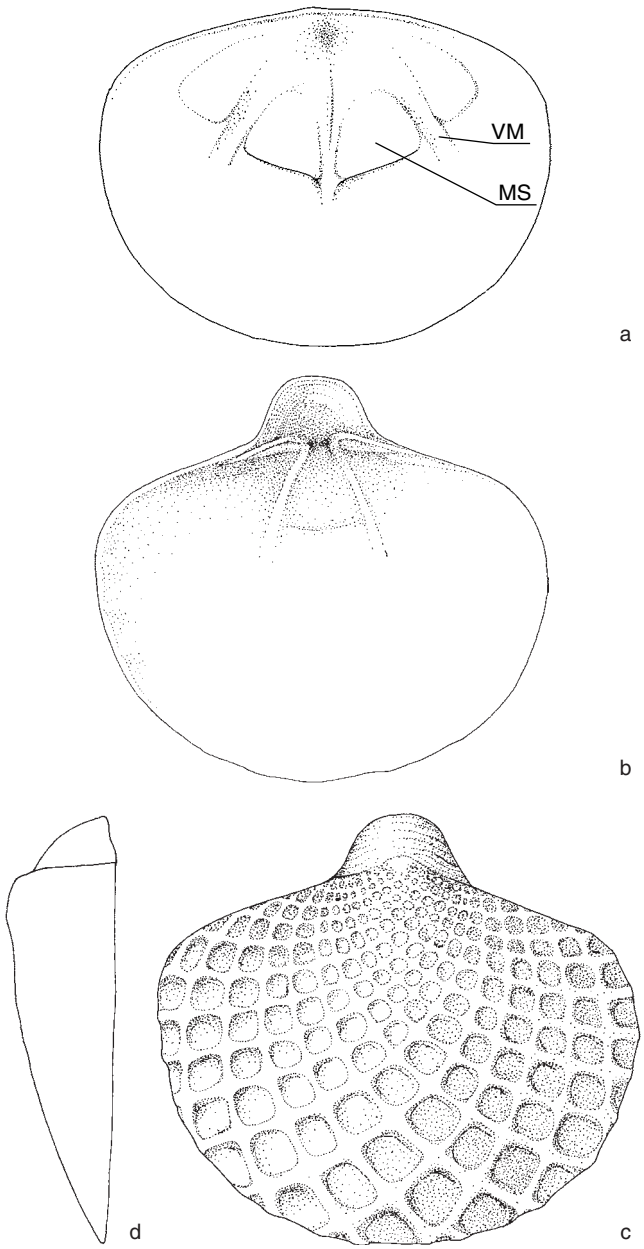
Remarks: The genus *Petrocrania* RAYMOND has a very long stratigraphical range, with the earliest species from the late Arenigian (Popov et al. 1999, Bassett 2000). It is one of the earliest craniid, because the great diversification of the craniids did not begin until the Llandeilian time. In the brachiopod collection from the Třenice and Mílina Formations widely conical and originally non-phosphatic brachiopod shells were rarely recognized. They lack fine morphological details and their original calcareous shell is not preserved but their shape and muscle impressions warrant their accommodation into the craniid stock. Their coeval occurrence with *Thysanotos siluricus* (EICHWALD) support the late Tremadocian age; they represent the earliest known craniid. Recent data presented by Sdzuy et al. (2001) indicate the presence of a craniid in the Vogtendorf Formation in Frankenwald; it occurs in volcano-sedimentary rocks with other brachiopod, trilobite and pelmatozoan fauna of the Upper Tremadocian age. The finds in the Bohemian Massif indicate that the early evolution of craniid brachiopods also took place in NE periphery of the Gondwana, probably extended into the temperate climate (Popov et al. 1999).

Petrocrania caputium sp. n.

Pl. 42, figs 17, 19, 20, 22–25

Holotype: Dorsal valve figured on pl. 42, figs 19, 20, 25, stored in the palaeontological collection of the University of West Bohemia in Plzeň (PCZCU 713).

Type horizon: Upper Tremadocian, Mílina Formation, horizon with *Thysanotos siluricus.*



Text-fig. 18. ***Lacunites walcotti*** **(RŮŽIČKA, 1927). Dorsal valve interior (a), ventral valve interior (b) and ventral valve exterior (c) and lateral profile of ventral valve (d). MS – muscle scars, VM – vascula myaria.**

Type locality: Barrandian, Kváň (field).

Material: Three dorsal valves.

Name: Latin, *caputium*, hood, reflecting the shell shape.

Diagnosis: *Petrocrania* with widely conical, thin-shelled subcircular dorsal valve, subcentral apex, lacking limbus; muscle impressions small and weak; mantle canal system unknown, exterior with fine radial riblets.

Description: The shell is small, 3.5 mm wide in the largest specimen, thin-shelled, transversely oval. The dorsal valve is widely conical, slightly asymmetrical, 80–90 % as long as wide, with the apex located posteriorly, at one third to one fourth of the length. The anterior slope is gently convex, the posterior slope is straight to gently concave in the lateral profile. The dorsal valve interior displays a pair of shallow, large imprints of muscles posterolaterally to the apex. These scars are probably the sites of posterior adductors, but there are not two discrete pairs of muscle scars as it is common in *Petrocrania* RAYMOND. The shell margins are evenly curved. The exterior of the dorsal valve bears densely crowded radial riblets, but these are poorly preserved in the shells available.

Remarks: Although there are only three specimens, the conical shells, acute apex, lack of limbus, thin shell without rugellate ornamentation distinguish the other species from other Lower and Middle Ordovician species. The shell is similar to *Philhedra* KOKEN, 1889 by radial rows of spines, namely to *P. rivulosa* (KUTORGA, 1846) but the species *P. baltica* KOKEN, 1889 (the type species; Middle Ordovician) has much coarser and sparsely arranged spines. The ornamentation of *P. caputium* sp. n. is similar to *Orthisocrania* ROWELL, 1963 but the latter has a very low dorsal valve.

Occurrence: The species is rare in cherts of the Mílina Formation (Upper Tremadocian) within the *Leptembolon-Thysanotos* Fauna, associated with orthid brachiopods, trilobites and pelmatozoans.

Locality: Barrandian; Kváň (field).

Petrocrania sp.

Pl. 42, figs 21, 26

Material: One dorsal valve.

Description: The shell is roundly subquadrate, 3.5 mm wide, depressed conical, preserved as internal mould without original shell or external mould. The apex lies at the midlegth. The slopes are slightly scalloped, with distinct growth laminae reflected by concentric ridges on the shell interior. There are two muscle scars in the posterior slope. The smaller pair is located immediately posterolateral to the apex, the larger pair is highly raised above the valve floor and lies at the midway between the apex and the posterior margin.

Remarks: The only valve differs from *P. caputium* sp. n. by the central apex, probably lamellose exterior reflected by the concentric lines in the interior, depressed conical shape and larger and better impressed adductor scars.

Occurrence: The valve is known from haematite of the Třenice Formation (Upper Tremadocian) as a very rare element of a rich brachiopod-trilobite association.

Locality: Barrandian; Holoubkov (V Ouzkém).

Tab. 1. Distribution of linguliformean and cranioformean brachiopods in the Lower and early Middle Ordovician of the Barrandian. O – Olešná Beds Member, C – *Corymbograptus v-similis* Biozone, H – *Hologratus tardibrachiatus* Biozone, A – *Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone.

Species	Třenice Formation	Mílina Formation	Klabava Formation				Šárka Formation	Dobrotivá Formation
			O	C	H	A		
Pseudolingula (?) *trimera* (BARRANDE 1879)								•
Sedlecilingula sulcata MERGL, 1997				•	•	•		
Expellobolus expulsus (BARRANDE, 1879)	•							
Josephobolus regificus MERGL, 1997						•		
Leptembolon insons (BARRADNE, 1879)	•	•						
Leptembolon testis (BARRANDE, 1879)			•					
Libecoviella arachne (BARRANDE, 1879)	•							
Libecoviella ovata HAVLÍČEK, 1982	•							
Lingulella lata (KOLIHA, 1924)			•					
Lithobolus plebeius MERGL, 1996						•		
Apatobolus sp.								•
Paldiskites sulcatus (BARRANDE 1879)				•	•	•		
Paldiskites peracutus sp. n.							•	
Teneobolus bukovensis (KOLIHA, 1924)	•	•						
Teneobolus gracilis MERGL, 1995			•	•				
Westonia sp. A						•		
Westonia sp. B								•
Westonisca lamellosa (BARRANDE, 1879)	•							
Mytoella pusilla (ŽELÍZKO, 1921)				•	•	•		
Mytoella krafti sp. n.							•	
Wosekella filiola sp. n.				•	•	•		
Wosekella debilis (BARRANDE 1879)							•	
Wosekella senilis sp. n.								•
Ectenoglossa (?) sp.								•
Rafanoglossa platyglossa HAVLÍČEK, 1982					•	•		
Rafanoglossa impar (BARRANDE, 1879)								•
Spondyglossella spondylifera HAVLÍČEK, 1980				•				
Spondyglossella (?) sp.							•	
Elliptoglossa celdai MERGL, 1995			•					
Fagusella indelibata MERGL, 1996						•		
Hyperobolus feistmanteli (BARRANDE, 1879)	•							
Pidiobolus minimus MERGL, 1995		•	•					
Pidiobolus (?) sp.								•
Rosobolus robertinus HAVLÍČEK, 1982	•							
Rosobolus cf. *robertinus* HAVLÍČEK, 1982			•					
Rosobolus magnus sp. n.	•							
Rosobolus sp.						•		
Rowellella distincta BEDNARCZ. et BIER., 1978			•					
Rowellella sp. A				•				
Rowellella sp. B							•	
Thysanotos primus (KOLIHA, 1924)	•							
Thysanotos siluricus (EICHWALD, 1840)		•						
Broeggeria ferraria sp. n.	•							
Elkania lineola (HAVLÍČEK, 1982)						•		
Elkania praelineola sp. n.				•				
Elkanisca obesa (HAVLÍČEK, 1980)	•		•					
Elkanisca klouceki (KOLIHA, 1918)			•					
Paterula prima KLOUČEK, 1924						•		
Paterula incognita MERGL, 1999							•	
Paterula circina HAVLÍČEK, 1982								•
Ferrobolus catharinus HAVLÍČEK, 1982	•							
Schizocrania salopiensis (WILLIAMS, 1974)							•	•
Orbiculoidea sp.								•
Acrosaccus cf. *posteroconvexus* (COOPER, 1956)								•
Eoschizotreta veterna sp. n.				•				
Schizotreta prilepensis sp. n.								•
Schizotreta sp.							•	

Species	Třenice Formation	Mílina Formation	Klabava Formation				Šárka Formation	Dobrotivá Formation
			O	C	H	A		
Orbithele discontinua MERGL, 1981	•							
Orbithele secedens (BARRANDE, 1879)	•							
Orbithele maior MERGL, 1981		•						
Orbithele undulosa (BARRANDE, 1879)			•	•				
Orbithele rimosa MERGL, 1981					•	•		
Acrotreta grandis KLOUČEK, 1919	•	•						
Acrotreta foetida sp. n.			•					
Acrotreta scabra sp. n.					•	•		
Cyrtonotreta osekensis sp. n.							•	
Dactylotreta prisca sp. n.	•	•	•					
Acrotretidae gen. et. sp. indet.			•					
Mamatia retracta (POPOV, 1980)			•					
Numericoma vulcanogena MERGL, 1996						•		
Numericoma campanula sp. n.							•	
Pomeraniotreta holmeri MERGL, 1995			•					
Eoconulus gemmatus MERGL, 1995			•					
Eoconulus commutabilis sp. n.						•		
Acanthambonia klabavensis HAVLÍČEK, 1982						•		
Celdobolus mirandus (BARRANDE, 1879)	•		•	•				
Celdobolus complexus (BARRANDE, 1879					•	•		
Collarotretella septata MERGL, 1997				•				
Eosiphonotreta krafti (RŮŽIČKA, 1927)	•		•					
Eosiphonotreta verrucosa (EICHWALD, 1840)					•	•		
Siphonobolus simulans (RŮŽIČKA, 1927)	•							
Siphonotretella filipi sp. n.		•	•					
Schizambon (?) sp.							•	
Kolihium kolihai (RŮŽIČKA, 1927)	•							
Kolihium sp.			•					
Lacunites walcotti (RŮŽIČKA, 1927)	•							
Lacunites sp.				•				
Petrocrania caputium sp. n.		•						
Petrocrania sp.	•							

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Explanation of plates

All photographs by author.

PLATE 1

Pseudolingula (?) *trimera* (BARRANDE, 1879). Dobrotivian, Dobrotivá Formation, siliceous nodule. Locality: Malé Přílepy (field).

1, 3, 5, 6, 8. Ventral valve, latex cast of exterior (1), oblique view of ventral apex (3), oblique view (5), detail of ornamentation on left flank (6, 8); NM L 36710a; ×6, ×21, ×11, ×25, and ×100.

2. Dorsal valve, internal mould showing vestigial pseudointerarea; NM L 36711; ×10.

4. Dorsal valve, incomplete internal mould; NM L 36710b; ×10.

Sedlecilingula sulcata MERGL, 1997. Lower Arenigian, Klabava Formation, *Corymbograptus v-similis* Biozone, brown-violet shale. Locality: Sedlec (gorge).

7. Ventral valve, latex cast of exterior; MBHR 66838; ×6.5.
9. Dorsal valve, latex cast of exterior; MBHR 66840; ×6.5.
10, 14. Holotype, ventral valve, figured by Mergl (1997d: fig. 4: A, B, I), internal mould (14) and detail of pseudointerarea (10); MBHR 66837; ×12, ×9.
12, 13. Ventral valve, internal mould and latex cast of exterior; ČGÚ MM 011; ×6.5, ×6.5.

Ectenoglossa sp. Dobrotivian, Dobrotivá Formation, sandy shale above the Skalka Quartzite. Locality: Praha-Dubeček.
11. Deformed valve; MBHR 23108 (coll. V. Havlíček; VH 3173); ×1.8.

PLATE 2

"*Lingula" distincta* BARRANDE, 1879. Probably Arenigian, Klabava Formation; clayey shale. Locality: Krušná hora.
1. Fragment of the shell, figured by Barrande (1879: pl. 104, case V, fig. 1); SBNM L 18192; ×8.3.

Expellobolus expulsus (BARRANDE, 1879). Upper Tremadocian, Třenice Formation, coarse greywacke. Localities: Krušná hora (2–4, 6–7), Zbiroh (Bukov, old quarries) (5).
2. Dorsal valve, internal mould; MBHR 21861 (coll. V. Havlíček; VH 3092); ×2.5.
3. Dorsal valve, internal mould; MBHR 21860 (coll. V. Havlíček; VH 3091); ×2.5.
4. Dorsal valve with original shell; MBHR 21939 (coll. V. Havlíček; VH 3130); ×2.5.
5. Dorsal valve, detail of pseudointerarea with original shell; NM L 28821; ×7.0.
6. Paralectotype, dorsal valve with original shell; figured by Barrande (1879: pl. 110, case VIII, fig. 4); NM L 18144; ×2.5.
7. Dorsal valve with original shell; NM L 30790; ×2.5.

Leptembolon insons (BARRANDE, 1879). Upper Tremadocian, Třenice (8–15) and Mílina Formations (16), chert (8, 9, 16), haematite (10, 14, 15), greywacke (11–13). Localities: Jivina (old quarries, horizon with *Thysanotos primus*) (8–9), Holoubkov (V Ouzkém) (10, 14, 15), Skomelno (Na Solích) (11–13), Kváň (field; horizon with *Thysanotos siluricus*) (16).
8, 9. Dorsal valve, internal mould and latex cast of exterior; PCZCU 530; ×6.5, ×9.
10. Ventral valve, internal mould; MBHR 23393 (coll. V. Havlíček; VH 3093a); ×6.2.
11. Ventral valve, detail of posterior, internal mould; PCZCU 531; ×8.0.
12. Dorsal valve, detail of posterior, internal mould; PCZCU 532a; ×8.0.
13. Ventral valve, detail of posterior, internal mould; PCZCU 533; ×8.0.
14. Minute, probably dorsal valve, internal mould; MBHR 23394 (coll. V. Havlíček; VH 3093c); ×6.2.
15. Minute, probably ventral valve, internal mould; MBHR 23395 (coll. V. Havlíček; VH 3093b); ×6.2.
16. Ventral valve, internal mould; MBHR 21998 (coll. V. Havlíček; VH 3217d); ×6.2.

PLATE 3

Leptembolon insons (BARRANDE, 1879). Upper Tremadocian, Mílina Formation (1–6), chert (1–6). Locality: Kváň (field; horizon with *Thysanotos siluricus*).
1. Ventral valve, internal mould with well defined visceral area; MBHR 21995 (coll. V. Havlíček; VH 3217a); ×7.0.
2. Ventral valve, detail of pseudointerarea; MBHR 21997 (coll. V. Havlíček; VH 3217c); ×7.0.
3. Dorsal valve, internal mould; PCZCU 534; ×6.2.
4, 5. Dorsal valve, internal mould; PCZCU 535; ×6.2.
6. Ventral valve, latex cast of exterior; PCZCU 536; ×6.2.

Leptembolon testis (BARRANDE, 1879). Lower Arenigian, Klabava Formation, lower part, Olešná Beds Member; red-brown siltstone and greywacke (7–14); Localities: Strašice (field near St. Vojtěch) (7), Strašice (east) (9, 10), Těně (west) (8, 11–14).
7. Ventral valve, internal mould; PCZCU 537; ×6.2.
8. Ventral valve, internal mould; PCZCU 538; ×5.5.
9. Ventral valve, latex cast of internal mould; ČGÚ MM 395; ×5.5.
10. Dorsal valve, latex cast of internal mould; ČGÚ MM 394; ×5.5.
11. Ventral valve, internal mould; PCZCU 539; ×5.5
12, 13. Dorsal valve showing larval shell in dorsal and oblique views; PCZCU 540; ×47, ×50.
14. Shell fragment showing concentric lines; PCZCU 541; ×130.

PLATE 4

Libecoviella arachne (BARRANDE, 1879). Upper Tremadocian, Třenice Formation, siltstone. Locality: Libečov (Na Močidle).
1. Dorsal valve, latex cast of exterior; NM L 32018; ×4.0.
2. Dorsal valve with original shell; MBHR 21746 (coll. V. Havlíček; VH 2992); ×4.0.
3, 6. Dorsal valve in dorsal and oblique views showing terminal vascular canals; MBHR 21856 (coll. V. Havlíček; VH 3088); ×4.0, ×4.0.
4. Incomplete ventral valve with original shell; NM L 32021; ×4.0.
5. Small ventral valve; NM L 32017; ×4.0.

Libecoviella ovata (HAVLÍČEK, 1982). Upper Tremadocian, Třenice Formation, conglomerate. Locality: Zbiroh (Bukov, old dump).
7. Fragment of ventral valve, internal mould; NM L 32029c; ×8.0.
8. Dorsal valve with original shell showing striation of intervascular ridges; NM L 32027; ×3.5.
9. Latex cast of exterior, probably ventral valve; NM L 32025; ×9.0.
10. Ventral valve, internal mould; NM L 32030; ×8.0.
11. Ventral valve showing vascula lateralia, internal mould; NM L 32033; ×7.0.

PLATE 5

Lingulella lata KOLIHA, 1924. Lower Arenigian, Klabava Formation, Olešná Beds Member, red-brown siltstone. Localities: Strašice (field near St. Vojtěch) (1–5, 7), Cerhovice (Cerhovská hora Hill) (6).
1. Ventral valve, internal mould; MBHR 66835; ×9.5.
2. Complete specimen, internal mould; PCZCU 542; ×9.5.
3, 7. Dorsal valve, internal mould and latex cast of exterior; MBHR 66833; ×9.5.
4, 5. Ventral valve, internal mould and latex cast of exterior; MBHR 66834; ×12, ×12.
6. Holotype, complete specimen, latex cast of exterior; figured by Koliha (1924: pl. 2, figs 10, 11), NM L 18190; ×6.0.

Lithobolus plebeius MERGL, 1996. Upper Arenigian, Klabava Formation, upper part, *Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone, tuffaceous shale. Localities: Zbiroh (Bukov, Joseph gallery) (10, 11, 13, 14), Ejpovice (9, 12).

8. Ventral valve, internal mould; PCZCU 543; ×6.5.
9, 12. Ventral valve, internal mould and latex cast of exterior; MBHR 66787; ×6.5.
10. Holotype, ventral valve, internal mould, figured by Mergl (1996: pl. 1, fig. 3); MBHR 66789; ×6.5.
11. Dorsal valve, internal mould with remains of original shell; MBHR 66784; ×6.5.
13. Dorsal valve interior; MBHR 66785; ×6.5.
14. Ventral and dorsal valves valve, internal moulds; MBHR 66788; ×6.5.

PLATE 6

Paldiskites peracutus sp. n. Llanvirnian, Šárka Formation, siliceous nodule. Localities: Osek (1, 7), Rokycany (2, 4), Mýto (3).
1. Ventral valve, internal mould; MBHR 5789; ×6.5.
2. Ventral valve, internal mould; MBHR 1422; ×6.5.
3. Holotype, ventral valve, internal mould; PCZCU 545; ×6.5.
4. Dorsal valve, internal mould; MBHR 1408; ×6.5.
7. Ventral valve, internal mould; PCZCU 543; ×6.5.

Apatobolus sp. Dobrotivian, Dobrotivá Formation, siliceous nodule. Locality: Malé Přílepy (field).
5, 8. Dorsal valve, internal mould and latex cast of exterior; NM L 36712; ×7.5, ×14.

Pidiobolus (?) sp.: Dobrotivian, Dobrotivá Formation, siliceous nodule. Locality: Malé Přílepy (field).
6. Dorsal valve with remains of original shell; MBHR 23153 (coll. V. Havlíček; VH 3407); ×10.

Paldiskites sulcatus (BARRANDE, 1879). Arenigian, Klabava Formation, *Corymbograptus v-similis* Biozone, siderite (11), *Hologratus tardibrachiatus* Biozone, clayey shale (10), *Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone, clayey shale (9, 12–18). Localities. Sedlec (village) (9), Rokycany (Stráň, gully) (10), Starý Plzenec (Kocanda) (11), Klabava (Old Castle) (12–18).
9. Detail of ventral pseudointerarea, internal mould; PCZCU 546; ×8.0.
10. Detail of dorsal pseudointerarea, internal mould, MBHR 22780 (coll. V. Havlíček; VH 3150b); ×5.0.
11. Ventral valve with partly preserved shell; PCZCU 548; ×6.2.
12. Ventral valve, internal mould, MBHR 21968 (coll. V. Havlíček, VH 3152b); ×5.0.
13. Complete shell, internal and external mould, MBHR 21967 (coll. V. Havlíček; VH 3152a); ×5.0.
14. Juvenile ventral valve, internal mould; PCZCU 550a; ×6.2.
15. Juvenile dorsal valve, internal mould; PCZCU 550b; ×6.2.
16, 17. Dorsal valve, internal mould and latex cast of exterior; PCZCU 549; ×6.5, ×6.2.
18. Juvenile dorsal valve, internal mould; PCZCU 550c; ×6.2.

PLATE 7

Teneobolus bukovensis (KOLIHA, 1924). Upper Tremadocian, Třenice Formation, basal beds, greywacke with haematite cement (1–4, 6); Mílina Formation, chert (5). Localities: Zbiroh (Bukov, old quarries) (1–4, 6), Zaječov (quarry near the school building) (5).
1. Ventral valve, internal mould; NM L 18197; ×9.0.
2. Holotype, ventral valve, internal mould, figured by Koliha (1924: pl. 2, fig. 8); NM L 18231; ×9.0.
3. Latex cast of exterior, probably dorsal valve; NM L 36713; ×9.0.
4. Latex cast of exterior, probably ventral valve; NM L 36714; ×9.0.
5. Ventral valve, internal mould; ČGÚ MM 508; ×10.
6. Latex cast of exterior, probably dorsal valve; NM L 36715; ×9.0.

Teneobolus gracilis MERGL, 1995: Lower Arenigian, Klabava Formation, Olešná Beds Member, red-brown shales and greywacke. Localities: Strašice (field near St. Vojtěch) (7, 8, 11, 14, 15), Těně (west) (9, 11–13).
7, 8, 10. Holotype, complete shell, latex cast of interior (7), latex cast of exterior (8) and internal mould (10), figured by Mergl (1995: fig. 7); ČGÚ MM 512; ×10, ×10, ×11.
9. Ventral valve interior; MBHR 65881; ×45.
11, 13. Juvenile, probably dorsal shell; PCZCU 551; ×55, ×65.
12. Ventral valve pseudointerarea, oblique view; PCZCU 552; ×60.
14, 15. Ventral valve, internal mould and its latex cast; ČGÚ MM 511; ×10, ×10.

PLATE 8

Westonisca lamellosa (BARRANDE, 1879). Upper Tremadocian, Třenice Formation, siltstone. Locality: Libečov (Na Močidle).
1. Ventral valve, internal mould; MBHR 66901; ×4.0.
2. Ventral valve, internal mould; MBHR 66898; ×4.0.
3. Dorsal valve, MBHR 99896; ×4.0.
4. Dorsal valve, internal mould; MBHR 66899; ×4.0.
5. Ventral valve, latex cast of exterior; MBHR 66896; ×4.0.
6. Detail of intervascular ridges along shell periphery; NM L 37007; ×10.

Josephobolus regificus MERGL, 1997. Upper Arenigian, Klabava Formation, upper part, *Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone, tuffaceous shale. Locality: Zbiroh (Bukov, Joseph gallery).
7, 8. Ventral valve, internal mould with partly preserved shell, detail of pseudointerarea (7) and entire shell (8); MBHR 66781; ×6.0, ×3.7.
9. Holotype, ventral valve, external mould with preserved shell, showing deep davisate pits, figured by Mergl (1997b: fig. 8); MBHR 66892; ×5.8.
10. Fragment of shell with terrace lines; MBHR 66893; ×8.0.

Westonia sp. A. Dobrotivian, Dobrotivá Formation, siliceous nodule. Locality: Malé Přílepy (field).
11. Poorly preserved internal mould, probably dorsal valve; NM L 36716a; ×10.
12. Dorsal valve, internal mould; NM L 36717; ×17.
13. Probably ventral valve, latex cast of exterior; NM L 36716b; ×15.

Westonia sp. B. Arenigian, Klabava Formation, siderite hyaloclastites of the Komárov volcanogenic complex. Locality: Malá Víska (Hlava mine).
14. Dorsal valve, external mould with partly preserved shell; PCZCU 554; ×5.0.

PLATE 9

Mytoella krafti gen. et sp. n. Llanvirnian, Šárka Formation, siliceous nodules. Localities: Osek (1–4, 8–10, 12, 15, 18), Mýto (St. Stephen pond) (5–7, 13, 14, 16, 17, 19, 20), Rokycany (11).
1. Dorsal valve, internal mould; PCZCU 555; ×6.4.
2. Dorsal valve, exterior; PCZCU 556; ×7.8.
3, 4, 12, 15, 18. Holotype, ventral valve, internal mould (3), external mould (4), detail of pseudointerarea (12), latex cast of exterior (15, 18); PCZCU 557; ×10, ×10, ×13, ×32, ×22.

5, 6. Ventral valve, detail of pseudointerarea in oblique (5) and ventral (6) views; PCZCU 561; ×32, ×24.
7. Ventral valve, interior; PCZCU 562; ×40.
8. Dorsal valve with remains of shell; PCZCU 558; ×7.8.
9. Dorsal valve exterior; PCZCU 559; ×7.8.
10. Two ventral valves, exterior; PCZCU 560a (right), PCZCU 560b (left specimen); ×7.8.
11. Dorsal valve, internal mould, detail of pseudointerarea; MBHR 1406; ×7.8.
14. Dorsal valve, detail of pseudointerarea; PCZCU 564; ×50.
16. Ventral valve posterior, oblique view; PCZCU 565; ×60.
17, 19. Ventral valve, exterior of apical part with larval shell in dorsal (17) and oblique (19) views; PCZCU 566; ×65, ×55.
20. Detail of ornamentation in posterior part of shell; PCZCU 567; ×40.

PLATE 10

Wosekella debilis (BARRANDE, 1879). Llanvirnian, Šárka Formation, siliceous nodule. Localities: Mýto (field) (1, 3, 4), Těškov (field) (2), Osek (field) (5–10, 12), Rokycany (11).
1. Juvenile dorsal valve, latex cast of exterior; PCZCU 568; ×7.8.
2. Juvenile ventral valve with partly preserved shell; PCZCU 569; ×7.8.
3, 4. Juvenile dorsal valve, latex cast of exterior and internal mould; PCZCU 570; ×7.8, ×7.8.
5. Ventral valve, internal mould; PCZCU 571; ×7.8.
6. Dorsal valve, internal mould; PCZCU 572; ×7.8.
7. Ventral valve, latex cast of exterior; PCZCU 573; ×7.8.
8. Ventral valve, latex cast of exterior; PCZCU 574; ×7.8.
9, 10. Dorsal valve and ventral valve of the same specimen, internal moulds; PCZCU 575a (9) and PCZCU 575b (10); ×7.8, ×7.8.
11. Ventral valve, internal mould; MBHR 1420; ×7.8.
12. Detail of ornamentation in ventral valve anterior in oblique view; PCZCU 577; ×30.

Wosekella senilis gen. et sp. n. Dobrotivian, Dobrotivá Formation, siliceous nodule. Localities: Malé Přílepy (field) (13), Praha-Vokovice (14, 15).
13. Ventral valve, latex cast of exterior; NM L 36718; ×7.2.
14. Dorsal valve, internal mould; NM L 36719; ×7.2.
15.Ventral valve with partly preserved shell; NM L 36720; ×7.2.

PLATE 11

Wosekella filiola gen. et sp. n. Arenigian, Klabava Formation, *Corymbograptus v-similis* Biozone, red-brown shale (2), *Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone, clayey shale (6, 7). Localities. Klabava (Old Castle) (1, 6, 7), Sedlec (gorge) (2).
1, 6. Holotype, ventral valve, internal mould and latex cast of exterior; PCZCU 578; ×7.2, ×7.2.
2. Ventral valve, latex cast of exterior; MBHR 66836; ×8.0.
7. Ventral valve, latex cast of external mould; PCZCU 582; ×7.2.

Mytoella pusilla (ŽELÍZKO, 1921). Arenigian, Klabava Formation, *Corymbograptus v-similis* Biozone, red-brown shale (5), *Hologratpus tardibrachiatus* Biozone, clayey shale (10), *Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone, clayey shale (3, 4, 8, 9). Localities: Klabava (Old Castle) (3, 4, 8, 9), Sedlec (gorge) (5), Starý Plzenec (U Blažeje) (10).
3, 4. Dorsal valve, internal mould and latex cast of exterior; PCZCU 579; ×8.2, ×8.2.
5. Dorsal valve, latex cast of exterior; PCZCU 580; ×8.2.
8, 9. Dorsal valve, internal mould and latex cast of exterior; PCZCU 581; ×8.2, ×8.2.
10. Holotype, dorsal valve, internal mould with partly preserved shell, figured by Želízko (1921: pl. 1, figs 8, 9); NM L 18215; ×9.0.

Spondyglossella spondylifera HAVLÍČEK, 1980. Arenigian, Klabava Formation, *Corymbograptus v-similis* Biozone, red-brown shale. Locality: Sedlec (gorge).
11. Dorsal valve, internal mould; MBHR 66831; ×12.
12. Dorsal valve, internal mould; MBHR 33832; ×12.
13. Ventral valve, internal mould; MBHR 66829; ×12.
14, 15, 17. Ventral valve, internal mould (14), detail of posterior (15) and latex cast of exterior (17); MBHR 66830a; ×12, ×18, ×12.
16. Dorsal valve, internal mould; MBHR 66830b; ×12.

Spondyglossella sp. Llanvirnian, Šárka Formation, clayey shale. Locality: Praha-Vokovice (excavation).
18. Complete specimen with partly preserved shell; ZČM S 01747, ×5.2.

PLATE 12

Rafanoglossa impar (BARRANDE, 1879). Dobrotivian, Dobrotivá Formation, siliceous nodule. Localities: Rokycany (1–5, 8, 10), Praha-Vokovice (7), Malé Přílepy (field) (6, 9), Kařízek (Veronika mine) (13).
1–5, 8, 10. Dorsal valve, latex cast of exterior in dorsal (1) and oblique (2) views, detail of apex (3, 4), posterior margin (5), detail of ornamentation (8) and concentric fila in anteromedian part of the shell (10); MBHR 1407; ×8.0, ×10, ×30, ×12, ×15, ×20, and ×50.
6. Ventral valve, detail of pseudointerarea; NM L 36721; ×10.
7. Ventral valve, latex cast of exterior; NM L 36722; ×8.0.
9. Dorsal valve, internal mould showing crescentic scar in umbonal chamber; NM L 36723; ×10.
13. Dorsal valve, internal mould; MBHR 23122 (coll. V. Havlíček; VH 3205); ×6.5.

Rafanoglossa platyglossa HAVLÍČEK, 1982. Arenigian, Klabava Formation, *Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone, clayey shale (11, 12, 14–16). Locality: Klabava (Old Castle) (11, 12, 14–16).
11. Complete shell, internal mound of ventral valve and external mould of dorsal valve; PCZCU 583; ×5.0.
12. Dorsal valve, latex cast of exterior; PCZCU 584; ×6.0.
14. Dorsal valve, with part with partly preserved shell; PCZCU 585; ×5.0.
15. Dorsal valve, internal mould; PCZCU 586; ×5.0.
16. Dorsal valve, latex cast of exterior; PCZCU 587; ×8.0.

PLATE 13

Elliptoglossa celdai MERGL, 1995. Lower Arenigian, Klabava Formation, Olešná Beds Member, clay clasts in siltstone. Locality: Těně (west).
1. Ventral valve, internal mould; MBHR 65888; ×25.
2. Ventral valve, internal mould; MBHR 65889; ×25.
3. Dorsal valve, internal mould; MBHR 65887; ×25.
4. Ventral valve, internal mould; MBHR 65890; ×25.
5, 9. Dorsal (?) valve exterior; dorsal and oblique views; PCZCU 588; ×47, ×50.
6. Ventral (?) valve exterior; PCZCU 589; ×47.

7, 8. Ventral valve exterior; oblique and ventral views; PCZCU 590; ×55, ×47.
10. Ventral valve, oblique view; PCZCU 591; ×50.
11, 16. Ventral valve exterior, oblique and ventral views; PCZCU 592; ×65, ×50.
12, 13. Ventral valve interior; PCZCU 593; ×75, ×50.
14. Ventral valve interior, oblique view; PCZCU 594; ×55.
15. Ventral valve interior, oblique view; PCZCU 595; ×50.
17. Dorsal valve interior, oblique view; PCZCU 596; ×55.
18. Ventral valve interior, oblique view; PCZCU 597; ×80.
19. Ventral valve interior, oblique view; PCZCU 598; ×45.

PLATE 14

Elliptoglossa celdai MERGL, 1995. Lower Arenigian, Klabava Formation, Olešná Beds Member, clay clasts in siltstone. Locality: Těně (west).
1. Ventral valve, oblique view; PCZCU 599; ×50.

Leptembolon testis (BARRANDE, 1879). Lower Arenigian, Klabava Formation, lower part, Olešná Beds Member; clay clasts in siltstone. Locality: Těně (west).
2. Detail of shell surface in oblique view; PCZCU 787; ×90.

Paterula prima KLOUČEK, 1924. Arenigian, Klabava Formation, upper part, brown-violet shale. Locality: Mýto (St. Stephen pond).
3. Ventral valve, internal mould; MBHR 85192; ×23.
4. Ventral valve, internal mould; MBHR 85191; ×23.
5. Ventral valve interior; MBHR 85189; ×23.
6. Ventral valve interior; MBHR 85190; ×23.
7. Dorsal valve exterior; MBHR 85195; ×23.
8. Ventral valve exterior; MBHR 85204; ×23.
9. Neotype, dorsal valve exterior, figured Mergl (1999b: fig.4: 6); MBHR 85193; ×23.
10. Dorsal valve exterior; MBHR 85194; ×23.

Paterula incognita MERGL, 1999. Llanvirnian, Šárka Formation, siliceous nodule. Localities: Díly (field) (11–13), Rokycany (14).
11. Ventral valve, internal mould; MBHR 12634; ×17.
12. Ventral valve, internal mould; MBHR 12873; ×17.
13. Holotype, ventral valve, internal mould, figured by Mergl (1999b: figs 4: 15, 16); MBHR 8870; ×17.
14. Dorsal valve, internal mould; MBHR 8930; ×17.

Paterula circina HAVLÍČEK, 1982. Dobrotivian, Dobrotivá Formation, siderite (15–20), black shale (21). Localities: Kařízek (Veronika mine) (15–20), Sedlec (village) ×21.
15. Dorsal valve, latex cast of exterior; MBHR 85268a; ×11.
16. Ventral valve, internal mould; MBHR 85268b; ×15.
17. Ventral valve, internal mould; MBHR 85268c; ×15.
18. Ventral valve, latex cast of interior; MBHR 85268d; ×11.
19, 20. Dorsal valve, latex cast of interior and its internal mould, MBHR 85268e; ×11, ×15.
21. Dorsal valve, internal mould; MBHR 85202; ×15.

PLATE 15

Fagusella indelibata MERGL, 1996. Arenigian, Klabava Formation, upper part, *Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone, tuffaceous shale. Locality: Zbiroh (Bukov, Joseph gallery).
1, 4. Incomplete dorsal (?) valve, oblique and dorsal views; PCZCU 600; ×19, ×15.
2. Incomplete dorsal (?) valve, oblique view; MBHR 66798; ×35.
3, 7. Fragment of dorsal valve in ventral and oblique views; PCZCU 602; ×19, ×24.
5. Dorsal valve exterior in posterolateral view; PCZCU 601; ×19.
6. Dorsal valve interior; MBHR 66799; ×20.
8. Ventral valve exterior; MBHR 66793; ×10.
9. Dorsal valve, internal mould; MBHR 66792; ×10.
10. Dorsal valve, internal mould; MBHR 66794; ×10.
11. Dorsal valve, internal mould; MBHR 66793; ×10.
12. Holotype, ventral valve interior, figured by Mergl (1996: pl. 2, fig. 11); MBHR 66790; ×10.
13, 14. Ventral valve interior and internal mould; MBHR 66790; ×10.

Rosobolus magnus sp. n. Upper Tremadocian, Třenice Formation, greywacke. Locality: Cheznovice (Žlebec).
15. Ventral valve, latex cast of exterior; PCZCU 603a; ×2.7.
16. Holotype, ventral valve, internal mould; PCZCU 603b; ×2.7.
17. Dorsal valve, internal mould; PCZCU 604; ×2.7.

PLATE 16

Hyperobolus feistmanteli (BARRANDE, 1879). Upper Tremadocian, Třenice Formation, coarse greywacke. Localities: Krušná hora (1, 2, 6, 7, 8), Drozdov (Obiš Hill) (3, 4), Drozdov (Holý vrch Hill) (5).
1. Dorsal valve, internal mould with remains of shell; MBHR 22780 (coll. V. Havlíček; VH 3130b); ×2.
2. Dorsal valve, internal mould with remains of shell; MBHR 21941 (coll. V. Havlíček; VH 3131b); ×2.
3. Ventral valve, internal mould; MBHR 21965 (coll. V. Havlíček; VH 3144b); ×2.
4. Dorsal valve, internal mould; MBHR 21964 (coll. V. Havlíček; VH 3144a); ×2.
5. Ventral valve, internal mould; MBHR 21945 (coll. V. Havlíček; VH 3133b); ×2.
6. Ventral valve, internal mould with remains of shell; MBHR 21938 (coll. V. Havlíček; VH 3129); ×2.
7. Dorsal valve showing muscle impressions and pallial markings; MBHR 21940 (coll. V. Havlíček; VH 3131a); ×3.7.
8. Ventral valve showing pallial markings and intervascular ridges; MBHR 21941 (coll. V. Havlíček; VH 3131c); ×3.7.

PLATE 17

Pidiobolus minimus MERGL, 1995. Lower Arenigian, Klabava Formation, Olešná Beds Member, clay clasts in siltstone. Locality: Těně (west).
1, 4. Ventral valve, interior in dorsal and oblique views; PCZCU 605; ×55, ×80.
2, 3. Ventral valve, interior in dorsal and oblique views; PCZCU 606; ×65, ×85.
5, 12, 14. Ventral valve, exterior, detail of posterior part in oblique view and detail of microornamentation in anterior part; PCZCU 607; ×65, ×140, ×300.
6, 8. Dorsal valve, exterior and oblique views; PCZCU 608; ×65, ×80.
7, 13. Ventral valve, interior in oblique view and detail of pseudointerarea; PCZCU 609; ×85, ×160.
9. Ventral valve, exterior in anterolateral view; PCZCU 610; ×90.
11. Dorsal valve, exterior in posterolateral view showing two nodes in larval shell; PCZCU 611; ×85.

PLATE 18

Rosobolus robertinus HAVLÍČEK, 1982b. Upper Tremadocian, Třenice Formation, haematite. Locality: Holoubkov (V Ouzkém).

1. Ventral valve, internal mould; MBHR 21833 (coll. V. Havlíček; VH 3064b); ×6.5.
2. Ventral valve, internal mould; MBHR 21832 (coll. V. Havlíček; VH 3064a); ×6.5.
3. Ventral valve, internal mould; MBHR 21466 (coll. V. Havlíček; VH 705a); ×6.5.
4. Ventral valve, internal mould; NM L 36725; ×5.0.
5. Ventral valve, internal mould; MBHR 21467 (coll. V. Havlíček; VH 706a); ×5.4.
6, 7, 10, 13. Ventral valve, latex cast of exterior in oblique and dorsal views, shell surface with microornamentation (10) and detail of pitting (13); MBHR 21463 (coll. V. Havlíček; VH 703); ×9.5, ×10, ×105, ×350.
8. Ventral valve exterior; NM L 36724; ×5.0.

Rosobolus cf. *robertinus* HAVLÍČEK, 1982b. Lower Arenigian, the base of the Klabava Formation, Olešná Beds Member, red-brown greywacke. Locality: Zaječov (quarry near the school building).
11. Ventral valve, internal mould; ČGÚ MM 268; ×4.0.

Rosobolus sp. Upper Arenigian, Klabava Formation, upper part. Locality: Kleštěnice (Stanislav mine).
9, 12. Ventral valve, internal and external moulds with partly preserved shell; PCZCU 612; ×8.5.

PLATE 19

Rowellella distincta BEDNARCZYK et BIERNAT, 1978. Lower Arenigian, Klabava Formation, Olešná Beds Member, red-brown siltstone and shale. Locality: Těně (west).
1–3. Dorsal valve, latex cast of exterior (1), internal mould in dorsal (2) and anterodorsal (3) views; ČGÚ MM 198; ×38, ×38, ×38.
8. Dorsal valve exterior; PCZCU 613; ×70.
9. Dorsal valve exterior; PCZCU 614; ×55.
10. Dorsal valve exterior in anterolateral view showing convexity; PCZCU 615; ×70.
14. Dorsal valve exterior in anterolatral view; PCZCU 616; ×50.
15. Dorsal valve exterior; PCZCU 617; ×60.
16. Dorsal valve exterior; PCZCU 619; ×55.
17, 20. Dorsal valve exterior and detail of anterior lamellae with oblique folds; PCZCU 618; ×50, ×130.
18, 19. Dorsal valve exterior in dorsal and oblique views; PCZCU 620; ×45, ×50.

Rowellella sp. B. Llanvirnian, Šárka Formation, siliceous nodule. Locality: Díly (field).
4–6. Dorsal valve, latex cast of exterior (4), external mould (5) and internal mould (6); MBHR 15667; ×20.

Rowellella sp. A. Lower Arenigian, Klabava Formation, lower part, red-brown siltstone. Locality: Hrádek (gorge).
7. Dorsal valve, external mould; MBHR 66843; ×20.
11. Dorsal valve, internal mould; MBHR 66841; ×20.
12. Dorsal valve, external mould; MBHR 66842; ×20.
13. Dorsal valve, external mould; PCZCU 618; ×20.

PLATE 20

Thysanotos siluricus (EICHWALD, 1840). Upper Tremadocian, Mílina Formation, chert. Localities: Kváň (field) (1–8), Březany II ("Na Chrástnici" Quarry) (9).
1, 4. Ventral valve, internal mould and latex cast of exterior; ČGÚ MM 440; ×3.0, ×3.0.
2, 3. Ventral valve, internal mould and its latex cast; ČGÚ MM 404; ×3.0, ×3.0.
5, 7. Dorsal valve, latex cast of exterior and latex cast of interior, ČGÚ MM 369; ×3.0, ×3.0.
6. Dorsal valve, latex cast of exterior; MBHR 66807; ×3.0.
8. Ventral valve, external mould showing numerous concentric lamellae and large shell size; MBHR 66818; ×3.0.
9. Ventral valve, internal mould; MBHR 21943 (coll. V. Havlíček; VH 3132); ×2.0.

Thysanotos primus (KOLIHA, 1924). Upper Tremadocian, Třenice Formation, upper part. Locality: Jivina (old quarries).
10. Ventral valve, external mould; MBHR 66812; ×3.5.
11. Ventral valve, latex cast of exterior; MBHR 66814; ×3.5.

Hyperobolus feistmanteli (BARRANDE, 1879). Upper Tremadocian, Třenice Formation, coarse greywacke with haematite cement (12) and haematite (13, 14). Localities: Zbiroh (Bukov, old quarries) (12), Holoubkov (V Ouzkém) (13, 14).
12. Juvenile ventral valve, latex cast of exterior; NM L 36726; ×8.5.
13. Medium-sized specimen, latex cast of exterior and internal mould; PCZCU 621; ×3.5, ×3.5.

PLATE 21

Elkania lineola (HAVLÍČEK, 1982). Arenigian, Klabava Formation, *Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone, clayey shale (1), tuffaceous red-brown shale (2, 3). Localities: Klabava (Old Castle) (1), Zbiroh (Bukov, Joseph gallery) (2), Ejpovice (quarry, NE part) (3).
1. Holotype, ventral valve, internal mould with partly preserved shell, figured by Havlíček (1982b: pl. 15, figs, 1, 3); MBHR 22775 (coll. V. Havlíček; VH 3134); ×4.2.
2. Ventral valve exterior; MBHR 66779; ×5.5.
3. Ventral valve, internal mould; MBHR 66783; ×5.5.

Elkania praelineola sp. n. Arenigian, Klabava Formation, *Corymbograptus v-similis* Biozone (5, 6, 8, 10, 11), *Holograptus tardibrachiatus* Biozone (4, 7), siderite (5, 6, 8, 10, 11), clayey shale (4, 7). Localities: Rokycany (Stráň, gully) (4, 7), Starý Plzenec (Kocanda) (5, 6, 8, 10, 11).
4, 7. Ventral valve, internal and external moulds; MBHR 4993; ×4.4, ×4.2.
5. Holotype, ventral valve, internal mould; MBHR 21946 (coll. V. Havlíček; VH 3135); ×4.2.
6. Fragment of valve showing ornamentation; MBHR 65774; ×8.5.
8, 10. Ventral valve, internal mould and detail of pseudointerarea; MBHR 21947 (coll. V. Havlíček; VH 3136); ×4.2, ×8.0.
11. Fragment of dorsal valve, interior showing muscle platform and divergent vascula media; MBHR 65775; ×8.0.

Broeggeria ferraria sp. n. Upper Tremadocian, Třenice Formation, haematite. Locality: Holoubkov (V Ouzkém).
9. Dorsal valve, internal mould with partly preserved shell; MBHR 22016 (coll. V. Havlíček; VH 3249); ×7.2.
12. Dorsal valve exterior; MBHR 21863 (coll. V. Havlíček; VH 3095); ×7.2.
13. Dorsal valve, internal mould; NM L 36727; ×7.2.
14. Holotype, dorsal valve, internal mould; NM L 36728; ×7.2.
15. Dorsal valve, internal mould; MBHR 22017 (coll. V. Havlíček; VH 3250); ×7.2.

PLATE 22

Elkanisca obesa (HAVLÍČEK, 1980). Upper Tremadocian, Třenice Formation, greywacke with siderite cement (1, 3–5), haematite (2, 6); Lower Arenigian, Klabava Formation, Olešná Beds Member, red-brown siltstone (7, 8). Localities: Skomelno (Na Solích) (1, 3–5), Holoubkov (V Ouzkém) (2, 6), Těně (west) (7, 8).

1. Dorsal valve, external mould; MBHR 65774; ×6.0.
2, 6. Dorsal valve, external mould showing microornamentation and internal mould with remain of shell; NM L 19198; ×10, ×8.2.
3, 5. Ventral valve, external and internal moulds; MBHR 65773; ×7.0, ×7.0.
4. Ventral valve, internal mould; MBHR 65776; ×6.0.
7. Fragment of shell showing intercalated rugae and microornamentation; PCZCU 622; ×100.
8. Detail of microornamentation; PCZCU 623; ×175.

Elkanisca klouceki (KOLIHA, 1918). Lower Arenigian, Klabava Formation, Olešná Beds Member, red-brown siltstone. Localities: Žebrák (9, 10, 12–14), Cerhovice (11).

9, 10, 12, 13. Holotype, dorsal valve, internal mould (9), external mould (10), detail of visceral area (12) and detail of ornamentation (13), figured by Koliha (1924: pl. 1, figs 11, 12); NM L 18156; ×4.6, ×4.6, ×8.8, ×8.0.
11. Ventral valve, external mould; MBHR 21962 (coll. V. Havlíček; VH 3142); ×4.6.
14. Ventral valve, internal mould; NM L 30674; ×4.6.

PLATE 23

Schizocrania salopiensis (WILLIAMS, 1974). Llanvirnian, Šárka Formation, siliceous nodule (4, 6, 11); Dobrotivian, Dobrotivá Formation, black shale (1, 2, 8), siliceous nodule (7, 10), siderite (3, 5, 9, 12). Localities: Sedlec (village) (1, 2, 8), Kařízek (Veronika mine) (3, 5, 9, 12), Díly (field) (4, 6, 11), Praha-Vokovice (7, 10).

1. Dorsal valve, internal mould; PCZCU 624; ×4.4.
2. Dorsal valve, internal mould; PCZCU 625; ×4.4.
3. Dorsal valve with exfoliated shell; NM L 36782; ×3.2.
4, 11. Dorsal valve, internal mould with rests of shell; PCZCU 626; ×3.2, ×7.5.
5. Two dorsal valves attached to conulariid test, internal moulds with exfoliated shell; NM L 36729; ×3.2.
6. Dorsal valve, internal mould; PCZCU 627; ×3.2.
7, 10. Ventral valve, internal and external moulds; MBHR 23094 (coll. V. Havlíček; VH 1370); ×3.7.
8. Dorsal valve, external mould showing paired muscle scar; PCZCU 628; ×4.4.
9. Dorsal valve with partly exposed ventral valve in situ; NM L 36730; ×3.2.
12. Ventral valve attached to conulariid test, showing radial striation; NM L 36731; ×5.5.

PLATE 24

Eoschizotreta veterna gen. et sp. n. Lower Arenigian, Klabava Formation, lower part, red-brown siltstone. Locality: Hrádek (gorge).

1–3, 7. Holotype, ventral valve, internal mould (1), latex cast of exterior (2), oblique view to cast (3), and detail of shell posterior (7); PCZCU 629; ×11, ×21, ×23, ×55.
4. Dorsal valve, internal mould with rest of shell; PCZCU 630, ×11.
5. Dorsal valve, internal mould with rest of shell; PCZCU 631; ×11.
6. Ventral valve, intwernal mould; PCZCU 632; ×11.

Schizotreta sp. Llanvirnian, Šárka Formation, siliceous nodule. Localities: Osek (field) (8, 9), Pětidomky (10–12).

8, 9. Dorsal valve, internal and external moulds; PCZCU 633; ×10, ×10.
10–12. Dorsal valve, fragment showing rugellae, oblique view to fragment and detail of exterior showing double radial rows of pits; PCZCU 634; ×45, ×52, ×300.

Orbiculoidea sp. Dobrotivian, Dobrotivá Formation, black shale. Locality: Březina (borehole).

13. Complete shell deformed in shale; MBHR 23160 (coll. V. Havlíček; VH 5736); ×6.2.

Schizotreta prilepensis sp. n. Dobrotivian, Dobrotivá Formation, siliceous nodule. Locality: Malé Přílepy (field).

14, 15, 18. Holotype, ventral valve, latex cast of exterior (14), posterolateral view (15) and detail of pedicle slit (18); MBHR 23205 (coll. V. Havlíček; VH 5768); ×14, ×14, ×40.

Acrosaccus cf. *posteroconvexus* (COOPER, 1956). Dobrotivian, Dobrotivá Formation, black shale. Locality: Kozojedy (gallery).

16. Ventral valve, internal mould with remain of shell; MBHR 23203 (coll. V. Havlíček; VH 5766); ×9.0.
17. Dorsal valve, internal mould showing median ridge; MBHR 23204 (coll. V. Havlíček; VH 5767); ×9.0.

PLATE 25

Orbithele discontinua MERGL, 1981. Upper Tremadocian, Třenice Formation, haematite. Locality: Holoubkov (V Ouzkém).

1. Dorsal valve, latex cast of exterior; NM L 36732; ×6.6.
2. Dorsal valve, latex cast of exterior; NM L 36733; ×6.6.
3. Dorsal valve, internal mould; NM L 36734; ×6.6.
4. Dorsal valve, internal mould; NM L 36735; ×6.6
5. Ventral valve, latex cast of exterior; NM L 36736; ×6.6.
6, 11, 13, 14. Ventral valve, latex cast of exterior (6), internal mould (11), view to posterior slope (13), and posterior view to internal mould (14); NM L 36737; ×6.6, ×6.6, ×10, ×6.6.
7. Ventral valve, latex cast of exterior; NM L 36738; ×6.6.
8. Ventral valve, latex cast of exterior; NM L 36739; ×6.6.
9. Ventral valve, internal mould showing pallial markings; NM L 36740; ×8.0.
10. Ventral valve, internal mould; NM L 367341; ×6.6.

Orbithele secedens (BARRANDE, 1879). Upper Tremadocian, Třenice Formation; coarse greywacke (15–17), greywacke with haematite cement (12). Localities: Zbiroh (Bukov, old quarries) (12), Drozdov (Holý vrch Hill) (15, 16), Krušná hora (17).

12. Ventral valve, latex cast of exterior, NM L 36742; ×5.5.
15, 16. Ventral valve, latex cast of exterior and internal mould; NM L 36742; ×3.8, ×3.8.
17. Dorsal valve; NM L 18193; ×3.3.

PLATE 26

Orbithele maior MERGL 1981. Upper Tremadocian, Mílina Formation, chert. Localities: Kváň (field) (1–6, 8–12), Olešná (quarry) (7).

1, 4, 8. Ventral valve, external mould and its latex cast, and internal mould; PCZCU 636; ×6.6, ×6.6, ×6.6.
2. Dorsal valve, internal mould; PCZCU 637; ×6.6.
3. Dorsal valve, internal mould; PCZCU 638; ×6.6.
5, 11. Ventral valve, latex cast of exterior (5) and detail of posterior slope (11); PCZCU 639; ×6.6, ×10.

6. Dorsal valve, internal mould; PCZCU 640; ×6.6.
7. Ventral valve, internal mould; MBHR 21838 (coll. V. Havlíček; VH 3069); ×6.6.
9. Ventral valve, internal mould; PCZCU 642; ×6.6.
10. Dorsal valve, latex cast of exterior; PCZCU 643; ×6.6.
12. Dorsal valve, internal mould; ČGÚ MM 010; ×7.6.

PLATE 27

Orbithele undulosa (BARRANDE, 1879). Lower Arenigian, Klabava Formation, Olešná Beds Member, red-brown siltstone and shales. Localities: Strašice (field near St. Vojtěch) (1), Těně (west) (2, 3, 5–12), Sedlec (gorge) (4).
1. Juvenile ventral valve, latex cast of exterior; PCZCU 644; ×6.6.
2, 3, 7. Ventral valve, latex cast of exterior (2), internal mould in ventral (3) and posterior (7) views showing complex pallial markings; PCZCU 645a; ×6.6, ×6.6, ×6.6.
4. Dorsal valve, latex cast of exterior; PCZCU 646; ×6.6.
5, 6. Dorsal valve, larval and brephic shell; PCZCU 647; ×65, ×75.
8, 9. Ventral valve, larval and brephic shell; PCZCU 648; ×50, ×75.
10. Radial fila on brephic shell; PCZCU 649; ×65.
11, 12. Marginal spines at edge of growth lamellae; PCZCU 650; ×95, ×45.

Orbithele rimosa MERGL, 1981. Arenigian, Klabava Formation, upper part of *Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone, clayey shale. Localities: Rokycany (Drahouš) (13, 15–17), Ejpovice (quarry, NE part) (14).
13, 15. Ventral valve, external mould showing radial fila on brephic shell (13) and latex cast of exterior (15); PCZCU 651; ×6.6, ×6.6.
14. Holotype, ventral valve, latex cast of exterior, figured by Mergl (1981: pl. 2, fig. 11); ČGÚ MM 012a; ×5.1.
16. Dorsal valve, latex cast of exterior; PCZCU 652; ×6.6.
17. Ventral valve, latex cast of exterior; PCZCU 653; ×6.6.

PLATE 28

Acrotreta grandis KLOUČEK, 1919. Upper Tremadocian, Třenice Formation, greywacke with haematite cement (1, 12), haematite (2–18, 19, 20), greywacke with siderite cement (19). Localities: Zbiroh (Bukov, old quarries) (1, 12), Holoubkov (V Ouzkém) (2–18, 19, 20), Skomelno (Na Solích) (19).
1. Dorsal valve exterior; MBHR 22026 (coll. V. Havlíček; VH 3305b); ×9.0.
2. Dorsal valve exterior; NM L 36745; ×9.0.
3. Dorsal valve exterior; NM L 36746; ×9.0.
4. Dorsal valve exterior; NM L 36747; ×9.0.
5–7, 18, 20, 21. Ventral valve, internal mould in apical (5), lateral (6), and posterior (7) views, and latex cast of exterior in posterior (18), lateral (20), and anterior (21) views; NM L 36749; ×9.0, ×9.0, ×9.0, ×12, ×12, ×12.
8. Dorsal valve, internal mould; NM L 36748; ×9.0.
9, 10. Ventral valve, internal mould in apical (9) and anterior views (10); MBHR 21501 (coll. V. Havlíček; VH 813b); ×9.0.
11. Ventral valve, internal mould in anterior view; MBHR 21502 (coll. V. Havlíček; VH 813c); ×9.0.
12. Dorsal valve, internal mould; MBHR 22025 (coll. V. Havlíček; VH 3305a); ×9.0.
13. Ventral valve, internal mould in lateral view; NM L 36750; ×9.0.
14. Ventral valve, internal mould in lateral view; NM L 36751; ×9.0.
15–17. Ventral valve, internal mould in posterior (15), lateral (16), and apical (17) views; NM L 36752; ×9.0.
19. Group of ventral valves in greywacke; PCZCU 635; ×7.5.

PLATE 29

Acrotreta foetida sp. n. Lower Arenigian, Klabava Formation, Olešná Beds Member, red-brown siltstone, clay clasts in siltstone and fine greywacke. Locality: Těně (west).
1. Dorsal valve, internal mould; PCZCU 715; ×9.0.
2. Holotype, dorsal valve, internal mould; PCZCU 716; ×9.0.
3. Dorsal valve, internal mould; PCZCU 717; ×9.0.
4. Dorsal valve, internal mould; PCZCU 718; ×9.0.
5. Dorsal valve, internal mould; PCZCU 719; ×20.
6. Paratype, dorsal valve, internal mould with remains of shell, posterior view; PCZCU 720; ×8.2.
7. Fragment of ventral valve showing ornamentation of pseudointerarea; PCZCU 721; ×60.

Acrotreta scabra sp. n. Arenigian, Klabava Formation *Holograptus tardibrachiatus* Biozone (8, 9, 13), *Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone, clay and tuffaceous shale (10–12, 14, 15). Localities: Klabava (Klabava dam) (8, 9, 13), Zbiroh (Bukov, Joseph gallery) (10, 14), Osek (old dump) (11, 12), Strašice (field near St. Vojtěch) (15).
8. Fragment of ventral valve showing intervascular ridges; PCZCU 722; ×7.5.
9. Ventral valve, internal mould in apical view; MBHR 16574; ×7.5.
10. Dorsal valve, internal mould; PCZCU 725; ×9.0.
11. Dorsal valve, internal mould; NM L 36755; ×9.0.
12. Holotype, dorsal valve, internal mould; NM L 36756; ×9.0.
13. Ventral valve, internal mould; MBHR 16572; ×7.5.
14. Paratype, ventral valve exterior; PCZCU 726; ×10.
15. Dorsal valve exterior; PCZCU 727; ×9.0.

Cyrtonotreta osekensis sp. n. Llanvirnian, Šárka Formation; siliceous nodule. Locality: Osek (field).
16, 17, 19. Paratype, ventral valve, latex cast of exterior in posterior (16), apical (17) and lateral (19) views; NM L 3654a; ×35, ×35, ×48.
18. Holotype, dorsal valve, internal mould; NM L 36754c; ×20.
20, 21. Dorsal valve, latex cast of exterior in dorsal and oblique views; NM L 36754b; ×45, ×45.

PLATE 30

Dactylotreta prisca sp. n. Lower Arenigian, Klabava Formation, Olešná Beds Member, clay clasts in siltstone. Locality: Těně (west).
1. Dorsal valve exterior; PCZCU 728; ×65.
2. Dorsal valve exterior; PCZCU 729; ×70.
3, 4. Paratype, dorsal valve exterior in dorsal and oblique views; PCZCU 730; ×50, ×55.
5, 15. Dorsal valve exterior (5) and detail of ornamentation (15); PCZCU 731; ×50, ×165.
6. Dorsal valve exterior in oblique view; PCZCU 732, ×100.
7. Dorsal valve interior in oblique view; PCZCU 733, ×70.
8, 9, 11, 12. Holotype, ventral valve, oblique (8), lateral (9), anterior (11) and apical (12) views; PCZCU 734; ×75, ×75, ×75, ×65.
10. Dorsal valve, interior in oblique view; PCZCU 735; ×55.
13, 14. Detail of dorsal larval shell and detail of dorsal valve surface with radial rows of pustules; PCZCU 736; ×155, ×190.
16. Dorsal valve exterior; PCZCU 737; ×110.

PLATE 31

Numericoma vulcanogena MERGL, 1996. Upper Arenigian, Klabava Formation, upper part, *Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone, bioclastic limestone. Locality: Zbiroh (Bukov, Joseph gallery).

1. Dorsal valve exterior; PCZCU 738; ×38.
2. Dorsal valve interior; PCZCU 739; ×30.
3, 6. Dorsal valve interior in ventral and lateral views; PCZCU 740; ×35, ×40.
4, 5, 15, 16. Dorsal valve exterior in dorsal (4), oblique (5) views, detail of larval shell (15) and detail of larval shell microornamentation (16); PCZCU 741; ×40, ×50, ×270, ×500.
7. Juvenile dorsal valve interior; PCZCU 742; v40.
8, 12. Ventral valve exterior, posterolateral view and detail of pseudointerarea; PCZCU 745; ×50, ×30.
9. Ventral valve, lateral view; PCZCU 744; ×30.
10. Ventral valve exterior, anterior view; PCZCU 743; ×27.
11. Ventral valve exterior, posterior slope; PCZCU 746; ×35.
13. Dorsal valve interior, postelateral view showing pseudointerarea and median septum; PCZCU 747; ×80.
14. Median septum of dorsal valve showing arrangement of spines; PCZCU 748; ×110.

PLATE 32

Numericoma campanula sp. n. Llanvirnian, Šárka Formation, siliceous nodule. Locality: Mýto (highway cut).

1. Dorsal valve interior; PCZCU 749; ×130.
2, 3. Paratype, dorsal valve interior, ventral and oblique views; PCZCU 750; ×140, ×130.
4. Dorsal valve interior; PCZCU 751; ×130.
5, 8, 13. Dorsal valve exterior in lateral and dorsal views, and detail of larval shell; PCZCU 752, ×140, ×100, ×400.
6, 9. Complete shell with broken off ventral apical part, in ventral and oblique views; PCZCU 754; ×140, ×170.
7. Dorsal valve interior in lateral view; PCZCU 753; ×140.
10, 11. Holotype, ventral valve, detail of larval shell, and whole valve in oblique view; PCZCU 755; ×400, ×130.
14. Ventral valve exterior showing concentric fila; PCZCU 756; ×130.

Numericoma vulcanogena MERGL, 1996. Upper Arenigian, Klabava Formation, upper part, *Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone, bioclastic limestone. Locality: Zbiroh (Bukov, Joseph gallery).

12, 15. Ventral larval shell in oblique and apical views; TJ 4; ×340, ×265.

PLATE 33

Family Acrotretidae gen. et. sp. indet. Lower Arenigian, Klabava Formation, Olešná Beds Member, clay clasts in siltstone. Locality: Těně (west).

1. Ventral valve exterior, lateral view; PCZCU 757; ×85.
2, 4, 5. Ventral valve exterior in oblique view (2), detail of pedicle tube (4) and contact of larval shell with postlarval shell surface; PCZCU 758; ×85, ×460, ×310.
3. Ventral valve in posterior view; PCZCU 759; ×85.
6. Dorsal valve probably referred to the species; PCZCU 761; ×70.

Mamatia retracta POPOV et HOLMER, 1994. Lower Arenigian, Klabava Formation, Olešná Beds Member, clay clasts in siltstone. Locality: Těně (west).

5, 8, 11. Dorsal valve exterior in dorsal (5), oblique (8) views and detail of larval shell (11); PCZCU 760; ×70, ×110, ×200.
9. Juvenile dorsal valve, exterior; PCZCU 762, ×130.
10. Dorsal valve interior (the same valve is figured on pl. 34, fig. 14); PCZCU 763; ×85.
12, 15. Ventral valve exterior in apical and oblique views; PCZCU 765; ×60, ×90.
13, 16. Ventral valve exterior in anterior and lateral views; PCZCU 766; ×110, ×120.
14. Ventral valve interior; PCZCU 764; ×150.

PLATE 34

Pomeraniotreta holmeri MERGL, 1995. Lower Arenigian, Klabava Formation, Olešná Beds Member, clay clasts in siltstone. Locality: Těně (west).

1, 5, 6, 7. Ventral valve exterior in lateral (1), anterior (5), apical (6), and oblique (7) views; PCZCU 767; ×120, ×120, ×130, ×130.
2, 3, 13. Ventral valve exterior in lateral (2) and posterior (3) views, and detail of larval shell (13); PCZCU 768; ×105, ×130, ×250.
4. Ventral valve exterior in lateral view; PCZCU 769; ×110.
8, 16. Dorsal valve interior in ventral and oblique views; PCZCU 770, ×65, ×130.
9, 17. Dorsal valve exterior in dorsal and oblique views showing larval shell; PCZCU 771; ×125, ×200.
10. Ventral valve exterior in lateral view; PCZCU 772; ×155.
11. Dorsal valve interior; PCZCU 773; ×85.
12. Dorsal valve exterior in oblique view; PCZCU 774; ×140.
15. Dorsal valve exterior in oblique views; PCZCU 775; ×130.

Mamatia retracta POPOV et HOLMER, 1994. Lower Arenigian, Klabava Formation, Olešná Beds Member, clay clasts in siltstone. Locality: Těně (west).

14. Dorsal valve interior in posterior view showing shape of pseudointerarea and convex larval shell; PCZCU 763; ×140.

PLATE 35

Eoconulus gemmatus MERGL, 1995. Lower Arenigian, Klabava Formation, Olešná Beds Member, clay clasts in siltstone. Locality: Těně (west).

1, 4. Dorsal valve exterior, dorsal and oblique views; PCZCU 776; ×95, ×120.
2, 5. Dorsal valve exterior of strongly asymmetrical specimen in dorsal and anterio views; PCZCU 777; ×90, ×100.
3. Dorsal valve exterior; PCZCU 778; ×95.

Eoconulus commutabilis sp. n. Upper Arenigian, Klabava Formation, upper part, red-brown tuffaceous shale. Locality: Kleštěnice (Stanislav mine).

6, 9. Ventral valve, latex cast of exterior in oblique and apical views; PCZCU 779; ×15.
7. Ventral valve, latex cast of exterior; PCZCU 780; ×15.
8. Juvenile dorsal valve, internal mould; PCZCU 781; ×15.
10. Ventral valve, internal mould; PCZCU 782; ×15.
11. Ventral valve, internal mould; PCZCU 783; ×15.
12. Holotype, ventral valve, internal mould; PCZCU 784; ×15.
13. Ventral valve, internal mould; PCZCU 785; ×15.

Ferrobolus catharinus HAVLÍČEK, 1982b. Upper Tremadocian, Třenice Formation, haematite. Locality: Holoubkov (V Ouzkém).

14. Ventral valve, latex cast of exterior; MBHR 21834 (coll. V. Havlíček; VH 3065); ×8.0.

15. Dorsal valve exterior; MBHR 21757 (coll. V. Havlíček; VH 2999); ×7.0.
16, 17. Ventral valve, internal mould and external mould showing pedicle foramen and vascula lateralia; MBHR 21837 (coll. V. Havlíček; VH 3067); ×5.3, ×5.3.
18. Holotype, ventral valve, latex cast of exterior, figured by Havlíček (1982b: pl. 15, figs 4, 5); NM L 18125; ×5.3.
19. Dorsal valve, internal mould; MBHR 21835 (coll. V. Havlíček; VH 3066a); ×8.0.
20. Ventral valve, internal mould; MBHR 21836 (coll. V. Havlíček; VH 3066b); ×8.0.

PLATE 36

Celdobolus complexus (BARRANDE, 1879). Arenigian, Klabava Formation, upper part (1–12, 14–16), *Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone (13, 20), red-brown tuffaceous shale (1–3, 10–12, 16), grey tuffaceous shale (4–9, 14), clayey shale (13, 15). Localities: Kleštěnice (Stanislav mine) (1–3, 10–12), Mýto (St. Stephen pond) (4–9, 13–15), Strašice (field near St. Vojtěch) (16), Díly (20).
1. Dorsal valve, internal mould; PCZCU 654; ×7.5.
2. Dorsal valve, internal mould; PCZCU 655; ×7.5.
3. Dorsal valve, internal mould showing papillae in visceral area; PCZCU 656; ×7.5.
4, 14. Ventral valve, interior and internal mould; PCZCU 657b; ×7.5, ×7.5.
5, 6. Dorsal valve, interior and internal mould of gerontic specimen; PCZCU 658; ×7.5, ×7.5.
7, 8. Dorsal valve, internal mould; PCZCU 659; ×7.5.
9. Dorsal valve, internal mould; PCZCU 660; ×7.5.
10. Dorsal valve, internal mould; PCZCU 661; ×7.5.
11.Ventral valve, internal mould; PCZCU 662; ×7.5.
12. Dorsal valve interior; PCZCU 663; ×7.5.
13. Dorsal valve, latex cast of exterior; PCZCU 664; ×7.5.
15. Dorsal valve, latex cast of exterior; PCZCU 665; ×7.5.
16. Ventral valve exterior; PCZCU 666; ×7.5.
20. Dorsal valve, internal mould showing papillae in visceral area; PCZCU 669; ×7.5.

Celdobolus aff. *complexus* (BARRANDE, 1879). Upper Arenigian (?), Šárka Formation, basal ferolite beds. Localities: Zbiroh (Bukov, Joseph gallery) (17), Strašice (field near St. Vojtěch) (18, 19).
17. Ventral valve, internal mould surrounded by very thick original shell; MBHR 12117; ×7.5.
18. Dorsal valve, internal mould; PCZCU 667; ×7.5.
19. Ventral valve, internal mould; PCZCU 668; ×7.5.

PLATE 37

Celdobolus mirandus (BARRANDE, 1879). Lower Arenigian, Klabava Formation, Olešná Beds Member, red-brown siltstone and shale (1–14, 17, 18). Locality: Strašice (field near St. Vojtěch) (1–8, 14, 18), Těně (west) (9–13, 17).
1. Ventral valve, internal mould; PCZCU 670; ×6.6.
2. Ventral valve, internal mould; PCZCU 671a; ×6.6.
3. Ventral valve, internal mould; PCZCU 671c; ×6.6.
4. Ventral valve, internal mould; PCZCU 672; ×6.6.
5. Dorsal valve, internal mould; PCZCU 673a; ×6.6.
6. Dorsal valve, internal mould; PCZCU 673b; ×6.6.
7, 8. Ventral valve, internal mould and latex cast of exterior; PCZCU 671b; ×6.6, ×6.6.
9. Ventral valve, internal mould; PCZCU 674; ×6.6.
10. Dorsal valve, internal mould; PCZCU 675; ×6.6.
11. Ventral valve, internal mould; PCZCU 676a; ×6.6.
12. Dorsal valve, latex cast of external mould, PCZCU 676b; ×6.6.
13. Ventral valve, internal mould showing infilling of pedicle tube; PCZCU 645b; ×10.
14. Juvenile dorsal valve, internal mould; PCZCU 677; ×10.
17. Detail of densely crowded spines on shell surface; PCZCU 680; ×50.
18. Two valves, probably of the same individual, with preserved superficial spines (uncoated by ammonium chloride); PCZCU 678; ×8.8.

Celdobolus aff. *mirandus* (BARRANDE, 1879). Upper Tremadocian, Třenice Formation, chert (15), haematite (16). Localities: Jivina (old quarries, horizon with *Thysanotos siluricus*) (15), Holoubkov (V Ouzkém) (16).
15. Dorsal valve, internal mould; PCZCU 679; ×9.0.
16. Dorsal valve, internal mould showing fine spines; NM L 36744; ×7.0.

PLATE 38

Celdobolus mirandus (BARRANDE, 1879). Lower Arenigian, Klabava Formation, Olešná Beds Member, clay clasts in siltstone. Locality: Těně (west).
1, 2, 3, 5, 10. Ventral valve exterior, ventral (1), and oblique views (2), and oblique view showing larval shell (3), posterior view (5) and detail of larval shell (10); PCZCU 681; ×45, ×62, ×30, ×75, ×130.
4, 6. Ventral valve exterior in oblique and ventral views; PCZCU 682; ×56, ×40.
7. Ventral valve exterior in oblique view; PCZCU 683; ×30.
8. Dorsal valve exterior in oblique view; PCZCU 684; ×50.
9. Ventral valve exterior; PCZCU 687; ×19.
11. Dorsal valve exterior showing larval shell; PCZCU 685; ×56.
12. Detail of dorsal larval shell; PCZCU 686; ×75.
13. Pseudointerarea of dorsal valve; PCZCU 688; ×52.
14. Ventral valve, posterior view; PCZCU 689; ×85.
15, 16. Dorsal valve, interior in ventral and oblique views; PCZCU 690; ×45, ×45.

PLATE 39

Celdobolus mirandus (BARRANDE, 1879). Lower Arenigian, Klabava Formation, Olešná Beds Member, clay clasts in siltstone. Locality: Těně (west).
1, 4. Shell fragment showing scattered spines and detal of spines; PCZCU 692; ×17, ×90.
2, 3, 5. Shell fragment showing dense aggregation of spines and details of spines; PCZCU 691; ×27, ×72, ×63.

Acanthambonia klabavensis HAVLÍČEK, 1982. Upper Arenigian, Klabava Formation, *Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone, clayey shale. Localities: Díly (field) (6, 10), Klabava (Old Castle) (7–9).
6, 10. Vental valve internal mould and shell interior showing internal projection of spines; PCZCU 693; ×10.
7. Dorsal valve, internal mould; PCZCU 694; ×10.
8. Dorsal valve, internal mould; PCZCU 695; ×10.
9. Dorsal valve, internal mould; PCZCU 696; ×10.

Siphonobolus simulans (RŮŽIČKA, 1927). Upper Tremadocian, Třenice Formation, haematite. Locality: Holoubkov (V Ouzkém).
11, Ventral valve, latex cast of exterior; NM L 36764; ×7.5.

12. Ventral valve, latex cast of exterior; NM L 37806; ×7.5.
13. Ventral valve, internal mould; MBHR 21694 (coll. V. Havlíček; VH 2083c); ×10.
14. Ventral valve, internal mould; MBHR 21692 (coll. V. Havlíček; VH 2083a); ×10.
15. Ventral valve, internal mould; MBHR 21693 (coll. V. Havlíček; VH 2083b); ×10.

Collarotretella septata MERGL, 1997. Lower Arenigian, Klabava Formation, lower part, red-brown siltstone. Locality: Hrádek (gorge).
16. Ventral valve, internal mould; MBHR 66844; ×15.
17. Holotype, ventral valve, internal mould, figured by Mergl (1997d: fig. 7: A); MBHR 66845; ×15.
18. Dorsal valve, internal mould; MBHR 66847; ×15.
19. Dorsal valve, internal mould; MBHR 66848; ×15.

PLATE 40

Eosiphonotreta krafti (RŮŽIČKA, 1927). Upper Tremadocian, Třenice Formation, haematite (1–5, 8); Lower Arenigian, Klabava Formation, Olešná Beds Member, clay casts in siltstone (6, 7, 9–11). Localities: Holoubkov (V Ouzkém) (1–5, 8), Těně (west) (6, 7, 9–11).
1. Dorsal valve, latex cast of exterior; PCZCU 786; ×10.
2.Ventral valve, internal mould; NM L 36761; ×7.5.
3. Ventral valve exterior; NM L 36762; ×7.5.
4. Dorsal valve, internal mould; MBHR 23744 (coll. V. Havlíček; VH 2040a); ×5.5.
5. Latex cast of exterior; NM L 38763; ×7.5.
6, 7. Ventral valve, apical part showing foramen in oblique and posterior view; PCZCU 702; ×70, ×75.
8. Dorsal valve, internal mould; NM L 36759; ×8.3.
9, 11. Fragment of ventral valve showing variability of spines; PCZCU 703; ×35, ×50.
10. Fragment of shell showing two macrospines and concetric row of microspines; PCZCU 704; ×35.

Eosiphonotreta verrucosa (EICHWALD, 1840). Upper Arenigian, Klabava Formation, upper part, *Azygograptus ellesi – Tetragraptus reclinatus abbreviatus* Biozone, tuffaceous shale. Locality: Zbiroh (Bukov, Joseph gallery).
12. Dorsal valve, internal mould; PCZCU 705; ×4.2.
13. Ventral valve, internal mould; PCZCU 706; ×4.2.
14. Dorsal valve, latex cast of external mould and detail of ornamentation; PCZCU 707; ×4.2, ×7.5.
15. Dorsal valve, internal mould; PCZCU 708; ×4.2.
16. Ventral valve, internal mould showing pedicle foramen; PCZCU 709; ×4.2.

PLATE 41

Siphonotretella filipi sp. n. Lower Arenigian, Klabava Formation, Olešná Beds Member, clay clasts in siltstone (1–11); Upper Tremadocian, Mílina Formation, chert (12–14). Localities: Těně (west) (1–11), Kváň (field) (12–14).
1–3. Holotype, ventral valve exterior in oblique (1), dorsal (2) and posterior (3) views; PCZCU 697; ×80, ×70, ×90.
4, 7. Ventral valve exterior in lateral and ventral views; PCZCU 699; ×135, ×125.
5, 6, 9. Paratype, dorsal valve exterior in posterior (5), dorsal (6) and oblique (9) views; PCZCU 698; ×60, ×45, ×45.
8, 10, 11. Dorsal valve exterior, oblique (8), and posterior views showing larval shell (10), and detail of ornamentation (11); PCZCU 700; ×90, ×120, ×190.
12. Dorsal valve, internal mould; MBHR 65897; ×25.
13. Dorsal valve, internal mould; MBHR 65898; ×25.
14. Ventral valve, internal mould; MBHR 65896; ×25.

Schizambon sp. Llanvirnian, Šárka Formation, siliceous nodule. Locality: Mýto (field).
15–17. Dorsal valve, latex cast, oblique (15) and lateral (16) views, and detail of ornamentation on preserved original shell (17); PCZCU 701; ×17, ×22, ×210.

PLATE 42

Kolihium kolihai (RŮŽIČKA, 1927). Upper Tremadocian, Třenice Formation, haematite. Locality: Holoubkov (V Ouzkém).
1, 2. Dorsal valve, interior and internal mould; MBHR 21991 (coll. V. Havlíček; VH 3214); ×10, ×10.
3. Dorsal valve, internal mould; MBHR 21520 (coll. V. Havlíček; VH 817b); ×10.
4, 7. Dorsal valve, internal mould in dorsal and posterior views; MBHR 21519 (coll. V. Havlíček; VH 817a); ×10, ×10.
5. Ventral valve, latex cast of exterior; NM L 18129; ×9.0.
6, 9. Ventral valve, internal mould, posterior (6) and ventral (9) views; MBHR 21517 (coll. V. Havlíček; VH 816a); ×10, ×10.
8. Ventral valve, external mould showing pitted ornamentation; NM L 36803; ×10.
10. Ventral valve, internal mould; MBHR 21518 (coll. V. Havlíček; VH 816b); ×6.5.

Lacunites sp. Lower Arenigian, Klabava Formation, *Corymbograptus v-similis* Biozone; silty brown-violet shale. Locality: Sedlec (gorge).
11, 12. Deformed, probably dorsal valve, exterior and external mould; PCZCU 710; ×15, ×15.

Kolihium sp. Lower Arenigian, Klabava Formation, Olešná Beds Member, clay clasts in siltstone. Locality: Těně (west).
16. Fragment of shell showing elongate pits; PCZCU 714; ×75.

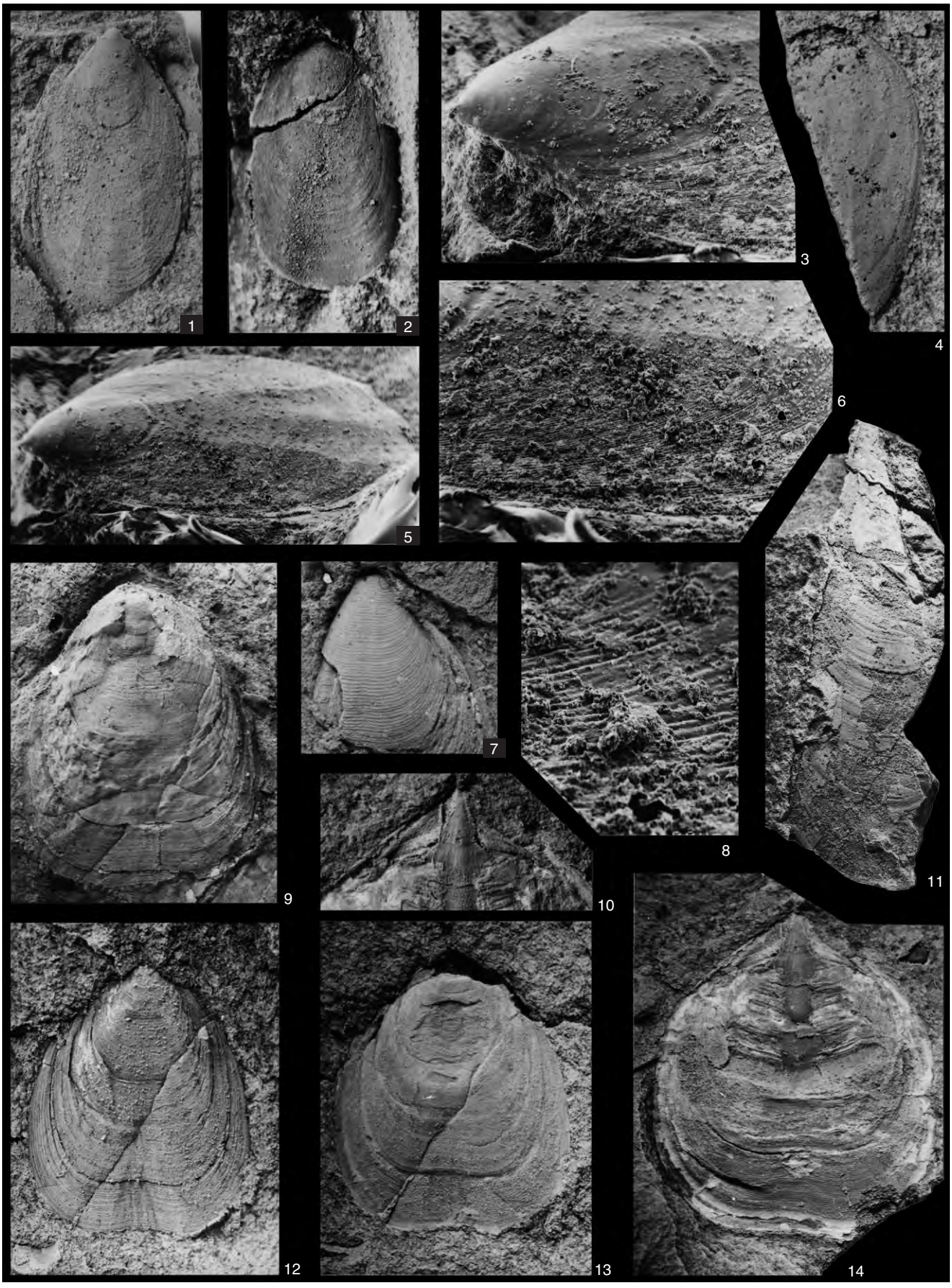
Lacunites walcotti (KOLIHA, 1927). Upper Tremadocian, Třenice Formation, haematite. Locality: Holoubkov (V Ouzkém).
13, 15. Ventral valve, internal mould in ventral and posterior views; MBHR 22015 (coll. V. Havlíček; VH 3230); ×10, ×10.
14. Ventral valve, external mould showing ornamentation; NM L 36757; ×10.
18. Dorsal valve, internal mould that may be referred to this species; NM L 36758; ×8.5.

Petrocrania caputium sp. n. Upper Tremadocian, Mílina Formation, chert. Locality: Kváň (field).
17, 22. Dorsal valve, external (17) and internal moulds (22); PCZCU 711; ×10, ×10.
19, 20, 25. Holotype, dorsal valve, internal mould in lateral (19), posterior (20) and dorsal (25) views; PCZCU 713; ×10, ×10, ×10.
23, 24. Dorsal valve, internal (23) and external moulds (24); ×10, ×10.

Petrocrania sp. Upper Tremadocian, Třenice Formation, haematite. Locality: Holoubkov (V Ouzkém).
21, 26. Dorsal valve, internal mould in oblique (21) and dorsal (26) views; MBHR 23396 (coll. V. Havlíček; VH 3229); ×9.0, ×9.0.

Cover: *Pomeraniotreta holmeri* (MERGL, 1995), Lower Arenigian, Klabava Formation, Olešná Beds Member, locality Těně (west), ventral valve exterior in lateral view, PCZCU 772, ×186.

Plate 1



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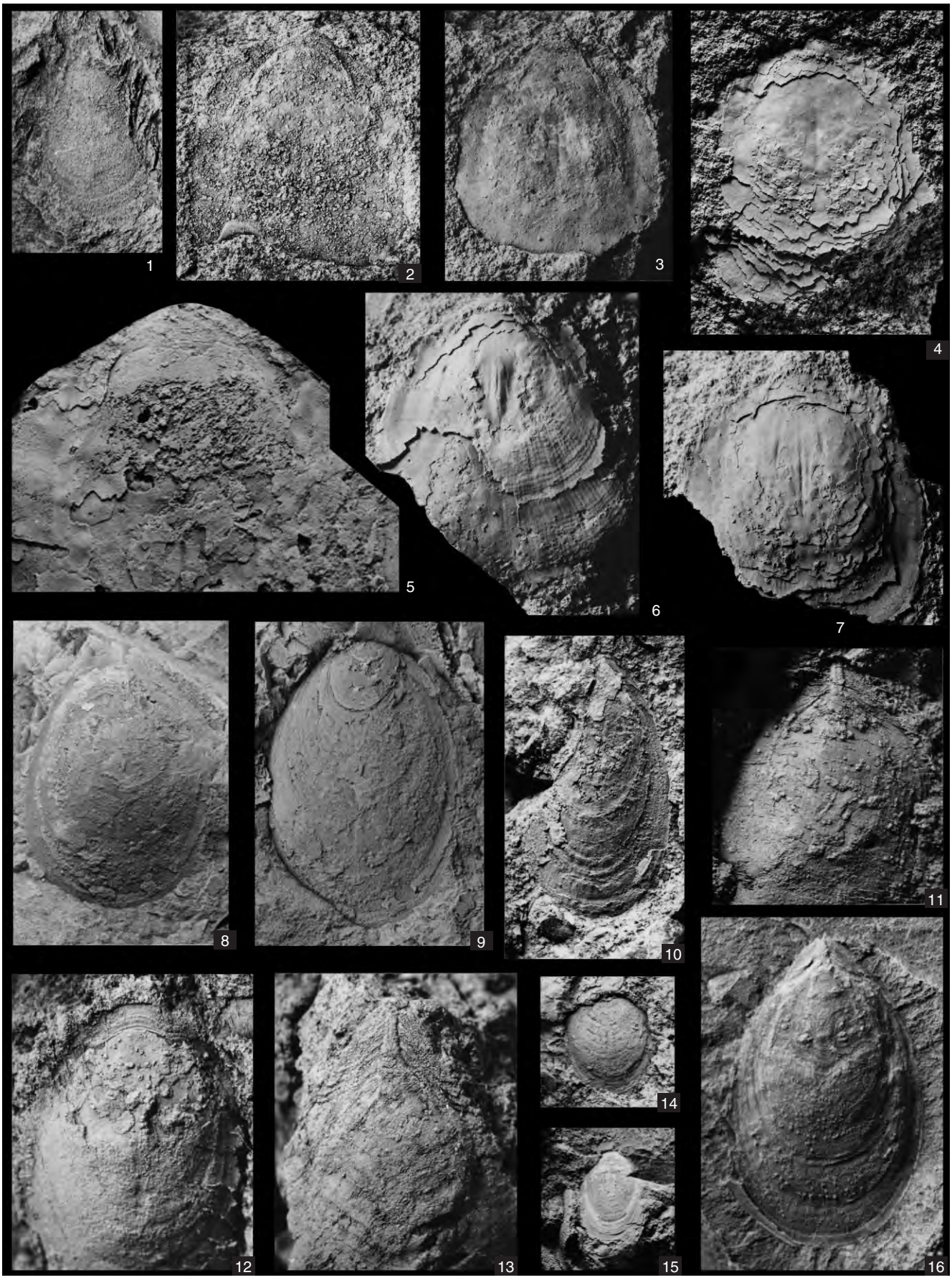

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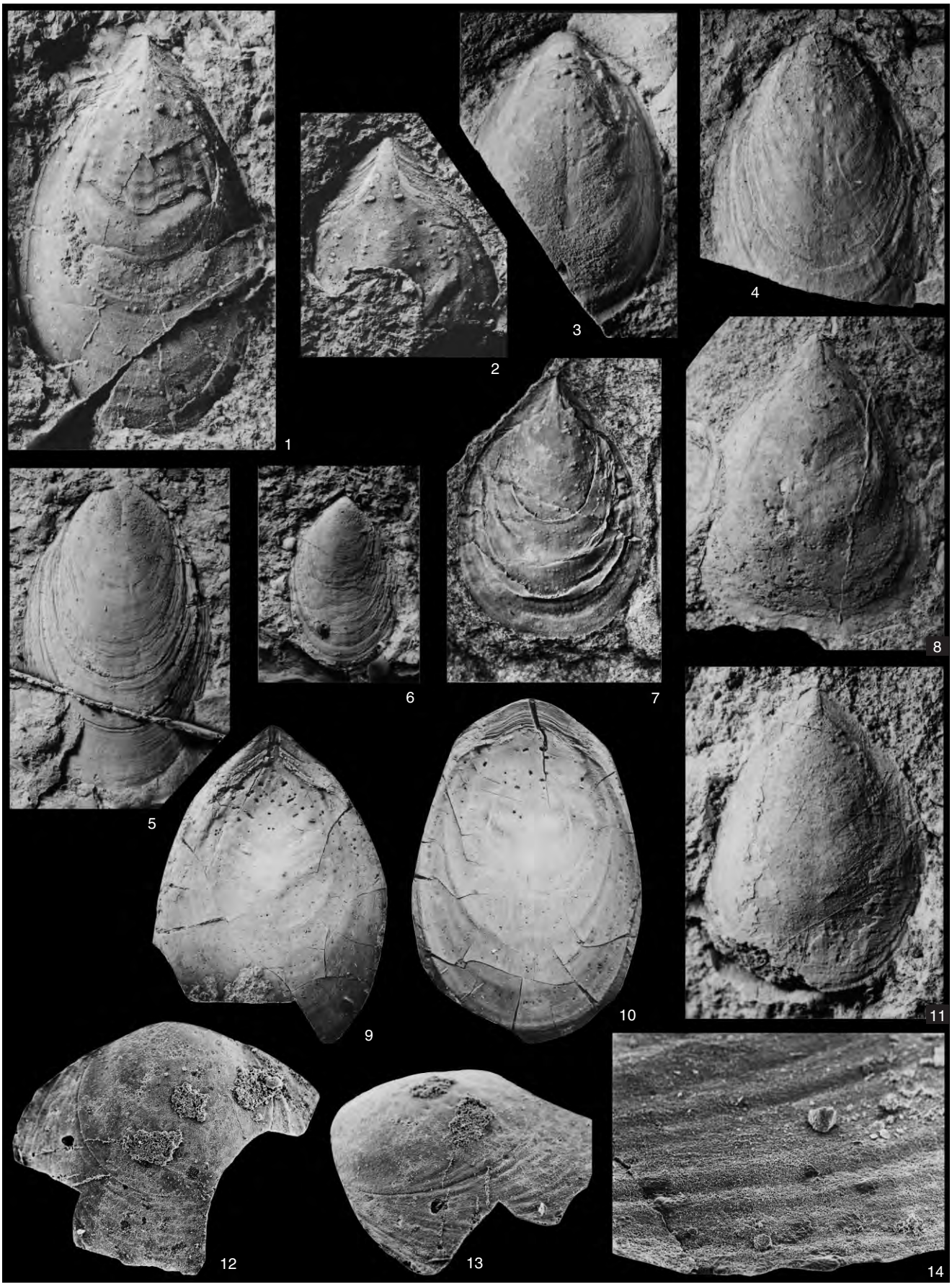

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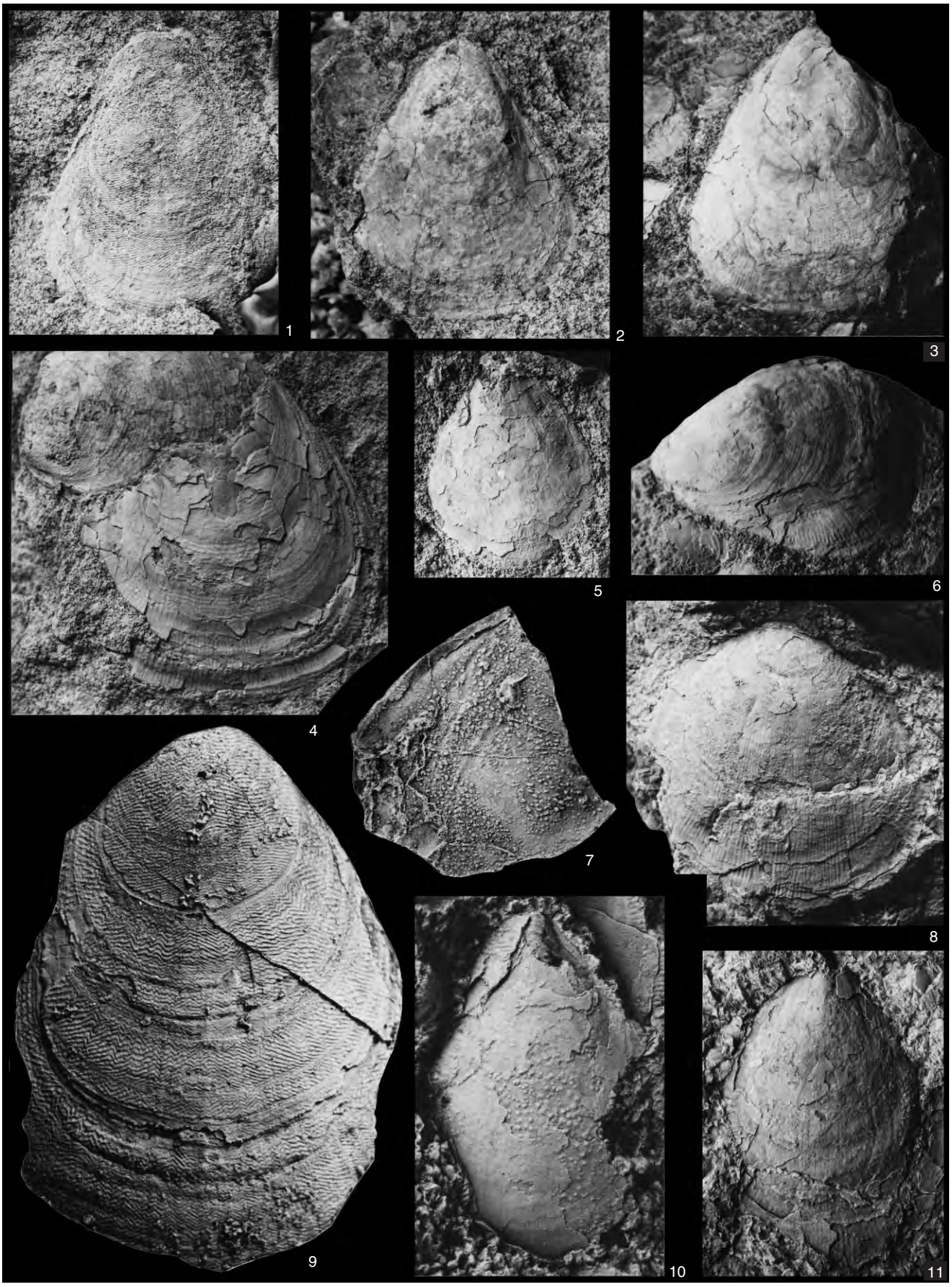

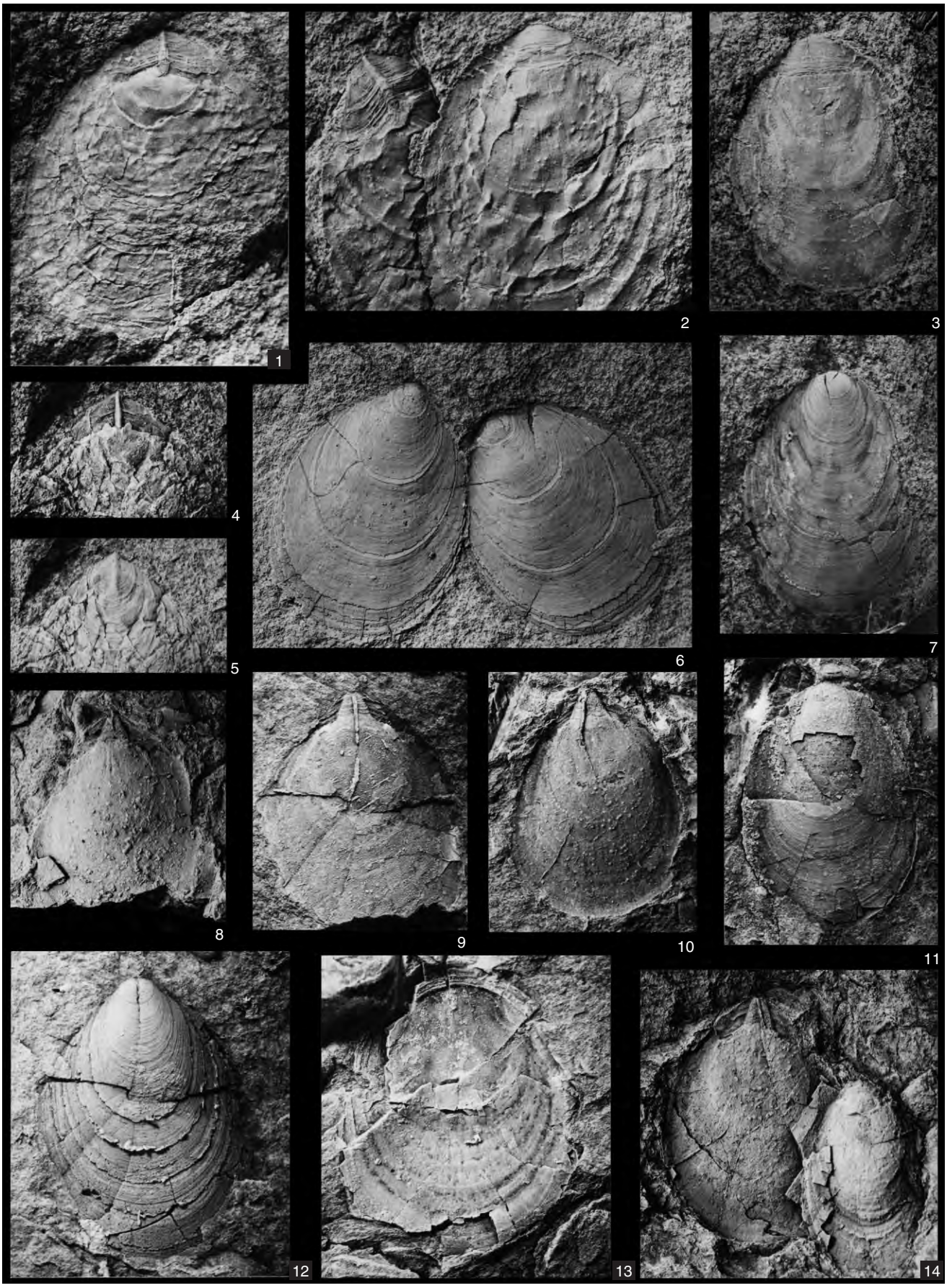
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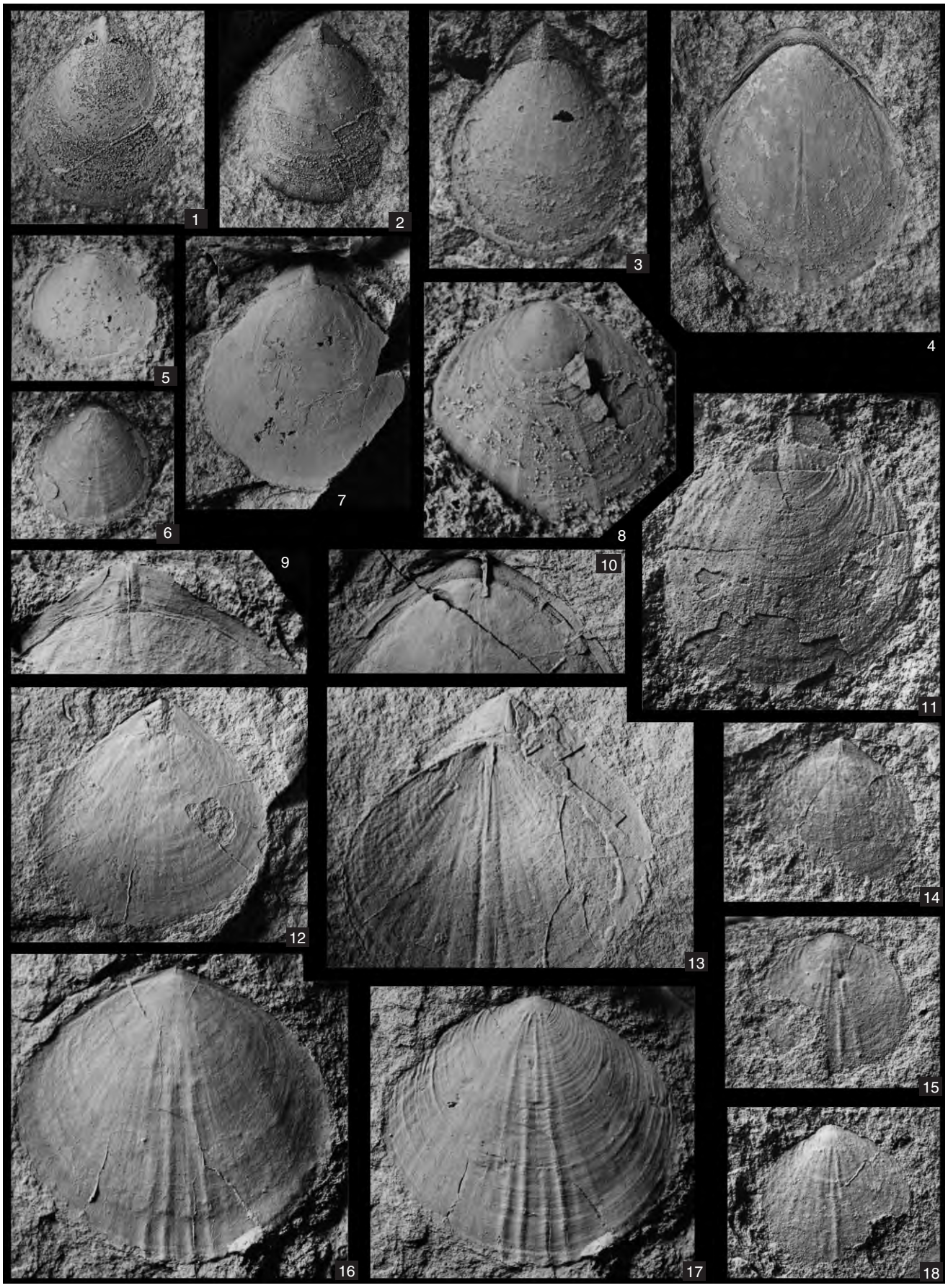

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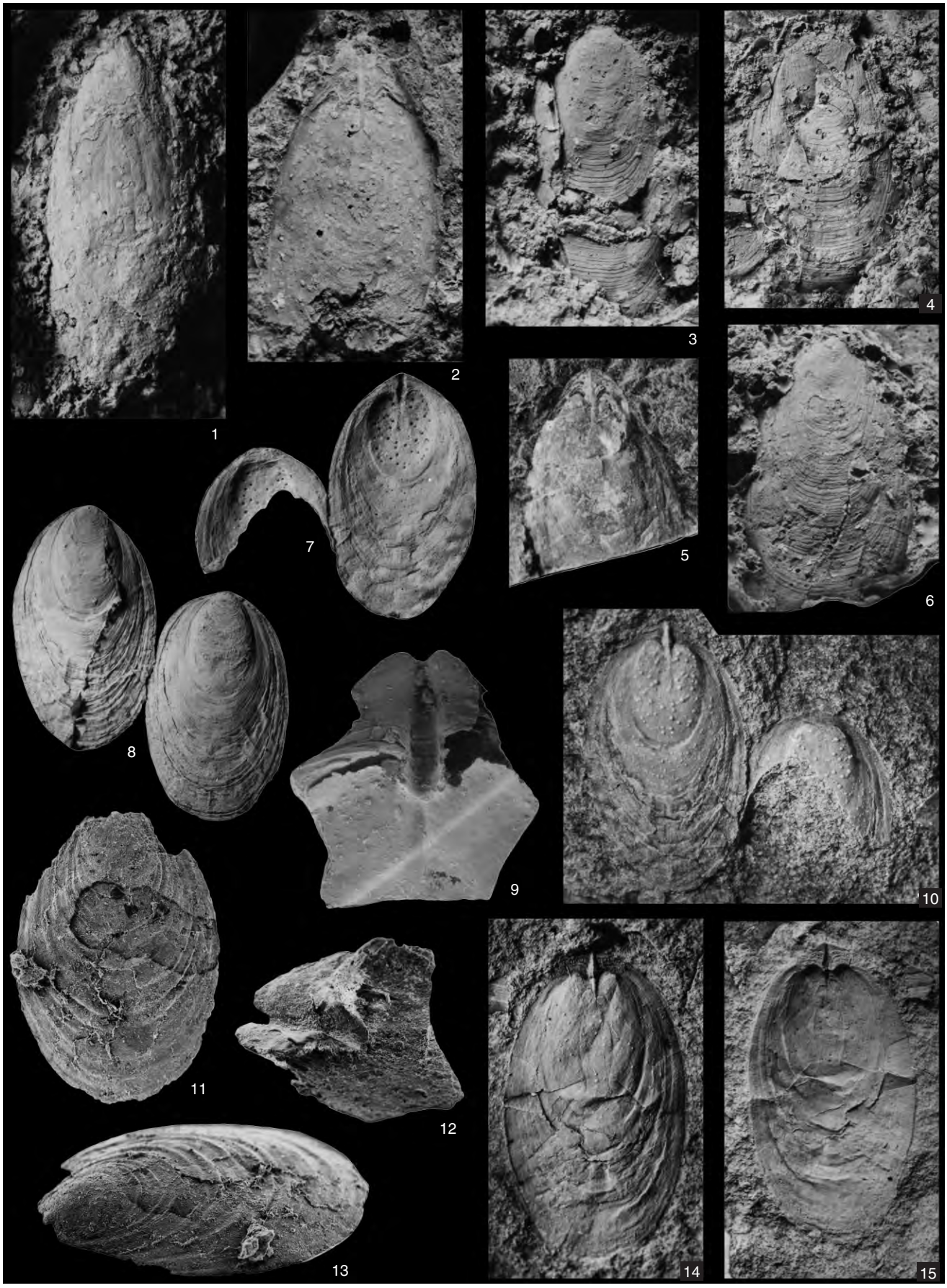

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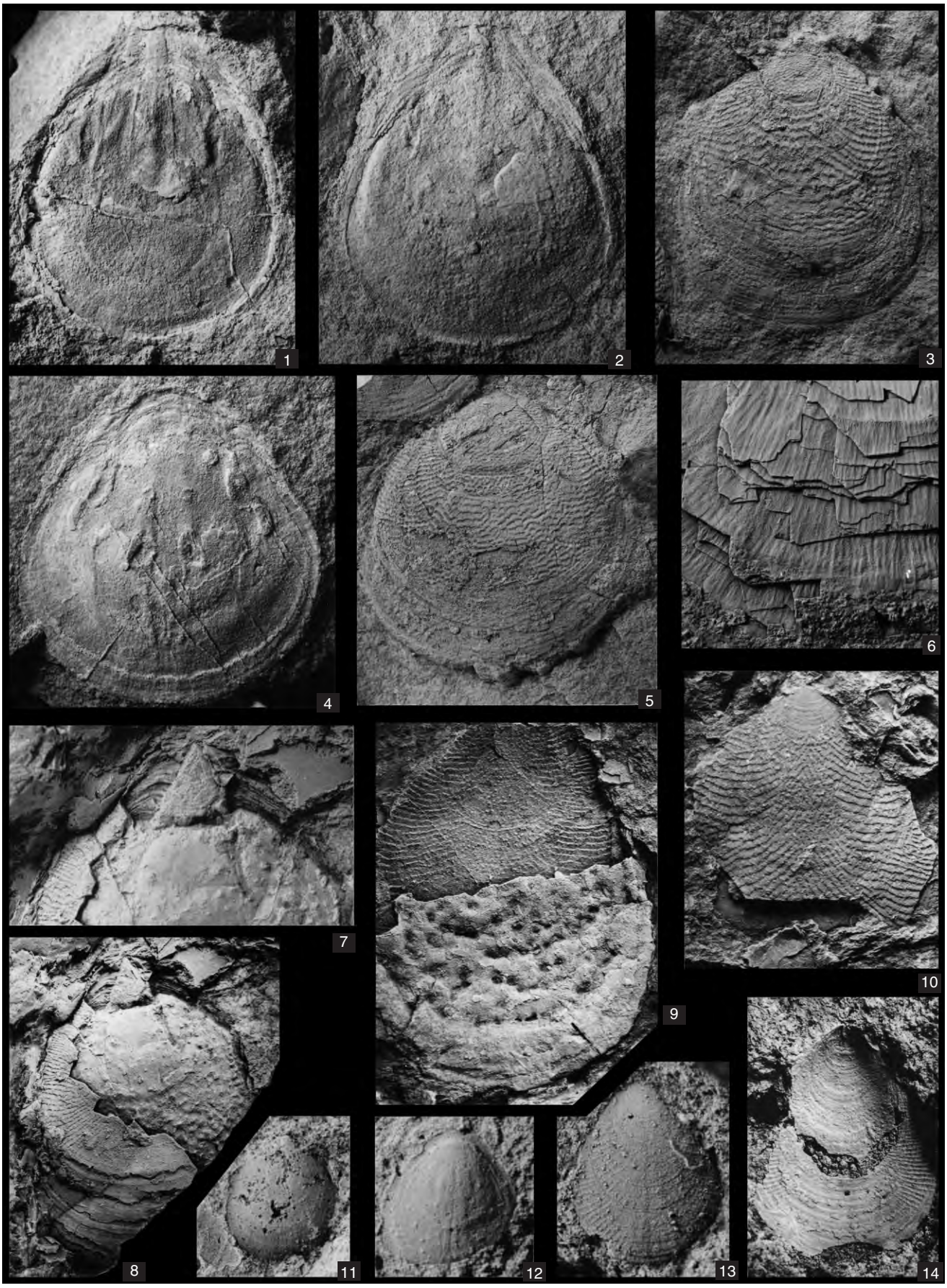

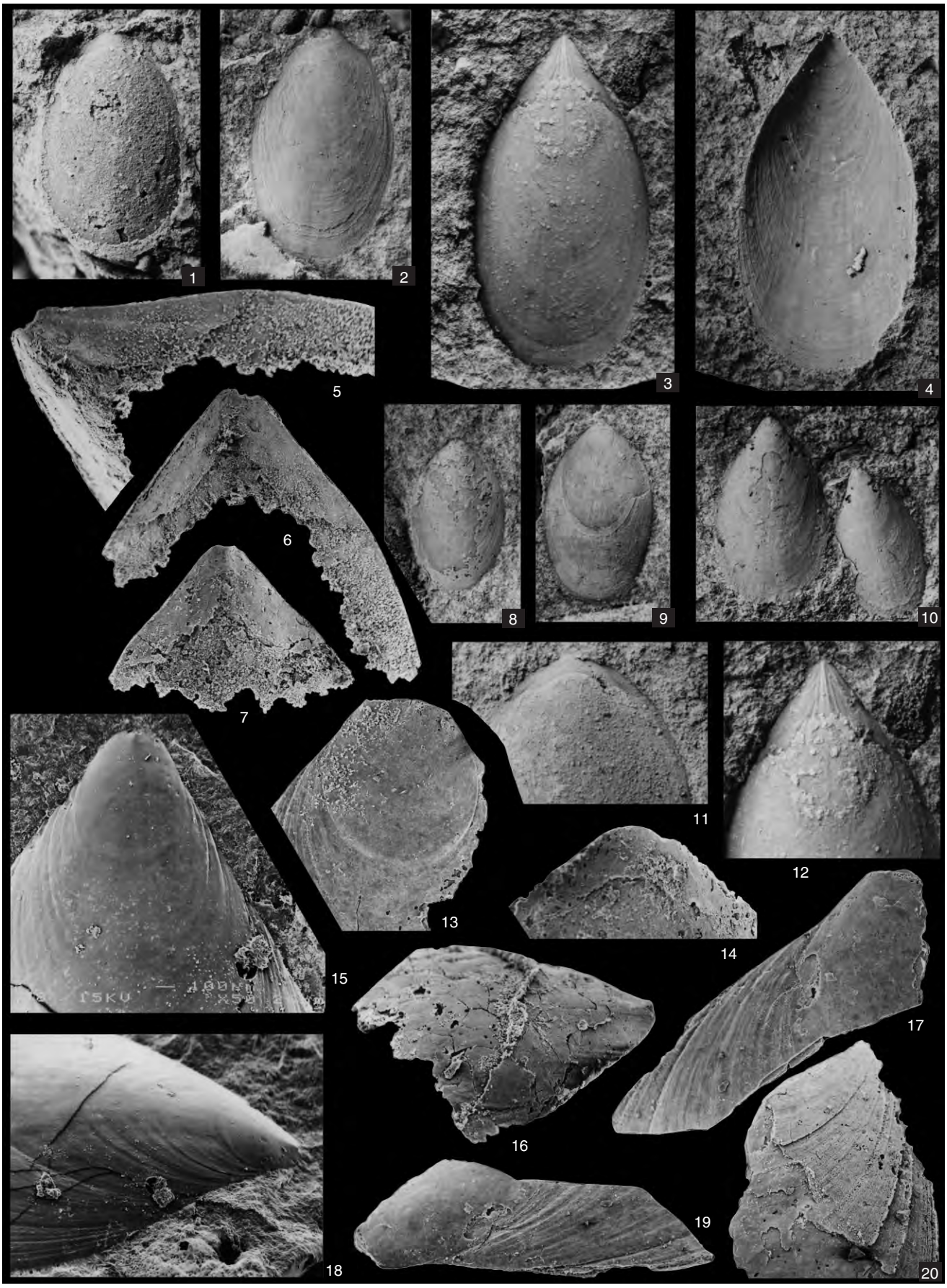
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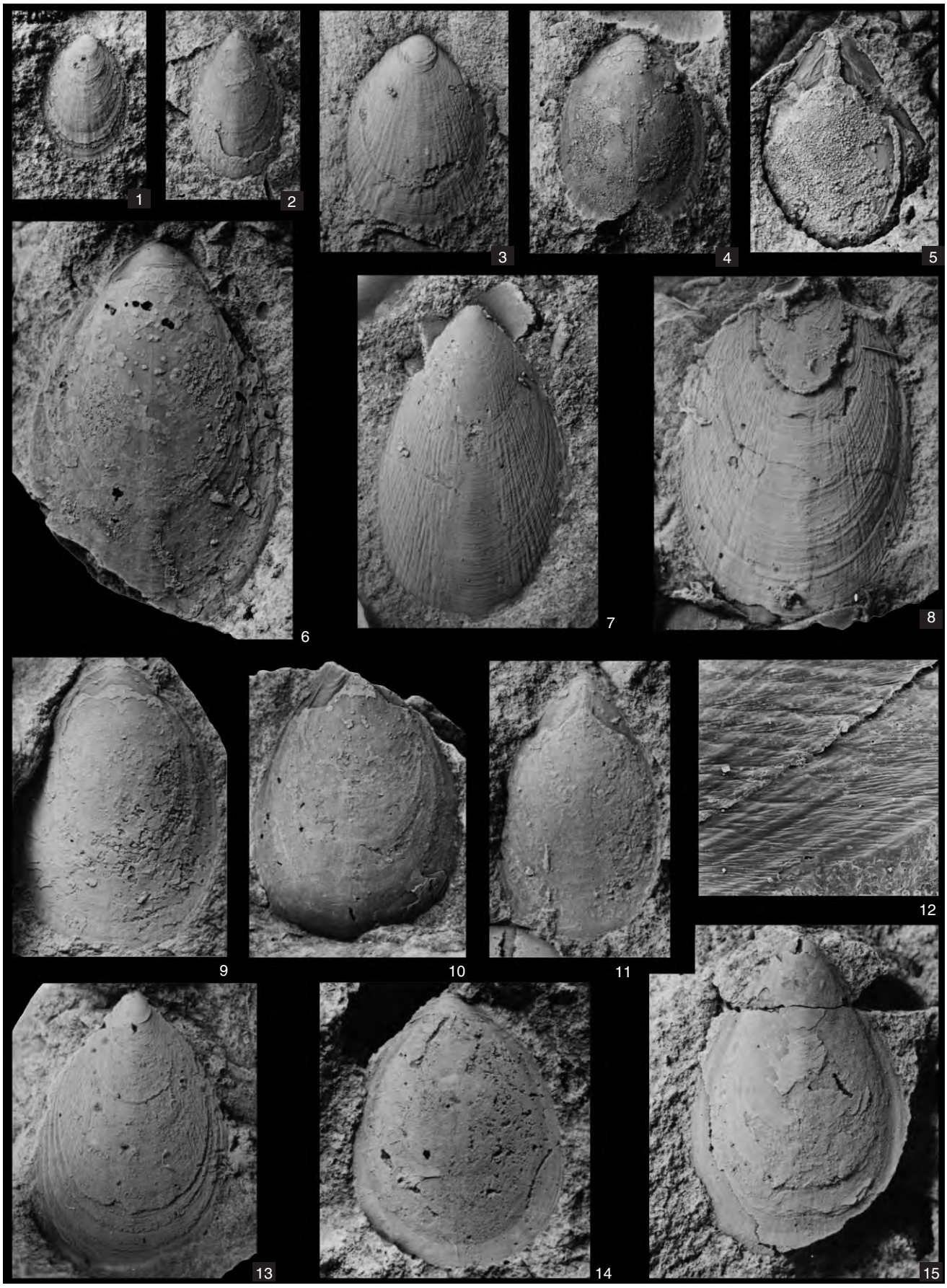
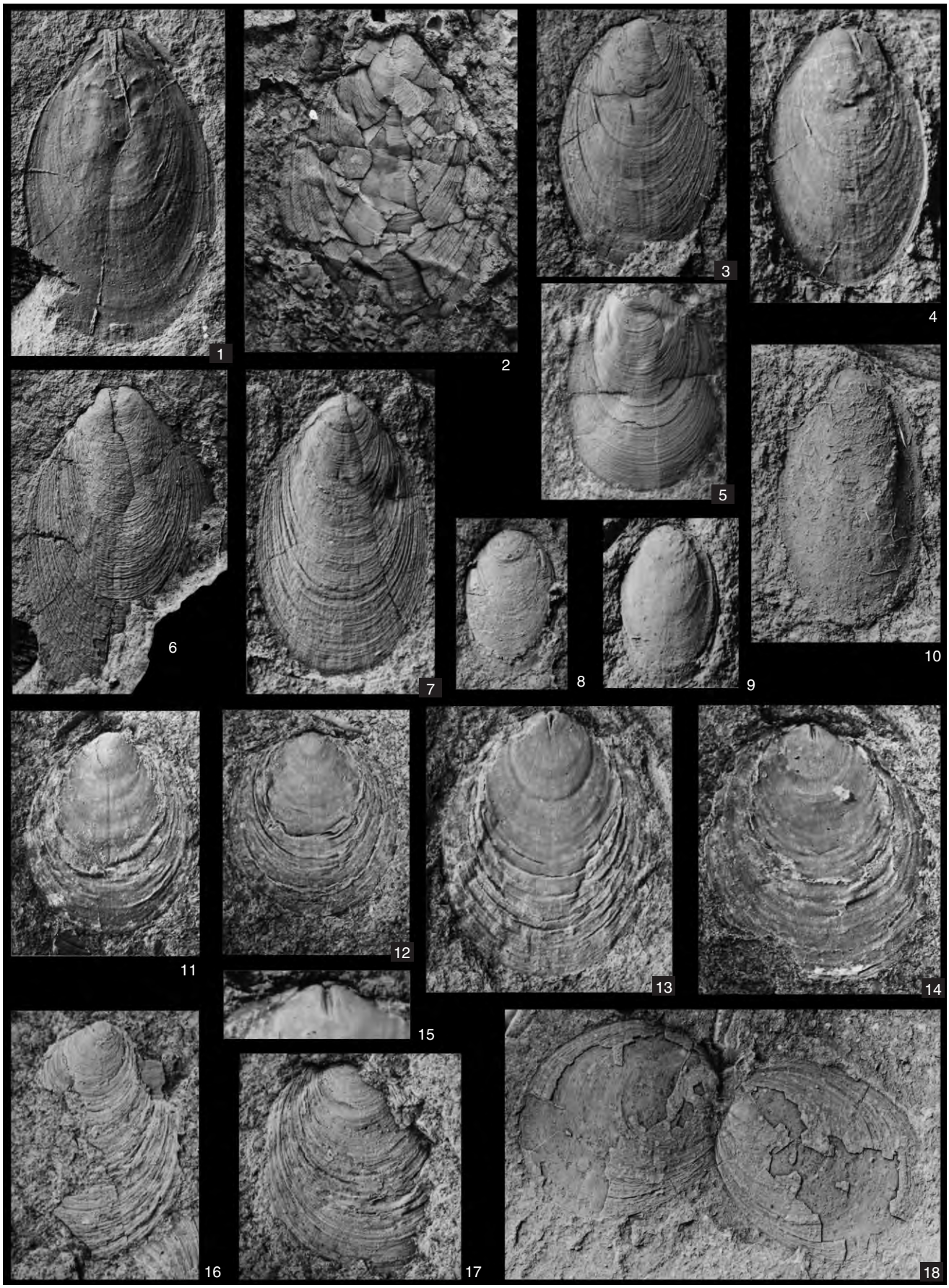
Plate 10

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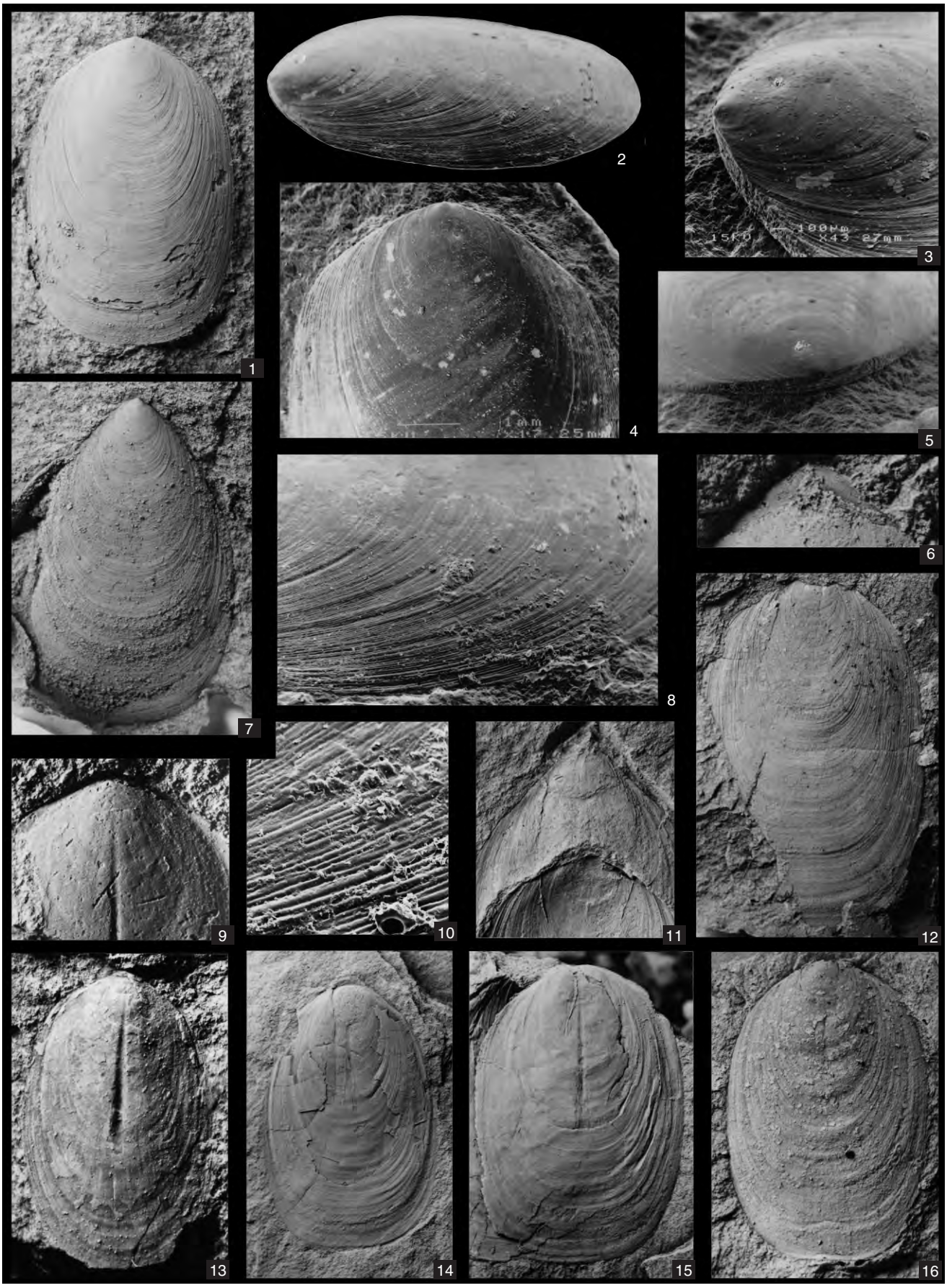

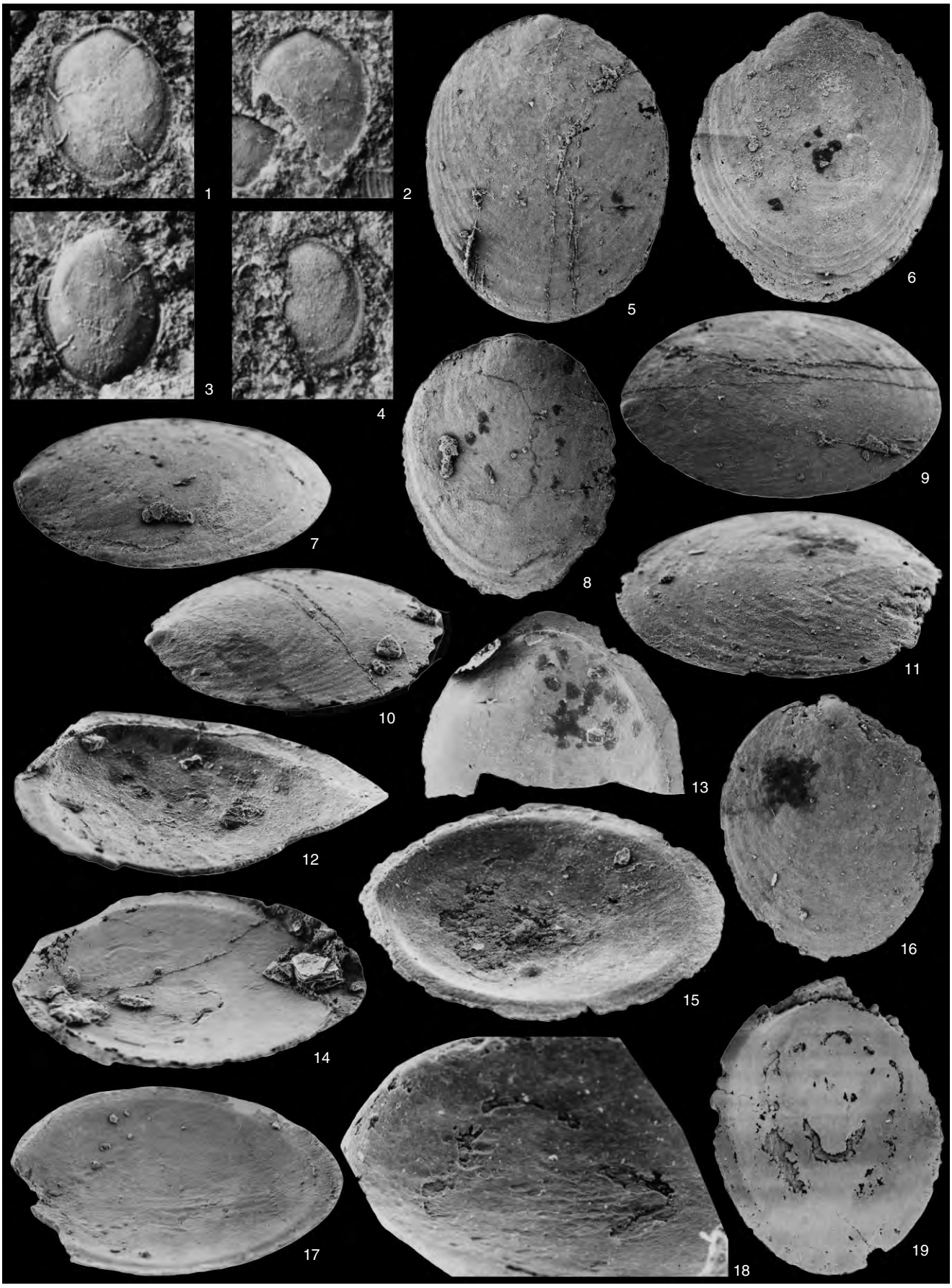
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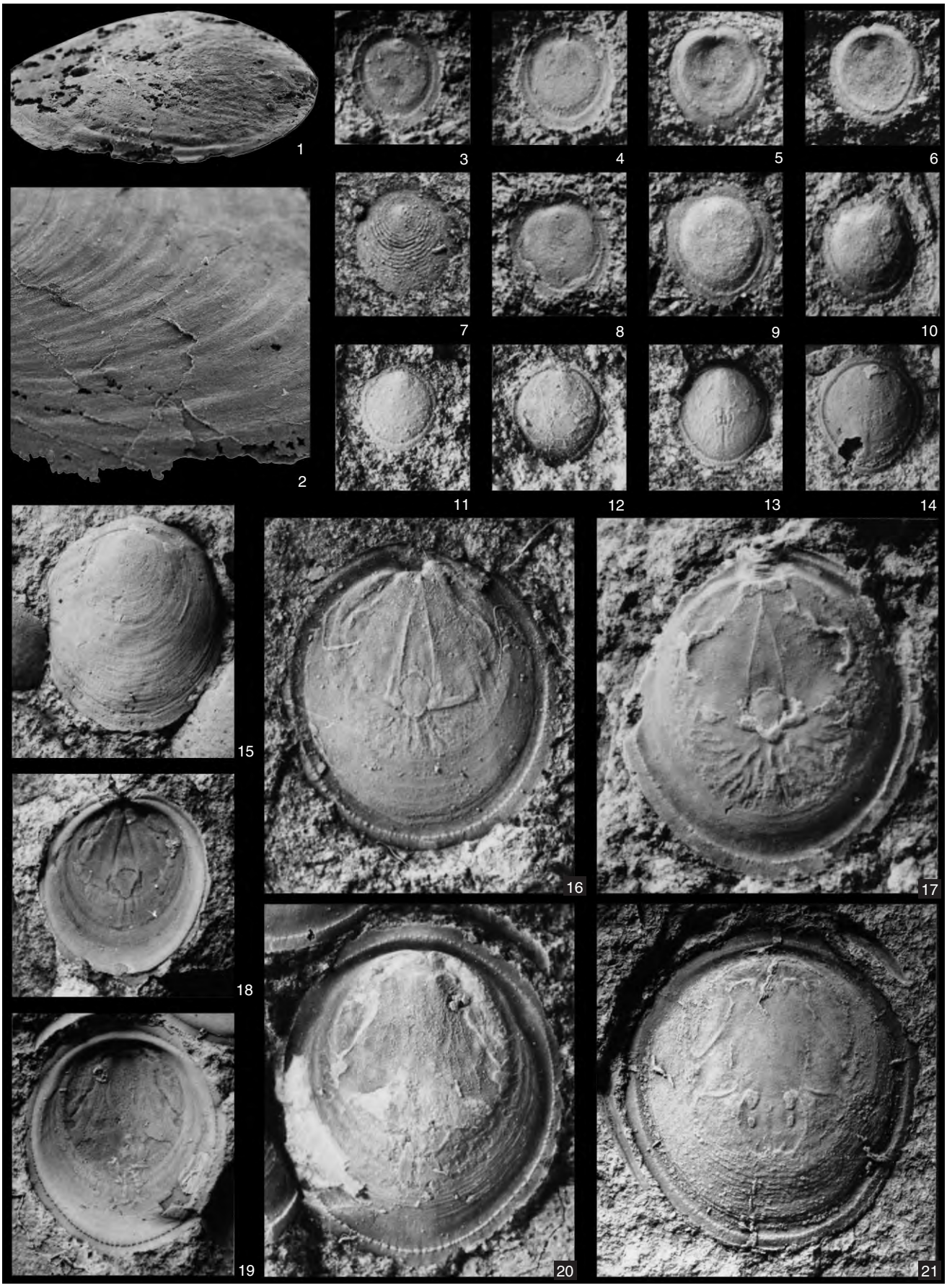

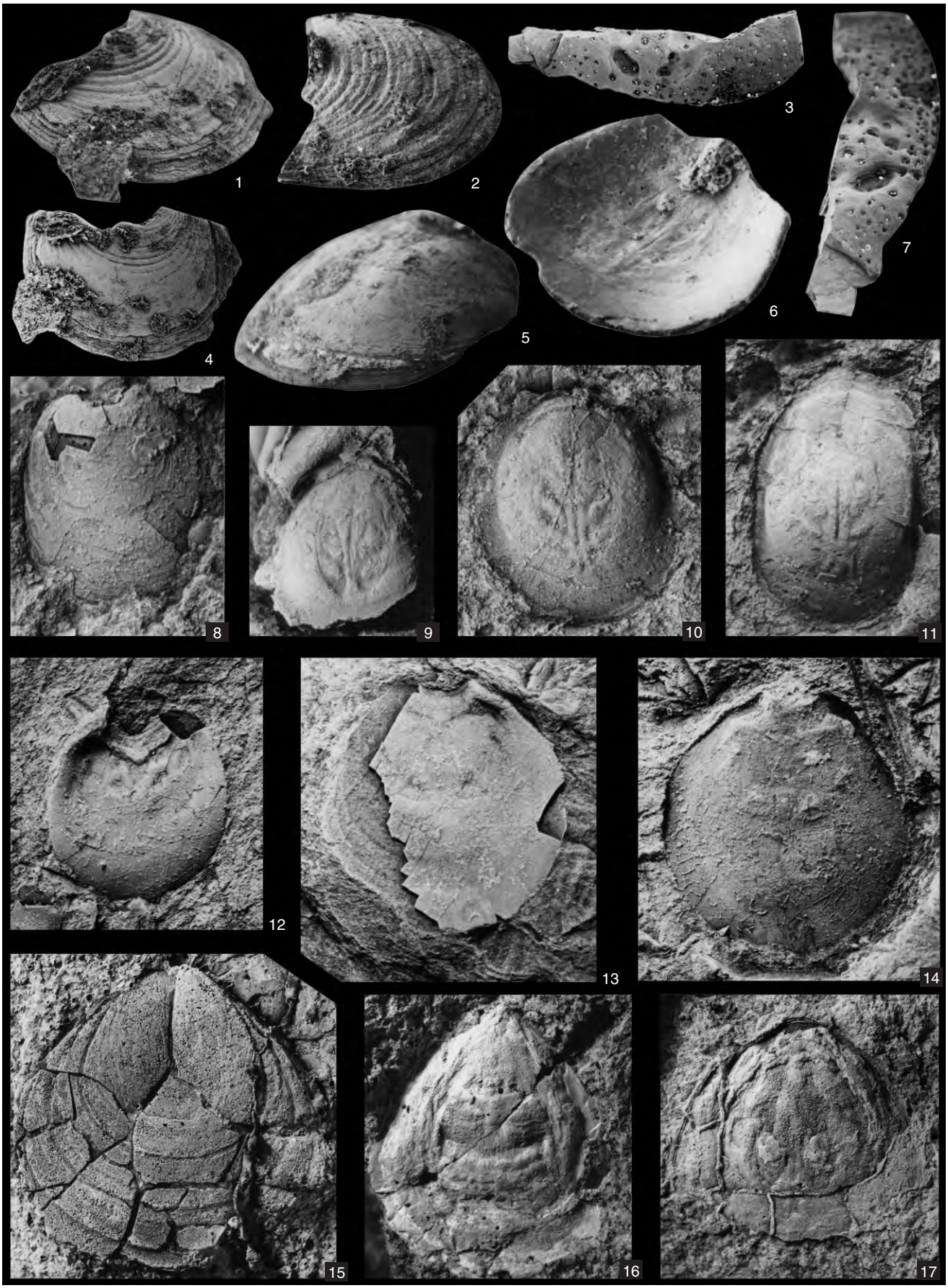
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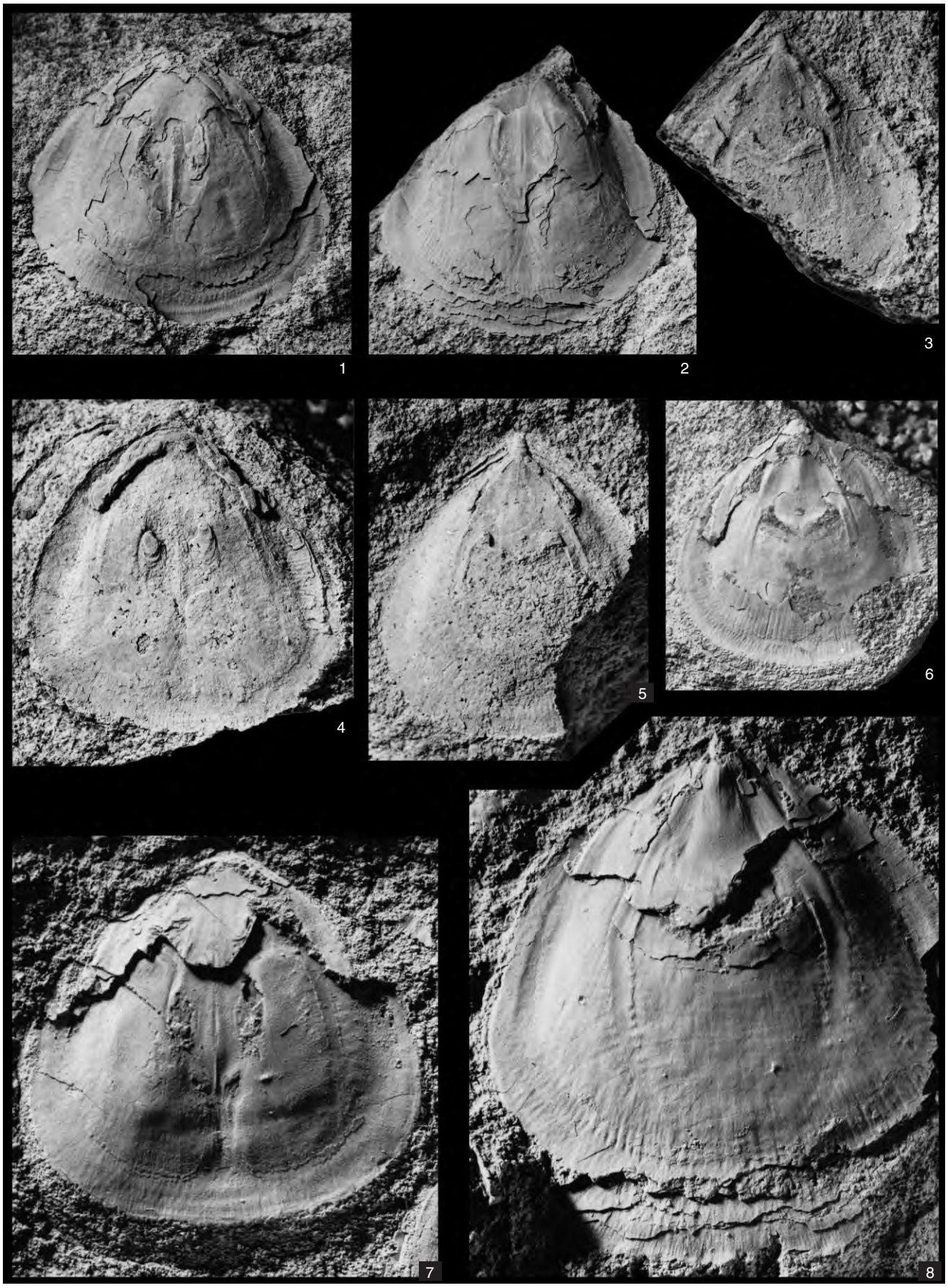


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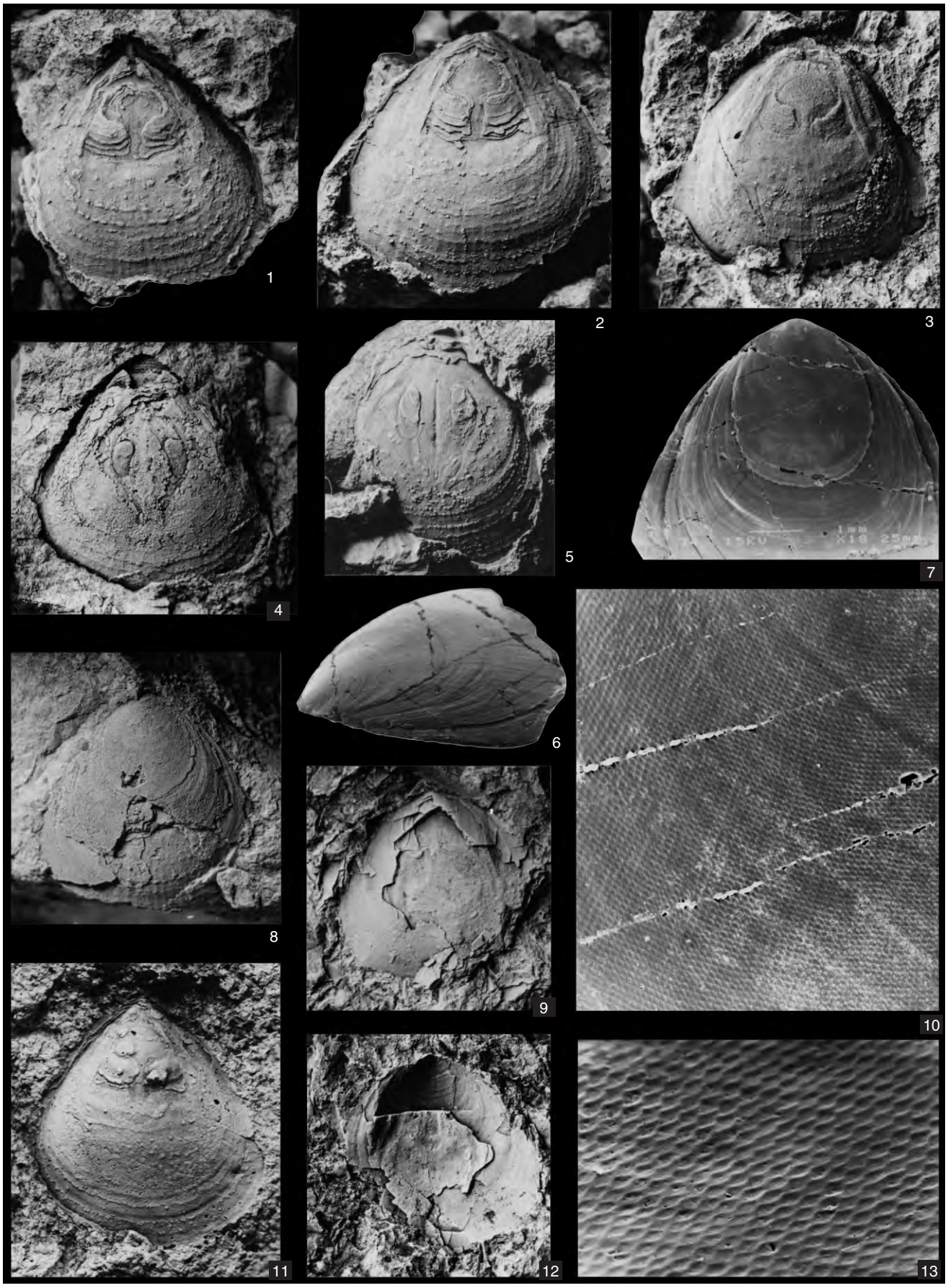
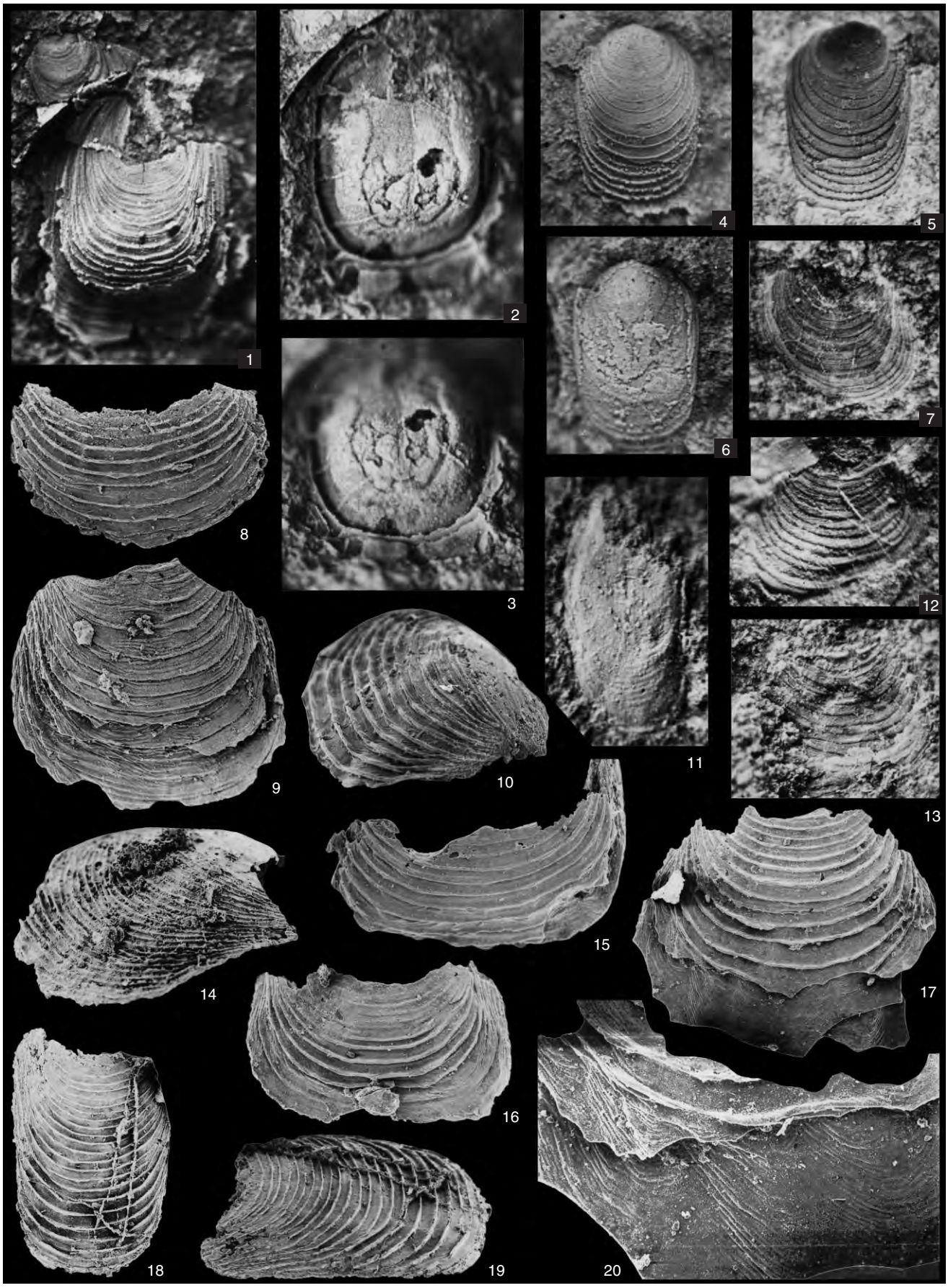
Plate 18

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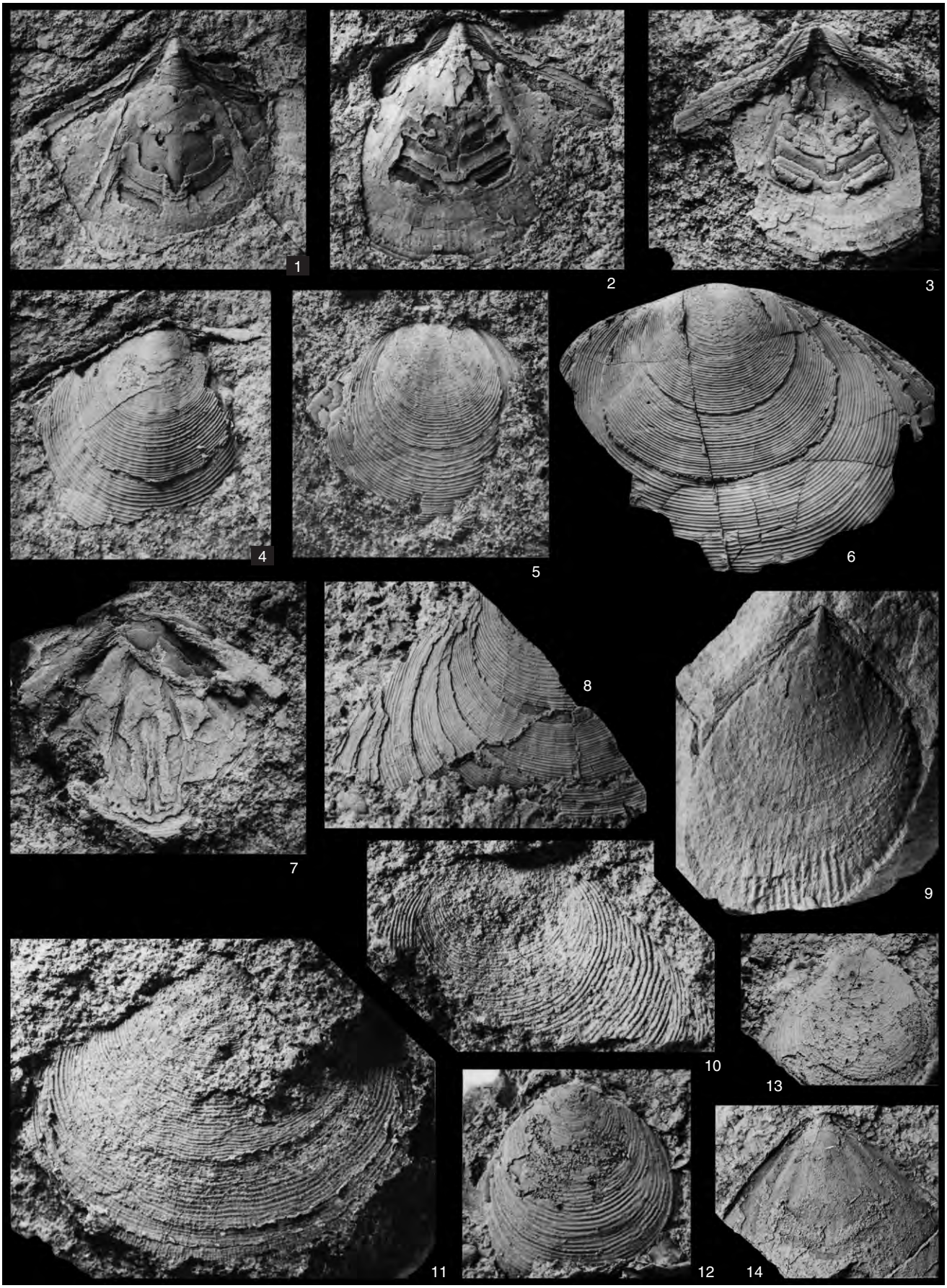

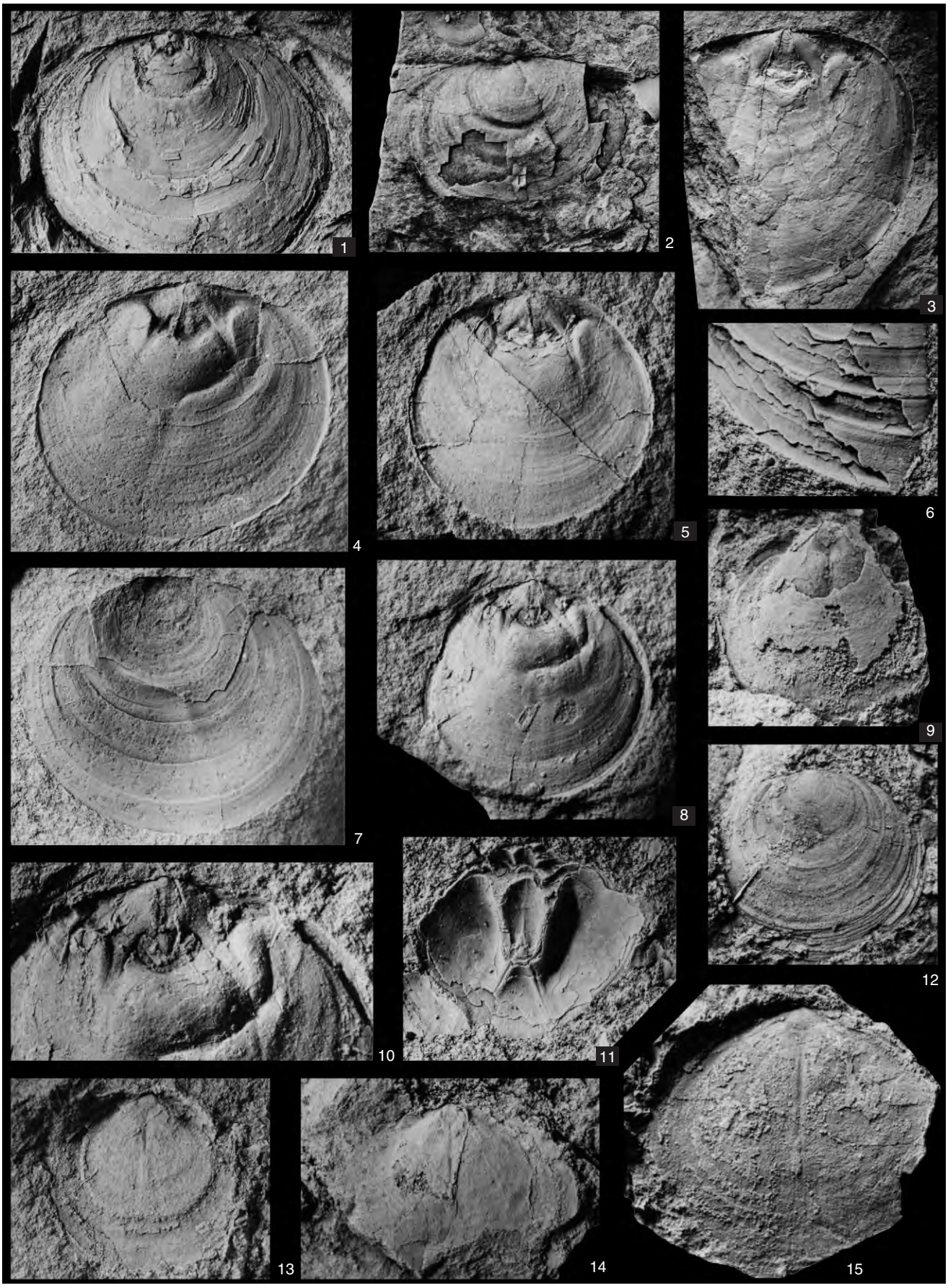
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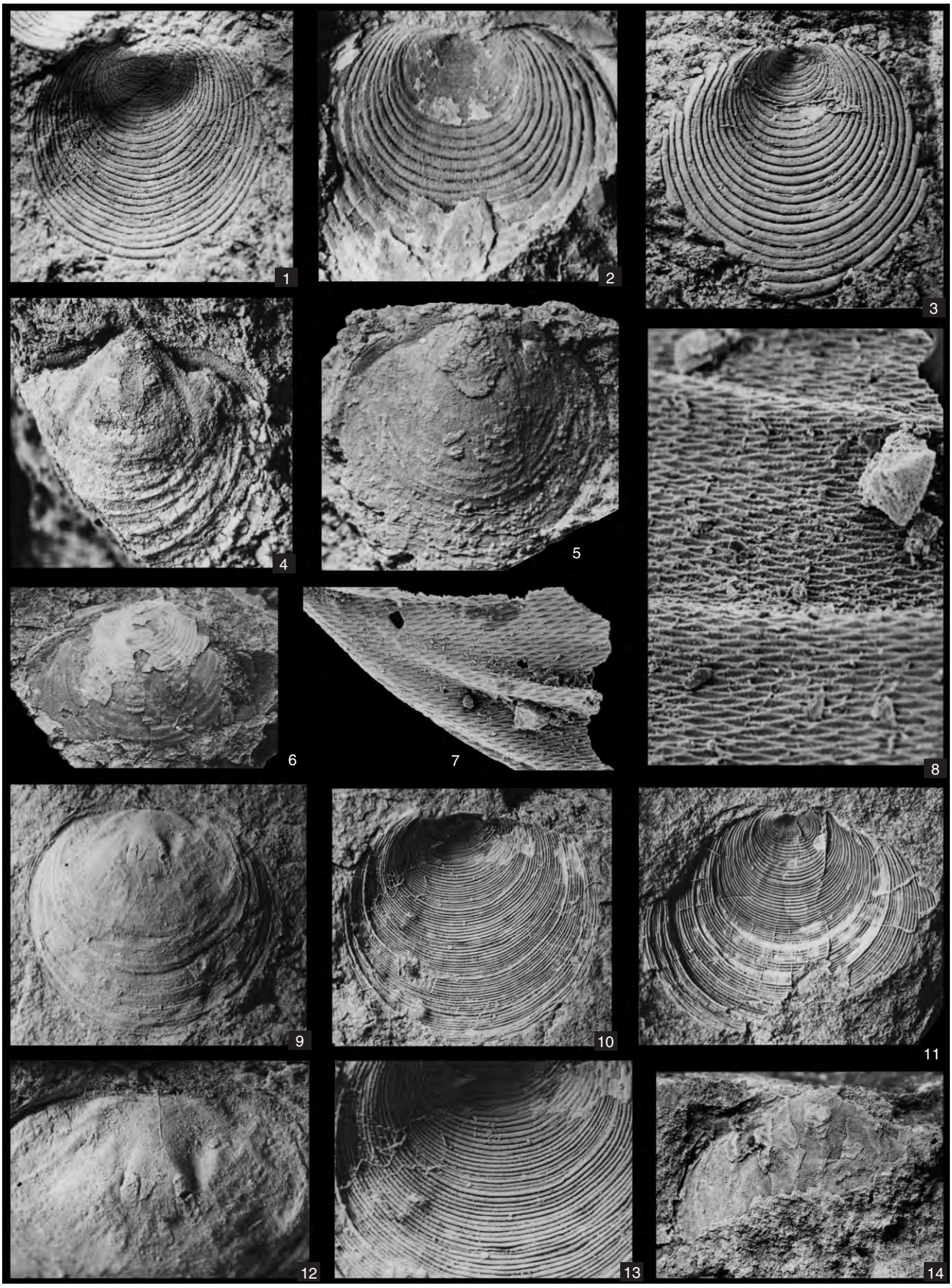

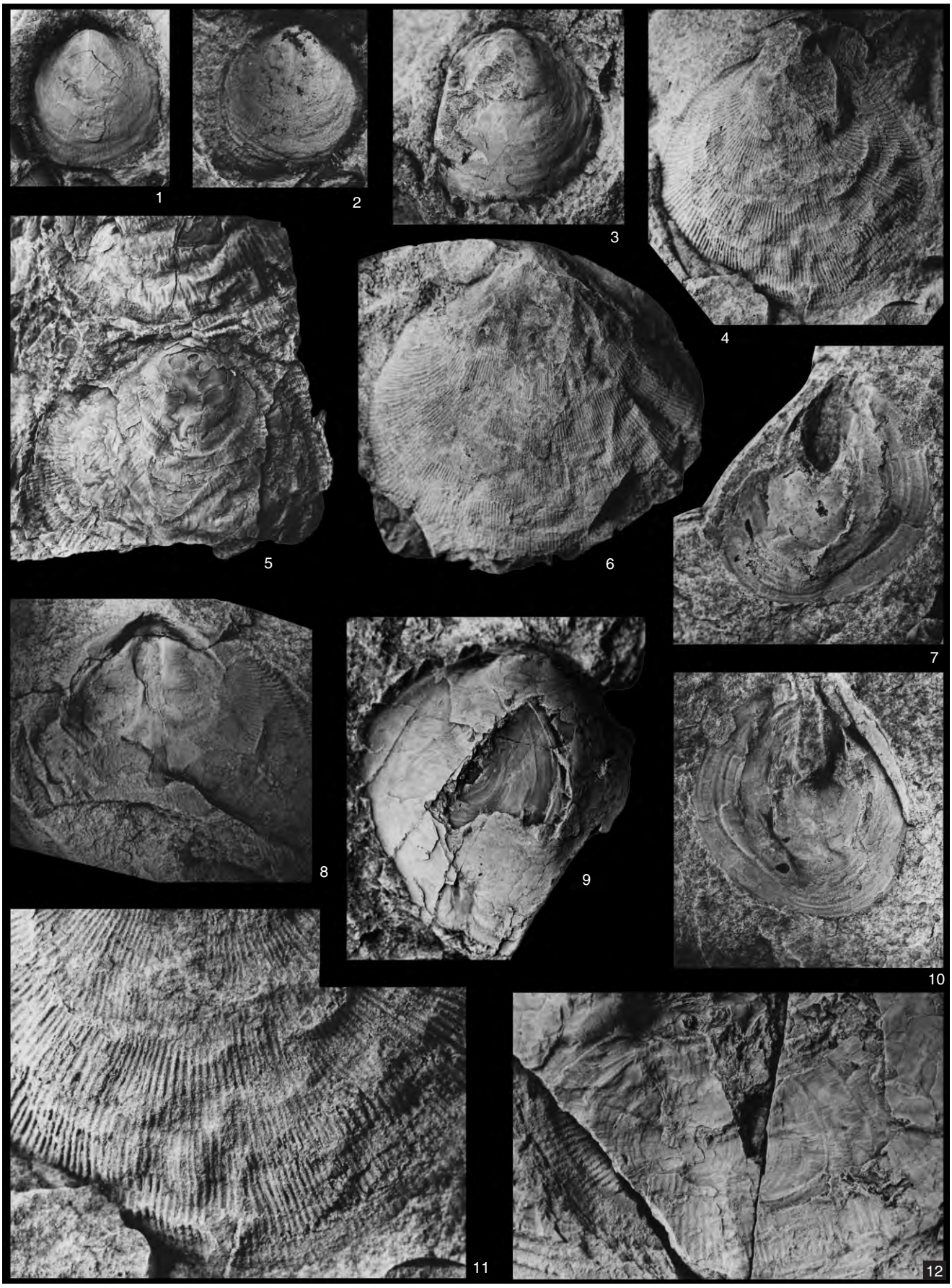
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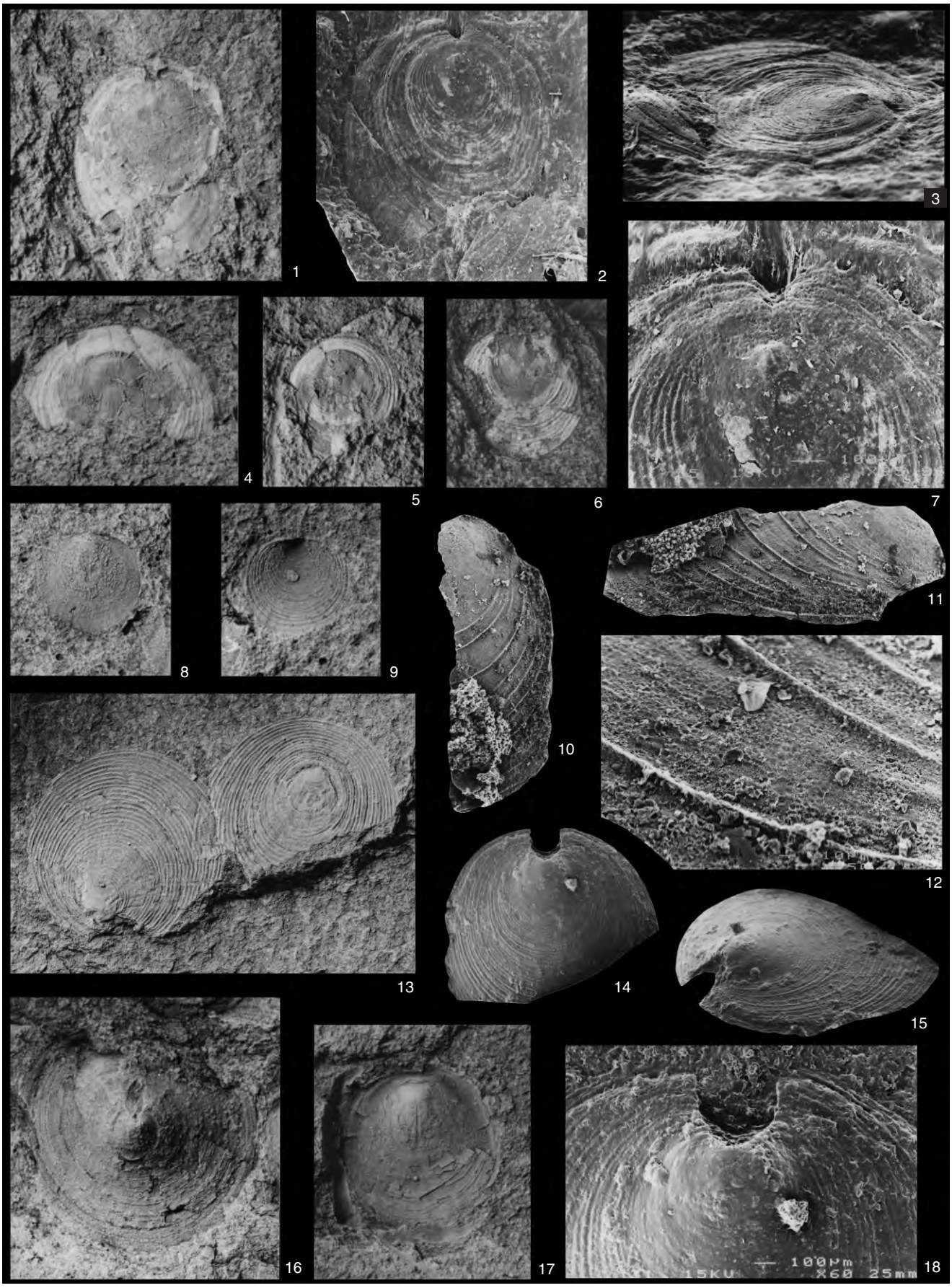

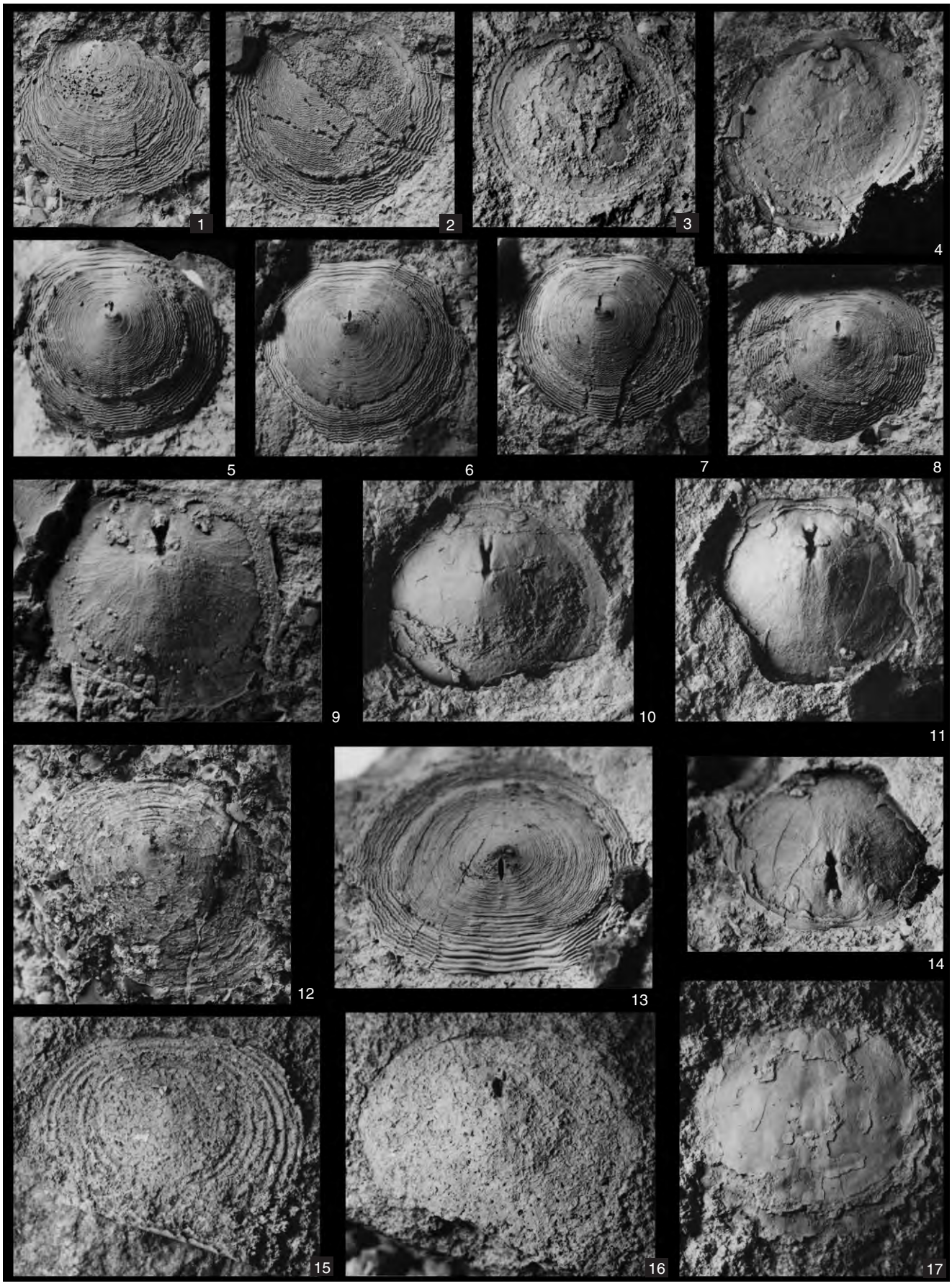
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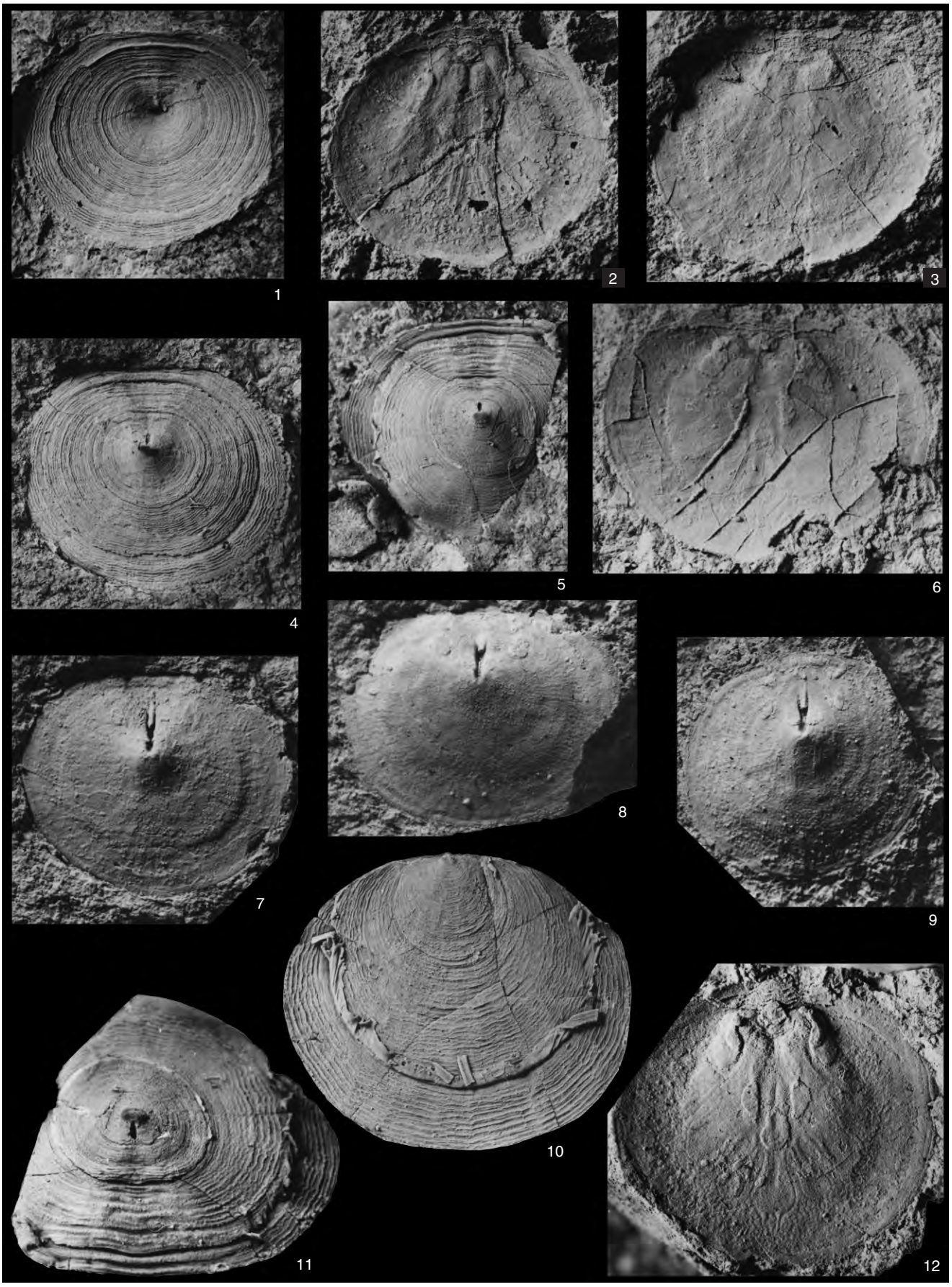

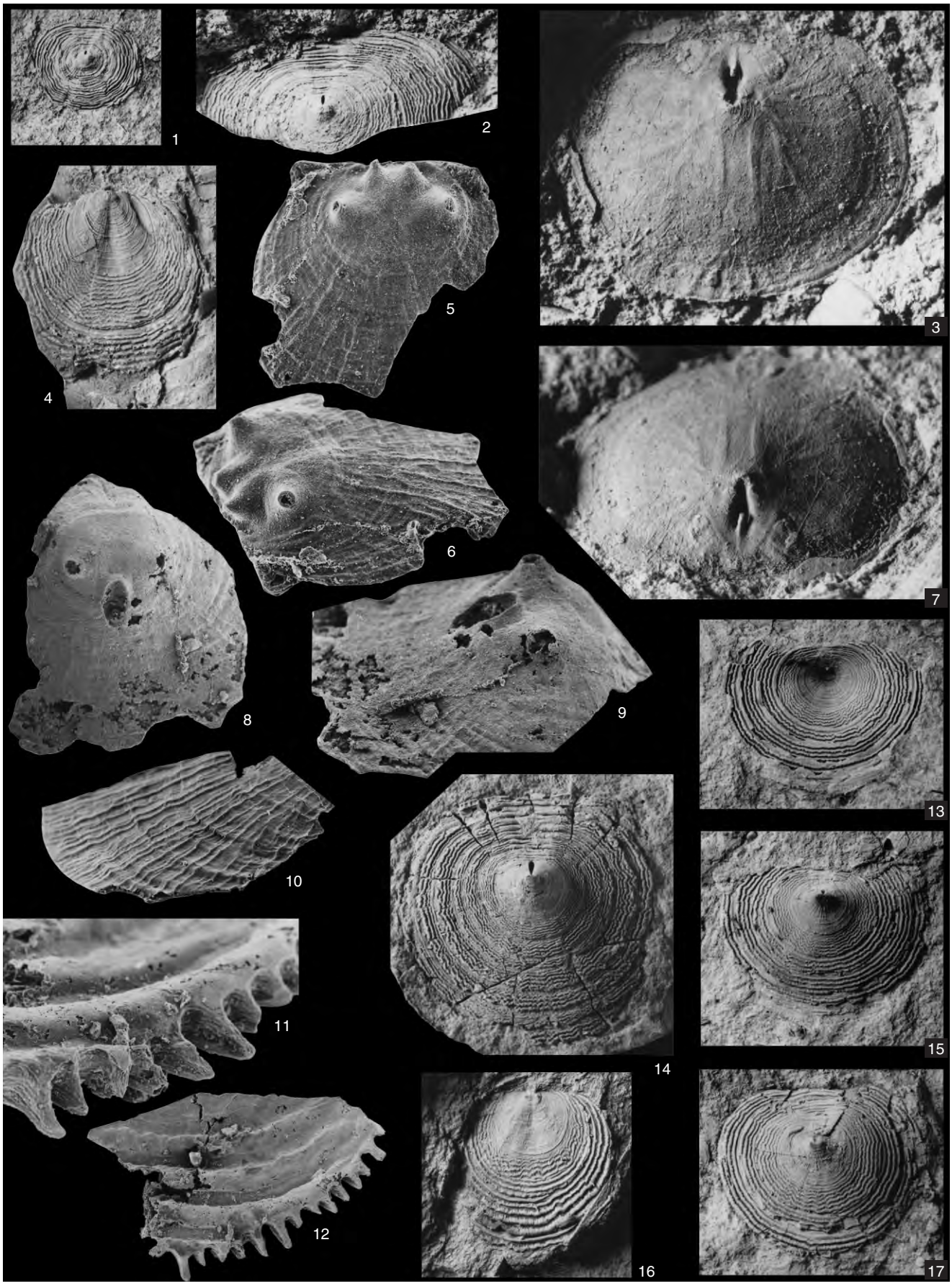
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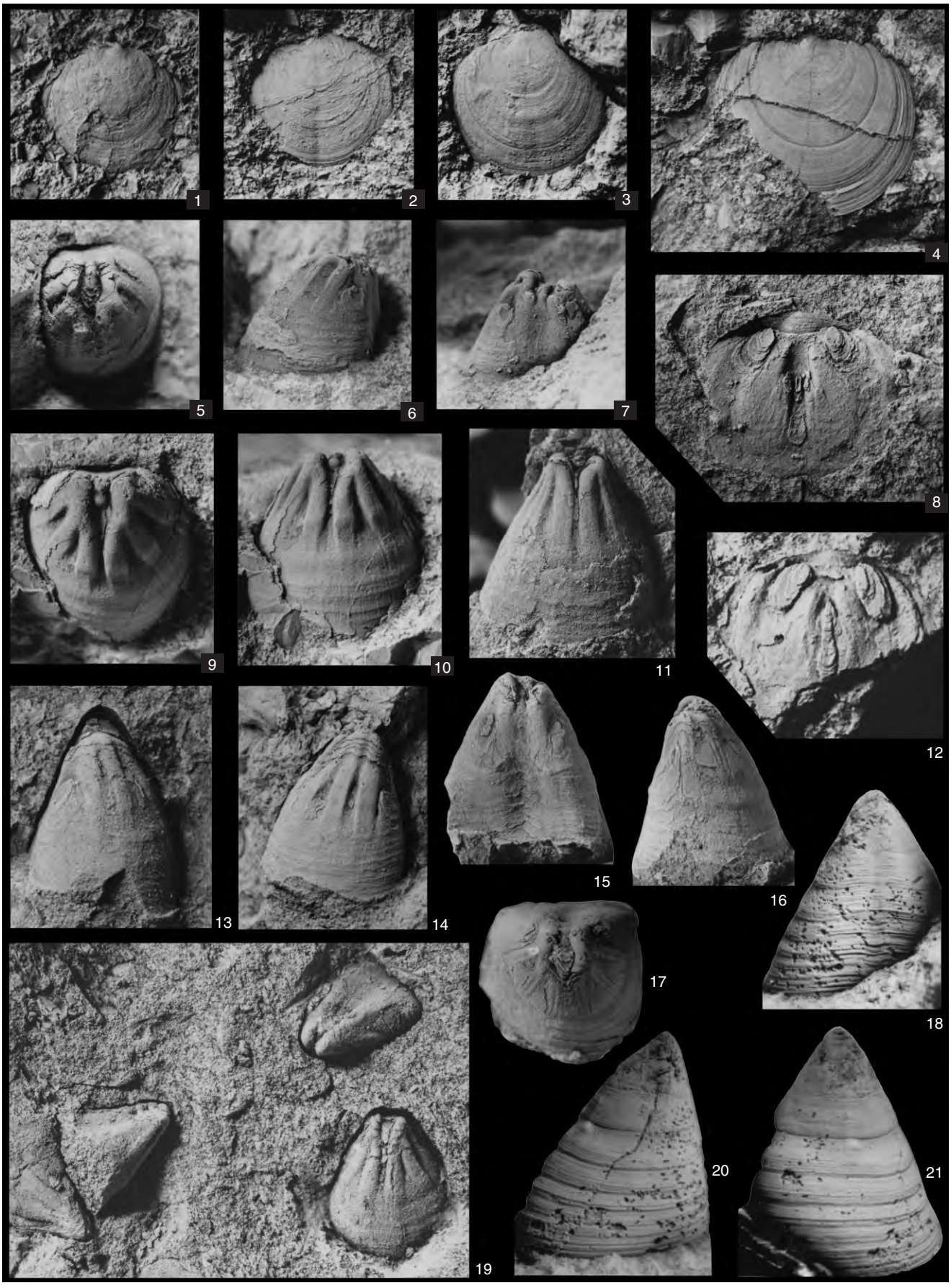
Plate 28



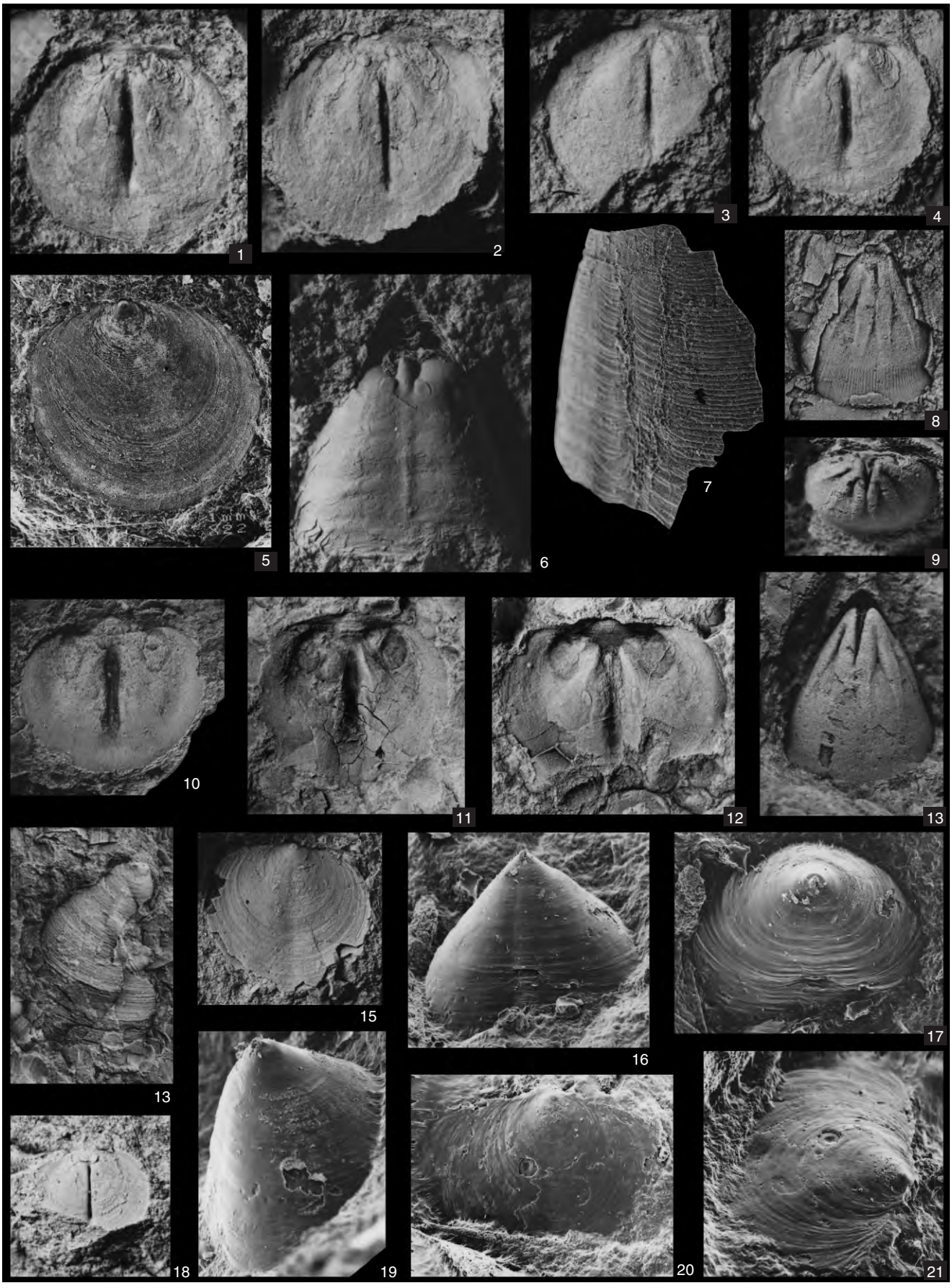

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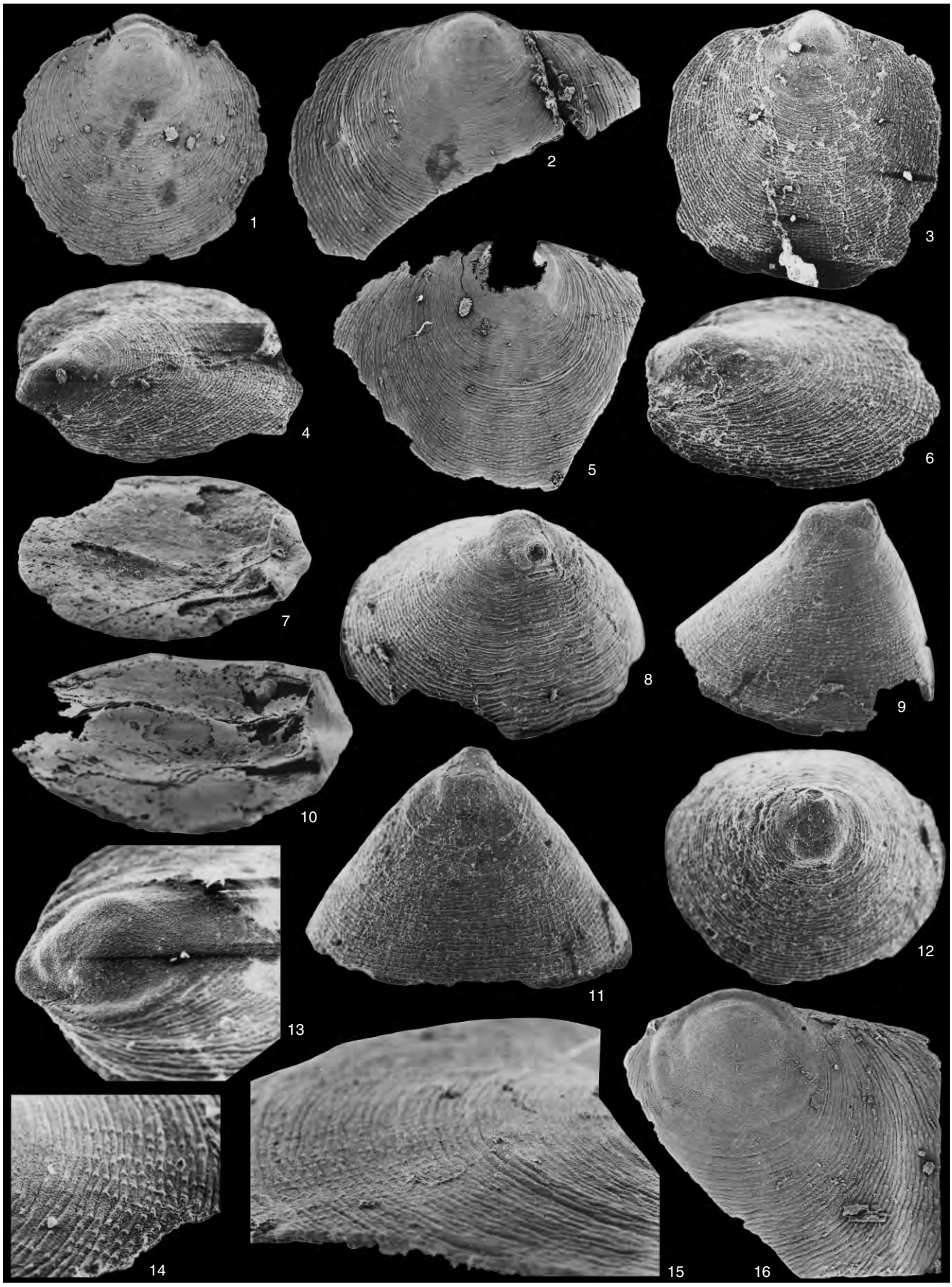
Plate 30



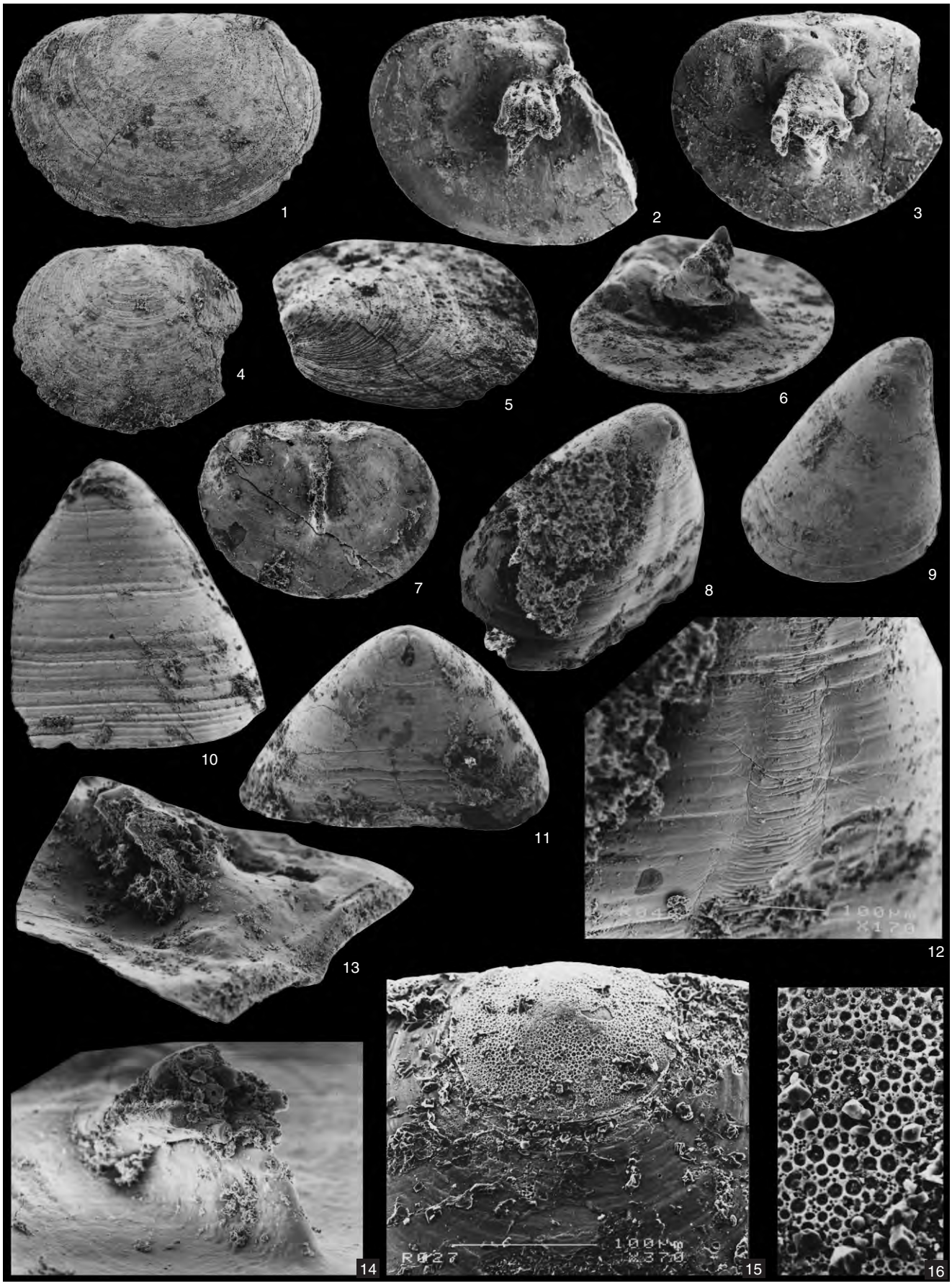

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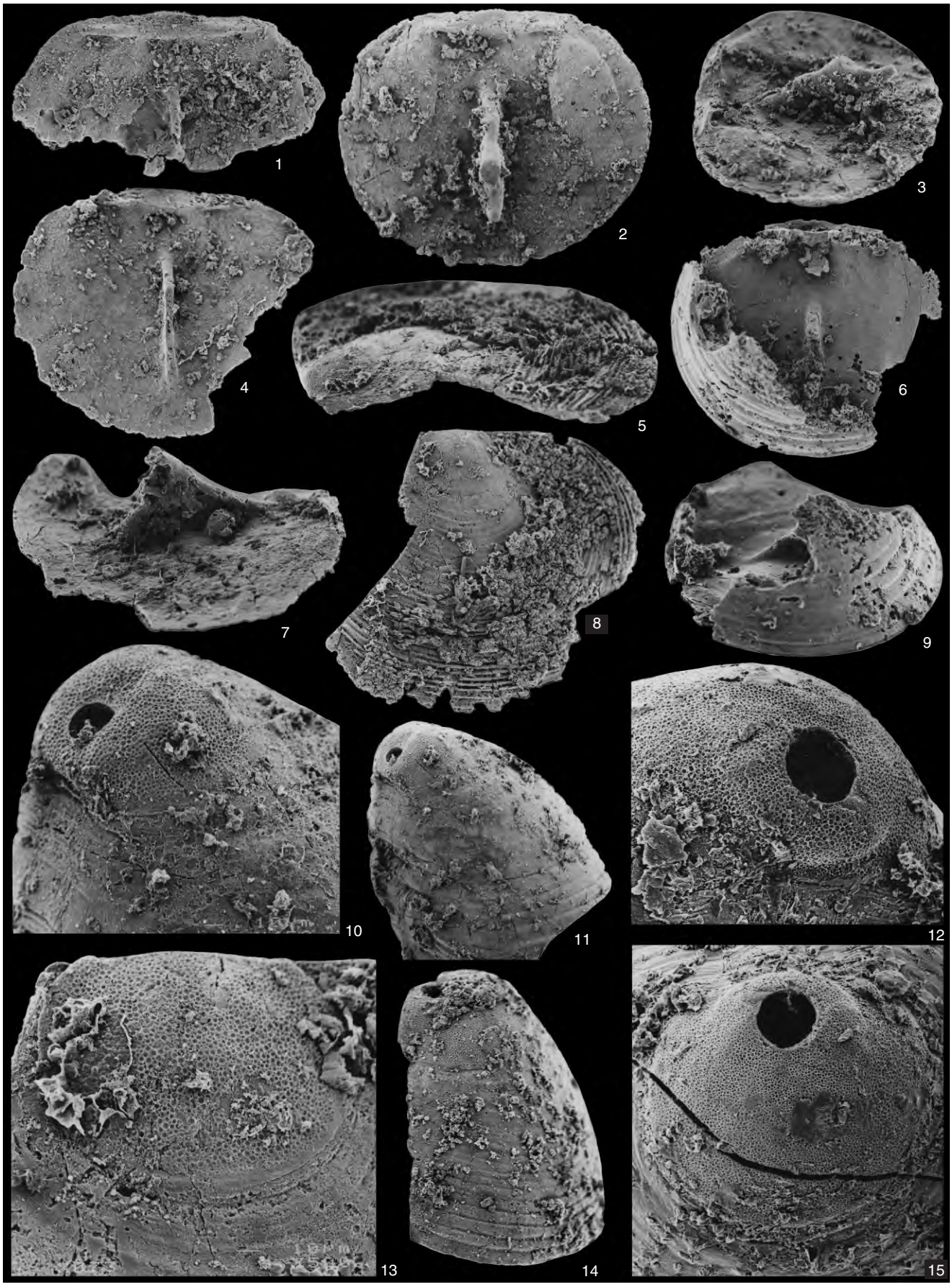
Plate 32



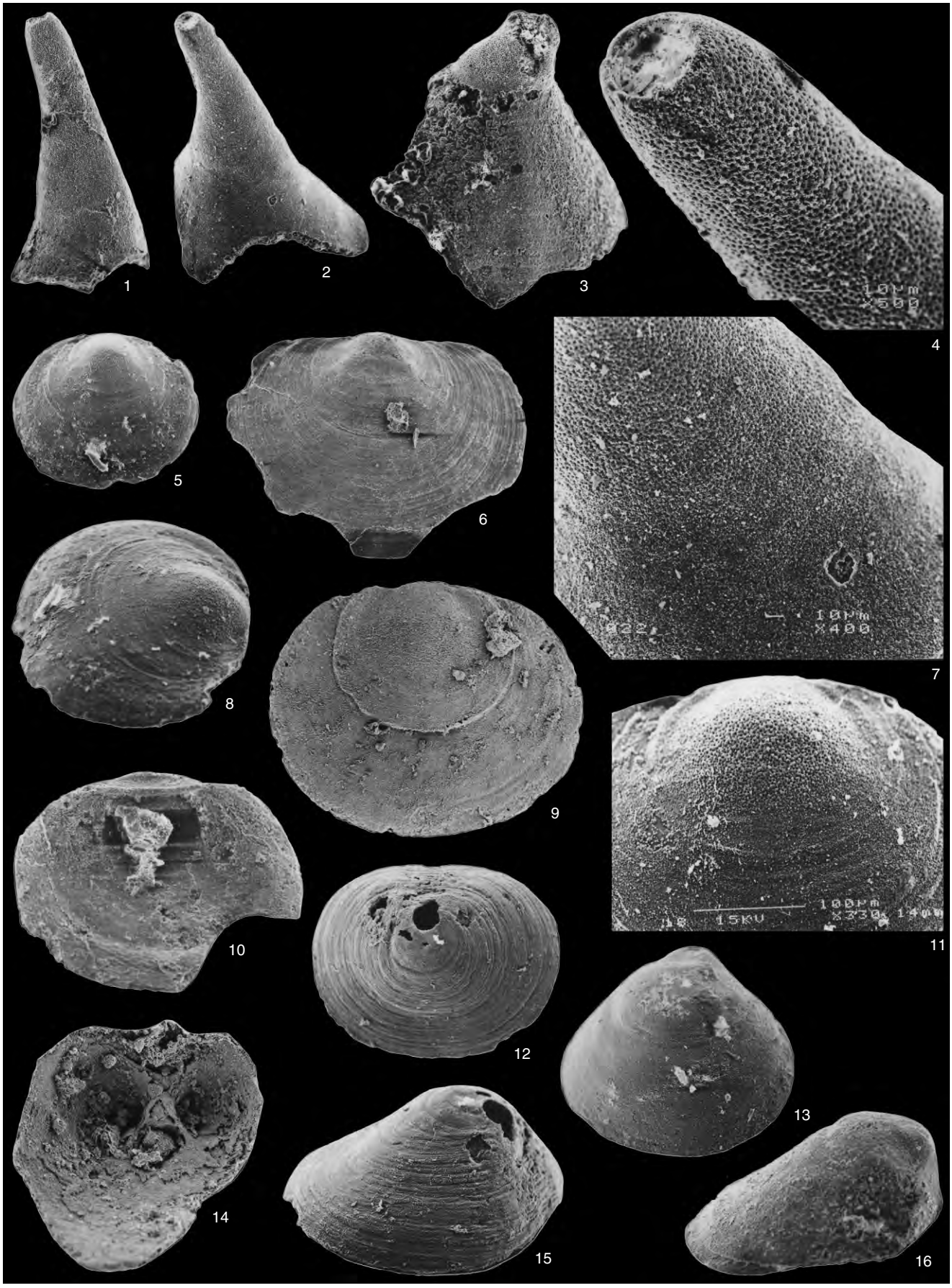

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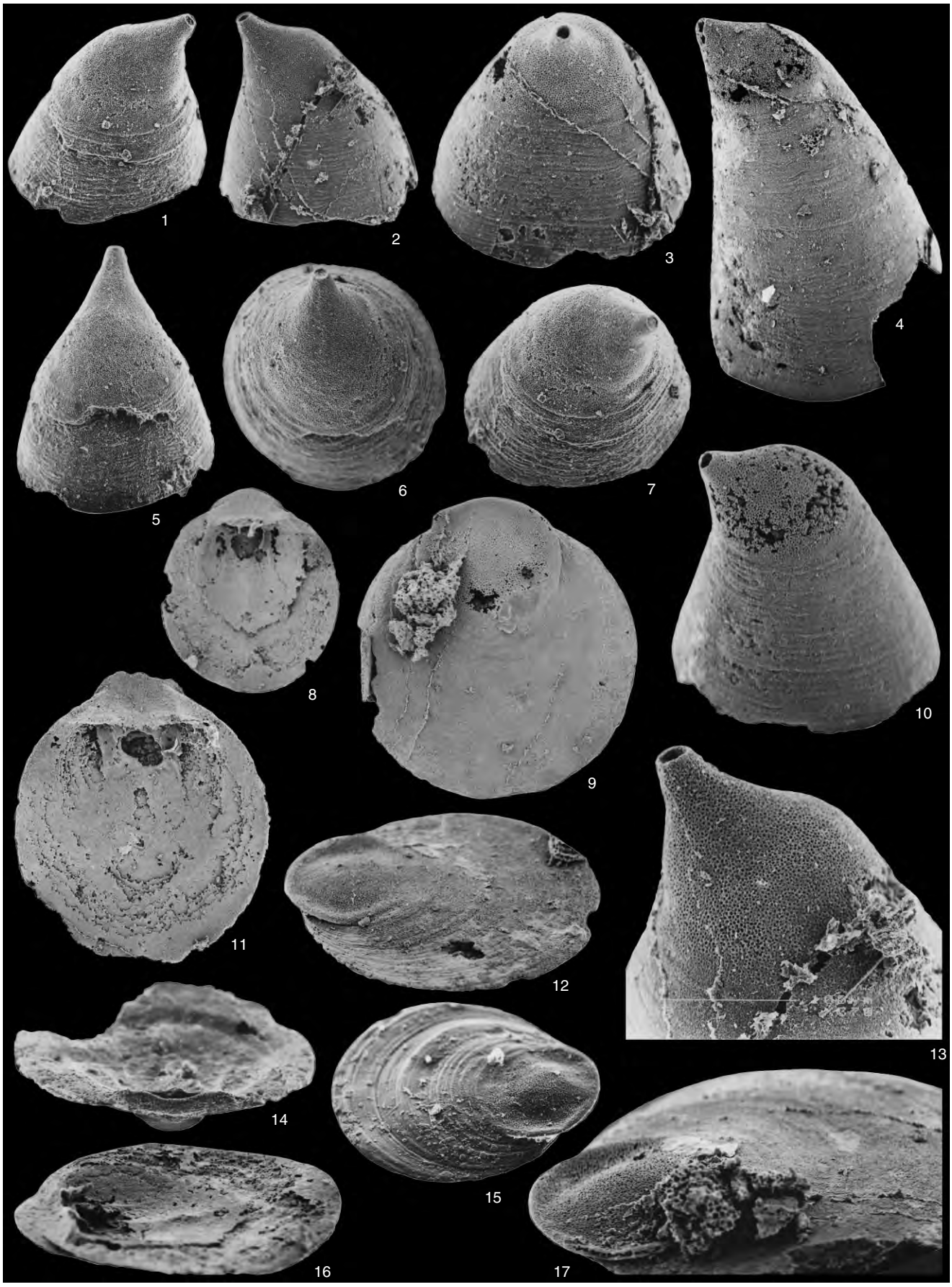
Plate 34



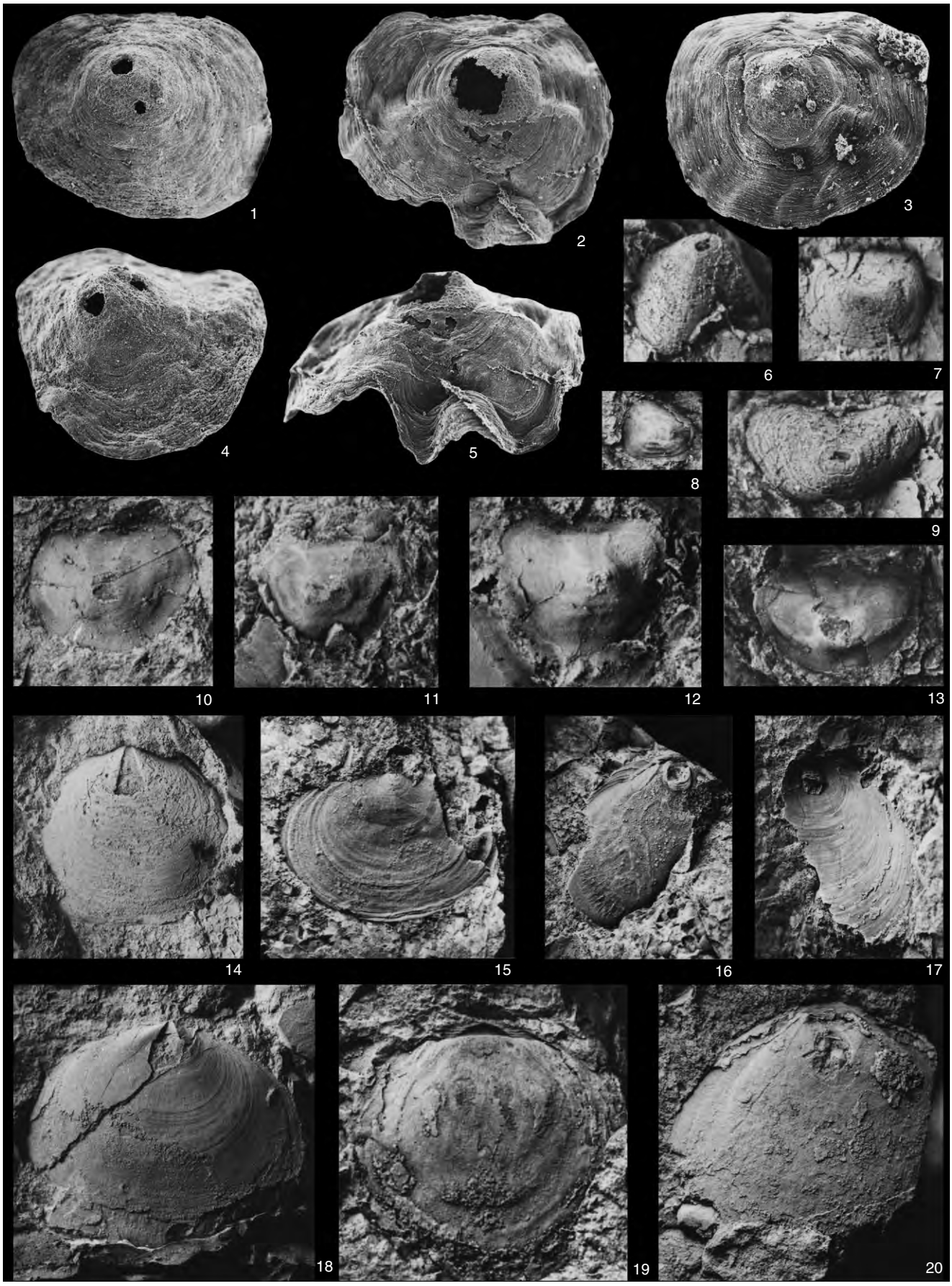

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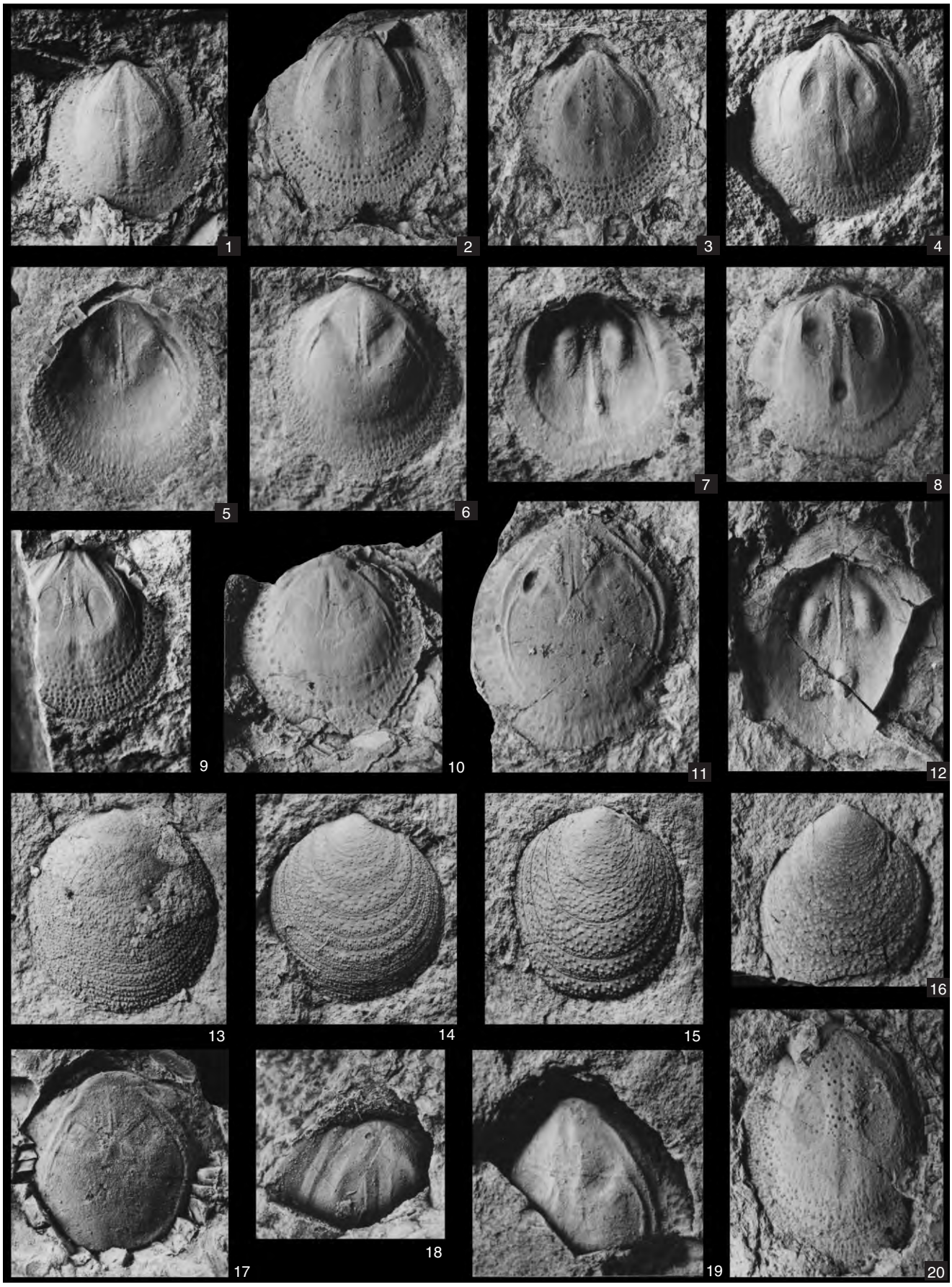
Plate 36



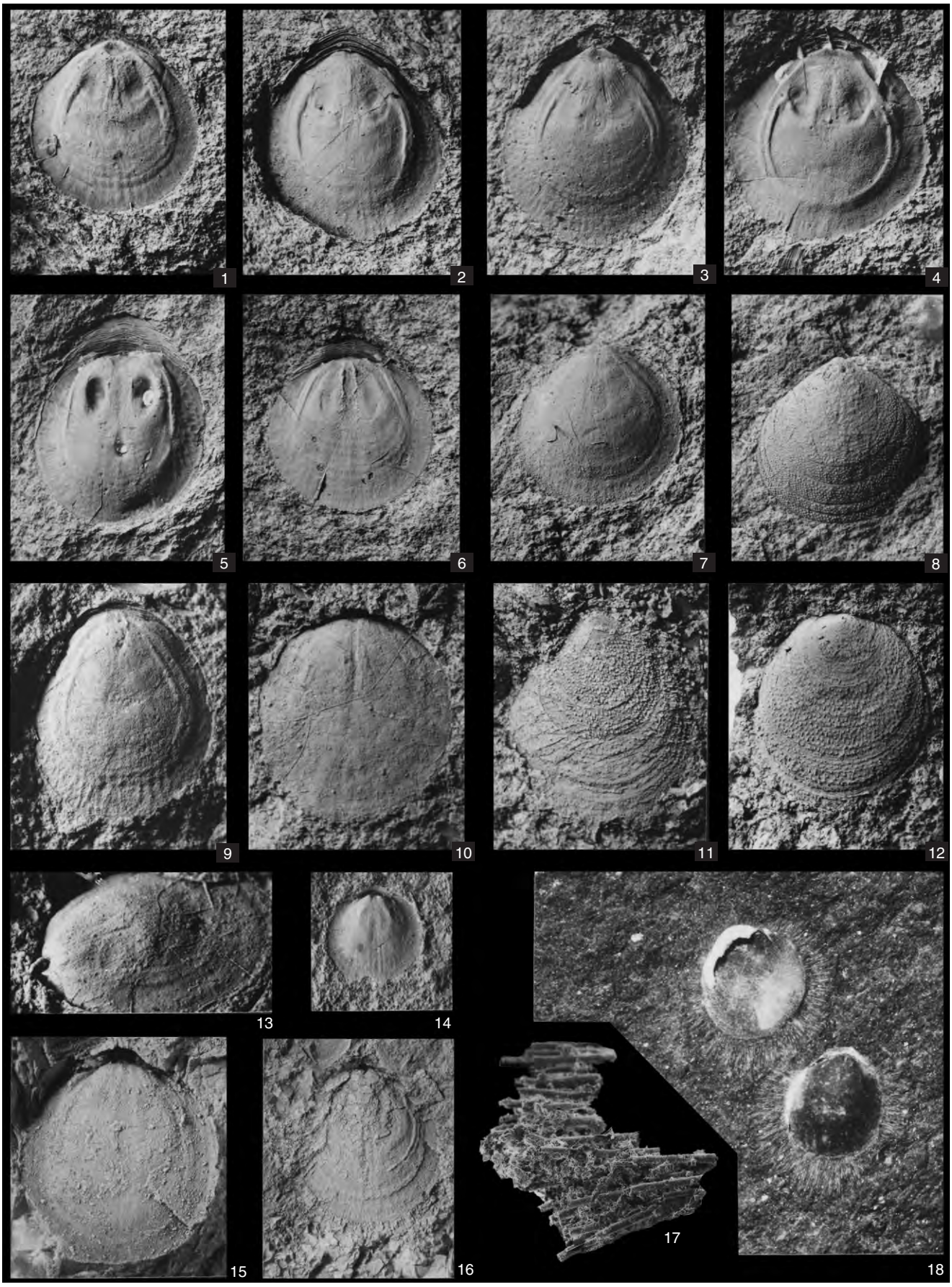

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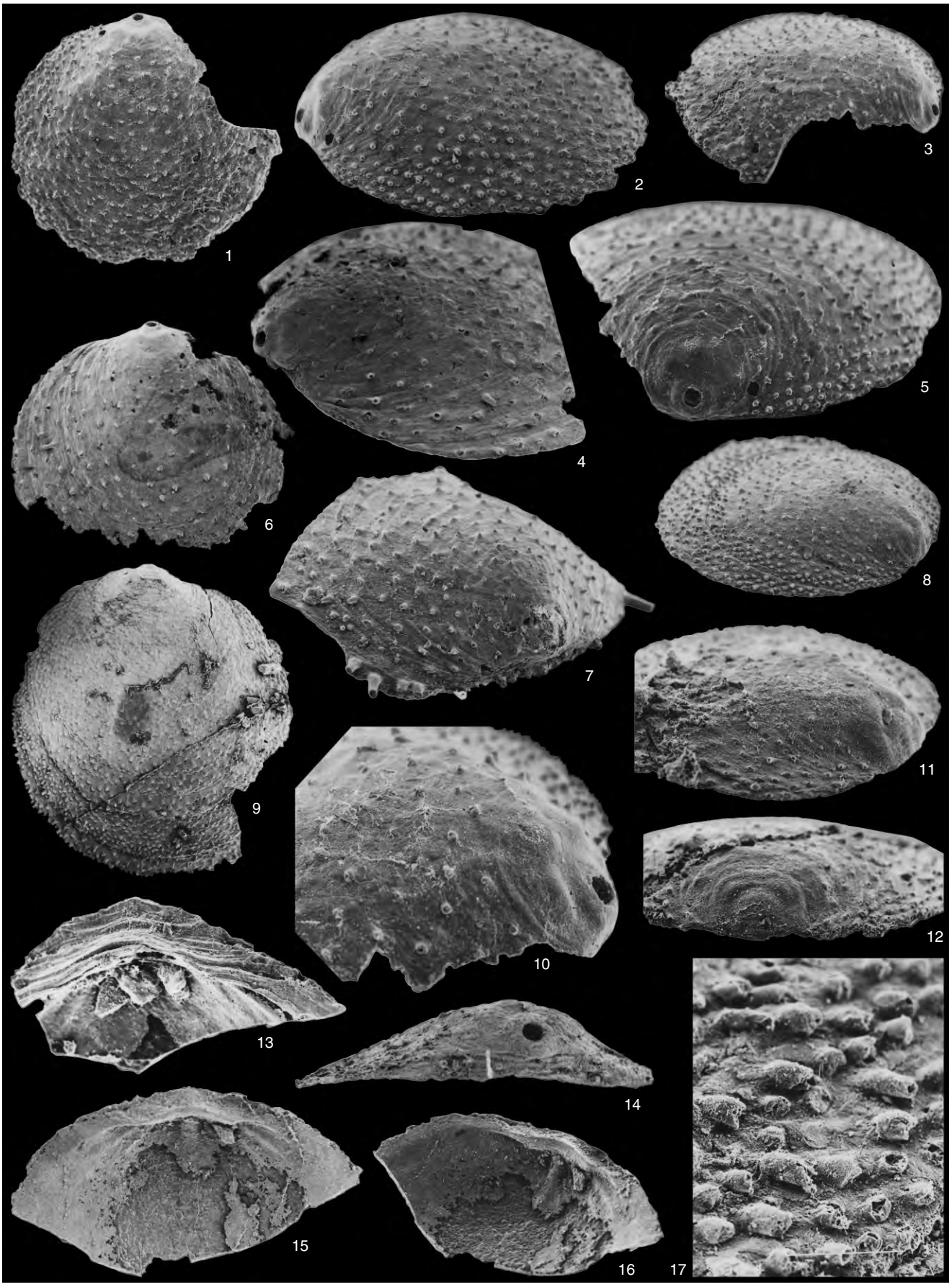
Plate 38



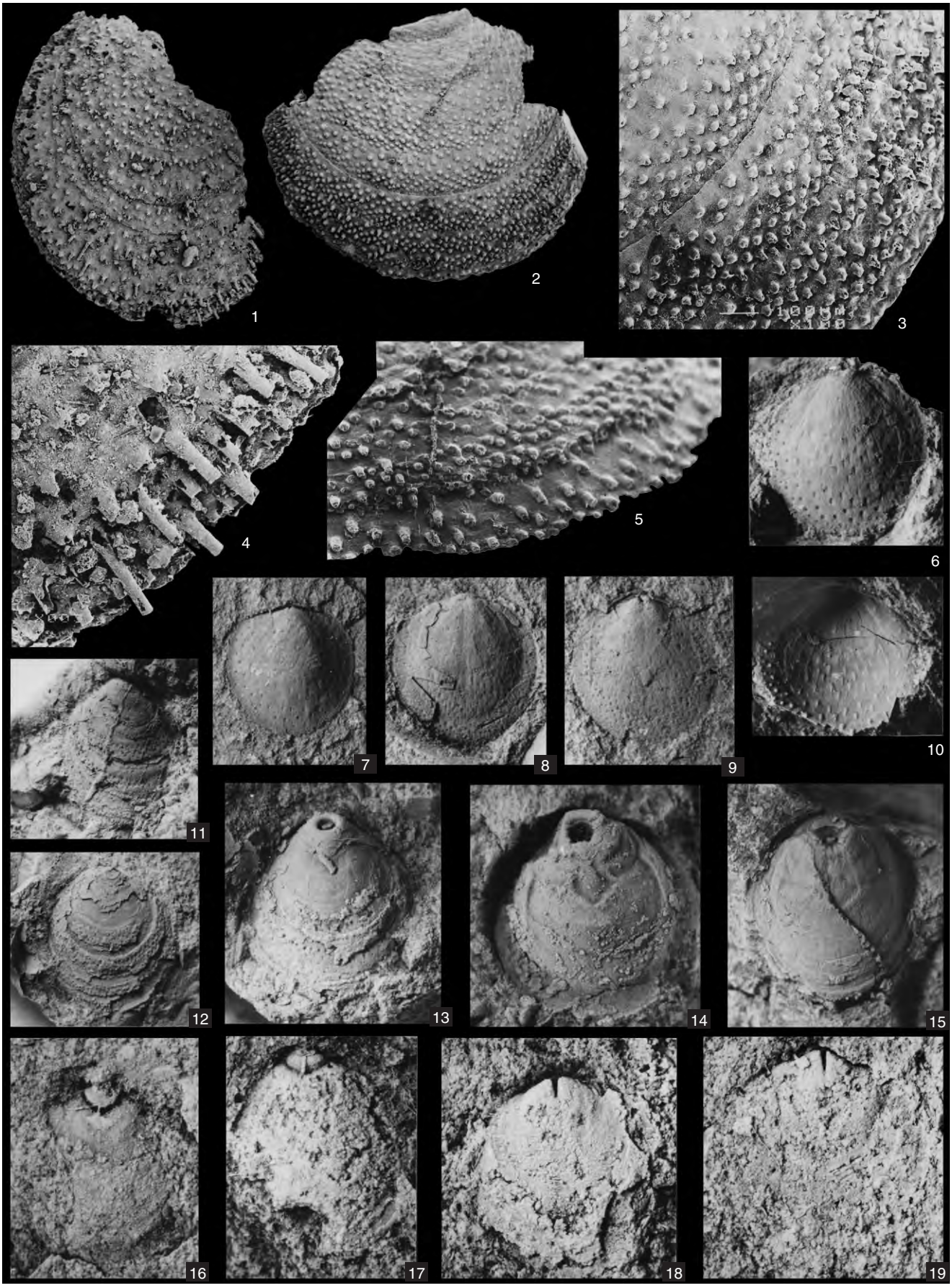

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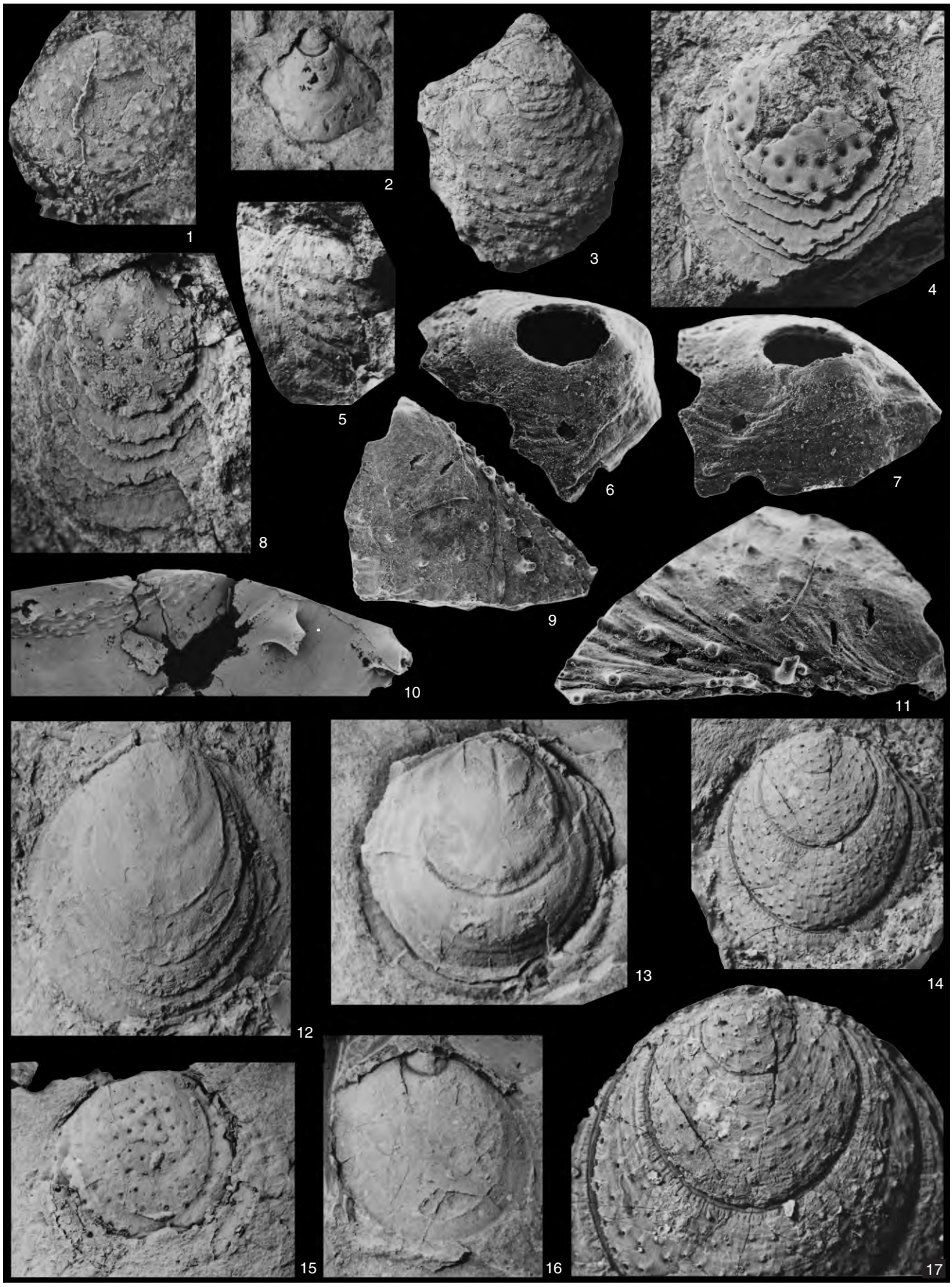
Plate 40



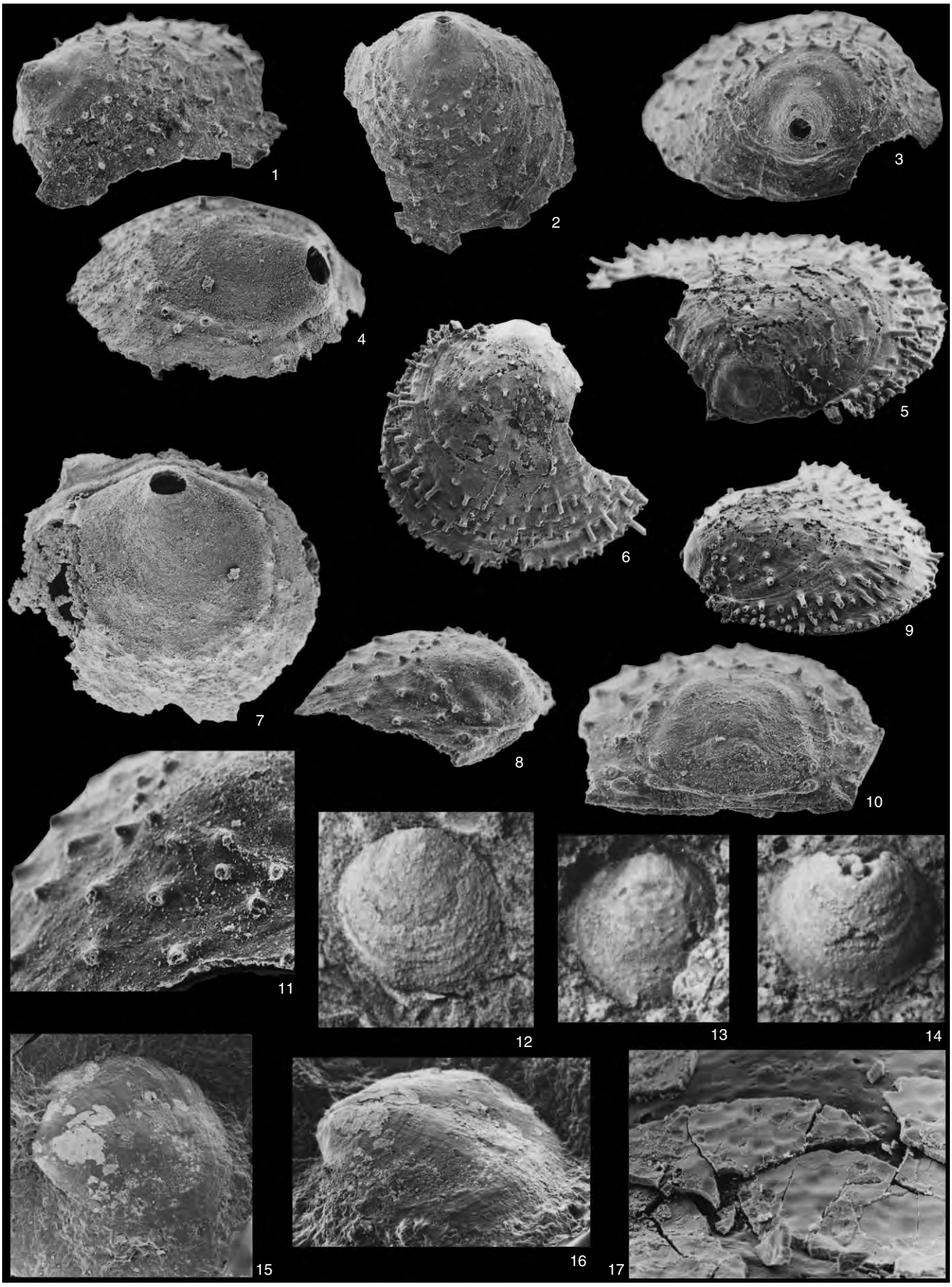

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Plate 42