

SILICIFIED BRACHIOPODS OF THE KOTÝS LIMESTONE (LOCHKOVIAN) IN THE BUBOVICE AREA (BARRANDIAN, BOHEMIA)

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Abstract: An exceptionally preserved silicified brachiopod material is described from the Kotýs Limestone (Lochkov Formation, Lochkovian) from two localities between Bubovice and Loděnice in the Central Bohemia. The shells have preserved the finest details of internal and external morphology, such as brachidia, crural plates, trails and spines, and represent the unique brachiopod material in the Barrandian. In total thirty-eight species have been determined, with new species *Dicoelosia praedimera*, *Muriferella pishulinae*, *Spinatrypina variabilis*, *Glassina gutta*, *Retzia piriformis*, *Ambocoelia bubovica*, and *Quadrithyrus subrobusta*. Genera *Muriferella*, *Anastrophia*, *Spinatrypina*, *Glassina*, *Retzia*, and *Quadrithyrus* have been recognized from the Lochkovian strata for the first time in the Barrandian. The composition of the brachiopod fauna in the studied sequence indicates a transition from a shallower, high-diversity assemblage with spiriferids, pentamerids, strophomenids, orthotetids, large orthids and spinose atrypids to a deeper, low-diversity assemblage with dominance of small orthids, and costellate and smooth atrypids.

■ Brachiopoda, taxonomy, shell morphology, Devonian, Lochkovian, Barrandian, Bohemia

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Introduction

In his latest published brachiopod paper, V. Havlíček (1999) described and evaluated the brachiopod fauna of the Lochkov Formation, the earliest Devonian unit of the Barrandian. His main attention was directed to a remarkably rich fauna of the Kotýs Limestone in the Svatý Jan pod Skalou area (Central Bohemia). The brachiopod list compiled by him comprises 53 rhynchonelliform brachiopods, of which V. Havlíček described six species as new. A remarkably rich brachiopod assemblage of the Lochkovian age occupied, according to Havlíček (1999), the top of submarine volcanogenic accumulation near Svatý Jan volcanic centre. This local shallow water environment was favourable for rich marine life, with dominant brachiopods and crinoids among the sessile animals. The brachiopod communities flourished on a shallow bottom surrounded by much deeper basinal environment in S and E, with less diverse level-bottom communities.

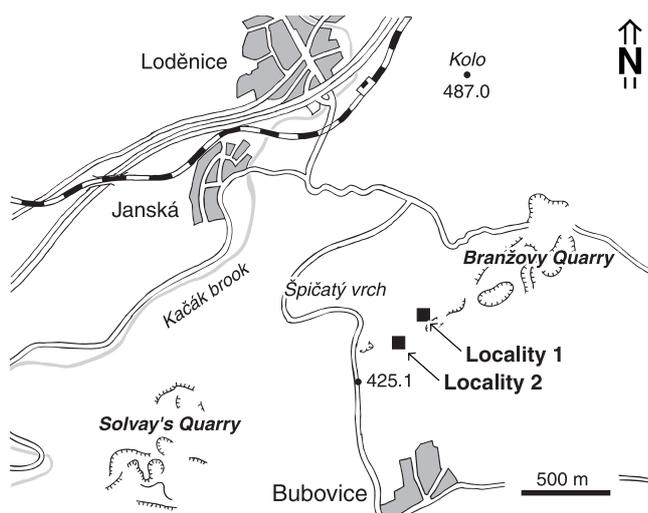
In historical overview, already Joachim Barrande knew some of the brachiopods of the Kotýs Limestone in mid of the 19th Century (Barrande 1847, 1848). Some thirty years later, in his *Système Silurien du centre de la Bohême*, Barrande (1879) described sixteen species, which were revised by Vladimír Havlíček in several papers between 1959 and 1999 years.

Despite the long time span of the study of the Lochkovian brachiopod fauna, numerous species remain poorly known. This is due to their rarity and poor preservation, with fragmentary shells, often lacking fine morphological details. Especially, the orthid brachiopods (Havlíček 1977)

were described on extremely fragmentary shells, even with obscure general outline and convexity. Other species were based on few specimens and only basic data of their internal morphology were described. Limited number of specimens did not allow any evaluation of the morphological variability and growth changes. The internal morphology of some brachiopod groups (e.g. atrypids, spiriferids) was studied by serial sectioning, but partial silicification obscured some details. Consequently, the illustration and description of many species do not correspond with a modern standard of a systematic taxonomy, and some taxa remain inadequately known for a comparison with foreign species. Indeed, although taxonomy of brachiopods from the Kotýs Limestone has been almost resolved by Havlíček (1999), much important information remained unknown.

This poor knowledge of some elements of the brachiopods fauna of the Kotýs Limestone was, among others, the result of sampling methods and mode of preservation. The shells used by Havlíček (1967, 1977, 1999) were partially collected by hammering and partially by washing of shells from deeply weathered limestone beds. However, a natural corrosion of the calcareous or partially silicified shells resulted into poorly preserved specimens, especially of thin-walled and minute species (e.g. *Navispira*, *Atrypina*, *Skenidioides*).

A discovery of unweathered limestone with abundant silicified brachiopods, corals and rarely other fauna made possible the etching of limestone blocks by hydrochloric acid solution. The residues yielded numerous and remarkably well-preserved brachiopod shells, sometimes with preserved lophophore supports, fine spines and trails, and other features undiscovered by the former sampling methods.



Text-fig. 1. Map of Loděnice – Bubovice area (Barrandian, Central Bohemia) showing localities 1 and 2.

The aim of the paper is to better illustrate the previously described species, to re-evaluate some described taxa on newly discovered morphological features, and to describe newly collected species. In the systematic part, all new important data for brachiopod taxonomy are presented. A short diagnosis of species is given where it is possible. The new descriptions, redescription of imperfectly known species or descriptions of new morphological features are presented in addition to the data already published. The species previously described in detail are only commented or illustrated. The answers to many expressed questions by Havlíček (1999) concerning the systematic position of particular taxa could be resolved. However, only the newly collected species are illustrated and commented, leaving some by Havlíček (1959, 1961b, 1967, 1977, 1992a, 1992b, 1999) described species from the Kotýs Limestone without any comments. The ecological evaluation and biogeographic affinity of the fauna will be published elsewhere.

Localities

New silicified material was collected in two localities between Bubovice and Loděnice, some 7 km NE from Beroun. The first site (locality 1) is situated in a short trench in N side of a small abandoned quarry, 1200 m NE from Bubovice, on N slope of wooded ridge called Špičatý vrch (text-fig. 1). Some seventeen metres thick section is built by dark grey well-bedded, platy micritic and sparitic limestone, bearing abundant shell accumulations (text-fig. 2). The dark-grey cherts, mostly in small irregular and often lobate lenses, are common. Limestone beds are steeply dipping to N, in the upper part of the trench being heavily weathered. The second site (locality 2) is located on westward prolongation of the same wooded ridge, some 200 m west from locality 1. Small natural outcrops of slightly weathered grey limestone in moderate slope yielded abundant but mostly

fragmentary and partly weathered silicified fauna. The quality of the material is worse than at the first locality, with small differences in taxonomic composition. The silicification in both localities occurs in 5 to 10 m thick sequence middle part of the Lochkov Formation, above the beds of grey crinoidal sparitic limestone near the base of the Lochkov Formation.

An effort to find the silicified material in the classical palaeontological localities of the Kotýs Limestone in the surrounding of Svatý Jan pod Skalou, especially in the Solvay's Quarry were unsuccessful.

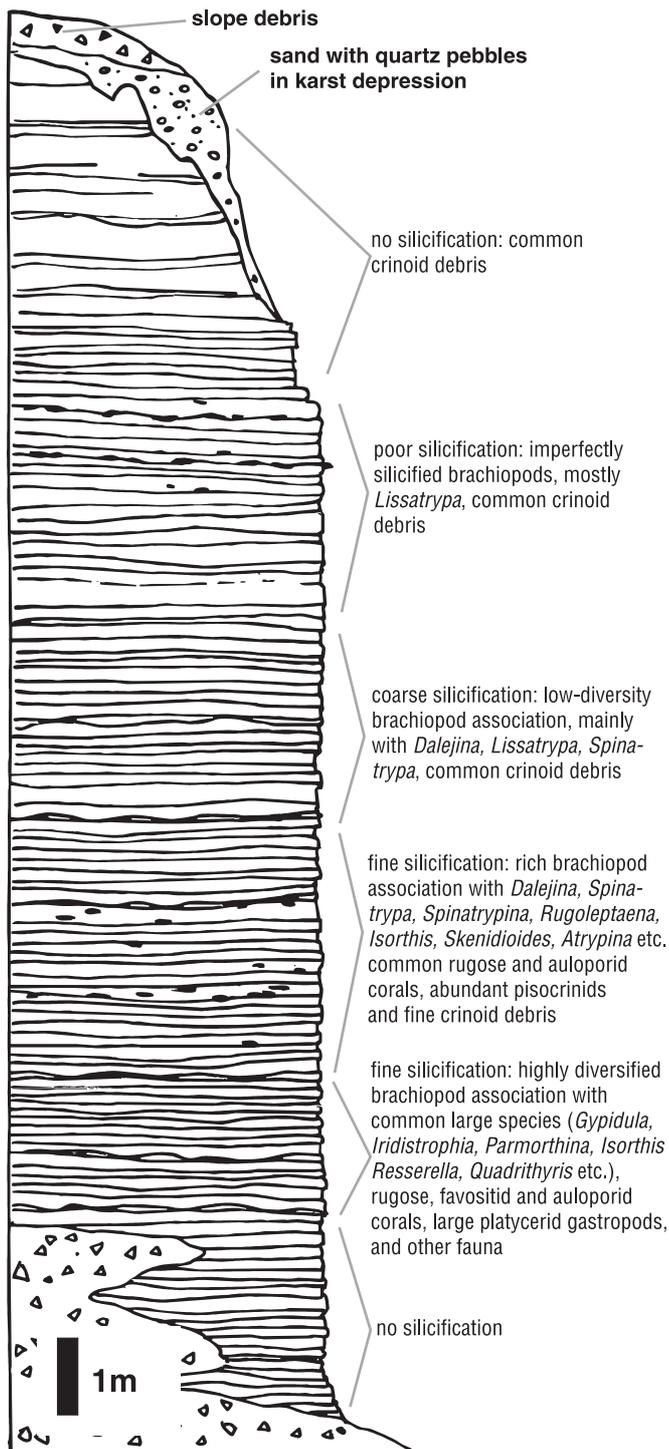
Methods

Blocks of limestone (5–10 kg) have been dissolved by a solution of 15% hydrochloric acid for one to three days. The residues were carefully washed by water and desiccated. In total, about 200–250 kg of limestone were dissolved. All complete specimens were carefully picked up. Richly fossiliferous fine fractions from some beds were picked up even under the binocular lens.

Material

The brachiopod shells prevail among the silicified fossils. Apart from common rugose corals, tabulate corals, crinoids, gastropods, bryozoans and tiny trilobites are rare. The quality of silicification differs among invertebrate groups as well as brachiopod groups. Brachiopods and rugose corals are generally well silicified, except of strophomenoids. This is probably due to thin fragile strophomenoid shell and incomplete silicification of their valves. Unlike brachiopods, small crinoids (*Pisocrinus*) are coarsely silicified leaving distinct only their basic morphology. Large, but rare platycerid gastropods, unlike other gastropods, are nicely silicified. Some ten to hundred thousands brachiopod shells were present in residues as may be estimated by the number of shells from the known volume of the rock. However, mostly incompletely silicified or broken shells were present in the residues. The amount of the shells and their fragmentation differ bed to bed. The finest silicification has been discovered in the lower beds, just above the lowest exposed limestone beds, which are without silicified fossils. The best silicification preserved the finest morphological details, e.g. short spines and free space between doublure and dorsal part of pleura on small odontopleurid trilobites, and it is comparable with the best examples of fossil silicification in other parts of the world. In general, the silicification is less favourable, often leaving margins and thick shell walls without silicification. Sometimes, the bivalved shells are silicified including the sediment infilling between the valves. Concentric silicification patterns are sometimes discernible.

In the studied section, the lowest exposed limestone beds did not yield silicified shells, but immediately the higher beds yielded numerous nicely silicified shells. Similarly, the uppermost exposed limestone beds are almost



Text-fig. 2. The 18 m thick succession of dark-grey Kotýs Limestone bearing the silicified fauna in the locality 1. The quality of silicification and dominant faunistic elements are noted.

without silicified shells. The interval with abundant and well-preserved silicified shells is about five metres thick.

The taxonomic composition of the brachiopod associations gradually change in observed sections. The lower beds

contain the most diversified assemblage, with numerous orthids (mainly *Parmorthina* and *Isorthis*), small atrypids, chonetids, orthotetids, large pentamerids, athyrids, and some strophomenoids. The middle part yielded mainly moderate sized atrypids (*Spinatrypa*, *Spinatrypina*), abundant medium to small-sized orthids (*Dalejina*, *Resserella*, *Dicoelosia*, *Isorthis*), locally associated by *Rugoleptaena* and *Atrypinella*. The topmost beds bearing silicified brachiopods contain low-diversity assemblage, with dominant *Lissatrypa*, and few other brachiopods. In general, medium-sized atrypids, orthids and small-sized brachiopods (*Skenidioides*, *Navispira*, *Plectodonta*) are dominant among the brachiopod associations. On the contrary, strophomenoids are less frequent, but this also may be the result of the selective silicification. The detailed changes of taxonomic composition and their explanation are the subject of another paper.

Repository

All new material including the types, figured specimens and measured specimens is deposited in the palaeontological collection of the Department of Biology, University of West Bohemia in Plzeň (PCZCU). The specimens from Havlíček's collection are deposited in the Museum of Dr. B. Horák in Rokycany; therefore, the present collection numbers (3RO) as well as the original Havlíček's numbers (VH) are noted in the text. Some material, mainly types of Barande (1847, 1848, 1879) are deposited the National Museum Prague (NM L).

Abbreviations: Vv – ventral valve, Dv – dorsal valve, L – length, W – width.

Systematic part

Class **Strophomenata** WILLIAMS et al., 1996

Order **Strophomenida** ÖPIK, 1934

Superfamily **Strophomenoidea** KING, 1846

Remarks: Unlike the localities near Svatý Jan pod Skalou (Solvay's Quarry, Herinky), the strophomenoid brachiopods are rare among the silicified brachiopods in the Loděnice area. Apart the leptaenid *Rugoleptaena skalicensis* (HAVLÍČEK, 1967) the shells are fragmental, only partly silicified and fine details of exterior are missing. Therefore, only four species are noted in text and figured, although a presence of other species is evident from small but otherwise undeterminable fragments.

Family **Rafinesquinidae** SCHUCHERT, 1893

Subfamily **Leptaeninae** HALL et CLARKE, 1894

Genus **Rugoleptaena** HAVLÍČEK, 1956

Type species: *Rugoleptaena hornyi* HAVLÍČEK, 1956; Devonian, Pragian, Dvorce-Prokop Limestone; Barandian, Bohemia.

***Rugoleptaena skalicensis* (HAVLÍČEK, 1967)**

Pl. 1, figs 1–15

1967 *Glossoleptaena skalicensis* sp. n.; Havlíček, p. 116, pl. 21, figs 8, 11.

1999 *Glossoleptaena skalicensis* HAVLÍČEK; Havlíček, p. 309 (noted in text).

Holotype: Ventral valve figured by Havlíček (1977) on pl. 21, fig. 8, deposited in the palaeontological collection of the Museum of Dr. B. Horák in Rokycany (3RO 63682, original signature VH 390).

Type horizon and locality: Lochkovian, Lochkov Formation, Kotýs Limestone; Svatý Jan pod Skalou, Solvay's Quarry.

New material: Three shells, 15 incomplete ventral and six incomplete dorsal valves showing interiors, and numerous fragments.

Diagnosis: *Rugoleptaena* with thickened posterolateral ventral valve; prominent, long tongue directed dorsally in anterior margin; high ridges bordering large rhomboidal ventral muscle field; ornament of obscure radial ribs in median sector of the ventral valve.

Description: Shell transverse but rather variable in outline, 25 mm wide, thin-walled anteriorly and laterally, but thickened along the posterior margin of the ventral valve.

The dorsal valve has almost flat disc, the sides are with ventrally deflected margins. The disc is anteromedianly extended into a narrow, long and dorsally directed trail. The dorsal interarea is anacline, very low, with a broad open nothyrium. The cardinal process is massive, bilobed, with posterodorsally faced striated myophores. The process is supported by stout and short median ridge. The lobes of the cardinal process diverge anteriorly. The dental sockets are deep, crenulated, rapidly widening anterolaterally. The socket ridges are absent. Large, broadly elongate posterior adductor scars are deeply impressed, and their inner sides confine smaller, elongate anterior adductor scars, sometimes with an elevated surface. The anterior pair is closely adjacent to thin, bifid anterior extension of the median ridge. The valve interior is densely pustulose, especially in a posteromedian part of the valve. Pustules are high, thin, with acute tips, which incline anteroventrally.

The ventral valve has a flat disc apart from the beak region, which is slightly convex in transverse and lateral profiles. Flanks are highly deflexed ventrally, but the anteromedian part is deflected dorsally and tightly attached as a long trail to the trail of the opposite valve. The ventral interarea is apsacline, flat, low, about twice as high as the dorsal interarea. The delthyrium is widely triangular, without distinct cover. The ventral muscle field is deeply impressed, rhomboidal, about one-third of the length of the valve. It is posteriorly confined to apical chamber, anteriorly and laterally bordered by very high, acute, robust ridges that disappear only in front of the anterior border of the muscle field. The muscle field is divided into narrow adductor impressions restricted to elevated pad bordering a thin myophragm, and much wider and deeply impressed

adductor scars. Posteriorly, the muscle field is undivided and bears coarse transverse striation. Teeth are massive, large. Thick deposits of the secondary shell form the peripheral ridge posterolaterally, laterally and anterolaterally but the callus is weak near the trail.

The exterior of the shell is nearly smooth, with several weak costellae extending from the ventral umbo toward the trail. The concentric ornament is inconspicuous, restricted to several low lamellae.

Remarks. This species has been referred to *Glossoleptaena* HAVLÍČEK, 1967 by Havlíček (1967). Later, the same author questioned this attribution (Havlíček 1999). New data about dorsal valve interior indicate that the socket ridges are absent in *Glossoleptaena skalicensis* HAVLÍČEK, a feature which distinguishes the genera *Glossoleptaena* and *Rugoleptaena* from each other. Externally, the weak radial ornament distinguishes *R. skalicensis* from *G. emarginata* (BARRANDE, 1879) and *G. prominens* HAVLÍČEK, 1967.

Distribution: *Rugoleptaena skalicensis* (HAVLÍČEK, 1967) is moderately common species in lower, less commonly in middle parts of the studied section in locality 1.

Occurrence: Lochkovian, Lochkov Formation, Kotýs Limestone; Barrandian, Bubovice (localities 1 and 2), Svatý Jan pod Skalou (Solvay's Quarry, right bank of the Kačák Brook).

Family Amphistrophiidae HARPER, 1973

Subfamily Mesodouvillininae HARPER et BOUCOT, 1978

Genus *Mesodouvillina* WILLIAMS, 1950

Type species: *Stropheodonta subinterstitialis seretensis* KOZŁOWSKI, 1929; Devonian, Lochkovian, Borshchov Formation; Podolia, Ukraine.

***Mesodouvillina herinkiana* HAVLÍČEK, 1999**

Pl. 1, figs 16–19

1999 *Mesodouvillina (Mesodouvillina) herinkiana* n. sp.; Havlíček, p. 310, pl. 5, figs 2–4, 10.

Holotype: Ventral valve figured by Havlíček (1999) on pl. 5, figs 10, deposited in the palaeontological collection of the Museum of Dr. B. Horák in Rokycany (3RO 85323, original signature VH 12694a).

Type horizon and locality: Lochkovian, Lochkov Formation, Kotýs Limestone; Herinky Hill near Záhrabská.

Material: Three fragments of dorsal valve, incomplete ventral valve and one fragment of ventral valve.

Description: The interior of the dorsal valve, unknown to Havlíček (1999), is recently known from three fragments. The cardinal process is prominent, highly bilobed, with deeply concave, and posteroventrally faced myophores with transversely striated surfaces. The inner socket ridges are very small, short. The dorsal interarea is

linear, on each side of the shell internally bordered by a tapering row of shallow sockets corresponding to well defined row of dentils along the hinge line of the ventral valve. The adductor muscle scars are shallow and small, posterolaterally bounded by robust, short and diverging ridges.

The ventral valve has a low apsacline interarea with a wide delthyrium apically closed by a convex pseudodeltidium. The ventral muscle field is large, halved by a low myophragm, posterolaterally bordered by widely divergent, thick and low ridges that become higher anteriorly. The anterior border of muscle field is weakly defined, free. The inner shell surface is covered by small pustules, chaotically arranged posterolaterally but laterally arranged in radial rows.

Remarks: New, fairly poor material is referred to *M. herinkiana* HAVLÍČEK, although the external ornament of silicified material is poorly preserved and it seems to be finer than described in typical specimens from Herinky Hill near Svatý Jan pod Skalou. The dorsal interior of new specimens is very similar to interior of *M. subinterstitialis subinterstitialis* (KOZŁOWSKI, 1929) from the Borschov Formation of Podolia, illustrated by Nikiforova et al. (1985, pl. 4, figs 3b, 4b) specimens. The interior of silicified dorsal valves, referred with some doubt to *M. herinkiana*, differs significantly from the associated species *Protocymostrophia costatula* (BARRANDE, 1879). The latter has much delicate and shorter lobes of the cardinal process and thinner walls of the dorsal valve. Another difference is a density of pseudopunctuation. Pseudopunctae are much finer in *P. costatula* than in *M. herinkiana*.

Distribution: *Mesodouvillina herinkiana* HAVLÍČEK, 1999 is rare in the lower part of the studied section in locality 1.

Occurrence: Lochkovian, Lochkov Formation, Kotýs Limestone; Barrandian, Bubovice (locality 1), Praha-Řeporyje (Černý lom Quarry), Svatý Jan pod Skalou (Herinky Hill).

Family **Douvillinidae** CASTER, 1939
Subfamily **Protodouvillininae** HARPER et
BOUCOT, 1978

Genus **Cymostrophia** CASTER, 1939
Subgenus **Cymostrophia (Protocymostrophia)**
HARPER et BOUCOT, 1978

Type species: *Strophomena ivanensis* BARRANDE, 1879; Devonian, Lochkovian, Lochkov Formation, Kotýs Limestone; Barrandian, Bohemia.

Cymostrophia (Protocymostrophia) costatula
(BARRANDE, 1848)

Pl. 2, figs 1–5

1848 *Leptaena costatula* BARR.; Barrande, p. 217, pl. 21, fig. 17.

1879 *Strophomena costatula* BARR.; Barrande, pl. 43, figs 6, 9, pl. 48, case III, figs 3–7, 10–13.

1967 *Mesodouvillina costatula* (BARRANDE, 1848); Havlíček, p. 170, pl. 34, figs 7, 9–12, text-fig. 69.

1999 *Mesodouvillina (Protocymostrophia) costatula* (BARRANDE, 1848); Havlíček, p. 310, pl. 5, figs 1, 8, 9, and 11.

Holotype: Ventral valve figured by Barrande (1848) on pl. 21, fig. 17, refigured by the same author (1879) on pl. 43, fig. 6, and by Havlíček (1967) on pl. 34, fig. 9, deposited in the palaeontological collection of the National Museum, Prague (NM L 6764).

Type horizon and locality: Lochkovian, Lochkov Formation, Kotýs Limestone; Svatý Jan pod Skalou.

Material: One fragment of dorsal valve, and five fragmentary ventral valves.

Description: See Havlíček (1967). The silicification of this species is unfavourable, and only the apical parts of the shells were sampled. The dorsal valve shows a high, small, bipartite cardinal process, with myophores facing posteroventrally. The adductor muscle scars are poorly impressed. The ventral valve has large muscle field bounded posteriorly by high divergent ridges. The hinge line bears dense, elongate denticles that are well marked on ventral interarea surface as oblique lines. The anterior border of the ventral muscle field is gently flabellate, weakly defined. The inner shell surface posterolaterally from the ventral muscle field bears dense cover of fine pustules.

Distribution: *Cymostrophia (P.) costatula* (BARRANDE, 1848) is rare in the lower part of the studied section in locality 1.

Occurrence: Lochkovian, Lochkov Formation, Kotýs Limestone; Barrandian, Bubovice (locality 1), Svatý Jan pod Skalou (Herinky Hill near Záhrabská, Solvay's Quarry).

Family **Leptostrophiidae** CASTER, 1939

Genus **Mesoleptostrophia** HARPER et BOUCOT, 1972
Subgenus **Mesoleptostrophia (Mesoleptostrophia)**
HARPER et BOUCOT, 1972

Type species: *Mesoleptostrophia kartalensis* HARPER et BOUCOT, 1972; Devonian, Emsian, Kartal Beds; Turkey.

Leptostrophiella index (HAVLÍČEK, 1967)

Pl. 2, figs 6–9, 11, 12, 14

1967 *Leptostrophia index* sp. n.; Havlíček, p. 151, pl. 30, figs 9–12, text-fig. 61.

1999 *Leptostrophiella index* (HAVLÍČEK); Havlíček, p. 303 (noted in species list), pl. 3, figs 19, 20, and 23.

Holotype: Ventral valve figured by Havlíček (1967) on pl. 30, fig. 10, deposited in the palaeontological collection of the National Museum, Prague (NM L 6769).

Type horizon and locality: Lochkovian, Lochkov Formation, Kotýs Limestone; Svatý Jan pod Skalou, Solvay's Quarry.

New material: Four shells, one dorsal and three dorsal incomplete valves.

Description: Havlíček (1967).

Remarks: Preserved specimens are mostly small individuals with poorly preserved exterior. The interior of the

ventral valve is marked by a deeply impressed muscle field, bordered by low, papillate lateral ridges. The field is halved by a low broad myophragm. The hinge line is coarsely denticulate. All available specimens are less than half the size that is noted by Havlíček (1967) in *L. index* (HAVLÍČEK), but this is probably combined result of sampling and unfavourable silicification.

Distribution: *Leptostrophliella index* (HAVLÍČEK, 1967) is rare in the lower part of the studied section in locality 1.

Occurrence: Lochkovian, Lochkov Formation, Kotýs Limestone; Barrandian, Bubovice (locality 1), Svatý Jan pod Skalou (right bank of Kačák brook, Solvay's Quarry).

Genus *Barbaestrophia* HAVLÍČEK, 1965

Type species: *Strophomena praestans* BARRANDE, 1879; Devonian, Lochkovian, Lochkov Formation, Kotýs Limestone; Barrandian, Bohemia.

Barbaestrophia praestans (BARRANDE, 1879)

Pl. 2, figs 10, 13

1879 *Strophomena praestans* BARR.: Barrande, pl. 51, fig. 4.

1967 *Barbaestrophia praestans* (BARRANDE, 1879); Havlíček, p. 160, pl. 31, figs 7–9, text-fig. 60 C.

1999 *Barbaestrophia praestans* (BARRANDE); Havlíček, p. 303 (noted in species list).

Lectotype: Designed by Havlíček (1967), ventral valve figured by Barrande (1879) on pl. 51, case 4, fig. 3, 4, refigured by Havlíček (1967) on pl. 31, fig. 8, deposited in the palaeontological collection of the National Museum, Prague (NM L 6672).

Type horizon and locality: Lochkovian, Lochkov Formation, Kotýs Limestone; Svatý Jan pod Skalou.

New material: One shell.

Description: Havlíček (1967).

Remarks: A characteristic feature of the genus, flat spines extending posterolaterally from the hinge line are unknown in the silicified specimen. The radial ornament shows curved posterolateral costellae and rather coarse, rounded costellae.

Distribution: *Barbaestrophia praestans* (BARRANDE, 1879) is very rare in the lower part of the studied section in locality 1.

Occurrence: Lochkovian, Lochkov Formation, Kotýs Limestone; Barrandian, Bubovice (locality 1), Svatý Jan pod Skalou (Herinky Hill, Solvay's Quarry).

Superfamily *Plectambonitoidea* JONES, 1928

Family *Sowerbyellidae* ÖPIK, 1930

Subfamily *Sowerbyellinae* ÖPIK, 1930

Genus *Plectodonta* KOZŁOWSKI, 1929

Subgenus *Plectodonta* (*Plectodonta*) KOZŁOWSKI, 1929

Type species: *Plectodonta mariae* KOZŁOWSKI, 1929; Devonian, Lochkovian, Borshchov Formation; Podolia, Ukraine.

Plectodonta mimica (BARRANDE, 1879)

Pl. 3, figs 8, 11, 14–26

1879 *Strophomena mimica* BARR.: Barrande, pl. 107, fig. 9.

1961 *Plectodonta mimica* (BARRANDE); Havlíček, p. 448, fig. 6.

1967 *Plectodonta mimica* (BARRANDE, 1879); Havlíček, p. 64, pl. 8, figs 6, 7, 10.

1989 *Plectodonta mimica* (BARRANDE); Cocks et Rong, p. 137 (noted in species list).

1999 *Plectodonta mimica* (BARRANDE); Havlíček, p. 303 (noted in species list).

Lectotype: Designed by Havlíček (1967), ventral valve figured by Barrande (1879) on pl. 107, case IX, fig. 1, deposited in the palaeontological collection of the National Museum, Prague (NM L 26039).

Type horizon and locality: Lochkovian, Lochkov Formation, Lochkov.

New material: Ten shells, 43 dorsal and 118 ventral valves.

Diagnosis: *Plectodonta* with 20 to 24 coarser costellae, with interspaces bearing 4 to 7 capillae; long and high lateral dorsal septa; the side septa shorter but evenly strong and high as the inner septa; visceral platform may be weakly defined.

Description: See Havlíček (1967), but some internal structures are newly commented.

The ventral valve shows fine denticles along the hinge, numbering 13–15 in each side of the large specimens. The pseudodeltidium is small, convex, covering the apex of the delthyrium.

The dorsal valve interior bears highly raised transverse socket ridges, prolonged laterally into short posteroventrally directed brachiophores. Two pairs of lateral septa are present. The septa of the inner pair are long, extending over two-third of the shell length, highest at about its midlength, diverging from each other in 35–40°. The crests of septae bear coarse short papillae that are directed anteroventrally. The side septa are shorter but of the same height or even higher than the inner septa, with the bases not-converging to the inner septa. The crests of the side septa are unevenly spinose, and sometimes even lobate. A low anteriorly finely spinose bema is weakly defined in some valves but may be absent in others. A thick pad of shell material is deposited between anterior extremities of the inner septa. Short coarse papillae are present in floor in anterolateral parts of the valve. The papillae are inclined anteroventrally, being arranged in five or more poorly defined radial rows. Much finer and numerous papillae cover the inner peripheral band of the dorsal valve. The coarse papillae are absent but much finer papillae densely cover the marginal parts in the ventral valve interior.

The external ornament consists of 20 to 22 coarser costellae and 4 to 7 fine radial capillae in interspaces in large shells.

Remarks: The species, already described by Barrande (1879) and revised by Havlíček (1967) shows some variation in the arrangement of the dorsal septum and papillae. The main difference between subgenera *P.* (*Plectodonta*)

KOZŁOWSKI, 1929 and *P. (Dalejodiscus)* HAVLÍČEK, 1961 is the presence of elevated and striated visceral field (= bema) of the latter genus (Havlíček 1977, Cocks et Rong 1989). This is distinct in the type species *Dalejodiscus comitans* (BARRANDE, 1879) from the Daleje Shale (Eifelian) of the Barrandian. The stratigraphically preceding species *D. subcomitans* (HAVLÍČEK, 1977) that is common in the Dvorce-Prokop Limestone (Pragian) has a less clearly defined bema. The similarly weakly defined bema has been, although rarely, found in some specimens of *P. mimica*. It seems likely that *P. mimica* of Lochkovian age with numerous costellae and without distinct bema is the forerunner of more scarcely costellate species *D. subcomitans* of Pragian age.

The species *Plectodonta mariae* KOZŁOWSKI, 1929 from the Taina and Mítkov Formations (Lochkovian) of Podolia, Ukraine differs in more numerous costellae and narrower interspaces with only two to four capillae.

Distribution: *Plectodonta mimica* (BARRANDE, 1879) is moderately common species and occurs in the whole studied section in locality 1, and it is common in locality 2.

Occurrence: Lochkovian, Lochkov Formation, Kotýs Limestone; Barrandian, Bubovice (localities 1 and 2), Svatý Jan pod Skalou (Solvay's Quarry), Tachlovice, Lochkov, and Kosoř.

Suborder **Chonetidina** MUIR-WOOD, 1955

Superfamily **Chonetoidea** BRONN, 1862

Family **Strophochonetidae** MUIR-WOOD, 1962

Subfamily **Strophochonetinae** MUIR-WOOD, 1962

Genus **Asymmetrochonetes** SMITH, 1980

Type species: *Asymmetrochonetes spinalonga* SMITH, 1980; Devonian, Lochkovian; Prince of Wales Island, Arctic Canada.

Asymmetrochonetes lanx (HAVLÍČEK et RACHEBOEUF, 1979)

Pl. 4, figs 1–10

1979 *Strophochonetes (Strophochonetes) lanx* n. sp.; Havlíček et Racheboeuf, p. 80, pl. 3, figs 6–8.

1999 *Asymmetrochonetes proliferus* (KOZŁOWSKI, 1929); Havlíček, p. 311, pl. 3, fig. 7.

Holotype: Ventral valve figured by Havlíček et Racheboeuf (1979) on pl. 42, figs 17, 18, deposited in the palaeontological collection of the Museum of Dr. B. Horák in Rokycany (3RO 49367, original signature VH 2368).

Type horizon and locality: Lochkovian, Lochkov Formation, Kotýs Limestone; Svatý Jan pod Skalou, Solvay's Quarry.

Material: Nine shells, one dorsal valve and 56 ventral valves.

Diagnosis: Small *Asymmetrochonetes* with cyrtomorph intraversed spines; some 22 to 26 capillae in ventral

valve; without enlarged median costa; short spine on left side of the ventral valve may be present.

Description: See Havlíček et Racheboeuf (1979), but some structures are commented.

The ventral valve interarea is apsacline, low and well defined, straight, with a broad delthyrium. The upper half of the delthyrium is closed by highly convex pseudodeltidium with weakly concave anterior edge. Teeth are well defined, transversely elongate. Cyrtomorph intraversed spines are known only in their proximal parts and their length is unknown. There are one or two spines on the right side of the valve. The base of the first spine is 0.3 mm from the apex, but this spine is commonly absent, and the next spine, 0.95 to 1.1 mm from the apex is always present. Left side of the ventral valve is without spines in all preserved valves apart from one (pl. 4, figs 3, 4), which has the base of small spine 0.5 mm from the apex.

The ornament consists of low rounded capillae separated by equally wide rounded shallow interspaces.

Remarks: Havlíček (1999) referred the species *Strophochonetes lanx* HAVLÍČEK et RACHEBOEUF, 1979 to the genus *Asymmetrochonetes* SMITH, and despite some minor differences, he expressed an opinion about the identity of *S. lanx* HAVLÍČEK et RACHEBOEUF and *A. proliferus* (KOZŁOWSKI). However, the new material indicates that specimens from the Barrandian are always smaller, attaining only 6.5–6.7 mm width and have coarser ornament with less numerous capillae. There are 22 to 26 capillae and this feature is constant in all newly sampled specimens in *A. lanx*. The specimens of comparable size of *A. proliferus* have always more than 30 capillae which are broader than adjacent interspaces and remain distinct also on posterolateral surface of the ventral valve, while in *A. lanx* the posterolateral corners are smooth. Therefore, the validity of species *A. lanx* is suggested.

Distribution: *Asymmetrochonetes lanx* (HAVLÍČEK et RACHEBOEUF, 1979) is uncommon species and occurs mostly in the lower part of the studied section in locality 1. It is common, that his shells are imperfectly preserved with broken hinge margin.

Occurrence: Lochkovian, Lochkov Formation, Kotýs and Kosoř Limestone; Barrandian, Bubovice (localities 1 and 2), Kosoř, Praha-Řeporyje, Svatý Jan pod Skalou (Solvay's Quarry, Herinky).

Order **Orthotetida** WAAGEN, 1884

Suborder **Orthotetidina** WAAGEN, 1884

Superfamily **Chilidiopsoidea** BOUCOT, 1959

Family **Chilidiopsidae** BOUCOT, 1959

Subfamily **Chilidiopsinae** BOUCOT, 1959

Genus **Iridistrophia** HAVLÍČEK, 1965

Type species: *Orthis umbella* BARRANDE, 1848; Devonian, Lochkovian, Lochkov Formation, Kotýs Limestone; Barrandian, Bohemia.

***Iridistrophia umbella* (BARRANDE, 1848)**

Pl. 2, fig. 15; pl. 3, figs 1–7, 9, 10, 12, 13

1848 *Orthis umbella* BARR.; Barrande, p. 206, pl. 19, fig. 1.

1879 *Orthis umbella* BARR.; Barrande, pl. 58, fig. 1.

1879 *Strophomena subtilis* BARR.; Barrande, pl. 51, fig. 1.

1965 *Iridistrophia umbella* (BARR.); Havlíček, pl. 1, figs 4–6, 9, 11.

1967 *Iridistrophia umbella* (BARRANDE, 1848); Havlíček, p. 194, pl. 41, figs 7–16; pl. 42, figs. 3, 5, 8.

1999 *Iridistrophia umbella* (BARRANDE); Havlíček, p. 303 (noted in species list).

Lectotype: Designed by Havlíček (1967), ventral valve figured by Barrande (1848) on pl. 1, fig. 1, refigured by the same author (1879) on pl. 58, fig. 1, and by Havlíček (1967) on pl. 42, fig. 8, deposited in the palaeontological collection of the National Museum Prague (NM L 6666).

Type horizon and locality: Lochkovian, Lochkov Formation, Kotýs Limestone; Sedlec.

Material: One ventral valve and several incomplete ventral and dorsal valves.

Description: See Havlíček (1967).

Remarks: New silicified material is figured to show morphology of cardinal structures, nicely preserved by silicification.

Distribution: *Iridistrophia umbella* (BARRANDE, 1848) is rare species and occurs only in the lowest part of the studied section in locality 1.

Occurrence: Lochkovian, Lochkov Formation, Kotýs Limestone; Barrandian, Bubovice (locality 1), Sedlec, Svatý Jan pod Skalou (Solvay's Quarry).

Order Protorthida SCHUCHERT et COOPER, 1931

Superfamily Protorthoidea SCHUCHERT et COOPER, 1931

Family Skenidiidae KOZŁOWSKI, 1929

Genus Skenidioides SCHUCHERT et COOPER, 1931

Type species: *Skenidioides billingsi* SCHUCHERT et COOPER, 1931; Ordovician, Champlainian, Black River Group; Ontario, Canada.

***Skenidioides famulus* HAVLÍČEK, 1977**

Pl. 4, figs 11–32

1977 *Skenidioides famulus* sp. n.; Havlíček, p. 103, pl. 42, figs 17–20.

1999 *Skenidioides famulus* HAVLÍČEK; Havlíček, p. 302 (noted in species list).

Holotype: Dorsal valve figured by Havlíček (1977) on pl. 42, figs 17, 18, deposited in the palaeontological collection of the Museum of Dr. B. Horák in Rokycany (3RO 64323, original signature VH 1380a).

Type horizon and locality: Lochkovian, Lochkov Formation, Kotýs Limestone; Svatý Jan pod Skalou, Solvay's Quarry.

New material: Twenty-four shells, 130 ventral and 35 dorsal valves.

Diagnosis: *Skenidioides* with deeply unisulcate commissure, high moderately curved apsacline ventral interarea, deep and long spondylium supported by short massive ridge continuing as a low and broad ridge anteriorly; cardinal extremities obtuse; dorsal valve deeply sulcate, with high septum and deeply impressed adductors; ornament of simple, rarely branched costellae; growth lamellae moderately developed.

Description: The shell is of medium size, with largest known specimens 5.1 mm wide. An average width ranges between 3.2–4.5 mm; the larger specimens show gerontic changes of the shell. The gerontic specimens finished the anterior growth and the shell becomes thickened along the periphery. The thickness of the valve changes with the shell age. Smaller shells are fairly thin-shelled, adult shells have obsolete posterior parts of the ventral valve and the cardinalia in the dorsal valve, but the shell periphery is relatively thin.

The dorsal valve is weakly convex, with deep angular sulcus, with the maximum width near or slightly anterior to the hinge line. The dorsal interarea is anacline, low, with a broad notothyrium. The cardinal process is ridge-like, with large concave myophore that is highly raised above the adjacent rhomboidal brachiophore plates. The cardinal process continues into very high triangular median septum, whose anteroventral edge is nearby the contact with the ventral valve floor. Large, deeply concave brachiophore plates are highly raised above the valve floor, having a concave floor, with anterior edges directed anteroventrally. The brachiophores are long and thin, straight, remarkably high, directed anteroventrally to almost ventrally. The dental sockets are large, deep, narrowly triangular, bordered by massive fulcral plates. Adductor scars are deeply impressed in gerontic specimens, otherwise are obscure. The muscle field consists of large triangular pair of anterior adductors and a smaller, posterolaterally placed pair of the posterior adductors. Pallial markings are obscure apart from vascula genitalia which are distinctly impressed along the hinge line.

The ventral valve is hemipyramidal, with a prominent beak. The shell is rather variable in outline (ranging from transverse to subrectangular) but the ventral valve is always distinctly convex in the lateral view. The cardinal extremities are acute to rectangular in small specimens and to obtuse in the large ones. The ventral interarea is large, steeply apsacline, slightly curved, especially near the apex. The interarea is separated from shell surface by acute edge. The delthyrium is large, occupying more than one-third of the hinge line. Teeth are large, supported by distinct teeth ridges along the sides of the delthyrium. The free spondylium is formed by a thin, and deeply concave plate apically supported by a short, massive median ridge. The length of the spondylium equals to some 50–60% of the delthyrium, and its anterior edge is deeply emarginate. In well-preserved but scarce specimens the surface of the spondylium is divided

into narrow median strip of constant width and lateral, narrowly triangular slopes. The supporting ridge continues anteriorly as broad and low median ridge to midlength of the valve.

The shell is externally covered by rounded costellae of almost uniform size, as wide as rounded interspaces. New but less numerous costellae originate mostly by intercalation, but some large specimens have also bifurcating costellae. Total number of costellae ranges between 20 and 26 in adult specimens. The early pair of costellae in the median sector of the ventral valve originates at the apex. New pair appears slightly anteriorly and further pair appears once more during the growth; these intercalated pairs of costellae rapidly attain the size of other costellae. Fine concentric ornament is not preserved, but probably was formed by fine wavy growth lines at the bottom of interspaces as developed in related species *S. moranus* HAVLÍČEK, 1977. Growth lamellae are not frequent, but when present, they are remarkably coarse, forming a step-like lateral profile. The lamellae are often situated more anteriorly.

Remarks: The species *Skenidioides famulus* HAVLÍČEK was based by Havlíček (1977) on rare and very fragmentary material (four dorsal valves and one incomplete shell). Therefore, the interior of the ventral valve and the shell variability could not be evaluated. Havlíček pointed out the close affinity to the early Ludlow species *S. moranus* HAVLÍČEK, 1977 (Kopanina Formation, Ludlow), which is common in shallow water tuffaceous limestone in Svatý Jan volcanic centre of the Barrandian. The species *S. moranus* is undoubtedly an evolutionary forerunner of *S. famulus*. This is evident from almost identical outline, size, inner morphology and ornament. Although both species display some variability, the main differences are as follows: 1) the ventral shell of *S. moranus* is less convex and in some specimens the valve is almost straight in lateral profile, 2) the ventral interarea of *S. moranus* is planar while in *S. famulus* is unevenly but always concave in lateral profile, 3) new median costellae of *S. famulus* originate as a pair of costellae at the same growth line (pl. 4, figs 11–13) while in *S. moranus* median costellae originate intermittently, with one costella on left side followed, after short break, by a new costella on the left side. Havlíček (1977) commented the relationships between *S. lewisii* (DAVIDSON, 1848) and *S. moranus*. *S. famulus* differs from the British species by less bifurcating costellae and shorter spondylium, but the common features are the short ridge supporting the septalium and obtuse cardinal extremities in adult specimens.

Perry (1984) described two species of the genus from the Delorme Formation (Lower Devonian, Canada). One of them, the species *S. variabilis* LENZ, 1977 occurs in abundance in Lochkovian to early Pragian. Among others, the Canadian species clearly differs in the extended hinge line and lower ventral interarea from *S. famulus*. Another closely related species is *S. robertsensis* JOHNSON, BOUCOT et MURPHY, 1973 from the early Devonian of Nevada (Johnson et al. 1973). Nevadan species differs from *S. famulus* by lower catacline ventral interarea and acute cardi-

nal angles. In addition, the authors note absence of concentric ornament while in *S. famulus* the growth lamellae are present. A skenidioid species from the early Devonian of Podolia, Ukraine, by Kozłowski (1929) referred to *Scenidium lewisi* is unnamed new species of *Skenidioides* (Nikiforova et al. 1985) and its affinity to *S. famulus* remains unclear.

The younger Devonian species of the genus from the Barrandian may be divided into two groups. The larger species with undoubted relations to *S. famulus* are represented by *S. boucoti* HAVLÍČEK, 1977 and probably *S. fascinatus* HAVLÍČEK, 1977. The second group represents lamellose and smaller species *S. suburbanus* (HAVLÍČEK, 1956) and *S. cingulatus* HAVLÍČEK, 1977 with fewer and lower costellae. The latter two species may represent another genus, but their revision will be made elsewhere.

Distribution: *Skenidioides famulus* sp. n. is an abundant species and occurs in the whole studied section in locality 1, and is common in locality 2.

Occurrence: Lochkovian, Lochkov Formation, Kotýs Limestone; Barrandian, Bubovice (localities 1 and 2), Svatý Jan pod Skalou (Solvay's Quarry).

Suborder **Dalmanellidina** MOORE, 1952

Superfamily **Dalmanelloidea** SCHUCHERT, 1913

Family **Dalmanellidae** SCHUCHERT, 1913

Subfamily **Isorthinae** SCHUCHERT et COOPER, 1931

Genus **Isorthis** KOZŁOWSKI, 1929

Subgenus **Isorthis (Isorthis)** KOZŁOWSKI, 1929

Type species: *Dalmanella (Isorthis) szajnochai* KOZŁOWSKI, 1929; Devonian, Lochkovian, Borshchov Formation; Podolia, Ukraine.

Isorthis (Isorthis) svatojanica HAVLÍČEK, 1977

Pl. 5, figs 1–20

1977 *Isorthis (Isorthis) svatojanica* sp. n.; Havlíček, p. 185, pl. 41, figs 8–14.

1999 *Isorthis (Isorthis) svatojanica* HAVLÍČEK; Havlíček, p. 302 (noted in species list).

Holotype: Shell figured by Havlíček (1977) on pl. 41, figs 9, 13, 14, deposited in the palaeontological collection of the Museum of Dr. B. Horák in Rokycany (3RO 63883, original signature VH 1926a).

Type horizon and locality: Lochkovian, Lochkov Formation, Kotýs Limestone; Svatý Jan pod Skalou, Solvay's Quarry.

New material: Sixty shells, 105 dorsal and 65 ventral valves.

Diagnosis: Large biconvex *Isorthis* with subcircular outline, distinctly sulcate dorsal valve and subcarinate ventral valve; deeply impressed, and almost parallel diductor scars in ventral valve; deeply impressed adductor scars in

dorsal valve bordered by low ridges; dorsal medium ridge low and short.

Description: See Havlíček (1977).

Remarks: Numerous shells of *Isorthis svatojanica* HAVLÍČEK in the new collection indicate, that the variability of outline and inner morphology is very low, expressed mostly by uneven thickness and height of the ridge between diductor scars in the ventral valve. A distinctive difference of *I. svatojanica* from *I. szajnochai* KOZŁOWSKI, 1929 is high convexity of valves of the latter species. In addition to other differences noted by Havlíček (1977), the species *I. svatojanica* has deeper sulcus in the dorsal valve, subcarinate ventral valve, less divergent diductor scars in the ventral valve, and its shell size never exceeds 20 mm, whereas in *I. szajnochai* the shell size may extend over 25 mm.

Distribution: *Isorthis svatojanica* HAVLÍČEK, 1977 is moderately common within the whole studied section, with fairly constant frequency. Apart from the studied section, it is common in locality 2.

Occurrence: Lochkovian, Lochkov Formation, Kotýs Limestone; Barrandian, Bubovice (localities 1 and 2), Svatý Jan pod Skalou (Solvay's Quarry).

Subfamily **Resserellinae** WALMSLEY et BOUCOT, 1971

Genus **Resserella** BANCROFT, 1928

Type species: *Orthis canalis* J. de C. SOWERBY in MURCHISON, 1839; Silurian, Wenlock, Coalbrookdale Formation; Herefordshire, England.

Resserella walmsleyi HAVLÍČEK, 1977

Pl. 6, figs 1–17, 21; text-fig. 3

? 1975 *Bouskia lineata* (HAVLÍČEK); Havlíček, p. 233, pl. 2, fig. 1 (partim).

1977 *Resserella walmsleyi* sp. n.; Havlíček, p. 166, pl. 41, figs 3–7.

? 1977 *Molongella lineata* (HAVLÍČEK); Havlíček, p. 161, pl. 42, figs 7, 8 (partim).

1999 *Resserella walmsleyi* HAVLÍČEK; Havlíček, p. 302 (noted in species list).

Holotype: Ventral valve figured by Havlíček (1977) on pl. 41, fig. 5, deposited in the palaeontological collection of the Museum of Dr. B. Horák in Rokycany (3RO 64273, original signature VH 1216a).

Type horizon and locality: Lochkovian, Lochkov Formation, Kotýs Limestone; Svatý Jan pod Skalou, Solvay's Quarry.

New material: Twenty shells, 110 dorsal and 210 ventral valves.

Diagnosis: Ventribiconvex *Resserella* with transversal, shield-shaped shell, deeply and broadly sulcate dorsal valve; high, blade-like brachiophores with acute crura at the tips; ornament of about ten more coarser costellae in median sector amongst numerous fine costellae; very narrow median sector with finer costellae is present in ventral valve.

Description: See Havlíček (1977).

Remarks: Havlíček (1977) based the description on an extremely fragmentary material. New material comprises about three hundred specimens, some of them articulated. This makes possible the biometric evaluation of the species. *Resserella walmsleyi* HAVLÍČEK may reach larger size than given by Havlíček (1977). A size range of adults is between 7.5–9.0 mm, the largest valve known is even 10.5 mm wide. The outline is more transverse than suggested by Havlíček (1977). In ventral valves over 7 mm wide the VvL/VvW ratio ranges from 0.86 to 1.04, with average 0.92 (65 specimens measured). There is a distinct tendency of increasing length of the valve with the shell size (text-fig. 3).

Havlíček (1977) compared *R. walmsleyi* only with *R. loganportensis* WALMSLEY et BOUCOT, 1971. *Resserella loganportensis* differs in a coarser ornament, more elongate shell and presence of the pedicle callist. The new material indicates, that *R. walmsleyi* has deeply sulcate dorsal valve and correspondingly unisulcate commissure, while *R. loganportensis* has rectimarginate anterior commissure. The deeply sulcate dorsal valve distinguishes Bohemian species from the otherwise very similar *R. elegantuloides* (KOZŁOWSKI, 1929). The neotype and specimens of *R. elegantuloides* from the Borshchov Formation of Podolia, figured by Walmsley et Boucot (1971) and Nikiforova et al. (1985) differs from *R. walmsleyi* in higher ventral interarea, shorter hinge line, longer shell and only weakly sulcate dorsal valve.

Distribution: *Resserella walmsleyi* HAVLÍČEK, 1977 is an abundant species in both studied localities. Its maximum occurrence is in the lower part of the studied section in locality 1.

Occurrence: Lochkovian, Lochkov Formation, Kotýs Limestone; Barrandian, Bubovice (localities 1 and 2), Svatý Jan pod Skalou (Solvay's Quarry), Tachlovice.

Genus **Molongella** SAVAGE, 1974

Type species: *Molongella talenti* SAVAGE, 1974; Devonian, Pragian, Maradana Shale; New South Wales, Australia.

Molongella lineata (HAVLÍČEK, 1975)

Pl. 6, figs 18–20, 22–25

1975 *Bouskia lineata* sp. n.; Havlíček, p. 233, pl. 2, figs 2–4 (non 1).

1977 *Molongella lineata* (HAVLÍČEK, 1975); Havlíček, p. 161, pl. 42, figs 1–6, 9 (non 7, 8).

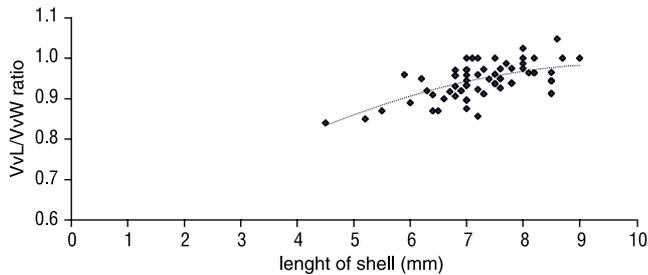
1999 *Molongella lineata* (HAVLÍČEK); Havlíček, p. 302 (noted in species list).

Holotype: Ventral valve figured by Havlíček (1977) on pl. 42, figs 1–2, deposited in the palaeontological collection of the Museum of Dr. B. Horák in Rokycany (3RO 50191, original signature VH 1917c).

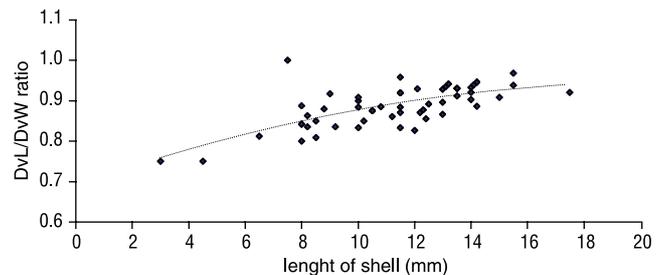
Type horizon and locality: Lochkovian, Lochkov Formation, Kotýs Limestone; Tachlovice.

Material: Eight dorsal and one ventral valves.

Diagnosis: Ventribiconvex, thick-walled, transverse *Molongella* with deep, acute dorsal sulcus, and evenly wide anterior and posterior pairs of dorsal adductor scars.



Text-fig. 3. *Resserella walmsleyi* HAVLÍČEK, 1977. VvL/VvW ratio variation and its changes with shell size. 71 specimens measured.



Text-fig. 4. *Parmorthina protopragensis* HAVLÍČEK, 1977. DvL/DvW ratio variation and its changes with shell size. 55 specimens measured.

Description: See Havlíček (1977).

Remarks: Already Havlíček (1975) briefly defined *Molongella lineata* (HAVLÍČEK), but its detail description has been presented later (Havlíček 1977). Savage (1974) described *Molongella talenti* SAVAGE, 1974 from the early Devonian (Gedinnian) of New South Wales. His reconstruction of the dorsal interior indicates, that the Australian species has more prominent dorsal median septum, and unevenly broad scars of adductors in the dorsal valve. The *M. lineata* has evenly broad both pairs of adductors and their bordering ridges are not excavated. In addition, the dorsal median ridge of *M. lineata*, unlike the type species, is weakly defined. The size of both species is comparable, the maximum width is 8.0 mm in the new material of *M. lineata*, and 7.6 mm in *M. talenti*.

The incomplete ventral valve, referred by Havlíček (1977: pl. 42, figs 7, 8) to *M. lineata* have ornament of coarser costellae intercalated by two or three finer costellae. This ornament is characteristic of *Resserella walmsleyi* HAVLÍČEK, and is unknown in dorsal valve of *M. lineata*. Therefore, these two specimens, out of which one is illustrated as *M. lineata* by Williams and Harper (2000) probably belong to *R. walmsleyi*.

Distribution: *Molongella lineata* (HAVLÍČEK, 1975) is a rare species, known in new material mainly in the lower part of the studied section in locality 1. Mainly dorsal valves were sampled, the ventral valves being very scarce.

Occurrence: Lochkovian, Lochkov Formation, Kotýs Limestone; Barrandian, Bubovice (locality 1), Tachlovice.

Genus *Parmorthina* HAVLÍČEK, 1975

Type species: *Parmorthis pragensis* HAVLÍČEK, 1956; Devonian, Zlíchovian, Zlíchov Formation; Barrandian, Bohemia.

Parmorthina protopragensis HAVLÍČEK, 1977

Pl. 7, figs 1–20; text-fig. 4

1977 *Parmorthina protopragensis* sp. n.; Havlíček, p. 170, pl. 42, figs 10–16.

1999 *Parmorthina protopragensis* HAVLÍČEK; Havlíček, p. 302 (noted in species list).

Holotype: Dorsal valve figured by Havlíček (1977) on pl. 42, fig. 16, deposited in the palaeontological collection of the Museum of Dr. B. Horák in Rokycany (3RO 64210, original signature VH 1936d).

Type horizon and locality: Lochkovian, Lochkov Formation, Kotýs Limestone; Svatý Jan pod Skalou, Solvay's Quarry.

New material: Twenty-five complete shells, 110 dorsal and 85 ventral valves, and numerous fragments.

Diagnosis: *Parmorthina* with subpentagonal outline, without narrow sulcus in the ventral valve, and DvL/DvW about 0.86–0.96 in adult shells.

Description: The shell is planoconvex, with moderate thick shell wall, in late adults 18–19 mm wide. Anterior commissure is weakly uniplicate and finely serrate.

The dorsal valve is subpentagonal, with straight hinge line that occupies about 80% of the valve maximum. The anteromedian margin is slightly but variably extended, mostly in late adult and gerontic specimens. The DvL/DvW ratio differs with the age. Juvenile shells are shorter, with DvL/DvW below 0.8, but during the growth the ratio shifts nearby and over 0.9 (average ratio of specimens longer than 10 mm is 0.90, but specimens longer than 13 mm is even 0.92) (text-fig. 4). The flanks are evenly rounded. The cardinal extremities are obtuse. The valve is almost planar, with a shallow broadly triangular sulcus and depressed posterolateral corners. The dorsal interarea is anacline, low, with small notothyrium completely filled by posterior face of the cardinal process. The cardinal process is bilobed, with massive bisected shaft and posteroventrally faced striated myophore. Its base extends into low and broad, anteriorly tapering median ridge that disappears at about the valve midlength. The brachiophores have massive bases, and they are posterolaterally thickened by obsolete inner socket ridges. The acute tips of brachiophores are directed almost ventrally and may extend nearby the ventral valve floor. The dental sockets are deeply concave, transversely crenulated, supported by obsolete shell wall. Two pairs of adductor scars are deeply impressed in posteromedian part of the valve, being adjacent to the median ridge. Their outer (lateral and anterolateral) borders are slightly raised above valve floor. The scars of posterior adductor are

shorter and broader than elongate triangular anterior scars. The periphery of the valve is coarsely crenulated. The elongate and high nodes are separated by narrow and deep interspaces. Nodes are externally undercut by groove paralleling the shell edge.

The ventral valve is subpentagonal, highly convex, and longer than the dorsal valve. VvL/VvW ranges near 1, with more transverse juvenile than adult shells (average ratio in valves over 13 mm length is 1.05). The beak is prominent, weakly curved above the delthyrium. The interarea is low, almost catacline, and weakly concave in profile, divided by large open delthyrium. Teeth are large, triangular, directed anterolaterally, anteriorly supported by very short and thin dental plates. The bases of teeth are united with thickened sides of the umbonal chamber. The ventral muscle field is weakly impressed, confined to the umbonal chamber. Small adductor scars lie in posterior floor of the umbonal chamber and extend into narrow elevated pad between much larger diductor scars. Very weak median ridge extends from the anterior scars to the nearly midlength of the valve but in any shell the ridge is missing.

Ornament is fascicostellate, described in detail by Havlíček (1977). Growth lamellae are weak, low, and more distinct anteriorly, three to five in number.

Remarks: Havlíček (1977) based the species on mostly incomplete specimens. He noted as maximum size the shell width 51 mm, but no specimen of this size has been found among the Havlíček's collection specimens housed in the Museum of Dr. B. Horák in Rokycany. Therefore, this large size seems unlikely as also no specimen in current collection exceeds 20 mm width, and the average size of adult specimens is 13 to 15 mm. Specimens above 15 mm show gerontic changes, with obsolete brachiophores, extended and irregular anteromedian margin and thickened shell wall.

Differences between *Parmorthina protopragensis* HAVLÍČEK and *P. pragensis* (HAVLÍČEK, 1956) (Zlíchovian, Zlíchov Formation; Barrandian) were pointed out by Havlíček (1977). The latter species has finer costellation in the median sector of the dorsal valve and its ventral valve has faint ventral valve sulcus that is missing in *P. protopragensis*. Another differences unknown to Havlíček (1977) concern the shell outline. *Parmorthina protopragensis* has subpentagonal outline with extended anteromedian margin, while the outline of *P. pragensis* is more transverse and its anteromedian margin is evenly rounded. This is evident from DvL/DvW , which is 0.86–0.96 in adult valves of *P. protopragensis*, but only 0.74–0.86 in *P. pragensis* (Havlíček, 1977: p. 171).

Distribution: *Parmorthina protopragensis* HAVLÍČEK, 1977 is very frequent in the lower part but occurs also but less commonly upward in the studied section in locality 1, and is known from locality 2. The shells frequently bear epizoic auloporids and rugose corals, mainly on the exterior of the ventral valve.

Occurrence: Lochkovian, Lochkov Formation, Kotýs Limestone; Barrandian, Bubovice (localities 1 and 2), Svátý Jan pod Skalou (Solvay's Quarry).

Family *Dicoelosiidae* CLOUD, 1948

Genus *Dicoelosia* KING, 1850

Type species: *Anomia biloba* LINNAEUS, 1767; Silurian, Wenlock, Mulde Marl; Gotland, Sweden.

Dicoelosia praedimera sp. n.

Pl. 8, figs 1–25; text-fig. 5

1977 *Dicoelosia nitida* JOHNSON, BOUCOT et MURPHY, 1973; Havlíček, p. 211, pl. 42, figs 21–24.

1999 *Dicoelosia nitida* JOHNSON, BOUCOT et MURPHY; Havlíček, p. 302 (noted in species list).

Holotype: Shell figured on pl. 8, figs 17, 23–25, deposited in the palaeontological collection of the University of West Bohemia, Plzeň (PCZCU 856).

Paratypes: Dorsal valve, figured on pl. 8, figs 14, 15 (PCZCU 857), and ventral valve figured on pl. 8, fig. 6 (PCZCU 865) deposited in the palaeontological collections of the University of West Bohemia in Plzeň.

Type horizon: Lochkovian, Lochkov Formation, Kotýs Limestone.

Type locality: Bubovice, old quarry in wooded ridge between the Branžovy Quarry and the road Loděnice-Bubovice.

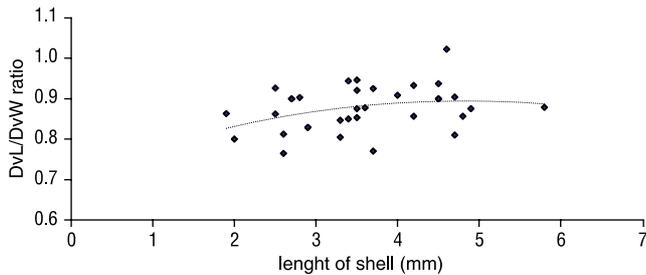
Name: *prae-* (Lat.) – referring the ancestry of the new species to *Dicoelosia dimera* (BARRANDE, 1879).

Material: Fifty shells, 29 dorsal and 27 ventral valves.

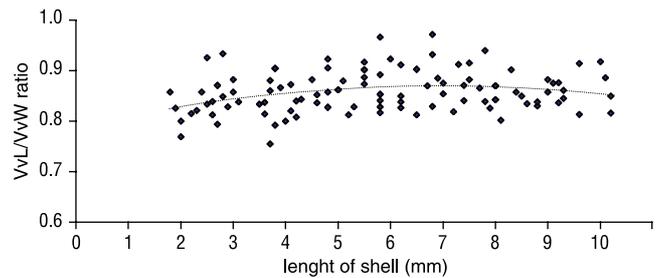
Diagnosis: *Dicoelosia* with planoconvex shell and short anterior emargination; hinge line of some one-third to half of the maximum width; short flattened ears in cardinal extremities; robust, highly elevated triangular pad at the bottom of the sulcus in the dorsal interior.

Description: The shell is planoconvex, with a broadly and shallowly sulcate commissure. The dorsal valve is more thick-shelled than the ventral valve. The largest available shell is 6.6 mm wide, but the average width is only 4.5–5.5 mm in the sample.

The dorsal valve is subtriangular, flat, bilobate, with a deep, rounded emargination in front margin. An inner angle of the emargination is always higher than 90°, and it commonly ranges near 120°. The lobes are slightly convex in transverse profile. The sulcus is prominent, with rounded bottom, originating at the beak. The hinge line equals, as the maximum, to about half of the valve width. The cardinal extremities are obtuse, distinctly flattened, forming incipient ears. The interarea is anacline, low and flat, with a broadly triangular open notothyrium. In the interior of the valve is prominent elevated pad, corresponding to the bottom of the sulcus. It extends from the midlength of the valve to the anterior margin. In side view, this pad is highly triangular, built of radially arranged, densely packed lobes. This elevation is in near contact with the ventral valve floor in closed shells, and it separates, as a septum, the filtration chambers in lateral lobes of the shell. The cardinal process is ridge-like, with short shaft and posteroventrally faced striated myophore. The brachiophores are blade-like, low, long, diverging each other,



Text-fig. 5. *Dicoelosia praedimera* sp. n., DvL/DvW ratio variation and its changes with shell size. 34 specimens measured.



Text-fig. 6. *Dalejina austera* HAVLÍČEK, 1977. VvL/VvW ratio variation and its changes with shell size. 111 specimens measured.

anterodorsally directed. The dental sockets are small and long. The muscle scars are not impressed.

The ventral valve is triangular, with a deep rounded emargination in front margin. The DvL/DvW ratio ranges between 0.76–0.94 (extreme 1.02) (text-fig. 5). The ratio slightly increases with the shell size, because small shells are more transverse than adult shells. The valve is strongly convex in lateral view, with the maximum depth at posterior third. The transverse profile of the valve is highly convex except for the axial part. The sulcus is prominent, deep, rounded, originating at the beak. The lateral lobes are evenly and highly convex along the whole length in the transverse profile. The beak is prominent, with the apical angle 80°. The ventral interarea is high, apsacline, and weakly concave in the lateral view. The delthyrium is triangular, about 30% as wide as the hinge line. The teeth are rather large, triangular. The cardinal extremities are obtuse, forming short, flattened ears in adjacent part of the valve. The ventral interior lacks distinct muscle impressions. Both valves are coarsely crenulated around the periphery.

The shell is finely costellate, with 11 primary costellae at the ventral valve. At the bottom of the ventral sulcus lies one finer costella, which is fine along whole length. The lobes are covered by subangular and anteriorly enlarged costellae. They are straight in the axis of the lobes, but one or two costellae adjacent to the sulcus slightly converge anteriorly. The costellae on flanks are curved laterally. New costellae are of the same size as the primary costellae and they originate exclusively by an intercalation. There are 15–17 costellae distinct on each lobe periphery of the large ventral valves. The concentric ornament is weak, with one or two growth lamellae anteriorly.

Remarks: The specimens from the Kotýs Limestone were originally referred (Havlíček 1977) to the species *Dicoelosia nitida* JOHNSON, BOUCOT and MURPHY, 1973 which occurs in Lower Gedinnian of Nevada, USA (Johnson et al. 1973). The new species differs from this species in shallower anterior emargination, broader lobes and larger posterolateral ears, and, in general, in a broader outline. The massive elevated pad that is present in *D. praedimera* is less prominent in the Nevadan species. Another American dicoelosiid of Lochkovian age, *D. varicaformis* JOHNSON, 1973 differs from *D. praedimera* in a convex dorsal valve,

low and rounded but coarser costellation, and smaller size, being only 4 mm wide. The type species *Dicoelosia biloba* (LINNAEUS, 1758) from Wenlock of Shropshire and Gotland is inadequately known, and the revision by Wright (1968), followed by other authors (Musteikis et Puura, 1983) brought less clarity to its morphology. The specimens referred by Wright (1968) to *D. biloba* differ in weak elevated pad in the dorsal valve interior, fewer costellation with more convergent submedian costellae. Specimens referred to *D. biloba* by Musteikis and Puura (1983) have much wider hinge line, deeper emargination and longer lobes. The species *D. dimera* (BARRANDE, 1879) is closely related to the new species, and it is probably its descendant, being known from the Dvorce-Prokop and Řeporyje Limestones (Pragian) of the Barrandian (Havlíček 1977). It also has remarkably transverse outline, broad, short and distinctly divergent lobes, and a shallow anterior emargination, but differs in wider hinge line and more extended ears in cardinal extremities.

Distribution: *Dicoelosia praedimera* sp. n. is moderately frequent and occurs in the whole studied section in locality 1. It is uncommon in locality 2.

Occurrence: Lochkovian, Lochkov Formation, Kotýs Limestone; Barrandian, Bubovice (localities 1 and 2), Svatý Jan pod Skalou (Solvay's Quarry).

Family **Rhipidomellidae** SCHUCHERT, 1913
Subfamily **Rhipidomellinae** SCHUCHERT, 1913

Genus **Dalejina** HAVLÍČEK, 1953

Type species: *Dalejina hanusi* HAVLÍČEK, 1953; Devonian, Pragian, Dvorce-Prokop Limestone; Barrandian, Bohemia.

Dalejina austera HAVLÍČEK, 1977

Pl. 9, figs 1–24; text-fig. 6

1965 *Dalejina* cf. *hanusi* HAVLÍČEK; Boucot, Johnson et Walmesley, pl. 46, figs 5–18.

1977 *Dalejina austera* sp. n.; Havlíček, p. 221, pl. 41, figs 15–24.

1977 *Loganella* sp.; Havlíček, p. 229, pl. 41, figs 1, 2.

1999 *Dalejina austera* HAVLÍČEK; Havlíček, p. 302 (noted in species list).

Holotype: Shell figured by Havlíček (1977) on pl. 41, figs 23, 24, deposited in the palaeontological collection of the Museum of Dr. B. Horák in Rokycany (3RO 63354, original signature VH 1675a).

Type horizon and locality: Lochkovian, Lochkov Formation, Kotýs Limestone; Svatý Jan pod Skalou, Solvay's Quarry.

New material: Several hundred of shells.

Diagnosis: Subequally biconvex, rather large, transversely oval *Dalejina* with pronounced ventral beak; ventral valve depressed anteromedianly, a shallow sulcus present in dorsal valve; anterior commissure broadly uniplicate; hinge line narrow; ventral interarea low, strongly curved.

Description: See Havlíček (1977).

Remarks: The species *D. austera* HAVLÍČEK was based by Havlíček (1977) on rich material, and he described it in fine details. However, the size of the species is actually larger than given by Havlíček (1977). Some available shells attain 12 mm width. Unlike some other orthid genera at the localities, the VvL/VvW does not change with the shell size, and it ranges from 0.75 to 0.97. The shell wall is never significantly thickened despite large shell size. The peculiar feature, nicely preserved in silicified shells, is the pointed crura at the anteroventral tips of the brachiophores (pl. 9, figs 14, 18). Also other details of internal morphology and variations of the shell shape with age are newly illustrated (pl. 9, figs 19–24).

Numerous material, comprising juvenile to gerontic specimens indicates, that the imperfect large ventral valve with median ridge between the diductor impressions, referred by Havlíček (1977: p. 229) to the genus *Loganella* BOUCOT et AMSDEN, 1958 is probably a gerontic valve of *Dalejina austera*. Another Lochkovian (= Gedinnian) occurrences of *Dalejina* are common worldwide. *Dalejina subfrequens* JOHNSON, BOUCOT et MURPHY, 1973 from Nevada differs in a subcircular outline. *Dalejina frequens* (KOZŁOWSKI, 1929) from Podolia (Ukraine) differs in larger flabellate ventral muscle field and more divergent dental plates. The type species *D. hanusi* HAVLÍČEK, 1953 of Pragian age differs from *D. austera* in less transverse outline, better-impressed dorsal muscle field and about half size.

Distribution: *Dalejina austera* HAVLÍČEK, 1977 is the commonest species in both studied localities. Its maximum occurrence is in the middle part of the studied section in locality 1. There the shells of *Dalejina* together with shells of the atrypid *Spinatrypa* are dominant in the coquina layers.

Occurrence: Lochkovian, Lochkov Formation, Kotýs Limestone; Barrandian, Bubovice (localities 1 and 2), Svatý Jan pod Skalou (Solvay's Quarry).

Superfamily **Enteletoidea** WAAGEN, 1884

Family **Draboviidae** HAVLÍČEK, 1950

Subfamily **Monelasminiinae** HARPER, 2000

Genus ***Muriferella*** JOHNSON et TALENT, 1967

Type species: *Muriferella masurskyi* JOHNSON et

TALENT, 1967; Devonian, Emsian, Wenban Limestone; Nevada, USA.

***Muriferella pishulinae* sp. n.**

Pl. 8, figs 26–42

Holotype: Complete shell figured on pl. 8, figs 30, 31, 37, and 39, deposited in the palaeontological collections of the University of West Bohemia in Plzeň (PCZCU 851).

Paratypes: Dorsal valve, figured on pl. 8, figs 32, 34 (PCZCU 852), and ventral valve figured on pl. 8, figs 29, 40 (PCZCU 848) deposited in the palaeontological collections of the University of West Bohemia in Plzeň.

Type horizon: Lochkovian, Lochkov Formation, Kotýs Limestone.

Type locality: Bubovice, old quarry in wooded ridge between the Branžovy Quarry and the road Loděnice-Bubovice.

Name: After the nickname of my daughter.

Material: Seven shells, 33 dorsal and six ventral valves.

Diagnosis: Small thick-shelled *Muriferella* with less transverse shell outline; non-carinate ventral valve; large ventral interarea; low rod-like dorsal median septum.

Description: The shell is ventribiconvex, thick-walled, with unisulcate commissure. The adult valves attain 6 mm width.

The dorsal valve is transversely oval, with shallow emargination at front margin, widest at the midlength. The DvL/DvW ranges from 0.64 to 0.75 in less than 3-mm-long valves, with the extreme 0.85 in the largest 5-mm long-valve. The valve is slightly convex in lateral and front views, with a deep, acute sulcus distinct from from the beak. The dorsal interarea is low, anacline, 70% of the width of the valve. The cardinal extremities are obtuse. The notothyrium is open, partially filled by a cardinal process. The dental sockets are small, deep, supported by massive fulcral plates. The cardinal process is small, undivided, ridge-like. The brachiophores are thin and high, slightly diverging, projecting anteroventrally, with acute tips. The dorsal muscle field is large, laterally bordered by raised edges, slightly excavated anterolaterally. The posterior adductor scars are oval, adjacent to the proximal part of a massive, low, rod-like median septum. The septum extends nearly to the front margin and terminates in a massive, rod-like projection. The anterior pair of adductor scars is triangular, larger than the posterior pair. Radially disposed high ridges, with highly raised anterior tips, surround the inner margin of the valve.

The ventral valve is highly convex in lateral and front views, non-carinate, without fold. The interarea is apsacline, prominent, with a slightly curved beak. The delthyrium is open, about 30% of the width of the valve. Teeth are small, triangular, supported by short and thin dental plates. The ventral muscle field is deeply impressed, undivided, with raised anterior edge and densely striated surface.

The shell is covered by angular costellae separated by broader interspaces. Some ten to twelve primary costellae are branched into thinner secondary costellae. There are

about fourteen to fifteen coarser costellae anterolaterally and about seven finer costellae on each flank. The concentric ornament consists of distinct growth lamellae (two or three) on the larger shells.

Remarks: All known species of the genus are morphologically similar, with only minor differences. Rich samples indicate (Perry 1984) wide variation in size of the type species *Muriferella masurskyi* (JOHNSON et TALENT, 1967). Our species is very near to the specimens from central Nevada, figured by Johnson et Talent (1967) in the description of the type species *M. masurskyi*. The new species differs from these specimens in about half shell size, never carinate ventral valve, and in a lower dorsal median septum which, according Johnson et Talent (1967) may be three- to four-times higher than its width. The specimens of younger age (Pragian and Emsian) referred to this species by Perry (1984) from Canada are generally more transverse and carinate, and may be better compared with *M. aliena* HAVLÍČEK, 1977 from the base of the Zlíčov Formation (Zlíčovian) from the Barrandian. This late Lower Devonian species differs from *M. pishulinae* in stronger ridges defining dorsal adductor scars, shorter and more divergent dental plates and correspondingly broader ventral muscle field, in a more transverse shell outline, and in a coarser external costellation. *Muriferella dissidens* (BARRANDE, 1879) from the Koněprusy Limestone (Pragian) is not well known, but has a narrow carina on the ventral valve that is lacking in *M. pishulinae*.

Distribution: *Muriferella pishulinae* sp. n. is an uncommon species and occurs mainly in the lower part of studied section in locality 1.

Occurrence: Lochkovian, Lochkov Formation, Kotýs Limestone; Barrandian, Bubovice (locality 1).

Order **Pentamerida** SCHUCHERT et COOPER, 1931
Suborder **Pentameridina** SCHUCHERT et COOPER, 1931

Superfamily **Camerelloidea** HALL et CLARKE, 1895
Family **Parastrophinidae** SCHUCHERT et LE VENE, 1929

Genus *Anastrophia* HALL, 1867
Subgenus *Anastrophia (Grayina)* BOUCOT, 1975

Type species: *Anastrophia magnifica* KOZŁOWSKI, 1929; Devonian, Lochkovian, Borshchov Formation; Podolia, Ukraine.

Anastrophia (Grayina) sp.
Pl. 10, figs 13, 14

Material: One incomplete dorsal valve.

Remarks: The available dorsal valve is large, 17 mm wide in incomplete width, strongly transverse and weakly convex, with low and broad sulcus. The surface bears some 22 to 24 strong subangular costae, which bifurcate irregu-

larly on sides of the sulcus. The interior has preserved anterior part of a long narrow septalium.

The genus *Anastrophia* HALL has been unknown from the early Devonian of the Barrandian, although it is known worldwide (Kozłowski 1929, Lenz 1967, Savage 1971, Johnson et al. 1973). The silicified specimen is almost identical with *A. (G.) magnifica* KOZŁOWSKI, 1929 from the Borshchov Formation of Podolia, sharing the same number of costae and transverse outline. Specimens from Podolia are considerably variable in convexity, outline and length of the hinge line. However, the single valve does not allow evaluation of variability of the Czech material and therefore its taxonomy is left open.

Distribution: *Anastrophia* sp. n. is very rare and was collected from the basal beds of the studied section in locality 1.

Occurrence: Lochkovian, Lochkov Formation, Kotýs Limestone; Barrandian, Bubovice (locality 1).

Superfamily **Gypiduloidea** SCHUCHERT et LE VENE, 1929

Family **Gypidulidae** SCHUCHERT et LE VENE, 1929

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

Genus *Gypidula* HALL, 1867

Type species: *Gypidula typicalis* AMSDEN, 1953; Devonian, Givetian; Iowa, USA.

Gypidula pelagica (BARRANDE, 1847)
Pl. 10, figs 1–3, 5, 7, 8

1847 *Pentamerus pelagicus*; Barrande, p. 496, pl. 22, figs 3a–3f.
1879 *Pentamerus pelagicus* BARR.; Barrande, pl. 22, figs 1–9, 12–15.

1985 *Gypidula pelagica* (BARR.); Havlíček, p. 295, text-fig. 1.
1999 *Gypidula pelagica* (BARRANDE, 1847); Havlíček, p. 312, pl. 4, figs 8–13, text-fig. 6.

Lectotype: Designed by Havlíček (1999), shell figured by Barrande (1847) on pl. 22, figs 3a, 3b, 3d, refigured by same author (1879) on pl. 22, figs 3a, 3b, 3d, 3e, and by Havlíček (1999) in pl. 4, figs 11–13, deposited in the palaeontological collection of the National Museum Prague (NM L 24009).

Type horizon and locality: Lochkovian, Lochkov Formation, Kotýs Limestone; Svatý Jan pod Skalou.

New material: Three ventral valves.

Description: See Havlíček (1999).

Remarks: Inner morphology of this species has been illustrated for the first time by Havlíček (1999) by serial sectioning of a complete shell. Three ventral valves have been found in the silicified material. They are illustrated to show a small and deep spondylium supported by a short, thin septum. The septum is present in two of the three preserved valves and it seems likely, that its size can significantly fluctuate.

uate. The ventral valve shell is remarkably thin. The dorsal valve has not been found among the silicified shells.

Distribution: *Gypidula pelagica* (BARRANDE, 1847) is rare and occurs only in lower part of the studied section in locality 1.

Occurrence: Lochkovian, Lochkov Formation, Kotýs Limestone; Barrandian, Bubovice (locality 1), Praha-Řeporyje (Černý lom Quarry), Svatý Jan pod Skalou.

Superfamily **Clorindoidea** RZHONSNITSKAIA, 1956

Family **Clorindidae** RZHONSNITSKAIA, 1956

Genus **Clorinda** BARRANDE, 1879

Type species: *Clorinda armata* BARRANDE, 1879; Devonian, Zlíchovian, Zlíchov Limestone; Barrandian, Bohemia.

Clorinda pseudolinguifera KOZŁOWSKI, 1929

Pl. 10, figs 4, 6, 9–12

1929 *Barrandella (Clorinda) pseudolinguifera* sp. n.; Kozłowski, p. 137, pl. 6, figs 4–13, text-fig. 40.

1990 *Clorinda pseudolinguifera* KOZŁOWSKI, 1929; Havlíček et Štorch, p. 121, pl. 33, fig. 8.

1999 *Clorinda pseudolinguifera* KOZŁOWSKI; Havlíček, p. 303 (noted in species list).

Synonymy and neotype: See Nikiforova et al. (1985).

New material: One shell, three ventral and two incomplete dorsal valves, and several fragments.

Description of Czech material: The shell is transverse, ventribiconvex, and 16 mm wide in adults.

The dorsal valve is thin-shelled, with prominent, anteriorly rapidly widening convex fold. The flanks are gently convex. The dorsal umbo is short but prominent, slightly curved ventrally. The beak angle is about 120–130°. The dental sockets are very shallow and poorly discernible in silicified shells. Outer hinge plates are narrow, with converging surface, divided by weak carina from inner socket ridges, subvertical outer hinge plates and anteriorly moderately divergent inner hinge plates. The bases of inner hinge plates diverge and rest almost horizontally on sides of the apical chamber. The crura are directed anterodorsally. Muscle scars are not preserved.

The ventral valve is transverse, strongly convex, with heavily thickened walls. The sulcus is shallow, distinct only anteromedianly. Flanks are slightly convex. The interarea is poorly defined, large, curved, apsacline to orthocline. The beak is short, curved dorsally. The bottom of the sulcus is flat to weakly convex. The sulcus extends anterodorsally to dorsally into a long rounded tongue. The delthyrium is small, probably open. The spondylium is small, short and deep, bordered by minute teeth, posteriorly supported by very short and thin median septum. Pallial markings are deeply impressed as radially arranged canals but otherwise they remains imperfectly known due to the incompleteness of the silicified shells.

The exterior is smooth, without coarser growth lamellae.

Remarks: The presence of *Clorinda pseudolinguifera* KOZŁOWSKI in the lower part of the Lochkov Formation has been stated by Havlíček et Štorch (1990). The complete shell, derived from the top of the Požáry or the basal Lochkov Formations and figured by these authors, although similar to new specimens, differs from the new material in a more distinct ventral sulcus and less rapidly expanding dorsal fold. The silicified specimens are much similar to the specimen figured by Nikiforova et al. (1985) from Podolia, which also shows strongly transverse dorsal valve, more expanded dorsal fold and absence of low plication in sulcus or flattened top of the fold. The specimen figured by Havlíček et Štorch (1990) may represent another although closely related species to the species in the Kotýs Limestone. The inner morphology of the silicified dorsal valves shows arrangement of the hinge plates in accordance with the diagrammatic scheme presented by Havlíček et Štorch (1990) for the genus *Clorinda* BARRANDE, 1879. Unfortunately, pallial markings in the available specimens are poorly known, and despite their importance for taxonomy (Sapelnikov 1985) they cannot be used as a support of the species affinity.

Distribution: *Clorinda pseudolinguifera* KOZŁOWSKI, 1929 is a rare species restricted to upper part of the studied section in locality 1.

Occurrence: Lochkovian, Lochkov Formation, Kotýs Limestone; Barrandian, Bubovice (locality 1), Praha-Řeporyje (Černý lom Quarry).

Order **Rhynchonellida** KUHN, 1949

Remarks: Rhynchonellid brachiopods are extraordinary scarce among the silicified material and their shells are highly fragmentary. Apart from the glossinotoechiid *Eoglossinotoechia mystica* HAVLÍČEK, 1961 which was determinable, two other species were found, probably of genera *Hebetoechia* HAVLÍČEK, 1959 and *Plethorhyncha* HALL et CLARKE, 1893. Due to the uncertainty of their determination, these fragments are neither commented nor figured.

Superfamily **Uncinuloidea** RZHONSNITSKAIA, 1956

Family **Glossinotoechiidae** HAVLÍČEK, 1992

Genus **Eoglossinotoechia** HAVLÍČEK, 1959

Type species: *Eoglossinotoechia cacuminata* HAVLÍČEK, 1959; Devonian, Pragian, Slivenec Limestone; Barrandian, Bohemia.

Eoglossinotoechia mystica HAVLÍČEK, 1961

Pl. 10, figs 15, 16

1961b *Eoglossinotoechia mystica* n. sp.; Havlíček, p. 154, pl. 19, figs 1–5, text-figs 62–66.

1992a *Eoglossinotoechia mystica* HAVLÍČEK, 1961; Havlíček, p. 98.

1999 *Eoglossinotoechia mystica* HAVLÍČEK; Havlíček, p. 303 (noted in species list).

Holotype: Shell figured by Havlíček (1961) on pl. 19,

fig. 1, deposited in the palaeontological collection of the Museum of Dr. B. Horák in Rokycany (3RO 63581, original signature VH 250).

Type horizon and locality: Lochkovian, Lochkov Formation, Kotýs Limestone; Skalice Hill near Měňany.

New material: One ventral valve and two fragments of shell margin.

Description: See Havlíček (1961b).

Distribution: *Eoglossinotoechia mystica* HAVLÍČEK, 1961 is very rare among silicified brachiopods. It has been found only in the lowest beds in the studied section in locality 1.

Occurrence: Lochkovian, Lochkov Formation, Kotýs Limestone; Barrandian, Bubovice (locality 1), Svatý Jan pod Skalou area; Radotín Limestone; Barrandian, Dvorce, Karlštejn (Javorka), Lejškov, Měňany (Skalice Hill), Praha-Řeporyje.

Order **Atrypida** RZHONSNITSKAIA, 1960

Suborder **Atrypidina** MOORE, 1952

Superfamily **Atrypoidea** GILL, 1871

Family **Atrypidae** GILL, 1871

Subfamily **Atrypinae** GILL, 1871

Genus **Kyrtatrypa** STRUVE, 1966

Type species: *Atrypa (Kyrtatrypa) culminigera* STRUVE, 1966; Devonian, Eifelian, Junkerberg Beds; Eifel, Germany.

Kyrtatrypa anulata (HAVLÍČEK, 1987)

Pl. 11, figs 1–3

1879 *Atrypa reticularis* LINNAEUS sp.; Barrande (partim), pl. 132, case 4, fig. 1.

1987 *Anulatrypa anulata* sp. n.; Havlíček, p. 74, pl. 1, figs 1–4.

1999 *Anulatrypa anulata* HAVLÍČEK; Havlíček, p. 303 (noted in species list).

Holotype: Dorsal valve figured by Havlíček (1987) on pl. 1, fig 4, deposited in the palaeontological collection of the Museum of Dr. B. Horák in Rokycany (3RO 49402, original signature VH 3991).

Type horizon and locality: Lochkovian, Lochkov Formation, Kotýs Limestone; Svatý Jan pod Skalou, Solvay's Quarry.

New material: Three fragmentary ventral valves.

Diagnosis: Large elongate elliptical dorsibiconvex *Kyrtatrypa* with highly plicate commissure, short curved ventral beak; ventral interarea absent; ornament of thin rounded low ribs; concentric lamellae extended into long trails.

Description: See Havlíček (1987). New material show large flabellate and deeply impressed ventral muscle field and rather small teeth in the ventral valve interior.

Remarks: The species has been based by Havlíček

(1987) on nice and rich material of large, mostly complete shells and several smaller specimens with preserved proximal parts of frills around the anterior margin, all coming from the Solvay's Quarry near Svatý Jan pod Skalou. The holotype is in fact numbered VH 3991, because number VH 4127b (Havlíček 1987, p. 74) is preoccupied by another species. New material comprises only several fragmentary valves, which differ from other associated atrypids in much larger shell size and low external ribs.

After Copper (2002), the *Anulatrypa* HAVLÍČEK, 1987 is a younger subjective synonym of *Kyrtatrypa* Struve, 1966.

Distribution: *Kyrtatrypa anulata* (HAVLÍČEK, 1987) is very rare in middle part of the studied section in locality 1.

Occurrence: Lochkovian, Lochkov Formation, Kotýs Limestone; Barrandian, Bubovice (localities 1, 2), Měňany (Skalice Hill), Svatý Jan pod Skalou (Solvay's Quarry).

Subfamily **Spinatrypinae** COOPER, 1978

Genus **Spinatrypa** STAINBROOK, 1951

Type species: *Atrypa hystrix* var. *occidentalis* HALL, 1858; Devonian, Givetian; New York, USA.

Spinatrypa senilis (HAVLÍČEK, 1987)

Pl. 12, figs 1–17; pl. 13, figs 1–8

1879 *Atrypa reticularis* LINNAEUS sp.; Barrande (partim), pl. 19, fig. 15.

1987 *Oglu senilis* sp. n.; Havlíček, p. 83, pl. 2, fig. 7, pl. 4, fig. 1.

1987 *Spinatrypa spinipleura* sp. n.; Havlíček, p. 86, pl. 6, figs 7–9, pl. 7, figs 4–6, text-fig. 12.

1999 *Oglu senilis* HAVLÍČEK; Havlíček, p. 303 (noted in species list).

1999 *Eospinatrypa spinipleura* HAVLÍČEK; Havlíček, p. 303 (noted in species list).

Holotype: Shell figured by Havlíček (1987) on pl. 4, fig 1, deposited in the palaeontological collection of the Museum of Dr. B. Horák in Rokycany (3RO 49606, original signature VH 4122).

Type horizon and locality: Lochkovian, Lochkov Formation, Kotýs Limestone; Špičatý vrch Hill near Loděnice.

New material: Several hundred complete shells, dorsal and ventral valves.

Diagnosis: Large subcircular to shield-shaped, strongly dorsibiconvex *Spinatrypa* with moderate thick shell; commissure distinctly plicate; short curved ventral beak without interarea and deltidial plates; ribs coarse, low, rounded, new originate mostly by intercalation; concentric lamellae numerous, regularly spaced, extended into high frills and/or long, tubular spines.

Description: See Havlíček (1987), but new data are presented, based on nicely preserved silicified shells. The shell is strongly dorsibiconvex, with highly arched dor-

sal and weakly convex subcarinate ventral valve. The commissure is uniplicate in adult shells, but rectimarginate in small-sized specimens. The species is of medium size for the genus, with thin dorsal and slightly thicker ventral valves, without frills, 13–14 mm wide in adults.

The dorsal valve is highly convex, with the maximum depth at about midlength. The dorsal interior has small, moderate divergent socket plates. The dental sockets are small, paralleling the posterior margin. Dorsal muscle field is weakly impressed, divided posteriorly by thin, short and low median ridge. The crural bases are directed anteroventrally. The jugal process is unknown. The cones of the brachidium are dorsomedianly directed, with cone apices slightly posterior to shell midlength. The primary lamellae are closely adjacent to the floor of ventral valve. All lamellae are ventrally convex, copying the convexity of the ventral valve. The primary lamellae are 0.4 mm broad and about 0.05 mm thick, becoming broader near the anterior deflection. Each whorl tapers anteriorly, with curved outer lamellae and almost straight inner lamellae. Two cones of spiralia are closely adjacent to inner shell surface, leaving only narrow space between lamellae and shell floor. Each cone in adult shell consists of six to eight whorls.

The ventral valve is slightly convex in lateral profile, and subcarinate in transverse profile in posterior part but almost planar anteriorly. The anterior margin is extended or somehow angular in large valve. The ventral beak is short, hypercline, with beak angle some 130–140°, covering the dorsal beak in closed shell. The ventral interarea is not developed, broadly triangular delthyrium is open, and the beak bears a transapical foramen. Distinct pedicle collar is absent, but the top of umbo has much thinner shell than rest of the valve. The ventral interior bears prominent, thin, transverse teeth. The ventral muscle field is deeply impressed in posterior part, embedded into thickened shell. The diductor scars are large, flabellate, extending over one-third of the valve. Adductor scars are much smaller restricted to a deeply impressed elongate scar in umbonal chamber just between teeth. Posterolateral and lateral floor is remarkably thick, leaving only small depression with a thinner shell anterocentrally in front of ventral muscle field.

The ornament is prominent, with almost uniform radial ribbing in all studied specimens. The ventral valve has eight primary ribs. The pair of axial ribs is coarser, than the remaining lateral ribs. New ribs originate mostly by intercalation between primaries, but the primary axial ribs divide by a dichotomy. There are 16 to 20 distinct ribs along periphery of large ventral valves. The dorsal valve bears the same type of ribbing, with single axial rib in a shallow sulcus that is distinct only posteriorly. The axial rib does not originate at the apex as adjacent pair of primary ribs. Ribs are rounded, slightly widening anteriorly, separated by shallow and narrower interspaces. Growth lamellae are regularly spaced in juvenile and medium sized shells, being densely packed along shell periphery in adult valves. The frills and spines appear already in juvenile specimens. The lamellae may extend into high, straight, deflected or slightly irregular frills

with radial ridges corresponding to ribs or to long tubular spines inclined under high angle to the shell surface. The spines are evenly wide along the whole length and may be terminated by a funnel-like opening. The high frills and spines are developed only in dorsal valves and underwent little changes during the animal life. The ventral valves show only low frills around shell periphery, otherwise their surface is nearly smooth, probably worn. Therefore, there are specimens with high frills around the shell (pl. 12, figs 3, 5), or specimens with prevalent spines (pl. 12, figs 1, 12). This indicates high phenotypic variability and stable condition during life of the individual.

Remarks: The ornament of this species is similar to other spinatrypid genera, but it is rather variable. Havlíček (1987) referred the specimens without preserved spines to genus *Oglu* HAVLÍČEK, 1987, and other specimens with long spines to *Spinatrypa* STAINBROOK, 1951. However, *Oglu* may be considered as a synonym of *Spinatrypa*, and not of *Eospinatrypa* COOPER, 1973 or *Punctspinatrypa* RZHONSNITSKAIA, 1975 as suggested by Copper (2002). The presence of the spines alone is a controversial feature, varying even among one species. The convexoplane shell is known in the type species *S. occidentalis* (HALL, 1858) and the absence of the ventral area and the deltidial plates, the features present in *S. senilis*, is noted in diagnosis of *Spinatrypa* given by Cooper (2002).

Distribution: *Spinatrypa senilis* HAVLÍČEK, 1987 is a very abundant species in the lower and middle parts of the studied sequence in locality 1, and is abundant in locality 2.

Occurrence: Lochkovian, Lochkov Formation, Kotýs Limestone; Barrandian, Bubovice (localities 1, 2); Svatý Jan pod Skalou (Solvay's Quarry), Tachlovice.

Genus *Spinatrypina* RZHONSNITSKAIA, 1964

Type species: *Spinatrypina margaritoides* RZHONSNITSKAIA, 1964; Devonian, Pragian; Siberia.

Spinatrypina variabilis sp. n.

Pl. 11, figs 4–23

Holotype: Complete shell figured on pl. 11, figs 13, 14, deposited in the palaeontological collections of the University of West Bohemia in Plzeň (PCZCU 1019).

Paratypes: Dorsal valve figured on pl. 11, fig. 22 (PCZCU 1023), and ventral valve figured on pl. 11, fig. 21 (PCZCU 1022), deposited in the palaeontological collections of the University of West Bohemia in Plzeň.

Type horizon: Lochkovian, Lochkov Formation, Kotýs Limestone.

Type locality: Bubovice, old quarry in wooded ridge between the Branžovy Quarry and the road Loděnice-Bubovice.

Name: *variabilis* (Lat.) – referring to variability of the external ornament.

Material: Thirty-three shells, 20 dorsal and 30 ventral valves

Diagnosis: Small, thin shelled, dorsibiconvex *Spina-*

trypina, with broadly uniplicate commissure; interarea orthocline with apical foramen, deltidial plates conjunct; ornament of rather coarse primary, imbricate ribs.

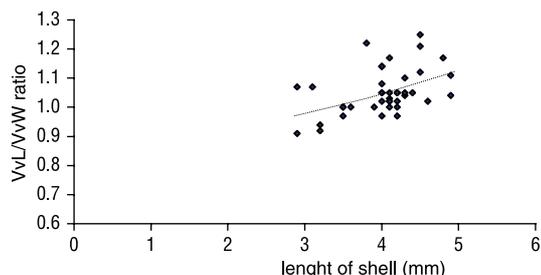
Description: The shell is ventribiconvex, thin-walled, with uniplicate commissure. The adult shells may reach 12 mm width, but most collected shells are only 8–9 mm wide, with subglobose shape by peripheral accumulation of growth lamellae. The shell outline varies from elongately elliptical to subcircular.

The dorsal valve is subcircular, gently tapering anteriorly, with the maximum width slightly posterior to the midlength. The posterior margin is rounded, with a short, rounded, ventrally directed beak. The convexity is moderate to high and increases with the age. The maximum depth is at the midlength. The shallow and narrow sulcus is developed in the umbonal region, becoming obscure anteriorly. The dental sockets are deep, broadly divergent, with distinct outer socket ridges and higher, thicker, widely divergent and short socket plates. The cardinal pit is narrow, the cardinal process is not preserved. The crural bases are distinct anterolaterally on socket plates and continue laterally to primary lamellae of the spiralia. The jugal process is unknown. Spiralia are dorsomedianly directed, formed by approximately 0.30 mm wide lamellae along the whole length of a whorl, evenly curved anteriorly and posteriorly, with some 0.5–0.6 mm between the first and second whorls. The lamellae of each whorl are gently arched ventrally. There are four to six whorls in the adult shell.

The ventral valve is convex, slightly depressed antero-medianly, with a prominent beak directed posteriorly. The VvL/VvW ranges between 0.92–1.11. The beak angle is 100–120°. The interarea is orthocline, low but distinct. The delthyrium is broadly triangular, basally closed by flat conjunct deltidial plates. The foramen is circular, apical. Teeth are rather large, transverse. The ventral muscle field is weakly impressed, with large, flabellate diductor scars that extend nearly to the shell midlength.

The ornament consists of fine ribs separated by narrower interspaces. The dorsal valve has one rib in the sulcus and four primary ribs on flanks. The number of ribs increase by dichotomy, mainly near concentric lamellae. New ribs may be weaker than primaries. Therefore, the ribbing around the shell periphery is finer than in juvenile shells. Rhythmic growth lamellae are numerous, evenly spaced, 0.2–0.3 mm apart, except for the periphery of adult shell, where they are more densely crowded. The lamellae extend into dense imbrications but never into spines. The imbricate ornament is rarely visible, because only ribs with bases of lamellae are mostly preserved as the shells were worn before fossilisation.

Remarks: *Spinatrypina variabilis* sp. n. differs from *S. soetenica* (STRUVE, 1964) from the Lower Givetian of Germany in less regular and finer ribbing. Numerous other Middle Devonian species of the genus described by Copper (1967) are not so similar to the new species. The shell of the new species is similar to small specimens of *Kyrtatrypa anulata* (HAVLÍČEK, 1987), but differs in thinner and higher



Text-fig. 7. *Atrypina eremita* HAVLÍČEK, 1999. VvL/VvW ratio variation and its changes with shell size. 40 specimens measured.

ribs, thin shell and much smaller size.

Distribution: *Spinatrypina variabilis* sp. n. is abundant mostly in the middle part, less uncommon also in the lower part of the studied section in locality 1.

Occurrence: Lochkovian, Lochkov Formation, Kotýs Limestone; Barrandian, Bubovice (localities 1, 2).

Family **Atrypinidae** GILL, 1871

Family **Atrypininae** McEVAN, 1939

Genus **Atrypina** HALL et CLARKE, 1894

Type species: *Leptoceelia imbricata* HALL, 1857; Devonian, Emsian; New York, USA.

Atrypina eremita HAVLÍČEK, 1999

Pl. 14, figs 1–15; text-fig. 7

1999 *Atrypina eremita* n. sp.; Havlíček, p. 313, pl. 3, figs 13–18.

Holotype: Shell figured by Havlíček (1999) on pl. 3, figs 16–18, deposited in the palaeontological collection of the Museum of Dr. B. Horák in Rokycany (3RO 83531, original signature VH 12915b).

Type horizon and locality: Lochkovian, Lochkov Formation, Kotýs Limestone; Svatý Jan pod Skalou, Solvay's Quarry.

New material: Fifty complete shells, 17 dorsal and 28 dorsal valves.

Diagnosis: Small, prominently ventribiconvex *Atrypina* with five to seven dorsal and six or eight distinct ventral ribs; ventral median ribs are much stronger than lateral ribs; concentric lamellae crowded anteriorly, where they may form a low geniculation.

Description: See Havlíček (1999).

Remarks: This species was described and commented by Havlíček (1999). The size-frequency distribution indicates (text-fig. 7), that the width of the species never exceeds 4.7 mm, and the average width lies between 3.8 and 4.3 mm in adult specimens with the first growth lamella. The outline may vary from broadly oval to elongate, invariably with prominent ventral beak. The dorsal valve is gently convex, with prominent changes in outline by an accretion of overlapping lamellae anteriorly in the adults.

One valve among available specimens shows three fragmentary whorls of left spire of brachidium. The ornament consists of simple strong ribs, but one valve (PCZCU 807) displays dichotomy of largest ventral ribs anteriorly (pl. 14, figs 1, 13)

Distribution: *Atrypina eremita* HAVLÍČEK, 1999 is moderately common species, mainly in the middle part of the studied section in locality 1.

Occurrence: Lochkovian, Lochkov Formation, Kotýs Limestone; Barrandian, Bubovice (locality 1), Svatý Jan pod Skalou (Solvay's Quarry).

Suborder **Lissatrypidina** COOPER, 1996

Superfamily **Lissatryoidea** TWENHOFEL, 1914

Family **Lissatrypidae** TWENHOFEL, 1914

Genus **Lissatrypa** TWENHOFEL, 1914

Type species: *Lissatrypa atheroidea* TWENHOFEL, 1914; Silurian, Llandoverly, Jupiter Formation; Anticosti, Canada.

Lissatrypa neglecta HAVLÍČEK, 1984

Pl. 13, figs 9–26

1984 *Lissatrypa neglecta* sp. n.; Havlíček, p. 220, pl. 1, figs 6,7, pl. 2, figs 3–8.

1990 *Lissatrypa leprosa* KOZŁOWSKI, 1929; Havlíček et Štorch, p. 193 (in text only).

1999 *Lissatrypa leprosa* KOZŁOWSKI, 1929; Havlíček, p. 303 (noted in species list).

Holotype: Shell figured by Havlíček (1984) on pl. 2, fig. 5, deposited in the palaeontological collection of the Museum of Dr. B. Horák in Rokycany (3RO 49513, original signature VH 3039a).

Type horizon and locality: Lochkovian, Lochkov Formation, Kotýs Limestone; Praha-Řeporyje (outcrops above the Černý lom Quarry).

New material: Thirty shells, many fragmentary ventral and dorsal valves.

Diagnosis: Equally biconvex, subpentagonal *Lissatrypa* with gently uniplicate commissure, medially depressed ventral valve; short dorsally curved ventral beak; bulbous cardinal plate; weak concentric ornament.

Description: See Havlíček (1984), but some poorly known details of morphology are commented.

The spiralia are dorsoventrally directed, with the axis of cones gently convergent dorsally, with four to five whorls in large specimens. The whorls are wider posteriorly than anteriorly. The crura are directed laterally to dorsolaterally, with the jugal processes running dorsally to slightly anterodorsally to crura. The jugal processes are straight proximally and curved dorsally by the distal parts (pl. 13, fig. 22). The lamellae of the spiralia are about 0.4 mm wide in the first ascending lamella, and their width decreases very slowly in the next whorls.

The exterior of the shell is smooth, with several weak

concentric lamellae. Delicate short spines are rarely preserved (pl. 13, figs 15, 26), but they probably covered entire or at least the anterior half of the shell during the life of an individual. The spines are short, inclined under low angle, being densely packed to form continuous outer cover of the shell.

Remarks: Havlíček (1984) based this species on material coming from weathered limestone of the lower part of the Kotýs Limestone above the east wall of the Černý lom Quarry (Praha-Řeporyje). Havlíček et Štorch (1990) referred the specimens from the earlier Požáry Formation (Přídolí) to *Lissatrypa leprosa* KOZŁOWSKI, 1929, a common species in early Devonian of Podolia (Ukraine), with a note, that *L. neglecta* HAVLÍČEK, 1984 differs only in a more robust cardinal structure. Because *L. neglecta* has been suggested synonymous with *L. leprosa*, the latter name had appeared in the faunal list of brachiopods from the Kotýs Limestone (Havlíček 1999) without any additional comments. However, the new material supports the validity of *L. neglecta*. All available silicified and undeformed specimens are distinctly uniplicate, with both valves equally convex, while in *L. leprosa* the dorsal valve is less convex than the ventral valve. The maximum depth of the ventral valve of *L. neglecta* lies at the midlength, in *L. leprosa* in the posterior third. Interior of *L. leprosa* is less thickened, with less massive teeth and cardinal block, and the dorsal median septum is thin and long. These structures are coarse already in the small specimens of *L. neglecta*, and the dorsal median septum is shorter and robust. The maximum size of *L. leprosa* is probably smaller; the specimens figured by Nikiforova et al. (1985) are 6 to 10 mm wide, the maximum width of *L. neglecta* attains 14 mm.

Distribution: *Lissatrypa neglecta* HAVLÍČEK, 1984 is abundant but generally poorly preserved species, which occurs mainly in the upper part of the studied section in locality 1.

Occurrence: Lochkovian, Lochkov Formation, Kotýs Limestone; Barrandian, Bubovice (locality 1), Měňany (Skalice Hill), Praha-Řeporyje (Černý lom Quarry), Svatý Jan pod Skalou (Na Stydlych vodách Hill).

Order **Athyridida** BOUCOT, JOHNSON et STATON, 1964

Suborder **Athyrididina** BOUCOT, JOHNSON et STATON, 1964

Superfamily **Athyridoidea** DAVIDSON, 1881

Family **Athyrididae** DAVIDSON, 1881

Subfamily **Didymothyridinae** MODZALEVSKAYA, 1979

Genus **Glassina** HALL et CLARKE, 1893

Type species: *Terebratula laeviscula* J. de C. SOWERBY, 1839; Silurian, Wenlock; Shropshire, England.

Glassina gutta sp. n.

Pl. 14, figs 31–38; text-fig. 8

Holotype: Shell figured on pl. 14, fig. 31, deposited in the palaeontological collection of the University of West Bohemia, Plzeň (PCZCU 1036).

Paratypes: Shell figured on pl. 14, figs 34, 38 (PCZCU 1035), and shell figured on pl. 14, figs 35, 36 (PCZCU 1039), deposited in the palaeontological collections of the University of West Bohemia in Plzeň.

Type horizon: Lochkovian, Lochkov Formation, Kotýs Limestone.

Type locality: Bubovice, old quarry in wooded ridge between the Branžovy Quarry and the road Loděnice-Bubovice.

Name: *gutta* (Lat.) – referring drop-like outline of the shell.

Material: Twenty-five shells.

Diagnosis: Equally biconvex, thin-walled *Glassina* with subpentagonal outline and weakly truncated anterior margin; ventral beak small, with area orthocline to hypercline; large delthyrium laterally closed by large convex deltidial plates; dorsal median septum absent; exterior smooth.

Description: The shell is equally biconvex, thin-walled, 5.2 mm wide in the largest available specimen. The anterior margin is slightly truncated, the commissure is recrimarginate or very weakly plicate.

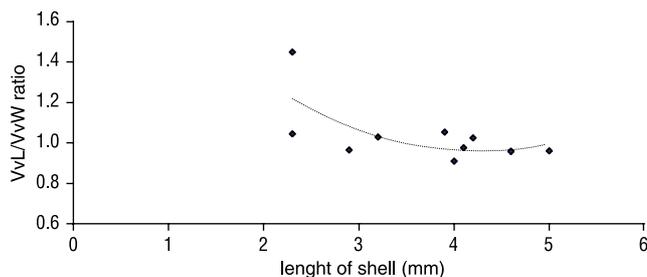
The dorsal valve is subcircular, in adults 0.95–0.97 as long as wide. The juvenile shells are more elongate, with DvL/DvW ranging between 1.02–1.05 (text-fig. 8). The valve is the widest at the midlength. The valve is evenly convex in transverse profile, but more convex posteriorly than anteriorly. The maximum depth is at the posterior third. The beak is rounded.

The dental sockets are small. The cardinal plate is small, poorly known, unsupported by median ridge. Thin and high crura extend ventrally from the anterolateral edges of the cardinal plate. The brachidium is imperfectly known (pl. 14, figs 34, 37, 38), with cones laterally directed. The primary lamellae are parallel with the dorsal valve floor. They are 1 mm far from each other in the midlength of the valve, and diverge in approximately 40° from each other. The primary lamellae are broad (0.45 mm in proximal part) and turn ventrally at about 70–80% of the dorsal valve length. Primary and second lamellae are 0.4 mm apart. Three spires have been observed in each cone of the large shells.

The ventral valve is subpentagonal, with prominent slightly incurved dorsal beak. The valve is evenly convex, with faint median depression near the front of the valve. The area is distinct, orthocline to hypercline in late adults, with a large triangular delthyrium. The large convex deltidial plates laterally cover the base of the delthyrium, leaving narrowly elongate foramen slit. The dental plates are thin, weakly diverging anteriorly and converging to the valve floor, supporting small teeth. Muscle impressions are unknown.

Shell exterior is smooth, without growth lamellae.

Remarks: Similarly shaped small non-strophic brachiopods have been by various authors (Johnson et al. 1973, Perry 1984) referred to the genus *Cryptatrypa* SIEHL, 1962. However, the type species of the genus *Cryptatrypa* is



Text-fig. 8. *Glassina gutta* sp. n. VvL/VvW ratio variation and its changes with shell size. 11 specimens measured.

ventribiconvex, uniplicate, thick-shelled, internally without dental plates and with a deeply impressed muscle field (Havlíček et Štorch 1990). The type species of genus *Glassina* HALL et CLARKE, 1893 is of Wenlock age, leaving the generic affinity of Devonian species unclear. Although the shape of brachidium of *Cryptatrypa* is unknown, Copper (1986, 2002) suggested this genus synonymous to *Glassina* DAVIDSON, 1881.

The new species is very similar to some specimens referred to *Cryptatrypa lenticula* PERRY, 1984 from the Delorme Formation (Emsian) of Yukon, Canada. One figured specimen (Perry 1984: pl. 40, fig. 19) with laterally directed cones of brachidium indicates an athyridid affinity. However, the shape and size of the holotype (Perry 1984: pl. 40, figs 1–4), and one of the paratypes (pl. 40, figs 21–23) differ from other figured specimens in non-truncated front margins, less convex shells and more elongate outlines. The same features distinguish *Glassina gutta* from *C. lenticula*. The remaining specimens figured by Perry (1984: pl. 40, figs 5–20, 24–27) are remarkably similar to Bohemian material, but probably belong to different species from the holotype and the mentioned paratype. The type species *Glassina laeviscula* (SOWERBY, 1839) from Wenlock of England differs from *G. gutta* in a dorsal median septum and more elongate shell. The species *G. pentagona* MODZALEVSKAYA, 1979 from the Ludlow of Podolia, is externally similar to the new species, but *G. gutta* is smaller, has less curved ventral beak, and unlike the new species, the shallow emargination is present in the Ukrainian species (Modzalevskaja 1985).

Distribution: *Glassina gutta* sp. n. is an uncommon species, which occurs mostly in the lower beds of the studied section in locality 1.

Occurrence: Lochkovian, Lochkov Formation, Kotýs Limestone; Barrandian, Bubovice (locality 1).

Superfamily **Meristelloidea** WAAGEN, 1883

Family **Meristidae** HALL et CLARKE, 1895

Subfamily **Meristellinae** HALL et CLARKE, 1895

Genus **Merista** SUESS, 1851

Type species: *Terebratula herculea* BARRANDE, 1847; Devonian, Pragian, Koněprusy Limestone; Barrandian, Bohemia.

***Merista pruniformis* HAVLÍČEK, 1999**

Pl. 15, figs 1–5

1879 *Merista Herculea* BARR.; Barrande (partim); pl. 13, case 1, figs 1–9; pl. 134, case 8.

1999 *Merista pruniformis* sp. n.; Havlíček, p. 315, pl. 3, figs 1–3.

Holotype: Shell figured by Havlíček (1999) on pl. 3, figs 1–3, deposited in the palaeontological collection of the Museum of Dr. B. Horák in Rokycany (3RO 85370, original signature VH 12659).

Type horizon and locality: Lochkovian, Lochkov Formation, Kotýs Limestone; Svatý Jan pod Skalou, Solvay's Quarry.

New material: Six dorsal and seven ventral, always incomplete valves.

Diagnosis: Medium sized, elongate *Merista* with thick shell, uniplicate commissure; dental plates thick and short, attached near sides of low shoe-lifter; cella narrow and low; dorsal median septum basally thickened, long and high.

Description: External shape of the complete shell and short description is given by Havlíček (1999), but silicified material presented some new data about the internal morphology.

Both valves are thick-walled, especially in posterolateral parts. The inner surface of thick walls bears shallow elongate pits arranged in a radial pattern.

The dorsal valve interior bears small, deep, thick-walled septalium supported by posteriorly thickened median septum. The septum extends into mid-length of the valve, continuing as a shallow groove at valve floor.

The dental plates are short, thick, in large valves deeply embedded into shell wall. They support small teeth. The bases of the dental plates rest laterally to sides of the shoe-lifter. The shoe-lifter is low, roundly triangular in a transverse profile, rapidly expanding anteriorly. Secondary shell deposits, leaving a wide space for an attachment of the muscles, cover the posterior part of the shoe-lifter between the bases of the dental plates.

Remarks: New material is highly fragmentary and is assigned to *Merista pruniformis* HAVLÍČEK with some doubts. Havlíček (1999) did not figure serial sections and the illustrated holotype does not show any data about the shell interior. However, Havlíček (1999) noted thickened and short dental plates and these are also present in the new material. The species belongs to group „B“ of meristids (Havlíček et Vaněk 1998), with the bases of dental plates touching the sides of the shoe-lifter. The species is a probable ancestor of similarly plicate *M. pseudoscalprum* (BARRANDE, 1847) from the Koněprusy Limestone (Pragian).

Distribution: *Merista pruniformis* HAVLÍČEK, 1999 is rare and poorly preserved species, which occurs mostly in the lower beds of the studied section in locality 1.

Occurrence: Lochkovian, Lochkov Formation, Kotýs Limestone; Barrandian, Bubovice (locality 1), Svatý Jan pod Skalou area (old collections).

***Merista* cf. *herculea* (BARRANDE, 1847)**

Pl. 15, figs 6–12

Material: Nine incomplete ventral valves and one dorsal valve.

Description: The shell is large, transverse as may be inferred from growth lamellae, at least 25 mm wide, thin-shelled.

The ventral valve is highly convex, with a short, posteriorly directed beak. The delthyrium is moderately triangular. Teeth are small, supported by thin, short and basally gently converging dental plates, leaving narrow and dorsally convex platform between their bases. The bases of dental plates rest on sides of the shoe-lifter, and they extend to about one-half of its length. The shoe-lifter is long, rapidly widening and elevating anteriorly, with the crest acute posteriorly but gently rounded anteriorly. The cella is highly triangular in a transverse profile. Thick deposits of the secondary shell are absent, leaving the basis of dental plates free even in large valves. The dorsal valve has small deep septalium supported by a thin and high septum.

Remarks: This species differs from shells referred to *Merista pruniformis* HAVLÍČEK, 1999 in a thin shell, the bases of the dental plates attached to sides of shoe-lifter, and more transverse shell outline. Its inner morphology corresponds to meristids of the group “A” of Havlíček et Vaněk (1998) and it may be well compared with *M. herculea* (BARRANDE, 1847) from the Koněprusy Limestone (Pragian) of the Barrandian. *Merista herculea* has similar internal morphology well illustrated by Havlíček et Vaněk (1998), without mistrochal plates and a high shoe-lifter with dental plates attached to its sides. The shell outline preserved apically in *M. cf. herculea* indicates similarly transverse shell outline as display the typical specimens of *M. herculea*. Noteworthy, the serial sections and specimens illustrated by Alvarez et Rong (2002) as *M. herculea* does not belong to *M. herculea* but to *M. pseudoscalprum* (BARRANDE, 1847).

Distribution: *Merista* cf. *herculea* (BARRANDE, 1847) is rare and poorly preserved species, which occurs only in the basal beds of the studied section in locality 1.

Occurrence: Lochkovian, Lochkov Formation, Kotýs Limestone; Barrandian, Bubovice (locality 1).

Superfamily Nucleospiroidea DAVIDSON, 1881

Family Nucleospiridae DAVIDSON, 1881

Genus *Nucleospira* HALL, 1859

Type species: *Spirifer ventricosus* HALL, 1857; Devonian, Gedinnian, New Scotland Formation; New York State, USA.

***Nucleospira robusta* KOZŁOWSKI, 1929**

Pl. 15, figs 13–26

1929 *Nucleospira robusta* sp. n.; Kozłowski, p. 216, pl. 11, figs 24–35, text-figs 78, 79.

- 1985 *Nucleospira robusta* KOZŁOWSKI, 1929; Nikiforova et al., p. 55, pl. 15, figs 5–7.
 1985 *Nucleospira robusta* KOZŁOWSKI, 1929; Modzalevskaja, p. 90, pl. 10, figs 5–8, pl. 15, fig. 30, text-fig. 57.
 1999 *Nucleospira robusta* KOZŁOWSKI: Havlíček, p. 303 (noted in species list).

Older synonymy and neotype: Nikiforova et al., 1985.

Description of Czech material: The shell is strongly and equally biconvex, thin-shelled, and large for the genus, with maximum width 15 mm.

The dorsal valve is circular, with evenly curved margins and small beak directed ventrally to anteroventrally. The valve is evenly convex in lateral and front views, with the maximum depth at about posterior third. Neither sulcus nor anterior emargination are present. Dental sockets are broadly divergent, deep, rapidly widening during the growth. The cardinal flange long, extending deeply into the apical chamber of the ventral valve, and it is strongly curved in a lateral view. The crura are short, acute, slightly diverging, directed ventrally to posteroventrally. The myophore, developed as a deep transverse pit with wrinkled bottom, is well defined at distal end of the cardinal flange. The median ridge is low, broad and rounded in posterior part, becoming low, slender and acute anteriorly. The ridge extends to nearly front margin, but in some specimens it is obscure. The dorsal muscle field is weakly impressed, with larger, slightly divergent posterior adductor scars and longer, parallel and less distinct anterior adductor scars. The brachidium has laterally, rapidly tapering cones of evenly wide lamellae. The umbonal blades are broad and long, strongly curved dorsally, acute apically. The primary lamellae are narrower than umbonal blade, with anteroventrally directed, converging lateral branches of the jugum (pl. 15, figs 20, 26). The saddle is subcircular, with a short ridge in ventral surface. There are eight to ten whorls in adult specimens, with regular interspaces (some 0.5 mm wide) between sigmoidally curved lamellae of each cone.

The ventral valve has similar outline and convexity as the dorsal valve, with short, strongly curved beak. The short apex is directed dorsally. The area is broadly triangular, low, defined by acute edges from the rest of the valve. The delthyrium is apically closed by convex plate. Teeth are blade-like, high, and widely divergent. Low, acute median ridge is present.

Short and thin spines densely cover the shell exterior. They are of a uniform size, approximate 0.05 mm in diameter and some 0.5 mm long, inclined in low angle to shell surface. The worn surface is smooth, with a few, generally weak concentric lamellae.

Remarks: All known species of *Nucleospira* are very similar, and the differences between the species concern outlines, convexity and possible emargination at the front margin. *Nucleospira bubovica* HAVLÍČEK et ŠTORCH, 1990 from the Požáry Formation (Přídolí) is, according to Havlíček and Štorch (1990), the precursor of *N. robusta* KOZŁOWSKI. The former differs in half size, but fine de-

tails of the interior are unknown and its real affinity to Podolian species is difficult to evaluate. The figured specimens of *N. robusta* from the Mitkov beds of Ukraine (Nikiforova et al. 1985) are more transverse than specimens from the Kotýs Limestone, but this is the only difference that may be inferred from Kozłowski (1929) and Nikiforova et al. (1985) descriptions and illustrations.

The presence of *N. robusta* in the Kotýs Limestone was noted by Havlíček (1999) in compiled brachiopod list, but no specimen was either described or illustrated. The study of the specimens in Havlíček's collection confirms, that V. Havlíček has only one small complete shell among the washed shells from the Solvay's Quarry near Svatý Jan pod Skalou.

Distribution: Specimens referred to *Nucleospira robusta* KOZŁOWSKI, 1929 but mostly incomplete, are moderately common throughout sections in localities 1 and 2.

Occurrence: Lochkovian, Lochkov Formation, Kotýs Limestone; Barrandian, Bubovice (locality 1), Svatý Jan pod Skalou (Solvay's Quarry).

Suborder **Retziidina** BOUCOT, JOHNSON et STATON, 1964

Superfamily **Retzioidea** WAAGEN, 1883
 Family **Retziidae** WAAGEN, 1883

Genus **Retzia** KING, 1850

Type species: *Terebratula adrieni* DE VERNEUIL et D'ARCHIAC, 1845; Devonian, Emsian; Asturias, Spain.

Retzia piriformis sp. n.
 Pl. 10, figs 17–20

Holotype: Complete shell, figured on pl. 10, figs 17–20, deposited in the palaeontological collections of the University of West Bohemia in Plzeň (PCZCU 811).

Type horizon: Lochkovian, Lochkov Formation, Kotýs Limestone.

Type locality: Bubovice, old quarry in wooded ridge between the Branžovy Quarry and the road Loděnice-Bubovice.

Name: *pirus* (Lat.) – referring pear-like outline of the shell.

Material: Only the holotype.

Diagnosis: Small strongly biconvex, elongate *Retzia* with five ventral and seven dorsal rounded ribs, perme-sothyridid foramen and small delthyrium closed by deltoidal plates.

Description: The shell is biconvex, with slightly deeper ventral valve, thin-shelled, 4.5 mm wide.

The dorsal valve is subcircular, as long as wide, and the depth is 37% of the width, strongly convex in side and front views. The margins are evenly curved, the umbo is rounded.

The ventral valve is subpyriform, the length is 125% and

the depth is 50% of the width, with the long, straight beak bearing large permesothyridd foramen. The valve is strongly convex, with maximum depth posterior to the midlength. The ventral cardinal area is reduced, orthocone. The delthyrium is broadly triangular, closed by a pair of flat deltidial plates.

Brachidial cones are laterally directed, with two or three thin lamellae.

Strong rounded ribs separated by rounded interspaces of the same size cover the shell. All ribs originate at umbones. There are five ribs of comparable size in the ventral valve and seven ribs on dorsal valve; however, two lateral ribs in dorsal valve are smaller than the remaining five ribs. Growth lamellae are prominent, situated anteriorly, two on the holotype.

Remarks: Only one shell is available in sampled shells, but its morphology is unique. The new species is prominent by very coarse ribbing, which distinguishes this species from other retziids of the Barrandian. Species *Retzia minuscula* BARRANDE, 1879 differs in finer ornament, with ten ribs in the ventral valve and nine in the dorsal valve. The new species is externally very similar to the atrypid *Atrypina eremita* HAVLÍČEK, 1999, which is fairly common amongst associated brachiopods, but the latter differs in flat dorsal valve, five instead of seven ribs on the dorsal valve, and dorsoventrally directed spires of the brachidium. Attribution of the new species to retziids is based on laterally directed cones of the brachidium (visible in a gap between valves in the holotype) and probably endopunctate shell. The surface of the silicified shell displays scarcely but regularly scattered points, which probably correspond to the silicified endopunctae that remained distinct after natural removal of outermost layers of the shell.

Distribution: *Retzia piriformis* sp. n. is very rare and is known from the lower part of the studied section in locality 1.

Occurrence: Lochkovian, Lochkov Formation, Kotýs Limestone; Barrandian, Bubovice (locality 1).

Suborder uncertain

Superfamily **Anoplothechoidea** SCHUCHERT, 1894

Family **Anoplothechidae** SCHUCHERT, 1894

Subfamily **Coelospirininae** HALL et CLARKE, 1894

Genus **Navispira** AMSDEN, 1983

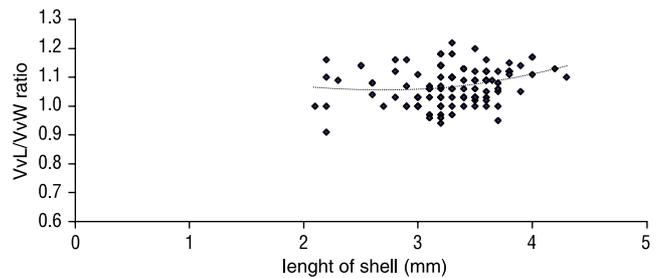
Type species: *Anoplothecha (Coelospira) saffordi* FOERSTE, 1903; Silurian, Ludlow, Henryhouse Formation; Tennessee, USA.

Navispira trepida HAVLÍČEK, 1999

Pl. 14, figs 16–30; text-fig. 9

1999 *Navispira trepida* n. sp.; Havlíček, p. 315, pl. 3, figs 4–12.

Holotype: Shell figured by Havlíček (1999) on pl. 3, figs 6, 7, deposited in the palaeontological collection of the



Text-fig. 9. *Navispira trepida* HAVLÍČEK, 1999. VvL/VvW ratio variation and its changes with shell size. 109 specimens measured.

Museum of Dr. B. Horák in Rokycany (3RO 85352, original signature VH 12804a).

Type horizon and locality: Lochkovian, Lochkov Formation, Kotýs Limestone; Svatý Jan pod Skalou, Solvay's Quarry.

New material: Several hundred of specimens.

Diagnosis: Small, ventribiconvex, elongate to subcircular *Navispira* with thick shell; fine ventral median rib; weakly divergent ridges extended from hinge plates.

Description: See Havlíček (1999). Based on very rich new material, the average length of the adult specimen is about 3.5 to 3.9 mm; the largest known specimen is 43 mm long. The common VvL/VvW ratio ranges from 100 to 114%, but there also are extremes (91%, 122%) (text-fig. 9).

Remarks: Havlíček (1999) noted an absence of the cardinal process. This is developed in large specimens as low short posterior projection overhanging the posterior margin. The outline of *Navispira trepida* is rather variable, being mostly elongate-oval, with VvL/VvW slightly over 100%, but there are also specimens much wider. However, the dorsal valves are almost subcircular and never taper anteriorly as the dorsal valve of the type species *N. saffordi* (FOERSTE, 1903). In addition, the ridges extending from the hinge plates in *N. saffordi* are less prominent and more divergent than the ridges in *N. trepida*. The ornament of *N. trepida* consists mostly of simple straight ribs, whereas in *N. trepida* specimens with curved or posteriorly branching lateral ribs, although rarely, may be seen. In general shell appearance, *N. trepida* is fairly similar to much larger *Coelospirina modica* (HAVLÍČEK, 1956) from the Zlíchov Formation (Zlíchovian) of the Barrandian. However, *C. modica* is larger, has less numerous and lower plications, and the internal muscle platform that is prominent in the ventral valve of *N. trepida* is less prominent in *C. modica*.

Distribution: *Navispira trepida* HAVLÍČEK, 1999 is the commonest small brachiopod in the studied section in locality 1, mostly present in the lower and middle part of the sequence. It is also common in locality 2.

Occurrence: Lochkovian, Lochkov Formation, Kotýs Limestone; Barrandian, Bubovice (locality 1, 2), Svatý Jan pod Skalou (Solvay's Quarry).

Order **Spiriferida** WAAGEN, 1883
Suborder **Spiriferidina** WAAGEN, 1883

Superfamily **Cyrtoidea** FREDERIKS, 1919
Family **Cyrtiidae** FREDERIKS, 1919
Subfamily **Eospiriferinae** SCHUCHERT et LE
VENE, 1929

Genus **Havlicekia** BOUCOT, 1963

Type species: *Spirifer secans* BARRANDE, 1848;
Devonian, Pragian, Vinařice Limestone; Barrandian, Bohemia.

Havlicekia amarantha HAVLÍČEK, 1980

Pl. 18, figs 16, 19–23

1980 *Havlicekia amarantha* sp. n.; Havlíček, p. 26, pl. 8, figs 5–12.

1999 *Havlicekia amarantha* HAVLÍČEK; Havlíček, p. 303 (noted in species list), pl. 1, figs 10, 11, and 16.

Holotype: Shell figured by Havlíček (1980) on pl. 8, figs 9–12, deposited in the palaeontological collection of the Museum of Dr. B. Horák in Rokycany (3RO 63755, original signature VH 2492b).

Type horizon and locality: Lochkovian, Lochkov Formation, Kotýs Limestone; Svatý Jan pod Skalou, Solvay's Quarry.

New material: Four shells, one dorsal and one ventral valve.

Description: In original description, Havlíček (1980) very shortly commented the ventral valve interior. Two well-preserved shells with nice interiors have newly been collected. The dental plates are thick basally but thin, lamellose in the anterior edges, with thick and irregular callus between their bases. The teeth are minute. The ventral muscle field is deeply impressed posteriorly, anteriorly resting on a low elevated pad. The field is divided by a fine myophragm. The posterior part of the field is nearly smooth, the anterior half is radially striated. Posterior valve floor lateral to the dental plates is strongly thickened, bearing shallow pits.

The exterior is covered by fine, rounded radial capillae, wider than interspaces, of various numbers per 1 mm. On an undeformed shell surface there are 4–5 capillae per 1 mm, the repaired shell in deformed valve shows much finer ornament, of nearly 7–8 capillae per the same distance (pl. 18, fig. 22).

Distribution: *Havlicekia amarantha* HAVLÍČEK, 1980 is a rare species in the lower and middle part of the studied section in locality 1, and rarely was found in locality 2.

Occurrence: Lochkovian, Lochkov Formation, Kotýs Limestone; Barrandian, Bubovice (localities 1, 2) and area between Loděnice and Svatý Jan pod Skalou.

Genus **Myriospirifer** HAVLÍČEK, 1978

Type species: *Myriospirifer myriofila* HAVLÍČEK, 1978; Devonian, Pragian, Koněprusy Limestone; Barrandian, Bohemia.

Myriospirifer sp.

Pl. 18, figs 17, 18

Material: One incomplete ventral valve.

Remarks: One incomplete ventral valve shows typical features of the genus. It is thin-shelled, with microornament of capillae wider than interspaces. The dental plates are very thin and short, supporting small teeth. The shells are covered by fine radial capillae separated by narrow interspaces, 11–12 per 2 mm. The sulcus is shallow, smooth, the flanks are nearly smooth, with four to five very weakly defined plications.

Remarks: The species is externally similar to *M. myriofila* HAVLÍČEK, 1978 from the Koněprusy Limestone (Pragian) of the Barrandian, but it is too poorly preserved for a comparison. The distinct difference is very weak trace of lateral plications on flanks of *M. sp.* while the flanks are wholly smooth in *M. myriofila*.

Distribution: *Myriospirifer* sp. is a very rare species in the lower part of the studied section in locality 1.

Occurrence: Lochkovian, Lochkov Formation, Kotýs Limestone; Barrandian, Bubovice (locality 1).

Superfamily **Ambocoelioidea** GEORGE, 1931

Family **Ambocoeliidae** GEORGE, 1931

Genus **Ambocoelia** HALL, 1860

Type species: *Orthis umbonata* CONRAD, 1842;
Devonian, Hamilton Group; New York State, USA.

Ambocoelia bubovica sp. n.

Pl. 16, figs 1–13

1999 *Ambocoelia praecox* KOZŁOWSKI; Havlíček, p. 303 (noted in species list).

Holotype: Complete shell figured on pl. 16, figs 2–5, 8, deposited in the palaeontological collections of the University of West Bohemia in Plzeň (PCZCU 942).

Paratypes: Dorsal valve, figured on pl. 16, figs 1, 6 (PCZCU 941), and complete shell figured on pl. 16, figs 7–13 (PCZCU 943), deposited in the palaeontological collections of the University of West Bohemia in Plzeň.

Type horizon: Lochkovian, Lochkov Formation, Kotýs Limestone.

Type locality: Bubovice, old quarry in wooded ridge between the Branžovy Quarry and the road Loděnice-Bubovice.

Name: After the village Bubovice nearby the type locality.

Material: Twenty-two shells, 3 dorsal and 28 ventral valves.

Diagnosis: Thin-shelled *Ambocoelia* with high ventral valve; delthyrium narrow; shallow ventral sulcus and low dorsal fold; thick peripheral callus in ventral valve interior; each dorsal flank with one low and broad plication.

Description: The shell is large for the genus, thin-shelled, with slightly but distinctly uniplicate commissure, 4.5–4.7 wide in large specimens.

The dorsal valve is subcircular, widest in the posterior third, with moderately curved anterior and rounded cardinal extremities. The hinge line equals to 80% of the valve width. The valve is gently convex in lateral and anterior views. Broad and low fold is distinct in the anterior half of the shell, occupying about one-third of the valve width at the front margin. A weak plication is present on each flank leaving flat posterolateral corners of the valve. The dorsal interarea is linear. The dental sockets are fairly large, deep, anteriorly broadly diverging, bordered by high, sharply edged inner socket plates. The cardinal process is not preserved. Outer and inner hinge plates are strongly converging to the valve floor, basally nearly touching one another. The crural bases are not distinct, the crura are robust, anteriorly passing into primary lamellae, which diverge at about 45°. The straight primary lamellae are turned ventrally, converge toward the bottom of the ventral valve and continue to three to four whorls laterally directed. The lamellae are thin, slightly become thinner laterally in a rapidly tapering brachial cone. Adductor scars are deeply impressed, elongate, located near the centre of the valve between the primary lamellae.

The ventral valve is high, with acute, prominent, posteriorly curved beak. The maximum depth is about the posterior third. A very shallow sulcus is discernible from the valve midlength. The ventral interarea is catacline, very high, strongly curved in the lateral view. The delthyrium is narrowly triangular, outside bordered laterally by low ridges and internally by prominent teeth ridges. The top of the delthyrium is closed by a short plate. Teeth are rather large, ponderous. The ventral muscle field is not discernible.

Remarks: The shells of the new species are similar to *Ambocoelia praecox* KOZŁOWSKI, 1929 from the Lochkovian of Podolia, and until recently they were referred to Ukrainian species. *Ambocoelia bubovica* differs in more acute ventral beak, in higher ventral interarea and in distinct dorsal fold and ventral sulcus, respectively. The specimens referred to *A. praecox* of the late Lochkovian age from Yukon, Canada (Perry 1984) have higher, apsacline ventral interarea and narrower sulcus and fold than *A. bubovica*. The species *A. praecox dorsiplicata* SAVAGE, 1969 is very similar to *A. bubovica* by dorsal fold and uniplicate commissure, but the former species differs in more transverse shell and shallow anterior emargination. *Ambocoelia operculifera* HAVLÍČEK, 1956 from the Řeporyje Limestone (Pragian) of the Barrandian differs in smaller size, absence of the dorsal fold and less acute and smaller ventral beak.

Distribution: *Ambocoelia bubovica* sp. n. is a moderately common species in the lower and middle part of the studied section in locality 1.

Occurrence: Lochkovian, Lochkov Formation, Kotýs Limestone; Barrandian, Bubovice (locality 1, 2), Svatý Jan pod Skalou (Solvay's Quarry).

Superfamily **Martinioidae** WAAGEN, 1883

Family **Martiniidae** WAAGEN, 1883

Subfamily **Martiniinae** WAAGEN, 1883

Genus ***Tenellodermis*** HAVLÍČEK, 1971

Type species: *Tenellodermis microdermis* HAVLÍČEK, 1971; Devonian, Lochkovian, Lochkov Formation, Kotýs Limestone; Barrandian, Bohemia.

Tenellodermis microdermis HAVLÍČEK, 1971

Pl. 17, figs 1–11

1959 *Eomartiniopsis* cf. *tenella* (BARR.); Havlíček, pl. 2, fig. 5.

1971 *Tenellodermis microdermis* sp. n.; Havlíček, p. 12, pl. 2, fig. 1; pl. 4, fig. 3; pl. 8, figs 3–5, 13, 14.

1999 *Tenellodermis microdermis* HAVLÍČEK; Havlíček, p. 303 (noted in species list).

Holotype: Shell figured by Havlíček (1971) on pl. 8, figs 4, 13, deposited in the palaeontological collection of the Museum of Dr. B. Horák in Rokycany (3RO 64366, original signature VH 640).

Type horizon and locality: Lochkovian, Lochkov Formation, Kotýs Limestone; Svatý Jan pod Skalou, Solvay's Quarry.

New material: Four shells, one dorsal and one ventral valve.

Description: See Havlíček (1971).

Remarks: In the original description, the shape of the brachidium is not commented. The crura extend anterodorsally being parallel with the floor of the dorsal valve. Each brachial cone consists of five to six whorls on each side, formed by narrow, evenly curved lamellae. The primary and secondary whorls are 0.8 mm apart and this distance differs little toward the apex of the spire.

Distribution: *Tenellodermis microdermis* HAVLÍČEK, 1971 is an uncommon species in the lower part of the studied section in locality 1.

Occurrence: Lochkovian, Lochkov Formation, Kotýs Limestone; Barrandian, Bubovice (locality 1).

Subfamily **Pinguispiriferinae** HAVLÍČEK, 1971

Genus ***Spurispirifer*** HAVLÍČEK, 1971

Type species: *Spurispirifer spurius* BARRANDE, 1848; Silurian, Ludlow, Kopanina Formation; Barrandian, Bohemia.

Spurispirifer fuscus HAVLÍČEK, 1971

Pl. 17, figs 12–25

1971 *Spurispirifer fuscus* sp. n.; Havlíček, p. 28, pl. 3, fig. 1, pl. 8, figs 2, 6–12.

1999 *Spurispirifer fuscus* HAVLÍČEK; Havlíček, p. 303 (noted in species list).

Holotype: Shell figured by Havlíček (1971) on pl. 8, figs 8, 9, deposited in the palaeontological collection of the

Museum of Dr. B. Horák in Rokycany (3RO 63364, original signature VH 689).

Type horizon and locality: Lochkovian, Lochkov Formation; Karlštejn, Budňanská skála locality.

New material: One shell, two dorsal and six ventral shells, numerous fragments.

Description: See Havlíček (1971). Nicely preserved silicified shells show deep, rapidly widening and deepening dental sockets bordered by thick and high inner socket ridges. The outer hinge plates are very thin, converging dorsally, with dorsally faced edges bordered by thickened crural bases. The hinge plates are posteriorly attached to the shell wall, being free high above the valve floor. The shape of crura and brachidium was unknown to Havlíček (1971). Unlike other silicified brachiopods from the locality, the brachidium has never been found complete. The crura extend from hinge in anterodorsally direction, paralleling the border of the dorsal fold.

Remarks. This species occurs, according to Havlíček (1971), in limestone with the index trilobite *Warburgella rugulosa rugulosa* (BOUČEK). In his list of brachiopods from the Kotýs Limestone (Havlíček, 1999) this species is missing. Slightly larger shells with width exceeding 14 mm, represent new material, displaying some variation in the outline from transversely elongate to subquadrate. Because other features are the same as described by Havlíček (1971) the specimens are referred to *Spurispirifer fuscus* HAVLÍČEK, 1971.

Distribution: *Spurispirifer fuscus* HAVLÍČEK, 1971 is uncommon species in the lower part of studied section in locality 1.

Occurrence: Lochkovian, Lochkov Formation, Kotýs Limestone; Barrandian, Bubovice (locality 1).

Suborder **Delthyridina** WAAGEN, 1846

Superfamily **Delthyridoidea** WAAGEN, 1846

Family **Acrospiriferidae** TERMIER et TERMIER, 1950

Genus **Howellella** KOZŁOWSKI, 1946

Type species: *Delthyris elegans* MUIR-WOOD, 1925; Silurian, Wenlock, Mulde Formation; Gotland, Sweden.

Howellella angustiplicata (KOZŁOWSKI, 1929)

Pl. 18, figs 1–15

1929 *Spirifer (Crispella) angustiplicatus* sp. n.; Kozłowski, p. 192, pl. 10, figs 10–19, text-fig. 64

1954 *Spirifer (Howellella) angustiplicatus* KOZŁOWSKI; Nikiforova, p. 146, pl. 16, figs 9, 10.

1957 *Howellella angustiplicata* (KOZŁOWSKI); Boucot, p. 316 (name only).

1960 *Howellella angustiplicata* (KOZŁOWSKI); Ivanova in Saryčeva, pl. 62, fig. 7a, b.

1968 *Howellella angustiplicata* (KOZŁOWSKI); Modzalevskaja, pl. 31, figs 1–5.

1985 *Howellella angustiplicata* (KOZŁOWSKI, 1929); Nikiforova et al., p. 50, pl. 14, figs 1–4.

Neotype, type horizon and locality: See Nikiforova et al. (1985).

New material: One shell, six dorsal and one ventral valves.

Description of Czech material: Shell ventribiconvex, thin-shelled, with uniplicate commissure, 10–11 mm wide in adults.

The dorsal valve is transverse, the length is 71–75% of the width, with gently emarginate commissure. The valve is widest at the posterior third, the cardinal extremities are rounded. The valve has evenly arched flanks and prominent rounded fold, which is evenly and regularly widening anteriorly. The fold equals to some 20% of the maximum width at the front margin. The dorsal beak is low and short. The dorsal interarea is almost orthocline, very low, with a broad notothyrium. The dental sockets are shallow, with flat base, rapidly expanding anterolaterally. The outer hinge ridges are not preserved, the inner socket ridges are thick, dorsally passing into thin and basally converging outer hinge plates. The hinge plates are moderately diverging anteriorly. Their dorsal edges are bordered by thin crural bases, which continue anterodorsally to crura. The crura are parallel to each other but being less divergent than the sides of the fold. The ctenophoridium is small, restricted to the top of the notothyrial chamber, with about eight plates.

The ventral valve is strongly convex, with prominent, moderately deep sulcus, which evenly expands anteriorly and extends into long rounded tongue. The ventral beak is prominent, distinctly curved. The ventral interarea is apsacline, gently curved, with flat surface, distinctly bordered by weak lateral ridges. The delthyrium is highly triangular, with sides enclosing 40°, bordered by low, lamellar deltoidal plates. The dental plates are vertical, anteriorly slightly diverging, gently thickened, and supporting small, stubby teeth. The muscle field is not distinct.

The shell exterior is covered by prominent rounded plications, separated by narrow and shallow interspaces. The size of plications rapidly decreases laterally, with seven plications distinct on each flank. The concentric ornament is weak, with regularly spaced fine lamellae. The microornament is poorly preserved due to the a silicification, but weak low spines are discernible on bottoms of the interspaces anteromedianly.

Remarks. The specimens are externally very similar to *H. angustiplicata angustiplicata* (KOZŁOWSKI) from the Borschchov Formation (Lochkovian) of Podolia and therefore they are referred to the Ukrainian species. The only differences seem to be the well-developed concentric lamellose ornament, which is weakly preserved in Czech specimens (this may be due to the silicification) and the lower number of plications on the specimens figured by Nikiforova et al. (1985). However, the same authors note five to nine plications on either side of the fold and sulcus, a range that is consistent with the number of plications in the Czech specimens. The subspecies *H. angustiplicata za-*

leszczykiensis (KOZŁOWSKI, 1929) from late Lochkovian of Podolia clearly differs in more numerous and closely spaced lateral plications and deeper sulcus.

The species *H. inchoans* (BARRANDE, 1879) from the Radotín Limestone (Lochkovian) of the Barrandian is similar to the newly collected specimens, but it differs in anteriorly rapidly expanding fold and sulcus, respectively, and in fewer and wider plications on flanks.

Distribution: *Howellella angustiplicata* (KOZŁOWSKI, 1929) is rare in the Barrandian and it is known mainly from locality 2, but poor material has been found also in locality 1.

Occurrence: Lochkovian, Lochkov Formation, Kotýs Limestone; Barrandian, Bubovice (localities 1, 2).

Superfamily **Reticularioidea** WAAGEN, 1883

Family **Reticulariidae** WAAGEN, 1883

Subfamily **Quadrithyridinae** GOURVENNEC, 1994

Genus ***Quadrithyris*** HAVLÍČEK, 1957

Type species: *Spirifer robustus* BARRANDE, 1848; Devonian, Pragian, Koněprusy Limestone; Barrandian, Bohemia.

***Quadrithyris subrobusta* sp. n.**

Pl. 16, figs 14–29

Holotype: Ventral valve figured on pl. 16, figs 17, 21, 24, 25, deposited in the palaeontological collection of the University of West Bohemia, Plzeň (PCZCU 935).

Paratypes: Dorsal valve, figured on pl. 16, figs 14, 26, 27 (PCZCU 933), and ventral valve figured on pl. 16, figs 18, 22, 29 (PCZCU 936), deposited in the palaeontological collections of the University of West Bohemia in Plzeň.

Type horizon: Lochkovian, Lochkov Formation, Kotýs Limestone.

Type locality: Bubovice, old quarry in wooded ridge between the Branžovy Quarry and the road Loděnice-Bubovice.

Name: *sub-* (Lat.) – a prefix referring distinct affinity to a stratigraphically younger species *Q. robusta* (BARRANDE, 1848).

Material: One incomplete shell, three dorsal and 21 ventral valves.

Diagnosis: Medium-sized *Quadrithyris* with transverse outline, thin-shell, and weak sulcus and fold; ventral median septum long, high and thin; concentric rugae 5–6 per 1 mm; ribs absent.

Description: The shell is ventribiconvex, thin-shelled, 20 mm wide in adults, with highly uniplicate commissure.

The dorsal valve is transversely elliptical, widest in the posterior third, with evenly curved anterior and lateral margins. The cardinal extremities are rounded. The valve is moderately convex, with a low, rounded and rather narrow

fold. Flanks are slightly convex. The dorsal beak is small, slightly extended over the hinge line. The dorsal interarea is almost orthocline, very low, with a small notothyrium filled by a raised ctenophoridium of several (probably 5 to 7) robust lamellae. The dental sockets are small and shallow, externally bordered by thin outer socket plates, and internally limited by thick inner socket plates. The outer hinge plates are plate-like, anteriorly slightly divergent, and converging to the valve floor. The crura are thin, extending anterodorsally, being anteriorly moderately divergent. The median septum is absent. The ventral valve is hemipyramidal, highly convex in transverse profile, with prominent beak. The interarea is apsacline, high, concave in lateral view, laterally poorly defined. The sulcus is shallow, rounded, anteriorly extended into long rounded tongue. The delthyrium is narrowly triangular, bounded by high, lamellose deltidial plates. Teeth are minute, stubby. The dental plates are thin, high, resting vertically on the valve floor. The median septum is prominent, thickened posteriorly, anteriorly extending into high, very thin septum that disappears at about two-thirds of the valve length. Edges of the median septum are concave anteriorly and dorsally. Muscle scars are not impressed.

The shell exterior is without distinct ribs. The concentric ornament is formed by weak rugellae, 0.15–0.2 mm apart, evenly covering the whole shell.

Remarks: The new species is similar to *Q. minuens* (BARRANDE, 1879) and *Q. robusta* (BARRANDE, 1848) from the Koněprusy Limestone (Pragian) of the Barrandian. Other Pragian age species *Q. tiro* (BARRANDE, 1848), *Q. falco* (BARRANDE, 1848), *Q. kotysensis* HAVLÍČEK, 1959, and *O. illecta* HAVLÍČEK, 1998 differ in larger sizes and some in more distinct ribs on the flanks. *Quadrithyris minuens* differs in more transverse outline, lower ventral interarea and by deeper, subangular ventral sulcus extending into subtriangular tongue. *Quadrithyris robusta* differs in deeper ventral sulcus, divergent dental plates, thicker posterior of the ventral valve and a bigger size. The early Devonian *Quadrithyris robusta molongensis* SAVAGE, 1969 from the early Siegenian of New South Wales is very near to the new species, differing only in more prominent dorsal umbo, longer tongue of the ventral valve, and after the data of Savage (1969) also in a shorter ventral median septum.

Distribution: *Quadrithyris subrobusta* sp. n. is an uncommon species in the lower part of the studied section in locality 1.

Occurrence: Lochkovian, Lochkov Formation, Kotýs Limestone; Barrandian, Bubovice (locality 1).

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Explanation of the plates

All figured specimens come from the Lower Devonian (Lochkovian), Lochkov Formation, Kotýs Limestone, Barrandian area (Czech Republic). Majority of the figured specimens come from Bubovice, old quarry in wooded ridge between the Branžovy Quarry and the road Loděnice-Bubovice (locality 1), specimens figured on pl. 18, figs 1–4, 6, 7, 9, 10 come from natural outcrops of the same area (locality 2). All photographs by the author.

PLATE 1

Rugoleptaena skalicensis (HAVLÍČEK, 1967)

- 1, 4. Complete, partly exfoliated shell in ventral and dorsal views; PCZCU 820, both $\times 2.0$.
- 2, 5, 7, 8. Complete, partly exfoliated shell in ventral, dorsal, anterior and posterior views. views; PCZCU 821, all $\times 2.0$.
- 3, 6, 9. Complete, partly broken shell in ventral, dorsal and lateral views; PCZCU 822, all $\times 2.0$.
10. Fragment of dorsal valve, interior; PCZCU 823, $\times 3.5$.
- 11, 14. Incomplete ventral valve, interior and detail of muscle field; PCZCU 825, $\times 3.5$, $\times 6.5$.
12. Incomplete ventral valve, interior; PCZCU 826, $\times 3.5$.
13. Fragment of dorsal valve, interior; PCZCU 824, $\times 3.5$.
15. Incomplete ventral valve, interior showing muscle field and pallial markings; PCZCU 827, $\times 6.5$.

Mesodouvillina herinkiana HAVLÍČEK, 1999

16. Fragment of ventral valve, interior; PCZCU 828, $\times 4.6$.
17. Fragment of ventral valve, interior; PCZCU 829, $\times 4.6$.
18. Fragment of dorsal valve, interior, showing denticles along hinge line; PCZCU 830, $\times 4.6$.
19. Fragment of dorsal valve, interior; PCZCU 831, $\times 4.6$.

PLATE 2

Cymostrophia (Protocymostrophia) costatula (BARRANDE, 1848)

- 1, 2. Incomplete ventral valve, exterior and interior; PCZCU 832, both $\times 3.0$.
4. Incomplete dorsal valve, interior; PCZCU 833, $\times 5.0$.
5. Incomplete dorsal valve, interior; posterior view to cardinal process, PCZCU 834, $\times 5.0$.

Leptostrophia index (HAVLÍČEK, 1967)

3. Incomplete ventral valve, interior; PCZCU 835, $\times 4.6$.
6. Ventral valve, exterior, partly exfoliated; PCZCU 836, $\times 4.6$.
7. Complete shell, hinge line showing denticles; PCZCU 837, $\times 4.6$.
- 8, 12. Incomplete dorsal valve, interior and exterior; PCZCU 838, both $\times 4.6$.
- 9, 11. Small complete shell, ventral and dorsal valve exteriors; PCZCU 839, both $\times 4.6$.
14. Small complete shell, exterior; PCZCU 840, $\times 4.6$.

Barbaestrophia praestans (BARRANDE, 1879)

- 10, 13. Complete shell, ventral and dorsal valve exteriors; PCZCU 841, $\times 3.0$.

Iridistrophia umbella (BARRANDE, 1848)

15. Almost complete ventral valve, exterior; PCZCU 842, $\times 2.5$.

PLATE 3

Iridistrophia umbella (BARRANDE, 1848)

- 1, 2. Fragment of small dorsal valve, exterior and interior, showing cardinal process; PCZCU 843, both $\times 3.3$.
- 3, 5. Fragment of large dorsal valve, exterior and interior, showing cardinal process; PCZCU 844, both $\times 3.3$.
- 4, 9. Fragment of ventral valve, exterior and interior, showing interarea; PCZCU 845, both $\times 3.3$.
- 6, 7, 10. Fragment of ventral valve, exterior and interior, showing interarea and divergent dental plates in anterior view $\times 10$; PCZCU 846, all $\times 3.3$.
- 12, 13. Fragment of ventral valve interior, showing interarea and divergent dental plates in anterior view $\times 13$; PCZCU 842, both $\times 3.3$.

Plectodonta mimica (BARRANDE, 1879)

- 8, 23. Complete shell, exterior, dorsal valve and posterior view; PCZCU 992, both $\times 8.5$.
11. Complete shell, exterior; PCZCU 996, $\times 8.5$.
- 14, 19. Ventral valve, exterior and interior; PCZCU 998, both $\times 8.5$.
15. Ventral valve, exterior; PCZCU 999, $\times 8.5$.
16. Ventral valve, interior; PCZCU 1000, $\times 8.5$.
17. Ventral valve, interior; PCZCU 1001, $\times 8.5$.
- 18, 20. Ventral valve, exterior and interior; PCZCU 997, both $\times 8.5$.
21. Dorsal valve, interior; PCZCU 993, $\times 8.5$.
22. Dorsal valve, interior; PCZCU 994, $\times 8.5$.
24. Incomplete dorsal valve, interior; PCZCU 995, $\times 8.5$.
- 25, 26. Dorsal valve, interior and posterolateral view showing shape of septa (SEM photo); PCZCU 800, both $\times 13$.

PLATE 4

Asymmetrochonetes lanx (HAVLÍČEK et RACHEBOEUF, 1979)

- 1, 8. Complete shell, ventral and dorsal valves exterior; PCZCU 1002, both $\times 8.5$.
- 2, 5. Complete shell, dorsal and ventral valves exterior; PCZCU 1003, both $\times 8.5$.
- 3, 4. Small ventral valve, exterior and interior, showing spines on both sides; PCZCU 1004, both $\times 8.5$.
- 6, 9. Ventral valve, exterior and interior showing interarea with chilidium and base of spine; PCZCU 1005, both $\times 8.5$.
- 7, 10. Ventral valve, exterior and interior showing interarea and base of spine; PCZCU 1006, both $\times 8.5$.

Skenidioides famulus HAVLÍČEK, 1977

- 11, 17, 23–25. Complete shell, exterior, ventral valve, dorsal valve, and anterior, lateral and posterior views to shell; PCZCU 909, all $\times 8.0$.
- 12, 28, 29. Ventral valve, exterior, interior and posterior view to valve; PCZCU 910, all $\times 8.0$.
- 13, 16, 19–21. Complete shell, ventral valve, dorsal valve, and lateral, posterior and anterior views to shell; PCZCU 911, all $\times 8.0$.
14. Ventral valve, exterior; PCZCU 912, $\times 8.0$.
- 15, 27. Dorsal valve, anterior view and interior; PCZCU 913, both $\times 8.0$.
- 18, 26. Dorsal valve, exterior and interior; PCZCU 914, both $\times 8.0$.
22. Complete shell, exterior, anterior view; PCZCU 915, $\times 8.0$.
- 30, 32. Dorsal valve, interior, showing high septum (SEM photo); PCZCU 801, $\times 17$, $\times 20$.
31. Ventral valve, interior, showing teeth and spondylium (SEM photo); PCZCU 802, $\times 11$.

PLATE 5

Isorthis (Isorthis) svatojanica HAVLÍČEK, 1977

- 1, 2. Complete small shell, exterior, ventral valve and posterior view; PCZCU 891, both $\times 3.0$.
- 3, 6, 11. Complete shell, exterior, ventral valve, dorsal valve, and anterior view; PCZCU 892, all $\times 3.0$.
- 4, 7, 10. Complete shell, exterior, ventral valve, dorsal valve, and posterior view; PCZCU 893, all $\times 3.0$.
- 5, 8, 12. Complete shell, exterior, ventral valve, dorsal valve, and anterior view; PCZCU 894, all $\times 3.0$.
9. Dorsal valve, interior; PCZCU 895, $\times 3.0$.
13. Dorsal valve, interior; PCZCU 896, $\times 3.0$.
- 14, 16, 18. Dorsal valve, interior and detail of cardinalia; PCZCU 897, $\times 3.0$, $\times 4.3$, $\times 4.3$.
- 15, 17. Ventral valve, interior, dorsal and oblique views; PCZCU 898, both $\times 3.0$.
- 19, 20. Ventral valve, interior in anterodorsal and dorsal views; PCZCU 899, both $\times 3.0$.

PLATE 6

Resserella walmsleyi HAVLÍČEK, 1977

- 1, 9, 12. Complete shell, exterior, ventral valve, anterior view, and dorsal valve; PCZCU 903, all $\times 5.0$.
- 2, 6, 13. Ventral valve, exterior, and interior in dorsal and oblique views; PCZCU 906, all $\times 5.0$.

- 3, 7, 8. Ventral valve, exterior, and interior in dorsal and oblique views; PCZCU 907, all $\times 5.0$.
- 4, 10, 21. Complete shell, exterior, ventral valve, anterior and side views; PCZCU 908, all $\times 5.0$.
5. Ventral valve, interior; PCZCU 905, $\times 5.0$.
11. Complete shell, exterior, dorsal valve; PCZCU 904, $\times 5.0$.
- 14, 16. Dorsal valve, interior, oblique and ventral views; PCZCU 901, both $\times 5.0$.
15. Dorsal valve, interior; PCZCU 902, $\times 5.0$.
17. Dorsal valve, interior; PCZCU 900, $\times 5.0$.

Molongella lineata (HAVLÍČEK, 1975)

- 18, 24. Dorsal valve, interior and posterior view; PCZCU 1041, both $\times 6.5$.
- 19, 25. Dorsal valve, exterior and anterior view; PCZCU 1042, both $\times 6.5$.
- 20, 23. Dorsal valve, exterior and interior; PCZCU 1043, both $\times 6.5$.
- 22, 26. Dorsal valve, interior and exterior; PCZCU 1044, both $\times 6.5$.

PLATE 7

Parmorthina protopragenis HAVLÍČEK, 1977

- 1, 2. Ventral valve, exterior and interior; PCZCU 881, both $\times 4.3$.
- 3, 6. Complete shell, dorsal and ventral valves; PCZCU 882, both $\times 5.5$.
- 4, 7. Complete shell, dorsal valve and anterior view; PCZCU 883, both $\times 3.8$.
- 5, 8, 9. Complete shell, dorsal valve, anterior and side views; PCZCU 884, all $\times 3.8$.
10. Incomplete shell, interior showing dental plates and brachiophores; PCZCU 885, $\times 3.8$.
- 11, 18. Ventral valve, exterior and interior; PCZCU 886, $\times 3.8$, $\times 4.3$.
12. Dorsal valve, exterior; PCZCU 887, $\times 3.8$.
- 13, 16, 19. Dorsal valve, interior, posterior view and detail of cardinalia; PCZCU 888, $\times 3.8$, $\times 3.8$, $\times 7.0$.
- 14, 15. Dorsal valve, interior, and posterior view; PCZCU 889, both $\times 3.8$.
- 17, 20. Ventral valve, interior and oblique view; PCZCU 890, $\times 4.3$, $\times 3.8$.

PLATE 8

Dicoelosia praedimera sp. n.

1. Complete small shell, exterior, dorsal valve; PCZCU 866, $\times 6.5$.
- 2, 8, 18. Complete shell, exterior, dorsal valve, ventral valve, and posterior view; PCZCU 864, all $\times 6.5$.
- 3, 7. Complete shell, exterior, dorsal valve and ventral valve; PCZCU 863, both $\times 6.5$.
4. Complete shell, exterior, dorsal valve; PCZCU 862, $\times 6.5$.
- 5, 10. Complete shell, exterior, dorsal valve and ventral valve; PCZCU 861, both $\times 6.5$.
6. Paratype, ventral valve, interior; PCZCU 865, $\times 6.5$.
- 9, 16, 21, 22. Complete shell, exterior, ventral valve, dorsal valve, anterior and posterior views; PCZCU 860, all $\times 6.5$.
- 17, 23–25. Holotype, complete shell, exterior, dorsal valve, posterior and anterior views, and ventral valve; PCZCU

- 856, all \times 6.5.
 11, 13, 20. Dorsal valve, interior, oblique, ventral and anterior views; PCZCU 859, all \times 6.5.
 12, 19. Dorsal valve, interior, and anterior view; PCZCU 858, both \times 6.5.
 14, 15. Paratype, dorsal valve, interior, and anterior view; PCZCU 857, both \times 6.5.

Muriferella pishulinae sp. n.

- 26, 38. Dorsal valve, exterior and interior; PCZCU 854, both \times 8.0.
 27, 28, 36. Complete shell, exterior, dorsal valve, ventral valve, and anterior view; PCZCU 849, all \times 8.0.
 29, 40. Paratype, ventral valve, exterior and interior; PCZCU 848, both \times 8.0.
 30, 31, 37, 39. Holotype, complete shell, exterior, ventral valve, dorsal valve, anterior and side views; PCZCU 851, all \times 8.0.
 32, 34. Paratype, dorsal valve, interior and exterior; PCZCU 852, both \times 8.0.
 35. Dorsal valve, interior; PCZCU 853, \times 8.0.
 41. Ventral valve, interior; PCZCU 847, \times 8.0.
 42. Complete shell, exterior, dorsal valve; PCZCU 850, \times 8.0.

PLATE 9

Dalejina austera HAVLÍČEK, 1977

- 1, 11. Complete shell, exterior, ventral valve; PCZCU 876, both \times 3.8.
 2, 5, 12. Complete shell, exterior, ventral valve, dorsal valve, and anterior view; PCZCU 877, all \times 3.8.
 3, 6, 13. Complete shell, exterior, ventral valve, dorsal valve, and anterior view; PCZCU 878, all \times 3.8.
 4, 10. Complete shell, exterior, ventral valve, and posterior view; PCZCU 879, both \times 3.8.
 7, 8, 9. Complete shell, exterior, dorsal valve, ventral valve, and posterior view; PCZCU 880, all \times 3.8.
 14, 18. Dorsal valve, interior and oblique view; PCZCU 875, both \times 3.8.
 15. Juvenile ventral valve, interior; PCZCU 872, \times 3.8.
 16. Dorsal valve, interior; PCZCU 873, \times 3.8.
 17. Dorsal valve, interior; PCZCU 874, \times 3.8.
 19. Juvenile ventral valve, interior; PCZCU 871, \times 3.8.
 20. Ventral valve, interior; PCZCU 870, \times 3.8.
 21. Ventral valve, interior; PCZCU 869, \times 3.8.
 22, 23. Ventral valve, interior and anterodorsal view; PCZCU 867, both \times 3.8.
 24. Gerontic ventral valve, interior; PCZCU 868, \times 3.8.

PLATE 10

Gypidula pelagica (BARRANDE, 1847)

- 1–3, 5, 7. Ventral valve, interior in dorsal, oblique, anterodorsal and side views and exterior (3); PCZCU 923, all \times 1.8.
 8. Ventral valve, interior; PCZCU 924, \times 1.8.

Clorinda pseudolinguifera KOZŁOWSKI, 1929

- 4, 6. Complete shell, exterior, dorsal valve with ventral apex, and anterior view; PCZCU 922, both \times 2.8.
 9, 10. Ventral valve, exterior in posterior view and valve interior; PCZCU 921, both \times 2.8.
 11. Dorsal valve, interior; PCZCU 920, \times 4.0.

12. Dorsal valve, interior; PCZCU 919, \times 4.0.

Anastrophia (Grayina) sp.

- 13, 14. Dorsal valve, exterior and interior; PCZCU 918, both \times 2.8.

Eoglossinotoechia mystica HAVLÍČEK, 1961

- 15, 16. Ventral valve, exterior and interior; PCZCU 916, both \times 2.8.

Retzia piriformis sp. n.

- 17–20. Holotype, complete shell, exterior, anterior view, dorsal valve, ventral valve, and side view; PCZCU 917, all \times 7.5.

PLATE 11

Kyrtatrypa anulata (HAVLÍČEK, 1984)

1. Incomplete ventral valve, exterior; PCZCU 959, \times 2.1.
 2. Incomplete ventral valve, exterior; PCZCU 961, \times 3.0.
 3. Incomplete ventral valve, interior; PCZCU 960, \times 2.1.

Spinatrypa variabilis sp. n.

- 4–6. Complete shell, exterior, side view, ventral and dorsal valves; PCZCU 1015, all \times 4.3.
 7, 18. Complete shell, exterior, dorsal valve and opened shell in anterior view; PCZCU 1016, both \times 4.3.
 8, 9. Complete shell, exterior, dorsal and ventral valves; PCZCU 1017, both \times 4.3.
 10, 15, 17. Complete shell, exterior, side view, ventral valve and anterior view; PCZCU 1024, all \times 4.3.
 11, 12. Complete shell, exterior, ventral and dorsal valves; PCZCU 1018, both \times 4.3.
 13, 14. Holotype, complete shell, exterior, ventral valve and anterior view; PCZCU 1019, both \times 4.3.
 16. Complete irregular shell, exterior, dorsal valve; PCZCU 804, \times 4.3.
 19, 23. Complete shell, exterior, ventral valve and detail of ventral apex; PCZCU 1020, \times 4.3, \times 7.0.
 20. Dorsal valve, interior; PCZCU 1021, \times 4.3.
 21. Paratype, ventral valve, interior; PCZCU 1022, \times 4.3.
 22. Paratype, dorsal valve, interior, showing detached part of primary lamella; PCZCU 1023, \times 4.3.

PLATE 12

Spinatrypa senilis (HAVLÍČEK, 1987)

- 1, 6, 12. Complete shell, exterior, dorsal valve, side view, and ventral valve, showing prominent spinose ornament; PCZCU 967, all \times 3.8.
 2, 4, 11. Complete shell, exterior, dorsal valve, anterior view, and ventral valve; PCZCU 968, all \times 3.8.
 3, 5. Complete shell, exterior, ventral valve and dorsal valve, with prominent trail, PCZCU 803, both \times 3.8.
 7, 9. Complete shell, exterior, ventral valve and anterior view, showing prominent trail; PCZCU 970, both \times 3.8.
 8. Dorsal valve with prominent trail but without spines; PCZCU 969, \times 3.8.
 10. Gerontic ventral valve, interior with prominent thick brim along periphery; PCZCU 973, \times 3.8.
 13. Ventral valve, interior; PCZCU 972, \times 3.8.
 14, 16. Dorsal valve interior and detail of cardinalia; PCZCU 971, both \times 3.8.

15. Complete shell, exterior, dorsal valve with detail of ventral apex; PCZCU 805, $\times 3.8$.
17. Gerontic ventral valve, lateral view showing geniculate profile of numerous broken trails; PCZCU 974, $\times 3.8$.

PLATE 13

Spinatrypa senilis (HAVLÍČEK, 1987)

- 1, 2, 6. Dorsal valve with almost entire brachidium in ventral and two oblique views (from right and left sides), note convexity of lamellae copying convexity of the ventral valve; PCZCU 975, all $\times 3.8$.
- 3, 7. Complete shell with broken ventral valve showing the brachidium, oblique and anteroventral views; PCZCU 976, both $\times 3.8$.
4. Isolate primary lamellae; PCZCU 978, $\times 5.5$.
5. Cardinalia showing crura attached to fragment of primary lamellae (arrow); PCZCU 979, $\times 3.8$.
8. Complete shell showing apical parts of the brachidium; PCZCU 977, $\times 3.8$.

Lissatrypa neglecta HAVLÍČEK, 1984

- 9, 17. Complete shell, exterior, dorsal valve, and anterior valve; PCZCU 980, both $\times 4.0$.
- 10, 13. Complete shell, exterior, dorsal valve and ventral valve; PCZCU 981, both $\times 4.0$.
- 11, 14, 18. Complete shell, exterior, dorsal and ventral valves, and anterior view; PCZCU 982, all $\times 4.0$.
- 12, 16. Complete shell, exterior, dorsal valve, and anterior view; PCZCU 983, both $\times 4.0$.
15. Complete shell, exterior, ventral valve showing spinose ornament; PCZCU 984, $\times 4.0$.
19. Fragment of complete shell, interior showing cardinal block and teeth; PCZCU 985, $\times 4.0$.
20. Incomplete dorsal valve, interior; PCZCU 987, $\times 4.0$.
21. Incomplete dorsal valve, interior; PCZCU 988, $\times 4.0$.
- 22, 26. Complete shell, showing primary lamellae, part of brachidial cones and jugal process, viewed ventrally, and detail of spinose ornament; PCZCU 990, $\times 4.0$, $\times 5.5$.
23. Fragment of complete shell, interior showing cardinal block and teeth; PCZCU 986, $\times 4.0$.
24. Incomplete ventral valve, interior; PCZCU 989, $\times 4.0$.
25. Incomplete ventral valve, interior; PCZCU 991, $\times 4.0$.

PLATE 14

Atrypina eremita HAVLÍČEK, 1999

- 1, 13. Complete shell, exterior, ventral valve showing branched median costae, and anterior view; PCZCU 1030, both $\times 7.5$.
- 2, 4, 14. Complete shell, exterior, ventral valve, dorsal valve, and anterior view; PCZCU 1031, all $\times 7.5$.
- 3, 15. Complete shell, exterior, ventral valve, and anterior view; PCZCU 1032, both $\times 7.5$.
- 5, 11. Complete shell, exterior, dorsal valve, and side view; PCZCU 1033, both $\times 7.5$.
6. Ventral valve, interior; PCZCU 1028, $\times 7.5$.
7. Ventral valve, interior; PCZCU 1026, $\times 7.5$.
8. Dorsal valve, interior; PCZCU 1027, $\times 7.5$.
9. Dorsal valve, interior; PCZCU 1025, $\times 7.5$.
10. Complete shell, exterior, side view; PCZCU 1034, $\times 7.5$.
12. Complete shell, exterior, anterior view; PCZCU 1029,

$\times 7.5$.

Navispira trepida HAVLÍČEK, 1999

- 16, 28. Complete shell, exterior, dorsal valve and anterior view; PCZCU 1053, both $\times 7.5$.
- 17, 22, 30. Complete shell, exterior, dorsal valve, ventral valve, and anterior view; PCZCU 1050, all $\times 7.5$.
- 18, 29. Complete shell, exterior, dorsal valve, and anterior view; PCZCU 1054, both $\times 7.5$.
- 19, 25. Complete shell, exterior, dorsal and ventral valves; PCZCU 1049, both $\times 7.5$.
20. Ventral valve, interior; PCZCU 1045, $\times 7.5$.
21. Ventral valve, interior; PCZCU 1046, $\times 7.5$.
23. Complete shell, exterior, ventral valve; PCZCU 1051, $\times 7.5$.
24. Complete shell, exterior, ventral valve; PCZCU 1052, $\times 7.5$.
26. Dorsal valve, interior; PCZCU 1047, $\times 7.5$.
27. Dorsal valve, interior; PCZCU 1048, $\times 7.5$.

Glassina gutta sp. n.

31. Holotype, complete shell, exterior, dorsal valve and ventral apex showing deltidial plates and pedicle foramen; PCZCU 1036, $\times 6.5$.
32. Complete shell, exterior, dorsal valve; PCZCU 1037, $\times 6.5$.
33. Complete shell, exterior, dorsal valve; PCZCU 1038, $\times 6.5$.
- 34, 38. Paratype, complete shell, exterior, dorsal valve showing left lamella of the brachidium, and ventral valve showing distal parts of primary lamellae of both cones of the brachidium; PCZCU 1035, both $\times 6.5$.
- 35, 36. Paratype, complete shell, interior, dorsal valve showing crura and dental plates; PCZCU 1039, both $\times 6.5$.
37. Complete shell, interior in side view showing spires of brachidium; PCZCU 1040, $\times 6.5$.

PLATE 15

Merista pruniformis HAVLÍČEK, 1999

- 1, 5. Incomplete ventral valve, interior, and oblique views; PCZCU 925, both $\times 3.2$.
2. Incomplete ventral valve, interior; PCZCU 926, $\times 3.2$.
3. Incomplete dorsal valve, interior; PCZCU 927, $\times 3.2$.
4. Incomplete dorsal valve, exterior; PCZCU 928, $\times 2.4$.

Merista cf. *herculea* (BARRANDE, 1847)

- 6–9. Incomplete ventral valve, interior, anterodorsal and oblique views, and exterior; PCZCU 929, $\times 3.2$.
10. Incomplete dorsal valve, interior; PCZCU 930, $\times 3.2$.
11. Incomplete dorsal valve, interior; PCZCU 931, $\times 3.2$.
12. Incomplete ventral valve, posterior view; PCZCU 932, $\times 3.2$.

Nucleospira robusta KOZŁOWSKI, 1929

13. Complete shell, exterior, ventral valve; PCZCU 1010, $\times 4.5$.
14. Complete shell, exterior, dorsal valve; PCZCU 1011, $\times 4.5$.
- 15–17. Complete shell, ventral valve, dorsal valve with preserved spinose ornament, anterior view; PCZCU 1012, all $\times 4.5$.
- 18, 19, 23. Incomplete dorsal valve, interior, exterior and oblique view; PCZCU 1007, all $\times 4.5$.

20. Complete shell showing primary lamellae of brachidium; PCZCU 1013, $\times 4.5$.
21. Complete shell, interior showing cardinal flange and teeth; PCZCU 1008, $\times 4.5$.
- 22, 25. Dorsal valve, interior and posterior view; PCZCU 1009, both $\times 4.5$.
24. Ventral valve, interior; PCZCU 1014, $\times 4.5$.
26. Complete shell with detached brachidium and circular jugal plate; PCZCU 1055, $\times 4.5$.

PLATE 16

Ambocoelia bubovica sp. n.

- 1, 6. Paratype, dorsal valve, exterior and interior; PCZCU 941, both $\times 7.0$.
- 2–5, 8. Holotype, complete shell, dorsal valve, ventral valve, posterior, side and anterior views; PCZCU 942, all $\times 7.0$.
9. Complete shell, posterior view; PCZCU 944, $\times 7.0$.
- 7, 10–13. Paratype, complete shell, dorsal valve, posterior view, anterior view, and oblique view and apical view showing oblique primary lamella; PCZCU 943, all $\times 7.0$.

Quadrithyris subrobusta sp. n.

- 14, 26, 27. Paratype, incomplete dorsal valve, exterior, interior and detail of cardinalia; PCZCU 933, $\times 3.0$, $\times 3.0$, $\times 7.0$.
15. Incomplete dorsal valve, exterior; PCZCU 934, $\times 3.0$.
16. Complete shell, posterior shell; PCZCU 940, $\times 3.0$.
- 17, 21, 24, 25. Ventral valve, exterior, interior, oblique view and posterior views; PCZCU 935, $\times 3.0$, $\times 3.5$, $\times 3.5$, $\times 3.0$.
- 18, 22, 29. Paratype, ventral valve, interior anterodorsal view and detail of external ornament; PCZCU 936, $\times 3.0$, $\times 3.0$, $\times 6.0$.
19. Ventral valve, exterior; PCZCU 937, $\times 3.0$.
- 20, 23. Ventral valve, interior in oblique view, side view; PCZCU 938, both $\times 3.0$.
28. Ventral valve, exterior, anterior view showing shape of tongue; PCZCU 939, $\times 3.0$.

PLATE 17

Tenellodermis microdermis HAVLÍČEK, 1971

- 1, 7. Complete shell, exterior, ventral valve and anterior view; PCZCU 947, both $\times 3.8$.

- 2–4, 6, 9. Complete shell, exterior, dorsal valve, ventral valve, side and anterior views, and detail of shell showing two lamellae of brachidium; PCZCU 946, all $\times 3.8$.
- 5, 10. Dorsal valve, exterior and interior; PCZCU 948, both $\times 3.8$.
- 8, 11. Ventral valve, exterior in posterior view, and interior; PCZCU 945, both $\times 3.8$.

Spurispirifer fuscus HAVLÍČEK, 1971

- 12, 17, 20. Ventral valve, exterior, anterior view, and interior; PCZCU 951, all $\times 3.5$.
- 13, 18, 21. Complete shell, ventral valve, anterior and posterior views, PCZCU 949, all $\times 3.5$.
- 14, 23–25. Dorsal valve, exterior, interior and two details of crura; PCZCU 952, $\times 3.5$, $\times 3.5$, $\times 6.5$, $\times 6.5$.
- 15, 16, 19, 22. Ventral valve, exterior, anterior and oblique views, and interior; PCZCU 950, all $\times 3.5$.

PLATE 18

Howellella angustiplicata (KOZŁOWSKI, 1929)

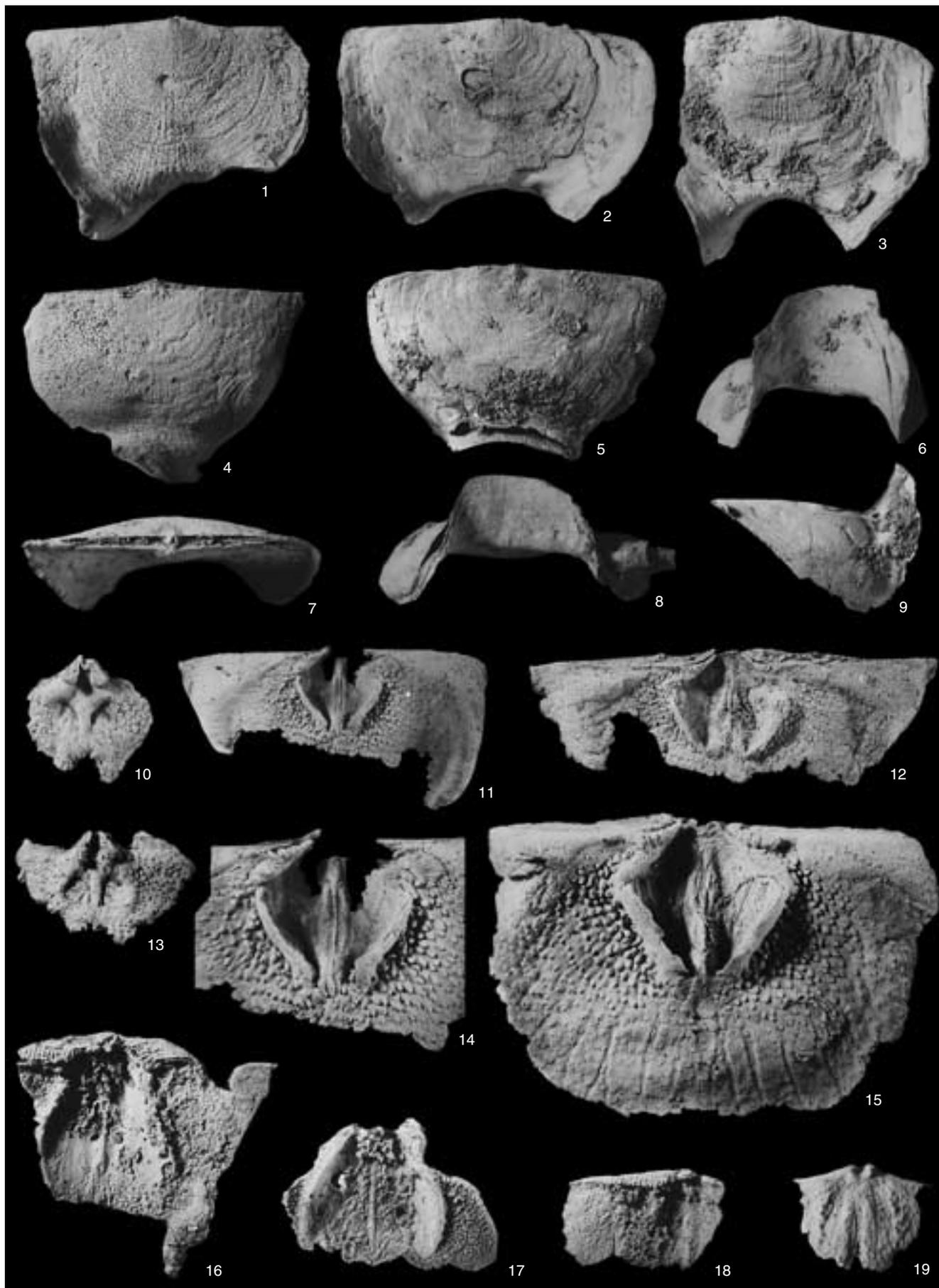
- 1, 9. Dorsal valve, exterior and interior; PCZCU 955, both $\times 3.5$.
- 2, 10. Dorsal valve, exterior and interior; PCZCU 956, both $\times 3.5$.
- 3, 4, 6, 7, 11, 15. Complete shell, exterior, dorsal valve, ventral valve, anterior, posterior and lateral views, and detail of ornament; PCZCU 953, $\times 3.5$ (3, 4, 6, 7, 11), $\times 7.0$ (15).
- 5, 12, 13. Dorsal valve, exterior, detail of cardinalia, and interior; PCZCU 957, $\times 3.5$, $\times 7.0$, $\times 3.5$.
- 8, 14. Ventral valve, exterior and interior; PCZCU 954, both $\times 3.5$.

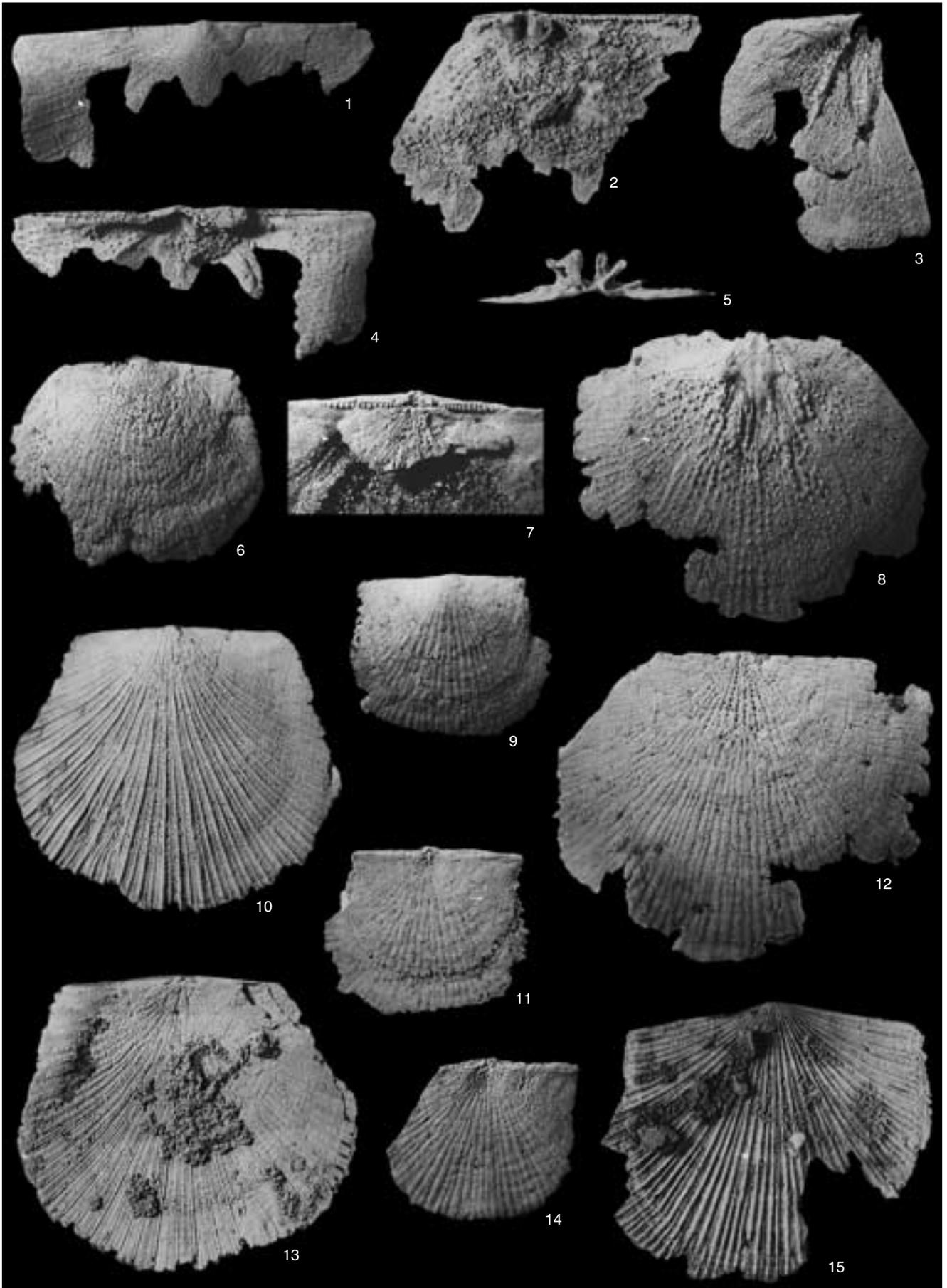
Havlicekia amarantha HAVLÍČEK, 1980

16. Ventral valve, exterior, posterior view; PCZCU 963, $\times 3.2$.
19. Ventral valve, interior; PCZCU 962, $\times 3.2$.
20. Dorsal valve, interior; PCZCU 964, $\times 3.2$.
- 21–23. Ventral valve, detail of ventral muscle field, detail of microornament, and exterior; PCZCU 965, $\times 3.2$, $\times 4.0$, $\times 3.2$.

Myriospirifer sp.

- 17, 18. Ventral valve, exterior and interior; PCZCU 958, both $\times 3.5$.





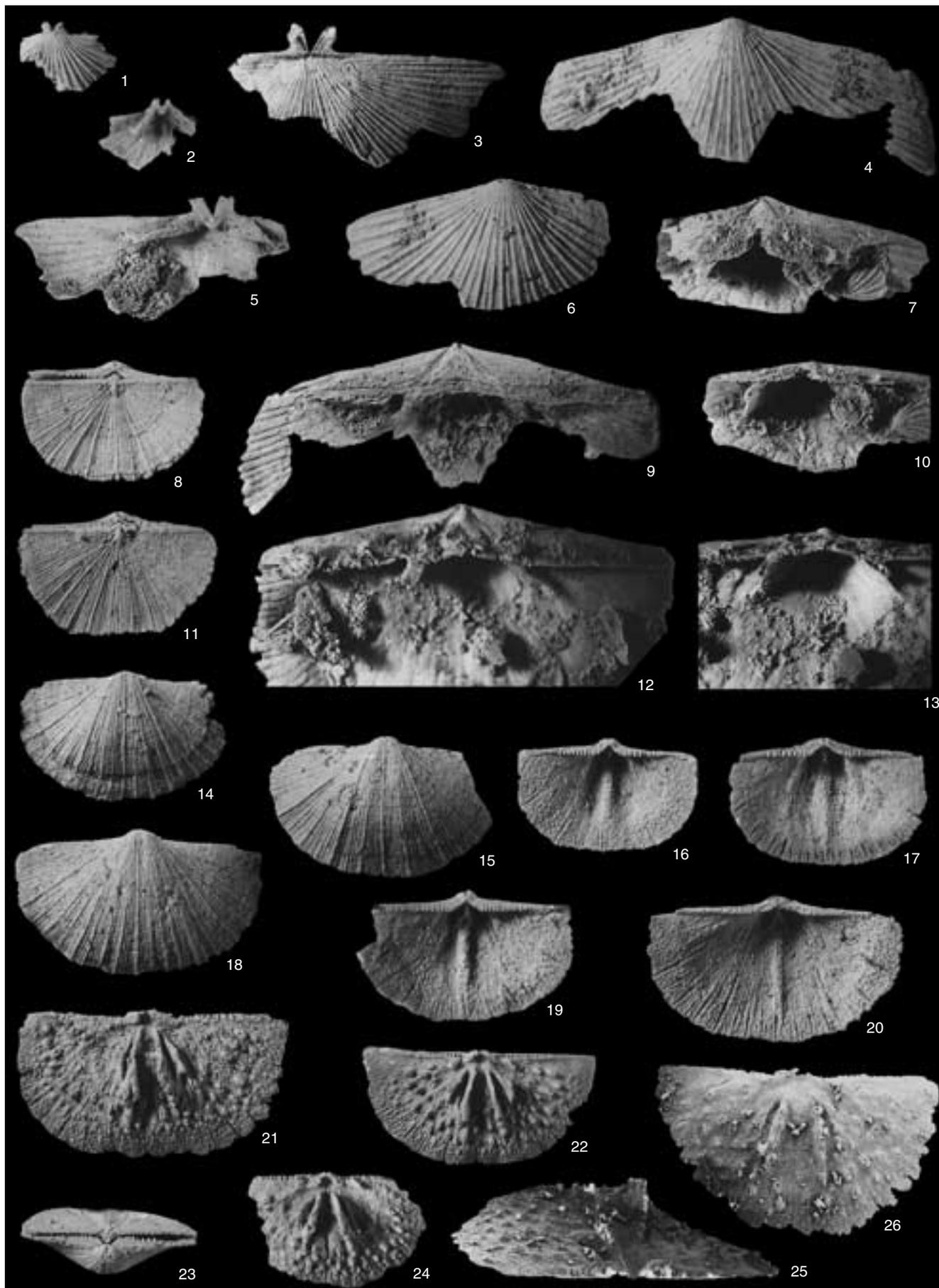
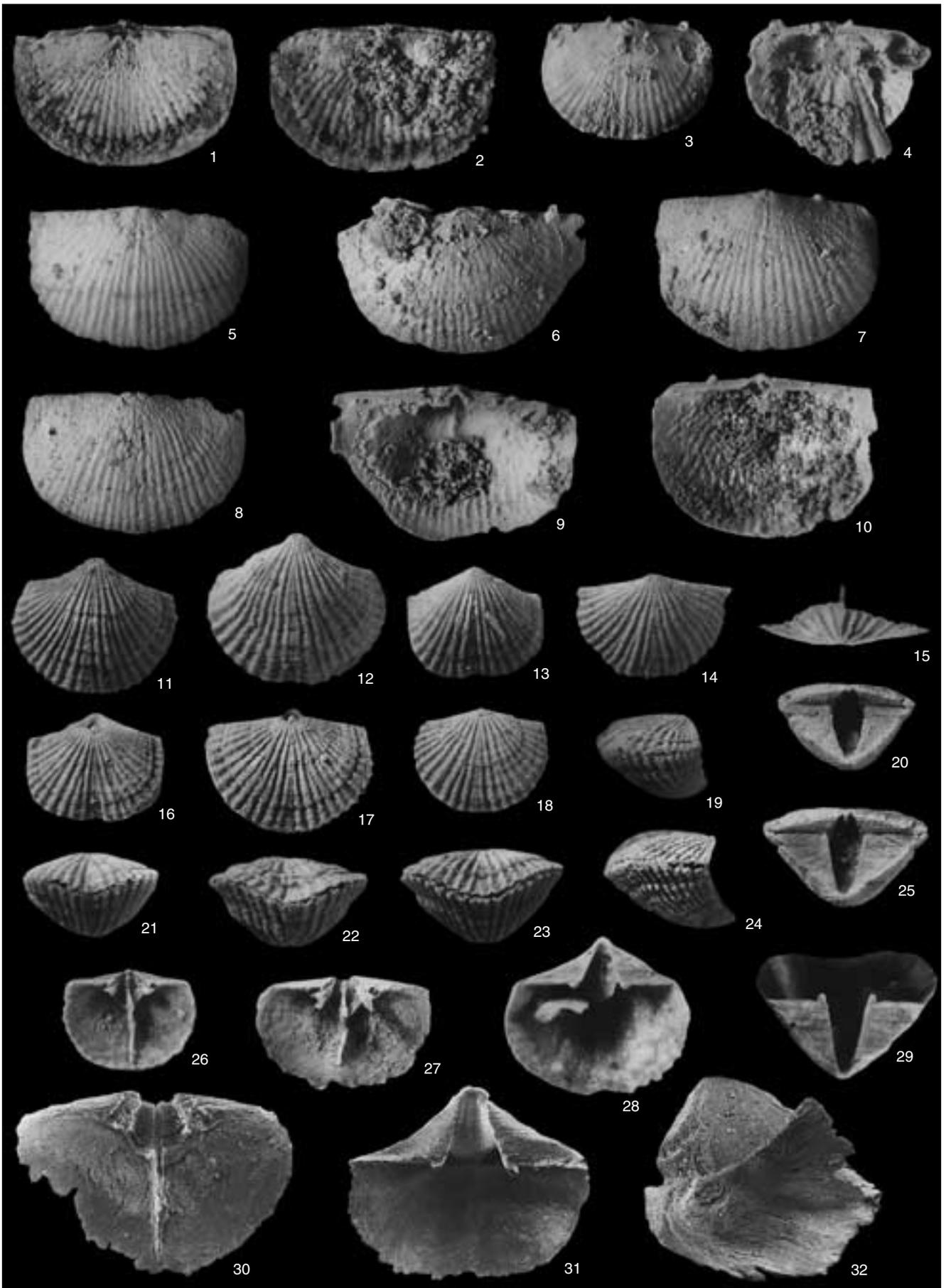


Plate 4



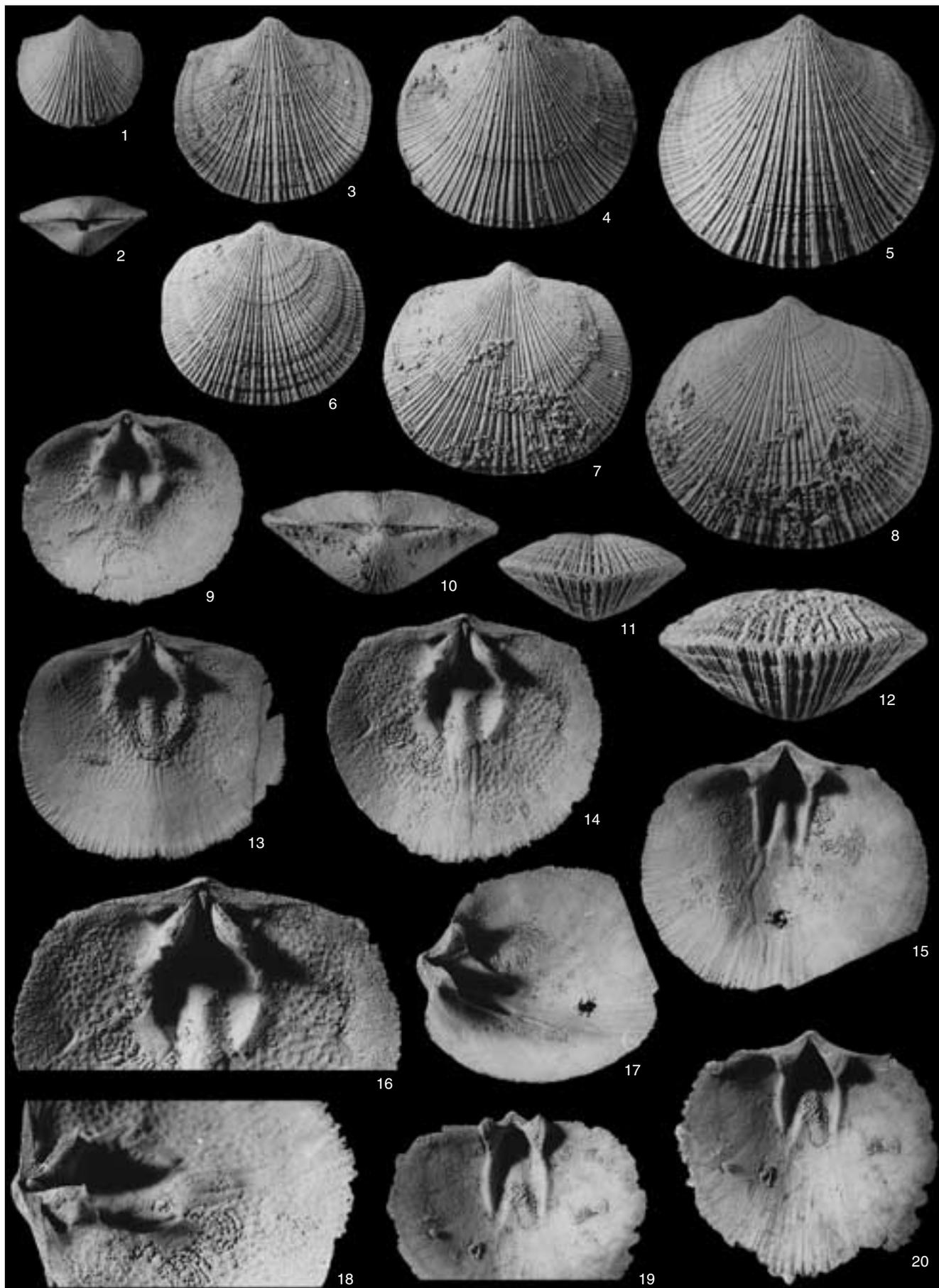
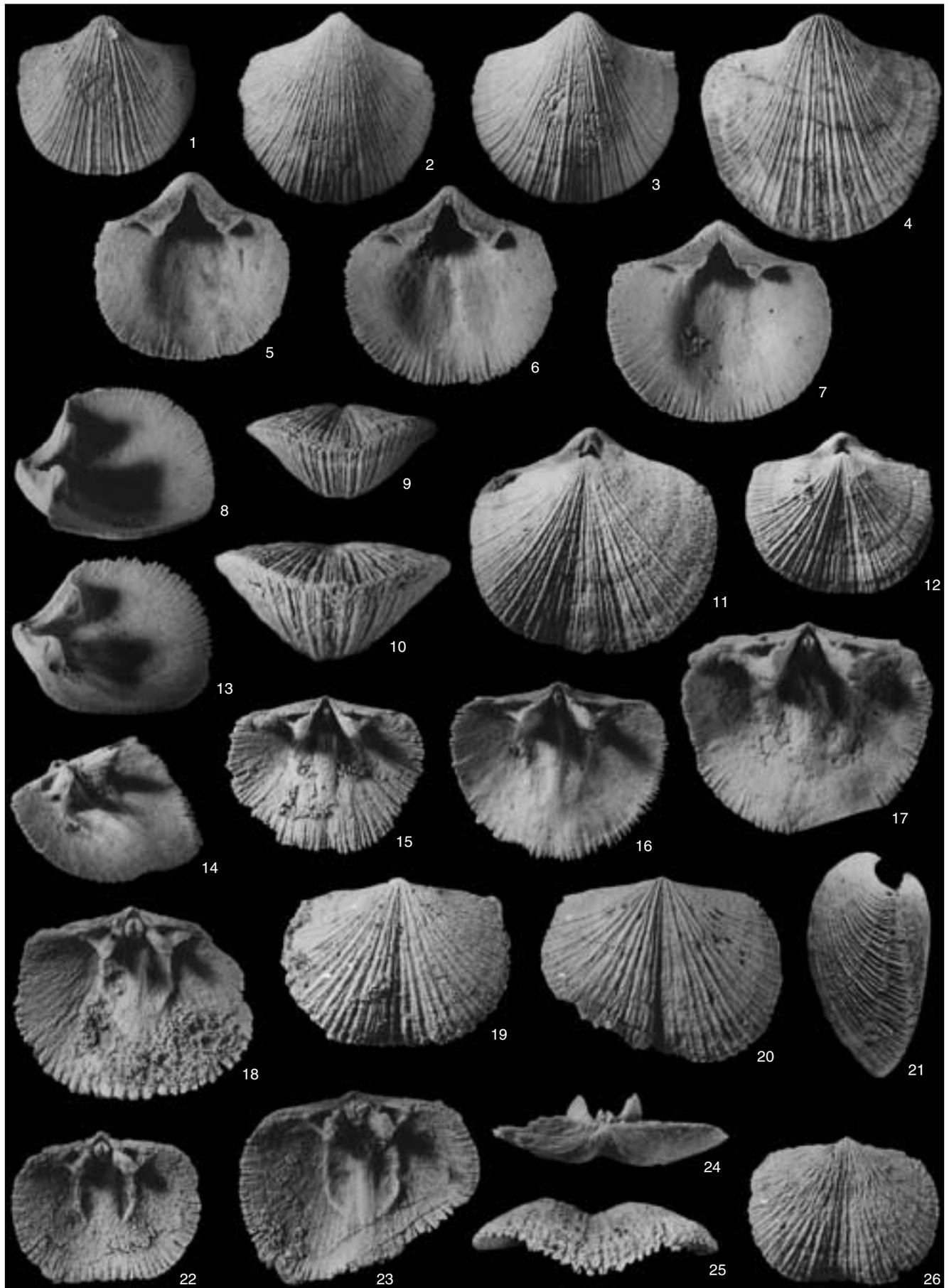
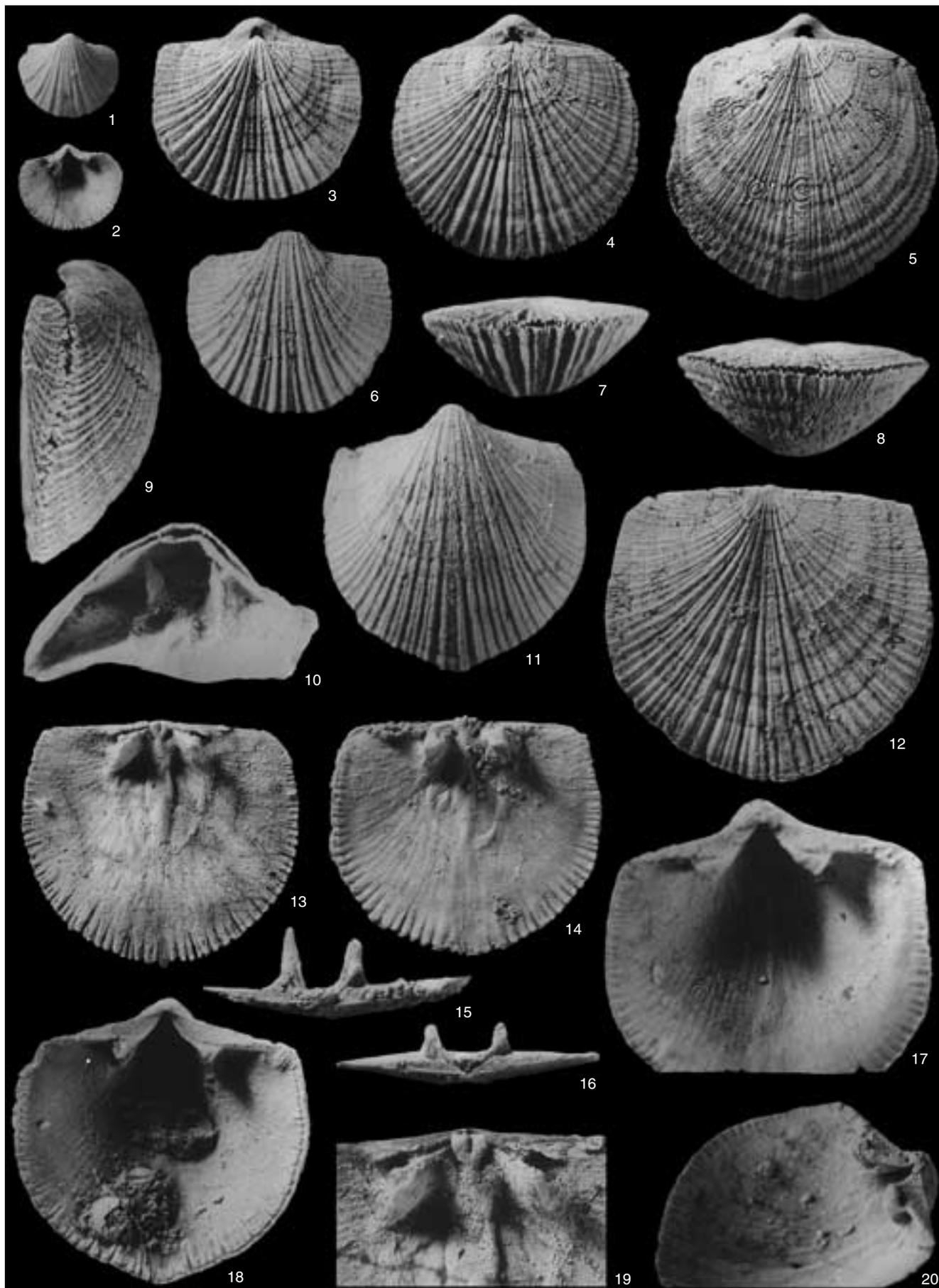
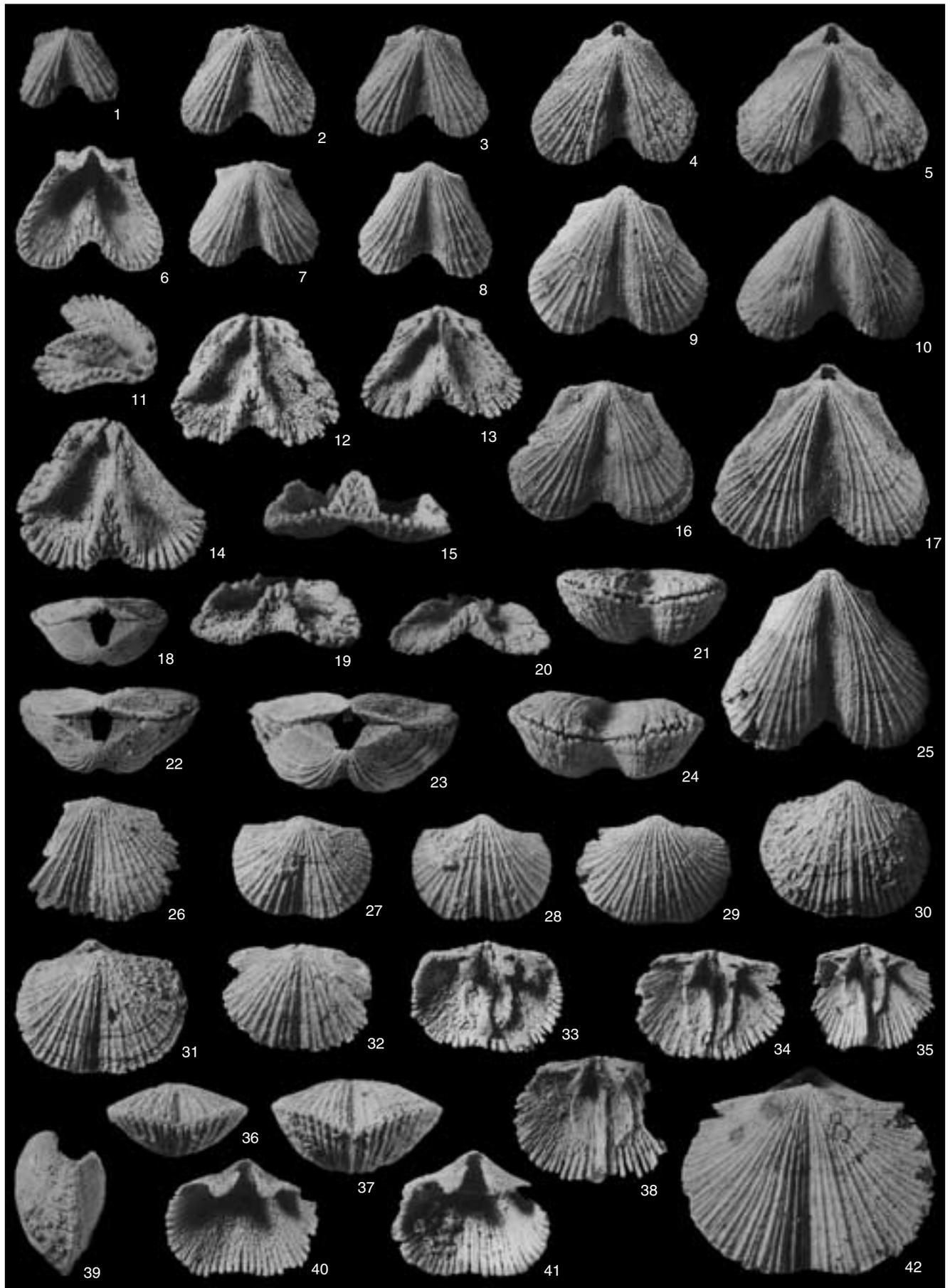
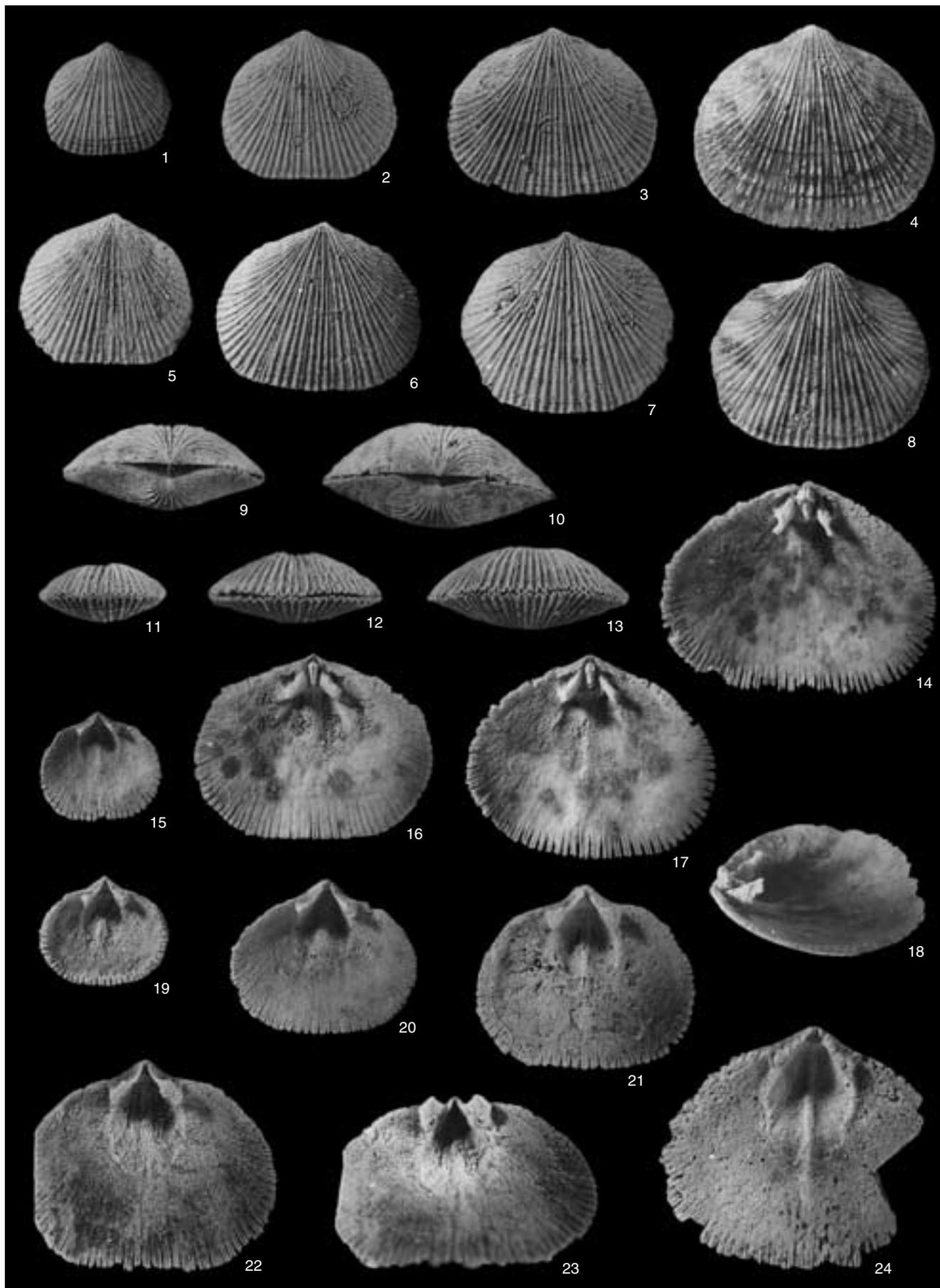


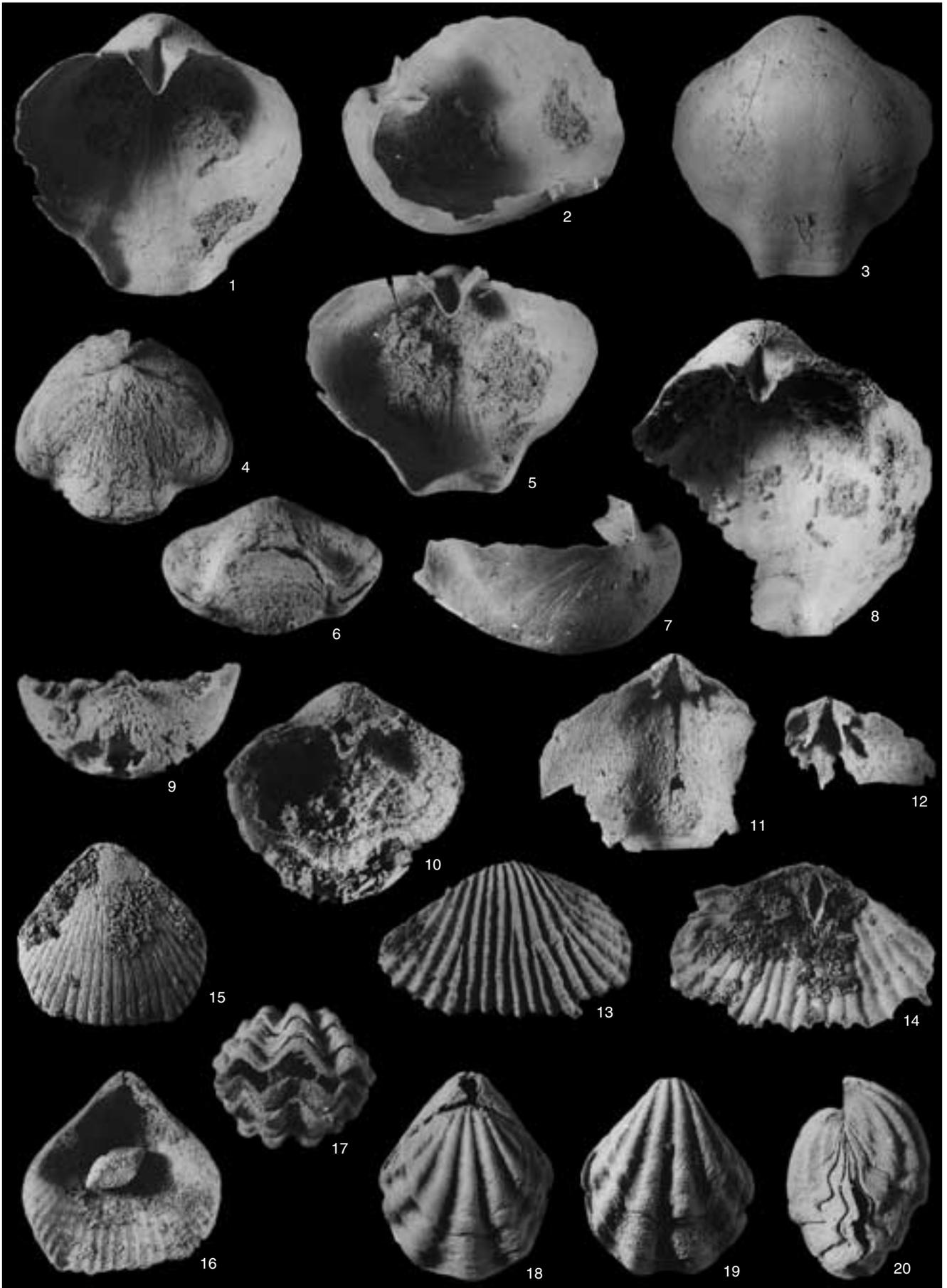
Plate 6

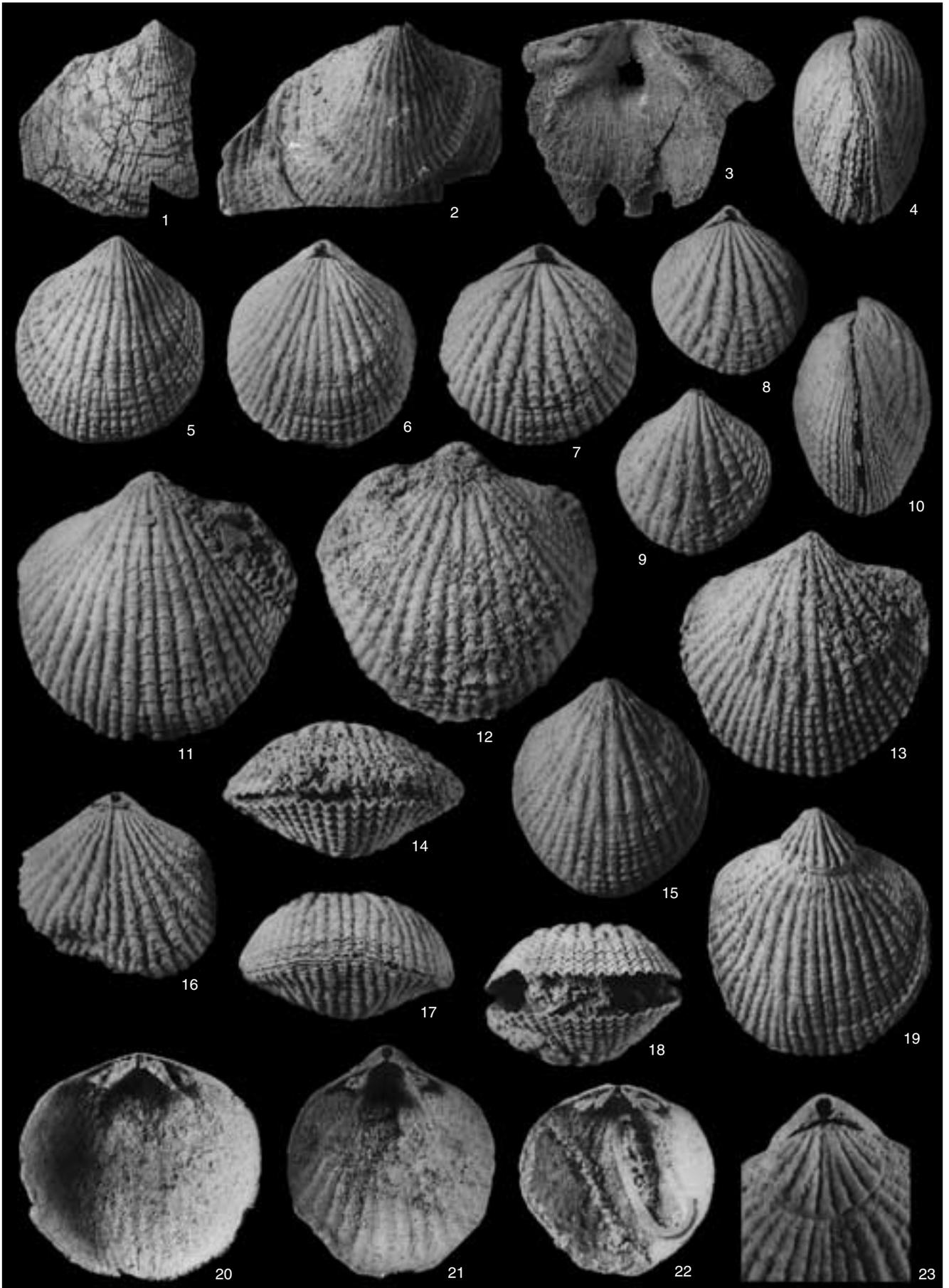


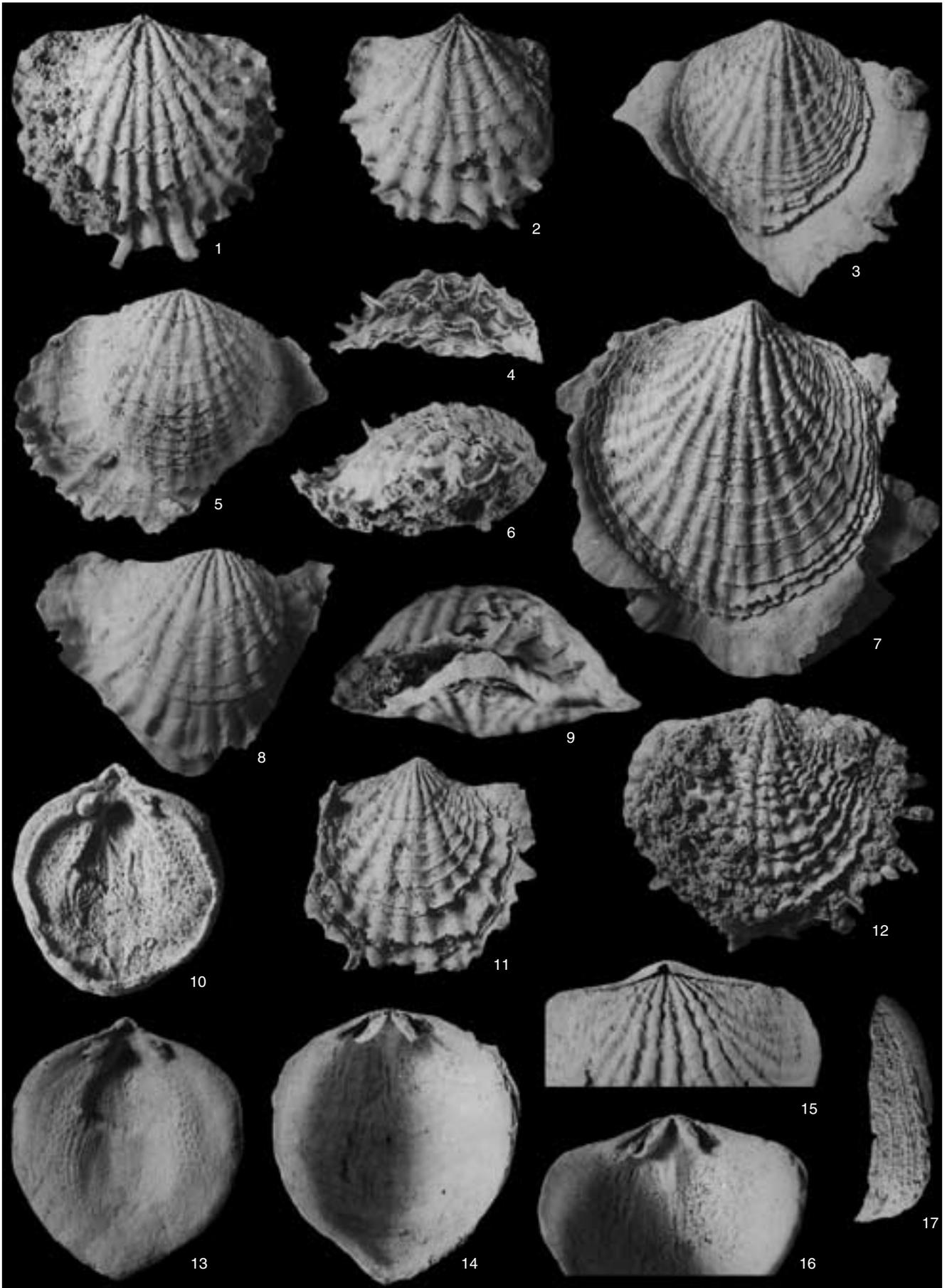












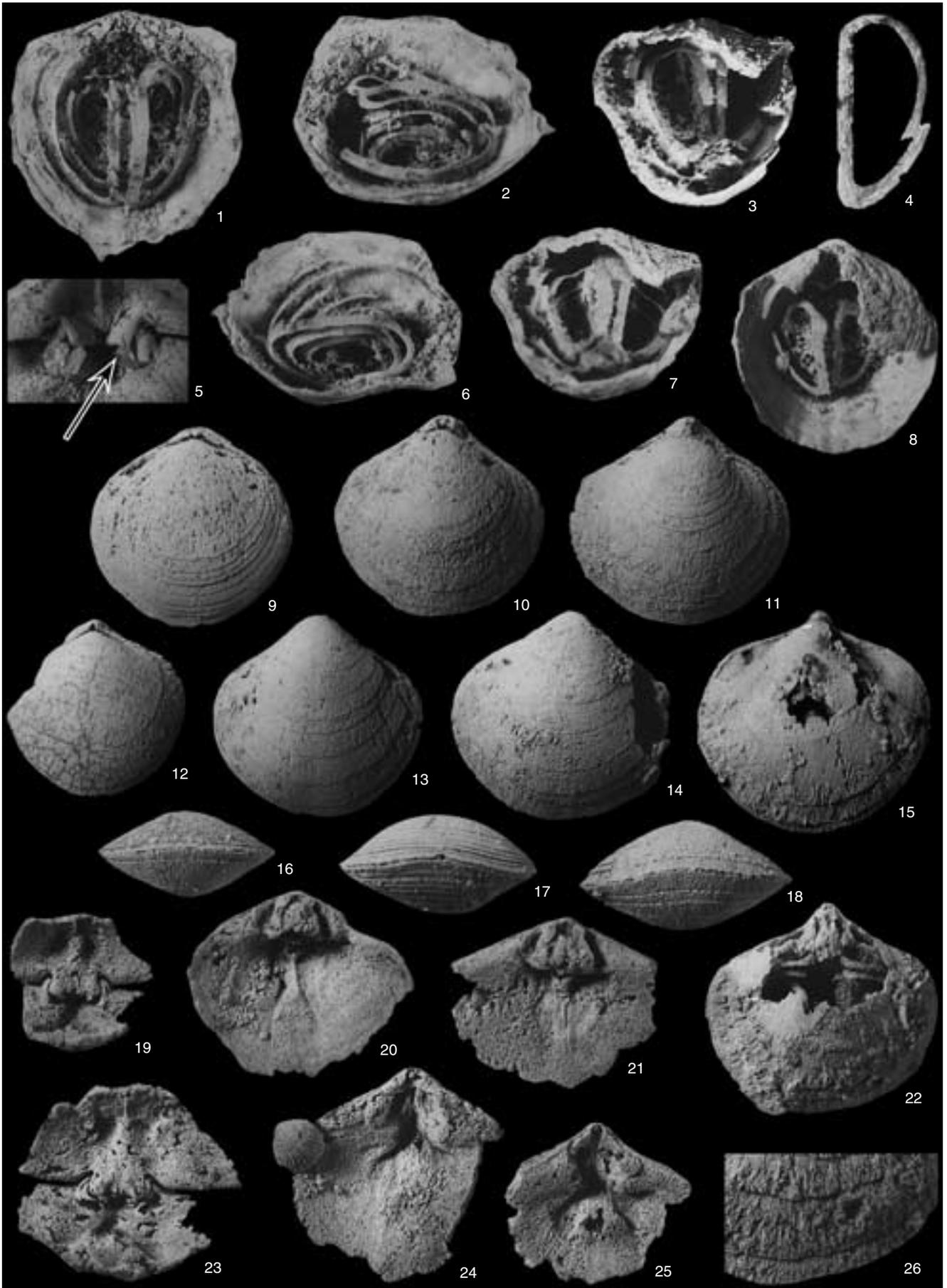


Plate 14

