



## RHYNCHONELLIFORM BRACHIOPODS AND TRILOBITES OF THE 'UPPER DARK INTERVAL' IN THE KONĚPRUSY AREA (DEVONIAN, EIFELIAN, KAČÁK EVENT; THE CZECH REPUBLIC)

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**Abstract:** The dark pelbiotrital limestone beds of the 'upper dark interval' in the Koněprusy area, Central Bohemia, the Czech Republic, the assumed manifestation of the Kačák Event in this area, yielded a moderately diverse faunule of rhynchonelliform brachiopods and trilobites. In total, 15 species have been recognized (13 brachiopods and 2 trilobites), but the majority of them are only tentatively determined to generic level due to fragmentation, rarity or poor preservation. Brachiopod genera *Leptaenopyxis*, *Protodouvillina*, *Douvillina*, *Holynetes*, *Polonipproductus*, *Iridistrophia*, *Mystrophora*, *Pentamerella*, *Quasidavidsonia*, *Carinatina*, *Mimatrypa*, *Leptathyris*, *Eoreticularia* and a single trilobite *Astycoryphe* were determined. The mode of preservation indicates transport of skeletal bioclasts from shallower parts of the basin and their fragmentation in debris flows together with fragments of terrestrial plants, crinoid detritus and numerous pelagic fossils, especially the dacryoconarid *Nowakia* ex gr. *otomari*. Associated conodonts (as well as trilobites) indicate a late Eifelian age for the fauna (*Polygnathus ensensis* Zone).

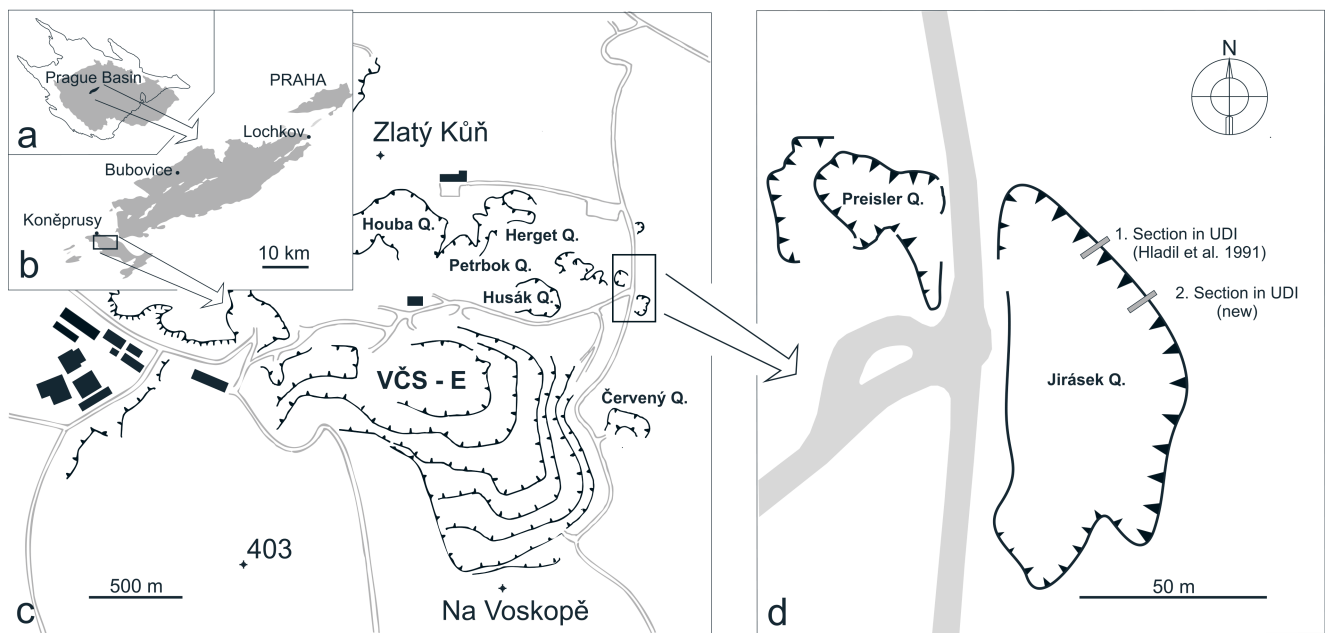
**Key words:** Brachiopoda, Trilobita, Devonian, Eifelian, Kačák Event, *Polygnathus ensensis* Zone, Koněprusy, the Czech Republic

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### Introduction

The 'dark interval' ('dark horizon', 'upper dark interval', UDI) is an informal name used originally by Galle and Hladil (1991) for a 0.7 m thick interval of thin-bedded dark-grey pelbiotrital limestone in the small abandoned Jirásek's Quarry near Koněprusy, Central Bohemia. This distinct dark interval above light grey Acanthopyge Limestone is known only from this locality and represents (together with the bed of lithoclastic breccia above) the youngest carbonate sediments in the Koněprusy area. The interval is correlated with the onset of the Kačák Event (Galle and Hladil 1991, Budil 1995). Fossils of the UDI were studied by Budil (1995), who noted the presence of dacryoconarid tentaculites, crinoids, brachiopods, foraminifers, trilobites and remains of terrestrial plants referred to *Rellimia* sp. New observations indicate the presence of fenestrate bryozoans, hyolithids and ostracods. The rich conodont fauna from this interval indicates a latest Eifelian age, *Polygnathus ensensis* Zone or *Polygnathus eiflii* Zone (Zikmundová and Kalvoda 1991, Kalvoda 1992, Hladil et al. 1993, Berkyová 2004, Vodrážková in prep.).

Dacryoconarid tentaculites were firstly determined by Pavel Lukeš (in Hladil et al. 1993, Budil 1995), who noted the presence of *Nowakia* (N.) ex gr. *otomari* BOUČEK et PRANTL, 1959. *Nowakia* (*Cepanowakia*?) cf. *chlupacina* ALBERTI, 1979 and *Metastyliolina* sp. Dacryoconarids were subsequently revised by Berkyová (2004), who recognized *Nowakia* (*Cepanowakia*) *pumilio* ALBERTI, 1978, *Nowakia* ex gr. *otomari* BOUČEK et PRANTL, 1959, *Styliolina* ? *fissurella* (HALL, 1843), *Lukesia elixi* BERKYOVÁ, 2004 and ? *Metastyliolina* sp. Correlation of the UDI with the Kačák Member as assumed by Hladil et al. (1993) was not supported by Berkyová (2004) because specimens of N. ex gr. *otomari* from Jirásek's Quarry differ in some morphological aspects from the specimens of N. *otomari* found elsewhere. The presence of fishes in the middle part of the UDI was already noted by Hladil et al. (1993). Mergl et al. (2017) observed abundant and diverse remains of vertebrates in the UDI, with acanthodes *Nostolepis* sp. and *Cheiracanthoides* sp. together with teeth of sarcopterygians. Organophosphatic brachiopods from the UDI are rare but remarkably diversified (Mergl 2019). Apart from the ubiquitous lower – middle Devonian genera *Opsiconidion* and

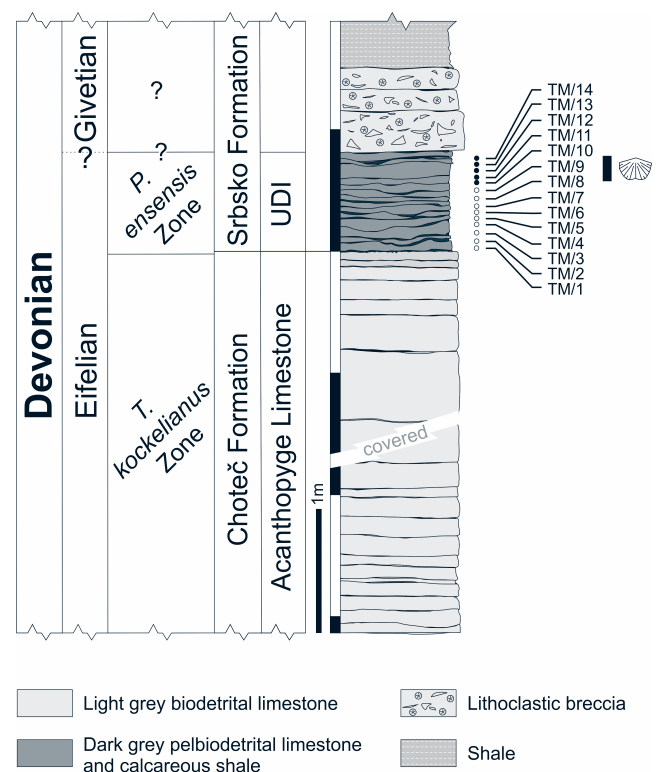


**Text-fig. 1.** Schematic maps showing location of the Prague Basin in the Barrandian area of the Czech Republic (a), the Koněprusy area (b), quarries in the Koněprusy area (c) and Jirásek's and Preisler's quarries (d). The exact location of the section described by Hladil et al. (1993) (1) and the new sections where the brachiopods were extracted (2) are figured. Abbreviations: UDI – upper dark interval, VČS-E – Velkolom Čertovy schody – východ quarry.

*Opatrlikiella*, the genera *Lingulipora*, *Paterula* and *Orbaspina* were determined, but the original diversity was much higher than could be assumed from the common minute fragments of discinoideans and linguloideans. The presence of chonetid and strophomenid brachiopods was reported by some authors (Hladil et al. 1993, Budil 1995) but the sampled material was poor in quantity and so far the only determination of brachiopods made by V. Havlíček (in Budil 1995) is dubious.

## Geological setting

The Devonian of the Prague Basin continues from the underlying Silurian (Chlupáč 1998 and references therein). Resting on the Lochkovian to Emsian shallow-water reef complex, the shallow-water limestones of Eifelian age are restricted to a small area in the Koněprusy vicinity. Apart from the summit of Zlatý Kůň Hill, the Acanthopyge Limestone and younger strata form a narrow strip between the entry to the Koněprusy Cave and Zadní Kobyla Hill. There are numerous abandoned small quarries, pits and small outcrops, but their stratigraphic correlation is not clear because of weak folding, faulting and by the cover of debris, soil and vegetation (Hladil et al. 1991, 1993). The most complete sequence of the upper part of the Acanthopyge Limestone is situated in the N wall of the abandoned Jirásek's Quarry (also known as the Acanthopyge Quarry) (Text-fig. 1). Above the Acanthopyge Limestone there follows a 0.7 m thick 'upper dark interval' covered by a 2.5 m thick sequence of limestone and shale beds which were referred to the Srbsko Formation (Givetian) by Hladil et al. (1993) (Text-figs 2, 3). The UDI is observable only in Jirásek's Quarry, but similar dark limestone infillings are known from neptunian dykes in the nearby quarry 'Na Voskopě' (Berkyová 2004).



**Text-fig. 2.** Studied section in Jirásek's Quarry with essential data on lithology and samples studied on rhynchonelliform brachiopods and trilobites (black dots – productive, white dots – barren).

The Kačák Member of the Srbsko Formation is a 2 to 15 m thick unit of dark-grey thinly laminated calcareous shales and cherts (Svoboda and Prantl 1950, Budil 1995). The fauna shows a dominance of pelagic protozoans including





Srbsko Formation
UDI
beds with brachiopods, trilobites and plants
UDI

**Acanthopyge  
Limestone**

**Text-fig. 3.** Eastern wall of Jirásek's Quarry with studied section, with light-grey Acanthopyge Limestones in lower half of the wall, the UDI (in brown) in upper half followed by bioclastic breccia (Bed 46 sensu Hladil 1993) near the edge of the wall (a) and detail of UDI and adjacent limestones with the most productive beds (b). Photo January, 2019.



radiolarians (Bouček 1964, Chlupáč and Turek 1983, Budil 1995) although relics of land plants are also frequent (Obrhel 1961, 1968). The Kačák Member is not typically developed in the Koněprusy area. Therefore, the UDI with abundant dacryoconarids and conodonts, poor benthic fauna and plant remains above the karstified beds of the Acanthopyge Limestone at Jirásek's Quarry section was assumed to be the time-equivalent of the Kačák Member by Hladil et al. (1991, 1993), Kalvoda (1992), Galle (1994) and Budil (1995). The UDI is followed by bioclastic breccia (Bed 46 sensu Hladil 1993) with tabulatormorphs and stromatoporoids, dominated by *Caliopora* ex gr. *battersbyi*. This species is typical for the Eifelian/Givetian boundary interval (Hladil 1993). Siltstones and shales above the breccia were tentatively referred to the Roblín Member of the Srbsko Formation by Hladil et al. (1991, 1993). The lithological character of the UDI, however, retains the main features of the Choteč Formation, e.g. carbonate sedimentation. Therefore, the UDI and bioclastic breccia above are still referred to the Acanthopyge Limestone facies (see Chlupáč 2003: 303), although chronostratigraphically they correspond to the Kačák Member of the Srbsko Formation.

## Material and methods

All specimens of rhynchonelliform brachiopods and trilobites were sampled by hammering. Their remains are fairly common, but shell remains are often millimetre sized and featureless. Only some small-sized shells are complete or even articulated, but larger shells are always disarticulated, fragmented or with broken thinner parts of the shell. Intensive fragmentation is also distinct in other shells, noteworthy in shells of dacryoconarids, but without signs of abrasion. The mode of preservation indicates transport and intensive fragmentation of shells in the debris flow. Consequently, the quality of shells is not sufficient for precise taxonomic affiliation and the determination of some species has been only to generic level.

Fourteen samples from the UDI were tested for conodonts, organophosphatic brachiopods and dacryoconarids (Text-fig. 2), but only the upper part of the sequence (samples TM 10 to TM 14) was more productive for rhynchonelliform brachiopod shells. Brachiopods from the bioclastic breccia bed above the UDI (Bed 46 sensu Hladil 1993) are not incorporated into the present work.

## Repository

All specimens, including the types, are housed in the palaeontological collections of the Center of Biology, Geoscience and Environmental Education in the Faculty of Education at the University of West Bohemia in Plzeň (PCZCU), the Czech Republic.

## Systematic palaeontology

### Phylum Brachiopoda DUMÉRIL, 1806

#### Subphylum Rhynchonelliformea WILLIAMS, CARLSON, BRUNTON, HOLMER et POPOV, 1996

#### Class Strophomenata WILLIAMS WILLIAMS, CARLSON, BRUNTON, HOLMER et POPOV, 1996

### Order Strophomenida ÖPIK, 1934

#### Superfamily Strophomenoidea KING, 1846

#### Family Rafinesquinidae SCHUCHERT, 1893

#### Subfamily Leptaeninae HALL et CLARKE, 1894

#### Genus *Leptaenopyxis* HAVLÍČEK, 1963

Type species. *Leptaena bouei* BARRANDE, 1848; Praha Formation, Pragian; Bohemia, the Czech Republic.

#### *Leptaenopyxis* (?) sp.

Pl. 1, Fig. 5

Material. One ventral valve (PCZCU 2265).

Description. The shell is small, 6.6 mm wide and 3.5 mm long, transversely subrectangular, widest at the hinge line, with a few weak incomplete rugae on the flat disc. The folding of the shell along its periphery most likely represents the first entire ruga. The interior bears fine endospines.

Remarks. The shell apparently belonged to an immature individual lacking a geniculation and prominent concentric rugae which are characteristic for larger shells of leptaenids. The shell may belong to *Leptaenopyxis irena* (HAVLÍČEK, 1967). This species is rare in the Suchomasty Limestone of Emsian age (Havlíček and Kukal 1990) but the same or closely related but yet undescribed leptaenide occurs in the upper part of the Acanthopyge Limestone (Eifelian, *Tortodus kockelianus* Zone).

Occurrence. UDI, sample TM 10.

### Family Douvillinidae CASTER, 1939

#### Subfamily Protodouvillininae HARPER et BOUCOT, 1978

#### Genus *Protodouvillina* HARPER et BOUCOT, 1978

Type species. *Strophomena inaequistriata* CONRAD, 1842; Hamilton Group, Eifelian; New York, USA

#### *Protodouvillina* cf. *interstitialis* (PHILLIPS, 1841)

Pl. 1, Figs 1–3

- 1841 *Orthis interstitialis*, *Leptaena interstitialis*; Phillips, pp. 61, 62, pl. 25, fig. 103a–e.
- 2009 *Protodouvillina interstitialis* (PHILLIPS, 1841); Halamski, pp. 53, 54, pl. 3, figs 1–6, 8–17, 19, 20, 30–32, text-fig. 4.
- 2013 *Protodouvillina interstitialis* (PHILLIPS, 1841); Halamski and Baliński, pp. 281, 282, fig. 4A–F, L [for complete synonymy see Halamski (2009) and Halamski and Baliński (2013)]

Material. Two incomplete ventral valves (PCZCU 2261, PCZCU 2263) and one shell fragment (PCZCU 2262).

Description. The unbroken ventral valve is 10 mm wide and 8.8 mm long, but another fragment (Pl. 1, Fig. 3) indicates a larger sized individual of this species. The ventral valve is thin-shelled, subsemicircular in outline, moderately convex in transverse and axial profiles. The maximum width is near the hinge line, cardinal extremities are subrectangular. The interior of the ventral valve has a small muscle field posteriorly divided by a weak ridge (Pl. 1, Fig. 1a). The entire inner surface is densely covered by fine uniformly sized endospines. Ornamentation is parvicostellate, in the ventral valve more strong costellae are separated by much broader interspaces with two to seven finer costellae.



**Remarks.** The shell is assigned to *Protodouvillina* HARPER et BOUCOT, 1978 due to the typical parvicostellate ornamentation and moderate convexity of the ventral valve. Similarly shaped *P. interstitialis* (PHILLIPS, 1841) is known from the Emsian to the Upper Devonian, with more or less evidenced occurrence in England, Belgium, Spain, Poland and the eastward extension towards the Ural Mts. and Afghanistan (Halamski 2009). To date, the species was not observed in the Barrandian area but newly presented material may belong to this species. This must be evidenced by a greater number of better preserved specimens.

**Occurrence.** UDI, samples TM 10, TM 12.

**Genus *Douvillinella* SPRIESTERSBACH, 1925**

**Type species.** *Stropheodonta filifer* SCHMIDT, 1913; Eifelian; Germany.

***Douvillinella* sp.**

Pl. 1, Fig. 4

**Material.** One incomplete dorsal valve (PCZCU 2264).

**Description.** The dorsal valve is flat, with an estimated 22 mm width, thin-walled. The cardinal process is of a stropheodontid type. Socket ridges are short, widely divergent, not joined by cardinal process lobes. Long thin dorsal side septa and a faint median ridge are present. Endospines are low, densely covering the visceral area. Ornamentation is multicostellate with straight costellae also on the posterolateral flanks.

**Remarks.** The dorsal valve (Pl. 1, Fig. 4) is referred to *Douvillinella* on the basis of its interior and uniform ornamentation. Due to its multicostellate ornamentation, the shell differs from the associated fragments which have parvicostellate ornamentation and are herein referred to *Protodouvillina* cf. *interstitialis* (PHILLIPS, 1841).

**Occurrence.** UDI, samples TM 10.

**Order Productida SARYTCHEVA et SOKOLSKAYA, 1959**

**Suborder Chonetidina MUIR-WOOD, 1955**

**Family Anopliidae MUIR-WOOD, 1962**

**Subfamily Holynetae RACHEBOEUF, 1981**

**Genus *Holynetes* HAVLÍČEK et RACHEBOEUF, 1979**

**Type species.** *Holynetes holynensis* HAVLÍČEK et RACHEBOEUF, 1979; Choteč Formation, Eifelian; Bohemia, the Czech Republic.

***Holynetes* cf. *holynensis* HAVLÍČEK et RACHEBOEUF, 1979**

Pl. 2, Figs 1, 2

**Material.** One incomplete dorsal valve (PCZCU 2272) and one ventral valve (PCZCU 2273).

**Description.** The shell is concavo-convex, thin-shelled, rectimarginate, 3.2 mm wide in the larger specimen, with semicircular outline. The dorsal valve is deeply concave in axial profile and weakly concave in transverse profile, widest at the hinge line. The ventral valve is highly convex in axial profile and mound-like in transverse profile with flattened posterolateral corners. Hinge spines not seen.

Ornamentation consists of some 32 to 38 evenly sized and low rounded capillae. New capillae occasionally originate by bifurcation in the dorsal valve. Narrowly triangular posterolateral corners lack radial ornamentation and bear only very fine concentric growth lines.

**Remarks.** Only limited material is available and it lacks information about the internal features. Based on external morphology only, with some doubts, the shells are referred to *Holynetes holynensis* HAVLÍČEK et RACHEBOEUF, 1979. However, the valves of *H. holynensis* described by Havlíček and Racheboeuf (1979) from the Choteč Formation (horizon with *Pinacites jugleri*; *Nowakia sulcata* Zone) are larger, from 6.5 mm to 7.7 mm in size and have more numerous capillae than the two shells sampled from the UDI.

**Occurrence.** UDI, samples TM 12.

**Suborder Productidina WAAGEN, 1883**

**Superfamily Linoproductoidea STEHLI, 1954**

**Family Monticuliferidae MUIR-WOOD et COOPER, 1960**

**Subfamily Devonoproductinae**

**MUIR-WOOD et COOPER, 1960**

**Genus *Poloniproductus* BIERNAT et LAZAREV, 1988**

**Type species.** *Productella varians* BIERNAT, 1966; Skaly Beds, Eifelian; Poland.

***Poloniproductus varians* (BIERNAT 1966)**

Pl. 1, Figs 6–11

1896 *Productella subaculeata* var. *angustior*; Gürich, p. 217.

1896 *Productella subaculeata* var. *latior*; Gürich, p. 218.

1966 *Productella varians* n. sp.; Biernat, pp. 66–77, text-figs 19–21, pl. 11, figs 1–23, pl. 12, figs 1–16, pl. 13, figs 1–10.

1988 *Poloniproductus varians* (BIERNAT, 1966); Biernat and Lazarev, pp. 67–68, text-fig. 2, pl. 17, figs 1–5, pl. 17, figs 1–5, pl. 18, figs 1–4, pl. 19, figs 1–3, pl. 20, figs 1, 2.

2009 *Poloniproductus varians* (BIERNAT, 1966); Halamski, pp. 67, 68.

2013 *Poloniproductus varians* (BIERNAT, 1966); Halamski and Baliński, p. 253, fig. 5.

[for complete synonymy see Halamski (2009) and Halamski and Baliński (2013)]

**Material.** Three ventral valves (PCZCU 2266, PCZCU 2268, PCZCU 2269a), two dorsal valves (PCZCU 2267, PCZCU 2294) and one juvenile dorsal valve (PCZCU 2270).

**Description.** The shell is deeply concavo-convex, with a thin-walled dorsal valve and much thicker ventral valve. The outline is transversely ovate. The largest entire shell is 8.5 mm wide and 6.0 mm long but fragments indicate slightly larger shell size.

The dorsal valve is deeply concave, with maximum concavity anteriorly, having flattened corners and a weakly concave posteroaxial part of the shell. The cardinal extremities are subrectangular, the maximum width lies at the posterior one-third. The interior is unknown except for the presence of fine endospines. Ornamentation of the dorsal valve consists of fine concentric growth lines arranged ca. 0.1 mm apart having a somewhat wavy course. These lines change to coarse rugellae near the hinge line. Shallow

imperfectly bordered large pits covering the dorsal surface have the same spacing as the spines on the opposite (ventral) valve.

The ventral valve is highly convex in transverse and axial profiles, with flattened posterolateral corners. The beak is prominent, with asymmetric cicatrix, shortly overturned above the hinge lines. The interior has densely evenly spaced pustules. Ornamentation of the ventral valve consists of evenly spaced fairly coarse thick-walled suberect spines. Proximal parts of the spines are distinctly curved. The entire spine length is unknown. Concentric ornamentation consists of fine growth lines having a wavy course around the base of the spines. Lines closer to the hinge lines are coarser, forming short rugellae. Radial ornamentation is absent.

**Remarks.** The disarticulated valves found in the UDI of the Srbsko Formation clearly resemble externally those of *Poloniprductus varians* (BIERNAT, 1966) which is an abundant productid of the Skaly Beds of the Holy Cross Mountains (Biernat 1966, Biernat and Lazarev 1988). The only difference is the smaller size of specimens from the UDI, but they most likely represent immature individuals.

**Occurrence.** UDI, samples TM 10, TM 11, TM 12; outside Bohemia, the species is known from the Upper Eifelian (Skaly Beds) to Lower Givetian of the Lysogóry region of the Holy Cross Mountains, Poland (Biernat and Lazarev 1988, Halamski 2009), and from the Upper Eifelian to Lower Givetian of eastern Anti-Atlas, Morocco (Halamski and Baliński 2013).

**Order Orthotetida WAAGEN, 1884**  
**Suborder Orthotetidina WAAGEN, 1884**  
**Superfamily Chilidiopsoidea BOUCOT, 1959**  
**Family Chilidiopsidae BOUCOT, 1959**  
**Subfamily Chilidiopsinae BOUCOT, 1959**

**Genus *Iridistrophia* HAVLÍČEK, 1967**

**Type species.** *Orthis umbella* BARRANDE, 1848; Lochkov Formation, Lochkovian; Bohemia, the Czech Republic.

***Iridistrophia* sp.**  
Pl. 1, Figs 12, 13

**Material.** Two ventral valves (PCZCU 2269b, PCZCU 2271).

**Description.** The ventral valve is moderate in size, 15 mm wide and 11.5 mm long, weakly convex in transverse and axial profiles, thin-walled relative to shell size, widest at the hinge line. Ornamentation is parvicostellate, with 12 straight primary costellae originating at the umbo. The costellae do not branch and gently increase in size anteriorly. New costellae originate exclusively by intercalation and rapidly attain the size of primary costellae. Interspaces are wider than the costellae. Their floors are covered by fine concentric fila of subequal size (Pl. 1, Fig. 12b, c). The costellae crests are not crenulated. Anteromedianly, there are 10–11 costellae per 5 mm. Shell substance is impunctate.

**Remarks.** The preserved shell is slightly deformed having partly broken flanks. Therefore it is not clear whether the deviation from bilateral symmetry is original or caused

by fossilization. The shell resembles the moderate-sized specimen of *Xystostrophia umbraculum* (VON SCHLOTHEIM, 1820), but costellae on the latter are crenulated even in small specimens. *Iridistrophia* HAVLÍČEK, 1967 is known from the Lochkovian to Lower Eifelian (Jansen 2001) but Halamski (2009) and Halamski and Baliński (2013) referred *Iridistrophia undifera* (SCHNUR, 1854) from the Upper Eifelian of Germany, Poland and Morocco to this genus. The shell is similarly shaped to *Schuchertella* Girty, 1904 but this genus has an extropunctate shell. The small specimen with triangular ventral muscle field (Pl. 1, Fig. 13) bordered by widely divergent dental plates may belong to the same species.

**Occurrence.** UDI, sample TM 12.

**Order Orthida SCHUCHERT et COOPER, 1932**  
**Suborder Dalmanellidina MOORE, 1952**  
**Superfamily Dalmanelloidea SCHUCHERT, 1913**  
**Family Mystrophoridae SCHUCHERT et COOPER, 1931**

**Genus *Mystrophora* KAYSER, 1871**

**Type species.** *Orthis areola* QUENSTEDT, 1871; Eifelian; Germany.

***Mystrophora* sp.**  
Pl. 2, Fig. 3

**Material.** One dorsal valve (PCZCU 2274).

**Description.** The dorsal valve is 6 mm wide, transversely oval, with a deep wide sulcus and obtuse cardinal extremities. Ornamentation is formed by fine bifurcate radial costellae, 30–35 along the anterior margin of the valve.

**Remarks.** Despite its poor preservation, the valve is referred to *Mystrophora* KAYSER, 1871 due to its size, outline, presence of sulcus and form of ornamentation. More material is required to assess its relationship to *M. areola* QUENSTEDT, 1871 which is known from the Eifelian of Germany and Burma (Anderson et al. 1969).

**Occurrence.** UDI, sample TM 12.

**Order Pentamerida SCHUCHERT et COOPER, 1931**  
**Suborder Pentameridina SCHUCHERT et COOPER, 1931**  
**Superfamily Clorindoidea RZHONSNITSKAYA, 1956**  
**Family Clorindidae RZHONSNITSKAYA, 1956**  
**Subfamily Pentamerellinae SAPELNIKOV, 1973**

**Genus *Pentamerella* HALL, 1867**

**Type species.** *Atrypa arata* CONRAD, 1841; Schoharie Formation; New York, USA.

***Pentamerella* sp.**  
Pl. 2, Figs 4, 5

**Material.** One dorsal valve (PCZCU 2275) and one ventral valve (PCZCU 2276).

**Description.** The shell is thick walled, strongly biconvex, 5 mm wide, most likely rectimarginate. The dorsal valve is transversely oval, with a length 80 % of the width and widest in the posterior one-third region.



Maximum convexity is in the posterior one-third. Posterior corners are rounded, slightly flattened. The ventral valve is subpentagonal, more elongate, strongly convex in posterior third. Ornamentation is formed by ten strong costae in the dorsal valve and nine costae in the ventral valve. The costae are weakly defined at the beaks, but progressively increase anteriorly. There are three coarser median costae in the dorsal valve and two coarser costae in the ventral valve compared to those on the flanks.

**Remarks.** The shells are referred to *Pentamerella* HALL, 1867 due to their small size, thick shell and coarse costae, but lack of data about the interior makes this affiliation only tentative. The specimens may be related to some yet undescribed small pentamerid which is present in the upper part of the Acanthopyge Limestone (Eifelian, *Tortodus kockelianus* Zone) in the Koněprusy area.

**Occurrence.** UDI, samples TM 10, TM 12.

**Order Atrypida RZHONSNITSKAYA, 1960**

**Suborder Davidsoniida COPPER, 1996**

**Superfamily Davidsonioidea KING, 1950**

**Family Davidsoniidae KING, 1950**

**Genus *Quasidavidsonia* HAVLÍČEK, 1987**

**Type species.** *Pro davidsonia vicina* HAVLÍČEK, 1967; Choteč Formation, Eifelian; Bohemia, the Czech Republic.

***Quasidavidsonia mediocarinata* (HAVLÍČEK, 1967)**

Pl. 2, Fig. 15

1967 *Pro davidsonia mediocarinata* sp. n.; Havlíček, p. 215, pl. 49, figs 10–14.

1990 *Quasidavidsonia mediocarinata* (HAVLÍČEK, 1967); Havlíček and Kukal, p. 166, pl. 3, figs 11–15.

**Material.** One dorsal valve (PCZCU 2285).

**Description.** The valve is 12 mm wide and 8.5 mm long, with a thick shell-wall. The dorsal valve is semicircular, weakly convex in transverse profile and moderately convex in axial profile, with a narrow shallow sulcus and flattened posterolateral corners.

**Remarks.** A single poorly preserved dorsal valve is known from the UDI. Its size and profile is consistent with affiliation to *Q. mediocarinata* HAVLÍČEK, 1967. This is a common species in the Acanthopyge Limestone (Havlíček and Kukal 1990), but the genus ranges from the Emsian to the upper Givetian.

**Occurrence.** UDI, sample TM 12.

**Family Carinatinidae RZHONSNITSKAYA, 1960**

**Genus *Carinata* NALIVKIN, 1930**

**Type species.** *Orthis arimaspus* EICHWALD in VON BUCH, 1840; Middle Devonian; Russia.

***Carinata arimaspus* (EICHWALD in VON BUCH, 1840)**

Pl. 2, Figs 8, 9, 14

1840 *Orthis Arimaspus* EICHW.; von Buch, pp. 108, 112.

1975 *Carinata arimaspus* (EICHWALD, 1840); Rzhonsnitskaya, p. 139, text-fig. 45, pl. 31, figs 1–3, 12.

1978 *Carinata arimaspus* (EICHWALD, in Buch 1840); Copper, p. 310, pl. 7, figs 1–6.

1987 *Carinata arimaspus* (EICHWALD, 1840); Havlíček, p. 93, pl. 11, figs 7–9.

1990 *Carinata arimaspus* (EICHWALD, 1840); Havlíček and Kukal, pp. 165, 166, pl. 17, fig. 9, pl. 23, fig. 4.

**Material.** Three incomplete ventral valves (PCZCU 2279, PCZCU 2280, PCZCU 2293).

**Description.** The ventral valve is carinate, moderate thick walled and bears laterally curved rounded coarse costae. New costae originate by both bifurcation and intercalation. The shell surface is covered by faint concentric growth fila at regular, ca. 0.3 mm, intervals (Pl. 2, Fig. 14). The secondary shell layer is distinctly fibrous.

**Remarks.** Although strongly fragmented and poorly preserved, the size, moderately thick shell, form of radial ornamentation and carinate ventral valve justify assignment of these valves to *Carinata arimaspus* (EICHWALD in VON BUCH, 1840). Although rare, this species is present in the Acanthopyge Limestone (Havlíček and Kukal 1990), and a similar mode of preservation indicates that fragments from the UDI likely belong to this geographically widespread and phenotypically variable species from the Emsian (Khodalevich et al. 1959, Halamski and Baliński 2013).

**Occurrence.** UDI, sample TM 10, TM 12.

***Carinata* ? sp.**

Pl. 2, Figs 6, 7, 18

**Material.** Three incomplete dorsal valves (figured PCZCU 2277, PCZCU 2278) and one small complete shell preserved as external moulds (PCZCU 2288).

**Description.** The shell is small, ventri-biconvex, subcircular, 5 mm wide, with carinate ventral and sulcate dorsal valve, and with a moderately thick wall. The dorsal valve has 13 to 15 rounded undivided ribs slightly curved laterally. Microornamentation consists of fine growth fila.

**Remarks.** The shell is similar to fragments referred to *Carinata arimaspus* which is present in the UDI but differs in its finer ribbing.

**Occurrence.** UDI, sample TM 10, TM 12.

**Family Karpinskiidae POULSEN, 1943**

**Subfamily Karpinskiinae POULSEN, 1943**

**Genus *Mimatrypa* STRUVE, 1964**

**Type species.** *Terebratula flabellata* ROEMER, 1844; Eifelian; Germany.

***Mimatrypa* (?) sp.**

Pl. 2, Fig. 10

**Material.** Ventral (?) valve (PCZCU 2281).

**Description.** One smooth and poorly preserved flattened ventral (?) valve covered by 24 rounded simple evenly sized costae separated by evenly sized interspaces, all covered by fine concentric lines. The outline of the valve is slightly transverse, with obtuse cardinal extremities. Shell substance is impunctate.

**Remarks.** The valve is similar to the small ventral valve of *Mimatrypa* STRUVE, 1964 in its undivided fine ribs but this determination is somewhat speculative. The valve resembles a minute shell of *Tropidoleptus* HALL, 1857, but small individuals of this enigmatic genus are less transverse and have an endopunctate shell substance (Harper et al. 2010). Costae on the flanks of specimen *Mimatrypa* (?) sp. are more prominent with smaller ones on the axial part, but in *Tropidoleptus* the sizes of costae decrease laterally.

**Occurrence.** UDI, sample TM 10.

**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 *Leptathyris* SIEHL, 1962**

**Type species.** *Leptathyris gryphis* SIEHL, 1962; Eifelian; Rhineland, Germany.

***Leptathyris* sp.**

Pl. 2, Figs 11–13

**Material.** Two figured complete shells (PCZCU 2283, PCZCU 2284), one ventral valve (PCZCU 2282) and several unfigured mostly incomplete dorsal and ventral valves.

**Description.** The shell is biconvex, thin-walled, rectimarginate, small, with a maximum width of 3.3 mm. The shell substance is impunctate. The dorsal valve is subcircular, with a short beak, lenticular in transverse and axial profiles, with evenly rounded margins. The ventral valve has similar convexity but has an erect posteriorly extended beak with low apsacline palintrope.

**Remarks.** This species is the commonest brachiopod in the UDI. Three articulated specimens were observed, but their interior is unknown. *Leptathyris gryphis* SIEHL, 1962 from the Greifenstein Limestone (Eifelian) of Rhineland differs by the shallow sulcus in both valves. *Leptathyris deino* HAVLÍČEK, 1990 (in Havlíček and Kukal 1990) from the Suchomasty Limestone (Emsian) is similar in its rectimarginate commissure but is much larger than specimens observed in the UDI. In terms of shape and smooth outer surface, the shell is also similar to *Leptathyris circula* (WALCOTT, 1884), a common species from the Eifelian of Nevada (Johnson 1966), but differs in its rectimarginate anterior commissure. Externally, the shell is similar to *Eobiernatella* BALIŃSKI, 1995 from the Givetian and Frasnian of Poland and Russia in its rectimarginate commissure and absence of a sulcus.

**Occurrence.** UDI, sample TM 12.

**Order Spiriferida WAAGEN, 1883**

**Suborder Delthyridina PHILLIPS, 1841**

**Superfamily Reticularioidea WAAGEN, 1883**

**Family Reticulariidae WAAGEN, 1883**

**Subfamily Eoreticulariinae GOURVENNEC, 1994**

**Genus *Eoreticularia* NALIVKIN in FREDERIKS, 1924**

**Type species.** *Spirifer indifferens* BARRANDE, 1848; Emsian; Bohemia, the Czech Republic.

***Eoreticularia* ? sp.**

Pl. 2, Figs 16, 17

**Material.** Two incomplete dorsal valves (PCZCU 2286, PCZCU 2287).

**Description.** The dorsal valve is thin-walled, transversally elliptical, 14 mm wide, widest at about midlength, moderately convex in axial profile and weakly and evenly convex in transverse profile, without any distinct sign of a fold or sulcus. The apex is blunt and rounded. Thin median septum and a pair of gently divergent ridges are observable on the valve interior. The shell exterior lacks distinct macroornament, but traces of short granules or spines in concentric and radial rows were observed.

**Remarks.** The material is badly preserved and an only approximate determination is possible. Lack of a distinct dorsal fold, presence of thin median septum, finely spinose or granulose microornamentation, convexity and outline are consistent with *Eoreticularia* NALIVKIN in FREDERIKS, 1924 or other related genera.

**Occurrence.** UDI, sample TM 12.

**Phylum Arthropoda VON SIEBOLD, 1848**

**Subphylum Trilobitomorpha STØRMER, 1944**

**Class Trilobita WALCH, 1771**

**Order Proetida FORTEY et OWENS, 1975**

**Family Tropidocoryphidae PŘIBYL, 1946**

**Subfamily Tropidocoryphinae PŘIBYL, 1946**

**Genus *Astycoryphe* RICHTER et RICHTER, 1919**

**Type species.** *Astycoryphe senckenbergiana* RICHTER et RICHTER, 1919; Eifelian; Germany.

***Astycoryphe tureki* sp. nov.**

Pl. 2, Figs 19–21

**Holotype.** Incomplete cranidium with exoskeleton, PCZCU 2290, figured on Pl. 2, Fig. 21.

**Paratype.** Isolated librigena, PCZCU 2289, figured on Pl. 2, Fig. 20.

**Other material.** Fragment of thoracic segment (PCZCU 2292) from type locality and horizon can be questionably affiliated to this species.

**Type locality.** Koněprusy, Jirásek's Quarry, sample TM 12.

**Type horizon.** Uppermost part of the Acanthopyge Limestone, UDI (Eifelian/Givetian boundary interval), *Polygnathus ensensis* Zone with *Nowakia* ex gr. *otomari*.

**Diagnosis.** *Astycoryphe*, which is closely related to *Astycoryphe exilis* VAN VIERSEN et PRESCHER, 2010 with respect to these specific characters: marginal rim with three terrace lines sub-parallel with the border; outline of glabella wider (tr.), more pear-like posteriorly; S1–S3 only inconspicuously impressed, perceptible especially by effacing of generally much more prominent sculpture



consisting of randomly arranged terrace lines (distinct especially posterolaterally). Fine pits randomly scattered on the preglabellar field are less numerous but more perceptible; these are missing on L1 and L2 and on the adaxial part of the palpebral lobes. Posterior border furrow on librigena is less sharply bent posteriorly.

**Description.** The cranium is only moderately vaulted. The anterior contour of the cranium is broadly rounded. The anterior border is strongly vaulted, narrow, bearing three well-defined, border-parallel terrace ridges. The glabella is well-demarcated anteriorly and laterally by deep furrows, anterior to S0 it broadens slightly between the front and S2, strongly between S2 and S1, and slightly between S1 and deep S0.  $\beta$  is positioned further abaxially than  $\delta$ ;  $\delta$  is positioned opposite S1. S0 is narrow, deepens abaxially. S1 and S2 are only slightly impressed; L1 and L2 are poorly defined. S3 is almost indiscernible. The entire glabella and palpebral lobes are covered with randomly oriented prominent terrace ridges that are distinctly inflated especially posterolaterally. The occipital ring is not preserved. Preglabellar and librigenal fields are slightly more downward sloped outside of the well-developed tropidium, represented by one ridge only. The lateral and posterior borders are strongly vaulted. The proximal part of genal spine is robust, wide, and the posterior border furrow is arched. The librigenal field is devoid of ornamentation.

**Remarks.** *Astycoryphe tureki* sp. nov. appears to be closely related to *A. exilis* VAN VIERSEN et PRESCHER, 2010 from the upper Eifelian of Ardennes (lower part of the Hanonet Formation). Both species share the general configuration of the cranium, especially very moderate vaulting of the glabella, characteristic pits on the preglabellar field and its vaulting in sag. cross-section. Both species also share minute dimensions and, furthermore, their stratigraphical occurrence in the uppermost Eifelian. Both species differs by features mentioned in differential diagnosis. *Astycoryphe tureki* sp. nov. shares, however, some features also with *A. jorusi* VAN VIERSEN et PRESCHER, 2010, also from the upper Eifelian of Ardennes (lower part of the Hanonet Formation). These include in particular the glabella outline and less prominent S1–S2, as well as shape of the free cheeks with robust base of genal spine and the course of the anterolateral and posterior border furrows. The two species differ, however, in their different ornamentation and presence of pits on the preglabellar field in the new species. As *A. jorusi* occurs in the same stratigraphical interval (uppermost Eifelian), it probably forms a group of species including *A. exilis* and *A. tureki* – possibly belonging to the latest representatives of the *Astycoryphe* evolutionary lineage which was terminated by the Taghanic Event (see Feist 2003: 433). The poorly preserved cephalon of the holotype specimen of the type species, *Astycoryphe senckenbergiana* RICHTER et RICHTER, 1919 (figured by van Viersen and Prescher 2010: fig. 7) does not enable a sufficiently detailed comparison with new species but they appear to share similar sculpture on the glabella but differ especially in the more prominent vaulting of the cranium, wider preglabellar furrow and more prominent tropidium. *Astycoryphe arduinnae* VAN VIERSEN, VAN ROSSUM et PRESCHER, 2012 differs from *A. tureki* sp. nov.

in particular in the medially discontinuous tropidium and different ornamentation of the glabella but in common has faintly impressed S1–S3 and wider outline of the glabella. *Astycoryphe planifrons* FEIST, 2003 differs from the new species in the “the extremely weak relief unique among all hitherto known species of *Astycoryphe* that have generally upraised border rims and a shorter glabella” (Feist 2003: 437), by tr. narrower outline of the glabella and by the absence of pits on the preglabellar field.

**Occurrence.** UDI, sample TM 12.

## Family Proetidae HAWLE et CORDA, 1847

### Proetidae indet.

Pl. 2, Figs 22, 23

**Material.** One fragment of librigena (PCZCU 2291) and one fragment of cranium (PCZCU 2295).

**Remarks.** The studied and figured fragment of librigena is unfortunately so fragmentary that it does not enable any exact affiliation. It is tr. vaulted in cross-section, with a wide inflated anterolateral margin possessing 4–5 fine ridges; the anteriormost three are almost sub-parallel with the margin, the remaining two have a rather irregularly undulating course. The anterolateral border furrow is wide, moderately deep, rather discontinuous, interrupted by inconspicuous finger-like anterolateral projections of the librigenal field. No traces of tropidium on the librigenal field. The eyes (broken off) are large, a sub-ocular groove is present. The surface of the free cheek is smooth, posterolateral border (mostly broken off) with fine short striation sub-parallel with the posterior border.

**Occurrence.** UDI, sample TM 12.

## Conclusion

Although poorly preserved, the brachiopods and trilobites from the ‘upper dark interval’ in the Koněprusy area represent a new fossil assemblage in the Barrandian area. Along with some taxa known from the subjacent Acanthopyge Limestone (*Leptaenopyxis*, *Quasidavidsonia*, *Carinatina*), some typical upper Eifelian taxa (*Protodouvillina*, *Poloniproductus*, *Mystrophora*, *Pentamerella*) are reported for the first time from the Barrandian area. Among them, the productide brachiopod *Poloniproductus varians* is stratigraphically important for the Eifelian-Givetian boundary interval. It is not only the commonest brachiopod in the recently observed assemblage but this species, together with *Protodouvillina* cf. *interstitialis*, also indicates faunal exchanges with the Rhenish-type fauna. Unlike the commonest brachiopod fauna of the Acanthopyge Limestone summarized by Havlíček and Kukal (1990), the new fauna bear more strophomenides, a productide, a chonetidine and only a few smooth spire-bearing smooth-shelled biconvex or coarsely costate brachiopods. The rare occurrence of *Astycoryphe tureki* sp. n. supports the observations based on brachiopods – it clearly belongs to the *A. exilis* group typical for the uppermost Eifelian strata from Ardennes and indicates immigration of at least some Rhenish-type trilobite taxa.

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## Explanations of plates

### PLATE 1

*Protodouvillina* cf. *interstitialis* (PHILLIPS, 1841)

1. Ventral valve showing exterior (b), details of the apex (a) and ornamentation (c); PCZCU 2261.
2. Fragment of ventral valve; PCZCU 2263.
3. Fragment of ventral valve showing multicostellate ornamentation; PCZCU 2262.

*Douvillinella* sp.

4. Incomplete dorsal valve interior; PCZCU 2264.

*Leptaenopyxis* (?) sp.

5. Small ventral valve, external (a) and internal (b) moulds; PCZCU 2265.

*Poloniprductus varians* (BIERNAT, 1966)

6. Small ventral valve (a) and in oblique view (b); PCZCU 2266.
7. Dorsal valve external mould (a) and in oblique view (b); PCZCU 2267.
8. Ventral valve (a) and in anterolateral view (b) and detail of surface (c); PCZCU 2268.
9. Deformed ventral valve partly preserved as internal mould showing fine pustules; PCZCU 2269a.
10. External mould of juvenile dorsal valve; PCZCU 2270.
11. Detail of hinge line of dorsal valve, external mould; PCZCU 2294.

*Iridistrophia* sp.

12. Ventral valve (a), and detail of ornamentation on left (b) and anterior (c) margins; PCZCU 2269b.
13. Internal mould of small ventral valve; PCZCU 2271.

All: Eifelian/Givetian boundary interval, 'upper dark interval', *Polygnathus ensensis* Zone. Locality: Koněprusy, Jirásek's Quarry, new section. Scale bar = 1 mm.

### PLATE 2

*Holynetes* cf. *holynensis* HAVLÍČEK et RACHEBOEUF, 1995

1. Dorsal valve (a) and its external mould (b); PCZCU 2272.
2. Ventral valve, partly exfoliated; PCZCU 2273.

*Mystrophora* sp.

3. Dorsal valve; PCZCU 2274.

*Pentamerella* sp.

4. Dorsal valve (a) and in oblique view (b); PCZCU 2275.
5. Ventral valve; PCZCU 2276.

*Carinata* (?) sp.

6. Ventral valve internal mould; PCZCU 2277.
7. Dorsal valve external mould; PCZCU 2278.
18. External mould showing high ventral interarea; PCZCU 2288.

*Carinata arimaspus* (EICHWALD in VON BUCH, 1840)

8. Ventral valve, incomplete internal mould; PCZCU 2279.
9. Incomplete ventral valve; PCZCU 2280.
14. Detail of external microornament; PCZCU 2293.

*Mimatrypa* (?) sp.

10. Deformed ventral (?) valve; PCZCU 2281.

*Leptathyris* sp.

11. Ventral valve; PCZCU 2282.
12. Ventral valve, partly exfoliated; PCZCU 2283.
13. Ventral valve of complete articulated specimen; PCZCU 2284.

*Quasidavidsonia mediocarinata* (HAVLÍČEK, 1967)

15. Dorsal valve; PCZCU 2285.

*Eoreticularia* sp.

16. Exfoliated dorsal valve; PCZCU 2286.
17. Exfoliated dorsal valve; PCZCU 2287.

*Astycoryphe tureki* sp. nov.

19. Fragment of thoracic segment, only questionably affiliated to the new species; PCZCU 2292.
20. Paratype, librigena; PCZCU 2289.
21. Holotype, cranidium in dorsal (a) and oblique (b) views; PCZCU 2290.

Proetidae indet.

22. Librigena; PCZCU 2291.
23. Incomplete cranidium; PCZCU 2295.

All: Eifelian/Givetian boundary interval, 'upper dark interval', *Polygnathus ensensis* Zone. Locality: Koněprusy, Jirásek's Quarry, new section. Scale bar = 1 mm.



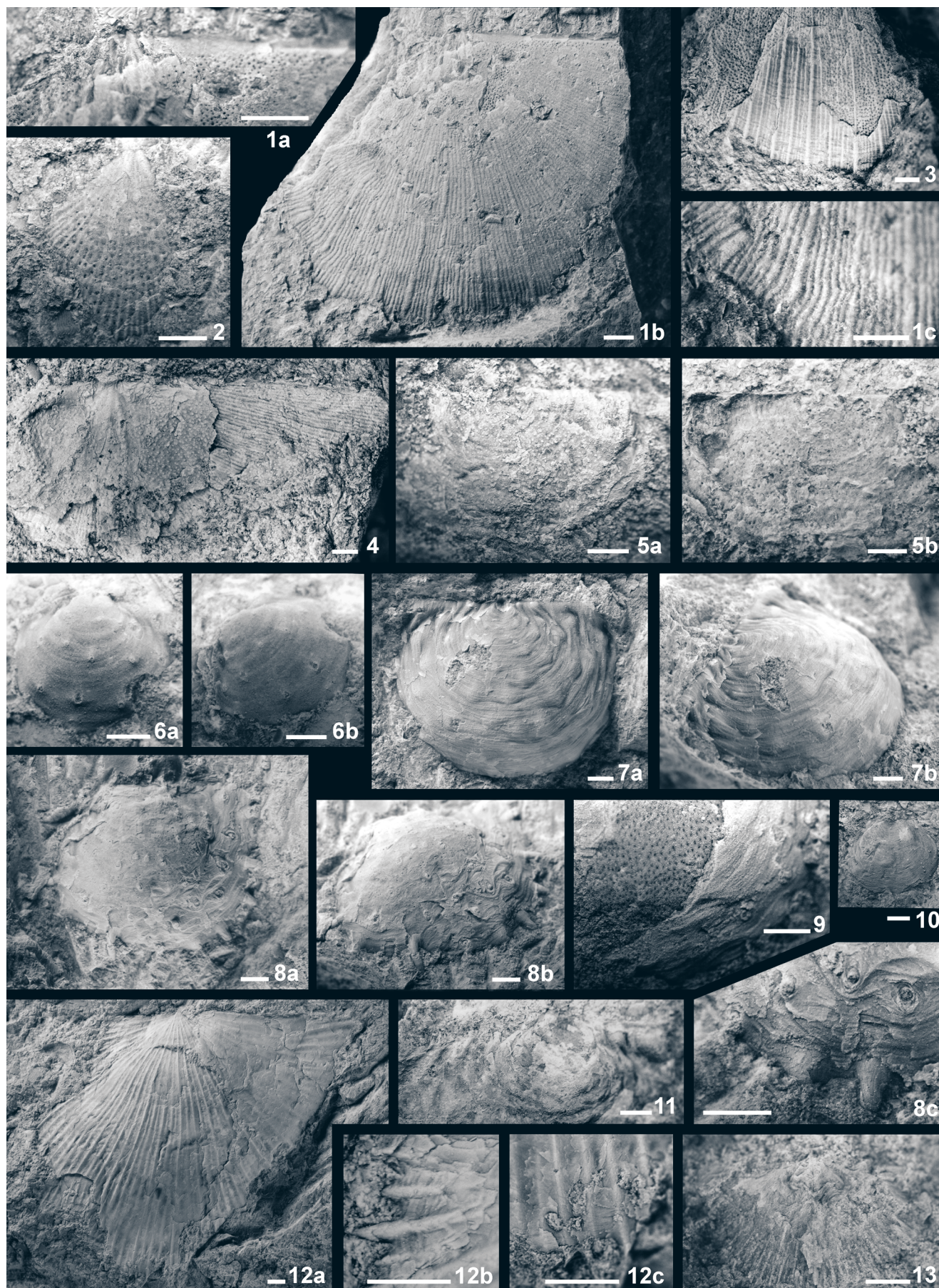




PLATE 2

