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The earliest ostracods from the Ordovician of the Prague Basin, Czech Republic

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ABSTRACT:

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The earliest ostracods from the Bohemian Massif (Central European Variscides) have been recorded from the Middle Ordovician of the Prague Basin (Barrandian area), in the upper Klabava Formation, and became an abundant component of fossil assemblages in the overlying Šárka Formation. Both early ostracod associations consist of eight species in total, representing mainly eridostracans, palaeocopids, and binodicopids. The revision, description, or redescription of all species and their distribution in the basin is provided. Their diversification patterns and palaeogeographical relationships to ostracod assemblages from other regions are discussed.

Key words: Ostracoda; Middle Ordovician; Barrandian area; Prague Basin; Taxonomy; Palaeobiogeography.

INTRODUCTION

Ostracods belong to the most abundant arthropods, with their fossil record extending back to the Early Ordovician. They represent one of the most successful crustacean groups. They first appeared in the middle Tremadocian of Baltica, represented by the genus *Nanopsis* (Tinn and Meidla 2004). The diversity of ostracods started to grow distinctly during the Middle Ordovician (late Floian to Darriwilian), with the peak of their Ordovician diversity reached in the Late Ordovician (Braddy *et al*. 2004; Meidla 1996; Tinn and Meidla 2004; Williams *et al*. 2008). In the sediments of the peri-Gondwanan Prague Basin (Barrandian area of the Bohemian Massif; Czech Republic; Text-fig. 1), the oldest ostracods have been noted in the Klabava Formation (Text-fig. 2). The formation is up to 300 m thick and is dated as Arenigian (roughly Floian to Dapingian), of the middle Lower to middle Middle Ordovician. The oldest ostracods appear rarely in the volcanosedimentary Ejpovice Member at the top of the Klabava Formation, dated as late Dapingian. They started to be common in the overlying Šárka Formation, of latest Arenigian to Oretanian age (early to middle Darriwilian; Text-fig. 2) (e.g. Budil *et al*. 2007; Polechová 2013), although their species diversity was still low, at least as compared to Baltica (Tinn and Meidla 1999, 2004; Tinn *et al.* 2006; Schallreuter 1980), Avalonia (Siveter 2009) and Laurentia (Burr and Swain 1965; Swain 1962; Swain 1987; Landing *et al*. 2013). Ostracod faunas of the Klabava and Šárka formations record the beginning of the successive increase of ostracod diversity that reached its peak in the early Katian of the Late Ordovician (Přibyl 1979; Schallreuter and Krůta 1988).

The Prague Basin ostracods show obvious affinities to ostracods from Baltoscandia (e.g. Öpik 1935;

Hessland 1949; Henningsmoen 1953; Jaanusson 1957; Schallreuter 1993; Tinn *et al*. 2010) and Avalonia (e.g. Siveter 2009), as discussed earlier by Dzik (1983) and Schallreuter and Krůta (1988, 1994), and commented on more recent papers dealing with Early Ordovician ostracods of other regions, e.g. from Argentina (Salas *et al*. 2007; Salas 2011; Salas and Vaccari 2012) and Iran (Ghobadi Pour *et al*. 2011).

The present paper provides a taxonomic revision of Early and Middle Ordovician ostracods from the Prague Basin, based on existing collections and on newly acquired material. Also, it discusses their palaeobiogeographical affinities and changes of their taxonomic diversity in these early stages of their evolution.

HISTORY OF RESEARCH

The ostracods of the Klabava Formation constitute the oldest known ostracod fauna in Bohemia. Because of their restricted occurrence confined to one specific facies of calcareous tuffites, in which the ostracods are rare and often poorly preserved, they were first reported as late as 1980 (Krůta 1980). Based on specimens visible on undissolved slabs, Krůta (1980) recognised the following taxa: *Primitiella* sp. A, *Primitiella* sp. B; ? *Bythocypris* sp. A, ? *Bythocypris* sp. B and *Conchoprimitia* sp. Dzik (1983) isolated specimens from calcareous rewashed tuffs (tuffites) with hydrofluoric acid and figured two species from the same facies: *Cerninella* sp. n. and *Pyxion* sp. Schallreuter and Krůta (1988) revised Dzik's (1983) material and used the same methods for isolating ostracod specimens. They established several new taxa (one genus and four species): *Glossomorphites* (*G.*) *mytoensis* Schallreuter and Krůta, 1988 (= *Cerninella* sp. n. of Dzik 1983), *Paraconchoprimitia ventronasata* Schallreuter and Krůta, 1988, *Karinutatia eoren* Schallreuter and Krůta, 1988 and *Mytoa* Schallreuter and Krůta, 1988 with *Mytoa klabava* Schallreuter and Krůta, 1988 (= *Pyxion* sp. of Dzik 1983), as its type species.

The first ostracods from the Šárka Formation (= d_1 Horizon, Etage D in the original), in which ostracods are very abundant, were mentioned by Barrande (1856), who reported a new fauna from the siliceous nodules from near the town of Rokycany. He quoted *Cytherina prunella* ? Barr. (*nomen nudum*), the species later formally designated based on the specimen from the Upper Ordovician (Králův Dvůr Formation now, d_5 Horizon of the Etage D originally). Shortly afterwards, Reuss (1857) found a similar fauna in nodules near Úvaly (Auval in the original) east of Prague, listing *Cytherina prunella* Barr. [= *Conchoprimitia osekensis* (Přibyl, 1979)] among the recognised species. Barrande (1872) established two species from the Šárka Formation: *Beyrichia bohemica* Barrande, 1872 (= *Brephocharieis ctiradi* Schallreuter and Krůta, 1988) and *Primitia prunella* Barrande, 1872 [= *Conchoprimitia osekensis* (Přibyl, 1979)]. After Barrande's (1872) descriptions, no systematic study was made for almost hundred years, although ostracods of the Šárka Formation were listed in various publications. Krejčí and Feistmantel (1885, 1890) mentioned *Beyrichia* as a typical Ordovician fossil and this genus together with *Primitia* as typical of unit $d_1\gamma$ (corresponding to the present Šárka and Dobrotivá formations combined). Wentzel (1891) compared the Barrandian Lower Palaeozoic with that from the British Isles. He noted a possible correlation of unit $d_1\gamma$ in the Barrandian area with the British Llandeilo, based on faunal similarities, including respective occurrences of the ostracod species *Beyrichia Bohemica* Barr. and *Beyrichia complicata* Salt. It should be noted that all previously mentioned ostracods were exclusively from siliceous nodules. The first ostracods from shales of the Šárka Formation were reported by Iserle (1903) based on material from a new locality west of Rokycany, in the slope called "Klabavka" (Klabavská stráň nowadays). Among other fossils, he listed *Primitia prunella* Barr.? as quite abundant but unfavourably preserved. Holub (1908) published a revised faunal list from the same locality (called Drahouš by him) and mentioned *Beyrichia bohemica* Barr. and *Primitia prunella* Barr. He also reported the new locality with shales of the Šárka Formation at Kamenný Újezd near Rokycany, from where he listed *Primitia prunella* Barr. Subsequently, however, again most of the papers reported on ostracods from nodules, with notes on specimens from shales being exceptional. Želízko (1905) recorded abundant *Primitia bohemica* Barr. (= *Conchoprimitia osekensis*) from the Šárka Formation; Horizon D-$d_1\gamma$ in the original, at Cekov – Cekovský rybník Pond. Holub (1910) mentioned abundant occurrence of *Primitia prunella* in siliceous nodules. Bouček (1926a) published lists of fossils from shales and nodules from a measured section in the brickyard in Praha-Vokovice. He listed two ostracods, *Primitia prunella* Barr. and *Beyrichia bohemica* Barr. (?). In the French version of the same paper, Bouček (1926b) mentioned only the former species. Kraft (1928) summarised data on fossil sites of the Osek-Kváň Zone ($d\gamma$), which includes those belonging to the Šárka Formation in its modern concept. He quoted

Beyrichia bohemica, *Primitia prunella* Barr. and *Primitia transiens* from nodule sites north of Rokycany (referred to by him as cumulative locality "Osek, Díly, Rokycany"). Havlíček and Vaněk (1966), in their overview of the Ordovician of the Prague Basin, noted that ostracods were abundant in the Šárka Formation but were in need of revision. They listed two species, with their revised generic assignment: *Parapyxion prunellus* (Barr.) (= *Conchoprimitia osekensis*) [*Parapyxion prunella* in the text part] and *Talinella complicata* (Salt.) (= *Brephocharieis ctiradi*). Přibyl (1966) revised the British species *Beyrichia complicata* Salter, 1848 (in Phillips and Salter 1848), assigning it to the new genus *Cerninella* Přibyl, 1966, and synonymized the Bohemian species *Beyrichia bohemica* with it. *Cerninella complicata* (Salter, 1848) has been mentioned from the Šárka Formation since then. Přibyl (1979) published his monograph and overview of the Ordovician ostracods including the revision of *C. complicata*, stating its occurrences in Pětidomky near Kařez, Osek, Díly near Rokycany and Prague-Šárka in the Prague Basin. He also redescribed material of conchoprimitids and split the single species mentioned above into two new taxa: *Conchomprimitia* ? *dejvicensis* Přibyl, 1979 and *Conchoprimites osekensis* Přibyl, 1979. Both species are referred herein to *C. osekensis* (Přibyl, 1979).

Přibyl (1979) also described the new species, *Dilobella grandis* Přibyl, 1979, which he claimed to be from the Šárka Formation (see also Schallreuter and Krůta 1988 and Lajblová 2010). The original black shale slab of Přibyl (1979) was restudied during the course of this study. It appears that the ostracods on the slab are arranged in a linear cluster together with flattened small hyolithids. No index fossil accompanies the three-dimensionally preserved ostracods. The slab was reported to have been found in Praha 4-Lhotka by Přibyl (1979). There are three labels attached to the slab in the box in the collection of the National Museum in Prague. Two of them are apparently written by Přibyl, and the above-mentioned locality and the Šárka Formation are stated on each of them. However, only the Lhotka locality is stated on the third, old label. In the museum's Catalogue of Acquisitions, the number of the slab indicates the record of the purchase of specimens from $D_{1\gamma}$ from Kozinec near Beroun from the private collector Marek. Kozinec is the name of a hill north-west of Lhotka u Berouna, some 4.5 km north-west of Beroun. The fossil sites at Lhotka u Berouna were described by Perner (1903) and Želízko (1903) and fossils have been proven to come from the Dobrotivá Formation. Thus, the only sample with all of the specimens of *Dilobella grandis* was found near the village of Lhotka u Berouna and comes from the Dobrotivá Formation and not from the Šárka Formation, as hitherto claimed.

The systematic position of *Cerninella complicata* (Salter, 1848) remained uncertain in the revision of *Beyrichia bohemica* Barrande, 1872, the type species of *Cerninella* Přibyl, 1966, made by Schallreuter *et al.* (1984). This species was later redescribed by Siveter (1985) who referred it to a new genus *Brephocharieis* Siveter, 1985, consequently excluding Přibyl's material from the genus *Cerninella*. Schallreuter and Krůta (1988) pointed out that the British species *Brephocharieis complicata* (Salter, 1848) is not conspecific with the material from the Šárka Formation and established the new species *Brephocharieis* ? *ctiradi* Schallreuter and Krůta, 1988. They reported *B.* ? *ctiradi* only from its type locality (Osek) and briefly discussed all species from the Šárka Formation.

Králík *et al*. (1984) mentioned *Parapyxion prunella* (Barrande) from the "younger fossil assemblage" of the brickyard in Praha-Vokovice (see above; Bouček 1926a). As the index species of the upper biozone of the Šárka Formation is mentioned in the same list, it is the only published record of ostracods in the *Didymograptus clavulus* Biozone.

Mikuláš (1998) reported ostracods inside linear ichnofossils found in siliceous nodules at Rokycany and Díly – Šůlovo pole. Vaněk (1999) mentioned the ostracod *Parapyxion prunellus* (Barrande) from two localities in the Brandýs n/L area: Popovice – field "V zahradách" (northwest and northeast of the village of Popovice) and Brandýs n/L-Hrušov (a field between the railway station Brandýs n/L and Vinořský potok Brook). The very rich fauna of the Šárka Formation was discovered in a temporary exposure of grey shales south of Osek during the construction of a new sewage water treatment plant. Slavíčková and Budil (2000) listed three ostracod species from there: *Conchoprimitia*? *dejvicensis* Přibyl, *Conchoprimites osekaensis* Přibyl and *Ceraninella complicata* Salter (= *Cerninella complicata*). Recently, Peršín and Budil (2009) reported the ostracod *Conchoprimites osekensis* (Přibyl) from the locality "Ke Dvoru" (outcrop in the Ke Dvoru Street in Praha-Vokovice).

Summarizing, ostracods of the Šárka Formation are reported predominantly from siliceous nodules rather than from shales, and are better known from the south-western rather than from north-eastern part of the basin (Text-fig. 1).

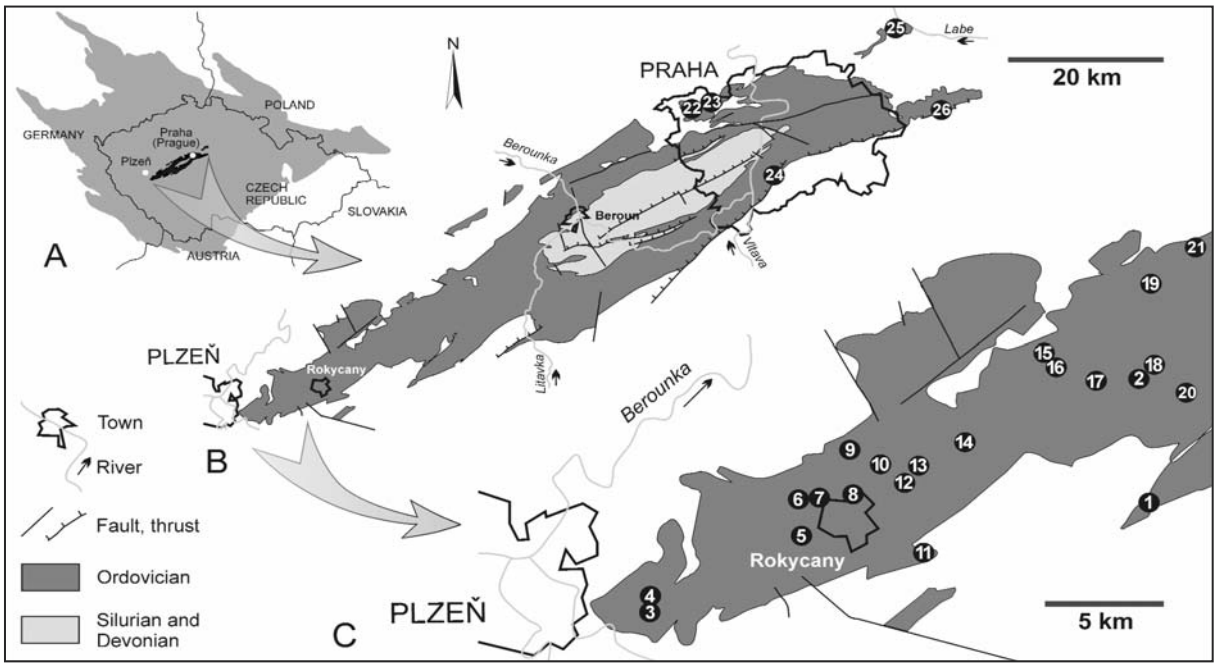
GEOLOGICAL AND STRATIGRAPHICAL SETTINGS

The Klabava and Šárka formations form the lower part of the volcano-sedimentary infill of the Prague Basin. Palaeogeographically, the basin (Havlíček 1981) was situated in peri-Gondwana from the earliest Ordovician to the late Middle Devonian (Havlíček 1998a). Later, it was uplifted during the Variscan Orogeny (Havlíček 1998b) and only a denudation relict has survived to date.

The Ordovician portion of the infilled succession is mostly siliciclastic, with carbonate rocks occurring exceptionally. The Klabava Formation was formed in early stages of the Prague Basin, resulted in variable sedimentary facies accompanied by volcanism (Havlíček 1998a), which is reflected in its member subdivision (Text-fig. 2; Kraft and Kraft 2003, fig. 2).

Good stratigraphical control exists only in the Mýto Shale, based on graptolites (Kraft and Kraft 1999). In the remaining, Ejpovice and Olešná members, no biozonation has been established because of the lack of appropriate index fossils. The rewashed tuffs of the Ejpovice Member which yielded ostracods occur mainly in the top of the formation (Text-fig. 2).

The Šárka Formation is more uniform with respect to facies. It is dominated by grey to black shales, accompanied by volcanites (Havlíček 1998a). Siliceous nodules occur in some levels within the shale succession. The nodules contain a three-dimensionally preserved fauna, which is much better preserved than the fauna yielded by the surrounding shales. Unfortunately, weathered out of the shales, the nodules were collected loose in the farmed fields restricted to Rokycany and Prague areas (Text-fig. 1), and thus their stratigraphical location is mostly uncertain. Only nodules with index species of two graptolite biozones, established in the Šárka Formation (Text-fig. 2; Kraft and Kraft 1999), have a stratigraphical relevance. *Corymbograptus retroflexus* was recorded in all nodule localities that provided material for our study. We had available ostracods from nodules neither associated with *Didymograptus clavulus* nor from localities with occurrence of this index species, even if it is reported in literature (Králík *et al.* 1984). As no material we also had from shales of the *D. clavulus* Biozone, this study of the ostracods from the Šárka Formation is limited to the *C. retroflexus* Biozone despite our intensive searching in collections.



Text-fig. 1. Sketch map of the Prague Basin relic and localities which yielded the studied ostracods (partly modified after Manda 2008). **A** – Position of the Prague Basin (black) in the Bohemian Massif (grey). **B** – Overview of the relic. **C** – detail of the south-western part of the relic of the Prague Basin. The key to B and C in lower left corner. Localities indicated by numbers in B and C – Klabava Formation: **1** – Strašice – "U hnoje", **2** – Mýto – Svatoštěpánský rybník Pond (near the watchhouse); Šárka Formation: **3** – Sedlec 5 – studna (Mr. Kůs), **4** – Tymákov – Sutice 2, **5** – Rokycany 19 – eastern slope of Čilina Hill, **6** – Rokycany – Drahouš (all sections), **7** – Rokycany 2 – u hřbitova, **8** – Rokycany 17 – Osecký vrch Hill, **9** – Osek 1, **10** – Díly (all sites), **11** – Kamenný Újezd 1, **12** – Rokycany – Borek 2, **13** – Rokycany – Borek 1, **14** – Svojkovice 4, **15** – Těškov – borehole V19, **16** – Těškov 1, **17** – Mýto 1 – field near the villa, **18** – Mýto 4 – Svatoštěpánský rybník Pond 2, **19** – Cekov 2, **20** – Cheznovice 3, **21** – Kařez 2 – Pětidomky, **22** – Praha – Šárka (pole u vily), **23** – nearby localities Praha – Veleslavín (Litovický potok), Praha – Vokovice, Praha – Vokovice (cihelna) and Praha – Jenerálka, **24** – Praha – Libuš, **25** – Popovice, **26** – Úvaly

FOSSIL ASSOCIATIONS

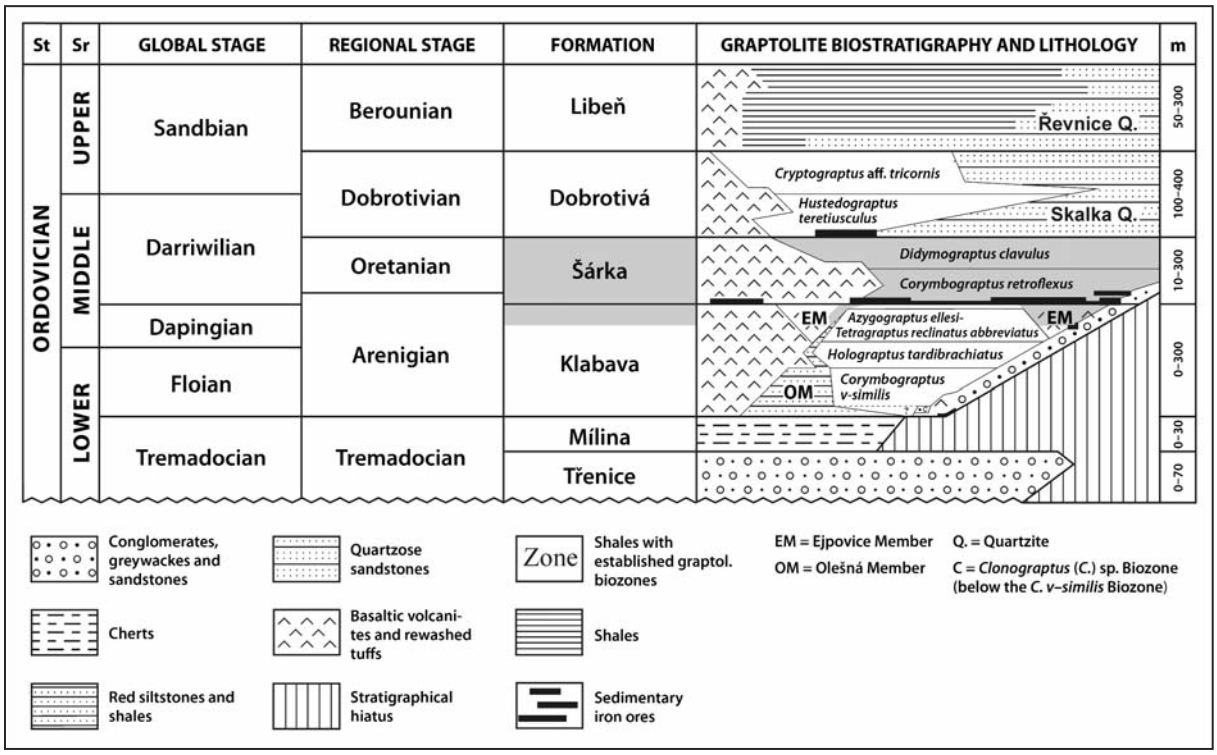
Particular members of the Klabava Formation, which correspond to the main lithofacies types, are characterized by distinct fossil associations (Kraft and Kraft 2003, fig. 3). The Mýto Shale (unit with graptolite zones in Text-fig. 2) is characterized by a predominance of graptolites, linguliformean brachiopods and locally trilobites (benthic elements assigned to the *Rafanoglossa* Association by Havlíček 1982; it should be noted that it is a community in the original sense, see also Havlíček and Fatka 1992). Fossils with phosphatic shells markedly predominate in the Olešná Member, with linguliformeans being the most abundant (*Leptembolon* Association; Havlíček 1982; Havlíček and Fatka 1992). The Ejpovice Member yielded rhynchonelliformean as well as linguliformean brachiopods, trilobites and also sparse ostracods (*Nocturnellia* Community; Havlíček 1982; Havlíček and Fatka 1992).

The fauna of the Šárka Formation is abundant and highly diverse. It belongs to the *Placoparia-Euorthisina* Association (Havlíček and Vaněk 1990) and is more uniform geographically and stratigraphically than the fauna in the Klabava Formation (Budil *et al.* 2007). In terms of abundance and diversity it is dominated by trilobites. Echinoderms, brachiopods, hyolithids, bivalves, gastropods, graptolites and other groups are also common but their diversities are variable. Ostracods form a significant, abundant but very low diversity part of this association.

MATERIAL AND METHODS

There are different modes of preservation of the ostracods of the Klabava and Šárka formations depending on the facies and lithology. The material from both formations appears either as internal or external moulds (counterparts). Whereas the ostracod fauna in the Klabava Formation is deposited in the rewashed volcano-detrital rocks, in the Šárka Formation it is found occasionally in dark grey shales but mainly in the siliceous nodules (see above). These nodules were perhaps primarily calcareous and subsequently became silicified (Kukal 1962). The nodules contain common and well-preserved invertebrate faunas.

Schallreuter and Krůta (1988) extracted isolated ostracod shells when they dissolved the calcareous tuffites from the Klabava Formation using hydrofluoric acid (HF). The external moulds were cast with latex rubber, mounted on stubs, sputter-coated in gold and imaged with Scanning Electron Microscopy (SEM). Other specimens were coated with ammonium chloride



Text-fig. 2. Partial statigraphical chart of the Ordovician in the Prague Basin. The studied ostracods come from the shaded units. St – System, Sr – Series; ranges of the units are related to the average thicknesses of the formations (modified after Kraft *et al*. 2001 and Kraft and Kraft 2003)

and photographed under microscopes with digital cameras (Leica DFC495 and Olympus DP72). The studied material is deposited in the collections of the National Museum in Prague, the Museum of Dr. Bohuslav Horák in Rokycany, the Czech Geological Survey, the University of West Bohemia in Plzeň (collection of Dr. Michal Mergl) and in private collections.

SYSTEMATIC PALAEONTOLOGY

Institutional abbreviations: NM – National Museum, Prague; MBHR – Museum of Dr. Bohuslav Horák, Rokycany; CGS – Czech Geological Survey, Prague; SBAP – collection of A. Přibyl (an original prefix used by Přibyl 1979). A small part of Přibyl's large collection is deposited in the National Museum, Prague; the type specimens are numbered according to the system of the museum (NM), other material is partly with the original numbers (SBAP) and partly without numbers. Most of the specimens in Přibyl's collection, however, have not been found and are considered lost.

Morphological abbreviations: L – maximum length of the valve; H – maximum height of the valve; L:H – length:height ratio; L_1–L_4 – lobes from the anterior to the posterior one; N_1 – anterior node; N_2 – preadductorial node; S_1–S_3 – sulci from the anterior to the posterior one; LV – left valve; RV – right valve.

Class Ostracoda Latreille, 1802
Order Beyrichiocopida Pokorný, 1954
Suborder Palaeocopina Henningsmoen, 1953
Superfamily Tetradelloidea Swartz, 1936
Family Tetradellidae Swartz, 1936
Subfamily Glossomorphitinae Hessland, 1954

Genus *Glossomorphites* Hessland, 1954

TYPE SPECIES: *Glossopsis lingua* Hessland, 1949 = *Beyrichia digitata* Krause, 1889 (according to Jaanusson, 1962, p. 227) from the Lower Ordovician of Sweden.

Glossomorphites (*Glossomorphites*) *mytoensis*
Schallreuter and Krůta, 1988
(Text-figs 3A–B, 5A–C)

1983. *Cerninella* sp. n.; J. Dzik, p. 352, fig. 6a.
1988. *Glossomorphites* (*Glossomorphites*) *mytoensis* sp. n.; R. Schallreuter and M. Krůta, p. 107–108, pl. 2, figs 1–4.
2007. *Glossomorphites mytoensis* Sch. & Krůta, 1988; I. Hinz-Schallreuter and R. Schallreuter, tab. 4, 5, pl. 3, fig. 6A.
2010. *Glossomorphites* (*Glossomorphites*) *mytoensis* Schallreuter & Krůta; K. Lajblová, p. 154.

HOLOTYPE: Incomplete heteromorphic right valve, NM L 28829, originally designated and figured by Schallreuter and Krůta (1988, pl. 2, fig. 1, dimensions p. 108), and refigured herein in Text-fig. 3B. The specimen comes from the Ejpovice Member of the Klabava Formation (Dapingian, Arenigian, Middle Ordovician); Mýto – Svatoštěpánský rybník Pond (near watch-house), Prague Basin, Bohemia.

MATERIAL: Five valves, more or less incomplete: three specimens dissolved from the bluish-grey calcareous rewashed tuffs from the type locality (NM L 28829, 28830 and 28831) and two external moulds from the light yellowish-brown rewashed tuffs from Strašice – "U hnoje" (CGS MM 527 and MM 528).

Specimen	Valve	Text-figure	*L*	*H*	*L:H*
NML 28829 holotype	RV	3B	> 1.01	0.70	>1.44
NML 28830 paratype	RV	5A	> 0.93	0.74	>1.26
NML 28831 paratype	RV	3A	1.03	0.63	1.70
CGS MM 527	RV	5B	0.97	0.58	1.67
CGS MM 528	LV	5C	1.05	0.56	1.87

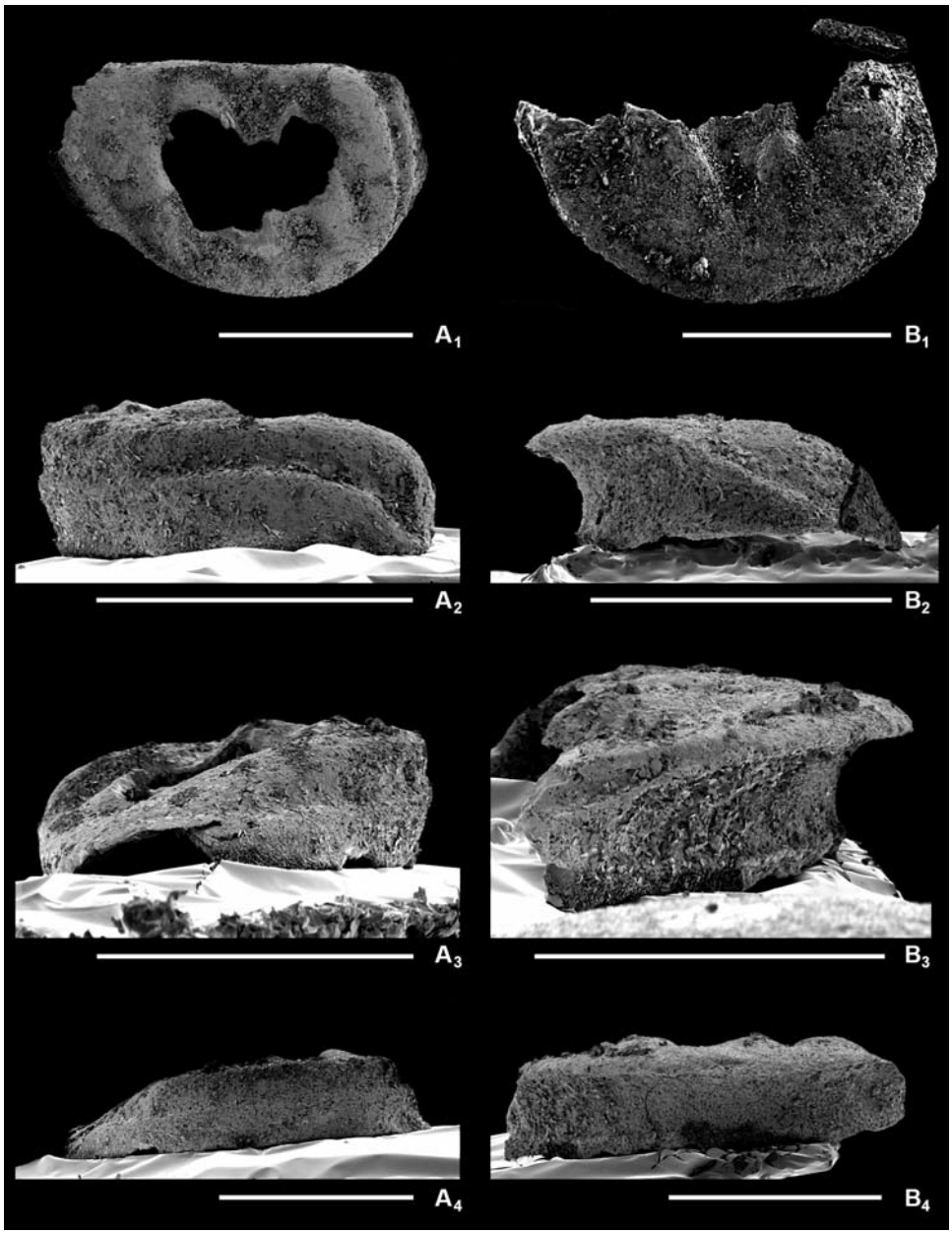
Table 1. *Glossomorphites* (*Glossomorphites*) *mytoensis*, dimensions (mm) and proportions

EMENDED DIAGNOSIS: Valves trisulcate, quadrilobate and preplete. Dorsal margin straight and long. L_1 at dorsal border slightly bulb-like.

DESCRIPTION: The valves are incompletely preserved, and are up to 1.05 mm long, moderately high. The lobes are relatively small, all are of similar width. The bulb-like L_1 does not project over the hinge line, L_2 is always shorter than the other lobes. L_3 and L_4 slope backwards, and are slightly subdued dorsally. S_1 reaches ventrally slightly over mid-length, S_2 is deeper and broader than other sulci. Tecnomorphic valves are characterized by a long histial flange and a ridge-like velum that ventrally converges continuously in a posterior direction with the free margin (Text-fig. 3A). In heteromorphic valves, the histiovelum flange is widest anteroventrally, starts below the anterior cardinal corner and terminates in the posteroventral part (Text-fig. 3B).

DISCUSSION: Dzik (1983) described *Cerninella* sp. n. from Mýto as a transitional morphotype between the Baltoscandian genus *Glossomorphites* and the genus *Cerninella* described from the Prague Basin. Schallreuter and Krůta (1988) assigned it to the genus *Glossomorphites* based on the presence of a histial dimorphism and more rounded and wider lobes. The isolated specimens of *Glossomorphites* (*Glossomorphites*) *mytoensis* of Schallreuter and Krůta (1988) and the new material from the locality Strašice – "U hnoje" prove the general morphology of *Glossomorphites*, such as histial dimorphism and the lobation. According to Schallreuter and Krůta (1988), *G*. (*G*.) *mytoensis* resembles the genus *Ogmoopsis* in lobation pattern but differs from it in possessing adventral sculptures and dimorphism, marked by the velum running parallel to the free margin.

The Bohemian species is very similar to *Glossomorphites digitatus* Krause, 1889 (see Tinn and Meidla 2004, pl. 1, fig. 12) from the lower Middle Or-



Text-fig. 3. *Glossomorphites* (*G.*) *mytoensis* Schallreuter and Krůta, 1988. **A –** incomplete tecnomorphic RV, paratype, NM L 28831: A_1 – lateral view, A_2 – anterior view, A_3 – posteroventral view, A_4 – ventral view; **B –** incomplete heteromorphic RV, holotype, NM L 28829: B_1 – lateral view, B_2 – anterior view, B_3 – posteroventral view, B_4 – ventral view. Both specimens from the Klabava Formation, locality Mýto – Svatoštěpánský rybník Pond (near the watch-house). Abbreviations are RV – right valve, LV – left valve. All scale bars equal 500 μm

dovician of Baltoscandia. *G. digitatus* has a very spine-like L_1 above the hinge line of the valve and broader lobes, except L_2 (see Tinn and Meidla 1999, pl. 1, figs 3–4). *G. acutus* Hessland, 1949 differs because of broader lobes and a narrow S_3. *G.* (*G.*) *kielcensis* Olempska, 1994 (see Olempska 1994, pl. 41, figs 11–13) differs from *G.* (*G.*) *mytoensis* in having broader lobes L_1 and L_3 and in a fissum-like S_3.

OCCURRENCE: The species is rare in rewashed tuffs of the Ejpovice Member in the uppermost part of the Klabava Formation. Localities: Mýto – Svatoštěpánský rybník Pond (near watch-house), Strašice – "U hnoje".

Family Ctenonotellidae Schmidt, 1941
Subfamily Tallinnellinae Schallreuter, 1976

Genus *Brephocharieis* Siveter, 1985

TYPE SPECIES: *Beyrichia complicata* Salter, 1848 from the Middle Ordovician of England.

Brephocharieis ctiradi Schallreueter and Krůta, 1988
(Text-figs 4A–E, 6M–O)

part 1872. *Beyrich*. *Bohemica.* Barr.; J. Barrande, p. 499, 588.
1908. *Beyrichia bohemica* Barr.; K. Holub, p. 3.
1934. *Beyrichia bohemica* Barrande; R.S. Bassler and B. Kellet, p. 187.
1966. *Tallinella complicata* (Salt.); V. Havlíček and J. Vaněk, p. 51.
part 1966. *Cerninella* (*Cerninella*) *complicata* (Salter); A. Přibyl, p. 206, pl. 2, figs 4–9, text-fig. 4a–c.
part 1979. *Cerninella complicata* (Salter, 1848); A. Přibyl, p. 67, pl. 3, figs 3–7, text-figs 3.3–5, 10.1, 11.4, 16.2.
1983. *Cerninella complicata* Přibyl, 1966; J. Dzik, p. 352.
1984. *Ogmoopsis* ? sp. or *Cerninella* s. s.; R. Schallreuter, D.J. Siveter and M. Krůta, p. 129.
1988. *Brephocharieis* ? *ctiradi* sp. n.; R. Schallreuter and M. Krůta, p. 107, pl. 3, figs 1–4.
1994. *B.* ? *ctiradi* Schallreuter & Krůta, 1988; R. Schallreuter and M. Krůta, p. 366.
2007. *Quadridigitalis ctiradi* (Schallreuter & Krůta, 1988); I. Hinz-Schallreuter and R. Schallreuter, p. 49, 53, tab. 4, pl. 4, fig. 1B.
2010. *Brephocharieis ctiradi* Schallreuter a Krůta; K. Lajblová, p. 155, text-fig. 1.

HOLOTYPE: External mould of a left heteromorphic valve, NM L 28817, originally designated and figured by Schallreuter and Krůta (1988, pl. 3, fig. 1) and refigured herein in Text-fig 6M. The type comes from the Šárka Formation (lower to middle Darriwilian, Oretanian, Middle Ordovician); Osek, Prague Basin, Bohemia.

MATERIAL: More than 100 specimens.

Specimen	Valve	Text-figure	*L*	*H*	*L*:*H*
NML 28817a holotype	LV	6M	1.42	0.96	1.47
NML 28817b	RV	6N	1.66	1.01	1.64
NML 28817c	LV	4A	2.08	1.33	1.56
NML 28878	LV	4B	1.87	1.12	1.66
MBHR 2535	LV	4C	1.94	1.14	1.70
MBHR 4489	RV	4D	1.72	1.03	1.66
MBHR 12442	LV	4E	1.92	1.12	1.71

Table 2. *Brephocharieis ctiradi*, dimensions (mm) and proportions

EMENDED DIAGNOSIS: Weakly preplete outline and quadrilobate valves with narrow ridge-like lobes. L_1 dorsally elongate, bulb-like; L_2 rather long, not reaching the dorsal margin, L_3 cusp-like at dorsal end, L_4 uninterrupted.

DESCRIPTION: Studied specimens range from 0.68 mm to 2.10 mm in length and probably represent several instars. The shape in apparent adults (*L*:*H* ratio) is rather high. The specimens show the presence of a laterovelar furrow also in the ventral part of the valves. In some heteromorphs antral dimorphism can be distinguished. The dolon is broadest anteriorly (e.g. Text-fig. 4A). The posterior end of the valve extends over the velum in lateral view forming a postvelar field. The lobes are equally elevated. L_2 slopes towards the end of the dorsal part of L_3.

DISCUSSION: *Brephocharieis complicata* (Salter, 1848) differs from *B. ctiradi* in having a larger maximum size of the valves, less narrow ridge-like lobes, a stronger bulbous dorsal end of L_1 and L_3, a shorter L_2 and a depressed dorsal half of L_4 (Schallreuter and Krůta 1988). *B. complicata* also differs in its narrower velum in the antral area, in the weak or indistinct ventral laterovelar furrow and in the nearly missing postvelar field (see Siveter 1985, pl. 12).

Brephocharieis hloubetinensis (Jaanusson, 1957), from the Upper Ordovician of the Prague Basin, differs mainly in smaller size (up to 1.47 mm), indistinctly de-

veloped, flat lobes and the absence of a laterovelar furrow. This lack of a laterovelar furrow is explained as the result of the admarginal positioning of the antrum and flattening of the lobes (Schallreuter and Krůta 1994).

Ogmoopsis (*Quadridigitalis*) *siveteri* Jones, 1986 was also considered to be a member of the genus *Brephocharieis* (see Schallreuter and Krůta 1988). Although the antral dimorphism and its other features are very similar to *Brephocharieis,* its lobes are broader, they do not extend over the dorsal margin and L_2 is not clearly connected with the lateral furrow. *Brephocharieis ctiradi* does not possess the prominent dorsal bulb of L_1.

Jones (1986, p. 29) considered *Cerninella* to be a monotypic subgenus of *Piretopsis* Henningsmoen, 1953. *Piretopsis* (*Cerninella*) *bohemica* (see more in Schallreuter *et al.* 1984), the taxon to which Barrande (1872) and Holub (1908) assigned the species, is distinguished by the larger size of the valves (3.72 mm), the weaker dorsal part of L_1, stronger dorsal end of L_3 and weaker dimorphism (Schallreuter and Krůta 1988).

OCCURRENCE: The species is relatively uncommon (in comparison with *Conchoprimitia osekensis*) in the Šárka Formation. We had this species available only from the siliceous nodules in the studied material; no specimen has been recorded in shales. Localities (in alphabetical order): Díly 1, Díly 3, Díly 4, Díly 5, Díly 6, Mýto 1, Osek 1, Rokycany, Rokycany 2 – u hřbitova, Rokycany 17, Těškov 1, Těškov – borehole V19. This list illustrates that we found material in public collections only from the south-western part of the Prague Basin in contrast to the list of occurrences of Přibyl (1979) who reported the species also from Prague – Šárka in the north-eastern part of the basin.

No specific aspects of the occurrences of this species have been observed, with the exception of the localities at Díly. It can be found there mostly in nodules of typical character: they are of more sandy appearance in the centre, i.e. the surface looks more coarsely grained than the margins; this part is also paler coloured, usually grey to dark grey in contrast to the darker, blackish margins; limonite coats often occur in these nodules but are more frequent in the margins than in the centres of nodules.

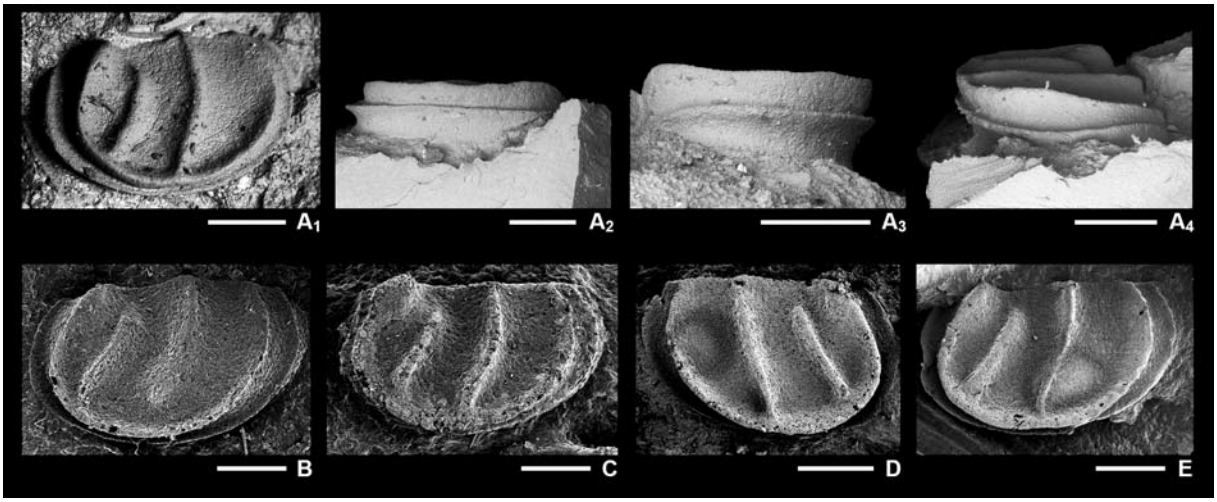
Suborder Binodicopina Schallreuter, 1972
Family Circulinidae Neckaja, 1966

Genus *Pariconchoprimitia* Schallreuter, 1980

TYPE SPECIES: *Primitia conchoides* Hadding, 1913, from the lower Upper Ordovician of Sweden.

Pariconchoprimitia ventronasata Schallreuter and Krůta, 1988
(Text-fig. 5D–I)

1988. *Pariconchoprimitia ventronasata* sp. n.; R. Schallreuter and M. Krůta, p. 108, pl. 1, figs 1–2.
2010. *Pariconchoprimitia ventronasata* Schallreuter & Krůta; K. Lajblová, p. 154.



Text-fig. 4. *Brephocharieis ctiradi* Schallreuter and Krůta, 1988, casts of the external moulds. **A –** heteromorphic LV, NM L 28817c: A_1 – lateral view, A_2 – ventral view, A_3 – anterior view, A_4 – posterior view; **B –** tecnomorphic LV, lateral view, NM L 28878; **C –** tecnomorphic LV, lateral view, MBHR 2535; **D –** heteromorphic RV, lateral view, MBHR 4489; **E –** heteromorphic LV, lateral view, MBHR 12442. All specimens from the Šárka Formation, A and C from locality Osek; B from Díly; D from Díly 1; E from Osek 1. Abbreviations are RV – right valve, LV – left valve. All scale bars equal 500 µm

HOLOTYPE: Left valve, NM L 28823, originally designated and figured by Schallreuter and Krůta (1988, pl. 1, fig. 1, dimensions p. 108) and refigured herein in Text-fig 5D. The type comes from the Ejpovice Member of the upper Klabava Formation (Dapingian, Arenigian, Middle Ordovician); Mýto – Svatoštěpánský rybník Pond (near watch-house), Prague Basin, Bohemia.

MATERIAL: Twelve valves, more or less incomplete. Two specimens isolated from the calcareous rewashed tuffs (NM L 28823 and 28824) from the type locality, other specimens are external moulds from rewashed tuffs of the locality Strašice – "U hnoje" (CGS MM 520, 524, 525 and 526 studied in detail).

Specimen	Valve	Text-figure	*L*	*H*	*L*:*H*
NML 28823 holotype	LV	5D	1.76	1.21	1.46
NML 28824 paratype	RV	5E	1.16	0.74	1.57
CGS MM 520	LV	5F	1.54	1.03	1.50
CGS MM 524	RV	5G	1.54	1.03	1.50
CGS MM 525	RV	5I	1.37	0.94	1.46
CGS MM 526	RV	5H	1.60	1.14	1.40

Table 3. *Pariconchoprimitia ventronasata,* dimensions (mm) and proportions

EMENDED DIAGNOSIS: Valves weakly postplete. Straight hinge line, dorsal angles obtuse. Surface punctuate.

DESCRIPTION: Valves are 1.76 mm long at maximum. Shape (*L*:*H* ratio) is high. Valves show distinct, coarsely punctate sculptures. The only impunctate areas are in the median area and the areas along the free margin and the hinge line. Specimen NM L 28824 (paratype) is probably a juvenile stage which is more elongated and the punctae are missing or very indistinct (Text-fig. 5E).

DISCUSSION: *Pariconchoprimitia ventronasata* is similar to *P. conchoides* Hadding, 1913, from Sweden, except the absence of punctuation, and the presence of the sulcament on the internal surface of the valves in *P. conchoides* (figured in Schallreuter 1980, pls 6–8). This species also resembles the Baltic *Conchoprimitia luxuriosa* Sarv, 1959, from which it differs in an oblique lateral outline (see Sarv 1959, Pl. 29, Figs 13–19).

OCCURRENCE: Rare in the rewashed tuffs of the Ejpovice Member in the uppermost Klabava Formation. Localities: Mýto – Svatoštěpánský rybník Pond (near watch-house) and Strašice – "U hnoje".

Genus *Mytoa* Schallreuter and Krůta, 1988

TYPE SPECIES: *Mytoa klabava* Schallreuter and Krůta, 1988, from the lower Middle Ordovician, Czech Republic.

Mytoa klabava Schallreuter and Krůta, 1988 (Text-fig. 5J–L)

1983. *Pyxion* sp.; J. Dzik, p. 352, fig. 6b.
1988. *Mytoa klabava* gen. n. sp. n.; R. Schallreuter and M. Krůta 1988, p. 108, pl. 1, figs 3–4.
2010. *Mytoa klabava* Schallreuter & Krůta; K. Lajblová, p. 154.

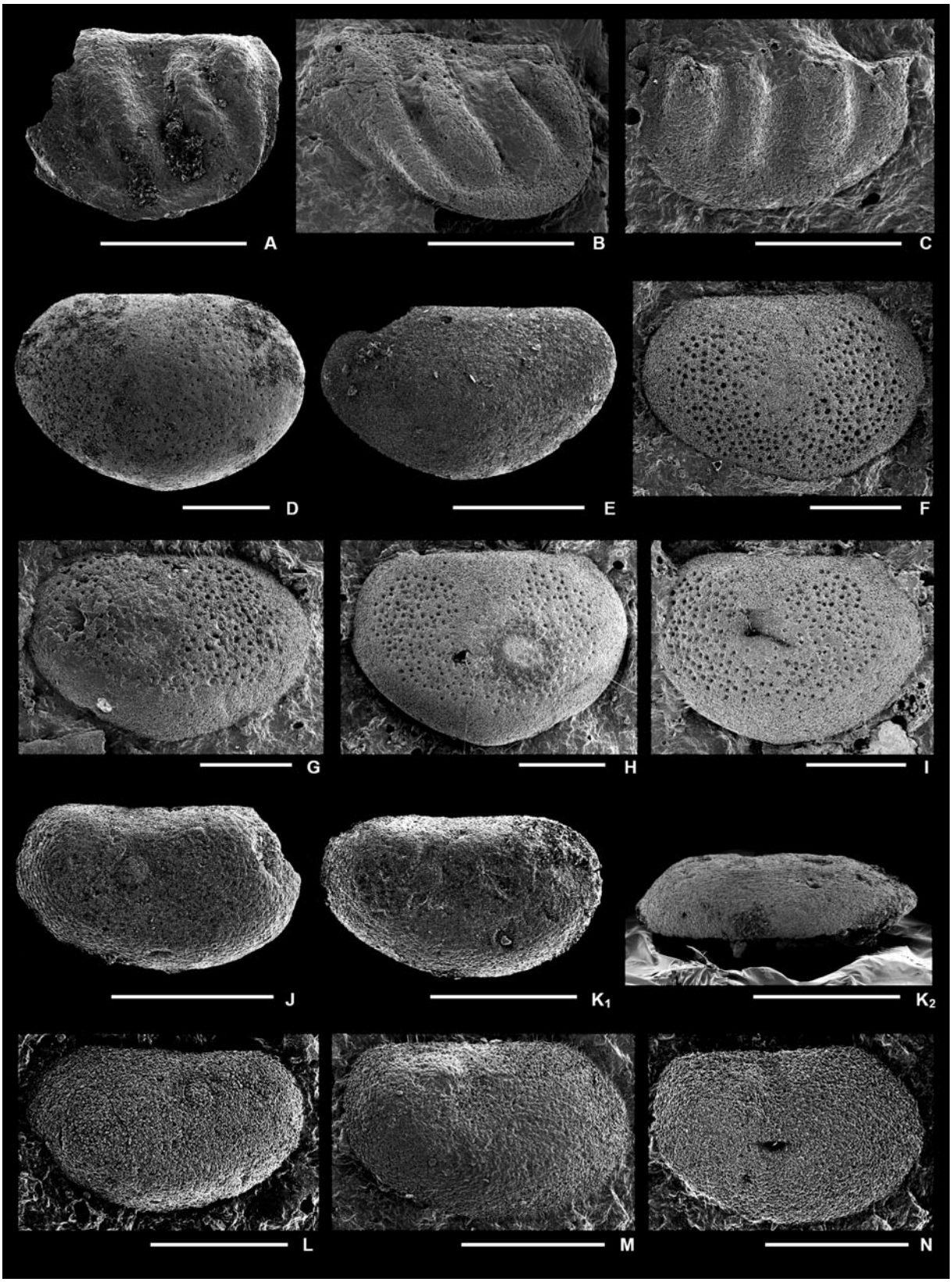
HOLOTYPE: Left, posterodorsally incomplete valve, NM L 28825, originally designated and figured by Schallreuter and Krůta (1988, pl. 1, fig. 3, dimensions p. 109) and refigured herein in Text-fig 5J. The type comes from the Ejpovice Member of the Klabava Formation (Dapingian, Arenigian, Middle Ordovician); Mýto – Svatoštěpánský rybník Pond (near watch-house), Prague Basin, Bohemia.

MATERIAL: Two isolated specimens (NM L 28825 and 28826) from the calcareous rewashed tuffs of the type locality and one external mould from rewashed tuffs from Strašice – "U hnoje" (CGS MM 523).

Specimen	Valve	Text-figure	*L*	*H*	*L*:*H*
NML 28825 holotype	LV	5J	0.90	0.53	1.71
NML 28826 paratype	LV	5K	0.98	0.57	1.72
CGS MM 523	RV	5L	1.05	0.60	1.75

Table 4. *Mytoa klabava*, dimensions (mm) and proportions

Text-fig. 5. **A–C –** *Glossomorphites* (*G.*) *mytoensis* Schallreuter and Krůta, 1988, lateral views: A – incomplete tecnomorphic RV, paratype, NM L 28830, B – cast of the external mould, incomplete tecnomorphic RV, CGS MM 527, C – cast of the external mould, LV, CGS MM 528; **D–I –** *Pariconchoprimitia ventronasata* Schallreuter and Krůta, 1988, lateral views: D – LV, holotype, NM L 28823, E – incomplete RV, paratype, NM L 28824, F – cast of the external mould, LV, CGS MM 520, G – cast of the external mould, RV, CGS MM 524, H – cast of the external mould, RV, CGS MM 526, I – cast of the external mould, RV, CGS MM 525; **J–L –** *Mytoa klabava* Schallreuter and Krůta, 1988: J – incomplete LV, lateral view, holotype, NM L 28825, K – LV, paratype, NM L 28826: K_1 – lateral view, K_2 – ventral view, L – cast of the external mould, RV, CGS MM 523; **M–N –** *Conchoprimitia* sp. A, lateral views: M – cast of the external mould, LV, CGS MM 521, N – cast of the external mould, LV, CGS MM 522. All specimens from the Klabava Formation, A, D, E, J, K from locality Mýto – Svatoštěpánský rybník Pond (near the watch-house); B, C, F–I, L–N from locality Strašice – "U hnoje". Abbreviations are RV – right valve, LV – left valve. All scale bars equal 500 μm


A
B
C
D
E
F
G
H
I
J
K1
K2
L
M
N

EMENDED DIAGNOSIS: Elongated, amplete to postplete outline. Dorsal margin straight, obtuse cardinal angles. Adductorial narrow sulcus S2 and the muscle spot. Valves reticulate.

DESCRIPTION: The valves are small-sized, about 1 mm long. Shape (*L*:*H* ratio) is moderately high. The clearly defined sulcus depression, with more or less distinct muscle spot in its ventral part, is slightly above mid-height and anterior to the mid-length of the valve. There are two visible nodes at the front and also behind the dorsal part of the sulcus depression. Fine reticulation covers the surface of the carapace. The dorsal margin is straight and shorter than the maximum length. The maximum length is situated at the mid-height of the valve. The anterior area is more convex than the posterior one (Text-fig. $5K_2$). The node in the front of the sulcament is rather rounded, whereas the latter one is more elongated. These morphological sculptures are less visible on the cast of the external mould (Text-fig. 5L), but the muscle spot and part of the frontal node are present.

DISCUSSION: Schallreuter and Krůta (1988) mentioned that this species combines features of the circulinids, specifically in the presence of the muscle spot and adjacent nodes, with features of the spinigeritids in its elongate shape, and with its own features such as a steeper marginal surface. That is why they placed *Mytoa* provisionally within the Spinigeritidae. In the present study we compared *Mytoa* with other representatives of the two above-mentioned taxonomic groups, e.g. *Vogdesella subovata* (Thorslund, 1948) (in Schallreuter 1980, pl. 5, figs 3–6), *Dronoviella lauta* (Melnikova, 1999) (in Tinn and Meidla 2004, pl. 2, fig. 15) and *Pseudoancora parovina* (Sidaravičiene, 1975) (in Meidla 1996, pl. 17, fig. 12), and found reasons to replace it within the Circulinidae. *Mytoa* is mostly comparable to the circulinid *Orechina violetae* (Salas and Vaccari 2012, figs 7A–C, E) from the Tremadocian of Argentina in the presence of an indistinct sulcus and a rounded muscle spot. Nevertheless, *O. violetae* has a subelliptical to semicircular outline, the lateral surface is rather convex and reticulated with elongated rectangular cells. *M. klabava* also resembles *Mytoa* ? *expressoreticulata* (Hessland, 1949) but differs in size and outer features: *M*. ? *expressoreticulata* is smaller and possesses a short sulcus dorsal of the muscle spot.

OCCURRENCE: Very rare in the rewashed tuffs of the Ejpovice Member in the uppermost part of the Klabava Formation. Localities: Mýto – Svatoštěpánský rybník Pond (near watch-house) and Strašice – "U hnoje".

Suborder Eridostracina Adamczak, 1961
Family Conchoprimitiidae Henningsmoen, 1953

Genus *Conchoprimitia* Öpik, 1935

TYPE SPECIES: *Conchoprimitia gammae* Öpik, 1935, upper Dapingian – lower Darriwilian, Tallinn, Estonia.

SYNONYMS: *Conchoides* Hessland, 1949 and *Conchoprimites* Hessland, 1949.

Conchoprimitia osekensis (Přibyl, 1979)
(Text-fig. 6A–H)

part 1872. Primit. *prunella* Barr.; J. Barrande, p. 550, pl. 34, figs 10–11.
part 1908. *Primitia prunella* Barrande; K. Holub, p. 3.
part 1934. *Primitia prunella* Barrande; R.S. Bassler and B. Kellet, p. 453.
part 1966. *Parapyxion prunellum* (Barr); V. Havlíček and J. Vaněk, p. 51.
1979. *Conchoprimites osekensis* sp. n.; A. Přibyl, p. 54, 97, text.-figs 7.1, 14.1–3, 17.2.
1979. *Conchoprimitia* ? *dejvicensis* sp. n.; A. Přibyl, p. 96, text.-figs 7.2, 14.4.
1988. *Conchoprimitia* ? *dejvicensis* Přibyl; R. Schallreuter and M. Krůta 1988, p. 102.
1988. *Conchoprimites osekensis* Přibyl; R. Schallreuter and M. Krůta 1988, p. 102, pl. 3, fig. 5 (incorrectly named *Conchoprimitia osekensis* Přibyl, 1979 in caption).
1993. *Conchoprimites osekensis* Přibyl; R. Schallreuter, p. 127.
2010. *Conchoprimitia* ? *dejvicensis* Přibyl; K. Lajblová, p. 154.
2010. *Conchoprimites osekensis* Přibyl; K. Lajblová, p. 154.

NEOTYPE: Internal mould of a left valve, NM L 42166, topotype specimen from the type series originally indicated as paratype by Přibyl (1979, text-fig. 17.2), refigured herein in Text-fig. 6A. Replacing the lost left valve, NM L 9568, original Přibyl's holotype (Přibyl 1979, text-fig. 14.2). The type comes from the Šárka Formation (lower to middle Darriwilian, Oretanian, Middle Ordovician); Osek, Prague Basin, Bohemia.

MATERIAL: More than 500 specimens.

Specimen	Valve	Text-figure	*L*	*H*	*L*:*H*
NML 42166 neotype	LV	6A	3.11	2.24	1.38
NM L28816	RV	6B	2.66	1.73	1.53
NML 35991	LV	6H	1.18	0.70	1.68
NML 8861	LV	6G	1.34	0.73	1.83
MBHR 9183	RV	6E	2.50	1.60	1.56
MBHR 2514	RV	6C	3.30	2.02	1.63
MBHR 6337	RV	6D	2.18	1.39	1.56
MBHR 8987	RV	6F	2.97	2.06	1.44

Table 5. *Conchoprimitia osekensis,* dimensions (mm) and proportions

EMENDED DIAGNOSIS**:** Valves weakly postplete, subcircular. Long and straight hinge line. Distinct N_2, short S_2. Cardinal angles obtuse.

DESCRIPTION: The valves attain relatively large sizes, up to 3.9 mm in adult specimens. The carapace possesses a distinct N_2 in the anterior half of the valve near the dorsal margin. Directly behind, there is a short, straight, and distinctly defined S_2, perpendicular to the dorsal margin, which is straight and long, only slightly shorter than the maximum length of the valves. The structure of the hinge is unknown. The cardinal angles are obtuse, with the posterior one bigger than the anterior one. In some specimens the posterior half is wider and more inflated than the anterior one. It could be due to sexual dimorphism if the more convex specimens are considered as heteromorphic valves (Přibyl 1979; herein e.g. Text-fig. 6A). The lateral surface is rather smooth, fractionally punctate.

DISCUSSION: The studied specimens were previously considered as representatives of the genus *Conchoprimites* that was defined by Hessland (1949, p. 236). The generic name *Conchoprimites* was later considered as synonym of *Conchoprimitia* Öpik, 1935 by Schallreuter (1993, p. 126–127). The coeval specimens, referred previously to *Conchoprimitia* ? *dejvicensis* Přibyl, 1979 (Text-fig. 6G–H), are synonymised herein with *C. osekensis* because they are considered as its early ontogenetic stages (Lajblová *et al.* 2014).

OCCURRENCE: It is the most common species of the Šárka Formation. It is very abundant in the siliceous nodules as well as in the shales. It is one of the major components of fossil assemblages of the Šárka Formation in the south-western part of the Prague Basin (Rokycany to Zbiroh area) while it is quite uncommon in the north-eastern part (Prague to Brandýs n/L area). Localities (ordered by basin segments and subsequently alphabetically): Cekov 2, Cheznovice 3, Díly 1, Díly 2, Díly 3, Díly 5, Díly 6, Kamenný Újezd 1, Kařez 2 – Pětidomky, Mýto 1, Mýto 4, Osek 1, Rokycany 2 – u hřbitova, Rokycany 17, Rokycany 19, Rokycany – Borek 1, Rokycany – Borek 2, Rokycany – Drahouš 1, Rokycany – Drahouš 3, Rokycany – Drahouš 4, Sedlec 5, Svojkovice 4, Těškov 1, Tymákov – Sutice 2; Popovice, Praha – Jenerálka, Praha –Libuš, Praha – Šárka (pole u vily), Praha – Veleslavín (Litovický potok), Praha – Vokovice, Praha – Vokovice (cihelna), Úvaly.

This species is distributed in many types of nodules and forms a component of different fossil associations of single nodules. However, a special type of occurrence is in dense linear clusters as infills of simple tube ichnofossils. Such occurrences are briefly described by Mikuláš (1998).

Conchoprimitia sp. A
(Text-fig. 5M–N)

2010. *Conchoprimites* sp.; K. Lajblová, p. 155.

MATERIAL: Two external moulds of the left valves (CGS MM 521 and 522)

Specimen	Valve	Text-figure	*L*	*H*	*L*:*H*
CGS MM 521	LV	5M	1.00	0.62	1.61
CGS MM 522	LV	5N	0.96	0.62	1.55

Table 6. *Conchoprimitia* sp. A, dimensions (mm) and proportions

DESCRIPTION: Postplete outline, rather high and unisulcate, the hinge line is straight. Length up to 1mm. The shallow sulcus extends from the dorsal margin to near the mid-point of the valve surface. The tiny and rounded N_2 is developed as a weak inflation on the anterior side of the sulcus. The cardinal angles are obtuse. The surface is smooth.

DISCUSSION: The specimens resemble *Conchoprimitia osekensis* (Přibyl, 1979) from the overlying Šárka Formation in the shape of the valves, the dorsally situated sulcus and the rounded node. However, the available material does not allow more precise determination.

OCCURRENCE: Rewashed tuffs of the Ejpovice Member in the uppermost part of the Klabava Formation. Locality: Strašice – "U hnoje".

Conchoprimitia sp. B
(Text-fig. 6I–L)

2010. *Pariconchoprimitia* ? *conchoides* (Hadding); K. Lajblová, p. 154.

MATERIAL**:** 12 external moulds.

Specimen	Valve	Text-figure	*L*	*H*	*L*:*H*
MBHR 2520	RV	6L	2.95	> 1.75	> 1.69
MBHR 4576	LV	6I	3.57	2.30	1.55
MBHR 6339	RV	6K	3.42	2.21	1.54
MBHR 12602	RV	6J	3.64	2.28	1.56

Table 7. *Conchoprimitia* sp. B, dimensions (mm) and proportions

DESCRIPTION: The outline is postplete and subcircular, the hinge line is long and straight. The sulcament is small and the surface is smooth. The maximum length is at mid-height of the valves. The cardinal angles are obtuse, the posterior one larger than the anterior one.

DISCUSSION: The genus *Conchoprimitia* includes a large number of species that are widespread in Gondwana and the peri-Gondwana regions. *Conchoprimitia* is characterized by a very simple morphology and attains a relatively large size, sometimes exceeding 4 mm in length. Tinn *et al*. (2010) mentioned recently in their comprehensive study on polymorphism in *Conchoprimitia socialis* (Brøgger, 1882) that this genus shows many intraspecific variations according to the habitats in which it occurs. The main variations observed include the size of the carapace, the presence or absence of a sulcus or muscles spots and the microsculpture. The material from the Šárka Formation is assigned to *Conchoprimitia* because of its long hinge line, the postplete outline, the convex carapace, the lack of distinct lobes and sulci and the presence of a muscle spot. This material shows variation in the morphology of the adductorial area as well.

The Eridostracans represent a group with a multilayer structure of the calcified carapace formed through the retention of unshed moults during the growth process called moult retention. This is a rare feature in ostracods, but a common feature among all eridostracans (Adamczak 1961; Olempska 2012, fig. 1). Specimens of this species with retained valves are lacking in the studied material. Also, microsculpture is one of the important features for distinguishing a species of *Conchoprimitia*; despite this, our material includes casts of the external moulds only and it is almost impossible to determine the character of the carapace, if it is punctate/pitted, rugose/striate, or reticulate (see also Tinn *et al*. 2010, fig. 7).

Conchoprimitia sp. B has valves significantly larger, up to 3.67 mm long, and more elongated than *Pariconchoprimitia conchoides* (Hadding, 1913) (cf. Schallreuter 1980, pl. 6, figs 1–8; pl.7, figs 1–4). The described material also resembles some Circulinidae such as *Vogdesella* Baker, 1924. For further investigations is necessary to know other important feautures of the valves that are unavailable in this type of preservation.

OCCURRENCE: Known only from siliceous nodules of the Šárka Formation. Localities: Rokycany, Díly, Osek.

Order Platycopida Sars, 1866
Suborder Cytherelliformes Skogsberg, 1920
Superfamily Kloedenelloidea Ulrich and Bassler, 1908
Family Monotiopleuridae Guber and Jaanusson, 1965

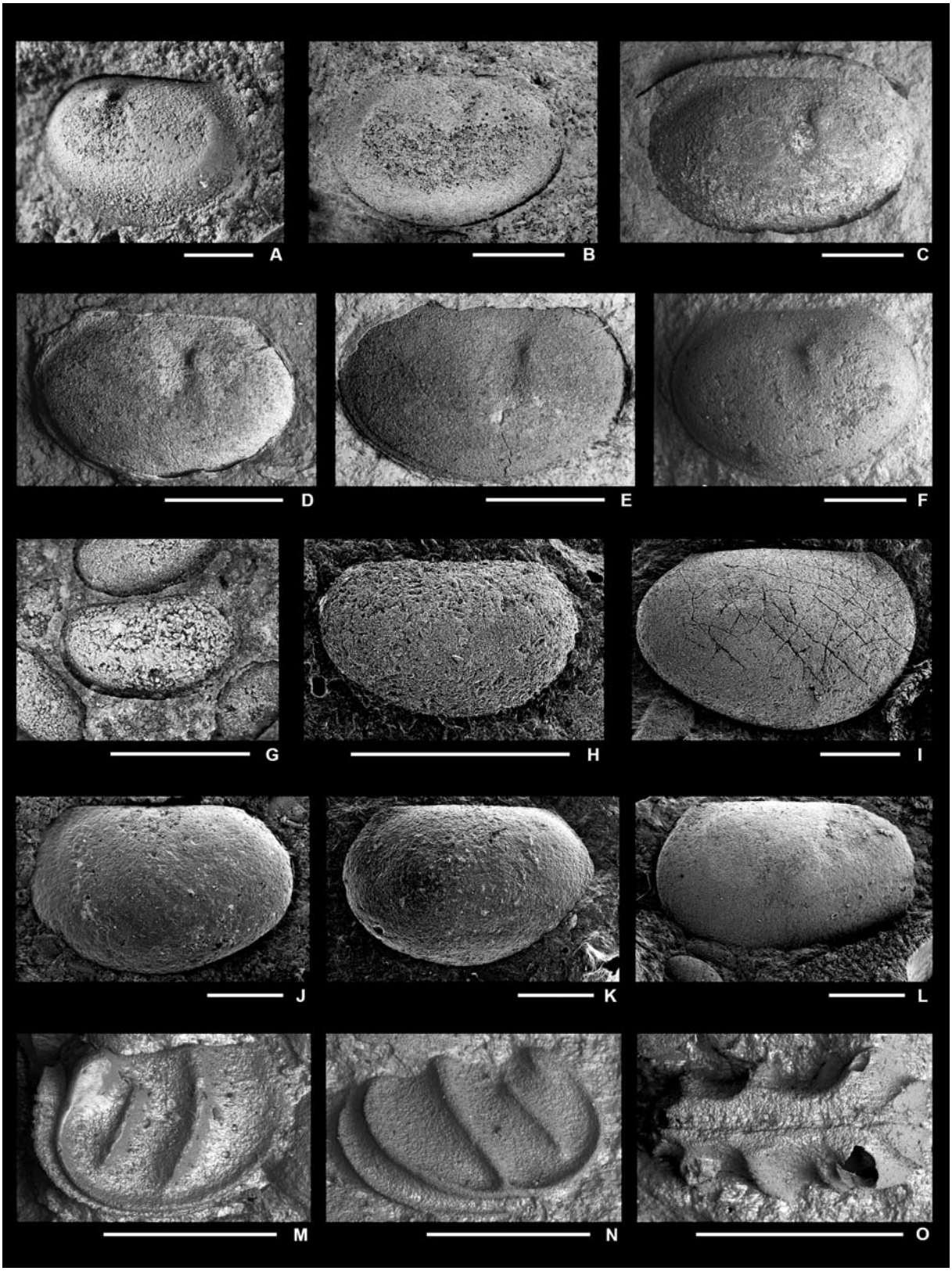
Genus *Karinutatia* Schallreuter, 1978

TYPE SPECIES: *Karinutatia crux* Schallreuter, 1978 from the Middle Ordovician, Gotland, Sweden.

Karinutatia eoren Schallreuter and Krůta, 1988
(Text-fig. 7A–B)

1988. *Karinutatia eoren* sp. n.; R. Schallreuter and M. Krůta, p. 109, figs 5–6.
2007. *Karinutatia eoren*; I. Hinz-Schallreuter and R. Schallreuter, tab. 60.
2010. *Karinutatia eoren* Schallreuter & Krůta; K. Lajblová, p. 154.

Text-fig. 6. **A–H –** *Conchoprimitia osekensis* (Přibyl, 1979), lateral views: A – LV, neotype, NM L 42166, B – RV, NM L 28816, C – RV, MBHR 2514, D – RV, MBHR 6337, E – RV, MBHR 9183, F – RV, MBHR 8987, G – larval LV, NM L 8861, H – cast of the external mould, larval LV, NM L 35991; **I–L –** *Conchoprimitia* sp. B, casts of the external moulds, lateral views: I – LV, MBHR 4576, J – RV, MBHR 12602, K – RV, MBHR 6339, L – RV, MBHR 2520; **M–O –** *Brephocharieis ctiradi* Schallreuter and Krůta, 1988, casts of the external moulds: M – heteromorphic LV, lateral view, holotype, NM L 28817a, N – tecnomorphic RV, lateral view, NM L 28817b, O – incomplete specimen, dorsal view, NM L 28817d. All specimens from the Šárka Formation, A, G and M–O from locality Osek; B and H from Díly; C and L from Rokycany; D–E from Rokycany – Drahouš 3; F from Díly 1; I from Rokycany 2 – u hřbitova; J–K from Osek 1. Abbreviations are RV – right valve, LV – left valve. All scale bars equal 1 mm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HOLOTYPE: Isolated left valve, NM L 28827, originally designated and figured by Schallreuter and Krůta (1988, pl. 1, fig. 5, dimensions p. 109) and refigured herein in Text-fig. 7A. The specimen comes from the Ejpovice Member of the Klabava Formation (Dapingian, Arenigian, Middle Ordovician); Mýto – Svatoštěpánský rybník Pond (near watch-house), Prague Basin, Bohemia.

MATERIAL: Two isolated specimens: holotype (NM L 28827) and incomplete paratype (NM L 28828).

Specimen	Valve	Text-figure	*L*	*H*	*L:H*
NML 28827 holotype	LV	7A	0.49	0.30	1.60
NML 28828 paratype	RV	7B	0.52	0.32	1.63

Table 8. *Karinutatia eoren,* dimensions (mm) and proportions

EMENDED DIAGNOSIS: Carapace of elliptical outline, valves slightly preplete. Anterior margin area broader rounded than posterior one. A weak sulcal depression near the dorsal margin. Fine surface reticulation.

DESCRIPTION: Valves are up to 0.52 mm long. Shape (*L:H* ratio) is rather high. The anterior cardinal corner is much larger than the posterior one. The hinge line is straight. The reticulation and more or less vertical shallow sulcus (extending from the dorsal margin to the posterocentral area) are distinguishable on the holotype (Text-fig. 7A). The holotype specimen is anteriorly wider and more rounded from the dorsal view than the paratype specimen (Text-fig. 7B), which indicates the presence of kloedenellid dimorphism and reveals the holotype as a heteromorphic valve.

DISCUSSION: *K. eoren* shows similar morphological features to those of *K. ren* (see Schallreuter 1996, pl. 23) and the type species *K. crux* (see Schallreuter 1978, pl. 5). Both compared species differ in having significant coarse reticulation and a small pit-like sulcus (anterior of mid-length, slightly dorsal of mid-height). On the other hand, *K. ren* has a similar shape, size and kloedenellid dimorphism. Schallreuter and Krůta (1988) mentioned that *K. ren* could possibly have evolved from a species similar to *K. eoren*.

The genus *Karinutatia* resembles another species from the Monotiopleuridae, namely *Priminsolenia minima* (see Meidla 1996, pl. 21, figs 4, 6–7) in having a preplete and very small carapace, where the ends and ventral margin are rounded. They differ in the presence of an adductorial pit located above the mid-length and in coarse reticulation (except the belt along the entire free margin) in *Priminsolenia.*

OCCURRENCE: Type locality only.

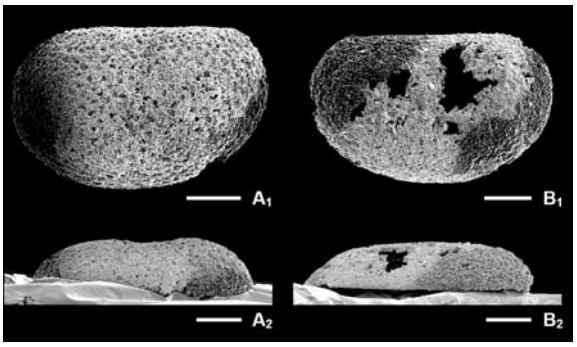
DISCUSSION

Early distribution and biodiversity of ostracods from the Klabava and Šárka formations

The wide geographical distribution and coeval occurrences of ostracod taxa on several palaeocontinents and palaeoplates during the Early Ordovician suggest their rapid dispersal, tolerance of a range of different climatic belts, or a much reduced latitudinal temperature gradient (Williams *et al*. 2008). The phosphatocopids and bradoriids (considered originally as ancient groups of ostracods) were highly diversified and of a cosmopolitan distribution during the long-lasting period of lowstand in the late Cambrian (Williams *et al*. 2007).

The Ordovician starts with the global marine Tremadocian transgression. The earliest ostracod record, represented by the genus *Nanopsis*, comes from the mid Tremadocian of Baltica (Tinn and Meidla 2004). The ostracods were then already characterized by a wide geographical distribution as shown by their occurence in Gondwana (Cordillera Oriental, Argentina, Salas *et al*. 2007, Salas and Vaccari 2012; Alborz, Iran, Ghobadi Pour *et al*. 2011), Avalonia (Williams and Siveter 1998) and Kazakhstan (Melnikova *et al.* 2010). Based on data from Hou (1953), Ghobadi Pour *et al*. (2011) suggested that some Tremadocian ostracods also occurred in China. As Laurentia and Siberia lack any evidence of Tremadocian ostracods, it may suggest a latitudinal distribution of them from the southern high latitude of Avalonia up to the tropical zone (North China Palaeoplate).

Post-Tremadocian ostracods underwent a major diversification and reached their first taxonomic diversity peak during the Darriwilian. In Laurentia, ostracods became abundant in the Dapingian and early Darriwilian (Berdan 1988) while in Siberia they became abundant during the Darriwilian (Abushik 1990). In Avalonia, ostracod diversity remained low up to the Darriwilian (Botting 2002). The rapid diversification is best illustrated in Baltica (Tinn *et al*. 2006). The Baltoscandian faunas are composed mostly of eridostracans and palaeocopes in the Floian and Dapingian (Tinn *et al.* 2006). Their initial species diversity is quite low (14 species recorded from the Floian; see Salas 2011; some 50 species in the Floian to Dapingian according to Tinn *et al.* 2006) followed by an increase



Text-fig. 7. *Karinutatia eoren* Schallreuter and Krůta, 1988. **A** – heteromorphic LV, holotype, NM L 28827: A_1 – lateral view, A_2 – dorsal view; **B** – incomplete tecnomorphic RV, paratype, NM L 28828: B_1 – lateral view, B_2 – dorsal view. Both specimens from the Klabava Formation, locality Mýto – Svatoštěpánský rybník Pond (near the watch-house). Abbreviations are RV – right valve, LV – left valve. All scale bars equal 100 μm

reaching its maximum in the latest Ordovician (Meidla 1996). Williams *et al.* (2008) concluded that many post-Tremadocian ostracod morphotypes can form distinct lineages that continued throughout the Ordovician, resulting in a remarkable ostracod biodiversity peak with hundreds of species in the Late Ordovician.

Similar to the situation in other regions, ostracod species diversity in the Prague Basin was significantly low during the Early Ordovician. The earliest ostracod fauna has been recorded from the upper part of the Klabava Formation (Dapingian; Text-fig. 2). It is composed of five genera; two of them belonging to binodicopids, with the remaining three representing the palaeocopids, platycopids and eridostracans. Such a low diversity is comparable with the Floian ostracod associations from Baltica, which is interpreted by Tinn *et al*. (2006) as due to unfavourable climate conditions or to the early evolutionary stage of ostracods.

During the early to mid Darriwilian (time span of the Šárka Formation; see Text-fig. 2), the number of ostracod species in the Prague Basin decreased significantly and the species composition changed. The ostracod association is represented by three species assigned to two genera; one of the genera belongs to the palaeocopids and the other to the eridostracans. These two groups dominated the Floian to Dapingian interval in the Baltic region (Tinn *et al.* 2006) and retained their dominance from the Dapingian to Darriwilian in the Prague Basin. Although poorly diversified, both were common to abundant, as in the case of *Conchoprimitia osekensis* in the Barrandian area.

Starting in the mid Darrwilian, the ostracod diversity in the Prague Basin increases. Nineteen genera have been recorded in the Dobrotivá Formation of the mid-late Darriwilian to early Sandbian age (Schallreuter and Krůta, 2001a), overlying the Šárka Formation (Text-fig. 2), and sixteen genera in the Sandbian age Letná Formation (Schallreuter and Krůta 2001b). Palaeocopids dominate in both the above-mentioned formations, with increasing diversity throughout the Letná Formation. The most diverse ostracod fauna in the Ordovician of the Prague Basin is known from the Bohdalec Formation (upper Ordovician, lower/middle Katian) with more than twenty species recorded (Schallreuter and Krůta 1988), with a prevalence of binodicopids. Palaeocopids are clearly of subordinate importance in contrast to coeval assemblages from Baltica.

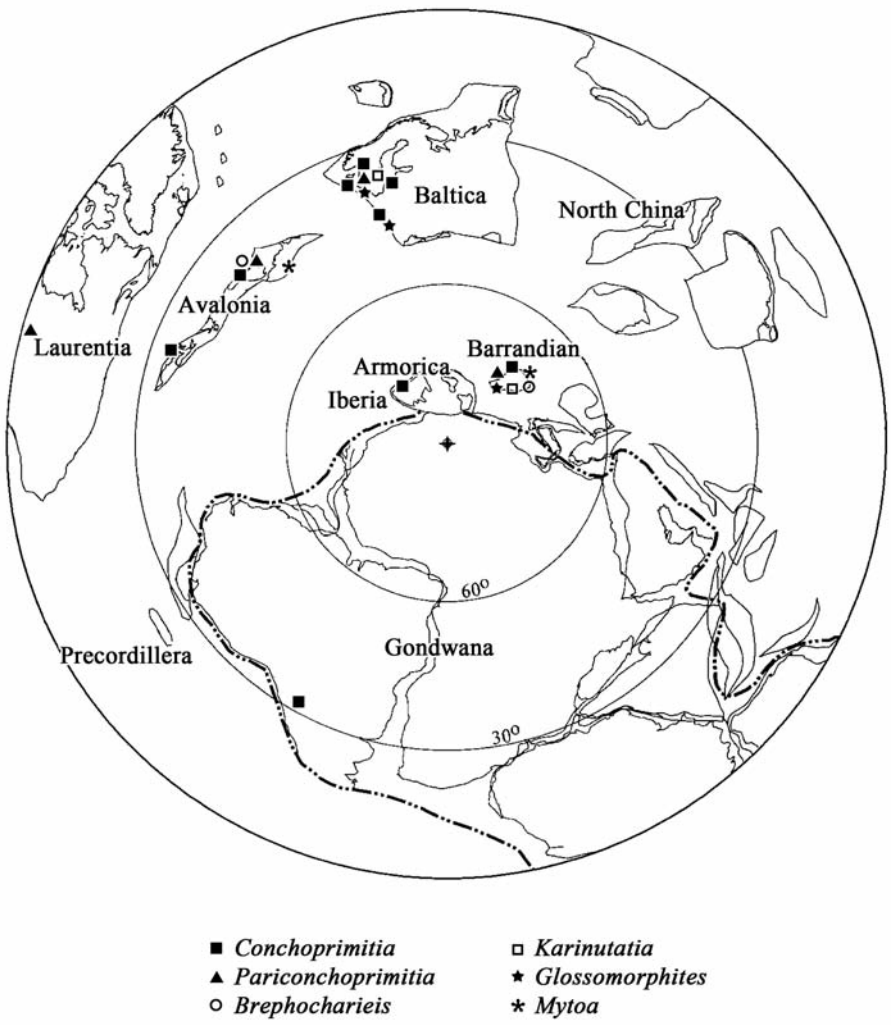
Palaeobiogeography

The palaeobiogeography of the Ordovician ostracods has recently been discussed in a number of papers (e.g. Williams *et al*. 2008; Hinz-Schallreuter and Schallreuter 2007). The significance of ostracods as palaeobiogeographical indicators increased since the Middle and Late Ordovician according to Salas (2011). Ordovician ostracods are recorded from all of the continents except Antarctica, with the prevalence of species in the Northern Hemisphere (Braddy *et al.* 2004).

The palaeogeographical distribution of the ostracod genera found in the Klabava and Šárka formations related to their worldwide occurrences in the Early and Middle Ordovician are summarized in Text-fig. 8 and discussed below.

The Bohemian ostracods are dominated by one eridostracan genus, namely *Conchoprimitia*, represented by three species (*C. osekensis*, *C*. sp. A and *C.* sp. B). The genus *Conchoprimitia* is geographically widespread with a high abundance mainly in Baltoscandia (Tinn *et al*. 2010). Some of its species are known from the Malopolska Block (Olempska 1994). It has also been recorded from other palaeocontinents: Avalonia (East Avalonia, Wales, Siveter 2009; West Avalonia, New Brunswick, Canada, Landing *et al*. 2013) and from Gondwana (Ibero–Armorica,Vannier *et al*. 1989; Cordilerra Oriental, Argentina, Salas 2011, Salas and Vaccari 2012). However, due to homeomorphic species of this almost featureless genus (Tinn *et al*. 2010; Williams *et al*. 2003), their palaeobiogeographical interpretations may be confusing.

The genera reported from the Prague Basin occur mainly in peri-Gondwanan and Baltic regions (see Text-fig. 8). Some of them, however, have been also recorded from very distant regions, as e.g., *Pariconchoprimitia*, known from Laurentia (Burr and Swain



Text-fig. 8. Palaeogeographical distribution of the ostracod genera occurring in the Klabava and Šárka formations in strata of Early to Middle Ordovician age. (Palaeogeographic map modified after Cocks and Torsvik 2002). *Brephocharieis*: Llann Mill, Lampeter Velfrey F., South Wales (Siveter 2009; Siveter 1985); *Conchoprimitia*: Komstad Limestone, Denmark (Tinn and Meidla 1999), Tallinn, Estonia (Öpik 1935), Røyken, Slemmestad, Norway (Öpik 1939), Siljan district, Sweden (Hessland 1949), Santa Victoria area, Central Andean Basin, Northwest Argentina (Salas 2011), Mojcza, Malopolska Block, Holy Cross Mountains, Poland (Olempska 1994), Whitlandian Stage, South Wales (Siveter 2009), New Brunswick, Canada, West Avalonia (Landing *et al.* 2013), Cacemes, Bucaco syncline, Portugal (Vannier *et al*. 1989); *Glossomorphites*: Komstad Limestone, Denmark (Tinn and Meidla 1999), Mojcza, Malopolska Block, Holy Cross Mountains, Poland (Olempska 1994); *Karinutatia*: Backsteinkalk erratic boulder, Gotland (Schallreuter 1978); *Mytoa*: Kiesbert, Ebbe-Sattel, Rheinisches Schiefergebirge, Germany (Schallreuter and Koch 1999); *Pariconchoprimitia*: Skåne, Röstånga, Sweden (Schallreuter 1980), Ffairfach Group, Welsh Basin, Wales (Siveter 2009), Dubuque and Maquoketa F., Northeastern Iowa, USA (Burr and Swain 1965)

1965), Avalonia (Siveter 2009) and, in the Late Ordovician, even from Iran (Schallreuter *et al.* 2006).

Glossomorphites was widespread in Baltica. It occurs in Baltoscandia (Hessland 1954; Tinn and Meidla 1999) and Malopolska (Olempska 1994) in the Lower and Middle Ordovician and is also known from the Upper Ordovician of Himalaya (Schallreuter *et al.* 2008). Based on the palaeobiogeographical pattern of this genus, and its comparison to other Ordovician genera, as well as to modern taxa, Schallreuter *et al*. (2008) suggested that most of all known Ordovician ostracods were benthic crawlers or swimmers comparable to Recent ostracods.

The palaeogeographical distribution of Ordovician ostracods was recently studied by Hinz-Schallreuter and Schallreuter (2007). They established three ostracod provinces characteristic of different parts of Gondwana and peri-Gondwana: Thuringian, Australian and Armorican; and discussed their relationships to other provinces. The Barrandian area ("Perunica"), together with Iberia, North Africa, east Central Iran (Tabas Block) and the Carnic Alps, they included into their Ar-

morican Province, indicating that the Barrandian area displayed the closest relationship to Baltica. Their conclusions (Hinz-Schallreuter and Schallreuter 2007, fig. 2) were recently supported by Landing *et al*. (2013) who inferred an exchange of open marine, cool-water biotas between Avalonia, Baltica, and West and North Gondwana, with its beginning as early as in the late early Cambrian.

Our results accord with the observations of Schallreuter and Krůta (1994) about the cosmopolitan nature of Bohemian ostracods in the Klabava and Šárka formations. They also showed that Middle Ordovician ostracod fauna from the Barrandian area (Prague Basin) have the closest affinities to the coeval fauna occurring in Baltica as well as Avalonia (four genera in common for both regions). It is partly in contrast to results of Havlíček *et al.* (1994) who illustrated the very close relationships of benthic faunas of the Prague Basin with coeval faunas occurring in Armorica and Avalonia, but very weak with Baltica based on brachiopods and trilobites. Later, their conclusions were discussed and generally advocated by Fatka and Mergl (2009).

CONCLUSIONS

The ostracods from the Klabava and Šárka formations are of Middle Ordovician age and are the oldest ostracods as recorded so far from the Prague Basin (Barrandian area, Bohemian Massif, Czech Republic). The ostracod fauna in the Klabava Formation is composed of five species. One of them, *Conchoprimitia* sp. A, is reported as new for this unit; the genus was previously known only from the overlying units. The Šárka Formation fauna is comprised of three species, including one, *Conchoprimitia* sp. B, first described herein. Taking into account the recent study of the ontogeny of *Conchoprimitia* (see Lajblová *et al*. 2014), *Conchoprimitia* ? *dejvicensis* Přibyl, 1979 is synonymised with *Conchoprimitia osekensis* (Přibyl, 1979) as its early ontogenetic stages.

The record of ostracods in the Šárka Formation is surprisingly very unbalanced. Most of the specimens in the collections were found in localities in the southwestern part of the Prague Basin rather than in the north-eastern part where, in addition, *Brephocharieis ctiradi* is absent. All of the specimens available for study came from the *Corymbograptus retroflexus* Biozone. The absence of ostracods in the younger *Didymograptus clavulus* Biozone, although exceptionally mentioned in the literature, is curious but it could have been caused by a collecting or documentation bias.

The Middle Ordovician ostracod faunas in the Prague Basin are dominated by eridostracans and palaeocopids. The palaeogeographical distribution of the studied ostracod genera shows their closest affinities to Baltica and Avalonia.

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APPENDIX – SURVEY OF LOCALITIES

Only localities which could be verified from the material housed in the institutional and the private collections and from our own field investigations have been included. If an occurrence is reported in literature but the material has not been found neither in the collections nor in the field we refer to the relevant paper as mentioned in the chapter on history of previous research (see above). The localities are ordered after formations and subsequently alphabetically. Locality indexes are used in accordance with the system used in the Museum of Dr. Bohuslav Horák in Rokycany.

KLABAVA FORMATION

Mýto – **Svatoštěpánský rybník Pond (near the watch-house)**. The artificial outcrop west of Štěpánský rybník Pond in the area protected by state law PP Štěpánský rybník, about 400 m SE of St. Štěpán Church, 1.5 km ENE of the St. Jan Křtitel Church in the centre of Mýto. Ostracods were found in the firm, bluish-grey rewashed tuffs exposed in the north-eastern part of protected area below the former road to the railway watch-house (N49°47′28.4″, E013°45′18.8″).

Strašice – "**U hnoje"**. Yellowish-brown rewashed tuffs with ostracods were exposed in the roadside ditch near the crossroads of a former military road and a small road from Strašice to Těně in the fields E of Strašice, 1 km ENE from the St.Vavřinec Church in Strašice (N49°44′37.0″, E013°46′24.4″).

ŠÁRKA FORMATION

Cekov 2. Siliceous nodules found in the eastern part of the Cekovský rybník Pond, some 400 m SW of the chapel in Cekov (point inside the area N49°49′9″, E013°45′40″).

Cheznovice 3. Field with siliceous nodules W of Cheznovice between a village and a forest.

Díly. The general name for several fields near the hamlet of Díly north of Rokycany. The fields with siliceous nodules concentrated in the soil stretch south of Díly along the D5 motorway. This road, built at the beginning of the 1990s, destroyed part of the original localities in the southern edge of distribution of nodules. All the following parts are located inside the area protected by state law NPP Vosek.

Díly 1. The main and the richest locality in the surroundings of the hamlet of Díly. The field with the siliceous nodules is situated south of Díly. The main nodule concentrations were bounded by the former road from Rokycany to Volduchy (removed when the D5 motorway was built). Nodules occured up to a hundred metres east of this road (point inside the area N49°45′25″, E013°36′20″).

Díly 2 – **opposite side of the road**. Narrow, some 200 m long lane of the field along former road from Rokycany to Volduchy, adjacent to its west side, opposite the southern part of Díly 1.

Díly 3 – **u božích muk**. Part of field west of former road from Rokycany to Volduchy, south of present road, south-west of Díly. Main concentration of nodules is just west of wayside cross (49°45′30.1″N, 13°36′18.75″E).

Díly 4 – **southern slope of Hůrka**. Field with siliceous nodules west of Díly, north of the road from Rokycany to Volduchy, between this road and line from Hůrka (elevation point 407 near the road from Rokycany to Osek) to centre of Díly.

Díly 5 – **northern slope of Hůrka**. Field with siliceous nodules west of Díly, north of the road from Rokycany to Volduchy, northwards of northern limit of Díly 4 approximately to the northern limit of the protected area in this part.

Díly 6 – **Šůlovo pole**. Concentration of nodules inside the tetragon between the D5 motorway and the road from Rokycany to Osek as well as the present and former road from Rokycany to Volduchy, south-west of Díly (point inside the area N49°45′25.1″, E013°36′5.7″).

Kamenný Újezd 1 – **classical locality**. An outcrop of dark grey shale in the bank of the River Klabava (also called Padrťský potok Brook) in Kamenný Újezd. The studied ostracod comes from historical material collected from a not precisely known site. However, it can be supposed to be placed not far from a recently discovered outcrop in the left bank of the river, about 150 m downstream from the stony bridge in Kamenný Újezd (for details see Kraft and Kraft 1990).

Kařez 2 – **Pětidomky**. Field with siliceous nodules E of Pětidomí near Dvorský rybník Pond, 1.8 km NNE of St. Jan Nepomucký Church in Kařez, some 500 m north of the former Zbiroh railway station (point inside the area N49°50′16″, E013°47′12″).

Mýto 1 – **field near the villa**. The field with siliceous nodules north of Mýto, some 750 m NW of the St. Jan Křtitel Church in Mýto, 450 m NE of the highway D5 exit 50 Mýto (point inside the area N49°47′29″, E013°43′27″).

Mýto 4 – **Svatoštěpánský rybník Pond**. Siliceous nodules collected in the north shore of the Štěpánský rybník Pond and adjacent fields north of the pond, all located around the railway underpass 900 m SW of the Kařízek railway station, 650 m E of St. Štěpán Church (N49°47′39.6″, E013°45′37.3″).

Osek. The general name for fields with siliceous nodules south of the village of Osek (Wosek or Vosek in old literature). This name is usually used for old material without an exact location.

Osek 1. Main locality at the Osek area. Large field south of Osek, west of the road from Rokycany to Osek, west of elevation point 407, 1.3 km SSW of ruins of Kamýk (point inside the area N49°45′35″, E013°35′20″). It is part of the area protected by state law NPP Vosek.

Popovice. Fields with siliceous nodules north and northeast of Popovice, 2 km WSW of the Brandýs nad Labem railway station. The locality is described by Vaněk (1999) under the name Popovice, field "V Zahradách".

Praha – **Jenerálka**. Mining of the drainage in black shales along Horoměřická Street near the state-protected area PP Jenerálka.

Praha – Libuš. Former fields with siliceous nodules south of the western end of K Lesu Street in Praha 4-Kamýk.

Praha – Šárka (pole u vily). Former field with siliceous nodules W of Vokovice cemetery, north of the intersection of Evropská and Libocká streets in Praha 6-Liboc. The exact position of the fossil site is not clear.

Praha – Veleslavín (Litovický potok). Siliceous nodules found along the Litovický potok Brook in the gardening colony between Libocký rybník Pond and Hotel Krystal, south of Evropská Street.

Praha – **Vokovice**. General location; we suppose that the main part of material comes from the former brickyard between Vokovice and Jenerálka in the northwestern part of Prague. Fossils from shales as well as nodules are included.

Praha – Vokovice (cihelna). The section of shales with nodules in former brickyard in Praha 6-Vokovice between the Červený vrch housing estate and Horoměřická Street, along Na Krutci Street. The excavations are filled and the section is covered now.

Rokycany. Cumulative name for the historical material of siliceous nodules from fields in vicinity of Rokycany without exact location. Most of them are situated north of the city.

Rokycany 2 – **u hřbitova**. Field with siliceous nodules north-west of Rokycany, west of the Litohlavská road, i.e. opposite the cemetery, 1.2 km NW of Panna Marie Sněžná Church in Rokycany. The area with nodules is protected by state law as PP U hřbitova (point inside the area N49°44′56″, E013°34′55″). Nodules are typical light brownish-grey in contrast to other localities where nodules are dark.

Rokycany 17 – **Osecký vrch Hill**. Field with siliceous nodules in northern margin of Rokycany, some 300 m SSW of the top of Osecký vrch Hill, west of Osecká Street and north of Nad Husovými sady Street, about 950 m N of Panna Marie Sněžná Church in Rokycany (point inside the area N49°45′5″, E013°35′46″).

Rokycany 19 – **eastern slope of Čilina Hill**. Shale from excavation on the south-eastern slope of Čilina Hill, W of Rokcany, some 2.7 km SW of Panna Marie Sněžná Church in Rokycany.

Rokycany – **Borek 1**. Siliceous nodules occurring in the field north of "Boreček" Forest (small wooded area between Borek and Svojkovice N of road No. 605), south of Volduchy.

Rokycany – **Borek 2**. Field with siliceous nodules north of Borecký rybník Pond in Rokycany-Borek.

Rokycany – **Drahouš 1**. Section of shales in the Klabavská stráň slope above the Klabava River alluvial plain. The outcrop near the western border of the westernmost piece of the protected area PP Rokycanská stráň, 800 m south of Navštívení Panny Marie Church on the top of Vršíček Hill, north-west of Rokycany (N49°45′5.8″N, E013°33′54″).

Rokycany – **Drahouš 3**. Main outcrop in the shales at Drahouš, in the Klabavská stráň slope above the Klabava River alluvial plain, just beside the embankment of the D5 motorway, near the eastern border of the westernmost piece of the protected area PP Roky-

canská stráň, 850 m SSE of Navštívení Panny Marie Church on the top of Vršíček Hill, north-west of Rokycany (N49°45′4.4″, E013°34′2″).

Rokycany – **Drahouš 4**. Temporary outcrop during construction of the D5 motorway at Drahouš some 50 m E of the outcrop Rokycany – Drahouš 3, now covered by the motorway tarmac.

Sedlec 5 – **studna (Mr. Kůs)**. Weathered yellow-grey shales with large ostracod carapaces were taken from the well excavated in Starý Plzenec-Sedlec No. 120 (N49°41′35.0″, E013°29′52.5″), in the southern part of Sedlec, 2 km SE of the rotunda of St. Petr and Pavel Church in Starý Plzenec, some 650 m NW of Sedlecká skála (elevation point 462).

Svojkovice 4. Very poorly preserved ostracod in micaceous shale comes from a small outcrop in the south-facing slope above the alluvial plain of Holoubkovský potok, E of Svojkovice, 520 m N of the railway station Svojkovice (N49°45′35.7″, E013°39′25.2″).

Těškov 1. Fields on both sides but mainly east of the road Holoubkov-Těškov, some 1.3 km SSW of Těškov, north of Chýlavy Forest (point inside the area N49°47′23″, E013°41′43″).

Těškov – **borehole V19**. One ostracod was found in the shale from the hole situated south-south-west of Těškov, 1150 m from the chapel in Těškov, in the field west of the road from Holoubkov to Teškov (N49°47′30.75″, E013°41′28.39″).

Tymákov – **Sutice 2**. Black shales exposed on the western slope of Sutice Forest, north of Starý Plzenec-Sedlec, east of the road from Starý Plzenec-Sedlec to Tymákov, 1.7 km ENE of the rotunda of St. Petr and Pavel Church in Starý Plzenec (N49°42′24″, E013°29′54″). The locality is inside the area PP Sutice protected by state law.

Úvaly. Small field with siliceous nodules in the western margin of Úvaly, 200 m N of the intersection of Jirenská (road No. 101 to Jirny) and the U Přeložky (road No. 12 Praha – Kolín) streets, 800 m W of the Náměstí Svobody Squre in Úvaly.