



## Two unique Middle Ordovician trilobites from the Prague Basin, Czech Republic

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**ABSTRACT.** Two specimens of rare trilobites from the Middle Ordovician Šárka Formation (= Darriwilian, Oretanian), both coming from Osek near Rokycany locality, are shortly described. An excellently preserved entire proetide specimen substantially differs from all other Middle Ordovician representatives of this order known from the Prague Basin. We place it tentatively in the genus *Mezzaluna* as a new species *Mezzaluna? xeelee* sp. n. Malformed exoskeleton of the rare cheirurid *Areiaspis barrandei* shows atypically developed left 9<sup>th</sup> pleural tip. Possible mechanisms of this malformation are shortly discussed and unpublished observations on the morphology of the species are added.

**KEYWORDS.** Middle Ordovician, Prague Basin, *Mezzaluna? xeelee* sp. n., *Areiaspis barrandei*, Trilobita

### INTRODUCTION

Trilobites known from the Darriwilian Šárka Formation constitute one of the most diversified associations in the peri-Gondwanan Middle Ordovician. As noted by Budil et al. (2007), Mergl et al. (2008) and Fatka & Mergl (2009), more than 60 trilobite species have been identified from different localities in the Šárka Formation. All major feeding habits *sensu* Fortey & Owens (1999) are present. Some species are known from hundreds of specimens and are common at numerous outcrops, while other taxa occur sporadically or even very rarely, being represented by several specimens only. For instance the sporadic occurrence of proetid trilobites (see Šnajdr 1983, Příbyl & Vaněk 1987) could be explained by the early evolutionary stage of the entire family (cf. Owens 1970, 1973a, b, Párnaste et al. 2009) and possibly also by the supposed palaeogeographic position of Perunica in the cold-water northern peri-Gondwana realm (Fatka & Mergl 2009). The facies development of the Šárka and Dobrotivá formations, e.g. the dysoxic to anoxic deeper-water conditions (dark colored to black claystones and siltstones), was probably not entirely favorable environment for the particle feeding trilobites, including proetids.

On the other hand, rare specimens of the blind genus *Areiaspis* Příbyl & Vaněk, 1964 were interpreted as deeper-water nektonic or benthic trilobites by Budil et al. (2007). There are no more than twenty articulated specimens of *Areiaspis barrandei* (Novák in Perner, 1918) stored in different institutional and private collections. Some evolutionary important features of this rare species have not been discussed. So far, no malformed specimen of *Areiaspis* was described, although malformations of Cambrian to Devonian trilobite exoskeletons were thoroughly studied in the Barrandian area (see especially Prantl 1948, 1954, Šnajdr 1978a,b, 1979a,b, 1980a, 1981, 1985, 1990a,b, Petr 1981, 1983 and Vokáč 1996).

All material described and illustrated in the present paper is housed in the National Museum, Prague (numbers prefixed with NMP L).

## SYSTEMATIC PART

### Order Proetida Fortey & Owens, 1975

### Family Proetidae Hawle & Corda, 1847

### Subfamily ? Proetinae Hawle & Corda, 1847

### Genus *Mezzaluna* Karim, 2009

TYPE SPECIES: *Mezzaluna tatavrudensis* Karim, 2009. Upper Ordovician, Ashgill (= late Katian?), Tatavrud, Iran.

DIAGNOSIS (see Karim 2009): Glabella subrectangular; palpebral lobes large, crescent shaped; anterior border short (sag.); surface covered with fine granules or pits. Librigena with short genal spine. Pygidium semicircular in outline; axis of four axial rings; margin with sculpture of raised lines.

REMARKS: So far, the representatives of this genus are known from the Upper Ordovician of peri-Gondwanan terranes in Asia (Iran and Uzbekistan-Kyrgyzstan border). The affiliation of the newly described *Mezzaluna ? xeelee* sp. n. to this genus substantially extends its stratigraphical and palaeogeographical range.

### *Mezzaluna ? xeelee* sp. n.

Fig. 2A-D.

DERIVATIO NOMINIS: Xeelee – a legendary civilization of very advanced extraterrestrial beings forming a mainstay of excellent science-fiction sequence of Stephen Baxter.

HOLOTYPE: External exoskeletal surface (negative mould of almost entire, 3D preserved specimen in silicified nodule), NMP L 40802.

MATERIAL: Only the holotype, found by the junior author (MZ).

LOCUS TYPICUS: Osek near Rokycany, Prague Basin, Teplá-Barrandian area, Czech Republic.

STRATUM TYPICUM: Šárka Formation, Middle Ordovician, Lower Darriwilian (Oretanian).

MEASUREMENTS: A sagittal length of the holotype (entire specimen without anterior part of cephalon which slightly imbricates the thorax, left cheek partially displaced) is 5.5 mm.

GLOBAL			REGIONAL	
SYSTEM	SERIES	STAGES	STAGES	FORMATIONS
ORDOVICIAN	UPPER	HIRNANTIAN	KOSOVIAN	KOSOV
		KATIAN	KRALODVORIAN	KRÁLŮV DVŮR
		SANDBIAN	BEROUNIAN	BOHDALEC ZAHORÁNY VINICE LETNÁ LIBEŇ
	MIDDLE	DARRIWILIAN	DOBROTIVIAN	DOBROTIVÁ
			ORETANIAN	ŠÁRKA
		DAPINGIAN	ARENIGIAN	KLABAVA
	FLOIAN			
	LOWER	TREMADOCIAN	TREMADOCIAN	MÍLINA
				TŘENICE

**Fig. 1. Ordovician stratigraphy of the Prague Basin (adopted from Budil et al. 2007).**

DIAGNOSIS: Exoskeleton vaulted. Glabella of pear to bell-like outline, with anterior part of L1 and L2 slightly expanding laterally. Narrow occipital lobe. Shallow axial furrows. S1 shallow, indistinct, S2-S3 very shallow, S4 imperceptible. Eyes large, reaching anteriorly S2, distant abaxially from the glabella. Intraocular part of fixigena wide and vaulted, Small eye socle. Short, sharp librigenal spine. Thorax composed of eight segments. Axial rings vaulted, with indistinct axial node. Pygidium wide, vaulted, with prominent axis. Four to five axial rings but only first three well-defined. Three to four unequally deep and wide pleural furrows; the first one prominently deep and abaxially widened (of lanceolate outline), other slightly impressed. Pygidial border shallow. Sculptation of fine dense pits.

DESCRIPTION: Exoskeleton vaulted, with prominent axis. Glabella moderately vaulted, wide, of pear to bell-like outline. Preglabellar field unknown but it is estimated (from the supposed cephalic outline) to be narrow or absent. L0 narrow, lateral lobes imperceptible. Inexpressive glabellar lobation: L1 and L2 moderately vaulted, wide, L3 - 4 less vaulted. Axial furrows shallow, moderately bent abaxially at slight lateral expansion of anterior part of L1 and especially L2. S1 shallow but perceptible, almost cutting L1 from remain of glabella. S1 shallow, its y-shape somewhat reminiscent *Rorringtonia* Whittard, 1966. S2-S3 are very shallow, S4 is imperceptible. Anterior part of cephalon unknown. Eyes

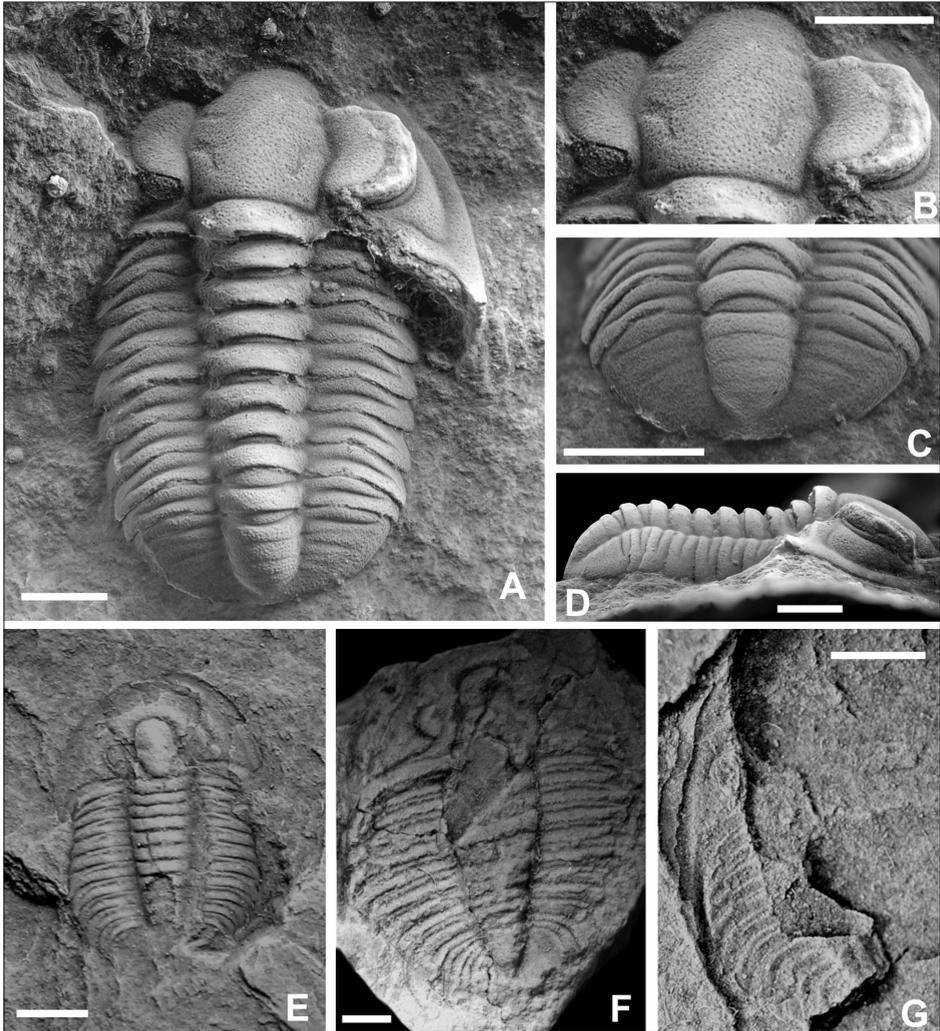


Fig. 2A-D. *Mezzaluna? xeelee* sp. n., a silicone rubber cast of the holotype NML L 40802. Šárka Formation, Middle Ordovician (= Darriwilian, Oretanian), Prague Basin, Osek near Rokycany. A – dorsal view, B – detail of the glabellar ornamentation in dorsal view, C – dorsal view of the pygidium, D – left lateral view. Scale bar = 1 mm.

2E. *Rokycanocoryphe krafti* (Šnajdr, 1983), Šárka Formation, Middle Ordovician (= Darriwilian, Oretanian), Drahouš hill near Rokycany, holotype, MBH 6628, dorsal view. Scale bar = 1 mm.

2F-G. *Phaseolops? primulus* (Barrande, 1872), Dobrotivá Formation, Middle Ordovician (= Darriwilian, Oretanian). A – holotype, NML L 16945, Sancta Benigna near Komárov, B – fragment of the right side of entire specimen, negative counterpart (positive part is missing), CGS JV 9229, Praha-Veleslavín, a pit of the “Sewer D”. Scale bar = 1 mm.

large but low, comparatively distant from the glabella, intraocular part of fixigena wide (this feature may be optically pronounced by partial displacing of the left librigena from the cranium) and relatively vaulted. Visual surface narrow (dorsoventrally) but shows a tendency to be slightly wider anteriorly and posteriorly. Small and vaulted eye socle. Free cheeks moderately vaulted, protruded into short, sharp spine. Lateral border vaulted, expressive. Thorax composed of eight segments. Axial rings vaulted, with indistinct axial node. Narrow but deep PF. Last thoracic segments, to compare with *Rokycanocoryphe* or *Phaseolops* straight, only very gently bent backward, not overhanging the outline of pygidium. Pygidium wide, vaulted, with prominent axis. About four to five axial rings but only first three are well-defined. There are three to four unequally deep and wide pleural furrows; the first one prominently deep, other slightly impressed (second one is, nevertheless, slightly deeper than remaining furrows). A weakly vaulted border is present, border furrow very shallow, indistinct. Sculpture of fine dense pits. The pygidial border and the border of the free cheek bears fine terrace lines subparallel with margin.

REMARKS: The systematic position of the new species remains somewhat doubtful. Distinct similarities are shared particularly with the Upper Ordovician proetide *Mezzaluna* Karim, 2009, namely with the type species *M. tatavrudensis* Karim, 2009. These similarities include especially large eyes and wide (tr.) palpebral lobes, similar glabellar outline with glabella widening opposite the middle of the palpebral lobe (since the anterior part of the glabella is missing, further comparison of this part of the exoskeleton is impossible). The thoracic pleurae are similarly moderately wide (tr.). Also the pygidium of the new species possesses a similar rib structure to that of *Mezzaluna*, including number of axial rings and number, shape and orientations of pleural furrows. However, there are also differences: glabella of *M.? xeelee* sp. n. is wider (tr.) and less arched, axial furrows are shallower, genal spines possess a different, more robust base (they are probably also longer) and similarly effaced pygidia have a different outline – semicircular in *Mezzaluna* but only sector (= segment of circle *sensu* Šnajdr 1980b) in *M.? xeelee* sp. n. Pygidial axis is substantially shorter in the new form, meanwhile in *M. tatavrudensis* the axis is longer with scarcely segmented terminal part. The first pygidial pleural furrow is similarly deepest, comparing with other pleural furrows, in both taxa; however, this furrow lies closer to the anterior pygidial margin in *M.? xeelee* sp. n.

The morphology of the new species somewhat resembles also the tropidocoryphids *Stenoblepharum* Owens, 1973b, *Decoroproetus* Přibyl, 1946, *Parvigena* Owens, 1973b, *Ogmocnemis* Kielan, 1960 and *Paraproetus* Přibyl, 1964. All these genera differ in the size of palpebral lobe, glabellar outline and by pygidial structure. Representatives of all these genera also have a different exoskeleton sculpture consisting of fine terrace ridges arranged in a Bertillon pattern on the glabella – the feature which is entirely absent in *M.? xeelee* sp. n.

From all of the above-discussed characters, only the similar size of palpebral lobe (as in the holotype of *M.? xeelee* sp. n.) was recorded in young (meraspid or early holaspid) cranium of *Stenoblepharum astinii* Edgecombe et al., 1997 (see Edgecombe et al. 1997, Fig. 4, 15). Because of the small size of the holotype of the new species (its total length

is about 5.5 mm), it could not be entirely excluded that this prominent character is related to its possible juvenile (holaspid) stage.

The new species also strongly differs from all so far described proetoids from the Ordovician of the Prague Basin, including the slightly older *Rokycanocoryphe krafftii* (Šnajdr, 1983), known from the lower part of the Šárka Formation (Lower Darriwilian) and the somewhat younger *Phaseolops ? primulus* (Barrande, 1872), known from the Dobrotivá Formation (Upper Darriwilian). The main differences (see Fig. 2) include the vaulting of the exoskeleton and the prominence of axis, dimension of eyes, width of intraocular area of fixigena, depth of S1, architecture of the last thoracic segments, the vaulting of pygidium and axial prominence together with depth of the first pair of pleural furrows.

The new species is considered as a basal proetide, with some features of possible archaic character (shape of base of the genal spine). Although only the holotype is known, the above-mentioned prominent differences make the classification as new species justified.

## **Order Phacopida Salter, 1864**

### **Family Cheiruridae Salter, 1864**

#### **Genus *Areiaspis* Přibyl & Vaněk, 1964**

TYPE SPECIES: *Areia barrandei* Novák in Perner, 1918, Šárka Formation (= Darriwilian, Oretanian), Czech Republic.

DIAGNOSIS: See Přibyl & Vaněk (1964).

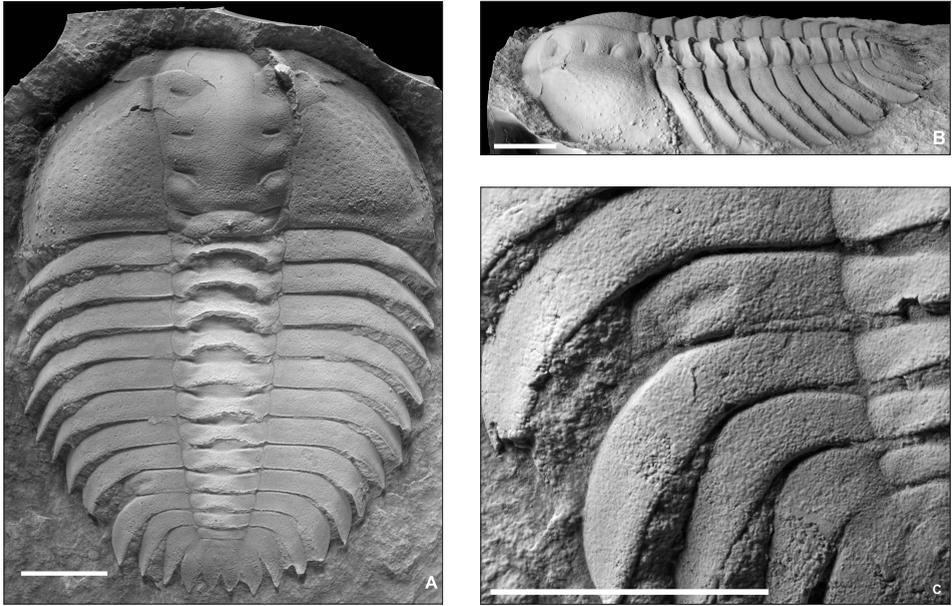
#### ***Areiaspis barrandei* (Novák in Perner, 1918)**

Fig 3.

REMARKS: An external mould of the unique entire, well-preserved and malformed specimen<sup>1</sup> was found by one of us (MZ) at the Osek locality (Šárka Formation) in 1978. The specimen NMP L 40803 enables (together with other supplementary material) to complete the formal description of the species done by Novák in Perner (1918) and Šnajdr (1990), and discussed partially also by Přibyl & Vaněk (1964), Přibyl & Vaněk in Přibyl et al. (1985) and Vaněk (1999).

Exoskeleton micropygous, moderately vaulted, egg-shaped in overall outline. Average length 25- 40 mm. Cephalon very wide, of sector (= segment of circle) outline. Glabella rounded, oblong, slightly expanding forwards and moderately vaulted (tr.), sagittally longer than exsag. width of genae, extending in front of anterior genal margin. Relatively flat frontal glabellar lobe slopes steeply into the preglabellar furrow. Frontal cephalic border conforms to protruded glabella being shifted forwards and forming a step in front of a glabella. Axial furrows shallow. Four pairs of narrow but deep lateral glabellar impressions do not reach axial furrows. S1 deepest, directed obliquely adaxially. S2 transversal,

<sup>1</sup> During final stages of the preparation of this paper, Mr. V. Kozák told us that he stores a replica of very probably the same specimen, made from the internal mould found at the same locality by V. Plas, an excellent private collector of Lower Palaeozoic fauna in the 1940-80ties. His collection is stored in the National Museum, Prague.



**3A-C. *Areiaspis barrandei* (Novák in Perner, 1918), a silicone rubber cast of the malformed specimen NMP L 40803. Šárka Formation, Middle Ordovician (= Darriwilian, Oretanian), Prague Basin, Osek near Rokycany. A – dorsal view, B – left lateral view, C- detail of the malformation. Scale bar = 5 mm.**

S3 slightly oblique. Occipital furrow with distinct occipital impressions shallowing and narrowing markedly before reaching dorsal furrows. Lateral glabellar lobes almost flat to moderately vaulted only. The L1 is the best-developed, moderately vaulted. Occipital ring moderately vaulted, sagittally wider than posterior cephalic border, with minute but distinct node. No facial sutures on dorsal side of exoskeleton. Genae of widely subtriangular outline, genal angle with short genal spine. Frontolateral and posterior borders narrow. Frontal border furrow shallow, posterior border furrow faint, widening and diminishing exsagittally but connected with frontolateral border furrow in genal angle. Genal field moderately vaulted, pitted. No eyes. Cephalic doublure very narrow, lying below frontolateral border. Rostrum unknown. Hypostoma with subtriangular vaulted median body tapering posteriorly; wide lateral and posterior borders. Thorax of eleven segments. Axis moderately vaulted, tapering backwards; rings smooth. Flat, only slightly insinuated (especially anteriorly) lateral axial lobes. Pleurae flat, non-furrowed; pleural furrows replaced by a row of tiny pits unequal in size (on internal moulds, on external mould, the pits almost disappear). Distally pleurae sloping downwards. Their posteriorly bent distal ends slightly diverging adaxially but imbricate each other (they are anteriorly inclined forming probably articulating apparatus). Pleural tips blunt but shortly pointed posteriorly. Pygidium very small. Axis subtriangular with two-three rings (only first one or two well-defined) and flat terminal piece, tapering and lowering remarkably posteriorly. Three

paired ribs on pleural lobes terminated in pleural spines. First pair of the ribs partially separated from remain of pygidium by faint furrow.

Fig. 3 shows the first malformed specimen known in this genus. Its 9th left segment was apparently successfully healed after being bitted off and/or ripped off. Abaxially, in its first third, the deep linear depression appears in the central part of the pleura, forming a false “pleural furrow”. The segment steeply inclines ventrally and diminishes – it is probably sliced off. In the place of the exoskeleton, the rock fills the gap. The malformation corresponds with the type 2.7 sensu Owen (1985) and is partially reminiscent of the malformation described in *Paradoxides* (*P.*) *paradoxissimus gracilis* (Boeck, 1827) by Šnajdr (1990: 61, upper figure). It is questionable whether such shortening of the pleura was caused by injury made during an attack of a predator and/or during moulting process, but the former possibility seems to us to be more probable. Especially, the oval impression at the end of the shortened pleura may represent an incision caused by trapping structure like jaws and/or a nipper-like organ. On the other hand, in the case of a predator attack, also some of the adjacent segments should be damaged, but they are apparently intact. Therefore, the ripping of the segment caused by the moulting should be also evaluated as a plausible scenario of injury.

#### CONCLUSION

Despite the advanced stage of knowledge of the Barrandian area, it is apparent that new findings can substantially supplement data gathered so far. More specimens are necessary for deeper understanding of the systematic position of the new proetid species and its importance for the early evolution of entire group. The well-preserved specimen of *Areiaspis* together with other newly gathered material enabled to discuss the detail morphology of the genus so far described on less complete material. Its malformation also presents an interesting case of healed injury, supplementing appropriately the wide spectrum of already known types.

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