

THE RARE TRILOBITES *EXALLASPIS* (ODONTOPLEURIDAE) AND *KOSOVOPROETUS*? (TROPIDOCORYPHIDAE) IN THE HOMERIAN (SILURIAN) OF THE PRAGUE BASIN, BOHEMIAN MASSIF

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Abstract: The deep-water *Aulacopleura koninckii* Assemblage in the lower Homeric (T. testis Sub-Bio-zone) “*Aulacopleura* shales” strata at the classical ‘Barrande’s pits’ locality on the Černidla hillside at Loděnice in the Prague Basin is supplemented by the addition of two new trilobite taxa, viz. *Exallaspis? perunicana* sp. n. and *Kosovoproetus? aff. praecursor* (Příbyl & Vaněk 1987). The palaeogeographic distribution of *Exallaspis* Ramsköld & Chatterton, 1991 is extended by the occurrence of *Exallaspis? perunicana* sp. n. and the younger *Exallaspis* sp. in the upper Homeric (the P. parvus – G. nassa Biozone) of the Prague Basin, reflecting the faunal migration between the southern shelf of the Baltica palaeocontinent and the Perunica microcontinent across the Rheic Ocean. The small dimensions of the K.? aff. praecursor exoskeletons compared to those of K.? praecursor in the bordering shallow-water Liolalax–Sphaerexochus–Cheirurus Assemblage represent another example of adaptive nanism in trilobites of the *Aulacopleura–Raphiophorus* Biofacies.

Keywords: Trilobita, Silurian, Homeric, *Aulacopleura–Raphiophorus* Biofacies, Perunica, Prague Basin, Czech Republic

INTRODUCTION

Silurian trilobites preserved in the so-called “*Aulacopleura* shales” of the Motol Formation (Homeric) at the type locality of ‘Barrande’s pits’ on the Černidla (or Na Černidlech) hillside near Loděnice in Beroun District, belonging to the *Aulacopleura koninckii* Assemblage (Chlupáč 1987), have been collected by generations of paleontologists for more than 160 years. Their diversity is therefore much better documented from this site compared to other, insufficiently explored localities with outcrops of the “*Aulacopleura* shales” biofacies in the Prague Basin, such as Prague-Řeporyje – Arethusinová rokle (*Arethusina* Gorge) in Velká Ohrada (Woldrich 1919, Prantl 1936, Bouček 1937), and Prague-Nová Ves – the foot of Hemrovy skály

(rocks) (Kříž 1962, Kříž in Chlupáč *et al.* 1998); not forgotten should remain the outcrop of the “*Aulacopleura* shales” with a diverse benthic fauna at the hillside “Na Mramoru” (= “On Marble”) between Lištice and Hostím in Beroun District, briefly described by Horný (1955) but now probably buried. Further field work at these ‘classical’ localities in similar lithofacies may provide in the future an additional, potentially very interesting scientific material and notable field observations.

This paper describes two very rare trilobite taxa originating from the “*Aulacopleura* shales”, collected in 2021 at the type locality on the Černidla hillside, the odontopleurid *Exallaspis? perunicana* sp. n. and the tropidocoryphid *Kosovoproetus? aff.*

praecursor (Příbyl & Vaněk 1987). This contribution is a follow-up to the systematic accounts on the trilobite assemblage and biostratigraphy of the “*Aulacopleura* shales” by Vokáč *et al.* (2015, 2021). Much attention is also paid to the trilobite nomenclature, namely to the representatives of the peculiar acidaspidine *Exallaspis* Ramsköld & Chatterton, 1991, especially those of the late Sheinwoodian–Homerian age, and their palaeogeographic distribution that may present another supporting argument for the autonomous position of the Perunica microplate (encompassing a major part of the Bohemian Massif) within the Rheic Ocean in the Silurian. The discovery of Homerian-age *Exallaspis? perunicana* sp. n. in the “*Aulacopleura* shales” (*Cyrtograptus lundgreni* Biozone) and the stratigraphically younger *Exallaspis* sp. (*Pristiograptus parvus* – *Gothopgraptus nassa* Biozone, cf. Vokáč *et al.* 2021) in the Prague Basin as the first representatives of the genus *Exallaspis* known from south of the Laurussian region is another cornerstone of this work.

Type and other illustrated specimens are deposited in the collections of the Czech Geological Survey (CGS) in Prague. Prefixes AH, FH, PA, ŠA and TM indicate specimens collected by Arnošt Hanák, František Hartl, Miroslav Pavlovič, Martin Šafka and Tomáš Mrázek, respectively.

‘BARRANDE’S PITS’ LOCALITY AT ČERNIDLA – STRATIGRAPHY AND PALAEOECOLOGY

The classical paleontological locality of Joachim Barrande, called ‘Barrande’s pits’, is situated in the forest below the top of the Černidla hillside [= Špičatý vrch (hill), 414 m above sea level] near the town of Loděnice. It consists of a discontinuous series of trenches and pits in the “*Aulacopleura* shales”, running almost linearly for about 200 m, and reaching as far as the Loděnice–Bubovice road (see Hughes *et al.* 2014, fig. 1). The material presented herein comes from a trench started in 2010 in the N-E part of these excavations, exposing a succession of strata of roughly 2–3 m thickness.

The “*Aulacopleura* shales” at Černidla, much like at other localities in the Prague Basin, are composed by yellow-brown, brown, gray to gray-black, calcareous, thinly laminated and abundantly fossiliferous shales with variable tuffitic admix-

ture. The shales often contain 5–20 cm thick layers or nodules of gray-black biomicritic limestones (cf. Kříž in Kovanda *et al.* 1984) with non-abundant fauna, mostly barren of trilobites. Bouček (1941) estimated the thickness of the “*Aulacopleura* shales” at Černidla as 8 m; but Hughes *et al.* (2014) established the total thickness as up to 22 m. Biostratigraphically, these sediments belong to the *Testograptus testis* Sub-Biozone of the *Cyrtograptus lundgreni* Biozone, i.e., the upper part of the Motol Formation (lower Homerian) (cf. Perner & Kodým 1919, Bouček 1941, Chlupáč 1987, Havlíček & Štorch 1990).

The roughly 1.4 m thick interval of the “*Aulacopleura* shales” with more than a hundred bedding planes (Hughes *et al.* 2014), exposed in the ‘Barrande’s pits’ at Černidla, represents the type locality of the highly diversified *Aulacopleura koninckii* Assemblage, as defined by Chlupáč (1987). He listed 17 trilobite species in this deep-water (BA 4–5, *sensu* Boucot 1975) assemblage, though its total diversity within the Prague Basin has been estimated at about 30 taxa. Vokáč *et al.* (2015, 2016, 2021) and the present authors have documented 22 trilobite species from the ‘Barrande’s pits’ at Černidla over the last two decades (Table 1).

The *Aulacopleura koninckii* Assemblage corresponds to the trilobite association of the “*Aulacopleura* shales” (the deep-water *Aulacopleura-Raphiophorus* Biofacies *sensu* Edgecombe & Sherwin 2001) with the dominant (roughly 90%) occurrence of the eponymous aulacopleurid. Subsequently, in their monograph on the Silurian brachiopods of the Prague Basin, Havlíček & Štorch (1990) defined the benthic community with *Aulacopleura koninckii* encompassing the trilobite and non-trilobite fauna occurring in (but not confined to) the “*Aulacopleura* shales”.

The *Aulacopleura* shales exhibit a highly variable thickness of 10–22 m within the Prague Basin. They reached the widest areal expansion probably in the Homerian-age *Testograptus testis* Sub-Biozone. Their lower stratigraphic boundary has been placed in Sheinwoodian strata directly overlying the *Monograptus belophorus* Biozone, as documented by Bouček (1941) in the section on the Černidla hillside slope exposed by the Loděnice–Bubovice roadcut.

The depositional environment and the taphonomy of the “*Aulacopleura* shales” at the locality of

Table 1. Trilobite species from the *Aulacopleura koninckii* Assemblage (Homerian, Motol Formation, *T. testis* Sub-Biozone) at Černidla near Loděnice, Prague Basin.

Taxon	Occurrence
<i>Aulacopleura</i> (A.) <i>koninckii</i> (Barrande, 1846)	abundant
<i>Aulacopleura</i> (A.) <i>soror</i> Přibyl, Vaněk & Hörbinger, 1985	rare
<i>Conoparia inculcata</i> (Přibyl & Vaněk, 1981)	rare
<i>Nitidocare nitidum</i> (Barrande, 1846)	rare
<i>Odontopleura</i> (O.) <i>ovata ovata</i> Emmerich, 1839	common
<i>Acidaspis</i> cf. <i>grayi</i> Barrande, 1852	very rare
<i>Ceratocephala barrandei</i> (Fletcher in Salter, 1853)	rare
<i>Radiaspis formosa</i> Prantl & Vaněk in Horný, Prantl & Vaněk, 1958	rare
<i>Exallaspis</i> ? <i>perunicana</i> sp. n.	rare
<i>Cheirurus obtusatus</i> Hawle & Corda, 1847	uncommon
<i>Sphaerexochus</i> (S.) <i>mirus</i> Beyrich, 1845	very rare
<i>Deiphon fleur</i> Šnajdr, 1980	very rare
<i>Dicranopeltis propinqua</i> (Barrande, 1846)	uncommon
<i>Planiscutellum planum pluto</i> Šnajdr, 1989	uncommon
<i>Liolalax bouchardi</i> (Barrande, 1846)	very rare
<i>Cyphoproetus putzkeri</i> Šnajdr, 1976	uncommon
<i>Lodenicia dentatula</i> (Novák, 1890)	uncommon
<i>Kosovoproetus</i> ? aff. <i>praecursor</i> (Přibyl & Vaněk, 1987)	very rare
<i>Scharyia wenlockiana</i> Přibyl, 1967	uncommon
<i>Phacopidella glockeri</i> (Barrande, 1846)	rare
<i>Bohemoharpes</i> (B.) <i>naumanni</i> (Barrande, 1872)	rare
<i>Raphiophorus rouaulti</i> (Barrande, 1852)	very rare

‘Barrande’s pits’ near Loděnice have been presented in detail by Hughes *et al.* (2014) as well as Hong *et al.* (2014).

The deep-water sedimentation environment of the *Aulacopleura*–*Raphiophorus* Biofacies (Edgecombe & Sherwin 2001, see also Sandford & Holloway 2006) in the Prague Basin spans the chronostratigraphic interval from Sheinwoodian (*Cyrtograptus rigidus* Biozone), possibly even Telychian (*Oktavites spiralis* Biozone), up to Gorstian. At the stratigraphic level of the Homerian-age *Testograptus testis* Sub-Biozone this habitat represented the palaeoecologic optimum for the trilobite taxa *Aulacopleura koninckii*, *Odontopleura ovata ovata*, *Lodenicia dentatula*, *Cyphoproetus putzkeri*, *Phacopidella glockeri*, *Radiaspis formosa* and *Bohemoharpes* (B.) *naumanni*, as evidenced by their more common occurrence in these strata compared to other coeval trilobite assemblages, though, in absolute numbers, the latter two species are rare components at the type locality of the “*Aulacopleu-*

ra shales”. The rare occurrence of some other trilobite taxa in the pelitic sedimentary environment of the *Aulacopleura*–*Raphiophorus* Biofacies probably corresponds with the periphery of their ecological niches. This mainly applies to the index species of the *Liolalax*–*Sphaerexochus*–*Cheirurus* Assemblage that dominated the shallow-water (BA2–3) palaeobiotopes with predominant tuffitic-carbonate sedimentation, namely *Liolalax bouchardi*, *Sphaerexochus mirus* and *Cheirurus obtusatus*. An occurrence of abnormally small individuals of the latter three taxa (*i.e.*, examples of nanism) in the “*Aulacopleura shales*” at the ‘Barrande’s pits’ locality at Černidla, has been discussed by Horný in Horný *et al.* (1958) and Vokáč *et al.* (2015). *Raphiophorus rouaulti*, the dominant element of gray-black graptolite shales of the upper Homerian deep-water (BA5) *Raphiophorus*–*Rubuloproetus* Assemblage (*sensu* Chlupáč 1987), bound by its occurrence to gray-black graptolite shales, also occurs rarely within the *Aulacopleura kon-*

inckii Assemblage. The holaspid exoskeletons of this species deposited in the *Aulacopleura–Raphiophorus* Biofacies, however, do not exhibit any abnormal dimensions.

Almost all trilobite species reported from the *Aulacopleura koninckii* Assemblage at the ‘Barrande’s pits’ locality at Černidla (see Table 1), except *Exallaspis? perunicana* sp. n., have also been documented in the highly diversified (45 species, cf. Vokáč *et al.* 2015, 2016 and 2021) shallow-water *Liolalax–Sphaerexochus–Cheirurus* Assemblage. These two assemblages intergrade both laterally and stratigraphically. Apart from direct communication between these two trilobite assemblages, it is also possible that a “contamination” of the *Aulacopleura koninckii* Assemblage occurred by a *post-mortem* transport of organic residues (bioclasts) from shallower water along the slope of the sea floor. However, this factor has probably played only a limited role at the ‘Barrande’s pits’ at Černidla, because the phacopid *Eophacops trapeziceps*, which is otherwise a very abundant (literally ubiquitous) element of the *Liolalax–Sphaerexochus–Cheirurus* Assemblage, has not been found at this locality.

SYSTEMATIC PART

Family **Odontopleuridae** Burmeister, 1843

Subfamily **Acidaspidinae** Salter, 1864

Genus ***Exallaspis*** Ramsköld & Chatterton, 1991

Type species: *Leonaspis bufo* Ramsköld, 1984; Wenlock, Homerian, Gotland, Sweden.

Remarks: *Exallaspis* was assigned by Ramsköld & Chatterton (1991) to the Acidaspidinae Salter, 1864 together with a few other genera also encountered in the Barrandian area, viz. *Acidaspis* Murchison, 1839, *Chlustinia* Přibyl & Vaněk, 1965, *Dudleyaspis* Prantl & Přibyl, 1949 and *Priaspis* Richter & Richter, 1917. The representatives of *Acidaspis* and *Dudleyaspis* in the Silurian of the Prague Basin were revised by Šnajdr (1988) and Vokáč *et al.* (2021).

Ramsköld and Chatterton (1991) listed 11 named species that they assigned to *Exallaspis*, with a stratigraphic range of Rhuddanian to Ludfordian, and a palaeogeographic distribution in Laurentia, Avalonia and Baltica. To these should be added *E. bruntoni* and *E. maccrackeni*, both of

Chatterton & Ludvigsen (2004), from the Aeronian and Telychian of Anticosti Island (Laurentia), and *E. whittardi* Curtis & Lane, 1998 from the Aeronian–Telychian of England and Wales (Avalonia).

All previous reports of *Exallaspis* from Avalonia, Baltica and southern Laurentia are from areas that in the Silurian were warm and laid north of the Rheic Ocean (Ramsköld & Chatterton 1991, Chatterton & Ludvigsen 2004). As noted by Vokáč *et al.* (2021), the occurrence of *Exallaspis* in the middle to upper Homerian of the Prague Basin, on the Perunica microplate, extends the southern boundary of their palaeogeographic range into the Rheic Ocean and suggests an early Homerian age for the pioneering migration by ocean currents, most likely from Baltica (cf. Manda and Turek 2018, fig. 11), perhaps even latest Sheinwoodian (known from upper part of the *C. perneri* Biozone). The palaeogeographic position of the Perunica microplate in the early Cambrian to Late Ordovician in the cold-water areas of the peri-Gondwanan shelf (see Ramsköld & Chatterton 1991, Frýda & Frýdová 2014), as a part of the Armorican terrane assemblage, drifted during the Silurian to a position closer to Baltica in the late Wenlock. This trajectory, favoured by Cocks & Torsvik (2002), Budil *et al.* (2014), and Manda & Turek (2018), receives further support herein, based on the occurrence of the *Exallaspis* representatives outside the Laurussian region, in the distinct Homerian-age trilobite assemblages of the Motol Formation in the Prague Basin.

***Exallaspis? perunicana* sp. n.**

(Plate I, figs 1–3)

Type material: The holotype is an incomplete pygidium with original exoskeleton compressed in tuffaceous shale, depicted here on Plate I, fig. 1 (PA1750/47). The paratypes are two pygidia figured here on Plate I, figs 2 (ŠA002) and 3 (ŠA001).

Other material: In addition to the type material, it comprises six pygidia with relicts of exoskeleton.

Type locality: Loděnice in Beroun District – the locality of ‘Barrande’s pits’ on the Černidla hillside, Prague Basin, Barrandian area, Czech Republic; Silurian, Wenlock, Homerian; Motol Formation; *C. lundgreni* Biozone, *T. testis* Sub-Biozone.

Etymology: This species is named after its occurrence in the lower Silurian epicontinental sea of the microcontinent Perunica. The name of Perunica derives from Perun, the god of war, thunder and lightning in the Slavic mythology.

Diagnosis: A species of *Exallaspis* with pygidium bearing pair of prominent major border spines separated by two pairs of subequal minor border spines. Two pairs of unequal minor border spines distal to major pair. Very prominent pleural ridges crossing pleural fields between first axial ring and major border spines. Pygidial border furrows poorly defined, indistinct. Consequently, depressions on pleural fields, typically delimited by elevated anterior and posterior pygidial borders, pleural ridges and axis, are very shallow or absent, especially the anterolateral ones. Second ring furrow narrow and deep. Conspicuous terminal piece behind the second axial ring, reaching posterior border but not tapering toward it. Medium-sized tubercles scattered over the lateral lobes and axis but absent on border spines. Cranidium, free cheek, rostral plate and thorax unknown.

Description: Pygidium relatively short and wide, with a length/width ratio of 0.30 ± 0.03 (not including border spines). Major pair of border spines about twice as long as four posteriorly oriented medial minor border spines. The medial secondary spines more ventrally directed and usually not fully exposed without preparation. Two pairs of unequal short lateral minor border spines, both well-defined. Major border spines and adjacent longer pair of lateral border spines slightly curved abaxially. Dense sculpture consisting of fine granules and much larger tubercles scattered over the axis and pleural areas. On posterior border, tubercles are present at the base of each border spine. Lateral border spines bearing dense small, almost spinose granules and scarce larger granules, but lacking the large tubercles. Anterior and posterior pygidial borders inconspicuous in all type specimens and additional reference material at disposal, as prominent feature. Axis consisting of two axial rings and terminal piece separated by deep furrows. Narrow (*sag.*) terminal piece prominent, reaching posterior border. No postaxial elevation developed. Well-impressed articulating furrow and axial furrow at second axial ring and around terminal piece, except its posterior part (*abax.*) fused with pygidial border. Prominent, vaulted pleural

ribs curved inward from major border spines, reaching shallow axial furrow at first axial ring.

Remarks: Pygidia of coeval *Exallaspis mutica* (Emmrich 1844) from the Baltica continent resemble *Exallaspis? perunicana* sp. n. by bearing relatively short median pairs of minor border spines reaching about a half of length of robust major border spines. On the contrary, major border spines are more incurved and only one pair of outer minor spines is formed in *E. mutica*. Further, second axial ring is smaller and coarse blunt tubercles on axis and pleural fields are missing.

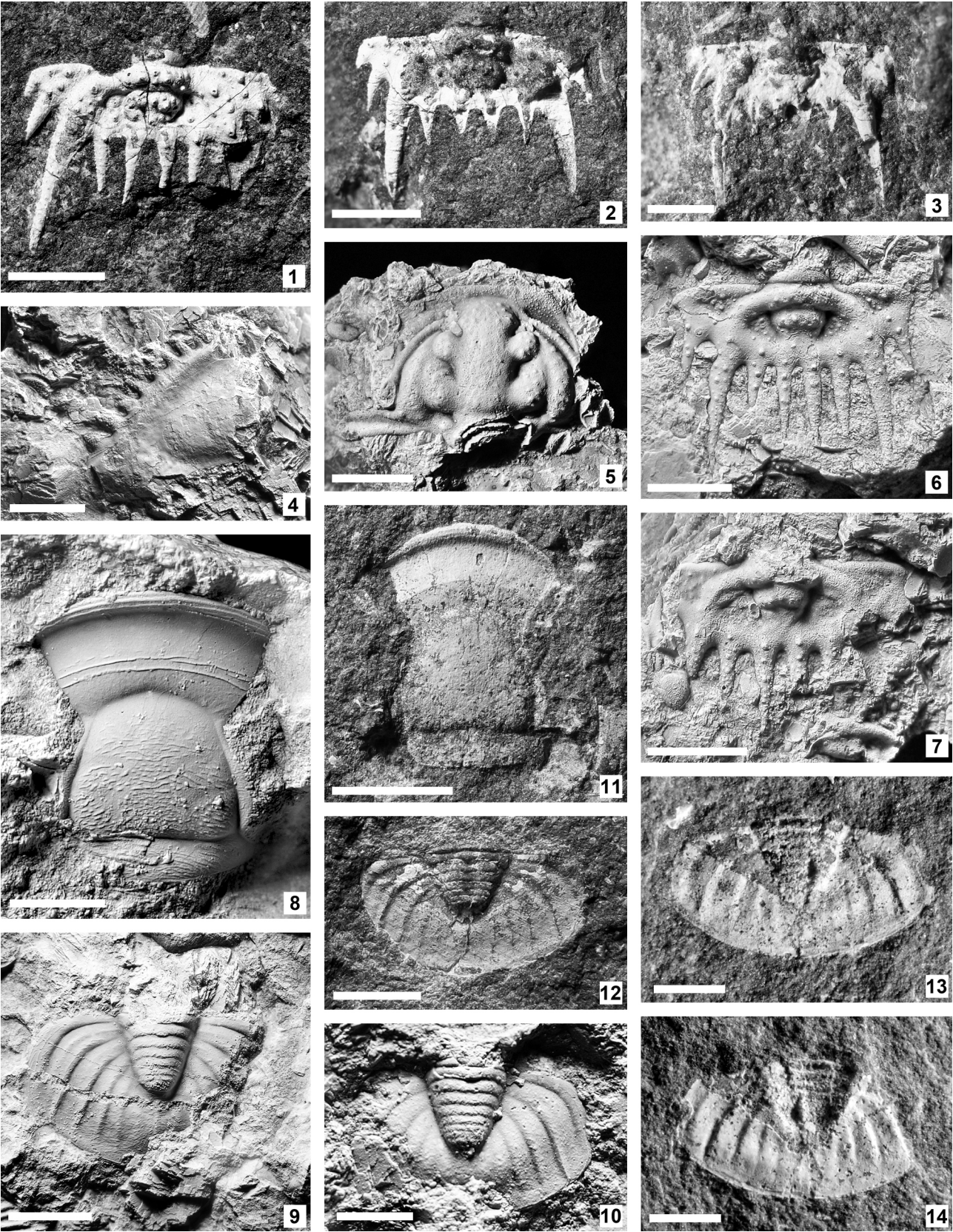
Pygidia of stratigraphically younger *Exallaspis* sp. from the Motol Fm. (see Plate I, figs 6 and 7) differ from *Exallaspis? perunicana* sp. n. by significantly longer median minor border spines, less robust major border spines and only rudimental second pair of outer minor border spines. Axial terminal piece is flattened in *Exallaspis* sp., connected with posterior border by short postaxial elevation. Anterior and posterior borders are well perceptible. Apparent depressions on pleural fields bear corser granules that are lacking on pleural ridges and anterior pygidial border. Larger tubercles are present only at the base and in upper half of border spines.

Exallaspis? perunicana sp. n. is stratigraphically the oldest representative of the genus *Exallaspis* identified so far in the Silurian deposits of the Prague Basin.

Notably, some species of another acidaspidine genus, *Meadowtownella* Přibyl & Vaněk (1965), share some morphologic characters, e.g., the number and configuration of pygidial border spines, with *Exallaspis* (see Ramsköld & Chatterton 1991). Siveter (1989) reported *Meadowtownella mendica* (Siveter 1989) as the youngest (and so far the only Silurian) representative of the genus from the likely early Gorstian-age deposits [in conformity with accompanying *E. coronata* (Salter 1853)] at the Dingle Peninsula, Ireland (Avalonia). The pygidia of *M. mendica* resemble those of *Exallaspis* sp. by the configuration of the border spines (with two pairs of both medial and lateral minor spines) as well as the coarse granulation; the lateral border spines are longer in the *mendica* species.

Occurrence: *Exallaspis? perunicana* sp. n. has so far been collected only at the type locality (tuffaceous shales), as a rare component of the *Aulacopleura koninckii* Assemblage.

Plate I



***Exallaspis* sp.**

(Plate I, figs 4–7)

Exallaspis aff. *mutica* (Emmrich, 1844): Vokáč *et al.* (2021, p. 75, pl. 6, figs 1–3)

Material: Four pygidia, fragmentary fifteen cranidia and two librigenae.

Remarks: The two pygidia and the almost complete cranidium, refigured here on Plate I, figs 5–7, were originally reported by Vokáč *et al.* (2021) and provisionally assigned with some reservations to *Exallaspis mutica* (Emmrich). Herein we present on Plate I, fig. 4, for the first time, an incomplete left librigena (as a cast) lacking the genal spine and some anterolateral border spines. Nevertheless, closer inspection of the Barrandian material reveals a stronger resemblance to specimens of *Exallaspis marklini* (Angelin 1854) from German “Graptolithengestein” erratics figured by Schrank (1969) on pl. 4, figs 9–10, pl. 5, figs 1–6 and pl. 6, figs 1, 3 and 4–7.

The definition of the taxon *Exallaspis marklini* is, however, restricted by the poor state of preservation of the Angelin's holotype [an external mould of incomplete exoskeleton, figured by Bruton (1967) on pl. 30, fig. 7] and lacking paratypes. Given the lack of some key distinguishing characters, *E. marklini* was considered a *nomen dubium* by Ramsköld (1984) and Ramsköld & Chatterton (1991). The complex current situation requires a thorough revision, also considering the variability aspect, of the upper-Homerian taxa *E. marklini*, *E. muldensis* (Bruton 1967) and *E. bufo* (Ramsköld 1984) from Gotland (including the material from the German erratics). All these taxa have been re-

ported from the *P. parvus* – *G. nassa* Biozone, much like the Barrandian species *Exallaspis* sp. at Tachlovice. The following specific features distinguish *Exallaspis* sp. from the closely related specimens of *E. marklini* (= *E. bufo* ?) figured by Schrank (1969): (a) major lateral border spines on pygidium are only 1.5× longer than medial minor border spines, compared to 2.2× in *E. marklini* (pl. 6, fig. 1); (b) blunt tubercles on the posterior pygidial border at the base of border spines are coarser in *E. marklini* (pl. 5, figs 1, 2, 5 and 6); (c) median tubercle on occipital ring very close to posterior margin (but in the lower third of the occipital ring (*sag.*) in *E. marklini* (pl. 5, fig. 2; pl. 6, fig. 6); (d) abaxial part of the glabellar frontal lobe subdivided into two parts by very shallow lateral furrows at a position where eye ridges approach frontal lobe – a striking feature present in neither *E. marklini* (bulbous frontal lobe with rounded anterior margin; pl. 5, fig. 6; pl. 6, fig. 6) nor *E. mutica* [shorter (*sag.*), flatter (*tr.*) and less inflated frontal lobe; pl. 3, fig. 3; pl. 4, fig. 6]. These differences in the morphology of pygidia and cranidia strongly indicate that *Exallaspis* sp. represents a new species, or a subspecies of *E. bufo*. However, at this stage we leave it under open nomenclature.

Occurrence: Known only from the former mill race at the Prostřední mlýn (mill) near Tachlovice on the outskirts of Prague. Tuffaceous limestone of the Motol Formation, Silurian, upper Homerian, the *P. parvus* – *G. nassa* Biozone interval, the *Paraleiolicas versutus* – *Eophacops trapeziceps* Assemblage (the type locality, cf. Vokáč *et al.* 2021).

Plate I. 1–3 - *Exallaspis*? *perunicana* sp. n., 1 - incomplete pygidium with corroded original exoskeleton, holotype, PA1750/47. 2 - incomplete pygidium, internal mould with relics of exoskeleton, paratype, ŠA002. 3 - incomplete pygidium with corroded exoskeleton, paratype, ŠA001. ‘Barrande's pits’ on the Černidla hillside at Loděnice in Beroun District, Prague Basin, Czech Republic; Silurian, Homerian; Motol Fm.; *T. testis* Sub-Biozone; *Aulacopleura koninckii* Assemblage; 4–7 - *Exallaspis* sp. (Angelin 1854). 4 - fragment of left librigena (internal mould), PA1645/T. 5 - incomplete cranidium with partially corroded exoskeleton, orig. Vokáč *et al.* (2021, pl. 6, fig. 1), TM572/5a. 6 - pygidium (internal mould with relics of exoskeleton), orig. Vokáč *et al.* (2021, pl. 6, fig. 2), TM569/5b. 7 - incomplete pygidium (internal mould with relics of exoskeleton), orig. Vokáč *et al.* (2021, pl. 6, fig. 3), TM568/5b. Tachlovice – Prostřední mlýn (mill), Prague Basin, Czech Republic; Silurian, Homerian; Motol Fm.; *P. parvus* – *G. nassa* Biozone; *Paraleiolicas versutus* – *Eophacops trapeziceps* Sub-Assemblage; 8–10 - *Kosovoproetus*? *praecursor* (Příbyl & Vaněk 1987). 8 - complete cranidium with exoskeleton, FH1259. 9 - incomplete pygidium with exoskeleton, FH0715. 10 - incomplete pygidium with exoskeleton, orig. Vokáč *et al.* (2021, pl. 8, fig. 2), FH0714. Srbsko – “V Kozle” (rock), Prague Basin, Czech Republic; Silurian, Homerian; Motol Fm.; *T. testis* Sub-Biozone; *Liolalax–Spaherexochus–Cheirurus* Assemblage; 11–14 - *Kosovoproetus*? aff. *praecursor* (Příbyl & Vaněk 1987), 11 - cranidium with corroded exoskeleton, PA1829/47. 12 - complete deformed pygidium (internal mould with relics of exoskeleton), orig. Vokáč *et al.* (2021, pl. 8, fig. 3), AH001. 13 - complete deformed pygidium (internal mould), FH1783. 14 - negative counterpart to FH1783 with relics of exoskeleton, FH 1784. ‘Barrande's pits’ on the Černidla hillside at Loděnice in Beroun District, Prague Basin, Czech Republic; Silurian, Homerian; Motol Fm.; *T. testis* Sub-Biozone; *Aulacopleura koninckii* Assemblage. Scale bars equal 1 mm (figs 3, 13 and 14), 2 mm (figs 1, 2, 5, 6, 8, 11 and 12), 3 mm (figs 7, 9 and 10), 4 mm (fig 4). The specimens on figs 4–10 were coated by ammonium chloride prior photographing; photographs taken by M. Pavlovič (1–12) and F. Hartl (13, 14).

Subfamily **Tropidocoryphidae** Přibyl, 1946

Genus **Kosovoproetus** Šnajdr, 1981

Type species: *Kosovoproetus migrenin* Šnajdr, 1981; Silurian, Ludlow, upper Ludfordian, Kopanina Formation, horizon with *Prionopeltis archiaci*, Kosov Quarry near Beroun, Prague Basin, Barrandian area, Czech Republic.

Remarks: The type species known only from pygidia (Šnajdr 1981, Vokáč *et al.* 2021). The stratigraphically older *Kosovoproetus? praecursor* (Přibyl & Vaněk 1987) from lower Homerian (*C. lundgreni* Biozone, *T. testis* Sub-Biozone, the trilobite *Liolalax–Sphaerexochus–Cheirurus* Assemblage), *Kosovoproetus?* aff. *praecursor* from upper Homerian (*P. parvus* – *G. nassa* Biozone) and Gorstian (*N. nilssoni* Biozone) in Vokáč *et al.* (2021), and *Kosovoproetus? krizi* Vaněk & Vokáč (2004) from lower Ludfordian (*S. leintwardinensis* – *B. tenuis* Biozone, the *Sphaerexochus–Proetus* Assemblage) are all tentatively assigned to the genus because of the inadequately known type species (*cf.* Vokáč *et al.* 2021). The pygidium illustrated by Vokáč *et al.* (2019, pl. 2, fig. 3) as *Kosovoproetus?* sp. from lower Ludfordian strata in the Kosov Quarry near Beroun (basal layers with the *Encrinuraspis–Eophacops* Assemblage) bears a strong resemblance to *Kosovoproetus? krizi*, the main difference being that the first two pleural ribs that are bent backwards less abruptly in the former.

The tropidocoryphine fragments illustrated by Adrain (1997, pl. 28, figs 1–3, 5, 6, 8–11, 13) from the Cape Phillips Formation (Wenlock, upper Sheinwoodian (*C. perneri* Biozone) of Bailie-Hamilton Island in the central Canadian Arctic Archipelago possibly also belong to *Kosovoproetus*. The cranidia (representing two different species) exhibit a wide tropidium composed of up to four subparallel ridges or undulating crests. This material may represent the earliest occurrence of *Kosovoproetus?*. It is tempting to suggest a migration route in the late Sheinwoodian from northern Laurentia (located near the Equator) across the already closing Iapetus Ocean to Avalonia-Baltica and across the Rheic Ocean (Cocks & Torvik 2011).

Kosovoproetus? praecursor (Přibyl & Vaněk, 1987)

(Plate I, figs 8–10)

1987 *Tropidocoryphe* (subg.?) *praecursor* sp. n. Přibyl & Vaněk, 1987, p. 69, pl. 1, figs 5–7.

1989 "*Tropidocoryphe? praecurrens* (sic) Přibyl & Vaněk; Pek & Vaněk, p. 27.

1990 *Tropidocoryphe praecursor* Přibyl & Vaněk; Vaněk, p. 122.

1993 *Tropidocoryphe? praecurrens* (sic); Kříž *et al.*, p. 819.

2000 *Kosovoproetus* (?) *praecursor* (Přibyl & Vaněk); Vokáč, p. 7.

2002 *Kosovoproetus praecursor* (Přibyl & Vaněk, 1987); Vaněk & Valíček, p. 39.

2004 *Kosovoproetus praecursor* (Přibyl & Vaněk, 1987); Vaněk & Vokáč, text-fig. 1a–c.

2014 *Tropidocoryphe? praecurrens* Šnajdr (sic); Frýda & Frýdová, p. 620.

2021 ?*Kosovoproetus praecursor* (Přibyl & Vaněk, 1987); Vokáč *et al.*, p. 81, pl. 8, figs 1 and 2.

Material: The type specimens consist of a cranidium lacking the occipital ring (holotype, NM-L 23755 in National Museum, Prague), a fragmentary cranidium with well-preserved palpebral lobes and an incomplete right librigena with eye (paratypes). Vaněk & Vokáč (2004) further illustrated two well-preserved cranidia and one pygidium. The reference material is supplemented with two additional cranidia and two fragmentary pygidia illustrated by Vokáč *et al.* (2021) and in the present work.

Occurrence: *Kosovoproetus? praecursor* is a rare to very rare component of the highly diverse *Liolalax–Sphaerexochus–Cheirurus* Assemblage (*sensu* Chlupáč 1987, redefined by Vokáč 2000), with the index species *L. bouchardi*, *S. mirus* and *Ch. obtusatus*. This trilobite community thrived in the shallow-water (BA2–3) tuffitic-carbonate sediments of the Prague Basin within the interval of the *C. perneri* Biozone – *T. testis* Sub-Biozone (Motel Formation, uppermost Sheinwoodian – lower Homerian). The present material comes from the type locality of this species, a 1 m-thick bed of a brown-red bioclastic limestone exposed in the synclorium at “V Kozle” (rocks) near the village of Srbsko in Beroun District.

Kosovoproetus*? aff. *praecursor (Příbyl & Vaněk, 1987)

(Plate I, figs 11–14)

Kosovoproetus? cf. *praecursor* (Příbyl & Vaněk 1987): Vokáč *et al.* (2021, p. 82, pl. 8, fig. 3).

Material: A cranidium and two pygidia compressed in tuffaceous shale.

Remarks: The cranidium of *Kosovoproetus*? aff. *praecursor* (Plate I, fig. 11), despite the deformation and corroded exoskeleton, bear a close resemblance to those of *K.*? *praecursor* from the shallow-water *Liolalax*–*Sphaerexochus*–*Cheirurus* Assemblage. The only striking difference is the presence of a single tropidial ridge on the preglabellar field instead of two tropidial ridges typically present in the established species (Plate I, fig. 8). The outline of the glabella appears to be more pear-like in *K.*? aff. *praecursor*, which, however, may have been affected by the unfavourable preservation. The pygidia of *K.*? aff. *praecursor* (Plate I, figs 12–14) differ from those of the established species (Plate I, figs 9, 10, and Vaněk & Vokáč 2004) in being relatively shorter, with the ratio of length (without articulating half-ring) to maximum width reaching 0.49 compared to 0.56; the axis is relatively shorter, comprising up to 0.49 times the pygidial length compared to 0.52, and contains merely 6+1 rings (with a small terminal piece) compared to 7+1 rings.

The holaspid cranidia and pygidia of *Kosovoproetus*? *praecursor* from the shallow-water limestones at the type locality “V Kozle” are more than twice as large as those of *K.*? aff. *praecursor* from the deep-water sediments at the ‘Barrande’s pits’ at Černidla. This difference may represent another example of nanism in the “*Aulacopleura* shales”, resulting from an adaptation to the different habitat, much like some other trilobite taxa from the *Liolalax*–*Sphaerexochus*–*Cheirurus* Assemblage. If so, the specimens of *K.*? aff. *praecursor* from the “*Aulacopleura* shales” probably do not represent carapace parts transported along the sloping sea bottom from a shallower to a deeper environment.

The comparably small solitary pygidium of stratigraphically younger *Kosovoproetus*? aff. *praecursor* A (see Vokáč *et al.* 2021, pl. 8, figs 5 and 6) from the tuffaceous limestone at Prostřední mlýn (mill) near Tachovice (the *P. parvus* – *G. nassa* Biozone interval, the *Paraleiolicas versutus* – *Eophacops trapeziceps* Assemblage) also bears

only 6+1 axial rings; although, the sag. length to *tr.* width ratio of about 0.57 complies with the established species. The analysis of morphological variability depending on the palaeobiootope requires more material than is available, including juvenile stadia.

Occurrence: Type locality of “*Aulacopleura* shales” at ‘Barrande’s pits’ at Černidla near Loděnice. *Kosovoproetus*? aff. *praecursor* was a very rare component of the deep-water *Aulacopleura koninckii* Assemblage.

CONCLUSIONS

In this contribution two very rare new taxa have been supplemented into the *Aulacopleura koninckii* Assemblage at the type locality of the “*Aulacopleura* shales” at Černidla near Loděnice: *Kosovoproetus*? aff. *praecursor*, adapted by small dimensions to the deep-water *Aulacopleura*–*Raphiophorus* Biofacies (Edgecombe & Sherwin 2001, Sandford & Holloway 2006), and *Exallaspis*? *perunicana* sp. n. that is currently the earliest representative of this acidaspidine genus in the Silurian strata of the Prague Basin. It remains to be unravelled to which extent the striking morphological differences between the pygidia of the new *Exallaspis* taxon and other Silurian representatives of this genus, especially the coeval *E. mutica* from southern Baltica, depend on the local lithofacial conditions. The two pairs of lateral border spines in *E.*? *perunicana* also resemble the only known Silurian representative of the acidaspidine genus *Meadowtownella*, namely *M. mendica* (Siveter 1989). *Exallaspis*? *perunicana* is a rare trilobite taxon from the deep-water biocenosis preserved in the clay-tuffaceous shales of the lower Homerian, *T. testis* Sub-Biozone, which has not been known to date in the limestone deposits from the well-lightened shallow-water environment inhabited by the *Liolalax*–*Sphaerexochus*–*Cheirurus* Assemblage.

On the other hand, the stratigraphically younger *Exallaspis* sp. from the upper Homerian of the Prague Basin, the *P. parvus* – *G. nassa* Biozone interval, at Tachovice closely resembles representatives of the Homerian-age taxon *E. marklini* with an uncertain taxonomic position (a *nomen dubium*), from Gotland, Sweden, and German “Graptolithengestein” erratics (Schränk 1969), reflecting the continuing faunal exchanges between the southern Baltica shelf and the Perunica microcontinent within the Rheic Ocean in the late Wenlock.

ACKNOWLEDGEMENTS

We deeply thank both reviewers, Dr. D. J. Holloway and Dr. P. Budil, for their thorough reviews, insightful comments, valuable critical remarks and editorial help. Roman Šach and Arnošt Hanák kindly provided photographs of six additional specimens (pygidia) of *Exallaspis? perunicana* sp. n. from the 'Barrande's pits', housed in their private collections. P. Kryda collected and kindly donated the pygidium of *Exallaspis? perunicana* sp. n. figured herein on Plate I, fig. 1.

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