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FIRST PALAEOZOIC PHYLLOCARID CRUSTACEANS AND PTERYGOTID EURYPTERIDS IN SERBIA

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Abstract

Palaeozoic phyllocarid crustaceans and pterygotid eurypterids from the Gethicum Zone of Carpatho-Balkanides in Serbia are herein documented for the first time. The described and illustrated phyllocarid remains consisting of a coupled telson and furcal rami were collected from upper Silurian (?) shale. This specimen is fragmented and poorly preserved to allow identification to species level, and has thus been assigned to *Ceratiocaris* sp. indet. The eurypterids are represented by part of a fragment, showcasing the distinct scale-like ornamentation of the pterygotids, and a segment of a walking leg. The pterygotid remains were found together with a few graptolite taxa (*Monograptus sudeticus* Porębska, *"M." microdon microdon* Reinh. Richter, *Neomonograptus aequabilis* (Přibyl), *Uncinatograptus hercynicus* (Perner), *U. subhercynicus* (Willefert)), which are characteristic for the lower part of the *U. hercynicus* graptolite zone (Lochkovian, Lower Devonian). There are at least two species in this stratigraphic interval that correspond to the pterygotid eurypterids remains from Serbia – *Acutiramis perneri* Chlupáč and *Pterygotus* cf. *barrandei* Semper, but without the chelicerae, it is impossible to make precise identification. These new finds from eastern Serbia, together with the Bulgarian ones, are a further confirmation of peri-Gondwanan origin of pre-Variscan Palaeozoic sediments in the West Srednogorie Unit in Bulgaria and in the Gethicum Unit in Serbia.

Key words: phyllocarid crustaceans, pterygotid eurypterids, Palaeozoic, palaeogeography, Serbia

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Introduction. The low-grade metamorphic Palaeozoic rocks of the Gethicum Zone of the Carpatho-Balkanides in Serbia yielded a variety of fossils. Although some of the fossiliferous sites with conodonts, graptolites, molluscs, etc., are well known [1,2], fossils belonging to startigraphically less important groups have been in many cases overlooked or only sporadically mentioned. Given the spatial continuation of the tectonic units in western Bulgaria and eastern Serbia, West Srednogorie Unit and Gethicum Unit, respectively [1,3], all groups of Orodovician to Devonian fossils could be beneficial for regional correlation and palaeogeographic interpretation.

The features of sporadic but important finds of arthropods in Bulgaria [4,5] and in Serbia (this study) point towards similarity in the assemblages of the Silurian phyllocarid crustaceans [6–8], and Devonian pterygotid eurypterids [9–12] of the peri-Gondwanan Realm. Furthermore, similar occurrences are known from wider geographical area, i.e., Czech Republic, Germany, France, Italy, and Spain. The subject of this paper is a description of the first record of the above-mentioned arthropods in the Palaeozoic of the Gethicum Zone of Serbia and their stratigraphic position.

Geological setting. The Palaeozoic of the Gethicum Zone (or Kučaj Zone in local literature) represents the low-metamorphosed basement which has been covered and deformed during the Alpine orogenic cycle (Fig. 1A). The Upper Cambrian to Lower Carboniferous metamorphosed sediments were described from a variety of depositional environments along the peri-Gondvanan margin [2]. Most of the early Palaeozoic of the Gethicum could be observed in the central part of the zone, in the Kučaj Mountains (Fig. 1A). Of special interest for this contribution are the upper Silurian (?) and Lower Devonian sedimentary rocks exposed on the road-cut located in the Omaniš Creek in central part of the Kučaj Mts. (Fig. 1C). The upper Silurian in the Gethicum Zone in Serbia is represented by fine-grain terrigenous sedimentary rocks (silty shale and siltstone) belonging to basinal metapelites with several known localities providing graptolites [1]. The transition to Devonian is lithologically continuous and is marked by Lochkovian graptolites. During the Late Lochkovian, the sedimentary environment changed to the so-called "preflysch" regime and siliceous shales, black cherts, siltstones and sandstones were deposited [2].

The outcrop at the Omaniš Creek exposes $\sim$ 70 m of upper Silurian (?) and Lower Devonian rocks (Fig. 1B). The bedding is deformed into open folds with E-dipping axes. The sedimentary succession is truncated by a thrust with top-to-S transport. The hanging wall is made of brown to gray sandstone with crinoids ($\sim$ 5 m) interbedded by yellowish shale with phyllocarids (2 m). The footwall consists of black shale with graptolites, brachiopods and eurypterids ($\sim$ 10 m), which pass into a 15-m-thick succession of gray siltstone, black chert and shale. The rest of the column is made of thin bedded sandstone and siltstone ($\sim$ 30 m).

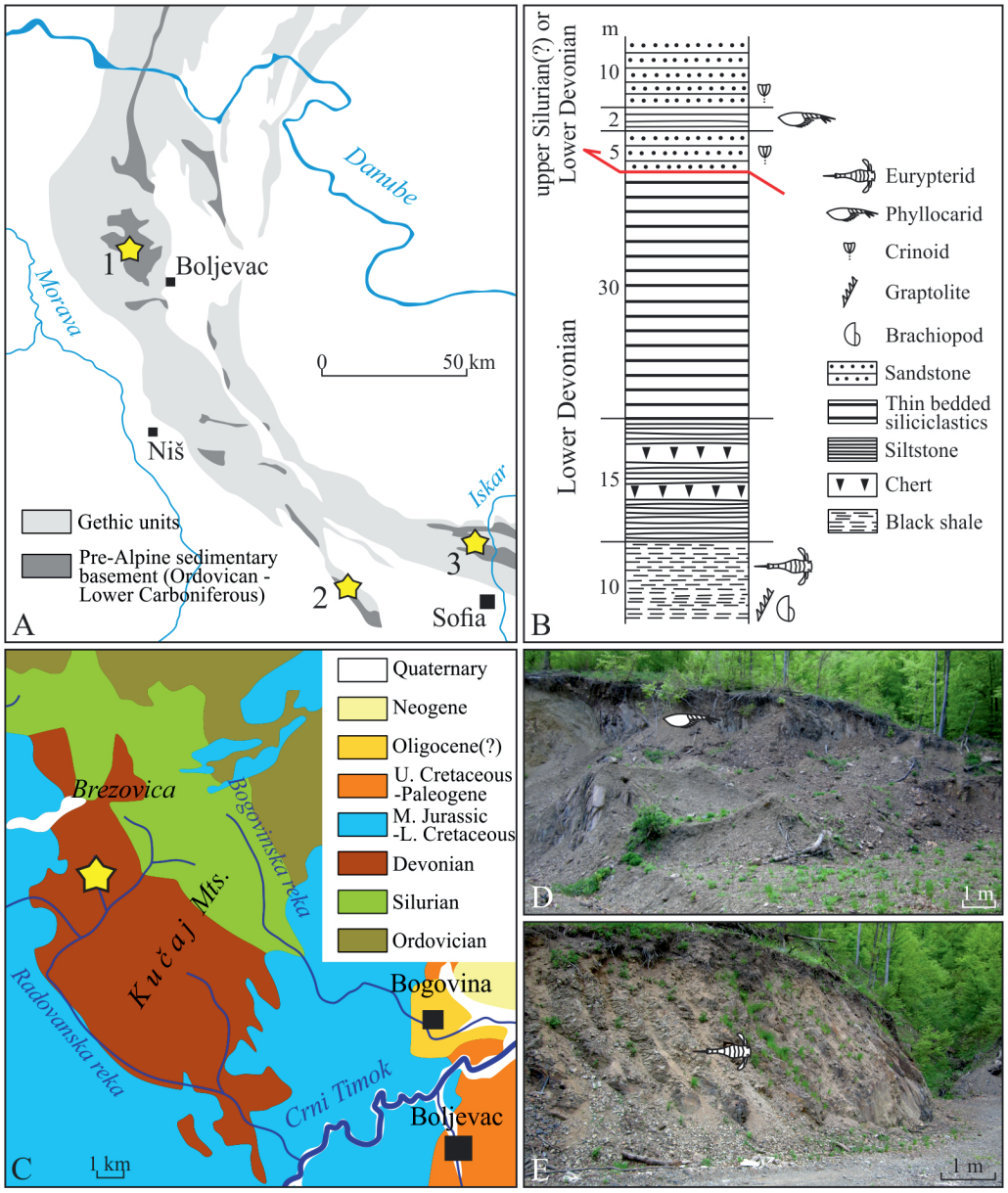


Fig. 1. A – Position of sites with fossil arthropod finds in the central Balkan Peninsula [13]: 1 – Omaniš (Serbia), 2 – Stanyovtsi (Bulgaria), 3 – Busin Dol (Bulgaria); B – Lithological log of the Omaniš site; C – Geological sketch map of the central part of Kučaj Zone [13], the star indicates position of Omaniš Creek; D – Position of the find of Phillocarid fossil at the Omaniš site; E – Position of the find of Eurypterid fossil at the Omaniš site

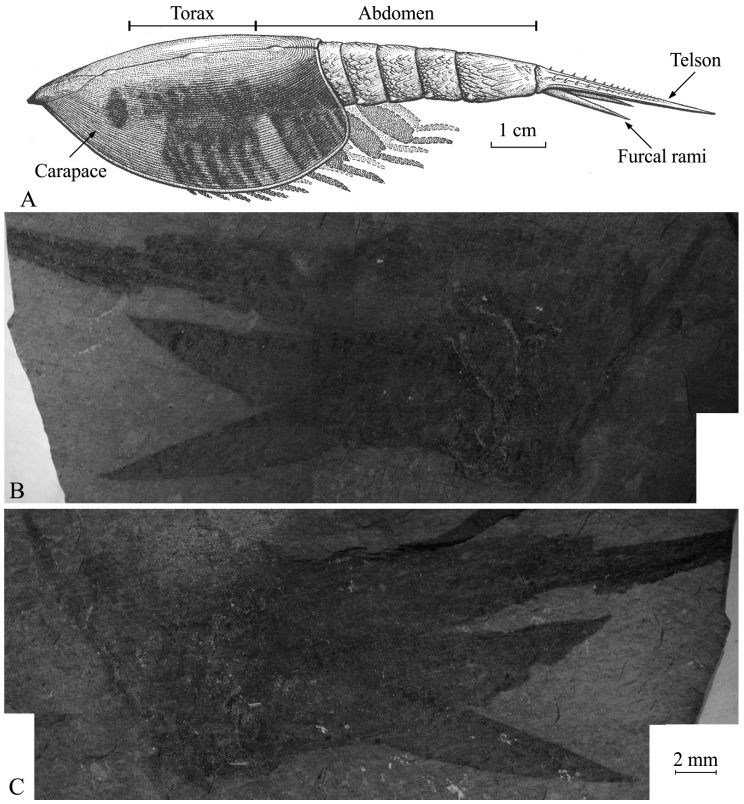


Fig. 2. A – Reconstruction of a phyllocarid [14]; B, C – part and counterpart of a telson and furcal rami in connection, specimens DC622/1.1 and DC622/1.2

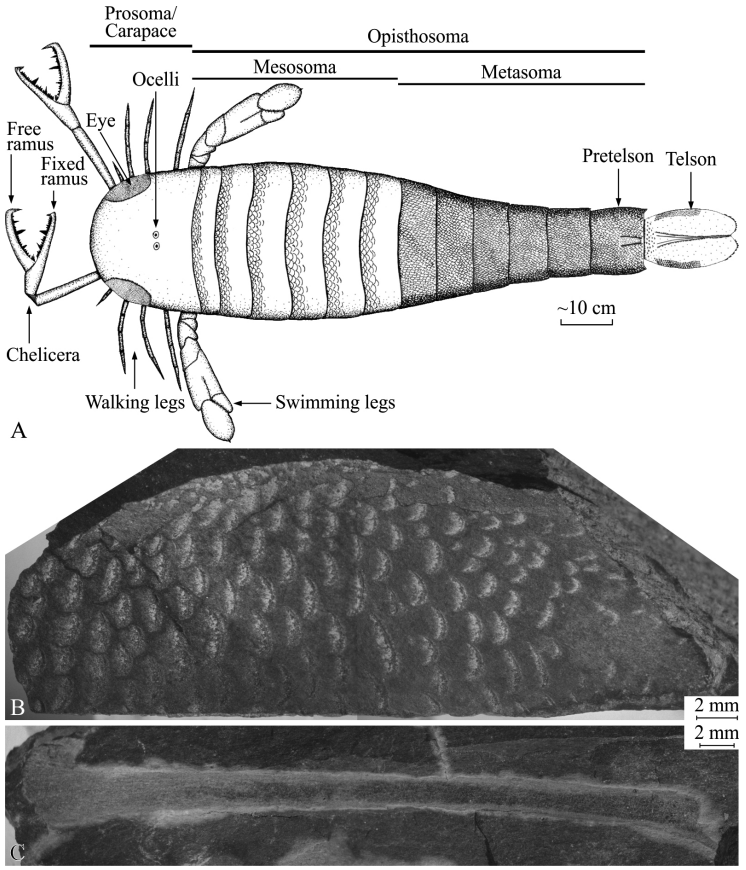


Fig. 3. A – Dorsal reconstruction of a pterygotid eurypterid [17,18]; B – part of a tergite, showcasing the distinct scale-like ornamentation of the pterygotids, specimen DB622/14.3; C – incomplete walking leg, specimen DB622/14.4

Materials and methods. The described fossils were found in two levels of the studied section – DC622 and DB622. The level DC622 (Fig. 1D) contains a telson and furcal rami in connection which are represented by both part and counterpart (Fig. 2). They are preserved as organic remains of the cuticle, which tends to flake off when the rock is split. Some cuticle fragments remain on the part and other – on the counterpart and show tectonic distortion. Remains of pterygotid eurypterids were found at level DB622 (Fig. 1E), represented only by part of a fragment, showcasing the distinct scale-like ornamentation of the pterygotids and a segment of a walking leg (Fig. 3). They are preserved in very low relief and do not seem to show tectonic distortion.

All specimens figured herein were collected by one of us (MR) during the field study of Lower Palaeozoic of Kučaj Mts. The described and figured material is currently stored at a private collection (MR). Photographs of the specimens were taken in the Geological Institute, Sofia, under polarized light using a binocular microscope Stemi 305 Zeiss equipped with an Axiocam 208 color digital camera. Photographs were processed and arranged into figures using Adobe Photoshop CS6.

Palaeontological, stratigraphical and palaeogeographic notes. Phyllocarids are malacostracan crustaceans that possess a bivalved carapace (with or without dorsal hinge line), eight limb-bearing thoracic somites, an abdomen of seven somites (five-to six-bearing limbs) terminating in a telson, and generally, furcal rami (Fig. 2A). Phyllocarids are divided into two classes, an extinct one, middle–late Cambrian to Permian, Archaeostraca (which can be large, have five limb-bearing abdominal somites, a carapace with hinge line, and a telson produced into elongate structure located medially between two lateral furcal rami), and the other one, Permian to recent Leptostraca (which are small, have six limb-bearing abdominal somites, a carapace without a hinge line, and a telson not produced into medial process between lateral furcal rami). These arthropode fossils occur in intertidal facies, an ecological niche that a substantial portion of modern leptostracan species still recently inhabit [15].

The phyllocarid crustacean specimens DC622/1.1 and DC622/1.2 are a telson and furcal rami in connection, which are represented by both part and counterpart (Fig. 2B, C). The telson is elongate, styliform, with very indistinct striations and non-preserved spine. The telson head is robust, strongly broadened. Furcal rami are broad and flattened, styliform, tapering evenly to a sharp terminus. Dorsal surface is smooth, with thickened margins. Distal termini of furcal rami are slightly upturned dorsally. The phyllocarid crustaceans are found at level DC622 above the crinoid beds. The Gethicum Zone in Eastern Serbia is an analogue of the Lyubash-Golo Bardo Unit in Bulgaria [3], where crinoids appear at the base of the Pridoli (upper Silurian). The phyllocarid crustaceans with furcal rami of similar age are found in: the Czech Republic [6] – *Warneticaris grata* (Chlupáč) synonymized by Collette and Hagadorn [15], *Ceratiocaris bohem-*

ica (Barrande); France [7] – *C. bohemica*, "*C.*" *rubini* Péneau, *W. cenomanensis* (Tromelin); Sardinia [8] – *C. bohemica*, *W. cenomanensis*. In shape and size, the telson and furcal rami are closest to *Ceratocaris papilio* Salter in Murchison from peri-Gondwanan Prague Basin (Ludlow, Silurian) [16], but this is not enough for species determination. Therefore, they are identified in our study as *Ceratiocaris* sp. indet.

The pterygotids are typified by a set of characters: enlarged chelicerae, slender non-spiniferous appendages, undivided genital appendages, laterally expanded pretelson and a medially carinated, broad paddle-like telson with a complex marginal cuticula (Fig. 3A). The pterygotids ranged from the late early Silurian (Llandovery/Wenlock boundary, c. 428 ma) to the Middle Devonian (Eifelian, c. 391 ma), during around 37 myr [19].

At level DB622 of the Omaniš section, two eurypterid remains were found (Fig. 3B, C). The specimen DB622/14.3 shows a typical scale-like ornament found mainly on the tergites of pterygotid eurypterid genera. The segment of a walking leg (specimen DB622/14.4) is non-spiniferous, long (40 mm) and thin (2–4 mm). The podomere is not of uniform width, but the proximal and distal bases are broader than the medial width. The only known pterygotid genera known to survive by the end of Silurian are *Pterygotus*, *Acutiramus* and *Jaekelopterus*, the latter one without a peri-Gondwana affinity [19]. The pterygotid remains associate with few graptolite taxa in this level, which are characteristic of the lower part of the *Uncinatograptus hercynicus* graptolite zone (Lochkovian, Lower Devonian). There are at least two eurypterid species in this stratigraphic interval that correspond to the pterygotid eurypterid remains from Serbia – *Acutiramis perneri* Chlupáč and *Pterygotus* cf. *barrandei* Semper. The first one is common in the upper Lochkovian *U. hercynicus* graptolite zone in the Czech Republic, as well as in the lower Lochkovian *U. uniformis* graptolite zone [9]. It has also been found in Catalonia (NE Spain) in the middle Lochkovian *U. praehercynicus* graptolite zone [12]. All known specimens of *Pterygotus barrandei* from Bohemia derived from the uppermost Silurian strata of Pridolian age. In contrast, the Catalonian specimen designated as *Pterygotus* cf. *barrandei* comes from younger, namely Lochkovian strata, which may indicate the overlap of the *Pterygotus barrandei* lineage from the Silurian into the Lower Devonian (Lochkovian) without marked changes [12]. The pterygotid remains in Bulgaria from the lower Lochkovian *U. uniformis* graptolite Zone [5] should also be considered *Pterygotus* cf. *barrandei*. They were documented in the Lyubash–Golo Bardo Unit [3]. It is possible that the pterygotid eurypterid remains from Serbia also belong to this species, but without the chelicerae, it is impossible to make precise identification.

Conclusions. The first reported eurypterids in Western Bulgaria are from the Lower Devonian (Lochkovian, *Uncinatograptus uniformis* graptolite zone) dark shales in the Lyubash–Golo Bardo Unit. One fragment shows a typical scale-like ornament found mainly on the tergites of pterygotid eurypterid genera,

and two fragments of a chelicera belong to *Acutiramis bohemicus* and/or *Pterygotus barrandei*. Prolongation of the Lyubash–Golo Bardo Unit in Eastern Serbia is the Gethicum Zone. Eurypterids there are represented by a fragment with the distinct scale-like ornamentation of the pterygotids, and a segment of a walking leg. The pterygotid remains were found together with a few graptolite taxa, which are characteristic of the lower part of the *U. hercynicus* graptolite zone (Lochkovian, Lower Devonian). There are at least two species in the world from this stratigraphic interval that correspond to the pterygotid eurypterid remains from Serbia, namely *Acutiramis perneri* Chlupáč and *Pterygotus barrandei* Semper.

The Silurian phyllocarid crustaceans from the Balkans were found in the Wenlockian shale of the Svoge Unit, West Bulgaria, and in the upper Silurian (?) grayish to yellow siltstones of the Gethicum Zone (= Kučaj Zone), Eastern Serbia. Both specimens represent a telson and furcal rami in connection. These phyllocarid remains are too poorly preserved to allow identification to species level, and have thus been assigned to *Ceratiocaris* sp. These finds, nevertheless, suggest that phyllocarids may have been a common component of assemblages present in shale facies from the Silurian in the peri-Gondwanan Europe.

These new finds from eastern Serbia, together with the Bulgarian ones, are a further confirmation of peri-Gondwanan origin of pre-Variscan Palaeozoic sediments in the West Srednogorie Unit in Bulgaria and in the Gethicum Unit in Serbia.

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