A fossil arachnid from Slovakia: the Carboniferous trigonotarbid *Anthracomartus voelkelianus* Karsch, 1882

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Summary

A trigonotarbid arachnid referable to *Anthracomartus voelkelianus* Karsch, 1882 is described from the Late Carboniferous (Moscovian) (= Westphalian C) of Jerusalemsberg near Dobšiná in eastern Slovakia. This record is significant as both the first fossil arachnid formally described from Slovakia and, whilst it does not come from a classic Coal Measures locality with a terrestrial palaeoenvironment, the sediments were deposited in a marine–deltaic environment typical for arachnid fossils. An overview of the distribution of the 17 currently recognized species of Anthracomartidae is presented.

Introduction

Trigonotarbids form an extinct order of diverse spider-like arachnids which are currently known from Late Silurian (Přídolí) to Early Permian (Asselian) strata (Dunlop 2010). Arachnids are generally uncommon as fossils, therefore the discovery of any well-preserved specimen is of note. Trigonotarbids have been recovered most frequently from the Upper Carboniferous Coal Measures of Europe and North America, where they are commonly one of the more abundant fossil arachnid groups (e.g. Dunlop & Rössler 2002; Garwood & Dunlop 2011). Here, we redescribe a trigonotarbid specimen, originally reported as *Pleomartus* sp. indet. by Vaňová (1987), which we refer to *Anthracomartus voelkelianus* Karsch, 1882 (Anthracomartidae). Because Vaňová (1987) described and figured the material insufficiently, and her report apparently did not reach the (palaeo)arachnological community, we treat the specimen here as the first formal record of a trigonotarbid from Slovakia. Moreover, it constitutes the first fossil chelicerate reported from the country. The trigonotarbid family Anthracomartidae currently comprises 17 valid species, all Upper Carboniferous in age, spanning a time period from about 300–314 Ma. The geographical occurrences of these taxa are summarized in Table 1.

Material and methods

The fossil described here was discovered during routine revision of samples from an Upper Carboniferous (Moscovian) site – equivalent to the Westphalian C in more traditional terminologies – near Dobšiná in Slovakia (Fig. 1). These specimens were collected in 1981 by Štefan Meszáros and deposited at the Geological Institute of Dionýz Štúr in Bratislava and the Department of Geology and Palaeontology of the Comenius University in Bratislava, Slovakia. The trigonotarbid specimen is currently deposited under the repository number KGP-MH DO-001 at the latter institution. The specimen described herein is fairly complete (Figs. 2–3), but possesses damaged lateral margins of the opisthosoma, the shape of which is often critical in the assignment to a genus (see the systematic section). To aid identification, the fossil was photographed using several different methods: 1) dry in cross-polarized light, 2) dry under ultraviolet light, 3) under alcohol in cross-polarized light, and 4) coated with ammonium chloride. Photographs using methods 1 and 3 were made with a Canon EOS 5D MkIII camera and 50 mm macro lens; photographs using other methods were made with an Olympus SP-510UZ camera. An interpretative drawing (Fig. 2B) was prepared from these photographs. All measurements are in millimetres.

Geological setting

The fossil-bearing strata are exposed near the Dobšiná outcrop at one of the oldest documented sites with well-preserved macrofossil content in Slovakia. Upper Carboniferous deposits usually occur within the slightly metamorphosed complex of the Dúbrava massif, forming the Gemeric morphotectonic belt of the Western Carpathians (Bajaník *et al*. 1983). The Zlatník Formation forms a narrow, *c.* 25 km long belt running in an east–west direction, and was deposited during the Variscan cycle in the southern external part of the orogene (Kováč & Plašienka 2003).

The sites are situated slightly to the north of Dobšiná, Slovakia (Fig. 1) in the northern surroundings of an abandoned magnesite quarry. The local name of the locality is Jerusalemsberg (48.828183°N 20.358313°E).

The Zlatník formation is composed of fine-grained to slightly sandy siltstones and limestones. These shallow marine deposits with fine terrigenous admixture sometimes bear abundant plant remains (Sitár & Čapo 1999). The organodetritic admixture mostly consists of fragmented bivalve, brachiopod, or echinoid shells, which can sometimes be observed. The upper part of the formation is composed of fine- to coarse-grained organodetritic limestones with reef communities such as corals, bivalves and crinoids (Bajaník *et al*. 1983).

Based on the macrofaunal records, the age of the formation resolves as Late Carboniferous (probably Moscovian), equivalent to Westphalian C (Rakusz 1932). Bouček & Přibyl (1960) identified several trilobite taxa: *Griffithides*

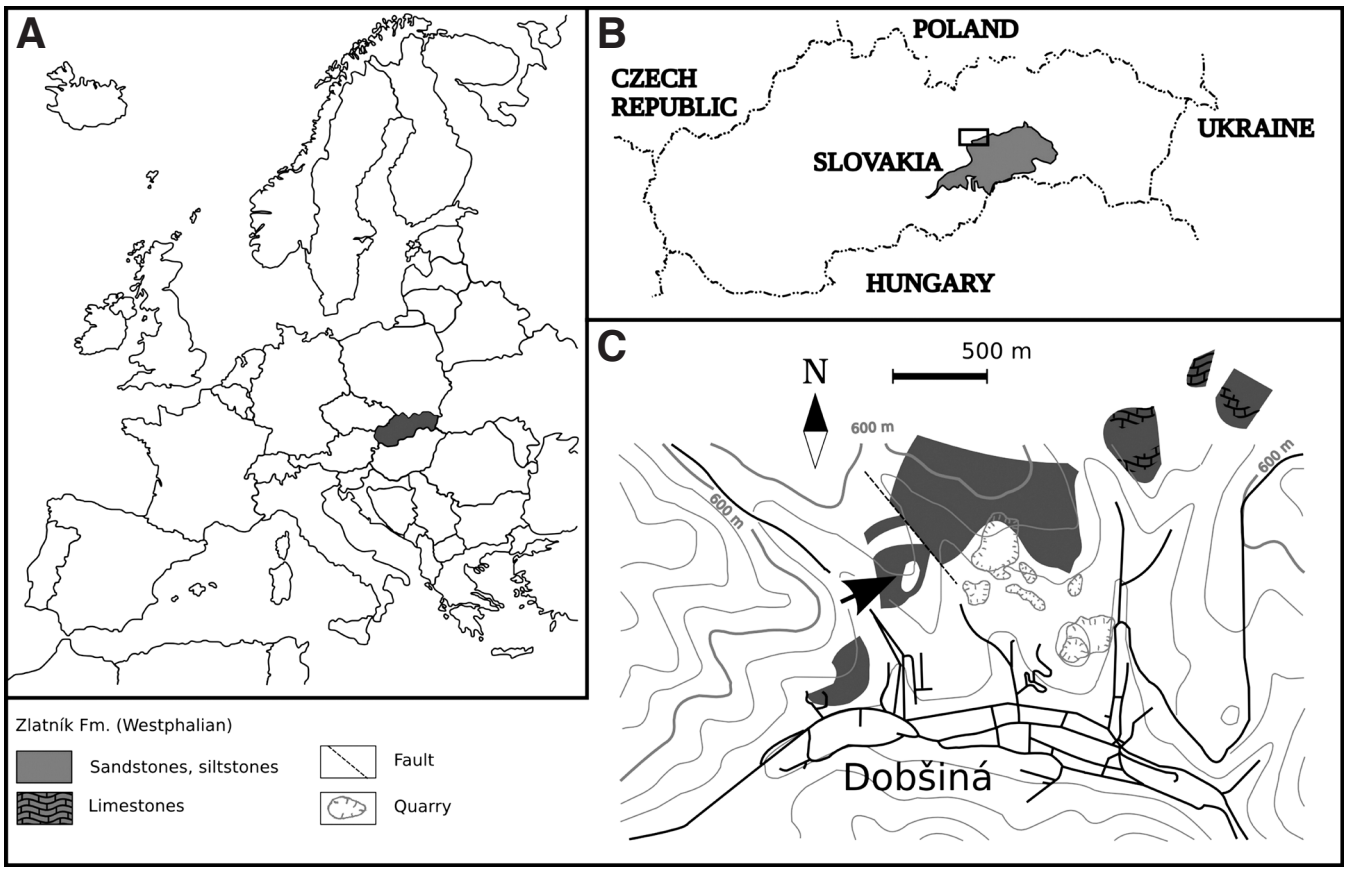

Fig. 1: Geographical position of the locality. **A** location of Slovakia; **B** extent of the Western Carpathian Gemer Superunit, mostly with Late Palaeozoic rocks; **C** position of the Jerusalemsberg locality (arrowed).

Taxon	Distribution	Selected references
Anthracomartus		
A. bohemica (Frič, 1901)	Czech Republic	Frič (1901)
A. carcinoides (Frič, 1901)	Czech Republic	Frič (1901)
A. elegans Frič, 1901	Czech Republic	Frič (1901)
A. hindi Pocock, 1911	Germany, UK	Pocock (1911); Guthörl (1964, 1965); Brauckmann (1984)
A. granulatus Frič, 1904	Poland	Frič (1904)
A. janae (Opluštil, 1986)	Czech Republic	Opluštil (1986)
A. kustae Petrunkevitch, 1953	Czech Republic	Petrunkevitch (1953)
A. minor Kušta, 1884	Czech Republic	Kušta (1884, 1888)
A. nyranensis (Petrunkevitch, 1953)	Czech Republic	Petrunkevitch (1953)
A. palatinus Ammon, 1901	Germany	Ammon (1901)
A. priesti Pocock, 1911	Belgium, UK	Pocock (1911); Pruvost (1922); Petrunkevitch (1949)
A. radvanicensis (Opluštil, 1985)	Czech Republic	Opluštil (1985)
A. triangularis Petrunkevitch, 1913	Canada (Nova Scotia)	Petrunkevitch (1913)
A. trilobitus Scudder, 1884	USA (Arkansas)	Scudder (1884)
A. voelkelianus Karsch, 1882	Poland, Italy (Sardinia), **Slovakia**	Karsch (1882); Selden & Pillola (2009); **this study**
Anthracomartus sp.	USA (Kansas)	Wright & Selden (2011)
Brachypyge		
B. carbonis Woodward, 1878	Belgium	Woodward (1878)
Maiocercus		
M. celticus (Pocock, 1902)	Belgium, Germany, UK (Wales, England)	O'Connor (1896); Pocock (1902); Pruvost (1919); Dorlodot (1920); Dunlop & Horrocks (1996); Essen, Steur & Brauckmann (1997)
undescribed Anthracomartidae	USA (Illinois)	Beall (1997)

Table 1: Overview of the 17 anthracomartid species currently recognized in the literature. The restriction to three valid genera follows the revision of Garwood & Dunlop (2011). For species synonyms see Petrunkevitch (1953) and Garwood & Dunlop (2011); summarized in Dunlop, Penney & Jekel (2012).

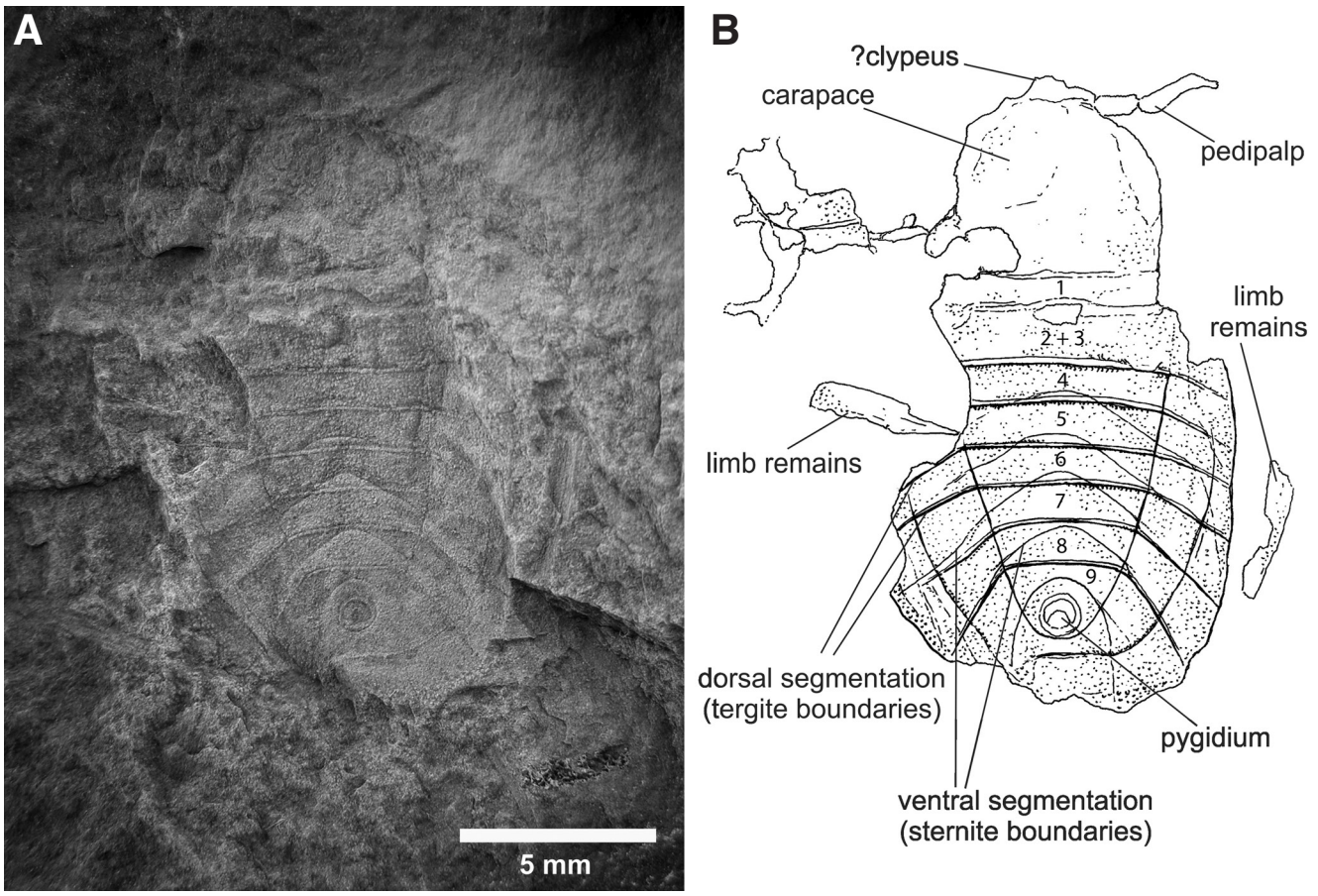

Fig. 2: *Anthracomartus voelkelianus* Karsch, 1882; specimen KGP-MH DO-001. **A** coated with ammonium chloride; **B** interpretative drawing.

dobsinensis Illés, 1902, *G*. (*Bolandia*) *rozlozsniki* Rakusz, 1932, *Cummingella* aff. *balladoolensis* Reed, 1942, and *Paladin* aff. *eichwaldi* (Fischer von Waldheim, 1825). Some of these taxa were also mentioned by Osmólska (1970), but little research has been conducted focusing on the trilobite fauna or other arthropod groups within the Zlatník Formation. The only exceptions are a short note on the trigonotarbid find in Vaňová (1987) and the Masters thesis of Koubek (1992).

Trigonotarbida Petrunkevitch, 1949

Anthracomartidae Haase, 1890

Diagnosis: See Garwood & Dunlop (2011: 147).

Remarks: Members of Anthracomartidae can be recognized on the basis of their five tergal plates across the dorsal opisthosoma, as opposed to three plates present in all other trigonotarbid families (Garwood & Dunlop 2011). Anthracomartids are relatively common arachnids at many Coal Measures localities. Garwood & Dunlop (2011) synonymized most of the previously recognized genera, thereby reducing the number to three: *Anthracomartus* Karsch, 1882 (the type genus); *Brachypyge* Woodward, 1878; and *Maiocercus* Pocock, 1911.

Anthracomartus Karsch, 1882

Type species: *Anthracomartus voelkelianus* Karsch, 1882

Diagnosis: Anthracomartids with a smooth opisthosomal margin, lacking the scalloping seen in *Brachypyge* and *Maiocercus* (after Dunlop & Rössler 2002; Garwood & Dunlop 2011).

Anthracomartus voelkelianus Karsch, 1882: figs. 2A–B, 3A–B.

Anthracomartus Völkelianus Karsch, 1882: 560–561, pl. 21, fig. 1; Scudder 1884: 14, 17; Haase 1890: 645–646, pl. 30, figs. 8, 9; Frič 1904: 40, fig. 47.

Anthracomartus völkelianus Karsch: Pocock 1911: 3–4, 63; Schwarzbach 1935: 5; Petrunkevitch 1949: 195–198, figs. 192, 193; Petrunkevitch 1953: 58, 68; Petrunkevitch 1955: 107, fig. 67(1).

Anthracomartus voelkelianus Karsch: Petrunkevitch 1913: 94, 99; Dunlop & Rössler 2002: 211–216, figs. 1, 3; Garwood & Dunlop 2011: 150.

Pleomartus sp. indet.: Vaňová 1987: 64, text-fig. 5, pl. 10, fig. 5.; Koubek 1992: 77.

Diagnosis: Carapace with slightly bilobed anterior region divided by median sulcus. Opisthosoma broadly oval, almost circular in outline, but slightly longer than wide and widest midway along its length (after Dunlop & Rössler 2002).

Material: Department of Geology and Palaeontology, Comenius University in Bratislava under the repository number KGP-MH DO-001; from Jerusalemsberg near

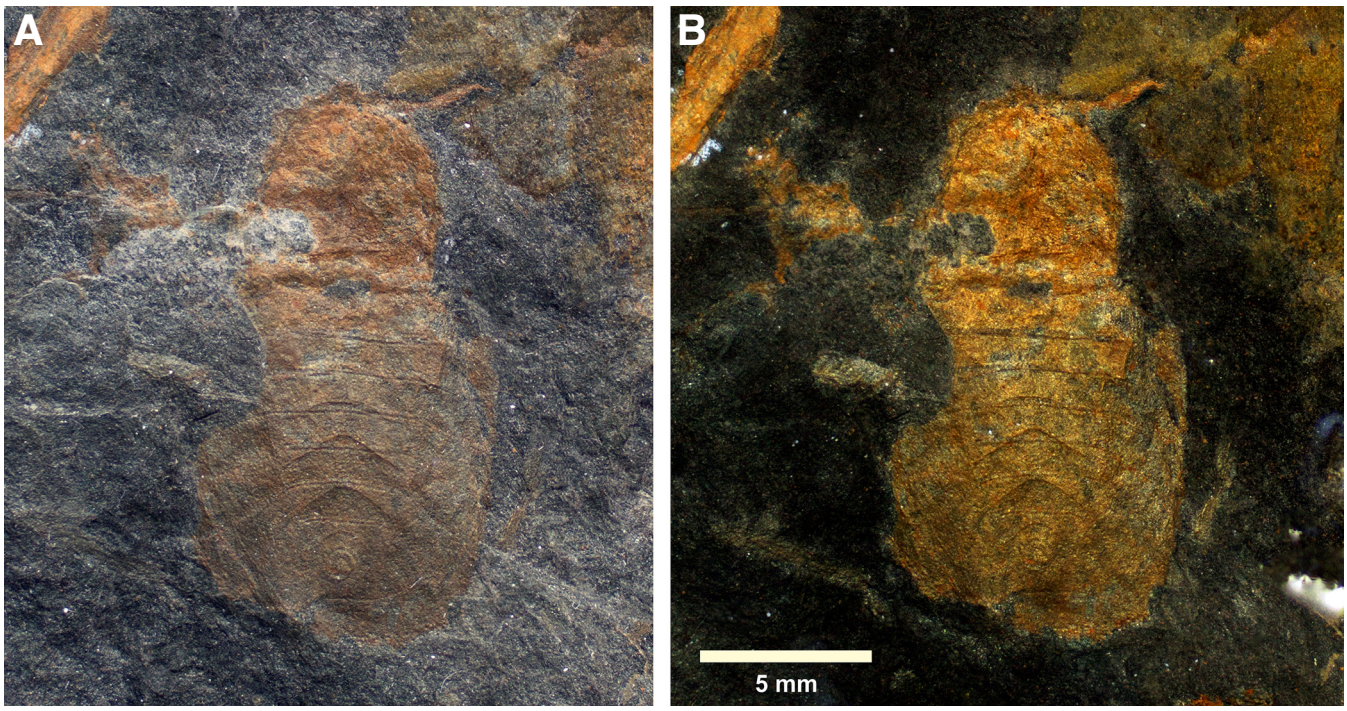

Fig. 3: *Anthracomartus voelkelianus* Karsch, 1882; specimen KGP-MH DO-001; note the plant fragment in the upper left corner of the photographs. **A** dry in cross-polarized light; **B** under alcohol in cross-polarized light.

Dobšiná, Slovakia (horizon ε *sensu* Rakusz 1932); Upper Carboniferous, Moscovian.

Description: Single specimen consisting of a nearly complete carapace and opisthosoma, and fragments of appendages; total preserved length 16.3. Carapace subquadrate in outline, slightly rounded anteriorly; length 5.4, width 5.2. Eyes, and an expected projecting anterior clypeus from the carapace, equivocal. Limbs poorly preserved: one pedipalp fragment present close to carapace, possibly still attached. Equivocal remains of two legs preserved at both sides of opisthosoma. Opisthosoma oval, length 11.7, maximum width 8.6, lateral regions damaged; opisthosomal tergites divided into median, two lateral and two marginal rows of plates, creating five dorsal sclerites per segment; segments two and three fused (diplotergite); chevron-shaped sternites at *c.* 115° angle; terminal sternite almost triangular, bearing prominent pygidium.

Remarks: Vaňová (1987) provided a first description and (rather poor) figures of the material. She identified the specimen as *Pleomartus* sp. indet.; Garwood & Dunlop (2011) considered *Pleomartus* Petrunkevitch, 1945 a junior subjective synonym of *Anthracomartus* Karsch, 1822. The new specimen is flattened; the opisthosoma preserving both dorsal and ventral features. This is a rather common mode of preservation in shale-preserved trigonotarbids. More three-dimensional specimens hosted in ironstone concretions allow a better impression of the appearance of these animals in life (see e.g. Garwood & Dunlop 2011). Despite this flattening, five plates across the opisthosoma are clearly visible in the new fossil and support its referral to Anthracomartidae. Damaged lateral regions mean that the opisthosoma margin is preserved only in few places, but where it is visible it does not demonstrate any unequivocal scalloping, as would be typical for *Brachypyge* or *Maiocercus*. For this reason we can place the fossil with some confidence in *Anthracomartus*.

Following Garwood & Dunlop (2011), who focused on the British Middle Coal Measures, *Anthracomartus* now encompasses fifteen nominal species found across the Euramerican Coal Basins and into the Mediterranean (Sardinia) (Table 1). However, as has been previously noted (Dunlop & Rössler 2002), these animals are fairly homogeneous in their morphology and fifteen is probably an overestimate of their true diversity. A number of these taxa are presently diagnosed on rather trivial differences (e.g. the species raised by Opluštil 1986), prone to being influenced by the state of preservation, such as ratios of body proportions in compressed fossils. This is especially true for the eight species currently recognized from the Coal Measures of Bohemia (Table 1).

Pending a complete revision of the family, assignment of our Slovak fossil to any given individual species should be made with caution. That said, superimposing the outline of our specimen on a drawing of *A. voelkelianus* in Dunlop & Rössler (2002) reveals a close match in shape and proportions. Given the likelihood that other taxa may prove to be synonyms of *A. voelkelianus* (the oldest available name for the species) we feel that a preliminary assignment of our fossil to this species is appropriate.

Palaeoecology and palaeobiogeography

The Silesian type material of *Anthracomartus voelkelianus* comes from the Žacleř Formation (Dunlop & Rössler 2002), which accumulated under a fluviolacustrine regime and the sediments represent sub-environments of river channels of low and high sinuosity. The present material comes from deposits which were formed in a low energy, shallow

marine environment with terrigenous influx. According to Bajaník *et al*. (1983) these sediments were deposited in a marine–deltaic environment. The Zlatník Formation records sea level oscillations of a diverse offshore shallow marine environment, thus, different faunal composition across the formation can be observed. Unfortunately, estimation of the stratigraphic span of the Zlatník Formation is unknown because of the lack of data, although all its faunal components point to a Westphalian age (Vaňová 1987; Koubek 1992).

Basal conglomerates and sandstones of the Rudná Formation, representing a distal deltaic environment, are exposed around Dobšiná (Bajaník *et al*. 1983). They are overlain by sequences of pelitic sediments associated with vulcanites, and biohermal and organodetritic limestones of the Zlatník Formation. Correlation of the sites with the exposed Zlatník Formation is difficult due to tectonics, metamorphism, and denudation during the Alpine Orogeny (Bajaník *et al*. 1983).

Rakusz (1932) recognized several lithological horizons (or members) in the vicinity of Dobšiná with different macrofaunal and macrofloral content. Koubek (1992) criticized this division because of its simplification. More research is needed to re-evaluate relationship between proposed horizons. The studied specimen was directly associated with macrofloral remains; no other faunal elements were found in this horizon (Koubek 1992). Fully marine associations consisting of e.g. corals, trilobites, brachiopods, and cephalopods were identified in different lithological members below and above the horizon ε with the arachnid fossil. Thus, the palaeoenvironment of this particular find can be characterized as low-lying swamps, and was thus not very different from the typical palaeoenvironment of other arachnid fossils found in the Coal Measures.

Palaeogeographically, the studied area was situated south of the East European Platform (i.e. close to the Equator) during the Westphalian (Dercourt *et al*. 2000). It was part of an intramontane post-tectonic Hercynian (Variscan) basin with prevailing river, swamp, lake, and deltaic palaeoenvironments (Vozárová 1998). The type specimen of *A. voelkelianus* comes from the Westphalian Coal Measures of Silesia (Dunlop & Rössler 2002); thus, it is both geographically and stratigraphically fairly close to our Slovak record.

Irrespective of the exact number of species, Table 1 implies that anthracomartids have been discovered more frequently as fossils, from at least a dozen localities, in the European part of the original Euramerican continent, in contrast to only four localities in what is now North America. Whether this is an artefact of collecting intensity, or a biologically significant difference due to, for example, different faunal provinces during the Carboniferous, has yet to be resolved. If one accepts the idea of a Carboniferous faunal continuum (Schram 1979) – the hypothesis that the Coal Measures were a fairly uniform environment which hosted a similarly uniform fauna – then differences between the American and European records may, indeed, point to a faunal province effect. However, the dataset (17 species from nine countries) remains quite small, and potential abiotic influences should also be borne in mind, e.g. the amount of suitable rock outcrop available, and the degree to which it has been exploited for coal mining thus yielding fossil-rich spoil heaps. In any case, compared to the other penecontemporaneous arachnid fauna, the fairly substantial number of specimens and wide geographical distribution documented for the anthracomartids suggests they may have been among the most successful arachnids at the time.

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