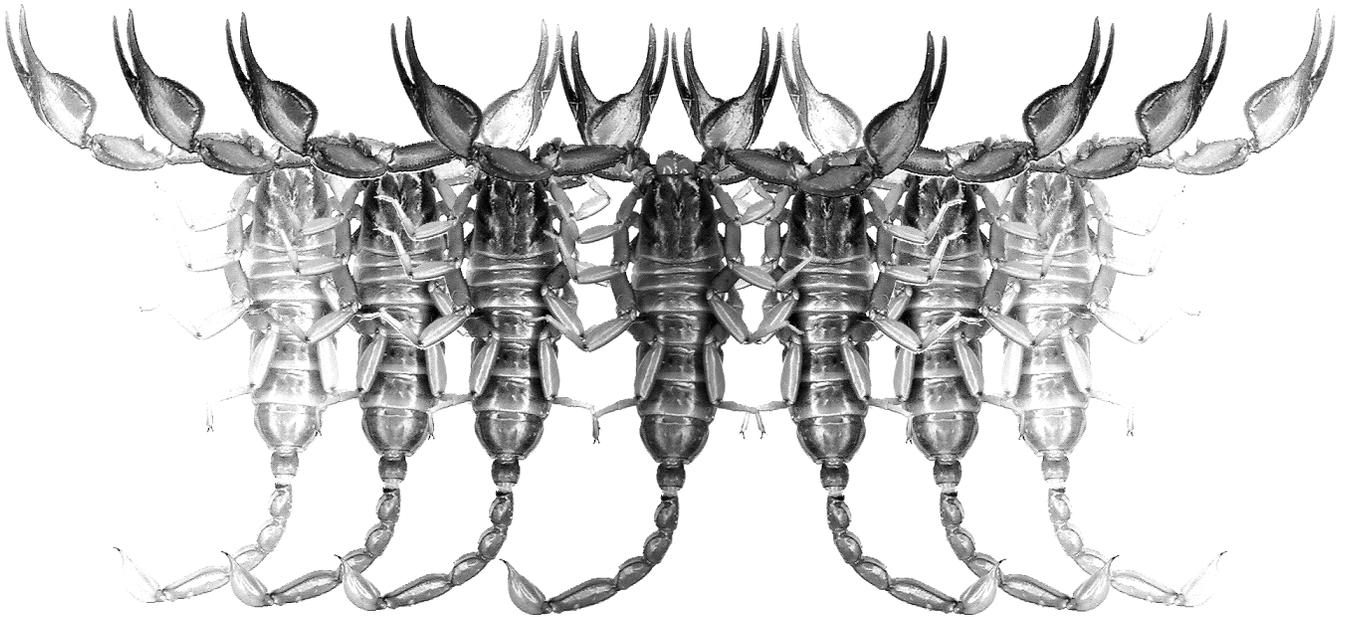


# *Euscorpius*

Occasional Publications in Scorpiology



**A Scorpion from a Peatbog: the First Arthropod  
Fossil from the Late Viséan of the Moscow Coal Basin**

**Victor Fet, Michael E. Soleglad, Yulia V. Mosseichik,  
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**August 2004 — No. 13**

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## Occasional Publications in Scorpiology

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- **ZISP**, Zoological Institute, Russian Academy of Sciences, St. Petersburg, Russia
- **WAM**, Western Australian Museum, Perth, Australia
- **NTNU**, Norwegian University of Science and Technology, Trondheim, Norway

## A scorpion from a peatbog: the first arthropod fossil from the Late Viséan of the Moscow Coal Basin

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### Summary

This note describes a fossil fragment from the Upper Viséan (ca. 330 Ma), of the Moscow Coal Basin (Novgorod Region, Russia). The fossil is identified as the cuticle of a single leg segment (left femur) of a scorpion (Arachnida: Scorpiones), without any further taxonomic placement. The anatomical details of the fragment are given, along with ecological considerations. It is the first fossil scorpion record from Russia.

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### Introduction

The present note addresses a unique fossil found in Lower Carboniferous deposits of the Moscow Coal Basin (Fig. 1). This fragment is identified as the cuticle of a single leg segment of a scorpion (Arachnida: Scorpiones), and is the first fossil scorpion from Russia.

### Locality and Horizon

The material comes from the northwest flank of the Moscow Coal Basin (Malinovets quarry of the Joint Stock Company “Borovichskii Refractory Works”, 25 km NW of the town of Borovichi, Novgorod Region, Russia). The strata are dated as the Tulsy Horizon of the Upper Viséan (ca. 330 Ma), regional palynozone *Cingulizonates bialatus*–*Simozonotriletes brevispinosus*, equivalent of the *Perotrilites tessellatus*–*Schulzospora campyloptera* palynozone of Western Europe (Byvsheva, 1997).

The locality represents a thin (about 15 cm) lens of brown coal, embedded in a series of sandy-clay lacustrine deposits. The coal consists of a mass of the well-preserved, *in situ* buried compression remains of endemic tree lycopods *Ogneuporia seleznevae* Mosseichik, gymnosperms of indeterminate affinity and putative cordaites (*Cordaites* sp.), etc. This fossil peat was formed in the ancient fresh-water lake mire. The lake was presumably a relict of the regressed Late Devonian sea basin.

The cuticle of a scorpion leg segment was extracted together with plant remains (leaf and stem cuticles,

megaspores, etc.) during coal maceration. A piece of coal was placed for several hours in Schultze’s mixture (nitric acid, to which potassium chlorate crystals were added) and, after washing, treated with an ammonium hydrate solution.

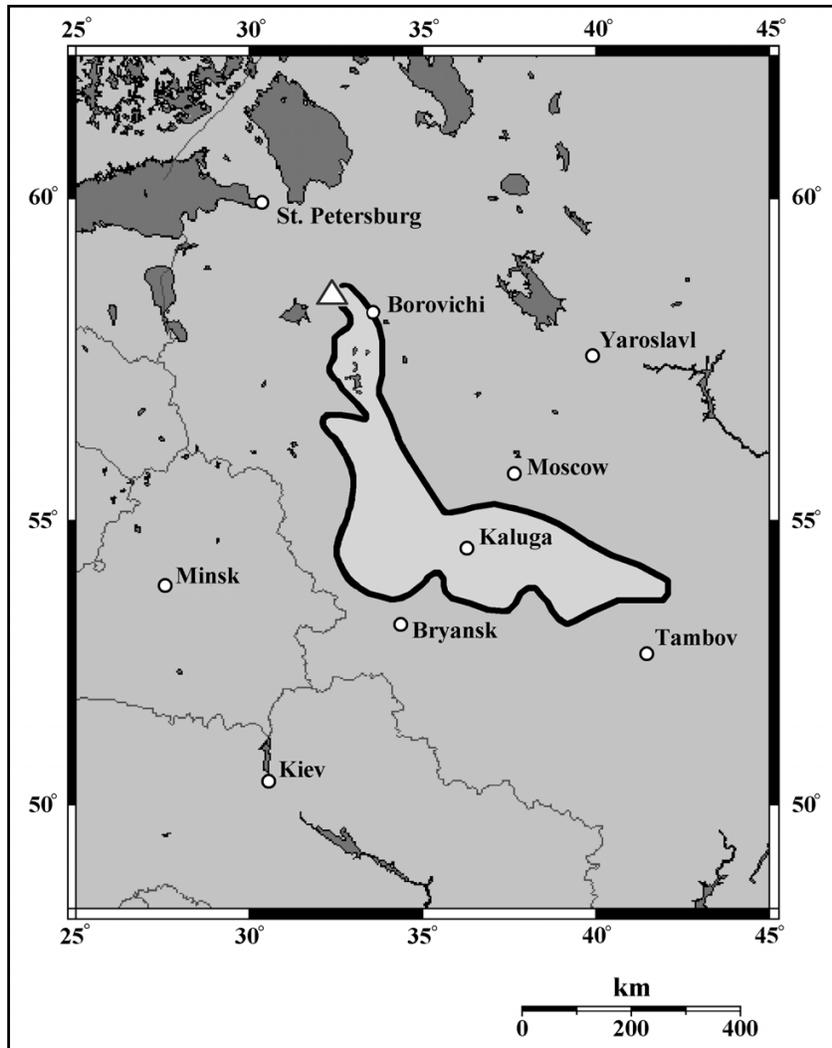
The material is deposited in the Paleontological Institute of the Russian Academy of Sciences, Moscow, specimen PIN no. 5072/1.

### Comments on Preservation

The exceptional and excellent preservation of scorpion cuticle in Carboniferous assemblages is unique among arthropods, and has been described for a number of sites in Europe and North America (Bartram et al., 1987; Jeram, 2001). In some assemblages, only scorpion cuticles are present. Such preservation could be related to the unusual stability against biodegradation of the so-called hyaline cuticle—the upper layer of scorpion cuticle (Jeram, 2001), which has other unique properties such as fluorescence under UV light in all modern scorpions (i.e., fossil cuticles do not fluoresce).

### Morphology

This fossil is a cuticle of an entire left leg segment (Fig. 2), most likely a femur, with elaborate articulatory structures at both ends. Fig. 3 shows the basal, trochanter-femur joint area (ventral view). After comparing this leg segment with several Recent scorpion legs, we believe it is most likely a femur for the following rea-

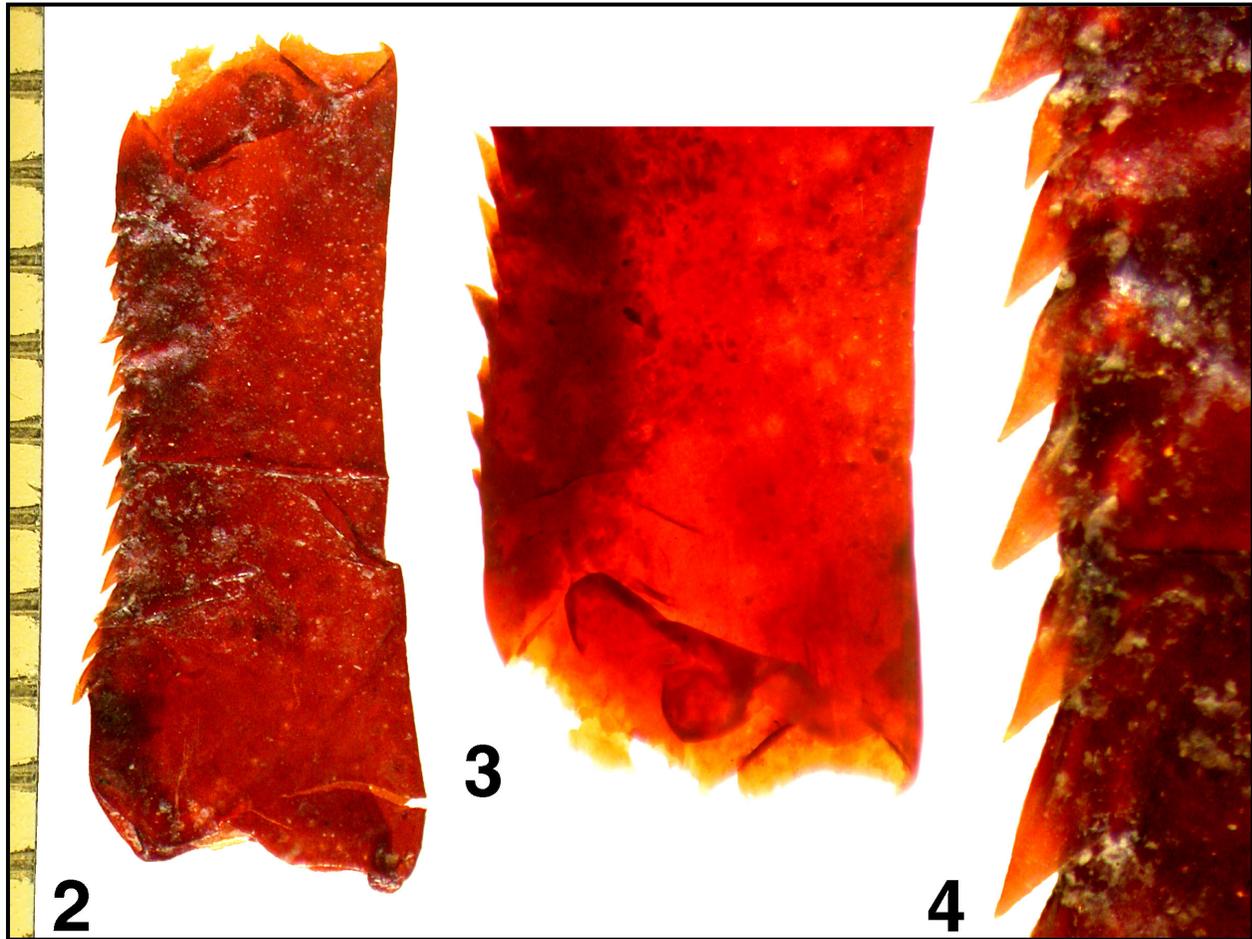


**Figure 1:** Geographic position of the locality (*triangle*) yielding the scorpion remains.

sons: 1) on the external edge of the femur-patella joint in Recent scorpions, we find a projection extending from the cuticle, presumably protecting the articular membrane connecting the two leg segments. This projection is visible slightly in Figure 2 (bottom inside aspect, the external edge); 2) on the dorsointernal surface of the femur-patella joint in Recent scorpions, we see a conspicuous darkly pigmented articulation mechanism. A similar darkening mechanism is visible on the fossil leg segment shown in Figure 2 (bottom outside aspect, the internal edge); and 3) on the ventrointernal edge of the femur in Recent scorpions, we usually see a highly granulated or serrated carina, with the denticles angling towards the femur-patella joint. In the fossil we see an exaggerated row of sharp denticles/spinules angling towards the presumed femur-patella joint. Finally, based on these observations and deduced perspectives, we also conclude that the segment is from a left leg and the views shown in Figs. 2 and 4 are dorsal.

Smooth cuticle without any patterns is consistent with other scorpion leg cuticles known from the Car-

boniferous (Jeram, 2001; J. Dunlop, pers. comm., P. Selden, pers. comm.). A prominent, sawlike single row of 14 denticles (Figs. 2 and 4) on the internal aspect allows the assumption that these are true extensions of the cuticle (i.e. modified “spinules”) rather than modified socketed setae. These two different forms of leg armament in extant scorpions were studied in detail recently by Soleglad & Fet (2003). These teeth are roof-like in cross-section, ridged dorsally and slightly overlapping (each tooth housing the base of the next distal one). Numerous irregular rounded “pores”, especially concentrated in the exterolateral area of the segment, are most likely areolae of socketed setae, common in all fossil scorpions. In extant scorpions such setae serve as both mechano- and chemoreceptors. There are about thirty, apparently larger, rounded pores (13 on the dorsal surface, 13 on the ventral surface and possibly also 4 along the mid-external line), which show some order in their arrangement (Fig. 2). Most of the smaller pores are concentrated in a rounded external area at 0.2–0.45 of the segment length; some of these pores are elliptical, perpendicular to the segment axis.



**Figures 2-4:** Scorpion leg segment (PIN no. 5072/1). **2.** Leg segment showing scale at 1 mm, dorsal view. **3.** Details of basal joint, ventral view. **4.** Close-up of denticles, dorsal view. Leg segment orientation is based on a scorpion positioned vertically with prosoma facing upwards and metasoma facing downwards.

The size of this fossil segment (length ca. 10 mm) implies a large scorpion. If this segment is a femur, then a projected comparison with extant scorpion proportions (based on leg III) gives us a fossil scorpion with ca. 80–100 mm total body length. Of course, if this segment is from leg I or II, then its projected overall size would be much larger. Many Paleozoic scorpions were much larger. According to Jeram (2001), undoubtedly terrestrial forms in the Lower Carboniferous reached 700–800 mm, and in the Upper Carboniferous, 300 mm. The largest extant scorpions are over 200 mm (*Hadogenes*, *Liochelidae* and *Pandinus*, Scorpionidae).

### Systematics

Placement of this fossil is unclear; it cannot be placed even in a suborder as none of its features are diagnostic. Jeram (1998, p. 20), in a cladistic analysis of Paleozoic scorpions, used the “ventral row of thorns” on the basitarsus and tarsus as a derived character, among

others, defining an important clade which includes two suborder-rank groups. These groups, the Mesoscorpiones (now extinct) and Neoscorpiones, coexisted during the Carboniferous (Kjellesvig-Waering, 1986; Jeram, 1994a, 1998). All extant scorpions belong to Neoscorpiones, infraorder Orthosterni, which already existed in the Carboniferous. Among Mesoscorpiones, at least several unrelated taxa exhibit single or double rows of denticles on various leg segments, e.g. the genus *Mazonia* with a double ventral spinule rows on the tarsus or *Waterstonia* with a single denticle row on the internal aspect of the femur (Kjellesvig-Waering, 1986), and *Pulmonoscorpis* with a single ventral spinule row on the tarsus (Jeram, 1994b). Although such rows are not known in Carboniferous Orthosterni, extant scorpions have a wide variety of ventral or internal denticle-like structures (usually single rows) on various leg segments, often diagnostic at lower taxonomic levels from family to tribe (Soleglad & Fet, 2003). The concentration of numerous setae at the dorsal part of the segment is a new feature not previously observed in fossil scorpions.



**Figure 5:** Litter in which scorpions presumably lived.

### Ecological Comments

The function of denticle rows on scorpion leg segments is probably adaptive as a traction device in many surface-active and burrowing forms (e.g. the families Caraboctonidae and Vaejovidae: Soleglad & Fet 2003) or those actively climbing on vegetation (in particular many modern Buthidae). Jeram (1994a, 1994b, 2001) and Selden & Jeram (1989) demonstrated that many Carboniferous scorpions were undoubtedly terrestrial.

The structural preservation of plant remains in the coal (the structureless main bulk is practically absent) proves the low intensity and duration of the gelification processes. Pyritization also confirms anoxic conditions in which the peat formation took place. It can be assumed that the surface of the peatbog was very moist and partly covered by water. The uppermost layer of peat, where the scorpion was buried (and probably lived in, since the plant remains were buried *in situ* and show no signs of transportation by water), consisted of a litter of dead plant remains (Fig. 5).

The presence of a large scorpion indicates its necessary co-existence with smaller prey objects, so far un-

known detritivorous, litter-reducing groups (e.g. millipedes including minute arthropleurids, springtails, etc.), which, as in the Late Devonian, probably remained the major link between the plant and animal trophic levels of the food web (Behrensmeier et al., 1992).

### Acknowledgements

We thank Paul Selden (Manchester University, Manchester, England), Jason Dunlop (Museum für Naturkunde der Humboldt-Universität Berlin, Berlin, Germany), Irina N. Selezneva (JSC “Borovichskii Refractory Works”, Borovichi, Russia), and Igor A. Ignatiev (Geological Institute, Russian Academy of Sciences, Moscow, Russia) for their comments and help. The field investigations were supported by RFBR research grant No. 03-05-64331 to Yu.V. Mosseichik.

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